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# (54) AN APPARATUS FOR FORMING CERAMIC SHEETS

VORRICHTUNG ZUR HERSTELLUNG VON KERAMIKPLATTEN

APPAREIL POUR FORMER DES FEUILLES CÉRAMIQUES

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(73) Proprietor: **G.Tech S.R.L.**
**42019 Scandiano (Reggio Emilia) (IT)**

(72) Inventor: **FERRETTI, Massimo**
**I-42019 Scandiano (Reggio Emilia) (IT)**

(74) Representative: **Inchingalo, Simona**
**Bugnion S.p.A.**
**Viale Lancetti, 17**
**20158 Milano (IT)**

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**WO-A1-2013/011174**
**WO-A2-98/23424**
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## Description

**[0001]** The present invention relates to an apparatus for forming, by compacting ceramic powder material (hereinafter "powders" for the sake of simplicity), large-sized raw sheets in particular, that is, sheets that have side dimensions considerably larger than those of normal ceramic tiles. The raw sheets thus obtained must then undergo firing in order to have the desired finished ceramic sheets for flooring and wall claddings.

**[0002]** As is well known to those skilled in the art, the forming of normal raw ceramic tiles, ready for firing, is traditionally obtained by means of specific presses which enable the ceramic powders to be compacted in cavities having the same side dimensions as the tiles it is desired to obtain. These presses have a very robust structure, since they must withstand the resulting compression force, which is equal to the specific pressure (force per unit of surface area) that must be exerted on the powders in each cavity in order to obtain the desired compacting, multiplied by the surface enclosed in the (one or more) cavities simultaneously pressed.

**[0003]** Therefore, the larger the surface area of the tiles it is desired to obtain, the larger will be the resulting compression force that the press must exert, it being equipped for this purpose with hydraulically and pneumatically driven cylinder and plunger devices.

**[0004]** These presses are rather complex, costly machines, whose pressing cycle involves various steps that require adequate time and condition their production, in addition to requiring powder deaeration and suction devices and adequate safety devices.

**[0005]** It is known a forming system that provides a continuous pre-compacting apparatus comprising a conveyor belt, on which a uniform thick layer of powders is loaded and made to pass through a roller mill to obtain a first compression and deaeration thereof. The layer thus pre-compacted is then divided longitudinally into a series of products or semi-finished products having side dimensions that are substantially those of the tiles it is desired to obtain. These semi-finished products are then unloaded from the aforesaid belt so as to be positioned inside a corresponding cavity of a conventional press provided with an upper and lower half-die to complete the compacting and then the forming thereof, so as to obtain the raw tiles to undergo firing.

**[0006]** Despite giving good results, such a system, due to the very fact of involving a pre-compacting step, implies larger overall dimensions and an even longer production cycle, as well as an increase in both purchase and operating costs compared to a traditional forming system.

**[0007]** It is already known a system for forming large-sized raw ceramic sheets, i.e. sheets with decidedly larger side dimensions (for example 1 m x 3m) than normal ceramic tiles, but reduced thickness (for example 3 mm) compared to the latter. This system also provides a conveyor belt on which means is provided to load the powders in order to form a layer of uniform thickness and, further downstream, pressing means consisting substantially of a lower half-die vertically movable in both directions so that once the conveyor belt has stopped it can press the corresponding surface portion of the aforesaid layer against the lower branch of the aforesaid conveyor belt, above which branch a flat opposing surface is arranged acting as an upper half-die.

**[0008]** Since this system is especially designed to produce large-sized sheets, the lower half-die must exert a very high force. Moreover, to enable deaeration of the powders, it is provided for the pressing to take place in several steps, the final pressing being preceded by some preliminary steps of lowering and raising the lower half-die. This clearly has a significant impact on the duration of the production cycle and on costs. In any case, with this system it is not possible to obtain sheets of a thickness analogous to that of normal ceramic tiles. In fact, only for sheets of small thickness (for example 3 mm) is it possible to obtain an acceptable deaeration.

**[0009]** Examples of known apparatus and method are described in documents WO-A-2013/011174 and WO-A-98/23424. WO-A-2013/011174 discloses an apparatus for forming ceramic sheets according to the preamble of claim 1. In this context, the technical task at the basis of the present invention is to propose an apparatus for forming ceramic sheets which overcomes the aforementioned drawbacks of the prior art.

**[0010]** In particular, the object of the present invention consists in providing an apparatus making it possible to obtain raw ceramic sheets of large side dimensions, but which also have, if required, a thickness analogous to that of conventional ceramic tiles.

**[0011]** A further object of the present invention is to provide an apparatus for forming ceramic sheets which permits considerable pressure to be exerted on the ceramic powder material to be compacted, while simultaneously reducing the forces in play applied by the compression element.

**[0012]** Another object consists in realizing an apparatus of the aforesaid type which has manufacturing and operating costs decidedly lower than those of the known systems.

**[0013]** The stated technical task, specified objects and still others are substantially achieved by an apparatus for forming ceramic sheets comprising the technical features disclosed in one or more of the appended claims.

**[0014]** Additional features and advantages of the present invention will become more apparent from the approximate and thus non-limiting description of a preferred but not exclusive embodiment of an apparatus for forming ceramic sheets.

**[0015]** The description will be set forth below with reference to the accompanying, illustrative and non-limiting, drawings, in which:

- figures 1-3 are schematic side elevation views, with some parts removed to make them easier to interpret, of an apparatus for forming ceramic sheets ac-

cording to the present invention, during the various operating phases;

- figure 4 represents an enlarged detail of the apparatus illustrated in figure 2;
- figure 5 shows a front view of the apparatus according to the present invention.

**[0016]** In the appended figures, 1 generically denotes an apparatus for forming ceramic sheets according to the present invention.

**[0017]** The apparatus 1 comprises a horizontal conveyor belt 2 whose direction of travel is indicated by the arrow X.

**[0018]** The conveyor belt 2 comprises an upper branch 2' and a lower branch 2" and is wound between two pulleys 31 and 32 positioned at respective ends 21 and 22 of the conveyor belt.

**[0019]** The forward travel of the conveyor belt 2, moved by virtue of a driving gear motor 4 associated with one of the two pulleys 31 or 32, makes it possible to deposit on the upper branch 2' thereof, by means of a suitable feed means 5, ceramic powder material 6a suitable for obtaining ceramic tiles, so as to form a layer 6 thereof of uniform thickness. In this specific case, the feed means 5 comprises a hopper 7. It is worth noting, however, that the loading hoppers could be more than one, arranged in succession. The layer 6 will have a length depending on the length of the raw sheet 8 it is desired to obtain. Associated lateral delimiting and containment means are provided to delimit the layer 6 laterally, in this specific case two side portions 9 (shown only in fig. 5 for the sake of simplicity), whose distance is selected in such a way as to be able to accommodate a pressing roller 10 in a precise manner.

**[0020]** Provided below the upper horizontal branch 2' of the conveyor belt 2 it is provided a rigid structure that defines a horizontal rigid abutting deck 11 adjacent to the lower face of the upper branch 2'.

**[0021]** The apparatus 1 further comprises a first pressing roller 10, which is positioned above the upper branch 2' of the conveyor belt 2, and at least a second pressing roller 20 arranged below the rigid abutting deck 11.

**[0022]** The pressing roller 10 is rotatable around its horizontal axis 10a and perpendicular to the direction of forward travel X of the conveyor belt 2. Analogously, the second pressing roller 20 is rotatable around its horizontal axis 20a and perpendicular to the direction of extension X of the conveyor belt 2. Preferably, a plurality of second pressing rollers 20 is present, as can be seen in the appended figures, all aligned and parallel to each other along horizontal axes perpendicular to the direction of extension X of the conveyor belt 2.

**[0023]** The first pressing roller 10 and second pressing rollers 20 reciprocally interact in an active manner, in an opposite and contrary direction, to compress the layer 6 of ceramic powder material and produce a raw sheet 8 of ceramic material, as will be explained in the detailed description of operation below.

**[0024]** The pressing roller 10 is keyed onto a shaft 12 rotatably supported at both ends by support and moving means 13.

**[0025]** The support and moving means 13 of the first pressing roller 10 are directly connected to and operatively interacting with the second pressing rollers 20, not only so as to move the first pressing roller 10 vertically, but also to exert a vertical pressing force from above and simultaneously a vertical reaction from below on the abutting deck and, therefore, on the layer of ceramic powder material 6.

**[0026]** In detail, the support and moving means 13 comprise at least a framework 14 for supporting and containing the first pressing roller 10 and the second pressing rollers 20, and at least one linear actuator 15, connected to the second pressing rollers 20, and directly active on the framework 14.

**[0027]** The framework 14 comprises two parallel vertical frame portions 16, positioned on opposite sides of the conveyor belt 2, orthogonal to the rotation axis 10a of the first pressing roller 10.

**[0028]** The pressing roller 10 is supported, via the rotation shaft 12 and other constraining portions, directly by said frame portions 16, vertically moved by activation of the linear actuator 15.

**[0029]** Preferably, at least two linear actuators 15 are present, one for each side of the conveyor belt 2, each connected to and active on a respective frame portion 16.

**[0030]** The second pressing rollers 20, on the other hand, are supported and associated with one another by support means 17 which comprise two parallel vertical plates 18 positioned on opposite sides of the conveyor belt 2, orthogonal to the rotation axis 20a of the second pressing rollers 2. Each plate 18 is contained in a respective frame portion 16 of the framework 14.

**[0031]** Each linear actuator 15 is connected at a first end 15a to said support means 17, in particular to a respective plate 18, and at a second end 15b to the respective frame portion 16.

**[0032]** Advantageously, each linear actuator 15 is arranged vertically, between the plate 18 and the frame portion 16, in such a way as to extend downwards when in operation and take its second end 15b away from the abutting surface 11.

**[0033]** The linear actuator 15 can be of the hydraulic or pneumatic type; it preferably comprises a piston sliding in a cylinder, driven by a hydraulic unit with a hydraulic pump.

**[0034]** As can be seen in figures 1-4, each vertical support plate 18 is connected to the respective frame portion 16 by means of at least one pair of sliding blocks 19, preferably two, which enable the sliding and the relative translation between the frame portion 16 and the respective plate 18.

**[0035]** The pair of plates 18, which support and axially delimit the second pressing rollers 20, are constrained to the support framework 14 and maintain a vertically fixed height during all the operating phases. Analogously,

the second pressing rollers 20, connected to the plates 18, maintain their height for all the operating phases, remaining constantly in contact with the abutting deck 11, acting against it from below, as described previously during the compression of the ceramic powder material.

**[0036]** The apparatus 1 further comprises an adjustment system, not illustrated, for adjusting the height of the vertical support plates 18 when the apparatus is not in operation. This system thus makes it possible also to adjust the vertical position of the second pressing rollers 20.

**[0037]** Upon the activation of each linear actuator 15, the piston exits the cylinder and, extending downwards, draws with it the respective frame portion 16 on which a respective end of the first pressing roller 10 is mounted; the latter is consequently made to translate vertically downward until coming to rest on and exert a certain pressure against the layer of ceramic powder material 6 to be compacted.

**[0038]** The first pressing roller 10 is vertically movable between a non-operative position (figures 1 and 3) in which it is raised and distanced from the layer of ceramic powder material 6, without exerting, therefore, any compression action on it, and an operative position (figure 2) in which it is in contact with the underlying layer of ceramic powder material 6 so as to exert a compression action on it.

**[0039]** In the non-operative position the linear actuator 15 is in a rest configuration, thus completely retracted, and the frame portion 16 is in raised position (figures 1 and 3). In the operative position, in contrast, the linear actuator 15 is operational and thus completely extended and elongated downwards, and the frame portion is in a lowered position (figure 2).

**[0040]** In the operative configuration, the pulling action exerted by the linear actuator 15 on the frame portion 16 and therefore on the first pressing roller 10, which thus compresses the layer of ceramic powder material 6 from top to bottom, is accompanied by a simultaneous pushing reaction, again exerted by the actuator on the second pressing rollers 20, which thus press on the abutting deck 11 from bottom to top, thereby increasing the compression effect on the layer of ceramic powder material 6.

**[0041]** In this manner, a precise compression is exerted on the layer of ceramic powder material 6 at the point of tangency with the first pressing roller 10. The compression and pressing of the entire layer of ceramic powder material 6 take place via the translation of the first pressing roller 10 and of the second pressing rollers 20 along the entire conveyor belt 2, until they have travelled the entire length of the layer 6 deposited on the belt 2.

**[0042]** The movement of the pressing rollers 10 and 20 is a rotational-translational movement in a direction parallel to the direction of forward travel X of the conveyor belt 12, active for the first pressing roller 10 and passive for the second pressing rollers 20, which, being mounted idle, are drawn by the rotational-translational movement imposed by the first roller 10.

**[0043]** In fact, associated with the rotation shaft 12, the first pressing roller 10 has driving means 27, such as a gear motor which drives the shaft 12: when the first roller 10 is detached from the resting surface it only rotates; when, however, the first roller 10 is in contact with the layer of ceramic powder material 6, it rolls upon the latter, compressing it and translating horizontally.

**[0044]** The framework 14 comprises a structural member 23, which is horizontally movable in the two directions parallel to the direction of extension X of the belt 2. This structural member 23 bears the plates 18, the frame portions 16, the linear actuators 15 and other connecting structural elements between these elements and two projecting arms 24 (figure 5) sliding along a mechanical slide 25 on a fixed portion 26 of the framework 14. The structure consisting of the structural member 23, the pressing rollers 10 and 20 as well as other structural parts not explicitly described and/or illustrated is horizontally movable in a compact manner.

**[0045]** During use, starting from the condition illustrated in figure 1, it can be seen that the first pressing roller 10 is in the non-operative position, raised and distanced from the layer of ceramic powder material 6 previously deposited on the upper branch 2' of the conveyor belt 2 by means of the loading hopper 7. The deposition of the layer of ceramic powder material 6 takes place by gradual release of the powder material from the hopper 7 directly onto the conveyor belt 2, which, in the meantime, is moved in the direction X for a given time interval.

**[0046]** Once a layer of the desired length has been obtained, the conveyor belt 2 stops and the pressing of the material can proceed. In the subsequent phase, illustrated in figure 2, the conveyor belt 2 is stationary and the pressing roller 22 has been lowered upon the activation of the linear actuators 15, which cause the frame portion 16 to translate vertically downwards. In this phase, the action of the linear actuators 15 creates a simultaneous pressure from above by virtue of the first pressing roller 10 and from below by virtue of the second pressing rollers 20. A single compression system is capable of exerting a downward force (first pressing roller 10) on the abutting deck (above which there is the layer of ceramic powder material 6) and receiving at the same time an opposite contrary force (given by the opposing rollers beneath the deck, integral with the reaction given by the compression), so that the forces in play are placed in perfect equilibrium.

**[0047]** The maximum compression of the powder takes place along the generatrix of the first pressing roller 10 situated along the line of tangency with the layer of ceramic powder material 6.

**[0048]** At this point, starting the gear motor 27 begins the rotation of the first pressing roller 10 on the layer of powder material 6 to be compacted.

**[0049]** The entire structural member 23 and the pressing rollers 10 and 20 translate horizontally along the conveyor belt 2 for the entire length of the layer 6 to be pressed.

**[0050]** It should however be noted that for some processes the first pressing roller 10 could conveniently be not motorized, but rather idle. In this situation another gear motor, not illustrated, should advantageously be provided, one that is active directly on the structural member 23 so as to promote the translation of the structural member 23 and, consequently, of the pressing rollers 10 and 20 connected to it.

**[0051]** On completion of the pressing of the entire layer 6, the first pressing roller 10 is raised by duly activating the linear actuators 15, which, by retreating, promote the raising of the frame portions 16 and of the first pressing roller 10. The first pressing roller 10 remains in a non-operative position until the next loading of powder material 6, at the end of which it can begin a new pressing phase.

**[0052]** The raw sheet 8 thus obtained can be spaced away by once again activating the conveyor belt 2, which unloads the sheet 8 onto an outward roller conveyor 28 situated downstream of the conveyor belt 2 at the end opposite that of the hopper 7.

**[0053]** In accordance with a first preferred operating mode, the first pressing roller 10, upon completing the pressing phase (from right to left in the appended figures), is raised, waits for a new bed of ceramic powder material to be loaded and the raw pressed sheet consequently to be unloaded, is again lowered and pressing in the opposite direction begins, from left to right. Therefore, in the illustrated configuration, it is not necessary for the roller always to be repositioned at a same end of the conveyor belt 2 each time pressing is started, since the pressing cycle, and therefore the movement of the pressing rollers 10 and 20 and of the structural member 23, can take place in either direction.

**[0054]** By contrast, according to an alternative operating mode, the compression of the layer of ceramic powder material 6 can take place in only one direction. In this situation it is necessary for there to be a repositioning system, not illustrated, which enables the entire compression mechanism to be located again always at a same end of the conveyor belt 2.

**[0055]** Preferably, this repositioning system can always be present, with either unidirectional or bidirectional compression, since it can advantageously serve to move the pressing rollers 10 and 20 and the structural member 23 even during a phase of no compression, for example if the need arises to move the structural member 23 and the rollers 10 and 20 to any point along the belt 2, for example for maintenance or other purposes.

**[0056]** Advantageously, the repositioning system has a recirculating ball screw assembly with a clutch mechanism and driven by a gear motor, not illustrated, which can work in perfect synchronism with the rotation of the first pressing roller or be disconnected during pressing.

**[0057]** In other words, this system, driven in turn by gear motor, can cooperate with the gear motor 27 (active on the rotation shaft 12 of the latter), so as to promote the translation of the first roller 10 and of the entire compression mechanism (i.e. the structural member 23) along the direction of extension X of the conveyor belt 2 during compression of the layer of ceramic powder material 6, or be disconnected during compression so as to permit the first pressing roller 10 to act alone in compression.

**[0058]** In both situations, the repositioning system can cooperate with the bidirectional movement of the pressing rollers 10 and 20 and of the support and moving means 13 so as to position the entire structural member 23 horizontally during the non-compression phases; as mentioned, this can serve both to place the structural member 23 and the pressing rollers 10 and 20, at the end of every pressing cycle, always at a same end of the belt 2 so as to be able to repeat the unidirectional pressing cycle, and to place them in any desired position along the belt, for example for maintenance or other purposes.

**[0059]** The surface 10b of the first pressing roller 10 can be smooth or also shaped so as to obtain, for example, ceramic sheets whose surface has reliefs or profiles that can also constitute particular patterns. This surface can be, for example, made of steel or also of vulcanized rubber.

**[0060]** The apparatus according to the present invention compared to known systems.

**[0061]** A ceramic mixture requires, as is well known, pressing forces of 400- 500 Kg/cm$^2$; with the dynamic roller pressing system, the forces in play are drastically reduced, since the resulting compression force is developed and released on the layer of powder material to be compacted only locally, along the strip of tangency of the roller, thus along a portion of very limited width. This ensures that there will not be any problems of deaeration during the pressing of the layer of powder material.

**[0062]** Furthermore, a single compression system exerts a downward force and at the same time receives an opposite and contrary force, so that the forces in play are in perfect equilibrium. It is therefore possible to use two hydraulically or pneumatically driven linear actuators with a power that is decidedly less than that necessary in devices of this type used in conventional presses for forming large-sized raw sheets, whilst nonetheless obtaining considerable pressures on the layer to be pressed. One of the substantial differences compared to prior art systems is that in the present apparatus the abutting deck can be much thinner, since it only has to support its own weight and is not stressed by downward thrusts resulting from the pressing, since the second pressing rollers create a sandwich effect through their counter-thrust, which balances the forces in play.

**[0063]** During the pressing phase, the ceramic powder bed remains stationary on the pressing surface, and thus does not undergo any type of tensioning provoked by different extrusion systems.

**[0064]** It should be noted, finally, that thanks to the apparatus according to the present invention, the maximum length of the raw sheets produced by the apparatus according to the present invention could be any whatsoever

(in theory indefinite, provided that a conveyor belt of adequate length is provided, together with adequate horizontal movements of the pressing rollers). The maximum length is in practice simply imposed by the possibility of moving, conveying and using the ceramic sheets obtained.

## Claims

1. An apparatus for forming ceramic sheets comprising:

   - a conveyor belt (2) having a rigid abutting deck (11) below an upper branch (2') thereof and adjacent to the upper branch (2');
   - means (5) for feeding ceramic powder material (6a) so as to release a layer of ceramic powder material (6) onto said upper branch (2');
   - a first pressing roller (10) with a horizontal axis (10a) perpendicular to the direction of extension (X) of the conveyor belt (2) and which is disposed above said conveyor belt (2);
   - driving means (27) for the first pressing roller (10) which determine the rotation thereof around its axis (10a);
   - at least a second pressing roller (20) with a horizontal axis (20a) perpendicular to the direction of extension (X) of the conveyor belt (2) **characterized in that**:
   - said second pressing roller (20) is disposed below said rigid
   abutting deck (11) and is designed to actively interact, in an opposite and contrary direction, with said first pressing roller (10) in order to compress said layer of ceramic powder material (6); and **in that** the apparatus comprises:
   - support and moving means (13) for said first pressing roller (10) which are directly connected to and operatively interact with said at least second pressing roller (20) so as to move said first pressing roller (10) vertically and exert a vertical pressing force from above and simultaneously a vertical reaction from below on said abutting deck (11) and on said layer of ceramic powder material (6).

2. The apparatus according to claim 1, **characterized in that** said support and moving means (13) comprise at least a framework (14) for supporting and containing said first pressing roller (10) and said at least second pressing roller (20), and at least one linear actuator (15) connected to said at least second pressing roller (20) and active on said framework (14).

3. The apparatus according to claim 2, **characterized in that** it comprises a plurality of second horizontal pressing rollers (20) perpendicular to the direction of extension (X) of the conveyor belt (2), aligned with respective axes (20a) parallel to each other.

4. The apparatus according to claim 2 or 3, **characterized in that** said first pressing roller (10) is vertically movable between a non-operative position in which it is raised and distanced from the layer of ceramic powder material, without exerting any compression action on it, and an operative position in which it is lowered and in contact with the underlying layer of ceramic powder material (6) so as to exert a compression action on it.

5. The apparatus according to one of claims 2 to 4, **characterized in that** said framework (14) comprises two parallel vertical frame portions (16) positioned on opposite sides of the conveyor belt (2), orthogonal to the rotation axis (10a) of the first pressing roller (10), and which support said first pressing roller (10) and slide vertically following activation of the linear actuator (15).

6. The apparatus according to the preceding claim, **characterized in that** said second pressing rollers (20) are supported and associated with each other by support means (17), to which said linear actuator (15) is connected.

7. The apparatus according to the preceding claim, **characterized in that** said support means (17) comprise two parallel vertical plates (18) positioned on opposite sides of the conveyor belt (2), orthogonal to the rotation axis (20a) of the second pressing rollers (20); said plates (18) each being contained in a respective frame portion (16) of said framework (14).

8. The apparatus according to the preceding claim, **characterized in that** each vertical support plate (18) is connected to the respective frame portion (16) by means of at least one pair of sliding blocks (19), preferably two, which enable relative translation between the frame portion (16) and the respective plate (18), and by means of a respective linear actuator (15) which, upon actuation, causes the vertical translation of the frame portion (16) and of the first pressing roller (10).

9. The apparatus according to one of claims 7 and 8, **characterized in that** the vertical position of said second pressing rollers (20) can be adjusted by adjusting the height of the vertical support plates (18) when the apparatus is not operating; said second pressing rollers (20) always remaining in contact with the abutting deck (11) during compression of the layer of ceramic powder material (6).

10. The apparatus according to one of the preceding

claims, **characterized in that** said driving means (27) for said first pressing roller (10) comprise a gear motor active on the rotation shaft (12) of said first pressing roller (10) so as to cause the rotation of said first pressing roller (10), when it is in the non-operative position distant from the abutting deck (11), and the horizontal rotational translation of said first pressing roller (10) when it is in the lowered, operative position, in contact with said layer of ceramic powder material (6).

**11.** The apparatus according to one of the preceding claims, **characterized in that** said second pressing rollers (20) are mounted idle and apply an upward force from below on the abutting deck (11) in reaction to the downward compression force exerted from above by the first pressing roller (10), drawn downward by the frame portion (16) by actuation of the linear actuator (15).

**12.** The apparatus according to claim 10 or 11, **characterized in that** it comprises a repositioning system driven by a gear motor, which can selectively work in synchronism with driving means (27) of said first pressing roller (10), in order to collaborate with the translation of the pressing rollers (10 and 20) along the direction of extension (X) of the conveyor belt (2) during compression of the layer of ceramic powder material (6) or be disconnected during compression; said repositioning system further being activatable during a non-compression phase in order to position the first pressing roller (10), the second pressing rollers (20) and the support and moving means (13) in any point whatsoever along the belt (2).

**Patentansprüche**

**1.** Vorrichtung zur Herstellung von Keramikplatten, umfassend:

- ein Förderband (2), aufweisend eine steife Auflagefläche (11) unter einem oberseitigen Abzweig (2') davon und angrenzend an den oberseitigen Abzweig (2');
- Mittel (5) zum Zuführen von keramischem Pulvermaterial (6a), sodass eine Schicht aus keramischem Pulvermaterial (6) auf dem oberseitigen Abzweig (2') freigegeben wird;
- eine erste Andrückwalze (10) mit einer horizontalen Achse (10a), die rechtwinklig zur Ausdehnungsrichtung (X) des Förderbands (2) verläuft und über dem Förderband (2) angeordnet ist;
- Antriebsmittel (27) für die erste Andrückwalze (10), welche deren Drehung rund um deren Achse (10a) bewirkt;
- mindestens eine zweite Andrückwalze (20) mit einer horizontalen Achse (20a), die rechtwinklig zur Ausdehnungsrichtung (X) des Förderbands (2) verläuft, **dadurch gekennzeichnet, dass**
- die zweite Andrückwalze (20) unter der Auflagefläche (11) angeordnet und ausgestaltet ist, um aktiv in einer gegenseitigen und gegenständigen Richtung mit der ersten Andrückwalze (10) zu interagieren, um die Schicht aus keramischem Pulvermaterial (6) zu komprimieren, und dadurch, dass die Vorrichtung umfasst:
- Stütz- und Bewegungsmittel (13) für die erste Andrückwalze (10), die direkt mit der mindestens zweiten Andrückwalze (20) verbunden sind und betriebswirksam mit dieser interagieren, um die erste Andrückwalze (10) vertikal zu bewegen und eine vertikale Druckkraft von oben auszuüben und gleichzeitig eine vertikale Reaktion von unten auf die Auflagefläche (11) und auf die Schicht aus keramischem Pulvermaterial (6).

**2.** Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Stütz- und Bewegungsmittel (13) mindestens ein Gestell (14) zum Stützen und Enthalten der ersten Andrückwalze (10) und der mindestens zweiten Andrückwalze (20) umfassen sowie mindestens einen Linearantrieb (15), verbunden mit der mindestens zweiten Andrückwalze (20) und aktiv am Gestell (14).

**3.** Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** sie eine Vielzahl an zweiten horizontalen Andrückwalzen (20) umfasst, die rechtwinklig zur Ausdehnungsrichtung (X) des Förderbands (2) verlaufen, ausgerichtet zu jeweiligen Achsen (20a), die parallel zueinander verlaufen.

**4.** Vorrichtung nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die erste Andrückwalze (10) vertikal zwischen einer Nichtbetriebsposition, in der sie angehoben und von der Schicht aus keramischem Pulvermaterial beabstandet ist, ohne eine Kompressionswirkung auf diese auszuüben, und einer Betriebsposition verfahrbar ist, in der sie gesenkt und in Kontakt mit der darunter befindlichen Schicht aus keramischem Pulvermaterial (6) ist, um eine Kompressionswirkung auf diese auszuüben.

**5.** Vorrichtung nach Anspruch 2 bis 4, **dadurch gekennzeichnet, dass** das Gestell (14) zwei parallele vertikale Gestellabschnitte (16) umfasst, die an entgegengesetzten Seiten des Förderbands (2) positioniert sind, im rechten Winkel zur Rotationsachse (10a) der ersten Andrückwalze (10), und die die erste Andrückwalze (10) stützen und vertikal folgend der Aktivierung des Linearantriebs (15) gleiten.

**6.** Vorrichtung nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die zweiten An-

drückwalzen (20) durch Stützmittel (17) gestützt werden und miteinander assoziiert sind, mit denen der Linearantrieb (15) verbunden ist.

**7.** Vorrichtung nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die Stützmittel (17) zwei parallele vertikale Platten (18) umfassen, positioniert an entgegengesetzten Seiten des Förderbands (2) im rechten Winkel zur Rotationsachse (20a) der zweiten Andrückwalzen (20), wobei die Platten (18) jeweils in einem jeweiligen Gestellabschnitt (16) des Gestells (14) enthalten sind.

**8.** Vorrichtung nach dem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** eine jede vertikale Stützplatte (18) mit dem jeweiligen Gestellabschnitt (16) mithilfe von mindestens einem Paar Gleitblöcke (19), vorzugsweise zwei, verbunden ist, die die relative Verfahrung zwischen dem Gestellabschnitt (16) und der jeweiligen Platte (18) ermöglichen, und mithilfe eines jeweiligen Linearantriebs (15), der bei Betätigung die vertikale Verfahrung des Gestellabschnitts (16) und der ersten Andrückwalze (10) bewirkt.

**9.** Vorrichtung nach einem der Ansprüche 7 und 8, **dadurch gekennzeichnet, dass** die vertikale Position der zweiten Andrückwalzen (20) durch die Verstellung der Höhe der vertikalen Stützplatten (18) justiert werden kann, wenn die Vorrichtung nicht in Betrieb ist, wobei die zweiten Andrückwalzen (20) stets mit der Auflagefläche (11) während des Komprimierens der Schicht aus keramischem Pulvermaterial (6) in Kontakt bleiben.

**10.** Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Antriebsmittel (27) für die erste Andrückwalze (10) einen Getriebemotor umfassen, der auf die Rotationswelle (12) der ersten Andrückwalze (10) wirkt, sodass die Drehung der ersten Andrückwalze (10) bewirkt wird, wenn diese sich in der Nichtbetriebsposition entfernt von der Anschlagfläche (11) befindet, sowie die horizontale Drehverfahrung der ersten Andrückwalze (10), wenn sich diese in der abgesenkten Betriebsposition in Kontakt mit der Schicht aus keramischem Pulvermaterial (6) befindet.

**11.** Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die zweiten Andrückwalzen (20) leerlaufend montiert sind und eine Aufwärtskraft von unten auf die Auflagefläche (11) als Reaktion auf die nach unten gerichtete Druckkraft ausüben, die von oben durch die erste Andrückwalze (10) ausgeübt wird, die vom Gestellabschnitt (16) durch die Betätigung des Linearantriebs (15) nach unten gezogen wird.

**12.** Vorrichtung nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** sie ein Neupositionierungssystem umfasst, das über einen Getriebemotor angetrieben wird, der wahlweise im Synchronlauf mit den Antriebsmitteln (27) der ersten Andrückwalze (10) arbeiten kann, um an der Verfahrung der Andrückwalzen (10 und 20) entlang der Ausdehnungsrichtung (X) des Förderbands (2) während der Kompression der Schicht aus keramischem Pulvermaterial (6) mitzuwirken oder um während der Kompression deaktiviert zu werden, wobei das Neupositionierungssystem zudem während einer Nichtkompressionsphase aktiviert werden kann, um die erste Andrückwalze (10), die zweiten Andrückwalzen (20) und die Stütz- und Bewegungsmittel (13) an irgendeiner beliebigen Stelle des Bands (2) zu positionieren.

## Revendications

**1.** Appareil pour former des feuilles céramiques comprenant :

- une bande transporteuse (2) comportant une plateforme de butée rigide (11) en dessous de sa branche supérieure (2') et adjacente à la branche supérieure (2') ;
- des moyens (5) servant à alimenter le matériau de poudre céramique (6a) de sorte à relâcher une couche de matériau de poudre céramique (6) sur ladite branche supérieure (2') ;
- un premier cylindre presseur (10) doté d'un axe horizontal (10a) perpendiculaire à la direction d'extension (X) de la bande transporteuse (2) et étant disposé au-dessus de ladite bande transporteuse (2) ;
- des moyens d'entraînement (27) pour le premier cylindre presseur (10) déterminant sa rotation autour de son axe (10a) ;
- au moins un second cylindre presseur (20) doté d'un axe horizontal (20a) perpendiculaire à la direction d'extension (X) de la bande transporteuse (2) **caractérisé en ce que** :
- ledit second cylindre presseur (20) est disposé en dessous de ladite plateforme de butée (11) et est conçu pour interagir activement, dans une direction opposée et contraire, avec ledit premier cylindre presseur (10) afin de comprimer ladite couche de matériau de poudre céramique (6) ; et **en ce que** l'appareil comprend :
- des moyens de support et de déplacement (13) pour ledit premier cylindre presseur (10) étant directement reliés au dit, et interagissant fonctionnellement avec ledit au moins second cylindre presseur (20) de manière à déplacer ledit premier cylindre presseur (10) verticalement et à exercer une force de pression verticale par le

haut et simultanément une réaction verticale par le bas sur ladite plateforme de butée (11) et sur ladite couche de matériau de poudre céramique (6).

**2.** Appareil selon la revendication 1, **caractérisé en ce que** lesdits moyens de support et de déplacement (13) comprennent au moins une structure (14) servant à supporter et à contenir ledit premier cylindre presseur (10) et ledit au moins second cylindre presseur (20), et au moins un actionneur linéaire (15) relié au dit au moins second cylindre presseur (20) et actif sur ladite structure (14).

**3.** Appareil selon la revendication 2, **caractérisé en ce qu'**il comprend une pluralité de seconds cylindres presseurs horizontaux (20), perpendiculaires à la direction d'extension (X) de la bande transporteuse (2), alignés à des axes respectifs (20a) parallèles les uns aux autres.

**4.** Appareil selon la revendication 2 ou 3, **caractérisé en ce que** ledit premier cylindre presseur (10) est mobile verticalement entre une position non fonctionnelle dans laquelle il est surélevé et éloigné de la couche de matériau de poudre céramique, sans exercer une action de compression sur celle-ci, et une position fonctionnelle dans laquelle il est abaissé et en contact avec la couche sous-jacente de matériau de poudre céramique (6) de sorte à exercer une action de compression sur celle-ci.

**5.** Appareil selon l'une des revendications de 2 à 4, **caractérisé en ce que** ladite structure (14) comprend deux parties de châssis (16) verticales parallèles, positionnées sur des côtés opposés de la bande transporteuse (2), orthogonales à l'axe de rotation (10a) du premier cylindre presseur (10), et qui supportent ledit premier cylindre presseur (10) et coulissent verticalement suite à l'activation de l'actionneur linéaire (15).

**6.** Appareil selon la revendication précédente, **caractérisé en ce que** lesdits seconds cylindres presseurs (20) sont supportés et associés réciproquement par des moyens de support (17) auxquels est relié ledit actionneur linéaire (15).

**7.** Appareil selon la revendication précédente, **caractérisé en ce que** lesdits moyens de support (17) comprennent deux plaques verticales parallèles (18), positionnées sur des côtés opposés de la bande transporteuse (2), orthogonales à l'axe de rotation (20a) des seconds cylindres presseurs (20) ; lesdites plaques (18) étant chacune contenue dans une partie (16) de châssis respective de ladite structure (14).

**8.** Appareil selon la revendication précédente, **caractérisé en ce que** chaque plaque de support verticale (18) est reliée à la partie de châssis (16) respective au moyen d'au moins une paire de blocs coulissants (19), de préférence deux, activant la translation relative entre la partie de châssis (16) et la plaque (18) respective, et au moyen d'un actionneur linéaire (15) respectif qui, en l'actionnant, provoque la translation verticale de la partie de châssis (16) et du premier cylindre presseur (10).

**9.** Appareil selon l'une des revendications 7 et 8, **caractérisé en ce que** la position verticale desdits seconds cylindres presseurs (20) peut être réglée en ajustant la hauteur des plaques de support verticales (18) lorsque l'appareil ne fonctionne pas ; lesdits seconds cylindres presseurs (20) restant toujours en contact avec la plateforme de butée (11) lors de la compression de la couche de poudre céramique (6).

**10.** Appareil selon l'une des revendications précédentes, **caractérisé en ce que** lesdits moyens d'entraînement (27) pour ledit premier cylindre presseur (10) comprennent un moteur à engrenages actif sur l'arbre de rotation (12) dudit premier cylindre presseur (10) de manière à provoquer la rotation dudit premier cylindre presseur (10) lorsqu'il se trouve dans la position non fonctionnelle éloignée de la plateforme de butée (11), et la translation horizontale en rotation dudit premier cylindre presseur (10) lorsqu'il se trouve dans la position fonctionnelle abaissée en contact avec ladite couche de matériau de poudre céramique (6).

**11.** Appareil selon l'une des revendications précédentes, **caractérisé en ce que** lesdits seconds cylindres presseurs (20) sont montés libres et appliquent une force vers le haut à partir du bas sur la plateforme de butée (11) en réponse à la force de compression vers le bas exercée par le haut par le premier cylindre presseur (10), tiré par le bas par la partie de châssis (16) par activation de l'actionneur linéaire (15).

**12.** Appareil selon la revendication 10 ou 11, **caractérisé en ce qu'**il comprend un système de repositionnement entraîné par un moteur à engrenages pouvant fonctionner de façon sélective de façon synchronisée avec les moyens d'entraînement (27) dudit premier cylindre presseur (10), afin de collaborer avec la translation des cylindres presseurs (10 et 20) le long de la direction d'extension (X) de la bande transporteuse (2) lors de la compression de la couche de matériau de poudre céramique (6) ou d'être désaccouplé lors de la compression ; ledit système de repositionnement pouvant être de plus activé lors d'une phase de non compression afin de positionner le premier cylindre presseur (10), les seconds cylindres presseurs (20) et les moyens de support et de

déplacement (13) en tout point quelconque le long de la bande transporteuse (2) .

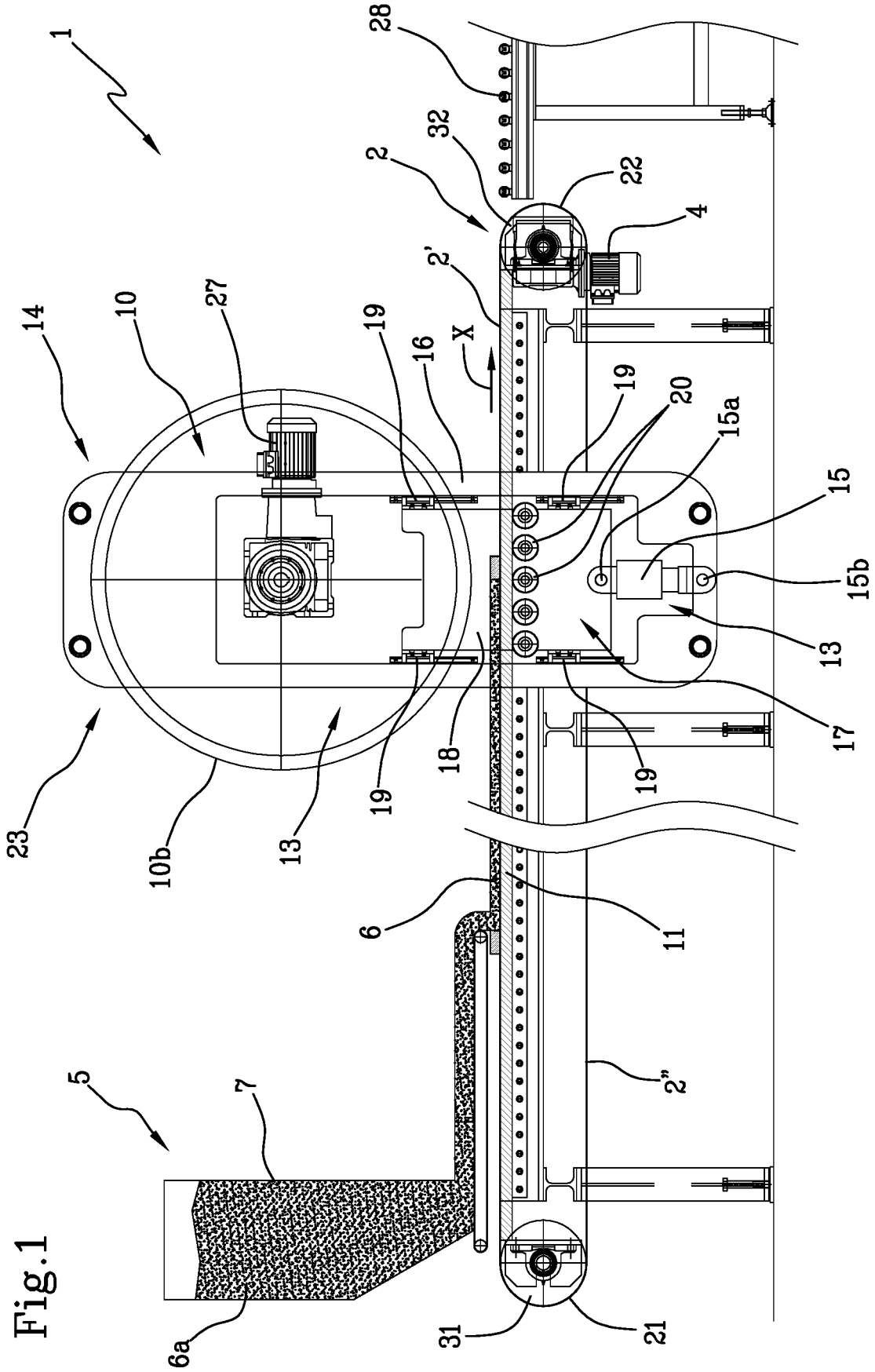

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2
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X
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10
27
19
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15a
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15b
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7
6a
31
21

Fig.1

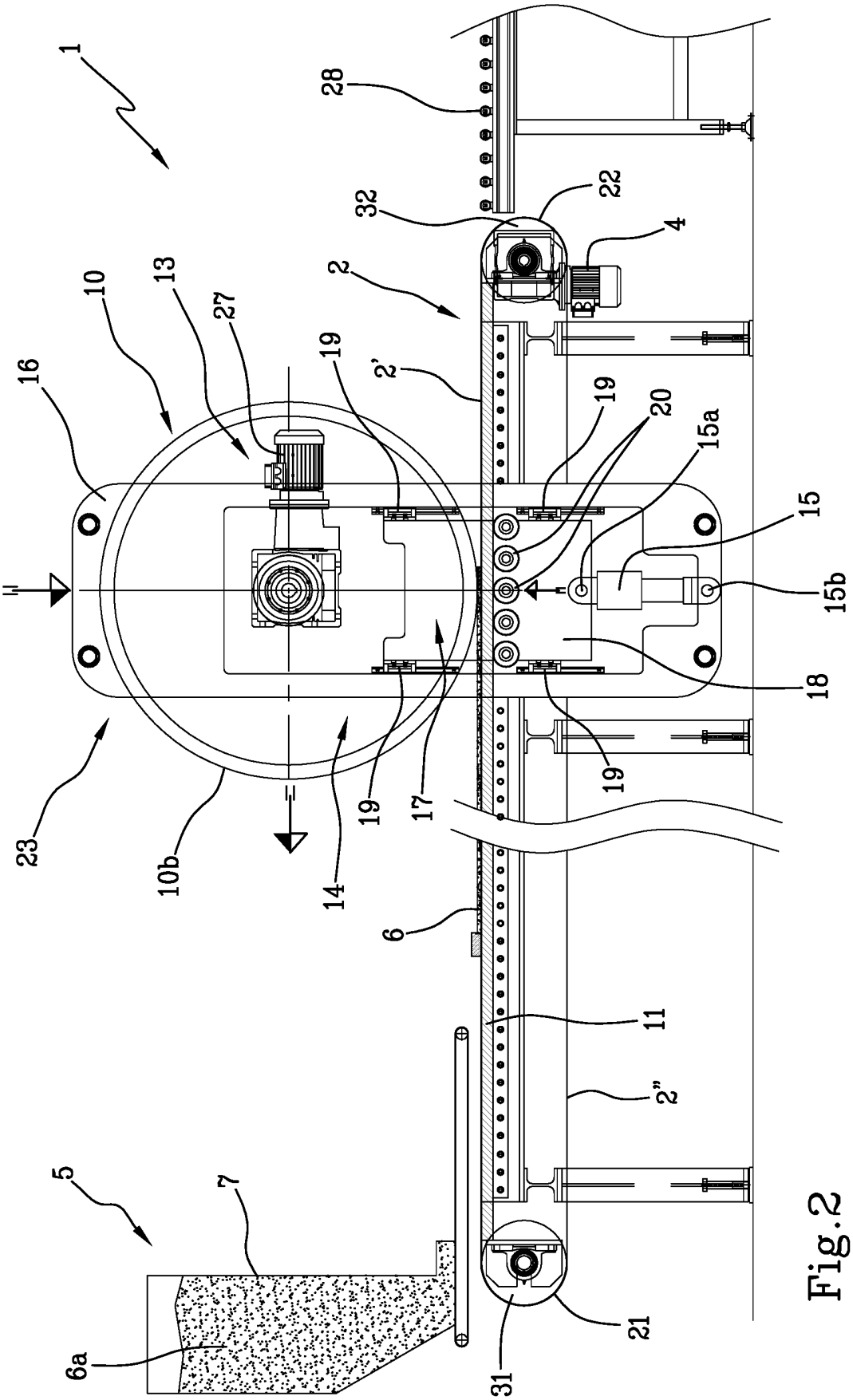

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Fig.2

Fig.3

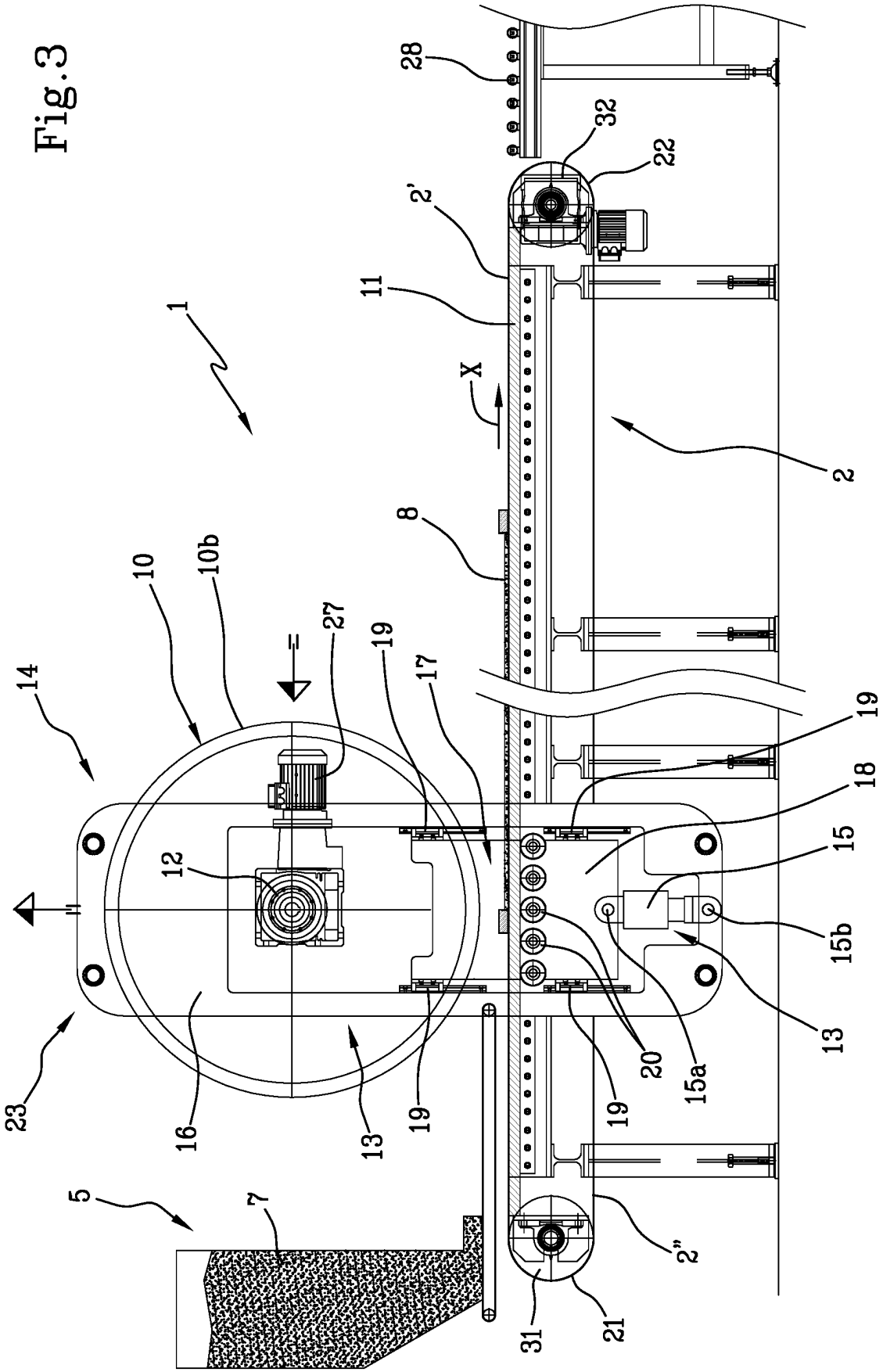

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Fig.4

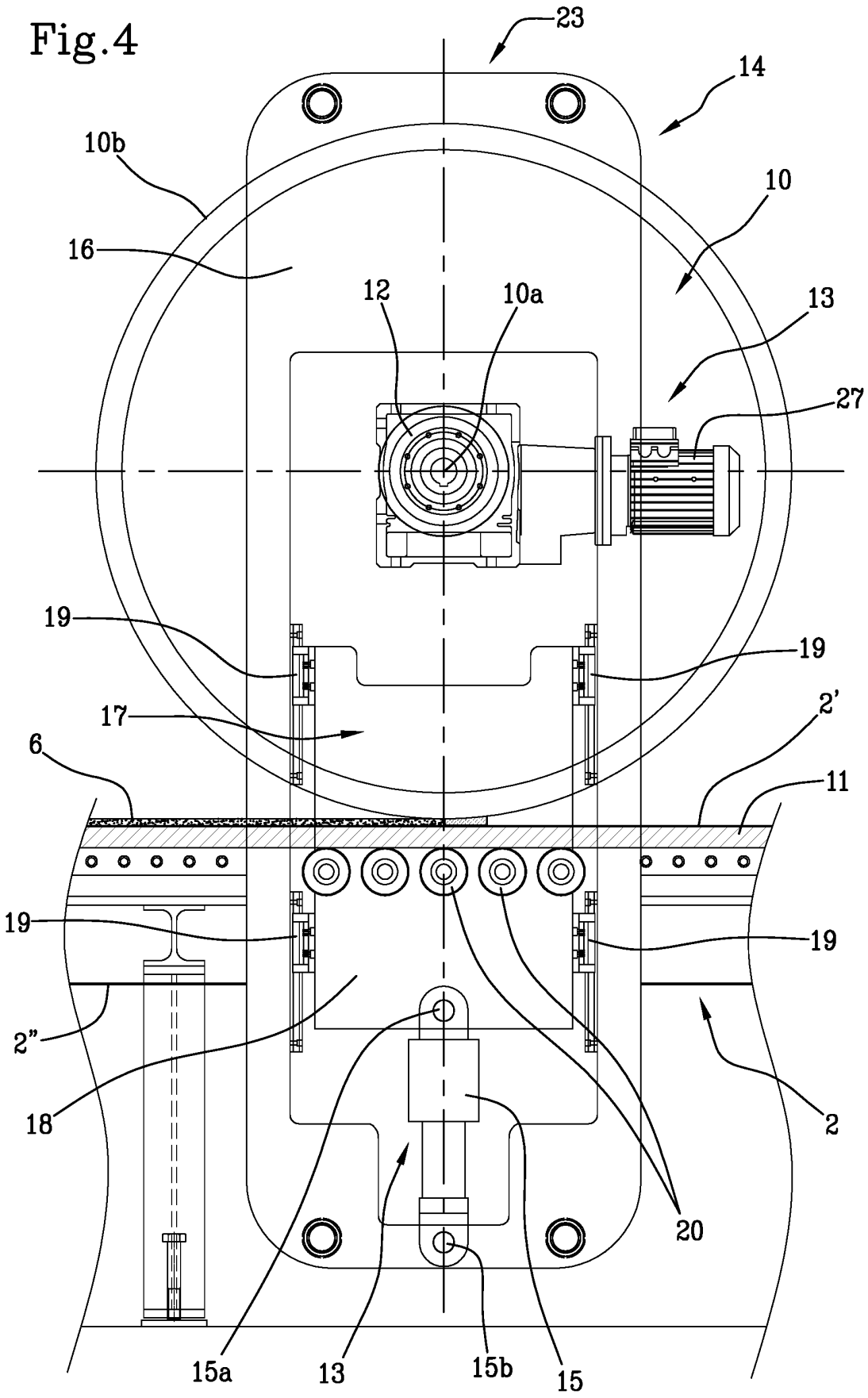
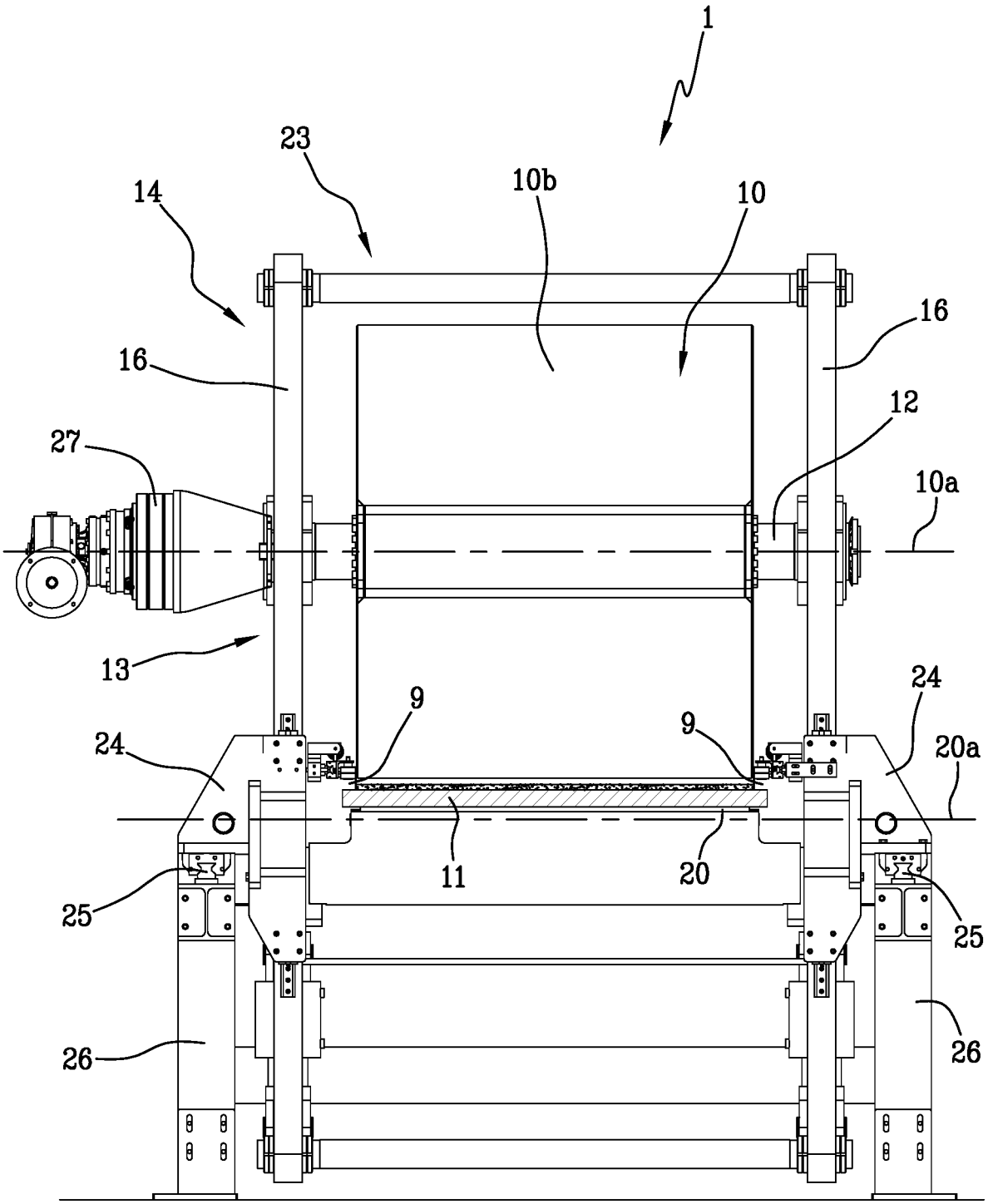

23
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10b
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10a
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27
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19
17
2'
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19
2"
18
2
20
15a
13
15b
15

Fig.5



## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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