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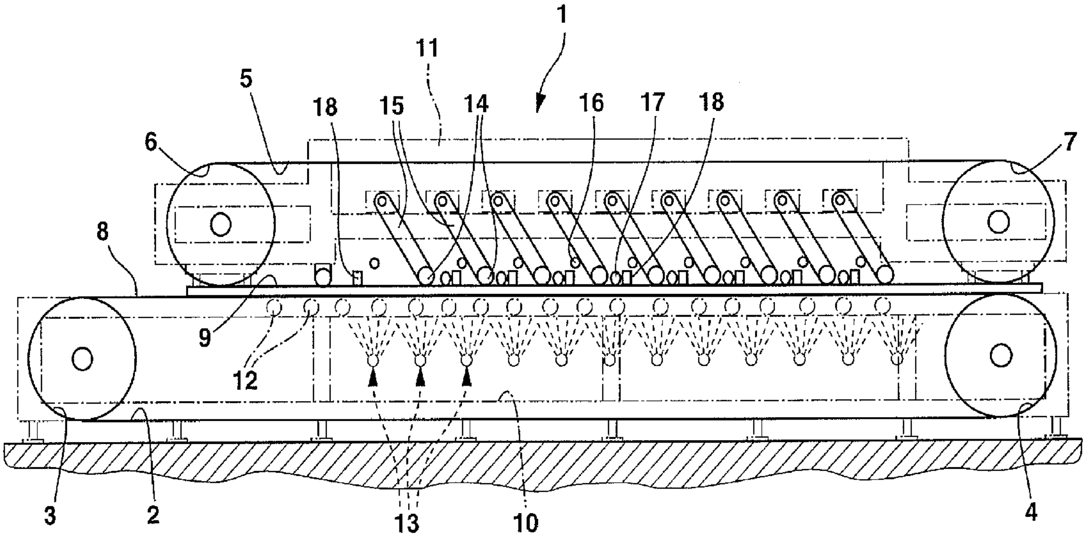
(54) **SYSTEME A COURROIE DOUBLE**
(54) **DOUBLE-BELT SYSTEM**



(57) 1. Système à courroie double. 2.1 Les systèmes à courroie double actuels ne conviennent pas à la consolidation de matières fondues à basse viscosité qui réagissent de façon hautement exothermique. 2.2 La présente invention comprend une série de dispositifs de compensation placés sur le côté postérieur de la bande de travail et à l'opposé du passage de traitement. Les dispositifs de compensation sont répartis sur au moins une partie de la longueur du passage de traitement, chacun se prolongeant au moins au-dessus de presque toute la largeur de la bande de travail. Les dispositifs de compensation maintiennent la bande de travail à plat sur toute la largeur du passage de traitement contre la charge permanente de la bande de travail. 2.3 La présente invention est destinée à la fabrication de marbre synthétique. 3. Fig. 1.

(57) 1. Double-belt system. 2.1 Known double-belt systems are not suitable for the consolidation of low-viscosity melt materials which react in highly exothermic fashion. 2.2 According to the invention, on a back side, facing away from the process gap, of the working run of the upper belt there are provided a plurality of compensation devices, distributed over at least a portion of the length of the process gap and each extending over at least almost the entire width of the working run, which keep the working run positioned flat over the width of the process gap against the dead weight of the working run. 2.3 Utilization for continuous production of synthetic marble. 3. Fig. 1.

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Abstract

1. Double-belt system.

2.1 Known double-belt systems are not suitable for the consolidation of low-viscosity melt materials which react in highly exothermic fashion.

2.2 According to the invention, on a back side, facing away from the process gap, of the working run of the upper belt there are provided a plurality of compensation devices, distributed over at least a portion of the length of the process gap and each extending over at least almost the entire width of the working run, which keep the working run positioned flat over the width of the process gap against the dead weight of the working run.

2.3 Utilization for continuous production of synthetic marble.

3. Fig. 1.

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Double-belt system

The invention relates to a double-belt system having a continuously recirculating upper belt and a continuously recirculating lower belt, the mutually facing working runs of which delimit a process gap, the height of the process gap being adjustable by means of calibration rollers which are associated with the working run of the upper belt as well as the working run of the lower belt.

Double-belt systems for processing viscous melts into plastics in slab form are commonly known. A double-belt system has a continuously recirculating upper belt as well as a continuously recirculating lower belt, the mutually facing working runs of which delimit a process gap in which the melt product is cured into the slab form, under defined pressure and temperature conditions, in a continuous flowthrough process through the double-belt system. Difficulties have previously been encountered, however, in the processing of, in particular, highly free-flowing (i.e. relatively low-viscosity) melts.

It is the object of the invention to create a double-belt system of the kind cited initially which allows improved processing of highly free-flowing melts.

This object is achieved by the fact that on a back side, facing away from the process gap, of the working run of the upper belt there are provided a plurality of compensation devices, distributed over at least a portion of the length of the process gap and each extending over at least almost the entire width of the working run, which keep the working run positioned flat over the width of the process gap against the dead weight of the working run. The solution according to the invention is based on the recognition that with relatively highly free-flowing, i.e. low-viscosity, melts, the counterpressure of the melt product in the process gap is not sufficient to keep the working run of the upper belt flat. The working run instead sags at least slightly under its own weight, thus calling into question the accuracy of the cured slab products to be produced. The solution according to the invention prevents sagging of the working run over its width, the compensation devices pulling the working run of the upper belt upward against the dead weight of the working run. It is thus possible to produce slab material very accurately, with extremely low tolerances. Since a steel belt, in particular, is used as the upper belt, magnet arrangements, which either are configured in roller fashion and thus roll along the working run as the upper belt circulates, or are equipped with associated sliding elements which allow noncontact action of the magnet arrangements, are particularly suitable as compensation devices. Also suitable as compensation devices are vacuum mechanisms which exert suction on the working run. Vacuum bars can be used with particular advantage. In the same fashion, mechanical means for pulling up the working run and keeping it flat can be used as compensation devices. The solution according to the invention thus allows even relatively highly free-flowing melts to be processed easily and accurately into slab products. The solution according to the invention is particularly suitable for the production of acrylic- or polyester-based synthetic marble. The solution according to the invention is equally well suited for the production of other thermoplastic or thermosetting plastic slabs.

In an embodiment of the invention, at least one magnet element is fastened in each case on a support beam extending over the width of the process gap. In a further embodiment, the at least one magnet element is arranged adjustably as to height relative to the support beam. As a result, the attractive force of the at least one magnet element acting on the working run can be modified by modifying the spacing of the magnet element from the working run.

The object on which the invention is based is also achieved in that there are associated with the back side of the working run of the upper belt at least one delivery mechanism and at least one associated extraction mechanism, spaced apart in the belt travel direction, for a liquid temperature-control medium, which apply the temperature-control medium onto the working run over its entire width and extract it from the working run over the entire width. In addition to temperature control, known per se, of the working run of the lower belt associated with the process gap, the solution according to the invention also results in precise temperature control of the working run of the upper belt, so that the melt product present in the process gap can be temperature-controlled, over its entire thickness, much more precisely than is possible in the existing art on either single-belt or double-belt systems. The reason is that delivery of the liquid temperature-control medium onto the back side of the working run of the upper belt allows both working runs delimiting the process gap to be temperature-controlled in identical fashion, so that uniform curing - and thus uniform polymerization, reaction, and cooling - are guaranteed over the entire thickness of the melt product. Water is provided, in particular, as the liquid temperature-control medium. If curing of the melt product takes place in multiple zones of the process gap, provision can also be made for delivery and extraction of the liquid temperature-control medium only in the region of an individual zone. Simultaneous application and extraction of the temperature-control medium over the entire width of the process gap also allows correspondingly uniform temperature control over the width of the melt product.

In a further embodiment of the invention, one delivery mechanism and one associated extraction mechanism are arranged before and after each calibration roller in the belt travel direction. This makes possible relative precise temperature control of the working run, since with multiple calibration rollers and respectively associated delivery and extraction mechanisms, new temperature-control medium (in particular water), controlled to a defined temperature, can be applied in each case onto the working run.

In a further embodiment of the invention, the calibration rollers positioned between the delivery and extraction mechanisms are equipped with multiple circumferential contours distributed over the width of the process gap and oriented in the belt travel direction. These circumferential contours guarantee that the liquid temperature-control medium, in particular water, is guided in the belt travel direction, in essentially unhindered fashion between the calibration rollers and the back side of the working run, to the respective extraction mechanism.

The object on which the invention is based is also achieved by the fact that at least one adjustable positioning stop, for establishing a defined process gap height, is associated with each calibration roller. Precise adjustability of the process gap height also allows precise control over the chemical reactions which occur during curing of the melt product.

Further advantages and features of the invention are evident from the dependent claims and from the description below of a preferred exemplifying embodiment of the invention, which is presented with reference to the drawings.

Fig. 1 schematically shows, in a side view, an embodiment of a double-belt system according to the invention which is divided into multiple temperature-control zones over the length of the process gap;

Fig. 2 shows, in an enlarged representation, a portion of the double-belt system according to Fig. 1 in the region of delivery and extraction mechanisms for temperature-controlled water, a compensation device in the form of a magnet beam being additionally shown;

Fig. 3 shows a cross section through the double-belt system according to Figs. 1 and 2, at the level of section line III-III in Fig. 2;

Fig. 4 shows, in a schematic and enlarged sectional representation which is not to scale, the magnet beam according to Figs. 2 and 3;

Fig. 5 shows, in a side view, a further portion of the double-belt system according to Figs. 1 and 2, similar to Fig. 2 but shown in simplified fashion as compared with said Fig. 2;

Fig. 6 shows a section through the double-belt system according to Fig. 5, at the level of section line VI-VI in Fig. 5; and

Fig. 7 shows, in an enlarged representation, a cross section through the double-belt system according to Figs. 1 to 6, the fluted longitudinal contour of the calibration rollers of the upper belt being visible.

As shown in Fig. 1, a double-belt system 1 according to Figs. 1 to 7 has a continuously circulating lower belt 2, in the form of a steel belt, which is laid around an infeed drum 3 and an outfeed drum 4. Infeed drum 3 and outfeed drum 4 are mounted in a stable lower frame 10 of double-belt system 1. Arranged on lower frame 10 is an upper frame 11, associated with which is a continuously circulating upper belt 5 also configured as a steel belt. Upper belt 5 runs on the infeed side over an infeed drum 6, and on the outfeed side over an outfeed drum 7, each of which is mounted in upper frame 11. Infeed drum 6 is set back in the belt travel direction with respect to infeed drum 3 of lower belt 2, whereas the two outfeed drums 4 and 7 are arranged at the same level (viewed in the belt travel direction). An upper working run 8 of lower belt 2 and a lower working run 9 of upper belt 5 delimit the top and bottom of a process gap through which a melt product to be treated runs, in the belt travel direction, from an infeed region to an outfeed region at the level of outfeed drums 4, 7.

The process gap is divided, in the belt travel direction, into multiple zones so as to obtain cured slab material from a low-viscosity melt product. Double-belt system 1 that is shown serves in particular for continuous production of synthetic marble, the melt of which is delivered at very low viscosity to the infeed region of double-belt system 1. To prevent the low-viscosity melt from flowing laterally out of the process gap constituted by the mutually facing working runs 8, 9, lateral delimiting strips are provided which pass through the process gap together with the melt product. The process gap is divided, in the belt travel direction, into two mutually adjoining regions; in a first region, the melt material is still very low in viscosity and cannot handle any stresses. Thermal reactions or polymerization have not yet begun in this region. In the second region of the process gap, consolidation of the melt material takes place, in particular by means of an exothermic reaction. Consolidation of the melt material, present in monomeric form, occurs in the course of the overall process within double-belt system 1 by means of polymerization. The process protocol requires multiple temperature-control zones, preheating occurring in a first zone. The exothermic reaction takes place in a second zone. In a third zone used for post-processing, the temperature is raised again so as additionally to polymerize out any residual monomers. The last zone represents a cool-down zone.

To prevent the low-viscosity melt material, which in the case of the exemplifying embodiment described is an MMA compound, from flowing out forward or backward in terms of the belt direction, there are also provided, in addition to the lateral delimiters described, dam delimiters running transversely to the belt travel direction, which, like the lateral delimiters, also pass through the process gap together with the melt material. Both the lateral delimiting strips and the dam delimiters must be designed, in terms of thermal and mechanical stress, for the melt material and for the particular requirements in the process gap.

In order to be able to adjust the height of the process gap relatively accurately over its length, a plurality of calibration rollers 12, 14, arranged at regular spacings one behind another, are associated both with working run 8 and with working run 9. The arrangement of calibration rollers 12 and 14 is Fig. 1 is shown only schematically, and does not correspond to actual conditions. As disclosed by the practical embodiment of double-belt system 1 as shown in Fig. 2, calibration rollers 12 which are arranged at regular spacings over the entire length of the process gap are associated with lower working run 8. Calibration rollers 12 are arranged below working run 8 transversely to the belt travel direction, and support working run 8 from below. Calibration rollers 12 are mounted on corresponding longitudinal supports of lower frame 10. Calibration rollers 14 are arranged with respect to one another with double the spacing relative to the spacing between calibration rollers 12, each calibration roller (Figs. 2, 7) being mounted parallel to the lower calibration rollers 12 between two arms 15 of a pivoting yoke 35, arms 15 extending in the belt travel direction and obliquely downward from a pivot shaft 35 of the pivoting yoke. Yoke shaft 35 of pivoting yoke 15, 35 is mounted, pivotably about a pivot axis parallel to the rotation axis of the associated calibration rollers 14, on lateral, mutually opposite longitudinal supports of upper frame 11 by means of bearing brackets 36. As is evident from Fig. 2, calibration rollers 14 are each arranged at the same level as corresponding lower calibration rollers 12, so that they constitute, with said lower calibration rollers 12, pressure roller pairs for pressure loading of the process gap. Pressure loading of the process gap by means of calibration rollers 14 will be discussed in more detail below.

In order to allow temperature control of the melt material being temperature-controlled in the process gap, from both the top and the bottom, uniformly and simultaneously in accordance with the intended process protocol, both the associated working run 9 of upper belt 5 and the corresponding working run 8 of lower belt 2 are temperature-controlled. Water is used as the temperature-control medium, the water being sprayed onto an underside of lower working run 8 through spray devices 13 which have a plurality of spray nozzles arranged at regular spacings over the length of the process gap below working run 8. The temperature-controlled water is applied to and extracted from the back side, facing away from the process gap, of upper working run 9 via a plurality of delivery and extraction mechanisms 16, 17, each delivery mechanism 16 also having associated with it an extraction mechanism 17 which is dimensioned such that all the water applied through delivery mechanism 16 onto the back side of working run 9 can be extracted again. To prevent the applied water from emerging laterally via the edges of working run 9, the back side of upper belt 5 has lateral delimiters 23 in the region of the opposing lateral edges.

Delivery and extraction mechanisms 16, 17 are associated with working run 9 in the zones of the process gap in accordance with the need for corresponding temperature control, i.e. heating or cooling, of the product in the process gap. In the illustrated exemplifying example, a delivery mechanism 16 is provided in front of each calibration roller 14 (viewed in the belt travel direction), and a corresponding extraction mechanism 17 is provided behind the respective calibration roller 14. With other exemplifying embodiments of the invention, however, a smaller number of delivery and extraction mechanisms may also be provided, limited to only one or two temperature-control zones. Because of the good thermal conductivity of the steel belt, temperature control of the back side of upper belt 5 makes possible corresponding temperature control of the process gap. In order to prevent the particular calibration roller 14 resting on the back side of working run 9 from blocking water flow along with the circulation of working run 9, each calibration roller 14 is equipped over its entire width with circumferential longitudinal contours (Fig. 7). These longitudinal contours 37 allow water to be guided through under the respective calibration roller 14 without influencing its function of pressing onto working run 9. Delivery mechanism 16 has a nozzle bar (not further designated), extending over the width of working run 9, through which the temperature-controlled water is delivered, simultaneously over the entire width of the process gap, onto the back side of working run 9. The nozzle bar, extending transverse to the belt travel direction, is held on a carrier yoke 33 which is immovably joined, via retaining blocks 30, to the longitudinal supports of upper frame 11. In order to strengthen the attachment of carrier yoke 33 to retaining blocks 30, each carrier yoke 33 is attached to a crossmember 24 which in turn is immovably joined to retaining blocks 30. Water delivery to the nozzle bar is accomplished, in a manner not shown in further detail, by means of a corresponding line system into which a pressure pump is incorporated.

Each extraction mechanism 17 has a suction bar, resting on the surface of the back side of working run 9, which extends over the width of working run 9 between lateral delimiters 23. The suction bar extracts water from the surface of working run 9 over the entire width of working run 9 between lateral delimiters 23. The suction bar is in communication with a vacuum pump via a corresponding line system. Heating and cooling of the delivered or extracted water is accomplished in a manner known per se, so that no further explanation thereof will be given here.

Each suction bar is retained by means of a pivoting frame 31 which is mounted pivotably on the associated carrier yoke of the corresponding nozzle bar of the delivery mechanism. Corresponding pivot mounting extensions 32 are provided for this purpose on the carrier yoke. Each suction bar rests, as a result of the weight of pivoting frame 31 and of the suction bar, on the back side of working run 9. Since the next nozzle bar of delivery mechanism following the extraction mechanism in the belt travel direction is arranged immediately behind the suction bar, each suction bar has, on the side facing the nozzle bar, an oblique deflector plate (not designated further) which also rests on the back side of working run 9. Said deflector plate prevents the previous suction bar from also drawing in, in addition to the water to be accepted from the corresponding delivery mechanism, water applied by the next delivery mechanism 16.

To prevent upper working run 9 from sagging under its own weight into the process gap over its width or even in the belt travel direction, there are associated with working run 9 a plurality of compensation devices, described in more detail below, which are arranged, spaced apart from one another in the belt travel direction, above the back side of working run 9. Said compensation devices are necessary in particular in the regions of the process gap in which the melt material is still of relatively low viscosity, so that the melt material itself produces no counterpressure which can absorb the forces resulting from the weight of working run 9. Since, however, sagging of working run 9 in those regions in which the melt material is still low in viscosity can cause the melt material, once consolidated into the slab material, to have a curved surface and/or one impaired by thickness tolerances, compensation devices 18 described below are provided. In the case of the exemplifying embodiment shown, compensation devices 18 are each configured as magnet bars (Figs. 3 to 5), each of which extends parallel to upper belt 5, transversely over the width of working run 9. Each magnet bar 18 is linear in configuration, and has a support profile 18 that is attached at its opposite ends to lateral retaining brackets of a carrier arrangement 25. Arranged on an underside of support profile 18, distributed over the width of the process gap, are a plurality of slider shoes 28 which rest on the surface of the back side of working run 9. A magnet block 27, configured as a permanent magnet, which is attached by means of threaded connectors 29 to the underside of support profile 18, is embedded between each two adjacent slider shoes 28. Laid in between each magnet block and the associated underside of support profile 18, at the height of threaded connectors 29, are respective shim washers by means of which the spacing between the underside (facing working run 9) of each magnet block 27 and the back side of working run 9 can be modified. In any case, the height of magnet blocks 27 is less than the height of the adjacent slider shoes 28, so that magnet blocks 27 are arranged on support profile 18 in noncontact fashion with respect to working run 9. The attractive force on working run 9 can be modified as a function of the spacing between magnet blocks 27 and working run 9 that is selected. The attractive forces of magnet blocks 27 cause working run 9 to be kept, against its own weight, in a flat position in contact against slider shoes 28. Working run 9 thus does not exert any compressive forces as a result of its own weight on the low-viscosity melt material. Support profile 26 of each magnet bar 18 is articulated, via the retaining brackets and two support rods of carrier arrangement 25, on retaining clips 34 of carrier yoke 33 for the associated delivery mechanism 16. Each magnet bar 18 is arranged, in the belt travel direction, directly behind an associated suction bar 17. The retaining brackets of each carrier arrangement 25 additionally overlap the opposing ends of the associated suction bar 17. Carrier arrangement 25 is configured in such a way that together with pivoting frame 31 for the adjacent suction bar 17, a parallelogram linkage results (Fig. 5). As a result, each magnet bar 18 can be lifted, together with pivoting frame 31 of the associated suction bar 17, away from the back side of working run 9.

In an exemplifying embodiment of the invention that is not shown, the extraction mechanisms for extracting the water applied onto the working run are designed with sufficient strength that they can also simultaneously serve as compensation devices to prevent sagging of the working run. Because of the suction effect of the extraction mechanisms, the working run is pulled up, against its own weight, up to the respective extraction mechanism, and thus held in position. This embodiment is particularly suitable for upper belts which are made of a non-magnetizable material, for example stainless steel.

In order to be able to exert pressure, in specific regions of the process gap, on working runs 8, 9 which delimit the process gap, Fig. 2 shows that there are associated with the lower and upper calibration rollers 12, 14, arranged respectively in pairs one above another, tension spring arrangements 20 which are each suspended on a fixed articulation point of lower frame 10 and engage with their opposite spring ends on support arms 21 which are rigidly joined to the associated arms 15 of the pivoting frames for the upper calibration rollers 14. Tension spring arrangements 20 are joined to support arms 21 adjustably by means of corresponding screw threads, so that the resulting tensile forces can be modified.

In order additionally to make possible precise calibration of the process gap irrespective of additional tensile forces, an adjustable stop 22 that is attached to lower frame 10 is additionally associated with each support arm 21. Each stop 22 is configured like a plunger in the form of a micrometer, and has at its upper end a flat, horizontal end surface on which, in the functional position of the stops, a stable contact plate of each associated support arm 21 rests (Figs. 2 and 7). The contact plunger of each stop 22, carrying the end surface, is precisely adjustable, in terms of its height relative to lower frame 10 and thus relative to lower working run 8, by means of the micrometer arrangement using corresponding screw threads. The position of the contact plunger of each stop 22 established by screwing the contact plunger in or out can be fixed by means of a mechanical locking device. Because each support arm 21, which in the functional position of each stop 22 rests on the associated contact plunger of each stop 22, is joined in rigid and stable fashion to the associated arm 15 of each pivoting yoke, each of which carries a calibration roller 14, it is possible by means of stops 22 to establish precisely the spacing of calibration rollers 14 from lower working run 8, and thus also the height of the process gap. In the functional position of stops 22, the respective associated tension spring arrangement 20 serves exclusively to hold the respective support arm 21 in its position resting on stop 22, and thus to prevent support arm 21, and hence calibration roller 14, from lifting off inadvertently.

In order to produce synthetic marble as a cured slab material in a continuous pass through double-belt system 1, the low-viscosity MMA compound serving as the melt material is first heated to a starting temperature which depends on the particular initiator being used. This starting temperature is preferably approximately 70°C. Heating to approximately 50°C can first occur relatively quickly, but a dwell time of at least ten minutes at this temperature level is necessary in order to allow polymerization to begin even at a relatively low level. At this relatively low level, all monomers can be incorporated into oligomers. If the temperature is elevated too quickly to the starting temperature, the resulting exothermic reaction might cause the temperature within the melt material to rise too quickly to over 100°C, which would cause bubbling and, as a result, evaporation of monomers. Because of the sensitive temperature-control capabilities of both the lower belt and the upper belt, the desired effect can be achieved, if necessary also by means of cooling. In a post-processing zone, a temperature elevation is then performed once again, to a level which allows even residual monomers to polymerize out. Provided subsequent to this zone is a temperature-control zone which ensures cool-down of the consolidated slab material.

In the regions in which a rapid elevation in viscosity and subsequent consolidation of the melt material occur in the process gap, upper working run 9 can also be kept flat by a continuous decrease in the process gap in the belt travel direction, so that the pressure buildup occurring in the process gap acts on the upper working run and keeps it flat. If this type of continuous decrease in the process gap were also implemented in the front feed-in region of the process gap, the low-viscosity melt material would be pushed out again toward the front. It is thus advantageous to arrange the above-described compensation devices particularly in these front feed-in regions. The low-viscosity melt material is delivered, in a delivery region, onto the lower belt which extends forward in front of the upper belt, and flows out in planar form. The fill level of the melt material in the delivery region before the process gap must be substantially higher than the height of the process gap in order to prevent air inclusions in the later slab material.

Claims:

1. Double-belt system having a continuously recirculating upper belt and a continuously recirculating lower belt, the mutually facing working runs of which delimit a process gap, the height of the process gap being adjustable by means of calibration rollers which are associated with the working run of the upper belt as well as the working run of the lower belt,
   wherein
   on a back side, facing away from the process gap, of the working run (9) of the upper belt (5) there are provided a plurality of compensation devices (18), distributed over at least a portion of the length of the process gap and each extending over at least almost the entire width of the working run (9), which keep the working run (9) positioned flat over the width of the process gap against the dead weight of the working run.

2. Double-belt system according to Claim 1, wherein the compensation devices have magnet elements (27) which are positioned in noncontact fashion with respect to the working run (9).

3. Double-belt system according to Claim 2, wherein at least one magnet element (27) is fastened in each case on a support beam (26) extending approximately over the width of the process gap.

4. Double-belt system according to Claim 3, wherein at least one magnet element (27) is arranged adjustably as to height relative to the support beam (26).

5. Double-belt system according to Claim 3, wherein at least one slider shoe (28), resting on the working run (9), is associated with the support beam (26).

6. Double-belt system according to the preamble of Claim 1 or as defined in Claim 1, the process gap having at least one temperature-control zone, wherein there are associated with the back side of the working run (9) of the upper belt (5) at least one delivery mechanism (16) and at least one associated extraction mechanism (17), spaced apart in the belt travel direction, for a liquid temperature-control medium, which apply the temperature-control medium onto the working run over its entire width and extract it from the working run (9) over the entire width.

7. Double-belt system according to Claim 6, wherein one delivery mechanism (16) and one associated extraction mechanism (17) are arranged before and after each calibration roller (14) in the belt travel direction.

8. Double-belt system according to Claim 7, wherein the calibration rollers (14) positioned between the delivery and extraction mechanisms (16, 17) are equipped with multiple circumferential contours (37) distributed over the width of the process gap and oriented in the belt travel direction.

9. Double-belt system according to the preamble of Claim 1 or according to one of the foregoing Claims, wherein at least one adjustable positioning stop (22), for establishing a defined process gap height, is associated with each calibration roller (14).

10. Double-belt system according to Claim 9, wherein the calibration rollers (12, 14) of the upper belt (5) and the lower belt (2) are positioned in pairs with respect to one another, and are loaded by spring arrangements (20) in opposite directions to one another, perpendicular to the belt travel direction.

Fig. 1

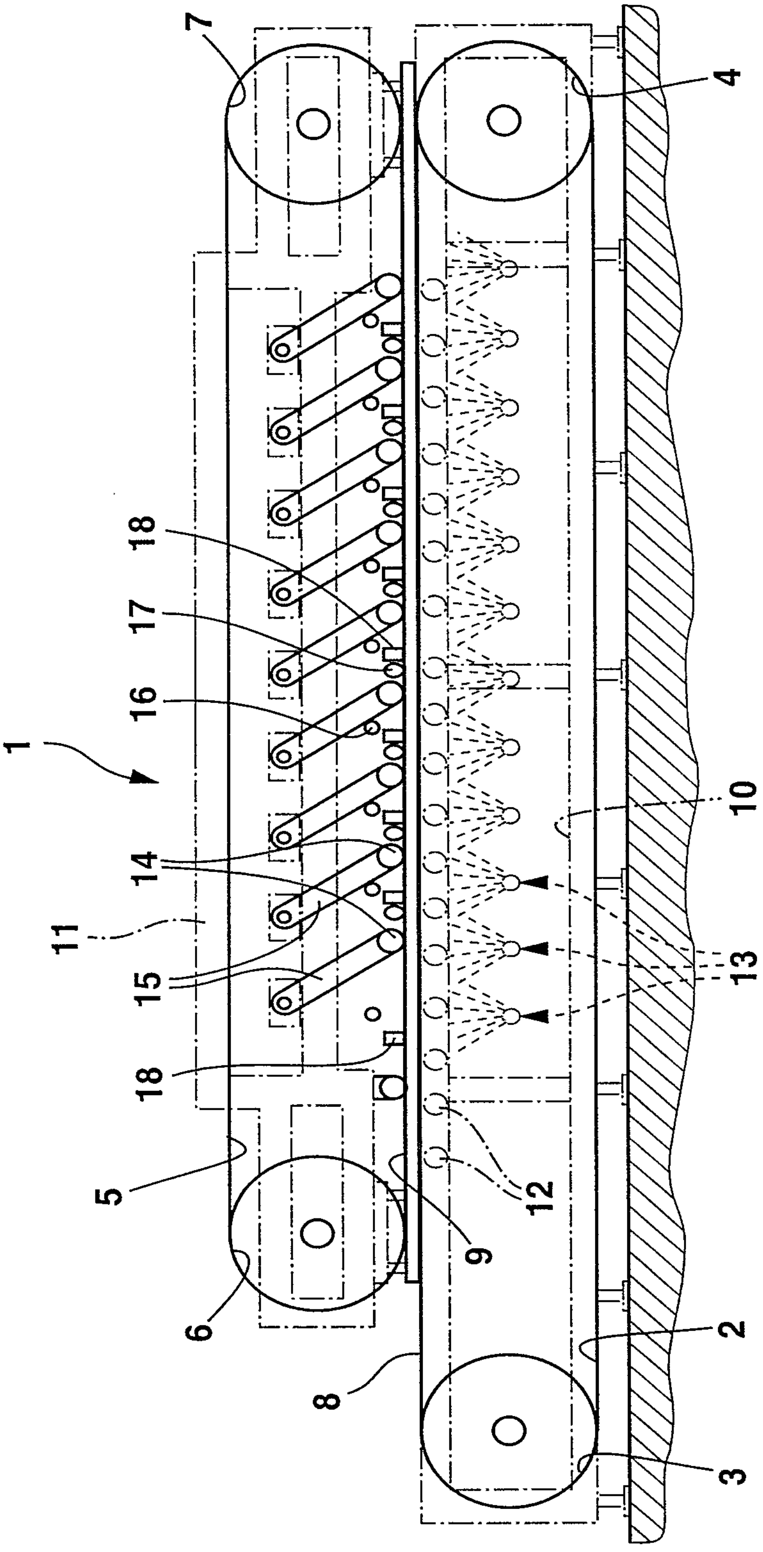

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Fig. 2

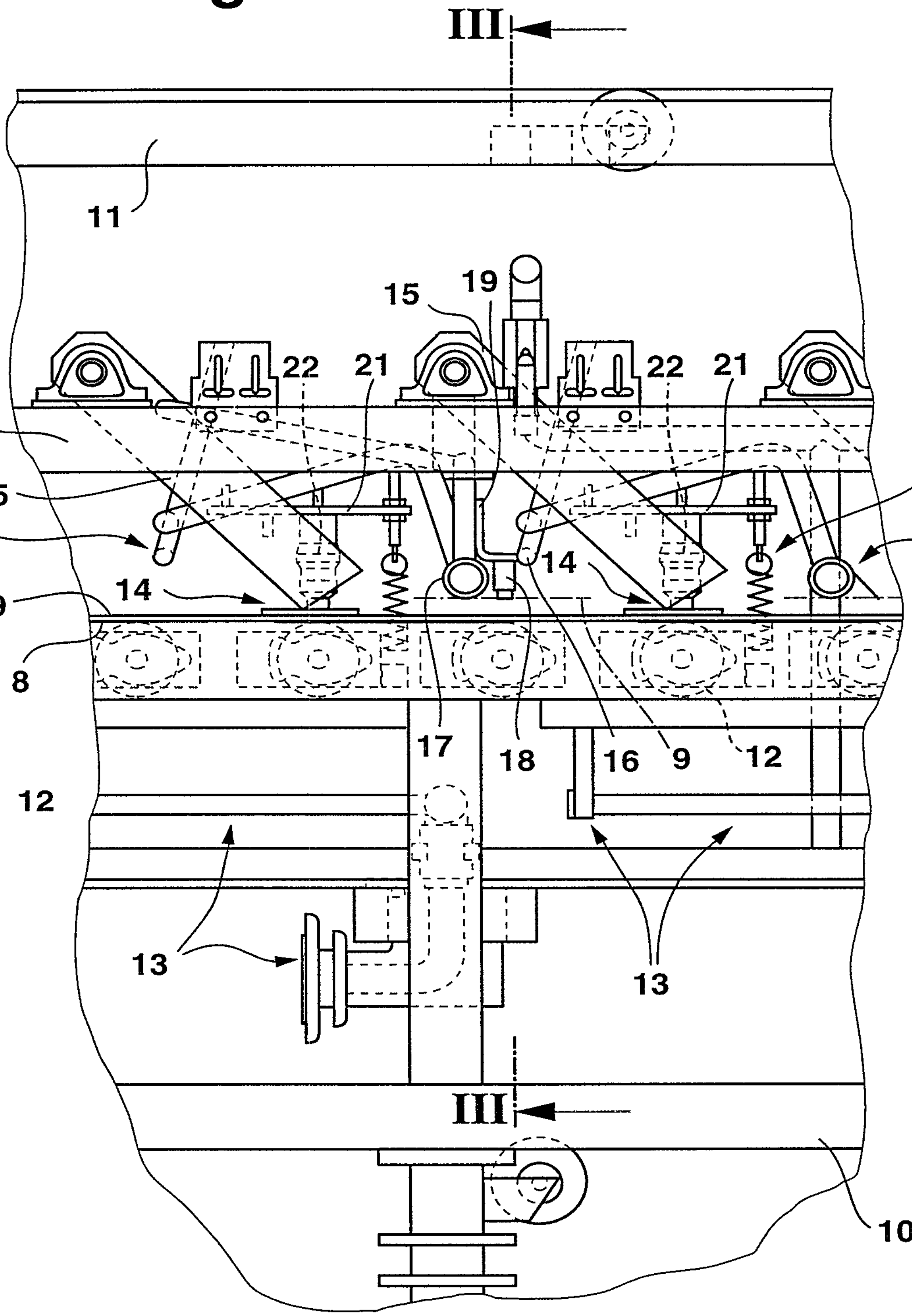

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Fig. 3

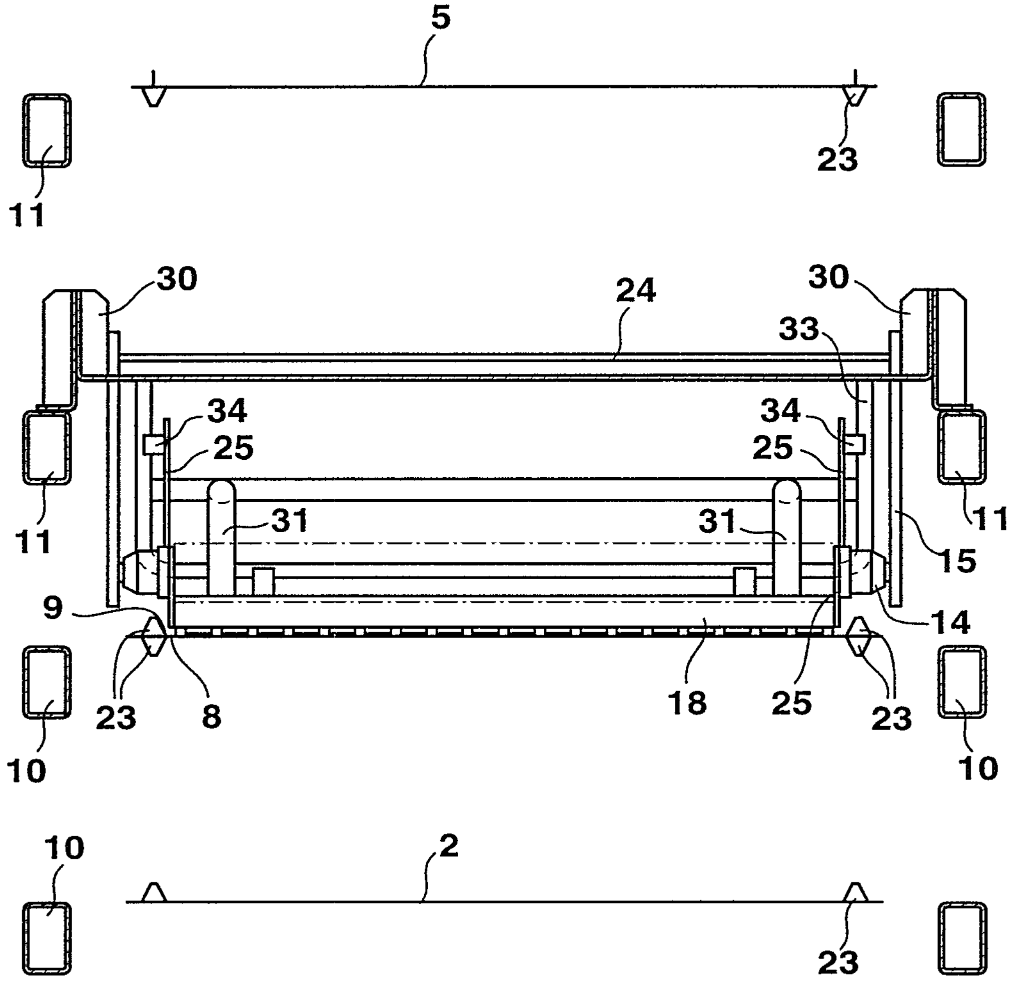

Fig. 4

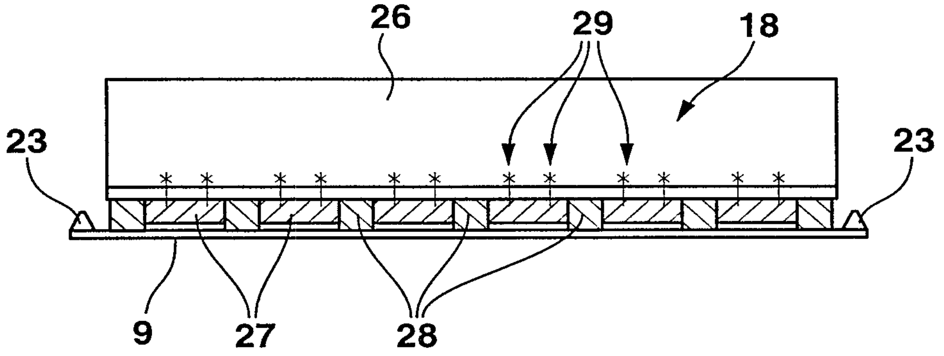

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Fig. 5

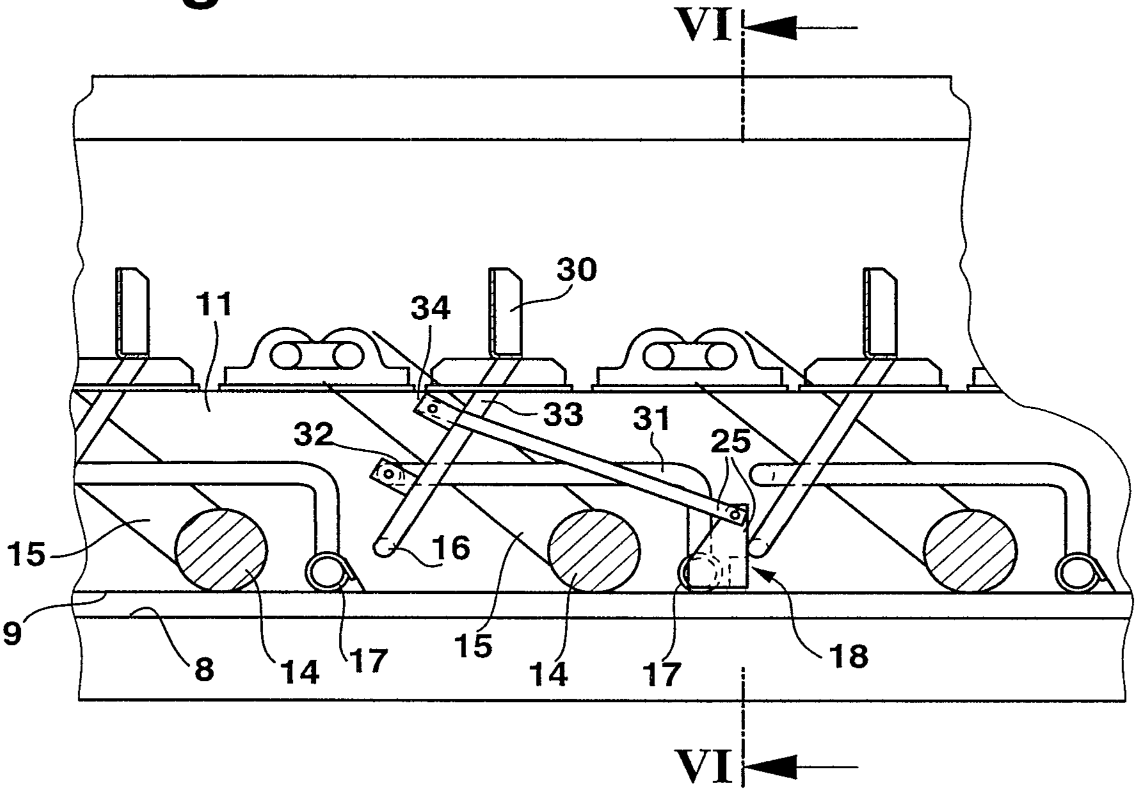

Fig. 6

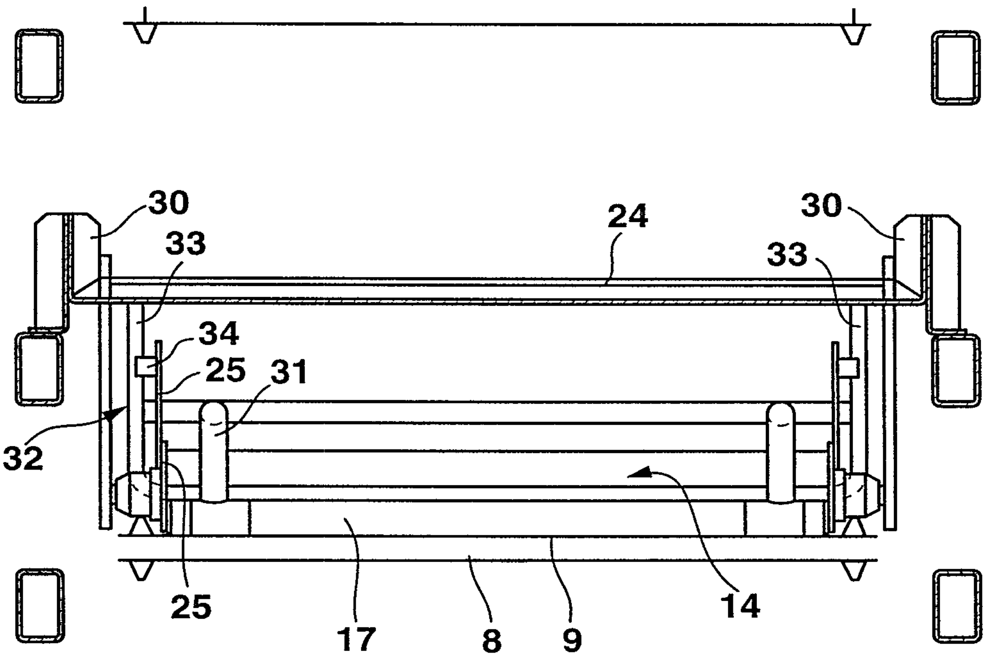

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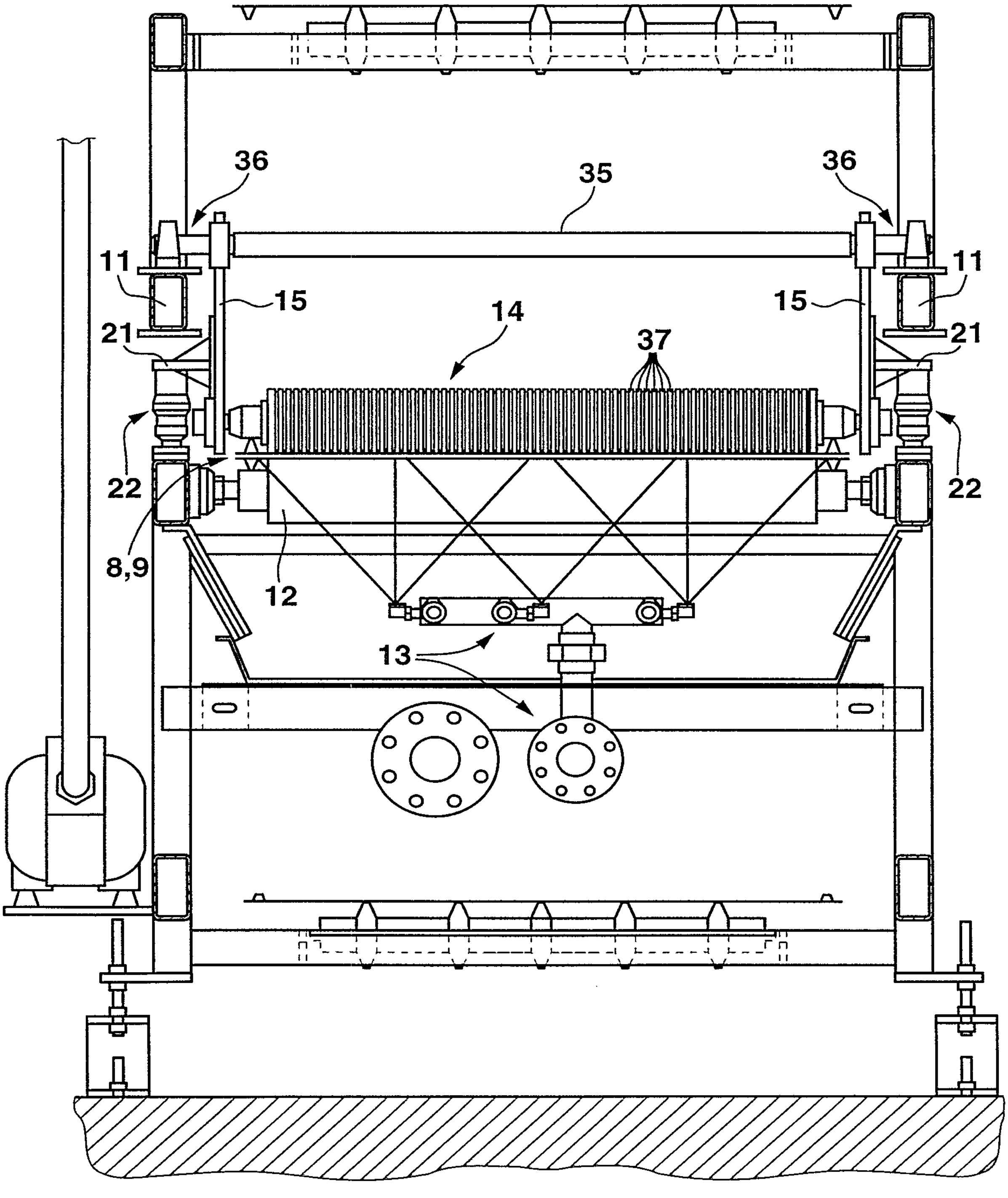
Fig. 7



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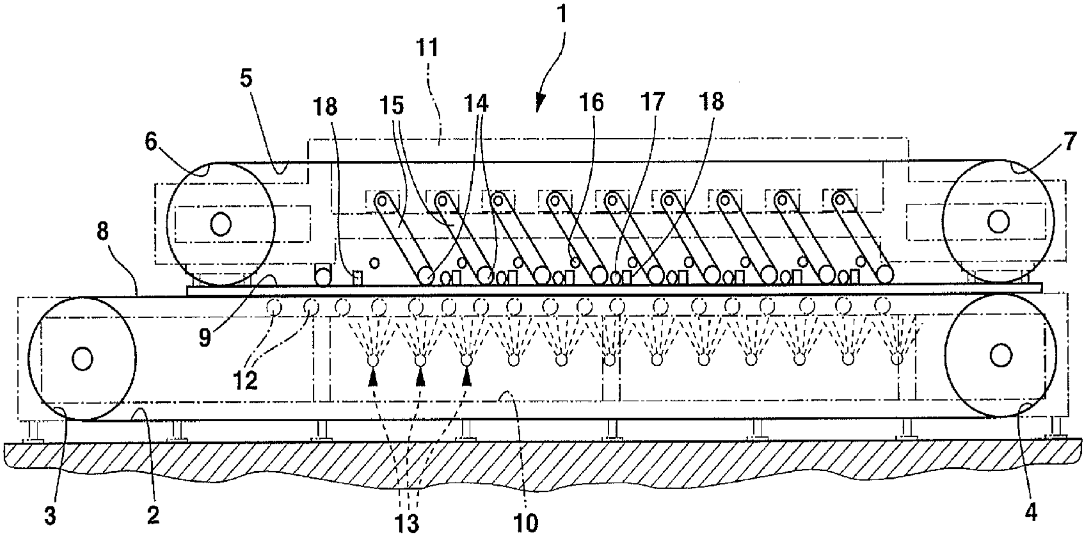
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