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(54) **Linear pressing machine for compacting powders**

(57) The purpose of the machine (10) is to compact powders (for example to form crude ceramic tiles) and comprises: a lower belt conveyor device (12) and an upper belt conveyor device (14), the operation of which is synchronized such that the facing branches (28, 30) and the distant branches of the relative belts (16, 22) move in the same direction and with the same horizontal velocity component, the lower conveyor device (12) having a greater upstream extension than that of the upper conveyor device (14); means (32) for depositing in the vicinity of the upstream end of the lower conveyor device

(12) a uniform layer (36) of powder of the required thickness; and powder retention means (42, 44). The facing branches (28, 30) of the two belts (16, 22) converge in their direction of advancement. The rollers (18, 20, 24, 26) of the conveyor devices (12, 14) and the relative supports are dimensioned to withstand the actions deriving from said convergence. The retention means (42, 44) are provided on each side of the conveyor devices (12, 14). The machine (10) exerts its maximum pressure along a line or band transverse to the direction of advancement.

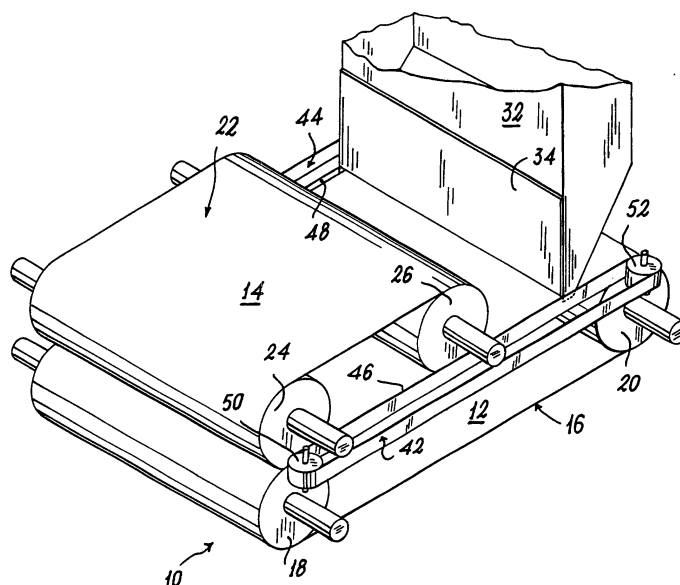


FIG. 1

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Description

[0001] The present invention relates to a machine for compacting powders, powder mixtures or other semi-agglomerated or agglomerated materials of various kinds which, at determined pressures, possibly in combination with specifically created environmental situations, have permanent or temporary aggregating power, and are used to form various laminar structures, for example crude ceramic tiles. The aforesaid materials to be compacted will be all known hereinafter for simplicity as "powders", it being understood that this term also includes all the other aforesaid materials.

[0002] As is well known to the expert of the art, the traditional presses for compacting powders all comprise: a containing box or cavity defining the plan shape of the tile to be obtained; a loading device for filling the cavity; two or more opposing pressing members, known as dies, divided into upper and lower (with respect to the cavity) and movable in the two vertical directions to entrap and compress the powders inserted into the cavity.

[0003] The product obtained by compacting the powders is released by moving the dies into a position which enables the crude tile formed in this manner to be extracted and then removed by moving the loading carriage, which performs this function in addition to again loading the cavity. In the meantime the dies return to their starting (loading) position, ready for a new cycle.

[0004] Traditional presses are provided with a heavy robust structure as they have to withstand the high resultant force equal to the specific pressure (force per unit of surface area) multiplied by the area of the surface to be pressed. The work rate achievable by such presses is limited by the fact that the pressing cycle is divided into several sequences involving movements obtained mechanically and hydraulically. The powder must also be able to be deaerated while being pressed, the air contained in the powder, especially in the most inner part of the pressed system, having to move as rapidly as possible (this in itself involving some difficulty as the compacting of the powder takes place simultaneously over the entire central and peripheral surface) towards the cavity periphery, where it can be expelled.

[0005] Moreover the fact that the powder is transported uncovered during various stages of the cycle (i.e. prior to pressing) means that suction devices have to be used at various points of the press.

[0006] Again, the noise and danger of traditional tile presses mean that these machines have to be provided with protection devices for operator safety, with their relative costs.

[0007] A new machine for pressing crude ceramic tiles has recently appeared on the market, comprising essentially not only a press provided with two opposing flat dies mutually movable in a vertical direction, but also two belt conveyor devices, one lower and the other upper. A branch of each of the two belts lies in front of the face of one of the two dies, the branches concerned (the

facing branches) of the two belts being parallel to each other. The two belt conveyor devices are operable in synchronism, the said branches moving in the same direction and at the same speed. The lower conveyor device extends further upstream than the upper conveyor device to enable a hopper, into which the powder is loaded, to cause a uniform layer of powder of the required thickness to fall onto it. This thickness is in any event less than the distance between the two said branches.

[0008] If the two conveyor devices are now operated for a predetermined time, a first portion of the powder layer deposited on the lower belt can be made to lie between the two said dies. At this point the press is operated, so that the two dies approach each other to press said first powder layer portion, this pressing taking place with the relative branches of the belts of the conveyor device interposed between each die and the powder.

[0009] On the surface of one of the two belts there are also provided lateral retention means consisting essentially of a series of elastic ridges projecting from the belt surface to basically define the plan shape of the tile.

[0010] When the two dies have been moved apart, the two conveyor devices are again operated to bring the next portion of yet to be pressed powder to the dies, the already pressed first portion, in the form of a crude tile, consequently moving downstream onto the lower belt, where a suitable conveyor device is provided to receive it.

[0011] By repeating this operation an indefinite number of times, an indefinite number of crude tiles can be produced, their plan dimensions being determined by the internal dimensions of said elastic retention ridges.

[0012] With the described machine it is possible, for example, to obtain tiles having plan dimensions of 270 x 90 cm and a thickness of 3 mm.

[0013] However, because of the considerable surface area of the dies of the relative press, such a result requires an enormous press, with the cost that this involves.

[0014] An object of the invention is to provide a powder compacting machine which uses considerably less energy than traditional presses and also than the aforesaid pressing machine.

[0015] Another object of the invention is to provide a powder compacting machine which is considerably more simple (and consequently less costly) and less bulky than the aforesaid pressing machine, while being able to produce tiles of at least the dimensions of those producible with this latter, and with at least the same (if not better) quality characteristics.

[0016] These objects are attained by the powder compacting machine of the present invention, comprising: a lower belt conveyor device and an upper belt conveyor device, the operation of which is synchronized such that the facing and distant branches of the relative belts move in the same direction and with the same horizontal velocity component, the lower conveyor device having

a greater upstream extension than that of the upper conveyor device; means for depositing in the vicinity of the upstream end of the lower conveyor device a uniform layer of powder of the required thickness; and lateral retention means; characterised in that:

- the facing branches of the two belts converge in their direction of advancement;
- the rollers of the conveyor devices and the relative supports are dimensioned to withstand the actions deriving from said convergence;
- the retention means (42, 44) are provided on each side of the conveyor devices (12, 14).

[0017] In the machine of the present invention presses are therefore not provided, this being a considerable advantage compared with the known pressing machine. In this respect, the pressing action is provided by the convergence of the facing branches of the belts of the two conveyor devices (of which the belts and rollers, and the relative supports, must be suitably dimensioned as stated). The machine of the invention is therefore considerably more simple and decidedly less bulky and less costly than traditional presses and also than the known pressing machine (precisely because of the elimination of the press).

[0018] If high powder compaction pressures are required to be obtained, counteracting means are conveniently provided disposed on the inside of each of the two belt conveyor devices, between one roller and the other, at least along the most downstream portion of each of the two facing branches of the relative belts. This avoids having to provide excessively robust belts (with the problems that this involves) and/or powder accumulators, due to excessive belt deformation which can occur particularly before the more downstream roller of the two belt conveyor devices.

[0019] The said counteracting means preferably comprise two substantially rigid plates positioned in contact with the relative belt branch and presenting uniformly distributed through perforations which communicate with a source of compressed air, to create between the counteracting plate and the belt a very thin air cushion which facilitates the sliding of the belt and prevents its wear by rubbing. Conveniently, the surface of the counteracting plates is formed of an anti-wear material.

[0020] The counteracting means can also be of another type, for example ball or roller slide tables, or simple plates coated with an anti-wear material.

[0021] Conveniently, the lateral retention means can consist of two bands mounted taut about relative pulleys, one for each side, one branch of each band lying in the vertical plane and grazing the relative edges of the belts of the upper and lower conveyor devices, the operation of the two lateral retention bands being synchronized with the operation of the belts.

[0022] In the case of high pressure, it is also convenient

to provide, for the lateral retention means, counteracting means of the type already specified for the belts of the upper and lower conveyor devices.

[0023] The invention will be more apparent from the ensuing description of one embodiment thereof. In this description reference is made to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of the machine of the present invention;

Figure 2 is a longitudinal vertical section there-through;

Figure 3 is a top plan view thereof; and

Figure 4 is an enlarged partial longitudinal vertical section through a variant of the machine of the invention.

[0024] From the figures it can be seen that the powder compacting machine 10 comprises a lower belt conveyor device, indicated overall by 12, and an upper belt conveyor device, indicated overall by 14. In this specific case, the lower conveyor device 12 comprises a flexible belt 16 mounted taut about two rotatable rollers 18 and 20, of which the downstream (or terminal) roller is motorized. The upper conveyor device 14 also comprises a flexible belt 22 mounted taut about two rotatable rollers 24 and 26, the downstream roller of which is motorized. The operation of the two conveyor devices 12 and 14 is synchronized such that the facing branches (the upper branch 28 of the lower belt 16 and the lower branch 30 of the upper belt 22) move in the same direction with the same horizontal velocity component.

[0025] From Figure 2 it can be seen that the branch 30 of the upper belt 22 is inclined to the branch 28 of the lower belt 16, the two branches 30 and 28 converging in the direction of advancement.

[0026] The machine 10 also comprises a hopper 32 loadable with powder (for example powder for forming ceramic tiles). The lower aperture of the hopper 32 has a width substantially equal to that of the belt 16 and is provided with an adjustment device which, when the conveyor devices 12 and 14 are operated, enables a uniform layer of powder of the required thickness to be formed on the upper branch 28 of the belt 16. This adjustment device comprises a shutter 34 movable vertically in the two directions. For obvious reasons (see Figure 2), the thickness of the powder layer must be less than or at most equal to the maximum distance (upstream) between the lower branch 30 of the upper belt 22 and the upper branch 28 of the lower belt 16.

[0027] To counteract the thrust which the powder layer 36 exerts on the branches 28 and 30, relative counteracting means indicated by 38 and 40 are provided. These latter consist in this specific case of relative rigid plates which make contact with the relative branch (28, 30), or at least the most downstream portion of this branch (as in Figure 2), and present uniformly distributed through perforations (shown for simplicity only in the

variant of Figure 4 and indicated by 41), which communicate (in a manner not represented in Figure 4, for simplicity) with a compressed air source (also not shown), in order to create between the counteracting plate 38, 40 and the relative belt portion a very thin air cushion which facilitates the sliding of the belt and prevents its wear by rubbing. In this specific case, the counteracting plates are coated with an antifriction material, for example the sintered material known by the name of FRIMET and produced by BSA of Milan.

[0028] As can be seen from Figures 1 and 3, the machine 10 is completed by lateral retention means consisting in this specific case of two bands 42 and 44, one per side, mounted about relative pulleys 50, 52, 54, 56, one of which may be motorized. The more inner branch, 46 and 48 respectively, of each band grazes the relative edges of the belts 16 and 22, to hence prevent lateral escape of the powder and at the same time define the width of the compacted powder laminar structure produced by the machine 10. The movement of the lateral bands 42, 44 is synchronized with that of the belts 16 and 22 (if both the pulleys of each band are idle, the synchronization takes place by dragging) so that there is no relative movement between the bands and the corresponding edges of the belts 16 and 22.

[0029] Lateral retention means different from those just described could however be used, and in particular retention means consisting of two longitudinal elastic ribs applied along each side of the lower belt 16.

[0030] As already stated, counteracting means (not shown for simplicity) can also be provided on the inside of the lateral bands 42 and 44 to prevent, in the case of high working pressures of the machine 10, any outward deformation of the inner branches of the bands 42 and 44. This deformation can cause significant lateral loss of powder or even damaging displacements thereof. These lateral counteracting means can be of the same type as those already described in relation to the counteracting means 38 and 40 of the lower and upper conveyor devices 12 and 14.

[0031] From the foregoing it will be apparent that in the machine of the invention the maximum pressing action (in contrast to known machines in which this action occurs simultaneously over the entire surface of the pressed system) is essentially exerted along a line or a narrow band extending transversely to the direction of advancement.

[0032] According to one embodiment of the invention, to prevent any damaging movements within the pressed powder on its exit from the downstream pair of rollers 18, 24, the counteracting means 38 and 40 take a rectilinear parallel path along their final downstream portion (indicated by A in Figure 4), with their distance apart substantially equal to the distance between the surfaces of the two most downstream rollers 18, 24. The maximum compaction pressure occurs along the portion A.

[0033] Means are provided at the supports for the rollers 24 and 26 of the conveyor device 14 for adjusting

their position. It has been found very useful to provide means for fine adjustment both in a horizontal and in a vertical direction. These adjustment means can in particular comprise a bush (not shown), the inner cylindrical aperture of which is eccentric to its outer cylindrical surface. An end pin of the relative roller 24, 26 is inserted into the inner aperture of the eccentric bush, this latter being in its turn rotatably supported by a normal support bush carried by the structure of the machine 10. Means are also provided for rotating the eccentric bush with respect to the support bush, this enabling optimum fine adjustment of the relative pin to be obtained both in a horizontal and a vertical direction.

[0034] It should be noted that the belts 16, 22 and the bands 42, 44 can have a non-smooth surface, for example provided with reliefs or ribs (so-called texturing).

[0035] The operation of the machine 10 is totally apparent from the foregoing.

[0036] It is however important to note that, in contrast to the aforescribed known pressing machine in which the belts of the two conveyor devices have an intermittent movement, in the case of the machine 10 both the belts 16 and 22 and the bands 42 and 44 are operated continuously, this enabling a decidedly higher production rate to be achieved than the traditional tile presses and the known pressing machine.

[0037] Downstream of the machine 10 there emerges a continuous strip, in the manner of a rolled strip, of compacted powder having a width equal to that of the belts 16 and 22. This (crude) strip deposits on a suitable conventional conveyor device (not shown, for example of the band type) positioned downstream of the machine 10, which removes the strip and conveys it to a cutting station in which the strip is divided into portions (in particular to form crude tiles) of the required length. It will be apparent that the maximum length of these portions (theoretically infinite) is in practice influenced by the need for their handling (without their breaking) imposed by the subsequent processing and/or transport of the finished product.

[0038] It should also be noted that with the machine of the present invention, there is very little movement of uncovered powder, resulting in reduced environmental impact and a lesser need for expedients for the protection of operator health, with all the evident advantages which this brings.

[0039] In addition, the said convergence of the belt branches of the conveyor devices facilitates deaeration of the powder during its compacting. In this respect the air between the powder particles always finds an exit path in the opposite direction to the direction of advancement towards downstream), where the powder is less compact.

[0040] Because of the fact that no moving pressing dies are provided and that the only part of the machine that can represent a danger to the operator is that where the powder layer 36 enters between the two conveyor devices 12 and 14 (i.e. the region between the hopper

32 and the roller 26, the hopper 32 also acting as a protection device), this machine is much less dangerous for the operator than traditional presses.

Claims

1. A powder compacting machine (10) for forming crude ceramic tiles, comprising: a lower belt conveyor device (12) and an upper belt conveyor device (14), the operation of which is synchronized such that the facing and distant branches (28, 30) of the relative belts (16, 22) move in the same direction and with the same horizontal velocity component, the lower conveyor device (12) having a greater upstream extension than that of the upper conveyor device (14); means (32) for depositing in the vicinity of the upstream end of the lower conveyor device (12) a uniform layer (36) of powder of the required thickness; and lateral retention means (42, 44);

characterised in that:

- the facing branches (28, 30) of the two belts (16, 22) converge in their direction of advancement;
 - the rollers (18, 20, 24, 26) of the conveyor devices (12, 14) and the relative supports are dimensioned to withstand the actions deriving from said convergence;
 - the retention means (42, 44) are provided on each side of the conveyor devices (12, 14).
2. A machine (10) as claimed in claim 1, wherein if high powder compaction pressures are required to be obtained, counteracting means (38, 40) are provided disposed on the inside of each of the two belt conveyor devices (12, 14), between one roller (18, 24) and the other (20, 26), at least along the most downstream portion of each of the two facing branches (28, 30) of the belts (16, 22).
 3. A machine (10) as claimed in claim 2, wherein the counteracting means comprise substantially rigid plates (38, 40) positioned in contact with the relative branch (28, 30) of the belt (16, 22), and presenting uniformly distributed through perforations which communicate with a source of compressed air, to create between the counteracting plate and the belt a very thin air cushion.
 4. A machine (10) as claimed in claim 3, wherein the surface of the counteracting plates (38, 40) is formed of an anti-wear material.
 5. A machine as claimed in claim 2, wherein the counteracting means comprise ball or roller slide tables.
 6. A machine (10) as claimed in claim 1, wherein the lateral retention means consist of two bands (42, 44) mounted taut about relative pulleys (50, 52, 54, 56), one for each side, one branch (46, 48) of each band (42, 44) lying in the vertical plane and grazing the relative edges of the belts (16, 22) of the upper and lower conveyor devices (12, 14), the operation of the two lateral retention bands (42, 44) being synchronized with that of the belts (16, 22).
 7. A machine (10) as claimed in claim 6, wherein in the case of high powder compaction pressures, lateral counteracting means are provided disposed on the inside of each of the two lateral bands (42, 44), between one pulley (50, 54) and the other (52, 56), at least along the most downstream portion of each of the two inner branches (46, 48) of the two bands (42, 44).
 8. A machine (10) as claimed in claim 7, wherein the lateral retention means are of the same type as the counteracting means provided for the belts (16, 22) of the upper (12) and lower (14) conveyor devices.
 9. A machine (10) as claimed in claim 1, wherein adjustment means are provided at the supports for the rollers (24, 26) of the upper conveyor device (14) for adjusting their position.
 10. A machine as claimed in claim 9, wherein the adjustment means allow fine adjustment.
 11. A machine as claimed in claim 10, wherein the adjustment means comprise a bush, the inner aperture of which is eccentric to its outer cylindrical surface, an end pin of the corresponding roller (24, 26) being inserted into the inner aperture of the bush, this latter being in its turn rotatably supported by a second eccentric bush carried by the structure of the machine (10), means also being provided for rotating the eccentric bush with respect to the pin of the roller (24, 26).
 12. A machine (10) as claimed in claim 1, wherein the belts (16, 22) and/or the bands (42, 44) have a surface provided with reliefs or ribs (textured).
 13. A machine (10) as claimed in claim 12, wherein the surface of the belts (16, 22) and/or of the bands (42, 44) is of a non-stick and/or antiwear material.
 14. A machine (10) as claimed in claim 1, wherein the counteracting means (38, 40) are rectilinear and parallel along their final downstream portion (A), within this portion (A) the distance between the counteracting means being substantially equal to the distance between the surfaces of the most downstream rollers (18, 24).

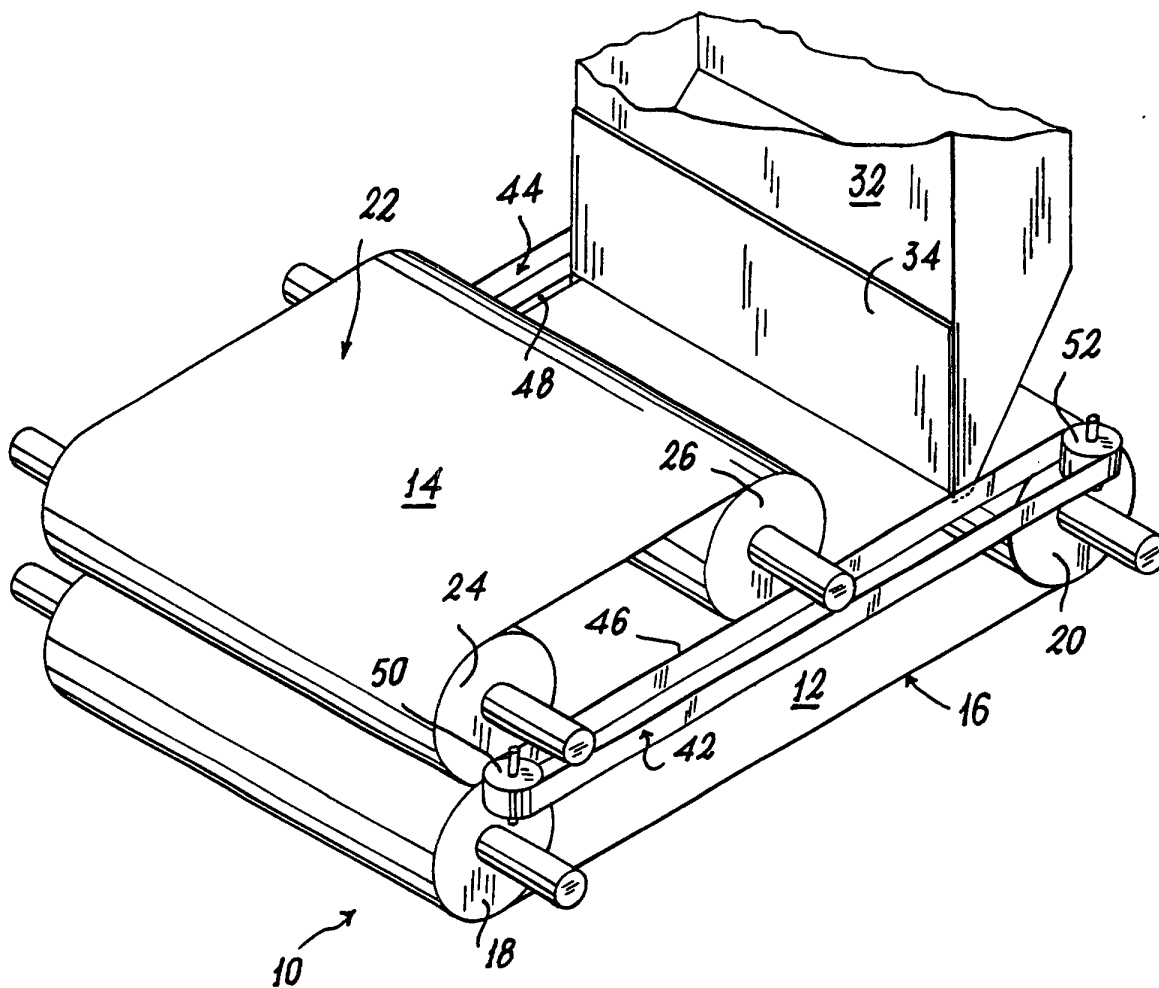
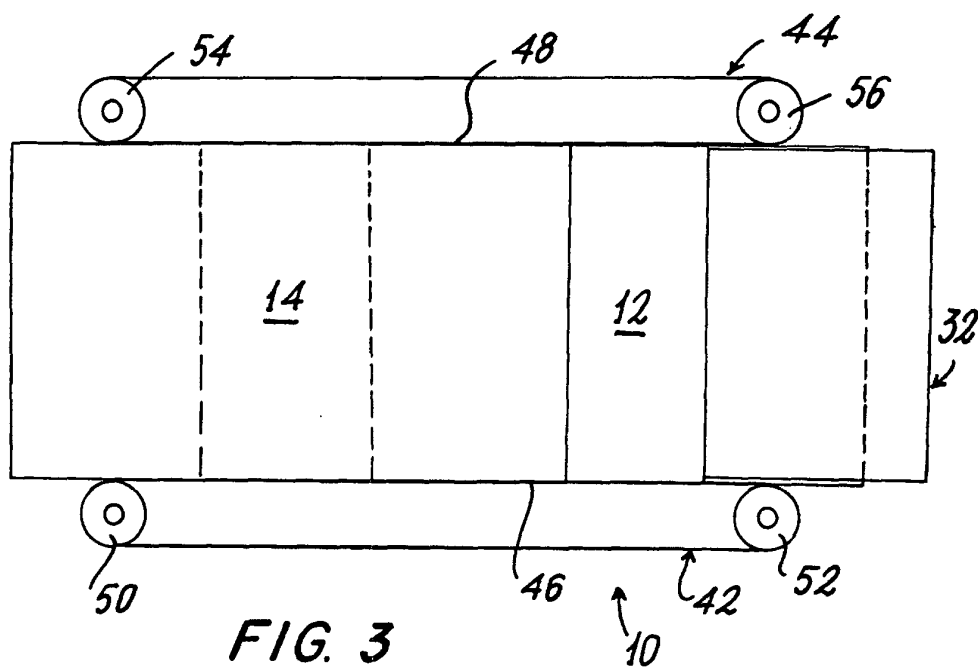
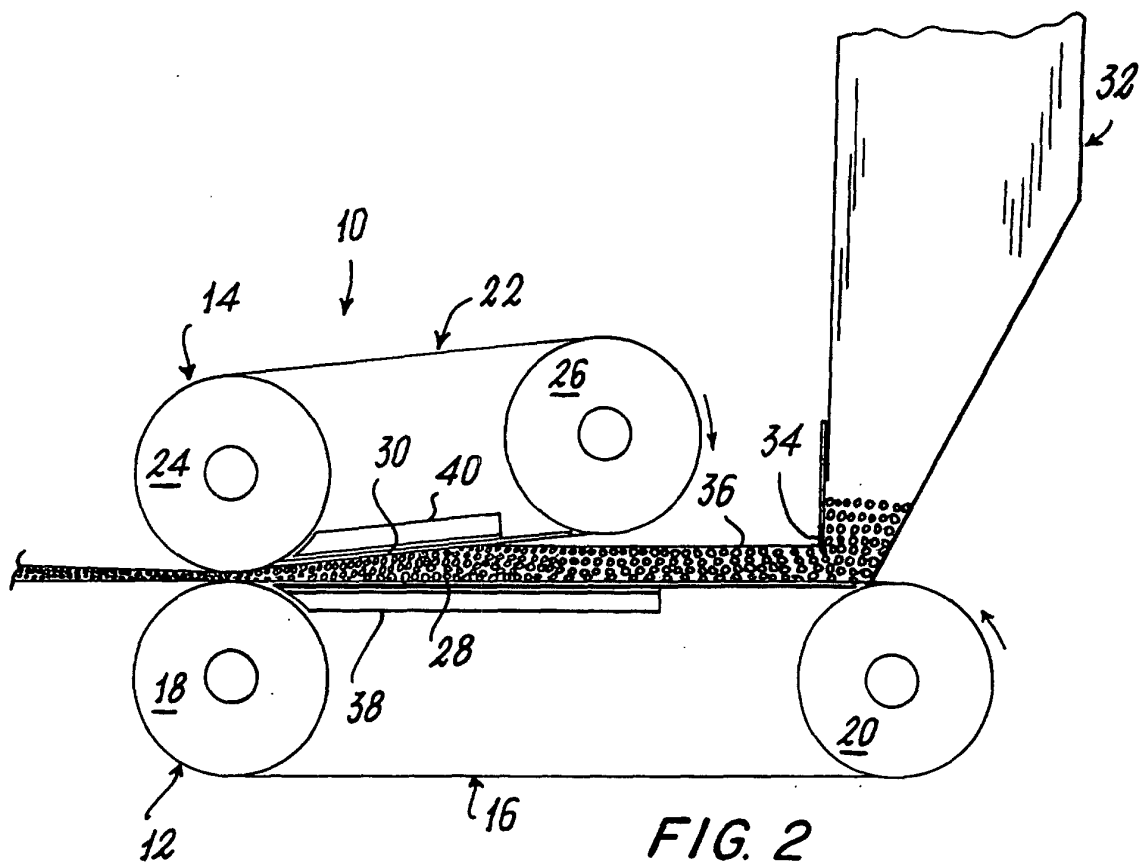


FIG. 1



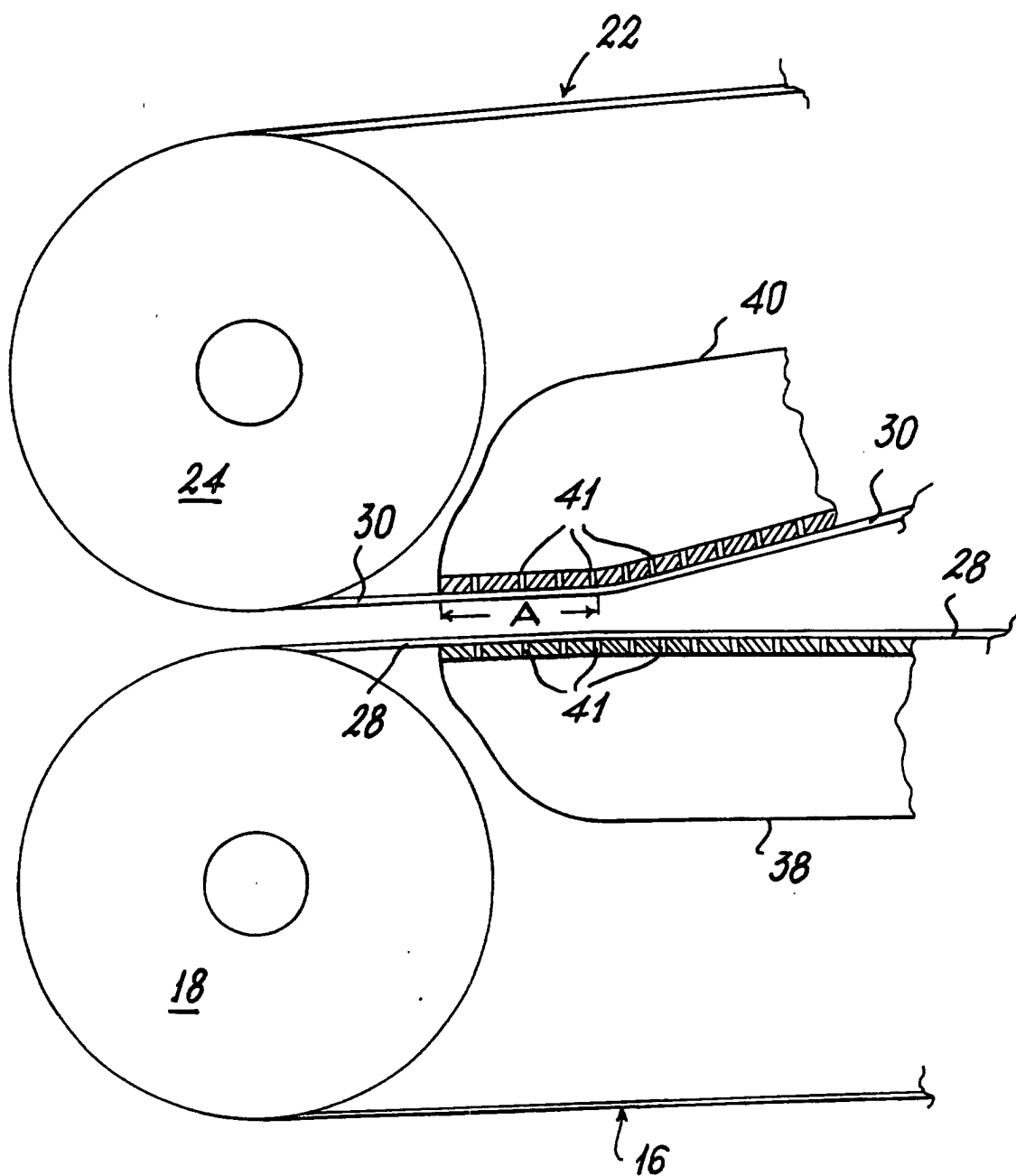


FIG. 4