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(54) **MACHINE FOR OPTIMIZED CUTTING OF SLABS IN STONE OR LITHOID MATERIAL**

MASCHINE ZUM OPTIMIERTEN SCHNEIDEN VON PLATTEN AUS STEIN ODER
LITHOIDMATERIAL

MACHINE DE DECOUPE OPTIMISEE DE DALLES EN PIERRE OU MATERIAU LITHOIDE

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Description

[0001] The present invention relates to the optimized cutting of slabs of stone or stone-like material and more specifically to a machine as per the preamble of claim 1 for performing this operation. Such a machine is known from DE 101 09 007 A1.

[0002] It is known that from the sawing of blocks of stone material it is possible to obtain rough slabs, in particular with a jagged and irregular edge and often with defects such as marks or cracks. For some applications the slabs are processed superficially and then converted into tiles, skirting or the like (referred to below as "tiles"), which are substantially rectangular, by a plurality of successive cuts performed perpendicularly along two main directions.

[0003] Obviously from each slab it is desirable to obtain the maximum possible number of tiles, thereby reducing as far as possible the waste and excess material.

[0004] For many years it has been (and still continues to be) common practice to use cutting machines with one or more spindles able to perform simultaneously a predetermined number of cuts both in the longitudinal direction and in the transverse direction.

[0005] In a particular type of machine the spindles supporting the cutting tools (preferably in the form of disks with diamond-particle segments) were mounted slidably on a bridge arranged perpendicularly with respect to the direction of entry of the slabs, the axis of rotation of the disks being parallel to the beam. The tools were able to be moved and positioned simultaneously and independently of each other, with the only obvious constraint of the dimensions of each supporting spindle.

[0006] In this type of machine, underneath the bridge on which the spindles are mounted, a slab support surface or bench was provided which is rotatable about its vertical axis, thus allowing rotation of the slab resting on the bench depending on the direction of the cuts to be made.

[0007] An optical reading device arranged at the feeding side of the machine, was connected to the computer controlling the machine and able to detect both the contour of the rough slabs and any surface defects thereon.

[0008] Depending on the recording performed by the reading device the rough slab was able to be divided up into two or more quadrants, for each of which a specific cutting procedure is defined so to ensure an optimum utilization of the slab portion contained in the said quadrant, with the possibility of performing a different cutting procedure from each quadrant.

[0009] During machining of each quadrant the cut was interrupted along the edges of each quadrant and then resumed, after positioning of the spindles, once the next quadrant had been passed to.

[0010] Despite these provisions there inevitably continued to exist a waste of material essentially corresponding to the slab portion which is comprised between the edges of adjacent quadrants and is cut by the disks when

leaving the material.

[0011] The elimination of, or at least the reduction of, said waste appears to be possible if the cut along the rough slab is performed in such a way that each cutting pass extends from one edge to the opposite edge, initially along the whole slab and then along the slab portions, resulting from the initial cutting passes.

[0012] For example, it is possible to proceed by dividing up the rough starting slab through the initial cutting pass into longitudinal strips ("longitudinal" is understood as meaning normally the direction parallel to the larger dimension of the slab and "transverse" as the direction parallel to the smaller dimension), obviously discarding as waste the end lateral zones of an irregular contour, which are referred to as longitudinal trimmings.

[0013] Then the bench is rotated through 90° and the longitudinal strips are in turn individually cut into tiles, which may have dimensions different from each other, so as to optimize the utilization of the slab, eliminating obviously as waste the extreme end zones with an irregular contour, referred to as transverse trimmings. It is also possible to start with cutting the slab into transverse strips and then reduce them into tiles.

[0014] Obviously, the non-automated execution of such a cycle involves considerable industrial costs both in terms of manpower, of working time and downtime between successive machining steps, requiring repeated handling and repositioning of the material on the cutting bench.

[0015] Italian patent No. 1 247 367 (corresponding to DE-A-4 206 274) discloses an apparatus consisting of a single-block unit for automatically cutting slabs of stone material, the apparatus being able to perform automatically both sensing of the profile and any surface defects of the rough slab, as well as optimization of the cutting operations into tiles and strips, using, however, one or two spindles supporting a cutting tool. The spindles are arranged in the apparatus on the basis of two coordinates in order to perform the single cutting passes.

[0016] More recently a machine for improved cutting of slabs through rotary tools (disks) has been developed, said machine comprising a station for a computerized detection of the profile and the surface condition of the rough slab and also comprising conveyor means for moving the slab, once examined by the said station, to a cutting station along a feeding direction.

[0017] The cutting station comprises a bench rotatable about a vertical which is positioned underneath the group of vertical spindles, each of which supports a cutting tool acting in a vertical plane and has the possibility of being positioned independently with respect to the other cutting tools.

[0018] The spindles are mounted on a support beam movable in a direction parallel to said feeding direction of the slab so that the axes of rotation of the cutting disks are parallel to the beam. The spindles are also mounted so that both their position and their relative distance may be adjusted

[0019] When the rough slab lying on the bench has been cut into a plurality of strips (for example parallel to the feeding direction), the strips are placed again on the roller surface situated upstream and means for partially intercepting the strips are activated so that only one or more selected strips are subsequently repositioned on the bench, the bench being rotated about its vertical axis.

[0020] The beam on which the spindles are mounted, and consequently the cutting tools in the suitable arrangement, is actuated so as to cut through a plurality of passes in a direction perpendicular to the previous direction the strip or strips lying on the bench, so that the said strip or strips are divided up into tiles.

[0021] Once this step has been completed, after rotating the bench through 90°, the tiles are discharged, downstream of the bench, and operation with the other strips still present on the conveyor belt is resumed.

[0022] The intercepting means consist substantially of a transversely movable bar able to clamp the front end of the strips to be retained on the conveyor belt.

[0023] Preferably, means for compaction of the strips which are intercepted also cooperate with the intercepting means.

[0024] This machine obviously has represented a step forward compared to previous machines, but it would obviously be advantageous from an industrial point of view to simplify its operation and increase its output.

[0025] The present invention achieves precisely these objects and proposes a machine for cutting rough slabs, comprising the combination of features of claim 1.

[0026] Preferred embodiments of the present invention are disclosed by the dependent claims.

[0027] In a preferred embodiment of the present invention, said handling means comprise a support provided with a plurality of suction cups connected to a vacuum source, said support being attached to a second beam through driving means so as to vertically displace the suction cups, the said second beam being arranged movably on the said supporting means parallel to the first beam either independently from or integrally with the said first beam

[0028] In a preferred embodiment of the invention an auxiliary bench is also provided for temporarily storing the strips removed from said primary bench and the said handling means ensure the transfer of the strips from the primary to the auxiliary bench and vice versa.

[0029] As will appear more clearly from the following detailed description of a preferred but not exclusive embodiment illustrated in the accompanying drawings, the present invention fully achieves the above mentioned objects. In particular, the machine has an increased productivity and can be fit into a complete line for processing rough slabs, in particular the slabs leaving a polishing machine.

[0030] In the drawings:

- Fig. 1 is a plan view of the machine according to the present invention;

- Fig. 2 is a more detailed plan view of the machine according to Fig. 1;
- Fig. 3 is a partially sectioned front view of the machine according to Fig. 1 and 2;
- Figs. 4-9, similar to Fig. 2, are views showing the various steps of a processing cycle performed by a machine according to the invention.

[0031] With reference firstly to Fig. 1, the machine comprises a feeding section A, a cutting section B and a discharge section C.

[0032] In the feeding section A, conveyor means such as a motor-driven rollerway 12 are associated with a device 14 known per se for detecting the contour and any surface defects of the rough slabs 16 which are fed and then moved forwards in the direction indicated by the arrow F.

[0033] In turn, the discharge section C comprises a conveyor belt 18 which is movable on wheels (not shown) so as to be able to be positioned next to the rotatable primary bench and to receive from the cutting section B the cut tiles 20 together with any trimmings and direct them for storage or further finishing operations. Smaller belts may be envisaged in cascade with the conveyors 34 and 18 for collecting and conveying the trimmings (i.e. the waste of the cutting operations) into suitable bins.

[0034] Let us now consider more in detail the cutting section B of the machine with reference to Fig. 2 and 3 where is shown a frame having two lateral travelways 24 and 26 on which a first beam 28 is mounted.

[0035] A plurality of spindles (seven in number as shown in the illustration of Fig. 2) generally designated by the reference numeral 30 are mounted on the first beam 28. The spindles 30 are not described in further detail since they are well-known in the technology of the field.

[0036] Each of the spindles 30, which are displaceable vertically, supports a cutting tool in the form of a rotary disk 32, for example of the type comprising diamond particles. Each disk 32, having an axis parallel to the beam 28 is rotatably driven by motor means (not shown).

[0037] The spindles 30 are displaceable along the first beam 28 so as to assume desired positions in which they are fixed to the beam in order to perform the cutting passes.

[0038] As it will be understood, the distance between two adjacent spindles 30, and consequently between two cutting disks 32, defines the width of the slab strips and of the resulting tiles, respectively (when one or more strips are cut into tiles).

[0039] Through other motor means, also not shown, the first beam 28 is movable along the travelways 24 and 26 so that it performs alternate displacements in the direction of the double arrow F1, as shown in Fig. 2.

[0040] A cutting surface or primary bench 34 is positioned in the zone delimited by the travelways 24 and 26, underneath the first beam 28 and the bottom ends of the cutting disks 32, said primary bench being preferably in

the form of a conveyor belt made of multiple layers, the upper one of which is made of rubber or a similar material with a thickness of 5 ÷ 8 mm, able to absorb the action of the cutting disks at the end of the cutting action through the thickness of the slab.

[0041] The bench 34 is mounted on a base 36 - shown in broken lines in Fig. 2 - which is in turn rotatable about a vertical axis.

[0042] Parallel to the first beam 28, the two travelways 24, 26 support a second beam 38 so that it is also movable in the direction of the arrow F1. A support 40, from the bottom surface of which a plurality of suction cups 42 project, is attached to the second beam 38, said suction cups being arranged in one or more rows and connected in a manner known per se to a vacuum source which can be activated on demand when the support 40 has to handle (namely to grip, raise, lower, transfer) a strip obtained from the starting slab.

[0043] To this end the support 40 is attached to the second beam 38 by means of two vertical guides with two actuators of the cylinder and piston type which are generally designated by the reference numeral 39, the cylinder thereof being fixed to the beam 38 while the free end of the piston rod is fixed to the support 40.

[0044] Finally, from Fig. 1 it can be seen that, parallel to the bench 34, the machine is provided with an auxiliary bench 44 which is positioned opposite and below the second beam 38, this beam being in this manner able to handle and displace the strips between the primary bench 34 and the auxiliary bench 44.

[0045] In the present embodiment, the second beam 38 has a driving system separate from that of the first beam 28 so as to be displaceable along the travelways 24, 26. Alternatively the second beam 38 may be attached to the first beam 28 and moved integrally therewith by the drive system ensuring the displacement of the first beam.

[0046] An operating cycle of the machine according to the invention will now be described with reference to Fig. 4 to 9.

[0047] Fig. 4 shows a slab 16 which is transferred from the section A onto the primary bench 34 in the section B by means of the motor-driven rollerway 12.

[0048] The primary bench 34 is then rotated through +90° so that the slab 16 assumes the configuration shown in Fig. 5. In the meantime the spindles 30 have been positioned so as to obtain a plurality of strips (designated by the reference numbers 46a-f) from the cutting of the slab 16. Obviously the strips can be obtained from a plurality of passes of the cutting disks 30.

[0049] It should be noted that, if necessary (even though quite often the slab 16 is a rough slab having irregular edges) the side edges (namely the longitudinal edges of the slab 16) are also ground during the cutting operation. In this manner slivers which are referred to as longitudinal trimmings and as narrow as possible - depending on the edge irregularities of the slab - are eliminated as waste.

[0050] In this condition the primary bench 34 on which lies the slab is rotated through -90°, i.e. is brought back into the starting position, so that the strips 46(a-f) obtained from cutting the slab are arranged parallel to the first beam 28 on which the spindles 30 are mounted, as shown in Fig. 6.

[0051] In this condition, the second beam 38 is also displaced so that the support 40 carrying the suction cups 42 is positioned on the strips 46(a-f) to be transferred onto the auxiliary bench 44.

[0052] In each movement the support 40 is displaced together with the second beam 38 until the suction cups 42 are in vertical alignment with the desired strip or strips. The actuators 39 are then driven to cause a downward movement of the support 40 until the suction cups 42 engage with the upper surface of the said strip or strips.

[0053] In this condition, the vacuum pump is energized so that the suction cups 42 grip firmly the strip or strips. The actuators 39 are then driven and the strip or strips are lifted from the primary bench 34 and the second beam 38 is displaced so as to bring the removed strip into a selected zone of the auxiliary bench 44.

[0054] The actuators 39 are lowered again and, when the strip or strips rest on the bench 44, the vacuum is released so that the strip or strips are disengaged from the suction cups.

[0055] The operation is repeated as many times as required so that at the end there is one or more strips left on the primary bench 34 after the other strips have been transferred onto the auxiliary bench 44. It is also possible displacing, if necessary, a single strip onto the auxiliary bench 44 and spacing from each other the strips left on the primary bench 34.

[0056] This condition is shown in Fig. 7. As already mentioned, in the case of rough slabs having irregular edges, after cutting into strips thin longitudinal trimmings are also present on the primary bench 34 and are discharged separately therefrom, if necessary after being cut into short pieces.

[0057] In this condition, after adjusting the relative positions of the spindles 30 along the first beam 28 and after lowering the spindles 30 so that the cutting disks 32 come into contact with the upper surface of the strips present on the said bench, the first beam is displaced along the travel ways 24, 26. In this manner the strips are cut in the transverse direction so as to obtain a plurality of tiles or the like 48, as shown in Fig. 8.

[0058] If, as already mentioned, the primary bench 34 is in the form of a conveyor belt, actuation thereof causes discharging of the tiles 48 onto the conveyor belt 18 of the section C which in the meantime has moved up toward the said bench. The thin transverse trimmings at the ends of the strips fall into the gap between the primary bench 34 and the conveyor belt 18 and are either collected in a bin or removed by a conveyor (not shown) dedicated to the waste.

[0059] Once cutting of the strips positioned on the bench 34 has been completed and the tiles 48 with any

trimmings have been removed, the suction-cup support 40 picks up and transfers the strips from the auxiliary bench 44 back onto the primary bench 34. Obviously the transfer may involve a single strip or more or even all of the strips.

[0060] At the end of this step, the machine is in the condition shown in Fig. 9 and the transverse cutting of the strips is performed as already described above, followed by discharging of the resultant tiles and removal of the corresponding transverse trimmings.

[0061] Compared to the above described preferred embodiment, several constructional variants are possible and may be envisaged within definition of the present invention provided in the appended claims.

[0062] In addition to the already mentioned possibility of attaching the second beam 38 to the first beam 28 on which the spindles 30 are mounted, the auxiliary bench 44 can be movably mounted so as to be displaceable towards and away from the primary bench 34 so as to reduce the path of the strips with the suction-cup support 40 and the second beam 38 and consequently shorten the duration of the machining cycles.

[0063] Furthermore, instead of the auxiliary bench 44, if there is a sufficient room availability, it is also possible to use a primary bench 34 which is sufficiently wide, i.e. transversally large, so as the strips are allowed to be spaced from each other without the transverse cutting passes performed on one of strip interferes with the adjacent strip.

[0064] It is understood that, the construction of the specific components of the machine, which in some cases here above have not been described in detail, is of a well known type in the field of the invention or in any case within the grasp of a person skilled in the art.

Claims

1. Machine for cutting rough slabs, comprising:

- a primary bench (34), which is rotatable about a vertical axis and in the rest position aligned upstream with means (12) for feeding rough slabs to be cut (16) and downstream with means (18) for discharging the products obtained from cutting operations;
- a set of spindles (30), each of which supports a tool in the form of a disk (32) able to perform the cuttings in a fixed cutting direction;
- a first beam (28) on which the spindles (30) are mounted in individually adjustable arrangements so that the axis of rotation of the cutting disks (32) is parallel to the beam (28), said first beam being mounted on movable supporting means (24, 26) so as to perform displacements where the spindles (30) and the associated cutting disks (32) pass across said primary bench (34);

- handling means (40, 42) for transferring products (46a-f) obtained from the cutting performed on the slabs (16),

the machine being **characterized in that** said movable supporting means (24, 26) are so arranged that said first beam (28) is parallel to the direction (F) along which the rough slabs (16) are fed to said primary bench (34).

2. Machine for cutting rough slabs according to Claim 1, **characterized in that** said handling means comprise a support (40) provided with a plurality of suction cups (42) connected to a vacuum source, said support (40) being attached to a second beam (38) through driving means (39) so as to vertically displace the suction cups (42), the said second beam (38) being arranged movably on the said supporting means (24, 26) parallel to the first beam (28) either independently from or integrally with the said first beam.

3. Machine for cutting rough slabs according to Claim 1, **characterized in that** it also comprises an auxiliary bench (44) for temporarily storing strips (46a-f) removed from said primary bench (34) and said handling means (40, 42) perform transfer of the said strips from the primary bench (34) to the auxiliary bench (44) and vice versa.

4. Machine for cutting rough slabs according to Claim 2, **characterized in that** said supporting means consist of a frame with two parallel travelways (24, 26) on which said first and second beam (28, 38) are slidably mounted.

5. Machine for cutting rough slabs according to Claim 2, **characterized in that** said second beam (38) supporting said handling means (40, 42) is movable independently of the first beam (28) on which the spindles (30) are mounted.

6. Machine for cutting rough slabs according to Claim 3, **characterized in that** said auxiliary bench (44) is movably mounted with respect to the primary bench (34).

Patentansprüche

1. Maschine zum Schneiden von groben Fliesen, mit:

- einer Hauptbank (34), die um eine vertikale Achse drehbar ist und in der Ruheposition stromaufwärts mit einer Einrichtung (12) zum Verschieben von zu schneidenden, groben Fliesen (16) und stromabwärts mit einer Einrichtung (18) zum Abgeben der durch die Schneidvorgänge erhaltenen Produkte ausgerichtet ist;

- einem Satz von Spindeln (30), die jeweils ein Werkzeug in Gestalt einer Scheibe (32) stützen, die das Schneiden in einer festen Schneidrichtung durchführen kann;
 - einem ersten Träger (28), an dem die Spindeln (30) in individuell einstellbaren Anordnungen so angebracht sind, dass die Drehachse der Schneidscheiben (32) parallel zu dem Träger (28) ist, wobei der erste Träger an einer bewegbaren Stützeinrichtung (24, 26) angebracht ist, um Verschiebungen durchzuführen, bei denen die Spindeln (30) und die dazugehörigen Schneidscheiben (32) die Hauptbank (34) quer passieren;
 - einer Handhabungseinrichtung (40, 42) zum Transportieren der Produkte (46a-f), die durch das bei den Fliesen (16) durchgeführten Schneiden erhalten werden, die Maschine ist **dadurch gekennzeichnet, dass** die bewegbare Stützeinrichtung (24, 26) so angeordnet ist, dass der erste Träger (28) parallel zu jener Richtung (F) ist, entlang der die groben Fliesen (16) zu der Hauptbank (34) vorgeschoben werden.
2. Maschine zum Schneiden von groben Fliesen gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Handhabungseinrichtung eine Stütze (40) aufweist, die mit einer Vielzahl von Saugnäpfen (42) versehen ist, die mit einer Unterdruckquelle verbunden sind, wobei die Stütze (40) an einem zweiten Träger (38) durch eine Antriebseinrichtung (39) angebracht ist, um so die Saugnäpfe (42) vertikal zu verschieben, wobei der zweite Träger (38) an der Stützeinrichtung (24, 26) parallel zu dem ersten Träger (28) entweder unabhängig von oder einstückig mit dem ersten Träger bewegbar angeordnet ist.
 3. Maschine zum Schneiden von groben Fliesen gemäß Anspruch 1, **dadurch gekennzeichnet, dass** sie eine Hilfsbank (44) zum vorübergehenden Aufnehmen von Streifen (46a-f) aufweist, die von der Hauptbank (34) entnommen werden, und wobei die Handhabungseinrichtung (40, 42) den Transport der Streifen von der Hauptbank (34) zu der Hilfsbank (44) und umgekehrt bewirkt.
 4. Maschine zum Schneiden von groben Fliesen gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Stützeinrichtung aus einem Rahmen mit zwei parallelen Fahrtwegen (24, 26) besteht, an denen der erste und der zweite Träger (28, 38) gleitbar angebracht sind.
 5. Maschine zum Schneiden von groben Fliesen gemäß Anspruch 2, **dadurch gekennzeichnet, dass** der zweite Träger (38), der die Handhabungseinrichtung (40, 42) stützt, unabhängig von dem ersten Trä-

ger (28) bewegbar ist, an dem die Spindeln (30) angebracht sind.

6. Maschine zum Schneiden von groben Fliesen gemäß Anspruch 3, **dadurch gekennzeichnet, dass** die Hilfsbank (44) hinsichtlich der Hauptbank (34) bewegbar angebracht ist.

10 Revendications

1. Machine pour couper des dalles brutes, comprenant :

un plan de coupe principal (34) qui peut tourner autour d'un axe vertical et dans la position de repos, aligné en amont avec des moyens (12) pour alimenter les dalles brutes à couper (16) et en aval avec des moyens (18) pour décharger les produits obtenus par des opérations de coupe ;

un ensemble de mandrins (30), dont chacun supporte un outil se présentant sous la forme d'un disque (32) pouvant réaliser les coupes dans une direction de coupe fixe ;

une première poutre (28) sur laquelle les mandrins (30) sont montés dans des agencements individuellement ajustables de sorte que l'axe de rotation des disques de coupe (32) est parallèle à la poutre (28), ladite première poutre étant montée sur des moyens de support mobile (24, 26) afin de réaliser des déplacements où les mandrins (30) et les disques de coupe (32) associés traversent ledit plan de coupe principal (34) ;

des moyens de manipulation (40, 42) pour transférer des produits (46a - f) obtenus par la coupe réalisée sur les dalles (16),

la machine étant **caractérisée en ce que** lesdits moyens de support mobile (24, 26) sont agencés de sorte que ladite première poutre (28) est parallèle à la direction (F) le long de laquelle les dalles brutes (16) sont alimentées audit plan de coupe principal (34).

2. Machine pour couper des dalles brutes selon la revendication 1, **caractérisée en ce que** lesdits moyens de manipulation comprennent un support (40) prévu avec une pluralité de ventouses (42) raccordées à une source de vide, ledit support (40) étant fixé à une seconde poutre (38) par le biais de moyens d'entraînement (39) afin de déplacer verticalement les ventouses (42), ladite seconde poutre (38) étant agencée de manière mobile sur lesdits moyens de support (24, 26) parallèles à la première poutre (28) indépendamment ou de manière solidaire à ladite première poutre.

3. Machine pour couper des dalles brutes selon la revendication 1, **caractérisée en ce qu'**elle comprend également un plan de coupe auxiliaire (44) pour stocker temporairement des bandes (46a - f) retirées dudit plan de coupe principal (34) et lesdits moyens de manipulation (40, 42) réalisent le transfert desdits bandes du plan de coupe principal (34) au plan de coupe auxiliaire (44) et vice versa. 5

4. Machine pour couper des dalles brutes selon la revendication 2, **caractérisée en ce que** lesdits moyens de support se composent d'un châssis avec deux voies de déplacement parallèles (24, 26) sur lesquelles lesdites première et seconde poutres (28, 38) sont montées de manière coulissante. 10 15

5. Machine pour couper des dalles brutes selon la revendication 2, **caractérisée en ce que** ladite seconde poutre (38) supportant lesdits moyens de manipulation (40, 42) est mobile indépendamment de la première poutre (28) sur laquelle les mandrins (30) sont montés. 20

6. Machine pour couper des dalles brutes selon la revendication 3, **caractérisée en ce que** ledit plan de coupe auxiliaire (44) est monté de manière mobile par rapport au plan de coupe principal (34). 25

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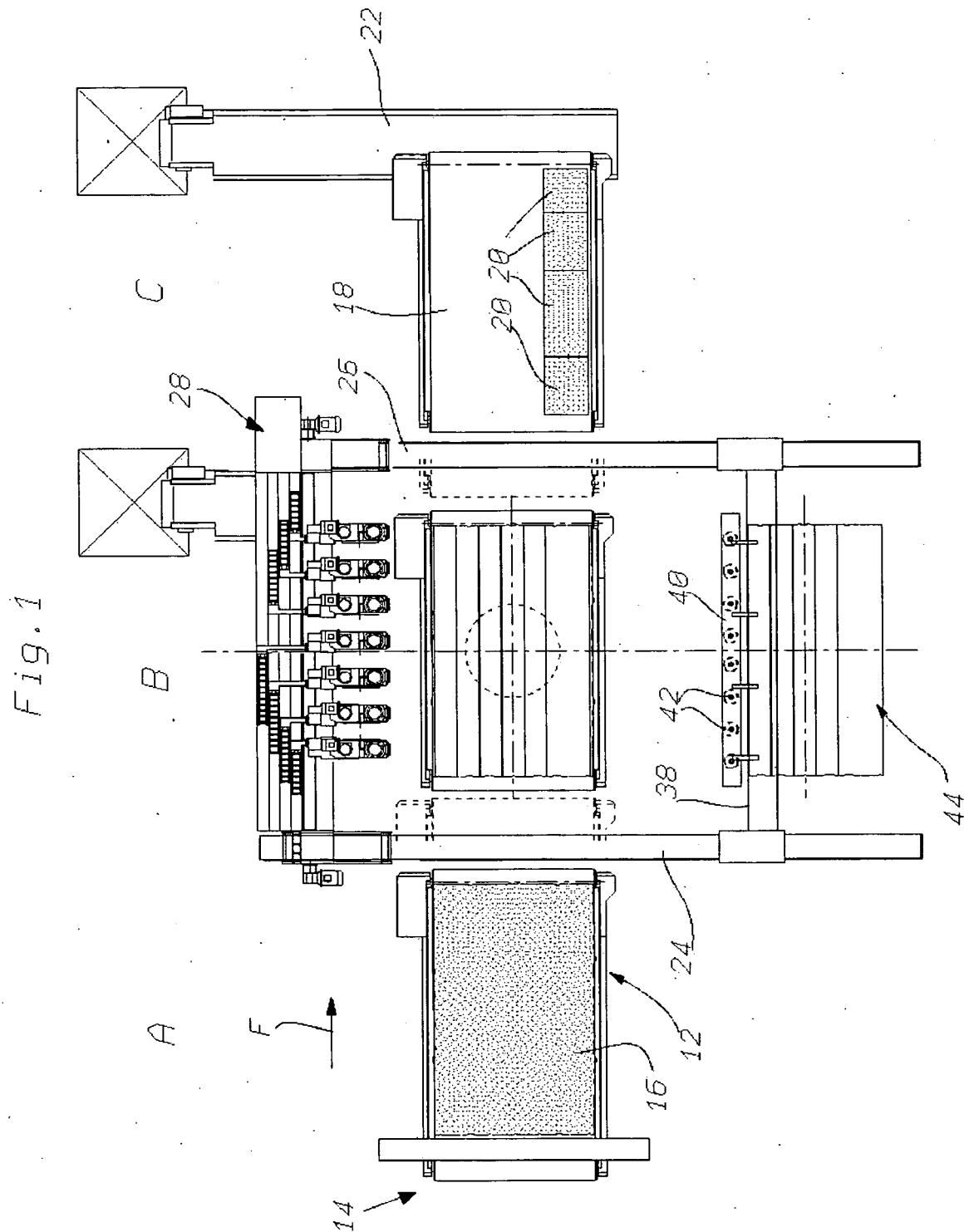
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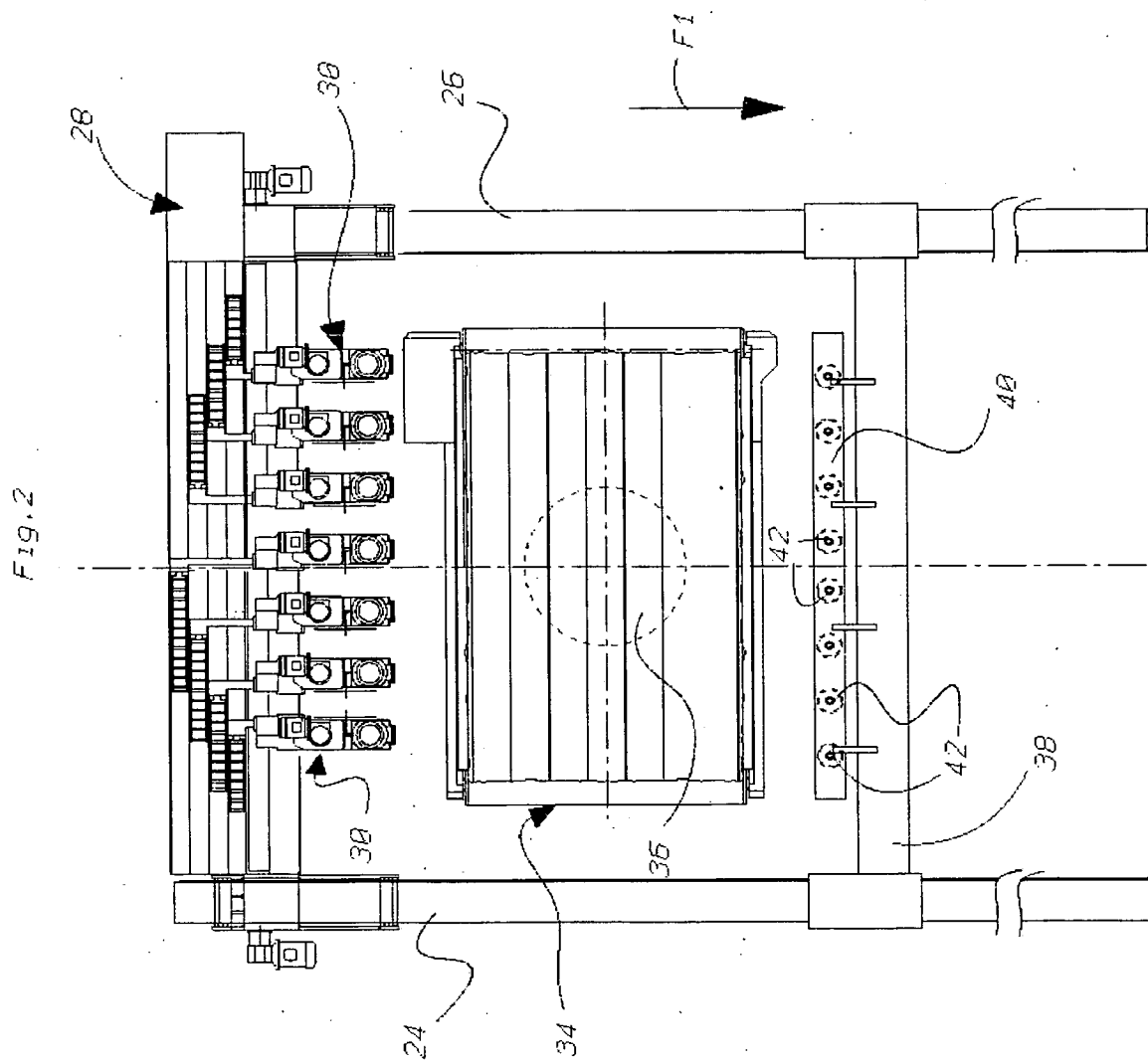


Fig.3

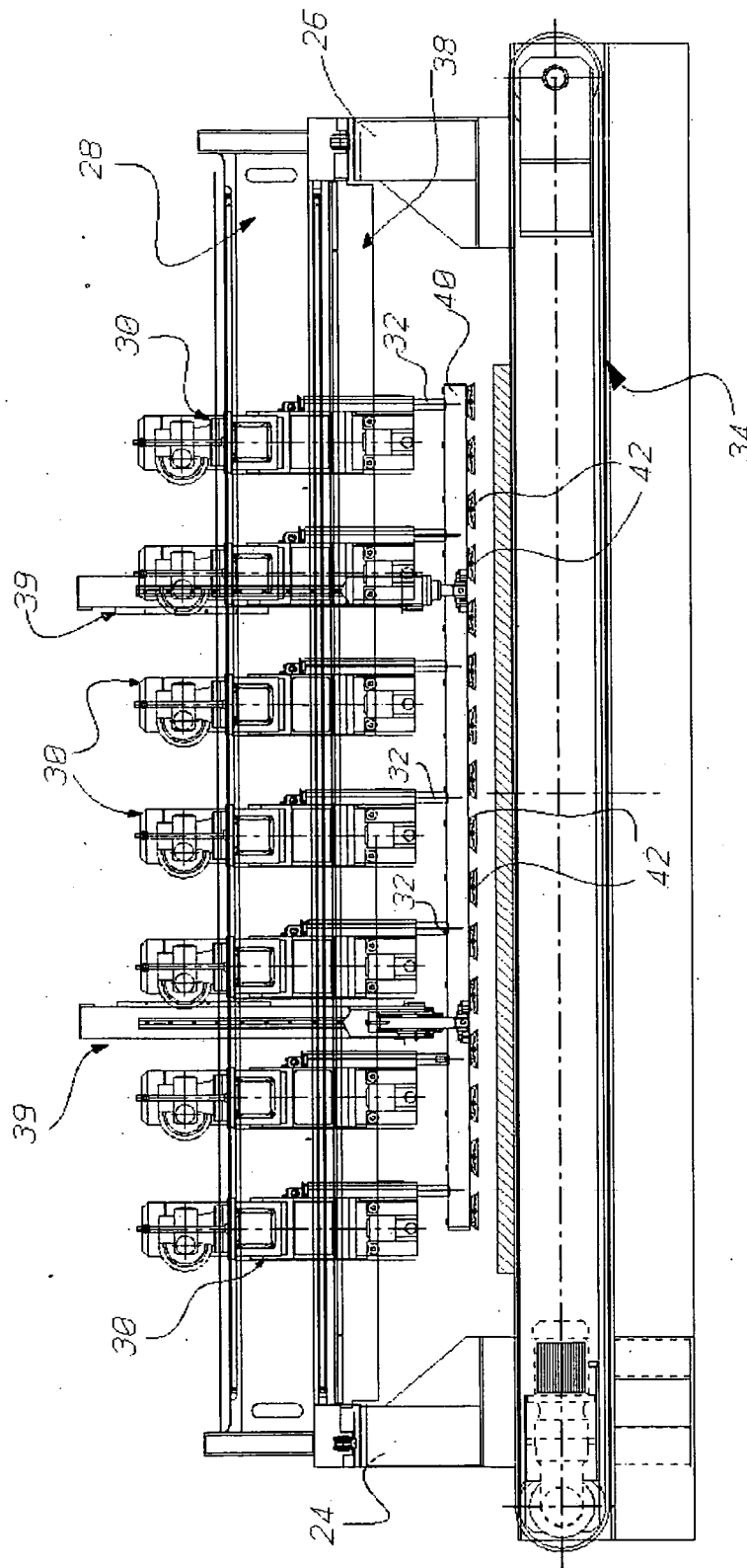
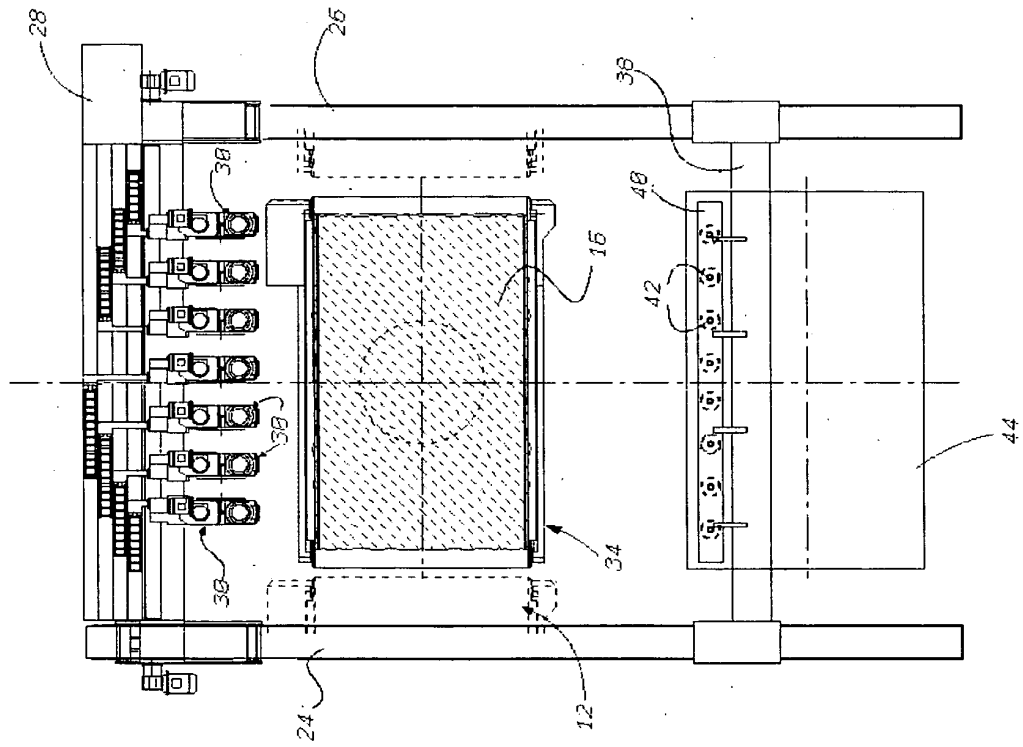


Fig. 4



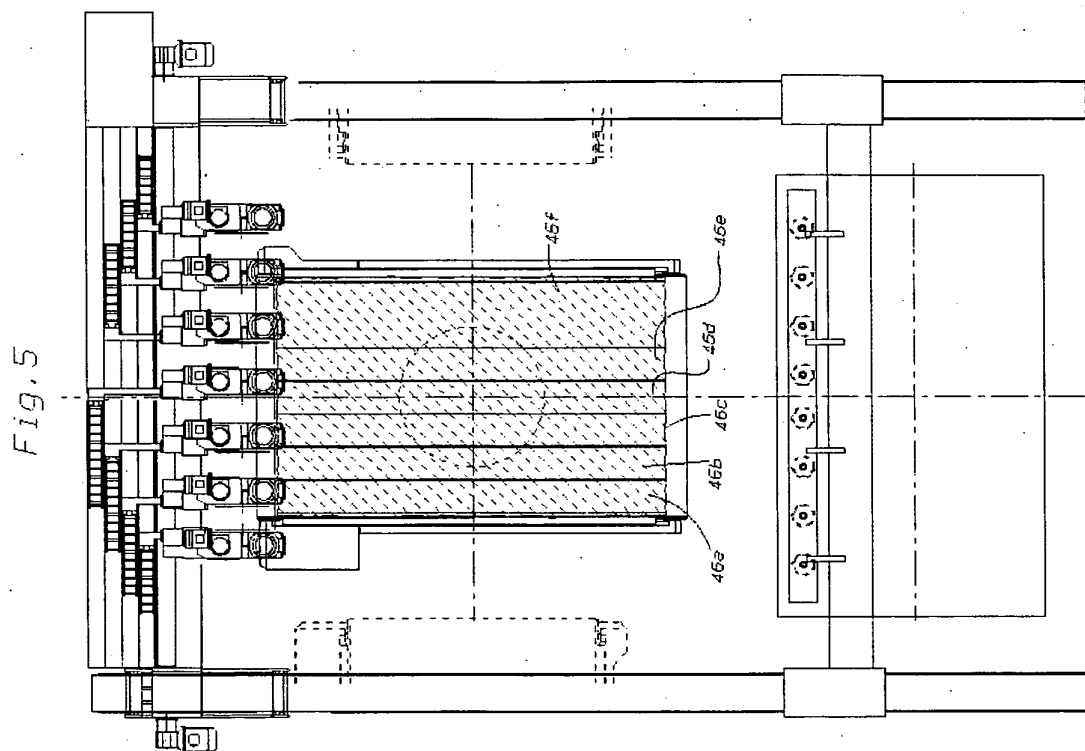


Fig. 6

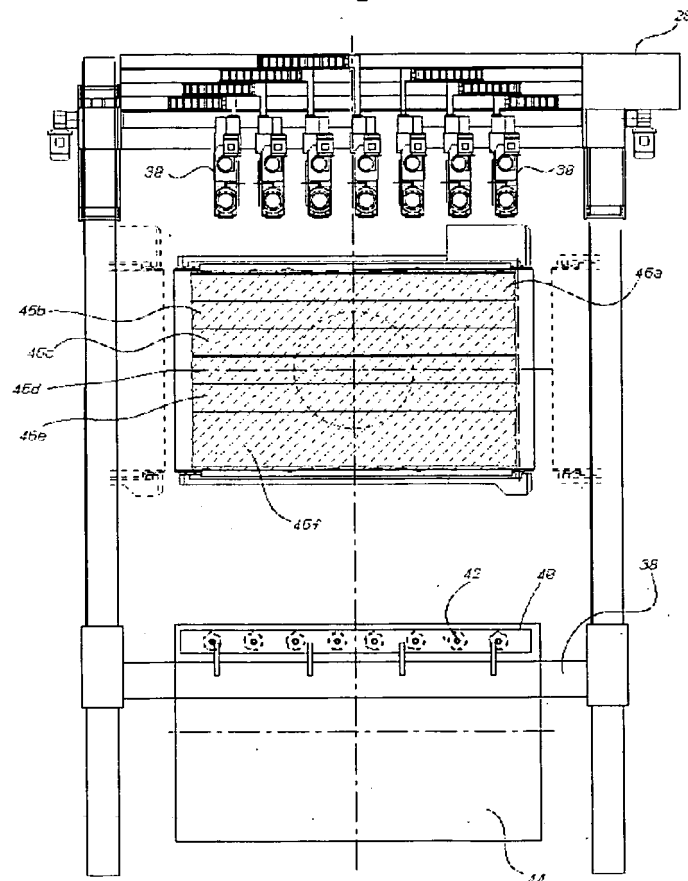


Fig. 7

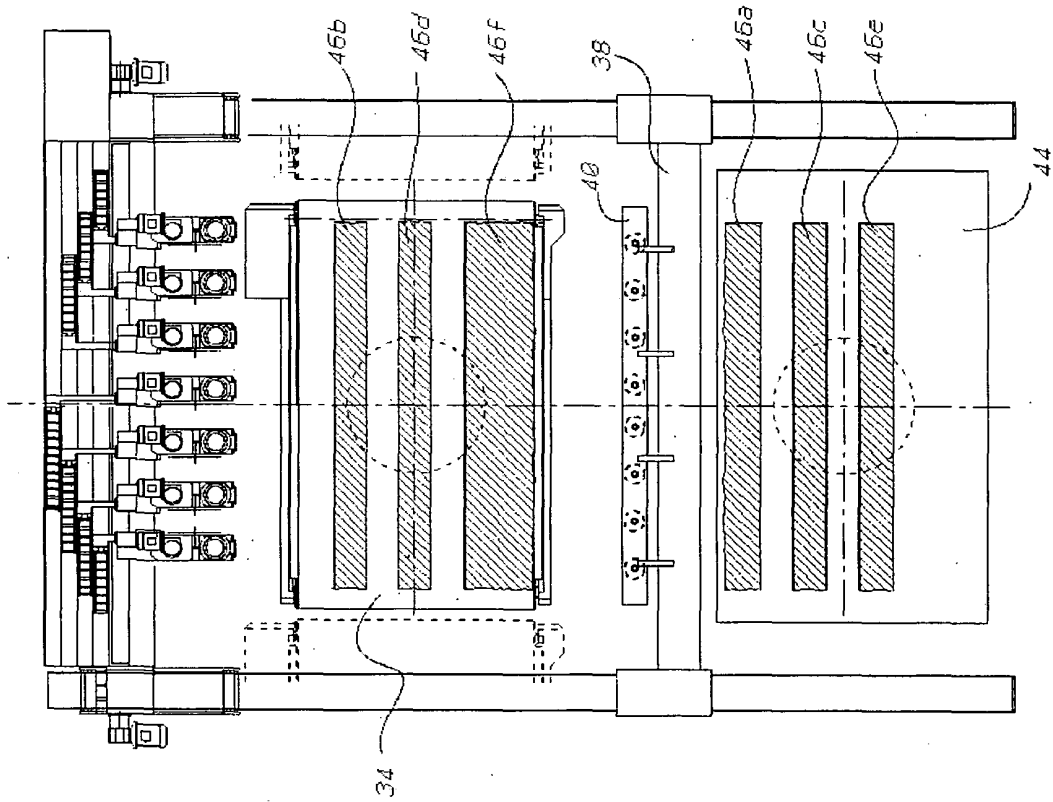
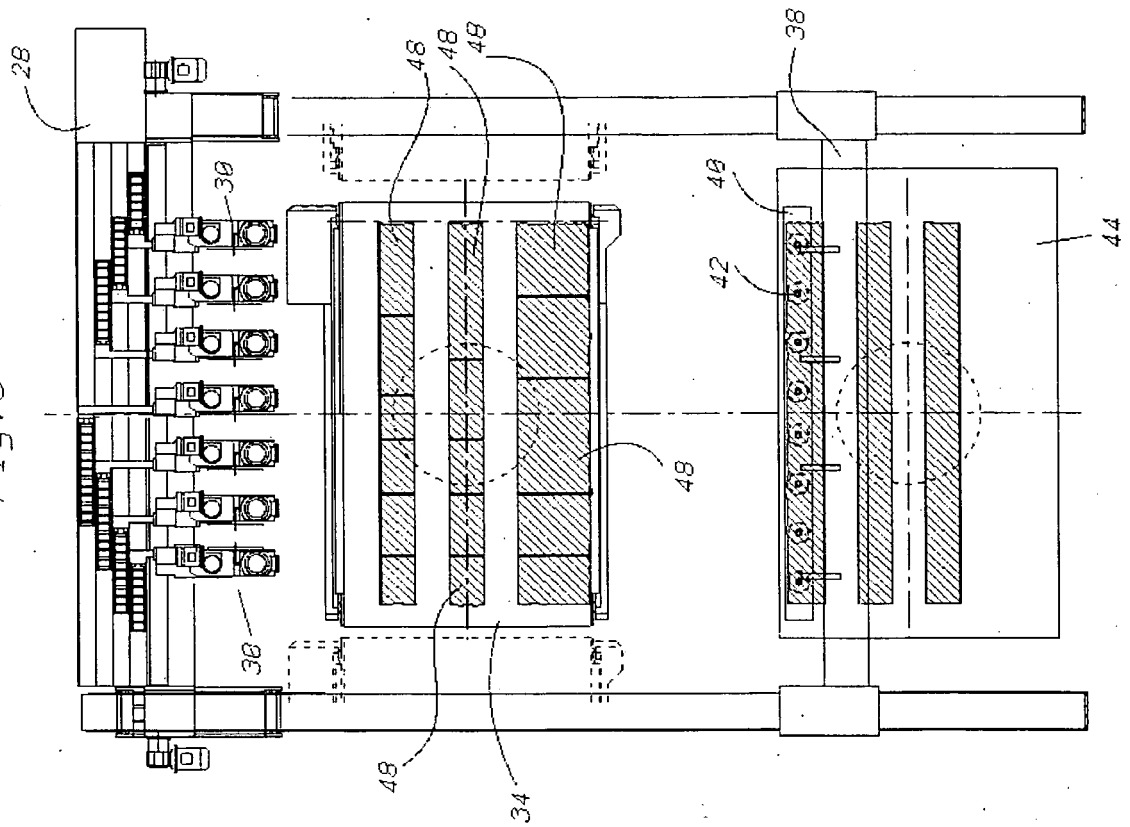
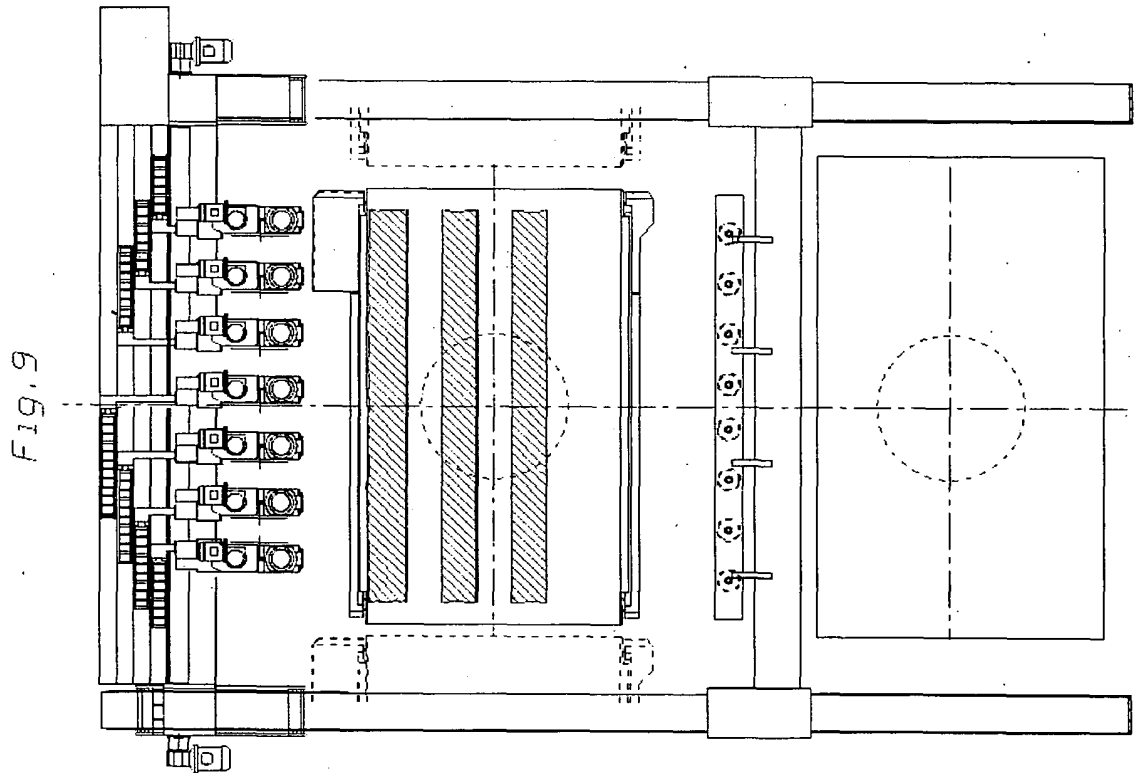


Fig. 8





REFERENCES CITED IN THE DESCRIPTION

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