

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 686 466 A2

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **95102804.2**(51) Int. Cl.⁶: **B28D 1/00, B28D 1/04**(22) Date of filing: **27.02.95**(30) Priority: **17.03.94 IT MO940036**(43) Date of publication of application:
13.12.95 Bulletin 95/50(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI NL PT SE(71) Applicant: **Pedrini, Luigi**
c/o Pedrini S.p.A.,
Via Fusine 1
I-24060 Carobbio degli Angeli (Bergamo) (IT)(72) Inventor: **Pedrini, Luigi**
c/o Pedrini S.p.A.,
Via Fusine 1
I-24060 Carobbio degli Angeli (Bergamo) (IT)(74) Representative: **Gislon, Gabriele**
Marietti e Gislon S.r.l.
Via Larga, 16
I-20122 Milano (IT)(54) **Multiple discs machine for cutting granite blocks, hard stone and stone slabs in general and relative plant**

(57) The machine is equipped with a trolley (6), mobile with reciprocating motion on a bridge (5), carrying a horizontal shaft (A) with a cluster of diamond cutting disks (7) for vertical cutting, arranged with progressively increasing diameters from the smallest (8) to the largest (9); a second vertical shaft (B) is mounted on the said trolley and is equipped with a group (10) of disks cutting horizontally in the same

plane slabs or offcuts, cut simultaneously from the block (1) by the said cluster and group during the working runs. The blocks are handled on carriages (2) which in turn are anchored under the machine with clamps, tie rods and plinths. The plant includes at least one facing machine (3) and one block cutting machine (36) with separate access points and division of the enclosures with soundproofing.

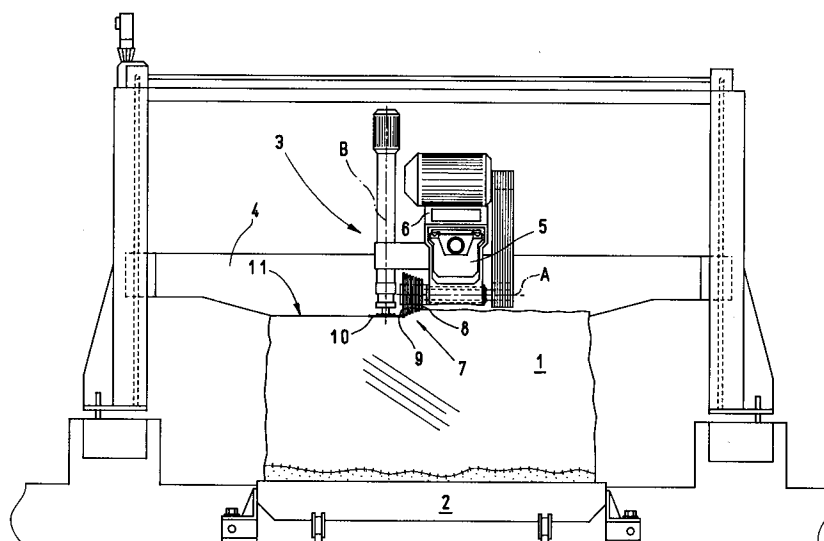


FIG. 1

EP 0 686 466 A2

The invention concerns a multiple disk machine for cutting granite blocks, hard stone and stone slabs in general and relative plant, namely, a machine which faces the blocks, prior to cutting into slices, in a single operation without the direct intervention of the operator, the plant for the optimum use of the normal block-cutters also being included in the patent application.

The prior art involves block-cutting machines consisting of a horizontal shaft on which is keyed a cluster of diamond cutting disks of equal diameter or of two diameters, the so-called "step-up", for cutting the blocks in successive runs and at gradually increasing depth until the desired depth is reached: subsequently, by means of a diamond cutting-disk mounted on a vertical shaft, the block-cutter cuts the base of the slices, said cluster of diamond disk-cutters being raised and inoperative so as not to interfere with the cutting of the horizontal disk. The facing of the top of the block is carried out in a similar manner, the offcut being discarded as being of varying thickness, depending on the original shape of the block being cut. Hence, although the present cutting system may prove acceptable for a low-volume operation, it is not viable for high-volume operations, since the block-cutting machine is not being fully utilised during the block-facing operation or while the base cut is being made in the slices. A further disadvantage is connected with the sequence of necessarily separate operations, of vertical and horizontal cutting, as well as with the carrying out of successive runs, including the block-facing operation, to reach the desired depth.

The prior art also involves plant for the cutting of granite and hard stone consisting of two machines, a block-cutter which cuts the block vertically, used both for facing and for the cutting of slices, and a machine featuring a tool with a horizontal disk that performs only the horizontal cut both in facing and in detaching the slices, with two pairs of rails that cross the block-cutter to reach the area where the machine cutting horizontally operates. Thus, the arrangement whereby two or more pairs of rails with carriages side by side invade the operating area of the block-cutter does not allow for the complete separation of the different operations: work with the block-cutter has to be stopped to permit the carriages to move to and from the horizontal cutting machine.

Such prior art may be subject to considerable improvements with a view to improving on the alternate use of the block cutter so as to optimise the production capacity of the machine itself.

From the foregoing emerges the need to solve the technical problem of inventing a new arrangement of the tools that carry out the horizontal and vertical cuts and the facing of the granite blocks in

a single run and a plant that that will make for a more integrated succession of phases in the various cutting operations.

The invention solves the said technical problem by adopting a machine for cutting blocks having a shaft with horizontal axis carrying a cluster of disks for vertical cutting and a shaft with vertical axis for horizontal cutting, having on the said shaft with horizontal axis a cluster of diamond cutting disks the diameters of which gradually increase by a constant amount from the first with the smallest diameter to the last with a diameter depending on the maximum depth of cut required: the two shafts are supported on a mobile carriage moving to and fro on a structure, transversally to the block; having completed its cutting and return run, said carriage is shifted onto lines parallel to the grooves cut by said vertical-cutting disks by an amount equal to the thickness of the slab or offcut plus the thickness of cut of the disk: in the subsequent phase of work the next disk in the cluster enters the groove created by the previous disk of smaller diameter and cuts to a depth equal to the difference between the two radii; the subsequent phases of work are carried out at the same elevation; said shaft with vertical axis being adjusted, for the simultaneous cutting of the slabs or offcuts, to the cut of the said shaft with horizontal axis, but farther out with respect to the said cluster of disks.

Also adopting: coupled to said vertical shaft, a support driven by the same shaft, inclined or that may be inclined in a direction parallel to said grooves, carrying a minimum of two vertical spindles, keyed to each of which is a diamond disk cutting horizontally along a common plane, advantageously positioned with the first disk, in the direction of feed, being farther out than the cut to be effected and the subsequent disk(s) being farther in until the slab or offcut is completely cut through.

Adopting also: a flap device, hinged on a horizontal axis, coupled to said carriage, that oscillates during the cutting run and stops in a vertical position during the return run, with its lower end brushing the surface of the block only along a strip close to the facing offcut cut by said horizontal cutting disk(s).

Also adopting: a block cutting plant consisting of a machine for facing the blocks and separating the slices paired with one or more block cutters, each machine being served by appropriate entrance for guided or self-propelled carriages, with the block(s) to be machined positioned and held by means of brackets and tie rods mounted on plinths in the working area of the machine; the working areas of the block cutter being sound-proofed using panels on all the walls.

The advantages offered by the present invention are: the cutting with the cluster of disks with horizontal axis occurs at the same time as the offcut disks with vertical axis for the block to be faced; the height of the tools does not vary with each run, however, the depth of each individual cut varies with each consecutive run, in function of the difference in the diameter of each consecutive disk in the cluster with horizontal axis: hence, apart from a first number of runs to engage each disk in the cluster and the last runs to carry out the cut at the base of the facing offcuts, the two horizontal and vertical tool groups work at the same time significantly reducing the time required to face the block. Furthermore, the operator does not need to intervene manually or with instruments in order to clean the faced surface, in that the flap, in the return run, removes the facing offcuts.

Finally, the facing machine, with the vertical axis tool group, is particularly advantageous for the base cut in a different station with the vertical slices cut using a block cutter that is not equipped with a horizontal cutting disk; the removal of the slices can in this way be concentrated on a single machine enabling the block cutter to continue working in the most convenient conditions.

Some embodiments of the invention are illustrated, purely by way of example, in the nine tables of drawings attached in which Figure 1 is the transverse view of the machine for facing the blocks as described; Figure 2 is a partial view, perpendicular to the cutting direction, of the two horizontal and vertical groups of tools; Figure 3 is an enlarged plan view of Figure 2; Figure 4 is an enlarged view in a direction parallel to the cuts; Figure 5 is a transverse view during the cutting phase at the base of the slices, cut beforehand with a normal block cutter; Figure 6 is the cutting plant consisting of a facing machine and a block cutter; Figures 7 and 8 are the side views of the two machines in different phases of operation; Figure 9 is the cutting plant consisting of a facing machine and two block cutters.

The figures show: 1, Figure 1, the block being machined, positioned on a carriage 2 in the working area of the machine 3 for heading the blocks, having a structure with transverse beam 4, on whose bridge 5, the trolley 6, moving with reciprocating motion, carries on a horizontal shaft A the diamond cutting disk cluster 7, for vertical cutting, with progressively increasing diameter from the first 8 to the last 9; B, the vertical shaft with, at its lower extremity, the group 10 with two diamond disks for cutting horizontally, at the same level, but offset with respect to each other in the cutting direction; 11, the faced surface of the block.

The figures also show: 12, Figure 2, the facing offcut, undergoing the horizontal cut by means of

cutting disk 13, slightly offset with respect to the subsequent disk 14 of the said group 10; 15, the support for the group of horizontal disks, driven by a coupling to the said vertical shaft B; 16, the axis of the front disk 13 and 17, the axis of the rear disk 14 in relation to the cutting direction; 18, the grooves generated by the cutting action of the disks of the cluster 7; 19, the vertical flap coupled so as to rotate in a single direction around horizontal axis 20 on the said trolley 6, to remove, on the return run, the facing offcuts.

The figures also show: 21, Figure 3, the bottom of the cut at the base of the facing offcut 12 left by the first horizontal disk 13; L, the thickness of the facing offcut 12; S, the width of the grooves 18; I, the depth of the cut carried out by the said first disk 13; P, the deepening of the horizontal cut carried out by the second disk 14; C, the distance between the axes 16 and 17 parallel to the said grooves; D8, the diameter of disk 8 and D9 the diameter of disk 9; IR, the increase in radius between one disk and the next in the cluster of disks 7, with $2 \times IR$ being the corresponding increase in diameter; 22, Figure 5, the slices cut in a vertical direction by a normal block cutter and 23, the resulting surface after the row of slices 22 has been cut at the base using the group 10 of horizontal diamond cutting disks.

The figures also show: 24, Figure 6, the enclosure in which the facing machine 3 is positioned; 25, the anchoring elements for the carriage 2 in the working area; 26, a suction device for gripping and removing the slices 27; 28, the control cabin for the facing operations of the block 1 and the cutting of the slices 22; 29, the doors for closing off and soundproofing the working environment of each machine; 30, the rails for sliding the carriages 2 up to the transfer carriage 31; 32, carriages on stretches of rail 33, waiting to be sent for machining or for loading blocks 34 to be cut; 35, the block being machined in the block cutter 36, placed in a separate enclosure 37 equipped with soundproofing 38; 39, the access door in the soundproofed wall of the block cutting enclosure; 40, Figure 7, the clamps the carriages are equipped with that couple to plinths 41 by means of eye bolt tie rods 42.

Finally, the figures also show: 43, Figure 9, the enclosure in which the facing machine 3 is positioned, with the suction device 44 for removing the slices 45; 46, the control cabin for the machine; 47, the exit rails towards the double transfer carriage 48; 49, carriages on stretches of rail 50, waiting to be sent for machining or for loading blocks 51; 52, the enclosure of the two block cutters 36 separated by sliding doors 53 and equipped with soundproofing 54; 55, the doors of the soundproof panelling; 56, the fork lift truck for transporting the slices 45 to the subsequent processing stations.

The facing machine operates in the following manner: once the block 1 has been positioned in the working area of the machine, the bridge 5, with the cluster 7 of disks for the vertical cuts positioned outside the block, is lowered to the desired level, so that the resulting faced surface 11 does not include areas that have not been machined; the horizontal group of disks 10 is positioned at a level which is a few tenths of a millimetre lower than the deepest groove 18, in function of the diameter D9 of the last disk 9 of the cluster 7; the machining is started by making the trolley perform a working run sufficiently longer than the width of the block 1: the first disks to come into contact with the block are those with the smallest diameter close to D8; after the first run and after the return run of the trolley the whole bridge is moved parallel to shaft A by a step $S + L$ so that the disk with the larger diameter enters into the groove 18 left by the preceding disk with smaller diameter and so that the cut is deepened by an amount equal to the increase in radius IR between the radii of two consecutive disks.

After the penetration of the last disk 9, having diameter D9, the facing offcut 12 is ready for the horizontal cut by means of the group of disks 13 and 14, conveniently of the same diameter and mounted, by means of motorised support 15, on two axes offset by a distance C, equal to the deepening P of the cut of the second disk 14 with respect to the first. The positioning of the two cutting disks offset by an amount P enables a faster advancement speed to be reached, thereby enabling simultaneous cutting with the vertical cutting of the disks of cluster 7.

At the end of the run the facing offcut 12 is completely cut and left lying, often broken into lengths at the points of minimum height: on the return run, carried out with the bridge 5 in the same position, the flap 19 positions itself in the vertical position and pushes the said lengths off the faced surface 11 without the manual intervention of the operator, so that, in the following cutting run, the disks 13 and 14 can cut the new facing offcut 12 without encountering obstacles.

The cutting run and the return run are repeated consecutively, moving the bridge 5 before each new cutting run by a step $S + L$ between the disks of the cluster 7: at the end the block is completely faced. The block 1 can then be moved to the working area of one of the block cutters for the vertical cutting, in the normal way, of the slices 22.

The block facing machine is also advantageously used for the horizontal cutting of the slices 22 with the group 10 of disks 13 and 14, positioned at a height of a few tenths of a millimetre lower than the cutting height of the vertical disks of the block cutter; the cluster 7 of vertical cutting disks is

positioned beyond the extent of the slices, lowering shaft B. During the cutting of the slices 22, the operator in the cabin 28, 46 checks and controls the suction device 26, 44 for gripping and moving the slices 27, 45.

The plant in Figure 6 is arranged with the combination of a block cutter with a facing and horizontal cutting machine: the block cutter can be fed in each working shift even with blocks of the largest commercially available size, and the time required to cut a row of slices 22 is much longer than the time required to cut them horizontally on the facing machine 3. Therefore, it is highly advantageous to equip the block cutter 36 with a wide cluster of disks with horizontal axis for cutting the slices, as it is no longer penalised by the working phase where the slices are cut horizontally. The carriages 32 can therefore be prepared with blocks 1 that have already been faced and, in the following shifts, they are consecutively positioned under the block cutter to cut the vertical slices 22: the precise positioning and the clamping of the carriage under the machines are achieved with anchorage points 25 where the clamps 40 are locked onto the plinths 41. The separation of the cutting phases therefore enables the block cutter to operate continuously, with three working shifts per day, and the facing machine to operate one or two shifts, thereby significantly reducing the number of hours of labour used; the operator enters into block cutter enclosure only for the positioning of the block closing the doors 29 and 39 until the subsequent completion of the row of slices 22. The noise during the facing operation is much lower than the noise generated during the vertical cutting of the slices: the absence of an operator on the block cutters 36 enable noise pollution in the plant to be significantly reduced. The operator spends his time checking the operation of the facing machine that generates much less noise both during the facing and when detaching the slices.

The plant in Figure 9 operates in a similar way to the previous one with the operator solely engaged with the facing machine 3 over the three working shifts, both for facing the blocks and detaching the slices: the operator enters the block cutter enclosure 36 only for the positioning of the block; the block cutters are separated from each other by a soundproofed wall 54 so that any one of them, during operation, does not disturb the operator if he is in the enclosure of another block cutter positioning the block.

The combination of the two disks 13 and 14 to detach the slices enables a significant reduction in the time required for the operation, sufficient to enable one facing machine to be combined with a number of block cutters.

Tests have been carried out to find the most convenient arrangement of the cluster 7 of disks: keeping the peripheral velocity between 23 and 36 m/sec, clusters of from 6 to 15 disks have been adopted; the best results were obtained with a nine disk cluster starting with a diameter $D_8 = 350$ mm up to a diameter $D_9 = 590$ mm, that is with $IR = 15$ mm; this arrangement enables the facing offcut to be cut with a step $S+L = 29$ mm, with a cut width $S = 6$ mm and an advancement speed of the trolley 6 of 3 m/min, up to a maximum height of 140 mm; the best cutting condition, as regards the wearing of the tools, is achieved with dimensions I , P and IR of similar value ($I \sim P \sim IR$).

The two disks of the group 10 can even have different diameters, which can easily be compensated for with a different adjustment of the support 15 so as to make C even much greater than or less than the deepening of the cut P , which conveniently has to be equal to I . It is therefore easy to adjust the group 10 for a different thickness L of the slice to be detached from the block or even for the wearing down of one of the disks 13 or 14: with a simple adjustment of the position of the support 15 the group is ready to cut in the different condition as required.

In practice the materials, dimensions and details of execution may be different from, but technically equivalent to those described without departing from the juridical domain of the present invention. The shaft B , for example, even though less advantageously, can be equipped with just a single disk instead of the group 10, advantageous for thinner sections, thereby reducing equipment costs.

Furthermore, with a considerable increase in complexity of construction, group 10 can consist of three or more disks, similarly adjusted, for cutting thicker sections.

Finally, both the cluster of disks with progressively increasing diameter of the increase IR of the radius, and the group 10 of two horizontal cutting disks, can be mounted, even though less advantageously, both separately or together, on a normal block cutting machine, so as to use it as a granite block facing machine, after having modified its work cycle eliminating the deepening of the same groove with consecutive runs of the same vertical cutting disk.

Claims

1. A multiple disk machine for cutting granite blocks (1, 35), hard stone and stone slabs in general having a shaft (A) with horizontal axis carrying a cluster of disks for vertical cutting and a shaft (B) with vertical axis for horizontal cutting, characterised in that on the said hori-

zontal shaft there is a cluster (7) of diamond cutting disks having diameter gradually increasing by a constant value ($2 \times IR$), from the first (8) with the smallest diameter (D_8) to the last (9) with diameter (D_9) in function of the maximum depth of the cut to be achieved: the two shafts are supported on a mobile trolley (6), with reciprocating motion, on a structure (4, 5) transversely to the block (1, 35); the said trolley, having completed its working and return run, is moved on lines parallel to the grooves (18) cut by the said vertical cutting disks by a step ($L+S$) equal to the thickness (L) of the slab or offcut plus the width of the cut (S) of the disk: the following disk in the cluster (7) enters, in the following working run, in the groove (18) left by the preceding disk with smaller diameter cutting to a depth equal to the difference between the two radii (IR); the consecutive working runs are carried out at the same elevation; the said shaft with vertical axis (B) being adjusted for the simultaneous cutting of the slabs or offcuts, to the cut of the said shaft (A) with horizontal axis, but farther out with respect to the said cluster (7) of disks.

2. A machine for cutting blocks, as claimed in the previous claim, characterised in that there is, coupled to the said vertical shaft (B), a support (15) driven by the said shaft, inclined or that may be inclined with respect to a direction parallel to the said grooves (18), having a minimum of two vertical spindles (16, 17), keyed to each of which is a diamond disk (13, 14) cutting horizontally along a common plane, advantageously positioned with the first disk (13), in the direction of feed, being farther out than the cut to be effected and the subsequent disk(s) (14) being farther in until the slab or offcut (12) is completely cut through.

3. A machine for cutting blocks, as claimed in one or more of the previous claims, characterised in that there is a flap device (19), hinged on a horizontal axis (20), coupled to the said trolley (6), that oscillates during the cutting run and stops in a vertical position during the return run, with its lower end brushing the surface of the block (11) only along a strip close to the facing offcut (12) cut by said horizontal cutting disk(s) (13, 14).

4. A machine for cutting blocks, as claimed in one of the previous claims 2, 3, characterised in that it has the cluster of vertical diamond cutting disks (7) and the group (10) of horizontal cutting disks adjusted to simultaneously cut the block, with cut depth (I) of the first disk

(13), deepening of the cut (P) with the second disk (14) and the increase of the radius (IR) between the disks of the said cluster being of an approximately equal in value ($I \sim P \sim IR$).

5. A plant for cutting blocks including a machine for facing (3) the blocks and detaching the slices associated with one or more block cutters (36), characterised in that it has: each machine served by an appropriate entrance (30, 47) for guided or self-propelled carriages (2, 32, 49) with the block(s) (1, 35) to be machined positioned and held by means of brackets (40) and tie rods (42) mounted on plinths (41) in the working area of the machine; the working areas of the block cutter (36) being soundproofed (38, 39, 54 and 55) using panels on all the walls.

5
10
15
6. A diamond cutting disk cluster (7) tool with horizontal axis for use in a facing machine or block cutter, characterised in that it has disks with diameter increasing progressively by a constant value ($2 \times IR$), from the first (8) with smallest diameter (D8) to the last (9) with diameter (D9) in function of the maximum depth of the cut to be achieved.

20
25
7. A group of diamond disk cutting tools (10) with vertical axis for use in a facing machine or block cutter, characterised in that it has, coupled to the said vertical shaft (B), a support (15) driven by the said shaft, inclined or that may be inclined with respect to a direction parallel to the said grooves (18), having a minimum of two vertical spindles (16, 17), keyed to each of which is a diamond disk (13, 14) cutting horizontally along a common plane, advantageously positioned with the first disk (13), in the direction of feed, being farther out than the cut to be effected and the subsequent disk(s) (14) being farther in until the slab or offcut (12) is completely cut through.

30
35
40

45

50

55

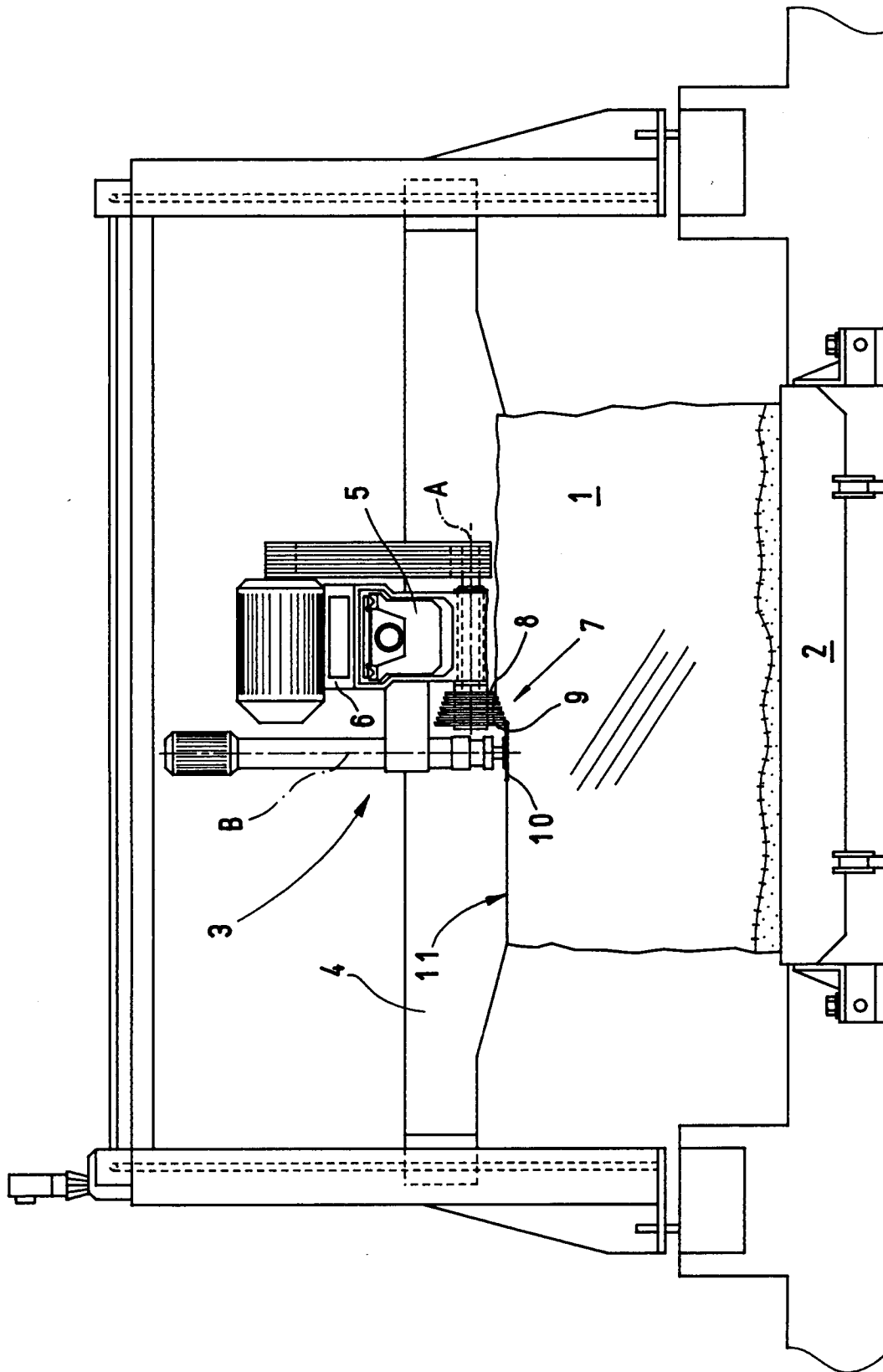


FIG. 1

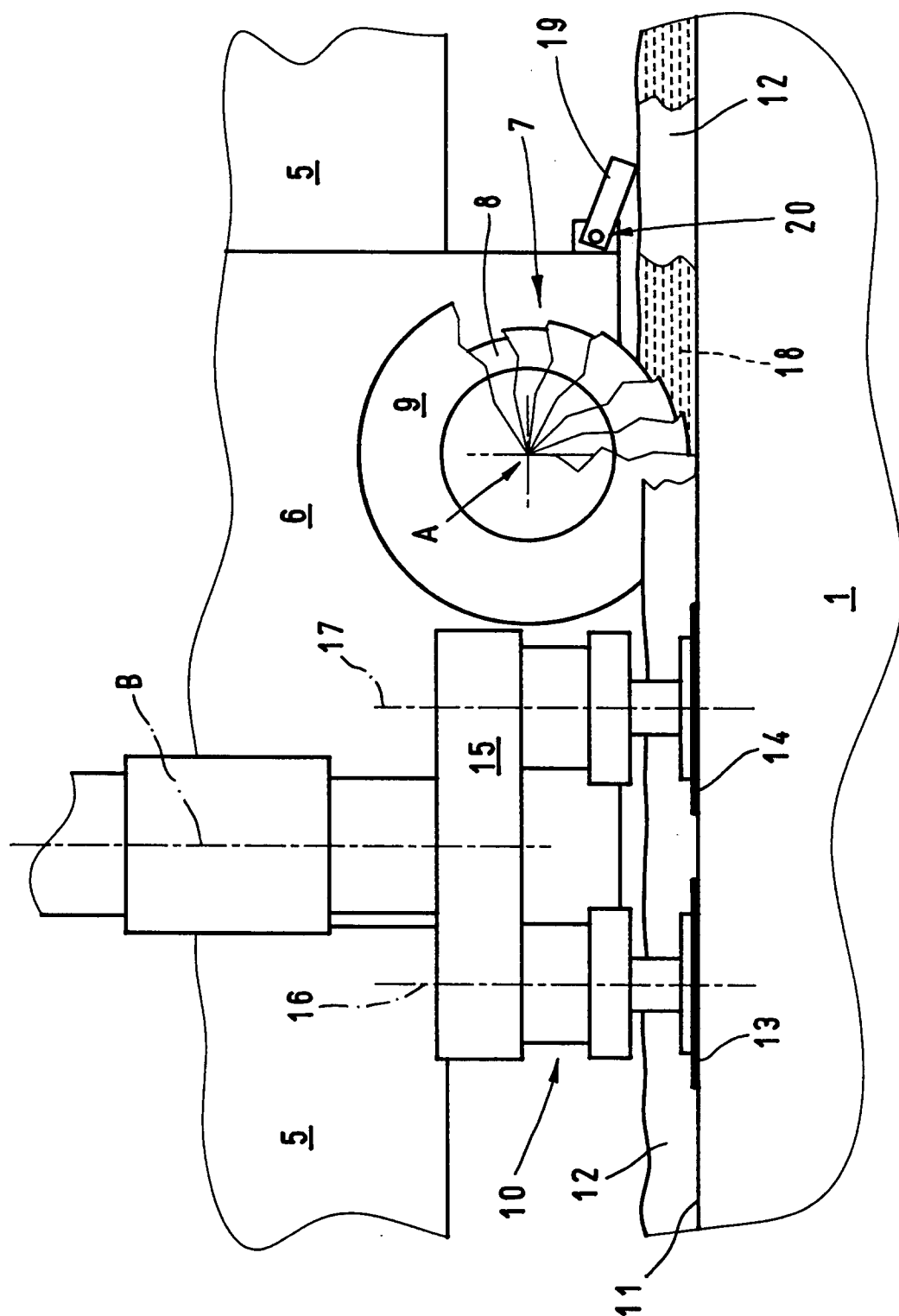
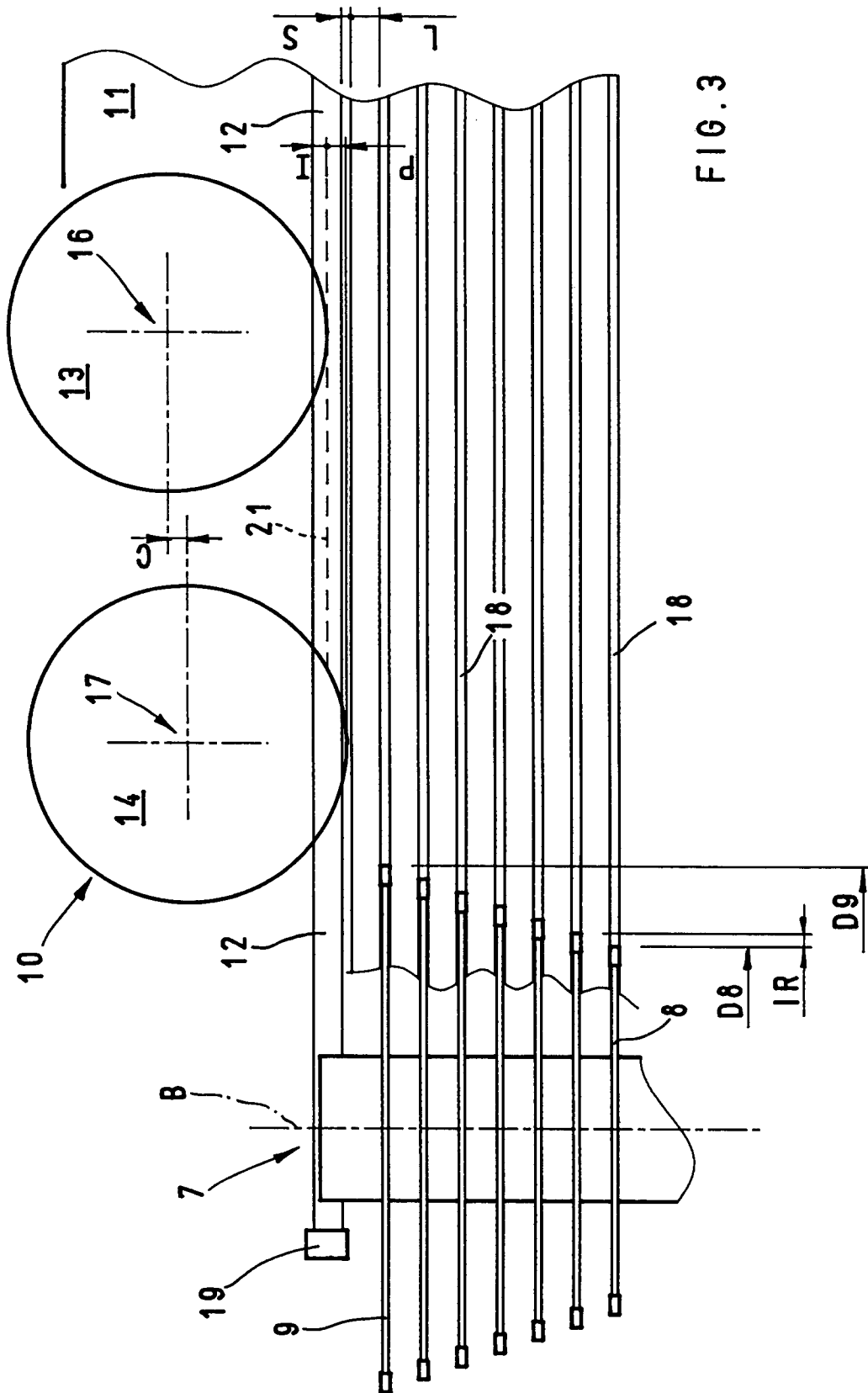
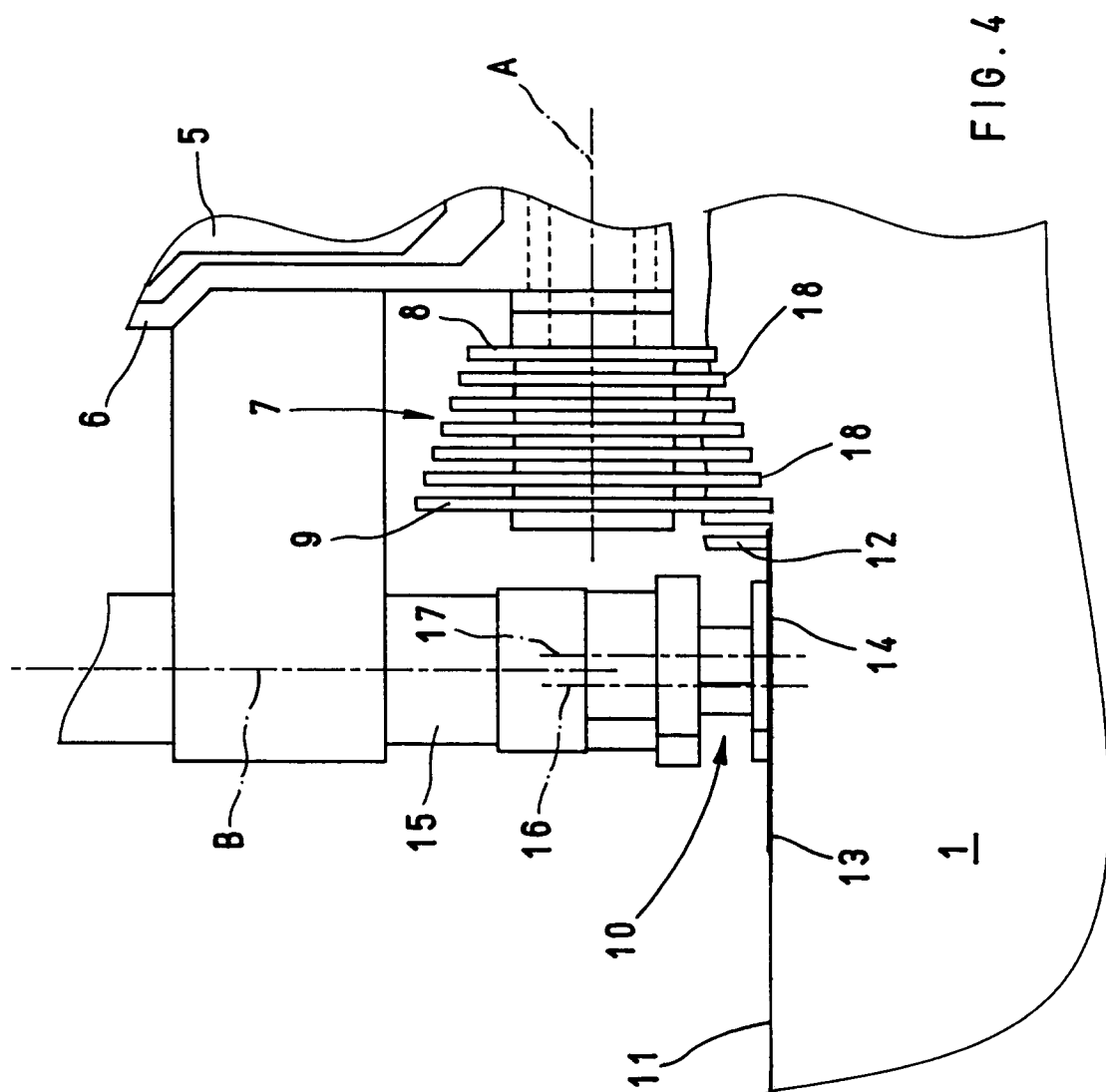
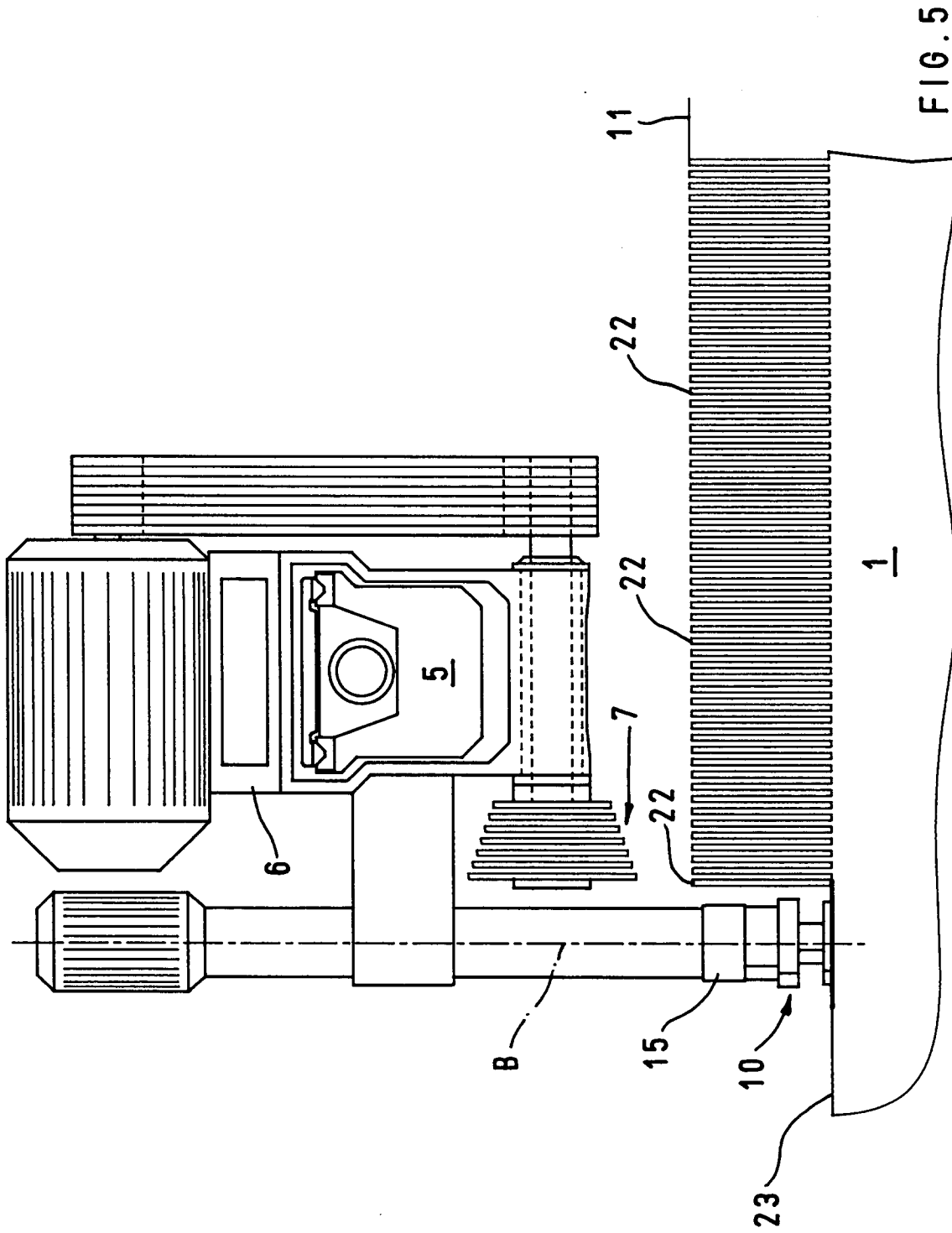


FIG. 2







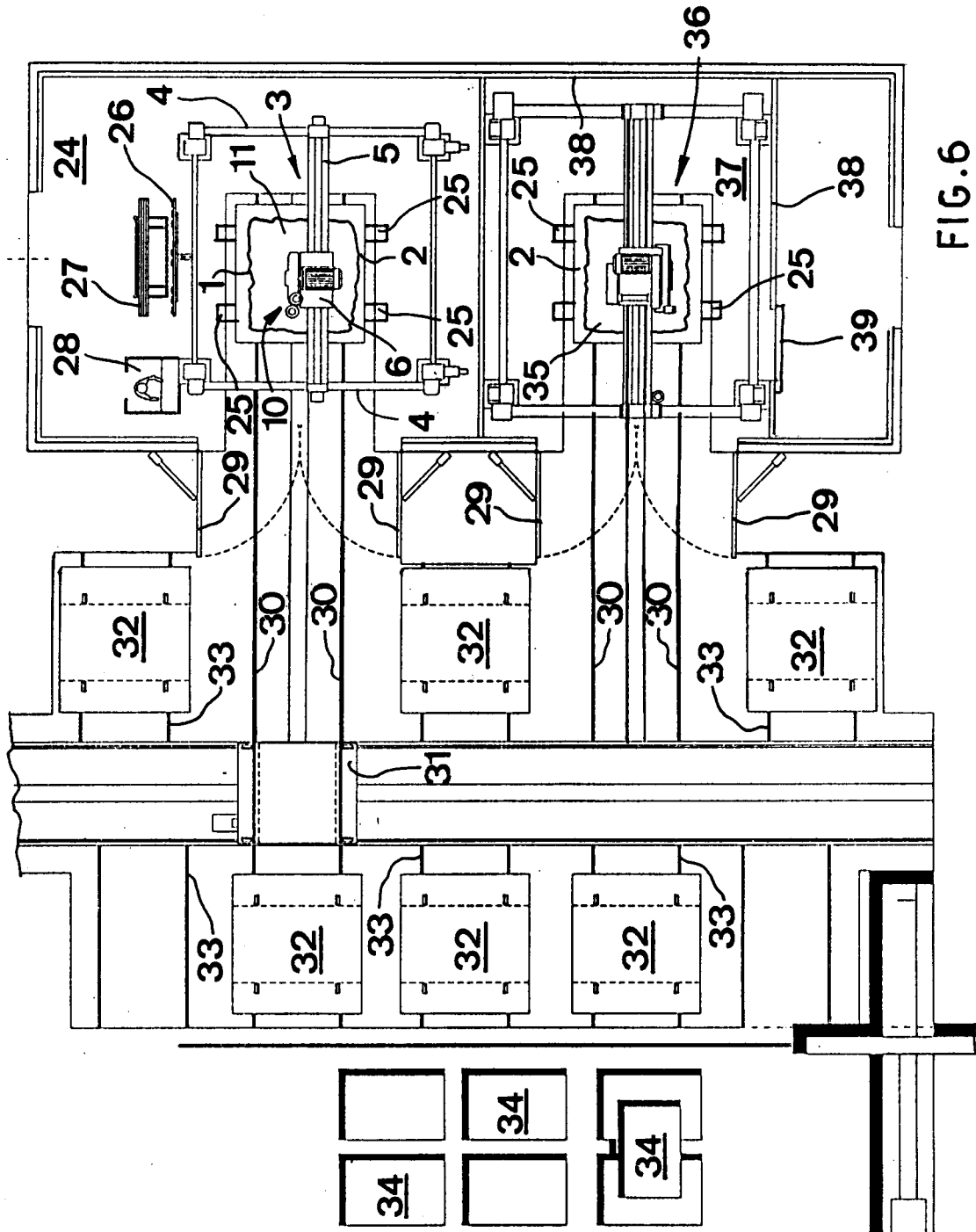


FIG. 6

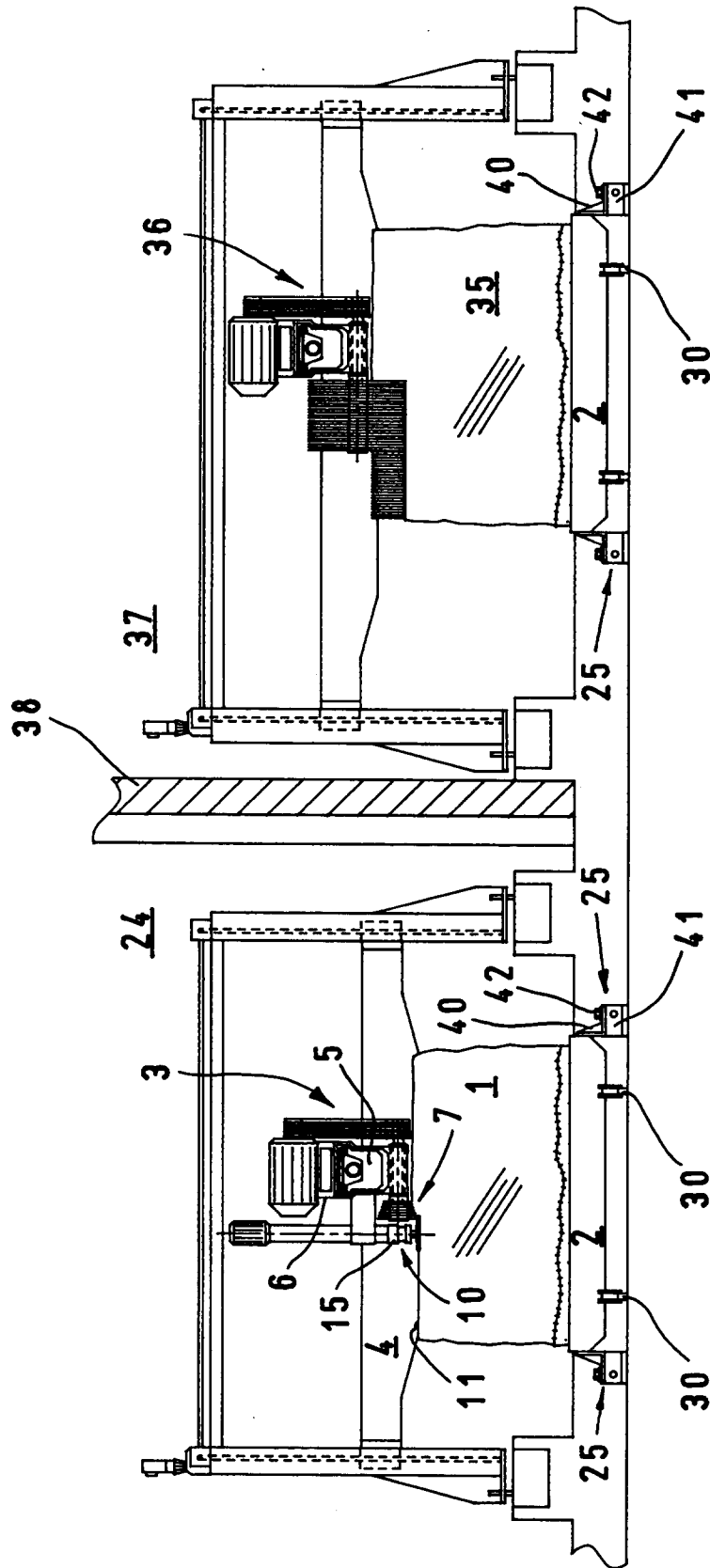


FIG. 7

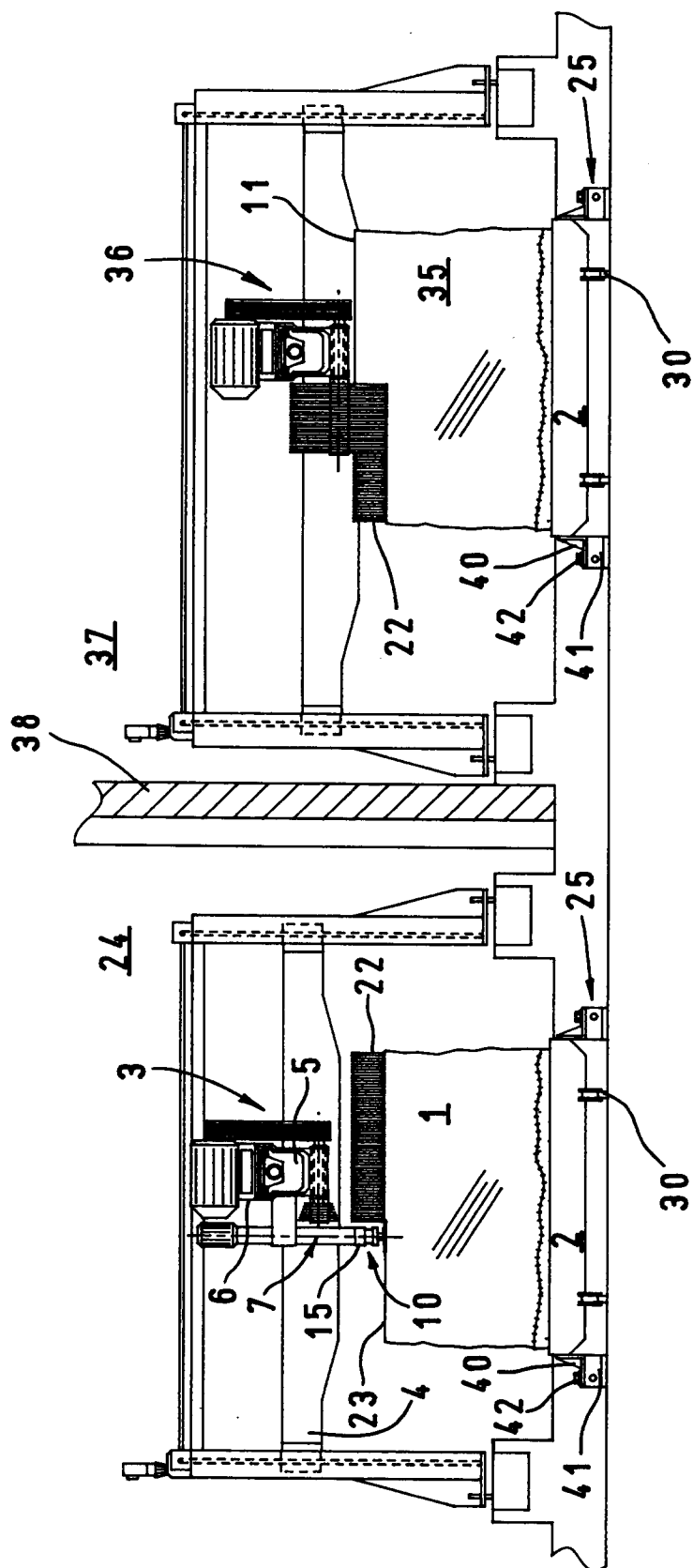


FIG. 8

