(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 013 829 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.06.2000 Bulletin 2000/26

(51) Int. Cl.[7]: **E01C 23/088**, E01C 23/085

(21) Application number: **99204507.0**

(22) Date of filing: **27.12.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **27.12.1998 NL 1010895**

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(54) Milling apparatus

(57) Milling apparatus for milling a road surface (2) of concrete or asphalt with the aid of a rotating milling roll (16,31). Inside the milling roll (16,31) a hammer axis (22) is mounted, to which hammers (28a,..,28f) are connected. The hammer axis (22) rotates faster than the milling roll (16,31), which causes the hammers (28a,..28f) to strike a number of strike shoulders (29,30), mounted inside the milling roll (16,31). In this way, additional impulse moments are transferred to the rotating milling roll.

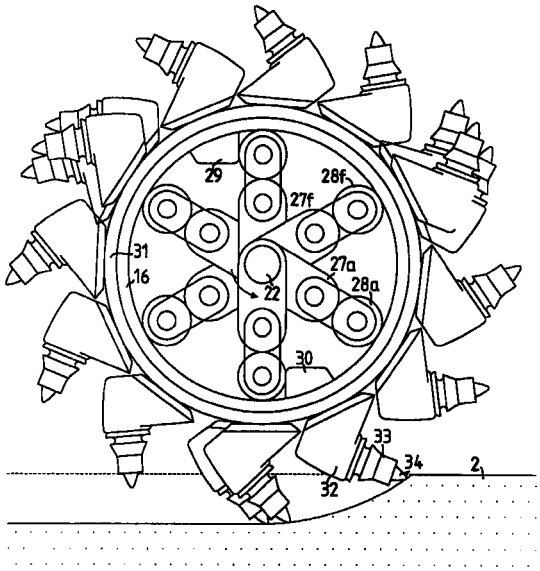

FIG.3

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Description

[0001] The invention relates to a milling apparatus, for the milling of hard materials like concrete, rock or asphalt, provided with a milling roll mounted for rotation around a central longitudinal axis, to a surface of which milling roll a number of milling bits are connected, and a hammer axis, mounted for rotation around the central longitudinal axis, for operationally applying additional impulse moments to the milling bits.

[0002] A milling apparatus of this kind is known from WO 89/01837. The known milling apparatus is used, like the inventive milling apparatus, for example for equalizing a road surface, in which process a partly worn off wearing course is removed. For that application, the milling roll is mounted in a wheeled frame with an adjustable height and the frame is provided with a power source for driving the milling roll and for propelling the apparatus. The milling bits mounted on an outer surface of the milling roll are usually welded-on tool holders, in which the actual bits made for example of tungsten carbide are mounted.

[0003] In the known milling roll an additional impulse moment generated by providing the hammer axis with an additional eccentrically located weight, for generating radial directed vibrations in the milling roll. These radial directed vibrations generate an additional radial impulse moments on the milling bits, which supports a scraping action of the milling bits.

[0004] The present invention is based on the observation that an moment should be preferably directed in the direction of movement of the milling bits. A favourable embodiment according to an aspect of the invention is therefore characterized in that the hammer axis is arranged for applying the additional impulse moments in at least substantially a tangential direction to the milling bits.

[0005] A favourable embodiment according to another aspect of the invention, in which a relatively slow rotating hammer axis may generate an additional impulse moment at a relatively high repetition frequency, is characterized in that an inner wall of the milling roll is provided with strike shoulders and that the hammer axis is provided with hammers, mounted for operationally engaging the strike shoulders.

[0006] In order to arrive at a situation in which the hammers can engage the strike shoulders on one hand and in which the hammers may pass the strike shoulders after an impulse has been exchanged on the other hand, the apparatus is according to another aspect of the invention characterized in that every hammer is pivotally mounted to an arm connected to the hammer axis, such that the hammer can strike a strike shoulder if the hammer is at least substantially in line with the arm.

[0007] The invention moreover aims at reducing the wear and tear of the bearings of the hammer axis and to increase the control convenience of the milling apparatus by reducing tangential directed vibrations. A favourable embodiment according to another aspect of the invention, which realizes these improvements, is characterized in that the hammers are distributed around the hammer axis to obtain a well-balanced arrangement.

[0008] A favourable embodiment according to another aspect of the invention, which has as an advantage that even with a milling roll with a limited stiffness a good distribution of the additional impulse moments over the milling bits is obtained is characterized in that the hammers are distributed at least substantially regularly spaced along the hammer axis.

[0009] Every time a hammer strikes a strike shoulder, an impulse is transferred to the milling roll for obtaining the desired effect. A very favourable embodiment according to another aspect of the invention is characterized in that a hammer is mounted such that it can strike a plurality of strike shoulders. In a favourable realization, the strike shoulders run at least substantially regularly spaced along at least substantially the entire length of the inner wall of the milling roll.

[0010] A further favourable embodiment according to an aspect of the invention is characterized in that the milling roll and the hammer axis each are provided with individual drive means. This embodiment is more expensive than an embodiment in which only the hammer axis is driven but is provides an opportunity to select for a particular material to be milled the rotational speed of the milling roll and the rotational speed of the hammer axis in combination in order to optimize a particular parameter, like the speed of the milling process or the smoothness of the milled surface.

[0011] A further very favourable embodiment according to an aspect of the invention is characterized in that in an operational mode the hammer axis rotates four to eight times as fast as the milling roll. It is possible then to generate an additional impulse moment with a very high frequency, which greatly enhances the effectiveness of the milling process.

[0012] With the additional impulse moments arriving at such a high frequency, it is even possible to drive only the hammer axis, in which situation the additional impulse moments together drive the milling roll.

[0013] In order to prevent the drive means of the milling roll to absorb part of the additional impulse moments, a favourable embodiment according to another aspect of the invention is characterized in that coupling means are provided between the drive means and the milling roll, in which at least in a tangential direction some clearance exists.

[0014] The invention will now be explained in more detail with reference to the following figures, in which:

Fig. 1 represents a possible embodiment of a milling apparatus according to the invention;

Fig. 2 represents a longitudinal cross section of a possible embodiment of a milling roll;

Fig. 3 represents a transverse cross section of a

possible embodiment of a milling roll;

Fig. 4 represents a possible distribution of the milling bits on a developed milling roll.

[0015] Fig. 1 represents a possible embodiment of a milling apparatus 1, arranged for removing a layer of a road surface 2, consisting of concrete, asphalt or a stone product. Milling apparatus 1 comprises a front wheel 3, enabling the apparatus to be steered with the aid of a steering wheel 4 and two back wheels 5, connected via a transmission 6 to a diesel motor 7 for driving the milling apparatus 1. Moreover milling apparatus 1 is provided with a milling roll 8, covered with milling bits and connected via a transmission 9 to diesel engine 7. According to the invention, milling roll 8 comprises a hammer axis 10, provided with hammers, which hammer axis 10 is connected via a transmission 11 to diesel engine 7.

[0016] Transmissions 6, 9 and 11 comprise multiple v-belts for connecting them to a main axis of diesel motor 7 via variable transmission units, well known in the art, such that the speed of milling apparatus 1, the peripheral velocity of milling roll 8 and the linear speed of hammer axis 10 can be adjusted mutually independent with control devices 12,13,14, dependent upon the operational circumstances, like the desired milling depth, the smoothness of the milled surface and the hardness of the road surface 2. It is also possible to drive a hydraulic pump unit with diesel engine 7 and to provide back wheels 5, milling roll 8 and hammer axis 10 each with a hydraulic motor, in which case the linear speeds can be adjusted independently in a manner well known in the art.

[0017] Fig. 2 represents a longitudinal cross section of a possible embodiment of a milling roll according to the invention, in which a first pulley 15, driven by transmission 9, drives an inner roll 16. Inner roll 16 and pulley 15 are connected by a hollow axis 17, which hollow axis 17 is supported by two ball bearings 18,19 mounted in a housing 20, which housing 20 in turn is rigidly mounted to the frame of milling apparatus 1. Under operational conditions an outer roll, on which the milling bits are placed, is placed round inner roll 16 and is fixed to it with bolts. The outer roll is not shown in this figure. Moreover, a second pulley 21 is provided, driven by transmission 11, for driving a hammer axis 22. Hammer axis 22 is supported by four ball bearings 23,24,25,26, mounted in hollow axis 17 and in inner roll 16. Hammer axis 22 is provided with six arms 27a,..27f, which are distributed regularly spaced along hammer axis 22 and which are each successively rotated over an angle of 60 degrees. On the ends of the six arms 27a,..27f six hammers 28a,..,28f are pivotally connected, which can, if they are located in line with the corresponding arms, hit the two strike shoulders 29,30 which are located on an inner wall of inner roll 16, to which they will transfer a tangentially directed impulse. During this transfer the hammer is slowed down, but the linear speeds of the inner roll and the hammer axis are chosen such that the hammer is again in line with the corresponding arm when it approaches the next strike shoulder.

[0018] Fig. 3 represents a transverse cross section of a possible embodiment of a milling roll, with an inner roll 16 on an inner wall of which the two strike shoulders 29,30 are connected and with an outer roll 31, the inner roll 16 and the outer roll 31 together forming the milling roll 8. On outer roll 31, a large number of milling bits is mounted, for milling the road surface 2. The milling bits used are known in the art and consist of a holder 32, which is welded onto outer roll 31 and a cutter 33 of a cutting metal which is rotatable mounted in holder 32 and which may be provided with a tip 34 made of tungsten carbide. From Fig. 3 it is clear that the impulse moments generated by the hammers 28a,..,28f in combination with the strike shoulders 29,30 always are directed to a large extent in line with a point 34 acting upon road surface 2, in the process of which hard material that is present in road surface 2 is shattered. Fig. 3 moreover shows that the hammers 28a,..,28f are evenly distributed round the circumference, which means that hammer axis 22 is always well balanced and that hammer axis 22 is substantially free of radial directed vibrations.

[0019] Fig. 4 represents a possible distribution of the milling bits on a milling roll 31, which milling roll 31 is showed for clarity in a developed position, in the sense that in an operational position the lines AA' and BB' coincide. It may be noticed that in a direction indicated by an arrow, which is also the direction of propagation, the milling bits are located such that always a limited number of cutting metal cutters 33 are active and will receive the additional impulse moments of the hammers 28a,..,28f, while in a direction perpendicular to the direction of propagation the milling bits are located such that the surface to be milled will be evenly milled.

Claims

1. Milling apparatus, for the milling of hard materials like concrete, rock or asphalt, provided with a milling roll mounted for rotation around a central longitudinal axis, to a surface of which milling roll a number of milling bits are connected, and a hammer axis, mounted for rotation around the central longitudinal axis, for operationally applying additional impulse moments to the milling bits, characterized in that the hammer axis is arranged for applying the additional impulse moments in at least substantially a tangential direction to the milling bits.

2. Milling apparatus according to claim 1, characterized in that an inner wall of the milling roll is provided with strike shoulders and that the hammer axis is provided with hammers, mounted for engaging the strike shoulders.

3. Milling apparatus according to claim 2, characterized in that every hammer is pivotally mounted to an arm connected to the hammer axis, such that the hammer can strike a strike shoulder if the hammer is at least substantially in line with the arm.

4. Milling apparatus according to claim 3, characterized in that the hammers are distributed around the hammer axis to obtain a well-balanced arrangement.

5. Milling apparatus according to claim 3, characterized in that the hammers are distributed at least substantially regularly spaced along the hammer axis.

6. Milling apparatus according to claim 2, characterized in that a hammer is mounted such that it can strike a plurality of strike shoulders.

7. Milling apparatus according to claim 2, characterized in that the strike shoulders run at least substantially regularly spaced along at least substantially the entire length of the inner wall of the milling roll.

8. Milling apparatus according to claim 2, characterized in that the milling roll and the hammer axis each are provided with individual drive means.

9. Milling apparatus according to claim 2, characterized in that in an operational mode the hammer axis rotates four to eight times as fast as the milling roll.

10. Milling apparatus according to claim 8 or 9, characterized in that coupling means are provided between the drive means and the milling roll, in which at least in a tangential direction some clearance exists.

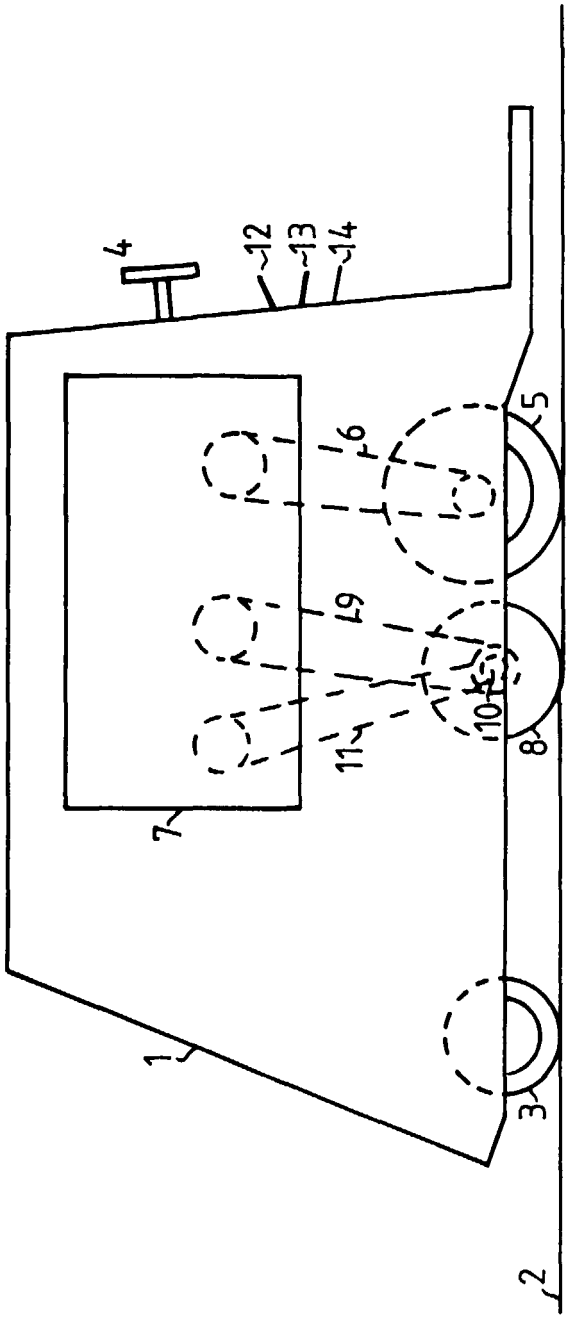

FIG.1

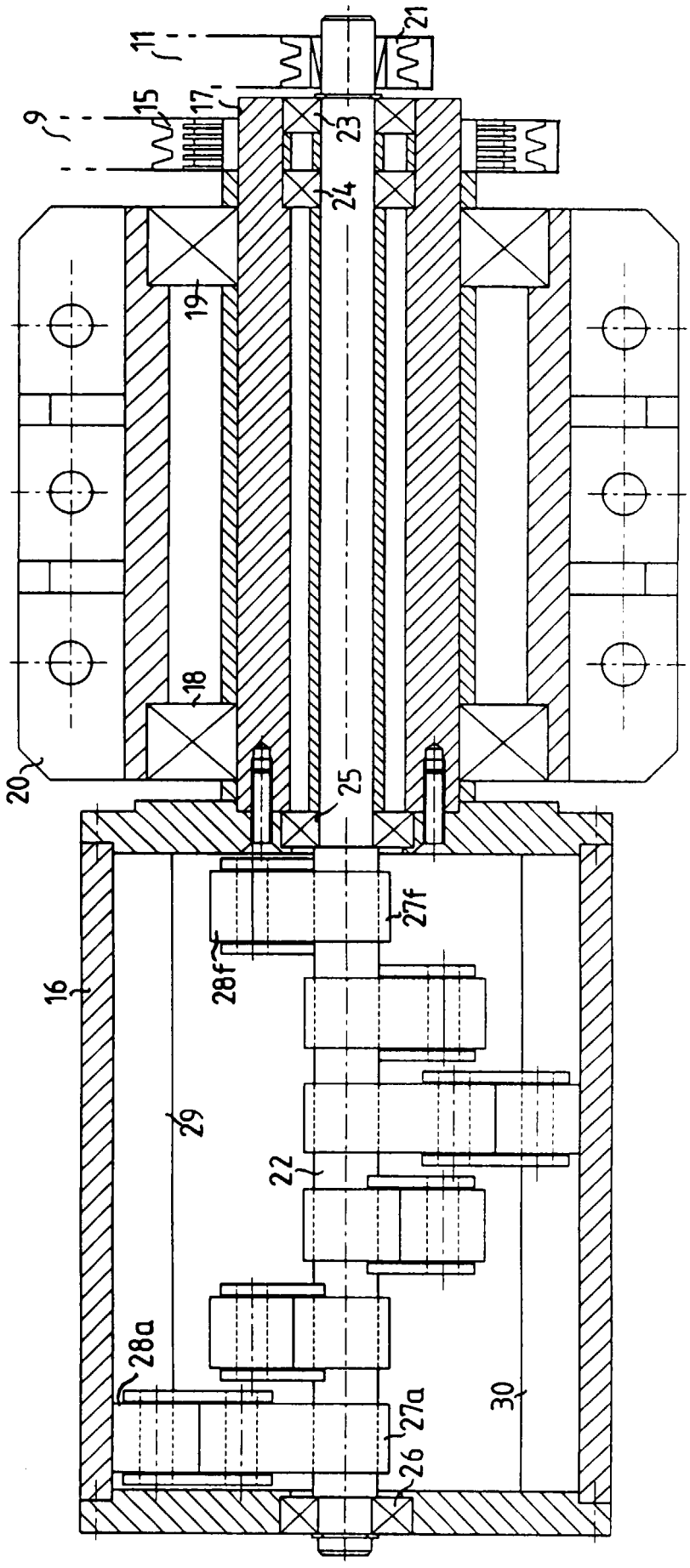

FIG.2

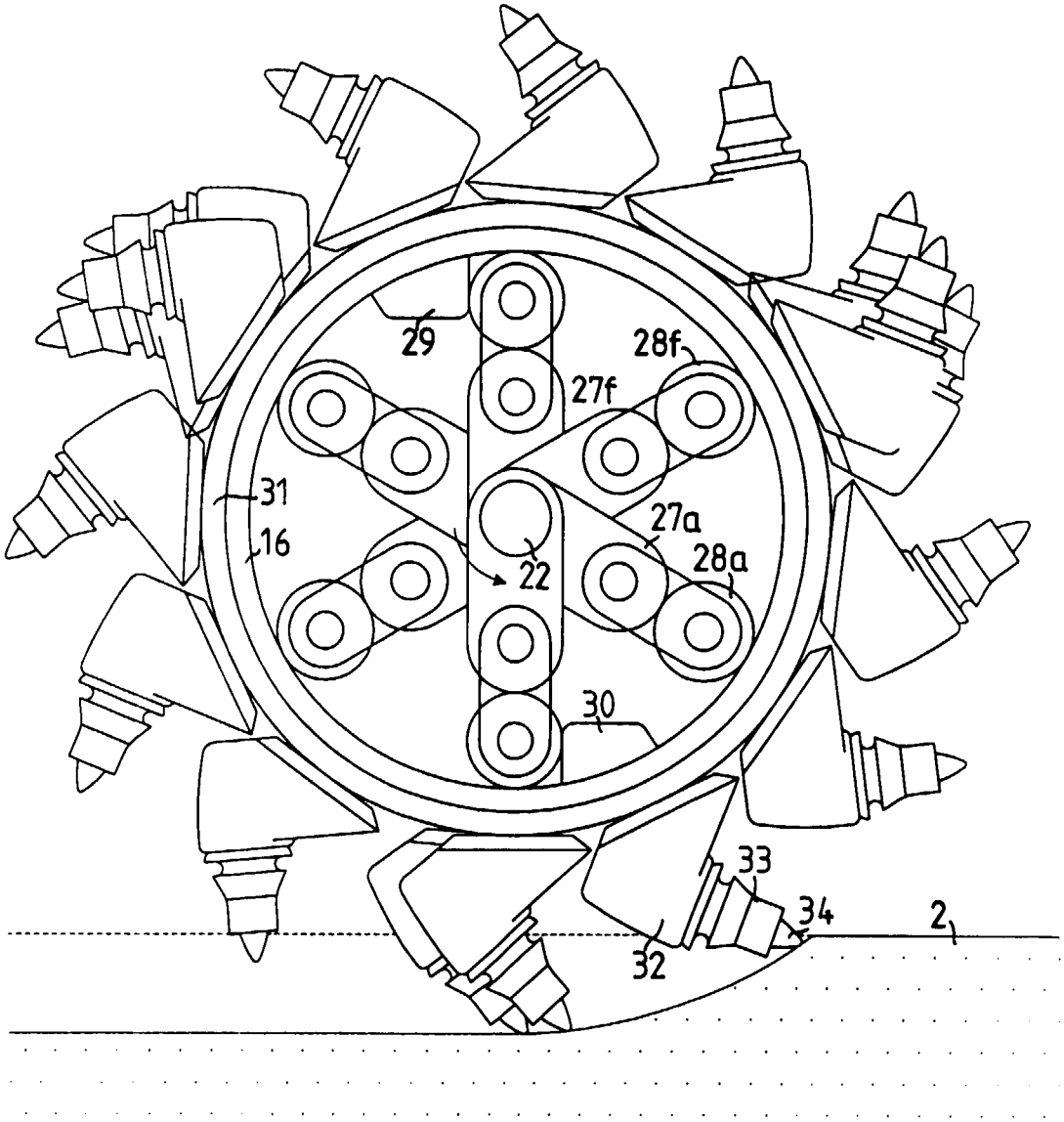

FIG. 3

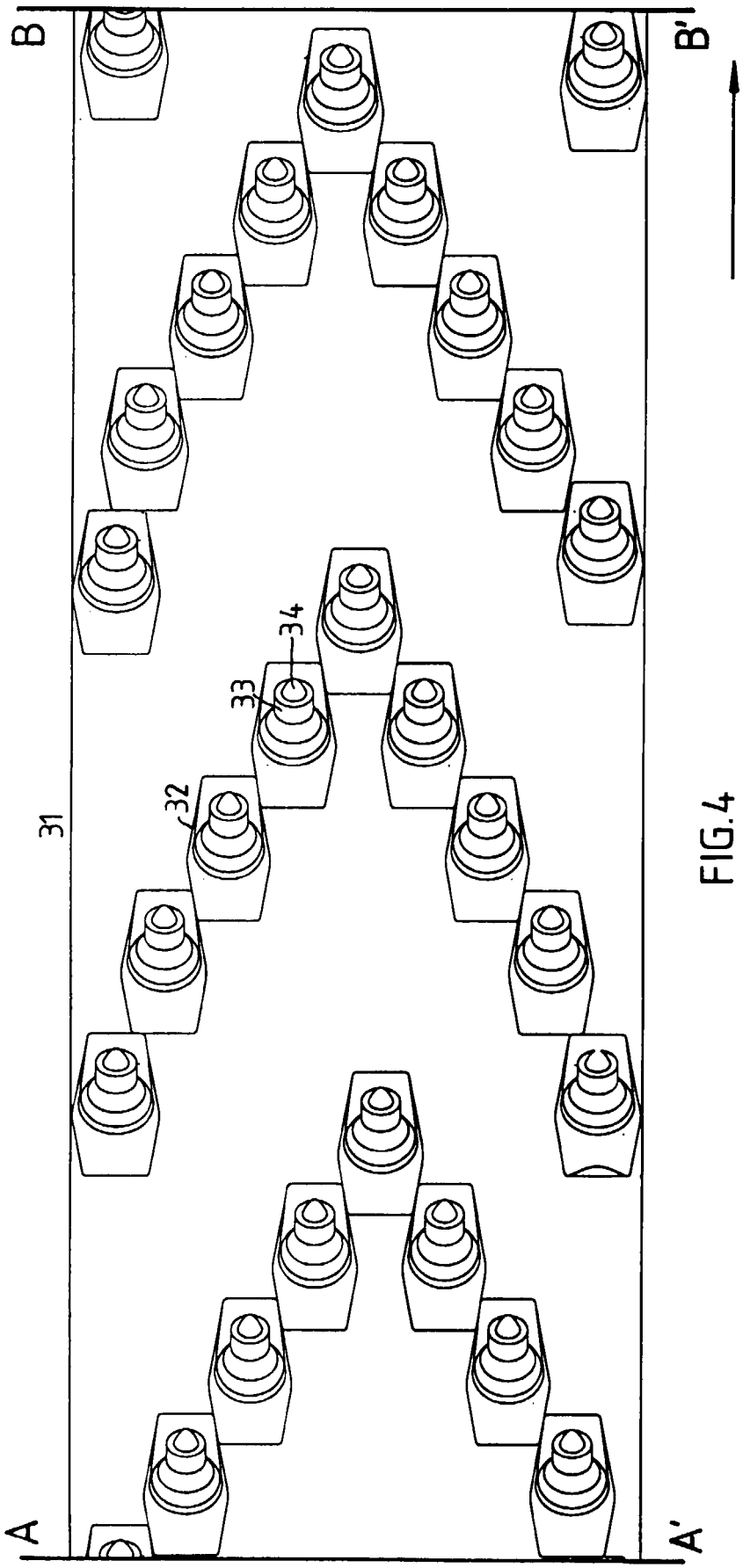

FIG.4