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Olsson

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[54] **METHOD AND APPARATUS FOR ANCHORING A CEMENT CONCRETE BODY SUCH AS A ROADWAY ONTO A BASE OF SAND, GRAVEL, SOIL OR SIMILAR MATERIAL**

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[52] **U.S. Cl.** **404/72,** 404/27, 404/83

[51] **Int. Cl.** **E01c 21/00**

[58] **Field of Search** 404/27, 31, 71, 75, 81, 404/82, 116, 121, 124; 172/21, 22, 91, 29

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[57] **ABSTRACT**

The invention relates to an improved method of anchoring and bonding a layer of cement concrete, primarily a roadway, onto a base of such resilient material as sand, gravel, stony soil and similar material by forming anchoring elements extending from the cement concrete layer into holes formed in the base and filled with cement concrete flowing down from the cement concrete layer before the hardening thereof. The method operates with elongated hole forming members which are forced downwards in axial direction through the not yet hardened cement concrete layer at an inclined angle to the surface of said layer and into the base to a predetermined depth and thereupon turned about their lower ends to at least vertical and preferably an opposite inclined angular position and thereupon retracted in their axial direction to be swung back to the primary angular position for beginning a new cycle of operations. A preferably travelling apparatus for carrying out the novel method is equipped with at least one hole forming member which is swingably mounted on a horizontal axis and in an articulated manner connected with power means for causing the member to perform its sequence of axial advance, turning, axial retraction, and swinging return movements with adjustable speed and pressure of advance, preferably together with a plurality of cooperating hole forming members mounted on the same horizontal axis and individually controllable as to their speed and pressure by a common program work. The travelling apparatus is equipped with means to exercise a pressure on the cement concrete layer adjacent the hole forming members to force cement concrete into the holes when formed by the members.

8 Claims, 9 Drawing Figures

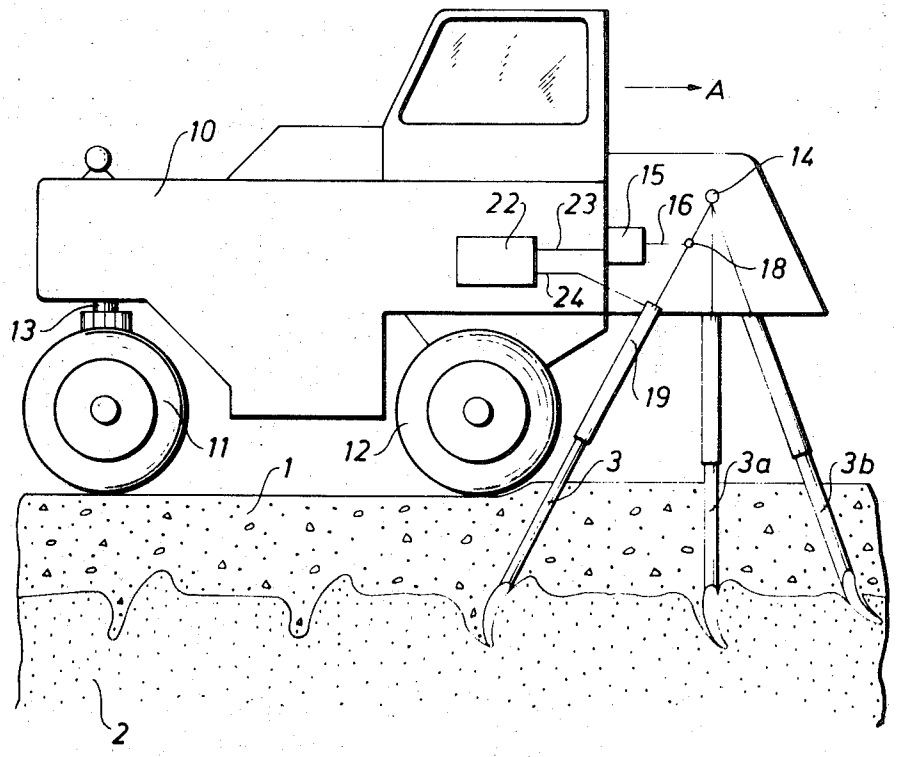


Fig. 1

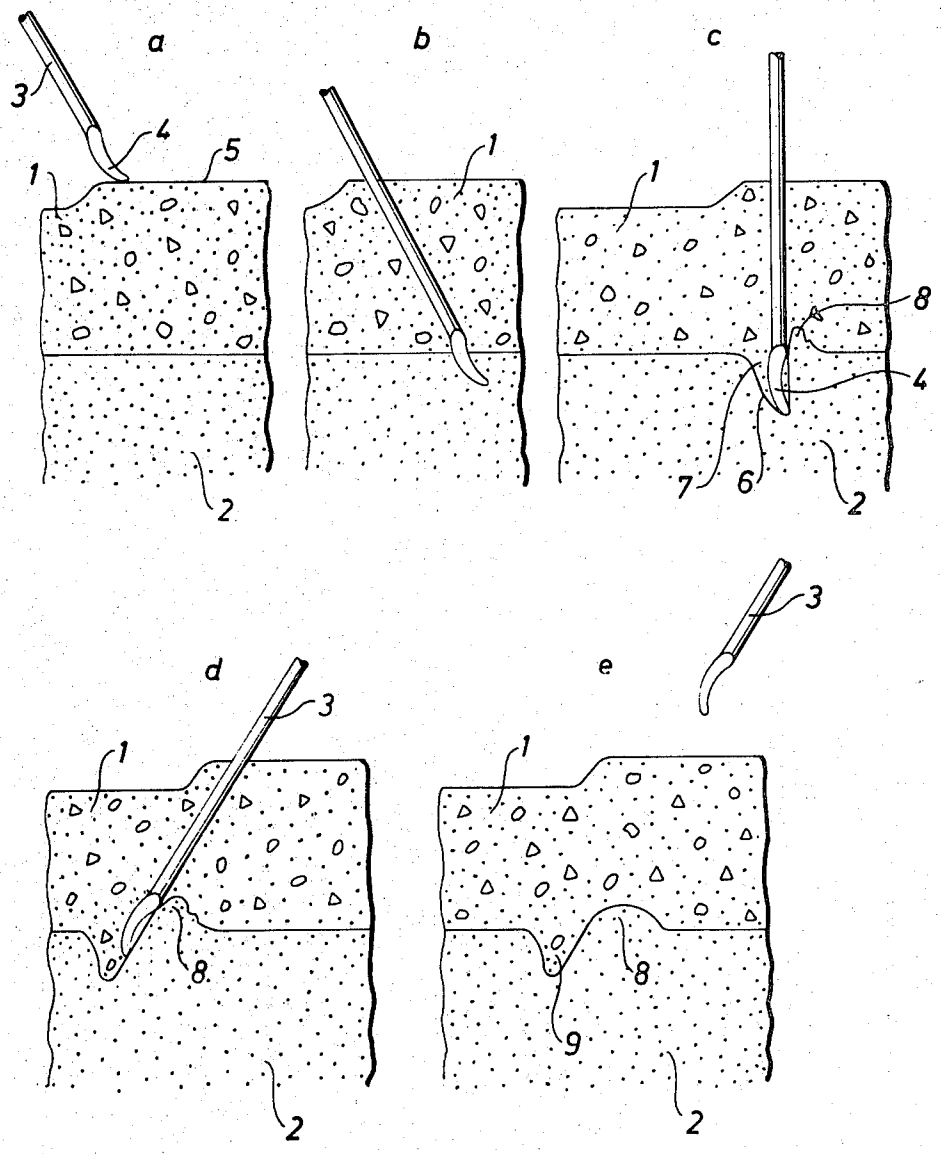


Fig. 2

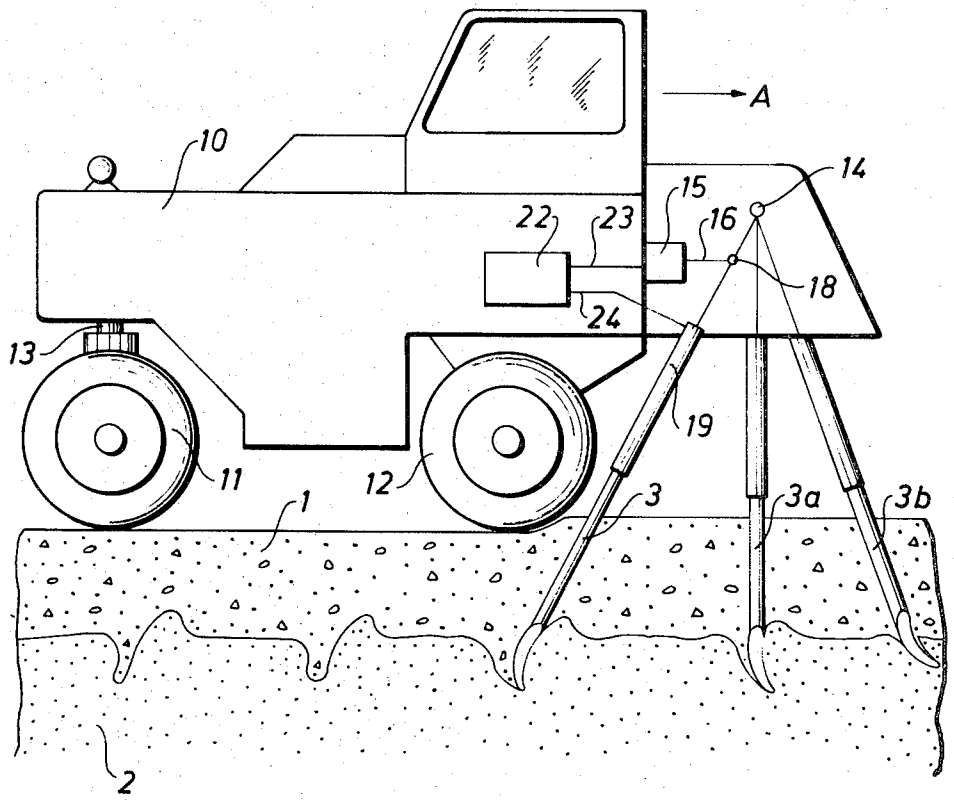


Fig.3

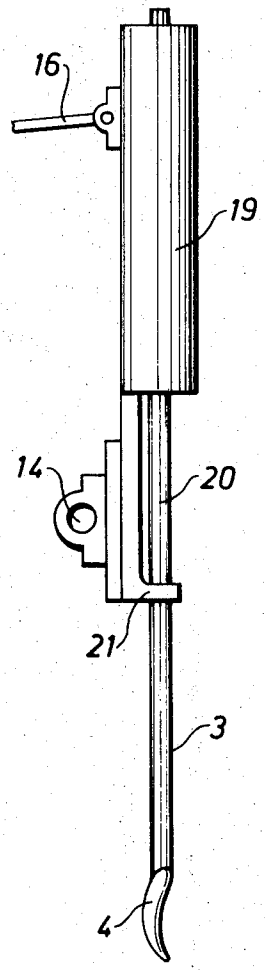


Fig.4

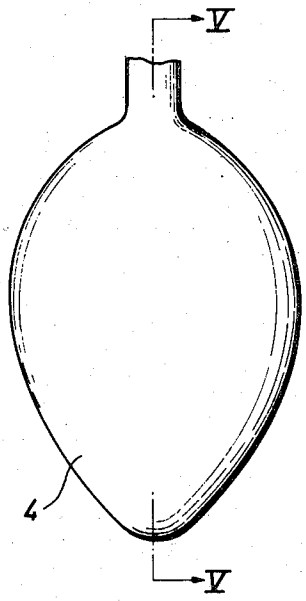
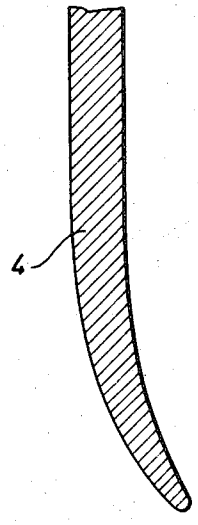


Fig.5



METHOD AND APPARATUS FOR ANCHORING A CEMENT CONCRETE BODY SUCH AS A ROADWAY ONTO A BASE OF SAND, GRAVEL, SOIL OR SIMILAR MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to a method of anchoring a cement concrete body such as a roadway, for example, onto a base of sand, gravel, soil and similar material in order to bring about a uniform distribution of cracks of contraction coming to existence in the body in connection with the hardening of the cement concrete. The method comprises molding a layer of cement concrete on the base and forcing elongated, hole forming devices downwards through the cement concrete layer and down into the base so as to cause cement concrete after removal of the hole forming devices to flow down into the holes in the base and when becoming hardened to form anchoring elements. The invention also comprises an apparatus for carrying out the novel method.

THE PRIOR ART

In the co-pending patent application Ser. No. 51,794 filed on July 2, 1970, now Pat. No. 3,680,450, issued on Aug. 1, 1972, it is disclosed already to force devices corresponding to the shape of the anchoring elements through the cement concrete layer prior to the hardening thereof and into the base, whereupon the holes or impressions formed in this way in the base are filled with cement concrete in order to provide a maximum of friction between the cement body and the base, whereby the cement concrete body due to the movements appearing in connection with the hardening of the cement concrete and afterwards due to changes in temperature accumulates in each little area around each anchoring element stresses of such nature that a very high number of fine fissures of contraction come into existence instead of one or a few big cracks.

However, it has been experienced that the use of hole forming devices having a shape corresponding to the desired shape of the anchoring elements will not always result in will defined holes because the formed holes often are slipped together by the hole forming devices during their movement in an arcuate path through the soil, causing the holes to be filled with base material before the cement concrete has had time to flow down into the holes. Such sliding of material from the base into the holes becomes particularly striking when the base consists of sand, and the difficulty of forming holes by means of devices of the previously disclosed type is especially prominent when the base or soil is stony.

THE OBJECTS OF THE INVENTION

One main object of the invention is thus to provide a method for forming holes for the anchoring elements which surely are filled with cement concrete irrespective of the nature of the base material. Base material is in the following to be understand as primarily comprised of sand, gravel, stony soil, or a base of maccadam and soil reinforced by admixed concrete.

Another object of the invention is to provide an apparatus which is capable irrespective of the nature of the base material of forming holes of such shape that they are not collapsed by surrounding base material but

retain their form until filled with cement concrete from superimposed, not yet hardened cement concrete.

Further objects and advantages of the invention will become apparent from the following description, considered in connection with the accompanying drawings, which form part of this specification.

GENERAL PRESENTATION OF THE DRAWINGS

FIGS. 1*a* to 1*e* are diagrammatic illustrations of the operation of a hole forming device.

FIG. 2 is a diagrammatic side view of a travelling apparatus equipped with hole forming devices.

FIG. 3 is a simplified side view of a hole forming device of the type with which the apparatus of FIG. 2 is equipped.

FIG. 4 is a front view of the lower portion of the hole forming device shown in FIG. 3.

FIG. 5 is a section following the line V—V of FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The method of forming anchoring elements between a not yet hardened cement concrete body 1 and a base 2 is illustrated in FIGS. 1*a* to 1*e*. These figures show in a simplified manner the lower portion of a hole forming device 3 having a digging end portion or shovel 4. FIG. 1*a* illustrates the moment when the hole forming device 2 as a result of an axial displacement with a predetermined inclination to the cement concrete layer 1 with its end portion 4 has reached the surface 5 of said cement concrete layer. The axial advancement of the rod-shaped device 3 is continued until its end portion 4 has penetrated downwards to the predetermined depth in the base 2. In the illustration of FIG. 1*b* this advancement movement is almost finished. FIG. 1*c* shows the end portion in its final position of axial displacement while the device 3 with its end portion 4 as axis of rotation has been turned upwards to a vertical position. The turning movement which in FIG. 1 is shown to be effected clockwise is preferably commenced only after that the axial advancing displacement has been finished, but may also be started earlier.

FIG. 1*d* illustrates the moment when the hole forming device has been turned further clockwise past the vertical line and an axial retraction movement has been imparted thereto. FIG. 1*e* shows the moment when the hole forming device has been retracted still more and left the cement concrete layer 1. Thereafter, the hole forming device is turned counterclockwise and the cycle of operations is repeated.

As will appear from the FIGS. 1*c* to 1*e*, the preferably shovelformed lowermost portion 4 of the device 3 during its turning movement about the lowermost point thereof with its front will displace a quantity of base material corresponding to the shovel surface ahead and thereby form a hole or aperture 6 which is represented in axial section. This hole will be filled in accordance with the widening of its mouth 7 by the movement of the shovel 4 with cement concrete and will be completely filled with concrete when the shovel 4 has been retracted. The filling out of the hole 6 is facilitated by continously compressing the cement concrete layer 1 by means of a roller or a similar element as shall be explained below in more detail.

From the FIGS. 1*c* to 1*e* it will further be understood that the lowermost portion of the shovel **4** during its turning movement forces base material to form a bank **8.** This bank **8** results in that the spacing between the upper surface of the base, i.e. the top ridge of the bank **8** and the surface of the cement concrete layer will be reduced adjacent each anchoring element **9,** and thereby a fracture indication for release of fissures of contraction in the body adjacent the anchoring element is created.

FIG. **2** shows in a simplified manner a travelling apparatus or truck **10** intended to be advanced in the direction of the arrow A, e.g. by its own driving means, over the not yet hardened cement concrete layer **1.** The truck **10** has in the shown embodiment supporting rollers **11** and **12** engaging the ground, of which the rear roller **11** is assumed to be pivotable about a vertical shaft **13** to render possible the steering of the truck. The front roller **12** brings about the afore-mentioned compression of the cement concrete layer in order, i.a., to make sure that the holes formed in the base are filled with cement concrete. In FIG. **2** there are illustrated three hole forming devices **3,** 3*a* and 3*b*, which are mounted swingably about an axis **14,** which extends at a right angle to the direction of drive A. The three hole forming devices are mounted spaced from one another in the direction of the axis **14** and will thus form three mutually parallel rows of holes in the base **2.** Even if only three hole forming devices have been shown, any desired number can be mounted depending on the breadth of the base **2** to be provided with anchoring holes.

All three hole forming devices **3** operate as described in connection with the FIGS. 1*a* to 1*e;* but in order to bring about various hole patterns they may be arranged to become operative at mutually different moments and also be driven with mutually different speeds.

In FIG. **2** the hole forming device **3** is thus assumed to be in the working position according to FIG. 1*d*, whereas the devices 3*a* and 3*b* are in the working positions corresponding to FIGS. 1*c* and 1*b*, respectively. The spacing between two adjacent holes in each row will depend on the working speed of the device forming this hole, i.e. of the time spent to perform a working cycle according to the FIGS. 1*a* to 1*e*. The swinging movement which each hole forming device performs about the upper pivot axis **14** is carried out on actuation by a driving device diagrammatically indicated at **15.** This driving device **15** may e.g. consist of a hydraulic motor having a reciprocating piston rod **16** for each of the hole forming devices **3,** 3*a*, 3*b*. The piston rod **16** is articulately connected to its cooperating hole forming device at **18.**

FIG. **3** shows more detailed though still diagrammatically a hole forming device **3** of the type employed in the apparatus according to FIG. **2.** A holder member **21** is pivotably mounted on the axis **14.** Said holder member **21** carries a hydraulic cylinder **19** having a piston **20** formed integrally with a prolongation constituted by the rod-shaped hole forming device **3** and terminating with a shovel **4.** The piston **20** is by the cylinder **19** imparted an axially directed movement towards the shovel **4** during the pressing down thereof into, or retraction from, the cement concrete layer **1** and the base **2.** The turning movement of the hole forming device about the lowermost point of the shovel and the simultaneous pivoting of the holder member **21** about the axis **14** during the continuous travel of the truck is, as mentioned already, brought about by the piston rod **16.** It should be observed, however, that a direct driving by means of the piston rod **16** is not absolutely necessary when the shovel is inside the base **2** since an automatic turning movement can be brought about by the own motion of the truck. However, when the device **3** has been retracted and is to be returned to commence a new working cycle from the position according to FIG. 1 *a*, a driving force must be supplied from the piston rod **16.**

The cylinder **19** may be devised to allow a certain return movement of the piston **20** from its most projected position in order to compensate for the reduction of the spacing between the outermost point of the shovel and the axis **14** when the hole forming device approaches the vertical position. A compensation for this reduction of the distance can also be brought about by a resilient mounting in bearings of the axis **14.**

Both the cylinder **15** and the cylinder **19** are suitably controlled by a program unit **22** of conventional kind. The program unit controls the supply of a pressure fluid such as oil to and from the cylinders through pipes **23, 24** and determines in this way axial movements and turning and pivoting movements, respectively, of the individual hole forming devices. Preferably the program unit is operated with punched cards so as to enable the forming of various hole patterns in response to the nature of the base, and preferably the program unit is further devised to feed oil to each cylinder **19** with a pressure corresponding to the density of the base so as to ensure that holes with a predetermined minimum depth are formed in the base. In case that the density of the base varies, which is the most usual case, the force is determined with regard to the highest density and the program unit is adjusted in accordance thereto. In this way the depth of the holes will be automatically adapted to occurring variations in density and correct anchoring or bonding will be obtained.

FIG. **4** shows a front view of a suitable shovel **4** and FIG. **5** a section through said shovel. The shape and the size of the lower, hole-forming portion of each device may, however, be varied in various manners and such shovel may have a purely rectangular contour or a triangular one with a downward directed point.

If a further concrete layer shall be molded on the layer **1** and a bonding of the uppermost layer with the underlying layer or layers is desired, the same technique as described above may be applied, the holes being formed in the cement concrete layer **1** prior to the hardening thereof.

While one more or less specific embodiment of the method and the apparatus according to the invention has been described and shown, it is to be understood that this is for purpose of illustration only and that the invention is not to be limited thereby, but its scope is to be determined by the appended claims.

What is claimed is:

1. A method of anchoring a cement concrete body in a base of sand, gravel, soil, or similar material to bring about a uniform distribution of cracks of contraction coming to existence in the body in connection with the hardening of the cement concrete, said method comprising the steps of molding a layer of cement concrete on the base and forcing elongated, hole forming devices through the cement concrete layer and down into the base so as to cause cement concrete after removal

of the hole forming devices to flow down into the holes in the base and when becoming hardened to constitute anchoring elements, characterized in that each hole forming device initially is displaced (1) without any substantial swinging motion and (2) in its axial direction at an angle of inclination through the cement concrete layer and down into the base, whereupon it is turned so much about its lowermost point carried down into the base while that lowermost point remains substantially stationary that its longitudinal axis at least reaches a vertical line, and then it is retracted substantially in the direction of said longitudinal axis.

2. The method as claimed in claim **1,** characterized in that the turning movement is continued until the longitudinal axis of the hole forming device forms an angle with the vertical line.

3. The method as claimed in claim **1,** characterized in that each hole forming device during its downward displacement into the base is actuated by an axially directed pressure force the magnitude of which is determined by the density of the base.

4. The method as claimed in claim **1,** characterized in that the cement concrete layer is compressed in the area of each hole forming device simultaneously with the performance of the turning movement of said device.

5. A method of anchoring a cement concrete body in a base of sand, gravel, soil, or similar material, said method comprising the steps of:

1. molding a layer of cement concrete on the base;
2. forcing an elongated, hole forming device through the layer of cement concrete and down into the base at an angle of inclination with respect to the surface of the layer, the motion of said elongated, hole forming device during this step being essentially along its longitudinal axis and without any substantial swinging motion;
3. turning said elongated, hole forming device about its lowermost point while the lowermost point remains substantially stationary until said elongated, hole forming device at least reaches a vertical position; and
4. retracting said elongated, hole forming device substantially in the direction of its longitudinal axis.

6. A method as claimed in claim **5** wherein the step of turning said elongated, hole forming device continues until it forms an angle of inclination with respect to the surface of the layer of cement concrete opposite in sense to the angle at which said elongated, hole forming device is initially forced through the layer.

7. A method as claimed in claim **5** wherein said elongated, hole forming device is actuated during the forcing step by an axially directed pressure force the magnitude of which is determined by the density of the base.

8. A method as claimed in claim **5** and further comprising the step of compressing the layer of cement concrete in the area of said elongated, hole forming device at substantially the same time as the turning step is performed.

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