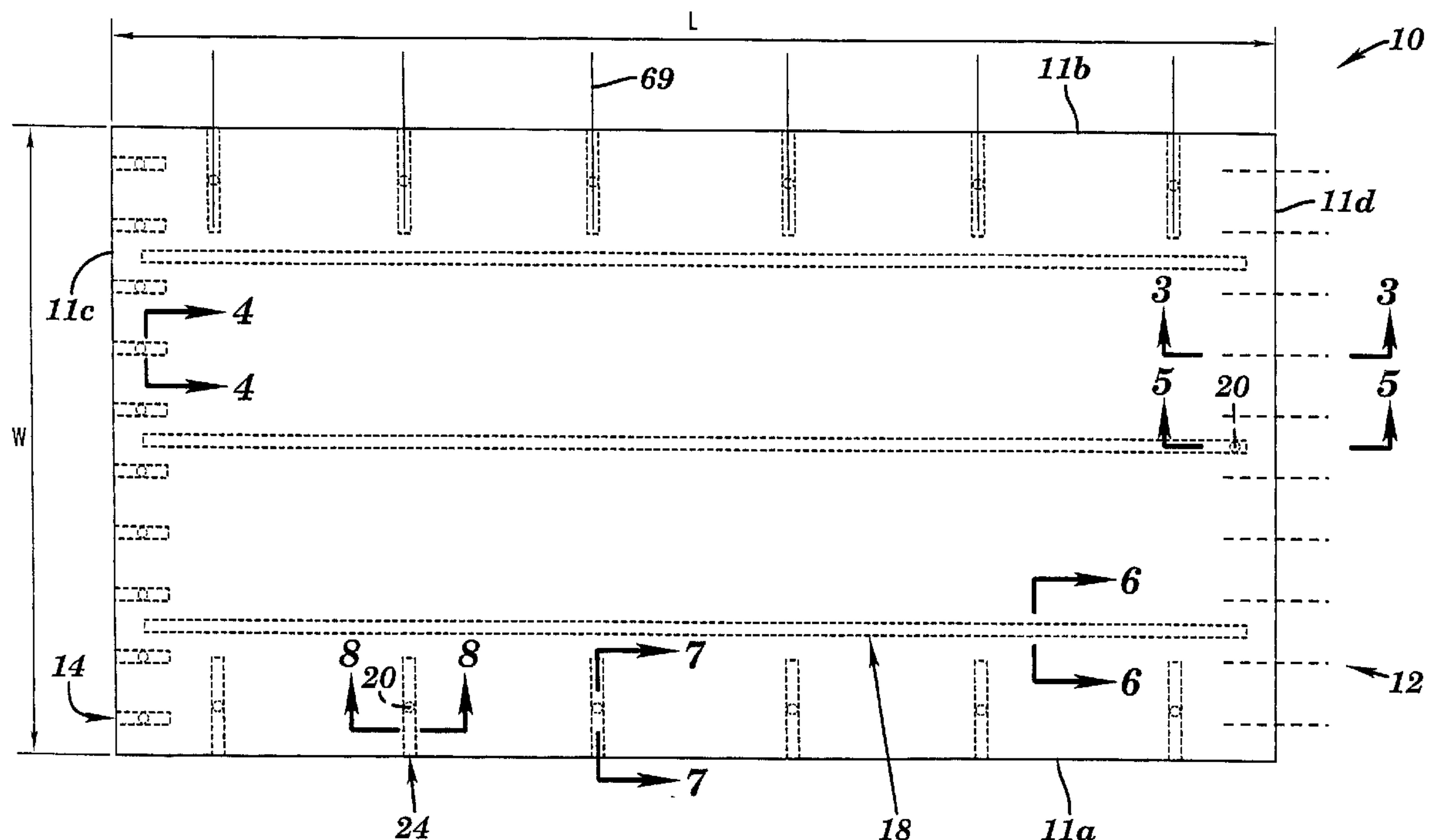




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(57) **Abrégé/Abstract:**

A pre-fabricated warped pavement slab and a forming system for making the slabs. The forming system includes a plurality of forming sections which can be adjusted so as to form a warped-plane pavement slab. Also disclosed are methods for making the pavement slab and forming system. Also disclosed is a method for installing the warped pavement slab.



PRE-FABRICATED WARPED PAVEMENT SLAB, FORMING AND PAVEMENT
SYSTEMS, AND
METHODS FOR INSTALLING AND MAKING SAME

ABSTRACT OF THE DISCLOSURE

A pre-fabricated warped pavement slab and a forming system for making the slabs. The forming system includes a plurality of forming sections which can be adjusted so as to form a warped-plane pavement slab. Also disclosed are methods for making the pavement slab and forming system. Also disclosed is a method for installing the warped pavement slab.

**PRE-FABRICATED WARPED PAVEMENT SLAB, FORMING AND PAVEMENT
SYSTEMS, AND
METHODS FOR INSTALLING AND MAKING SAME**

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates generally to roadway construction and repair, and more particularly, to the formation, installation and system for making and attaching a pre-fabricated warped pavement slab, and the warped slab so formed.

Related Art

Heretofore, attempts have been made to construct and install pre-fabricated or precast pavement slabs. However, most attempts have been unsuccessful due to a combination of factors. For example, it is difficult to prepare and maintain a perfectly smooth sub-grade which is necessary to uniformly support the slab. It is even more difficult to prepare a subgrade that is warped meeting profile and cross-slope changes normally encountered in roadway construction. Attempts to make a pre-fabricated pavement slab with an accurate and predictable warp have been unsuccessful. Likewise, it is difficult to connect adjacent slabs in a manner that uniformly transfers shear loading from one slab to the next. Heretofore attempts to prefabricate

such pavement slabs have been of an experimental nature and have been entirely inadequate and inefficient. Accordingly, there exists a need in the industry for a pre-fabricated warped pavement slab and a method of installing the warped slab that solves these and other problems.

SUMMARY OF THE INVENTION

In a broad aspect, the present invention relates to an apparatus comprising: a pre-fabricated pavement slab of uniform thickness formed of a hardenable, flowable material, wherein said pre-fabricated pavement slab is warped, wherein all the edges of the slab are straight, wherein an edge is the line of intersection between a top surface of the slab or a bottom surface of the slab and a side plane of the slab, further wherein if a non-perpendicular cross section is taken of the warped slab, the resultant edges will be non-linear, wherein resultant edges are either line at a top surface or bottom surface of the cross-sectional cut of the slab.

In another broad aspect, the present invention relates to a system for forming a pre-fabricated warped pavement slab comprising: a plurality of form sections having edges for forming a hardenable, flowable material wherein the form sections can be arranged to produce the warped pavement slab; and a device for adjusting a warp of the form sections by moving at least one edge out of plane from at least one other edge.

In yet another broad aspect, the present invention relates to a method for making a pre-fabricated warped pavement slab

comprising: providing a plurality of form sections; adjusting a first portion of the plurality of form sections out of plane with a second portion of the plurality of form sections; and placing a hardenable, flowable material onto the form sections.

5 In a further broad aspect, the present invention relates to a method for making a pre-fabricated warped pavement slab forming system comprising: providing a plurality of form sections having edges for forming a hardenable, flowable material wherein the form sections can be arranged to produce
10 the warped pavement slab; providing a device for adjusting a warp of the form sections; and moving with the device at least one edge out of plane from at least one other edge.

 In a still further broad aspect, the present invention relates to a method for installing a pre-fabricated warped
15 pavement slab, comprising: placing a pre-fabricated warped pavement slab on a graded subbase; and placing a binder material between a bottom surface of the warped slab and the graded subbase.

 In another broad aspect, the present invention relates to
20 a pavement system comprising: a graded subbase; a plurality of pre-fabricated warped pavement slabs placed on the graded subbase; a binder distribution system attached to a bottom surface of the plurality of pre-fabricated warped pavement slabs; and an interconnection system along edges of the
25 plurality of pre-fabricated warped pavement slabs.

 In still another broad aspect, the present invention relates to a precision pre-fabricated warped pavement slab

comprising: a pre-fabricated pavement slab formed of a
hardenable, flowable material, wherein a top surface of the
pavement slab is warped; and at least one edge of a cross
section taken perpendicular to a longitudinal side is straight.

5 The foregoing and other features of the invention will be
apparent from the following more particular description of the
embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The embodiments of this invention will be described in
detail, with reference to the following figures, wherein like
designations denote like elements, and wherein:

Fig. 1 depicts a plan view of a pre-fabricated pavement
slab in accordance with the present invention;

15 Fig. 2 depicts a cross-sectional view of the pre-
fabricated pavement slab in accordance with the present
invention;

Fig. 3 depicts a cross-sectional view of a transverse
dowel bar in accordance with the present invention;

20 Fig. 4A depicts a cross-sectional view, taken along line
4-4 of Fig. 1, of a connector slot in accordance with
embodiments of the present invention;

Fig. 4B depicts Fig. 4A using an alternative connector
slot in accordance with embodiments of the present invention;

25 Fig. 4C depicts Fig. 4A using an alternative connector
slot in accordance with embodiments of the present invention;

Fig. 5 depicts a cross-sectional view, taken along line 55 of Fig. 1, of a channel in accordance with embodiments of the present invention;

Fig. 6 depicts a cross-sectional view, taken along line 6-6 of Fig. 1, of the channel in accordance with embodiments of the present invention;

Fig. 7 depicts a cross-sectional view, taken along line E-E of Fig. 1, of a connector slot in accordance with the embodiments of the present invention;

Fig. 8A depicts a cross-sectional view, taken along line 8-8 of Fig. 1, of a connector slot in accordance with embodiments of the present invention;

Fig. 8B depicts Fig. 8A using an alternative connector slot in accordance with embodiments of the present invention;

Fig. 8C depicts Fig. 8A using an alternative connector slot in accordance with embodiments of the present invention;

Fig. 9 depicts a top mat in accordance with the present invention;

Fig. 10 depicts a bottom mat in accordance with the present invention;

Fig. 11 depicts a gasket in accordance with the present invention;

Fig. 12 depicts Fig. 11 using additional sections of a gasket in accordance with embodiments of the present invention;

Fig. 13A depicts a cross-sectional view of a dowel and an existing slab in accordance with embodiments of the present invention;

Fig. 13B depicts a cross-sectional view of a two-piece connector and an existing slab in accordance with embodiments of the present invention;

Fig. 13C depicts a plan view of a slot cut in an existing slab in accordance with the present invention;

Fig. 13D depicts a cross-sectional view of a slot cut in an existing slab in accordance with the present invention;

Fig. 14 depicts a grading device used in accordance with the present invention;

Fig. 15 depicts a form used to construct the slab in accordance with the present invention;

Fig. 16 depicts a perspective view of a warped slab in accordance with the present invention;

Fig. 17A depicts a side view of a side of a warped slab in accordance with the present invention;

Fig. 17B depicts a side view of an end of a warped slab in accordance with the present invention;

Fig. 18 depicts a perspective view of a portion of a forming system in accordance with the present invention;

Fig. 19 depicts a side sectional view of a portion of a forming system in accordance with the present invention;

Fig. 20 depicts a perspective view of a moveable jacking beam portion of a forming system in accordance with the present invention;

Fig. 21A depicts a plan view of a portion of a forming system in accordance with the present invention;

Fig. 21B depicts a plan view of a portion of a forming system in accordance with the present invention;

Fig. 22A depicts a side view of a roller assembly portion of a forming system in accordance with the present invention;

Fig. 22B depicts a side view of a roller assembly portion of a forming system in accordance with the present invention;

Fig. 23A depicts a side view of a mobile jacking trolley portion of a forming system in accordance with the present invention;

Fig. 23B depicts a side view of a mobile jacking trolley portion of a forming system in accordance with the present invention;

Fig. 24A depicts a side view of a portion of a forming system in accordance with the present invention;

Fig. 26 depicts a perspective view of a portion of a side rail of a forming system in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Although certain embodiments of the present invention will be shown and described in detail, it should be understood that various changes and modifications may be made without departing from the scope of the appended claims. The scope of the present invention will in no way be limited to the number of constituting components, the materials thereof, the shapes thereof, the relative arrangement thereof, etc. Although the drawings are intended to illustrate the present invention, the drawings are not necessarily drawn to scale.

Referring to the drawings, Fig. 1 shows a plan view of a pre-fabricated pavement slab 10. The slab 10 may be constructed by pouring a pavement material, such as concrete, or other similarly used material, into a form 60, having a plurality of raised channel forming surfaces 62, raised slot forming surfaces 64, connector openings 66 and port forming surfaces 68 (refer to Fig. 15). The raised channel forming surfaces 62 may be independent from the raised slot forming surfaces 64. The slab 10 may be used in high traffic areas, such as highways, on/off ramps, airport runways, toll booth areas, etc. The pavement slab

10 can vary in length and width. The length of the pavement slab 10 can be in the range from 1 foot up to 18 feet. The width of the pavement slab 10, likewise, can vary from a width of 2 feet up to 12 feet wide. A typical pavement slab 10 for use in a highway roadway may be approximately 10-12 feet (3.049-3.658 m) wide W, as required by the New York State Department of Transportation, and approximately 18 feet (5.486 m) in length L, for example. Similarly, a pavement slab 10 which has dimensions of approximately 2 feet in length by a full roadway lane (e.g., 12 feet) wide can be installed to replace a damaged or deteriorated roadway joint. Additionally, a pavement slab 10 may have dimensions, for example, of approximately 2 feet in length by 2 feet in width, which would be useful as a roadway replacement patch. The slabs 10 may range in thickness T from approximately 9-12 inches. These dimensions, L, W, T, however, may vary as desired, needed or required and are only stated here as an example.

The top surface 9 of the slab 10 is a roughened astroturf drag finish, while the sides 11a, 11b, 11c, 11d, and bottom surface 13 of the slab 10 have a substantially smooth finish (refer to Fig. 2, which shows a cross-sectional view of a corner of the slab 10). The bottom surface 13, the sides 11a, 11b, 11c, 11d of the slab 10 come together to form a chamfer 15 around the perimeter of the slab 10. The chamfer 15 prevents soil build-up

between two mating slabs which may occur if the slab 10 is tipped slightly during installation.

The slab 10 further includes a plurality of connectors 12 that may comprise transverse slippable connecting rods or dowels. The plurality of connectors 12 may be embedded within an end of the slab 10. In one embodiment, the connectors 12 are post tensioned interconnections, as known and used in the industry, wherein multiple slabs may be connected in compression. The connectors 12 are spaced approximately 1 ft. apart along the width W of the slab 10, and comprise steel rods, or other similar material conventionally known and used. Each connector 12 is of standard dimensions, approximately 14 inches in length and 1.25 inches in diameter. The slippable connectors 12 are mounted truly parallel to the longitudinal axis L of the slab 10 to allow adjacent slabs 10 to expand and contract without inducing unwanted damaging stresses in the slabs 10. The connectors 12 [are preferentially] can be mounted such that approximately half of the connector 12 is embedded within the pavement slab 10 and half of the connector 12 extends from the side of the slab 10.

Fig. 3 shows a cross-sectional view (along line A-A of Fig. 1) of the slab 10 and a connector 12 extending therefrom. As illustrated, the connectors 12 are embedded within the side 11d of the slab 10 at approximately the midpoint of the thickness T of the slab 10. The connectors 12 aid in transferring an applied

shear load, i.e., from traffic, evenly from one slab 10 to the adjacent slab, without causing damage to the slab 10.

The slab 10 further includes a plurality of inverted interconnection slots 14 formed within the bottom surface 13 of the slab 10 at a side 11c thereof. Each interconnection slot 14 is sized to accommodate the connectors 12 extending from the side of an adjacent slab 10, thereby forming an interconnection between adjacent slabs once the slot 14 is filled around the connectors 12 with a binder material. Fig. 4A shows a cross-sectional view (along line B-B of Fig. 1) of an interconnection slot 14, wherein the slot 14 is wider at the top of the slot 14 than at the bottom of the slot 14. This wedged shape prevents the slab 10 from moving downward with respect to the adjacent slab with the application of a load once the binder material has reached sufficient strength.

In the alternative, the interconnection slots 14 may take the form of a "mouse hole" having a pair of cut-outs or holes 17 formed on both sides thereof, as illustrated in Fig. 4B. In this case, when the slots 14 are filled with a binder material, the holes 17 form shear pins on the sides of the mouse hole that would have to be sheared in order for the slab 10 to move downward with respect to the adjacent slab. In the alternative, the slots 14 may have vertically oriented sides, as illustrated in Fig. 4C. In this case the sides of the slot 14 are

sandblasted to provide a roughened surface, thereby frictionally limiting the ability of the slab 10 to move downward with respect to the adjacent slab.

As illustrated in Figs. 4A-4C, each interconnection slot 14 further includes an opening, access or port 16. In particular, a binder material such as structural grout or concrete, a polymer foam material, or other similar material, may be injected within each port 16 thereby filling the interconnection slot 14 receiving the inserted connector 12 (not illustrated) to secure adjacent slabs end to end.

It has been previously noted that the connectors 12 are preferentially mounted as described above with approximately half of the connector 12 embedded in an adjacent slab while the other half is engaged and embedded in the interconnections slots 14 of slab 10. Alternatively, the same connector 12 may be preplaced on the subgrade, not shown, such that interconnections slots 14 in both slabs engage the connectors 12, such interconnection slots 14 being subsequently filled with binder material in the same manner described in the foregoing.

The slab 10 further includes a plurality, in this example three, channels 18 running longitudinally along the length L of the slab 10. The channels 18 formed within the bottom surface 13 of the slab 10 facilitate the even dispersement of a bedding material, such as bedding grout or concrete, a polymer foam

material, or other similar material, to the underside of the slab 10. As shown in Fig. 5, which depicts a cross-sectional view of the slab 10 (along line 5-5 of Fig. 1), each channel 18 includes a port 20 at each end of the channel 18 (one end shown in Fig. 5). Each port 20 extends from the top surface 9 of the slab 10 to the channel 18, thereby providing access to the channel 18 from the top surface 9 of the slab 10. This facilitates the injection of bedding material beneath the bottom surface 13 of the slab 10 via ports 20 which are accessible from the top surface 9 after the slab 10 has been installed.

As illustrated in Fig. 6, which shows a cross-sectional view of the channels 18 along a line 6-6 of Fig. 1, the channels 18 are in the shape of half round voids. The rounded shape aids in the uniform distribution of bedding material along the bottom surface 13 of the slab 10 to fill any gaps between the slab 10 and the subbase (not shown). In the alternative, the channels 18 may take other shapes, such as rectangles, etc. Furthermore, instead of using channels 18 to facilitate the even dispersment of the bedding material beneath the slab 10, a pipe system may be used. For instance, the pipe system (not shown) may comprise a plurality of pipes, approximately one inch in diameter, having holes or continuous slots formed therein.

The slab 10 further includes a plurality of interconnection slots 24, shown in this example within a first side 11a of the

slab 10 (Fig. 1). The slots are illustrated more clearly in Figs. 7 and 8A-8C. In particular, Fig. 7 shows a cross-sectional view of an interconnection slot 24 taken along a line 7-7 of Fig. 1. As illustrated, each interconnection slot 24 comprises a pair of openings, accesses or ports 26 at each end of the slot 24 which extend from the top surface 9 of the slab 10 to the interconnection slot 24 thereunder.

The slab 10 further includes a plurality of connectors 69 that may comprise longitudinal connectors, non-slippable connecting rods or dowels embedded within a second side 11b of slab 10 along the length L of the slab 10. As with the connectors 12, the connectors 69 may be post tensioned interconnections. The connectors 69 may be one-piece, where approximately half of the connector 69 is embedded within the pavement slab 10 and half of the connector 69 extends from the second side 11b of the slab 10. Alternatively, the connector 69 may be of a two-piece design comprising a first connector 54 and a second connector 56 as shown in Fig. 13B. The two-piece design would be used if it is desirable to keep shipping width of slab 10 to a minimum.

Fig. 8A depicts a cross-sectional view of the interconnection slot 24 and port 26 along line 8-8 of Fig. 1. Similar to the interconnection slots 14 along the sides 11c, 11d of the slab 10 (shown in Figs. 4A-4C), the interconnection slots

24 along the sides 11a, 11b of the slab 10 may alternatively take the form of a mouse hole 24 having cut-outs or holes 25 (Fig. 8B), or a slot 24 having vertically oriented sandblasted sides (Fig. 8C). The interconnection slots 24 receive connectors 69 that may comprise non-slippable connecting rods or dowels located within and extending from an adjacent new slab 10 or from an existing slab 50, such has been described embedded in the second (i.e., other) side 11b of slab 10.

After the slab has been installed and the connectors are in their final location, a binder material, such as structural cement-based grout, a polymer foam, etc., is then injected into the interconnection slots 24, having the rods inserted therein, from the top surface 9 of the slab 10 via the ports 26. This aids in rigidly interconnecting adjacent slabs of the roadway and facilitates a relatively even load transfer between lanes.

The slab 10 further includes a top mat 32 and a bottom mat 34 (Figs. 9 and 10, respectively). Both mats 32, 34 comprise reinforcing bars, or in the alternative reinforced steel mesh. The top mat 32, comprising longitudinal bars 31 and at least two transverse or cross bars 29, is formed within the slab 10 substantially near the top surface 9 of the slab 10. The top mat 32 aids in minimizing the slab 10 from "curling" or bending at the edges as a result of cyclic loading produced by temperature differentials. Likewise, the bottom mat 34 comprises

longitudinal bars 33 and transverse or cross bars 35 formed within the slab 10 substantially near the bottom surface 13 of the slab 10. The bottom mat 34 provides the slab 10 with additional reinforcement and stability during handling.

A seal or gasket 36, comprising a compressible closed cell foam material, such as neoprene foam rubber or other similar material, is attached to the bottom surface 13 of the slab 10 around the perimeter of the slab 10, as illustrated in Fig. 11. In one embodiment, the gasket 36 is approximately 18 mm thick and 25 mm wide, and is soft enough to fully compress under the weight of the slab 10. The gasket 36 forms a chamber or cavity 38 thereby sealing the boundary of the slab 10. This allows for the application of pressure to the bedding material during installation to ensure that all voids between the bottom surface 13 of the slab 10 and the subbase are filled.

In another embodiment, the gasket 36 can be made from a material selected of such a softness so that the slab 10 is held up a predetermined amount so as to create a design space for grout or other bedding material to be inserted. The softness of the selected material for the gasket 36 in this embodiment will conform so that the top surface 9 and bottom surface 13 of the slab 10 is held generally parallel to the surface of the prepared subgrade. This embodiment is useful when the subgrade, rather

than compacted stone dust, is a dense graded base, as discussed below.

Optionally, additional sections of the gasket 36, having the same or similar width and thickness, may be applied to the bottom surface 13 of the slab 10 to form a plurality of individual chambers or cavities 38, as illustrated in Fig. 12. The additional sections of the gasket 36 forming the cavities 38 reduce the amount of upward pressure exerted on the slab 10 during the injection of the bedding material as compared to that experienced by the slab 10 using one large sealed cavity (as illustrated in Fig. 11). Forming at least 3 to 4 cavities 38 effectively reduces the lift force produced from below the slab 10 as the bedding material is being forced thereunder.

In an alternative embodiment (not shown) of the present invention, a different binder distribution system is employed. In lieu of gasket material 36, a geotech fabric, or the like, is used to hold the binder material. For example, two layers of a geotech fabric is attached to the slab 10 in various locations. The layers of geotech fabric may be additionally attached to each other in selective locations thereby forming pockets between the fabric layers which receive the pumped in grout. In addition, the bottom surface 13 of the slab 10 may be flat. The geotech fabric thus acts as a series of chambers to hold and distribute the grout, or similar binder material. In another embodiment, a

connectors 12 and connectors 69 in slab 10 (refer to Figs. 13C and 13D). The sawing operation would be done ahead of the slab 10 installation operation. The slots 70 would be opened up and burrs removed using a light-weight pneumatic chipping hammer, or other similar tool. This option would be chosen to avoid the above described drilling process that should be done during the night-time grading operation.

In preparation for slab installation, the replacement area (the area in which the slab 10 will be placed) is cleaned of all excess material to provide a subbase or sub-grade approximately 25 mm below the theoretical bottom surface 13 of the slab 10. The subbase is graded with conventional grading equipment such as a grader, backhoe, skid steer loader, etc., and fully compacted with a vibratory roller or other similar device. The compacted subgrade is subsequently overlaid with approximately 30mm of finely graded material such as stone dust that can be easily graded with the precision grading equipment described below.

The stone dust is then graded with a grading device, such as the Somero Super Grader™ (Somero Enterprises of Jafrey, New Hampshire), as illustrated in Fig. 14. The Somero Super Grader™ is controlled by a rotating laser beam, or 3-D total station, that is continuously emitted by a laser transmitter 42, located at a remote location and at least 6-8 feet above ground level. The transmitter is adjusted to emit a beam of unique cross-slope

and grade corresponding to the plane required for the slab 10. The cross-slope allows for water run-off and the grade represents the longitudinal slope required for vertical alignment of the roadway.

For straight highways, where the cross-slope and the grade are constant, the rotating laser beam set as described above will serve to set multiple slabs. For both horizontally and vertically curved highways the rotating laser beam will have to be set to a distinct plane for each slab. This continuous adjustment may be done manually or automatically with software designed for that specific purpose. Alternatively, the screed may be controlled by other electronic means unique to the Somero Super Grader™.

Specific to the Somero Super Grader™, laser receivers 44, mounted on posts 46 above the screed 48, receive and follow the theoretical plane emitted from the transmitter 42 as the grading screed 48 is pulled over the replacement area leaving the stone dust approximately 3/4" high. After the first grading pass, the stone dust layer is damped with water and fully compacted with a vibratory roller or other similar device and a second, and final, grading ("shaving") pass is made in which the subbase is brought to within 1/16th of an inch (or "Super-Graded") of the required theoretical plane. The stone dust layer is dampened with water,

as needed for the subsequent grouting process, in final preparation for installation of the slab 10.

In an alternative embodiment, the layer of finely grade material such as stone dust is omitted. In lieu of the stone dust, a dense graded base is placed in two lifts. The first lift is placed about 1" lower than theoretical elevation. It is then wetted and rolled such that its final average elevation is slightly lower than the required final elevation of the bottom surface 13 of the slab 10. The second lift is super graded in a similar fashion to an elevation slightly higher (e.g., 1/4") than theoretical elevation and wetted and rolled as required in final preparation for installation of the slab 10. The second lift of dense graded base typically cannot be supergraded ("shaved") after it has been wetted and rolled because unlike the stone dust the dense graded base has variable size and larger stone that would get pulled up from the subgrade. Thus, when dense graded base is used as a subbase material, the finished surface is more apt to be slightly rougher in that there will exist larger stone that sticks up above the surface of the rest of the field of dense graded base. It is because of these projecting stones, that the embodiment for the gasket 36 material discussed above that is not fully compressible is used. The non-fully compressible gasket 36 is able to mold around and conform to the

projecting stones in the final graded dense graded base without changing the final average elevation of the placed slab 10.

The slab 10 is placed within the replacement area such that the slab 10 contacts the subbase uniformly so as not to disrupt the subbase or damage the slab 10. During placement, the slab 10 is lowered vertically to the exact location required to match the adjacent existing slabs 50. Care is taken to insure the interconnection slots 14 and 24, within the sides and end (if an adjacent slab is present at the end of the slab 10) of the slab 10 are lowered over the connectors 12 and connectors 69 extending from the ends and sides of the adjacent slabs 50 respectively. In the case where connectors 12 and connectors 69 extend from the slab 10, the slab 10 is also lowered vertically and carefully to insure the connectors 12 and connectors 69 are set within the slots 70 of the adjacent existing slabs 50. At this time, the slab 10 should be within 6+/- mm of the theoretical plane emitted from the rotating laser transmitter 42. In the event the surface 9 of the slab 10 is out of the required tolerance it is planed with a conventional diamond grinder until it is brought within tolerance.

The interconnection slots 14, 24 or 70, as the case may be are filled from the top surface 9 of the slab 10 with a binder material such as structural grout, or in the alternative, a polymer foam material, thereby fastening the slab 10 to the</

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connectors 12, 54, 56, 69 or the slot 70 of the adjacent existing slabs 50. In particular, the binder material is injected under pressure into a first port 16, 26 of the interconnection slots 14, 24, respectively, until the binder material begins to exit the port 16, 26 at the other end of the interconnection slot 14, 24. It is desirable for the binder material within the slots 14, 24 to reach sufficient strength to transfer load from one slab to the other before opening the slab 10 to traffic.

The chamber(s) 38 formed by the gasket 36 on the bottom surface 13 of the slab 10 is/are then injected from the top surface 9 of the slab 10 with bedding material, such as grout including cement, water and fly ash, or in the alternative with a polymer foam material. In particular, starting from the lowest or downhill region, bedding material is injected into the port 20 at one end of the channel 18 until the bedding material begins to exit the port 20 at the other end of the channel 18. The bedding material is injected into the channels 18 to ensure that all voids existing between the bottom surface 13 of the slab 10 and the subbase, regardless of size, are filled. The slab 10 should be monitored during injection of the bedding material to ensure the slab 10 is not vertically displaced due to the upward pressure created thereunder. It is desirable for the bedding material under the slab 10 to reach a minimum strength of approximately 10.3 MPa before opening the slab 10 to traffic.

It should be noted that due to the precision of the Super Graded subbase, the channels 18 may not need to be filled prior to exposure of the slab 10 to traffic. Rather, the channels 18 may be filled within 24-48 hours following installation of the slab 10 without damaging the slab 10 or the subbase. In other words, if required, vehicular traffic can be allowed on the slabs 10 immediately after the placement of the slabs 10. This is particularly useful due to time constraints.

A warped slab is defined as a slab that has a warped surface. A slab being a body of uniform thickness in which the sides are substantially perpendicular to both the top and bottom surfaces. A warped surface being a surface in which all the points of the surface are not in a single plane. That is, the slab is not entirely planar, but warped. For example, with a rectangular-shaped warped slab, three of the four corners of the slab could be in a single plane. The fourth corner conversely would not reside in this same single plane. This fourth corner would be either "higher" or "lower" in relationship to the plane in which the other three corners reside. With the warped slab, typically both the top and bottom surfaces are parallel and warped. Thus, the warped slab's top and bottom surfaces will both match and be substantially parallel to the surface of the subgrade on which the warped slab is placed. A warped slab is further defined wherein all the edges are straight, wherein an

edge is the intersecting line between any side and either the top or bottom surface of the slab. Further, with a warped slab, when any cross section is taken that is perpendicular to a longitudinal side, the resultant edges (i.e., the lines at the top and bottom surface of the cross-sectional "cut") will likewise be straight lines. Conversely, if a diagonal (i.e., non-perpendicular) cross section is taken of the warped slab, the resultant edges (i.e., the lines at the top and bottom surface of the cross-sectional "cut") will not be straight, but non-linear.

The use of a warped slab in roadway construction is typically called for when the cross-sectional slope of a road lane changes over the longitudinal length of the roadway slab. Similarly, a warped slab in roadway construction could also be used when the roadway lane is both curved over the longitudinal length of the roadway slab and has a change in elevation over the longitudinal length (i.e., profile change) of the roadway slab. Prefabricated warped pavement slabs could be used, for example, both over subgrade in a roadway as well as in an elevated condition such as bridge, viaduct, or parking garage construction.

The present invention is able to make precision prefabricated warped pavement slabs with precision tolerances throughout the whole plan area of the slab. The device is able to thus make prefabricated pavement slabs either in a flat slab

configuration or a warped slab having a total warp in the range from 3-4 mm to approximately 3 inches. Although the shape, in plan, of the warped slab can be rectangular, other non-rectangular shapes are readily attainable with the present invention. Another advantage of the present invention is the ability to construct a pre-fabricated warped pavement slab wherein the warp in the slab matches precisely and uniformly throughout the whole area of the slab a predetermined warp required for the specific roadway section being built, as well as, precisely matching the warp of the entire subgrade in the location where the slab will be placed. Another advantage of the present invention is the ability to quickly install prefabricated pavement slabs in their final location and to allow vehicular traffic use the installed pavement shortly after the installation.

FIG. 16 shows a perspective view of a pre-fabricated warped pavement slab, designated as 100. The top 9 of the warped slab 100 is shown as are some of the sides 11. A rectangular pre-fabricated warped pavement slab 100 is shown. However, pre-fabricated warped pavement slabs 100 can be made with different footprint shapes (i.e., non-rectangular). The pre-fabricated rectangular warped pavement slab 100 has four corners 102 (i.e., 102A, 102B, 102C, 102D). The first corner 102A, or non-planar corner, is shown lifted above the planar surface of the other

three corners 102B, 102C, 102D. Thus, the first corner 102A is out of plane with the other three corners 102B, 102C, 102D. A flat slab with all four corners 102 in the same plane is shown in phantom. Although in FIG. 16 the first corner 102A is shown above the other three corners 102B, 102C, 102D, the first corner 102A could conversely be lower than the other three corners 102B, 102C, 102D. Similarly, the non-planar corner could be any one of the other three corners of the pre-fabricated warped pavement slab 100 instead of just the first corner 102A, since any three corner define a plane.

FIGS. 17A and 17B show side views of a pre-fabricated warped pavement slab 100. The non-planar corner 102A is shown higher than the rest of the warped slab 100. The top and bottom edges (i.e. intersecting line between sides 11 and top surface 9 and bottom surface 13) of all the sides 11 of the pre-fabricated warped pavement slab 100 are straight. Similarly, if a cross-section was taken of the warped slab 100 at any location along the warped pavement slab 100, wherein the cross-section is taken perpendicular to a side 11, the resultant edges will similarly be straight.

In order to create a pre-fabricated warped pavement slab 100 a portion of the formwork must be placed out

side rails 160. The side rails 160 are movable, as denoted by directional arrow "B", so that they can match both the shape of the desired warped slab 100 and the location of the jacking beam 140 below. As the perspective view in FIG. 26 shows, each side rail 160 is L-shaped in cross section. A vertical face 163 is connected to a horizontal base 164A and a horizontal top rail 164B. Additional vertical gussets 162 provide additional strength to the side rail 160. The vertical faces 163 of all the side rails 160 are perpendicular, at all points, to the casting deck 180. Located on the base 164 are a plurality of magnets 161, such as the "EZY-STRYP" Button Magnet made by Spillman (Spillman Inc. of Columbus, OH). The magnets 161 provide a simple, quick and non-penetrating attachment to form sections 170. Other types of clamping devices may clamp abutting side rail 160 sections together to form a more positive connection. Within the space between the side rails 160 is placed a hardenable, flowable material, such as concrete for forming into the final warped slab 100.

It should be apparent to one skilled in the art that the form system 110, while able to make warped pavement slabs 100, can be used just as readily make a flat (i.e., non-warped) pavement slab 10. Similarly, the various devices, appurtenances, methods, and pavement systems disclosed above for use with a flat

pavement slab 10, can readily be applied as well in making and installing the warped pavement slab 100.

While this invention has been described in conjunction with the specific embodiments outlined above, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the embodiments of the invention as set forth above are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention as defined in the following claims.

We Claim:

1. A method comprising:

forming a plurality of prefabricated pavement slabs at a remote location;

grading a subgrade;

placing the prefabricated pavement slabs on the subgrade;

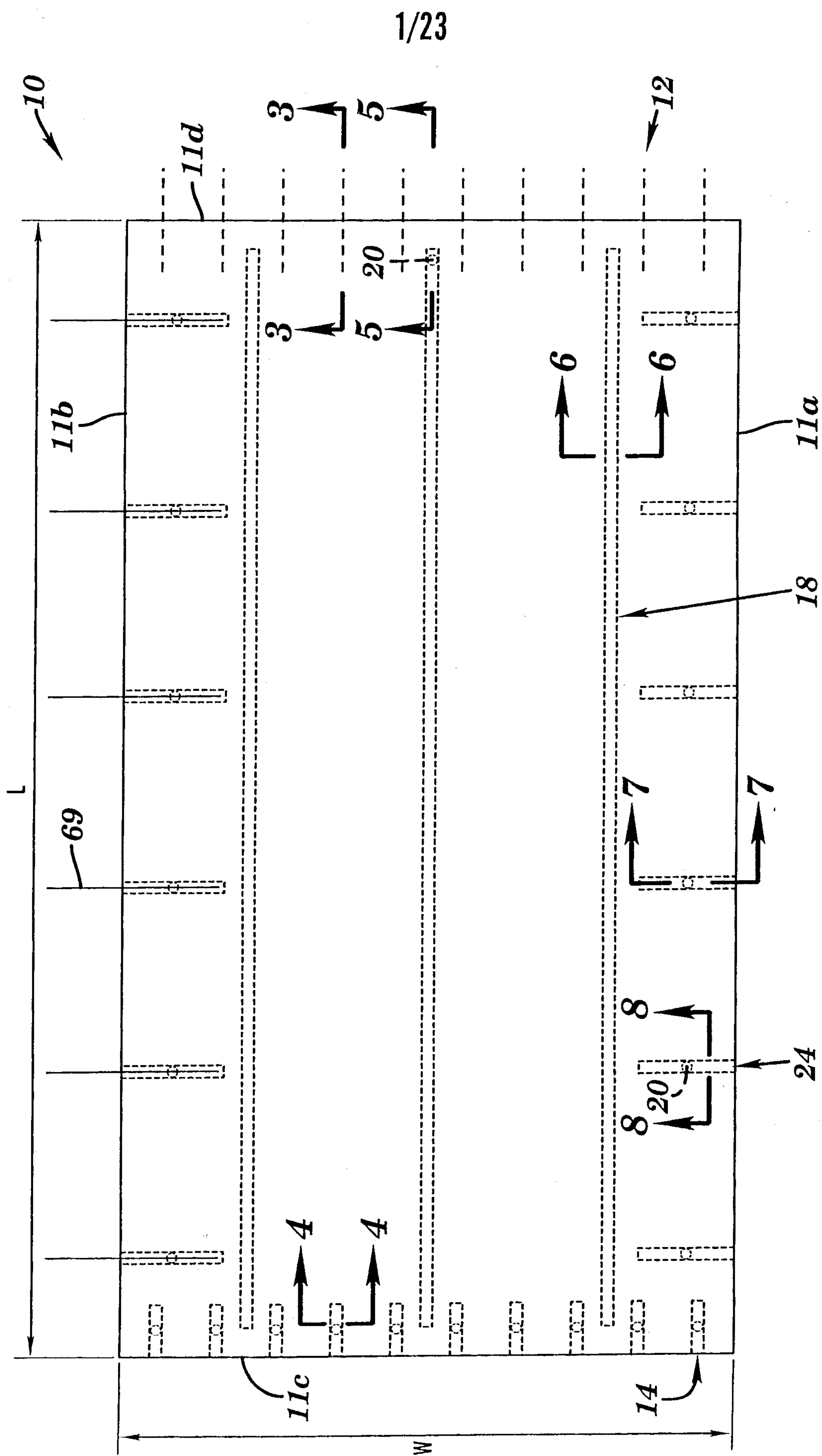
and

leveling at least one of the prefabricated pavement slabs with a flowable material.

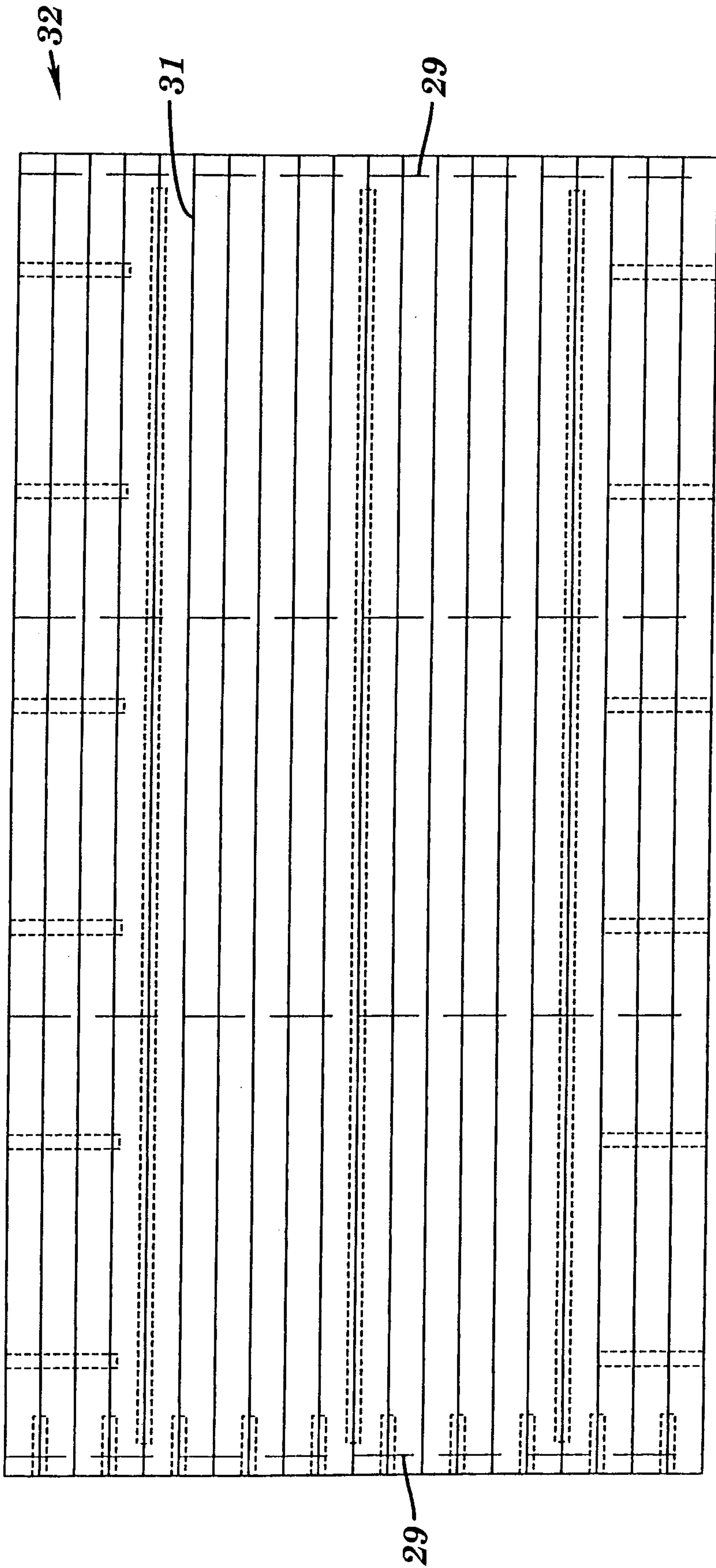
2. The method of claim 1 further comprising:

allowing vehicular traffic to use at least one of the prefabricated pavement slabs.

3. The method of claim 2 wherein the time between the placing and the allowing is immediate.



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**FIG. 9**

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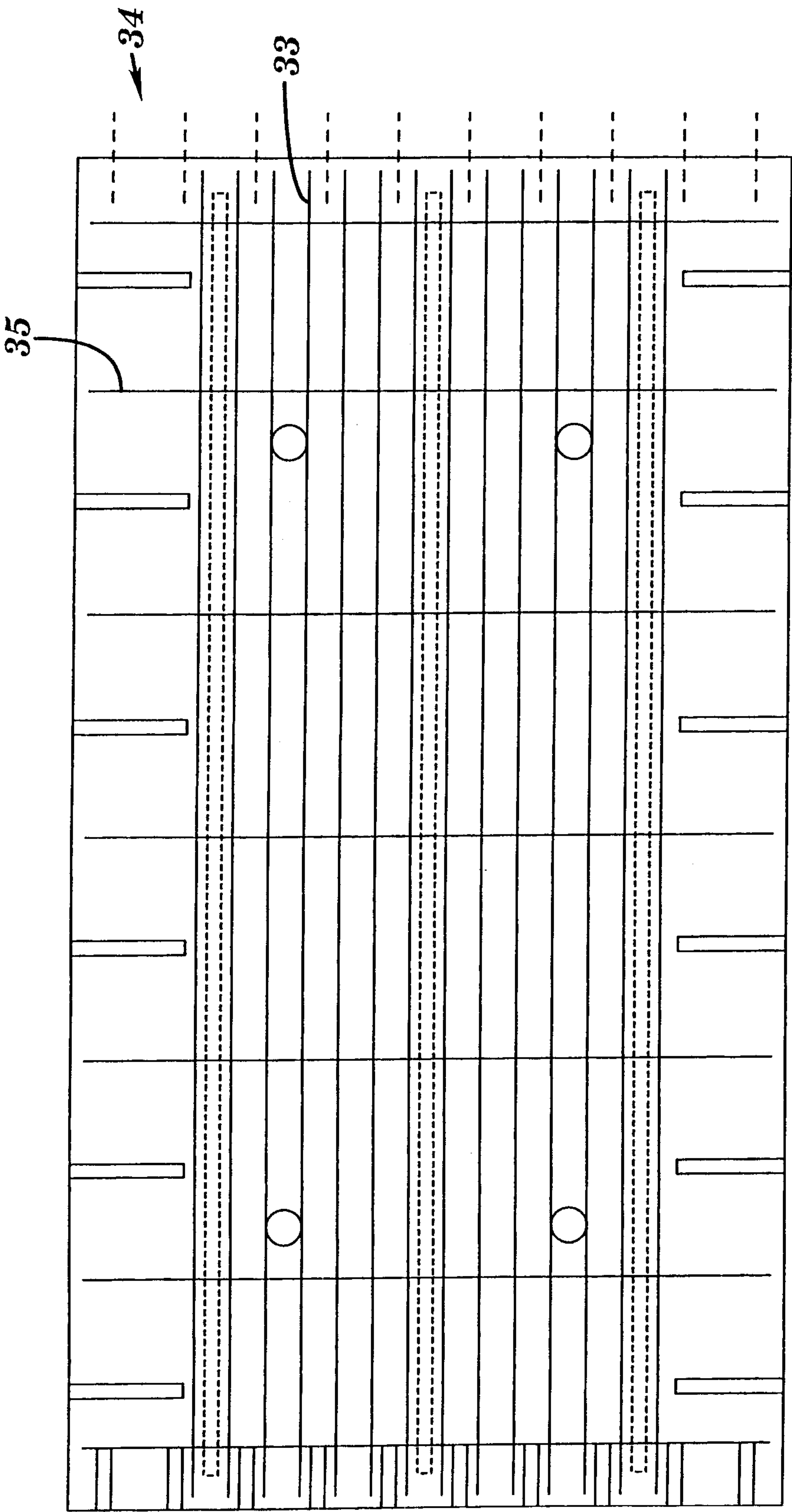


FIG. 10

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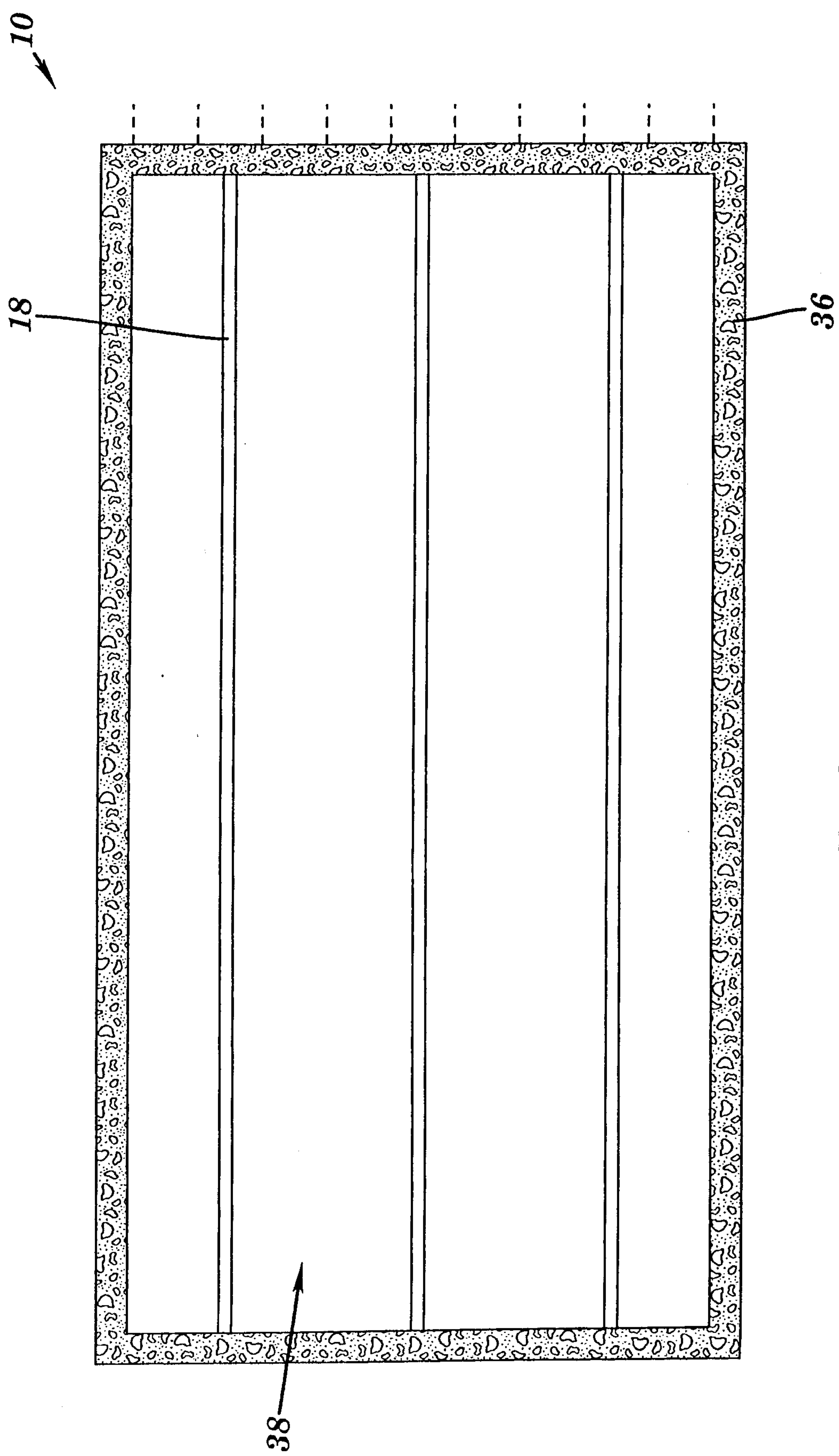


FIG. 11

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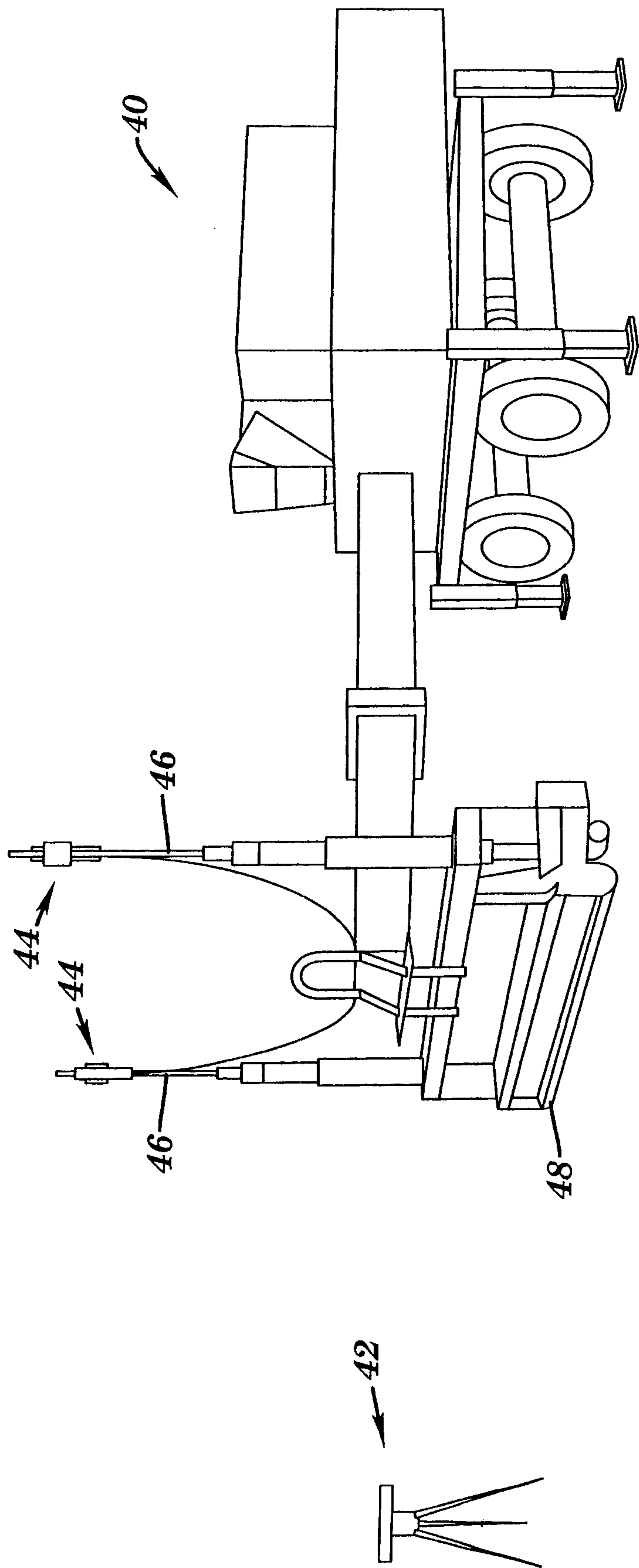
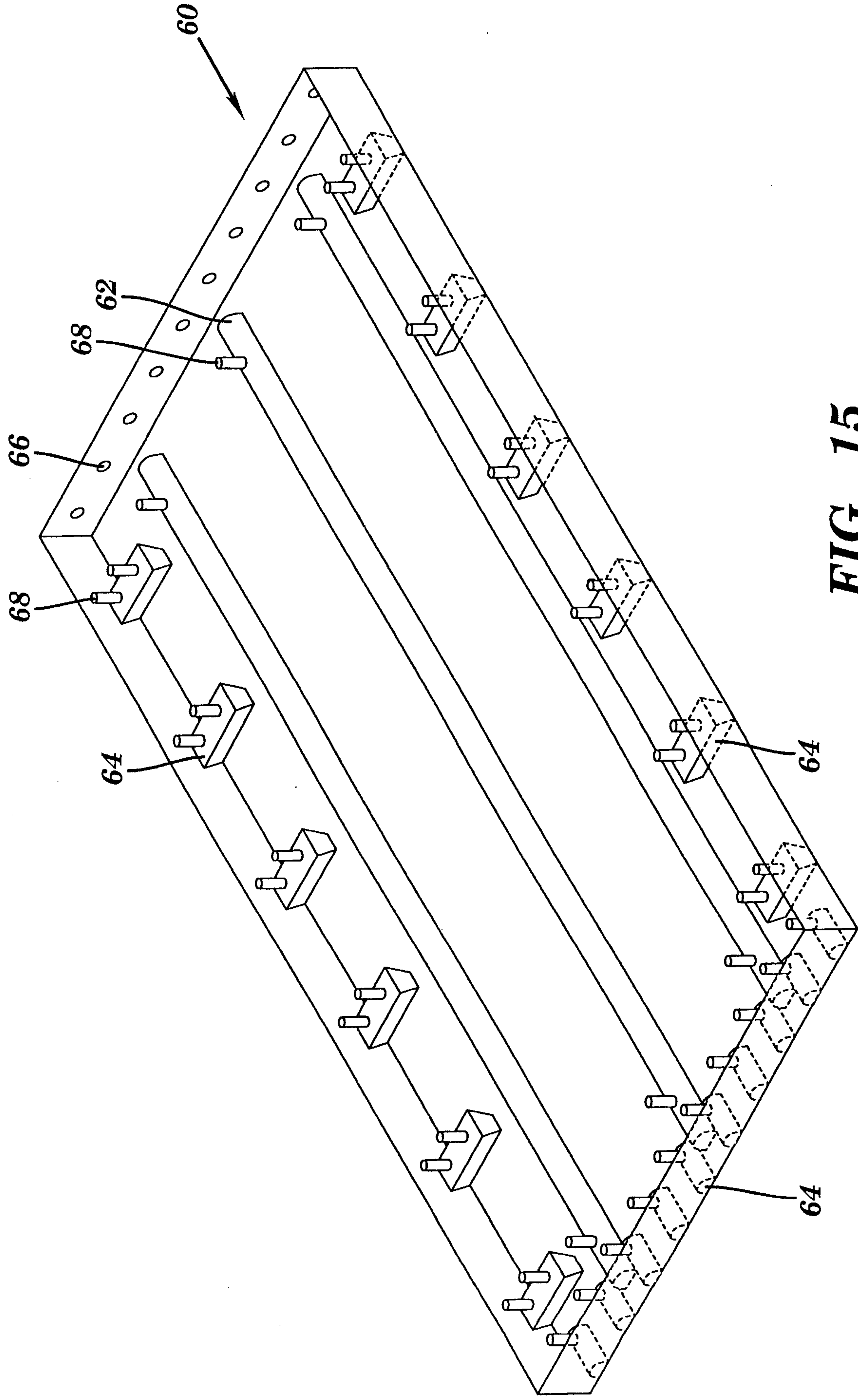


FIG. 14

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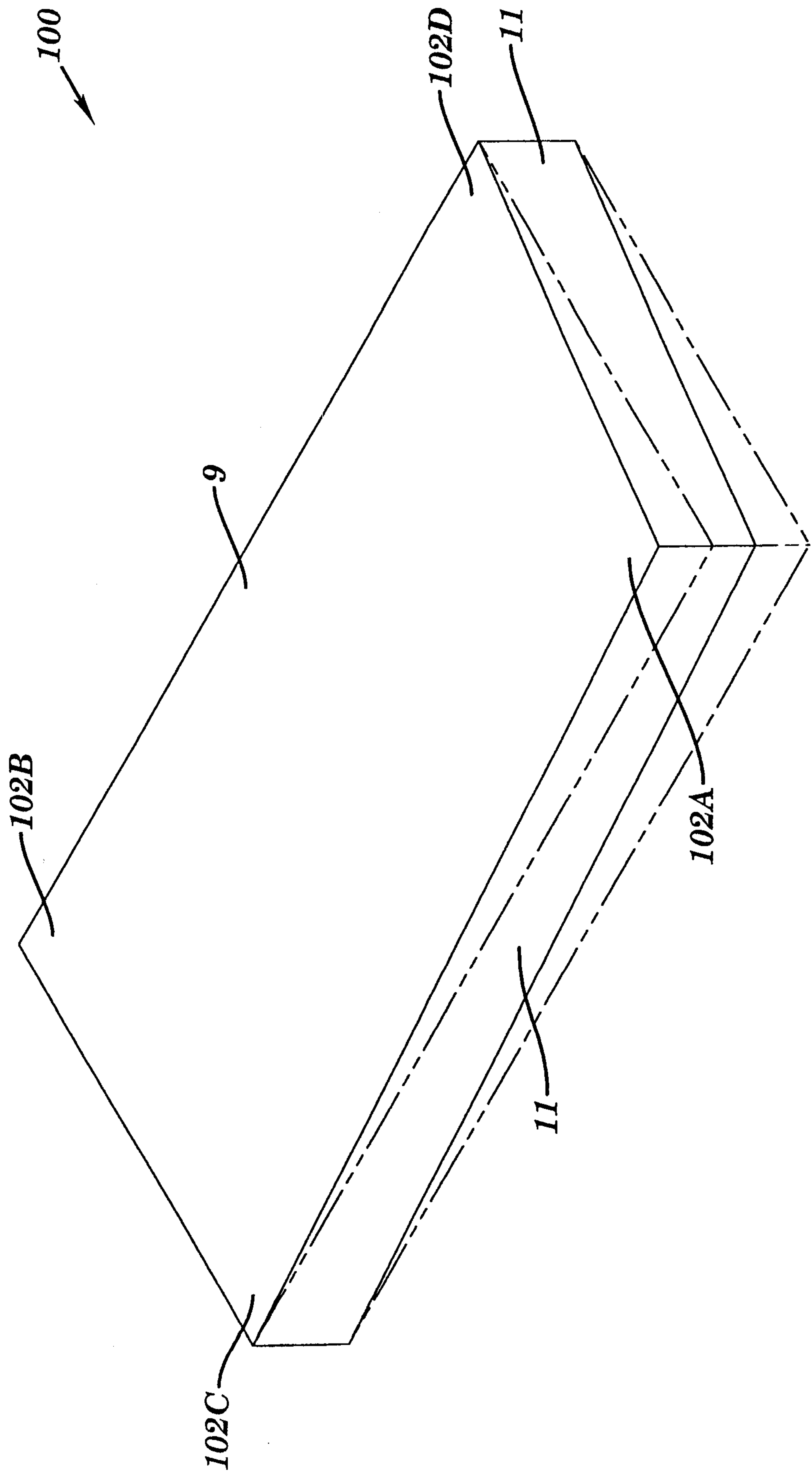


FIG. 16

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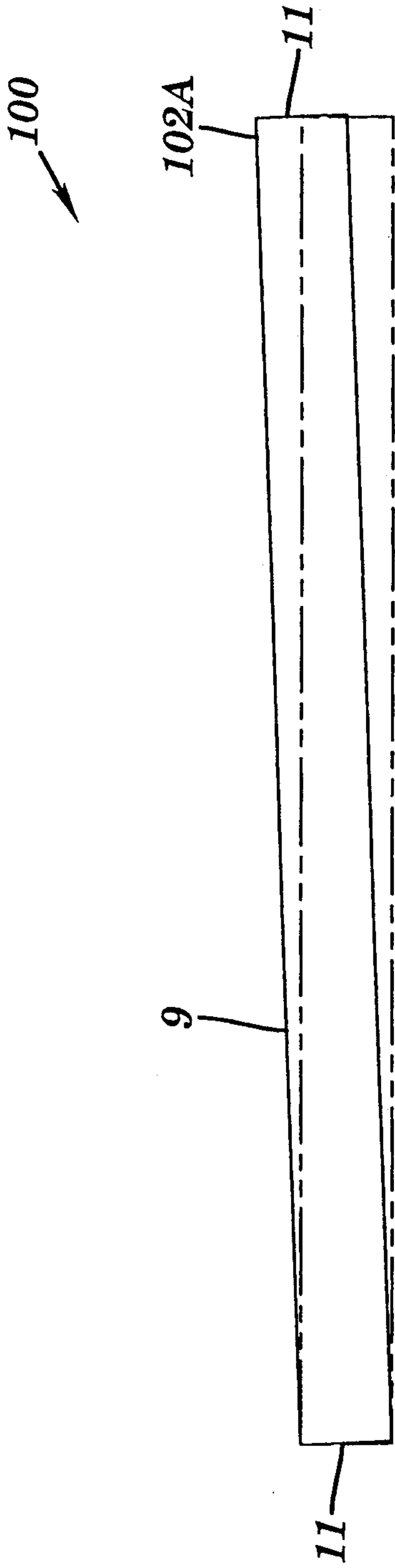


FIG. 17A

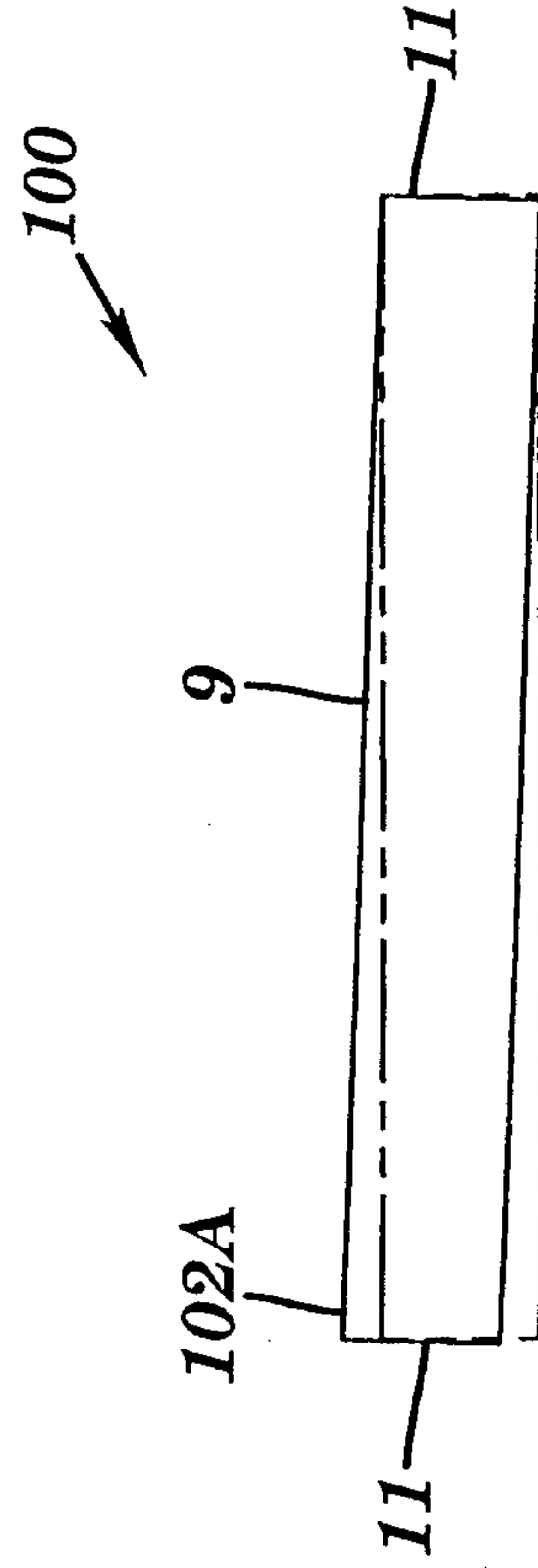


FIG. 17B

