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(54) **Apparatus and method for the production of wiring harnesses.**

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(73) Proprietor: **LANSING BAGNALL LIMITED**
Kingsclere Road
Basingstoke Hampshire RG21 2XJ (GB)

(72) Inventor: **Gibbons, Ralph David**
23 Edgehill Close
Basingstoke Hampshire, RG22 5AD (GB)

(74) Representative: **Saul, David Jonathan et al**
British Aerospace plc Corporate Patents Dept.
Brooklands Road
Weybridge Surrey KT13 0SJ (GB)

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Description

This invention relates to the production of wiring harnesses or cable forms and in particular to the production of a multiplicity of similar wiring harnesses in a production run comprising a multiplicity of cycles in each of which a wiring harness is produced.

In general, the production of a wiring harness requires the provision of a wiring table which can hold a multiplicity of terminal pins or devices adapted to hold the ends of the plurality of wires that make up each harness. It has been proposed to employ an automatic manipulator or robot for the laying of wires. In general, the wires in each harness start and terminate at different positions on the wiring table but are laid along paths which for part of their length are adjacent each other. This technique enables the wires to be bundled or taped together in the regions where the paths of the wires are parallel and facilitates the maintenance of the respective ends of the various wires separate.

The present state of the art is illustrated by, for example, United States Patents Nos. 3186077, 3842496 and 4126935, which relate to the manufacture of wiring harnesses and United States Patent No. 3346020 and our British Patent Specification No. 2025272 which relate to the construction and manner of use of a wiring loom table.

In United States Patent Specification No. 3186077 is disclosed an arrangement in which the loom board is provided with a multiplicity of terminal posts and the ends of an individual wire are attached to respective terminal posts by means of a clip which is fastened to the respective terminal post by a clip pusher operating in association with a cutter for the wire. The arrangement is mechanically rather complicated and requires the feeding of wire by means of a wire nozzle or guide through which the wire is fed and which is shiftable in synchronism with the movements of the clip pusher and the cutter.

United States Patent No. 3842496 discloses an arrangement in which a machine applies identifying indicia to several portions of a continuous wire and marks the termination of each of the wire portions in a predetermined sequence along the continuous wire. After the wire is respooled it is placed in a numerically controlled layer machine which lays down the individual wires in a predetermined sequence along a predetermined path on the loom board. The machine severs the continuous wire to produce individual wires as they are laid on the wiring loom. The loom includes means defining gripping apertures for holding the ends of wires; these means are provided by elastomeric slitted sheets which are screwed to the form board. The form boards are not readily changeable and it is necessary, particularly for larger harnesses, to prepare different form boards for each harness assembly.

United States Patent No. 3346020 discloses an arrangement in which pins are screwed to a base board in positions defining the paths of the wires constituting each harness, the pins extending upwardly through two perforated plates. Special devices are provided for holding the ends of the wires; these devices consist of helical springs between the convolutions of which the end of a wire may be inserted. The two plates are moved as one unit upwards relative to the base board to free the harness partly from the pins and thereby to enable the bundling of the wires. Thus the arrangement is effectively a two-layer table.

In our British Patent Specification No. 2025272 (corresponding to EP—A—0007228) we describe a loom table which has certain advantages over the prior art of which examples have been discussed above. That specification discloses a loom table for use in the production of wiring harnesses and for use in combination with a multiplicity of shouldered guide pins, the loom table being capable of receiving and releasably holding a plurality of said guide pins in position such that the pins project on one side of the table and comprising first and second superposed parallel layers, the first layer including at least one sheet of resilient material adapted to be penetrated by the pins so as to releasably hold the pins in place and to inhibit lateral movement of the pins, and the second layer permitting partial passage of the pins and passage of wire through it but preventing by cooperation with the shoulders of the pins complete passage of the pins through it, and actuator means for effecting relative separation of the first layer from the second layer in a direction normal to the layers. Such a table is more versatile than earlier proposals because with the aid of an automatic manipulator or robot the pins may be laid out in any desired predetermined pattern, to define the paths along which the wires in a harness are to be laid and, at the end of a sequence of production of harnesses, the two layers can be relatively separated so as to release the pins from the table, the relative separation of the layers being preferably accompanied by an inversion of the table so that the pins fall from the table onto a conveyor whence they may be collected and fed back to a delivery point at which they can be picked up by the automatic manipulator when it is desired to set out a new array of pins.

In one aspect, the present invention concerns a loom table which is an improvement over the loom table described in our British Specification No. 2025272. This improvement consists of providing, instead of a two layer table, a three layer table characterised by a third or uppermost layer comprising a mesh of resiliently flexible material, the third layer allowing the easy passage of the shouldered pins, and actuator means for effecting relative separation of the third layer and the second layer, so that a completed harness is released from the pins and can be lifted away from the table at the completion of the laying of a harness.

Another aspect of the invention concerns an improved method of producing wiring harnesses including the use of a three layer table as already characterised and including for each wire that is

to be laid, the steps of injecting the leading end of the wire into the layers, looping the wire around a start pin, laying the wire along a predetermined path defined by other pins and finally looping the wire around a final pin so that both ends of the wire are temporarily secured until the upper mesh layer is raised to release the wire from the pins. This method of temporarily securing the wire to the pin is very convenient and requires no special clips or attachments to the table such as are characteristic of the current state of the art.

Preferably double ended pins are used and although the wire may be laid between pairs of pins and supported by upper shoulders thereof, a preferred form of the method includes the use of collars which are supported by the pins and provide spaced platforms for supporting the wire of the harness clear of the upper mesh.

The invention will now be described in greater detail and by way of example. Reference will be made hereinafter to the accompanying drawings of which Figure 1 illustrates schematically in side elevation a loom table and the disposition of pins in the table and Figure 2 is a plan view of a final pair of pins on the table shown in Figure 1.

Figure 1 illustrates a worktable 1 in simplified form. In practice the table may be a metre wide and two metres longs. Figure 1 is intended to illustrate in greatly simplified form a completed laying operation for one wire.

The table 1 comprises a rigid base board 2 which is carried in a frame 3 provided with clamps 4 for holding the base board 2 within the frame. The board 2 is overlain by a sheet 5 of readily penetrable material such as a dense natural or synthetic form, for example polystyrene. Over this sheet 5 is a sheet 6 which is intended to be penetrable by the pins hereinafter described but is capable of restraining lateral and upward movement of the pins. A suitable material for the sheet 6 is a silicone rubber. Above the sheet 6 is a steel wire mesh 7 which is carried by a frame 8 disposed around and slightly above the frame 3. Disposed above and somewhat separated from the mesh 7 is a second steel wire mesh 9 which is supported by a frame 10 extending around and disposed somewhat above the frame 8. Overlying the mesh 9 is a light mesh 11 of a resilient polymeric material such as "nylon" (Registered Trade Mark"). This mesh is supported by a frame 12 which extends around and is disposed slightly above the frame 10.

The table 1 is intended for use in conjunction with locating pins such as the pins 13. These pins, in the preferred form shown in the drawings, each comprise a central part 14 of slightly greater diameter than two shanks 15 extending one from each end of the central part 14. The step between each shank 15 and the central part 14 constitutes a shoulder of which the purpose will be described later. At each end, the pin terminates in a respective head 16 separated from the shank 15 by a short narrow neck 17.

The pins 13 are double ended in order that an automatic manipulator which picks them up from a loading station such as a chute fed by a bowl feeder need not distinguish one end of the pin from the other. In other circumstances, a single ended pin could be used. Nevertheless the pins 13 in the form shown in the drawings have the advantage that they can receive a collar 18 which can be pushed over the upper head and shoulder of a pin. such a collar is useful for pins which are to support a multiplicity of wires extending along the same general path.

At the commencement of a run of production of a multiplicity of wiring harnesses, an automatic manipulator will insert pins 13 in the table in a predetermined array. Normally, for each wire in the array there will be a respective start pin (13*a*) and a respective final pin (13*d*) and intermediate pins (13*b* and 13*c*) of which there may be as many as suitable for the particular length of the wire. Since the wires will over part of their length share a common path, although over short lengths the wires can be supported by the upper shoulders of the pins, it is preferable to dispose collars 18 over intermediate pins. Preferably, along the path of a wire, pins are inserted in the table in pairs, side-by-side, the path of the wire extending between the pins of each pair. Although the design of the manipulator is not part of the present invention, it is preferable to use a manipulator which can change its heads. For disposing the collars 18 over selected pins, the automatic manipulator may use a head which is in the form of a tube of annular cross-section, this tube being coupled when in place on the manipulator to a source of vacuum suction so that it can pick up a collar and deposit it over the head of a pin, the head of the pin being received within the recess within the annulus.

Subsequent to the deposition of collars on appropriate pins, the manipulator would change its head for a suitable wire laying tool, such as preferably that described in our European Patent Application EP—A—0062412.

As has been mentioned, the wire mesh 9, in this embodiment of the invention the intermediate layer, serves to limit the entry of the pins into the worktable and to facilitate their insertion to a constant depth. The lower layer serves to restrain the pins against lateral movement.

Each wire-laying operation preferably proceeds as follows.

A wire-laying tool to which a metered length of wire 20 has been fed and which is preferably capable of advancing the length of the wire for a short distance from the lower tip of a probe extending forwardly of the tool, is brought adjacent and parallel to the start pin 13*a*. The tip of the probe of the tool is passed through the upper mesh 11 and into contact with the mesh 9; the wire in the tool is advanced. This action drives the wire through the meshes 11, 9 and 7 so that the wire, is temporarily trapped. This trapping of the leading part 19 of the wire affords it a temporary anchorage. The tool is then rotated about the start pin 13*a* so as to produce a turn 21 of wire about the start pin 13*a*. This turn or loop provides a

more secure anchorage for the wire 20. The tool, of which the probe is normally raised at some suitable time from the position close to the mesh 11 to a somewhat higher position, preferably to a height just above the top shoulders of the pins 13, is then maintained upright but traversed so as to lay the wire between the pairs of intermediate pins and over the collars 18 thereon in the predetermined path according to the programme which controls the automatic manipulator. Finally, the end of the wire 20 is, by means of a movement similar to that required for producing the loop 21, traversed quickly around one of the final pair of pins 13*d* and 13*e* (Figure 2), so as to produce a final loop 22 of the wire 20 around the pin 13*d*, and is then passed between these pins, the final part of the wire thereby extending between these pins. This action prevents the unwinding of the final loop and would usually be necessary if the wire is springy.

The wire-laying operation is repeated for each of the multiplicity of wires in the particular wiring harness.

At the termination of the laying of all the wires required for a particular harness, the manipulator preferably changes its wire-laying tool for a tool which is preferably as described in our European Patent Application EP—A—0039188 or other tool which can apply securing tape at appropriate locations of the harness so as to bundle together those wires which share a common path. The bundling of the wires could be performed by hand but the use of a pneumatic tape-applying tool is preferred.

After the various wires in the harness have been bundled together as desired and in accordance with the programme controlling the manipulator, the manipulator is returned to a position in which it can change its tape applying tool for the collar-placing tool which replaces the collars on the pins ready for the next harness.

In order to release the harness from the table, actuators diagrammatically shown as a jack 23 are operated to cause mutual separation of the frames 10 and 12. This separation causes the mesh 11 to be raised relative to the mesh 9, by an amount sufficient to release the ends of the wires 20 from the meshes 11, 9 and 7 but less than the height of the collars 18 above the mesh 11 so that the mesh 11 does not foul the collars 18. Subsequently or simultaneously the table is inverted so that the harness can fall on to a conveyor. Reinversion of the table and the resetting of the jacks so as to restore the original relative positions of the meshes 11 and 9 renders the table ready for the production of the next harness in the batch. The wiring of all the harnesses in the batch proceeds by repetition of the wire-laying process which has been described. At the end of the batch, after the last harness has been removed, actuators such as jacks 24 (of which only one is shown) are operated to cause separation of the frames 8 and 10 and thereby separation of the meshes 9 and 11 with respect to the lower layer constituted by the sheet 6 and the sheets associated therewith. Because the lower shoulders of the pins cannot pass through the mesh 9, the force of separation is sufficient to withdraw the lower heads of the pins from the sheet 6 and the mesh 7. The separation of the intermediate and lower layers in this manner releases the pins from the table. Preferably the table is inverted before the intermediate and lower sheets are relatively separated, in order that the pins, when they are released, can fall onto the aforementioned conveyor.

The collars 18 may be removed from the pins 13 after each wire-laying operation by the raising of the mesh 11 relative to the mesh 9 a sufficient amount to free the collars from the pins. If this expedient is adopted, the collars must be collected and fed back to a loading point so that they can by means of the appropriate tool be reinserted on the selected pins before each respective wire-laying operation. Alternatively, the collars may be removed at the end of the last wire-laying operation by a preliminary movement of the mesh 11 relative to the mesh 9. Various modifications may, of course, be made to the worktable and it may be used in a manner other than that particularly described above.

Claims

1. A loom table for use in the production of wiring harnesses and for use in combination with a multiplicity of shouldered guide pins, the loom table being capable of receiving and releasably holding a plurality of said guide pins (13) in position such that the pins project on one side of the table and comprising first and second superposed parallel layers, the first layer (5, 6, 7) including at least one sheet (6) of resilient material adapted to be penetrated by the pins so as to releasably hold the pins in place and to inihibit lateral movement of the pins, and the second layer (9) permitting partial passage of the pins and passage of wire (20) through it but preventing by cooperation with the shoulders of the pins complete passage of the pins through it, and actuator means (24) for effecting relative separation of the first layer from the second layer in a direction normal to the layers, characterised by a third layer (11) above the second, the third layer comprising a mesh of resiliently flexible material which allows the easy passage of said shouldered pins, and actuator means (23) for effecting relative separation of the third and second layers.

2. A method of wiring a multiplicity of harnesses, comprising mechanically inserting a multiplicity of shouldered pins (13) in a predetermined pattern on a loom table according to claim 1, mechanically executing, for each harness, a multiplicity of wiring operations, each wiring operation comprising injecting the leading end of a metered length of wire (20) into at least the third and second layers whereby it is ensnared, looping a part of said wire adjacent the leading end thereof around a first one (13*a*) of said pins, laying the wire along a predetermined path defined by

others (13*b*, 13*c*) of said pins and looping the trailing end of said wire around a particular one (13*d*) of said pins, separating said third layer (11) from the second layer (9) in a direction normal to these two layers so as to release the harness from the layers and subsequently replacing the third layer (11) relative to the second layer (9); and subsequent to the production of a multiplicity of similar harnesses, separating the third and second layers (9, 11) from the first layer (5—7) in a direction normal to the layers so as to release the pins from the loom table.

3. A method according to claim 2, further comprising disposing collars (18) on said pins and wherein the steps of laying the wire includes laying part of the wire such that the wire (20) is supported by selected ones of said collars.

4. A method according to claim 2 or claim 3 including the step of binding some of the wires (20) in each harness together at selected locations before the wire is released from said loom table (1).

Patentansprüche

1. Kabelbaumformbrett zur Benutzung bei der Erzeugung von Kabelbäumen und zur Benutzung in Kombination mit einer Vielzahl abgestufter Führungsstifte, wobei das Kabelbaumformbrett eine Vielzahl dieser Führungsstifte (13) in einer solchen Lage aufnimmt und lösbar haltert, daß die Stifte auf einer Seite des Brettes vorstehen, wobei erste und zweite übereinandergefügte parallele Lagen vorgesehen sind, von denen die erste Lage (5, 6, 7) wenigstens eine Schicht (6) aus elastischem Material aufweist, welches von den Stiften derart durchdrungen wird, daß diese lösbar an ihrer jeweiligen Stelle gehaltert werden und eine seitliche Bewegung der Stifte verhindert ist, und von denen die zweite Lage (9) einen teilweisen Durchtritt der Stifte und dem Durchtritt des Drahtes (20) zuläßt, jedoch in Zusammenwirken mit den Stufenschultern der Stifte einen vollständigen Durchtritt der Stifte durch die zweite Lage verhindert und wobei ein Abtrieb (24) vorgesehen ist, um eine relative Trennung der ersten Lage von der zweiten Lage in Richtung normal zu den Lagen zu bewirken, gekennzeichnet durch eine dritte Lage (11) über der zweiten Lage, wobei die dritte Lage aus einem Gitter elastisch flexiblen Materials besteht, das den leichten Durchtritt der abgestuften Stifte ermölicht und durch einen Antrieb (23) zur relativen Trennung von dritter und zweiter Lage.

2. Verfahren zur Verdrahtung einer Mehrzahl von Kabelbäumen, wobei mechanisch eine Vielzahl abgestufter Stifte (13) in einem vorbestimmten Muster in ein Kabelbaumformbrett gemäß Anspruch 1 eingesteckt wird, wobei für jeden Kabelbaum eine Vielzahl von Verdrahtungsoperationen mechanisch durchgeführt wird und jede Verdrahtungsoperation eine Stuft umfaßt, während der das Vorderende einer abgemessenen Länge eines Drahtes (20) in wenigstens die dritte und die zweite Lage eingeführt wird, wodurch der Draht gefangen wird, wonach ein Teil des Drahtes benachbart zu seinem Vorderende um einen ersten Stift (13a) geführt wird, wonach der Draht längs eines vorbestimmten Pfades ausgelegt wird, der durch weitere Stifte (13b, 13c) definiert ist und wonach das Nachlaufende des Drahtes um einen speziellen Stift (13d) geschlungen wird, worauf die dritte Lage (11) von der zweiten Lage (9) in einer Richtung normal zu diesen Zwei Lagen derart getrennt wird, daß der Kabelbaum von den Lagen freigegeben wird, worauf die dritte Lage (11) wieder auf die zweite Lage (9) zurückgeführt wird, wobei nach der Erzeugung einer Mehrzahl gleicher Kabelbäume dritte und zweite Lage (9, 11) von der ersten lage (5—7) in einer Richtung normal zu den Lagen getrennt werden, so daß die Stifte aus dem Kabelbaumformbrett herausgezogen werden.

3. Verfahren nach Anspruch 2, bei welchem außerdem jeder der Stifte mit einem Kragen (18) versehen wird, wobei beim Legen des Drahtes ein Teil des Drahtes so geführt wird, daß der Draht (20) von jeweils vorgewählten Kragen abgestützt wird.

4. Verfahren nach den Ansprüchen 2 oder 3, bei welchem eine Stufe vorgesehen ist, in der einige Drähte (20) eines jeden Kabelbaumes an vorgewählten Stellen miteinander verbunden werden, bevor der Draht von dem Kabelbaumformbrett (1) freigegeben wird.

Revendications

1. Table de métier pour utilisation dans la production de harnais de câblage et pour emploi en combinaison avec une multitude d'axes de guidage à épaulement, la table étant capable de recevoir et de maintenir de façon amovible une pluralité d'axes de guidage (13) dans une position telle que les axes sont en saillie sur un côté de la table et comprenant des première et seconde couches parallèles superposées, la première couche (5, 6, 7) comportant au moins une feuille (6) de matériau élastique destinée à être pénétrée par les axes de manière à maintenir de façon amovible les axes en place et à empêcher le déplacement latéral des axes, et la seconde couche (9) permettant un passage partiel des axes et le passage du fil (20) à travers elle mais empêchant en coopération avec les épaulements des axes un passage complet des axes à travers elle et un moyen d'actionneur (24) pour effectuer une séparation relative de la première couche vis-à-vis de la seconde couche dans une direction perpendiculaire aux couches, caractérisée par une troisième couche (11) au-dessus de la seconde, la troisième couche comportant un tamis en matériau élastique qui permet un passage facile des axes à épaulement, et un moyen d'actionneur (23) pour effectuer la séparation relative des troisième et seconde couches.

2. Procédé de câblage d'une multitude de harnais, comprenant l'insertion mécanique d'une multitude d'axes à épaulement (13) dans une configuration prédéterminée sur une table de métier

selon la revendication 1, exécutant mécaniquement, pour chaque harnais une multitude d'opérations de câblage, chaque opération de câblage comprenant l'injection de l'extrémité avant d'une tronçon mesuré de fil (20) dans au moins les troisième et seconde couches ce qui a pour effet de l'emprisonner, la formation d'une boucle d'une partie du fil contiguë à son extrémité avant autour d'un premier axe (13*a*), la pose du fil le long d'un trajet prédéterminé défini par d'autres axes (13*b*, 13*c*), et la formation d'une boucle de l'extrémité arrière du fil autour d'un axe particulier (13*d*), la séparation de la troisième couche (11) et de la seconde couche (9) dans une direction perpendiculaire à ces deux couches de manière à libérer le harnais vis-à-vis des couches, puis la remise en place de la troisième couche (11) par rapport à la seconde couche (9) et à la suite de la fabrication d'une multitude de harnais similaires, la séparation des troisième et seconde couches (9, 11) vis-à-vis de la première couche (5—7) dans une direction perpendiculaire aux couches de manière à libérer les axes vis-à-vis de la table du métier.

3. Procédé selon la revendication 2, comprenant en outre le placement de colliers (18) sur les axes, et où l'étape de pose du fil comporte la pose d'une partie du fil de façon que le fil (20) soit supporté par des colliers sélectionnés parmi les colliers.

4. Procédé selon la revendication 2 ou la revendication 3, comportant l'étape de liage d'une partie des fils (20) dans chaque harnais à des emplacements choisis avant que le fil soit libéré de la table (1) du métier.

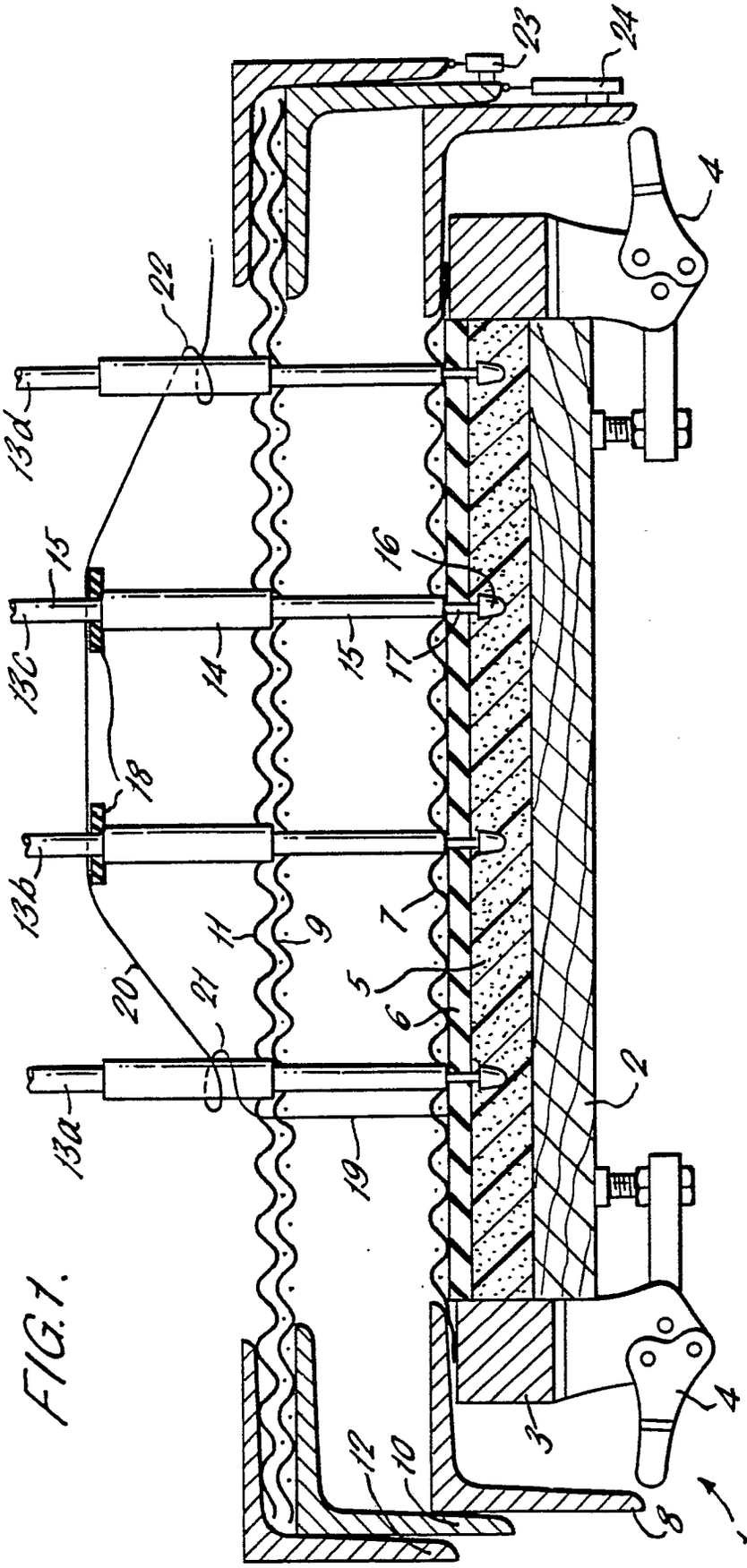
23
24
4
22
13d
15
16
13c
14
15
17
18
13b
11
9
7
20
21
5
6
2
13a
19
4
3
12
10
8
1

FIG.1.

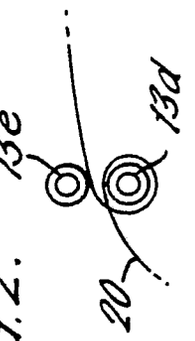
13e
13d
20

FIG.2.