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

(11) EP 0 783 943 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
16.07.1997 Bulletin 1997/29

(21) Application number: **95920083.3**

(22) Date of filing: **09.06.1995**

(51) Int. Cl.⁶: **B28B 1/08**

(86) International application number:
PCT/ES95/00072

(87) International publication number:
WO 96/41706 (27.12.1996 Gazette 1996/56)

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

(71) Applicant: **Vasquez Ruiz Del Arbol, Jose Ramon**
08348 Cabrils (ES)

(72) Inventor: **Vasquez Ruiz Del Arbol, Jose Ramon**
08348 Cabrils (ES)

(74) Representative: **Elzaburu Marquez, Alberto et al**
Elzaburu S.A.,
Miguel Angel, 21
28010 Madrid (ES)

(54) PROCESS FOR CONSTRUCTING LINEAR CONCRETE WORKS WITH INTERNAL CAVITIES, AND DEVICES FOR IMPLEMENTING SUCH PROCESS

(57) The process comprises using a slip-form in order to shape the internal cavities, injecting a fluid, preferably wet hot air inside the sealed cavity or cavities created by said slip-form, at appropriate rate and pressure, and performing the required operation in order to conform the concrete. The device comprises said slip-form consisting of a plurality of tubes coupled to the concrete casting machine, and also provided with antivibration mechanism, the vibrating means of said machine being arranged parallel to the axes of the tubes and in lines intermediate to said tubes, means being provided to supply said fluid inside the slip-form or directly into the cavities. The invention applies to the construction of roads or collectors with internal cavities.

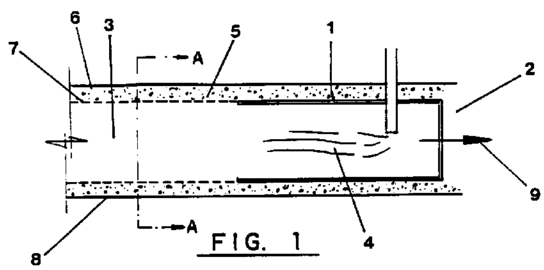


FIG. 1

EP 0 783 943 A1

Printed by Rank Xerox (UK) Business Services
2.14.11/3.4

Description

Field of the invention

The present invention relates to a process for continuously constructing linear concrete works formed "in situ" on the ground, such as roads or culverts with internal cavities, and to devices for implementing the process.

Background of the invention

The methods usually employed in constructing linear works with internal cavities, whose most characteristic example is probably culverts, are twofold: the construction of the culvert "in situ" in stretches by means of fixed shuttering and the construction of the culvert using prefabricated elements. The selection of one or the other method depends fundamentally on the cross-section of the culvert. For culverts with a cavity cross-section of medium or small surface area the use of prefabricated elements is preferred, while for culverts with a cavity cross-section of large surface area formation "in situ" is preferred.

Concrete materials with internal cavities are prefabricated mainly by means of the traditional system of shaping the concrete with appropriate shuttering which is removed when the concrete gains the strength necessary to be self-supporting, but strictly controlling the different variables which influence the process in order to achieve levels of optimization which are difficult to reach in works formed "in situ".

However, prefabrication systems are also known in which, instead of the traditional system of fixed shuttering, sliding moulds are used to form internal cavities in concrete components such as beams or arches. Systems of this type are described in the Spanish patent no. 249.605 and in the patents US 3,994,639 and US 3,401,438.

In these prefabrication systems, the sliding shuttering creates a cavity which is self-supporting due, on the one hand, to the use of concretes with a dry consistency (Abrams cone of 0 to 2), under appropriate conditions of humidity, temperature and control, which are only possible in factory production and, on the other hand, due to the cavities being of small size. These systems constitute the sole known background in relation to the basic subject of the present invention, although, as we shall see later, the latter has totally different purposes and characteristics. Finally, I mention, as background, my application PCT/ES94/00132, not published, by comparison with which the present invention incorporates novel characteristics.

Summary of the invention

The basic purpose of the present invention is to propose an effective process for constructing linear works with internal cavities which can be implemented "in situ", continuously on each working day.

As can well be understood, the construction of linear concrete works by means of a continuous process offers many advantages compared with the construction of the said works using prefabricated elements or construction of the work stretch by stretch using traditional shuttering.

Moreover, the said process, as will be explained in detail later, allows alternative solutions which are advantageous in the design of certain concrete works and, in particular, in the case of roads and culverts. At the present time, all known concrete roads are constructed by means of solid slabs. However, the process which is the subject of this invention makes it viable to construct roads with slabs with internal cavities, which offers a substantial saving of concrete.

On the subject of culverts, at the present time there are no culverts in existence formed "in situ" which do not require internal shuttering and subsequent removal thereof. By means of the process which is the subject of the present invention, it is possible to construct culverts "in situ", practically eliminating shuttering.

The first subject of the present invention is a continuous process for constructing linear works in which:

- An internal sliding shuttering is used to form the desired internal cavities, which is moved in conjunction with the device used to form the external shape of the required concrete cross-section;

- A fluid, preferably humid and hot air, is injected into the cavity left by the sliding shuttering which allows the cavity left by the shuttering to be maintained without significant deformation and, additionally, accelerates the setting of the layers of concrete in contact. In short, this fluid fulfils the function of the traditional shuttering while the concrete is reaching sufficient strength to be self-supporting, and it must therefore be supplied until this strength has been reached;

- Means are deployed so that the operations necessary for shaping the concrete with the characteristics required in each type of work, especially the vibrating and the obtaining of the desired external shape, are carried out on the concrete which envelops the sliding shuttering.

As mentioned previously, the essential advantage of the process which is the subject of the present invention over the known processes is the possibility of constructing linear concrete works with internal cavities at a higher daily rate and at a lower cost than the alternative construction processes, whether of the type implemented in situ or based on the use of prefabricated elements.

More particularly, the process which is put forward would allow the construction of concrete roads with internal cavities, which would make it possible advantageously to replace the sections of roadbeds having layers of concrete which are currently projected - combining layers of concrete of different types and/or layers of other materials in their lower parts - by slabs lightened by means of the formation of internal cavities. For its part, it would make it possible to form culverts "in situ" with continuous concrete casting as long as there is an open trench for constructing them.

A second subject of the invention consists of processes which can be used in combination or separately, for forming joints in linear concrete works constructed by means of the above-mentioned process, but also applicable to concrete works constructed by means of other processes.

In general, and as is well known, all linear concrete works are divided into stretches in order to control the cracks produced by shrinkage of the concrete.

In a process for continuous construction of linear concrete works, the known solutions for forming joints are inapplicable, and for that reason new processes are now proposed.

The first process, applicable to road surfaces and, in general, to works formed by concrete slabs, consists in:

- Forming appropriately spaced grooves, in the upper part of the slab, of shallow depth in relation to the thickness of the slab and of a similar shape to those produced in known systems;

- Arranging, on the ground or close to it, either in the vertical to each above-mentioned groove or with a lateral shift with respect to the said vertical, a tube of a preferably elastic material, for example PVC, parted through its upper generatrix and supported in a half-tube, also of an elastic material, or other similar means. With this arrangement the concrete cross-section is weakened, not only in the upper part but also in the lower part, so predetermining the lines of cracking of the concrete.

With the above-mentioned means, as the above-mentioned tube is parted through its upper generatrix, the matching of the upper part of the tube to the movements of the contiguous slabs is facilitated, the lower generatrix remaining free of stress. For its part, the presence of the above-mentioned half-tube isolates the lower part of the above-mentioned tube from the concrete, and guarantees the leaktightness of the joint.

This joint exhibits great durability and has significant advantages compared with other types of joints. In particular, it eliminates the problem of pumping of fines through the joints between concrete slabs. It also prevents water reaching the levelled surface.

In one variant of this process applicable to culverts, the joint is formed, arranging the above-mentioned means (tube supported in a half-tube) in the cross-section of the trench and fixed appropriately to it so as to keep them in position while the concrete is poured, in order to form a weakened region which controls the shrinking of the concrete. The above-mentioned means must finally loop around the culvert via its external upper part, along a groove arranged for that purpose, keeping the joint leaktight.

The second process is for the purpose of allowing loads to be transmitted between contiguous slabs, with an intermediate joint, in works constructed by means of the process which constitutes the first subject of this invention, but which is also applicable to concrete works constructed by means of other processes.

The known solutions for allowing loads to be transmitted between contiguous slabs are based, in general, on the fitting of metal bushes between them.

However, a more advantageous process has been found, consisting in arranging for inclined cracks to form, at the positions envisaged for the joints, to left and right of the upper joint line, which define support regions between slabs which transmit the load from one slab to the next one in alternately changing directions.

This is achieved by arranging means, on the ground, which define a broken line of weakness of the concrete cross-section so that the crack is directed either to the left or to the right of the upper groove, following the line of weakness.

An appropriate means is a metal mesh parted along the desired broken line so that, logically, the crack will be directed towards the line of discontinuity of the reinforcement.

As can easily be understood, if a metal mesh is arranged in a region of the concrete next to the ground, to left and right of the upper groove, the cracks will be directed from the upper groove towards the regions where no reinforcement exists, leaving the reinforced regions protected against the appearance of cracks directed towards them.

Given that this metal mesh has to remain embedded in the concrete, it has to be located at a certain height from the ground, and, that being so, it may be convenient to situate it above another metal mesh parted along the desired broken line.

It would also be possible to achieve the broken line of weakness in the lower part of the cross-section of the concrete by means of a tube located along the above-mentioned line, or other equivalent means.

This process provides:

- The necessary shrinkage joint for any concrete work;
- A solution to the problem of transmitting loads between contiguous slabs which is distinct from and advantageous by comparison with the well known one of fitting metal bushes between slabs. With the arrangement described, an inclined crack is obtained from the upper groove to the lower broken line of weakness, directed alternately, by regions, to one side or the other of the groove. In this way, two contiguous slabs are supported on one another - in various directions in distinct regions - thus allowing an effective mechanism for transmitting loads between them.

Combining the use of a parted metal mesh with the fitting of two tubes (supported in half-tubes) with the previously mentioned characteristics, in two lines parallel to the line of the groove, to the side of the corresponding lines of parting of the metal mesh, an advantageous system for transmitting loads between slabs will be obtained simultaneously with a durable and leaktight joint, which will completely avoid the problem of pumping of fines.

A third subject of the invention is a device which can be coupled to a concrete-laying machine for implementing the process in the construction of roads of the type which has just been mentioned, and which will be described in detail later.

A fourth subject of the invention is a specific device for implementing the above-mentioned process in the construction of culverts which will be described in detail later.

Brief description of the drawings

Fig. 1 shows a diagrammatic side elevation of a linear work constructed by means of the process which is the subject of the present invention.

Fig. 2 shows a diagrammatic front elevation of a culvert constructed by means of the process which is the subject of the present invention.

Fig. 3 shows a diagrammatic front elevation of a road constructed by means of the process which is the subject of the present invention.

Fig. 4 shows a typical cross-section of a traditional concrete roadbed and an equivalent cross-section using the process which is the subject of the present invention.

Figs. 5 and 6 diagrammatically show two variants of the implementation of the process which is the subject of the present invention.

Fig. 7 diagrammatically shows a side elevation of a joint according to the present invention, represented in plan view in Fig. 8.

Fig. 9 shows the tubes employed in the joint in detail.

Figs. 10 and 11 diagrammatically show, in elevation and in plan view respectively, a concrete-laying machine for roads, to which there will be coupled a device for implementing the process which is the subject of the present invention.

Fig. 12 shows, in elevation, the device for implementing the process which is the subject of the present invention.

Fig. 13 shows a detail of the above-mentioned device, in which the system for supplying fluid to the sliding shuttering can be appreciated.

Fig. 14 shows a longitudinal cross-section of a laying machine which has the above-mentioned device coupled to it.

Fig. 15 shows a detail of sliding shuttering divided into two parts.

Fig. 16 shows a diagram of the system used to supply fluid to the above-mentioned device.

Fig. 17 shows a front elevation of a device for constructing culverts by means of the process which is the subject of the present invention; Fig. 18 shows the said device in plan view, Fig. 19 shows it in profile and Fig. 21 in perspective.

Fig. 20 shows a detail of the hermetic closure of the mould through its front part.

Fig. 22 shows a diagram of the process employed for forming joints in culverts.

Detailed description of the invention

In the first place, we will describe the basic process which is the subject of the present invention, making reference to Figs. 1 to 7.

The end purpose of the process is the construction of linear concrete works with cross-sections such as those shown in Figures 2 and 3 by means of a process which is continuous throughout a working day. Figure 2 shows a typical cross-section of a culvert and Figure 3 a cross-section of a lightened slab for road surfaces or other types of works (airports, etc.). Both figures correspond diagrammatically to the section A-A indicated in Fig. 1.

Following this Fig. 1, the process consists in using a sliding shuttering 1, in the form of a tube of circular cross-section for example, closed at its front part 2 and open at its rear part, which is moved in the direction indicated by the arrow 9, drawn along by defined means (not represented in Fig. 1). The concrete is laid, vibrated, compacted and shaped on the said shuttering.

The movement of the shuttering leaves an internal cavity 3 which is maintained without deformation by virtue of the continuous supply of a fluid 4 at a flow rate determined by the speed of advance of the sliding shuttering and by the surface area of the cavity and at a pressure depending on the weight of the concrete 5 lying above the cavity 3.

For example, for a thickness of the layer of concrete between the outer surface 6 and the edge 7 of the cavity 3 of 10 cm, the pressure necessary would be approximately 0.024 kg/cm^2 (assuming that the density of the concrete is 2.4 T/m^3).

The pressure must never exceed the limit determined by the weight and the internal friction of the concrete on tending to be moved upwards, and must not fall below the limit determined by the weight of the concrete minus the arch effect of the circular or similar shape.

The cavity manages to retain its shape without shuttering before the start of the setting phase - between minutes and hours depending on the consistency and strength of the concrete and on the humidity and temperature conditions - by virtue, on the one hand, of the injection therein of the pressurized fluid and, on the other hand, of the use of sliding shuttering with shapes which allow a certain self-supporting capacity for a material such as wet concrete and in particular a shape which facilities the arch effect. The preferable shapes are curves such as a circle, a semicircle and an oval. The process would still be viable if it were desired to form internal cavities with polygonal shapes.

The concrete can be laid, vibrated and shaped on the sliding shuttering in accordance with the systems shown diagrammatically in Figures 5 and 6.

In the case of Fig. 5 a system is represented very diagrammatically in which the concrete is supplied via a hopper 11 and there are means 12 for vibrating the concrete and a plate 13 which allows the outer surface of the concrete section to be given the desired shape.

As can be inferred from the diagram, with the shuttering 1 advancing at the working speed of the towing device, concrete is poured through the hopper 11 onto the first part of the shuttering 1, and the combined action of the means 12 and the plate 13, which is situated on the second part of the shuttering, distributes the concrete uniformly in the desired shape, bounded below by the ground 8 (or by one of the sheets or other means arranged on the ground in order to avoid direct contact between the concrete and the soil), and above by the plate 13, laterally by means arranged for the purpose, not represented in the figures (in the particular case of culverts, the side walls of the trench itself) and internally by the sliding shuttering.

In the case of Fig. 6 a system is represented, also diagrammatically, in which the concrete is supplied by means of lorries (not represented) which pour concrete in front of the sliding shuttering which is distributed by specific means 14, for example a screw conveyor. In this case, the shuttering 1 penetrates into the concrete (to that end its front part might conveniently have a pointed shape 15), and, once the concrete is lying above the shuttering, vibrating means 12 and a shaper plate 13 are applied to it in a way similar to the previous system.

The systems which have just been described correspond in general terms to the two types of specific devices for implementing the process which will be described in detail later; these descriptions will enable a better understanding of the process which is the subject of the invention.

In any case, setting aside the details, from the diagrams of Figures 5 and 6 it can be seen that, for implementing the process which is the subject of the invention, it is necessary to use a device which moves the sliding shuttering and, simultaneously, the abovementioned means of processing the concrete. The said device could also include means for supplying the fluid to the cavity through the sliding shuttering itself. In parallel or alternatively it may have another system for supplying fluid directly to the cavity at any point thereof, particularly at the extreme end created at the start of the working day.

As has been said, two regions can clearly be distinguished in the sliding shuttering: the first, on which the concrete distributing and vibrating processing is carried out, and a second on which the shaper plate 13 acts. As the processing carried out on the concrete on the first part of the sliding shuttering necessarily includes vibrating, it may be appropriate to use means which prevent at least the second part of the shuttering vibrating, so that the hollow concrete region which is left behind the track of the shuttering remains free from any forces other than its own weight.

In trials carried out with the process, it has been proven that the preferable fluid is air and that it should conveniently have a saturation humidity content to facilitate the curing and the setting of the concrete in the regions close to the cavities. If the air is supplied hot, preferably at temperatures lying between 40°C and 70°C, the concrete would rapidly gain initial strength which is convenient with culverts of medium and large cross-sections.

Moreover, the viability of the process described has been proven in the said trials for concretes with the consistencies usually used for roads (Abrams cone of 2 to 7) and for the concretes used in culverts constructed "in situ" with fixed shuttering (Abrams cone of 2 to 10), which implies that the process is perfectly applicable to practically any of the linear works constructed on the basis of concrete.

In principle, the process which is the subject of this invention is applicable to any linear work with internal cavities. Purely by way of example, works are listed below in which the process has been found to function effectively:

a) Culverts		
- Diameter of the circular cavity (cm)	80	150
- Thickness of the layer of concrete above the cavity (cm)	12	20

b) Roads (variable width)		
- Diameter of the cavity (cm)	18	23
- Horizontal distance between cavities (cm)	8	10

As for the advantages of the process which is the subject of the present invention, two sections of roadbeds have been represented in Fig. 4; the one on the left corresponds to Section 026 of the Catalogue of Roadbeds from the Spanish Instruction 6.1 and 2.I-C, and the one on the right would be a lightened section, obtained by means of the process which is the subject of this invention, structurally equivalent and meaning a substantial saving of concrete. All the dimensions in the said Figure are expressed in centimetres.

Finally, it should be mentioned that, at the start and end of each working day, it will be necessary to use appropriate means so that, respectively, the sliding shuttering starts to advance with the rear part guaranteed to be plugged, and it is possible to withdraw the shuttering maintaining the necessary pressure in the cavity.

We will now describe in detail the processes for the formation of joints which constitutes the second subject of the present invention, by reference to Figures 7 to 9, in which is represented a joint which combines the two above-mentioned processes.

On the ground 8, either directly or above a plastic sheet 38, on which the lightened concrete is going to be laid by means of the exhaustively described process, tubes 20 are arranged, shifted laterally in relation to the position envisaged for the joint indicated by the line 21. The said tubes are situated above the metal meshes 22 and 23, parted by the broken line 37.

Once the concrete has been laid, the groove 24 is formed in the position of the line 21.

With this arrangement, the forces supported by the road will determine the appearance of cracks 25 between the upper groove 24 and the lower tubes 20. These cracks will be directed to the stretches 26 to the left and to the stretches 27 to the right, following the broken line 37 of parting of the metal mesh.

In this way the slab 28 transmits forces to the slab 29 in the regions 30 and the slab 29 transmits forces to the slab 28 in the regions 31. It is therefore unnecessary to use the metal bushes usually used to transmit forces between contiguous slabs in concrete works.

In Fig. 9 it can be seen that what we have called tubes 20 are formed by a half-tube 30 of, for example, foam polyethylene, a tube 31 of, for example, the same material or corrugated PVC, parted through its upper generatrix 32. In consequence, the crack 25 will be directed from the groove 24 to the generatrix 32. In this way, the tube 31 could drain the water received by the joint to the sides of the road, preventing it reaching the ground 8, since it is impermeable and is bonded to both sides of the concrete, performing adequately even in the event of clogging.

Moreover, the tube 31 is fitted above a half-tube 30 which protects the lower part of the former from adhering to the concrete. The half-tube 30 could be an arc of less than a semicircle, fulfilling the same function.

In the case of roads, the tubes 31 can be protected by means of bars 33 in the concrete-laying phase, in order to avoid them being damaged by the passage of the concrete-pouring lorries. The said bars would be withdrawn after the section has been formed.

In Fig. 8 two metal meshes 22 and 23 have been represented, the latter performing a function solely of supporting the first one in order to guarantee that it remains correctly positioned in the lower region of the concrete section, which could also be achieved with other alternative means. It will be observed in the said Fig. that, although the broken line is coincident in both, the metal meshes are not superimposed, but that they are shifted relatively in order to form a denser reinforcing mesh.

We will now describe a device for implementing the process in the construction of roads, by reference to Figures 10 to 16.

In Fig. 12 a device has been represented for constructing a paved width of 8.3 m, with an edge of 40.5 cm, circular cavities of 23 cm - except for the ends which have a diameter of 18 cm - separated from each other by 10 cm. A blade

45 can be observed in the said figure, which produces a longitudinal groove in the middle of the pavement, and below it can be seen the means for forming joints as was described previously.

The device is formed in essence by a set of tubes 50 of circular cross-section, which are coupled to a concrete-laying machine 35 and to which a pressurized fluid is supplied via the ducts 40.

The said fluid supply ducts 40 have been represented in the left-hand half of Fig. 12, and, in the right-hand half, plates 41 for connecting the tubes 50 to a fluid manifold 43 which is coupled to the machine 35 by means which are not represented in detail. The plates 41 are braced by means of tubes 44.

The system for supplying fluid to the tubes 50 can be appreciated in detail in Fig. 13. The fluid, originating from the manifold 43, enters the tubes 50 via the ducts 40.

In Fig. 14, it can be seen that vibrating means 51 exist, parallel to the line of advance 52 of the device and acting on the first part of the sliding shuttering.

The tubes 50 are divided into two parts, the front part 54, fastened to the plate 41 at two points 56, and a rear part 58. Both parts are joined together by a common shaft 53 and a support 57.

Within the front part 54 of the tubes 50, anti-vibration means 59 are arranged, for example those from the firm URBAR, TP 50, code 8612000623.

In Fig. 15 a variant can be appreciated which can be applied to the general configuration of Fig. 14 so that the rear part 58 can have a certain angle of turn with respect to the front part; instead of a common support 57 for both parts of the tube, two supports 57 and 66 are used, one for each part, with a rubber ring 65 arranged at their junction.

In Fig. 16 a compressor 67 is represented diagrammatically, with its storage tank 68 and a non-return valve 69 which gives a pressure between 2 and 8 kg/cm^2. As the necessary pressures are very much lower, a regulation system is used, formed by a tank 70 with a liquid 71 which lets the air out when the pressure overcomes the column of liquid existing between the inlet orifice 72 and the free surface 73. A perforated wall 74 is arranged in the said tank, which keeps the liquid level stable.

The fluid which leaves the valve 69 is saturated with humidity in the tank 75 where there is water 76 and means for controlling its level, and reaches the manifold 43 through the tubing 78 with its pressure controlled by the above-mentioned regulation system. The fluid can be heated to temperatures of 30°C to 70°C by means of resistance elements located in the tank 75.

Following Fig. 14, the operation of the device will now be explained briefly. On putting the machine 35 into action, the sliding shuttering formed by the tubes 50 leaves cavities 64 which are supported without appreciable deformation by virtue of the humid hot pressurized air supplied through the ducts 40. The concrete which surrounds the tubes is processed by the vibration means 51 and the plate 13 so that the cross-section is given the desired shape. The means 51 close the cuts made in the concrete by the plates 41. The division of the tube into two parts 54 and 58, and the arrangement of the above-mentioned anti-vibration means, allow the part 58 to be free of stress, facilitating the formation of the cavity.

Finally, we will describe a device for implementing the process in the construction of culverts, with reference to Figures 17 to 22.

Following Figure 21, it can be seen that the device is formed basically by means of the assembly of a tube 93 - which can be ballasted by means of stones or other means to improve stability - which will perform the function of sliding shuttering, a front plate 81 which will serve as a means for closing off the tube, of a hopper 96 - defined by the front plate 81 and the plate 94 - through which the concrete is supplied, and of a plate 87 for giving the outer surface of the culvert the desired shape. The front plate is extended by means of bibs 82, of, for example, plastic fabric, for adequately controlling the pouring of the concrete into the trench in the working region. The said device is moved along the trench, previously opened up, by towing means which are not represented. To that end, it has wheels 80.

The concrete supplied to the hopper 96 surrounds the tube 93 shaping the cross-section of the culvert by virtue of the action of the vibrating means 97 and the plate 87.

It can be seen in Figs. 17, 18 and 19 that the tube 93 has internal threaded spindles 84 in order to enable the shuttering to be removed from the mould. Given that, in a culvert, the internal cavity must necessarily be continuous, it is convenient to leave the mould at the end of the working day, in this case shaping the cavity in a static way, and to withdraw it at the start of the following day.

Rings 85 can also be seen for passing the hoses of the vibrators 97 and flanges 86 for supporting them.

Unlike what happened in the device for constructing roads with internal cavities, it is considered preferable for the pressurized fluid supply not to come through the sliding shuttering itself but through a closure 89 formed at the starting position of the cavity on each working day. Means 91, for example a rubber O-ring, are arranged in the said closure 89, in order to achieve a perfectly hermetic seal.

The fluid is supplied to the cavity by means of a supply tubing 90 which passes through the closure 89 and supplies the fluid to the cavity created by the sliding shuttering. The system for supplying fluid at the necessary pressure is formed by the system which has already been described in the device for road construction.

Figure 22 diagrammatically shows the system for forming joints following an already described system. Elements 98 are positioned in the positions required for the joint which predetermine regions of weakness for forming the shrinkage joints. The said elements 98 may, for example, be flexible tubular shells of the AF/ARMAFLEX type, manufactured by ARMSTRONG, with internal diameter of 26 mm for the half-tube and of 13 mm for the tube. The possible presence of a concrete bed, which is to be recommended for culverts with large cross-section, is indicated in the said figure by the number 99.

Claims

1. Process for continuously constructing linear concrete works "in situ", such as road surfaces or culverts, with internal cavities, characterized in that:

   - a sliding shuttering is used to form the internal cavities, closed at its front part and open at its rear part, which is moved in conjunction with the device used to form the external shape of the concrete cross-section;

   - a fluid, preferably humid and hot air, is injected into the leaktight cavity created by the sliding shuttering, at a flow rate determined by the surface area of the cavity and the speed of advance of the sliding shuttering and at a pressure determined by the weight of the concrete above the upper generatrix or vertex of the cavity, through the sliding shuttering and/or directly into the cavity;

   - the operations necessary for shaping the concrete with the characteristics required in each type of work are carried out on the concrete which envelops the sliding shuttering and in its front part.

2. Process for constructing pavements according to Claim 1, characterized in that the sliding shuttering consists of a plurality of tubes of circular or oval cross-sections.

3. Process for constructing culverts according to Claim 1, characterized in that the sliding shuttering consists of a mould of circular, arched or oval cross-section.

4. Process for forming joints in concrete pavements produced according to the process of Claim 1 or other processes, characterized in that means are arranged on the ground in order to predetermine that the cracking of the concrete will occur in surfaces directed from grooves produced in predetermined positions in the upper part of the pavement, towards the said means.

5. Process for forming joints according to Claim 4, characterized in that the means for predetermining the cracking consist of elastic tubes with their upper generatrix parted supported on elastic half-tubes located on the ground in the vertical to the groove or in positions shifted slightly to left or right with respect to the said vertical.

6. Process for forming joints in concrete pavements produced according to the process of Claim 1 or other processes, characterized in that means are arranged on the ground in order to predetermine the cracking of the concrete, from grooves produced in predetermined positions in the upper part of the pavement, in surfaces inclined from the said grooves towards the said means, various regions existing in the joint in which the direction of the inclination of the cracking surfaces varies from one region to the next.

7. Process for forming joints according to Claim 6, characterized in that the means for predetermining the cracking consist of a metal mesh parted along a broken line which determines the regions with cracking surfaces inclined in a different direction.

8. Process for forming joints according to Claim 7, characterized in that, above the metal mesh, two elastic tubes are arranged with their upper generatrix parted, supported on elastic half-tubes, in two lines parallel to the line of the upper groove and shifted by a certain distance to left and right of it, the said tubes being to the side of those parts of the broken line of the metal mesh which are parallel to the upper groove.

9. Process for forming joints according to Claims 7 or 8, characterized in that the parted metal mesh is situated above another parted metal mesh, the parting lines of both metal meshes coinciding.

10. Process for forming joints in concrete culverts produced according to the process of Claim 1 or other processes, characterized in that, along the trench and at appropriate distances, elastic tubes are arranged in a direction transverse to the axis of the trench, with their generatrix closer to the cavity of the culvert parted, supported at the opposite generatrix on elastic half-tubes, both having to be of a length which makes it possible completely to surround the culvert through its upper wall.

11. Device for constructing pavements according to the process of Claim 1, and using a concrete-laying machine, characterized in that:

- the sliding shuttering which shapes the cavities consists of a plurality of tubes coupled to the laying machine in such a way that their movement is determined by that of the machine;

- the tubes are equipped with anti-vibration mechanisms;

- the vibrating means of the laying machine are arranged parallel to the lines of the axes of the tubes and in intermediate lines between them;

- means exist for supplying a fluid, preferably humid and hot air, at low pressure, into the sliding shuttering or directly to the cavity.

12. Device according to Claim 11, characterized in that the tubes which make up the sliding shuttering are divided into two or more parts, all but the first one being free from vibration stresses and being joined together with means which allow small turning movements by the separate parts.

13. Device for constructing culverts in trenches according to the process of Claim 1, characterized in that:

- it consists of a mobile framework which incorporates a tube or mould closed at its front part, a plate for shaping the outer surface of the culvert and means for laying and processing the concrete at the front part of the tube;

- it has means for supplying a fluid, preferably humid and hot air at low pressure, to the cavity through the tube or, alternatively, directly to the cavity at a point fixed on each working day.

Amended claims under Art. 19.1 PCT

1. Process for continuously constructing linear concrete works "in situ", such as road surfaces or culverts, with internal cavities, in which a sliding shuttering is used to form the cavities and a fluid is injected into the cavity created by the sliding shuttering for the purpose of maintaining its shape during the setting process and of closing any possible pores in the concrete, characterized in that:

- the sliding shuttering which shapes the cavities consists of a plurality of tubes parallel to the ground coupled to a concrete-laying machine in such a way that their movement is determined by that of the machine;
- the vibrating means of the laying machine are arranged in planes parallel to the lines of the axes of the tubes and in intermediate lines between them;
- the said vibration means act on the concrete situated around a first part of the tubes which make up the sliding shuttering, in which are located the means for fastening to the laying machine; the second part of the tubes slides on the already vibrated concrete;
- means are arranged for injecting a fluid, preferably humid and hot air, to the whole of the leaktight cavity created by the sliding shuttering during a working session, at a flow rate determined by the surface area of the cavity and the speed of advance of the sliding shuttering and at a pressure determined by the weight of the concrete above the upper generatrix or vertex of the cavity, through the sliding shuttering and/or directly into the cavity.

2. Process for forming joints in concrete pavements produced according to the process of Claim 1 or other processes, characterized in that means are arranged on the ground in order to predetermine that the cracking of the concrete will occur in surfaces directed from grooves produced in predetermined positions in the upper part of the pavement, towards the said means.

3. Process for forming joints according to Claim 2, characterized in that the means for predetermining the cracking consist of elastic tubes with their upper generatrix parted supported on elastic half-tubes located on the ground in the vertical to the groove or in positions shifted slightly to left or right with respect to the said vertical.

4. Process for forming joints in concrete pavements produced according to the process of Claim 1 or other processes, characterized in that means are arranged on the ground in order to predetermine the cracking of the concrete, from grooves produced in predetermined positions in the upper part of the pavement, in surfaces inclined from the said grooves towards the said means, various regions existing in the joint in which the direction of the incli-

nation of the cracking surfaces varies from one region to the next.

5. Process for forming joints according to Claim 4, characterized in that the means for predetermining the cracking consist of a metal mesh parted along a broken line which determines the regions with cracking surfaces inclined in a different direction.

6. Process for forming joints according to Claim 5, characterized in that, above the metal mesh, two elastic tubes are arranged with their upper generatrix parted, supported on elastic half-tubes, in two lines parallel to the line of the upper groove and shifted by a certain distance to left and right of it, the said tubes being to the side of those parts of the broken line of the metal mesh which are parallel to the upper groove.

7. Process for forming joints according to Claims 5 or 6, characterized in that the parted metal mesh is situated above another parted metal mesh, the parting lines of both metal meshes coinciding.

8. Process for forming joints in concrete culverts produced according to the process of Claim 1 or other processes, characterized in that, along the trench and at appropriate distances, elastic tubes are arranged in a direction transverse to the axis of the trench, with their generatrix closer to the cavity of the culvert parted, supported at the opposite generatrix on elastic half-tubes, both having to be of a length which makes it possible completely to surround the culvert through its upper wall.

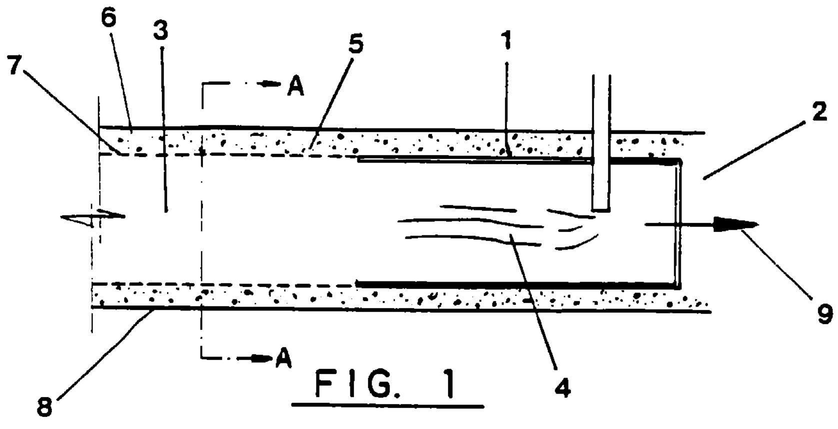


FIG. 1

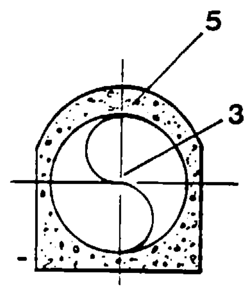


FIG. 2

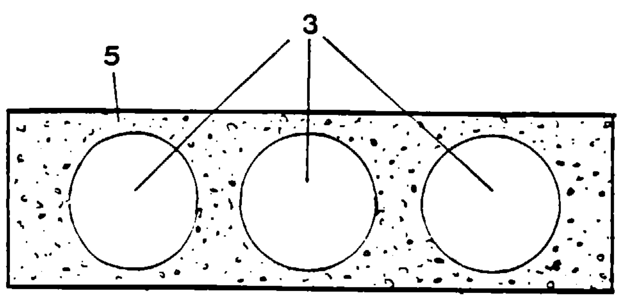


FIG. 3

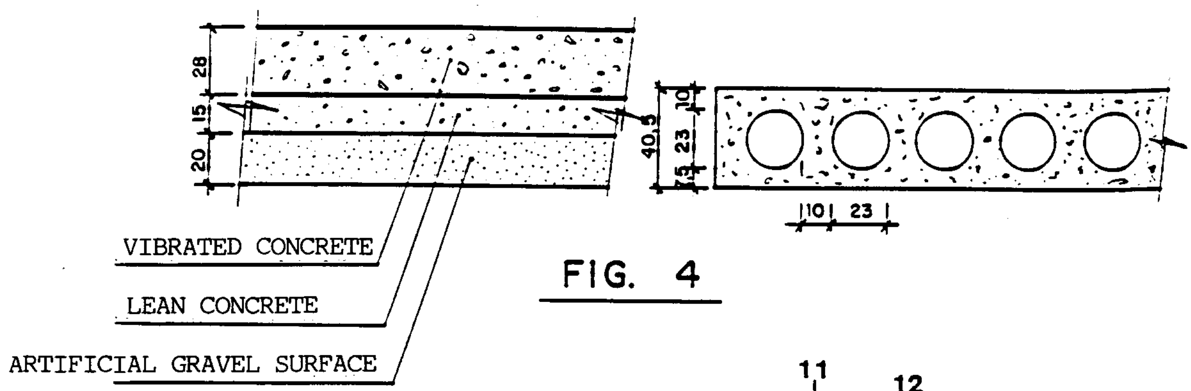


FIG. 4

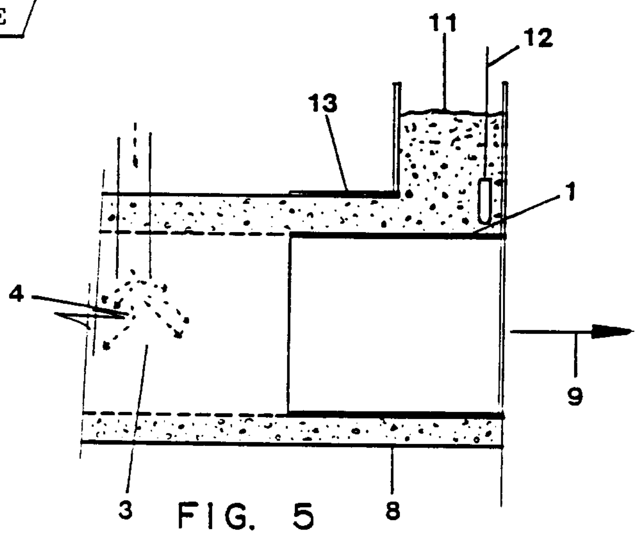


FIG. 5

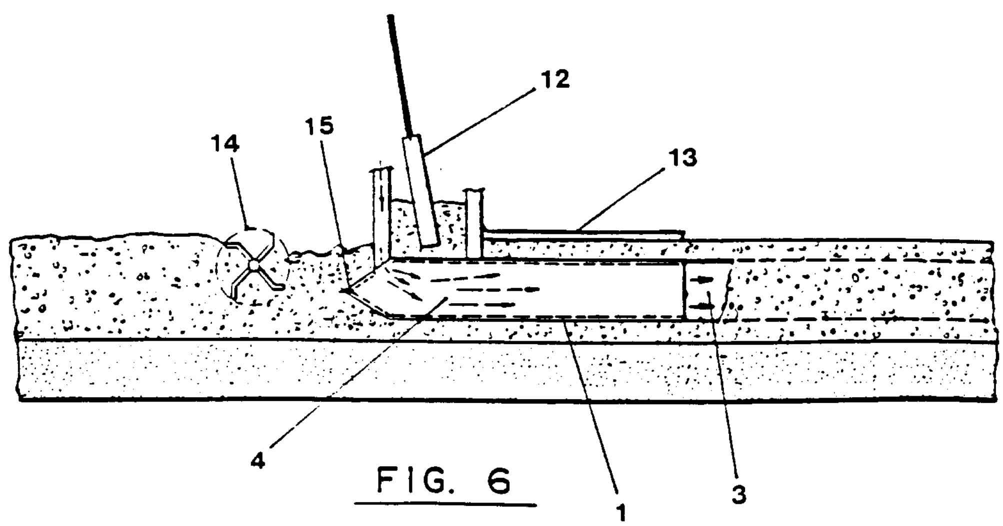


FIG. 6

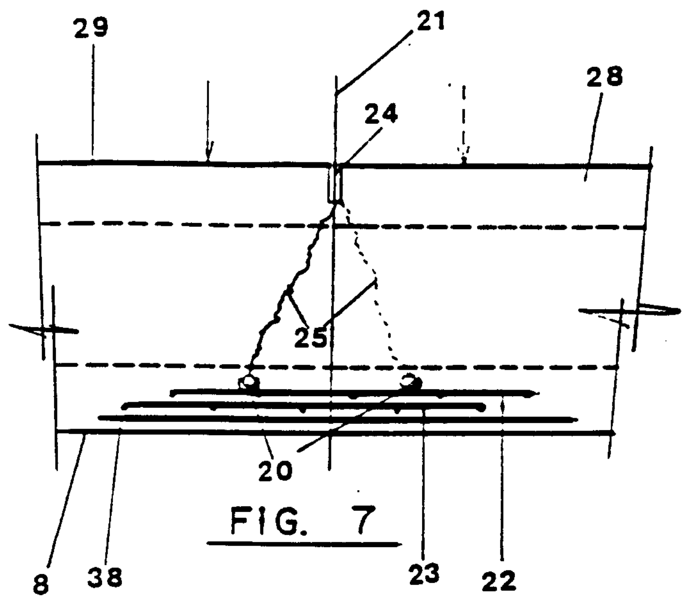


FIG. 7

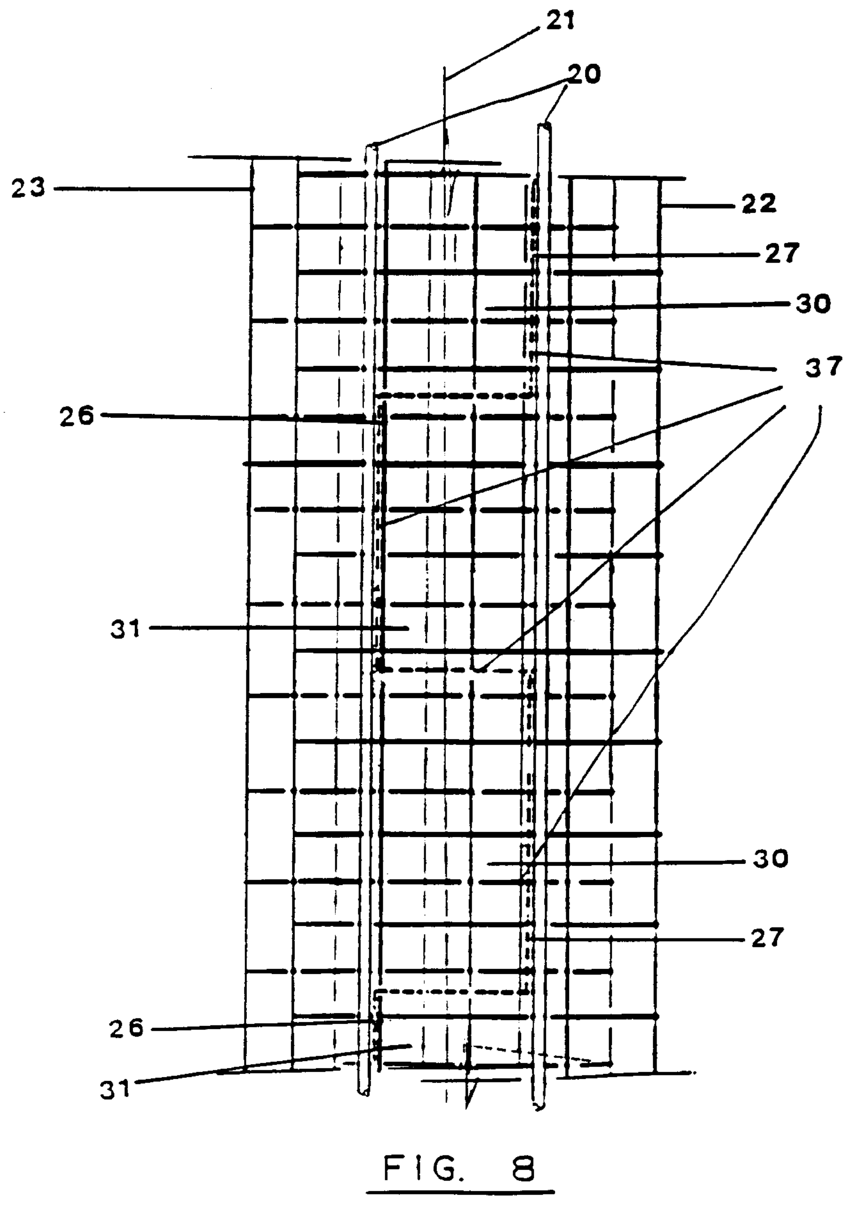


FIG. 8

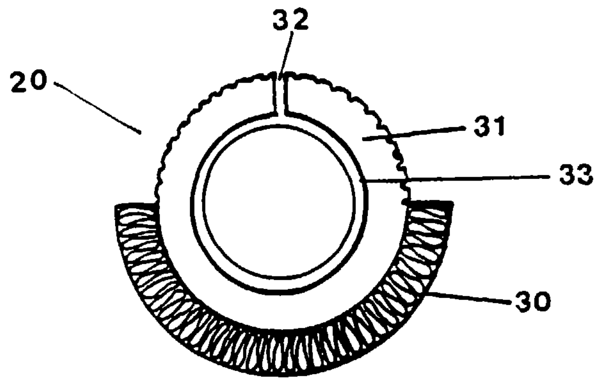


FIG. 9

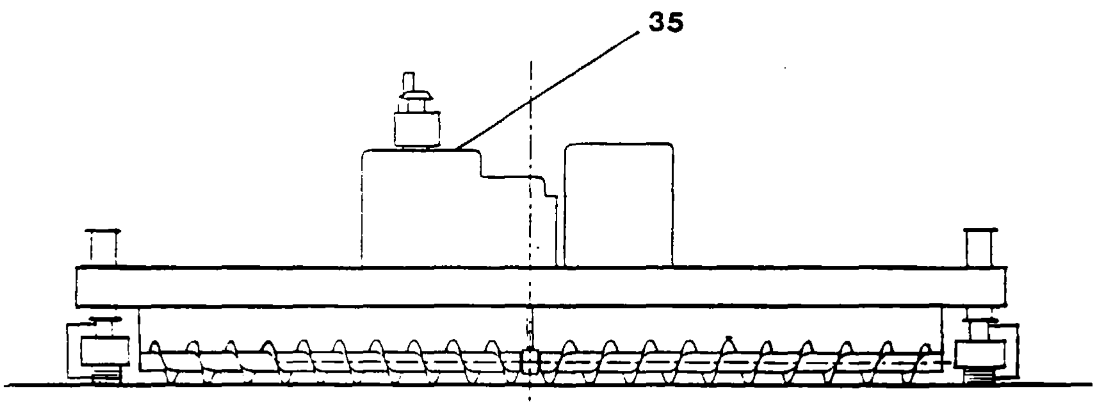


FIG. 10

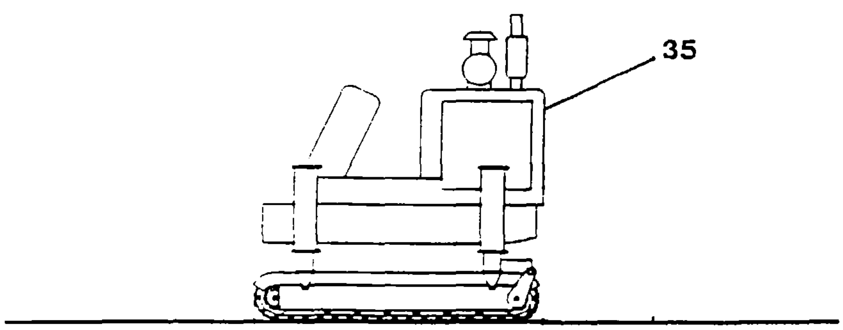


FIG. 11

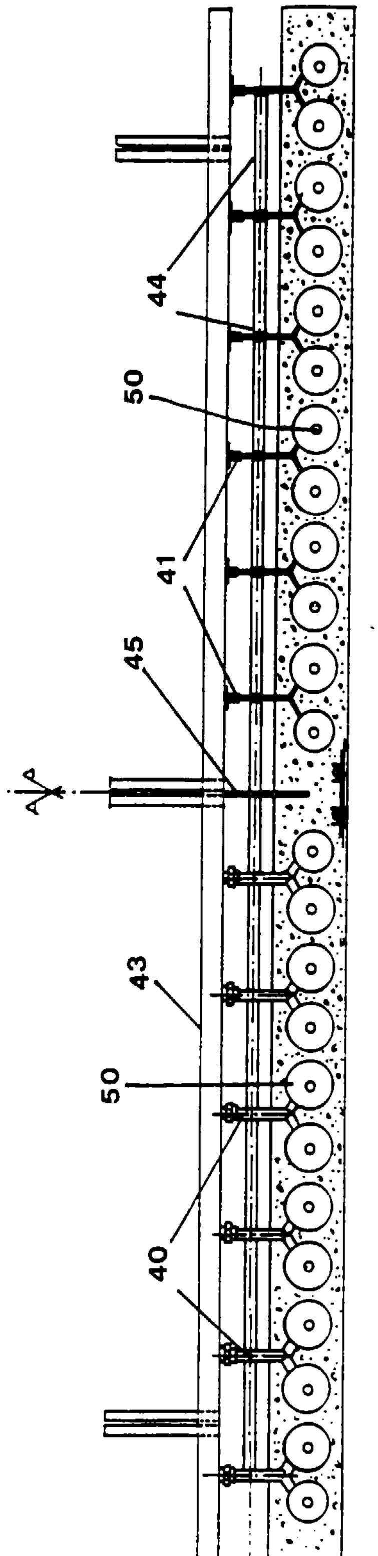


FIG. 12

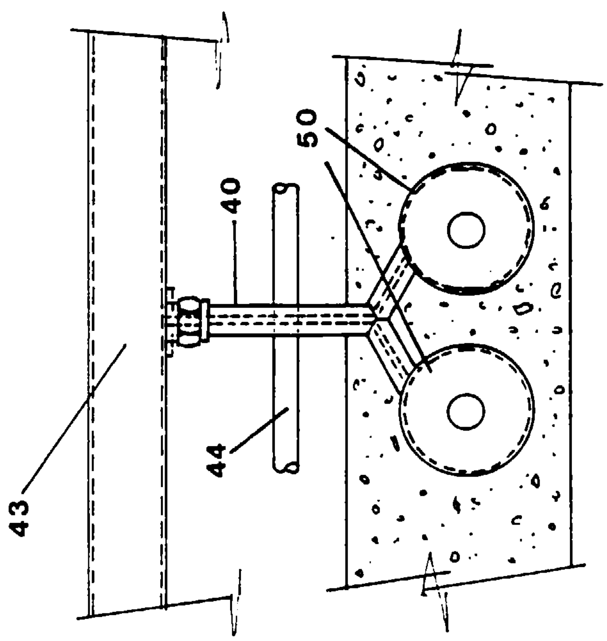


FIG. 13

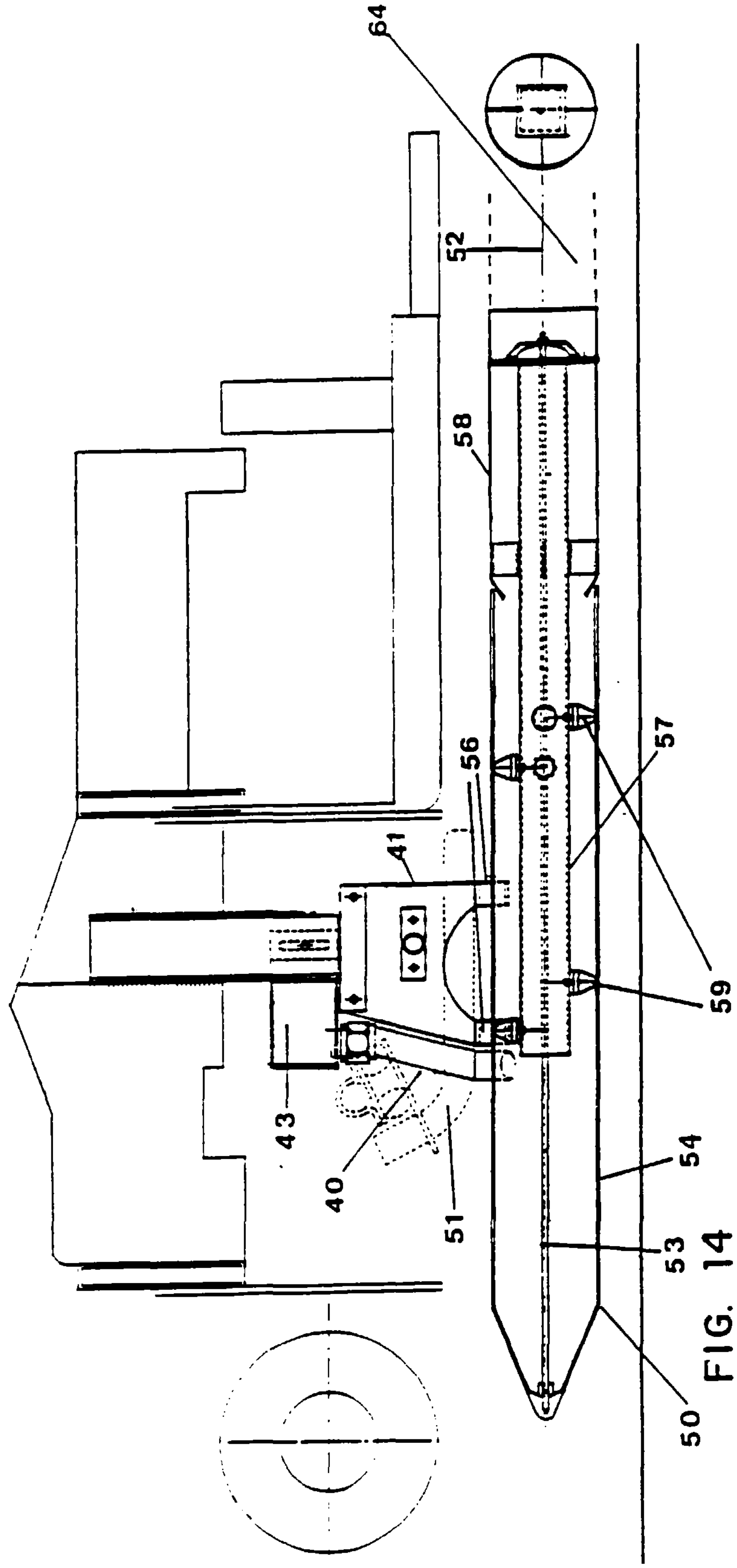


FIG. 14

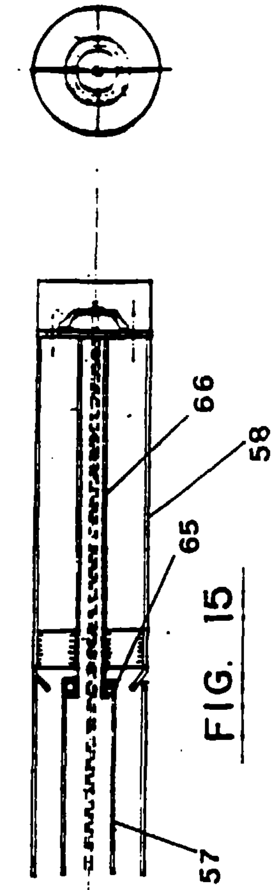


FIG. 15

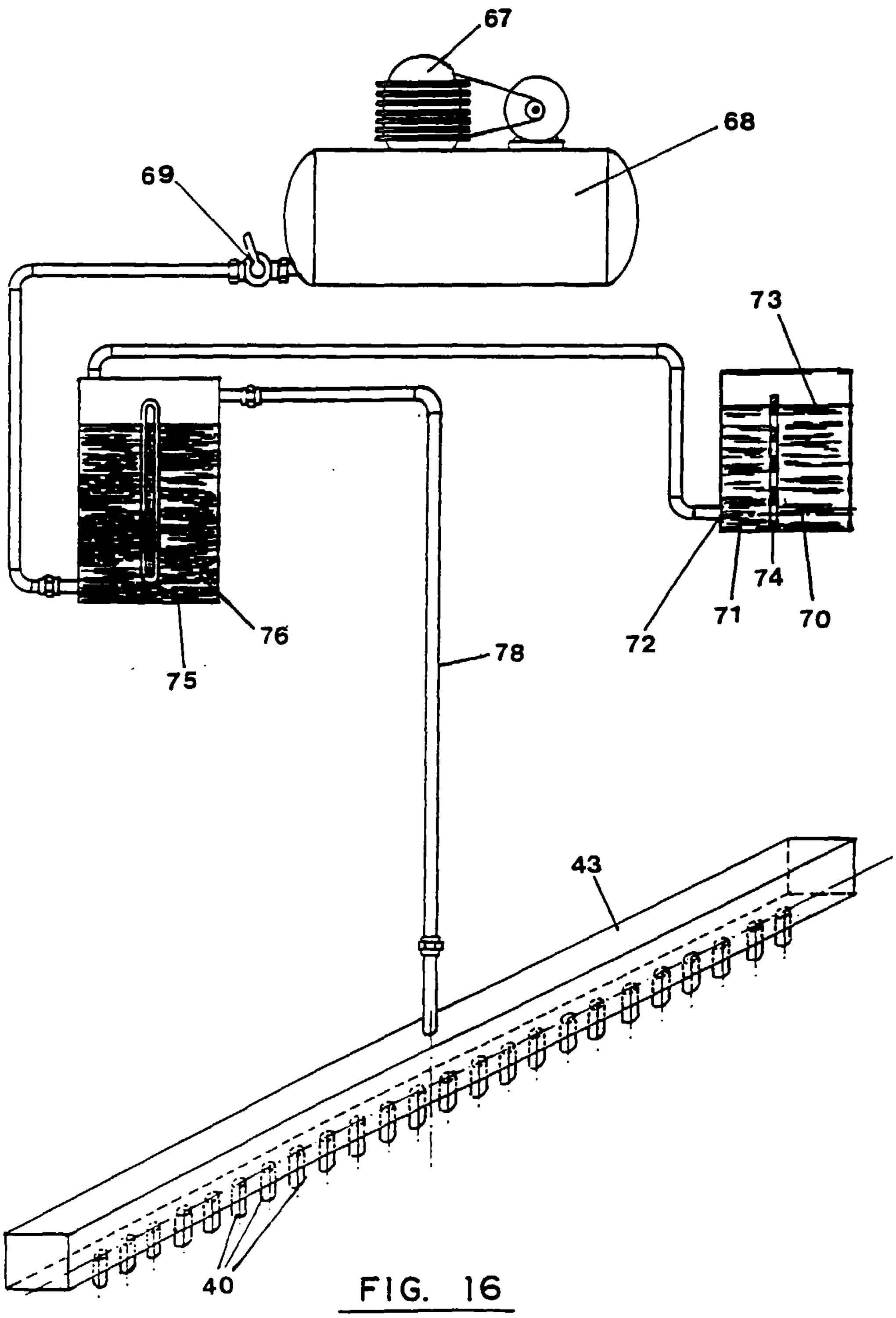


FIG. 16

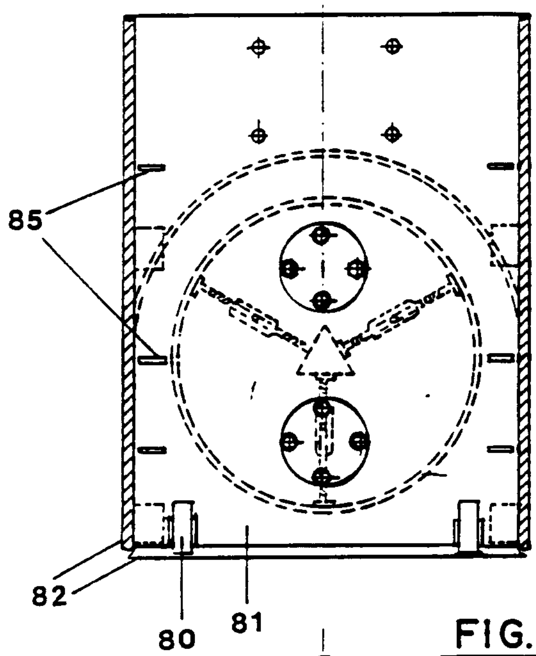
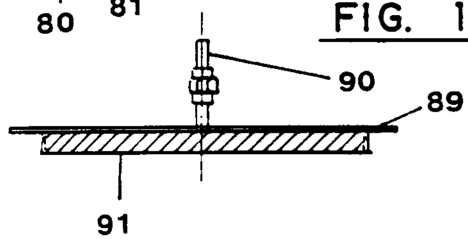


FIG. 17



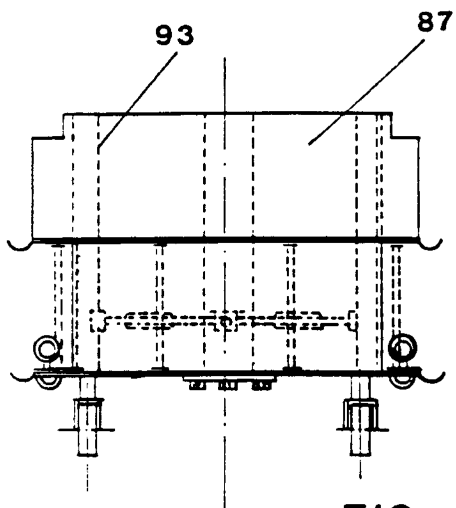


FIG. 18

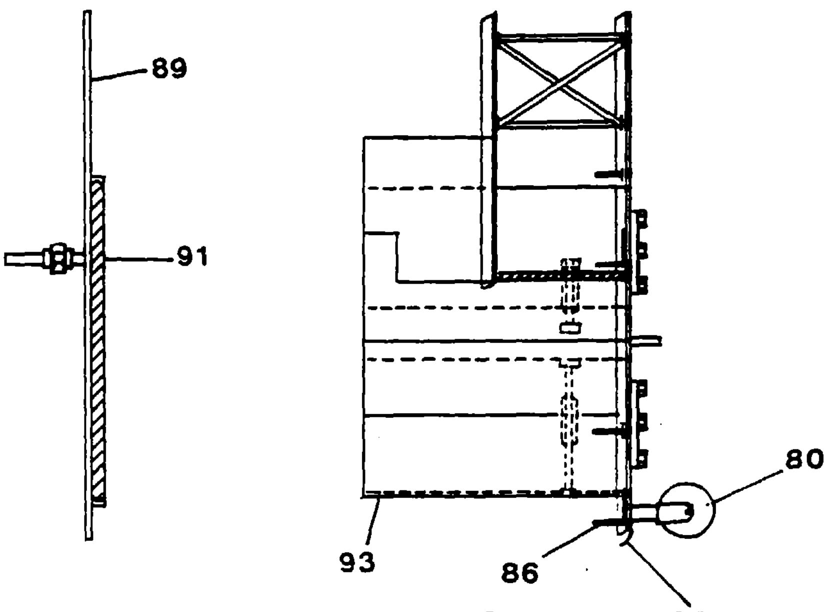


FIG. 19

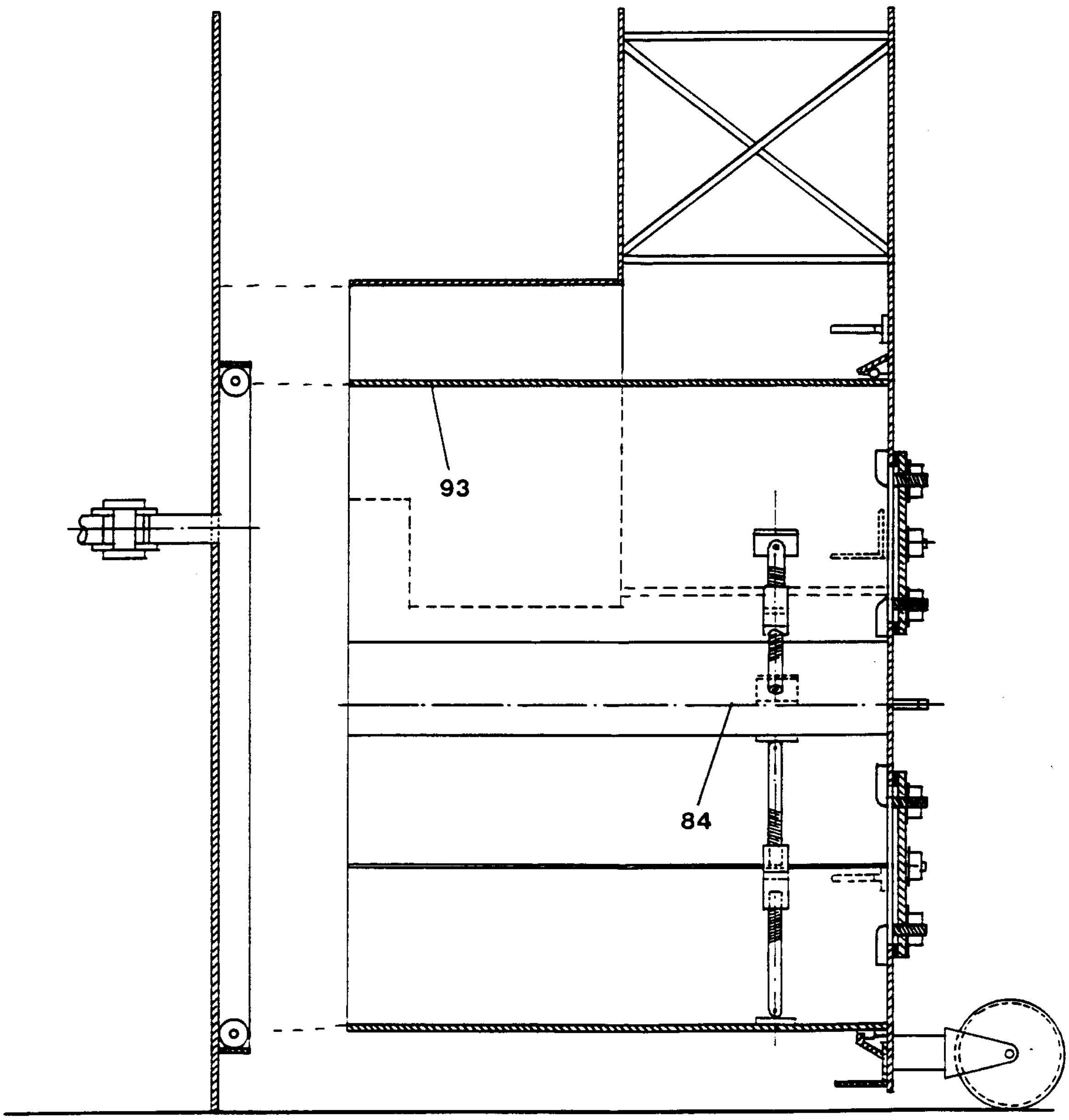


FIG. 20

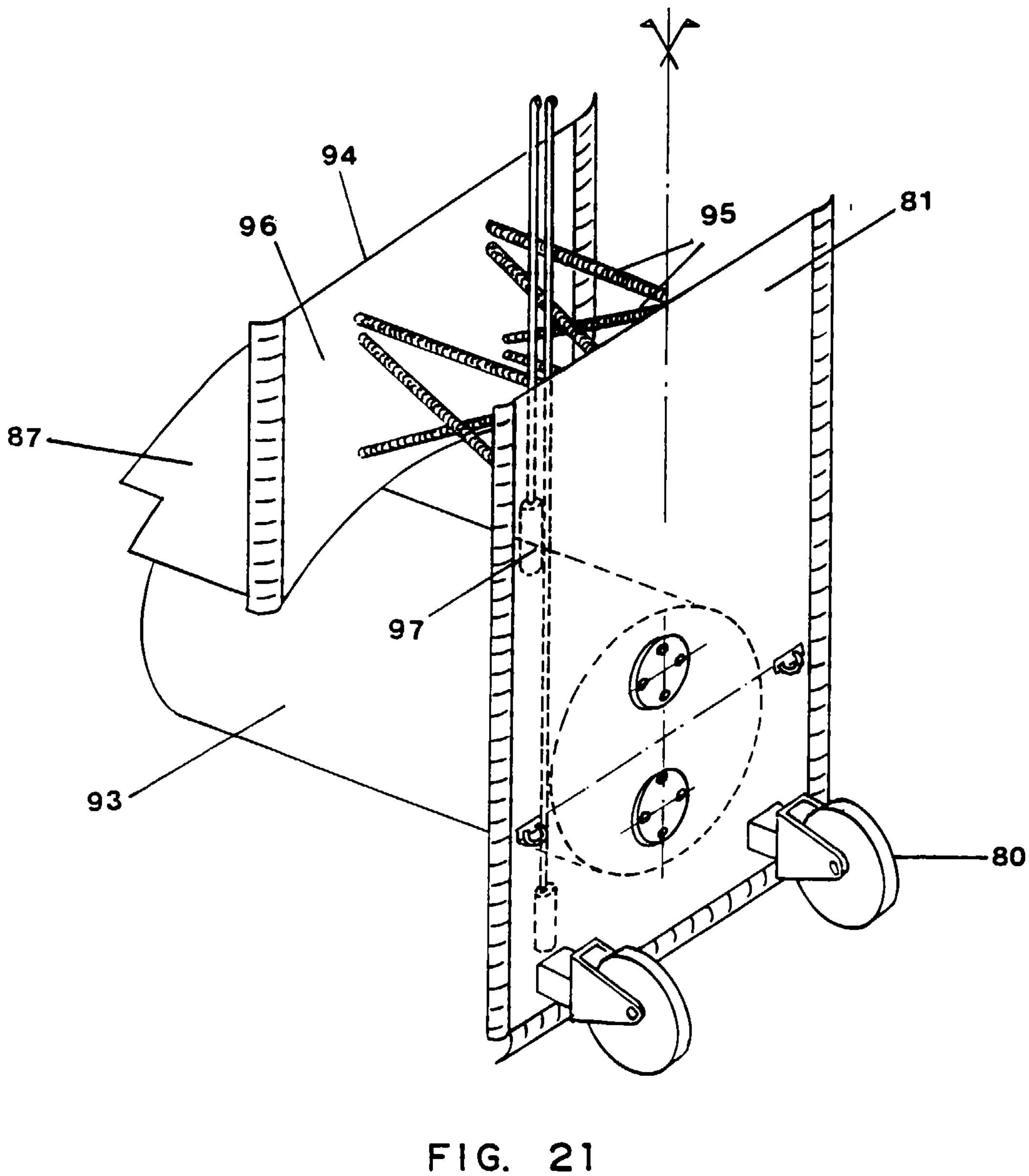


FIG. 21

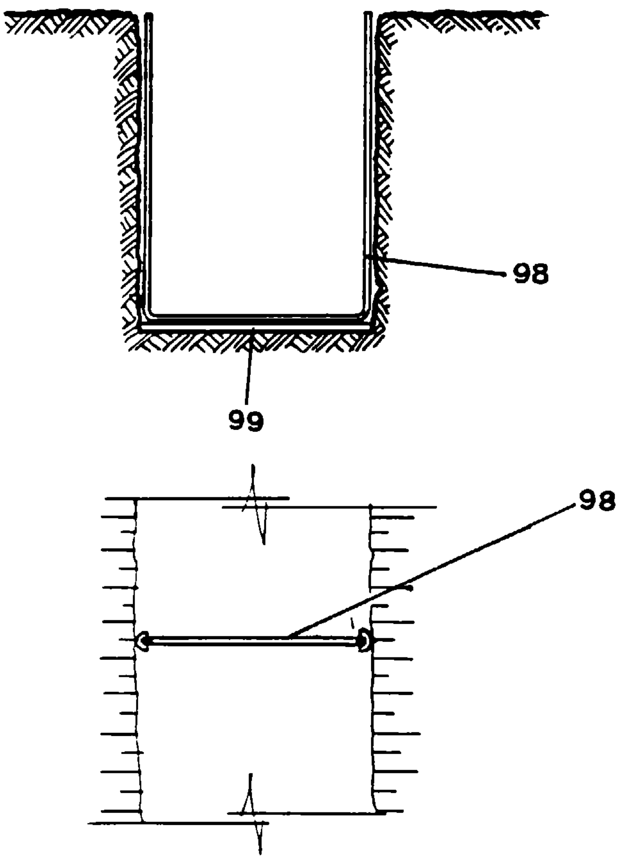


FIG. 22

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/ES 95/00072

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B28B1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B28B E02D E01B E01C E01D E01F E02F E04B E04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,83 03571 (KAUTAR OY) 27 October 1983 see the whole document see page 6, line 35 - line 37 ---	1-3
X	US,A,3 959 977 (HAROLD W. GODBERSEN) 1 June 1976 see the whole document ---	1-6, 10-13
A	US,A,3 994 639 (FREDERICK M. HEWITT) 30 November 1976 see the whole document ---	1,3,11
A	FR,A,2 299 132 (A/S NORCEM) 27 August 1976 see the whole document ---	1-3
A	US,A,3 284 867 (GLEN BOOTH) 15 November 1966 see the whole document ---	4-10

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 February 1996	19/02/96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Molto Pinol, F

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/ES 95/00072

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DATABASE WPI Section PQ, Week 8822 Derwent Publications Ltd., London, GB; Class PQ, AN 88-153865 (22) & SU,A,1 350 018 (CONS. MANAGERS WORKE) , 7 November 1987 see abstract ---	1
E	WO,A,95 15838 (JOSE RAMON VAZQUEZ RUIZ DEL ARBOL) 15 June 1995 see the whole document -----	1-3,11, 13

Form PCT/ISA/210 (continuation of second sheet) (July 1992)