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

(11) Publication number: **0 029 044**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **27.10.82**

(51) Int. Cl.³: **E 04 G 11/22**, E 02 D 15/06

(21) Application number: **80900972.3**

(22) Date of filing: **30.05.80**

(86) International application number:
PCT/NO80/00018

(87) International publication number:
WO 80/02708 11.12.80 Gazette 80/28

(54) **A method of carrying out slip form casting of concrete structures under water and apparatus for carrying out the method.**

(30) Priority: **30.05.79 NO 791798**

(43) Date of publication of application:
27.05.81 Bulletin 81/21

(45) Publication of the grant of the patent:
27.10.82 Bulletin 82/43

(84) Designated Contracting States:
AT CH DE FR GB LI LU NL SE

(56) References cited:
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DK - C - 84 819
FR - A - 1 097 630
GB - A - 1 315 210
SE - B - 319 892
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EP 0 029 044 B1

Courier Press, Leamington Spa, England.

A method of carrying out slip form casting of concrete structures under water and apparatus for carrying out the method

The present invention relates to a method and apparatus for performing underwater casting of concrete structures.

Underwater casting of concrete structures, such as foundations for piers, bridges, etc. conventionally is carried out with stationary shuttering which is fixed to the sea bottom or to a ready-made portion of the structure. Initially is usually cast a foundation bed on the sea bottom, subsequent to a suitable levelling thereof, whereafter the shuttering is mounted onto the foundation bed. In this fashion is carried out underwater casting of solid foundations such as columns and the like, with a shuttering which is exposed to external concrete pressure only, as well as wall structures and the like, whereby the shuttering must be formed for sustaining bilateral concrete pressures. Required reinforcement of the concrete structures must usually take place, at least partly, with the help of diving operators. Poured concrete is usually brought down to the working location by means of so-called casting tubes conveying the poured concrete from a suitable source in position above water down into the shuttering. Particularly in connection with the casting of structures requiring bilateral concrete pressures on the shuttering, the reinforcement work is costly and cumbersome because the reinforcing elements, such as steel rods or mats, must be positioned downwards between cross-bracing elements which are interconnecting the shuttering elements. Frequently it is difficult to avoid that the reinforcing elements subsequent to positioning are displaced, for instance onto the shuttering boards, so that the reinforcing elements are subseqently exposed to seawater resulting in heavy corrosion. It would therefore be of great importance if a better and more dependable method for reinforcing such underwater concrete works could be developed.

The principal object of the present invention is to provide a more effective method for carrying out casting of concrete structures below water.

A further object for the invention is to provide better means and apparatus for carrying out various types of underwater concrete work.

A particular object of the invention is to provide a method and apparatus which can make it easier and with less danger for the workers to carry out reinforcing of underwater concrete works.

When forming concrete structures ashore it is today conventional to utilize the slip forming principle i.e. utilizing a slip form unit with a limited length or height which is moved continously in the casting direction parallel with the pouring and hardening of the supplied concrete. The slip forming equipment is usually moved as a unit which is supported and raised on so-called climbing steel elements which are located and in some cases embedded in the concrete structure. The climbing steel elements may consist of reinforcement steel rods or rods which are embedded in the concrete, or alternatively rods which are positioned loosely in piping which is embedded in the concrete. The reinforcing of concrete structures in connection with slip forming may be comparatively cumbersome, particularly if the work concerns slip form with bilateral concrete pressure, that is concrete walls or the like, since then one will have a number of cross-bracers above the casting between the slip form walls on either side. These cross-bracers interconnect and position the slip form boards, while they simultaneously serve as supporting elements for jack-up means which stand in engagement with the steel elements positioned in the concrete work. The reinforcing must then, under the concrete pouring, be positioned one after the other down into the concrete as poured between and below the superimposed cross-bracers. Vertically extending reinforcing is comparatively simple while horizontally extending reinforcement and the positioning of mats may be difficult and interconnection of the reinforcement elements must frequently be carried out in situ.

Underwater casting of concrete by means of slip forming is, as far as is known, not hitherto carried out, at least not in full normal scale. This may be due to several reasons. Firstly, the development of underwater slip forming equipment requires the existence of equipment which is operable under water. Secondly, the reinforcement of underwater concrete works in connection with slip forming may of course be very difficult. The reinforcing of underwater concrete works must be mentioned usually be carried out by divers which in itself is expensive and dangerous, particularly due to very poor sight in the water due to water contamination in the vicinity of the working site.

The casting of concrete structures under water is proposed in British patent specification No. 1,315,210. In this specification is shown a type of slip forming equipment with bilateral concrete pressure for the casting of hollow columns and which equipment is supported by a surface vessel by means of cables or the like. The lifting of the slip forming shall take place by means of special buoyancy tanks which are mounted between the shuttering walls and which provide suitable buoyancy force by supplying a controlled quantity of compressed air. As far as the applicants know, the method in accordance with this patent specification has hitherto not been carried out. The method apparently has several substantial shortcomings. Firstly, it is clear that the slip forming equipment may be subjected to incidental

vertical movement in correspondence with the vertical movements of the floating vessel. Furthermore, it seems difficult to ensure that the slip forming equipment is given sufficiently secure and stable rising movements by means of the buoyancy equipment shown.

In accordance with the present invention a method carrying out slip form casting of concrete structures, under water at a casting site on the sea bottom, wherein a unitary slip form unit surrounding the object to be cast is moved upwards in correspondence with the casting and the hardening velocity of the concrete mass while additional concrete is supplied from an above water supply through supply tubes or the like is characterized by the steps of initially suspending the slip form unit by means of a number of mutually spaced suspension stays each of which is connected to a support- and hoisting system positioned above water level above the casting site and thereafter lowering the slip form unit to the casting site, whereafter the slip form unit is hoisted upwards by means of the stays in correspondence with the supply of poured concrete and the hardening of same, which concrete is supplied continuously and at the same time as the slip form unit is raised, the slip form unit being directionally controlled and if necessary adjusted as to angular position during the casting by individual, coordinated adjustment of each of the suspension stays.

Apparatus for carrying out such a method comprises a slip form unit, characterized in that the slip form unit is suspended from a number of individually adjustable and hoistable stays in the form of cables, pipe sections or the like, and which are connected to support- and hoisting systems positioned on an above water support construction, which support construction is immovably positioned in an above water position directly above the casting site.

The slip form unit may be supported by an overhanging rigid horizontally extending structure which again is suspended in at least three vertical hangers or stays which each are connected to a separate power jack or the like. Thereby the exact position of the slip form unit will be, at any time, subject to full control, because in a lateral direction the slip form unit will be kept immovable by means of the below positioned hardened concrete still in contact with the slip form and vertically, the slip form unit may not only be raised, but may be guided and directionally controlled by carrying out individual adjustment of one or more of the hangers by means of the raising jacks.

This method makes it possible to carry out a far more effective underwater casting of concrete structures. Furthermore, it will make it far more simple to carry out reinforcement of the concrete works, because the slip form unit may, in an upward direction, remain more or less open without obstructions, disregarding some very few horizontally extending elements which, however, may be positioned well above the casting or pouring site, and in some cases horizontally extending supporting elements may be entirely avoided.

The support structure in a position above the sea surface for supporting the slip form equipment may be of various types depending upon the kind of work involved, the sea depth, etc. The support structure may thus consist of a working platform of the jack-up type with legs, a centilevered structure mounted onto an existing foundation, or possibly also to a floating vessel, then preferably a vessel of semi-submersible type.

Examples of apparatus in accordance with the present invention will now be described with reference to the accompanying drawings, wherein:—

Figures 1 and 2 are a schematic plan view and elevational view, respectively, showing a construction for carrying out the method according to the present invention, and Figure 2 showing the construction with the equipment in position for initiating the casting work;

Figures 2*a* to 2*e* are simplified detail views illustrating the various steps in the procedure to carry out the casting work;

Figures 3*a* to 3*c* are detail views, similar to Figures 2*a* to 2*e*, illustrating a method for protecting freshly poured concrete against erosion;

Figures 4 and 5 show a schematic view and elevational view, respectively, of another example of a slip form unit; and,

Figure 6 is an elevational view of a further example of the supporting construction including a cantilevered support from an existing foundation.

The casting scaffolding or frame comprises a horizontal support or platform with a frame 2, in the shown embodiment comprising two side by side parallel hollow beams 4, 6, made as buoyancy elements. These beams are mutually connected with transverse hollow beams 8, 10. This platform structure is provided with four jackable supporting legs 12, 14, 16, 18, enabling same to be moved vertically down for support on the sea bottom for subsequent lifting of the platform structure to a position above the water surface directly above the working site. On the platform is installed the casting equipment, and the equipment for supporting and raising a slip form unit 20 which in the shown embodiment consists of a square slip form frame 19 for singular or one-sided, internal concrete pressure (solid column) and which on the inside is furnished with slip form boards 25, which are positioned with a downward outward slip to facilitate the raising of the form work and prevent damage to the concrete surface.

The slip form unit 20 is suspended on a rigid truss frame 22 which in the shown embodiment consists of two pairs of mutually crossing steel beam sections 23*a* and 23*b*, respectively. This design is aimed at obtaining large span widths between the sections 23 in the frame and

plenty of height below the frame, that is the height *h* down to the casting site in order to facilitate the equipment for easy positioning of necessary reinforcements in the concrete, such as steel rods or steel mats. The entire slip from unit 20 is, at anchoring points 24, suspended in the number of vertical stays, in the shown embodiment comprising four pipe strings 27*a—d*, each preferably consisting of inter-threaded sections. On the platform 2 these suspension stays are firmly engaged by so-called climbing jacks 30*a—d* (hydraulic/pneumatic/electrical) which are operationally connected to a not shown control system, such that the stays can be raised at equal or/and different speeds in order to allow for individual adjustment in one or more of the stay suspension.

On the platform 2 is further installed a complete casting gear 36. This gear comprises a crane boom 38 with a travelling winch crane 40 to carry a concrete container 42 for delivery of ready-made poured concrete to a number of hoppers 44*a, b, c, d, e, f*, which are suspended in trolleys 45 from a transverse beam 47. Each of the hoppers carries a downwardly pointing so-called casting tube or hose 46*a—f*, respectively, which lead directly down to the casting site in the slip form unit 20.

The above described aggregate or plant composes the main elements in an embodiment for an apparatus in order to carry out a method in accordance with the invention. The technical equipment involved can thus be conventional and should not be necessary to describe in detail. Thus, on the working platform 2 can be arranged a mixing plant for making ready-made poured concrete. Furthermore, the casting tubes or hoses 46*a—f* are suitably supplied in detachable sections in order to adjust the length of these tubes to the need at any stage of the casting operation.

Figure 2 illustrates the entire aggregate in working position in order to initiate the casting job utilizing a method in accordance with the invention. The platform etc. is in advance floated out to the working site. Under the floating operation the slip form unit 20 is raised up to a position between the hollow beams 8 and 10. Furthermore, the casting tubes 46 are obviously raised up. On the working site the jack-up legs 12, 14, 16, 18, are by means of the jack system moved down to resting locations 31, 31 on the sea bottom circumferentially around the casting site, and the platform 2 has been raised up to the above water position as shown. Of other preparatory works can be mentioned that the sea bottom on the casting site is usually prepared, for instance levelled, and if necessary, a special bottom foundation of concrete is made, in such case preferably including a number of free-standing upwardly pointing reinforcing steel rods, firmly embedded into the bottom concrete foundation. Thereafter the slip form unit has been sunk down onto the casting site. During this operation further sections of suspension stays are supplied as necessary. The slip form unit is in this fashion sunk down and positioned on the casting site. Simultaneously or subsequently the required number of casting tubes are sunk down and positioned as shown. The casting tubes can consist of rigid tubing or in part or wholly of flexible hosing, for instance reinforced plastic hosing.

The carrying out of the casting work shall now be described with reference to the detail views, Figures 2*a—e*, illustrating various stages during the casting operation. The slip form boards 25 are initially resting on the sea bottom or on the foundation 50 and may be firmly positioned utilizing upstanding reinforcing rods 52. This initial position is shown in Figure 2 (and 3a). The casting tubes 46*a—f* are filled with poured concrete from the hoppers on the platform deck 2. The poured concrete will, due to its gravity, fill out the tubing and initially flow out of the bottom openings of the tubes and will thereby soon fill up the surrounding slip form unit space until the pressure around the tubing openings equalizes the present static pressure in the tubings, cf. Figure 2*b*. The casting tubes may, if desired, in the bottom section be provided with remotely controlled check valves 33, among other things to prevent incidental, uncontrolled flow-out of poured concrete. Figure 3c illustrates a second stage during the casting procedure. At this stage the casting tubes 46 have been lifted up to a certain level corresponding approximately to half of the height of the form boards 25. The poured concrete in the casting tubes will in this position again flow out until the described automatic or internal locking takes place due to the pressure equalization. Reinforcing of the casting preferably takes place at intervals or rests in the supply of concrete. A supply of reinforcing rods or the like can be placed in a rack 53 mounted on the supporting beams 23, and these may also serve as working platform for divers during the work for positioning reinforcement 54 in the concrete as poured. When the concrete as poured has solidified or hardened to a sufficient degree one can initiate the raising of the slip form unit via the suspension stays by means of the jacks 30 positioned on the platform 2.

Partly to prevent leakages of poured concrete below the bottom edge of the slip form boards, and partly to protect the progressively exposed side surface of the cast concrete work, there is along the bottom edge of the slip form boards positioned downwardly pointing skirt means 55. As such protecting skirt means may be used boards made of wood or steel and they consist preferably of flexible material such as plastic sheeting or the like and the skirts are positioned as downwardly pointing extensions of the form plate boards. The required height of such skirt means will depend upon several factors, such as

the hardening speed of the concrete, the flow conditions in the water, etc. In Figures 3*a*—*c* is illustrated an embodiment for a such skirt means 55 wherein is used flexible curtains of plastic sheeting provided in the shape of one or more rolls 56. The top edge of this sheeting is attached to the bottom edge of the form boards 25. In correspondence with the raising of the slip form the curtain will roll off from the roll and position itself along the outside of the concrete as cast as is illustrated in Figures 3b and 3c. When the entire skirt or curtain has been rolled out one may at the lower edge of the curtain position a circumferentially running clamping frame or yoke or the like, such as indicated at the reference number 58.

Continued casting of the shown solid column may now take place more or less continously, since the slip form unit is raised in correspondence with the actual solidifying speed or hardening of the concrete as poured, simultaneously as poured concrete more or less continously is supplied to the slip form through the casting tubes 46.

It is important to be able to supply poured concrete, and to raise the casting tubes as quickly as possible and also continously in order to avoid the danger of the casting pipes being more or less permanently embedded into the concrete as poured in the slip form. The same counts for the slip form unit, even though the slip form boards are positioned with a slip. Interruptions in the raising thereof may result in that the slip form boards adhere to the concrete mass and have in result a possibility of damage to the equipment and the casting work and other problems. In this method one may however utilize relatively large or high slip form boards normally without any risk of the boards adhering to the solidifying concrete surface. With regard to the skirt or curtains 55, these are suitably given substantially the same height as the slip form boards. Otherwise, the vertical dimension of the slip form boards and the skirt will depend upon the dimensions of the casting work in question and other conditions.

It will be understood that this method can be carried out with various types of slip form unit and various types of casting equipment, etc.

Figures 4 and 5 show a plan view and an elevation, respectively, illustrating schematically a slip form unit for carrying out bilateral concrete casting. The slip form unit comprises an internal and an external support structure 60, 62 to which is attached the slip form boards in the same fashion as shown in Figures 1 and 2. The slip form unit is here suspended on two horizontal support means 64 and 66, which are suitably further suspended by four vertical stays 68 in anchoring points 70. Also in this embodiment it will likewise be suitable to utilize a protection skirt or curtain (not shown) on the outside of the casting, but not on the inside. A suitable number of casting tubes 72, 72, are directed down between the slip form walls. A slip form unit with bilateral concrete pressure as shown can without particular difficulty be designed such that it has full opening in direction upwards, disregarding the shown port beams, and the positioning of reinforcements in the casting during the pouring of the concrete will fall relatively simple.

Figure 6 shows an elevational view of an alternative set-up for carrying out the method, wherein the slip form unit and the lifting jacks 82 which otherwise can be similar to the equipment shown in Figures 1 and 2, are supported on a cantilever support 84 with a support foundation 86 which is anchored to an existing rigid foundation structure 88. The casting method otherwise will be identical to the one already described. When the casting work is completed up to height on level with the shown existing rigid foundation 88, the new foundation column or object can serve as foundation for a next casting work, etc.

Claims

1. A method for carrying out slip form casting of concrete structures under water at a casting site on the sea bottom, wherein a unitary slip form unit (20) surrounding the object to be cast is moved upwards in correspondence with the casting and the hardening velocity of the concrete mass while additional concrete is supplied from an above water supply through supply tubes (46) or the like, characterized by the steps of initially suspending the slip form unit (20) by means of a number of mutually spaced suspension stays (27) each of which is connected to a support- and hoisting system (30) positioned above water level above the casting site and thereafter lowering the slip form unit (20) to the casting site, whereafter the slip form unit is hoisted upwards by means of the stays in correspondence with the supply of poured concrete and the hardening of same, which concrete is supplied continously and at the same time as the slip form unit is raised, the slip form unit being directionally controlled and if necessary adjusted as to angular position during the casting by individual, coordinated adjustment of each of the suspension stays.

2. An apparatus for carrying out the method in accordance with claim 1, the apparatus comprising a slip form unit (20), characterized in that the slip form unit (20) is suspended from a number of individually adjustable and hoistable stays (27) in the form of cables, pipe sections or the like, and which are connected to support- and hoisting systems (30) positioned on an above water support construction (2), which support construction (2) is laterally immovably positioned in an above water position directly above the casting site.

3. An apparatus in accordance with claim 2, characterized in that the slip form unit (20) comprises a frame (19) rigidly mounted on a

horizontally extending support frame (22).

4. An apparatus in accordance with claim 2 or claim 3, characterized in that the support construction (2) in the above water position comprises a working platform including buoyant bodies (4, 6, 8, 10) in the shape of hollow box beams or the like, and a number of vertical, elevationally adjustable support legs (12, 14, 16, 18) arranged to be positioned on the sea bottom in locations surrounding the casting site, the box beams having a total buoyancy such that the entire suport construction (2) including all casting equipment can float with a free-board and with the support legs in a partly jacked up position.

5. An apparatus in accordance with claim 4, characterized in that the working platform is provided with an open are in a centre portion thereof, the dimensions of which are adapted for reception of the slip form unit (20) in a hoisted up position.

6. An apparatus in accordance with claim 5, characterized in that above the open area in the working platform is arranged an overhead transverse support structure (36, 47) for supporting the hoisting system (30) for the hoisting stays (27), and the equipment for supply of concrete mass, which equipment includes concrete hoppers (44), and connected to these hoppers downwardly directed hoses or tubes (46) leading down to the casting site.

7. An apparatus in accordance with any of claims 2 to 6, characterized in that the support structure comprises a centilevered structure including an inside part (86) adapted to be supported by an existing foundation (88), and an outside cantilevered part (84) adapted to be positioned directly above the casting site and to serve as a support for the hoisting equipment for the slip form unit (20) and the means for supply of concrete mass (44) and the supply tubes (46) for concrete mass to be supplied to the casting site.

8. An apparatus in accordance with any of claims 2 to 7, characterized in that along the bottom edges of slip form boards (25) of the slip form unit (20) are arranged downwardly pointing sheets or curtains (55, 56) adapted to slide along the concrete surface for protection of same against washing and erosion.

9. An apparatus in accordance with claim 8, characterized in that the curtains (55, 56) comprise flexible cloth such as plastic sheeting.

10. An apparatus in accordance with claim 9, characterized in that the curtains, when the casting is to be initiated, are in part roll form at the bottom edge of the slip form boards (25), the upper edges of the curtains being attached to the boards (25), the curtains being arranged to unroll in correspondence with the raising of the slip form unit (20) and to remain in contact with the concrete surface.

11. An apparatus in accordance with claim 9 or claim 10, characterized in that on the outer surface of the curtains is attached a horizontally extending frame or yoke (58) for keeping the curtains in position against the concrete surface.

12. An apparatus in accordance with any of claims 2 to 11, characterized in that slip form boards (25) of the slip form unit (20) are mounted to vertical supports (19, 60, 62) the upper ends of which are rigidly connected to a horizontally extending support structure (22, 64); and in that the vertical supports have such vertical dimensions that, in use, good access and height (h) for the operators is provided above the slip form unit in order to facilitate positioning of reinforcements in the concrete mass as poured.

13. An apparatus in accordance with claim 12, characterized in that the horizontal support structure (22, 64) is adapted to be utilized as a working platform in the under-water position, at least for placing reinforcements in the casting and as a storage site (53) for reinforcing elements.

Revendications

1. Procédé de coulée de structures en béton en coffrage glissant sous l'eau, à un emplacement de coulée qui se trouve au fond de la mer, selon lequel un coffrage glissant en une seule pièce (20) entourant l'objet à couler est déplacé vers le haut en fonction de la coulée et de la vitesse de durcissement de la masse de béton alors qu'une quantité supplémentaire de béton est transmise d'une réserve placée au-dessus de l'eau par l'intermédiaire de tubes d'alimentation (46) ou analogues, caractérisé en ce qu'il comprend la suspension initiale du coffrage glissant (20) à un certain nombre d'organes allongés et distants (27) de suspension raccordés chacun à un système de support et de levage (30) placé du niveau de l'eau, au-dessus de l'emplacement de coulée, puis l'abaissement du coffrage glissant (20) à l'emplacement de coulée, le coffrage glissant étant ensuite soulevé à l'aide des organes allongés d'une manière qui correspond à la transmission de béton coulé et à son durcissement, ce béton étant transmis de façon continue et, simultanément au soulévement du coffrage glissant, ce dernier est réglé directionnellement et le cas échéant la position angulaire est réglée pendant la coulée par réglage individuel et coordonné de chacun des organes allongés de suspension.

2. Appareil destiné à la mise en oeuvre du procédé selon la revendication 1, l'appareil comprenant un coffrage glissant (20), caractérisé en ce que le coffrage glissant (20) est suspendu à un certain nombre d'organes allongés (27) réglables et levables individuellement sous forme de câbles, de tronçons de tuyauterie ou analogues, et qui sont raccordés à des systèmes de support et de levage (30) placés sur une construction de support (2) disposée au-dessus de l'eau, la construction de

support (2) étant disposée au-dessus de l'eau directement au-dessus de l'emplacement de coulée, sans pouvoir se déplacer latéralement.

3. Appareil selon la revendication 2, caractérisé en ce que le coffrage glissant (20) comporte un bâti (19) monté rigidement sur un bâti horizontal (22) de support.

4. Appareil selon l'une des revendications 2 et 3, caractérisé en ce que la construction de support (2) disposée au-dessus de l'eau comporte une plateforme de travail comprenant des corps flottants (4, 6, 8, 10) sous forme de poutres rectangulaires creuses ou analogues, et un certain nombre de pieds verticaux de support (12, 14, 16, 18) réglables en hauteur, destinés à être disposés sur le fond de la mer à des emplacements entourant l'emplacement de coulée, les poutres ayant une flottabilité totale telle que l'ensemble de la construction de support (2), y compris tout l'équipement de coulée, peut flotter avec un franc-bord et avec les pieds de support en position partiellement soulevée.

5. Appareil selon la revendication 4, caractérisé en ce que la plateforme de travail comporte une zone ouverte dans une partie centrale, les dimensions de cette zone étant adaptées au passage du coffrage glissant (20) dans sa position haute.

6. Appareil selon la revendication 5, caractérisé en ce que, au-dessus de la zone ouverte de la plateforme de travail, une structure transversale suspendue de support (36, 47) est destinée à supporter le système de levage (30) des organes allongés (27), et l'appareillage de transmission d'une masse de béton, cet appareillage comprenant des trémies à béton (44) et des tubes ou tuyauteries souples dirigés vers le bas (46) raccordés aux trémies et descendant vers l'emplacement de coulée.

7. Appareil selon l'une quelconque des revendications 2 à 6, caractérisé en ce que la structure de support comporte une structure en porte-à-faux comprenant une partie interne (86) destinée à être supportée par une fondation existante (88) et une partie externe en porte-à-faux (84) destiné à être placée directement au-dessus de l'emplacement de coulée et à constituer un support pour l'appareillage de levage du coffrage glissant (20), du dispositif d'alimentation de la masse de béton (44) et des tubes d'alimentation (46) de la masse de béton qui doit être transmise à l'emplacement de coulée.

8. Appareil selon l'une quelconque des revendications 2 à 7, caractérisé en ce que des feuilles ou rideaux (55, 56) dirigés vers le bas et destinés à glisser le long de la surface du béton afin que celle-ci soit protégée contre le lavage et l'érosion sont placés le long des bords inférieurs des panneaux (25) du coffrage glissant (20).

9. Appareil selon la revendication 8, caractérisé en ce que les rideaux (55, 56) sont formés d'une étoffe souple, par exemple une feuille de matière plastique.

10. Appareil selon la revendication 9, caractérisé en ce que les rideaux, lorsque la coulée doit être commencée, sont en partie sous forme de rouleaux placés aux bords inférieurs des panneaux (25) du coffrage glissant, les bords supérieurs des rideaux étant fixés aux panneaux (25), les rideaux étant destinés à se dérouler d'une manière correspondant au soulèvement du coffrage glissant (20) et à rester au contact de la surface du béton.

11. Appareil selon l'une des revendications 9 et 10, caractérisé en ce qu'un cadre ou étrier horizontal (58) destiné à maintenir les rideaux en position contre la surface du béton est disposé sur la face externe des rideaux.

12. Appareil selon l'une quelconque des revendications 2 à 11, caractérisé en ce que les panneaux (25) du coffrage glissant (20) sont montés sur des supports verticaux (19, 60, 62) dont les extrémités supérieures sont raccordées rigidement à une structure horizontale de support (22, 64), et en ce que les supports verticaux ont des dimensions verticales telles que, lors du fonctionnement, des opérateurs ont un bon accès, notamment en hauteur, au-dessus du coffrage glissant afin que la mise en place d'armatures dans la masse de béton coulé soit facilitée.

13. Appareil selon la revendication 12, caractérisé en ce que la structure horizontale de support (22, 64) est destinée à être utilisée comme plateforme de travail en position sous-marine, au moins pour la mise en place d'armatures dans l'ouvrage coulé et comme emplacement de stockage (53) d'éléments d'armature.

Patentansprüche

1. Verfahren zur Durchführung des Gleitformgießens von Betonstrukturen unter Wasser an einer Gießstätte am Meeresboden, bei welchem eine einheitliche Gleitformeinheit (20), welche de zu gießenden Gegenstand umgibt, entsprechend dem Gießen und der Härtegeschwindigkeit der Betonmasse nach oben bewegt wird, während zusätzlicher Beton von einem oberhalb der Wasserfläche gelegenen Vorrat durch Zuführrohre (46) od.dgl. zugeführt wird, gekennzeichnet durch dei Schritte, daß zunächst die Gleitformeinheit (20) mittels einer Anzahl von mit gegenseitigem Abstand angeordneten Hängeträgern (27) aufgehängt wird, von denen jeder mit einem oberhalb des Wasserspiegels über der Gießstätte angeordneten Trag- und Hebesystem (30) verbunden ist, und danach die Gleitformeinheit (20) zur Gießstätte abgesenkt wird, worauf die Gleitformeinheit mittels der Hängeträger entsprechend der Zufuhr von Gießbeton und dem

Aushärten desselben hochgezogen wird, wobei der Beton kontinuierlich und zugleich mit dem Hochziehen der Gleitformeinheit zugeführt wird, und wobei die Gleitformeinheit richtungsmäßig gesteuert und, falls erforderlich, während des Gießens hinsichtlich der Winkellage durch individuelle, koordinierte Einstellung jedes der Hängeträger eingestellt wird.

2. Vorrichtung zur Durchführung des Verfahrens nach Anspruch 1, mit einer Gleitformeinheit (20), dadurch gekennzeichnet, daß die Gleitformeinheit (20) an einer Anzahl von individuell einstellbaren und hochziehbaren Trägern (27) in Form von Kabeln, Rohrabschnitten od.dgl. hängt, die mit Trag- und Hebesystemen (30) verbunden sind, welche auf einer Überwasser-Tragkonstruktion (2) angeordnet sind, welche Tragkonstruktion (2) in einer Überwasser-position direkt oberhalb der Gießstätte in Seitenrichtung unbeweglich positioniert ist.

3. Vorrichtung nach Anspruch 2, dadurch gekennzeichnet, daß die Gleitformeinheit (20) einen Rahmen (19) aufweist, der auf einem sich horizontal erstreckenden Tragrahmen (22) starr montiert ist.

4. Vorrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die Tragkonstruktion (2) in der Überwasserposition eine Arbeitsplattform aufweist, die Schwimmkörper (4, 6, 8, 10) in Form von hohlkastenartigen Trägern od.dgl. eineschließt, und eine Anzahl von vertikalen, in der Höhe einstellbaren Stützbeinen (12, 14, 16, 18), welche am Meeresboden an die Gießstätte umgebenden Stellen positionierbar sind, wobei die kastenartigen Träger eine solche Gesamptschwimmfähigkeit haben, daß die gesamte Tragkonstruktion (2) einschließlich der gesampten Gießausrüstung mit einem Freibord und mit den Stützbeinen in teilweise angehobener Stellung derselben schwimmen kann.

5. Vorrichtung nach Anspruch 4, dadurch gekennzeichnet, daß die Arbeitsplattform in einem zentralen Teil derselben mit einer offenen Fläche versehen ist, deren Dimensionen zur Aufnahme der Gleitformeinheit (20) in der hochgezogenen Position derselben gewält sind.

6. Vorrichtung nach Anspruch 5, dadurch gekennzeichnet, daß oberhalb der offenen Arbeitsplattformfläche eine diese frei querende Tragstruktur (36, 47) zum Abstützen des Hebesystems (30) für die Aufziehträger (27) und der Ausrüstung für die Zufuhr der Betonmasse angeordnet ist, welche Ausrüstung Betongießtrichter (44) aufweist, wobei mit diesen Trichtern nach unten gerichtete Schläuche oder Rohre (46) verbunden sind, die hinunter zur Gießstätte führen.

7. Vorrichtung nach einem der Ansprüche 2 bis 6, dadurch gekennzeichnet, daß die Tragstruktur eine auskragende Struktur mit einem inneren Teil (86) aufweist, der durch ein bestehendes Fundament (88) abstützbar ist, und einem äußeren auskragenden Teil (84), der direkt oberhalb der Gießstätte positionierbar ist und als Träger für die Hebeausrüstung der Gleitformeinheit (20) und der Mittel zum Zuführen der Betonmasse (44) und der Zuführrohre (46) für die der Gießstätte zuzuführende Betonmasse dient.

8. Vorrichtung nach einem der Ansprüche 2 bis 7, dadurch gekennzeichnet, daß entlang der Unterkanten der Gleitformtafeln (25) der Gleitformeinheit (20) nach unten ragende Platten oder Vorhänge (66, 67) angeordnet sind, die entlang der Betonoberfläche gleiten können, um diese gegen Auswaschen und Erosion zu sichern.

9. Vorrichtung nach Anspruch 8, dadurch gekennzeichnet, daß die Vorhänge (55, 56) aus flexiblem Stoff, z.B. Kunststoffolie, bestehen.

10. Vorrichtung nach Anspruch 9, dadurch gekennzeichnet, daß die Vorhänge am Beginn des Gießvorganges zum Teil in Rollenform an der Unterkante der Gleitformtafeln (25) angeordnet sind, wobei die oberen Ränder der Vorhänge an den Tafeln (25) befestigt und die Vorhänge so angeordnet sind, daß sie entsprechend dem Anheben der Gleitformeinheit (20) entrollbar sind und in Berührung mit der Betonoderfläche bleiben.

11. Vorrichtung nach Anspruch 9 oder 10, dadurch gekennzeichnet, daß an der Außenfläche der Vorhänge ein sich horizontal erstreckender Rahmen oder ein Bügel (58) befestigt ist, um die Vorhänge in Position an der Betonoberfläche zu halten.

12. Vorrichtung nach einem der Ansprüche 2 bis 11, dadurch gekennzeichnet, daß die Gleitformtafeln (25) der Gleitformeinheit (20) an vertikalen Stützen (19, 60, 62) montiert sind, deren obere Enden starr mit einer sich horizontal erstreckenden Tragstruktur (22, 64) verbunden sind, und daß die vertikalen Stützen solche Vertikalabmessungen haben, daß im Gebrauch ein guter Zugang und eine ausreichende Höhe (h) für die Bedienungspersonen oberhalb der Gleitformeinheit vorhanden ist, um das Positionieren der Bewehrungen in der Betonmasse beim Gießen derselben zu erleichtern.

13. Vorrichtung nach Anspruch 12, dadurch gekennzeichnet, daß die horizontale Tragstruktur (22, 64) als Arbeitsplattform in Unterwasserposition verwendbar ist, zumindest zum Anordnen der Bewehrungen in dem Gießkörper und als Vorratsstätte (53) für Bewehrungselemente.

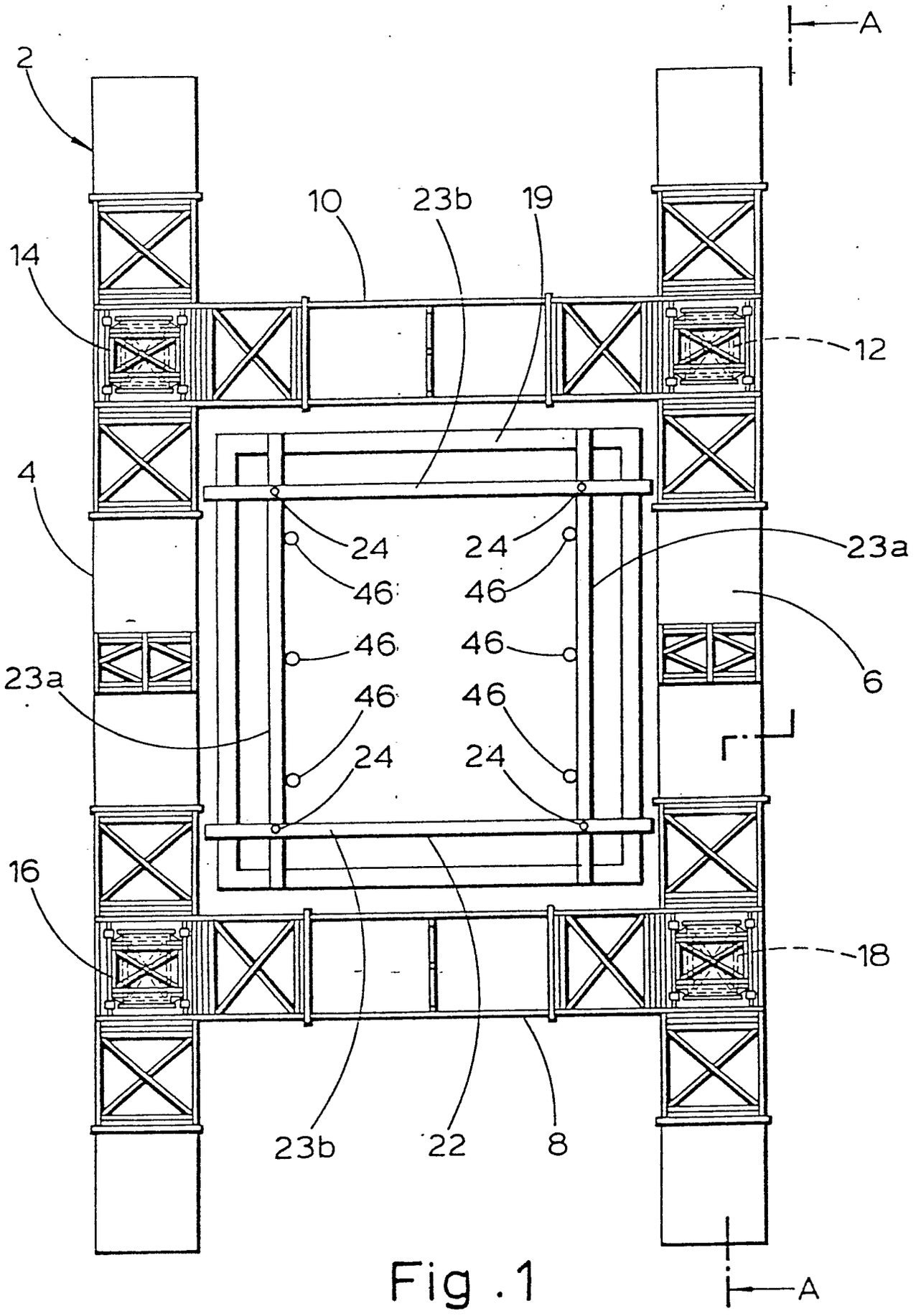
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Fig .1

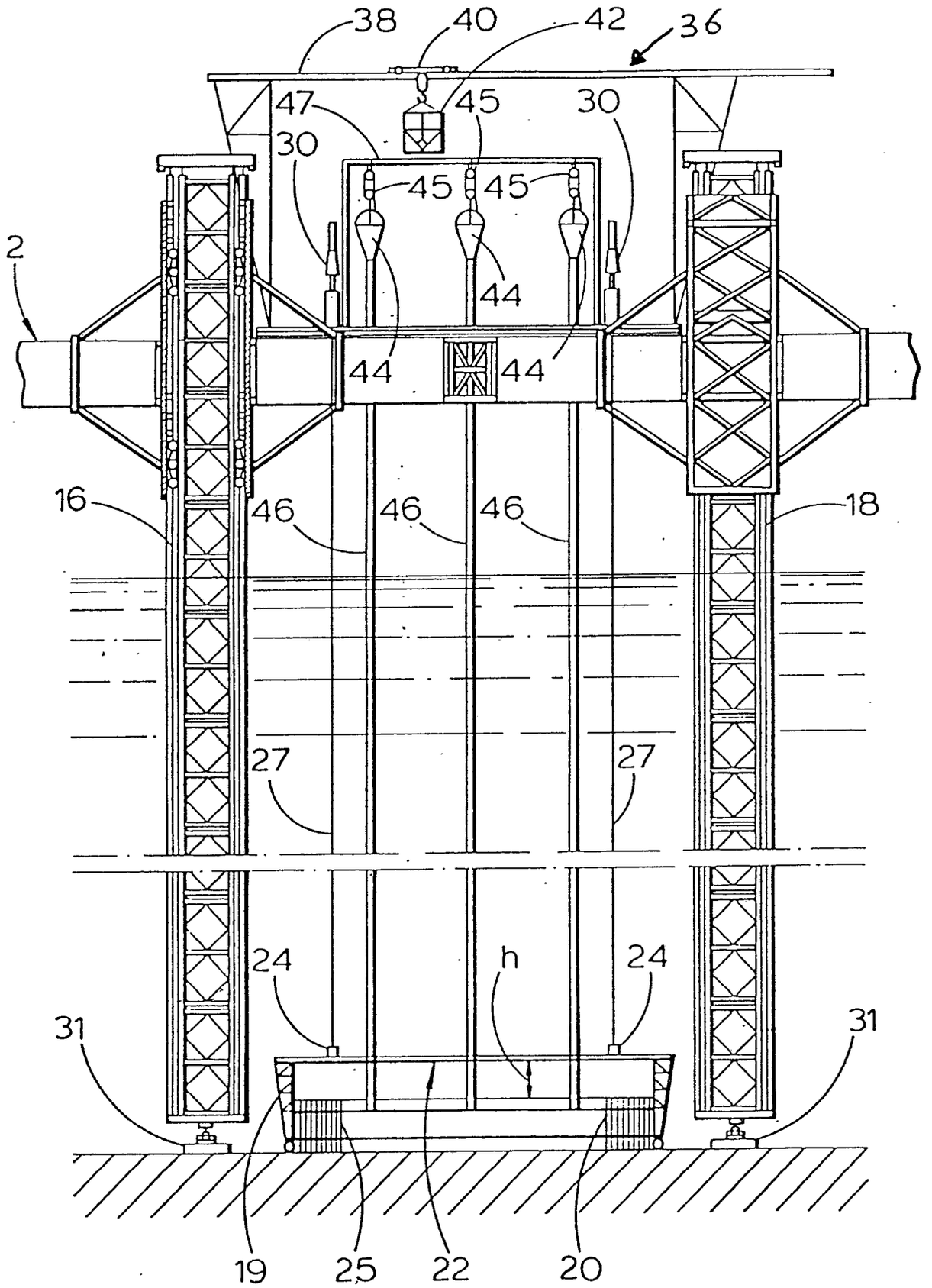
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Fig . 2

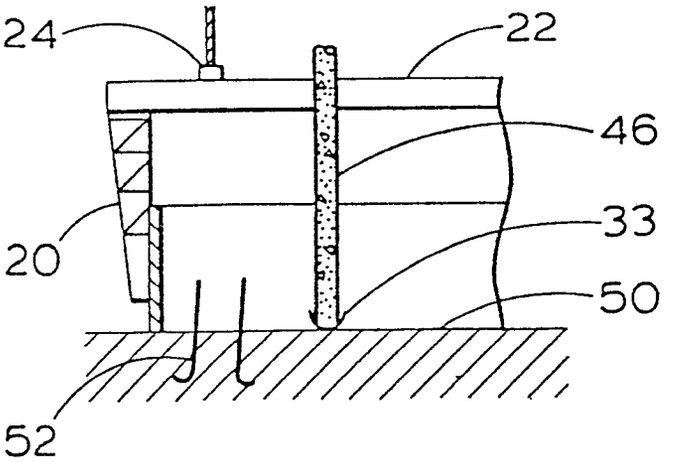

Fig . 2a

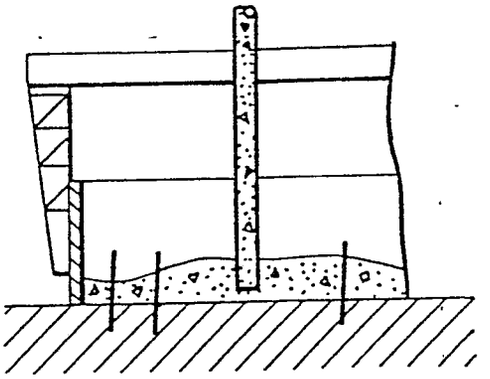

Fig . 2b

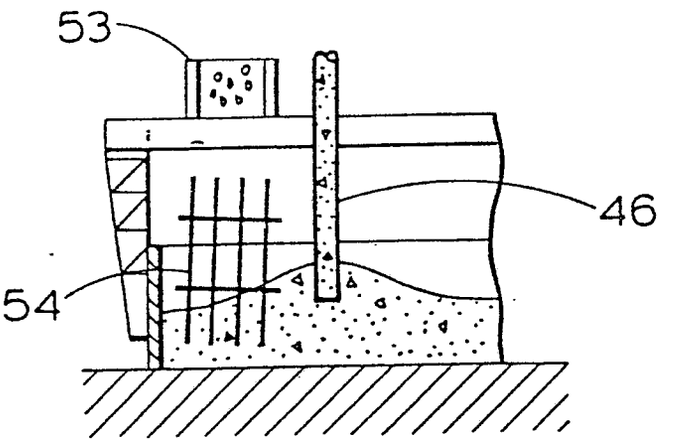

Fig . 2c

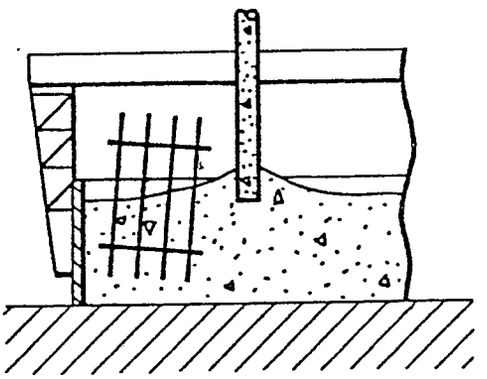

Fig . 2d

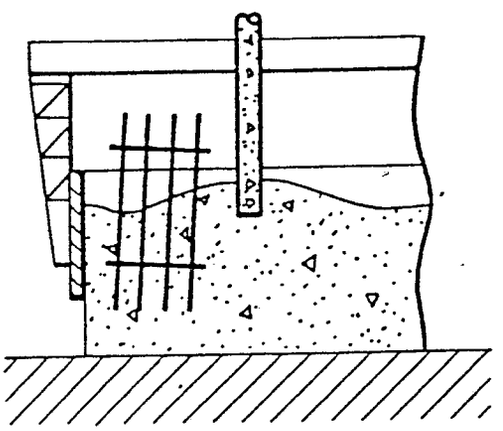

Fig . 2e

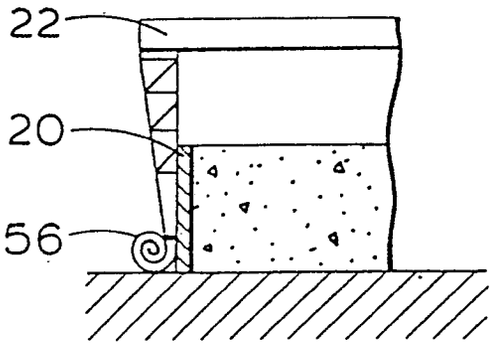

Fig . 3a

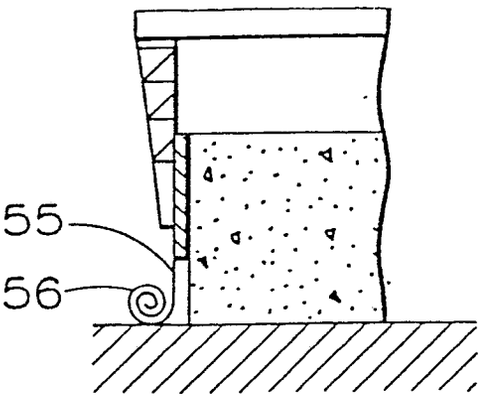

Fig . 3b

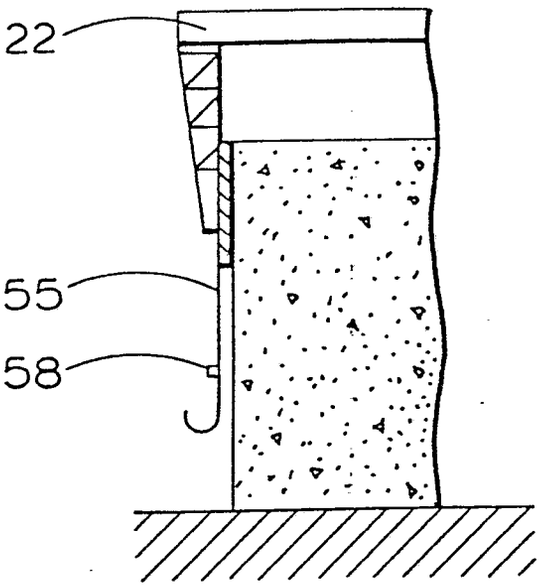

Fig . 3c

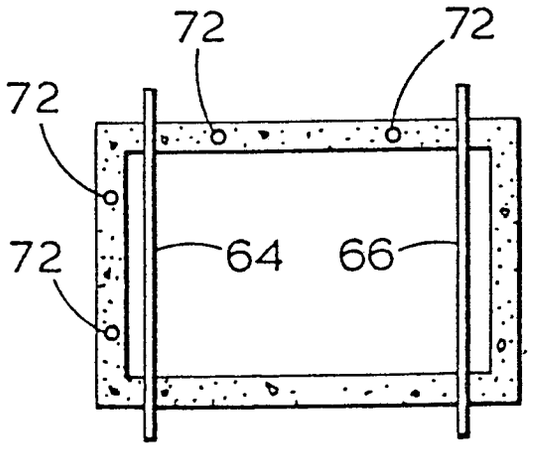

Fig . 4

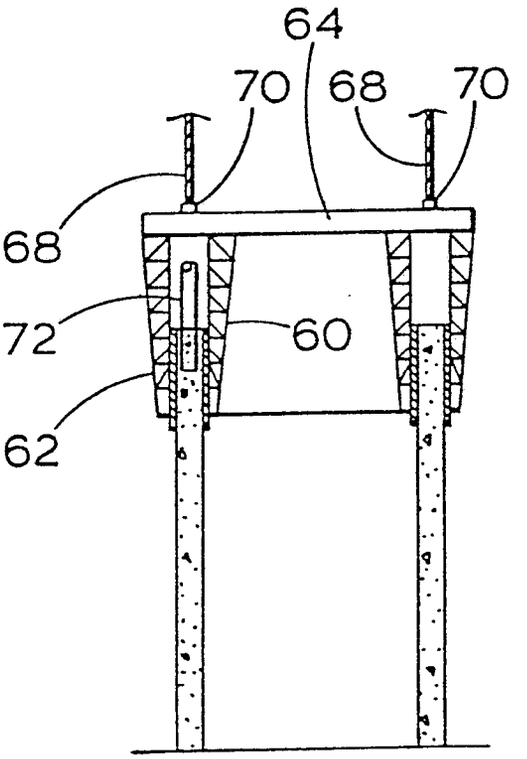

Fig . 5

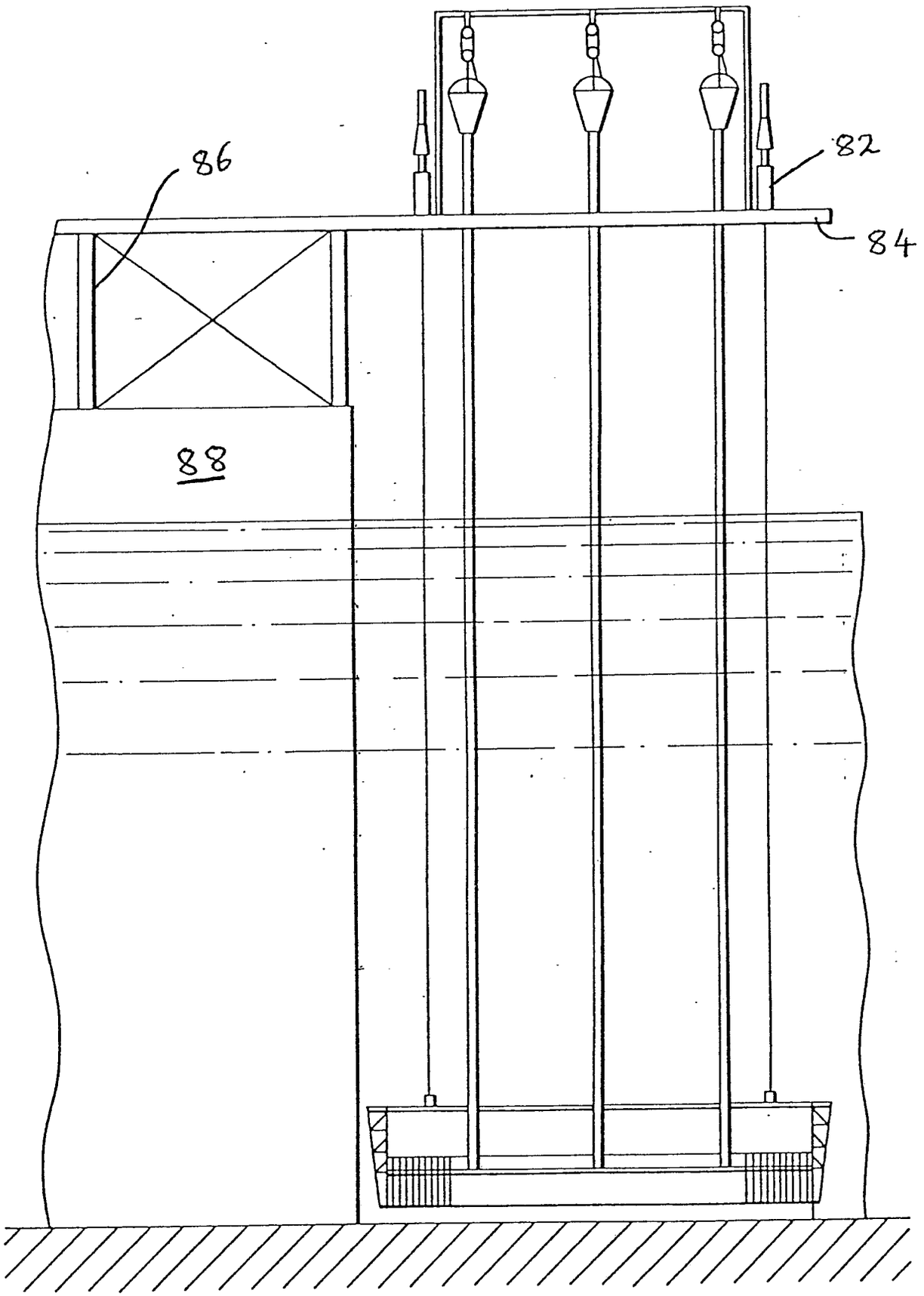

Fig. 6