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(54) System for making concrete floors.

(57) The invention relates to a floor leveling apparatus. According to the invention, it comprises a supporting frame (1), at least two cylindrical cage wheels (2,8) with a coarse-meshed circumferential surface (4), supported by the supporting frame (1), at least one of the cage wheels (2) being adapted to be driven in two directions, a control apparatus (12) acting on the cage wheels (2,8), two leveling cylinders (13,14) constructed as screw jacks and adapted to driven in rotational direction. The cylinders (13,14) are mounted, as viewed in the direction of travel, respectively, in front (13) of and behind (14) the cage wheels, and the terminal ends of each leveling cylinder (13,14) is mounted in supporting bars (15) which are continuously adjustable in vertical direction, relative to the supporting frame (1).

The invention further relates to an apparatus for uniformly supplying concrete and distributing same over a surface, comprising a transport duct connectable to a concrete pump of a concrete mixer. According to the invention the apparatus comprises a concrete distributing vehicle (CD) equipped with a two-part concrete distributing tube (73,74) hingedly connected to the vehicle (C), the two members (73,74) of the tube being pivotally interconnected and the distributing tube being connectable to the transport hose, in which a pulsation damper is mounted.

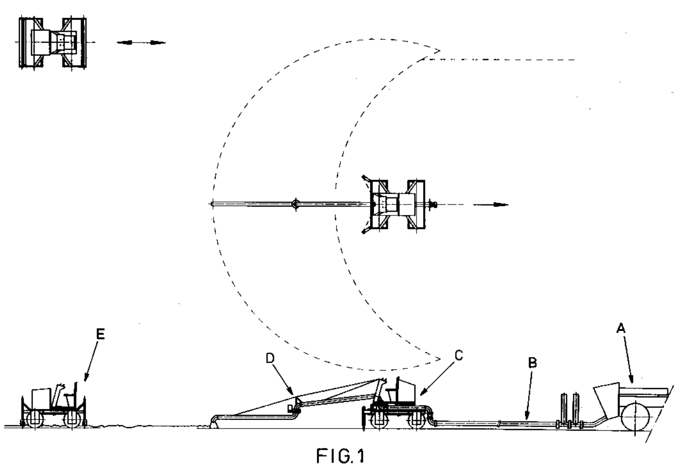

FIG.1

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Placing concrete floors that may or may not be reinforced in halls of large dimensions, such as factory halls and sport halls, comprises three consecutive steps:

1° - supplying concrete using a concrete pump from a mixer arranged outside the hall to a pouring place within the hall

2° - roughly distributing the concrete supplied, from this pouring place over the subfloor or the reinforcement fabric already provided

3° - leveling and smooth-finishing the roughly distributed concrete.

In operational steps 2 and 3 a number of problems arise which make the placing of concrete floors an extremely labour-intensive, laborious and time-consuming job. These problems are the following:

- the concrete pumps known at present are all of the pulsating type. Accordingly, the transport hose connected to the concrete pump delivers a given charge of concrete by intermittent thrusts. At the end of the transport hose, the pulsating pump generates a back and forth, thrusting motion which makes it extremely cumbersome, when the concrete pump is in operation, to move this hose end in such a way that a more or less uniform, be it rough, distribution of concrete over a part of the hall surface is obtained. This distribution from the pouring place over the adjacent floor surface must therefore be done with a spade or other auxiliary means. When the subfloor consists of a reinforcement fabric of concrete steel, there is a great chance that both the fabric and the transport hose are damaged by the back and forth, thrusting motion.
- once in some manner or other a rough concrete distribution over the floor surface has been effected, the floor must be leveled. Heretofore, such leveling has been effected by means of a series of rules arranged on the subfloor in spaced relationship, the top surface of these rules having been positioned at the desired height of the concrete floor to be placed. After the concrete has been poured between the rules, the concrete is distributed by means of manually operated vibrating beams in such a way that the level of the concrete floor lies in the plane containing the top surfaces of the rules arranged beforehand. These rules are then removed and the slots thus formed are filled with concrete, usually by sight and by hand, so that a continuous, substantially level floor is formed. The plane of the floor may be truly horizontal (level), or slope, if so desired. Leveling concrete floors in this manner is a very laborious process and, moreover, is not very accurate.

It is an object of this invention to provide apparatus in which the drawbacks outlined above have been overcome and which makes it possible to place concrete floors much more easily, more rapidly and, moreover, more accurately. To that effect, the invention provides

- a floor leveling apparatus as well as
- an apparatus for uniformly supplying and distributing concrete over a large surface.

The floor leveling apparatus according to the invention comprises a supporting frame, at least two cylindrical cage wheels having a coarse-meshed circumferential surface, supported by said supporting frame, at least one of said cage wheels being adapted to be driven in two directions, a control apparatus acting on said cage wheels, two leveling cylinders constructed as screw jacks and adapted to be driven in rotational direction, said cylinders being mounted, as viewed in the direction of travel, respectively, before and behind said cage wheels, the terminal ends of each leveling cylinder being mounted in supporting bars which are continuously adjustable in vertical direction, relative to said supporting frame.

By constructing the carrying wheels of the apparatus as cage wheels with a coarse-meshed circumferential surface, these wheels are capable of sinking through the newly poured concrete until they abut a support surface which, for example, is formed by the top surface of the concrete floor reinforcement. The leveling cylinders are controlled independently of the vertical position of the cage wheels, in such a way that the top surface of the concrete floor invariably forms the horizontal tangential plane of the leveling cylinders. This means that the supporting function and the leveling function of the apparatus have been separated. The coarse-meshed circumferential surface of the cage wheels makes it possible for the impressions made by them in the as yet soft concrete to fill up again with concrete from the surroundings upon displacement of the wheels. By reversing the drive of the cage wheels, the apparatus can be moved in two directions, namely forwards and backwards.

To enable the apparatus, after a given strip has been treated, to be moved to an adjacent strip, the apparatus must be controllable. Controllability is obtained by mounting a cage wheel in a wheel support bracket which is connected to the supporting frame for hinge movement about a vertical as well as a horizontal axis, the control apparatus consisting of a hydraulic control cylinder mounted between the wheel support bracket and the supporting frame.

To enable forward and lateral displacement of excess concrete which is disposed before the apparatus, the direction of rotation of the leveling cylinder mounted, as viewed in the direction of travel, before the cage wheels, is preferably opposite to that of the cage wheels, while the direction of rotation of the leveling cylinder mounted behind the cage wheels is the same as that of the cage wheels.

In this manner the leading leveling cylinder is enabled to move the excess concrete forwardly and laterally to a strip of the concrete floor that is yet to be leveled, while the trailing leveling cylinder more or less functions as a sweeping cylinder. When the direction of travel of the floor leveling apparatus is reversed, the directions of rotation of the leveling cylinders can be maintained while their functions are changed round.

For adjusting the leveling cylinders in vertical direction, preferably use is made of a known per se laser unit used for controlling a pick-up mounted on the free end of each supporting bar, which pick-up in the case of deviation from the desired height of said pick-up above the floor surface to be leveled, is capable of generating a signal to an adjustment apparatus for adjusting the set height of said supporting bar relative to the supporting frame. In this way a height-reference plane has been obtained which is independent of the configuration of the support surface for the cage wheels.

The apparatus for uniformly supplying concrete and distributing same over a surface comprises a transport hose connectable to the concrete pump of a concrete mixer and, according to the invention, comprises a concrete distributing vehicle, provided with a two-part distributing tube which is connected to the distributing vehicle for hinge movement and the two members of which are pivotally interconnected, which distributing tube is connectable to the transport hose, in which a pulsation damper is mounted.

By using the pulsation damper, the pulsating concrete supply has been converted into a uniform concrete flow, which makes it possible to connect the transport hose to a distributing apparatus. The distributing apparatus is a light vehicle which substantially corresponds to the above described floor leveling apparatus, comprising a distributing tube which can be manoeuvred when the vehicle is stationary and can be used for spreading over a large surface a uniformly distributed concrete layer over the subfloor or the reinforcement.

The system according to the invention as well as the main parts thereof will now be further explained with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic side-elevational and partly top plan view of the complete system for placing concrete floors;

Fig. 2 is a side elevational view of the floor leveling apparatus in a diagrammatic form;

Fig. 3 is an elevational/sectional view taken on the line III-III of Fig. 2;

Fig. 4 is an elevational/sectional view taken on the line IV-IV of Fig. 2;

Fig. 5 is a side-elevational and top plan view of the concrete distributing vehicle; and

Fig. 6 shows the pulsation damper for the transport duct.

Fig. 1 schematically shows the main parts of the system:

- a concrete mixer A with pulsating concrete pump, which, as shown, may be mounted on a vehicle but may also consist of a fixed plant. Such plants are known per se and need not be further explained.
- a transport hose having mounted therein by means of tube couplings a pulsation damper B, which is capable of converting the pulsating concrete flow supplied by the concrete pump into a uniform flow.
- a concrete distributing vehicle C coupled to the transport hose, the vehicle comprising a two-part distributing tube D. By manoeuvring the distributing tube D, when the vehicle C is stationary, concrete can be poured over a surface indicated by dotted lines in the top plan view of Fig. 1. It will be clear that the magnitude of this surface depends on the length of the distributing tube.
- a floor leveling vehicle E for leveling the concrete poured by distributing vehicle C.

The floor leveling vehicle E is shown in Figs. 2-4 and comprises a supporting frame 1 mounting a cylindrical cage wheel 2 adapted to be driven. The cage wheel 2 consists of a series of spokes 3 used for supporting a coarse-meshed circumferential surface 4. This circumferential surface 4 consists of helical, thin bars with a diameter of 10 mm, for instance, spaced at mutual center-to-center distances of approx. 6 cm. On the left and the right of the longitudinal median plane M (Fig. 3) the respective helical directions of the bars are opposite. By virtue of these thin bars, the cage wheel 2 can sink through an as yet unhardened concrete layer down to the top surface 5 of a reinforcement or a support floor, with the largest grains of gravel being capable of penetrating between the circumferential bars into the interior of the cage wheel 2. The top surface of the concrete floor is designated by reference numeral 6 in Fig. 2. The drive of the cage wheel 2 is effected by means of a hydraulic motor 7, which is arranged concentrically within the cage wheel 2.

A second cage wheel 8 is rotatably mounted in a wheel support bracket 9 which is connected to the supporting frame 1 by means of a double pivot 10, 26, the pivot 10 being capable of hinging about the vertical line S, so that the axes of the cage wheels 2, 8 may intersect under the action of a control cylinder 12 (Fig. 3), one end of this cylinder 12 being connected to the wheel support bracket 9 and the other to the supporting frame 1. The pivot 26 enables pivotal movement of the wheel support arm 9 about the horizontal line M, whereby a better adjustment of the apparatus to an uneven support surface 5 is obtained. The cage wheel 8 is identical to the cage wheel 2 and is preferably also driven by means of a hydraulic motor 7.

Intermediate between the cage wheels 2, 8, a vibrating beam 11 is mounted, which is flexibly connected to the supporting frame 1 and is dragged along with it. This vibrating beam 11 takes care of a smooth finishing of the top surface 6 of the concrete floor.

According to a variant, the cage wheel 2 may consist of two separate cage wheels 2, 2', each provided with a hydraulic driving motor 7. By driving the two cage wheels 2, 2' at different speeds, the apparatus can be controlled in the manner of a crawler vehicle. In that case, the second cage wheel 8, too, will consist of two separate cage wheels 8, 8' and the wheel support bracket 9 can be connected to the supporting frame 1 by means of a single pivot 26.

Viewed in the direction of travel A (Fig. 2), there is provided before the cage wheel 8 a leveling cylinder 13, which is constructed as a screw jack. The leveling cylinder 13 can be driven in the circumferential direction G by means of a hydraulic motor 17. The direction of rotation G is opposite to the direction of rotation F of the cage wheel 8 when the apparatus is displaced in the direction of travel A. At the rear end of the apparatus, a second leveling cylinder 14 is provided, likewise adapted to be driven by means of a hydraulic drive 17, with the direction of rotation H of the second leveling cylinder 14 corresponding to the direction of rotation F of the cage wheels 2, 8. The construction of the second leveling cylinder 14 is identical to that of the first leveling cylinder 13. Both leveling cylinders 13, 14 are connected at their terminal ends to supporting bars 15, which are slidably mounted in guide bushings 16 of the supporting frame 1 and are each pivotable about a pivot 25. The supporting bar 15 is slidable in vertical direction relative to the supporting frame 1 by means of the height adjustment apparatus 18, the lower end of which is connected to the supporting frame 1 at 19 and the upper end is connected at 20 with a sleeve 21 fixedly mounted on the supporting bar 15. Provided on top of each supporting bar 15 is a pick-up 23 capable of receiving a signal O coming from a laser unit 22 which is arranged separately from the apparatus in the space where a concrete floor is to be leveled. The laser unit 22 generates a height-reference signal which represents a fixed height above the top surface 6 of the concrete floor to be leveled. The signal O emitted by the laser unit 22 is successively received by the four pick-ups 23 mounted on the ends of the supporting bars 15. When, for example due to the cage wheels 2, 8 sinking deeper into the as yet unhardened concrete, the leveling cylinders 13, 14 are entrained in downward direction, a pick-up 23 can generate an electric height-correction signal to the control unit 24 from which the height-adjustment apparatus 18 for the supporting bar 15, associated with said pick-up, can be controlled in a manner direction such that the deviation in vertical direction detected by the pick-up 23 is compensated for. By differently correcting the height-adjustment apparatuses 18, associated with the supporting bars 15 shown in Fig. 3, the leveling cylinder 13 can assume an inclined position relative to, for example, the axis of the cage wheels 2, 8.

Leveling a placed concrete floor, for example in a large factory building, is effected as follows:

In a manner to be described hereinafter, a concrete layer is poured on the reinforcement already provided, which layer is in any case thicker than the desired eventual concrete layer above the top surface 5 of the reinforcement and which has a width which is greater than the working width of the floor leveling apparatus. The floor leveling apparatus is then arranged on this roughly poured strip and driven, for instance in the direction of travel A, with the cage wheels 2, 8 sinking into the newly poured concrete layer down to the top surface 5 of the reinforcement. The leveling cylinder 13 is arranged at the appropriate level by means of the laser unit 22 and the same applies to the leveling cylinder 14. The cylinders 13, 14 are driven in the direction of rotation indicated in Fig. 2 and the floor leveling apparatus is set in motion in the direction of travel A, with the leveling cylinder 13 moving the excess concrete above the set top surface 6 in forward and lateral direction. At the same time, a new strip of concrete can be poured adjacent the strip that has already been poured. The surface pretreated by the leveling cylinder 13 is finally smoothed by the vibrating beam 11.

As soon as the leveling cylinder 13 has reached the wall of the building, the floor leveling apparatus is laterally displaced by means of the control cylinder 12 and arranged on the adjacent strip that has already been poured, with some overlap relative to the newly leveled strip. The apparatus is now driven in opposite direction, the direction of rotation of the leveling cylinders 13, 14 being maintained. The leveling cylinder 14 now takes care of the forward and lateral displacement of the excess concrete and the leveling cylinder 13 functions as a sweeping cylinder when the direction of travel is opposite. In this manner, the entire floor is leveled strip by strip.

As observed hereinabove, the height adjustment of the leveling cylinders 13, 14 is effected independently of the support of the apparatus by the cage wheels. Accordingly, when the top surface 5 of the reinforcement has a slightly wavy configuration, the top surface 6 of the concrete floor will nevertheless be level and not follow the wavy configuration of the top surface 5 of the reinforcement. The thickness of the concrete floor above the reinforcement may therefore vary.

Of course, the floor leveling apparatus may well be used for leveling surfaces of beds built up from other pouring materials, such as a bed of sand for roads, sports grounds etc.

The concrete distributing vehicle C-D shown in Fig. 5 corresponds to a great extent with the leveling vehicle E shown in Figs. 2-4. The concrete distributing vehicle C-D also comprises cage wheels 52, 58, whose circumferential surfaces 54 consist of helical, thin bars forming a coarse-meshed circumferential surface. The cage wheels 52, 58 are mounted in supporting frames 51, 59, which are pivotally interconnected at 60 to enable control of the concrete distributing vehicle (see top plan view - Fig. 5). The cage wheels 52, 58 can be driven hydraulically in the same manner as cage wheels 2, 8 of Figs. 2-4.

At the front, the supporting frame 59 comprises two props 61, 62 for securing the distributing vehicle on the subfloor or the concrete reinforcement 55. The props 61, 62 are pivotally connected to the supporting frame 59 at 63, 64.

A concrete transport tube 65 is fixedly connected to the front supporting frame 59 and is supported by the rear supporting frame 51 in such a way that said supporting frame 51 is slidable in lateral direction relative to the transport tube 65. The free rear end of the transport tube 65 is provided with a tube coupling 66 for connecting thereto the concrete transport hose B coming from the concrete mixer A. At the front, the transport tube 65 terminates via an elbow 67 in the stationary part of a ring gear 68, the rotatable part of which consists of a supporting platform 69 mounting an operator's seat 70 and a motor compartment 71, and a control block 72. The supporting platform 69 is fixedly connected to one end of a two-part distributing tube 73, 74 which are connected to the control block 72 by span wires 75. The supporting platform 69 is rotatable about the stationary part of the ring gear 68 by means of a hydromotor 76. Upon excitation of the hydromotor 76, the supporting platform 69 is rotated about the axis of the ring gear 68, whereby the distributing tube 73, 74 rotates along through the same angle of rotation.

Mounted likewise between the parts 73, 74 of the distributing tube is a ring gear 78 controllable by a hydromotor 77, which ring gear makes it possible to swivel the tube members 73, 74 relative to each other, as shown in the top plan view of Fig. 5. By appropriate operation of the motors 76, 77, concrete can be distributed over a surface as indicated by dotted lines in Fig. 1. With a total length of the distributing tube 73, 74 of 6 m, in this way concrete can be poured over a surface of $1/2 \times \pi \times 36$ = approx. $60m^2$ when the distributing vehicle is stationary.

After uncoupling the concrete transport hose, moving the distributing vehicle 6 m and reconnecting the transport hose, concrete can be poured over an adjacent surface and subsequently leveled by means of the vehicle according to Figs. 2-4.

For the distributing vehicle to be employed, a non-pulsating, uniform concrete supply is required. Such uniform supply in the case of a pulsating concrete pump, is obtained by mounting a pulsation damper in the concrete transport tube as shown in Fig. 6.

The pulsation damper consists of a cylindrical tube 100 which by means of a quick-action coupling 101 is connectable to a tee 103 mounted in the transport hose 102, which tee can be coupled to the transport hose by means of quick-action couplings 101. The diameter of the tube 100 is preferably equal to the diameter of the transport hose 102. At the top of the tube 100 a gas pressure chamber 104 is provided and at the bottom a concrete buffer chamber 105. Between the gas chamber 104 and the buffer chamber 105 a double piston 106 is mounted, which separates the two chambers 104, 105 from each other. The space 107 between the two piston heads is filled with oil for lubrication and for improvement of the gas sealing. Mounted at the bottom of the buffer chamber 105 is a piston stop 108 which is adapted to support the piston 106 in a lowermost position, so that this piston 106 is prevented from jamming in the transport hose 102 or the tee 103.

At the top, the gas chamber 104 is closed off by means of a cover 109 in which a gas supply valve 110 is mounted, as well as a manometer 111. To the valve 110 a high-pressure gas cylinder can be connected for creating an appropriate gas pressure within the gas chamber 104. The pressure in the gas chamber 104 will be selected below the maximum pump pressure of the concrete pump, such that a maximum damping and maximum uniformity of the concrete flow are obtained.

The capacity of the pulsation damper can be enlarged without difficulties by adding one or more identical pulsation dampers which are connected in parallel to the transport hose, as shown in Fig. 6. When two or more pulsation dampers are used, in the gas chambers 104 thereof different prepressures can be allowed. Especially when great transport distances are involved, this may be useful to increase the constancy of the concrete flow supplied.

Claims

1. A floor leveling apparatus, characterized by
- a supporting frame (1),
- at least two cylindrical cage wheels (2, 8) having a coarse-meshed circumferential surface (4), supported by said supporting frame (1), at least one of said cage wheels (2) being adapted to be driven in two directions,
- a control apparatus (12) acting on said cage wheels (2, 8),
- two leveling cylinders (13, 14) constructed as screw jacks and adapted to driven in rotational direction, said cylinders (13, 14) being mounted, as viewed in the direction of travel, respectively, in front of (13) and behind (14) said cage wheels (2, 8),
- the terminal ends of each leveling cylinder (13, 14) being mounted in supporting bars (15) which are continuously adjustable in vertical direction, relative to said supporting frame (1).

2. A floor leveling apparatus according to claim 1, characterized in that one cage wheel (8) is mounted in a wheel support bracket (9) connected to said supporting frame (1) for hinge movement about a vertical axis (S) as well as a horizontal axis (M), the control apparatus (12) consisting of a hydraulic control cylinder (12) mounted between said wheel support bracket (9) and said supporting frame (1).

3. A floor leveling apparatus according to claim 1, characterized in that the direction of rotation (G) of the leveling cylinder (13) mounted, as viewed in the direction of travel, before said cage wheels (2, 8) is opposite to that (F) of said cage wheels (2, 8), the direction of rotation (H) of the leveling cylinder (14) mounted behind said cage wheels (2, 8) is the same as that (F) of said cage wheels (2, 8).

4. A floor leveling apparatus according to any one of claims 1-3, characterized in that there is provided at the free end of each supporting bar (15) a pick-up (23) adapted for control by a laser unit (22) which, in the case of deviation from the desired height of said pick-up (23) above the floor surface (6) to be leveled, is capable of generating a signal to an adjustment apparatus (18) for adjusting the set height of said supporting bar (15) relative to said supporting frame (1).

5. Apparatus for uniformly supplying concrete and distributing same over a surface, comprising a transport duct connectable to a concrete pump of a concrete mixer, characterized in that the apparatus comprises a concrete distributing vehicle (CD) equipped with a two-part concrete distributing tube (73, 74) hingedly connected to said vehicle (C), the two members (73, 74) of said tube being pivotally interconnected, said distributing tube being connectable to the transport hose, in which a pulsation damper is mounted.

6. Apparatus according to claim 5, characterized in that the concrete distributing vehicle comprises two cylindrical cage wheels (52, 58) having a coarse-meshed circumferential surface, supported by supporting frames (51, 59), at least one of said cage wheels being adapted to be driven in two directions, said supporting frames being hingedly interconnected about a vertical axis (60).

7. Apparatus according to any one of claims 5-6, characterized in that the front supporting frame (59) is constructed as a fixed supporting frame, on which a rearwardly extending transport tube (65, 66, 67) is fixedly supported, while the end of the two-part distributing tube (73, 74) that is turned towards the supporting frame (59) is rotatably connected to the end (67) of the transport tube (65) at the front supporting frame (59).

8. Apparatus according to any one of claims 5-7, characterized in that the end of the distributing tube (73, 74) that is turned towards the supporting frame (59) is mounted in the rotatable part of a ring gear (68), while the part (67) of the transport tube (65) coupled thereto is connected to the stationary part of said ring gear, there being provided a hydromotor (76) for rotating the rotatable part of said ring gear (68) relative to the stationary part.

9. Apparatus according to any one of claims 5-8, characterized in that the distributing vehicle comprises a supporting platform (69) connected to the rotatable part of said ring gear (68), said supporting platform (69) mounting an operator's seat (70) and a control block (72).

10. Apparatus according to any one of claims 5-9, characterized in that the two-part distributing tube (73, 74) consists of two tubes (73, 74) pivotally coupled with each other by means of a ring gear (78) which is adapted to be driven by means of a hydromotor (77).

11. Apparatus according to claim 5, characterized in that the pulsation damper consists of at least one tube (100) connectable to the transport hose (103), a double piston (106) being slidable within said tube (100), said double piston (106) forming a partition between a gas chamber (104) and a concrete buffer chamber (105) provided in the tube (100).

12. Apparatus according to claim 11, characterized in that the gas chamber (104) is connectable to a pressure source for creating an appropriate prepressure within the gas chamber (104) while the space (107) between the two pistons is filled with oil to seal the gas chamber (104) relative to the concrete buffer chamber (105).

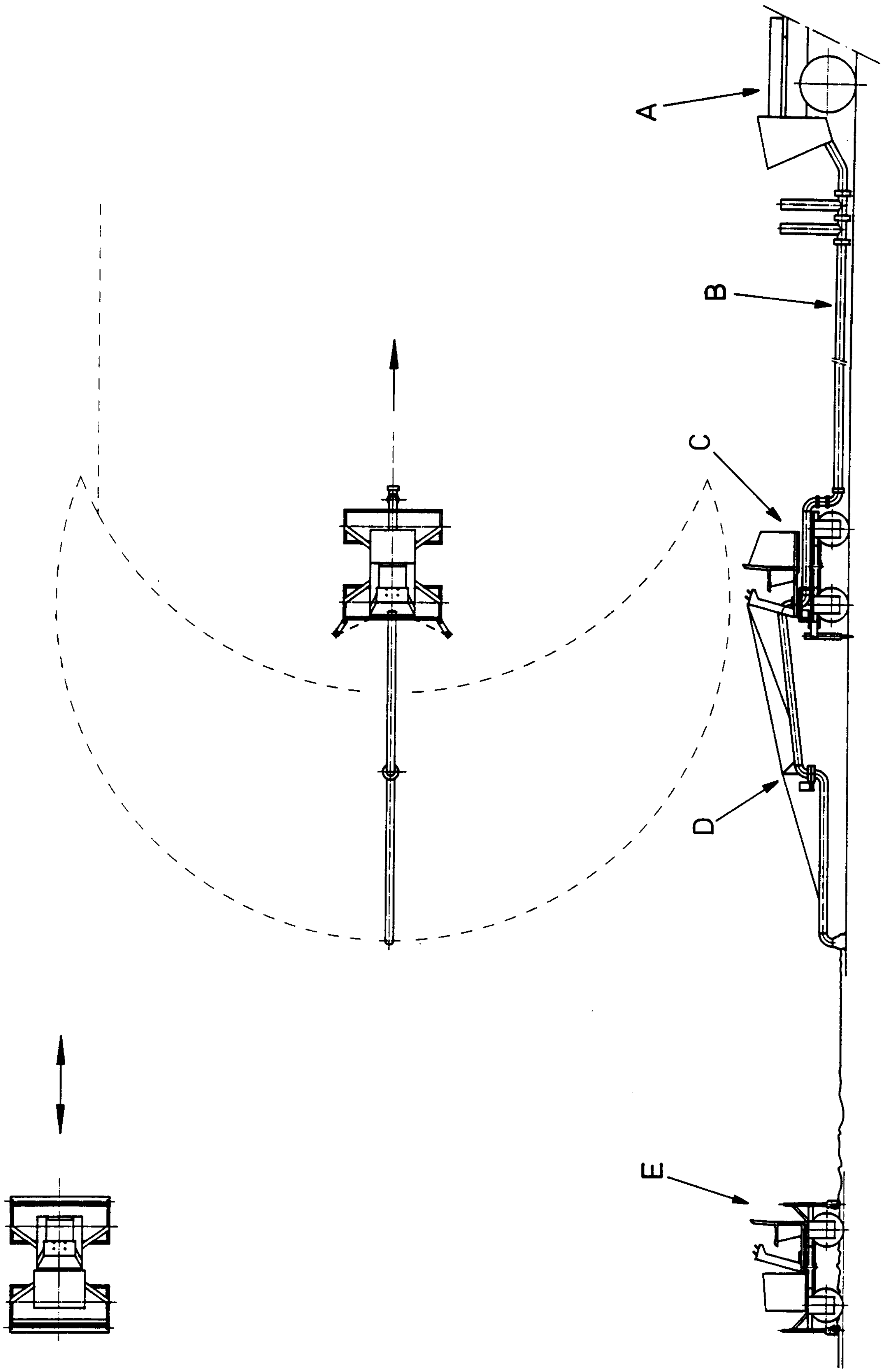

FIG.1

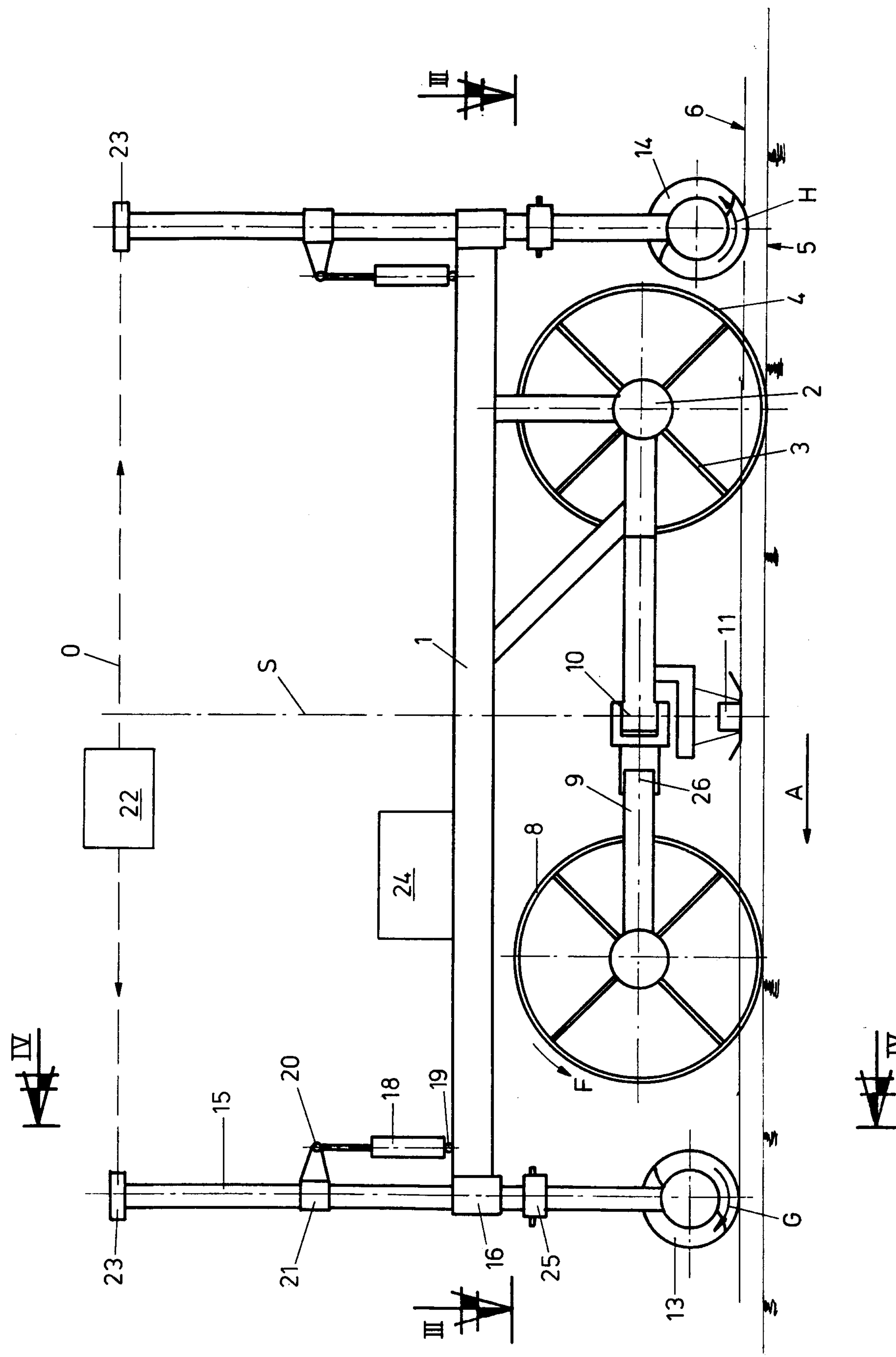
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FIG.2

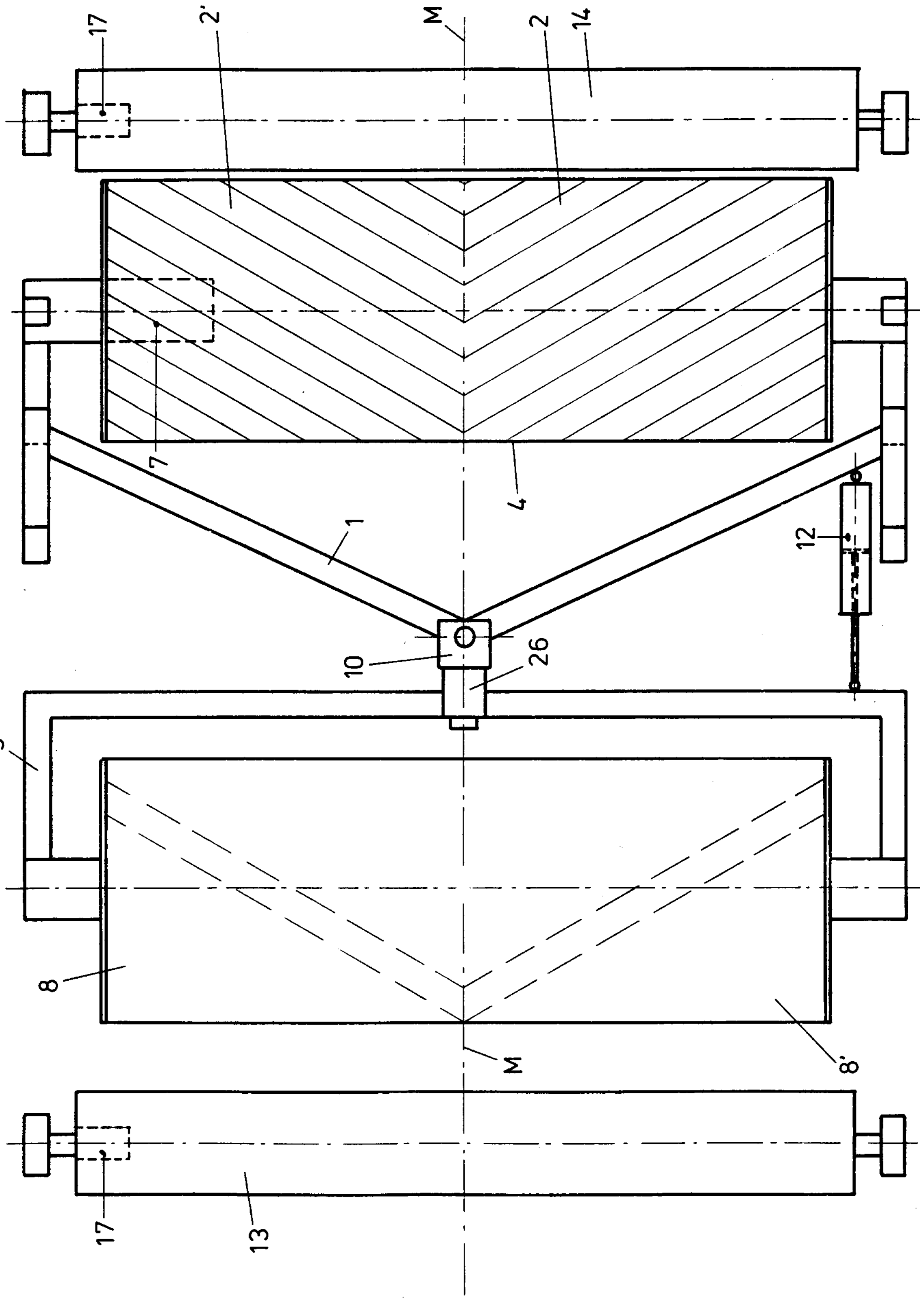

FIG.3

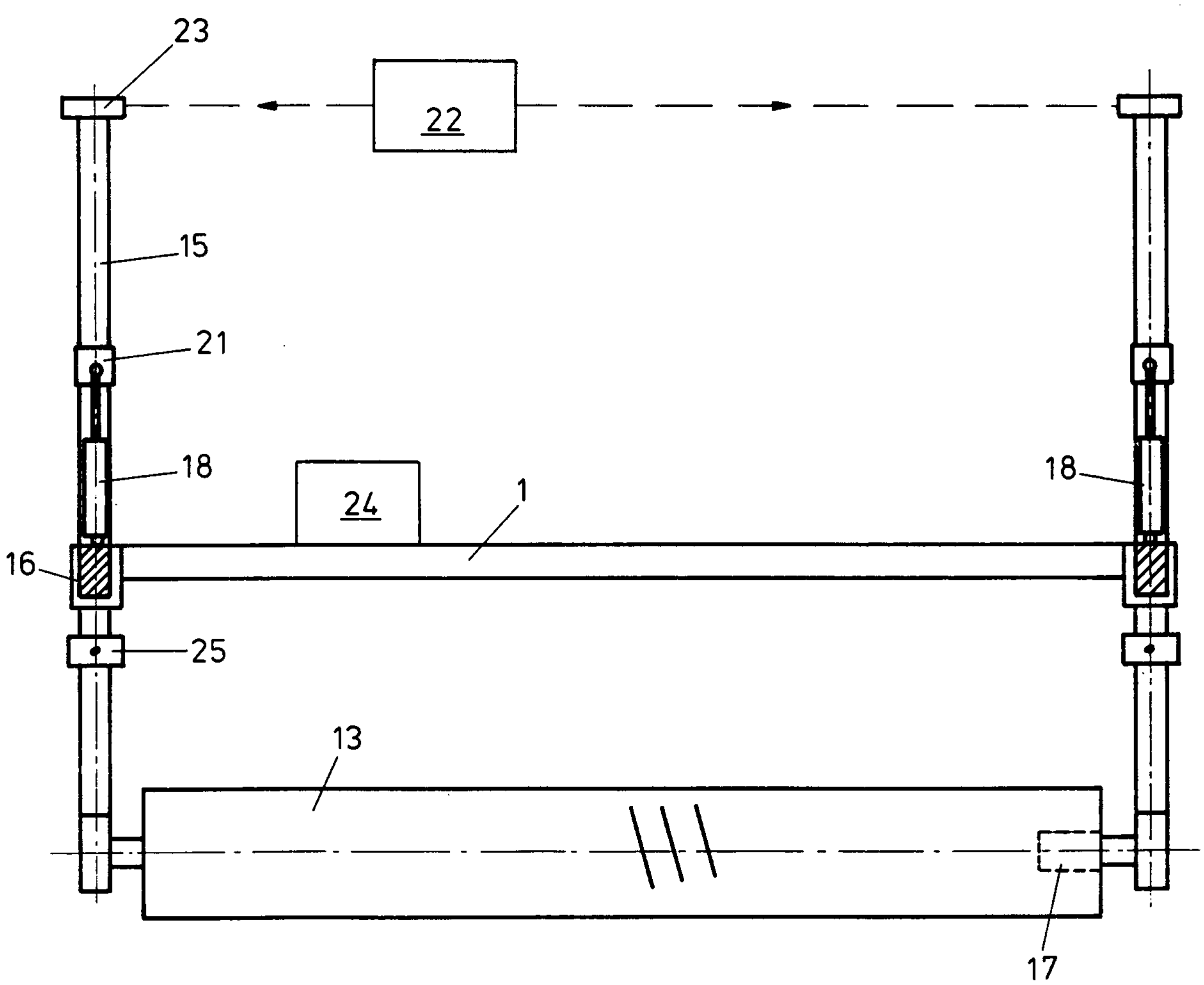

FIG.4

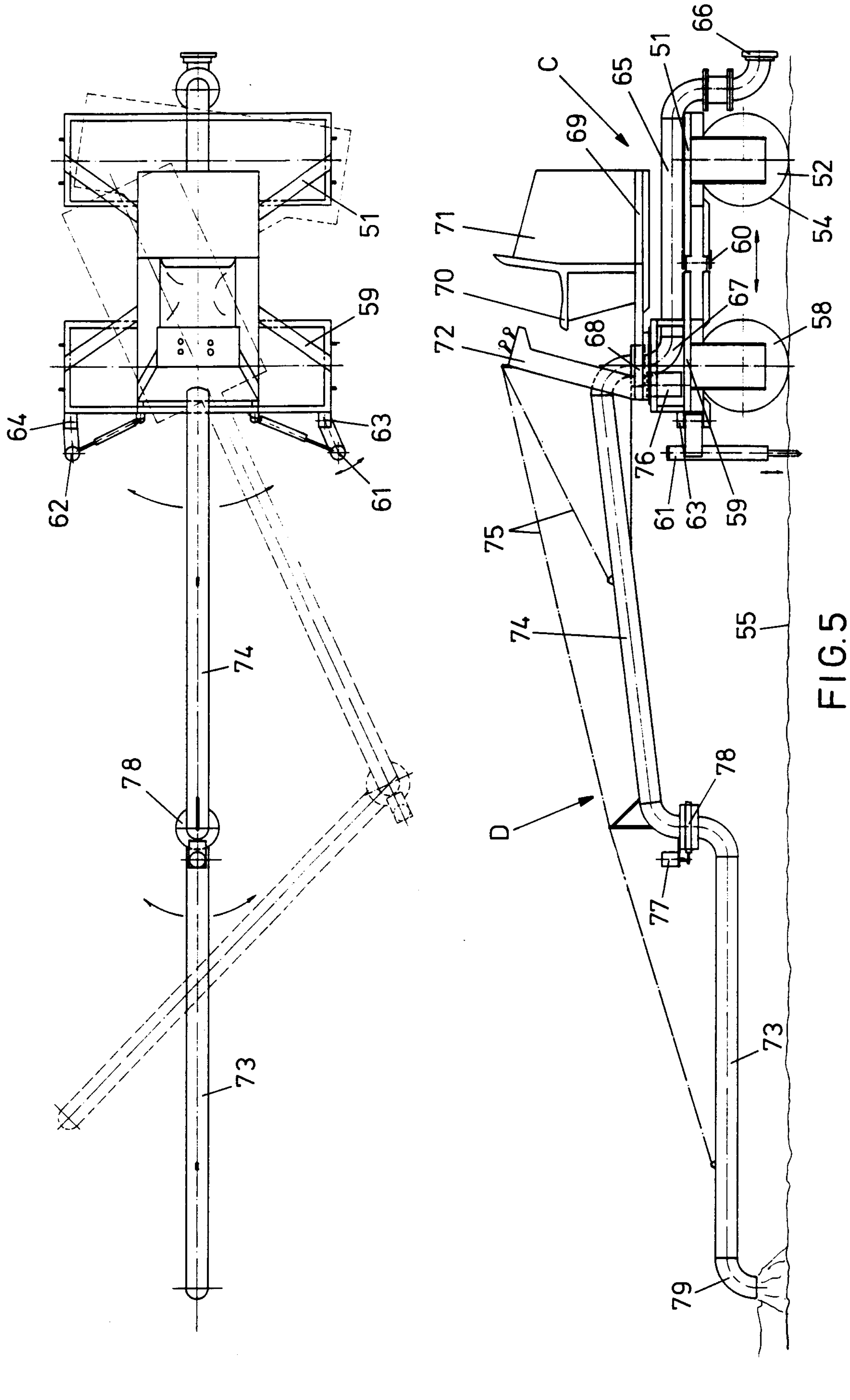
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FIG.5

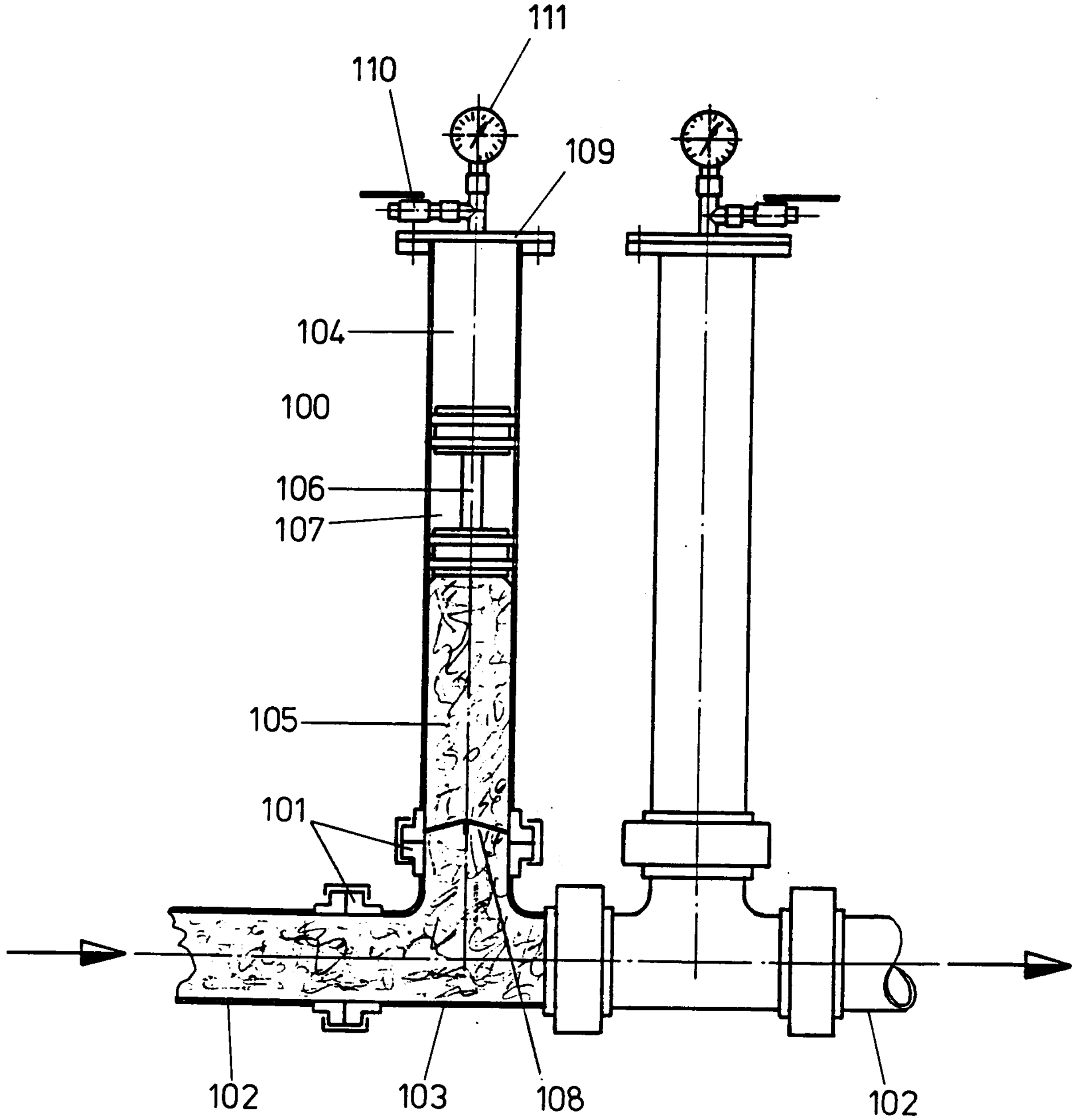

FIG.6