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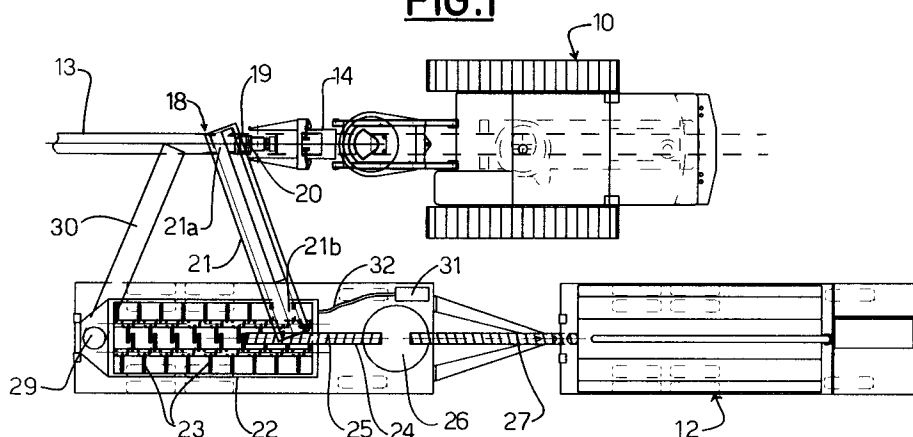
EUROPEAN PATENT APPLICATION(21) Application number: **94109778.4**(51) Int. Cl.⁶: **E02D 19/18, E02D 17/13**(22) Date of filing: **24.06.94**(30) Priority: **30.06.93 IT TO930477**(43) Date of publication of application:
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I-10128 Torino (IT)(54) **Apparatus and method of constructing monolithic trench walls, sills and hard standings.**

(57) A method of constructing monolithic trench walls, sills and hard standings, comprises the following steps in a continuous cycle:

- a) excavating a trench or channel (13) by means of a cutter (14) fitted to a moving excavating machine (10);
- b) extracting the soil excavated in the trench (13);
- c) transferring the extracted soil onto a conveyor belt (21) interposed between the cutter (14) and a

container (22, 34) provided with disgregating members (23, 35) for crumbling the extracted soil and mixing it with a consolidating agent so as to form with the extracted and crumbled soil a plastic and homogeneous mix;

- d) casting continuously the mix from said container (22) to the excavated trench or channel (13).

FIG.1**EP 0 633 361 A1**

The present invention refers to an apparatus and method of constructing monolithic trench walls, sills and hard standings.

Methods and apparatuses for constructing continuous monolithic trench walls are known from Italian Patent applications Nos. 3550-A/89 and 3551-A/89, in the name of the same Applicant, in which an equipment comprising a cutter having a vertical chain is used. The cutter is inserted in the soil down to the required depth, and the apparatus supporting the cutter is advanced, thereby excavating a trench in the direction of advancement. The walls of the trench are sustained by a formwork following the cutter. A grout supplying hose is inserted in the formwork, such that the apparatus leaves a trench filled with cement grout in advancing along a predetermined path.

It is an object of this invention to construct monolithic and continuous cement trench walls and sills, preferably but not exclusively for impermeabilization purposes utilising as aggregate the same soil material that is excavated. After being extracted, the soil is mixed to a consolidating agent, preferably cement, with a possible addition of water and concrete additives. In mixing, the soil has to be crumbled finely in order to have a homogeneous mix in which the aggregate granules remain covered with the consolidating mix. Big uncrushed sods in the finished work would compromise impermeability and cut down the final resistance of work, and therefore have to be carefully avoided.

Re-cycling of extracted soil has two purposes:

- that of saving addition of conventional aggregate, such as sand and gravel, avoiding any problem relative to their cost, availability and transportation;
- that of eliminating problems relative to elimination of the excavated material, with a consequent saving of time and work.

It is another object of this invention to provide a method of constructing concrete works in which the percentage of the various components (water, consolidating agent, aggregate) can be controlled by an operator at any time who can promptly adjust the percentages in order to construct works having maximum structural strength.

An apparatus for constructing piles with consolidated soil using excavated aggregate is known from Italian Patent applications No. 3592-A/89 and No. 3488-A/90 in the name of the same Applicant. This apparatus comprises a disaggregating and mixing tool mounted to the lower end of a rotating vertical rod. At first, the tool is positioned above the soil to be excavated, then it is forced into the ground. Air or water, if necessary, is simultaneously supplied to the tool. Upon reaching the required depth, a consolidating agent for binding the dis-

placed soil is supplied into the ground through suitable bores located near the disaggregating and mixing tool, as the latter is simultaneously raised. In this way, a pile of consolidated soil is formed.

Other attempts have been made recently in order to construct concrete trench walls using the excavated material as aggregate. A method is known wherein a vertical chain cutter is mounted to a moving excavating machine, and cement and water, if necessary, are added in the area being excavated. The cutter extracts the soil and lets it back down into the trench, partially mixed with a water and cement mixture that is cast in the trench in the tool operation zone. The quality of the work is rather poor because of insufficient mixing of consolidating agent and aggregate. Moreover, big integral and uncemented sods compromise the final resistance characteristics of the work. Further, this method is not suitable for constructing impermeable works.

It is a further object of this invention to provide a method of constructing monolithic continuous cement trench walls and sills through an uninterrupted operation without having to stop the casting, so as to avoid any idle time.

The above and further objects are attained according to the invention by a method of constructing monolithic trench walls, sills and hard standings, characterised by comprising the following steps in a continuous cycle:

- a) excavating a trench or channel by means of a cutter means fitted to a moving excavating machine;
- b) extracting the soil excavated in the trench;
- c) transferring the extracted soil onto conveyor means interposed between the cutter means and a container provided with disaggregating means for crumbling the extracted soil and mixing it with a consolidating agent so as to form with the extracted and crumbled soil a plastic and homogeneous mix;
- d) casting continuously the mix from said container to the excavated trench or channel.

The structural and constructional features of a preferred but not-limiting embodiment of an apparatus for carrying out the method of this invention are described hereinafter with reference to the accompanying drawings, in which:

FIG. 1

is a top view an excavating, mixing and grout casting apparatus illustrated in an operational step of the method of the invention;

FIG. 2

is a vertical cross-section view taken along the axis of a trench being excavated by one of the implements of the apparatus; and

FIGS. 3 and 4

are top views of two different embodiments of

the apparatus of FIG. 1, respectively.

With reference initially to FIG. 1, the method of this invention is carried out by an apparatus consisting of two separate means: a crawler track excavating machine 10 and a blade mixer 11 pulled by a moving cement container 12. By moving side by side to the mixer 10 and the container 12, the excavating machine 10 constructs a continuous and monolithic trench wall 13.

The embodiments here shown exploit an excavating machine as disclosed in greater detail in Italian patent applications No. 3550-A/89 and No. 3551-A/89. Said machine, which is particularly suitable for excavating considerably deep trenches, could also be substituted by another kind of excavating machine, as far as is suitable for trench or channel excavation. Synthetically, as shown in FIG. 2, the excavating machine 10 comprises a cutter 14, also known as "trencher", slidably mounted to a beam 15. Cutter 14 is provided with a chain 16 fitted with excavating tools or shovels 17. Fitted downstream of the cutter 14 is a formwork 18 substantially U-shaped in horizontal cross-section (FIG. 1). As known, the two opposite parallel walls 19 of the formwork temporarily sustain the walls of the trench, whilst joining transverse wall 20 separates the excavating area of the cutter from the rear zone 13 where cement grout is cast, as will be more apparent hereinafter.

An end portion 21a of a conveyor belt 21 is secured to the bearing structure of cutter 14 corresponding to the point where the shovels 17 on chain 16 begin their descending phase. The conveyor belt 21 projects over the mixing trailer 11 carrying a mixing tank 22 where suitable disgregating members or mixing blades 23 are provided. Still with reference to FIG. 1, the outlet end portion of a hose 24 having an inner screw feeder 25 is located proximate to the outlet 21b of conveyor belt 21, the other end being operatively connected to a conventional batching balance 26 mounted on the mixing trailer 11. Cement that is stored in the silo is conveyed to balance 26 through a further loading screw 27 located between the container 12 and the mixing trailer 11. Batching balance 26 consists of a cone-shaped vessel in which cement is let in and weighed. When a predetermined load is reached, cement is sent to a tank 22 by means of screw 25.

The bottom of tank 22 is downwardly inclined towards the rear end of the trailer 11, where an outlet port 29 communicates with a return channel 30 for casting mixed material into the trench 13.

A pump 31 for supplying water directly into the tank 22 through a conduit 32 is located on near balance 26 for further humidification of the mixture, if required.

In the variant form illustrated in FIG. 3, a first pump 31 on one side of balance 26 supplies water directly into the balance cone before cement is cyclically introduced therein. A first water and cement mixing takes place inside the balance. Also fitted near balance 26 is a second pump (not shown) for supplying the water and cement mixture to the mixing tank 22 through a mixture supply conduit 28.

In the variant embodiment shown in FIG. 4, tank 22 receives cement grout already prepared by a closed vertical cylindrical mixer 34 containing a rotating disgregating and centrifuging blade member 35. This solution, that is particularly suitable for crumbling clayish soil, does not let out cement grout continuously as in the examples set forth, but prepares it cyclically. Tank 22 serves to accumulate the ready mixture and deliver it continuously into the trench. As for the embodiment of FIG. 1, cement is conveyed dry by the screw feeder 25. Additional water may be supplied by the pump 31 and hose 32.

In the method of the present invention, the excavating machine 10 follows a predetermined path and excavates a trench by means of the cutter 14. As it proceeds, the excavating machine 10 is constantly flanked by the mixing trailer 11 which is towed by the moving cement container 12. While ascending, the shovels 17 (FIG. 2) excavate the soil bringing coarse fragments out of the trench and laying same onto the conveyor belt 21. Then, the excavated soil is brought up to the top of the mixing tank 22 or 34, where it is finely crushed by the moving disgregating members 23 and mixed to the cement (in the embodiments of FIGS. 1 and 4) or to the water and cement mixture (in the embodiment of FIG. 3). In this latter case, the presence of water in the mixture is advantageous in providing additional disgregating action that renders operation of members 23 easier.

Once in the tank, the mix of soil and consolidating mixture approaches the rear and lower end of the tank while it is progressively crumbled and rendered homogeneous by members 23. As it reaches the outlet opening 29, the mix possesses all features ideal for casting, so it is let out into the trench continuously through return channel 30.

Being open, the tank 22 allow an expert to control that the mix that is cast in the trench has the required plasticity. By controlling the amount of water of the cement grout that is let into the tank, the operator can always make sure that the mix possesses the best moisture ratio.

Should the trench be excavated under the water bed, so that the soil fragments bring into the tank a water content capable of forming a mix with the required plasticity, the operator may allow only cement inlet from the cement container.

If the soil water content is excessive, the operator may provide for expelling water in excess through an overflow system comprising an outlet valve (not shown) fitted in the top part of tank 22. It should be appreciated that water in excess is eliminated in any case as the soil fragments are conveyed on belt 21, where part of the water falls down the belt without reaching the tank.

A variant form which is different from the embodiments set forth is applicable for sill and hard standing construction. In this modified form, which is not illustrated as it involves minimum differences with respect to the apparatus of the above embodiments, comprises a cutter or excavating implement having a different shape, adapted for excavating channels larger and shallower than those for trenches. The cutter may be substituted by a bucket or shovel system for digging the soil and transferring it onto the belt to be mixed with cement and let back into the previously excavated channel.

Claims

1. A method of constructing monolithic trench walls, sills and hard standings, characterised by comprising the following steps in a continuous cycle:

- a) excavating a trench or channel (13) by means of a cutter means (14) fitted to a moving excavating machine (10);
- b) extracting the soil excavated in the trench (13);
- c) transferring the extracted soil onto conveyor means (21) interposed between the cutter means (14) and a container (22, 34) provided with disgregating means (23, 35) for crumbling the extracted soil and mixing it with a consolidating agent so as to form with the extracted and crumbled soil a plastic and homogeneous mix; d) casting continuously the mix from said container (22) to the excavated trench or channel (13).

2. A method according to claim 1, characterised in that the excavated soil is conveyed by the conveyor means (21) to the top of the container (22, 34) where also the consolidating agent is let in.

3. A method according to the preceding claims, characterised in that the excavated soil is progressively crumbled and mixed to the consolidating agent as it advances within the container (22) towards a mix outlet channel (30) for letting the mix back into the trench.

4. A method according to claims 1 and 2, characterized in that the soil is crumbled and

mixed to the consolidating agent within the container (34) by means of a rotating blade disgregating and centrifuging member (35).

5. An apparatus for constructing monolithic trench walls, sills and hard standings, comprising a moving excavating machine (10) provided with a cutter means (14) for excavating a trench or channel (13) and extracting the excavated material, characterized in that it comprises:

- conveyor means (21) for conveying the soil extracted by the cutter means (14) to a moving container (22, 34) having disgregating members (23, 35) therein for crumbling the soil and mixing it with a consolidating agent to form a plastic and homogeneous mix with the extracted soil;
- supply means (24, 25, 28, 33, 26) for supplying and batching the consolidating agent within the container (22, 34);
- casting means (30) for casting uninterruptedly the mix from the container (22, 34) to the excavated trench or channel (13).

6. An apparatus according to claim 5, characterised in that the container (22, 34) is located on a vehicle (11) moving side by side of said excavator (10), said supply means for supplying and batching the consolidating agent being located on the same vehicle (11).

7. An apparatus according to claim 5, characterised in that the container (22) consists of a tank having a sloping bottom wall inclined towards an outlet channel (30) for discharging the mix into the trench, the soil being progressively crumbled and mixed to the consolidating agent while approaching said outlet channel (30).

8. An apparatus according to claim 5, characterised in that the container (34) is a cylindrical mixer provided with rotating blade disgregating and centrifuging members (35) for crumbling the soil and mixing it with the consolidating agent.

9. An apparatus according to claim 8, characterised in that the mixer (34) is connected to an adjacent mix storing tank (22) having a bottom wall inclined towards an outlet channel (30) for discharging the mix into the trench.

10. An apparatus according to claim 5, characterised in that said vehicle (11) is towed by a moving cement container (12), cement supplying means (27) being interposed between

said moving cement container (12) and said batching means (26) fitted on said vehicle (11).

11. An apparatus according to claim 5, characterised in that the area that is excavated by the cutter means (14) is divided from the mix casting area (13) of the trench or channel by means of a formwork (18) supported by said cutter means.

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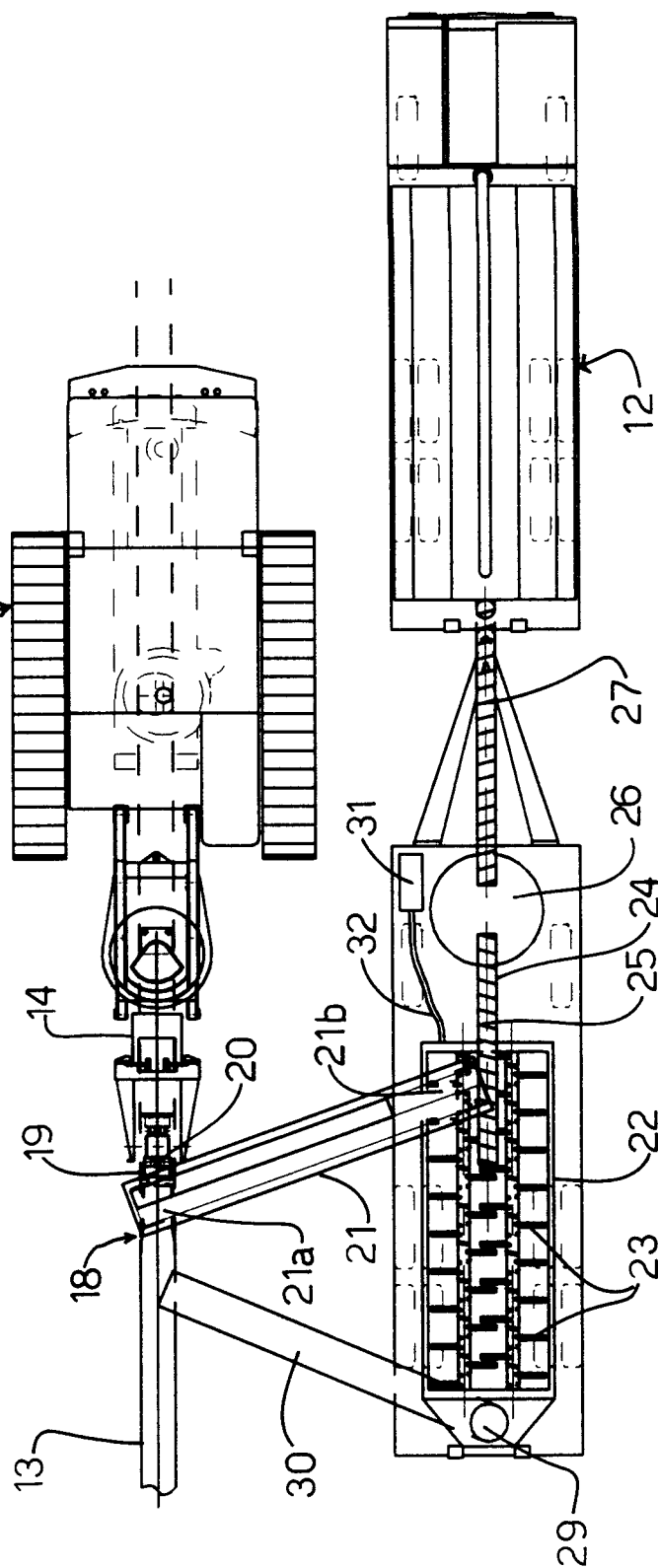
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FIG.1



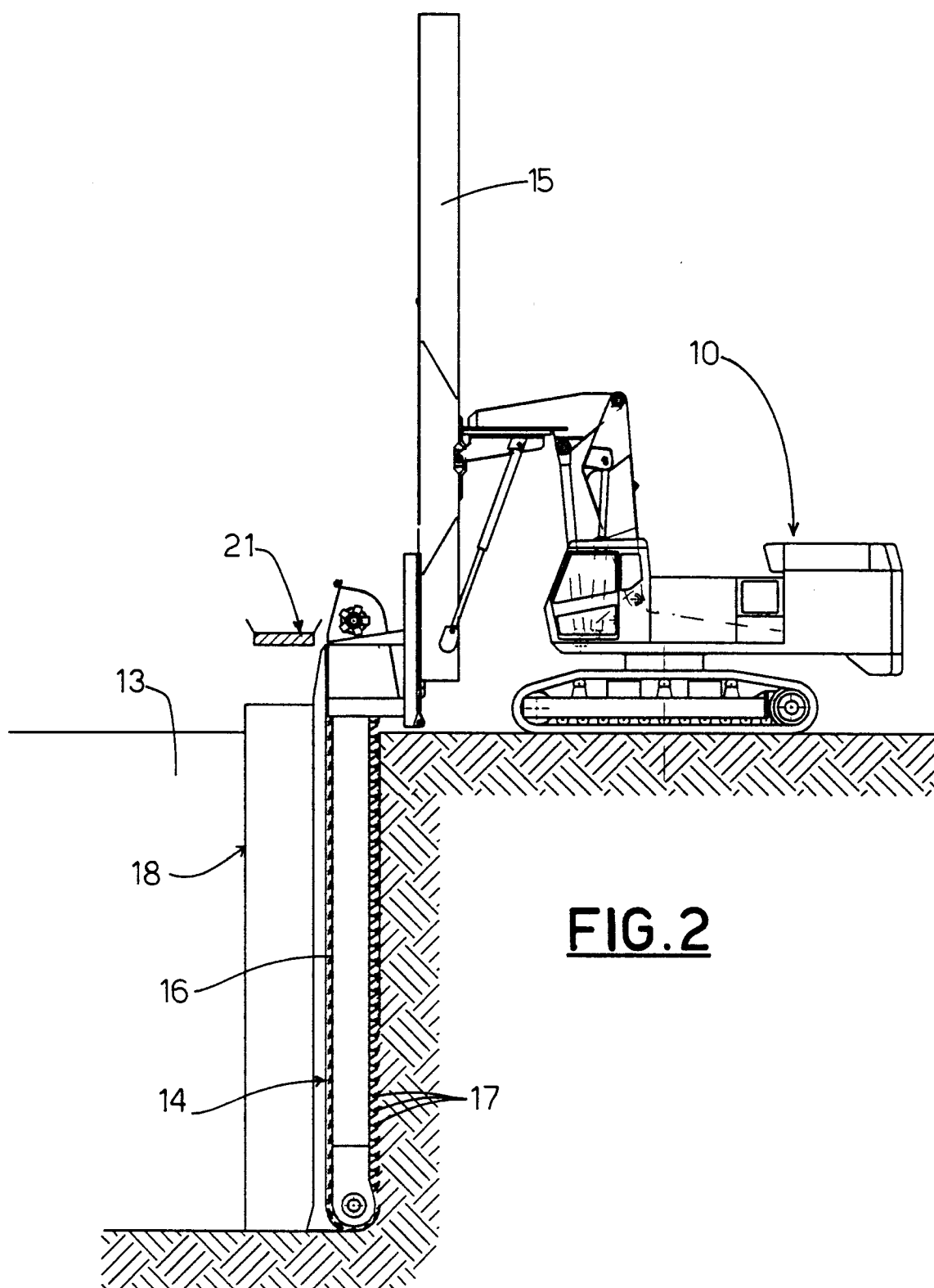


FIG. 2

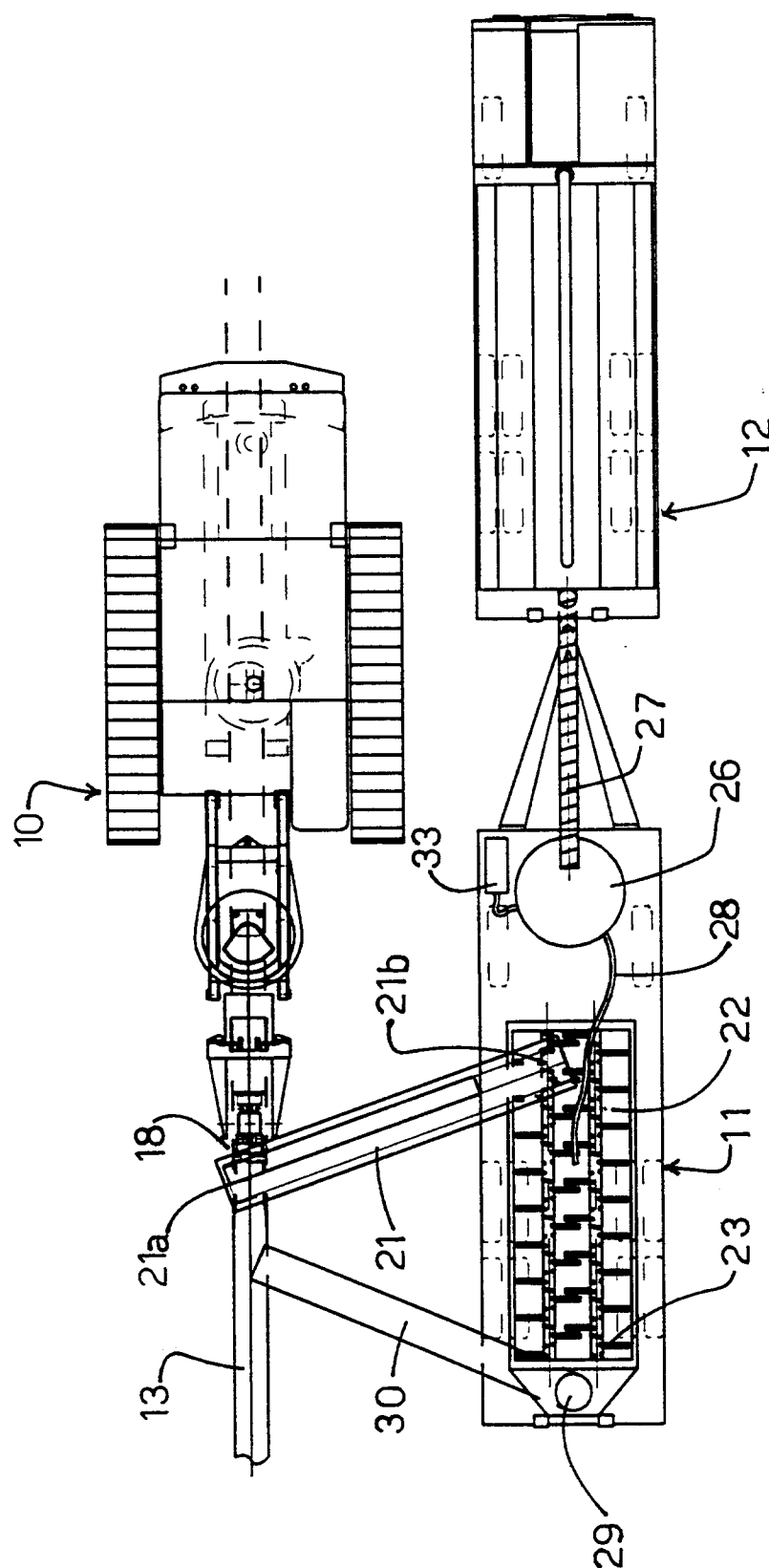
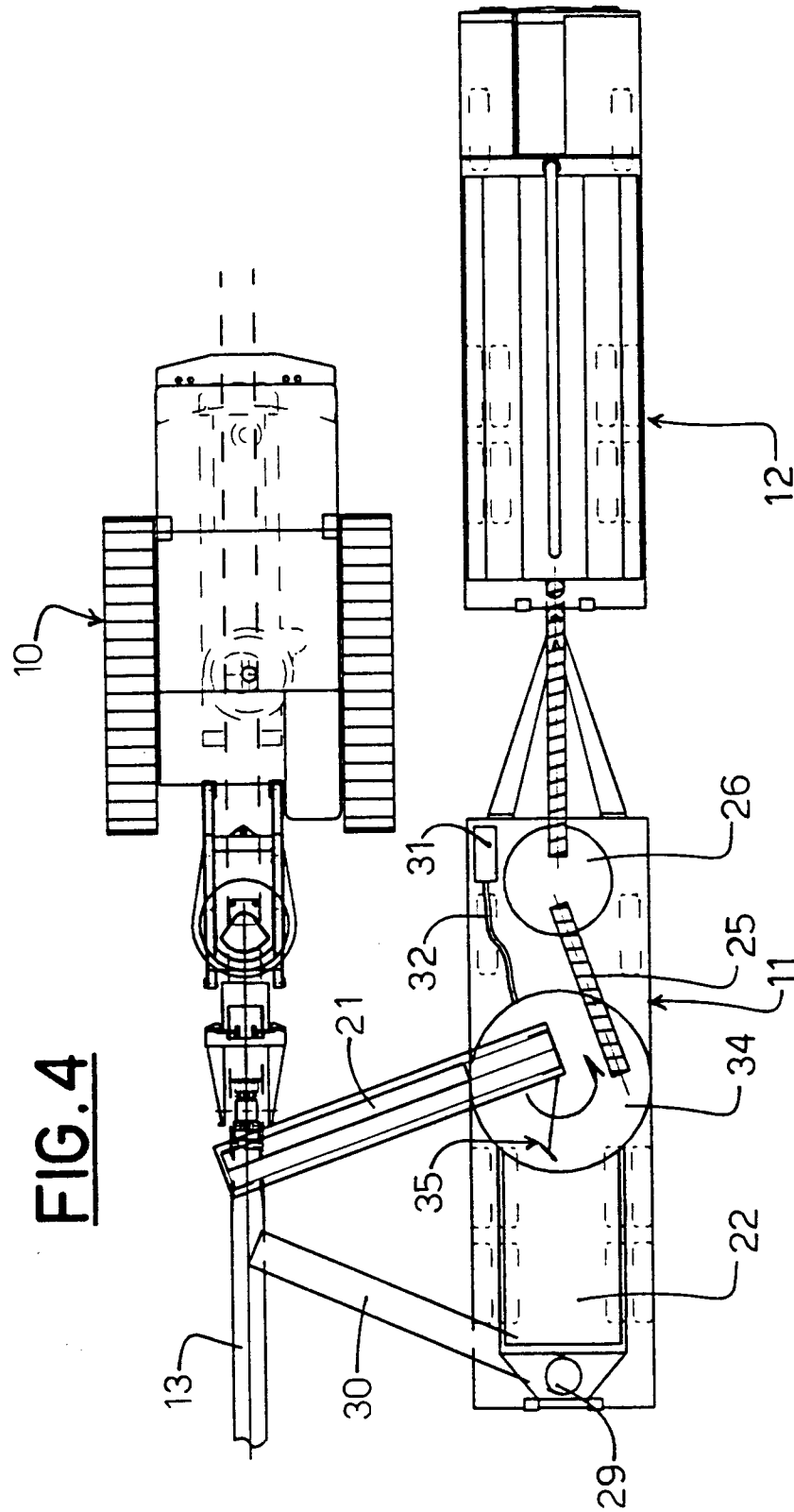


FIG. 3





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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 9778

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	EP-A-0 407 934 (TREVI S.P.A.) * the whole document * ---	1,5,6,11	E02D19/18 E02D17/13
A	FR-A-2 558 862 (VIDAL) * the whole document * ---	1,3-5	
A	FR-A-2 509 341 (RIBBERT) * page 2, line 1 - page 3, line 5 * * page 6, line 31 - page 7, line 17; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E02D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 October 1994	Examiner Blommaert, S
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			