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# **Bulk conveying system and method of controlling a bulk conveying system**

The invention relates to a bulk conveying system for conveying bulk material, especially construction material, to a location where the bulk material is further processed in a previously unknown quantity, for example a work location on a construction site, and to a method of controlling a bulk conveying system.

Wet mortar mix comprising of cement, sand and water, is widely used as a material for construction works. Providing the wet mortar at the actual work location of the construction site requires a lot of work, if the materials are separately carried to the location and mixed on site.

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Therefore, conventional systems are provided which store pre-mixed dry mortar, i.e. a mixture of sand and cement, at a silo and pump the pre-mixed dry mortar to a mixer unit where water is added to produce wet mortar. The mixer unit can be installed at the actual work location.

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However, the conventional systems are inefficient. Usually, on a construction site construction work is carried out simultaneously at a plurality of locations of the construction site. Construction materials such as cement or mortar are required at different locations at the same time. Therefore, it is necessary that either a plurality of conventional systems is used, or the mixer unit of a single system is moved frequently. Providing a plurality of systems results in high equipment costs and is often impossible due to a lack of space. Frequently moving a single system results in a great amount of work.

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It is an object of the invention to create a bulk conveying system which is appropriate to provide material at various remote locations of the same site at the same time, according

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to the actual needs at the particular remote locations, without causing high costs or a great amount of work, and to create a corresponding method of controlling a bulk conveying system.

- 5 According to the invention, the object of the invention is achieved by a bulk conveying system according to claim 1.

The bulk conveying system according to the invention comprises a container for storing bulk material, the container having a  
10 bulk inlet and a bulk outlet. A main conveying pipe connected to the bulk outlet of the container has a pump for driving the bulk material through the main conveying pipe. A plurality of distribution pipes are provided. Each one of the plurality of distribution pipes is connected to the main conveying pipe and  
15 has a distribution valve by means of which the distribution pipe can be opened and closed. Further, a plurality of distribution units is provided. Each one of the plurality of distribution units has a distribution unit container, an inlet connected to the main conveying pipe through a corresponding  
20 one of the distribution pipes, a material distribution outlet and a stock level detector. The stock level detector detects whether or not the actual stock level in the distribution unit container is equal to or falls below a predetermined minimum stock level and detects whether or not the actual stock level  
25 in the distribution unit container is equal to or exceeds a predetermined maximum stock level. Further, the material conveying system comprises a conveyance control system which sequentially receives detected values from the stock level detector of each of the distribution units. The conveyance  
30 control system controls the distribution valve of each of the distribution pipes and the pump on the basis of the detected values. The control is carried out in such a manner that, if the actual stock level in the distribution unit container of any of the distribution units is equal to or falls below the  
35 predetermined minimum stock level, bulk material is conveyed



from the container to the distribution unit container of one of the distribution units. The bulk material is conveyed to the distribution unit container of said one of the distribution units, until the actual stock level in the distribution unit container of said one of the distribution units is equal to the predetermined maximum stock level.

In this context said one of the distribution units can be that distribution unit which is just detected to have a low actual stock level, or can be another distribution unit to which material is already being conveyed when the latest detection is made.

Conveying bulk material to the distribution unit container of said one of the distribution units, until the actual stock level in the distribution unit container of said one of the distribution units is equal to the predetermined maximum stock level, does not necessarily mean that the distribution unit container is replenished in one single operation. It is also possible that the replenishing of the distribution unit container is interrupted in order to first convey material to another distribution unit container and is then continued.

In this context, conveying until the actual level is equal to the predetermined maximum stock level can also mean conveying until the actual level slightly exceeds the predetermined maximum stock level. Since the actual stock level might be detected at certain time intervals, it is possible that no detection is made when the actual stock level is equal the predetermined maximum stock level.

By providing the plurality of distribution units it is achieved that bulk material can be conveyed to a plurality of distribution locations, so that e.g. a plurality of work sites on a construction site can be provided with construction



material. Therefore, work can be carried out simultaneously at a plurality of locations even if at all the locations material is required at the same time.

- 5 By providing one distribution unit container for each of the distribution units it is achieved that a certain quantity of material can be stored at each particular distribution location, so that this certain quantity of material can be used instantaneously without requiring any waiting time resulting  
10 from a conveying process. Also, a material buffer is provided, avoiding a shortage of material in periods when more material is taken out from the distribution unit than is conveyed into it.
- 15 By providing one material container and one main conveying pipe for a plurality of distribution units it is achieved that the equipment costs and the space required for the conveying system are kept low. Further, a material mixture such as, e.g., dry mortar or even wet mortar can be premixed and stored in the  
20 container, so that the mixing process can be centralized and, thereby, the productivity can be increased. Further, at the first step material only must be delivered to one location, namely the container. No consideration is required in advance, regarding the question how much material will be taken out at  
25 which work location.

By providing the distribution valves and the pump it is achieved that material can be conveyed independently to each particular one of the distribution units.

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By providing a stock level detector in each of the distribution units and the conveyance control system it is achieved that the conveying process is carried out automatically. Further it is achieved that the process is carried out in such a way that the  
35 risk of falling short of material in any of the distribution



units is minimized. Whenever the actual stock level in the distribution unit container of any of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is conveyed from the container to the distribution unit container of one of the distribution units. That is, the pump is working continuously as long as any actual stock level is lower than targeted, and thereby the pump is used as effectively as possible.

10 It is possible that the conveyance control system receives the detected values from the stock level detector of each of the distribution units continuously or at certain receiving intervals.

15 According to the invention, it is possible that the predetermined minimum stock level is equal to the predetermined maximum stock level. This has the effect that immediately after material has been taken out of a distribution unit the distribution container of which is completely filled, material is conveyed from the container to the distribution unit. It is preferred, however, that the predetermined minimum stock level is different from the predetermined maximum stock level.

Thereby it is achieved that material is not immediately conveyed from the container to the distribution unit when only a smaller quantity of material has been taken out of the distribution unit container which previously had been completely filled. Thereby the pump does not start and stop frequently to convey small quantities of bulk material, which can result in a short lifetime for the pump and the whole conveying system.

It is possible that different values for the predetermined minimum stock level are provided for different distribution



units and/or different values for the predetermined maximum stock level are provided for different distribution units.

According to the invention, it is possible that the conveyance  
5 control system of the bulk conveying system has any appropriate  
detailed design providing for the replenishment of the  
distribution units. According to a preferred embodiment of the  
invention, however, the conveyance control system controls the  
distribution valve of each of the distribution pipes and the  
10 pump on the basis of the detected values in such a manner that  
if the actual stock level in the distribution unit container of  
more than one of the distribution units is equal to or falls  
below the predetermined minimum stock level, bulk material is  
conveyed to the distribution unit container of that one of the  
15 distribution units whose actual stock level was equal to or  
fell below the predetermined minimum stock level first (first-  
come-first-serve-mode).

By replenishing the distribution unit container of that one of  
20 the distribution units first whose actual stock level was equal  
to or fell below the predetermined minimum stock level first,  
it is achieved that a distribution unit is replenished which is  
very likely to be the first to run completely out of material.  
In the case that this distribution unit has already run out of  
25 material, it is very likely that it is this distribution unit  
which has already passed the longest waiting time without  
material. Therefore, it is likely that at this distribution  
unit no other work is left which can be carried out without a  
further material supply.

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According to another preferred embodiment of the bulk conveying  
system according to the invention, the stock level detector  
detects the exact actual stock level in the distribution unit  
container and the conveyance control system controls the  
35 distribution valve of each of the distribution pipes and the



pump on the basis of the detected values in such a manner that if the actual stock level in the distribution unit container of more than one of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container of that one of the distribution units whose actual stock level is the lowest (lowest-level-first-mode).

By replenishing the distribution unit container of that one of the distribution units first whose actual stock level is the lowest, it is achieved that the distribution unit is replenished which is very likely to run completely out of material.

Thus it is possible that bulk material is conveyed to the distribution unit container of that one of the distribution units whose actual stock level is the lowest for a predetermined time period, regardless of whether or not in the meantime another container becomes the one with the lowest stock level. It is further possible to determine the distribution unit to which material is conveyed by considering the material quantity taken out per time from those distribution units having the same level or from those distribution units having an actual stock level lower than the predetermined minimum stock level.

According to the invention it is possible that the bulk conveying system runs wholly automatically and without any need for operation staff to modify the conveying process. It is preferred, however, that the bulk conveying system comprises a manual conveyance control switch by means of which the operation of the conveyance control system can be modified or interrupted. Further preferably a conveyance control programming unit having programming keys is provided. It can be provided, for example, that by means of the manual conveyance



- control switch or the conveyance control programming unit the minimum and/or the maximum predetermined stock level can be changed, the mode of operation can be switched from the first-come-first-serve-mode to the lowest-level-first-mode, one or more distribution units can be switched off completely, or a termination program for a distribution unit can be started determining a residual quantity to be conveyed to the distribution unit etc.
- 10 By providing an appropriate manual conveyance control switch or the conveyance control programming unit it is achieved that the bulk conveying system can be adapted to the actual needs at the individual construction site.
- 15 According to a preferred embodiment of the bulk conveying system according to the invention each distribution unit has an weighing system which measures the accurate amount of material distributed through the material distribution outlet. Preferably, the weighing system is integrated into the distribution unit. Further, preferably the weighing system is formed so that it determines the distributed amount of material exactly enough to fulfill the needs of construction work, especially when the distributed material is sand or cement used to mix mortar. By providing a weighing system in each of the distribution units it is achieved that optimum doses of material and optimum mixing ratios can exactly be met. Further, the usage rate of the individual distribution unit can be recorded and monitored.
- 25
- 30 It is further preferred that each distribution unit has a material demand switch or panel, by means of which a desired amount of material can be preset and the distribution unit can be controlled in such a way that the exact desired amount of material is distributed through the material distribution
- 35 outlet.



Preferably an information regarding the material demand preset at the particular distribution unit is sent to the conveyance control system. The conveyance control system then carries out  
5 a modified control mode conveying the desired amount of material to the respective distribution unit. In the modified control mode the conveyance control system controls the distribution valves and the pump in such a way that material is conveyed to the respective distribution unit before or without  
10 a detection being made whether the actual stock level falls below the predetermined minimum stock level. According to the invention it is possible that the modified control mode is combined with the regular control mode described above in any appropriate way. By using the modified control mode the  
15 reaction time achieved with the bulk material conveying system is decreased. The conveying process can be immediately started when the process of distributing material is started at the distribution unit. Thereby a possible future shortness of material in a particular distribution unit is avoided in  
20 advance.

The material demand device can e.g. be a switch, wherein each pressing of the switch corresponds to the demand of a certain amount of material, e.g. 50 kg.

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According to the invention it is possible that each of the distribution pipes is formed as one piece and is fixed to the main conveying pipe. It is preferred, however, that each of the distribution pipes comprises a valve portion which forms that  
30 end of the distribution pipe joining the main conveying pipe and comprises the distribution valve, and a distribution unit portion which forms that end of the distribution pipe joining the distribution unit, which is disconnectably coupled to the valve portion and which is substantially longer than the valve  
35 portion.

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By forming each of the distribution pipes as two pieces, a valve portion and a distribution unit portion disconnectably coupled with each other, wherein the distribution unit portion being substantially longer than the valve portion, it is achieved that each distribution unit together with the greatest part of the distribution pipe can be disconnected from the main conveying pipe, e.g. for the purpose of installing it at another location. By providing the distribution valve in the valve portion of the distribution pipe it is achieved that the pipe system which remains when the distribution unit portion is disconnected can be shut down, so that no material flows out. Thereby the flexibility of the system is increased. It is possible to carry out a modification of the pipe system and a displacement of a distribution unit, while maintaining the operation of the remaining pipe system and the remaining distribution units.

According to the invention it is possible that the conveying pipe is formed as a one-piece unit. It is preferred, however, that the main conveying pipe comprises a hydrant portion forming that portion of the main conveying pipe where the distribution pipes are joined, and a conveying portion forming that portion of the conveying pipe which extends between the container and the hydrant portion and being disconnectably coupled to the conveying portion.

Preferably, a conveying pipe valve is provided at the end of the conveying portion close to the hydrant portion, so that the conveying pipe can be closed.

By forming the conveying pipe as a two-piece unit, i.e. of a conveying portion and a hydrant portion disconnectably coupled with each other, it is achieved that the conveying pipe can be extended or modified in another way by inserting an additional



pipe piece in order to displace the locations where the distribution units are arranged. For example, an additional vertical pipe piece can be inserted into the main conveying pipe when the distribution units are to be displaced from the levels one to five of a building under construction to the levels six to ten. Thereby the flexibility of the system is increased. It is possible to carry out a displacement of all the distribution units without modifying the greatest part of the conveying pipe. By providing the conveying pipe valve in the conveying portion it is achieved that the pipe system can be shut for the purpose of inserting an additional pipe piece.

According to the invention it is possible for the hydrant portion to have any appropriate design. According to a preferred embodiment of the invention, however, the hydrant portion is formed as a one-piece unit comprising a main pipe portion, joining pipe portions laterally protruding from the main pipe portion at different longitudinal positions of the main pipe portion, and a connection flange at each free end of the main pipe portion and the joining pipe portions.

By forming the hydrant portion as a one-piece unit it is achieved that the hydrant portion can be shifted or displaced easily as a whole.

Preferably, the hydrant portion comprises a shackle for fixing a shifting device, e.g. a hook of a crane.

According to another preferred embodiment of the invention, the hydrant portion is designed in modular system and comprises a plurality of hydrant elements, each hydrant element of which has a main pipe portion, a joining pipe portion laterally protruding from the main pipe portion and a connecting flange at each of the free ends of the main pipe portion and the joining pipe portion, with the hydrant elements being joined so



as to form a row, wherein pairs of the connecting flanges at the free ends of the main pipe portions are disconnectably joined to each other.

5 By designing the hydrant portion in modular system it is achieved that the hydrant portion can be modified easily in order to adapt the pipe system after the displacement of one or more of the distribution units. It is, for example, possible to shut down one of the hydrant elements at its joining pipe  
10 portion and, instead, to add a further hydrant element at the free end of the hydrant portion. Thereby it is, for example, possible to displace the plurality of distribution units from the levels one to five of a building under construction to the levels two to six. This can be achieved by just moving the  
15 distribution unit previously located on level one to level six. The operation of the distribution units of levels two to five can be continued during that displacement activity. Hence the hydrant portion designed in modular system serves to increase the flexibility of the conveying system.

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According to the invention it is possible that the bulk conveying system has only one conveying unit connected to the container and comprising a conveying pipe, a plurality of distribution pipes and a plurality of distribution units. It is  
25 preferred, however, that the bulk conveying system comprises a plurality of conveying units connected to the container, each conveying unit of which comprises a conveying pipe, a plurality of distribution pipes and a plurality of distribution units. Thereby a further increase of the flexibility of the conveying  
30 system is achieved .

According to the invention it is possible that the bulk conveying system is used with any material, e.g. chemicals, oil, hydraulic fluid, sugar etc.. It is also possible to use  
35 the system at any location. It is preferred, however, to use

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the bulk conveying system for conveying a construction material to different locations of the construction site, especially to different levels of a building under construction.

- 5 According to the invention it is possible that the bulk conveying system is used with any construction material, liquid or solid, e.g. wet mortar, sand etc. It is preferred, however, to use a dry construction material, especially dry cement or dry mortar, as construction material.

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With respect to the method, the object of the invention is achieved by a method for controlling a bulk conveying system according to claim 13.

- 15 The method for controlling a bulk conveying system for conveying bulk material from a container to a plurality of distribution units comprises the steps of:

detecting in each of the distribution units whether or not the actual stock level of bulk material in the distribution unit is  
20 equal to or falls below a predetermined minimum stock level, and whether or not the actual stock level of bulk material in the distribution unit is equal to a predetermined maximum stock level; sequentially receiving detected values from each of the distribution units; if a detected value is received from one of  
25 the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level, checking whether or not presently bulk material is being conveyed to any of the distribution units, and, if it is found that presently  
30 bulk material is being conveyed to none of the distribution units, controlling the bulk conveying system in such a manner that the conveying of bulk material to said one distribution unit is started; and, if a detected value is received from one of the distribution units indicating that the actual stock  
35 level of bulk material in said one distribution unit is equal



to the predetermined maximum stock level, checking whether or not presently bulk material is being conveyed to said one distribution unit, and, if it is found that presently bulk material is being conveyed to said one distribution unit, 5 controlling the conveying system in such a manner that the conveying of bulk material to said one distribution unit is stopped, and checking a queue of distribution units to be replenished whether the queue presently comprises another distribution unit, and, if it is found that the queue presently 10 comprises a distribution unit is in the queue, controlling the conveying system in such a manner that the conveying of bulk material to the distribution unit which is the next in the queue is started and deleting the distribution unit from the queue.

15

According to a preferred embodiment of the invention, after a detected value has been received from one of the distribution units indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the 20 predetermined minimum stock level, after it has been checked whether or not presently bulk material is being conveyed to any of the distribution units and after it has been found that presently bulk material is being conveyed to any of the distribution units, it is checked whether or not presently bulk 25 material is being conveyed to said one of the distribution units, and, if it is found that presently bulk material is being conveyed to said one of the distribution units, the conveying system is controlled in such a manner that the conveying of bulk material to said one of the distribution 30 units is continued, and, if it is found that presently bulk material is not being conveyed to said one of the distribution units, said one distribution unit is attached at the end to the queue of distribution units to be replenished, if said one distribution unit is not yet in the queue.

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According to a preferred embodiment of the invention, the exact value of the actual stock level of bulk material in each distribution unit is detected, and after a detected value has been received from one of the distribution units indicating  
5 that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level and after it has been found that presently bulk material is being conveyed to any of the distribution units, it is checked which of the distribution units has the  
10 lowest actual stock level. The conveying system is controlled in such a manner that bulk material is conveyed to that one of the distribution units which has the lowest actual stock level, and any other one of the distribution units which has an actual stock level which is equal to or falls below the predetermined  
15 minimum stock level is placed in the queue of distribution units to be replenished, wherein the position number in the queue depends on the actual stock level. The lower the actual stock level, the lower the position in the queue.

20 Preferred embodiments of the invention are described with reference to the drawing. In the drawing:

Figure 1 shows a schematic view of an embodiment of the bulk conveying system according to the invention being installed on  
25 a building construction site.

Figure 2 is a front view of an embodiment of the hydrant unit of the bulk conveying system according to the invention, wherein the hydrant unit is designed as a one-piece unit.

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Figure 3 is a front view of an embodiment of the hydrant unit of the bulk conveying system according to the invention, wherein the hydrant unit is designed in modular system.

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From figure 1 a bulk conveying system is obvious, which is arranged on a building construction site. A building under construction having eight levels is schematically shown. Besides the building a container 1 for storing bulk material  
 5 formed as a silo is arranged. The container 1 has a bulk inlet 11 and a bulk outlet 12. The bulk inlet 11 is connected, through a rubber hose, to a truck supplying fresh material to the container 1.

10 A main conveying pipe 2 is connected to the bulk outlet 12 of the container 1 which is at a distance from the ground. The main conveying pipe is formed by a conveying portion 23 and a hydrant portion 22. The conveying portion 23 extends from the bulk outlet 12 to the ground. In the portion where the  
 15 conveying portion 23 meets the ground, the main conveying pipe 2 has a pump 21 which is arranged on the ground and is provided for driving the bulk material through the main conveying pipe 2. The conveying portion 23 further extends along the ground towards the building and is upwardly curved close to the  
 20 building. At the position of the curve the conveying portion 23 is anchored by means of a pipe stand. Further, the conveying portion extends upwardly along the building and ends between the third and the fourth level of the building, and close to the end the conveying portion comprises a conveying pipe valve  
 25 24.

Above the conveying pipe valve 24 the conveying portion 23 is connected to the hydrant portion 22. The hydrant portion 22 is formed as a one-piece unit and has a main pipe portion  
 30 extending vertically along the building and ending at the eighth level of the building. Joining pipe portions protrude laterally from the main pipe portion towards the building. One joining pipe portion protrudes from the main pipe portion at the height of each of the fourth, fifth, sixth, seventh and  
 35 eighth level of the building. At each of the joining pipe



portions of the hydrant portion 22 a distribution valve 31 is provided.

Each of the joining pipe portions provided with the  
5 distribution valve 31 forms a valve portion 32 of a  
distribution pipe 3. Each of the distribution pipes 3 comprises  
the valve portion 32 and a distribution unit portion 33. The  
valve portion 32 and the distribution unit portion 33 are  
disconnectably coupled close to the distribution valve 31. Each  
10 of the distribution unit portions 33 extends parallel to the  
floor of the respective level into the center of the building.

The distribution unit portion 33 of each distribution pipe 3 is  
connected to a distribution unit 4 through an inlet 42 leading  
15 to a distribution unit container 41. At each inlet 42 of a  
distribution unit 4 a further valve is provided. Each of the  
distribution units 4 has a material distribution outlet 44 and a  
stock level detector 43 (only shown schematically). Each of the  
stock level detectors is connected via a data line (not shown)  
20 to a conveyance control system 5 (only shown schematically).

From figure 2 a hydrant portion 22 can be seen more in detail  
which is designed as one piece. The basic shape of the hydrant  
portion 22 is the same as that of figure 1, the difference  
25 being that no distribution valves 31 are provided for the  
hydrant portion 22. The hydrant portion 22 has a main pipe  
portion extending vertically. Joining pipe portions protrude  
laterally from the main pipe portion. A connection flange 223  
is provided at each free end of the main pipe portion and the  
30 joining pipe portions.

From figure 3 another embodiment of a hydrant portion 22 can be  
gathered in greater detail, which is designed as a modular  
system. The hydrant portion 22 comprises three hydrant elements  
35 224 which all have the same design. Each hydrant element 224



has a main pipe portion. A joining pipe portion laterally protrudes from the main pipe portion. A connecting flange 223 is provided at each of the free ends of the main pipe portion and the joining pipe portion. Each of the joining pipe portions  
5 comprises a distribution valve 31. Pairs of the hydrant elements 224 are joined, so that the three hydrant elements form a row. Therefore, pairs of the connecting flanges 223 at the free ends of the main pipe portions are disconnectably joined to each other.

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It is a preferred embodiment of the invention to use an embodiment of the method according to the invention in combination with an embodiment of the bulk conveying system according to the invention.

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## Claims

1. Bulk conveying system comprising
  - a) a container (1) for storing bulk material, the container
  - 5 (1) having a bulk inlet (11) and a bulk outlet (12),
  - b) a main conveying pipe (2) connected to the bulk outlet (12) of the container (1) and having a pump (21) for driving the bulk material through the main conveying pipe (2),
  - c) a plurality of distribution pipes (3), each distribution
  - 10 pipe (3) of which being connected to the main conveying pipe (2) and having a distribution valve (31) by means of which the distribution pipe (3) can be opened and closed,
  - d) a plurality of distribution units (4), each distribution unit (4) of which having a distribution unit container (41), an
  - 15 inlet (42) connected to the main conveying pipe (2) through a corresponding one of the distribution pipes (3), a material distribution outlet (44) and a stock level detector (43) detecting whether or not the actual stock level in the distribution unit container (41) is equal to or falls below a
  - 20 predetermined minimum stock level and whether or not the actual stock level in the distribution unit container (41) is equal to or exceeds a predetermined maximum stock level,
  - e) a conveyance control system (5) which sequentially receives detected values from the stock level detector (43) of
  - 25 each of the distribution units (4) and controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values such that, if the actual stock level in the distribution unit container (41) of any of the distribution units (4) is equal to
  - 30 or falls below the predetermined minimum stock level, bulk material is conveyed from the container (1) to the distribution unit container (41) of one of the distribution units (4) until the actual stock level in the distribution unit container (41) of said one of the distribution units (4) is equal to the
  - 35 predetermined maximum stock level.





2. Bulk conveying system according to claim 1, wherein the predetermined minimum stock level is different from the predetermined maximum stock level.

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3. Bulk conveying system according to claim 1 or 2, wherein the conveyance control system (5) controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21), on the basis of the detected values in such a manner that, if  
10 the actual stock level in the distribution unit container (41) of more than one of the distribution units (4) is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container (41) of that one of the distribution units (4), the actual stock level  
15 of which was equal to or fell below the predetermined minimum stock level first.

4. Bulk conveying system according to any one of claims 1 to 3, wherein the stock level detector (43) detects the exact actual  
20 stock level in the distribution unit container (41) and the conveyance control system (5) controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values in such a manner that, if the actual stock level in the distribution unit container (41) of  
25 more than one of the distribution units (4) is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container (41) of that one of the distribution units (4), the actual stock level of which is the lowest.

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5. Bulk conveying system according to any one of claims 1 to 4, comprising a manual conveyance control switch (6) by means of which the operation of the conveyance control system (5) can be modified or interrupted.

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6. Bulk conveying system according to any one of claims 1 to 5, wherein each distribution unit (4) has a weighing system which measures the accurate amount of material distributed through the material distribution outlet (44).

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7. Bulk conveying system according to any one of claims 1 to 5, wherein each distribution unit (4) has a material demand switch or panel, by means of which a desired amount of material can be preset and the distribution unit (4) can be controlled  
10 in such a way that the desired amount of material is distributed through the material distribution outlet (44).

8. Bulk conveying system according to any one of claims 1 to 7, wherein each of the distribution pipes (3) comprises

15 a) a valve portion (32) forming that end of the distribution pipe (3) which joins the main conveying pipe (2) and comprising the distribution valve (31), and

b) a distribution unit portion (33) forming that end of the distribution pipe (3) which end joins the distribution unit  
20 (4), being disconnectably coupled to the valve portion (32) and being substantially longer than the valve portion (32).

9. Bulk conveying system according to any one of claims 1 to 8, wherein the main conveying pipe (2) is formed of

25 a) a hydrant portion (22) forming that portion of the main conveying pipe (2) where the distribution pipes (3) are joined, and

b) a conveying portion (23) forming that portion of the conveying pipe (2) which extends between the container (1) and  
30 the hydrant portion (22), and being disconnectably coupled to the conveying portion (23).

10. Bulk conveying system according to claim 9, wherein the hydrant portion (22) is formed as one piece comprising a main  
35 pipe portion, joining pipe portions laterally protruding from





the main pipe portion at different longitudinal positions of the main pipe portion, and a connection flange (223) at each free end of the main pipe portion and the joining pipe portions.

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11. Bulk conveying system according to claim 9, wherein the hydrant portion (22) is designed in modular system and comprises a plurality of hydrant elements (224), each hydrant element (224) of which having a main pipe portion, a joining  
10 pipe portion laterally protruding from the main pipe portion and a connecting flange (223) at each of the free ends of the main pipe portion and the joining pipe portion, the hydrant elements (224) being joined so as to form a row, wherein pairs of the connecting flanges (224) at the free ends of the main  
15 pipe portions are disconnectably joined to each other.

12. Bulk conveying system according to any one of claims 1 to 11, wherein a plurality of conveying units are connected to the container (1), each conveying unit of which comprising a  
20 conveying pipe (2), a plurality of distribution pipes (3) and a plurality of distribution units (4).

13. Use of the bulk conveying system according to any one of claims 1 to 12 for conveying a construction material to  
25 different locations of the construction site, especially to different levels of a building under construction.

14. Use according to claim 13, wherein a dry construction material, especially dry cement or dry mortar, is used as  
30 construction material.

15. Method for controlling a bulk conveying system for conveying bulk material from a container to a plurality of distribution units comprising the steps of



a) detecting in each of the distribution units whether or not the actual stock level of bulk material in the distribution unit is equal to or falls below a predetermined minimum stock level, and whether or not the actual stock level of bulk material in the distribution unit is equal to a predetermined maximum stock level,

b) sequentially receiving detected values from each of the distribution units,

c) if a detected value is received from one of the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level,

c1) checking whether or not presently bulk material is being conveyed to any of the distribution units, and,

c2) if it is found that presently bulk material is being conveyed to none of the distribution units, controlling the bulk conveying system in such a manner that the conveying of bulk material to said one distribution unit is started,

d) if a detected value is received from one of the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to the predetermined maximum stock level,

d1) checking whether or not presently bulk material is being conveyed to said one distribution unit, and,

d2) if it is found that presently bulk material is being conveyed to said one distribution unit, controlling the conveying system in such a manner that the conveying of bulk material to said one distribution unit is stopped, and

d3) checking a queue of distribution units to be replenished whether the queue presently comprises another distribution unit, and,

d4) if it is found that the queue presently comprises a distribution unit, controlling the conveying system in such a manner that the conveying of bulk material to the





distribution unit being the next in the queue is started and deleting the distribution unit from the queue.

16. Method for controlling a bulk conveying system according to  
5 claim 15, wherein, after receiving a detected value from one of  
the distribution units indicating that the actual stock level  
of bulk material in said one distribution unit is equal to or  
falls below the predetermined minimum stock level, after  
checking whether or not presently bulk material is being  
10 conveyed to any of the distribution units and after finding  
that presently bulk material is being conveyed to any of the  
distribution units,

a) it is checked whether or not presently bulk material  
is being conveyed to the one of the distribution units,  
15 and,

b) if it is found that presently bulk material is being  
conveyed to the one of the distribution units, the  
conveying system is controlled in such a manner that the  
conveying of bulk material to that one of the distribution  
20 units is continued, and,

c) if it is found that presently bulk material is not  
conveyed to the one of the distribution units, said one  
distribution unit is placed at the end of the queue of  
distribution units to be replenished if said one  
25 distribution unit is not yet in the queue.

17. Method for controlling a bulk conveying system according to  
claim 15, wherein

a) for each of the distribution units the exact value of  
30 the actual stock level of bulk material is detected, and

b) after receiving a detected value from one of the  
distribution units indicating that the actual stock level of  
bulk material in said one distribution unit is equal to or  
falls below the predetermined minimum stock level and after





finding that presently bulk material is being conveyed to any of the distribution units,

b1) it is checked, which of the distribution units has the lowest actual stock level,

5        b2) the conveying system is controlled in such a manner that bulk material is being conveyed to that one of the distribution units which has the lowest actual stock level, and

10        b3) any other one of the distribution units which has an actual stock level which is equal to or falls below the predetermined minimum stock level is placed in the queue of distribution units to be replenished, wherein the position number in the queue is the lower the lower the actual stock level is.



Abstract**Bulk conveying system and method of controlling a bulk conveying system**

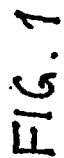
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The bulk conveying system comprises a container (1) for storing bulk material having a bulk inlet (11) and a bulk outlet (12). A main conveying pipe (2) connected to the bulk outlet (12) of the container (1) has a pump (21) for driving the bulk material through the main conveying pipe (2). Each one of a plurality of distribution pipes (3) is connected to the main conveying pipe (2) and has a distribution valve (31) for opening and closing it. Each one of a plurality of distribution units (4) has a distribution unit container (41), an inlet (42) connected to the main conveying pipe (2) through a corresponding one of the distribution pipes (3), a material distribution outlet (44) and a stock level detector (43). The stock level detector (43) detects whether or not the actual stock level in the distribution unit container (41) is equal to or falls below a predetermined minimum stock level and whether or not it is equal to a predetermined maximum stock level. A conveyance control system (5) sequentially receives detected values from the stock level detector (43) of each of the distribution units (4) and controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values. The control is carried out in such a manner that bulk material is being conveyed from the container (1) to the distribution unit container (41) of one of the distribution units (4).

Figure 1

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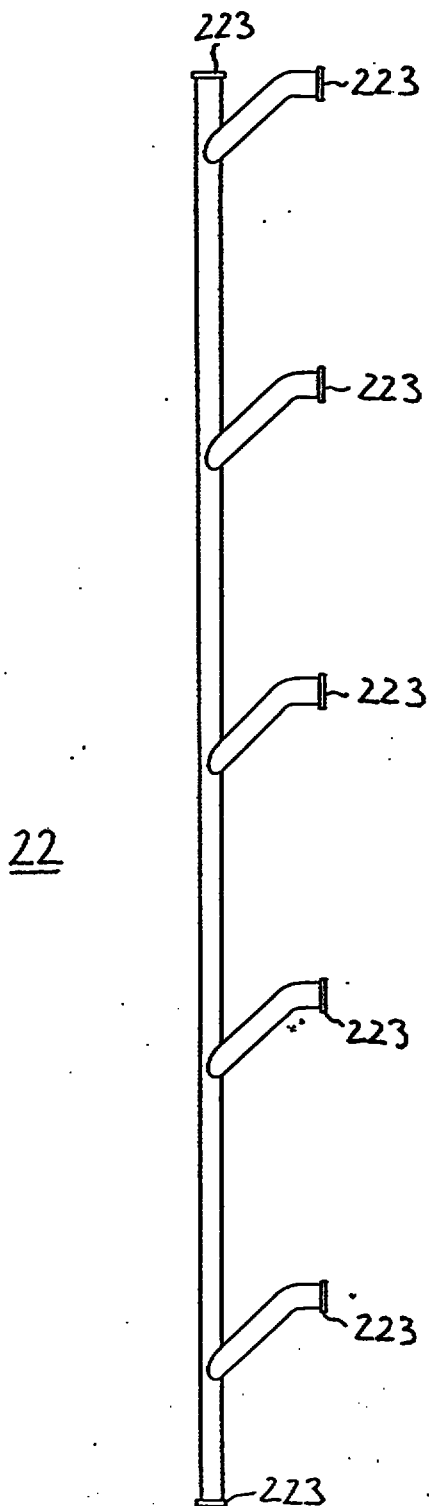


FIG. 2

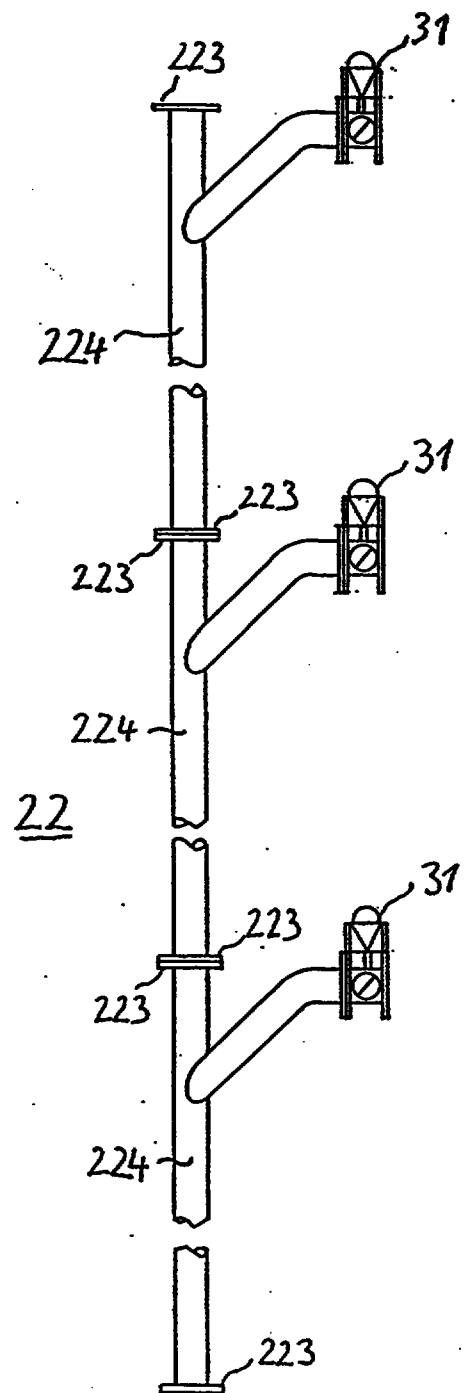


FIG. 3



**Bulk conveying system and method of controlling a bulk conveying system**

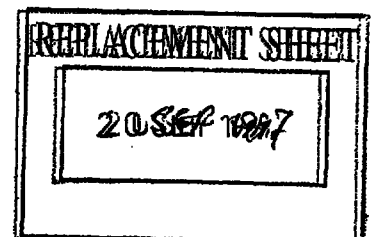
The invention relates to a bulk conveying system for conveying bulk material, especially construction material, to a location where the bulk material is further processed in a previously unknown quantity, for example a work location on a construction site, and to a method of controlling a bulk conveying system.

Wet mortar mix comprising of cement, sand and water, is widely used as a material for construction works. Providing the wet mortar at the actual work location of the construction site requires a lot of work, if the materials are separately carried to the location and mixed on site.

Therefore, conventional systems are provided which store pre-mixed dry mortar, i.e. a mixture of sand and cement, at a silo and pump the pre-mixed dry mortar to a mixer unit where water is added to produce wet mortar. The mixer unit can be installed at the actual work location.

However, the conventional systems are inefficient. Usually, on a construction site construction work is carried out simultaneously at a plurality of locations of the construction site. Construction materials such as cement or mortar are required at different locations at the same time. Therefore, it is necessary that either a plurality of conventional systems is used, or the mixer unit of a single system is moved frequently. Providing a plurality of systems results in high equipment costs and is often impossible due to a lack of space. Frequently moving a single system results in a great amount of work.

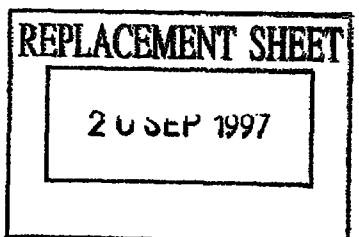
It is an object of the invention to create a bulk conveying system which is appropriate to provide material at various remote locations of the same site at the same time, according



to the actual needs at the particular remote locations, without causing high costs or a great amount of work, and to create a corresponding method of controlling a bulk conveying system.

- 5 According to the invention, the object of the invention is achieved by a bulk conveying system according to claim 1.

The bulk conveying system according to the invention comprises a container for storing bulk material, the container having a  
10 bulk inlet and a bulk outlet. A main conveying pipe connected to the bulk outlet of the container has a pump for driving the bulk material through the main conveying pipe. A plurality of distribution pipes are provided. Each one of the plurality of  
15 distribution pipes is connected to the main conveying pipe and has a distribution valve by means of which the distribution pipe can be opened and closed. Further, a plurality of distribution units is provided. Each one of the plurality of  
20 distribution units has a distribution unit container, an inlet connected to the main conveying pipe through a corresponding one of the distribution pipes, a material distribution outlet and a stock level detector. The stock level detector detects whether or not the actual stock level in the distribution unit  
25 container is equal to or falls below a predetermined minimum stock level and detects whether or not the actual stock level in the distribution unit container is equal to or exceeds a  
predetermined maximum stock level. Further, the material conveying system comprises a conveyance control system which sequentially receives detected values from the stock level  
30 detector of each of the distribution units. The conveyance control system controls the distribution valve of each of the distribution pipes and the pump on the basis of the detected values. The control is carried out in such a manner that, if the actual stock level in the distribution unit container of  
35 any of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is conveyed



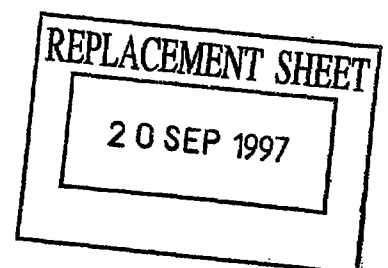
from the container to the distribution unit container of one of the distribution units. The bulk material is conveyed to the distribution unit container of said one of the distribution units, until the actual stock level in the distribution unit container of said one of the distribution units is equal to the predetermined maximum stock level.

In this context said one of the distribution units can be that distribution unit which is just detected to have a low actual stock level, or can be another distribution unit to which material is already being conveyed when the latest detection is made.

Conveying bulk material to the distribution unit container of said one of the distribution units, until the actual stock level in the distribution unit container of said one of the distribution units is equal to the predetermined maximum stock level, does not necessarily mean that the distribution unit container is replenished in one single operation. It is also possible that the replenishing of the distribution unit container is interrupted in order to first convey material to another distribution unit container and is then continued.

In this context, conveying until the actual level is equal to the predetermined maximum stock level can also mean conveying until the actual level slightly exceeds the predetermined maximum stock level. Since the actual stock level might be detected at certain time intervals, it is possible that no detection is made when the actual stock level is equal the predetermined maximum stock level.

By providing the plurality of distribution units it is achieved that bulk material can be conveyed to a plurality of distribution locations, so that e.g. a plurality of work sites on a construction site can be provided with construction



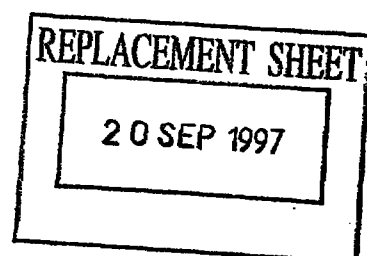
material. Therefore, work can be carried out simultaneously at a plurality of locations even if at all the locations material is required at the same time.

- 5 By providing one distribution unit container for each of the distribution units it is achieved that a certain quantity of material can be stored at each particular distribution location, so that this certain quantity of material can be used instantaneously without requiring any waiting time resulting  
10 from a conveying process. Also, a material buffer is provided, avoiding a shortage of material in periods when more material is taken out from the distribution unit than is conveyed into it.
- 15 By providing one material container and one main conveying pipe for a plurality of distribution units it is achieved that the equipment costs and the space required for the conveying system are kept low. Further, a material mixture such as, e.g., dry mortar or even wet mortar can be premixed and stored in the  
20 container, so that the mixing process can be centralized and, thereby, the productivity can be increased. Further, at the first step material only must be delivered to one location, namely the container. No consideration is required in advance, regarding the question how much material will be taken out at  
25 which work location.

By providing the distribution valves and the pump it is achieved that material can be conveyed independently to each particular one of the distribution units.

30

- By providing a stock level detector in each of the distribution units and the conveyance control system it is achieved that the conveying process is carried out automatically. Further it is achieved that the process is carried out in such a way that the  
35 risk of falling short of material in any of the distribution



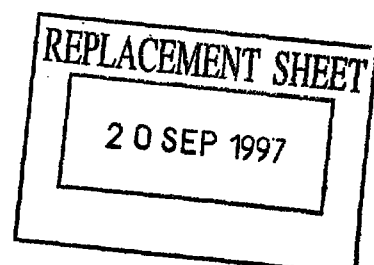
units is minimized. Whenever the actual stock level in the distribution unit container of any of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is conveyed from the container to the distribution unit container of one of the distribution units. That is, the pump is working continuously as long as any actual stock level is lower than targeted, and thereby the pump is used as effectively as possible.

10 It is possible that the conveyance control system receives the detected values from the stock level detector of each of the distribution units continuously or at certain receiving intervals.

15 According to the invention, it is possible that the predetermined minimum stock level is equal to the predetermined maximum stock level. This has the effect that immediately after material has been taken out of a distribution unit the distribution container of which is completely filled, material  
20 is conveyed from the container to the distribution unit. It is preferred, however, that the predetermined minimum stock level is different from the predetermined maximum stock level.

Thereby it is achieved that material is not immediately  
25 conveyed from the container to the distribution unit when only a smaller quantity of material has been taken out of the distribution unit container which previously had been completely filled. Thereby the pump does not start and stop frequently to convey small quantities of bulk material, which  
30 can result in a short lifetime for the pump and the whole conveying system.

It is possible that different values for the predetermined minimum stock level are provided for different distribution



units and/or different values for the predetermined maximum stock level are provided for different distribution units.

According to the invention, it is possible that the conveyance control system of the bulk conveying system has any appropriate detailed design providing for the replenishment of the distribution units. According to a preferred embodiment of the invention, however, the conveyance control system controls the distribution valve of each of the distribution pipes and the pump on the basis of the detected values in such a manner that if the actual stock level in the distribution unit container of more than one of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container of that one of the distribution units whose actual stock level was equal to or fell below the predetermined minimum stock level first (first-come-first-serve-mode).

By replenishing the distribution unit container of that one of the distribution units first whose actual stock level was equal to or fell below the predetermined minimum stock level first, it is achieved that a distribution unit is replenished which is very likely to be the first to run completely out of material. In the case that this distribution unit has already run out of material, it is very likely that it is this distribution unit which has already passed the longest waiting time without material. Therefore, it is likely that at this distribution unit no other work is left which can be carried out without a further material supply.

According to another preferred embodiment of the bulk conveying system according to the invention, the stock level detector detects the exact actual stock level in the distribution unit container and the conveyance control system controls the distribution valve of each of the distribution pipes and the

REPLACEMENT SHEET

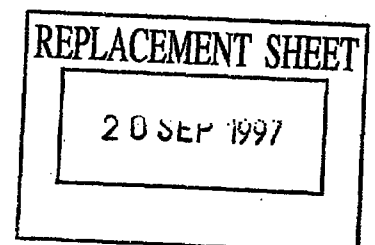
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pump on the basis of the detected values in such a manner that if the actual stock level in the distribution unit container of more than one of the distribution units is equal to or falls below the predetermined minimum stock level, bulk material is  
5 conveyed to the distribution unit container of that one of the distribution units whose actual stock level is the lowest (lowest-level-first-mode).

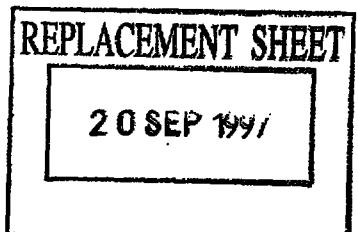
By replenishing the distribution unit container of that one of  
10 the distribution units first whose actual stock level is the lowest, it is achieved that the distribution unit is replenished which is very likely to run completely out of material.

15 Thus it is possible that bulk material is conveyed to the distribution unit container of that one of the distribution units whose actual stock level is the lowest for a predetermined time period, regardless of whether or not in the meantime another container becomes the one with the lowest  
20 stock level. It is further possible to determine the distribution unit to which material is conveyed by considering the material quantity taken out per time from those distribution units having the same level or from those distribution units having an actual stock level lower than the  
25 predetermined minimum stock level.

According to the invention it is possible that the bulk conveying system runs wholly automatically and without any need for operation staff to modify the conveying process. It is  
30 preferred, however, that the bulk conveying system comprises a manual conveyance control switch by means of which the operation of the conveyance control system can be modified or interrupted. Further preferably a conveyance control programming unit having programming keys is provided. It can be  
35 provided, for example, that by means of the manual conveyance



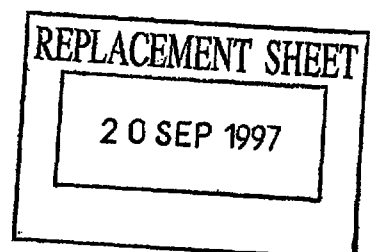
- control switch or the conveyance control programming unit the minimum and/or the maximum predetermined stock level can be changed, the mode of operation can be switched from the first-come-first-serve-mode to the lowest-level-first-mode, one or  
5 more distribution units can be switched off completely, or a termination program for a distribution unit can be started determining a residual quantity to be conveyed to the distribution unit etc.
- 10 By providing an appropriate manual conveyance control switch or the conveyance control programming unit it is achieved that the bulk conveying system can be adapted to the actual needs at the individual construction site.
- 15 According to a preferred embodiment of the bulk conveying system according to the invention each distribution unit has an weighing system which measures the accurate amount of material distributed through the material distribution outlet. Preferably, the weighing system is integrated into the  
20 ditribution unit. Further, preferably the weighing system is formed so that it determines the distributed amount of material exactly enough to fulfill the needs of construction work, especially when the distributed material is sand or cement used to mix mortar. By providing a weighing system in each of the  
25 distribution units it is achieved that optimum doses of material and optimum mixing ratios can exactly be met. Further, the usage rate of the individual distribution unit can be recorded and monitored.
- 30 It is further preferred that each distribution unit has a material demand switch or panel, by means of which a desired amount of material can be preset and the distribution unit can be controlled in such a way that the exact desired amount of material is distributed through the material distribution  
35 outlet.



Preferably an information regarding the material demand preset at the particular distribution unit is sent to the conveyance control system. The conveyance control system then carries out a modified control mode conveying the desired amount of material to the respective distribution unit. In the modified control mode the conveyance control system controls the distribution valves and the pump in such a way that material is conveyed to the respective distribution unit before or without a detection being made whether the actual stock level falls below the predetermined minimum stock level. According to the invention it is possible that the modified control mode is combined with the regular control mode described above in any appropriate way. By using the modified control mode the reaction time achieved with the bulk material conveying system is decreased. The conveying process can be immediately started when the process of distributing material is started at the distribution unit. Thereby a possible future shortness of material in a particular distribution unit is avoided in advance.

The material demand device can e.g. be a switch, wherein each pressing of the switch corresponds to the demand of a certain amount of material, e.g. 50 kg.

According to the invention it is possible that each of the distribution pipes is formed as one piece and is fixed to the main conveying pipe. It is preferred, however, that each of the distribution pipes comprises a valve portion which forms that end of the distribution pipe joining the main conveying pipe and comprises the distribution valve, and a distribution unit portion which forms that end of the distribution pipe joining the distribution unit, which is disconnectably coupled to the valve portion and which is substantially longer than the valve portion.

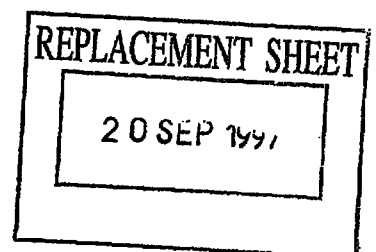


By forming each of the distribution pipes as two pieces, a valve portion and a distribution unit portion disconnectably coupled with each other, wherein the distribution unit portion  
5 being substantially longer than the valve portion, it is achieved that each distribution unit together with the greatest part of the distribution pipe can be disconnected from the main conveying pipe, e.g. for the purpose of installing it at another location. By providing the distribution valve in the  
10 valve portion of the distribution pipe it is achieved that the pipe system which remains when the distribution unit portion is disconnected can be shut down, so that no material flows out. Thereby the flexibility of the system is increased. It is possible to carry out a modification of the pipe system and a  
15 displacement of a distribution unit, while maintaining the operation of the remaining pipe system and the remaining distribution units.

According to the invention it is possible that the conveying  
20 pipe is formed as a one-piece unit. It is preferred, however, that the main conveying pipe comprises a hydrant portion forming that portion of the main conveying pipe where the distribution pipes are joined, and a conveying portion forming that portion of the conveying pipe which extends between the  
25 container and the hydrant portion and being disconnectably coupled to the conveying portion.

Preferably, a conveying pipe valve is provided at the end of the conveying portion close to the hydrant portion, so that the  
30 conveying pipe can be closed.

By forming the conveying pipe as a two-piece unit, i.e. of a conveying portion and a hydrant portion disconnectably coupled with each other, it is achieved that the conveying pipe can be  
35 extended or modified in another way by inserting an additional



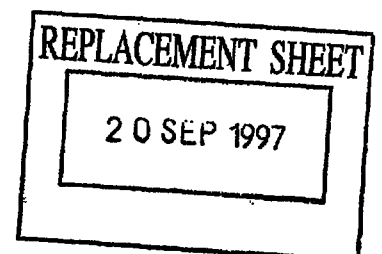
pipe piece in order to displace the locations where the distribution units are arranged. For example, an additional vertical pipe piece can be inserted into the main conveying pipe when the distribution units are to be displaced from the levels one to five of a building under construction to the levels six to ten. Thereby the flexibility of the system is increased. It is possible to carry out a displacement of all the distribution units without modifying the greatest part of the conveying pipe. By providing the conveying pipe valve in the conveying portion it is achieved that the pipe system can be shut for the purpose of inserting an additional pipe piece.

According to the invention it is possible for the hydrant portion to have any appropriate design. According to a preferred embodiment of the invention, however, the hydrant portion is formed as a one-piece unit comprising a main pipe portion, joining pipe portions laterally protruding from the main pipe portion at different longitudinal positions of the main pipe portion, and a connection flange at each free end of the main pipe portion and the joining pipe portions.

By forming the hydrant portion as a one-piece unit it is achieved that the hydrant portion can be shifted or displaced easily as a whole.

Preferably, the hydrant portion comprises a shackle for fixing a shifting device, e.g. a hook of a crane.

According to another preferred embodiment of the invention, the hydrant portion is designed in modular system and comprises a plurality of hydrant elements, each hydrant element of which has a main pipe portion, a joining pipe portion laterally protruding from the main pipe portion and a connecting flange at each of the free ends of the main pipe portion and the joining pipe portion, with the hydrant elements being joined so



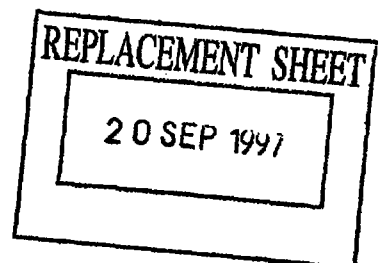
as to form a row, wherein pairs of the connecting flanges at the free ends of the main pipe portions are disconnectably joined to each other.

5 By designing the hydrant portion in modular system it is achieved that the hydrant portion can be modified easily in order to adapt the pipe system after the displacement of one or more of the distribution units. It is, for example, possible to shut down one of the hydrant elements at its joining pipe  
10 portion and, instead, to add a further hydrant element at the free end of the hydrant portion. Thereby it is, for example, possible to displace the plurality of distribution units from the levels one to five of a building under construction to the levels two to six. This can be achieved by just moving the  
15 distribution unit previously located on level one to level six. The operation of the distribution units of levels two to five can be continued during that displacement activity. Hence the hydrant portion designed in modular system serves to increase the flexibility of the conveying system.

20

According to the invention it is possible that the bulk conveying system has only one conveying unit connected to the container and comprising a conveying pipe, a plurality of distribution pipes and a plurality of distribution units. It is  
25 preferred, however, that the bulk conveying system comprises a plurality of conveying units connected to the container, each conveying unit of which comprises a conveying pipe, a plurality of distribution pipes and a plurality of distribution units. Thereby a further increase of the flexibility of the conveying  
30 system is achieved .

According to the invention it is possible that the bulk conveying system is used with any material, e.g. chemicals, oil, hydraulic fluid, sugar etc.. It is also possible to use  
35 the system at any location. It is preferred, however, to use



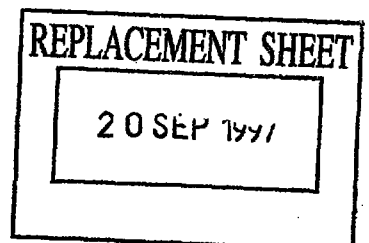
the bulk conveying system for conveying a construction material to different locations of the construction site, especially to different levels of a building under construction.

- 5 According to the invention it is possible that the bulk conveying system is used with any construction material, liquid or solid, e.g. wet mortar, sand etc. It is preferred, however, to use a dry construction material, especially dry cement or dry mortar, as construction material.

10

With respect to the method, the object of the invention is achieved by a method for controlling a bulk conveying system according to claim 13.

- 15 The method for controlling a bulk conveying system for conveying bulk material from a container to a plurality of distribution units comprises the steps of:  
detecting in each of the distribution units whether or not the actual stock level of bulk material in the distribution unit is  
20 equal to or falls below a predetermined minimum stock level, and whether or not the actual stock level of bulk material in the distribution unit is equal to a predetermined maximum stock level; sequentially receiving detected values from each of the distribution units; if a detected value is received from one of  
25 the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level, checking whether or not presently bulk material is being conveyed to any of the distribution units, and, if it is found that presently  
30 bulk material is being conveyed to none of the distribution units, controlling the bulk conveying system in such a manner that the conveying of bulk material to said one distribution unit is started; and, if a detected value is received from one of the distribution units indicating that the actual stock  
35 level of bulk material in said one distribution unit is equal

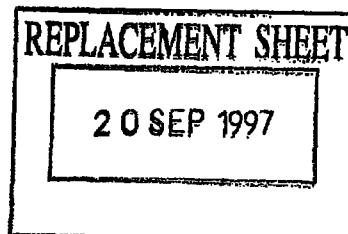


to the predetermined maximum stock level, checking whether or not presently bulk material is being conveyed to said one distribution unit, and, if it is found that presently bulk material is being conveyed to said one distribution unit, 5 controlling the conveying system in such a manner that the conveying of bulk material to said one distribution unit is stopped, and checking a queue of distribution units to be replenished whether the queue presently comprises another distribution unit, and, if it is found that the queue presently 10 comprises a distribution unit is in the queue, controlling the conveying system in such a manner that the conveying of bulk material to the distribution unit which is the next in the queue is started and deleting the distribution unit from the queue.

15

According to a preferred embodiment of the invention, after a detected value has been received from one of the distribution units indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the 20 predetermined minimum stock level, after it has been checked whether or not presently bulk material is being conveyed to any of the distribution units and after it has been found that presently bulk material is being conveyed to any of the distribution units, it is checked whether or not presently bulk 25 material is being conveyed to said one of the distribution units, and, if it is found that presently bulk material is being conveyed to said one of the distribution units, the conveying system is controlled in such a manner that the conveying of bulk material to said one of the distribution 30 units is continued, and, if it is found that presently bulk material is not being conveyed to said one of the distribution units, said one distribution unit is attached at the end to the queue of distribution units to be replenished, if said one distribution unit is not yet in the queue.

35



According to a preferred embodiment of the invention, the exact value of the actual stock level of bulk material in each distribution unit is detected, and after a detected value has been received from one of the distribution units indicating  
5 that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level and after it has been found that presently bulk material is being conveyed to any of the distribution units, it is checked which of the distribution units has the  
10 lowest actual stock level. The conveying system is controlled in such a manner that bulk material is conveyed to that one of the distribution units which has the lowest actual stock level, and any other one of the distribution units which has an actual stock level which is equal to or falls below the predetermined  
15 minimum stock level is placed in the queue of distribution units to be replenished, wherein the position number in the queue depends on the actual stock level. The lower the actual stock level, the lower the position in the queue.

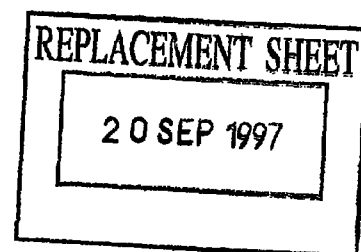
20 Preferred embodiments of the invention are described with reference to the drawing. In the drawing:

Figure 1 shows a schematic view of an embodiment of the bulk conveying system according to the invention being installed on  
25 a building construction site.

Figure 2 is a front view of an embodiment of the hydrant unit of the bulk conveying system according to the invention, wherein the hydrant unit is designed as a one-piece unit.

30

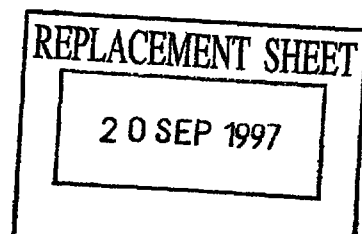
Figure 3 is a front view of an embodiment of the hydrant unit of the bulk conveying system according to the invention, wherein the hydrant unit is designed in modular system.



From figure 1 a bulk conveying system is obvious, which is arranged on a building construction site. A building under construction having eight levels is schematically shown. Besides the building a container 1 for storing bulk material  
5 formed as a silo is arranged. The container 1 has a bulk inlet 11 and a bulk outlet 12. The bulk inlet 11 is connected, through a rubber hose, to a truck supplying fresh material to the container 1.

10 A main conveying pipe 2 is connected to the bulk outlet 12 of the container 1 which is at a distance from the ground. The main conveying pipe is formed by a conveying portion 23 and a hydrant portion 22. The conveying portion 23 extends from the bulk outlet 12 to the ground. In the portion where the  
15 conveying portion 23 meets the ground, the main conveying pipe 2 has a pump 21 which is arranged on the ground and is provided for driving the bulk material through the main conveying pipe 2. The conveying portion 23 further extends along the ground towards the building and is upwardly curved close to the  
20 building. At the position of the curve the conveying portion 23 is anchored by means of a pipe stand. Further, the conveying portion extends upwardly along the building and ends between the third and the fourth level of the building, and close to the end the conveying portion comprises a conveying pipe valve  
25 24.

Above the conveying pipe valve 24 the conveying portion 23 is connected to the hydrant portion 22. The hydrant portion 22 is formed as a one-piece unit and has a main pipe portion  
30 extending vertically along the building and ending at the eighth level of the building. Joining pipe portions protrude laterally from the main pipe portion towards the building. One joining pipe portion protrudes from the main pipe portion at the height of each of the fourth, fifth, sixth, seventh and  
35 eighth level of the building. At each of the joining pipe



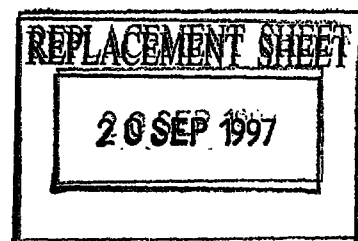
portions of the hydrant portion 22 a distribution valve 31 is provided.

Each of the joining pipe portions provided with the  
5 distribution valve 31 forms a valve portion 32 of a  
distribution pipe 3. Each of the distribution pipes 3 comprises  
the valve portion 32 and a distribution unit portion 33. The  
valve portion 32 and the distribution unit portion 33 are  
disconnectably coupled close to the distribution valve 31. Each  
10 of the distribution unit portions 33 extends parallel to the  
floor of the respective level into the center of the building.

The distribution unit portion 33 of each distribution pipe 3 is  
connected to a distribution unit 4 through an inlet 42 leading  
15 to a distribution unit container 41. At each inlet 42 of a  
distribution unit 4 a further valve is provided. Each of the  
distribution units 4 has a material distribution outlet 44 and a  
stock level detector 43 (only shown schematically). Each of the  
stock level detectors is connected via a data line (not shown)  
20 to a conveyance control system 5 (only shown schematically).

From figure 2 a hydrant portion 22 can be seen more in detail  
which is designed as one piece. The basic shape of the hydrant  
portion 22 is the same as that of figure 1, the difference  
25 being that no distribution valves 31 are provided for the  
hydrant portion 22. The hydrant portion 22 has a main pipe  
portion extending vertically. Joining pipe portions protrude  
laterally from the main pipe portion. A connection flange 223  
is provided at each free end of the main pipe portion and the  
30 joining pipe portions.

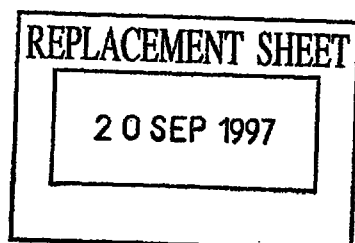
From figure 3 another embodiment of a hydrant portion 22 can be  
gathered in greater detail, which is designed as a modular  
system. The hydrant portion 22 comprises three hydrant elements  
35 224 which all have the same design. Each hydrant element 224



has a main pipe portion. A joining pipe portion laterally protrudes from the main pipe portion. A connecting flange 223 is provided at each of the free ends of the main pipe portion and the joining pipe portion. Each of the joining pipe portions  
5 comprises a distribution valve 31. Pairs of the hydrant elements 224 are joined, so that the three hydrant elements form a row. Therefore, pairs of the connecting flanges 223 at the free ends of the main pipe portions are disconnectably joined to each other.

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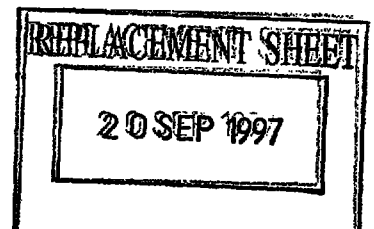
It is a preferred embodiment of the invention to use an embodiment of the method according to the invention in combination with an embodiment of the bulk conveying system according to the invention.





## Claims

1. Bulk conveying system comprising
  - a) a container (1) for storing bulk material, the container
  - 5 (1) having a bulk inlet (11) and a bulk outlet (12),
  - b) a main conveying pipe (2) connected to the bulk outlet (12) of the container (1) and having a pump (21) for driving the bulk material through the main conveying pipe (2),
  - c) a plurality of distribution pipes (3), each distribution
  - 10 pipe (3) of which being connected to the main conveying pipe (2) and having a distribution valve (31) by means of which the distribution pipe (3) can be opened and closed,
  - d) a plurality of distribution units (4), each distribution unit (4) of which having a distribution unit container (41), an
  - 15 inlet (42) connected to the main conveying pipe (2) through a corresponding one of the distribution pipes (3), a material distribution outlet (44) and a stock level detector (43) detecting whether or not the actual stock level in the distribution unit container (41) is equal to or falls below a
  - 20 predetermined minimum stock level and whether or not the actual stock level in the distribution unit container (41) is equal to or exceeds a predetermined maximum stock level,
  - e) a conveyance control system (5) which sequentially receives detected values from the stock level detector (43) of
  - 25 each of the distribution units (4) and controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values such that, if the actual stock level in the distribution unit container (41) of any of the distribution units (4) is equal to
  - 30 or falls below the predetermined minimum stock level, bulk material is conveyed from the container (1) to the distribution unit container (41) of one of the distribution units (4) until the actual stock level in the distribution unit container (41) of said one of the distribution units (4) is equal to the
  - 35 predetermined maximum stock level.





2. Bulk conveying system according to claim 1, wherein the predetermined minimum stock level is different from the predetermined maximum stock level.

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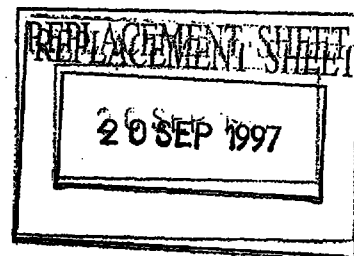
3. Bulk conveying system according to claim 1 or 2, wherein the conveyance control system (5) controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21), on the basis of the detected values in such a manner that, if  
10 the actual stock level in the distribution unit container (41) of more than one of the distribution units (4) is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container (41) of that one of the distribution units (4), the actual stock level  
15 of which was equal to or fell below the predetermined minimum stock level first.

4. Bulk conveying system according to any one of claims 1 to 3, wherein the stock level detector (43) detects the exact actual  
20 stock level in the distribution unit container (41) and the conveyance control system (5) controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values in such a manner that, if the actual stock level in the distribution unit container (41) of  
25 more than one of the distribution units (4) is equal to or falls below the predetermined minimum stock level, bulk material is conveyed to the distribution unit container (41) of that one of the distribution units (4), the actual stock level of which is the lowest.

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5. Bulk conveying system according to any one of claims 1 to 4, comprising a manual conveyance control switch (6) by means of which the operation of the conveyance control system (5) can be modified or interrupted.

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6. Bulk conveying system according to any one of claims 1 to 5, wherein each distribution unit (4) has a weighing system which measures the accurate amount of material distributed through the material distribution outlet (44).

5

7. Bulk conveying system according to any one of claims 1 to 5, wherein each distribution unit (4) has a material demand switch or panel, by means of which a desired amount of material can be preset and the distribution unit (4) can be controlled in such a way that the desired amount of material is distributed through the material distribution outlet (44).

8. Bulk conveying system according to any one of claims 1 to 7, wherein each of the distribution pipes (3) comprises

15 a) a valve portion (32) forming that end of the distribution pipe (3) which joins the main conveying pipe (2) and comprising the distribution valve (31), and

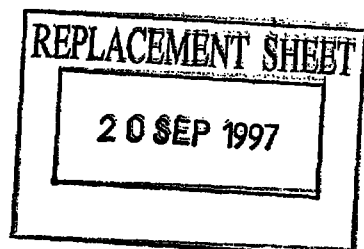
b) a distribution unit portion (33) forming that end of the distribution pipe (3) which end joins the distribution unit 20 (4), being disconnectably coupled to the valve portion (32) and being substantially longer than the valve portion (32).

9. Bulk conveying system according to any one of claims 1 to 8, wherein the main conveying pipe (2) is formed of

25 a) a hydrant portion (22) forming that portion of the main conveying pipe (2) where the distribution pipes (3) are joined, and

b) a conveying portion (23) forming that portion of the conveying pipe (2) which extends between the container (1) and 30 the hydrant portion (22), and being disconnectably coupled to the conveying portion (23).

10. Bulk conveying system according to claim 9, wherein the hydrant portion (22) is formed as one piece comprising a main 35 pipe portion, joining pipe portions laterally protruding from





the main pipe portion at different longitudinal positions of the main pipe portion, and a connection flange (223) at each free end of the main pipe portion and the joining pipe portions.

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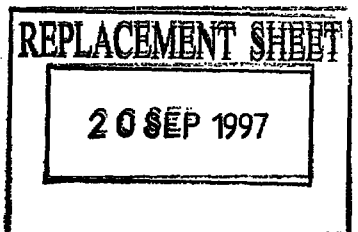
11. Bulk conveying system according to claim 9, wherein the hydrant portion (22) is designed in modular system and comprises a plurality of hydrant elements (224), each hydrant element (224) of which having a main pipe portion, a joining  
10 pipe portion laterally protruding from the main pipe portion and a connecting flange (223) at each of the free ends of the main pipe portion and the joining pipe portion, the hydrant elements (224) being joined so as to form a row, wherein pairs  
15 pipe portions are disconnectably joined to each other.

12. Bulk conveying system according to any one of claims 1 to 11, wherein a plurality of conveying units are connected to the container (1), each conveying unit of which comprising a  
20 conveying pipe (2), a plurality of distribution pipes (3) and a plurality of distribution units (4).

13. Use of the bulk conveying system according to any one of claims 1 to 12 for conveying a construction material to  
25 different locations of the construction site, especially to different levels of a building under construction.

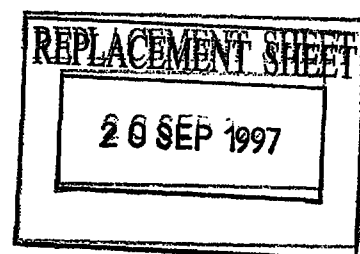
14. Use according to claim 13, wherein a dry construction material, especially dry cement or dry mortar, is used as  
30 construction material.

15. Method for controlling a bulk conveying system for conveying bulk material from a container to a plurality of distribution units comprising the steps of





- a) detecting in each of the distribution units whether or not the actual stock level of bulk material in the distribution unit is equal to or falls below a predetermined minimum stock level, and whether or not the actual stock level of bulk material in the distribution unit is equal to a predetermined maximum stock level,
- b) sequentially receiving detected values from each of the distribution units,
- c) if a detected value is received from one of the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level,
- c1) checking whether or not presently bulk material is being conveyed to any of the distribution units, and,
- c2) if it is found that presently bulk material is being conveyed to none of the distribution units, controlling the bulk conveying system in such a manner that the conveying of bulk material to said one distribution unit is started,
- d) if a detected value is received from one of the distribution units, indicating that the actual stock level of bulk material in said one distribution unit is equal to the predetermined maximum stock level,
- d1) checking whether or not presently bulk material is being conveyed to said one distribution unit, and,
- d2) if it is found that presently bulk material is being conveyed to said one distribution unit, controlling the conveying system in such a manner that the conveying of bulk material to said one distribution unit is stopped, and
- d3) checking a queue of distribution units to be replenished whether the queue presently comprises another distribution unit, and,
- d4) if it is found that the queue presently comprises a distribution unit, controlling the conveying system in such a manner that the conveying of bulk material to the





distribution unit being the next in the queue is started and deleting the distribution unit from the queue.

16. Method for controlling a bulk conveying system according to claim 15, wherein, after receiving a detected value from one of the distribution units indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level, after checking whether or not presently bulk material is being conveyed to any of the distribution units and after finding that presently bulk material is being conveyed to any of the distribution units,

a) it is checked whether or not presently bulk material is being conveyed to the one of the distribution units, and,

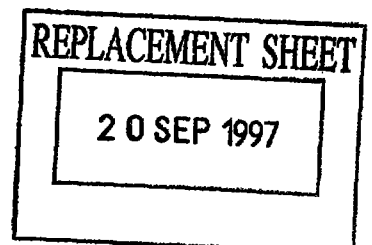
b) if it is found that presently bulk material is being conveyed to the one of the distribution units, the conveying system is controlled in such a manner that the conveying of bulk material to that one of the distribution units is continued, and,

c) if it is found that presently bulk material is not conveyed to the one of the distribution units, said one distribution unit is placed at the end of the queue of distribution units to be replenished if said one distribution unit is not yet in the queue.

17. Method for controlling a bulk conveying system according to claim 15, wherein

a) for each of the distribution units the exact value of the actual stock level of bulk material is detected, and

b) after receiving a detected value from one of the distribution units indicating that the actual stock level of bulk material in said one distribution unit is equal to or falls below the predetermined minimum stock level and after



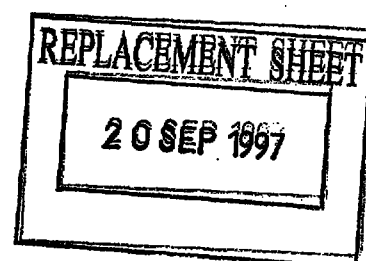


finding that presently bulk material is being conveyed to any of the distribution units,

b1) it is checked, which of the distribution units has the lowest actual stock level,

5           b2) the conveying system is controlled in such a manner that bulk material is being conveyed to that one of the distribution units which has the lowest actual stock level, and

10           b3) any other one of the distribution units which has an actual stock level which is equal to or falls below the predetermined minimum stock level is placed in the queue of distribution units to be replenished, wherein the position number in the queue is the lower the lower the actual stock level is.

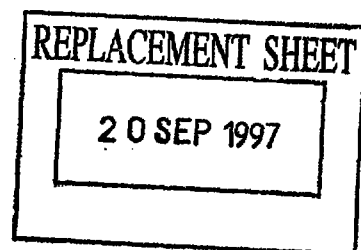


Abstract**Bulk conveying system and method of controlling a bulk conveying system**

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The bulk conveying system comprises a container (1) for storing bulk material having a bulk inlet (11) and a bulk outlet (12). A main conveying pipe (2) connected to the bulk outlet (12) of the container (1) has a pump (21) for driving the bulk material through the main conveying pipe (2). Each one of a plurality of distribution pipes (3) is connected to the main conveying pipe (2) and has a distribution valve (31) for opening and closing it. Each one of a plurality of distribution units (4) has a distribution unit container (41), an inlet (42) connected to the main conveying pipe (2) through a corresponding one of the distribution pipes (3), a material distribution outlet (44) and a stock level detector (43). The stock level detector (43) detects whether or not the actual stock level in the distribution unit container (41) is equal to or falls below a predetermined minimum stock level and whether or not it is equal to a predetermined maximum stock level. A conveyance control system (5) sequentially receives detected values from the stock level detector (43) of each of the distribution units (4) and controls the distribution valve (31) of each of the distribution pipes (3) and the pump (21) on the basis of the detected values. The control is carried out in such a manner that bulk material is being conveyed from the container (1) to the distribution unit container (41) of one of the distribution units (4).

Figure 1



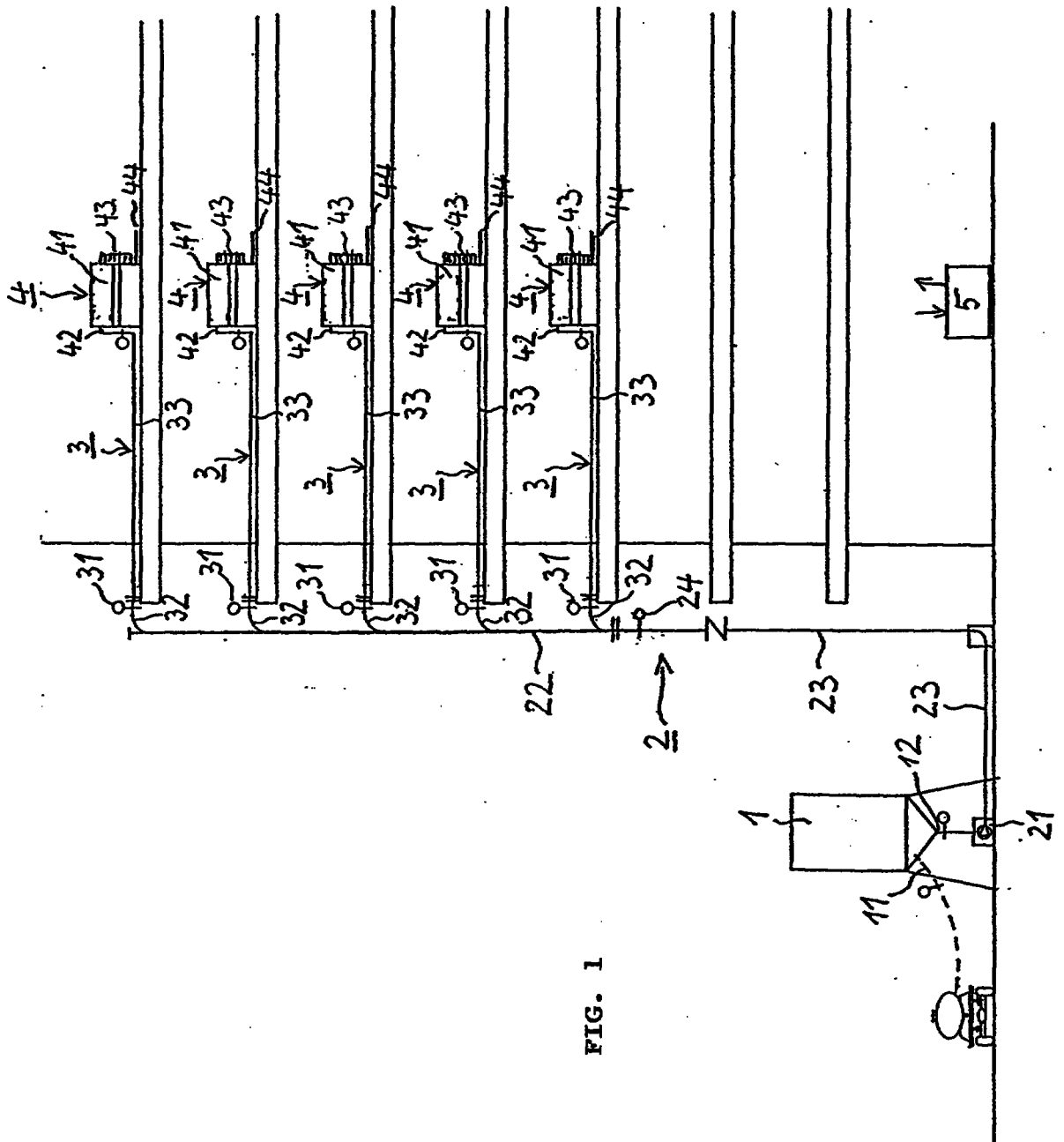


FIG. 1

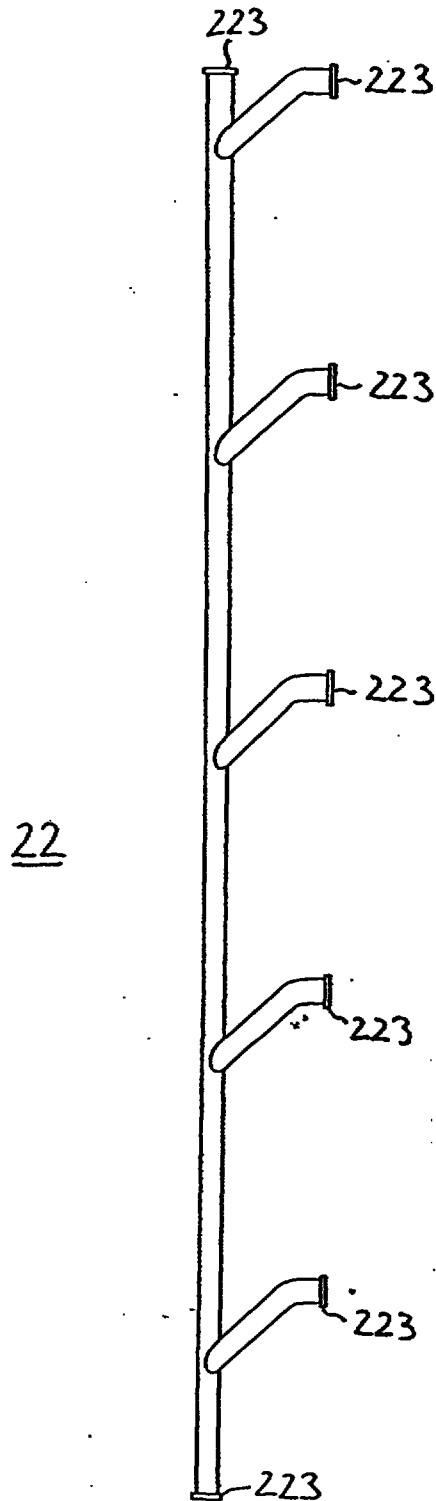


FIG. 2

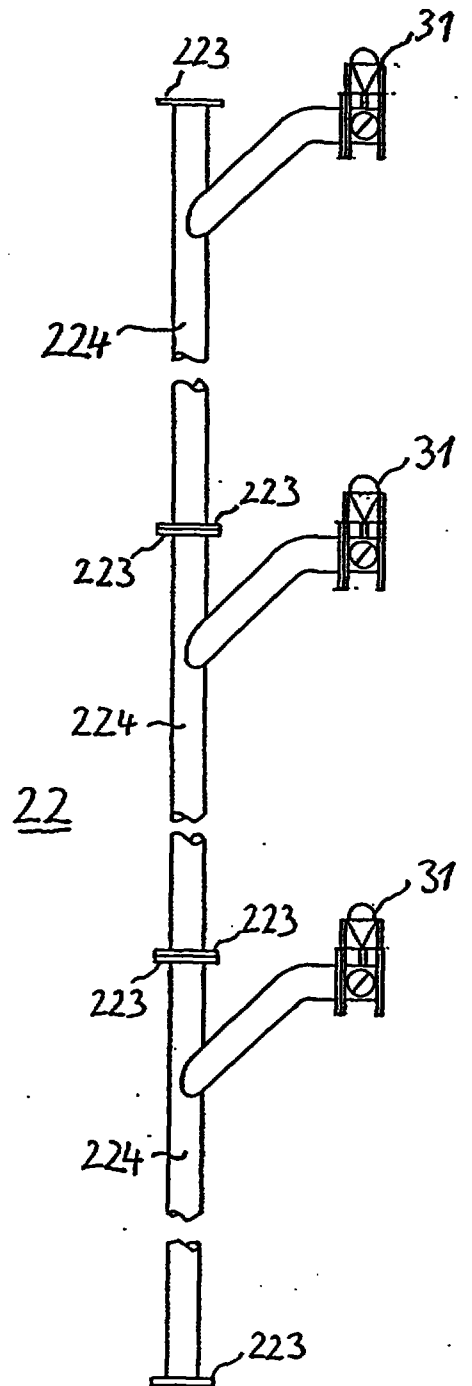


FIG. 3

REPLACEMENT SHEET

20 SEP 1997