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(54) **Pneumatically charged container weighing machine**

(57) Apparatus for pneumatically charging a container weighing machine with loose material from at least one supply container via at least one rigid pneumatic conveyor conduit includes connecting means for ensuring that the conveyor conduit (1) opens at least approximately perpendicularly downwardly into a weighing machine container (2), and a compensation means (6,7) for engaging the weighing machine container (2), the compensation means compensating for upward forces which act on the connecting means and on the weighing machine container (2) in a suction or reduced pressure mode of operation and for downward forces which act in an increased pressure mode of operation.

FIG. 3

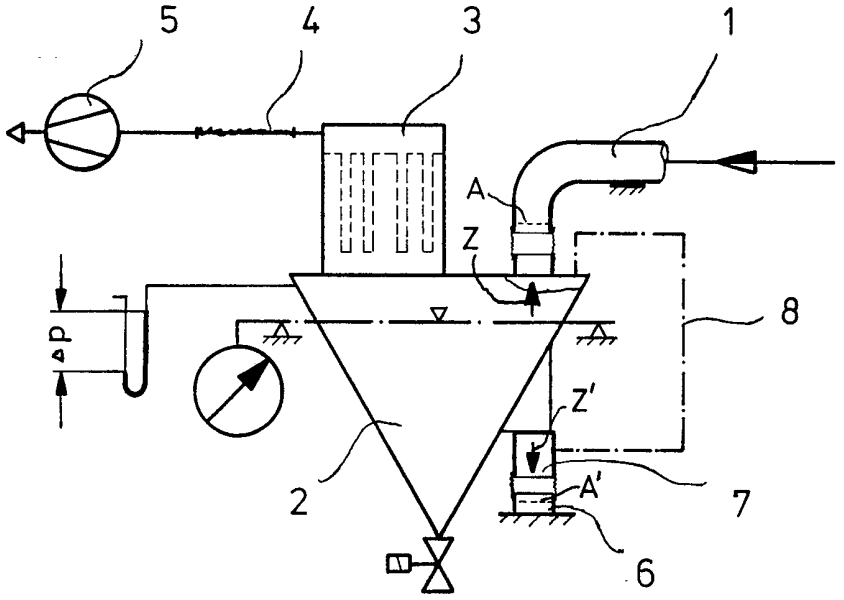

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FIG. 1

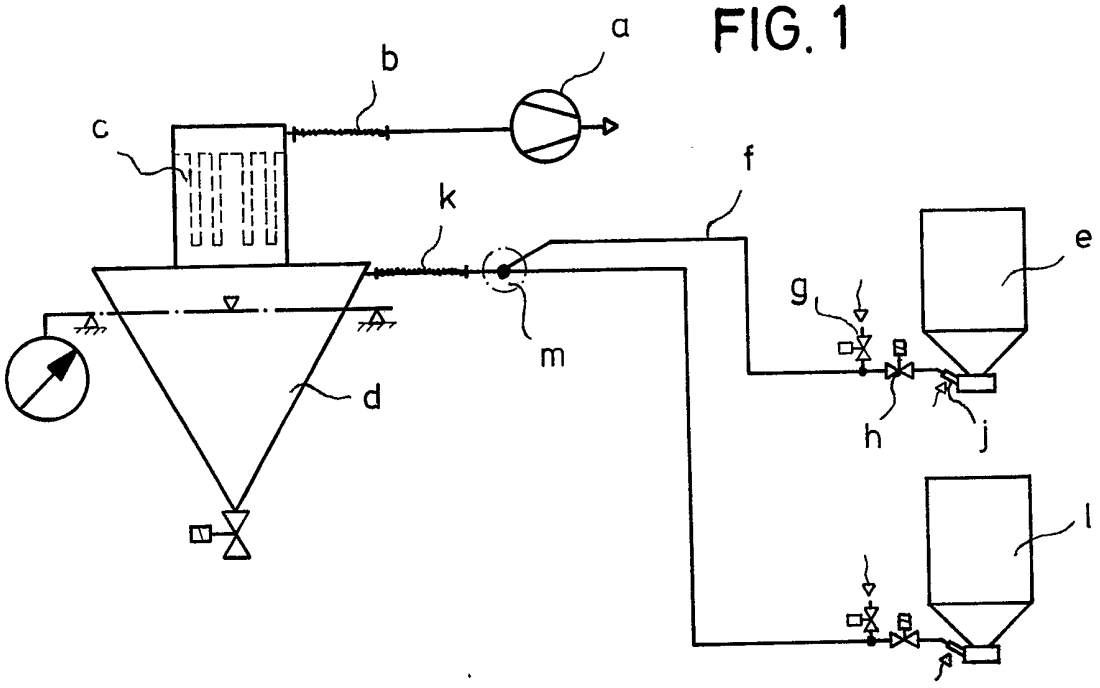


FIG. 2

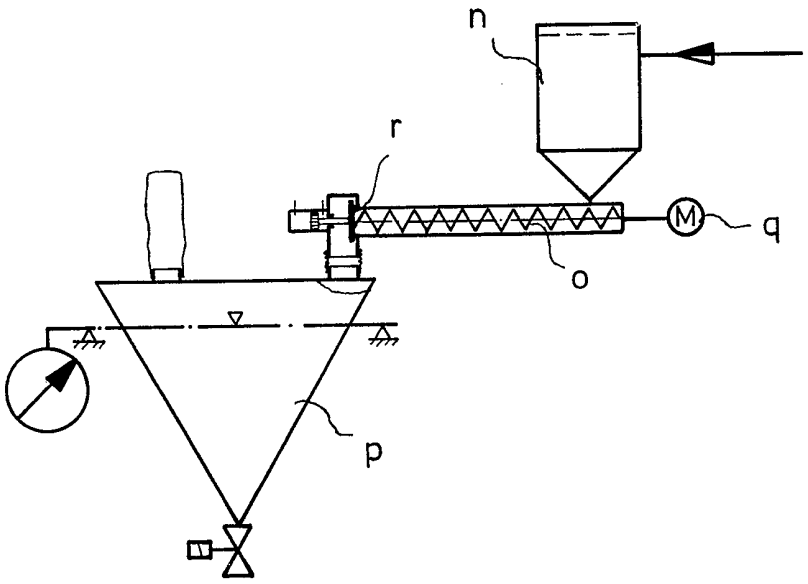


FIG. 3

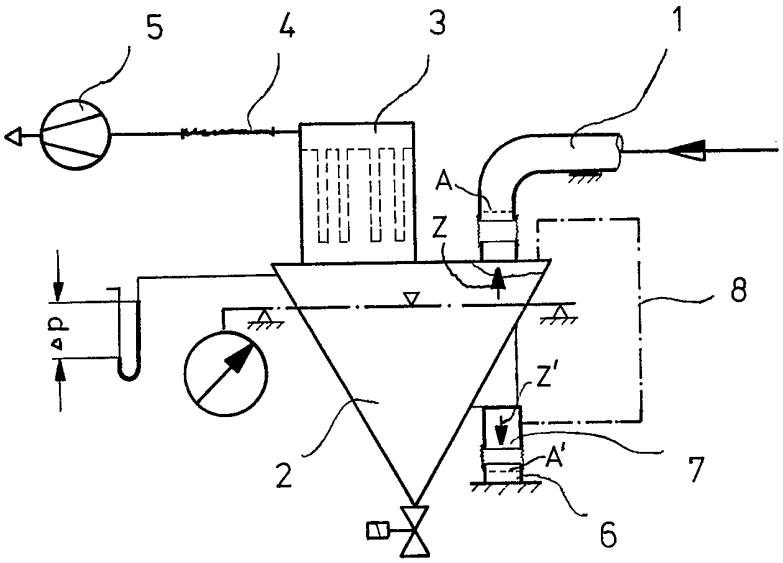


FIG. 3a

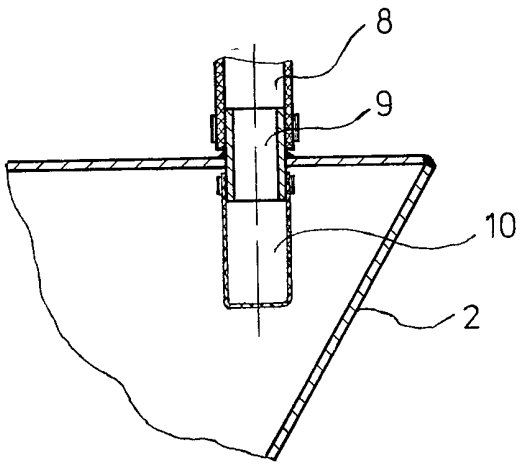


FIG. 4

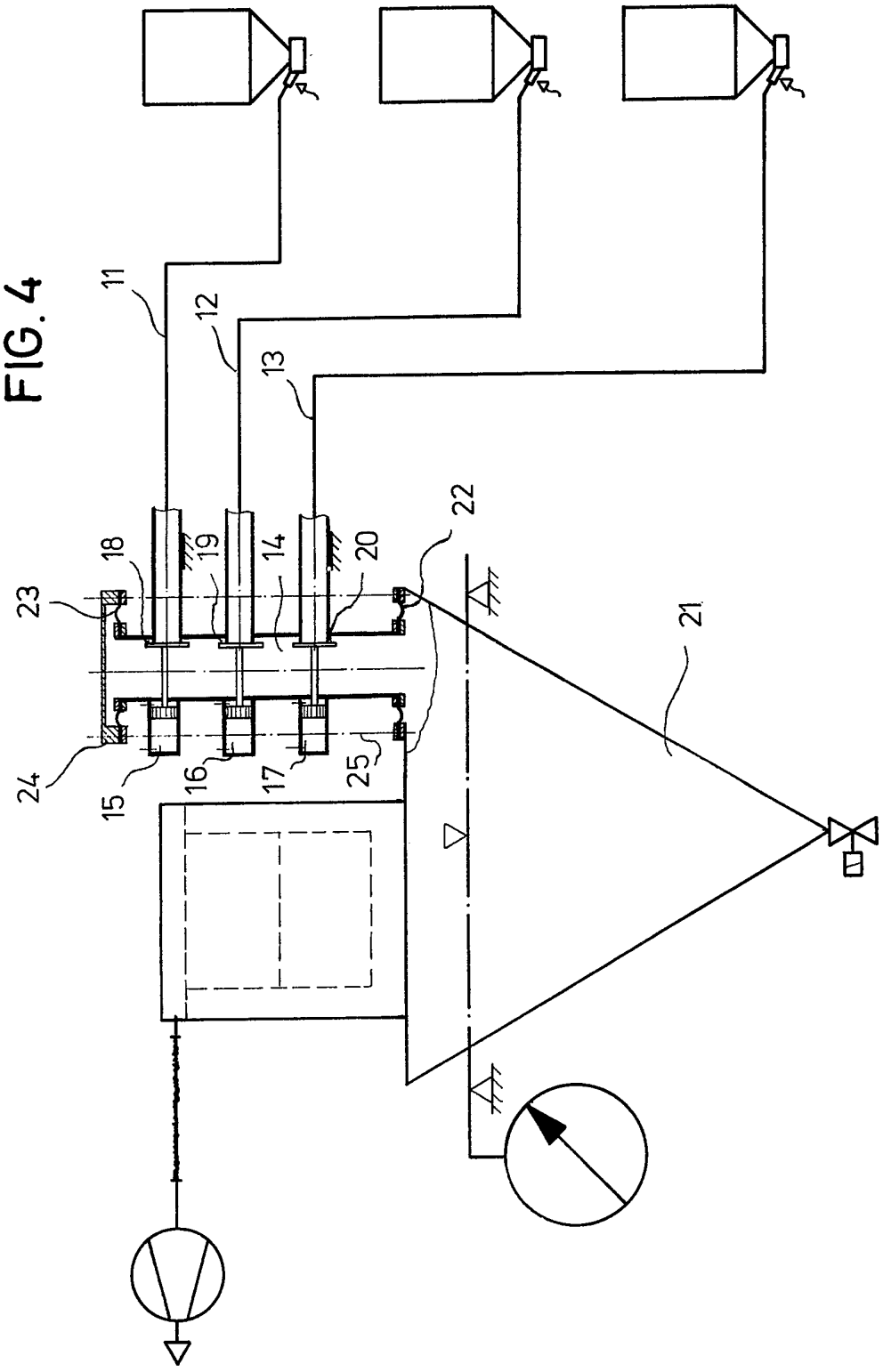


FIG. 5

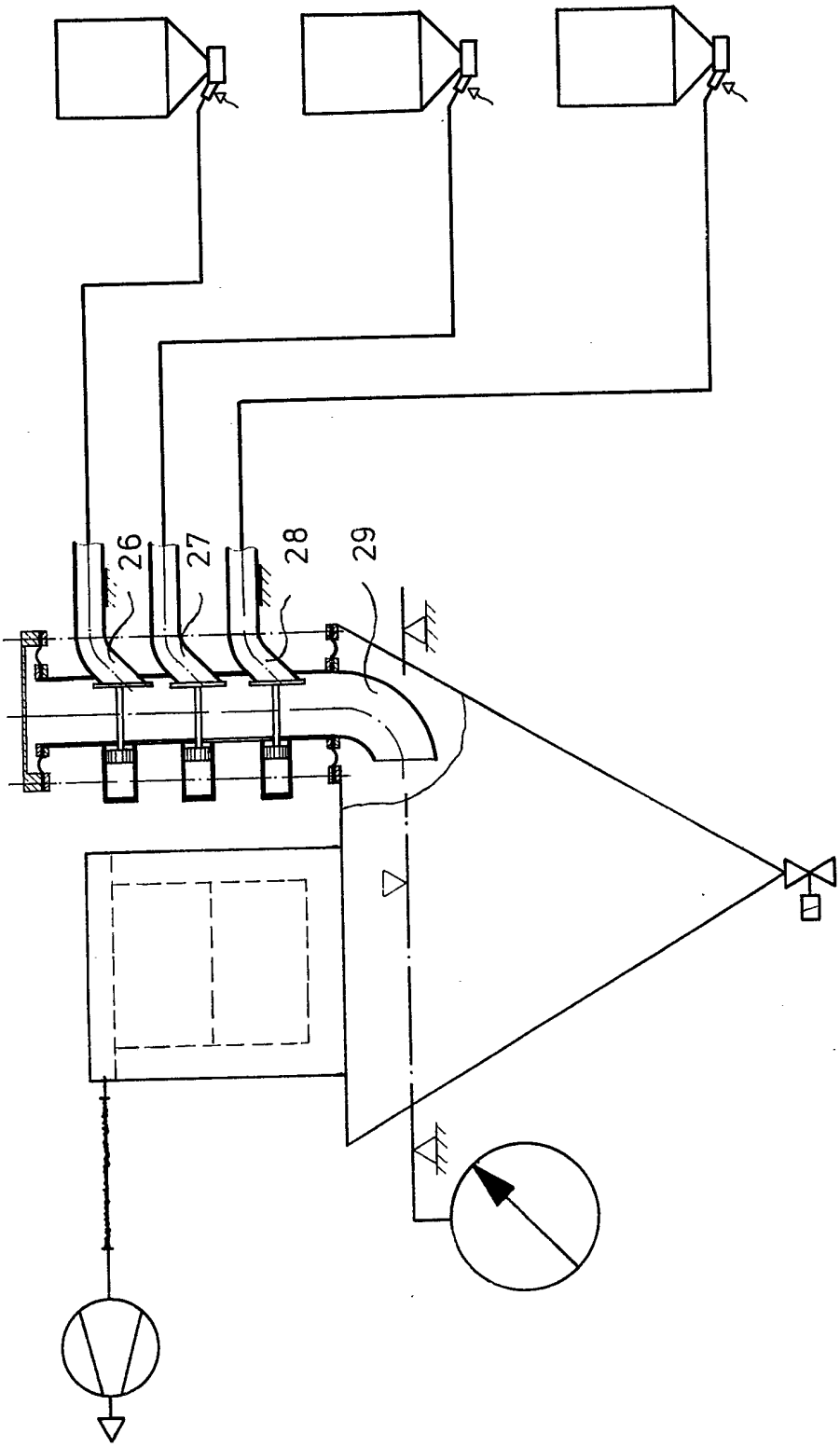


FIG. 6

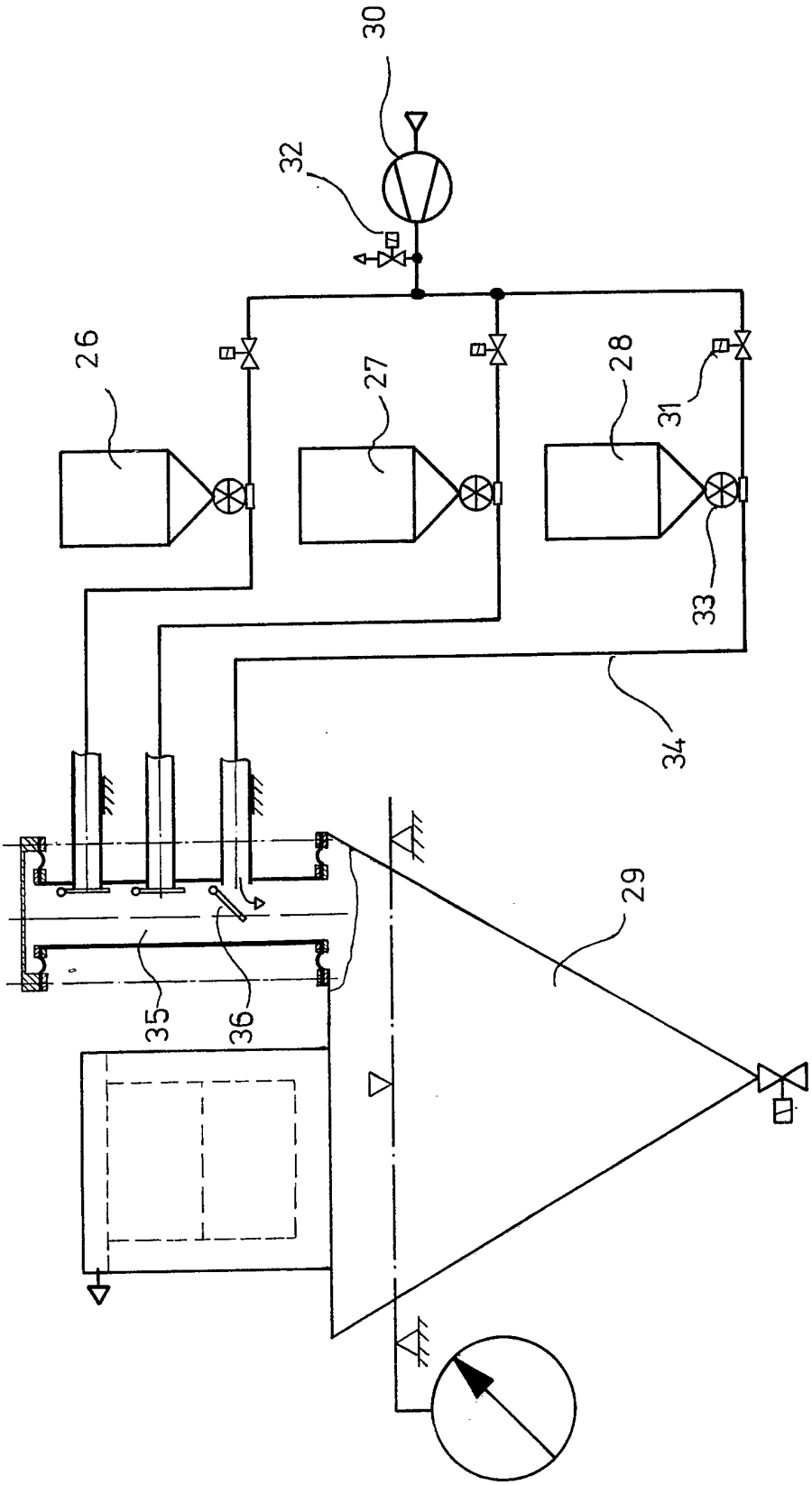
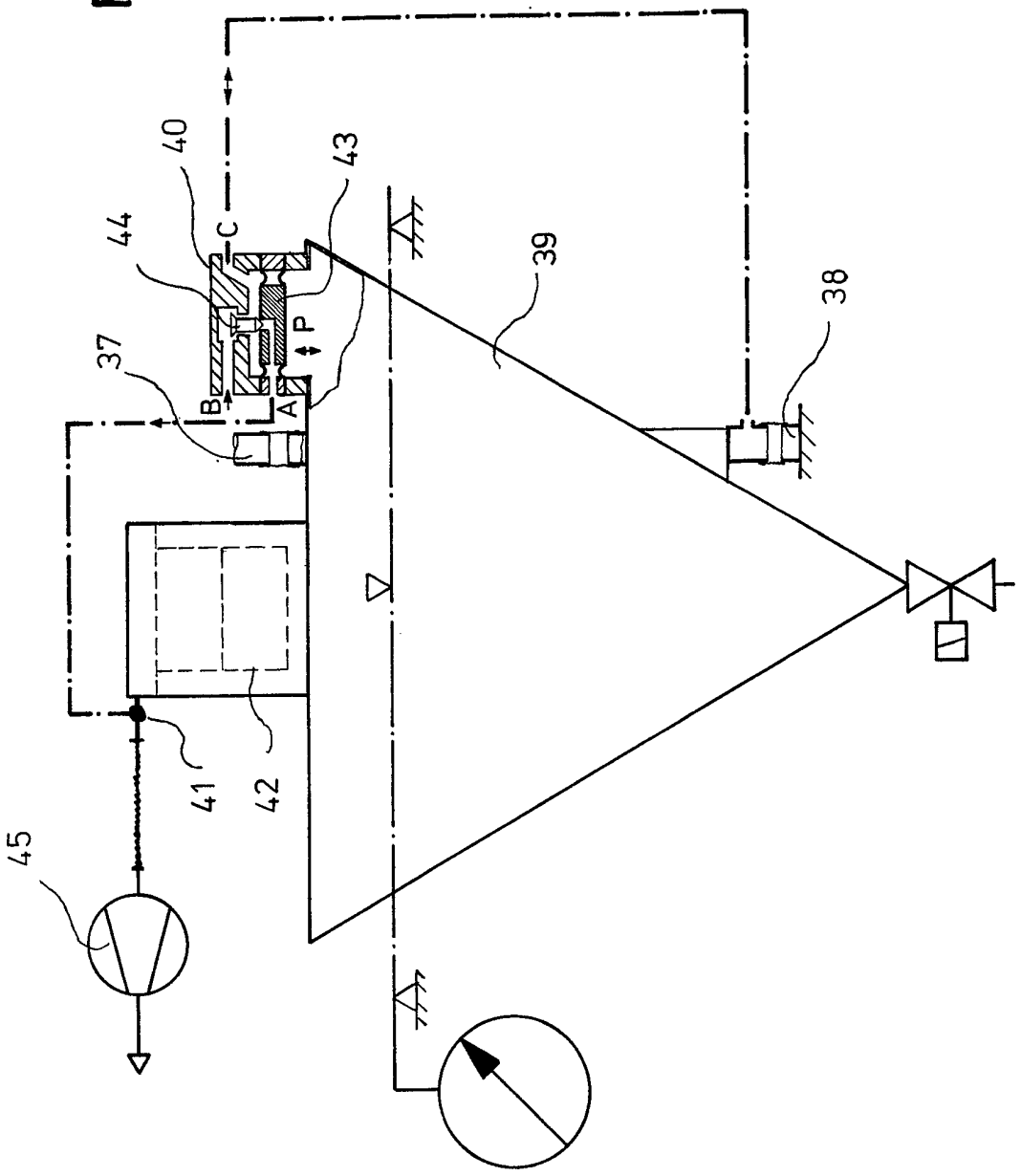


FIG. 7



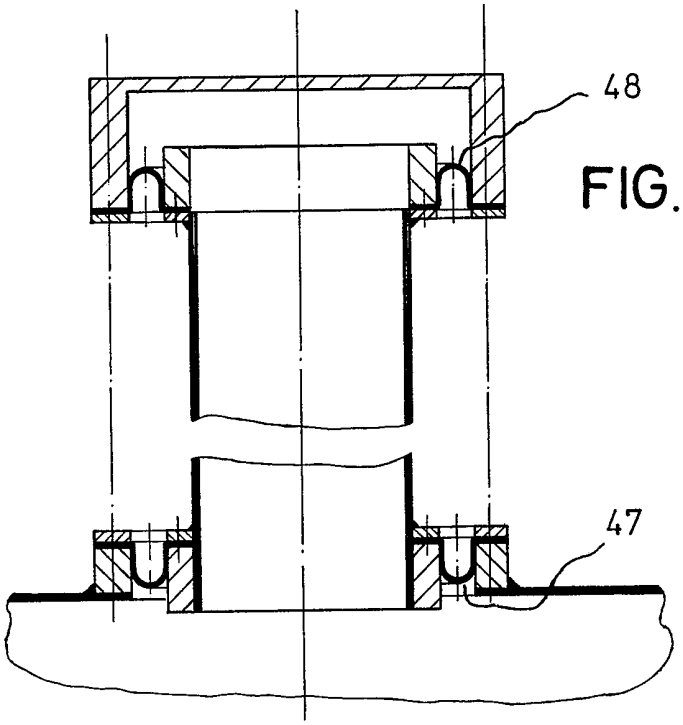


FIG. 8a

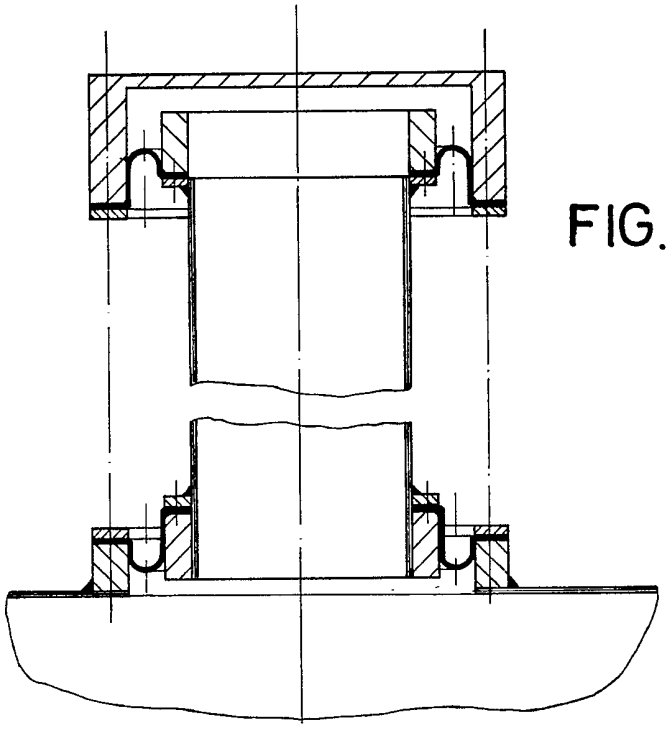


FIG. 8b

SPECIFICATION

Apparatus for pneumatically charging a container weighing machine

This invention relates to apparatus for pneumatically charging a container weighing machine with loose material from at least one supply container, by way of a rigid pneumatic conveyor conduit.

In previously proposed apparatus of this general kind (for example, as disclosed in German patent specification No. 2 034 983, DAS No. 27 33 201 or German patent specification No. 1 556 104), the conveyor conduit is connected to the weighing container by way of a resilient hose, for compensating the thrust force which occurs at the weighing bridge. This is disadvantageous from many points of view. Because of the pressure of vacuum, the wall thicknesses of the hoses used must be relatively thick. This means that the elasticity of the hose connection has an influence on the amount of loose material which is weighed out to form the charge. In addition, hoses of this kind have a different performance from the point of view of resiliency, under pressure conditions or under vacuum conditions, from the performance under no-pressure conditions. Therefore, the weighing machine can be adjusted, if at all, only with great difficulty. Furthermore, in spite of the resilient connection, it is impossible to avoid horizontal pulling forces on the weighing container and, as a consequence thereof, a rotary moment, in operation of the apparatus.

If the proposed apparatus is used for multi-component metering operations, the individual conveyor conduits are brought together before the resilient hose connection to the weighing container. When the desired weight in the container is reached, the conveying action is usually interrupted so that a residual amount of loose material remains in the resilient hose conduit. This residue is then generally conveyed into the weighing container by means of a so-called blow-through operation. In addition to causing time to be lost, this also has a detrimental effect on the accuracy of the weighing operation, for the amount of residual material left in the hose varies from one situation to another. Therefore, subtracting this amount of material, which is referred to as the post-run residue weight, from the overall weight of the components, only gives apparent success.

There is thus a need for apparatus for penumatically charging a container weighing machine with loose material, which permits particularly accurate weighing-out operations.

According to the present invention there is provided apparatus for pneumatically charging a container weighing machine with loose material from at least one supply container via at least one rigid pneumatic conveyor conduit, which apparatus includes connecting means for ensuring that the at least one conveyor conduit opens at least approximately perpendicularly downwardly into a weighing machine container and a compensation means for engaging the weighing machine container, the compensation means being operable to compensate for upwardly directed pulling forces which act on the connecting means and on the weighing machine container in a suction or reduced pressure mode of operation thereof and for downwardly directed pressing forces which act on the connecting means and on the weighing machine container in an increased pressure mode of operation thereof.

This construction provides the advantage that it is possible completely to omit a blow-through operation and the sources of error which that involves, whereby weighing-out operations can be carried out with a degree of accuracy such as is otherwise only possible when using a metering screw arrangement with a coarse flow/fine flow control action.

The same advantage is also achieved if a number of components are to be metered out into the same weighing container. The conveyor conduits corresponding to the individual components then all terminate above the weighing container in the connecting means, preferably in the form of a downpipe, and there have closure flaps or the like so that, when one component reaches the desired weight and the next component is subsequently weighed out, there is no residue of the preceding component left to pass into the weighing container.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows diagrammatically an apparatus with pneumatic conveying means, in a suction or reduced pressure mode, not according to the invention,

Figure 2 shows diagrammatically a container weighing machine with metering action by way of a metering screw, also not according to the invention,

Figure 3 shows a first embodiment of an apparatus according to the invention,

Figure 3a shows a detail of the embodiment of Fig. 3,

Figure 4 shows a second embodiment of an apparatus according to the invention,

Figure 5 shows a third embodiment of an apparatus according to the invention,

Figure 6 shows a further embodiment of an apparatus according to the invention, which is suitable for conveying in an increased pressure mode,

Figure 7 shows a control device for the compensating means for example as shown in Fig. 3, and

Figures 8a and 8b show a development of apparatus according to the invention for example as shown in Fig. 4.

Referring to the example of a known apparatus for pneumatically charging a container weighing machine, shown in Fig. 1, the vacuum required for the conveying operation is produced by a blower *a* which is resiliently connected by way of a connecting hose *b* to a conveyor housing *c* which is screwed to the weighing machine container *d*. The loose material which is stored in a supply container *e* is sucked along for example by way of a conveyor conduit *f*, a secondary or by-passed air valve *g* being closed and a valve *h* in the conveyor conduit being opened. The amount of conveying air required is drawn in by way of the suction intake means *j*. When the component has reached the required weight, less a fixed post-run amount, the valve *h* is closed again and the valve *g* is opened, by the weighing machine control means. This post-suction operation causes the residual amount of loose material which is still in the conveyor conduit *f* to be sucked into the container *d*. The stationary conveyor conduit is connected to the movable weighing container by way of a conveyor hose *k*. After the first component has been metered out, the second component is metered out of the container *l*, in the same manner. The conveyor conduits are desirably brought together upstream of the resilient conveyor hose *k* in a so-called suction collecting switching means *m* which, on the intake side, closes off the actual discharge flows, in the rest condition.

Fig. 2 shows further known apparatus with a screw metering operation which, on the basis of previous experience, provides for an optimum metering action. In such an arrangement, the loose material is generally first conveyed into a so-called day container *n* from which it is then conveyed machanically into the weighing container *p* by means of a metering screw *o*. When the desired weight is reached, a screw motor *q* is switched off and at the same time the screw discharge is closed by means of a compressed air-actuated shut-off flap *r*. When a number of components are to be metered, a plurality of metering screws are generally arranged in a star-like configuration around the weighing container.

Fig. 3 shows a metering apparatus according to the invention for pneumatically charging a container weighing machine with loose material transported by suction. The loose material is metered into a weighing container 2 by way of a rigid conveyor conduit 1 connected by connecting means to the container so that it opens at least approximately perpendicularly downwardly into the container 2. A filter 3 for separating out fine components is installed on the weighing container, the outlet of the filter 3 being connected by way of a resilient connection, for example a hose conduit 4, to a suction blower 5 which produces the required conveying vacuum Δp. As the weighing container is suspended movably, there is a pulling force Z acting with respect to the stationarily disposed conveyor conduit 1. The pulling force increases in proportion to increasing conveyor conduit cross-section A. If for example the conveyor conduit is assumed to have a nominal width of 80cm with a cross-sectional area A of about 50 cm^2 and if the conveying vacuum Δp is reckoned as being 200 mbar, the pulling force Z is $50 \times 0.2 = 10$ kg. As the pulling force Z would result in falsification of the desired weight, a counteracting force Z of equal magnitude is produced. For this purpose, compensation means is provided having a counteracting tube portion 6 of the same cross-section A' as the conveyor conduit 1 disposed stationarily below the container 2. The counteracting force Z' is produced by way of an internal space or vacuum chamber 7 which is fixedly connected to the weighing container 2. The vacuum chamber 7 and the volume of the weighing container are connected together by way of a pressure compensating conduit 8. As dust-laden air is usually to be found in the weighing container and as the accumulation of dust in the tube portion 6 is to be avoided, a connection pipe 9 at the top of the container 2 (see Fig. 3*a*) for the compensating conduit 8 is desirably provided with a filter bag (or a candle-type or plug-type) filter) as indicated at 10. The other end of the tube portion 6 is connectible to a stationary point.

Fig. 4 shows a weighing and metering apparatus according to the invention for three different loose material components, which also operates in a reduced pressure or suction mode. Conveyor conduits 11, 12 and 13 terminate in a so-called suction collecting switching means or connecting means 14. Provided at the end of each conveyor conduit is a closure unit 18, 19 and 20 controlled by compressed air cylinder units 15, 16 and 17. The movable suspended weighing machine container 21 is flexibly connected to the stationarily mounted switching means 14 by way of two compensating diaphragms 22 and 23 forming part of the connecting means.

When a reduced pressure is formed in the container 21 as a result of the suction conveyor operation, as already mentioned, the reduced pressure pulls the container 21 upwardly, with a pulling force Z. In order to compensate for this force a cup-shaped compensating member 24 which is rigidly connected to the weighing container by way of tie bolts 25 is arranged above the switching means 14. As the lift compensating diaphragms 22 and 23 are of germetrically idential configuration, the same pulling force acts downwardly at the diaphragm 22 as the pulling force acting upwardly at the diaphragm 23.

In the embodiment of the invention shown in Fig. 5, intake connections 26, 27 and 28 of the conveyor conduits into the switching means 14 are of a more advantageous configuration, from the point of view of material flow. This apparatus also has a pipe bend 29 at the discharge of loose material from the switching means 14; the pipe bend 29 causes pulse forces caused by the flow of solids-air mixture, which would have an effect in a vertical direction, to be diverted into horizontal direction. This arrangement avoids the weighing operation being detrimentally affected.

Fig. 6 shows an apparatus according to the invention, for an increased pressure mode of operation. The respective loose material components are successively metered into a weighing container 29*a* from respective supply containers 26*a*, 27*a* and 28*a*. A common blower 30 is provided to produce the conveying air flow required. If for example the first component is conveyed from the container 28*a*, then, with the conveyor blower 30 already operating, the conveyor system is actuated for a flow of material, by way of an associated conveyor valve 31, with an air outlet valve 32 being closed at the same time. After a delay period, the metering action in respect of the respective component is effected, for example by way of a bucket wheel-type charging valve 33, discharging material from the container 28*a* into a conveyor conduit 34. A non-return valve 36 is provided at each of the individual conveyor conduit inlets, in a collecting switching means 35. This arrangement is intended to ensure that, when operating other conveyor conduits, back-flow cannot occur, which would result in mixtures being formed in the conveyor conduits in which there was no pressure. When the component reaches the required weight, the conveyor valve 31 is abruptly closed, and at the same time the bucket wheel-type charging valve 33 is switched off and the blow-off value 32 is opened. Subsequently, the second component is metered for example from the container 27*a*, in the same manner.

In the pressure conveying operation, an increased pressure is produced in the weighing container, which means that the situation in regard to forces at the loose material inlet position is the reverse to the situation which occurred in the suction conveying mode. The situation in the pressure conveying mode can also be fully compensated by the apparatus according to the invention.

Fig. 7 shows a further embodiment of the apparatus of the invention with a so-called 1:1-controller which is suitable for heavily dust-laden loose materials. The apparatus operates in the suction mode. A vacuum is built up in the conveying container during the conveying operation. As a conveyor conduit 37 opens into the container vertically, the weighing machine is partly relieved of load, or drawn upwardly. This is counteracted, in accordance with the invention, by for example a compensating means 38 being arranged at the underside of the weighing container. As there must be equality of pressure (vacuum) obtaining both in the compensation means 38 and in the weighing container 39 and as a compensating conduit cannot be installed as a result of the heavy dust charge, the apparatus has a special control means 40. The control means 40 has a connection A which, bypassing the filter pressure drop, is connected to the higher degree of vacuum at a clean air connection 41 of a filter 42 on top of the weighing container. When vacuum occurs in the weighing container 39 as a result of the pneumatic conveying operation, a diaphragm core 43 in the control means is drawn downwardly by a force *P*. This movement results in a gap at the division between the connection A and an outlet C, at a control pin 44. As a result, air coming from C can flow in direction A and thence pass to a suction blower 45. When equal pressures obtain in the compensating means 38 and in the container 39, the diaphragm core 43 is pulled back to its original position. If the reduced pressure in the container 39 decreases, the pressure compensating chamber in the copensating means 38 pulls the diaphragm core 43 upwardly, as a result of its higher vacuum, and in so doing presses the control pin 44 upwardly and in this way opens an opening between the connection C and a further connection B which is connected to free atmosphere. This continues until pressure equality is restored in the system.

A control means of this kind is suitable for pressure conveying. For this purpose, the connection A of the control means 40 remains open and the connection B is connected to the source of pressure air. The control principle is the same, but the pressure conditions obtaining are different.

Figs. 8*a* and 8*b* show a pressure compensating means for apparatus of the invention as has already been described in greater detail hereinbefore with reference to Fig. 2. By making diaphragms 47 and 48 in the form of rolling diaphragms, it is possible for the compensating means of apparatus according to the invention also to be used in relation to weighing machines which have a long stroke. In such machines, the stroke movement from the unloaded condition to the fully loaded condition is several millimetres at the bridge. This is the case in particular in weighing machines with a circular pointer, with a scale range of less than 50 kg.

Fig. 8*a* shows such a machine in the unloaded condition, while Fig. 8*b* shows the same machine in the fully loaded condition. The force compensating action of the compensating means remains the same, due to the

rolling folds of the diaphragms 47 and 48 remaining the same.

CLAIMS

1. Apparatus for pneumatically charging a container weighing machine with loose material from at least one supply container via at least one rigid pneumatic conveyor conduit, which apparatus includes connecting means for ensuring that the at least one conveyor conduit opens at least approximately perpendicularly downwardly into a weighing machine container, and a compensation means for engaging the weighing machine container, the compensation means being operable to compensate for upwardly directed pulling forces which act on the connecting means and on the weighing machine container in a suction or reduced pressure mode of operation thereof and for downwardly directed pressing forces which act on the connecting means and on the weighing machine container in an increased pressure mode of operation thereof.

2. Apparatus according to claim 1, in which the compensation means operates pneumatically.

3. Apparatus according to claim 1 or claim 2, in which the compensation means has an internal space in which the pressure is maintained, in operation of the apparatus, the same as in the weighing machine container.

4. Apparatus according to any one of claims 1 to 3, in which the compensation means has a tube portion which is closed at both ends and which is of the same cross-section as the conveyor conduit and whose internal space in connectible to the interior of the weighing machine container by way of a pressure compensating conduit, which tube portion is connectible at an upper end thereof to the weighing machine container to be axially aligned with the mouth of the conveyor conduit and to be coaxial therewith, and is connectible at another end to a stationary point.

5. Apparatus according to any one of claims 1 to 3, in which the compensating means comprises a suction collecting switching means with connections for connecting to at least two conveyor conduits and a collecting pipe which opens perpendicularly downwardly into the weighing machine container via the connecting means which includes an annular diaphragm by means of which the lower end of the collecting pipe is connected to the weighing machine container with the upper open end of the connection pipe being connected by way of a further annular diaphragm to a cup-shaped compensating top member which is rigidly connectible to the weighing machine container by way of tie bolts.

6. Apparatus according to claim 5, in which the diaphragms are in the form of rolling diaphragms.

7. Apparatus according to claim 5 or claim 6, in which the connections for the conveyor conduits can be closed by means of closure units.

8. Apparatus according to claim 5 or claim 6, in which the connections for the conveyor conduits are passed into the collecting pipe by way of pipe bends and in which the lower end of the collecting pipe goes into a 90° bend.

9. Apparatus according to claim 5 or claim 6 for increased pressure conveying, in which the connections to the collecting switching means can be closed by means of non-return flaps.

10. Apparatus according to any one of claims 2 to 4, in which the interior of the compensating means is connected to one connection (C) of a 1:1-controller which further has a connection (A) connectible to the suction side of a conveyor blower, a connection (B) connected to free atmosphere, and a control means which is connectible to the interior of the weighing machine container.

11. Apparatus for pneumatically charging a container weighing machine with loose material from at least one supply container via at least one rigid pneumatic conveyor conduit, substantially as hereinbefore described with reference to, Figs. 3 and 3*a*, Fig. 4, Fig. 5 or Fig. 6 as modified or not by Figs. 7, 8*a* or 8*b* of the accompanying drawings.

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