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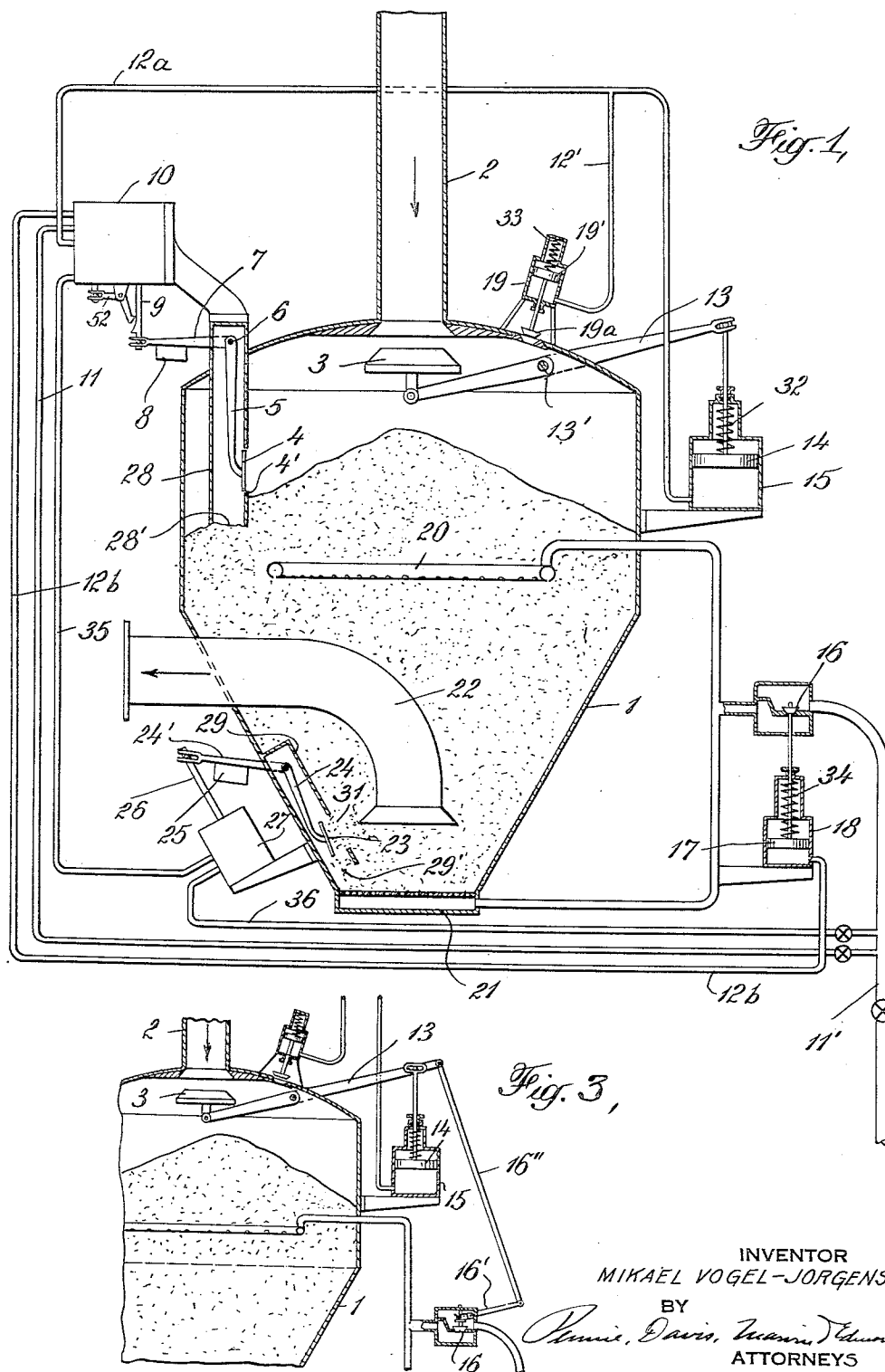
M. VOGEL-JORGENSEN

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PNEUMATIC CONVEYING APPARATUS

Filed March 16, 1938

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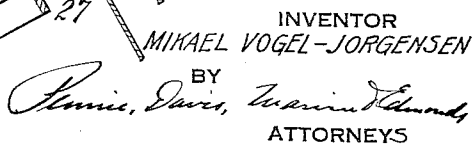


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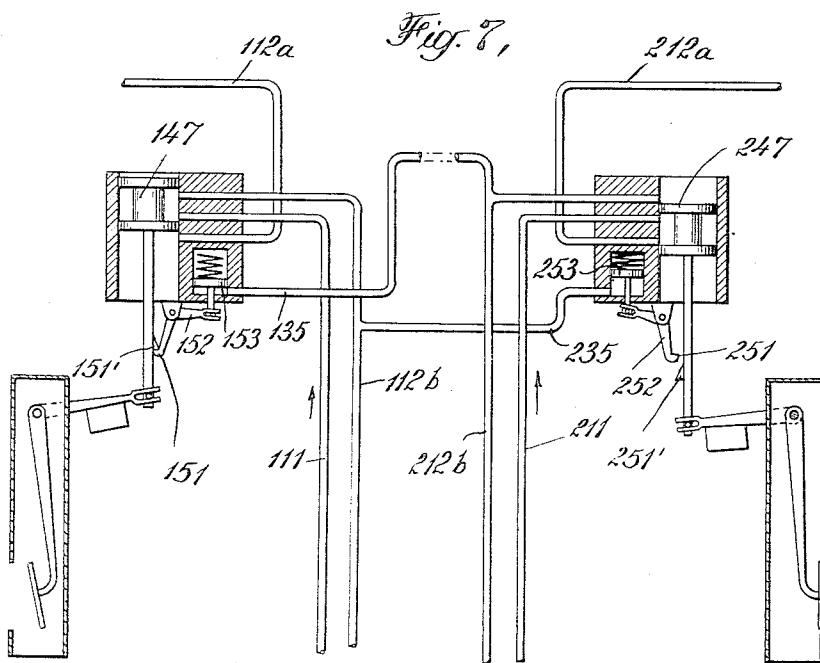
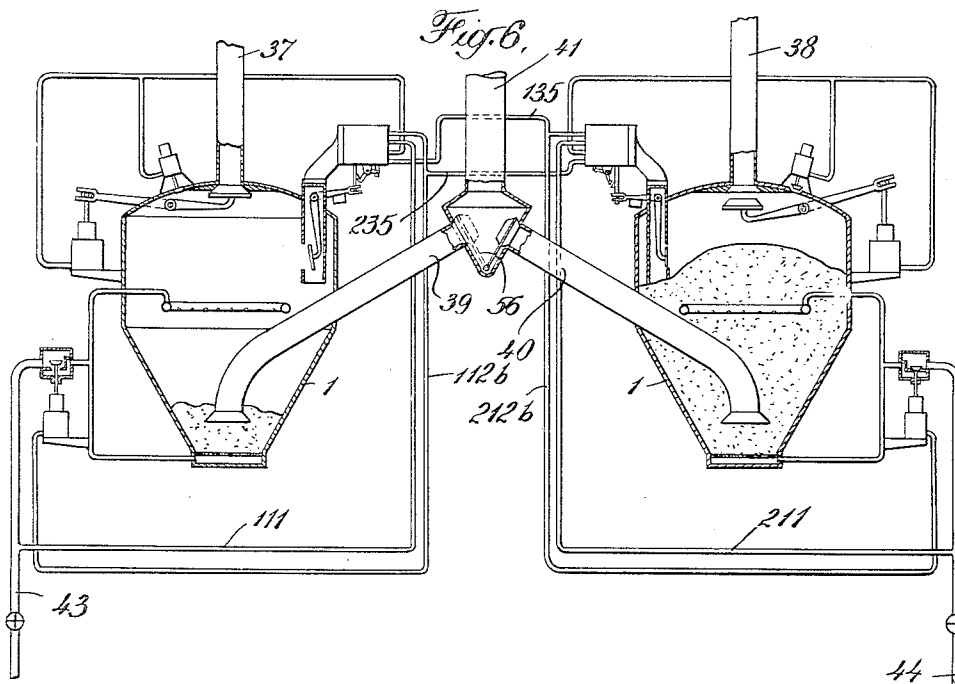
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2,221,741

PNEUMATIC CONVEYING APPARATUS

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Application March 16, 1938, Serial No. 196,168
In Great Britain March 24, 1937

4 Claims. (Cl. 302—53)

This invention relates to apparatus for pneumatically conveying powdered, granular or pulverulent material in a quasi-liquid state of the kind in which the material is admitted to a container in batches and each batch is expelled from it by compressed air.

In apparatus of this kind there is usually an inlet valve for controlling the admission of the material to the container and an air valve for controlling the admission of compressed air to the container. In order that the apparatus may work automatically means must be provided to reverse the valves when the container is full and when it is empty.

According to this invention a so-called top-level indicator, which is biased toward its normal position, is deflected to a second position when the pulverulent material accumulating in the container reaches it and presses upon it. This results in a closing of the inlet valve to stop the supply of pulverulent material, and an opening of the air valve to blow the material from the container through a discharge pipe. The indicator is latched or releasably retained in the deflected position even after the level of the pulverulent material drops below it and until substantially all of the material is discharged from the container, whereupon a bottom-level indicator, which is also biased toward its normal position, and which has been held in a deflected position by the pulverulent material pressing upon it, now moves back to its normal position and this brings about a release of the top-level indicator so that it returns to its normal position and reverses the valves. The releasing of the top-level indicator may be brought about by other predetermined conditions such as the lower air pressure condition which exists in the container when it has been emptied of its pulverulent material, or when two-containers are arranged in parallel so that one is discharging while the other is charging, the release of the top-level indicator in one container to reverse the valves and initiate charging in that container may be brought about when the second container becomes full and when the top-level indicator of the second container moves to its deflected position to close its inlet valve and open its air valve.

Several forms of apparatus constructed in accordance with the invention are illustrated diagrammatically in the accompanying drawings in which:

Figure 1 is a vertical section of a single container having associated therewith both a top-level indicator and a bottom-level indicator for controlling the reversal of the main valves;

Fig. 2 is a schematic view illustrating the operation of the relay or control valves which are actuated by the top level indicator and the bottom level indicator;

Fig. 3 is a vertical section of a portion of the container shown in Fig. 1 illustrating a modification in which the air valve may be mechanically connected with the inlet valve so that when the inlet valve is open the air valve is closed and vice versa.

Fig. 4 is a vertical section of a portion of the container shown in Fig. 1 illustrating a modification in which no bottom-level indicator is employed and the releasing of the top-level indicator is brought about by the lower air pressure condition existing in the container when it has been emptied of its pulverulent material;

Fig. 5 is a vertical section of two containers arranged in parallel and provided with interlock mechanism;

Fig. 6 is a vertical section through two containers arranged in parallel illustrating a modification in which the bottom-level indicator is omitted in each container and the release of the top-level indicator in one container to reverse the valves and initiate charging in that container is brought about when the second container becomes full.

Fig. 7 is a schematic view illustrating the operation of the relay valves of Fig. 6.

Referring first to Figures 1 and 2, the material to be conveyed is fed to the container 1 through a pipe 2 controlled by the inlet valve 3. In the drawings the apparatus is shown in the charging position so that the valve 3 is open.

The top level indicator comprises a plate 4 carried by an arm 5 which is mounted to rock about a pivot 6. An arm 7 moves with the arm 5 and carries a weight 8 which tends to turn the arms 5 and 7 in a counter-clockwise direction and tends to retain the plate 4 in the position shown in Fig. 1 which for convenience will be referred to as its first position. The arm 5 is mounted in a tube or shield 28 which forms a complete enclosure except that it has free communication at its lower end with the interior of the container as indicated at 28'. One lateral wall of the shield 28 is provided with an opening 4' which is substantially closed by the plate 4 when this plate is in its first position. It will now be noted that when the material in the container rises to the level of the plate 4 it exerts pressure only on that side of the plate which faces outwardly from the enclosure, because when the material is rising in the container the plate 4 is rocked before any material can arrive behind it. When the level of the material in the container is at or above the plate 4 the material presses upon it and swings the plate toward the interior of the enclosure to the position shown in Fig. 2 which for convenience will be referred to as its second position. This movement of the plate 4 swings the arms 5 and 7 in a clockwise direction. When the material in the container falls again

during discharging any portion of it which has risen in the shield 28 can readily escape through the freely open lower end of the shield.

The arm 7 is pivotally connected to the rod 9 of a relay slide valve 47 mounted in the casing 10. Rocking of the arms 5 and 7 causes the valve 47 to slide in its casing. In Fig. 2 this valve is shown in the position which it assumes during discharging of the container.

The apparatus illustrated makes use of compressed air for the operation of all the main valves. The relay valve 47 controls the supply of compressed air to the various pistons which operate the main valves. Compressed air is supplied to the casing 10 of the relay valve 47 through a pipe 11 which communicates with the main air conduit 11'. When the container is charging, relay valve 47 is in its lowermost position and then the compressed air leaves the casing 10 of the relay valve through a pipe 12a. The pipe 12a conducts the air to a cylinder 15 in which a piston 14 is moved by the air against the action of a spring 32. The rod of the piston 14 is pivotally connected to one end of a lever 13 which is pivotally mounted intermediate its ends as indicated at 13'. The other end of the lever 13 is connected to the inlet valve 3. When the piston 14 moves upwardly in its cylinder it opens the inlet valve 3 as shown in Fig. 1. Air is also supplied from the pipe 12a to a cylinder 19 through a branch pipe 12'. In this cylinder there is a piston 19' connected to a valve 19a which controls an opening in the container 1. Air supplied to the cylinder 19 moves the piston 19' against the action of a spring 33 thus opening the valve 19a and permitting air to escape from the container during charging.

When the relay valve 47 is moved to the position shown in Fig. 2 the supply of compressed air to the pipe 12a is cut off and this pipe is placed in communication with the atmosphere so that air escapes from the cylinders 15 and 19 thereby allowing the spring 32 to close the inlet valve 3 and the spring 33 to close the air escape valve 19a. The compressed air is then directed by the relay valve 47 through a pipe 12b to a cylinder 18 in which a piston 17 is mounted. The piston 17 is moved by the air pressure against the action of a spring 34 to lift a valve 16 off its seat. When this valve is open compressed air from the main supply conduit 11' passes to a perforated distributing ring 20 positioned in the middle of the container and to a distributor 21 at the bottom of the container. The compressed air thus admitted to the container converts the material into a quasi-liquid state and the pressure that is produced within the container forces the mixture of air and material out of the container through a discharge pipe 22. The air valve 16 is closed by the spring 34 to stop the introduction of air into the container when the relay valve 47 is in its lowermost position in which it places the pipe 12b in communication with the atmosphere.

When the relay valve 47 moves to the upper position shown in Fig. 2 a latch 51 on a bell crank lever 52 engages behind a projection 51' on the valve rod 9 and holds the valve 47 and the plate 4 in the position shown in Fig. 2 until this latch is released. The bell crank lever 52 is connected to a piston 53 operating in a cylinder 53' formed in the casing 10. When air is supplied to the cylinder 53' through a pipe 35 the piston 53 is moved against the action of a coil spring 53'' and thereby swings the bell crank lever 52 in a clockwise direction to release the latch 51. When the

air pressure in the cylinder 53' is released the coil spring 53'' rocks the bell crank lever 52 in an anticlockwise direction so that it will be in a position to engage the projection 51' the next time the valve stem 9 moves upwardly.

In the lower portion of the container there is positioned a bottom level indicator having a plate 23 carried by an arm 24. A tube or shield 29 forms an enclosure which has free communication at its lower end with the interior of the container as indicated at 29'. The lateral wall of the shield 29 is provided with an opening 31 which is substantially closed by the plate 23 when this plate is in its first position. An arm 24' moves with the arm 24 and carries a counterweight 25 which tends to move the arms 24 and 24' in a counter-clockwise direction and thus tends to retain the plate 23 in its first position in which it substantially closes the opening 31. The arm 24' is pivotally connected to the rod 26 of a control valve 48 moving in a cylinder 27. This valve controls the supply of compressed air to the cylinder 53' of the latch mechanism. For this purpose a pipe 36 supplies air to the cylinder 27 from the main air conduit 11'. When the valve 48 is in the position shown in Fig. 2 the cylinder 53' of the latch mechanism is in communication with the atmosphere through the pipe 35 and the exhaust vent 55 in the valve casing 27 thus allowing the latch 51 to assume its operative position. However, when the valve 48 is in its lowermost position the air pipe 36 supplies compressed air to pipe 35 and lifts the piston 53 of the latch mechanism to thereby release the latch 51.

The operation of the particular form of apparatus so far described may be briefly summarized as follows: Assuming that the container is being charged with material, the parts will be in the position shown in Fig. 1 with the inlet valve 3 open to admit the material to the container. The valve 19a will be open to vent the container and permit the escape of air from it. The top level indicator 4 will be in its first position and the relay valve 47 will be in its lowermost position supplying air to the cylinder 19 of the vent valve 19a and to the cylinder 15 which operates the inlet valve. The main air inlet valve 16 will be closed because the cylinder 18 has been placed in communication with the atmosphere by reason of the relay valve 47 being in its lowermost position. The bottom level indicator 23 will be in its second position because the material in the container is pressing upon it and therefore the control valve 48 will be in the position shown in Fig. 2 thereby placing the cylinder 53' of the latch mechanism in communication with the atmosphere allowing the spring 53'' to urge the latch 51 toward the rod 9 of the relay valve 47. When the material in the container reaches the level of the top indicator 4 this indicator will swing to the position shown in Fig. 2 (its second position) thereby moving the relay valve to the position shown in this figure and this results in closing the inlet valve 3, the vent valve 19a and opening the main air valve 16. The latch 51 snaps behind the projection 51' on the valve rod and holds the indicator 4 in the position to which it has been moved until the latch is released as hereinafter described. The compressed air admitted through the distributing ring 20 and the distributor 21 converts the material into a quasi-liquid state and the pressure within the container forces the mixture of air and material through the discharge pipe 22. When the level of the ma-

terial falls below the bottom level indicator 23 this indicator is swung by its weight 25 in a counter-clockwise direction to its first position in which it substantially closes the opening 31 in the shield. This results in a downward movement of the control valve 48 thus admitting compressed air to the cylinder 53' of the latch mechanism and thereby releasing the latch. This permits the weight 8 to swing the top level indicator 4 back to its first position shown in Fig. 1 whereupon the air valve 16 is closed, and the inlet valve 3 and vent valve 19a are opened. When the inlet valve 3 is first opened and enough material accumulates in the bottom of the container 1 to reach the level of the bottom level indicator 23 this indicator is moved back to the position shown in Fig. 1. This exhausts the air from the cylinder 53' of the latch mechanism allowing the latch 51 to resume its operative position so that it can again engage behind the projection 51' when the top level indicator is subsequently deflected upon completion of charging. It will be noted that the control valve 48 operated by the bottom level indicator does not of itself affect the supply of compressed air to the operating means for the valves 3, 16 and 19a but instead it releases the latch mechanism which permits the top level indicator to return to its first position and it is this movement of the top level indicator that directly reverses the valves 3, 16 and 19a.

Fig. 3 shows a modification in which the air valve 16 is operated by a direct mechanical connection from the lever 13 of the inlet valve 3. In this case the air valve 16 is operated by lever 16' connected by a link 16'' to the end of the lever 13. Thus when the inlet valve 3 is opened the air valve 16 is closed and vice versa. When the two valves are thus mechanically interconnected the pneumatic operating means for the valve 16 shown in Fig. 1 at 17-18-34 is omitted and the pipe 12b leading thereto from the casing 10 is also omitted. Otherwise the construction and operation of the modification shown in Fig. 3 is the same as that described above.

Fig. 4 illustrates a modification of the latch mechanism for the top level indicator. In this case after the top level indicator has been deflected by the material and compressed air has been admitted to the container the pressure within the container holds a diaphragm 57 in its raised position thereby lifting an arm 58 which may be pivoted at one end to a stationary bracket as indicated at 59. The free end of the arm 58 carries a hook 60 which engages the arm 7 of the top level indicator and retains it in its raised position until all of the material is discharged from the container. The pressure in the container thereupon drops and permits the diaphragm 57 to return to its normal position thereby lowering the hook 60 and allowing the top level indicator to move back to its first position and reverse the valves. It will be understood that when this type of latch mechanism is employed the bottom level indicator may be dispensed with and the valve casing simplified by omitting the cylinder 53' and its associated parts.

Fig. 5 shows two interconnected containers with the left hand container discharging and the right hand container charging. The material is supplied to the two containers through inlet pipes 37 and 38 respectively and is discharged through pipes 39 and 40 respectively. The discharge pipes 39 and 40 meet at the common discharge pipe 41 and a freely mounted flap valve 56 closes the exit end of either the pipe 39 or 40

depending upon which one is discharging. Compressed air is supplied from the main air conduits 43 and 44. The pipe 112b of the left hand container, which corresponds with the pipe 12b of Fig. 1, does not run directly to the cylinder 118 of the corresponding container but first runs to the neighborhood of the cylinder 218 of the right hand container. At this point a valve 46 controls the flow of air through the pipe 112b. This valve is mounted to move with the main air valve 216 of the right hand container. Similarly a valve 45 is mounted to move with the main air valve 116 of the left hand container and controls the flow of air through the pipe 212b associated with the right hand container.

When the left hand container is discharging, the compressed air and material passing through pipe 39 force the flap valve 56 over to the right hand position and this prevents any material from passing through the pipe 40 into the right hand container. If the left hand container is completely emptied before the right hand container is full the level indicators in it will operate to reverse the valves, and the valve 46 being open (because the main air valve 216 of the right hand container is now closed) nothing will prevent this reversal. Accordingly, both containers will be charging simultaneously for a short time. When the charging of the right hand container is complete there will be nothing to prevent its valves from reversing and it will begin to discharge. However, if the right hand container is filled before the left hand container is completely empty it will be prevented by the valve 45 from immediately beginning to discharge. This valve prevents the compressed air from passing through the pipe 212b to the cylinder 218 until the lower level indicator in the left hand container moves to its first position in which it substantially closes the opening in its shield. This only happens, as previously pointed out, when the container is substantially empty, and when it does happen the main air valve 116 of the left hand container is closed as previously described thereby opening the valve 45 and in consequence the right hand container can begin to discharge.

Thus it will be seen that the valves 45 and 46 and the associated parts constitute interlock mechanism whereby compressed air cannot be admitted to one container to discharge its contents until the other container has been emptied.

Figs. 6 and 7 illustrate an arrangement which may be used when conditions are such that the time required for charging is longer than the time required for discharging. Air is supplied from the main air conduits 43 and 44 by means of pipes 111 and 211 to the relay valves 147 and 247. The pipes 112a, 212a, 112b and 212b have the same purpose as previously described in connection with the other figures. In this form of apparatus the bottom level indicators are omitted and a pipe 135 branches off from the pipe 212b and similarly a pipe 235 branches off from the pipe 112b. With conditions as represented in Figs. 6 and 7 there is no compressed air beneath the piston 153 of the latch mechanism of the left hand container (the pipe 135 being placed in communication with the atmosphere by relay valve 247 of the right hand container). The bell crank lever 152 will be in its operative position with the latch 151 engaging behind the projection 151' on the rod of the relay valve 147, thus securing the level indicator of the left hand container in its deflected position. The piston 253

of the latch mechanism of the right hand container, however, will be in its upper position because compressed air has entered its cylinder through the pipe 235 from the pipe 112b. Thus the bell crank lever 252 will be in a position such that the latch 251 is not allowed to come in contact with the projection 251' on the valve rod of the relay valve 247 when the latter is first moved upward. When the left hand container is completely discharged compressed air only will flow through the discharge pipes 39-41 whereby these pipes will be thoroughly cleaned out. Shortly afterwards the level of the material in the right hand container will reach the level indicator and cause it to turn in a clockwise direction thus moving the relay valve 247 upwardly. Thereupon discharging of the right hand container will begin and compressed air will be admitted through the pipe 135 to the piston 153 of the latch mechanism of the left hand container whereupon this latch mechanism will be released and the level indicator of the left hand container will assume its first position and charging of this container will begin. As soon as the relay valve 147 reaches its lower position the compressed air beneath the piston 253 of the latch mechanism of the right hand container will escape through the pipe 235 and pipe 112b to the atmosphere above the relay valve 147. Consequently the latch 251 on the bell crank lever 252 will then engage behind the projection 251' thereby securing the level indicator of the right hand indicator in its deflected position and preventing it from reassuming its first position when the level of the material drops below the indicator.

It will be seen that in the form of apparatus illustrated in Figs. 6 and 7 when one container has been filled the deflection of the level indicator in that container by the pressure of the material upon it releases the latch mechanism of the level indicator associated with the other container thereby opening the inlet valve of that container and starting the charging operation. In other words, when one container is full it initiates the charging in the other container.

I claim:

1. Apparatus for pneumatically conveying pulverulent material comprising a container, an inlet valve controlling the admission of the material to the container, two members located in the container and adapted to be deflected from one position to a second position when the material in the container presses upon them, one of said members being located in the upper part of the container and serving as a top level indicator and the other being positioned in the lower part of the container and serving as a bottom level indicator, means actuated by the movement of the upper member to control the movement of said inlet valve, means for releasably retaining the upper member in its second position, and means actuated by movement of the lower member to its first position for releasing the upper member.

2. Apparatus for pneumatically conveying pulverulent material comprising a container, an inlet valve controlling the admission of the material to the container, an air valve for controlling the admission of compressed air to the con-

tainer, two members located in the container and adapted to be deflected from one position to a second position when the material in the container presses upon them, one of said members being located in the upper part of the container and serving as a top level indicator and the other being located in the lower part of the container and serving as a bottom level indicator, means actuated by the movement of the upper member to reverse said inlet valve and said air valve, means for releasably retaining the upper member in its second position, and means actuated by movement of the lower member to its first position for releasing the upper member.

3. Apparatus for pneumatically conveying pulverulent material comprising a container, an inlet valve in the upper part of the container adapted in its open position to permit pulverulent material to drop into the container and in its closed position to cut off the supply of the material to the container, a member within the container so mounted as to remain permanently in the upper portion of the container, said member being biased toward one position which it assumes when the material within the container is not pressing upon it and when it is otherwise unrestrained but adapted to be deflected to a second position when the pulverulent material accumulating in the container reaches the member and presses upon it, means actuated by the movement of said member to control the movement of said inlet valve, latch mechanism for retaining said member in its second position while the material is being discharged from the container and after the level of the material drops below the member, and means operating on the latch mechanism under predetermined conditions for releasing it, whereupon said member returns to its first position.

4. Apparatus for pneumatically conveying pulverulent material comprising a container, an inlet valve in the upper part of the container adapted in its open position to permit pulverulent material to drop into the container and in its closed position to cut off the supply of the material to the container, an air valve for controlling the admission of compressed air to the container, a member within the container so mounted as to remain permanently in the upper portion of the container, said member being biased toward one position which it assumes when the material within the container is not pressing upon it and when it is otherwise unrestrained but adapted to be deflected to a second position when the pulverulent material accumulating in the container reaches the member and presses upon it, means actuated by the movement of said member for controlling the movement of the inlet valve for the material and said air valve, latch mechanism for retaining said member in its second position while the material is being discharged from the container and after the level of the material drops below the member, and means operating on the latch mechanism under predetermined conditions for releasing it, whereupon said member returns to its first position.

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