

Aug. 24, 1954

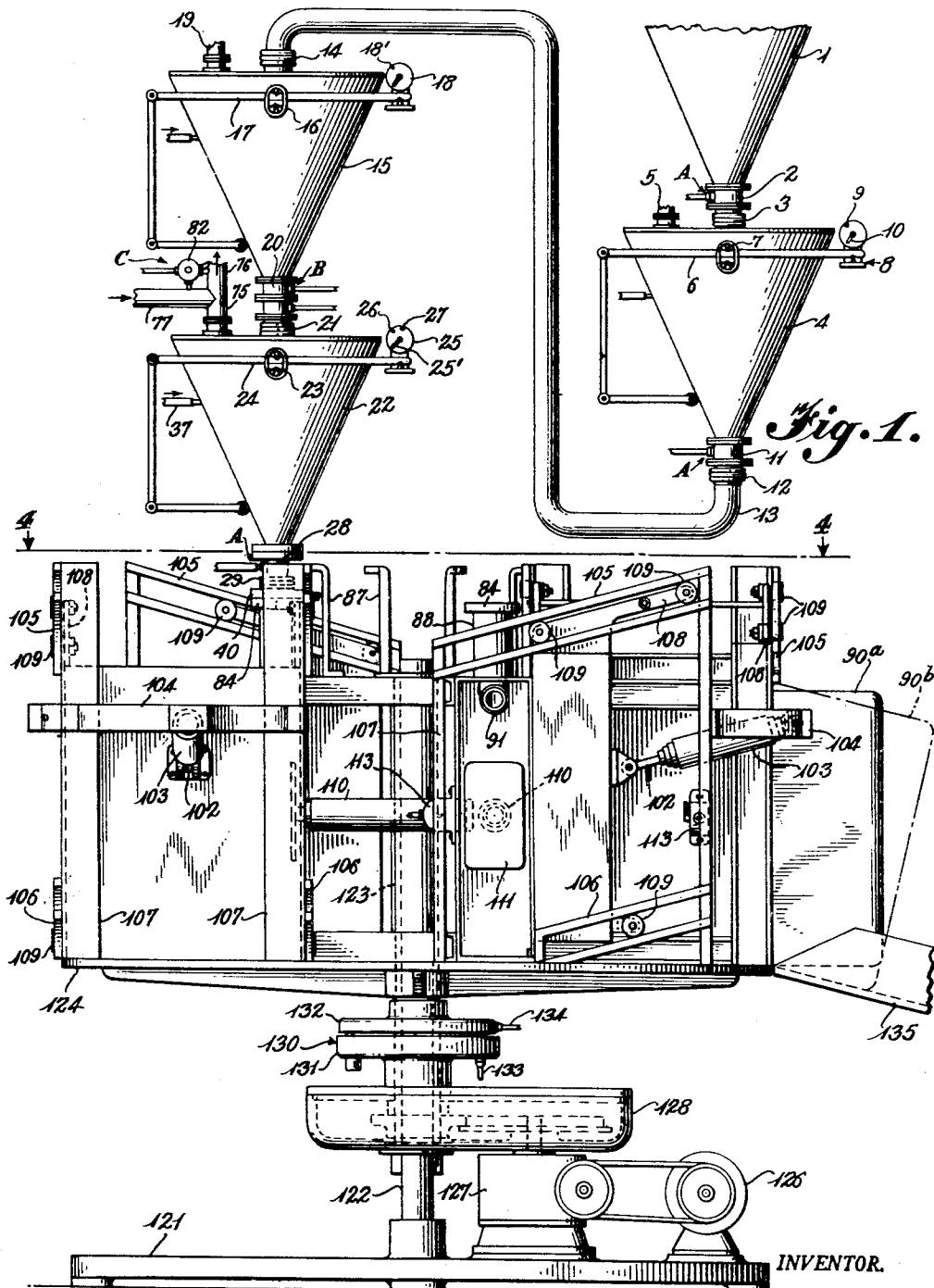
C. F. CARTER

2,687,271

WEIGHING AND FILLING MACHINE

Filed April 1, 1952

5 Sheets-Sheet 1



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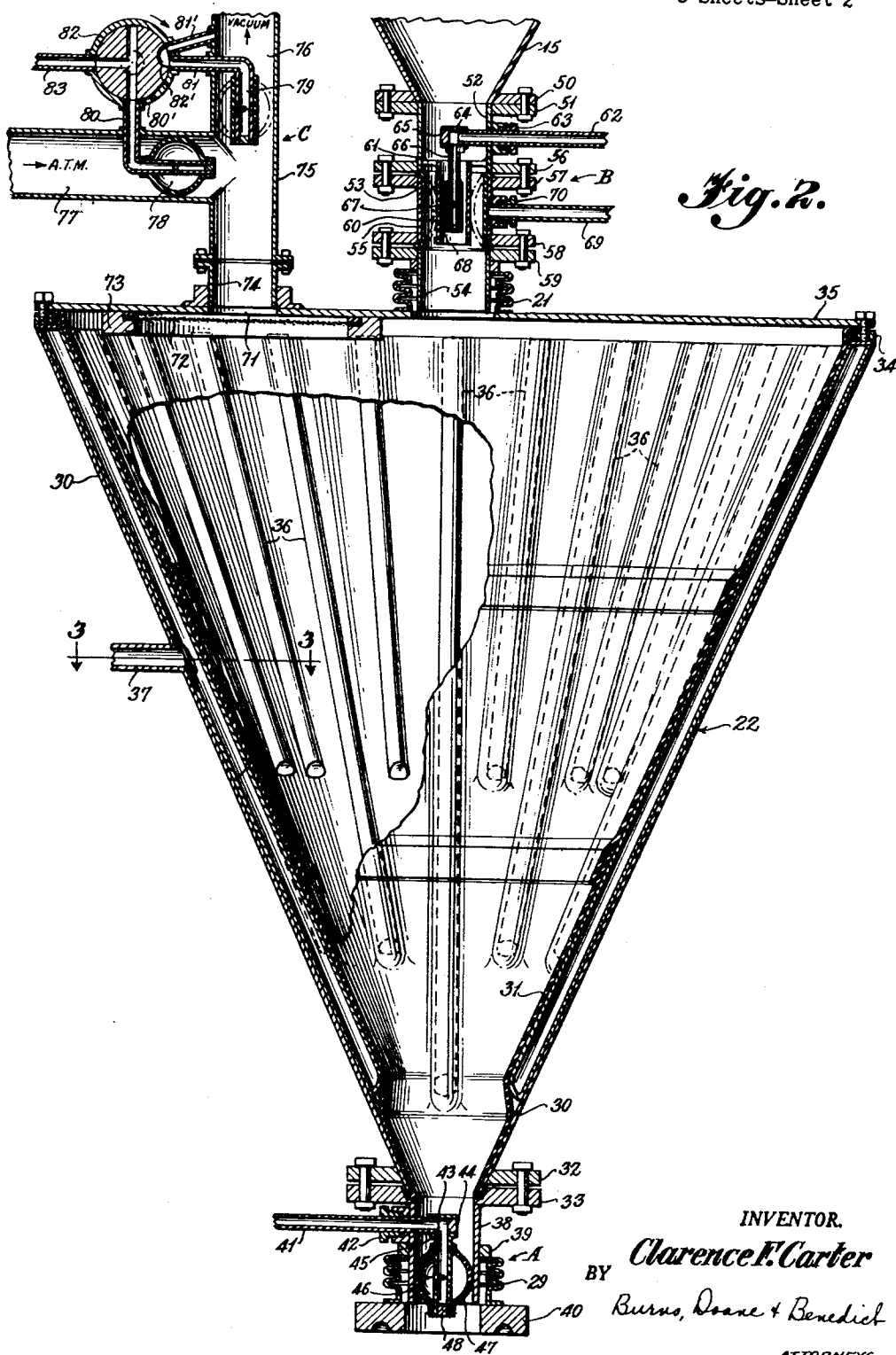


Fig. 2.

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Fig. 4.

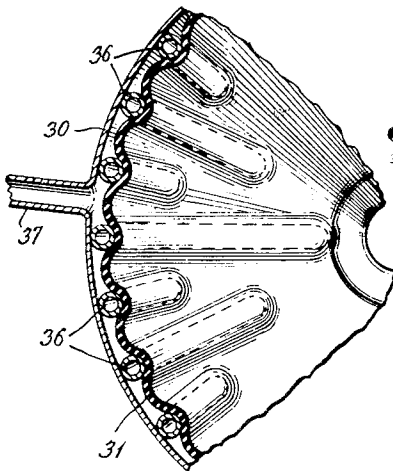
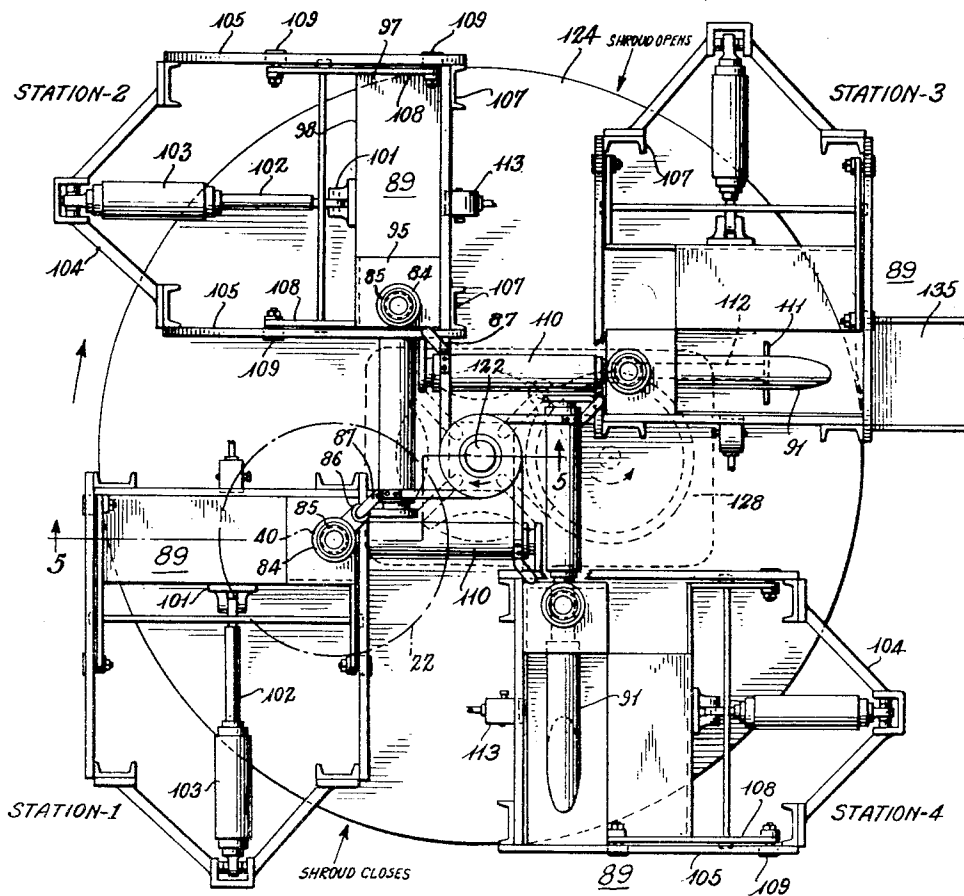


Fig. 3.

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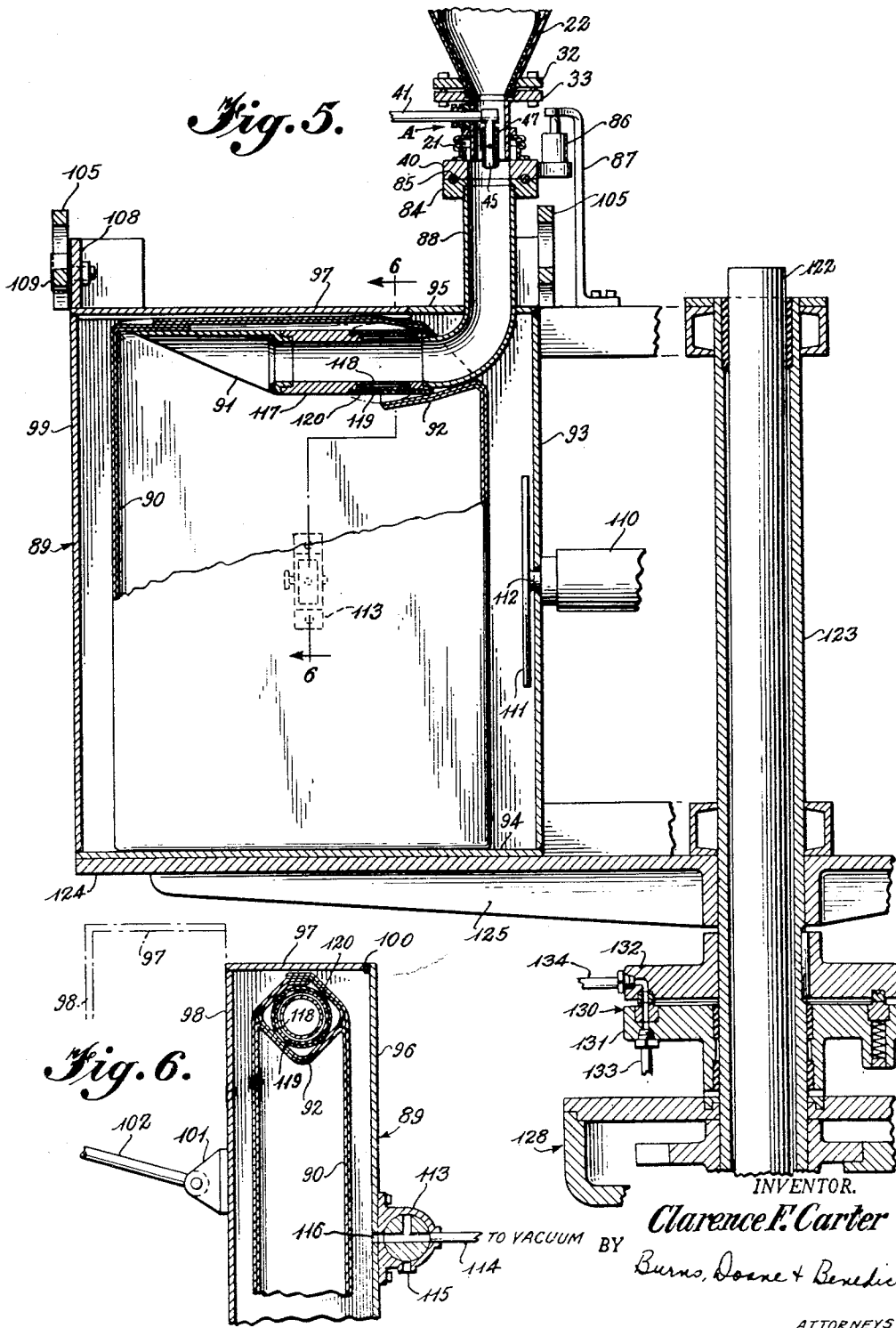
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WEIGHING AND FILLING MACHINE

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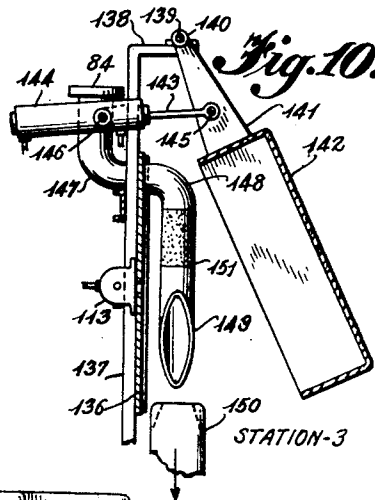
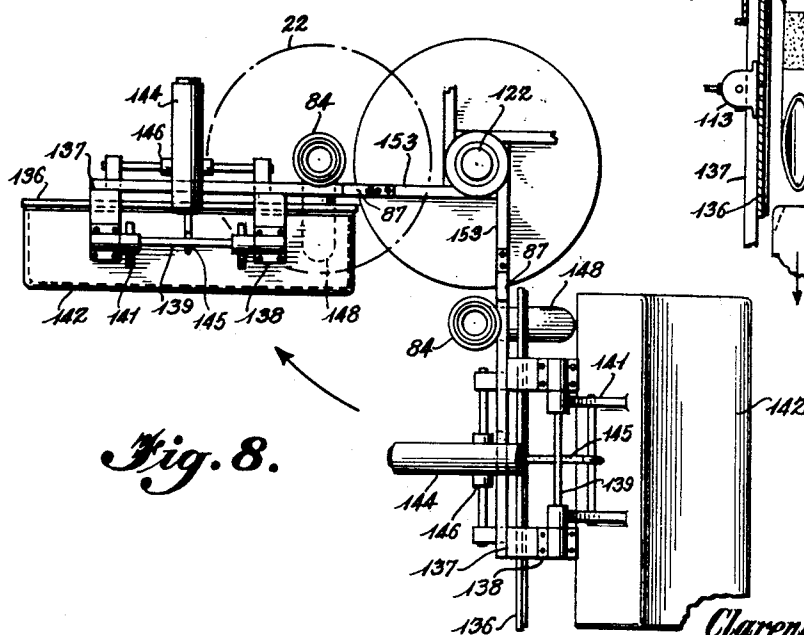
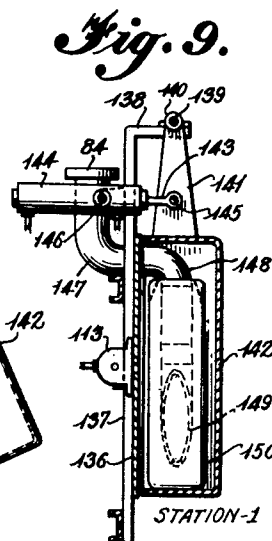
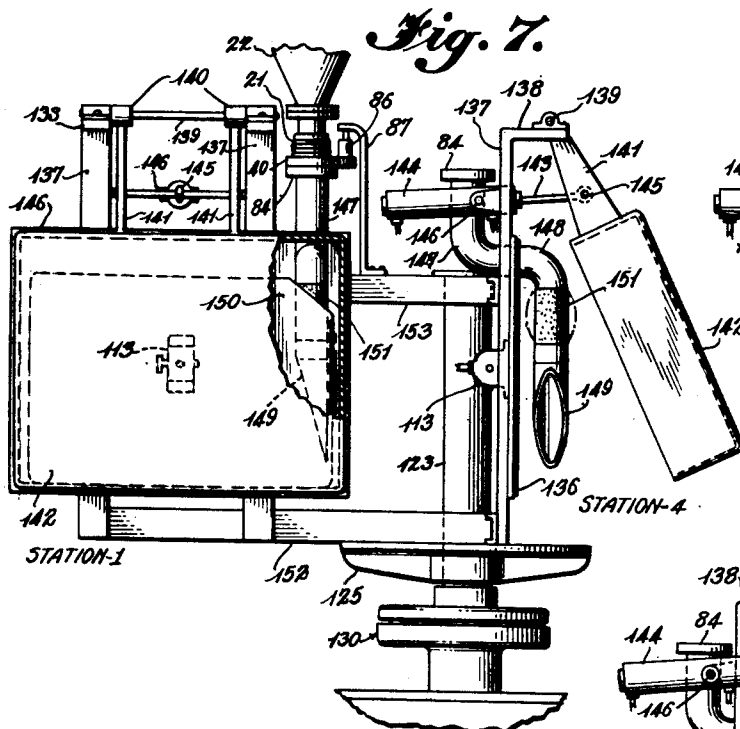
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WEIGHING AND FILLING MACHINE

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

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WEIGHING AND FILLING MACHINE

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Application April 1, 1952, Serial No. 279,889

8 Claims. (Cl. 249—3)

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This invention relates to an automatic machine for weighing fine powders and vacuum filling of containers.

It is an object to automatically weigh powders with substantial accuracy, and to deliver them by vacuum methods to bags, boxes, cartons and the like, particularly containers holding 10-100 pounds of powder.

It is a further object to de-aerate the powders before delivery to the container, so as to eliminate objectionable outage therein after the contents have settled.

Figure 1 is an elevation of a machine designed to accomplish these purposes.

Figure 2 is a sectional elevation of a hopper and valving mechanism shown diagrammatically in Figure 1.

Figure 3 is a plan view in section along the lines 3—3 of Figure 2.

Figure 4 is a plan view of the machine along lines 4—4 of Figure 1.

Figure 5 is an elevation in partial section of one of the shroud elements of the machine, with a bag in filling position.

Figure 6 is an end view in section along lines 6—6 of Figure 5.

Figure 7 is an elevation in partial section of a modification using a different type shroud and filling spout which may be used in place of those shown in Figure 1, one being in filling position and another with the shroud open and in position for receiving an empty bag.

Figure 8 is a plan view of Figure 7.

Figure 9 is an end view in section of a closed shroud with the bag filled.

Figure 10 is an end view in section showing the shroud open and the filled bag being dropped.

Referring to the figures, the automatic weighing feature will be described first, particularly in relation to Figures 1, 2 and 3. 1 is a large storage hopper of any conventional design. At the bottom of the hopper is a valve 2, connected by way of flexible coupling 3, to a first gross-weight hopper 4. Valve 2 is of the type generally designated A in Figure 2. A line 5, in the top of the hopper, leads to a source of vacuum and to atmospheric relief, through an arrangement generally designated as C in Figure 2. The hopper is suspended on a balance arm 6, by means of the knife edge 7. The lever actuates a conventional weighing scale 8. On the scale dial is a contact point 9, which may be contacted by the indicator hand 10 to close an electrical circuit not shown, thereby operating a solenoid valve and causing valve 2 to close, as hereinafter more fully

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explained. The contact 9 may be made adjustable by known means to correspond to any desired weight of material. At the bottom of hopper 4 is a second valve 11 of the type shown at A. A second flexible connection 12 joins the outlet of the valve with duct 13, which leads to a flexible connection 14 opening into weighing hopper 15. This hopper also is mounted by knife edge 16, on arm 17. This actuates a scale 18 similar to scale 8, equipped with a contact point 19, which actuates through appropriate electrical connections a solenoid valve which operates to cause valve 11 to close. The vacuum-relief line 19 is of the construction shown at C. At the outlet of the hopper is a valve 20, of the type designated B on Figure 2. A flexible connection 21 leads to final weighing hopper 22. This is mounted on the knife edge 23 and arm 24. A scale 25 is actuated by arm 24, has two contact points, one at 26 and one at 27, which may be contacted by pointer 25' to actuate solenoid valves controlling valve 20. Mounted on the bottom of the hopper is a valve 28, of the type designated A. A flexible connection 29 joins the hopper to a line discharging into a container as hereinafter described in greater detail.

Figure 2 is an elevation in section of hopper 22, showing details of the construction of valves A, B and C, as well as details of the internal hopper structure. Hoppers 4 and 15 are of similar construction. The hopper comprises an outer wall 30 of any suitable material such as sheet metal. The hopper is lined with a flexible material such as rubber, either synthetic or natural, the liner being designated 31. At the lower end, the liner is turned back over the end of the sheet metal hopper wall, and is held in place by flange 32 attached to the hopper and flange 33 attached to valve A. A channel 34 extends around the top of the hopper, and the liner 31 is turned back over the inside edge thereof and is held in place by the hopper lid 35 when it is clamped or bolted in place. Lying between the liner 31 and the outer wall 30 is a plurality of rubber tubes 36. These are sealed at their lower ends, and are held in position at the upper end by being turned back over the channel and held in place by the hopper top 35. These tubes are spaced apart as shown, the distance generally being of the order of 0.5-1 inch. Since the amount of surface at the upper end of the tapered hopper is greater than at the lower end, some of the tubes are necessarily shorter than others. An air-vacuum line 37 leads into the space between wall 30 and liner 31. This is con-

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nected to the atmosphere and to a source of vacuum not shown, through a three-way valve not shown, whereby the space between the wall 30 and the liner 31 may be alternately evacuated and relieved to the air. Since the tubes 36 are sealed and contain air, the flexible liner 31 will assume the position shown in Figure 3 when the space is evacuated, but upon relief of the air, the liner will return to its normal position. By rapidly alternating between vacuum and relief during the time the hopper is being filled and emptied, the liner is caused to vibrate and thus dislodge the powder that may be in the hopper, causing it to flow freely and quickly out of the hopper without substantial holdup. This action also assists in de-aerating the powder within the hopper.

The valve designated A is attached to hopper 22 by means of flanges 32 and 33. The body of the valve 38 is generally cylindrical. A flexible connection 29 is mounted by means of flange 39 to the exterior of the valve. The flexible connection is attached to flange 40. An air-vacuum line 41 extends through a compression fitting 42 to a T, 43, which is plugged at 44. Extending downwardly from the T is a tube 45, perforated at 46. Around the tube and covering the perforations is a rubber sleeve 47. Tube 45 is plugged at 48. The sleeve 47 is attached at each of its ends to tube 45, and when air pressure is applied through line 41, assumes the position shown, thus completely closing the passage through the valve. Line 41 leads to a three-way valve which connects to a source of air pressure and to a vacuum supply. When vacuum is applied to line 41, tube 47 assumes the position shown in the drawing. It is important that vacuum be applied, since otherwise the sleeve 47 may not resume its normal position but may wrinkle. Upon application of the vacuum, a substantially unobstructed annular passage is formed.

Hopper 15 is connected to the valve generally designated B, by means of flanges 50 and 51. This valve has three sections 52, 53 and 54, which are generally cylindrical. A rubber liner 55 is held terminally in section 53 by being pinched between flanges 56 and 57, and 58 and 59. This rubber liner may be beaded at the ends.

Inside the cylindrical body is a smaller tube 60, which is supported by means of spider 61 or other suitable means. A relatively large, annular passageway is formed between tube 53 and liner 55. An air-vacuum line 62 extends through an appropriate compression fitting 63 to T 64, which is plugged at 65. Extending downwardly therefrom is a small tube 66, which is perforated at 67. This tube is plugged at the lower end. A rubber sleeve 68 is attached, as was described in connection with valve A, to tube 66. The liner 55 is inflated by applying air pressure to air-vacuum line 69, which extends through the wall of the section 53, through compression fitting 70. Upon being inflated, the liner 55 assumes the position shown by the dotted line. In a similar manner, by applying air to line 62, the liner 68 may be inflated to close the passageway between tube 69 and the liner 68.

Cover plate 35 is provided with an opening 71, which is covered by a screen 72 mounted by any convenient means, such as bracket 73. Corresponding with the opening 71 is an outlet tube 74, which may be attached to the T 75, one arm 76 of which leads to a source of vacuum, and the other arm 77 leads to the atmosphere. Mounted

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within lines 76 and 77 are two valves 78 and 79, of the type described in greater detail in connection with valve A. From these lead the lines 80 and 81, connecting with a three-way valve or cock 82. This valve connects by way of line 83 to a source of compressed air. Through shell of cock 82 is an opening 80', and a line 81' leading to line 76. A groove 82' affords communication between lines 81 and 81' when the cock is in the position shown, to deflate valve 79. When the cock is turned 90° clockwise, valve 78 is relieved through line 80, groove 82' and opening 80'.

Refer to Figure 5. Flange 40 is designed to coincide with flange 84 in sealing relationship. Flange 40 is forced against flange 84 and sealing rubber 85 by applying air pressure to air cylinder 86, the piston of which strikes bracket 87, forcing the two flanges into sealing relationship. This is done after hopper 22 has been filled and the contents are to be drawn into the container.

Leading from flange 84 is the filling tube or head 88. This extends through the top of a split shroud 89, which, when closed completely, surrounds a container such as bag 90. The bag shown is of the multiwalled type, which is sealed or sewed before filling and which is filled through a small opening left in one corner for introduction of the filling spout 91. This opening is closed after the filling operation is complete, by a flap 92, which automatically covers the opening when the contents of the bag rest against it. Such bags are of familiar design and form no part of this invention. The shroud 89 is made up in two sections, and may be of the type shown in Figures 1, 4, 5 and 6, or may be of the type shown in Figures 7 to 10. These sections, when closed, form a vacuum-tight receptacle surrounding the bag, as shown in Figures 5 and 6. One section of the split shroud is stationary, and is made up of wall 93, bottom 94, top section 95, and wall 96. The other, movable section is made up of top section 97 and walls 98 and 99. At all points of contact between the movable and the stationary sections is a resilient washer or sealing member such as shown at 100, to insure a gas-tight seal. On the movable section is mounted a bracket 101, to which is pivotally attached the piston 102 of an air cylinder whereby the movable section can be moved away from and upwardly from the stationary section to the position shown in the dotted lines in Figure 6 and in plan view in the representations of the two open shrouds on the righthand side of Figure 4. In plan view, the closed shrouds are illustrated by the two shrouds on the lefthand side of Figure 4. Since the split shrouds and the mechanism for opening and closing them are identical, the same reference numerals are employed. The air cylinder 103 is pivotally mounted on a frame 104, which is attached to the main frame of the machine. A pair of upper guide tracks 105, 105, and a corresponding pair of lower guide tracks 106, 106 (best seen in Figure 1), are mounted on frame 104 and are attached to a frame 107, 107, on which the stationary member of the split shroud is rigidly mounted. These guide tracks slope upwardly and away from the stationary member of the split shroud.

Mounted on the movable member of the shroud is a bracket 108, supporting rollers 109, which follow the guides 105 and 106 when the movable portion of the shroud is retracted by the air cylinder 103 and its piston 102. The air cylinders are of conventional design and need not be explained in detail. The manner of opening the

shroud by swinging the movable portion outwardly and upwardly, permits ready placement of the bag on the filling nozzle 91 and removal of the filled bag from the shroud. The bag is removed from the shroud by operation of an air cylinder 110, which is mounted on wall 93 of the stationary member of the shroud and which has a platen 111 attached to piston 112 of the air cylinder. When the shroud is open, as shown in the upper righthand corner of Figure 4, the platen 111 thrusts the bag outwardly and off of the floor 94 of the stationary member of the shroud. An empty bag is then placed in position as shown by Figure 5, by slipping the opening at the valve end over the nozzle 91.

Mounted on wall 96 of the stationary member is a three-way valve 113, which leads to a source of vacuum attached to line 114 when the valve is in the position shown and when the shroud is closed for filling. The three-way valve has a port 115 open to the atmosphere. Communication to the interior of the shroud is made through port 116.

The filling spout 91 may be equipped with a sealing device to prevent passage of powder from the interior of the bag into the shroud during the filling operation. In this case a section of extra heavy pipe 117 is provided. A portion of the pipe is cut away at 118, and over this is placed a grid or screen 119. A rubber sleeve 120 is placed over and supported by the grid. The sleeve is preferably a section of thin-walled rubber tubing, which is attached at either end to the pipe, and which fits substantially flush with the outside of the pipe section 117. This leaves an annular space around a part of the length of the pipe 117, which serves as an air pocket. When the interior of the shroud is evacuated during the filling operation, the thin-walled tubing 120 is caused to expand into the position shown by the dotted lines, due to expansion of the air within this annular space. The expanded tube 120 thus presses against the end of the bag and the closure flap 92 sufficiently to prevent dust from escaping from between the filling spout and the bag into the shroud. Since the rubber tube 120 is substantially flush with the outside of pipe 117, it offers no impediment to the bag being placed over the spout.

The apparatus can be operated as a single-head unit, or a plurality of the shroud elements can be mounted on a rotatable dial, as shown in Figures 1 and 4, for a more rapid filling operation. In this case, the unit is mounted on a stationary base 121, supporting a vertical pipe 122, over which is a rotatable pipe 123 to which is rigidly attached a rotatable dial or platform 124, supported by a web 125. The supporting frames 107 for the stationary portion of the split shrouds are rigidly attached to dial 124. The dial is rotated by any suitable means, such as motor 126, speed reducer 127, and Geneva movement 128. These are all well known mechanical devices and need not be described in detail. Mounted above the Geneva movement is a conventional rotary air valve, generally indicated at 130. This supplies air to the air cylinders which open and close the shrouds and eject the filled bags, and is designed to time their operation at the appropriate stations. The rotary valve and timing means are not per se a part of the invention, since any suitable means may be used. The lower member 131 is stationary, and the upper member 132 revolves with the member 123. Air inlets 133, and air outlets 134, are provided. Air passes through

grooves (not shown) in the face of member 131. These coincide with the ports 134, so that air is supplied at the required time, and for the interval necessary, to operate the air cylinders for opening of the shroud and ejection of the bag at the proper stations.

The weighing hoppers are supported by any suitable structure not shown, above the rotating elements. As shown in Figure 4, station 1 is the filling station. As the device is rotated between stations 2 and 3, the air cylinder 103 is actuated by air received from rotary valve 130 through line 134 to cause the shroud to open, so that by the time it reaches station 3, it is completely open and the bag is ready for discharge. At this point, air cylinder 110 is actuated to push the bag out of the shroud into chute 135, whence it travels to the disposal point. The shroud unit at station 4 is open, and at this point a bag is slipped over the filling spout. It will be noted that the rotation of the unit is intermittent, so that during the period of time necessary to fill the unit in station 1, there is plenty of time for the filled bag to be ejected at station 3 and for another bag to be placed over the filling spout at station 4. After the bag is filled at station 1, and as the element to which the bag has been added at station 4 moves forward into station 1, the split shroud is closed by the air cylinder, and by the time the element reaches station 1, it is ready to be filled. In Figure 1, at 90a and 90b, a filled bag is shown as it is ejected from the open shroud.

The operation

As illustrated in Figure 1, three weighing hoppers and a storage hopper are provided. Two of the weighing hoppers are for obtaining rough weights, and likewise serve the purpose of de-aerating the powder. The third hopper 22 is a final-weight hopper.

A powder such as carbon black, zinc oxide, or any other finely divided bulk material, is placed in storage hopper 1. Hopper 4 is evacuated through line 5. Powder is drawn through valve 2, which is open. Since hopper 4 is suspended by means of the knife edge 7 and the lever 6, and is conducted by flexible coupling to the storage hopper 1 and the line 13, the arm 6 is free to act upon scale 8, the indicating pointer 10 of which is set at 0 before the filling operation begins. As the hopper fills with powder, the arm 10 rotates and eventually contacts point 9, which closes an electrical circuit actuating a solenoid valve, causing valve 2 to close as hereinbefore described. By the use of relays and a timing device, all well known, valve 2 can be kept closed until hopper 4 is ready to receive another charge of powder. Scale 8 is set so that the amount of material weighed into hopper 4 is in excess of that which is ultimately to be delivered to the container. This excess amount may vary from a few ounces to several pounds. The material having been delivered to hopper 4, hopper 16, which is empty at this point, is evacuated, line 5 is closed to vacuum and is relieved to atmospheric pressure; valve 11 is opened and the contents of hopper 4 move into hopper 15. The scale 18, actuated in a similar manner to scale 8, causes valve 11 to close when the pointer strikes contact 18'. Again the charge transferred to hopper 15 is slightly in excess of that to be ultimately delivered to the container, although in general it may be more nearly the desired amount than is that delivered to hopper 4. Hopper 15 is now released to atmospheric pressure by operation of the valve on line 19, and

hopper 22 is evacuated. Valve 20 is opened, this operating in the following manner to deliver an accurate, predetermined weight of powder to hopper 22.

The valves in Figure 2 are shown in position for drawing powder from hopper 15 into hopper 22. Valve 79 is open, valve 78 is closed, valve B is open, and valve A is closed. Hopper 22 is being evacuated, which causes powder to flow from hopper 15 into hopper 22 through the two annular spaces shown in valve B. Hopper 22 is suspended as shown in Figure 1. When the weight of material in hopper 22 is sufficient such that scale indicator 25' strikes contact point 26, the solenoid valve controlling line 69 is actuated, thereby applying air pressure to liner 55 and causing it to inflate and close the outer large annular space around tube 60. This shuts off the major flow of powder. The point of contact is selected so that the weight of powder introduced into hopper 22 is slightly less than that ultimately desired. This may be a matter of an ounce or several ounces, depending upon the size of the valve and the amount of powder to be weighed. Powder continues to be drawn through the inner annular space around tube 66, and the scale indicator 25 continues on as the weight of powder in hopper 22 increases until it contacts point 27, at which point another solenoid valve is actuated to apply air pressure to line 62 and inflate rubber sleeve 68, thus closing the valve and shutting off any further flow of powder from hopper 15. Hopper 22 now contains the exact amount of powder desired, and it is ready for transfer to the ultimate container. The solenoid valves referred to may be of type such as V-5 of Skinner Chuck Company, Norwalk, Connecticut.

Valve 20 is then closed, and hopper 22 is released to atmospheric pressure. By this time one of the shrouds, containing an empty bag and ready for filling, moves into position at station 1. Flanges 40 and 84 are clamped together as shown in Figure 5. The interior of the shroud is evacuated by pulling a vacuum through line 114, the three-way valve 113 being in the position shown in Figure 6. Until the shroud is substantially evacuated, valve 28 is kept closed. As it is evacuated, the thin rubber tube 120 expands to seal the opening in the corner of the bag. When the desired vacuum has been reached (and this is ordinarily within the range of about 15 to 20 inches of mercury), valve 28 is opened, and the entire contents of hopper 22 are pulled into the bag. The sudden release of the contents into the bag causes the material to pack. As previously pointed out, each of the hoppers is constructed as shown in Figure 2, so that the vibrating effect of the inner liner prevents hangup of powder inside the hopper, so that this, together with the difference in pressure on the powder in the hopper and within the bag, causes the complete delivery of an accurately weighted amount of material to the container.

At this point valve 113 is rotated 90° counter-clockwise to relieve the vacuum within the shroud, the air cylinder 86 is released, and the seal between flanges 40 and 84 is broken. Since the flexible coupling 21 is stretched when the flanges are clamped together, the contraction upon release allows flange 40 to swing clear of flange 84. In the rotary machine above described, the hopper 22 is again filled with an accurately weighed amount of powder while the dial is being rotated one quarter turn to bring the next unit into filling position. The normal position of flange 40

must be slightly above flange 85, to permit the shroud unit to move into filling position, and when it reaches this position, the air cylinder 86 may be actuated by any well known means to cause flange 40 to seal against flange 84 and gasket 85.

As previously mentioned, the operation of this filling apparatus causes a de-aeration of the powder. Many fine powders such as carbon black and the like, are light and fluffy due to the fact that air is entrapped between the particles. Such a condition is necessary to the free flow of the powder, but if this fluffy powder is placed directly in a container, the container must be of sufficient volume to hold the desired weight of aerated powder, which means that when the powder settles, the container will show considerable outage. This is undesirable.

In the present apparatus, each of the hoppers 4, 15 and 22 is constructed as shown in Figure 2. The operation of this device has been explained above. The walls alternately present the corrugated pattern shown in Figure 3 and then assume a substantially smooth inner surface when the vacuum is released. This exerts a lateral squeezing or kneading action on the powder as it lies in the hopper. This aids in releasing entrained air in the powder. Since, as the hopper is being filled, it is under vacuum, the combined effect of the vacuum and the kneading action is to hasten the removal of air from the powder, and to cause it to become more and more compact. When the hopper is discharged, either to the next hopper in line, or to the container, the body of the powder is drawn downwardly and into the constriction at the valve, so as to further tend to squeeze out the air entrapped in the powder. Thus, as the powder progresses from one hopper to the next, the ultimate effect is to continuously knead the powder and to force the air out of it, and as a consequence, it becomes more and more compact; that is, the apparent density is reduced. By the time it reaches the container, the largest portion of entrapped air has been removed, and as a consequence, a smaller container could be used than if the air-filled powder were directly introduced into the container. The movement of the withdrawn air is counter to the movement of the powder, so that it is continuously agitated, and this assures rapid and uniform flow without compacting the powder to such an extent that it will bridge, or collect on the walls.

In Figures 7 to 10 is illustrated another and preferred form of shroud. This shroud comprises a plate 136, rigidly mounted on the supports 152, 153 which may be used in place of dial 124. A support 137 is provided for this purpose. Support 137 is provided with an arm 138. Plate 136 serves as one side of the shroud. Mounted on the arm 138 is a rod 139, which passes through the bearings 140 attached to levers 141, which in turn are attached to the movable member of the shroud 142 which forms the remaining side thereof. The piston 143 of an air cylinder 144 is pivotally connected at 145 to cross bar 146, which extends between the members 141. The air cylinder is mounted on a bracket 146', which is attached to supports 137. A three-way valve 113 is attached to the stationary member 136, as previously described in connection with Figure 6. A filling spout is attached to the flange 84 as a vertical section 147, forming an S at 148 and passing through one corner of the stationary member 136 and thence downwardly to a spout 149. A

bag 150, which is sewed as previously described, and having a sealing flap at the top corner, is slipped over the vertical spout 149. In this case the bag lies on its side, resting on the bottom of the member 142, as may be seen by examination of the righthand portion of Figure 7, and Figure 9. The spout 149 may be provided with a sealing means 151, such as that illustrated in connection with Figure 5. When the bag is filled, it assumes the position shown in Figure 9. When the shroud element reaches station 3, the movable element 142 of the split shroud is thrust outwardly by actuating air cylinder 144, and the bag drops downwardly as shown in Figure 10 onto a chute or conveyor belt, to be removed to storage.

As illustrated, two elements of a four-shroud unit are shown in Figures 7 and 8. It is possible to construct the apparatus with only three units, and hence three stations, namely, a filling station, a dumping station, and a bag-placement station. As previously mentioned, this can also be constructed as a single-station machine. The multiple-station machines provide for greater filling capacity than can be realized with a single-unit machine. The various operations are synchronized by suitable timing devices, so that it is automatic. Generally the bags are placed in position by hand. The containers can be positioned for filling by automatic means, which will vary depending upon the type and construction of the container, appropriate modifications being made for this purpose. The machine can also be designed to operate with a larger number of units and having more than one filling station.

The invention is not limited to the exact embodiments illustrated.

I claim as my invention:

1. A powder filling machine which comprises a first weighing hopper, a powder inlet valve, a powder outlet valve, means for determining the net weight of powder within said hopper, means for evacuating the hopper to draw powder into the hopper from a supply source when the inlet valve is open, means for closing the inlet valve when a predetermined amount of powder has been added, means for restoring said hopper to atmospheric pressure, means for opening the outlet valve, a second weighing hopper, a conduit connecting the outlet valve to said second weighing hopper in series, means for determining the net weight of powder within said second hopper, means for evacuating the second hopper to draw powder from said first hopper, means for closing the outlet valve of the first hopper when a predetermined weight of powder is introduced into the second hopper, means for releasing said second hopper to atmospheric pressure, and vacuum means for introducing the weighed contents of said second hopper into a container.

2. The apparatus of claim 1 wherein the outlet valve from the first hopper comprises a relatively large passageway and a relatively small passageway for powder, means for opening and closing the large passageway, and independent means for opening and closing the smaller passageway.

3. The apparatus of claim 1 wherein the means for filling the container comprises a spout capable of being introduced into a flexible container, a container shroud, means for evacuating the shroud, means for releasing the vacuum in the shroud, the walls of said shroud being made up of sections, at least one of which is stationary and at least one of which is movable, means for moving the movable section to open the shroud,

whereby a container may be removed therefrom or placed therein.

4. The apparatus of claim 1 comprising a means for mounting said hoppers in a stationary position, said filling means comprising a plurality of container shrouds mounted for intermittent rotation on a dial, said shrouds being vertically divisible into sections, one section being stationary, said section having a filling spout extending therethrough and having means for joining and means for releasing it from filling relationship with the outlet of the second hopper, means for moving the second section of the shroud away from the first to provide access to the interior of the shroud for removing and replacing containers therein, means for moving the movable sections back into gas-tight relationship with the stationary section, means for intermittently moving each of said shrouds into filling relationship with the outlet of the second hopper, and means for removing filled containers from the shroud after said shroud has been moved out of filling relationship with said hopper.

5. A filling machine comprising a plurality of weighing hoppers connected in a series by conduits, valves in the conduits, an inlet valve connectible with a source of powder supply in the first hopper in the series, an outlet valve in the last hopper of the series, said hoppers being flexibly connected to permit weighing of the contents of each hopper, said hoppers being suspended on balance arms, weighing means actuated by said arms, means for evacuating each of said hoppers independently of the others, means for releasing the vacuum within each of said hoppers independently of the others, means for opening the outlet valve to the first hopper to permit introduction of powder from said supply source when said first hopper is evacuated, means for closing said inlet valve when a predetermined weight of powder has been admitted, means for opening the valve in the conduit between the first hopper and the second hopper to pass the powder from the first hopper into the second hopper, means for closing said valve when a predetermined weight of powder has been introduced into the second hopper, each of said hoppers in the series being similarly provided for transfer of a weighed amount of powder from one hopper to the next in the series, and vacuum means for delivering a weighed amount of powder through the outlet valve of the last hopper in the series to a container.

6. The apparatus of claim 5 wherein the valves comprise an inflatable member, means for inflating said member to close the valve, and vacuum means to deflate the member and open the valve.

7. A powder filling machine comprising at least two gross-weight weighing hoppers connected in series and an accurate-weight weighing hopper, vacuum means for passing a predetermined approximate weight of powder into the gross-weight hopper from a supply source, vacuum means for rapidly passing the bulk of the contents of the gross-weight hopper into the accurate-weight hopper, means for thereafter reducing the rate of powder flow, means for stopping powder flow when an accurate predetermined weight has been collected in the accurate-weight hopper, and vacuum means for rapidly passing the weighed contents of the accurate-weight hopper into a container.

8. A powder filling machine which comprises a first weighing hopper attachable to a powder supply source, an inlet valve to the hopper, a first

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weighing means for determining the weight of powder delivered to the hopper, means for evacuating the hopper to effect powder flow into it, a second weighing hopper, a flexible conduit connecting the outlet of the first hopper to the second hopper in series, valve means in said conduit, said valve means including a relatively large annular passageway and a relatively smaller annular passageway, inflatable means in each of said passageways for closing them independently of each other, means for evacuating said second hopper to effect flow of powder into it from the first hopper when the valve means is opened, and vacuum means for discharging the net contents of the second hopper into a container.

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