

**REDUCED SIZE GRAVIMETRIC BLENDER HAVING REMOVABLE
HOPPERS WITH INTEGRAL DISPENSING VALVES**

Background of the Invention

This invention relates generally to methods and apparatus for providing precisely measured amounts of granular materials preparatory to further processing of the combined granular materials and specifically to 5 gravimetric blenders providing precisely measured amounts of plastic resin material and mixing these components prior to supplying the blended mixture to plastics manufacturing and processing equipment such 10 as plastic injection molding, compression molding and extrusion equipment.

**Field of the Invention and
Description of the Prior Art**

The modern gravimetric blender was essentially 15 originated by the applicant of this invention and is widely used throughout the world by industries concerned with precision feeding of granular material, especially plastic resin material.

Gravimetric blenders operate by blending solid 20 plastic resin material components and additives, by weight, in batches. Typically batches of material may consist of several solid material components. One of these may be "regrind", consisting of ground plastic resin which had previously been molded or extruded and 25 which either resulted in a defective product or was excess material not formed into a desired product.

Another component may be "natural" plastic resin which is virgin in nature in the sense that it has not previously been processed into a molded or extruded 30 plastic part.

Yet another component may be a solid color material, typically pellets, flakes or freeze dried material, used to produce a desired color of the finished plastic part. The most common colorant is in

the form of pellets which are preloaded with pigment, perhaps 50 percent by weight, called "concentrate" or "masterbatch". Optionally, a liquid colorant may be added as an alternative to solid color material.

5 Still yet another component may be an additive used to adjust the blend to provide required performance characteristics during molding, extrusion or subsequent processing.

10 The gravimetric blender as originated by the applicant and as copied widely throughout the world typically includes hoppers for each of the components of the solid material to be blended together. Typically several hoppers or several compartments in a hopper may be provided, such as one compartment for
15 "regrind" material, one compartment for "natural" material, one component for solid color additive material and one compartment for "additive". When the gravimetric blender operates, the unit desirably operates automatically, adding each of the component
20 solid materials in the proper, desired percentages. Each solid material component is dispensed by weight into a single weigh bin. Once the proper amounts of each component have been serially dispensed into the weigh bin, all of the components are dropped together
25 into a mixing chamber from the weigh bin.

Mixing is performed, preferably continuously, and preferably even as additional batches component are dispensed in the mixing chamber. When mixing is complete, the resulting blend is preferably provided
30 directly to the desired molding or extrusion machine.

Feedback control of the dispensed amounts of each solid material component provided to the weigh bin and measured by weight assures that in the event of an error in the amount of a dispensed component, the
35 succeeding batch may have the blend adjusted to

account for the error detected in the preceding batch of blended material.

As one of the components forming a part of the resulting blend it is known to supply solid color additives to the blend in order to provide a blend of a desired color. These color additives may be preloaded pellets, flaked pigments on wax carriers or in freeze dried form. It is also known to provide the color as pigment powder or liquid constituting one component of the resulting blend.

Summary of the Invention

In one of its aspects this invention provides a gravimetric blender including a frame, a relatively lightweight material storage hopper removably mounted on the frame, valve means proximate the hopper bottom for dispensing material within the hopper, and means connected to the hopper and remaining so upon removal of the hopper from the frame, for actuating the valve means to downwardly dispense material within the hopper, a weigh bin connected to the frame below the hopper, means connected to the frame for sensing weight of material in the bin, and a mix chamber below the weigh bin.

Desirably, the means for actuating the valve is fixedly connected to the hopper, the actuating means is at least partially within the hopper, the valve means is at least partially within the hopper, the hopper is manually removable from the frame. Quick-connect fittings are provided to connect and disconnect the actuator to control means for the blender. The blender further includes a plurality of hoppers, each with valve means therewithin and respective individual valve actuation means. The actuating means is pneumatically driven and includes a vertically elongated member for transmitting motion to the valve.

The gravimetric blender includes a frame, a weigh bin, means connected to the frame for sensing weight of material in the bin, a mix chamber below the bin and connected to the frame, means connected to the frame for selectively contacting and opening the bin to release material in the bin downwardly into the mix chamber. The blender further preferably includes means for biasing an openable portion of the bin towards a closed position; the openable portion is preferably movable about a pivot; the openable portion preferably pivots about a horizontal axis; the means for selectively contacting and opening the bin is preferably pneumatically actuated; the means for selectively contacting and opening the bin is preferably a piston-cylinder combination; the cylinder is preferably outboard of the frame; the piston preferably moves transversely to the axis about which the openable portion pivots; the piston may contact the bin directly or indirectly; the openable portion is preferably pivotally connected to a remaining, stationary portion of the bin.

The piston is preferably separate from the openable portion and is operable to engage and displace the openable portion when the sensed weight of material in the bin closes the several hoppers and interrupts feed to the bin preparatory to discharge. The weigh bin is removably mounted on the weight sensor to facilitate changing of the bin when changing the character of the mix being blended. Furthermore, the weigh bin is supported in the frame behind a transparent wall so as to enable observation of the weigh bin during operation.

The blender also includes a mixing chamber into which the weigh bin is discharged. The mixing chamber is positioned below the weigh bin behind the transparent panel and includes a removable agitator. The removable agitator is journaled in the transparent

wall and the transparent wall with the agitator is readily removable so that the agitator may be removed from the mixing chamber for replacement.

The structures of the invention have been
5 designed to provide a lightweight apparatus which is fully effective to blend the granular or other components.

Brief Description of the Drawings

All of the objects of the invention are more
10 fully described hereinafter with reference to the accompanying drawings, wherein:

Fig. 1 is a side elevation of the gravimetric blender embodying the present invention which is of reduced size;

15 Fig. 2 is a top plan view of the blender shown in Fig. 1 with the lid on one of the hoppers thereof removed;

Fig. 3 is a front elevation of the blender shown in Fig. 1;

20 Fig. 4 is a sectional view through a hopper illustrating a valving device for controlling the outflow of the hopper, the valving device being in the open position;

Fig. 5 is a fragmentary sectional view similar to
25 Fig. 4 showing the valving device in a closed position;

Fig. 6 is a view similar to Fig. 4 showing an alternative valving device in the closed position;

Fig. 7 is an exploded view of the valving device
30 of Fig. 4; Fig. 8 is a similar view of the valving device of Fig. 6;

Fig. 9 is a fragmentary perspective view of the tubular valve element of the embodiment shown in Fig. 4;

35 Fig. 10 is a fragmentary sectional view showing the weigh bin removably mounted on the weight sensor;

Fig. 11 is a detached side elevation of the weigh bin showing the openable portion in closed position;

Fig. 12 is a front view partially in section and partially broken away of the structure shown in Fig.

5 11;

Fig. 13 is an exploded view in side elevation of the removable agitator for the mixer; and

Fig. 14 is an assembled view of the mixer shown in Fig. 13.

10 **Description of the Preferred Embodiments
and Best Mode Known for Practicing the Invention**

Referring to the drawings and to Figures 1-3 in particular, a gravimetric blender is designated generally 10 and includes a hopper assembly 11 including a plurality of hoppers, which are individually designated generally 12. The collection of hoppers 12, each of which is individually removable from blender 10 manually, without the use of tools, is supported by a frame designated generally 14 which holds a weigh bin 15 into which portions of solid plastic resin or other granular or powdery material can be metered and weighed prior to release into a mix chamber as described below.

Frame 14 preferably includes four upstanding side panel members, three of which are preferably steel and formed from a single sheet, bent to form the three sides, with the three sides being identified 30A, 30B and 30C. The remaining front side panel of frame 14, which is removable and detachable from sides 30, is designated 17 in the drawings and is preferably clear, transparent plastic.

Hopper assembly 11 with the desirable plurality of hoppers 12 allows a plurality of different solid resinous materials to be dispensed from the hoppers 12 into weigh bin 15 by suitable valve mechanisms, designated generally 19, located within and proximate to the bottom of a given hopper 12. The hoppers 12 are

individually manually mountable on and removable from gravimetric blender 10 by hand, without use of tools.

5 The upper extremity of each solid side panel 30 of frame 14 is formed into an outwardly flared guide flap 34. In the preferred configuration since there are three solid side panels 30A, 30B and 30C, three outwardly flared guide flaps 34 result. Outwardly flared guide flaps 34 are integral with and formed as a part of solid side panels 30A, 30B and 30C by
10 bending the upper extremities of solid side panels into a cradle having the shape illustrated in the drawings.

A fourth outwardly flared guide flap 34A (see Fig. 3) is positioned above transparent removable
15 front panel 17 and is welded to the upper extremities of the two solid side panels 30A and 30C between which transparent removable front panel 17 fits.

Outwardly flared guide flaps 34 of the panels 30A and 30C preferably include tab members 36 which are
20 perpendicular to the remaining portion of guide flap 34 and extend therefrom in a generally downwardly direction. This provides a convenient frame hand-hold for an operator while lifting a hopper 12 from the cradle formed by the flaps 34 and 34A on the frame 14
25 of the blender 10. Hoppers 12 are easily individually manually lowered into position in the cradle formed by the flaps 34, 34, 34 and 34A, and are easily manually lifted out thereof.

Gravimetric blender 10 further includes a valve
30 for each hopper. The valve is designated generally 19 in the drawings. Each valve includes a hollow tubular preferably cylindrically configured valve member designated 40. The member is slidable along its cylindrical axis through a circular valve opening or
35 orifice 80 in the bottom wall 81 of the hopper. As shown in Figs. 4-8, the hollow valve member is open at the lower end and is closed at the top end where it is

connected to the piston of a piston-cylinder combination. The cylindrical wall of the valve member 40 has a port 90 which affords flow of material from the hopper 12 to the interior of the valve member and
5 from the interior of the valve member 40 through the opening 80.

The valve is operated by a pneumatically actuated cylinder having spring-loaded piston means housed within a chamber 38 which is wholly within hopper 12.
10 As shown, the chamber is closed at the top by an end wall 66 and is open at the bottom. The piston-cylinder combination, which is designated generally 18 in the drawings, is mounted in the end wall 66 and thereby is connected to hopper 12 via the chamber end
15 wall 66. The piston of the piston-cylinder combination 18 is preferably spring-loaded and operates in response to pressurized air to actuate tubular valve members 40 projecting from the open bottom end of the chamber 38. When the pistons move
20 the tubular valve member 40 within chamber 38 downwardly into the position illustrated in Figure 4, the valve opens and permits discharging granular material contained within the associated hopper 12 to flow downwardly into the weigh bin of the blender.

25 When pneumatic pressure supplied to a given piston is released, an internal spring portion of the piston-cylinder combination causes the piston to retract, thereby retracting the valve member in an upward direction, into the position illustrated in
30 Figure 5, at which the valve is closed and granular material cannot flow downwardly from hopper 12 into the weigh bin 15.

It is noted that the valve member 40 passes through the hollow chamber 38 with ample clearance.
35 At its lower end, the valve member 40 slidably engages in an valve opening or orifice 80 in a bottom wall 81 of the hopper 12. Both the granular or powdered

material within the hopper 12 may only discharge through the opening 80 by passing through the center of the hollow valve element 40. When withdrawn to the closed position shown in Fig. 5, the hollow interior of the valve element 40 remains in communication with the valve opening 80, but because the port 90 enters the chamber 38 to a position above the open bottom end, the granular or pulverulent material in the hopper 12 cannot readily flow into the port 90 to the interior of the hollow valve element 40 and through the bottom opening 80. To be effective, the granular or pulverulent material must have a characteristic angle of repose greater than 0° so that when the valve element 40 is withdrawn into the chamber 38 above its open lower end 82, the material in the hopper 12 does not rise through the open bottom of the chamber 38. Thus, the chamber 8, the hollow valve element 40 and the circular opening 80 in the bottom wall 81 of the hopper cooperate to define the bottom valve means 19 for each of the hoppers.

The hollow valve member 40 is connected to a movable piston shaft 42 of piston-cylinder combination 18 as illustrated in Fig. 4. Hollow valve member 40 and piston shaft 42 are housed within a chamber designated generally 38 in the drawings and illustrated in stand-alone form in Figures 7, 8 and 9. Chamber 38 is of generally rectangular configuration, as illustrated in Figure 9, and has two adjoining closed sides 52, 54 and two adjoining open sides 56, 58, all as illustrated in Figure 9. Open sides 56, 58 of chamber 38 and therefore chamber 38 are secured to a sloping wall 60 and extends along an adjoining vertically-oriented wall 62 of a hopper 12. Walls 60, 62 adjoin one another at a right angle and combine with the sides 52 and 54 to form the rectangular chamber 38 which is closed at the top 66 and is open at the bottom 82 (see Fig. 7).

The closed top portion 66 has an aperture 68 formed therein (see Fig. 7). Piston-cylinder combination 18 is secured in place on closed top 66 of chamber 38 and passes through aperture 68 with
5 securement being effectuated by a nut 70 which threadedly engages a threaded portion 71 of the housing of piston-cylinder combination, retaining the piston-cylinder combination in position on closed top 66 of chamber 38 as illustrated in Figures 4 and 5.

10 Chamber 38 is preferably formed by folding a single piece of sheet metal into the shape of closed sides 52, 54 and open sides 56, 58. Closed top 66 is preferably welded onto the single piece of metal folded to form closed sides 52, 54 and open sides 56,
15 58 of chamber 38.

Further forming a portion of each valve assembly 19 in each hopper 12 is a bottom wall 81 disposed perpendicular to the sloping wall 60 within hopper 12, as shown in Figures 4 and 5. The bottom wall 81 has a
20 planar portion with a circular aperture or orifice 80 which is of suitable size for sliding clearance of the lower portion of tubular valve member 40, which resides within and reciprocates through orifice 80, as illustrated in Figures 4 and 5.

25 The configuration of the bottom wall 81 and the diameter of aperture 80 vis-a-vis the outer diameter of tubular valve member 40 are such that granular or other material contained within hopper 12 cannot pass between the exterior of tubular valve member 40 and
30 the periphery of aperture 80. Additionally, other than aperture 80, the bottom wall 81 closes off the bottom of hopper 40. As a result, for any granular material contained within hopper 40 to exit downwardly therefrom, that granular material must pass through
35 the hollow interior of tubular valve member 40.

Tubular valve member 40 has a port 90 formed therein, defined by a pair of semi-circular

circumferential edges 92 and a pair of axially extending edges 94 connecting edges 92 thereby to define a semi-cylindrical port 90.

As illustrated in Figures 4 and 5 showing the valve assembly 19 in hopper 12 in the open and closed positions respectively, at the open position the piston in piston-cylinder combination 18 is extended such that piston rod 42 is extended downwardly and port 90 in tubular valve member 40 passes the open bottom 82 of the chamber 38. With tubular valve member 40 in this relationship with chamber 38, port 90 permits flow of granular material downwardly from within hopper 12 into the hollow interior of tubular stem 40 and downwardly therethrough out of hopper 12. This configuration is illustrated in Figure 4.

When the piston in piston-cylinder combination 18 is retracted, tubular valve member 40 is carried upwardly into a position at which port 90 passes above the open bottom 82. At this position, communication from the interior of hopper 12 with port 90 is blocked by the bottom edge of chamber 38 as illustrated in Figure 5. As a result, granular material within hopper 12 cannot reach the hollow interior of tubular valve member 40 and thus cannot flow downwardly through the hollow interior of tubular valve member 40 out of hopper 12. Hence, the valve assembly 19 is closed when in the position illustrated in Figure 5.

Piston-cylinder combination 18 is preferably a spring-loaded piston-cylinder combination such that a spring within the cylinder serves always to urge the piston portion of the combination vertically upwardly considering Figures 4 and 5 into the position at which the port 90 of tubular valve member 40 does not confront the interior of hopper 12 and hence valve assembly 19 is closed. Application of pneumatic pressure to piston-cylinder combination 18 drives the piston of the combination downwardly, against the

force of the spring, thereby moving the port 90 of tubular valve member 40 into the position confronting the interior of the hopper, whereby the valve 19 is open. The valve member remains open for so long as
5 the pneumatic pressure is applied to piston-cylinder combination 18. When the pneumatic pressure is released, the spring forces the piston vertically upwardly in Figures 4 and 5, thereby closing valve member 19.

10 Depending on the particular material being fed and blended, piston-cylinder combinations 18 may be operated to open and to close valves 19, i.e. to move valves 19 between open and closed positions. Alternatively, if it is desired to very precisely
15 regulate the amount of granular material supplied from a given hopper 12, piston-cylinder combination 18 may be operated in a pulsating fashion with the piston rapidly reciprocating as pulses of pneumatic pressure are alternately applied and relieved respecting the
20 piston of piston-cylinder combination via pneumatic fitting 96.

Figures 6 and 8 illustrate an alternate embodiment of the tubular valve member which has been designated 40A in Figures 6 and 8. In this
25 embodiment, tubular valve member 40A has a blocking wall 100 positioned in port 90 where blocking wall 100 includes a bottom portion 102 and an upwardly vertically extending weir portion 104. Bottom portion 102 runs along and is secured to a lower one of
30 circumferential edges 92 while weir portion 104 extends upwardly therefrom and runs along and is connected to axial edges 94, as illustrated in Figure 6. With this configuration of the blocking wall 100 in place on tubular valve member 40A, when the
35 associated piston-cylinder combination is operated in a pulsed fashion, the rate of dispensing of granular material from the associated hopper may be extremely

5 closely controlled. As the valve member 40A is pulsed, the granular material flows up the blocking wall and over the weir portion 104 into the hollow interior of the element 40A from which it is discharged through the orifice 80.

10 With this arrangement of hoppers 12 as illustrated generally in Figures 1, 2 and 3, the blender of the invention may be operated with only a single hopper in place or with two or with three or all four hoppers in place. Absence of one hopper or more than one hopper does not adversely affect operation.

15 The control means for the blender operates to actuate the valves 19 sequentially so as to discharge material from each hopper into the weigh bin 15 which is positioned within the framework 14 below the lower ends of the nested hoppers. The weigh bin is mounted for ready removal and replacement within the frame 14, and is supported singly by a load cell 32 mounted on 20 the panel 30C of the frame 14. The weigh bin 15 is supported by the load cell in a manner that the weigh bin is effectively cantilevered from the load cell 32. The load cell 32 has a bracket 170 which projects through openings in the wall 30C so as to be exposed 25 within the interior of the frame as shown in Fig. 10. The load cell 32 is mounted on the bottom wall of a box 154 secured to the panel 30C so that the bracket 170 is exposed to the interior of the framework 14.

30 Referring to Figure 1, there is connected to weigh bin 15 a weigh bin bracket 156 which is fixedly secured to weigh bin 15. Weigh bin bracket 156, as shown in Figure 10, is preferably fixed in facing contact with the complementary bracket 170 of the load cell 32.

35 A hook portion 182 of weigh bin bracket 156 extends horizontally outwardly from the weigh bin

5 bracket at the upper extremity thereof while an abutment 186 of the weigh bin bracket 156 extends vertically downwardly from an outboard extremity of horizontally extending hook portion 182, which engages over an upstanding leg of the bracket 170.

10 The hook portion 182 and abutment permit weigh bin 15 and particularly weigh bin bracket 156 to move slidably horizontally, in a direction perpendicular to the plane of the paper in Figure 10, to be positioned so that weigh bin 15 effectively hangs on and is cantilevered from load cell 32. Load cell 32 senses the weight load of weigh bin 15 and any material contained therein.

15 To protect load cell 32 from contact and possible damage by operators, load cell 32 is preferably housed within load cell enclosure box 154 as illustrated in Figure 10. Load cell enclosure box 154 is in turn connected to upstanding panel member 30C of housing 14.

20 Positioned within and preferably slidably retained by frame 14 below weigh bin 15 is a mix chamber 20 having a mixing means which is preferably in the form of a mixing agitator 22 rotatably disposed therewithin. Agitator 22 is mounted for rotation about an axis 24 (see Fig. 13) preferably shared with a pneumatically powered reciprocating rotary drive 26.

25 Weight of material in weigh bin 15 is preferably sensed by the load cell 32 which is preferably connected to a microprocessor at a control station, not illustrated in the drawings, which regulates operation of gravimetric blender 10 through electrical connection with the load cell, the actuators which control the piston-cylinder combinations 18 which actuate the valves 19, the pneumatic drive, the piston-cylinder controlling weigh bin dump and the like.

The microprocessor provides control of gravimetric blender 10 by monitoring, preferably on a continuous basis, weight of material, if any, at a weighing station defined by weigh bin 15. By sensing weight of weigh bin 15 and actuating appropriate piston-cylinder combinations 18 in given hoppers 14, the microprocessor serially meters respective components of solid granular resinous material to the weighing station defined by weigh bin 15 until a pre-selected weight of each of the respective components has arrived at the weigh station. Blender 10 preferably operates by blending components by weight based on settings provided to and retained within the microprocessor.

Each granular material component is preferably dispensed separately into weigh bin 15 and then all components are dropped together into mixing chamber 20. Blender 10 is designed to mount directly over the feed throat of a process machine (not shown) used to mold or extrude plastic material with blender 10 being bolted or otherwise fixedly connected to the process machine. The blender 10 discharges the blended material from the mixing chamber 20 directly into the feed throat.

When exclusively solid materials are being blended, typically regrind material is dispensed first according to the percent of regrind material required. If no regrind material or a limited amount of regrind material is present, then portions of natural material, solid color material and additive material are increased to bring about a full batch weight. Natural material is typically added second. The amount of natural material added is preferably calculated by the microprocessor to leave exactly the right amount of room in the mix chamber for the solid color material and additive material. Once the natural material-fill portion of the cycle has been

completed, the exact weight of the natural material that has been actually dispensed is determined to detect any errors. Based on this actual weight of natural material dispensed, color additive in the form of solid color additive material is metered into the weigh bin, then other solid additive materials are metered into the weigh bin in the same manner. All components are then dumped into the mixing chamber which is preferably continuously running.

In the case where liquid color material is used in place of solid color material, a special hopper (not shown) is substituted which has a valve arrangement disposed to dispense liquids at a metered rate. Alternatively, a special injector may be positioned to dispense metered amounts of liquid material directly into weigh bin 15 or into the mixing chamber 20 as desired. The liquid color material is preferably added to the weigh bin last.

The microprocessor provides the serially metered components and the optional preselected weight of liquid color material unitarily to a mixing station defined by mix chamber 20 by opening weigh bin 15 thereby to permit the materials vertically supported thereby to fall downwardly into the mix chamber. Weigh bin 15 is preferably opened by a pneumatic piston-cylinder combination 136, which is controlled by the microprocessor and is illustrated Figure 3. Pneumatic piston-cylinder combination 136 is mounted on frame 14 and is proximate to, but not in contact with, weigh bin 15 so that weigh bin 15 opens responsively to movement of the piston member of the piston-cylinder combination.

Weigh bin 15 is illustrated in Figure 3 in the closed position. Weigh bin 15 is opened by actuating piston-cylinder combination 136, causing a piston rod to extend. When weigh bin 15 is in the closed

position, there is no contact nor connection with the piston or its actuating cylinder.

Desirably, monitoring of weight of material at the weighing station is performed continuously by the microprocessor continuously digitally sensing signals supplied by the load cell identified generally 32. Weigh bin 15 is suspended by and from load cell 32 with respect to frame 14, and the microprocessor actuates the piston 136 to dispense material as required.

The solenoid valves and especially the solenoid actuators of the valves are preferably maintained at a control station within an enclosed frame which is remote from the blender and hence is not shown in the drawings. As with the microprocessor, the valves and their associated actuators are preferably remote from the gravimetric blender, being connected thereto via suitable pneumatic tubing.

Load cell 32 is fixedly connected to the bottom of the load cell enclosure box 154 to hold the load cell in position vis-a-vis the load cell enclosure box. Hence the bottom of the load cell is fixed whereas the upper portion of the load cell, where the load is sensed, is free to deflect in response to loads applied as result of material being in the weigh bin. Deflection sends a signal to the control station which actuates the valves 19 through solenoid valves controlling the air supply to cylinders 18, and cylinder 136.

Suitable load cells are available from Tedea Huntleigh, an Israeli company. Model 1010 load cells available from Tedea Huntleigh may be used. Solenoid actuated valves are available in the United States under the trademark MAC; the model 45A-L00-DDAA-1BA9 is suitable.

Weigh bin 15 includes a stationary open bottomed basket portion 108 illustrated in Figures 11 and 12

where basket portion 108 is also visible in Figure 3. Basket portion 108 is preferably formed of sheet metal with planar front and rear portions designated 110, 112 in Figures 11 and 12. The top of basket 108 is
5 open to receive granular material, and optionally liquid color, from above, with the granular material being supplied from one or more of hoppers 12.

Basket 108 further includes one vertically elongated side 114 which mounts the bracket 156 at one
10 side of basket 108 and a vertically foreshortened side 116 at the other side of basket 108.

Basket 108 further includes a sloped downwardly facing surface 118. The bottom of basket 108, as shown in Figures 11 and 12, is open to permit downward
15 flow of granular and, optionally, liquid color material, out of basket 108.

Weigh bin 15 further includes a dump flap designated generally 120 in the drawings which is pivotally connected to basket portion 108 so that upon
20 pivotal motion of dump flap 120, the contents of basket 108 are dropped out of weigh bin 15 and permitted to fall into mix chamber 20. Dump flap 120 is illustrated in Figures 11 and 12 and is also clearly visible in Figure 3.

Dump flap 120 includes a pair of upstanding wall portions 122, 124, both of which extend generally vertically upwardly from a planar bottom portion 126. Dump flap 120 further includes an angled bottom
25 portion 128 which is positioned at an angle to essentially complementary fit against sloped
30 downwardly facing surface 118 of basket 108, as shown in Figure 11.

Upstanding walls 122, 124 of dump flap 120 have apertures 130 formed therein on a common horizontal
35 axis. Apertures 130 receive pin, screw or other pivotal connection means for pivotally connecting dump

flap 120 to basket 108 through similar apertures 132 formed in sides 110, 112 of basket 108.

Affixed to a vertical extremity of an upstanding extension portion of upstanding wall 124 of dump flap 120 is a flat head rivet 134, which is preferably welded in position to serve as an operator for pivoting the flap 120 relative to the basket 108.

Mounted in solid side panel 30A of frame 14, as illustrated in Figure 3, is a piston-cylinder combination designated generally 136 in Figure 3. Piston-cylinder combination 136 is preferably mounted using a suitably threaded nut, illustrated in Figure 3 but not numbered, which engages a threaded collar portion of piston-cylinder combination 136 protruding through an aperture of suitable size in side panel 30A.

Affixed to the end of a piston rod extending from piston-cylinder combination 136 is a preferably plastic, such as nylon, knob 138 illustrated in Figure 3.

When material within weigh bin 15 is to be dumped, piston-cylinder combination 136 is actuated at the control station by supply of pressured air thereto. This causes the piston portion of piston-cylinder combination 136 to extend, moving to the left in Figure 3. As a result, knob 138 contacts the operator 134 which is fixed in the upper extremity of vertical side wall 130 of dump flap 120 thereby causing dump flap 120 to pivot in a counterclockwise direction, viewed in Figure 3, about a pivot point defined by pivotal connections mounted in apertures 130 illustrated in Figure 12.

This pivotal, rotary motion of dump flap 120 in a counterclockwise direction (considering Figures 3 and 11) about pivot point 130 opens the bottom of basket 108 permitting material contained within the weigh bin

defined by dump flap 120 and basket 108 to drop into the mixing chamber 20.

Note that knob 138 only contacts operator 134 when piston-cylinder combination 136 has been actuated and the dumping operation is taking place. At all other times, there is no physical contact between weigh bin 15 and knob 138. A spring (not shown) biases dump flap 120 clockwise towards the closed position.

Weigh bin 15 is connected to load cell 32 through an aperture in solid side panel 30C of frame 14, by complementary brackets 156 and 186, as illustrated in Figure 10. Other suitable means for mounting weigh bin 15 respecting load cell 32 are disclosed in pending United States patent application 08/763,053, filed in the name of Stephen B. Maguire on 10 December 1996, and pending Patent Cooperation Treaty patent application PCT/US96/19485, filed 10 December 1996 by Maguire Products, Inc., the disclosures of which are incorporated as reference.

To afford thorough mixing of the blended materials deposited in the mixing chamber 20 by operation of the dump flap 120, mixing agitator 22 is rotatably journaled on preferably transparent, removable front panel 17 of frame 14. Panel 17 fits closely along forwardly facing edges of solid side panels 30A and 30C and is fixed thereto via quick release, hand-actuated clips designated generally 144 in Figure 3. These clips are mountingly connected to a horizontal bar 140 extending across front panel 17 at a lower portion thereof, which provides a solid, preferably metal receptacle mounting for journaling of agitator 22 in transparent removable front panel 17.

Fixed rotatable journaling of agitator 22 in transparent removable front panel 17 provides an important safety feature. If an operator removes front panel 17 by disengaging clips 144, agitator 22

remains fixed to front panel 17 and disengages from the rotary reciprocating drive means, discussed below, and is removed from the mix chamber 20 whenever front panel 17 is removed from blender 10. This provides an important safety advantage in that agitator 22 ceases rotation as panel 17 is moved even slightly away from contact with solid side panels 30A and 30C. Hence, if an operator reaches inside blender 10, there are no moving parts to inflict injury when front panel 17 has been removed.

As illustrated in Figures 13 and 14, agitator 22 includes a central shaft portion 140 with a number of spokes 148 extending radially outwardly therefrom. Extending longitudinally along the outer extremities of radial spokes 148 are mixer rails 150 which extend longitudinally along a major length of central shaft 140 and are curved radially inwardly at the ends of rails 150 which are remote from front panel 17 when the agitator is journaled in panel 17.

Journaling of central shaft 140 in front panel 17 is accomplished using a plastic, preferably Nylon or Celcon, cylindrical bearing member 152 illustrated in Figure 13. The left end of shaft 140 (when considering Figure 13) fits into bearing member 152. Mixer rails 150 and particularly the curved, radially inwardly facing extremities thereof 151 stop short of center shaft 136 in order to provide clearance for a coupling member which removably connects the agitator 22 to the rotary reciprocating drive means.

To facilitate removal of front panel 17 from blender 10, and to provide strength for journaling of bearing member 152 in front panel 17, the metal plate or strap 146 is affixed to front panel 17 and provides a position of attachment for clips 144. A handle 156 is mounted on strap 146 and provides convenient hand gripping for removal of front panel 17 when clips 144 have been disengaged.

Agitator 22 is driven in a manner to reciprocatingly rotate so that agitator 22 rotates about axis 24 defined by central shaft 140 through an angle of about 270° and then reverses, rotating in the opposite direction thorough an angle of about 270°. This is accomplished by using a drive means 26 having two pneumatically driven piston-cylinder combinations reciprocating a rack to which a pinion gear is connected. This drive means is a purchased item and is mounted on the exterior of a rear panel 30B of frame 14 in position to provide coaxial driving rotation of agitator 22.

Means for coupling and decoupling agitator 22 to the reciprocating rotational drive means is provided by a coupling assembly having male and female members which are illustrated generally in Figures 13 and 14. The smaller of the two members forming the coupling is a shaft 158 which is generally cylindrically configured with an axially-extending flat 160 in its cylindrical exterior surface. Female member 170 is of generally cylindrical configuration, with a bore 172 having a longitudinal bore 176 extending the longitudinal length thereof with a complementary flat 178 formed in bore 176 for fitting about the driving shaft 158 providing the source of reciprocating rotational movement for agitator 22.

An important aspect of the invention is the feature whereby the valves designated generally 19 are entirely contained within hoppers 12 and are fixedly secured thereto. As a result, when an operator desires to change a hopper, all that is required is for the operator to disconnect a pneumatic tube from a pneumatic fitting 96 (see Figs. 1 and 3) on a given hopper and lift the hopper off of the supporting outwardly flared cradle 34 on which the hopper rests. Note that hoppers 12 are not mechanically secured to the remainder of blender 10; this is not necessary.

The external pneumatic fitting 96 for each hopper is preferably a quick-connect fitting receiving a pneumatic line 98 connecting the blender control station to the piston-cylinder combination 18 within each hopper 12.

The integral construction of the valve and hopper assembly permits each valve to be removable integrally with its associated hopper, thereby permitting various size valves to be mounted in hoppers. This facilitates changing of valve size by the user so that the user merely need remove the hopper having a given size valve and substitute another hopper having a smaller or other desired size valve in its place. The integral valve-hopper design also contributes to safety in that individuals cannot actuate a valve and injure themselves when a hopper is removed from the blender. The valve and the shut-off mechanism for granular material simply is not present when the hopper is not in place. Once the hopper is in position, an individual cannot insert the individual's fingers into the way of any of the moving parts of the valve within the hopper.

The air cylinders actuating the valves are preferably spring return air cylinders; internal springs act to pull the cylinder pistons up and pull the rods attached to the pistons into the upper position, creating a shut-off. When the tubular members 40 are in the extreme upward positions, no material can flow downwardly therethrough; the hopper is necessarily closed at the bottom and can easily be removed from the cradle formed by the diverging guide flaps 34 without spilling any material that may be in the hopper.

In the variation of this valve which is illustrated in Figures 6 and 8, where the hemispheric or half-circular opening in a tubular portion is covered at the bottom and has a wall running upwardly,

this tubular valve member 40A may be reciprocated up and down to provide very accurate downward metering of material. When such accurate metering of material is desired, a stroke limiter may be used on the rod 42
5 which connects the associated piston.

The piston-cylinder combination 18 is desirably reciprocated electronically, permitting the piston to cycle up to six times per second providing the reciprocation of the tubular valve member 40A.
10 Chamber 38 is stationary, fitting around the reciprocating tubular valve member 40A and being secured to hopper 12. With the tubular valve member 40, when valve member 40 moves up and down, chamber 38 allows granular material to enter tubular valve member
15 40 only when tubular valve member 40 and particularly the port 90 therein is below the horizontal edge defining the lower boundary of chamber 38. Preferably, the valve member 40 is reciprocated to facilitate flow through the hollow valve 40.

20 One pneumatic line preferably goes to each hopper 12 with a quick disconnect fitting to allow the hopper to be removed from the blender. Air is pulsed back and forth by solenoid valves. Since the piston-cylinder combinations have spring return pistons, only
25 one line is needed to each piston-cylinder combination. This is in contrast to prior art gravimetric blenders in which two lines are provided to piston-cylinder combinations driving the various slide gates and other parts of the machine.

30 In the instant invention, the pneumatic supply line goes through the side of each hopper 12 and connects to the piston-cylinder combination within the hopper. Removal of the hopper and piston-cylinder combination is facilitated by disconnecting the
35 pneumatic line at the quick disconnect fitting 96 provided on the exterior of each hopper 12 and picking off each hopper 12 and its associated piston-cylinder

assembly 18 which is one effectively unitary assembly and may be lifted directly off from the cradle formed at the top of blender 10 by the guide flaps 34.

Another important aspect of the invention is in the provision of the separation of knob 138 from operator 134 for opening the dump flap 120 of weigh bin 15. With piston-cylinder combination 136 and knob 138 physically separated from weigh bin 15, there is no external connection to weigh bin 15 during the weighing process and therefore, there is no chance of something such as a pneumatic line introducing an error into the weighing procedure.

Respecting mixing chamber 20, mixing chamber 20 is equipped with a curved side and bottom member which slides into an out of the mixing chamber. This curved member is visible in Figure 3, and is sometimes referred to as a mix chamber insert slide. The slide rests on a plastic saddle 184 which is visible in Figure 3 and is secured to the metal bottom 186 of frame 14. Solid side panels 30A, 30B and 30C of frame 14 are preferably welded to bottom 186 along the three sides of respective contact therewith. Bottom 186 preferably protrudes forwardly relative to sides 30 so as to provide a bottom support transom for transparent removable front panel 17 when panel 17 is in place on blender 10.

Yet another feature of the invention is with agitator 22 being journaled within and removable unitarily with transparent removable front panel 17, there is no need for any interlock between front panel 17 and the drive means providing the reciprocating rotational drive for the agitator. Since agitator 22 is removed with transparent front panel 17, whenever panel 17 is removed, the only moving part remaining in the mixing chamber is the rotating shaft member 158.

When the blender of the invention is used, there is preferably a single controller provided for each

blender in a control station at a remote locale. The controller and microprocessor preferably are not mounted on the frame of the blender as is the case with known, larger gravimetric blenders.

5 Material components which should be fed and controlled in very, very small amounts, such as color components, may be controlled to levels of 3% or 4% of the total blend when the pulsing action of a piston-cylinder combination is applied to a modified version
10 of the tubular valve member 40A as illustrated in Figures 6 and 8. In addition to color additives, ultraviolet stabilizers, inhibitors, strengtheners and the like sometime need to be fed in such very, very small amounts into plastic resin blends prior to
15 molding.

 Using the modification of the tubular valve member 40 illustrated in Figures 6 and 8 and with pulsing action of the spring equipped piston-cylinder combination 18 allows very fine feeding of material.
20 If air pressure is reduced to piston-cylinder combination 18, so as to soften the severity of the reciprocation of the air cylinder, the air cylinder can be regulated to a point where as little as two to three grams of material per second can be accurately
25 fed and feeding can be repeatedly controlled at that rate.

 Another of the important features of this invention is the compact size of the gravimetric blender. The compact size of this blender facilitates
30 use of this blender with very small injection molding and compression molding machines and with small extruders. The small size of the blender in the preferred embodiment of the invention facilitates dispensing of exceedingly small and precisely measured
35 amounts of plastic resin material and other granular materials, as well as liquid color if that might be

desired as a part of the blend, for supplying such small molding machines and extruders.

In the preferred embodiment of the invention, hoppers 12 are eight inches square at the upper
5 extremities thereof; this is denoted by dimension A in Figure 2. The close spacing together of adjacent hoppers, with adjacent hoppers being only about one-eighth inch apart, results in an overall maximum width dimension indicated as B in Figure 2 of about sixteen
10 and one-eighth inches in the preferred embodiment of the invention.

Similarly, the blender in the preferred embodiment of the invention is very compact in height. In the preferred embodiment, the blender is only about
15 twenty-two inches from the top of the hoppers to the base portion of the blender frame. This twenty-two inch dimension is indicated by dimensional arrow C in Figure 3. The pneumatic piston which preferably actuates the weigh bin to dump the weigh bin contents
20 into the mixing chamber is preferably about eleven and five-eighth inches above the base; this dimension is indicated by dimensional arrow D in Figure 3.

Utilizing the reduced size gravimetric blender of the invention, batches of material of about 400 grams
25 may be produced with such batches being produced in less than one minute per batch. Hence, about fifty pounds per hour of blended resin material can be produced using the blender of the invention.

The valve members 19 with the full half-
30 cylindrical opening as illustrated in Figures 4, 5 and 7 may dispense material at about 35 grams per second. When the pulsing technique is used and the modified version of the tubular valve member 40A illustrated in Figures 6 and 8 is used, feeding of plastic resin
35 material pellets can be controlled to a level down below one gram of feed per second.

While particular embodiments of the invention have been herein illustrated and described, it is not intended to limit the invention to such disclosures, but changes and modifications may be made therein and
5 thereto within the scope of the following claims.

CLAIMS

1. A gravimetric blender comprising a vertically elongated housing; a material storage hopper removably mounted on or in said housing and comprising means proximate the hopper bottom within said hopper for
5 dispensing material from within said hopper; a weigh bin connected to said housing below said hopper to receive the dispensed material; means connected to said housing for sensing weight of material received in said bin; and a mix chamber below said weigh bin to
10 collect the material from the bin after its weight has been sensed, and operable to blend the collected material; characterized in that
- a. said housing comprises a metal frame having an open side exposing the interior of said housing for
15 access to said weigh bin and said mix chamber and a transparent panel closing said open side, said panel being removably mounted on said metal frame to permit accessing the interior of said housing;
- b. said housing having a cradle at its upper
20 end removably supporting said material storage hopper in a position overlying said weigh bin;
- c. said weigh bin having an openable portion for opening said bin to discharge the received material into said mixing chamber, and means mounted
25 on the frame to actuate said openable portion; and
- d. said mixing chamber has a mixer for blending the material collected in the chamber, said mixer being mounted on said transparent panel so as to be removed from said mixing chamber when said transparent
30 panel is removed to access the interior of said housing.

2. The gravimetric blender of claim 1 wherein said hopper includes a valve and means for actuating said valve to dispense material, said valve and said valve





actuating means being fixedly connected to said hopper for removal with said hopper.

3. The blender of claim 2, said frame having a plurality of sides with diverging guide flaps at the top of said sides forming said cradle with an open
5 top, wherein said hopper with said valve and actuating means affixed thereto is seated in said cradle so as to be manually removable from said housing.

4. The blender of claim 3 further comprising a
10 plurality of hoppers, each with valve means therewithin and respective individual valve actuation means.

5. The blender of claim 1 wherein said actuating means of said weigh bin comprises a cylinder outboard
15 of said housing and a piston projecting into said housing to displace said openable portion.

6. The blender of claim 5 wherein said weigh bin is mounted on said housing by a load cell, and has a open
20 bottom, said openable portion defining a portion of the bin bottom and having an operator engageable by said piston.

7. The blender of claim 1 further comprising drive means for operating said mixer, said drive means being mounted on said frame and having a releasable
25 connector between said drive means and said mixer operable to be disconnected upon removal of said mixer with said transparent panel.

8. A gravimetric blender comprising a vertically elongated housing; a material storage hopper removably
30 mounted on or in said housing and comprising means proximate the hopper bottom within said hopper for





dispensing material from within said hopper through an orifice in said hopper bottom; a weigh bin connected to said frame below said hopper to receive the dispensed material; means connected to said frame for
5 sensing weight of material received in said bin; and a mix chamber below said weigh bin to collect the material from the bin after its weight has been sensed, and operable to mix the collected material; characterized in that

10 said means for dispensing material from within the hopper comprises a valve for dispensing a precisely controlled flow of granular material, said valve comprising a reciprocable tubular valve member axially aligned with and slidably axially upwardly and
15 downwardly within said bottom orifice,

said tubular valve member having a lateral port formed therein remote from the vertical extremities of said member, a lower end of said tubular member defining a discharge opening for granular material
20 dispensed therefrom;

a chamber at least partially surrounding said tubular member, having an open lower end spaced above said orifice;

said chamber open end affording flow of material
25 from said storage device through the port in said tubular member when the port in said tubular member is at a first position below said open end, said port being displaced upwardly when said tubular member is at a second position; and

30 actuator means for vertically moving said tubular member upwardly and downwardly between said first and second positions.

9. The blender of claim 8 wherein said actuator includes control means to initiate operation of said
35 reciprocating means to cause flow of material from the interior of the storage device through the hollow





member, and to arrest operation of said reciprocating means to arrest flow.

10. The blender of claim 9 wherein said control means effects pulsating longitudinal displacement of said member between said initiation and said arrest of the operation of said reciprocating means.

11. The blender of claim 8 wherein said chamber has an upper end closed by a wall, and said second position of the tubular member disposes said port within said chamber above the lower end of the chamber, so that the chamber blocks direct access of the port to the interior of the hopper above said lower end when in the second position, and affords direct access of the port to the interior of the hopper when in the first position.

12. The blender of claim 8 including a wall extending from below the lower side of said port within said hollow member upwardly beyond the upper side of said port, said wall blocking downward flow from said port through the hollow member but affording upward flow through said member along the side of the wall confronting said port, said wall terminating at its upper end in a weir affording downward flow through said hollow member and the orifice along the side of the wall opposite to the said side confronting said port.

13. A gravimetric blender comprising a vertically elongated housing; a material storage hopper removably mounted on or in said housing and comprising means proximate the hopper bottom within said hopper for dispensing material from within said hopper through an orifice in said hopper bottom; a weigh bin connected to said frame below said hopper to receive the





dispensed material; means connected to said frame for sensing weight of material received in said bin; and a mix chamber below said weigh bin to collect the material from the bin after its weight has been
5 sensed, and operable to mix the collected material; characterized in that

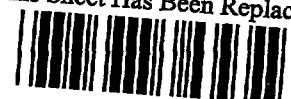
a. said housing comprises a frame having an open side exposing the interior of said housing for access to said weigh bin and said mix chamber and a
10 panel closing said open side, said panel being removably mounted on said frame to permit accessing the interior of said housing;

b. said weigh bin having an openable portion having an operator for opening said bin to discharge
15 the received material into said mixing chamber, and means mounted on the frame to actuate said openable portion; and

c. a load cell mounted on said housing in registry with said weigh bin, said cell having a
20 support bracket projecting into the interior of said housing to removably support the weigh bin;

d. said actuating means for opening said openable portion comprising a piston normally separated from said operator, and positioned in
25 alignment with said operator so that upon actuation, said piston engages said operator and opens said openable portion, whereby said weigh bin is manually removable from its support on the load cell bracket.

30 14. A gravimetric blender comprising a vertically elongated housing; a material storage hopper removably mounted on or in said housing and comprising means proximate the hopper bottom within said hopper for dispensing material from within said hopper; a weigh
35 bin connected to said housing below said hopper to receive the dispensed material; means connected to said housing for sensing weight of material received





in said bin; and a mix chamber below said weigh bin to collect the material from the bin after its weight has been sensed, and operable to mix the collected material; characterized in that

- 5 a. said housing comprises a frame having an open side exposing the interior of said housing for access to said weigh bin and said mix chamber and a panel closing said open side, said panel being removably mounted on metal frame to permit accessing
- 10 the interior of said housing;
- b. said mixing chamber comprises a bottom member and a mixer for blending the material collected in the chamber, said blender being mounted on said panel so as to be removed from said mixing chamber
- 15 when said panel is removed to access the interior of said housing; and
- c. a support pad in the bottom of said housing underlying and supporting mixing chamber bottom member for ready removal thereof from said housing when said
- 20 panel is removed from said open side.

15. A gravimetric blender according to any one of the preceding claims wherein all of the removable components are of a small size so that they may be removed and replaced in the blender without use of
- 25 power equipment by an operator of normal size and strength.

