May 18, 1965 C. W. VOGT 3,183,570

COMPACTING EQUIPMENT

Filed March 21, 1960

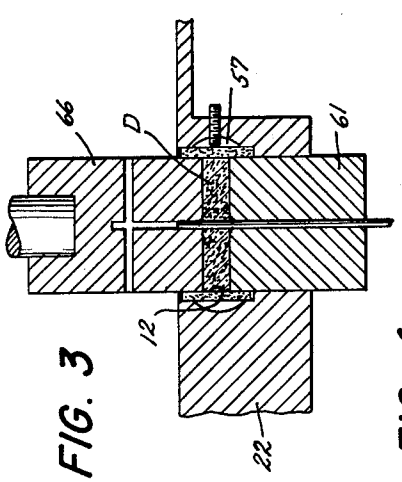


FIG. 3

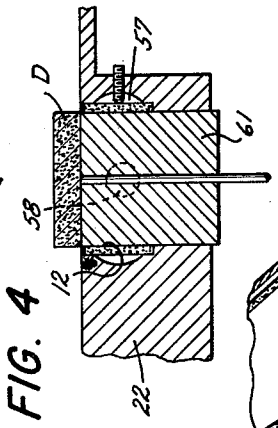


FIG. 4

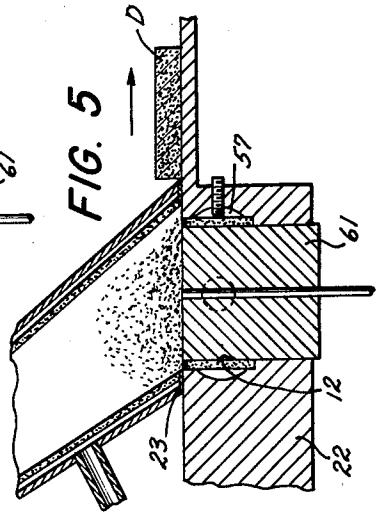


FIG. 5

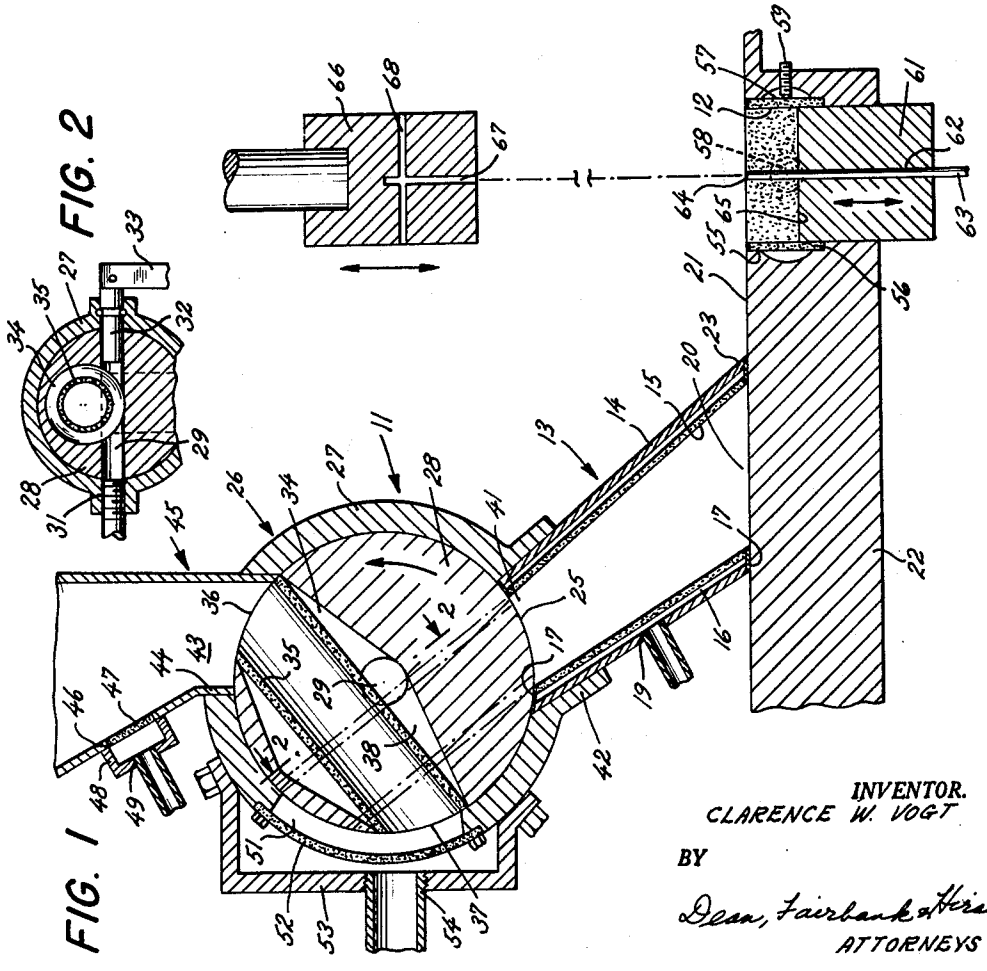


FIG. 2

FIG. 1

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COMPACTING EQUIPMENT

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This invention relates to equipment for compacting finely-divided or comminuted materials or the like, and more particularly to a method and equipment for forming discs, wafers or briquettes or the like of such material.

As conducive to an understanding of the invention, it is noted that where discs or similar articles are made from powdered glass or the like, such material, without the presence of a binder such as carbowax, is extremely difficult to handle, as it dusts readily and hence is quite dangerous to the workers. In addition, without the presence of such a binder, it is difficult to fill cavities in a mold with such material, as the latter does not flow readily.

Where, to prevent dusting and to permit more ready flow of the material, it is mixed with a binder such as carbowax, such operation is time-consuming and requires additional plant facilities, thereby adding greatly to the cost of the finished product.

Furthermore, where the material with the added binder after being formed in the cavity is removed therefrom and progressively increasing temperatures are applied toward the melting point of the glass particles to remove such binder and to bond such particles together, shrinkage of the resultant product will occur as the glass particles fill the voids created by removal of the binder.

Where, in making small discs, the mold cavity in which they are formed has one or more outstanding pins to form corresponding holes in the disc where desired, through which wires or terminal pins may later be inserted, when the material even with binder added is charged into the cavity by gravity flow, due to the presence of the pins, bridging may occur so that the cavity is not uniformly filled. Consequently, when a plunger is thereafter forced into the mold cavity under relatively great pressure to compact the material therein, since the quantity of material charged into the mold cavity may not be exactly the same for successive chargings, the resultant compacted discs may have different densities. This may be extremely important, for example, where the discs are used in the manufacture of capacitors, for differences in the densities of the discs may affect the capacitance of the resultant capacitor so that with any run of discs fabricated the capacitances may vary appreciably.

It is also to be noted that if when the mold cavity is charged, an appreciable amount of gas should be entrapped therein, when the material is subsequently fired, cracking of the resultant disc may occur so that it is not useful for its intended purpose.

Where, after the mold cavity is charged and a plunger forced into the cavity to compact the material therein, the floor of the cavity is raised to lift the disc formed therein to facilitate removal, if the material charged into the mold cavity adheres to the wall thereof, the disc when removed from the cavity may have an irregular periphery, which often necessitates discarding of the disc.

It is accordingly among the objects of the invention to provide a method and equipment which is relatively simple in construction and dependable in operation for forming discs or the like from finely-divided or comminuted materials such as powdered glass without the need of the addition of a binder thereto, yet without any dusting during the forming operation, and which will ensure dependable and accurate filling of the mold cavity

in which the discs are formed, with a predetermined volume and density of material in compacted form, and without bridging even when pins are present in the cavity, and will ensure that the disc when subsequently compacted by mechanical pressure may thereafter readily be removed from the cavity without crumbling and without the presence of excessive amounts of entrapped air, which might cause cracking of the disc when subsequently fired.

According to the invention, these objects are accomplished by the arrangement and combination of elements hereinafter described and particularly recited in the claims.

In the accompanying drawings in which is shown one of various possible embodiments of the several features of the invention,

FIG. 1 is a sectional view of the equipment,

FIG. 2 is a detail sectional view taken along line 2—2 of FIG. 1, and

FIGS. 3–5 are detail views of the mold cavity at various stages of the filling operation.

Referring now to the drawings, the filling head **11** shown in FIG. 1 is designed to charge one or more cavities **12** with a predetermined quantity of material.

The filling head desirably comprises a magazine **13** which may comprise an elongated hollow outer casing **14** having positioned therein a filter liner **15** slightly spaced from the adjacent wall of the casing, said liner preferably being of porous material such as sintered metal which has substantially no individual pores extending completely through the filter wall.

As shown in FIG. 1, the liner **15** is illustratively the length of the casing **14** and the ends of the annular space **16** between the liner and the casing are closed as at **17**, the casing **14** having a port **19** leading into said space **16**.

The outlet end **20** of the magazine **13** is designed slidingly to engage the top surface **21** of a plate **22** in which the mold cavities **12** are formed, with the periphery **23** of said outlet **20** forming a seal with respect to said plate **22** and being of diameter greater than the diameter of said cavity **12**.

Associated with the inlet end **25** of the magazine is a valve **26**, which desirably is a ball valve having an outer casing **27** in which a ball member **28** is rotatably mounted.

The ball member **28** has a bore **29** extending diametrically therethrough, one end of the bore **29** being in communication with a port **31** in casing **27**. A shaft **32** extends into the casing **27** and into the other end of the bore and is secured therein, the shaft having a handle **33** secured to its outer end for rotation of said ball member **28**.

As shown in FIG. 1, the ball member **28** has a bore **34** extending therethrough displaced from the bore **29** and illustratively extending at right angles thereto. The bore **34** has a cylindrical sleeve **35** extending completely therethrough between the ends **36**, **37** of the bore **34**, the sleeve **35** also being of porous material such as sintered metal. Desirably, the bore between its ends **36**, **37** is enlarged as at **38** to define a chamber in communication with the bore **29** of ball member **28**.

The casing **27** has an outlet port **41**, which preferably has a cylindrical outstanding peripheral flange **42** to accommodate the inlet end **25** of the magazine **13**, as shown in FIG. 1. In addition, the casing has an inlet port **43** to accommodate the discharge end **44** of a hopper **45**, the wall of the hopper adjacent its discharge end having an aperture **46** in which a porous filter **47** is positioned, a casing **48** being positioned over said filter **47** to permit entry of gas under pressure through a port **49** in said casing.

In addition to ports **41** and **43**, the casing **27** has an

aperture 51 over which is positioned a porous plate 52 and a casing 53 is secured to casing 27 over porous plate 52, said casing 53 having a port 54 leading thereinto.

The ports 41, 43, the aperture 51 and the bore 34 are so positioned that when the ball member 28 is in the filling position shown, the ends 36, 37 of bore 34 will be in communication with port 43 and aperture 51 respectively, and when the ball member 28 has been rotated substantially 90 degrees in a counterclockwise direction from the position shown in FIG. 1, the ends 36, 37 of bore 34 will be in communication with aperture 51 and port 41 respectively.

The mold cavity 12, as shown in FIG. 1, for example, is cylindrical and is of enlarged diameter at its upper end as at 55 to accommodate a cylindrical porous sleeve 56, also preferably of sintered material, the inner bore diameter of which is desirably the same as that of the cavity. The wall of the cavity 12 adjacent the sleeve 56 has an annular groove 57 and a port 58 leads into said annular groove.

The length of the sleeve is greater than the maximum height of the article to be formed therein and the sleeve is securely yet releasably retained in place as by a set screw 59.

Slidably mounted in the sleeve 56 and in cavity 12 is a plunger 61, which may be moved vertically in any suitable manner. The plunger illustratively has an axial bore 62 extending therethrough which may accommodate a pin 63, the upper end 64 of which illustratively is aligned with the plane of the top surface 21 of plate 22. The pin 63 normally is retained in fixed position so that the top surface 65 of the plunger, which defines the floor of the cavity 12, may be moved flush with the upper end 64 of the pin 63.

In addition, a second plunger 66 is provided, vertically aligned with cavity 12 and movable into the sleeve 56, the diameter of the plunger 66 being only slightly less than that of sleeve 56, so that only the slightest clearance will be provided sufficient to permit movement of the plunger 66 into and out of sleeve 56.

As shown in FIG. 1, the plunger desirably has a vertical bore 67 aligned with the pin 63 and a vent 68 is provided in the plunger leading into said bore 67.

In the operation of the equipment, the hopper 45 is filled with the material to be compacted which, for example, may be powdered glass without any binder. The ball member 28 is positioned as shown in FIG. 1, with the ends 36, 37 of bore 34 aligned with port 43 and aperture 51, and the outlet end 20 of the magazine is positioned so that it is spaced from the cavity 12.

Thereupon, gas is forced through bore 49 and porous plate 47 under a pressure sufficient to fluidize slightly the material at the lower end of hopper 45 to permit ready movement of such material but not sufficient to cause the material to blow out of the inlet to the hopper. Suction is then applied to port 54 and through porous plate 52 to react against the end 37 of bore 34 to cause the fluidized material in the hopper 45 to fill the porous sleeve 35. The movement of material from the hopper 45 into the sleeve 35 is expedited by applying suction through port 31 of casing 27 and bore 29 to chamber 38 and thence through the porous sleeve 35.

Thereupon, the ball member 28 is rotated in a counterclockwise direction from the position shown in FIG. 1 substantially 90 degrees so that the ends 36, 37 of bore 34 are aligned with aperture 51 and bore 41 respectively. In this position, the discharge end 44 of the hopper will be sealed by the ball valve.

The gas under pressure applied to port 49 may now be cut off or allowed to continue if desired, and instead of suction being applied to ports 31 and 54 gas under superatmospheric pressure is applied thereto.

As a result, the contents of the sleeve 35 will be forced therefrom and discharged into the magazine 13, the outlet end of which is closed by reason of its position against the top surface 21 of plate 22.

Gas entrained with the material forced into the magazine, and that displaced by such material, will be vented from the magazine through the porous liner 15 and bore 19.

The above operation is repeated until the magazine 13 has been filled with material and as such material is forced into the magazine under superatmospheric pressure, and as gas is vented from the magazine through the porous liner 15, the material in the magazine will be substantially compacted and with a minimum of entrapped gas.

With the magazine 13 charged as above set forth, the equipment is now ready to fill the mold cavity 12.

To this end, the magazine 13 and the associated valve 26 and hopper 45 are moved laterally so that the outlet end 20 of the magazine is directly over the cavity 12, the plunger 61 of which preferably has previously been moved upwardly so that its upper surface 65 is flush with the top surface of plate 22 and the upper end 64 of pin 63.

At this time, the ball member 28, the sleeve 35 of which had previously been charged as above described, is rotated so that the ends 36, 37 of sleeve 35 are aligned with aperture 51 and port 41.

Thereupon, gas under superatmospheric pressure is applied to ports 54 and 31 to react against the material in sleeve 35 to urge the latter through port 41. However, as the magazine is filled with compacted material, and as the top 65 of the plunger 61 is aligned with the top surface of plate 22 as shown in FIG. 5, no material will flow out of the magazine.

Substantially simultaneously with the application of gas under pressure to ports 54 and 31, the plunger 61 is lowered to a predetermined position in the cavity. By reason of the compaction of the material in the magazine, it has been found that often, even when the gas pressure is relatively great, depending upon the length of the magazine, the compacted material in the magazine will not readily move downwardly. Accordingly, gas under a pressure of say 25 p.s.i., which may be considerably less than that applied to ports 54 and 31, i.e., say 75 p.s.i., is also substantially simultaneously applied to port 19.

It is to be noted that in some cases there is no need to apply gas under pressure to ports 31 and 54, but only to port 19, and this is done when the port 41 is closed by the ball member 28.

The gas under pressure applied to port 19 will enter the annular chamber 16 and be dispersed through the porous liner 15 to react against the side wall of the column of material in the magazine.

As a result of the lateral pressure effected by the gas entering port 19, the column of material in the magazine will tend to be compacted laterally to free the outer surface of such column of material from the liner 15. This, together with the film of gas encompassing the column of material, will facilitate its downward movement by reason of the gas pressure applied to ports 54 and 31, which reacts against the upper end of the material in the magazine, or if port 41 is closed, the gas under pressure applied through port 19 will also react against the top of the material in the magazine, and as the plunger 61 is lowered the material in the magazine will follow its movement downwardly to fill the cavity with such material in compacted form.

As the material in the magazine is positively moved into the cavity in somewhat compacted form, no bridging of such material will occur by reason of the pin 63. Furthermore, since the top surface 65 of the plunger 61 is initially aligned with the top surface of the plate 22, and as the lower end of the magazine, which is filled with material in compacted form, is against such top surface 65, substantially no gas will be entrapped in the cavity when it is filled by downward movement of plunger 61. In addition, as the port 58 of cavity 12 is

vented to atmosphere at this time, gas that might be entrapped will escape from the cavity through the porous sleeve **56** and port **58**.

When the cavity **12** has been charged as above described with any given type of material, since the gas pressure applied and the downward position of the plunger **61** may be held to extremely close tolerances, it is apparent that the density of the material charged into the cavity will be the same for each successive filling and also, since the material is compacted in said cavity, it will be of uniform density.

At this time, the gas under pressure applied to ports **54** and **31** and port **19** is cut off and such ports are vented to atmosphere, for example. The magazine **13** and associated valve **26** and hopper **45** are moved laterally away from the cavity **12**, the outlet end **20** of the magazine being again sealed by the top surface of plate **22** over which the periphery **23** of said outlet end **20** of the magazine slides.

The ball member **28** may be rotated 90 degrees in a clockwise direction to the filling position of sleeve **35** thereof, in which the ends **36, 37** of the sleeve are aligned with port **43** and aperture **51**, and the sleeve charged as previously described by applying suction to ports **31** and **54** and gas pressure to port **49**.

It is to be noted that since the porous sleeve **35** and porous plate **52** were cleaned by the application of gas under pressure thereto as previously described, the suction effect will not be minimized by previous clogging of the porous members **35** and **52**.

With the magazine laterally displaced from the cavity **12**, which is charged with material as shown in FIG. 1, the plunger **66** is now moved downwardly into the sleeve **56** under a force sufficient to further compact the material a desired amount. The bore **67** of the plunger **66** will accommodate the pin **63** and gas entrapped in the bores will escape through the vents **68**.

If desired, in addition to moving the plunger **66** downwardly to effect such further compaction, the plunger **61** may also be moved upwardly.

As the plunger **66** is moved downwardly and enters the sleeve **56**, a source of gas under a pressure of say 25 p.s.i. is applied to port **58** to exert lateral pressure against the periphery of the compacted material in the sleeve **56** to ensure that any loose particles will be compacted laterally and to reduce adhesion of the periphery of such material to the sleeve **56**.

If desired, instead of relatively dry gas under pressure being applied to port **58**, in some applications, a moist gas, steam under pressure, a vaporized wax under superatmospheric pressure or the like may be applied to such port to cause bonding of the periphery of the material in the sleeve **56** in addition to reducing the adhesion of such periphery to the sleeve **56**.

When the plunger **66** has moved downwardly to a predetermined position, as shown in FIG. 3, the gas pressure applied to port **58** is cut off and the port **58** is vented to atmosphere and the plunger **66** is then completely withdrawn from the sleeve **56**.

To remove the compacted material, which is now in the form of a disc D for example, from the sleeve **56**, the plunger **61** is moved upwardly until its top surface **65** is aligned with the top surface **21** of plate **22**, as shown in FIG. 4.

Since the frictional engagement of the periphery of the disc with the wall of sleeve **56** has been greatly minimized by the lateral gas pressure applied through port **58**, upward movement of the plunger **61** and the disc D will be greatly facilitated, thereby reducing wear both on the plunger **61** and the inside surface of the sleeve **56**.

Although in the illustrative example shown, the disc D is removed by raising the plunger **61**, it is within the scope of the invention to have the mold cavity **12** and the porous sleeve **56** therein made in sections, as shown in co-pending application Serial No. 809,046, now Patent No. 3,059,275, granted October 23, 1962. In such case, the disc D may be removed by spreading the mold sections sufficiently to facilitate lateral movement of the disc from the top surface of the plunger **61**.

It is also within the scope of the invention to have one or more pins carried by the plunger **66** rather than by plunger **61**, in which case the pins would penetrate the compacted material in sleeve **56** as plunger **66** was moved downwardly.

When the magazine **13** is moved over the cavity for the next filling cycle, the periphery of the outlet end of the magazine will abut against the disc D previously formed to move it laterally away from the cavity as shown in FIG. 5.

Thereupon, the discs may be further processed as by heating in a suitable furnace.

With the equipment above described, since the sleeve **56** is removable from the cavity, it may readily be replaced when it has worn, thereby eliminating the necessity to replace the mold itself, which would be much more expensive.

As many changes could be made in the above method and equipment, and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. Filling equipment for comminuted material comprising a mold having a cavity therein, said cavity having a peripheral wall, a floor and a mouth, a filter member of porous material defining said wall of said cavity, means to apply pressure against the contents of said cavity in direction substantially parallel to said wall thereof, means to apply a source of gas under superatmospheric pressure through said filter member to apply lateral pressure against the contents of said cavity, means to discontinue application of said lateral pressure and substantially simultaneously discontinue said pressure parallel to said wall of the cavity and means forming part of the cavity to thereupon effect removal of the contents of said cavity.

2. The combination set forth in claim 1 in which the first pressure-applying means comprises a plunger movable into said cavity to compact the material therein.

3. The combination set forth in claim 1 in which a plunger is slidably mounted in said cavity, one end of said plunger defining the floor of said cavity, said plunger being movable in said cavity to bring said end thereof flush with the mouth of said cavity to effect removal of such material.

4. The combination set forth in claim 1 in which said cavity has a tubular seat, said filter is a sleeve positioned in said tubular seat, the end of said sleeve adjacent the mouth of said cavity being sealed.

5. Filling equipment for comminuted material comprising a mold having a cavity therein, said cavity having a peripheral wall, a floor and a mouth, a filter member of porous material defining said wall of said cavity, a filling head having a chamber therein having an outlet, a hopper for such material, means to charge said chamber from such hopper, means to align the outlet of said chamber with the mouth of said cavity, means to apply gas under superatmospheric pressure to said chamber to force the material therein into said cavity, means to move said outlet away from the mouth of said cavity, means to apply pressure against the contents of said cavity in direction substantially parallel to said wall thereof, means to apply a source of gas under superatmospheric pressure through said filter member to apply lateral pressure against the contents of said cavity and means to effect removal of the contents of said cavity.

6. The combination set forth in claim 5 in which said

chamber in said filling head has a porous liner, and means are provided to apply suction through said liner to said chamber to effect filling thereof from said hopper.

7. The combination set forth in claim 6 in which said filling head has a ball valve having a casing and a ball member rotatably mounted in said casing, said ball member has a bore therethrough, a porous liner is positioned in said bore defining said chamber, one end of the liner defining the outlet of the chamber and the other end the inlet thereof, said casing having an inlet port and an aperture, means to rotate said ball member to bring said inlet and outlet ports thereof in communication with said casing inlet port and said aperture respectively in one position of said ball member and to bring said inlet and outlet ports of said ball member in communication with said aperture and said outlet port respectively in another position of said ball member, said gas under pressure being applied to said casing aperture when said inlet port of the chamber is aligned therewith.

8. The combination set forth in claim 7 in which a porous member is positioned over said aperture and means are provided to apply suction through said porous member and said aperture when the outlet port of the chamber is aligned therewith.

9. The combination set forth in claim 7 in which a porous member is positioned over said aperture and means are provided to apply suction through said porous member and said aperture and through said porous liner when the outlet port of the chamber is aligned with said aperture.

10. Filling equipment for comminuted material comprising a plate having a mold cavity therein, said cavity having a peripheral wall, a floor and a mouth aligned with the top surface of said plate, a filling head having a chamber therein and having an outlet in communication with said chamber and adapted slidingly to engage the top surface of said plate to be closed thereby and to be moved over the mouth of said cavity, means to charge said chamber with such material, means to apply gas under super-atmospheric pressure to said chamber to force the material therein into said cavity in compacted form, means to effect movement of the outlet laterally away from said cavity and means to effect removal of the contents of said cavity, a filter member of porous material defining said wall of said cavity, means when the outlet of said chamber has been moved laterally away from said cavity to apply pressure against the contents of said cavity in direction substantially parallel to said wall thereof, and means to apply a source of gas under super-atmospheric pressure through said filter member to apply lateral pressure against the contents of said cavity.

11. Filling equipment for comminuted material comprising a plate having a mold cavity therein, said cavity having a peripheral wall, a floor and a mouth aligned with the top surface of said plate, a filling head having a chamber therein and having an outlet in communication with said chamber and adapted slidingly to engage the top surface of said plate to be closed thereby and to be moved over the mouth of said cavity, means to charge said chamber with such material, means to apply gas under super-atmospheric pressure to said chamber to force the material therein into said cavity in compacted form, means to effect movement of the outlet laterally away from said cavity and means to effect removal of the contents of said cavity, a plunger slidingly mounted in the cavity, one end of the plunger defining the floor of said cavity, a filter member of porous material defining said wall of said cavity, means when the outlet of said chamber has been moved laterally away from said cavity to apply pressure against the contents of said cavity in direction substantially parallel to said wall thereof, and means to apply a source of gas under super-atmospheric pressure through said filter member to apply lateral pressure against the contents of said cavity, whereby when said plunger is lifted the contents of said cavity will be readily removed therefrom.

12. Filling equipment for comminuted material comprising a plate having a mold cavity therein, said cavity having a peripheral wall, a floor and a mouth aligned with the top surface of said plate, a filling head having a chamber therein and having an outlet in communication with said chamber and adapted slidingly to engage the top surface of said plate to be closed thereby and to be moved over the mouth of said cavity, means to charge said chamber with such material, means to apply gas under super-atmospheric pressure to said chamber to force the material therein into said cavity in compacted form, means to effect movement of the outlet laterally away from said cavity and means to effect removal of the contents of said cavity, a plunger slidingly mounted in said cavity, one end of the plunger defining the floor of the cavity, a filter member of porous material defining said wall of said cavity, a plunger movable into said cavity, after movement of said outlet laterally away from said cavity, to apply pressure against the contents thereof in direction substantially parallel to said wall thereof, and means to apply a source of gas under super-atmospheric pressure through said filter member to apply lateral pressure against the contents of said cavity, whereby when said second plunger is removed from said cavity and the first plunger is lifted, the contents of said cavity will be removed therefrom.

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