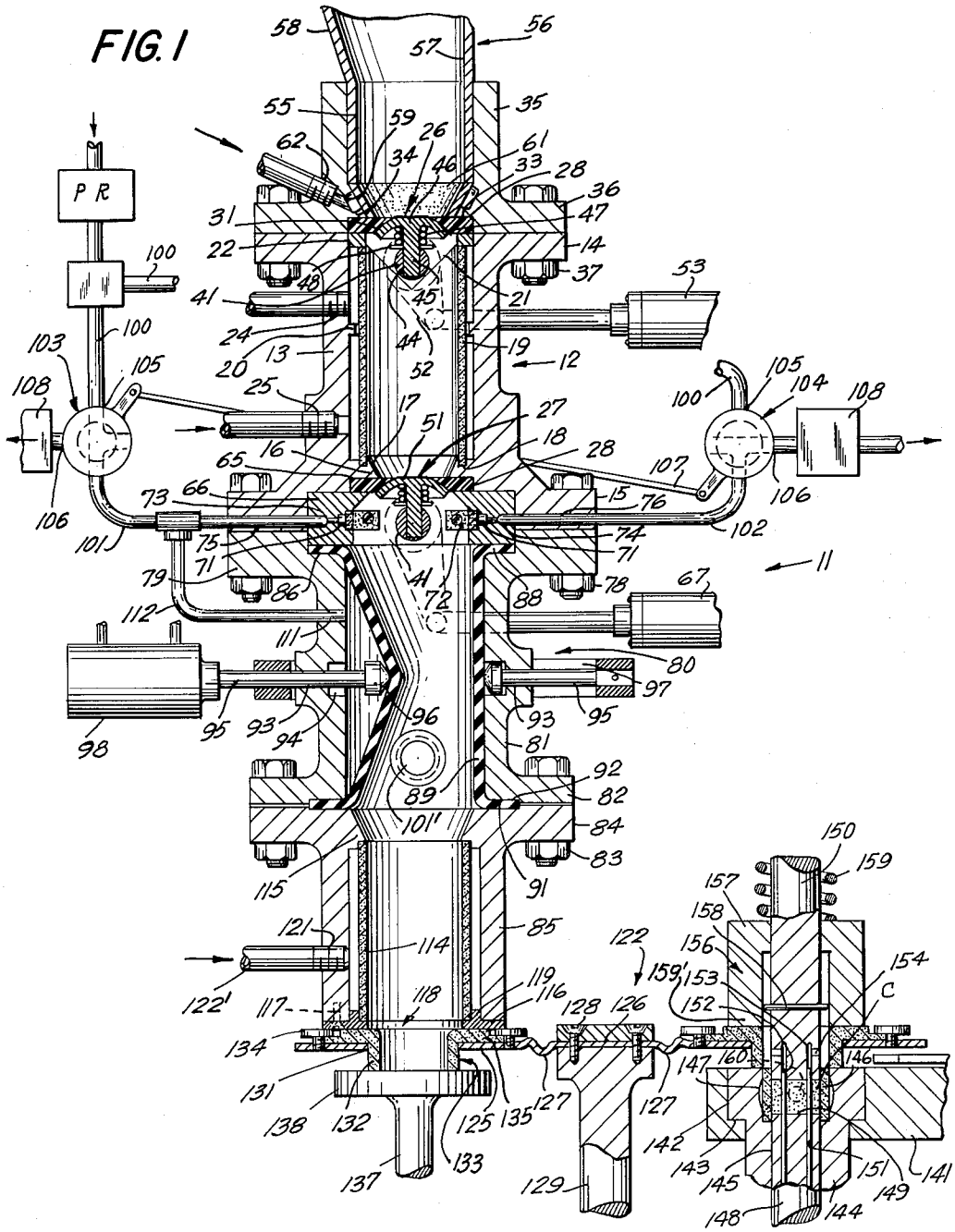
Aug. 18, 1964 C. W. VOGT 3,144,683

MATERIAL COMPACTING AND MOLD CHARGING APPARATUS

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FIG. 1



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FIG. 2

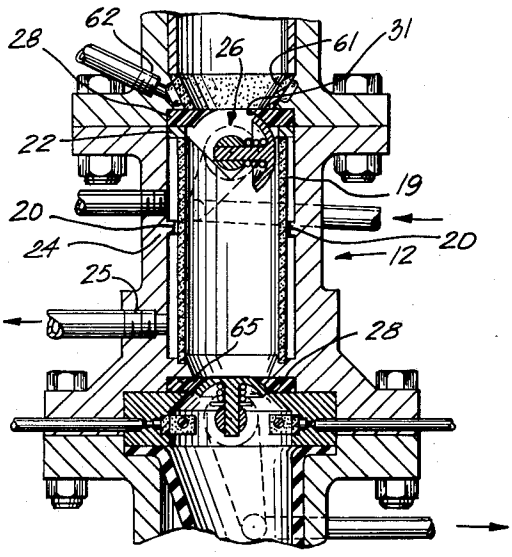


FIG. 3

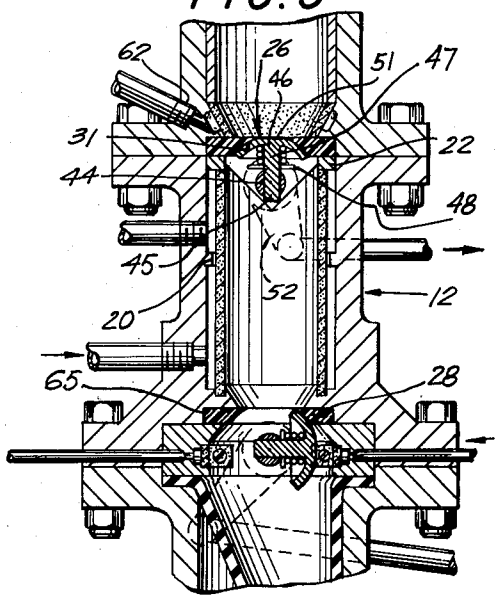


FIG. 5

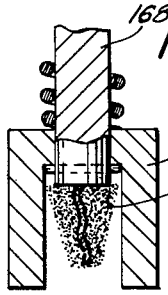
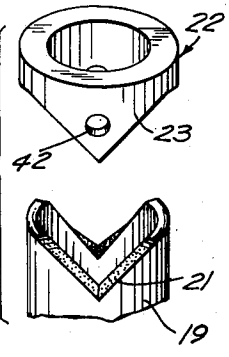


FIG. 6



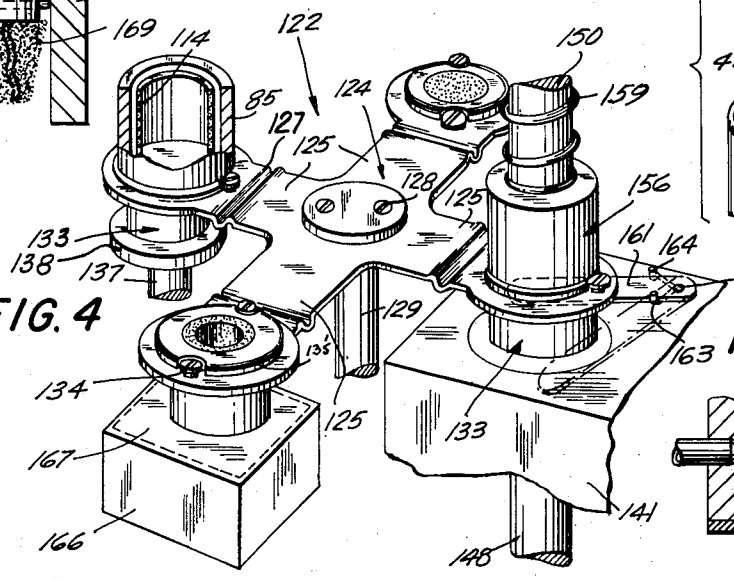
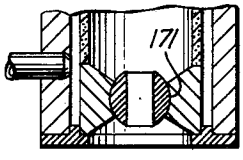


FIG. 4

FIG. 7



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3,144,683
MATERIAL COMPACTING AND MOLD CHARGING APPARATUS

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Filed July 26, 1960, Ser. No. 45,363
11 Claims. (Cl. 18—30)

This invention relates to equipment for compacting finely-divided or comminuted materials or the like, and more particularly to an automatic 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 exteremely 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 dos 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, when the material even with binder added is charged into the cavity by gravity flow and bridging occurs, the cavity will not be uniformly filled. Cnsequently, 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 perirphery, which often necessitates discarding of the disc.

It is accordingly among the objects of the invention to provide an equipment for automatically 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 one or more mold cavities in which the discs are formed, with a predetermined volume and density of material in compacted form, and will ensure that the discs when subsequently compacted by mechanical pressure may thereafter readily be removed from the cavities, without crumbling and without the presence of excessive amounts of entrapped air, which might cause cracking of the discs 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.

This application is a continuation-in-part of copending application Serial No. 16,543, filed March 21, 1960.

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

FIG. 1 is a longitudinal sectional view of the equipment with parts broken away,

FIG. 2 is a detail longitudinal sectional view of the charging chamber in communication with the hopper,

FIG. 3 is a view similar to FIG. 2 of the charging chamber in communication with the magazine,

FIG. 4 is a perspective view of the transfer member,

FIG. 5 is a detail view of the cleaning brush,

FIG. 6 is a fragmentary exploded perspective view of the liner of the charging chamber, and

FIG. 7 is a detail of a modification of the magazine outlet.

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

The filling head comprises a charging chamber **12**, which includes a cylindrical sleeve **13** having outsanding flanges **14**, **15** at its upper and lower ends, respectively. The lower end of the sleeve **13** has an inwardly extending flange **16** in a plane above that of flange **15**, the inner periphery of flange **16** being beveled as at **17** to define the outlet port of chamber **12**, said flange **16** having an annular groove **18** in its top surface.

Seated in said groove **18** is the lower edge of a cylindrical filter liner **19**, which is slightly spaced from the wall of sleeve **13**, said filter liner preferaby being of porous material such as sintered metal, which has no individual pores extending completely through the filter wall.

The upper end of the filter liner **19** has two diametrically opposed substantially V-shaped slots **21** (FIG. 6), and an annulus **22**, substantially rectangular in cross section and having a pair of diametrically opposed depending V-shaped plates **23** complementary to slots **21**, is positioned on said upper end. The annulus **22** and the plates **23** are secured as by welding to the upper end of the liner and to the edge of slots **21**, the top surface of the annulus **22** being flush with the top surface of flange **14**.

As shown in FIG. 1, the outer diameter of annulus **22** is substantially equal to the inner diameter of sleeve **13** so as to fit snugly therein, the inner periphery of the annulus defining the inlet port of the chamber **12**, the latter having two lateral ports **24**, **25**, the purpose of which will herenafter be described, the port **24** being positioned between the upper end of the sleeve **13** and an annular flange **20** extending inwardly from the sleeve **13** and spaced from liner **19**.

Valve means **26**, **27** are provided to control the inlet and outlet ports of the chamber **12**.

As illustratively shown, each of the valves comprises a valve seat **28** desirably formed from an annulus of plastic material such as "Nylon," the inner periphery of said annulus having an arcuate bevel **31**.

In the case of valve **26**, the annulus **28** is seated in an annular recess **33** at the lower end of an inwardly extending flange **34** at the lower end of a sleeve **35**, the latter having an outstanding flange **36** which is secured to flange **14** as by bolts **37**.

With the flanges **14**, **36** thus secured, the annulus **28** will be securely retained in place to form a gas-tight seal between sleeves **13** and **35**.

The movable portion of the valve **26** may comprise a shaft **41** which extends transversely through diametrically aligned openings **42** in plates **23**, suitable seal rings encompassing said shaft to provide a gas-tight seal with respect to openings **42**.

The shaft has a transverse bore **44** to receive the end of a stem **45**, which mounts a valve head **46** at one end, a coil spring **47** encompassing said stem and being compressed between the head **46** and a washer **48**.

As shown in FIGS. 1 to 3, the valve head **46** has a curved surface complementary to the curvature of valve seat **31** and the axial portion of said valve head is flattened as at **51**.

Thus, with the valve head **46** positioned as shown so that it is axially aligned with the seat **31**, the coil spring **47** will retain the valve head **46** in sealing engagement thereon. The shaft **41** mounts an actuating lever **52**, the lower end of which is connected to an actuator **53**, the rotation of shaft **41** being limited to retain the stem **45** in bore **44**.

The sleeve **35** accommodates the cylindrical lower end **55** of a hopper **56**, which preferably has a vertical wall **57** and an inclined wall **58** to facilitate feeding of material.

The lower end **55** of the hopper extends to the flange **34** which, as shown in FIG. 1, desirably has an inclined inner surface with an annular recess **59** over which is positioned an annular porous member **61**, also preferably of sintered material, a port **62** leading into said annular groove **59**.

In the case of valve **27**, the annulus **28** is seated in an annular groove **65** in the bottom of flange **16** and is retained in position by an annulus **66** of diameter greater than annulus **28**. As shown, the annulus **66** is seated in a recess in the undersurface of flange **15** and is of thickness so as to extend slightly beyond such undersurface.

The movable portion of valve **27** is identical to that of valve **26** and the shaft **41** thereof extends through diametrically aligned openings in the annulus **66** and is actuated by identical linkage controlled by actuator **67**.

The inner surface of annulus **66** desirably has two recesses **71** therein, preferably diametrically opposed and each occupying, say, sixty degrees of arc.

Each of the recesses **71** has a porous plate **72**, also preferably of sintered material, secured over the mouth thereof, and bores **73**, **74** extend laterally through the annulus **66** and each has one of its ends in communication with a recess **71** and its other end in communication with a passageway **75**, **76** extending laterally through the flange **15**.

The flange **15** of the chamber **12** is secured by bolts **78** to the outwardly extending flange **79** at the upper end of a sleeve **81** which defines a portion of the magazine **80**, said sleeve also having an outwardly extending flange **82** at its lower end.

Secured to the flange **82** as by bolts **83** is the outwardly extending flange **84** of another sleeve **85** which also forms part of the magazine **80**.

The flange **79** has an annular recess **86** in its upper surface of diameter substantially equal to that of annulus **66** so that it may snugly accommodate the latter, and the end **88** of a flexible tubular liner **89**, preferably of rubber, is clamped between the floor of recess **86** and the annulus **66** to both provide a gas-tight seal and to hold the end of the liner in place.

The other end **91** of the liner is clamped between flanges **82** and **84**, which desirably have an annular recess **92** to accommodate such end.

Means are provided to effect lateral movement of the liner **89**. To this end, as shown in FIG. 1, the sleeve **81** is provided with diametrically opposed bores **93**, each with an enlarged recess **94** at its inner end. Extending through each of said bores **93** is a rod **95**, the inner ends of which mount heads **96** which react against

the liner, the diameter of such heads being such that they may be accommodated in the recesses **94**.

The rods **95** are connected by a yoke **97** so that they may move in unison when actuator **98** connected to one of said rods is energized.

Desirably, a peephole **101'** covered by suitable transparent material is provided in the wall of the sleeve **81**, said peephole being provided with a sleeve which extends into the liner **89**, which may be clamped against the sleeve **81** so that a gas-tight seal is effected yet the interior of the liner **89** is visible.

Means are provided to admit gas under pressure to one of the passageways **75**, **76** and to vent the other passageway. To this end, each of the passageways **75**, **76** is connected by a line **101**, **102** to a valve **103**, **104**, each of which has a relief port **106** and an inlet port **105**, which is connected by line **100** to a source of gas under superatmospheric pressure through a pressure regulating valve PR to be maintained at say **100** to **101** p.s.i. The movable elements of the valves are connected by link **107**, so that when the port **105** of one of the valves is connected to pressure the port **106** of the other valve will be connected to relief, and vice versa. Desirably, each of the relief ports **106** has a pressure relief valve **108** connected thereto.

As it is important in the operation of the equipment, as hereinafter described, that the pressure be equalized on the interior and exterior of liner **89**, the sleeve **81** has a port **111** leading thereinto and said port is connected by line **112** to line **101**.

Positioned in the sleeve **85** is a cylindrical porous filter liner **114**, which is slightly spaced from the adjacent wall of said sleeve, said filter liner also preferably being of sintered material.

As shown in FIG. 1, the upper end of the sleeve is desirably seated against an inwardly extending flange **115** and is retained in position by means of an annular retainer **116** secured to the bottom of sleeve **85** as by screws **117**, the inner periphery of the retainer **116** defining the outlet **118** of the magazine **80**, the retainer **116** having an annular rib **119** extending between the wall of sleeve **85** and the liner **114** to prevent shifting thereof.

As shown, the sleeve **85** has a port **121** to which a line **122'** may be connected to apply a source of gas under pressure thereto or to vent said sleeve in the manner hereinafter described.

The filling head above described is utilized in conjunction with a transfer mechanism **122**, shown in FIGS. 1 and 4.

The transfer mechanism comprises a rotary member **124**, desirably having a plurality of arms **125**, illustratively four in number, radiating from a central hub **126**. The arms **125**, which illustratively are equidistantly spaced, preferably are designed to flex vertically, and to this end the arms are of resilient but substantially rigid material, and may be corrugated, as at **127**, transversely of their length to enhance such flexure.

As shown in FIG. 1, the rotary member **124** has its hub **126** secured by screws **128** to the upper end of a vertical shaft **129** positioned laterally of the vertical axis of the filling head **11** and rotatable in steps of, say, 90 degrees, in the illustrative embodiment shown, by suitable drive means (not shown).

Each of the arms **125** has an opening **131** at its outer end, through which extends the body portion **132** of a flanged bushing **133**. The bushing **133** is desirably of porous material such as sintered metal, and is releasably secured in place as by means of screws **134**.

Where the disc to be formed in the bushing is relatively thin, it is preferred to have the bushing with a tapered bore to facilitate retention of the compacted material.

The rotary member **124** is illustratively positioned so that the top surfaces of the flanges **135** of the bushings carried by arms **125** are in a horizontal plane just slightly

above the plane of the outlet 118 of the magazine 80, and the periphery of the flanges, as at 135', as well as the periphery of the outlet end of the magazine, desirably are rounded slightly. Thus, as the shaft 129 is rotated, the rounded edges of each flange will readily move beneath the outlet 118, with the bushing 133 substantially axially aligned with the outlet 118 of the magazine, and the arm 125 carrying such bushing 133 will be deflected downward slightly.

As shown in FIG. 1, a reciprocal shaft 137 is axially aligned with the magazine, said shaft having a flat head 138 adapted to engage the lower end of the bushing 133 to close the latter and to urge the flange of the bushing into sealing engagement with the outlet end 118 of the magazine 80 for charging of the body portion 132 of the bushing in the manner hereinafter described.

Rotation of the rotary member 124 is designed successively to advance each of the bushings 133 illustratively to four stations spaced 90 degrees apart, i.e., the filling station beneath the filling head, an inspection station, a compaction and removal station, and a cleaning station.

As shown in FIGS. 1 and 4, the compaction and removal station is laterally spaced from the filling station and comprises a base plate 141 having a vertical bore 142 therethrough of reduced diameter at its lower end defining an annular shoulder 143. Positioned in bore 142 is a cylindrical insert 144 having a head portion designed to seat on shoulder 143 and of diameter such as to fit snugly in bore 142.

The insert 144, which is retained in fixed position in bore 142, has an axial bore 145 therethrough, the upper end of which is defined by a cylindrical porous sleeve 146 which is securely retained in said bore 145. The portion of bore 145 encompassing sleeve 146 desirably has an annular groove 147, which is in communication with a port 160 to which a source of gas under pressure may be connected or which may be vented to atmosphere as desired.

Positioned in the bore 145 is a plunger 148, which may be reciprocated in any suitable manner between a position in which its top surface 149 is slightly above the lower end of sleeve 146 to a position in which its top surface is flush with the top surface of insert 144.

The sleeve 146 and the plunger 148 form a cavity C to be charged with material in the manner hereinafter described when one of the bushings 133 is moved over the insert into substantial axial alignment with said cavity C.

In the embodiment shown, the plunger has a plurality of longitudinal bores 151 therethrough, in each of which a pin 152 is positioned, said pins normally having their upper ends flush with the top surface of insert 144.

Positioned vertically over the cavity C and axially aligned therewith is a reciprocally mounted plunger 150, which has a pair of longitudinal bores 153 aligned with the pins 152 so as to receive the latter, said bores being vented by a transverse passageway 154.

Encompassing the plunger 150 at its lower end is an inverted cup-shaped casing 156, the floor 157 of which has a bore through which the plunger extends. A pin 158 extending through the plunger 150 coacts with the floor of the casing to lift the latter, a coil spring 159 reacting against the casing normally retaining the rim 159' of the latter below the end of plunger 150.

Pivotally mounted on the base plate 141 is a lever 161, which serves to remove the material compacted in the cavity C after it has been ejected therefrom in the manner hereinafter described.

As shown in FIG. 4, the lever 161 is pivoted at one end, as at 162, laterally outward of the cavity C and is normally urged in a clockwise direction by a spring 163, its movement being limited by a stop 164.

The cleaning station shown in FIGS. 4 and 5 desirably comprises a rigid container 166, over which the bushings 133 are successively positioned in the step by step rotation of member 124.

The container 166 has an opening in its top surface 167 of diameter such that it will support the periphery of the lower end of the bushing 133.

Positioned directly over the opening of the container 166 and axially aligned therewith is a reciprocally mounted plunger 168 beneath which the bushings will move as member 124 is rotated.

The plunger 168 mounts at its lower end a substantially conical brush 169 which has flexible bristles, and the maximum diameter of the brush at its upper portion is greater than the diameter of the bore of the bushing 133.

In the operation of the equipment, the hopper 56 is filled with the material to be compacted which, for example, may be dry powdered glass, with or without a binder.

The valve 26 is opened by actuator 53, and the valve 27 is closed as shown in FIG. 2.

Thereupon, gas is forced through port 62 and porous member 61 under a pressure sufficient to fluidize slightly the material at the lower end of the hopper 56 to permit ready downward movement of such material but not sufficient to cause the material to blow out of the inlet to the hopper 56.

Suction is then applied to port 25 and also to port 24 if desired, to cause the fluidized material in the hopper 56 to fill the porous sleeve 19.

Thereupon, the suction applied to ports 24 and 25 is discontinued and the valve 26 is closed to seal the inlet to chamber 12.

The gas for fluidizing the material in the hopper applied to port 62 may now be cut off or allowed to continue if desired, and gas under superatmospheric pressure is applied to port 24. Since the annular flange 20 restricts the downward movement of the gas entering port 24, the major part of the blow action will be at the top of the liner 19 to ensure that it is cleared of material prior to an equal build-up of pressure in the lower portion of liner 19. Since valves 26 and 27 are both closed, the pressure in chamber 12 will rapidly build up to a desired amount.

The shaft 129 of the rotary member 124 is turned to position one of the bushings 133 directly beneath the outlet 118 of magazine 80, and the plunger 137 is raised tightly to clamp the bushing against such outlet and to form a floor for such bushing.

The actuator 98 is energized when the equipment is first started to effect reciprocation of the yoke 97 so that the heads 96 on rods 95 will be moved alternately to the left and to the right, maintaining a constant distance therebetween and deflecting the mid portion of the flexible liner 89 in a corresponding manner.

The pressure on both sides of the liner 89 is equalized, since line 101, which leads to the interior of the liner, is connected by line 112 to port 111 on the exterior of the liner 89. Consequently, the liner 89 will deflect readily over a relatively wide area when the rods 95 are reciprocated.

By reason of the fact that the valves 103, 104 are set so that when the line 101 is connected to port 105 of valve 103, which is connected to a source of gas under superatmospheric pressure, the line 102 will be connected to port 106 of valve 104, which is connected through pressure relief valve 108 to atmosphere, the pressure in the liner may be maintained slightly below that in the chamber 12 to ensure flow of material into the magazine when the valve 27 is opened.

When valve 27 is opened after the pressure therein has attained a desired amount, the material in the chamber 12 will be forced therefrom and discharged into the magazine 80, and gas entrained with the material will be vented from the magazine through the porous liner 114 and port 121 to atmosphere, and also through the porous bushing 133 to atmosphere.

Since the volume of the magazine is greater than that of the chamber 12, the first charge of material from chamber 12 will only partially fill the magazine.

Consequently, the filling operation of the magazine is repeated. To this end, the valve **27** is closed and the valves **103**, **104** are actuated to reverse their connections. Thus, line **101** will be connected to port **106** of valve **103** connected through pressure valve **108** to atmosphere, and line **102** will be connected to port **105** of valve **104** connected to a source of gas under pressure.

With this arrangement of valves **103**, **104**, in the event that there was a flow of gas under pressure through one of the porous members **72** to maintain the pressure in magazine **80** below that in chamber **12**, which flow might clog the porous member **72** due to the material entrained therewith, reversal of the direction of gas flow through said porous member will clean the latter.

The valve **26** is now opened to charge the chamber **12** and, after it is charged, the valve **26** is closed and valve **27** is opened to charge the magazine, as previously described.

This operation is repeated until the magazine is filled from the bottom thereof to substantially the top thereof.

As the material is forced into the magazine under superatmospheric pressure, gas will only be vented therefrom at the lower end of the magazine through porous sleeve **114**, and hence the material in the sleeve will be substantially compacted and with a minimum of entrapped gas.

Since there is substantially no escape of gas from the material in the magazine until the gas pressure exceeds the pressure to which valves **108** are set, such material will not be substantially compacted and the repeated lateral displacement of such material, due to movement of the heads **96**, will prevent channeling of gas therethrough.

By reason of the fact that it least one of the valves **26**, **27** is always closed, it is apparent that the material in the magazine will always be under superatmospheric pressure, and the charging of the magazine **80** is independent of the discharging thereof, as will hereinafter be described.

By reason of the compaction of the material in the sleeve portion **114** of the magazine, it has been found that for most materials, even when the gas pressure in the magazine is relatively great, depending upon the length of said sleeve portion, the compacted material in the magazine will not move downwardly.

With materials where such movement will occur, it is necessary to provide a valve **171** in the outlet of the magazine, as shown in FIG. 7, which valve is normally in closed position when the magazine is being charged.

With the magazine thus charged, the equipment may now be automatically cycled.

Thus, assuming that an empty bushing **133** has been moved beneath the outlet of the magazine shown in FIG. 1, gas under a pressure of say 25 p.s.i. is applied to port **121**. This is considerably less than that applied to port **24**, i.e., 100 p.s.i., and that in the magazine, say 98 p.s.i.

The gas under pressure applied to port **121** will be dispersed through the porous sleeve **114** to react against the side wall of the column of material in the sleeve **114**.

As a result of the lateral pressure effected by the gas entering port **121**, the column of material in the sleeve **114** will tend to be compacted laterally to free the outer surface of such column from the sleeve **114**. This, together with the film of gas encompassing the column of material in the sleeve and the gas pressure in the magazine above the sleeve, will force the compacted material in the sleeve downwardly to fill the bore of the bushing **133** with a portion of such material in compacted form, the porous bushing **133** permitting escape of gas that is entrapped in the bore of said bushing **133**.

Thereupon, the gas under pressure applied to port **121** is cut off and the port vented to atmosphere.

The shaft **137** is then moved downwardly to move its head **138** away from the bottom of the bushing **133**. However, as the material therein is in compacted form, it will not be displaced but will remain in said bushing.

The shaft **129** is then rotated 90 degrees to move the filled bushing **133** to the inspection station where the operator can determine if the bushing is filled. As the top of the bushing is resiliently retained against the outlet of the magazine, such lateral movement of the bushing will cause a wiping action to provide smooth surfaces at the bottom of the material in the magazine and at the top of the material in the bushing. Such inspection is only required when the equipment is started, to make sure the filling head is operating properly.

The next 90 degree rotation of the bushing **133** will move the latter to the compaction and removal station in substantial axial alignment with the plunger **150** and the cavity C.

Thereupon, with the plunger **148** as its desired lowermost position, the plunger **150** is moved downwardly. The rim of the casing **156** will first engage the flange of the bushing **133** to form a seal and, with continued downward movement of the plunger **150**, it will enter the bushing **133**, and since the diameter of plunger **150** is less than that of the bushing bore it will displace only a portion of the compacted material therein downwardly into the cavity C. The plunger **150** is moved downwardly so that it enters cavity C slightly and with a force sufficient further to compact the material in the cavity a desired amount. The height of the compacted material in the bushing preferably does not exceed the depth of the cavity C to ensure that plunger **150** will be able to force the compacted material from the bushing slightly below the upper surface of the cavity C. The bores **153** of the plunger **150** will accommodate the pins **152** and gas entrapped in the bores will escape through vent **154**. Gas entrapped in the cavity C will be vented through the porous sleeve **146** and port **160** to atmosphere.

Immediately after the plunger has entered the sleeve **146**, which defines at least a portion of the side wall of the cavity C, the port **160** is connected to a source of gas under a pressure of say 25 p.s.i. to exert lateral pressure against the periphery of the compacted material in sleeve **146** to ensure that any loose particles will be compacted laterally and to reduce adhesion of the periphery of such material to the sleeve.

If desired, instead of a relatively dry gas under pressure being applied to port **160** in some applications, a moist gas such as steam under pressure, or the like, may be applied to such port to cause bonding of the periphery of the material in the sleeve **146** in addition to reducing the adhesion of such periphery to the sleeve.

When the plunger **150** is in the sleeve **146**, the plunger **148** may be moved upwardly slightly further to compact the material in the cavity C.

Thereupon, the plunger **150** is moved upwardly clear of the bushing **133** and prior to its movement out of the sleeve the gas under pressure to port **160** is cut off and the port is vented to atmosphere.

Since the diameter of the plunger **150** is less than that of the bushing **133**, it is apparent that the bushing **133** does not have to be exactly axially aligned with the plunger **150**, which is difficult to accomplish with a laterally moving member.

The bushing **133** from which a compacted charge has been removed is now moved with its residual charge in a clockwise direction, referring to FIG. 4.

As soon as the bushing **133** is clear of the cavity C, the plunger **148** is moved upwardly until its top surface **149** is aligned with the top surface of base plate **141**, the top of the pins **152** being retained flush with such top surface.

Since the frictional engagement of the periphery of the compacted material, which now forms a disc for example, with the wall of sleeve **146** has been greatly minimized by the lateral gas pressure applied through port **160**, upward movement of the plunger **148** and the disc

will be greatly facilitated, thereby reducing wear both on the plunger 148 and the inside surface of sleeve 146.

As the bushing 133 is moved away from the cavity, the next filled bushing will move toward the cavity C. As a result, such next bushing will engage lever 161, which is spring-retained against stop 164, to rotate said lever in a clockwise direction, thereby causing it to abut against the compacted disc removed from cavity C to move the latter laterally away from plunger 148.

After the next bushing 133 is filled, as previously described, and is in turn moved in a clockwise direction, as soon as it moves clear of the lever 161 it will release the latter, which will be spring-returned to stop 164, and thereupon the plunger 148 is lifted to move the compacted disc out of cavity C.

When the bushing from which a portion of the charge has been removed has completed its 90 degree movement from the compaction and removal station, it will be aligned with the cleaning station.

At this time, the plunger 168 is moved downwardly so that its substantially conical brush 169 will enter the bushing, forcing the remaining compacted material therein into the container 166, the casing 170 retaining the bushing against the top surface 167 of container 166 to ensure that no material will escape therefrom.

Thereupon, the plunger 168 is lifted and the cleaned bushing 133 is then moved 90 degrees further to the filling station and the operation above described is repeated.

It is, of course, to be understood that the operation is continuous, i.e., one bushing is being filled while a second bushing is being compacted, and a third bushing is being cleaned with a fourth bushing being at the inspection station.

As previously pointed out, where discs or the like were made by discharging powdered glass by gravity into a mold cavity and then mechanically compacting the material, in order to have the material flow into the cavity, it was first granulated and a binder of say six percent carbowax was added.

Such operation was expensive, and in addition, as the carbowax had to be burned out, it resulted in shrinkage of the final product.

It has been found, using the method and equipment herein described with Corning Glass Works Type 7761 ground glass without any binder, and without granulation of the material, and mixing say one percent stearic acid powder, that not only will the material be readily compacted but its weight per unit size is fifteen percent greater than that obtained with the method and equipment of said application Serial No. 16,543.

Such additional weight resulted from the additional compaction achieved when the compacted material was moved into the transfer bushing 133.

With the equipment above described, relatively high-speed forming of compacted discs, wafers, briquettes or the like may be effected, and the filling of the bushing with compacted material, and the additional mechanical compaction of the material, may be effected vertically, which is desirable, and only a relatively simple transfer member need be rotated to accomplish this result.

As many changes could be made in the above 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 two operating stations, one laterally displaced from the other, a receptacle having a porous wall portion, movable between said stations, said receptacle being open at both ends, means at said first station for supplying a charge of comminuted material to said receptacle, means to apply gas under superatmospheric pressure to such material to charge said receptacle with said comminuted material in compacted form, said porous wall portion permitting discharge of gas from said receptacle while restraining discharge of such material said second station having a mold cavity over which said charged receptacle is positioned, and means to displace a portion of such compacted material from said receptacle into said mold cavity.

2. The combination set forth in claim 1 in which said first station comprises a magazine having an outlet, means are provided to charge at least a portion of said magazine with such material in compacted form by the application of gas under superatmospheric pressure to the material, said magazine comprising the means for supplying a charge of comminuted material to said receptacle.

3. The combination set forth in claim 1 in which said first station comprises a magazine having an inlet and an outlet, said magazine having a casing, a filter member of porous material in said casing at least near the outlet thereof, means to charge at least the filter portion of said magazine with such comminuted material in compacted form, means to position said receptacle beneath the outlet of said magazine, means to close the bottom end of said receptacle, means to displace a portion of such compacted charge from the magazine into said receptacle, and means to open the bottom end of said receptacle prior to movement thereof to said second station.

4. The combination set forth in claim 1 in which the means to displace a portion of such compacted material from said receptacle comprises a plunger positioned above said mold cavity and axially aligned therewith, the cross sectional area of said plunger being less than the cross sectional area of said receptacle.

5. The combination set forth in claim 1 in which a plunger is slidably mounted in said mold cavity, the upper end of the plunger defining the floor of said cavity, the means to displace a portion of such compacted material from said receptacle comprises a second plunger positioned over said mold cavity and axially aligned therewith, the cross sectional area of said second plunger being less than the cross sectional area of said receptacle, means after said second plunger has displaced a portion of said compacted material from said receptacle into said mold cavity to effect movement of said second plunger out of said cavity, and means when said receptacle is moved clear of said mold cavity to effect upward movement of said first plunger to bring the upper end thereof flush with the mouth of the cavity to move the compacted charge out of said cavity.

6. The combination set forth in claim 5 in which means are provided to effect lateral movement of the compacted charge of material away from the cavity.

7. The combination set forth in claim 5 in which said mold cavity has a side wall, a filter member of porous material defines at least a portion of such side wall, means to apply a source of gas under pressure through said filter member to apply lateral pressure against the contents of said cavity, and means to discontinue application of said lateral pressure immediately prior to removal of said second plunger out of said cavity.

8. The combination set forth in claim 5 in which a casing is slidably mounted on said plunger and encompasses the latter, said casing engaging the periphery of said receptacle prior to movement of the plunger thereinto to define a closed chamber with respect to said receptacle as the plunger moves through the latter.

9. Filling equipment for comminuted material, comprising a transfer member having a plurality of receptacles equidistantly spaced thereon, means mounting said transfer member for step by step rotation in a horizontal plane, each of said receptacles comprising a bushing having a bore extending at right angles to the plane of said transfer member and open at both ends and having a

porous wall portion, a plurality of spaced operating stations including a first station and a second station, means to rotate said transfer member successively to present said bushing to said operating stations, means at said first station for supplying a charge of comminuted material to said receptacle, means to apply gas under superatmospheric pressure to such material to charge said bushing bore with such comminuted material in compacted form, said second station having a mold cavity over which said charged bushing is positioned, and means at said second station to displace a portion of such compacted material from said bushing bore into said mold cavity and to further compact the material in said cavity.

10. The combination set forth in claim 9 in which said plurality of operating stations includes a cleaning station to which the bushing from which a portion of such compacted material has been removed is next presented, and means at said station to remove the residual compacted material from said bushing.

11. The combination set forth in claim 10 in which said last named means comprises a reciprocally mounted brush beneath which said bushing is positioned, said brush being adapted to move through said bushing to clean the latter.

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