United States Patent [19]

Billett et al.

[11] **3,830,264**

[45] **Aug. 20, 1974**

[54] **POSITIVE DISPLACEMENT FILLING MACHINE**

[75] Inventors: **Ronald J. Billett**, Sunnyvale; **Gary O. Niemann**, Mt. View, both of Calif.

[73] Assignee: **FMC Corporation**, San Jose, Calif.

[22] Filed: **Mar. 27, 1972**

[21] Appl. No.: **238,321**

[52] **U.S. Cl.** **141/1**, 141/147, 417/513

[51] **Int. Cl.** **B65b 3/12**, B65b 43/60

[58] **Field of Search** ..... 141/86, 90, 1, 11, 128, 141/138–152, 156–162, 258–262, 392, ; 222/318, 439, 440, 442; 417/511, 513

[56] **References Cited**

UNITED STATES PATENTS

2,776,785 1/1957 Lyon 141/154

3,779,292 12/1973 Mencacci 141/11

Primary Examiner—Houston S. Bell, Jr.
Assistant Examiner—Frederick R. Schmidt
Attorney, Agent, or Firm—C. E. Tripp

[57] **ABSTRACT**

A multi-cylinder, positive displacement, turret type filler for containers includes cam lifted, gravity descending valve, plug and piston elements in each cylinder, in one embodiment the height to which the plug is lifted meters the charge and the plug supports the piston during descent. In another embodiment these functions are interchanged.

19 Claims, 20 Drawing Figures

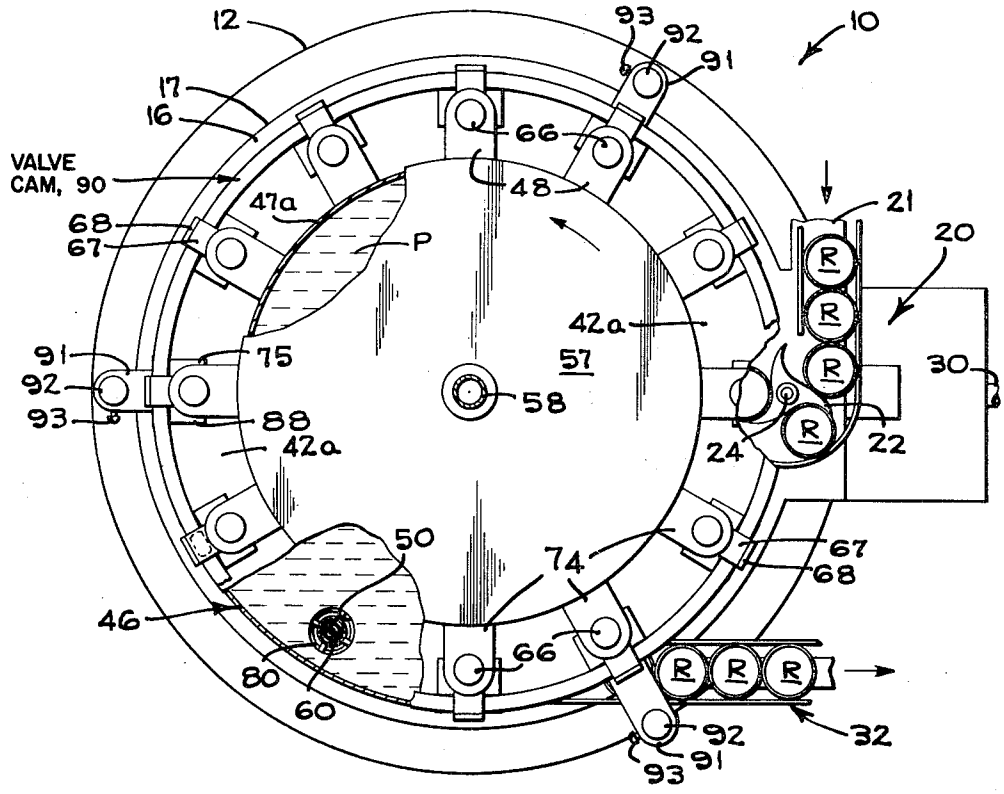
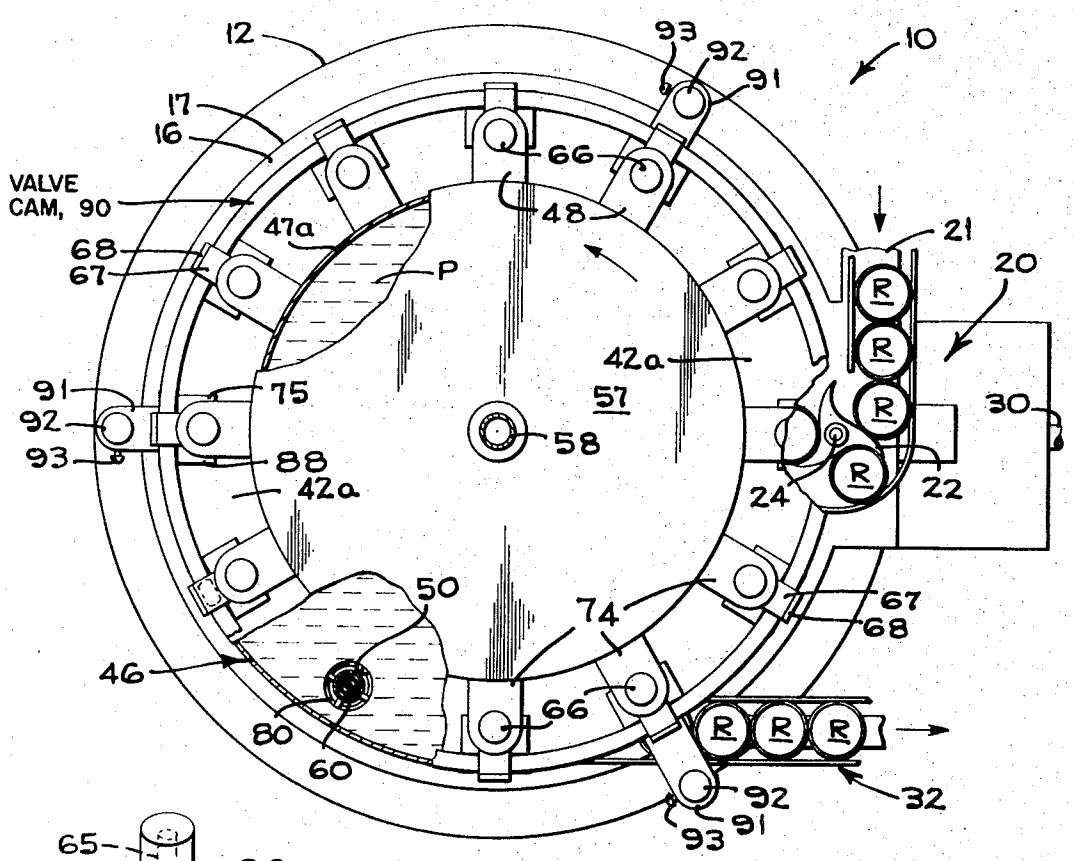


FIG_1


12
93
92
91
10
17
16
66
VALVE CAM, 90
48
21
47a
68
67
P
20
42a
91
75
57
30
92
93
88
58
42a
24
22
50
74
67
68
46
66
80
60
92
91
93
32

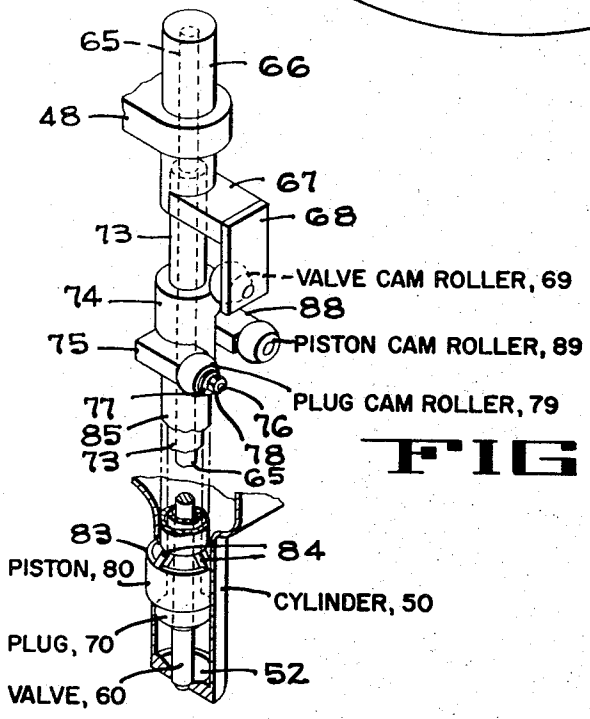

65
66
48
67
68
73
VALVE CAM ROLLER, 69
74
88
75
PISTON CAM ROLLER, 89
77
PLUG CAM ROLLER, 79
76
85
78
73
65
83
84
PISTON, 80
CYLINDER, 50
PLUG, 70
52
VALVE, 60

FIG_1A

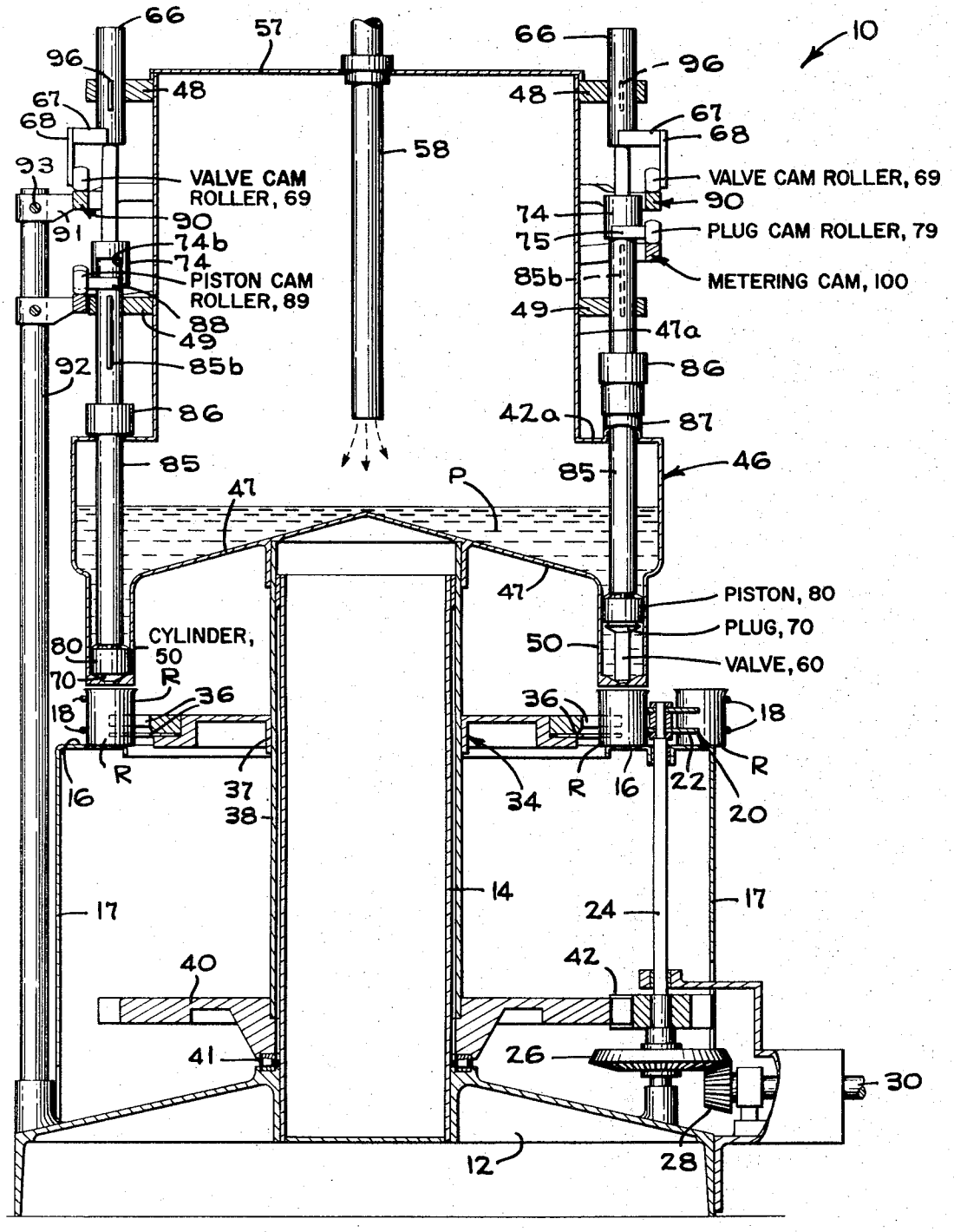

10
66
57
96
48
67
68
93
VALVE CAM ROLLER, 69
90
91
74b
74
PISTON CAM ROLLER, 89
88
49
92
85b
86
85
47
P
58
66
96
48
67
68
VALVE CAM ROLLER, 69
90
74
75
PLUG CAM ROLLER, 79
85b
METERING CAM, 100
49
47a
86
42a
87
85
46
47
PISTON, 80
PLUG, 70
VALVE, 60
50
80
CYLINDER, 50
70
R
36
18
16
R
37
38
17
40
41
36
18
R
34
R
16
22
20
14
24
17
42
26
30
12
28

FIG_2

FIG_3

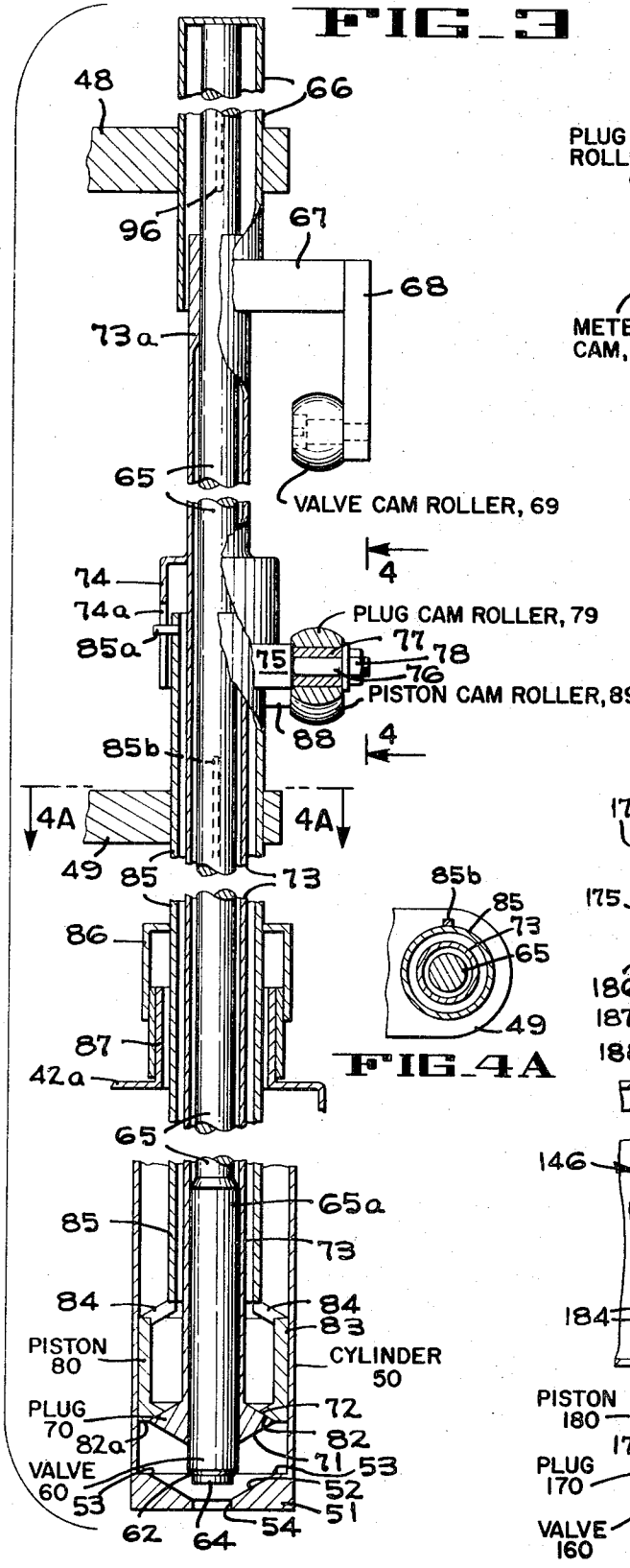


FIG_4

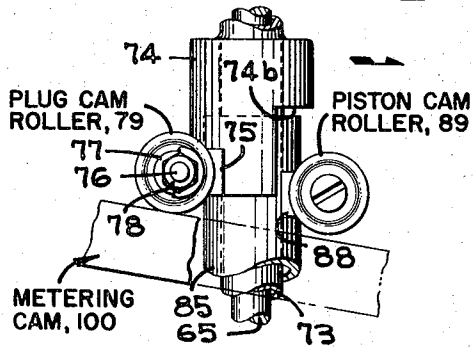
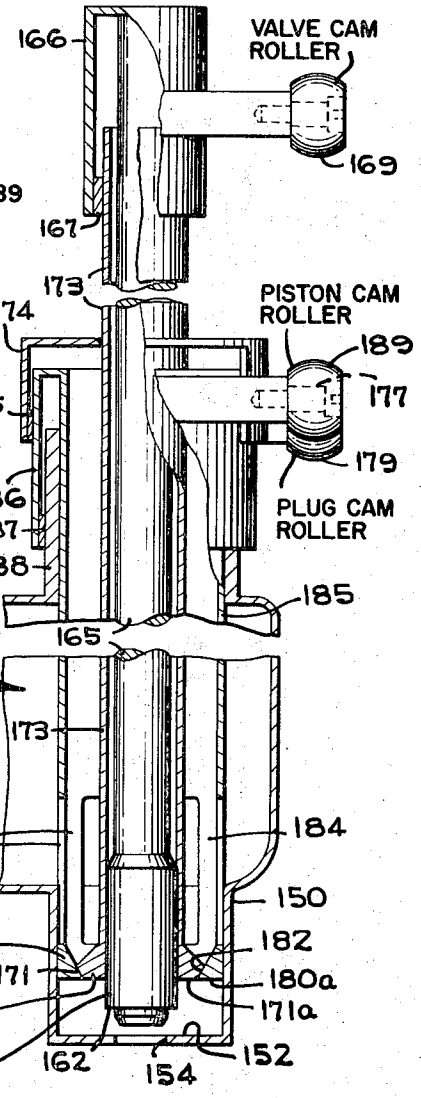


FIG_4A

FIG_11



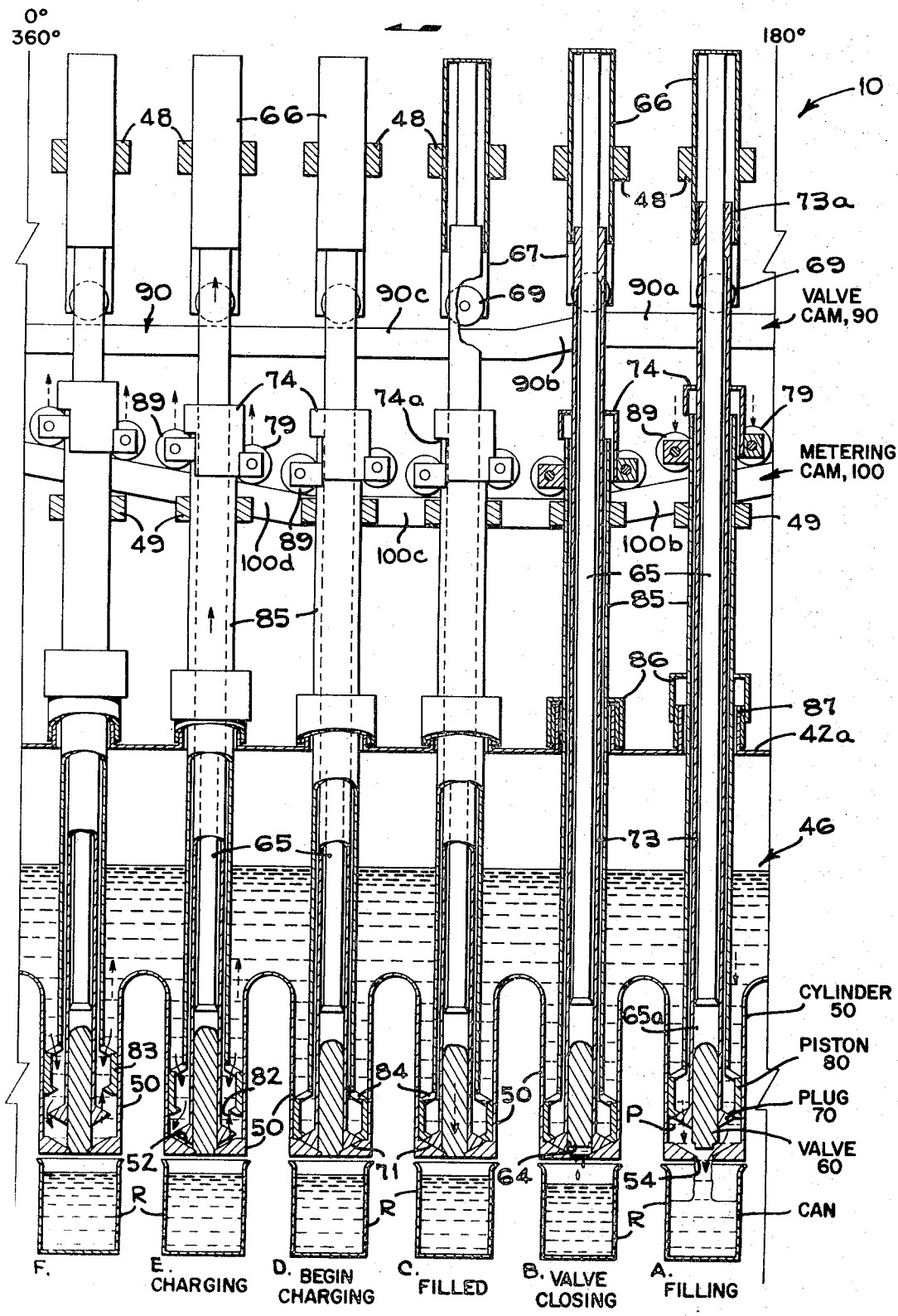

0°
360°
180°
10
48
66
48
66
48
73a
67
69
69
VALVE CAM, 90
90
90c
69
90a
90b
74
74a
74
79
89
79
89
METERING CAM, 100
49
89
100d
100c
100b
49
65
85
85
86
87
42a
65
73
46
CYLINDER 50
65a
PISTON 80
83
50
82
84
50
50
P
PLUG 70
VALVE 60
52
71
64
54
R
R
R
CAN
F.
E. CHARGING
D. BEGIN CHARGING
C. FILLED
B. VALVE CLOSING
A. FILLING

FIG_5

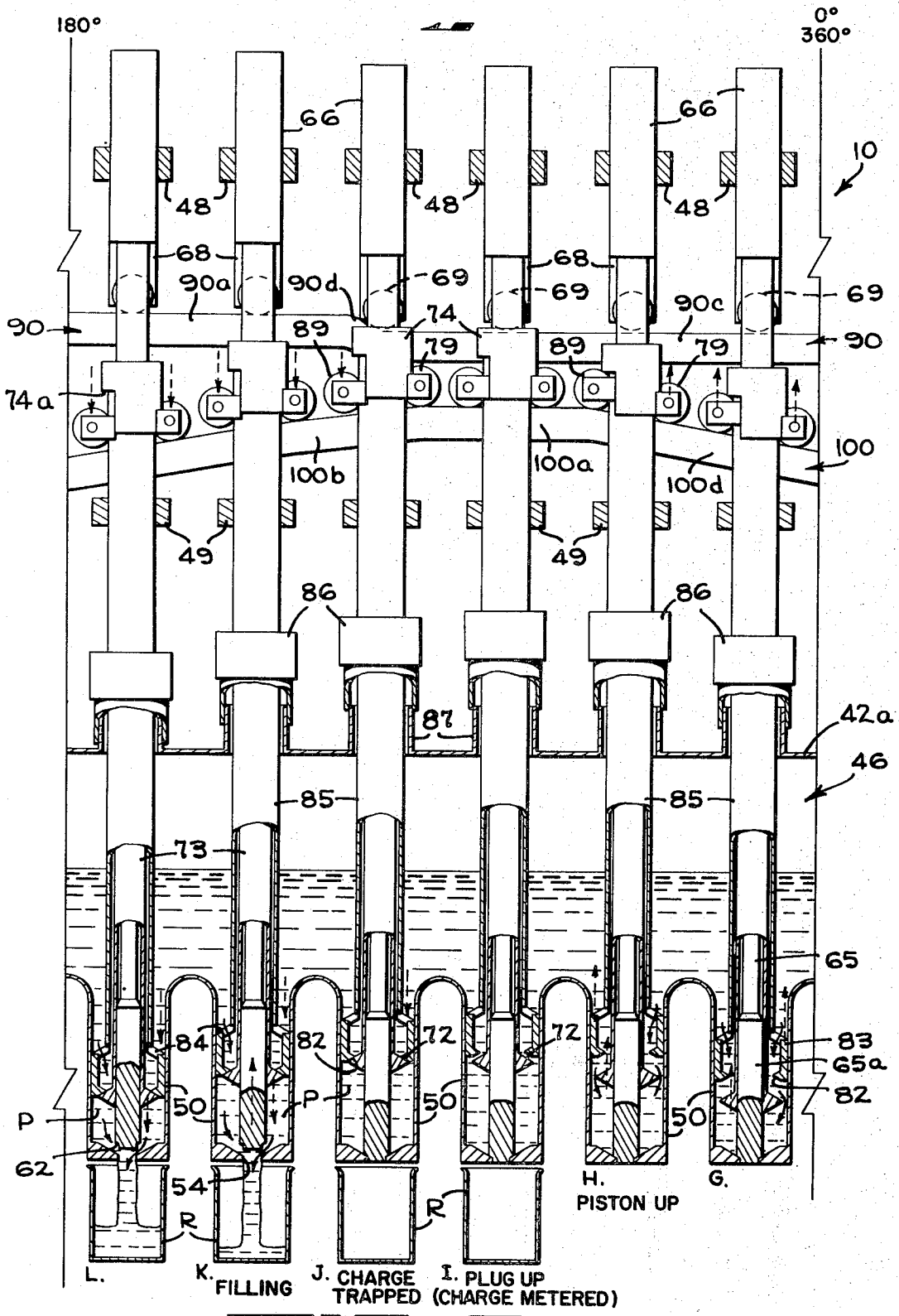

180°
0°
360°
10
66
48
68
69
90a
90d
90c
90
74
79
89
74a
100
100b
100a
100d
49
86
87
42a
46
85
73
65
84
82
72
83
65a
50
P
62
54
R
L.
K. FILLING
J. CHARGE TRAPPED
I. PLUG UP (CHARGE METERED)
H. PISTON UP
G.

FIG_6

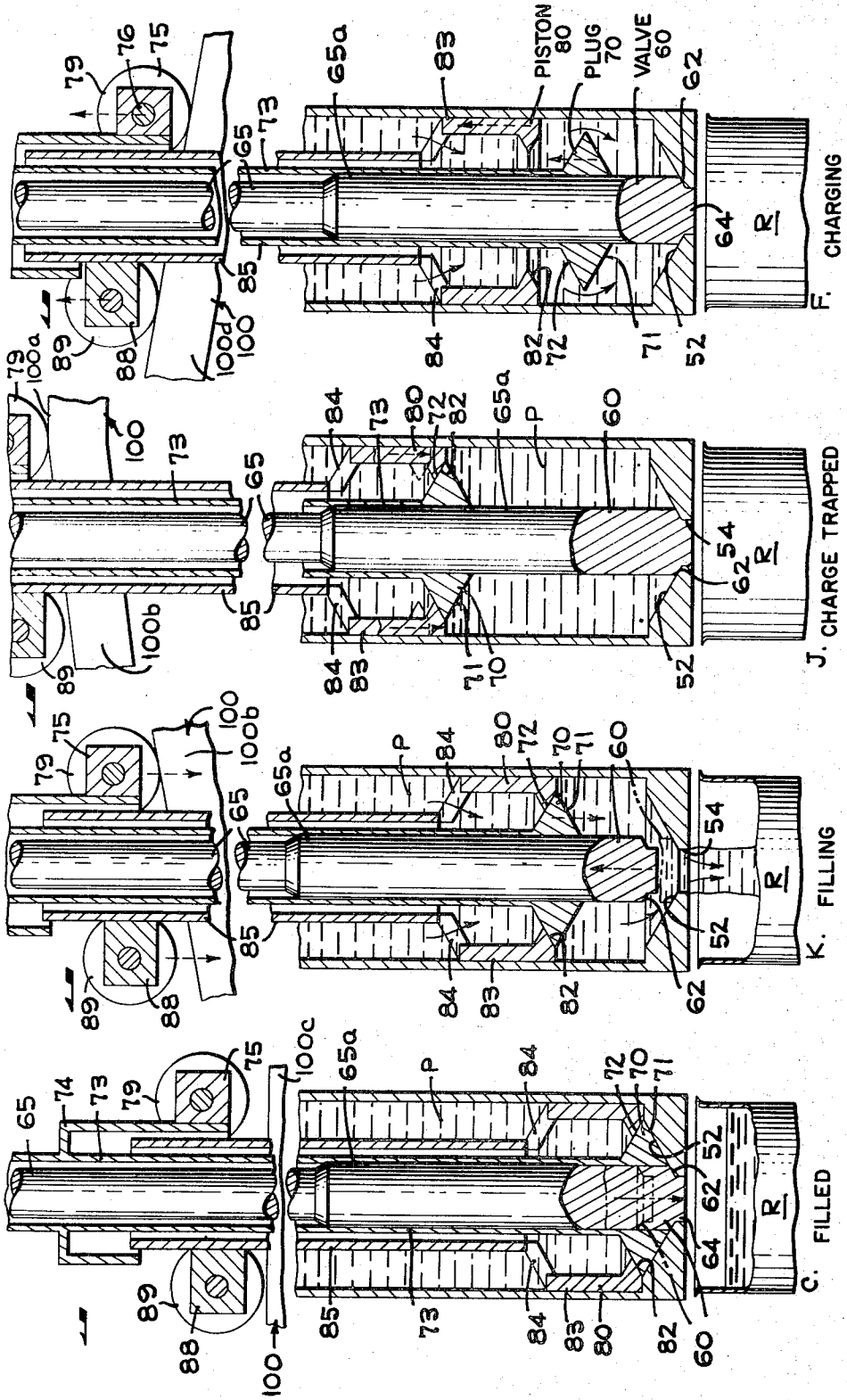


FIG_10 FIG_9 FIG_8 FIG_7

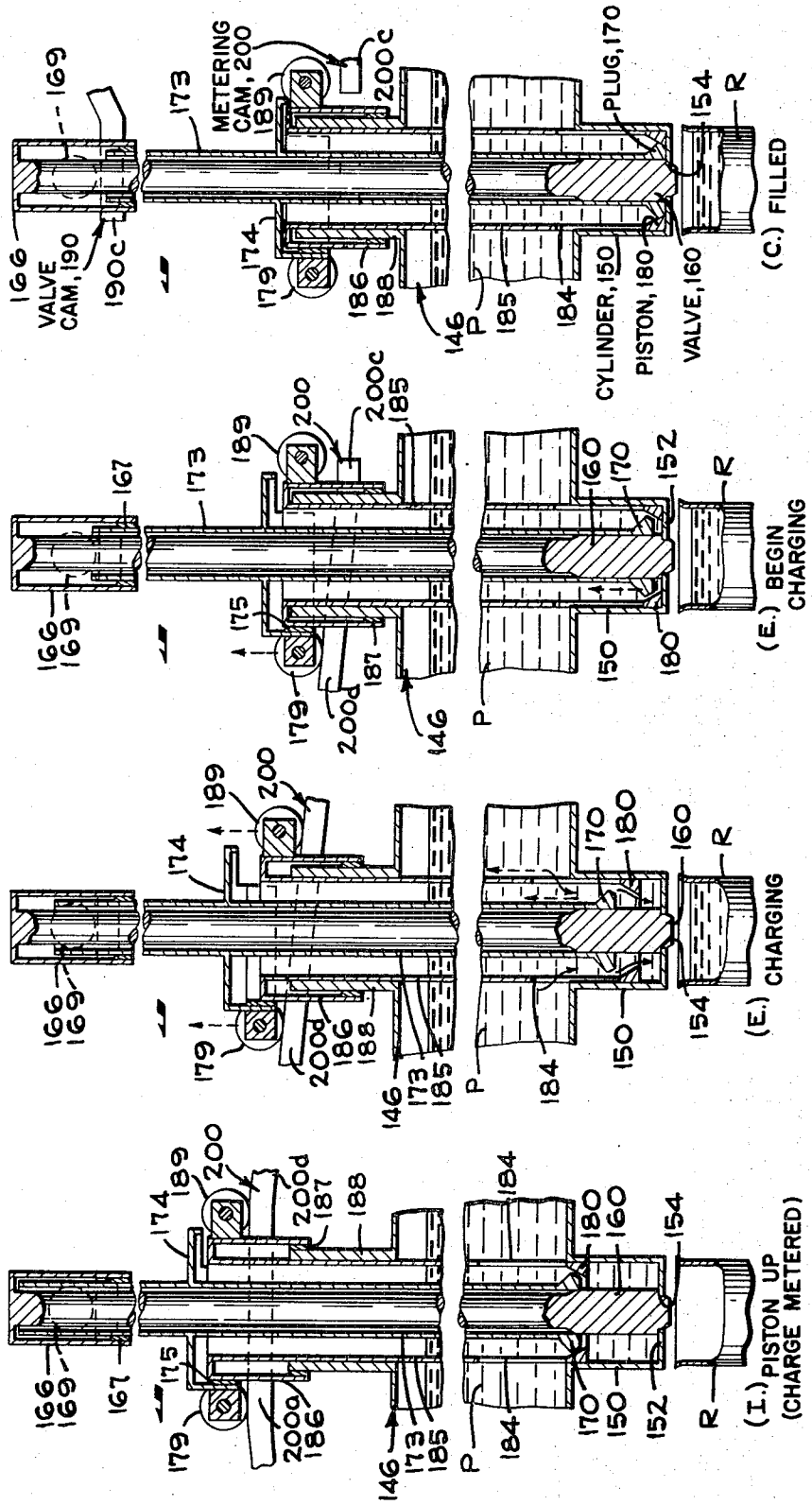


FIG. 12

FIG. 13

FIG. 14

FIG. 15

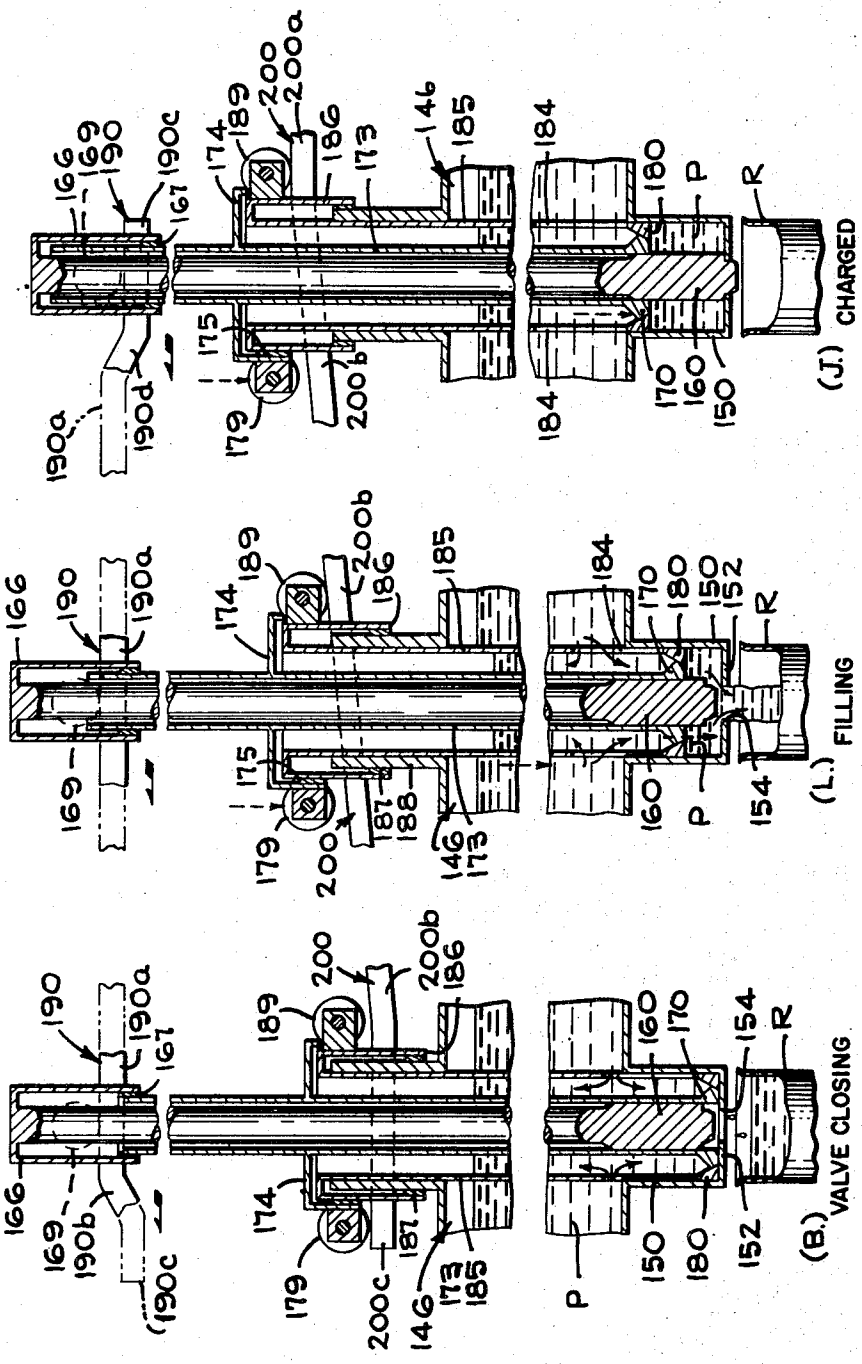


FIG_16

FIG_17

FIG_18

POSITIVE DISPLACEMENT FILLING MACHINE

FIELD OF THE INVENTION

This invention relates to fluent material handling and more specifically relates to a machine for filling cans or other containers with liquid such as fluent food products or the like.

DESCRIPTION OF PRIOR ART

The U.S. Pat. No. to Lyon 2,776,785, Jan. 8, 1957 discloses a displacement type container filling apparatus that embodies a pressure calibrated, spring loaded check valve for trapping a charge of the dispensed material.

The U.S. Pat. No. to Roth 2,820,579, Jan. 21, 1958 discloses a pair of valves on a common valve stem which are permitted to operate as a result of disabling a strong spring (34) in response to the opening of a lower valve by a cam.

The U.S. Pat. No. to Belshaw 2,825,494, Mar. 4, 1958, discloses a dispenser which has a floating check valve (12) that cooperates with a valve seat for automatically trapping the charge in a metering system.

The U.S. Pat. No. to Zerlin 2,894,665, July 14, 1959 traps fluid flow in a gravity displacer by using a float valve seat.

SUMMARY OF THE INVENTION

The filler of the present invention is preferably of the turret type such as that in the U.S. Pat. No. to Kerr 2,958,346, Nov. 1, 1960 assigned to the FMC Corporation. Under the preferred embodiment of the present invention, a circular row of charge forming cylinders depends from the product reservoir. Three telescoping dispensing members reciprocate in each cylinder. These dispensing members are: a valve for closing a discharge port at the bottom of the cylinder and a two part charge trapping and displacing assembly. The latter is made up of a plug that closes off a port in a surrounding piston, the latter having a close fit with the cylinder. Each charging stroke is performed by closing the valve, separating the plug and piston and lifting the two together so that liquid thereby inducted into the cylinder from the reservoir is displaced to the lower side of the plug and piston. In one embodiment of the invention, the amount of charge is ultimately determined by the height to which the plug is lifted. When the plug reaches its uppermost or metering position, the piston is closed against the plug thereby trapping the metered charge in the cylinder. The valve is then opened and the piston and plug are lowered together with the plug supporting the piston, thereby positively displacing the charge from the cylinder into the underlying container. The plug and piston conform to the bottom of the cylinders so when they reach the lowermost portions of their stroke, the cylinder is completely evacuated at which point the valve closes thereby completing the filling operation.

The above described apparatus of the present invention has the following advantages and features.

The charge is determined simply by the height to which a metering member (e.g., a plug or a piston is raised) in the cylinder. The container is filled by positive displacement of a previously measured charge. The cylinder is completely emptied in every filling stroke so that accuracy of fill is maintained even though the stroke is interrupted. No material experiences a residence time in the cylinder longer than one cycle, minimizing buildup of residues.

Upon completion of the fill, the final closing of the valve shears off and ejects the only remaining charge (that is a small slug remaining in the spout at the bottom of the cylinder) leaving no residues to drip or carry over.

The timing of the discharge valve, as to opening and closing are noncritical with respect to operation of the piston and plug elements which determine the amount of charge and dispense it. Thus, dwell periods are available at both ends of the piston stroke for valve actuation.

During charging of the cylinder and dispensing therefrom into the container, the liquid being dispensed is always disposed both above and below the plug and piston, eliminating the possibility of entraining the atmosphere and thereby enhancing the sterility of the operation.

Although the filling operation is conducted by a positive displacement which insures accuracy of fill, given a stroke of the appropriate rate no significant leakage between the piston and the cylinder will occur, even without seals. Since a head of liquid exists above the descending plug and piston elements during filling, so long as the displacement operation is not carried out too rapidly, or too slowly, there is no reason for liquid to flow up or down between the piston and the cylinder instead of merely flowing down into the container being filled.

As one charge is delivered to a container the following charge is entering the cylinder. This concurrent induction and delivery of charges enhances the permissible operating speeds significantly.

In one form of the present invention the descent of the displacing elements (plug and piston) is effected solely by the weight of these parts, which accommodates relatively rapid filling without creating low pressure above the parts with resultant bubbling of the liquid.

Since the valve, plug and piston elements are all telescoped and concentric with the cylinder, and as best seen in a modified form, it is a simple matter to design the apparatus so each part can be lifted completely or partially clear of the cylinder for cleaning operation.

In the preferred embodiment of the invention, the telescoped elements are supported from circular cams for positive lifting and for cam controlled, gravity driven descent. Another feature of the invention is that in one form of the invention the plug supports the piston during the dispensing cycle and in another form of the invention the piston supports the plug during dispensing, thereby insuring a seal between these parts for trapping and dispensing the charge without requiring niceties of construction of the cam and operating mechanisms and without requiring springs or the like to maintain the seal.

The adjustment of individual cylinder assemblies for providing uniform fill of all assemblies is readily accomplished by adjusting the cam follower for that one of the plug or piston elements, which supports the other during descent of the two elements together during filling.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a turret type filler embodying the invention.

FIG. 1A is a diagrammatic perspective for one set of the filling elements.

FIG. 2 is a section through the filling machine embodying the invention.

FIG. 3 is an enlarged fragmentary section of a set of filling elements.

FIG. 4 is a view looking on line 4—4 of FIG. 3.

FIG. 4A is a section taken on 4A—4A of FIG. 3.

FIGS. 5 and 6 are views looking from the inside of the filler, and taken together are diagrammatic operational views of a complete cycle.

FIGS. 7–10 are selected enlarged views of various stages in the filling cycle.

FIG. 11 is an enlarged section through a modified form of the invention wherein the piston supports the plug during filling.

FIGS. 12 – 18 are diagrammatical operational views of the modified form of FIG. 11 at selected stages in the cycle.

BRIEF DESCRIPTION OF THE APPARATUS

GENERAL DESCRIPTION

FIGS. 1 and 2 illustrate a filler embodying the present invention of the general type disclosed in the aforesaid U.S. Pat. No. to Kerr 2,958,346. Structural details of the can feeding and delivering mechanisms and of the filler drives are not critical in the present invention and are only illustrated to the extent necessary to understand the invention. Can feeding and delivery systems for fillers of this general type are well known in the trade.

The filler **10** (FIG. 2) has a base **12** with an upstanding fixed tubular post **14.** The base **12** also supports a cylindrical standard **17** having a circular container track or supporting platform **16** and guide rails **18** surrounding the platform. Receptacles R such as jars, cans or the like are introduced into the filler by a feeder mechanism indicated generally at **20** (FIG. 1) which is of conventional design and includes a lead-in conveyor **21** and a direction changing star wheel **22,** as is well known in the art. The star wheel **22** is driven by a vertical shaft **24,** lower bevel gears **26,28** and a horizontal drive shaft **30.** Filled receptacles R are removed from the machine by a conveyor illustrated generally at **32** in FIG. **1,** such conveyors being conventional and hence their details are not critical to the present invention.

The cans received from the feeding mechanism **20** are advanced around the support platform **16** by a rotating turret **34** (FIG. 2) having spaced pusher fingers **36** which form can receiving pockets in the conventional manner. The turret **34** is secured at **37** to a rotating sleeve **38** surrounding the fixed post **14.** The sleeve **38** projects up from a large drive gear **40** supported on bearings **41** at the base **12** of the machine. The drive gear **40** is driven by a pinion **42** secured to the vertical shaft **24** previously mentioned and hence is driven in synchronism with the feeder star wheel **22.**

RESERVOIR AND CYLINDERS

Concentric with the machine is a liquid product reservoir **46** (FIG. 2) having a bottom wall **47** that is supported on the rotating sleeve **38** previously described as operating the cam turret **34.** A circular array of cylinders **50** depend from the bottom wall **47** of the reservoir **46.** The reservoir has an upstanding well portion **47a** from which radial guide brackets **48,49** project for the dispensing mechanism to be described in detail presently. The well **47***a* is closed by a cover **57** which mounts a supply pipe **58** for keeping the reservoir filled with liquid in a conventional manner. Each cylinder **50** has a bottom wall **51** formed with a conical seat **52** for a valve **60** and a plug **70,** and a flat seat **53** for a cylinder **80** (FIG. 3). The bottom wall of the cylinder has a central discharge port **54,** closed by the valve **60.**

VALVES

Mounted for vertical movement in each cylinder **50** is the valve **60** and the plug and cylinder dispensing assembly of the present invention. The lower end of the valve **60** has a seating shoulder **62** (FIG. 3) that is complimentary to the conical bottom wall surface **52** of the cylinder and a slug ejecting tip **64** that makes a close fit with the port **54** in the cylinder bottom wall. The valve **60** comprises a vertical rod **65** enlarged at its lower portion **65***a* and terminating at its upper end in a downwardly projecting boot **66,** slidable in the fixed bracket **48** previously mentioned. Projecting radially from the boot **66** is an arm **67** having a depending arm **68** that mounts a valve cam follower roller **69.**

The valve roller **69** is supported by a circular valve cam track **90** (FIGS. 1 and 2). The cam track **90** is secured to radial brackets **91** which are adjustably supported on posts **92** that project upwardly from the base **12** of the apparatus. Set screws **93** secure the cam brackets **91** to the posts **92.** The valve cam **90** has an upper ramp **90***a* (FIG. 5), a descending ramp **90***b*, a lower ramp **90***c* which can be interrupted for removal of the parts, and an ascending ramp **90***d* (FIG. 6).

In order to prevent rotation of the valve assembly about its axis, any suitable means such as a key **96** (FIGS. 2 and 3) on the valve boot **66** is provided which rides up and down in a keyway formed in the fixed bracket **48.** Thus, upon rotation of the turret, reservoir and cylinders, the valve cam **90** lifts the valve **60** clear of the discharge port in a cylinder for filling the can and at other portions the cam **90** permits the valve to drop by gravity for closing the cylinder port **54.**

Although the force of gravity will seat the valves **60,** additional seating force can be applied by springs (not shown) between the valve boots **66** and the reservoir brackets **48.**

PLUGS

The metering plugs **70** are cam lifted and gravity lowered by mechanism similar to that described for the operation of the valves. Referring to FIG. **3,** each plug **70** has a lower conical surface **71** that is complementary to the conical seating surface **52** of the bottom wall of the cylinder **50.** The plug **70** is formed with a conical upper surface **72** that provides a valve seat with the piston **80.** The plug includes a vertical sleeve **73** that surrounds the valve rod **65** and makes a sliding fit with the lower valve rod end **65***a*. The sleeve **73** has a reduced upper end portion **73***a* that also slides on the valve rod **65.** An intermediate portion of the plug sleeve **73** mounts a re-curved boot **74** (FIG. **3**) carrying a bracket **75** from which projects a stub axle **76.** The axle **76** carries an eccentric bushing **77** that is clamped on the axle by a nut **78.** The plug cam roller **79** rotates on the ec-

centric bushing 77. The roller bracket 75 can be removably secured to the sleeve 73 by bolts or screws (not shown).

The plug cam rollers 79 are lifted during rotation of the turret by a circular metering cam 100 (FIG. 4). In order to hold the plug cam rollers in their proper radial positions, as seen in FIG. 3, the plug boots 74 are slotted at 74*a* for receiving a locating pin 85*a* projecting from the piston mechanism to be described presently. Thus, as the turret and reservoir cylinders 50 rotate around the filling apparatus, the metering cam 100 first raises the plug 70 and then permits it to lower by gravity in a timed sequence, as will be described.

PISTONS

The pistons 80 each have a downwardly facing conical seat 82 that forms a valve seat with the upper conical seat 72 of the plug, for trapping a charge. The piston also has a seating surface 82*a* that mates with a complementary surface 53 on the bottom wall 51 of the cylinder 50 (FIG. 3). The piston has a cylindrical portion 83 that makes a nice sliding fit with the wall of the cylinder 50 and is supported by spaced radial arms 84 (FIGS. 1A and 3) that form flow passages through the piston and hence accommodate free, downward flow of liquid from the reservoir through the piston during charging. The arms 84 project radially from a piston sleeve 85 that surrounds the plug sleeve 73 and the piston sleeve is slidably mounted in the lower fixed bracket 49. The upper end of the piston sleeve 85 carries the pin 85*a* (FIG. 3) riding in the slot 74*a* for preventing rotation of the plug assembly, as previously mentioned. An intermediate portion of the piston sleeve 85 mounts a downwardly turned boot 86 that cooperates with a cylindrical lip 87 (FIG. 3) projecting up from a horizontal upper wall portion 42*a* of the reservoir 46 (see the right side of FIG. 2), for excluding wash water or the like from the parts.

In order to raise the pistons 80 in a timed sequence, the upper end of each piston sleeve 85 carries a bracket 88 that mounts a cam follower roller 89. The brackets 88 can also be screwed to their sleeve. The metering cam 100 has an upper ramp 100*a* (FIG. 6), a descending ramp 100*b* (FIGS. 5 and 6), a lower ramp 100*c* (FIG. 5) which may be interrupted for parts removal, and an ascending ramp 100*d* (FIGS. 5 and 6). The ascending ramp 100*d* (left side of FIG. 5) is disposed to lift the piston cam roller 89 during certain portions of the cycle independently of the plug 70. As seen in FIG. 4, the boot 74 for the plug sleeve 73 is relieved at 74*b* to receive the piston roller bracket 88. In order to hold the piston cam roller 89 in radial position on the metering cam 100, the piston sleeve 85 is formed with a key 85*b* (FIGS. 3 and 4a) that slides in a keyway formed in a fixed bracket 49.

OPERATION

FIGS. 5 and 6 taken together represent a series of stages in an operating cycle. These figures can be considered to represent either the condition of a single piston and valve assembly at various portions of a cycle or can be considered to represent a number of assemblies rolled out flat on the paper. FIGS. 7 to 10 are enlarged views at selected portions of a cycle.

In FIGS. 5 and 6, the various illustrated portions of the cycle are arbitrarily designated as stations A-L, but it must be recognized that these are on a circular path.

At the right of FIG. 5 at Station A, filling is taking place. A raised section 90*a* of the valve cam 90 has lifted the valve cam roller 69 to open the cylinder discharge part 54 to a can R below the cylinder. A descending section 100*b* of the metering cam 100 is supporting the plug cam roller 79 and the plug 70 is approaching the bottom wall of the cylinder 50. The piston roller 89 clears cam section 100*b* so that the piston is descending with the plug as the entire assembly is moving to the left as viewed in the figure. A charge of liquid product P trapped by the plug and piston is flowing down through the cylinder port 54 into the can R by gravity, augmented by the force brought into the liquid charge by the weight of the plug and piston and the hydraulic head above it. It will be noted tha the gap between the piston roller 89 and the metering cam section 100*b* insures a fluid tight seat between the plug and the piston.

As the assembly continues moving around the filler (to the left in FIG. 5, but to the right in FIG. 4), the situation at station B is presented. The valve roller 69 is about to ride down a descending ramp section 90*b* of the valve cam 90 and hence the valve 60 begins closing. Here the descending section 100*b* of the metering cam 100 has dropped the plug until its lower surface 71 is urged by the weight of the unit by gravity against the conical bottom wall 52 of the cylinder. The piston remains sealed with the plug because of a gap between the piston roller 89 and a level section 100*c* of the metering cam at this station. Thus all of the charge of liquid has been ejected into the can except for a small slug above the valve 60.

At station C the can is filled, because the lower ramp section 90*c* of the valve cam 90 has allowed the valve 60 to drop into the cylinder discharge port 54, thereby closing off that port completely for clearing the remaining charge of liquid from the cylinder. As mentioned, it will be noted at the top of the view that there is a small gap between the valve roller 69 and the lower section 90*c* of the valve cam 90 when the valve is closed. In fact the section 90*c* has no seal function and can be wholly or partially omitted.

Station D illustrates the position of the parts when they are about to begin charging. The parts are positioned as at station C except that the rotation of the assembly above the fixed cams 90 and 100 has brought the piston cam roller 89 up to a point where it is about to ride up an ascending ramp section 100*d* of the metering cam 100.

At station E charging is taking place. The piston cam follower 89 is riding up the ramp 100*d* of the cam 100 and the plug cam 79 is also riding up the same ramp section but it is lower than the piston cam follower. This lifts the piston from the plug and hence provides a passage between these elements for charging liquid from the reservoir down through the piston ports 84, between the plug and piston seats 72, 82 and between the lower conical surface of the plug 71 and the bottom wall 52 of the cylinder. It will be noted that large area ports are provided for flow of the charging liquid into the cylinder so the upward lifting of the plug and piston can be rapid without undue turbulence and without the creation of vapor bubbles.

At station F charging is continued, this station also being shown in FIG. 7. The conditions are like those of station E except that the plug and piston have risen together further, but at a predetermined spacing that pro-

vides a minimum of resistance to transfer the liquid around the plug.

At station G, conditions are like those of station F, but the charging operation is near completion.

At station H, the piston cam roller **89** has reached the upper end of the ascending ramp **100***d* of the metering cam **100** and is about to ride over the upper horizontal section **100***a* of that cam. Thus the piston has been raised to its fully up position. The plug **70** is still being lifted towards its uppermost position by the ascending ramp section **100***d* of the metering cam **100** and the plug follower roller **79.**

Station I represents a critical position of the parts in that the plug roller **79** is now on the upper section **100***a* of the metering cam **100** and hence the plug **70** is in its fully up position. As will be seen, this means that the charge has been metered by the plug. It will be noted that both the piston and cam rollers **89, 79** are riding along the horizontal ramp portion **100***a* of the metering cam, and that the plug has approached, but not reached the piston. Of course, the valve **60** remains closed and in all of the charging operations steps heretofore described.

Station J (also illustrated in enlarged form in FIG. **8**) illustrates the condition wherein the charge of liquid product P is trapped beneath the plug and the piston by the descent of the piston to meet the plug. The valve **60** is still closed but its roller **69** is approaching the ascending section **90***d* of the valve cam **90.** As the assembly moved to the left in the figure, the piston cam roller **89** was brought over the descending ramp section **100***b* of the metering cam whereas the plug roller **79** is still maintained by the upper horizontal section **100***a* in its uppermost position. Thus, there is a gap between the descending metering cam section **100***b* and the piston roller **89** so that the piston **80** has been permitted to drop by its own weight against the plug. This forms a seal therewith between the seats **72** and **82,** as clearly shown in FIG. **8,** and hence the charge is trapped. Thus it can be seen that the fixed upward positioning of the plug at station I by the upper horizontal ramp section **100***a* of the metering cam acted to meter the charge.

At station K filling is in process. (See also FIG. **9**). Both the piston and plug cam rollers **89, 79** are riding down the descending metering ramp section **100***b*. Due to the relative placement of the parts the plug is supporting the piston by means of the plug roller **79** and the descending cam ramp **100***b* and there is a gap between the piston roller **89** and the cam ramp. This maintains, by gravity, the seal between the plug and piston and causes ejection of the trapped charge of liquid product P beneath these parts through the cylinder port **54** and into the can R. As can also be seen at station K, liquid from the reservoir is maintained above the mated piston and cylinder parts because of the large ports in the piston formed by the radial arms **84.** This accommodates rapid formation of a charge above the plug and piston without turbulence and without evolution of bubbles in the liquid. Also, since there is a head of liquid above the plug and piston, and since these parts are descending under control of the cam at a rate which experiment determines the fluid will follow, substantially no leakage occurs upwardly between the piston and the wall of the cylinder **50.** Even if some slight leakage did occur, this liquid would merely be returned to the reservoir.

Station L shows a further progression in the filling cycle with the plug supporting the piston and with both parts descending by gravity to further displace the trapped charge of liquid into the can. Again reference is made to FIG. **9** for a larger view of this operation.

Since the parts are circularly arranged and the cams are circular, the operation is continuous and the cycle can be picked up again at station A in FIG. **5,** for a still further illustration of the filling process and then on to station B where the plug and piston are fully lowered and the valve is closing, hence back to station C where the valve is closed and the can R is filled, that station being illustrated in enlarged form in FIG. **10.**

It can be seen by viewing the operation sequences just described how the various features and advantages of the present invention previously mentioned are attained by a relatively simple mechanism. It can also be seen that by making the mounting arms for the cam rollers removable, the parts can be lifted partially or completely clear of the cylinder and the other parts for cleaning. Alternatively the cams **90,100** can have open sections for lifting the parts for cleaning. In fact, the lower sections **90***c* and **100***c* can be partially or completely removed for this purpose, because they serve no real function. It can also be seen how vertical adjustment of the cams **90,100** on their vertical posts **92** (FIG. **2**) can be effected for determining the amount of fill. Of course, the fill rates can be determined by substituting various metering cams **100** having various ascending and descending angles of the ramp sections **100***d*, **100***b*.

MODIFIED FORMS

FIG. **11** is a view corresponding to that of FIG. **3** showing a modified embodiment of the invention, which in the form shown, is particularly adapted for ready removal and cleaning of the parts. FIGS. **12–18** illustrate its operation. In the embodiment of FIG. **11** the parts are essentially the same as those described previously but the interrelation of the plug and piston is reversed. During the filling operation of the previous embodiment the parts descended with plug supporting the piston whereas in the embodiment of FIG. **11** the parts descend with the piston supporting the plug.

In the modified form of FIG. **11** the reference characters for parts corresponding to those of the previous form are assigned as before except that they have been increased by **100,** and only the major differences between the two forms will be described in detail. In the form of FIG. **11,** there is an upper boot **166** on the valve stem **165** as before. A bearing seal **167** is mounted between the boot **166** and the upper end of the plug sleeve **173** which bearing also is formed to spline these parts together.

The lower end of the cylinder **150** has a flat surface **152** instead of a conical surface **52** as previously described. The plug **170** and piston **180** have seating valve surfaces **171, 182** as before but the lower face **171***a* of the plug is flat to mate with the flat lower wall **152** of the cylinder **150.** Similarly, the lower wall **180***a* of the piston **180** is flat to mate with the lower cylinder wall **152,** as in the previous embodiment. The valve and discharge port construction is like that of the previous form except that the valve shoulder **162** of the valve **160** is flat instead of being conical like the corresponding shoulder **62** of the valve of the previous form. The piston sleeve **185** forms an extension of the piston and

the charging ports formed by the radial arms **184** for the piston always extends up into the reservoir **146** (FIG. **18**). In this embodiment, the piston **180** meters the charge and supports the plug **170** during descent, (FIG. **17**). Hence the piston cam roller **189** (FIG. **11**) is mounted by an eccentric bushing **177** corresponding to the bushing **77** of the previous form.

In order to complete the drip proof design a reversed boot or sleeve **174** on the plug sleeve **173** has a splined seal **175** with a boat **186** on the cylinder sleeve **185**. Similarly, a boot **186** on the cylinder sleeve **185** has a splined seal **187** with a reservoir sleeve **188**.

In FIG. **12** the valve follower roller **169** has cleared the lower section **190c** of the valve cam **190** so that the valve **160** has closed the filler port **154** in the cylinder **150**. The section **190***c* is interrupted to permit lifting out of the filler valve parts. The cam followers **179, 189** for the plug **170** and the piston **180** both clear the lower section **200***c* of the metering cam **200** and the plug and piston are bottomed on the bottom wall **152** of the cylinder **150**. The lower cam section **200***c* also stops short for purposes of parts removal. The can R has just been filled with liquid from the reservoir **146**.

As the assembly moves to the left as viewed in these figures, it reaches the position of FIG. **13** and the apparatus begins charging. The valve **160** remains lowered. The ascending ramp section **200***d* of the metering cam **200** begins to lift the plug **170** by means of plug roller **179** while the piston roller **189** remains clear of the cam and leaves the piston **180** seated at the bottom of the cylinder.

In FIG. **14** charging is in process. Both the plug roller **179** and the piston roller **189** are being raised by the ascending section **200***d* of the metering cam **200**. The plug **170** has now attained maximum separation from the piston **180** so that liquid from the reservoir **146** flows down through piston sleeve ports, down past the plug **170**, past the piston **180** and into the bottom of the cylinder **150**. The valve **160** is still closed.

In the condition of FIG. **15** the piston **180** has been lifted up to its charge-metering position by the upper, level section **200***a* of the metering cam **200**. Due to the geometry of the parts although the plug roller **179** is also on the upper level section **200***a* of the cam **200**, the plug **170** has been raised somewhat higher than the piston (compare with Station I, FIG. **6**).

The position of the piston **180** meters the charge.

In the position of FIG. **16** the cylinder **150** is fully charged by trapping a body of liquid product P beneath the plug and piston. The piston roller **189** is still on the upper section **200***a* of the metering cam **200** and hence is at the metering position previously described in FIG. **15**. However, the descending section **200***b* of the cam **200** is now underneath the plug roller **179** so that the plug **170** has dropped and is supported by the piston **180**. This traps the charge of liquid product P in the cylinder **150**. It is to be noted that this situation is the reverse of that previously described in that in FIG. **16** the piston is supporting the plug whereas in the corresponding condition of the first embodiment the plug was supporting the cylinder. However, in both cases the parts are descending under the influence of gravity.

In FIG. **17**, filling is in progress. The valve roller **169** has moved up the ramp **190***d* (FIG. **16**) and onto the upper section **190***a* of the valve cam **190**, opening the valve **160**. The piston roller **189** is still riding down the descent section **200***b* of the cam **200**. The plug roller **179** clears that cam section because the plug **170** is being supported by the displacing elements through the cylinder port **154** and into the can R. Similarly liquid from the reservoir **146** is passing down through the ports in the piston sleeve **185**, maintaining a head above the seated plug piston elements.

In FIG. **18** filling has been substantially completed in that the plug and piston are both resting on the bottom wall of the cylinder **150**. It will be noted that in this condition, both the plug and piston rollers **179, 189** are riding clear of the lower section **200***c* of the metering cam **200** thus the cam may be discontinued, as mentioned. The valve **160** is about to close (descending ramp section **190***b* of the valve cam **190**) to expel the last remaining slug of liquid surrounding the valve into the can R. After the valve **160** is closed, the condition at FIG. **12**, previously described, is presented.

Thus, it can be seen that the modified form of the invention just described has the same features and advantages and the same general mode of operation as that of the first described embodiment. In both embodiments, a positive displacement, no leakage, no bubbling liquid filling mechanism for a container is provided and the mechanisms are easily controlled and easily cleaned and does not require the use of calibrated springs, floats or other precisely operated and sensitive mechanical devices. Because of the support relationship between the plug and the piston, and because the presence of fluid above and below the piston permits a low friction fit of the piston with the cylinder, gravity descent can be used where fluid viscosity permits. This eliminates the need for precise contouring of the valve and metering the cams at the critical stages when the parts must be seated to seal liquid.

Accuracy is maintained at all speeds, even with intermittent operation because all the fluid volume presented to the container by opening the valve port is swept by the descent of the piston-plug elements, and the final closure of the valve itself. By matching the piston-plug descent rate with the fluid viscosity, a relatively large clearance can exist between the piston and the cylinder (as can occur after wear occurs) without significantly disturbing the filling accuracy.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

What is claimed is:

1. A method for filling open top containers from a liquid reservoir having a depending, filling cylinder with a filler port in the bottom wall of the cylinder, comprising the steps of closing off the filler port of the cylinder, closing off the entire bottom of the cylinder from the head of liquid above with a two element upper and lower displacer, vertically separating the displacer elements and moving them up through said liquid head with the liquid flowing past the displacer elements until the lower element reaches a predetermined charge metering position, closing the upper displacer element against the lower element to trap a charge of liquid beneath the elements, opening the filler port of the cylinder, and lowering the closed displacer elements to expel the charge from the cylinder while maintaining a head of liquid above the displacer parts.

2. The method of claim **1**, including the steps of supporting one displacer element against gravity for raising

and lowering it, and supporting the other displacer element on said one element during lowering.

3. Apparatus for filling open top containers with a measured charge comprising a liquid reservoir with a depending filling cylinder having a bottom wall formed with a filler port, a valve extending down through said cylinder for closing off the cylinder filler port, concentric inner and outer dual displacer elements in said cylinder having lower surfaces that fit the bottom of the cylinder and with the inner element slidably fitting said valve for insuring complete delivery of a measured charge in said cylinder, said displacer elements having opposed, charge trapping seats, one of said displacer elements being ported to provide communication between liquid in said reservoir and said displacer element seats, means for separating the displacer elements and lifting them while separated up through liquid in said cylinder with said valve closed to accommodate liquid flow past the opened seats of said elements; means for arresting the lifting of one element at a predetermined charge-metering position, means for closing the other displacer element seat against that of said one element to trap a charge of liquid in the cylinder below the elements, means for thereupon opening said filler port valve, means for simultaneously lowering the closed displacer elements against the bottom wall of said cylinder to expel substantially all of the charge from the cylinder while maintaining a head of liquid above the displacer parts, and means for thereupon reclosing said filler port valve for the final expelling of all remaining charge from said cylinder and filler port.

4. The apparatus of claim 3, wherein said means for lifting said displacer elements up through the liquid comprises mechanical means for directly lifting one of said elements, with the seat of the other element resting on and supported by the seat on said one element to be lifted by the latter.

5. The apparatus of claim 3, comprising mechanical means connected to said valve above said displacer elements for opening said filler port valve.

6. The apparatus of claim 3, comprising a circular array of said cylinders depending from said reservoir, said valve and displacer element operating means comprising circular cams, and means for rotating the cylinders and the reservoir together relative to the cams.

7. A filler for open top containers comprising a reservoir bowl; a filler cylinder depending from said reservoir and having its upper end opening to said bowl, and having a bottom wall, a container filler port formed in the bottom wall of said cylinder; a valve for said filler port; means for presenting empty containers to said filler port; a displacer plug element vertically movable in and clearing the side wall of said cylinder; a displacer piston element slidable in said cylinder and surrounding said plug element, said plug and piston elements having bottom walls conforming to the underlying bottom wall of the cylinder, complementary valve seats on said plug and piston elements, charging port means formed in said piston element for establishing free liquid communication from the bowl past the elements when their valve seats are separated and into the bottom of the cylinder; said valve and said elements having a fill completion position wherein the valve closes said cylinder filler port, said elements nest against the bottom wall of said cylinder and said element valve seats are closed; and control means comprising means for first raising one of said elements relative to the other to open their valve seats, means for raising both elements together to charge the cylinder below said elements from the bowl, means for lowering said one element relative to the other to close said seats, means for opening said valve, and means for simultaneously lowering said closed elements back to the bottom of the cylinder for emptying the cylinder into a container beneath said cylinder filler port.

8. The filler of claim 7, wherein said means for raising said elements and the valve comprises cam means, said elements and the valve being lowered by gravity in response to the cam means.

9. The filler of claim 8, wherein said element seats are disposed so that when the plug element is lowered it supports the piston element.

10. The filler of claim 9, wherein said element seats are tapered.

11. The filler of claim 7, wherein said element seats are disposed so that when the piston element is lowered it supports the plug element.

12. The filler of claim 11, wherein said element seats are tapered.

13. The filler of claim 7, wherein said reservoir has a plurality of said cylinder assemblies and is mounted on a turret, said control means comprising circular cam means for said valve and said elements, a cam follower connected to a rod projecting up from said valve, and cam followers connected to telescoped sleeves surrounding said valve rod and leading down to their respective elements.

14. The filler of claim 13, wherein said element seats are disposed so that when one of said elements is lowered it supports the other element, the upper ends of said telescoping sleeves being re-curved to form telescoping boots.

15. The filler of claim 14, wherein said cam followers are connected to said boots.

16. The filler of claim 13, wherein said elements are lowered by gravity.

17. The filler of claim 16, wherein said circular cam means comprises a separate cam for the valves and a single cam for said plug and piston elements, the cam followers for said elements being offset in their direction of travel.

18. The filler of claim 17, wherein said element valve seats are disposed so that one of said elements is supported during lowering by its cam follower and cam and said one element supports the other element during lowering with the cam follower of the latter element clearing the cam, and with both elements being separately supported by the cam as raising occurs.

19. The filler of claim 7, wherein said filler port valve extends down through said filler cylinder, said displacer plug element slidably fitting around said valve so that when said plug and piston elements rest against the bottom of the cylinder and said valve is closed no charge remains in the cylinder or in the filler port.

* * * * *