VOLUMETRIC LIQUID DISPENSER
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HEAT EXCHANGE FLUID

CIRCULATING PUMP

TEMP. CONDITIONED METERED CHARGE

DISCHARGE PORT

BELT DRIVE

Fig. 1

CLUTCH OUT

CLUTCH IN

BELT STOPPED

CHARGING VALVE 65 OPEN

BELT

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The field of utility of the present invention is that of volumetric dispensation of temperature conditioned liquids, and more particularly that of apparatus suitable for filling metered amounts of cooled propellants into aerosol containers.

Two methods are at present used, generally speaking, for filling aerosol containers of various types, namely a so-called pressure filling technique and a so-called cold filling technique. The pressure filling technique operates with propellants at ambient temperature and presents various problems incident to the considerable pressure differences necessarily existing between the atmosphere at the container to be filled and the propellant, both at ambient temperature, and this technique is therefore ill suited for many purposes. Cold filling systems operate with propellants that are cooled below their boiling temperatures which may be as low as 25°F and lower. Conventionally, cold filling is accomplished by introducing propellant which has been refrigerated in a heat exchanger, into a separately refrigerated filling bowl. A controlled constant level of liquid is maintained at the filling bowl from which the aerosol containers are filled by opening a valve that is usually controlled by a timer. This conventional cold filling technique also has various disadvantages, such as unequal temperature distribution over the entire system and consequent uncertainties of predetermining the amount of liquid to be metered out, inaccurate metering due to inexperience of the operator, and other complications with respect to temperature control problems, inherent in the use of a separately heat-conditioned filling bowl in conjunction with a timed metering valve.

Objects of the present invention are generally to overcome the aforesaid and other disadvantages of heretofore used volumetric liquid dispensing apparatus operating at higher as well as lower than ambient temperatures. Some of the more specific objects are to avoid leakage or break-down due to uncontrollable temperature differentials within the system which is especially important in the dispensing of liquids at very low temperatures; to reduce the number of containers and conduits between dispensing mechanism and storage containers within a system of this type thereby to reduce caloric losses to a minimum; to enable such a system to charge containers directly from an agitated pool through an optimally uncomplicated, straight flow between pool and dispensing port; to maintain the fluid at the desirable temperature until it is dispensed; to provide a system of this type which has fluid conveying paths of minimal lengths, which permits easy regulation and setting of the volume to be dispensed and of the cycle of dispensing including synchronization with conveyor devices and the like; to provide a system of this type which is of optimally simple and comparatively inexpensive construction but nevertheless accurately controllable, reliable, easily adaptable to varying operating conditions and materials, and capable of securely continuous high speed operation.

The nature and substance of the invention may be shortly stated as involving, in a principal aspect, volumetric dispensing apparatus which has a preferably adjustable positively effective metering means (such as a reciprocating displacement plunger within a cylinder), a casing means or jacket surrounding to an appreciable optimal degree the metering means together with fluid carrying charging and discharge accessories, and forming a receiving and distributing reservoir space for the fluid to be dispensed such as in deeply refrigerated liquid form. Charging means (such as a valve) lead from this fluid reservoir into the meter (such as into the cylinder in front of the plunger), and discharge means (such as another value) lead from the meter into a nozzle. The nozzle or similar delivery means is in a practical embodiment arranged for discharge directly into open aerosol containers that are carried past and preferably shortly stopped at the nozzle. The charging and discharging valves are synchronized with the plunger metering means and with conveyor means for the containers. The metering means, such as a plunger or piston, are synchronized with the charging and discharge means in such a manner that the metered amount is determined by the plunger of the meter and not by the valves. The reservoir around the meter is preferably connected in a closed fluid circuit including a pump and a tank wherein the fluid is refrigerated. In this manner the complete system can be kept at practically uniform constant temperature, with the advantages pointed out or implied in the above-presented objects of the invention.

In particularly important aspects the invention contemplates the constructions of the metering and reservoir means and the incorporation of the discharge means in a bulky block such that heat transfer is kept at a minimum. These and other objects, and aspects of the substance of the invention will appear together with various advantages from the following detailed description of a preferred embodiment thereof illustrating its novel characteristics.

The description refers to drawings wherein—

FIG. 1 is a schematic cross section through a system according to the invention;

FIG. 2 is a diagram illustrating the cycle of performance of the system;

FIG. 3 is a partly schematic cross section through a practical embodiment of the invention; and

FIG. 4 is an axial section, partly in elevation, of the piston shown also in FIG. 3.

In FIG. 1, externally controllable fluid metering means are indicated at 11. These consist in this embodiment of a cylinder 12 wherein a piston 14 can be reciprocated, for example by means of a crank motion with piston rod 15, pitman 17 and connecting rod 18. By suitable means such as a slotted yoke crank motion 19 as described herebelow with reference to FIG. 3, the stroke of the piston 14 can be varied, thereby to adjust the displacement volume in the space below the piston, for metering fluid admitted thereto proportional to the piston excursion. It will be understood that instead of a piston, any suitable displacement means, such as a plunger, or a diaphragm, can be used.

A casing 21 surrounds the metering means of which in this instance the cylinder 12 constitutes the housing, forming a space between meter and casing means which serves as a storing, agitating, and distributing reservoir for the fluid to be dispensed and also as a heat exchange jacket for the meter. Charging means, in FIG. 1 indicated as a valve 23, lead from the reservoir space 22 into the metering cylinder portion 12.1. Discharge means, in FIG. 1 indicated by valve 25, lead from the cylinder space 12.1 to the outside, such as through a nozzle 26 for discharging fluid, for example into bottles or other containers 31 moved in a path adjacent the dispensing port means such as nozzle 26, through passages wherein
they can be filled from the nozzle. Suitable for that purpose are for example a conveyor 32 with a belt 33 driven at 34 either continuously or step-by-step. It will be noted that the reservoir space 22 wholly surrounds the metering means. Sealing means are provided for leading valve operating links through the casing such as conventional gland or diaphragm means. As indicated at 38, a duct leads from the cylinder 39 to another means to the outlet such as a nozzle 26. This duct can be arranged within the reservoir 22 proper, or within a body that will assume the temperature of the fluid within the reservoir.

Fluid is supplied from a tank 41 that can be filled through suitable receiving means indicated at 42. The tank has circulation ports 43 and 44, one of which connects at 45 to the jacket and the other to one side of a circulating pump 46, the other side of which leads at 47 into the reservoir 22. Within the tank 41 is arranged a suitable heat exchange means indicated by the coil 48, serving to maintain the fluid which circulates within the closed circuit including the pump 46 and the reservoir 22, at a given temperature, in the embodiment herein disclosed at a comparatively low temperature at which normally gaseous propellants are in liquid phase. It will be evident that the rythmic movement of plunger and valve chambers together with the uniform drive of the circulating pump, maintain the fluid throughout the closed system in continuous agitation, preventing separation of the fluid components.

Arrangements according to FIG. 1 operate generally speaking as follows—a more detailed description of the operation of a specific embodiment being presented below with reference to FIGS. 2, 3 and 4. The tank 41, the pump 46, the jacket reservoir 22, and the ducts 43-45-47 are completely filled with the aerosol fluid in question and the heat exchange unit 48 is put into operation. Examples for various fluids and fluids with suspension which have been successfully dispensed on a comparatively large scale with a dispenser of the present type are a mixture of 65% Freon and 35% of a pharmaceutical compound in ethylalcohol solution, or of 99% Freon carrying in suspension 1% of a pharmaceutical compound in powder form, cooled to a temperature of approximately -30° F. Cooled to this temperature, this mixture of Freon as a propellant and of the active agent proper can be exactly metered and dispensed in a continuous operation, with the herein described apparatus.

Assuming that the metering plunger is appropriately reciprocated preferably with harmonic motion, and that the opening and closing points of the charging and discharging means are appropriately associated with the metering cycle, the plunger will on the outstroke, with the charging means open, suck fluid from the reservoir into the metering space until the outermost position is reached. The charging means is then closed, the plunger movement reversed and the discharge means opened. The discharge of the amount of fluid that had been metered on the plunger outstroke is now discharged through the nozzle on the plunger instroke. Upon full discharge of the metered charge the metering is closed. This cycle is illustrated in FIG. 2 and will be explained in more detail hereinbelow within the description of the specific embodiment according to FIG. 3.

It will now be evident that the apparatus in its entirety is maintained at essentially the same temperature by the temperature conditioned fluid circulated through the jacket which at the same time serves to supply the metering means with that fluid. It will be further evident that the above outlined general construction of apparatus of this type lends itself well to incorporation of optimally direct flow lines including the arrangement of connecting ducts and other means in such a manner that vaporization with consequent impairment of accurate metering are essentially avoided, while the fluid is agitated.

The principle of the volumetric dispenser for temperature conditioned fluids according to the invention having been described with reference to FIG. 1, a specific embodiment thereof will now be described with reference to FIGS. 2, 3 and 4.

In FIG. 3, a tube 61 constitutes the cylinder means shown at 12 of FIG. 1, and 62 is a similar considerably wider tube 65 constituting the casing indicated at 21 of FIG. 1. The two tubular parts 61 and 62 are integral, or otherwise in good heat conductive relation with a bottom block 64, so that the tubes and the block with components therein will assume substantially the same temperature. A meter charging or suction duct 65 is arranged in tube 62 close to the bottom block 64. A discharge or filling valve 66 is located at the end of a duct 68 bored through the block 64, and leads to the discharge nozzle 26. The valves 65 and 66 are operated by pistons 67 of conventional hydraulically operated valve control means, the valve stems leading through appropriate conventional sealing rods. In this embodiment the valve control pistons are actuated by compressed air alternately admitted at 71 and 72 respectively, from the pneumatic control chambers 74 of conventional electromechanical control devices 75, 76. The electrical terminals 77, 78 of the magnetic devices 75, 76 lead to control of the electrical devices 113, 114 respectively, the function of which will be described hereinbelow. It will be understood that the electromechanical control arrangements for valves 65 and 66 are identical, as indicated by identical numerals in FIG. 3. The ports leading from the jacket 61 to the storage tank 41 and the pump 46 shown in FIG. 1 are indicated again at 45 and 47.

Particular care is taken that the contours of the measuring space below the piston 14, including the charging and discharging valves and the discharge duct, are as simple as possible such as to provide an optimally short path from intake to outlet also, and turbulences and vaporization effects should be as much as possible avoided, as detrimental to exact metering and undisturbed dispensation of composite fluids, as mentioned above.

The cylinder and casing tubes 61, 62 are with conventional sealing provisions inserted into a head plate 81 with an opening for the piston rod 15 which in this embodiment incorporates an arrangement for adjusting the piston 14 such as to insure a proper metering seal at all temperatures and for all metered fluids that might be encountered. This arrangement is shown in FIG. 4 and includes a disc 82 of synthetic material that will somewhat expand peripherally upon heating and that in thermal stress bear upon the discs 82, 83 on either side of the expandable disc 81 with ample clearance from the cylinder walls. A compression mechanism includes a rod 84 and a tube 85, the rod 84 ending in a head 86 and the tube 85 in a corresponding head 87 which surrounds the rod 84. By means of a conventional oppositely threaded sleeve and nut arrangement 91 (FIG. 4) the distance between discs 82 and 83 can be varied, and disc 81 more or less compressed thus adjusting its overall diameter and hence its fit within the cylinder 62. FIG. 3 indicates a guiding device leading through the head plate 81, but it will be evident the discharge be dispensed with. A breathing vent is indicated at 93.

The outer end 84 of the piston rod 15 is connected to a pitman arrangement 17 on which is pivoted a connecting rod 94. The outer end of the connecting rod is pivoted at 95 on the slide 96 of an adjustable slotted crank mechanism 98 that is integrated in the cylinder tube 85. The tube 85 is fastened to a revolving disc 97. The end pivot 95 of the connecting rod can thus be shifted to adjust the eccentricity and thus the stroke of the metering piston 14. The crank disc 97 is fastened to a shaft 99 which is driven by an electric motor and appropriate reduction gear 101, through a cogwheel that transmits the motion to the metering piston 14.

The complete apparatus including the metering and dispensing drive and the temperature maintaining and fluid supplying casing are mounted on a plate 110.1 which is
bolted to a firm base (not shown) which is appropriately associated with the conveyor. The plate 110 has a platform 111 for the reduction gear and the bearings required for supporting the shaft 99 with the accessories now to be described.

The shaft 99 carries at its free end the above mentioned crank disc 97 with a conventional drag brake 108, and between the clutch 102 and the crank it carries four cams 121, 122, 123 and 124. While the frictional drag brake is in most instances satisfactory for stopping the cam shaft immediately upon opening the clutch, it is understood that a brake positively actuated (such as electromagnetically, hydraulically or pneumatically) in synchronism with the clutch, will be advantageous when particularly precise operation is desired. The four cams control the switches, such as conventional microswitches, 111, 112, 113 and 114 respectively, which in turn operate the clutch 102, the conveyor control 135, the discharge valve 66, and the charging valve 65. The correlation of these controls with the respective controlled components will be described below.

The device for conveying containers 31, described above with reference to FIG. 1. is again shown in FIG. 3 at 32 and 33. FIG. 3 shows in addition suitable driving means such as a motor 131 which drives the belt wheel 33 through a step by step, start and stop device of conventional construction, here represented by a magnetic clutch 122. The cam control unit 131 of the conveyor drive is in the driving means as fingers 133 and 135 which actuate switches 134 and 136 once during each revolution, such that the switches deliver two impulses separated by a short time interval. Suitable conventional programming relay devices (indicated by box 138 with current supply terminals 139) cause an impulse from actuator 133 and switch 134 to stop the belt, whereas an immediately following impulse from actuator 135 and switch 136 energizes and closes the crank clutch 102. The switch 111 actuated by cam 121 on the meter shaft 99 is arranged to de-energize and disconnect, through the intermediary of relay 138, the clutch 132. The switch 112, actuated by cam 122 is arranged and connected through 138 to start the conveyor belt by energizing the clutch 132. The cams 123 and 124 which actuate the switches 113 and 114 respectively, cause the latter to energize the valve actuating devices 72, 76, keeping the valves open during periods of time which can be determined by the configuration and angular position of the respective cams. It will be understood that the above outlined conventional programming arrangement can be replaced by devices carrying out essentially analogous functions. For example, purely mechanical cam, follower, and valve rod mechanism can be used to advantage instead of the electromechanical controls 75, 76, especially if very precise metering is required.

A complete working cycle will now be described with reference to FIG. 2 which schematically illustrates one complete filling cycle.

The respective relative angular positions shown in FIG. 2 are referred to shaft 99 or the starting and stopping member of clutch 102, and it will be understood that the showing of the stop-start point at the top of FIG. 2 has no particular significance, so long as it synchronized with the fully retracted position of the piston.

Assuming that, as will appear below, the clutch 102 had been opened by action of the cam 121 shortly after the belt was stopped by its finger 135, the shaft 99 has come to a standstill with the piston 14 at its upper dead point, this position corresponding to the vertical axis of FIG. 2. The clutch 102 is then closed by finger 135 on the motor side of the conveyor clutch 132 or by an analogous expediency on a continuously running component of the belt drive. This point is marked a in FIG. 2.

The piston now begins to move down at a very slow rate, being near the dead point. Practically at the same time, the cam 123 causes the discharge valve 66 to open at c and the fluid begins to flow from nozzle 26 into a bottle on the stopped belt. The valve 66 is closed by cam 123 at point d near the lower dead center, with the piston crank still rotating and the belt still at a standstill. Just beyond the dead center, the charging valve 65 is opened by the cam 124, at e. A safe period after the closing at d of the discharge valve, the belt is started at g by cam 122. At h the conveyor is stopped by its own switch operating finger 133. The charging or suction valve 65 is closed at f, so close as feasible to the dead point, by its actuating mechanism that is timed by cam 124. Finally the magnetic clutch 102 is de-energized at b by cam 121 and the shaft 99 immediately stopped by the brake 108, the crank 96 and the piston 14 being then in their uppermost position. At this point, the cycle can be conveniently stopped, such as by manually opening the clutch switch 121.1 in the clutch energizing wire.

The next cycle then begins with the clutch closing at a and the discharging or filling valve opening at e, as above described. It will be noted that the opening and closing of the discharge valve 66 (at c and d respectively) and of the charging valve 65 (at e and f) take place practically simultaneously with the starting and stopping of the sucking up stroke and the metering down stroke, respectively, of the piston 14 when the piston speed is extremely low at the flat portions of its harmonic motion, so that the valve action does not appreciably interfere with the discharge metering function of the displacement element here constituted by the piston. Due to this relation of piston and valve cycles there is little danger of volatilization due to discontinuities of the pressure and flow of the fluid.

It will be evident that the present invention is not limited by such structural details as for example the above described piston drive and programming arrangement of conveyor belt, piston movement, and discharge and charging valve drives. All these can be accomplished in various ways within the concepts of the invention as will be evident to those skilled in this art.

It will also be evident that the above described cycle does not have to be adhered to for every purpose. For example, continuously moving belts can be used, and also continuously moving displacement bodies, if the charging and discharge provisos are appropriately placed within the metering and container moving cycles.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A volumetric dispenser for temperature conditioned fluids, comprising:

metering means including cylinder means with volume displacement means reciprocable therein;

means for reciprocating said displacement means;

means for casing means effectively surrounding said metering means to form a distribution chamber of appreciable volume, and of appreciable surface area common with the metering means;

means for circulating through said chamber temperature conditioned fluid in a closed circuit;

a charging valve leading from said chamber into said cylinder means;

dispensing port means closely adjacent to said casing means;

a discharge valve leading from said cylinder means to said dispensing port means;

control means for alternately opening and closing said charging and discharge valves, respectively; and

means for driving said reciprocating means and said control means in synchronism;

whereby the metering means, the valves, and the fluid within the metering means and the chamber are maintained essentially at the same temperature during metering and dispensing the fluid.
2. Dispenser according to claim 1, further including:
means for conveying containers in a path adjacent said dispensing port means through positions wherein they are adapted to be filled therefrom, and
means for actuating said conveying means in synchronism with said metering means and said driving means.

3. In a volumetric dispenser for temperature conditioned fluid, a metering subassembly comprising:
an inner hollow cylinder;
a displacement plunger mounted in said inner cylinder for sealed reciprocation therein;
an outer hollow cylinder concentric with said inner cylinder;
a heat distributing block integral with said hollow cylinders at their ends at one side thereof;
casing means at the other ends of said cylinders for closing the space between the cylinders and the heat distributing block to form a distribution chamber;
a charging valve means from said chamber into said inner cylinder closely adjacent to said block; and a discharge valve closely adjacent to said block leading from said inner cylinder to an outside dispensing means.

4. A volumetric dispenser for temperature conditioned fluid, comprising:
(a) externally controllable fluid metering means within a housing;
(b) casing means effectively surrounding an appreciable portion of said metering means, forming a reservoir and conditioning space between said metering means housing and said casing means, and adapted to receive said fluid;
(c) charging means leading from said space into said metering means;
(d) discharge means leading from said metering means to the outside of said metering and casing means;
(e) control means for cyclically opening and closing said casing means, when the charging means is open, and for closing and opening said discharge means;
(f) means for circulating through said space, in a closed circuit, fluid to be dispensed; and
(g) means in said closed circuit for cooling said fluid to maintain it in liquid form;
whereby the fluid within the metering means and the casing means, the metering means, and the charging and discharge means are maintained at essentially the same cooled temperature.

5. Dispenser according to claim 4 wherein the discharge means terminates in a filling nozzle closely adjacent to the casing means and adapted for cooling by the circulation of the fluid.

6. Dispenser according to claim 4, wherein said metering means include: cylinder means constituting said meter housing; displacement plunger means within said cylinder means; and means for automatically reciprocating said displacement means with an essentially harmonic motion; said charging means and discharge means being located on the same side of said displacement means for effecting fluid transfer between said reservoir and conditioning space and said cylinder means upon reciprocating.

7. A volumetric dispenser for temperature conditioned fluid, comprising:
(a) externally controllable fluid metering means within a housing;
(b) casing means effectively surrounding an appreciable portion of said metering means, forming a reservoir and conditioning space between said metering means housing and said casing means, and adapted to receive said fluid;
(c) charging means leading from said space into said metering means;
(d) discharge means leading from said metering means to the outside of said metering and casing means;
(e) control means for cyclically opening and closing said charging means, for operating said metering means, when the charging means is open, and for closing and opening said discharge means;
(f) a heat exchanger for refrigerating to liquid phase the fluid to be dispensed;
(g) means establishing a closed circuit for the fluid from the heat exchanger to said space and back to and through the heat exchanger; and
(h) means for circulating the fluid in said circuit, whereby the fluid within the metering means and the casing means, the metering means, and the charging and discharge means are maintained at essentially the same refrigerated temperature.

8. A volumetric dispenser for refrigerated low-boiling point fluid, comprising:
(a) cylinder means;
(b) reciprocating displacement means for drawing in fluid into the cylinder means and discharging the fluid therefrom in metered quantities;
(c) a discharge valve through which fluid leaves the cylinder;
(d) crank means for imparting a harmonic reciprocating motion to the displacement means;
(e) means for adjusting the effective throw of the crank means to adjust the length of stroke of the displacement means while preserving the harmonic character of such motion of the displacement means; and
(f) means for operating in timed relation to rotation of the crank means for closing the charging valve and opening the discharge valve at one flat portion of the harmonic motion of the displacement means and for closing the discharge valve and opening the charging valve at the other flat portion of such harmonic motion.

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