This invention is directed to a slug valve of the type which is used to dispense a measured volume of fluid into an ice tray or the like. The ice making apparatus and is more particularly directed to a new and improved form of slug valve utilizing a reciprocably movable piston rather than a flexible resilient bag and to a means for controlling the temperature of fluid dispensed from the slug valve and for controlling the flow of fluid through the valve as a function of the fluid temperature therein.

In general, slug valves comprise a hollow valve body having an inlet and an outlet and having a volumetrically variable chamber therein communicable with the inlet and the outlet. Fluid is directed through the inlet into the chamber within the valve body and thereafter the inlet is closed, the outlet is opened, and the volumetric capacity of the chamber within the valve body is decreased to expel the fluid therein through the outlet to a point of utilization.

In some types of ice making devices it is desirable, for reasons which need not be outlined here, to dispense heated fluid to the ice tray. In order to effect heating of the fluid it has generally been the practice to provide a heater means for the fluid supply conduit at a point remotely located from the slug valve and to continuously energize the heater means or to effect energization of the heater for predetermined intervals of time by a timer mechanism or through some other independent means.

It has also generally been the practice to control fluid flow through the inlet and the outlet from the slug valve by means of a pair of independently actuable solenoids. Difficulties have, however, been encountered in the past in such types of slug valves for several reasons. The utilization of a flexible bag within the slug valve body to provide a means for increasing and decreasing the volumetric capacity of the fluid chamber therein is hampered by the fact that the life of the bag is relatively short.

Furthermore, the utilization of two solenoids for the slug valve increases the cost of the valve since solenoids are relatively quite expensive. With regard to the heater coil for effecting heating of the fluid within the slug valve it is, of course, uneconomical to run the heater at all times while, on the other hand, the provision of an independent switch means for effecting energization and deenergization of the heater coil adds to the cost of the composite slug valve.

In order to obviate the foregoing disadvantageous features of prior slug valves, I have devised a slug valve wherein a reciprocable piston is utilized within the slug valve to provide a means for increasing and decreasing the volumetric capacity of the valve as desired and wherein a thermal sensitive snap action mechanism is utilized not only to open and close the outlet valve but also to effect energization and deenergization of the inlet solenoid and the heater coil.

In the embodiment of the invention which I have illustrated, a valve is cooperative with a flow port on the upstream side thereof to control fluid flow through the port. A valve stem extends from the valve through the port to the downstream side thereof and is sealed by means of a flexible diaphragm, bonded thereto, to the container body.

The valve stem is loosely guided within the port so that fluid may flow around the stem within the port to a chamber disposed intermediate a portion of the wall of the container and the flexible diaphragm and through an outlet communicable with that chamber.

I contemplate using a snap actuator mechanism having a snap blade cooperative with the valve stem to effect axial movement of the valve stem to thereby move the valve away from the flow port in an upstream direction to permit fluid flow through the port and consequently through the outlet from the container as a function of controlled actuation of the snap actuator.

The snap actuator is actuated as a function of the temperature of the fluid within the container or slug valve body by means of a thermally responsive element which is secured within a wall of the valve body in heat transfer relation with the fluid therein.

The power member or piston which is extensible from the thermally sensitive element upon increases in ambient temperature conditions around the heat sensing portion thereof is connected to a snap lever of the snap actuator. In the embodiment of the invention shown in the drawings the snap lever of the snap actuator is so pivotally mounted that pivotal movement thereof caused by axial movement of the power member of the thermal sensitive element acting through an over-center spring, pivotally moves the snap blade with a relatively great force to axially move the valve stem in the valve against the opposing biasing force of pressurized fluid within the container away from the valve port to openly communicate the interior of the container with the outlet.

The valve is disposed on the upstream side of the port so that the pressure of fluid within the container normally acts to maintain the valve in a seated relation with respect to the port to shut off fluid flow from the interior of the container to the outlet.

A piston is slidable disposed within the hollow interior of the valve body and is sealed to the walls thereof, being biased toward one end of the chamber by a relatively strong spring. A solenoid is utilized for controlling fluid flow through the slug valve inlet. Upon energization of the inlet solenoid, fluid flows through the inlet into the chamber and the pressure of incoming fluid acts to move the piston within the valve body against the opposing biasing force of the spring to increase the volumetric capacity of the chamber until the spring has been compressed to its maximum.

A heater coil is wound about the thermally conductive walls of the slug valve body and is energizable in a manner which will hereinafter become apparent to effect heating of the fluid within the slug valve chamber prior to its passage through the outlet. Upon opening of the outlet valve in the manner which has above been described, the spring acting against the piston will act to force the fluid within the slug valve body out through the outlet.

In order to simplify the operation of the slug valve and to greatly reduce the cost of its production, both the
inlet solenoid and the heater coil are energizable through the movement of the snap blade. The snap blade is elec-
trically conductive and constitutes a movable electrical contact which is associated with a stationary electrical
contact disposed at a point adjacent the end of the piv-
otal stroke of the snap blade. In this manner, when the
snap blade is pivoted by axial extensible movement of the
power member associated with the thermal sensitive
element to a point to open the outlet valve and permit
fluid flow through the outlet, the contact is broken and
the inlet solenoid and heater coil are simultaneously
denergized so that the inlet valve is closed simultaneously
with deenergization of the heater coil and fluid is then
expelled through the slug valve outlet.
It is therefore a primary object of the present inven-
tion to provide a new and improved slug valve which is
of simple construction and which may be economically
manufactured.
Another object of the invention resides in the provi-
sion of a poppet valve for controlling fluid flow through a flow port in a container which is controllable moved by a ther-
mally sensitive snap actuator.
A still further feature of the invention resides in the
provision of a slug valve of the class generally set forth
above wherein the snap actuator which is operable to
close fluid flow through the outlet is also operable to con-
trol the energization of the heater coil and the inlet sole-
loid.
These and other objects of the invention will appear
from time to time as the following specification proceeds
and with reference to the accompanying drawings,
wherein:
FIGURE 1 is a plan view of a slug valve constructed
in accordance with the principles of the present inven-
tion;
FIGURE 2 is a vertical sectional view through the valve
illustrated in FIG. 1 and taken along lines II—II of
FIG. 1;
FIGURE 3 is a vertical sectional view of the slug valve
illustrated in FIG. 1 which is similar in nature to FIG. 2,
but which shows the piston, outlet valve, and valve act-
ator mechanism in different positions;
FIGURE 4 is a fragmental vertical sectional view
through the inlet port and inlet diaphragm valve taken
along lines IV—IV of FIG. 1; and
FIGURE 5 is a schematic diagram of a wiring circuit
which might be employed in the present device.
In the embodiment of the invention illustrated in the
drawings, a slug valve 10 is shown as comprising a valve
body including an upper section 11 and a lower section
12 which are sealed together in fluid tight relation by
means of an annular bead 13.
The lower section 12 comprises a cylinder of heat con-
ducting material which has an intumescence annular
ring 14 extending therefrom at the opposite end of the
cylinder from the upper section 11. A piston 15 is slidable
within the cylinder and is formed in the shape of an in-
verted cup. An annular resilient sealing ring 16 is seated
on the upper surface of the piston 15 with its outer per-
iphery disposed in slidable engagement with the inner
wall of the cylinder 12. A circular plate 17 is seated on
a central raised portion 18 of the piston 15 and is riveted
thereto by means of rivets 19. The plate 17, in con-
junction with the stepped portion of the piston 15 forms
an annular groove 20 which receives the inner annular
surface of the sealing ring 16.
An annular boss 22 depends from the lower surface
of the upper section 11 and extends within the interior of
the cylinder 12, acting as a stop to limit the degree of
upward movement of the piston 15. A relatively heavy
compression spring 23 is disposed within the cylinder
12 having its lower end seated on the intumescence ring 14
and having its upper end disposed in engagement with the
piston 15 to bias the piston into engagement with the
annular depending boss 22. When pressurized fluid flows
into the chamber 35, the spring 23 is compressed as the
piston is urged to the lower end of the cylinder 12 until
the piston has moved to its lowermost extent where it
meets a radially extended shoulder 25 formed into the boss 22.
As shown in FIGURE 4, boss 24 is formed integrally
with the upper section 11 and has an inlet passage 25
formed therein which is communicable with an annular
inlet chamber 26 formed in the upper end of the upper
section 11. The inlet passage 25 has a radially enlarged
portion 25 formed within the boss 24 which is adapted
to encompass a filter screen 29 placed therein to filter water
flowing into the inlet passage 25 from a similar passage
formed within a connecting nipple 30 which is attached
to the hollow boss 24.
An upstanding boss 31 is formed at the upper end of
the upper section 11 centrally of the annular fluid inlet
chamber 26, and has an inlet port 33 leading therethrough
to communicate fluid from the fluid inlet chamber 26 to
the main fluid chamber 35 within the slug valve 10 which
is formed intermediate the lowermost portion of the up-
per section 11 and the piston 15.
An annular groove 36 is formed about the annular fluid
inlet chamber 26 which serves as a seat for an annular
peripheral depending lip 37 of a fluid pressure actuated
diaphragm valve 38. The diaphragm valve 38 is cooper-
able with the port 33 to control fluid flow therethrough
from the annular fluid inlet chamber in a manner which is
well known in the art, and is controlled by an electrically
retractable armature 39 which forms a composite part of
an inlet solenoid 40. As is now well known, upon ener-
gization of the solenoid 40, the armature 39 moves out of
engagement with the diaphragm 38. Since the flow area
through the central aperture within the diaphragm is
greater than the flow area through its peripheral bleed
aperture, the diaphragm is raised off of its seat by fluid
pressure differential to permit fluid to flow from passage
26 to port 33. The diaphragm is similarly closed by
fluid pressure differential upon deenergization of the sole-
nid 40 but, since this forms no part of the present inven-
tion, it will not here be further described.
An outlet flow port 44 opens through one wall of the
upper section 11 to a chamber 45 which, in turn, opens
to an outlet 46 which terminates in a connecting nipple
47 formed integrally with the upper section 11.
A valve 50, being formed in the configuration of a
truncated cone is disposed adjacent the point where the
port 44 opens to the chamber 35 in such a manner that the
conical wall 51 of the valve is cooperative with the
wall of the upper section 11 defining the port 44 to con-
trol fluid flow therethrough.
Assuming that the normal flow of fluid is from the
chamber 35 through the port 44, chamber 45, and thence
through the outlet 46, the valve 50 may be described as
being cooperative with the port 44 on the upstream side
thereof.
A valve stem 52 is formed integrally with the truncated
valve 50 and extends upwardly from the valve 50 within
the port 44. The diameter of the valve stem 52 is con-
siderably less than the diameter of the port 44 so that
when the valve stem and its associated valve 50 are moved
to the position illustrated in FIG. 3, fluid can flow past
the valve 50 through the port 44 in the passageway formed
intermediate the valve stem 52 and the wall of the upper
section 11 defining the port 44 to the chamber 45.
A flexible annular diaphragm 53, which may be formed
of rubber or other known resilient materials, has a peri-
ipheral bead 54 formed thereon which is adapted to be
seated in an annular groove 55, formed within the upper
section 11 proximately with and extending around the cy-
ldindrical chamber 45. It will thus be observed that the
diaphragm 53 in conjunction with a portion of the upper
section 11 serves to define the chamber 45. The diaphragm
53 is centrally apertured as at 57 to receive the
upper end portion of the valve stem 52. In order to main-
tain a fluid tight seal between the chamber 45 and the
outer surface of the diaphragm 53, the diaphragm 53 is bonded to the stem 52 at the central aperture 57. A conical annular ring 59 is seated over the diaphragm 53 so that the depending annular ring 59 seats against the peripheral edge of the diaphragm 53 to maintain a fluid tight seal between the diaphragm and the upper section 11. The cap 58 may, of course, be seated in the position illustrated in the drawings by any suitable means.

The cap 58 is centrally apertured as at 60 to loosely receive the upper free end portion of the valve stem 52. The valve stem 52 is formed of sufficient length so that when the stem is depressed to the position illustrated in FIG. 5, the upper free end portion of the stem will still extend exteriorly of the cap 58.

Assuming that pressurized fluid is disposed within the chamber 35 and that the valve member 50 is initially in the position illustrated in FIG. 2, communication between the chamber 35 and the outlet 46 will be closed. However, upon depression of the valve stem 52 the diaphragm 53 will flex downwardly and the stem 52 will axially move the valve 50 away from the wall of the upper section 11 defining the port 44 to the position illustrated in FIG. 3, to permit the passage of fluid from the chamber 35 through the port 44 to the chamber 45 and thence through the outlet 46.

Upon release of the downwardly directed force tending to hold the valve stem in the position illustrated in FIG. 3, the inherent resiliency of the diaphragm 53 act to return the valve 50 and its associated valve stem 52 to the position illustrated in FIG. 2. Upon closure of the valve 50 related to the port 44, the pressure fluid acting against the flat face of the valve 50 will be effective to maintain the valve in a port closing position. It will be understood that the fluid pressure differential on the valve itself in conjunction with the force of fluid acting on the underside of the diaphragm 53 will also act to return the valve 50 to a port closing position. I have found, however, that the resiliency of the diaphragm is necessary to close the valve due to the fluid turbulence created at the mouth of the port when the valve is in a port opened position.

An L-shaped bracket or stirrup 65 is mounted on the upper section 11 and has an upwardly extending arm 66 extensions thereof which terminates in a roller 67. A second bracket 68 is L-shaped in configuration and has an upwardly extending forked end 69.

A snap blade 70 has a forked end 71 which is pivotally secured to the upwardly forked end of the L-shaped bracket 65 so that the snap blade 70 can have pivotal movement with respect to the bracket 68.

A snap lever 73 is also substantially L-shaped in configuration and has a depending free end portion 75. The snap lever 73 also has a pair of depending tabs 76 (only one of which is visible in the drawings) which have a pivot pin 77 journalled for rotatable movement therein. The pivot pin 77 is, in turn, secured within the upwardly curved arm 66 so that the snap lever 73 is pivotally mounted on the bracket 65.

An over-center spring 80 has its opposite ends secured within apertures formed in the free ends of the snap blade 70 and the snap lever 73 in the usual manner which is well known in the art. The spring 80 is always under tension so that when the snap lever 73 is in the position illustrated in FIG. 2, wherein the point of connection of the spring 80 with the lever 73 is disposed above a straight construction line extending through the point of connection of the spring with the snap blade 80 and through the pivotal point of the blade 70, the snap blade will be disposed in the position illustrated in FIG. 2. Conversely, when the point of connection of the snap lever 73 with the spring 80 is moved to a point below the construction line hereinbefore mentioned, the snap blade 80 will be snapped from the position illustrated in FIG. 2 to the position illustrated in FIG. 3 by the over center spring 80.

It will be noted that when the snap blade 70 is pivotally snapped from the position illustrated in FIG. 2 to the position illustrated in FIG. 3, the pivotal movement thereof acts against the protruding end portion of the valve stem 22 to axially move the valve stem to thereby move the valve head 50 away from the port 44 to permit fluid flow from the chamber 35 through the port 44 and subsequently to the outlet 46.

As will hereinafter be described, the means utilized for effecting pivotal movement of the snap lever 73 is operable as a function of the temperature of fluid within the chamber 35.

The upper section 11 is apertured as at 82 to receive a thermal sensitive power element 83. The thermal sensitive power element 83 is of the type which is well known in the art and includes a sensing portion 84 which may have a fusible thermally expansible material disposed therein. Upon increases in the ambient temperature about the sensing portion 84 a point above the critical temperature of the thermal sensitive material within the sensing portion 84, the material will expand and thereby act to extensively move a power member or piston 85, slidably mounted within the guide portion of the element 83 from the element.

A hollow cylindrical cap 87 is threadedly mounted on the element 83 and is engageable, at its lower edge, with an annular shoulder 88 to draw up the element tightly against the inner surface of the upper section 11 and to provide a means for retaining a return spring 89 therein.

The return spring 89 is seated at one end against the end of the cylindrical cap 87 and is seated at its opposite end on a retainer disc 90 which is secured to a radially reduced portion 91 of the power member or piston 85.

The spring 89 acts to return the power member or piston 85 to its retracted position illustrated in FIG. 2 as the ambient temperature about the sensing portion 84 of the element 83 decreases to a temperature less than the critical temperature of the thermal sensitive material within the element 83.

The power member 85 has a radially reduced upper end portion 94 which protrudes from the cap 87 even when the snap lever 73 is in its most retracted position, with respect to the upper section 11, which the actuating end of the snap lever 73 is loosely connected. As a result, axial movement of the power member 85 will effect pivotal movement of the snap lever 73.

The snap blade 70 constitutes the movable contact of an electrical switch which is cooperated with the stationary contact 95 affixed to the bracket 65. It is preferable that the electrical connection to the movable contact or snap blade 70 be made to the bracket 68 so that electrical energy will travel through the bracket 68 and thence to the snap blade 70 at the point of contact of the blade with the bracket 65. In this manner freedom of movement of the snap blade will not be impaired.

Thus, when the snap blade 70 is in the position illustrated in FIG. 3, the circuit through the contacts will be open while upon movement of the snap blade to the position illustrated in FIG. 2 the electrical circuit will be closed. As a result, the contact 95 is insulated from the bracket 65 by an insulating member 95a.

A resistance heater coil 100, which may be embedded within a protective heat conducting sheathing, is wound about the exterior of the cylinder 12 to provide a means for heating the fluid disposed within the chamber 35 prior to the passage thereof through the outlet 46. The heater coil, like the solenoid coil 102 which is operable to effect flow controlling movement of the inlet valve, is energized through the snap switch and through a mold thermostat switch from a power source 101 as is clearly shown in the diagrammatic representation of the wiring diagram for the apparatus illustrated in FIG. 5.

As shown in FIG. 5 the resistance heater coil 100 and
the solenoid coil 102 are wired in parallel and are energized through a pair of serially connected switches. The switch associated at 104 may comprise the snap action switch which has hereinafore been described, while the switch indicated at 105 may comprise a mold thermostatic switch or a simple line switch.

In view of the foregoing detailed description of the operation of the individual components of the slug valve, the operation of the entire device might be described as follows:

Upon closure of the line switch or mold thermostatic 105 (and assuming that the snap switch 104 is in the closed circuit position) the resistor heater coil 104 and the solenoid coil 102 will be substantially simultaneously energized. Energization of the solenoid coil 102 will effect retractable movement of the armature 39 to permit fluid pressure operation of the inlet diaphragm valve 38, thereby permitting pressurized fluid to flow from the inlet 28 into the fluid chamber 35 within the slug valve body. As fluid flows into the chamber 35 the piston 15 will be caused to move downwardly, thus moving the ram 22 against the opposing biasing force of the compression spring 23 until the piston and spring have been moved to their lower limit. At the same time, the resistor heater 100 (energized simultaneously with energization of the solenoid coil 102) will act through the heat conducting walls of the cylinder 12 to heat the fluid within the chamber 35. During this interval it is assumed that the ice tray will be prepared for another filling operation.

When the temperature of fluid within the chamber 35 has reached the critical temperature of the fusible thermally expansible material within the thermal sensitive element 83, the power member 85 will move extensibly from the element to pivotally move the snap lever 73 about its pivotal connection point to the bracket 65 and the snap blade 70 will be snapped from the position illustrated in FIG. 2 to the position illustrated in FIG. 3. Such pivotal movement of the snap blade 70 will act to depressionally move the valve stem 60 to permit fluid flow from the chamber 35 through the outlet port and thence through the outlet.

Simultaneously, upon pivotal movement of the snap blade 70, the switch 104 will be disposed in the open circuit position thus causing deenergization of the solenoid coil 102 and the resistor heater 100. When the solenoid coil 102 is deenergized the inlet diaphragm valve will close by fluid pressure differential as is well known in the art. The compression spring 23 acting against the piston 15 will then act to force the fluid within the chamber 35 through the outlet port 44 and thence through the outlet and will urge the piston 15 upwardly within the cylinder 12. Inasmuch as the resistor heater 100 is deenergized the thermal sensitive element will be permitted to cool and upon cooling of the fusible thermally expansible material therein the spring acting against the retainer 90 on the power member 85 will act to retractably move the piston 15 upwardly, thus moving the ram 22 of the thermal sensitive element to return the snap lever and the snap blade to the positions illustrated in FIG. 2 to prepare the slug valve for another cycle of operation.

In this manner the thermally operable snap action switch mechanism is effective not only to control opening and closure of the inlet valve, but also opening and closure of the outlet valve and energization and deenergization of the heater coil at the proper times.

It will, of course, be understood that this embodiment of the invention has been used for illustrative purposes only and that various modifications and variations of the present invention may be effected without departing from the spirit and scope of the novel concepts thereof.

I claim as my invention:

1. A fluid control valve comprising a valve body having a fluid chamber and having inlet and outlet ports opening to said chamber adjacent one end thereof, a movable wall defining a portion of said chamber and movable to vary the volumetric capacity thereof, valve means associated with each of said ports being energizable to permit fluid flow therethrough, means for heating the fluid contained within said chamber, and means operable to effect energization of one of said valve means and simultaneous deenergization of the other of said valve means as a function of the temperature of fluid within said chamber.

2. A fluid control valve comprising a valve body having a fluid chamber and having inlet and outlet ports opening to said chamber adjacent one end thereof, a movable wall defining a portion of said chamber, and movable to vary the volumetric capacity thereof, valve means associated with each of said ports being energizable to permit fluid flow therethrough, heat means disposed in heat transfer relation with the interior of said chamber, and means operable to effect energization of one of said valve means and simultaneous deenergization of the other of said valve means and energization of said heater means when said inverter valve means is energized, as a function of the temperature of fluid within the said chamber.

3. A fluid control valve comprising a valve body having a fluid chamber and having inlet and outlet ports opening to said chamber adjacent one end thereof, a movable wall defining a portion of said chamber and movable to vary the volumetric capacity thereof, valve means at said inlet port being energizable to permit fluid flow therethrough, a poppet valve operable with the upstream side of said outlet port normally disposed in a port closing position by the pressure of the fluid within said chamber, heater means associated with said chamber for heating the fluid contained therein, an electrical switch mounted on said valve body having a movable contact forming a part thereof which is operable when in the closed circuit position to effect simultaneous energization of said valve means and said heater means, motion translation means intermediate said movable contact and said poppet valve operable to move said poppet valve to a port open position when said movable contact is moved to an open circuit position, and means for effecting movement of said movable contact as a function of the temperature of fluid within said chamber.

4. A fluid control valve comprising a valve body having a fluid chamber and having inlet and outlet ports opening to said chamber adjacent one end thereof, a movable wall defining a portion of said chamber, valve means associated with each of said ports being energizable to permit fluid flow therethrough, a poppet valve operable with the upstream side of said outlet port normally disposed in a port-closing position by the pressure of fluid in said chamber, heater means associated with said chamber for heating the fluid contained therein, an electrical switch mounted on said valve body having a movable contact forming a part thereof which is operable when in the closed circuit position to effect simultaneous energization of said valve means and said heater means, motion translation means intermediate said movable contact and said poppet valve operable to move said poppet valve to a port-open position when said movable contact is moved to an open circuit position, thermal sensitive power means mounted within said valve body in heat transfer relation with the fluid contained within said chamber having an element extending therefrom upon predetermined ambient temperature conditions therearound, and a mechanical transducer interconnecting said element with said movable contact to effect movement of said movable contact as a function of the temperature of fluid within the said chamber.

5. A fluid control valve comprising a ported body having inlet and outlet ports opening therethrough, a cylinder seated to said body with its interior in communication with said ports, a piston slidably disposed within said cylinder, a sealing ring mounted on said piston and engaging the wall of said cylinder, spring means biasing
said piston toward said body, valve means at said inlet being energizable to permit fluid flow therethrough, a poppet valve cooperating with the upstream side of said outlet port normally disposed in a port closing position by the pressure of fluid within said chamber, heater means associated with said chamber for heating the fluid contained therein, an electrical switch mounted on said valve body having a movable contact forming a part thereof which is operable when in the closed circuit position to effect simultaneous energization of said valve means and said heater means, and motion translation means intermediate said movable contact and said poppet valve operable to move said poppet valve to a port open position when said movable contact is moved to an open circuit position as a function of the temperature of the fluid contained within said chamber.

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