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Zemko et al.

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(54) **FROZEN BEVERAGE DISPENSING MACHINES WITH MULTI-FLAVOR VALVES**

(71) Applicant: **Cornelius, Inc.**, Osseo, MN (US)

(72) Inventors: **Christopher F. Zemko**, Elgin, IL (US); **Vincenzo DiFatta**, Wood Dale, IL (US)

(73) Assignee: **Cornelius, Inc.**, Osseo, MN (US)

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B67D 1/07 (2006.01)

(52) **U.S. Cl.**
CPC ***B67D 1/0048*** (2013.01); ***B67D 1/0021*** (2013.01); ***B67D 1/0081*** (2013.01); ***B67D 1/07*** (2013.01)

(58) **Field of Classification Search**
CPC .. B67D 1/0048; B67D 1/0021; B67D 1/0081; B67D 1/07
USPC 222/129.1, 145.1, 145.5–145.6
See application file for complete search history.

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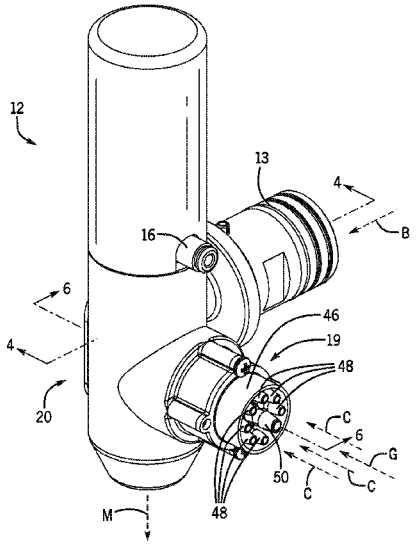
Primary Examiner — Nicholas J Weiss
Assistant Examiner — Andrew P Bainbridge
(74) *Attorney, Agent, or Firm* — Andrus Intellectual Property Law, LLP

(57) **ABSTRACT**

A beverage machine includes a valve that receives a base fluid and dispenses a mixed beverage comprising the base fluid and an additive fluid. The valve has a bore through which the base fluid flows, and the bore has a perimetral surface that defines a plurality of ports through which the additive fluid is injected to thereby mix with the base fluid. An injector is coupled to the valve and configured to radially inject the additive fluid into the base fluid through the plurality of ports as the base fluid flows through the bore such that the additive fluid mixes into the base fluid to form the mixed beverage.

22 Claims, 9 Drawing Sheets



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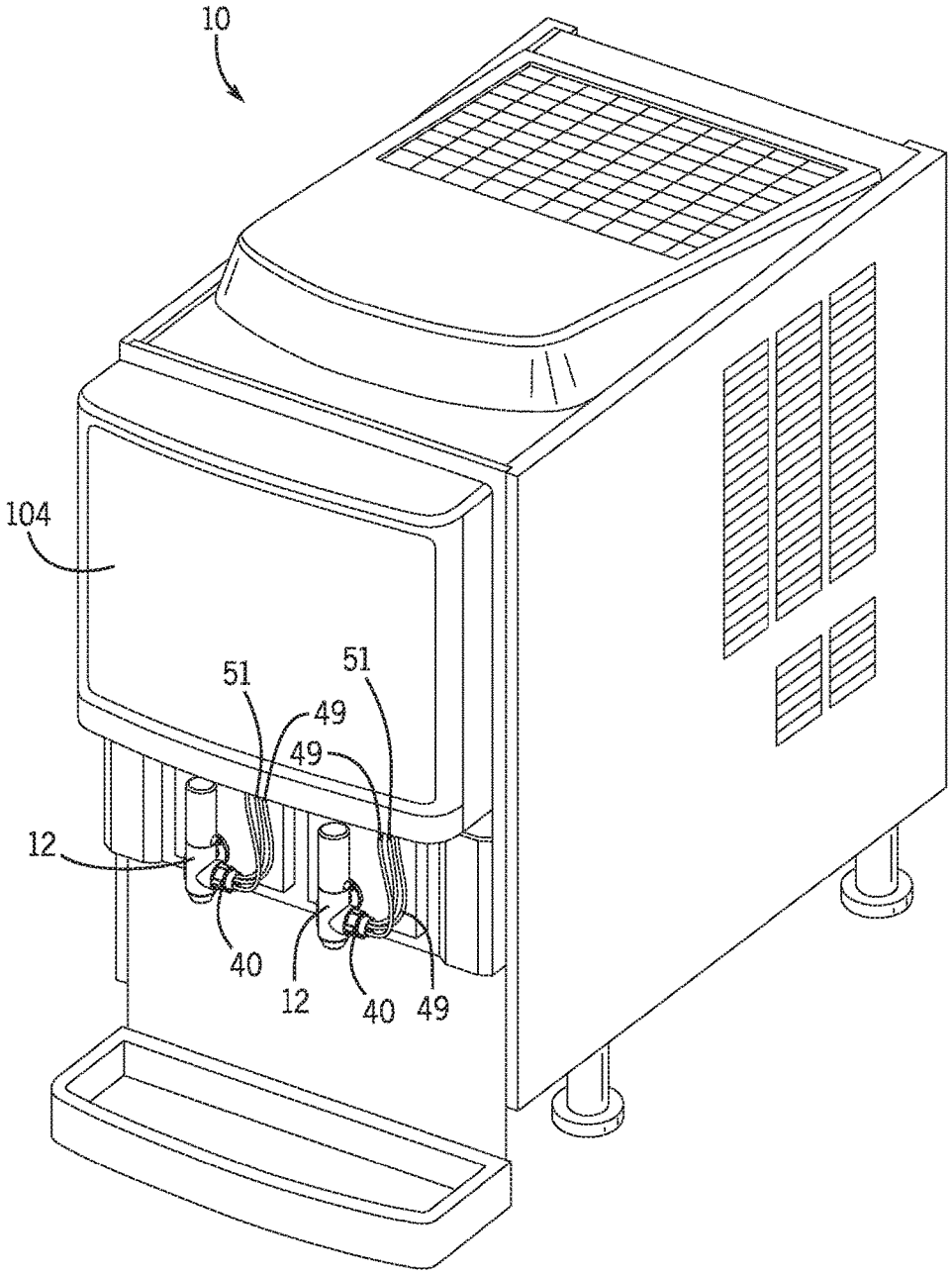

FIG. 1

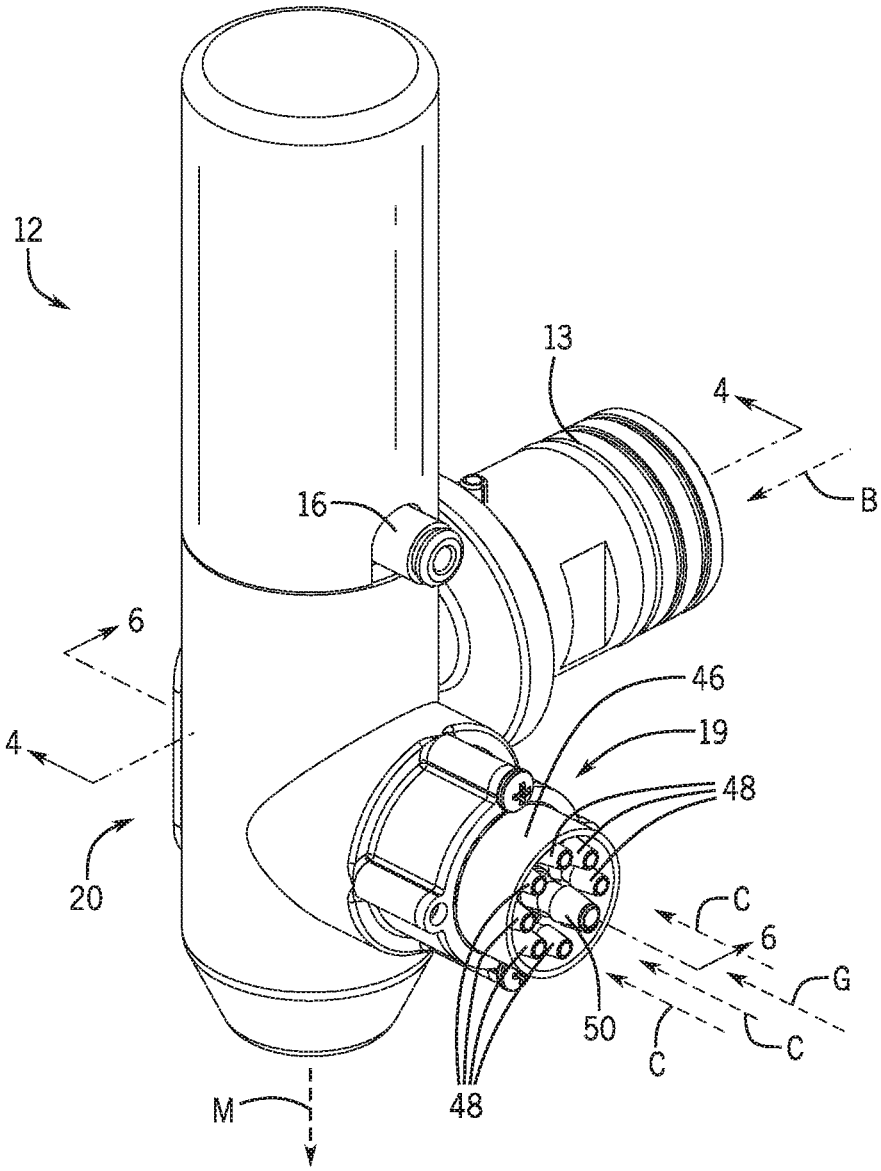

FIG. 2

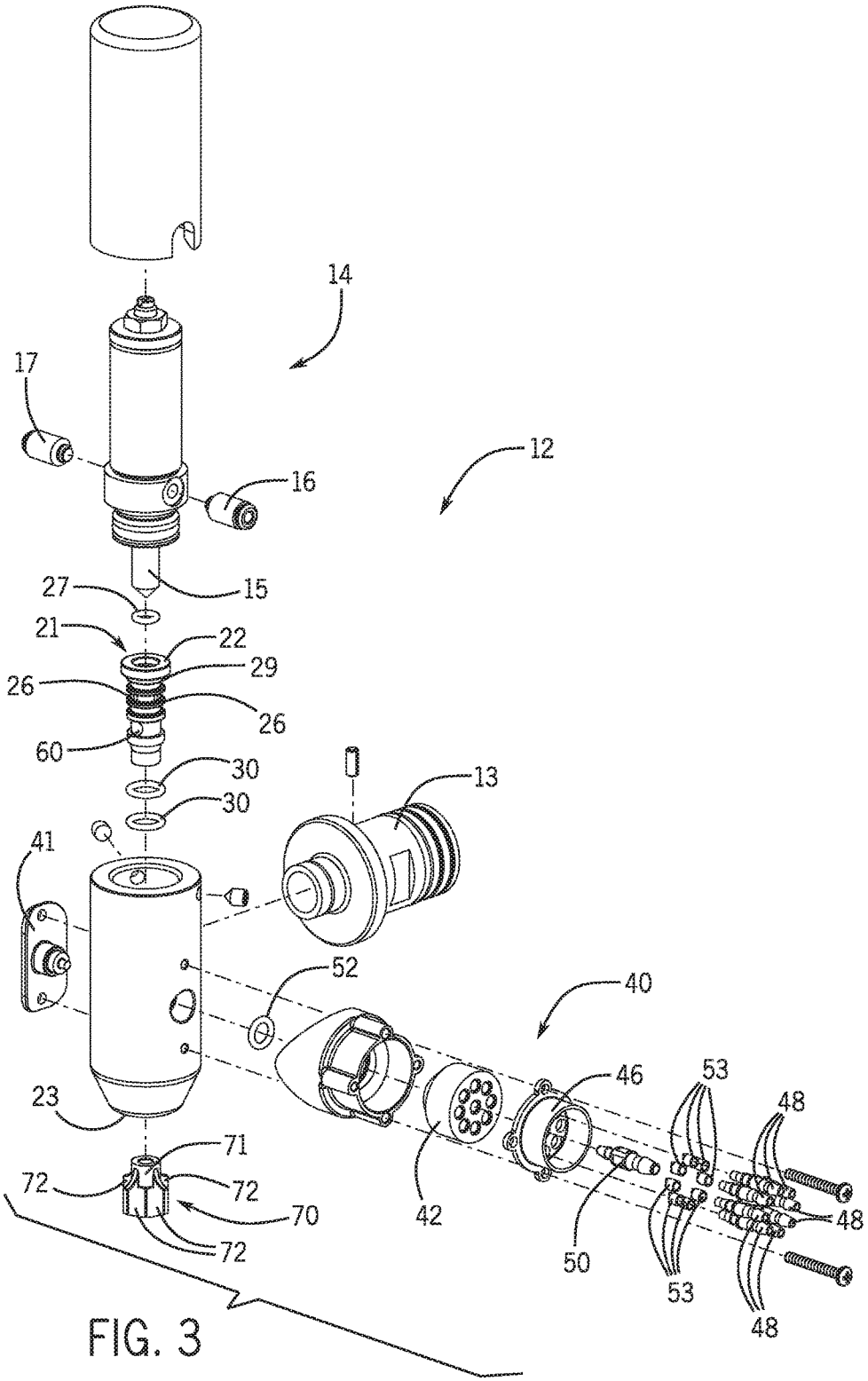
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FIG. 3

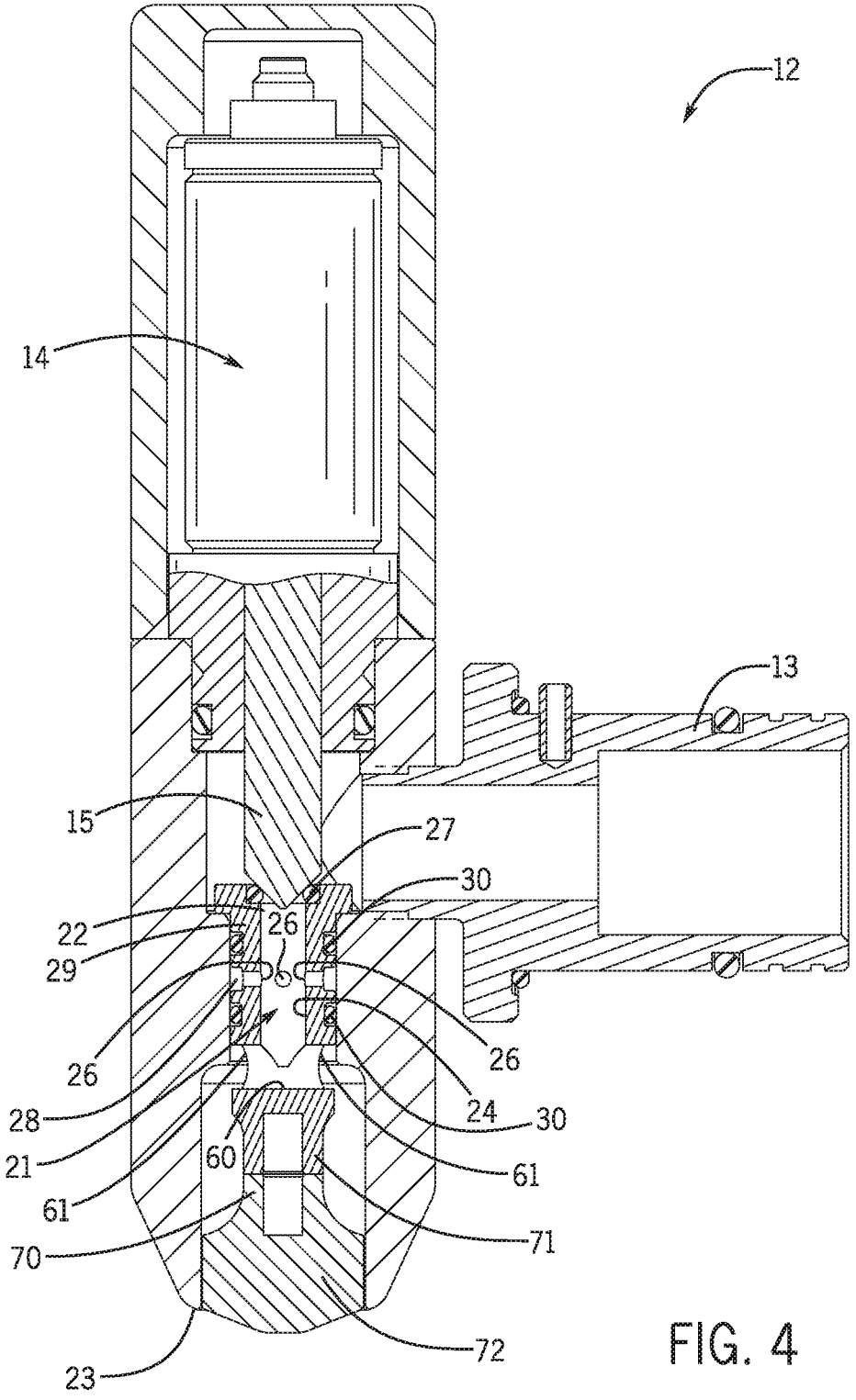

FIG. 4

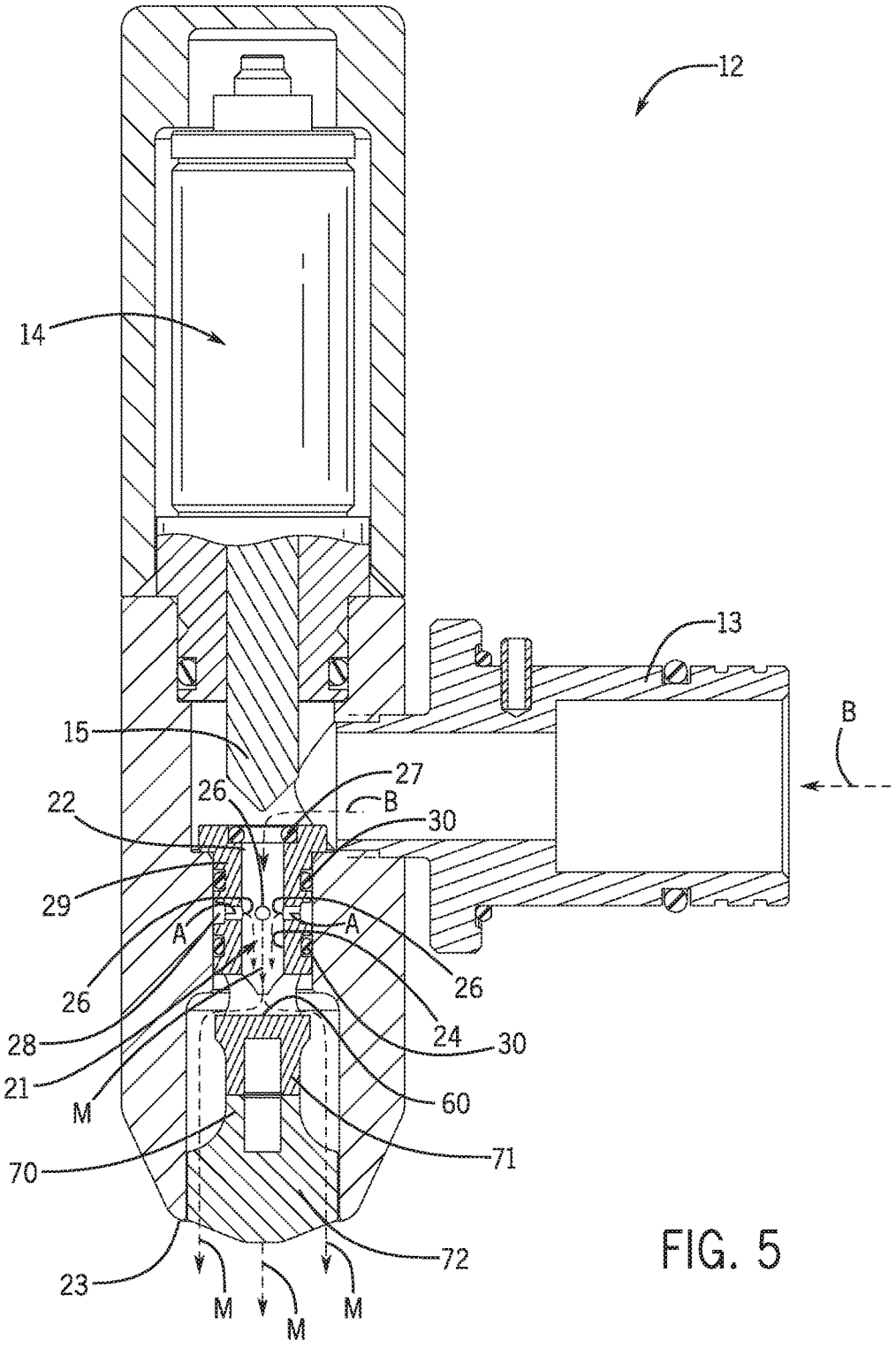

FIG. 5

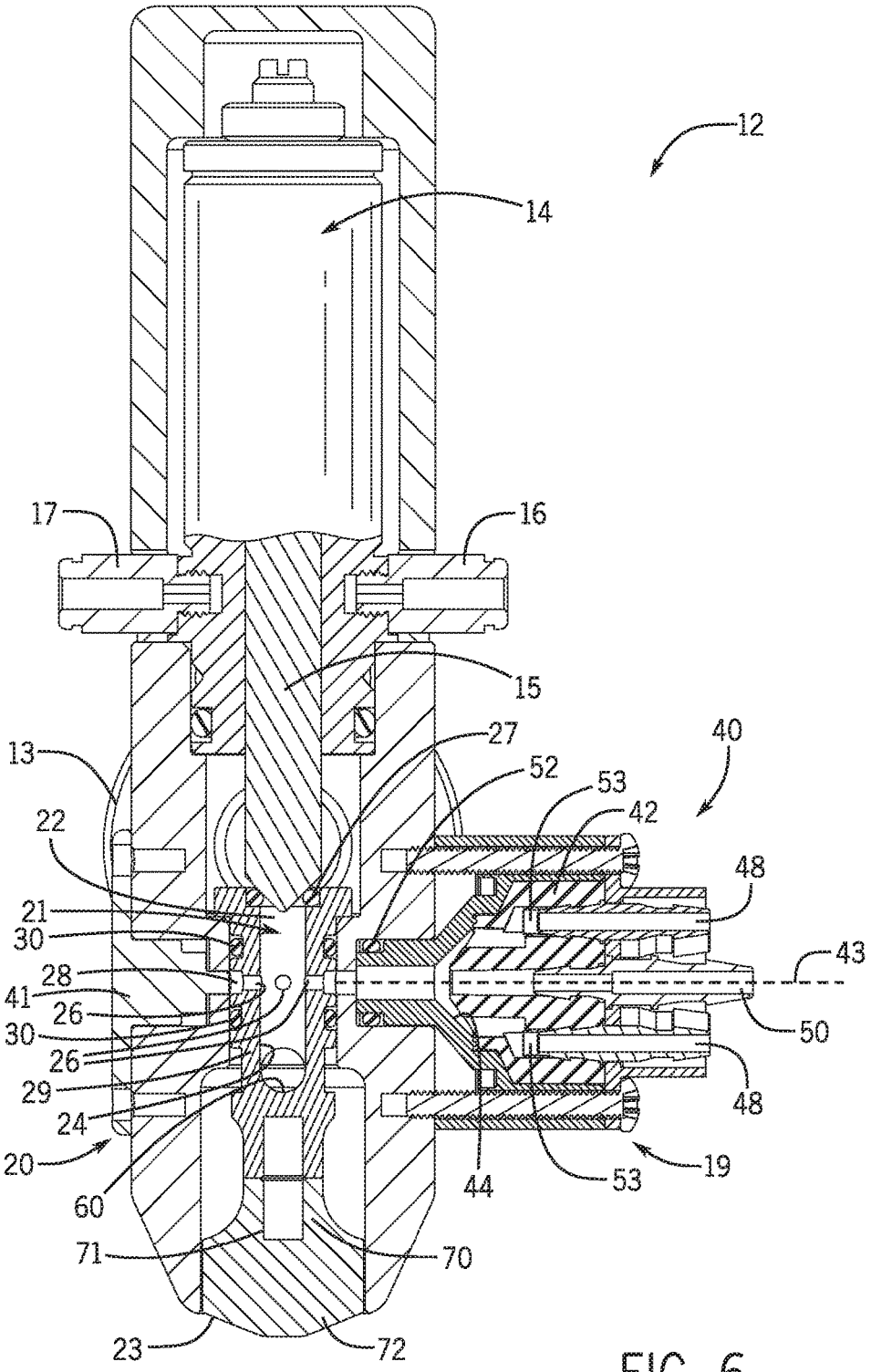
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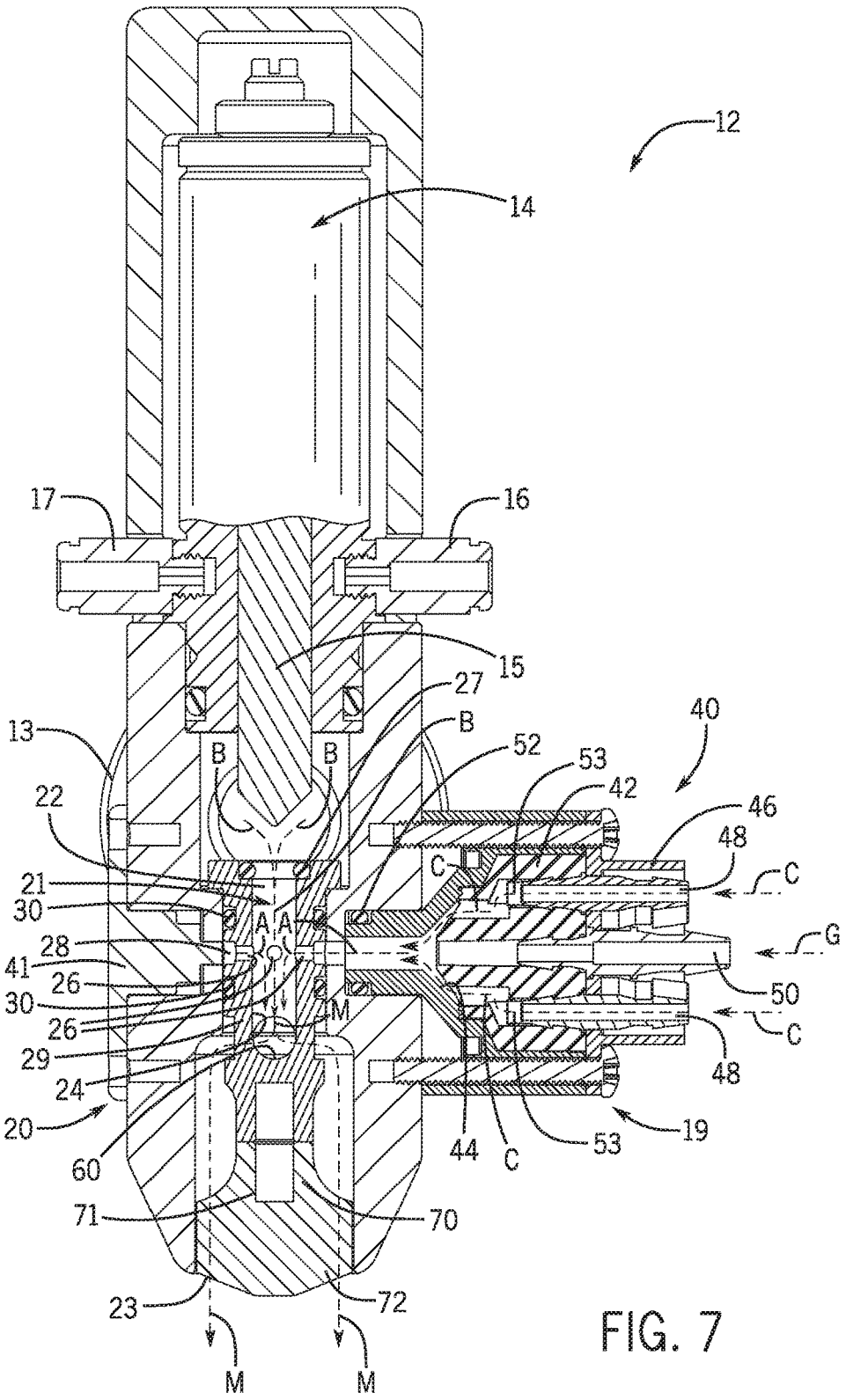
FIG. 6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B
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53
42
40
13
22
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48
C
C
21
30
A
A
G
28
41
26
30
M
50
26
C
29
48
24
20
19
60
44
C
53
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72
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M

FIG. 7

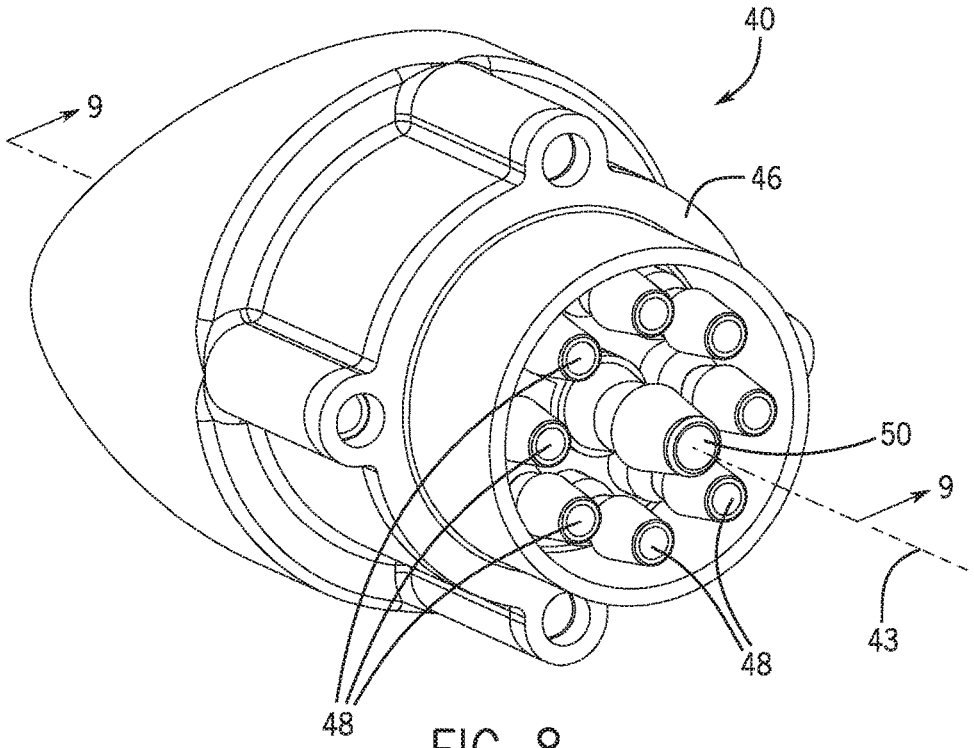

FIG. 8

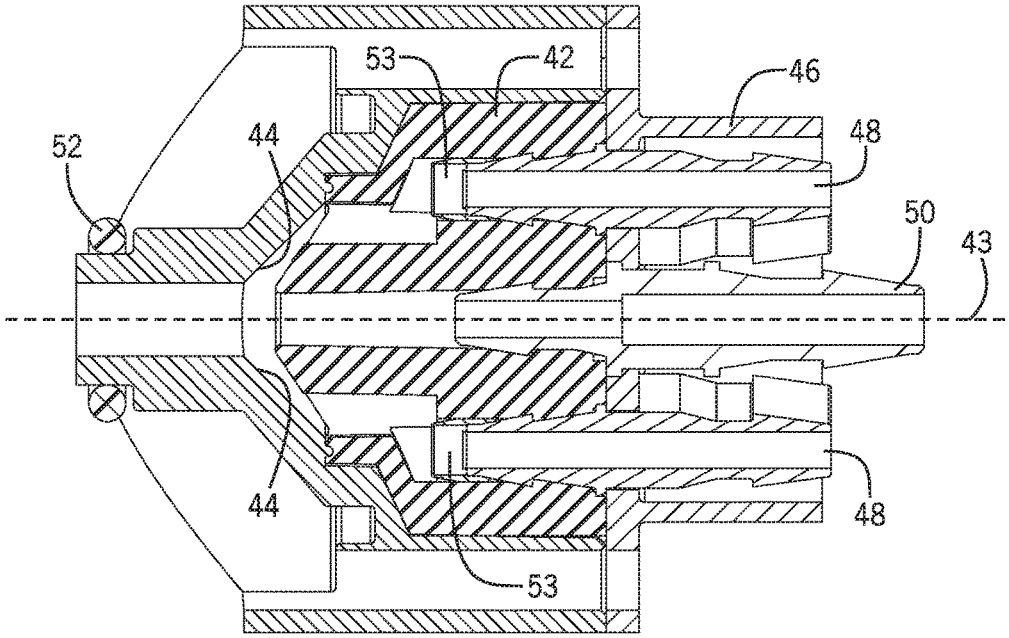

FIG. 9

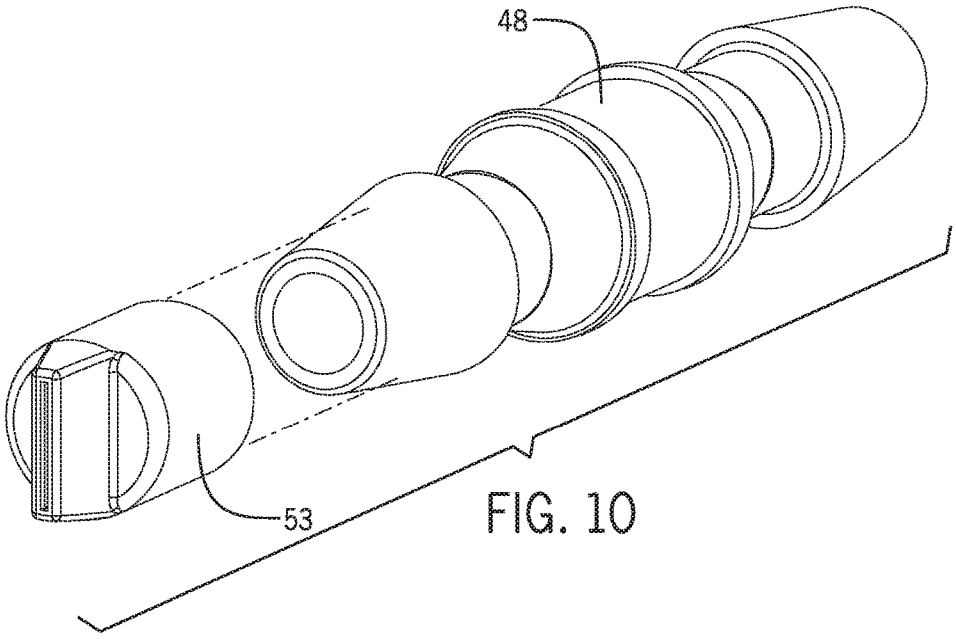
48
53

FIG. 10

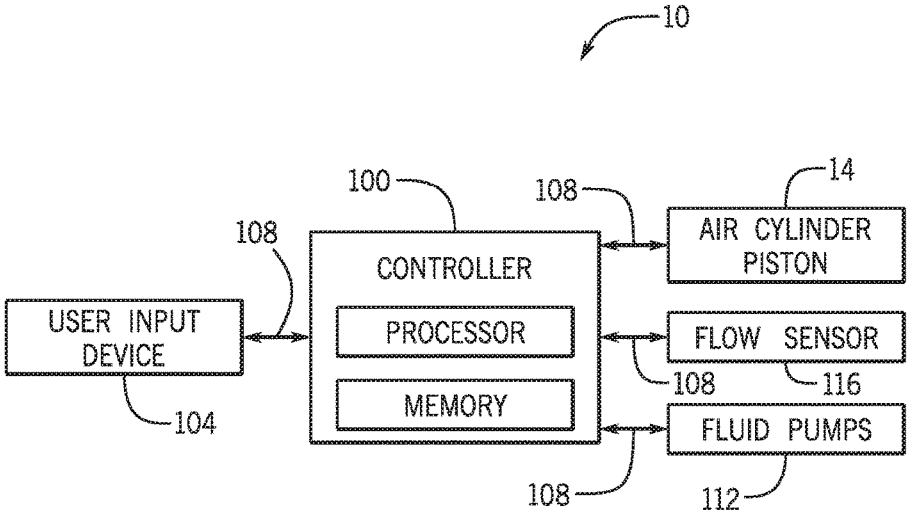
10
100
108
14
AIR CYLINDER PISTON
108
CONTROLLER
USER INPUT DEVICE
PROCESSOR
FLOW SENSOR
108
116
MEMORY
FLUID PUMPS
104
108
112

FIG. 11

FROZEN BEVERAGE DISPENSING MACHINES WITH MULTI-FLAVOR VALVES

CROSS-REFERENCE TO RELATED APPLICATION

The present application is based on and claims priority to U.S. Provisional Patent Application Ser. No. 62/332,258 filed May 5, 2016, the disclosure of which is incorporated herein by reference.

FIELD

The present disclosure relates to frozen beverage dispensing machines with multi-flavor valves.

BACKGROUND

The following U.S. Patent and U.S. Patent Application are incorporated herein by reference in entirety.

U.S. Patent Application Publication No. 2010/0147875 discloses a device for introducing additive fluids to a primary fluid that includes a body having a central bore for flow therethrough of a stream of primary fluid and a plurality of fluid flow channels in the body. Each channel extends between an inlet to the channel for connection to an associated supply of additive fluid and a plurality of outlet orifices from the channel that open into a surface of the body around and outside of an exit from the central bore.

U.S. Pat. No. 6,220,047 discloses a dual purpose carbonator/blending bottle connected to a source of beverage syrup, a source of potable water and to a source of pressurized carbon dioxide gas. The dual purpose bottle is retained within an ice bank water bath tank. A pair of ratio valves provide for metering the water and syrup at a desired ratio. The mixed beverage first flows through a serpentine coil, also located in water bath, and then flow into the dual purpose bottle.

SUMMARY

This Summary is provided to introduce a selection of concepts that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

In certain examples, a beverage machine includes a valve that receives a base fluid and dispenses a mixed beverage comprising the base fluid and an additive fluid. The valve has a bore through which the base fluid flows, and the bore has a perimetral surface that defines a plurality of ports through which the additive fluid is injected to thereby mix with the base fluid. An injector is coupled to the valve and configured to radially inject the additive fluid into the base fluid through the plurality of ports as the base fluid flows through the bore such that the additive fluid mixes into the base fluid to form the mixed beverage.

In certain examples, a beverage machine includes a valve that receives a base fluid and dispenses a mixed beverage comprising the base fluid and an additive fluid. The valve has a bore through which the base fluid flows, and the bore has an upstream end that receives the base fluid, a perimetral surface that defines a plurality of ports through which the additive fluid is injected to thereby mix with the base fluid, and a downstream end that dispenses the mixed beverage. An injector is coupled to the valve and configured to radially inject the additive fluid into the base fluid through the plurality of ports as the base fluid flows through the bore such that the additive fluid mixes into the base fluid to form the mixed beverage. A baffle is positioned in the bore downstream of the injector and configured to redirect the base fluid and the additive fluid to thereby further mix the additive fluid into the base fluid. A deflection member is positioned in the bore downstream of the baffle and configured to further mix the additive fluid into the base fluid. The deflection member has a center column and a plurality of fins that radially extend from the center column.

In certain examples, a method of dispensing a mixed beverage including a base fluid and an additive fluid includes receiving, with a valve having a bore with an upstream inlet end, the base fluid; injecting, with an injector coupled to the valve, the additive fluid through a plurality of ports in a perimetral surface of the bore radially into the base fluid as the base fluid flows through the valve such that the additive fluid mixes with the base fluid to form the mixed beverage; and dispensing the mixed beverage from the downstream end of the bore.

Various other features, objects, and advantages will be made apparent from the following description taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is described with reference to the following Figures. The same numbers are used throughout the Figures to reference like features and like components.

FIG. **1** is a perspective view of an example beverage machine with two valves.

FIG. **2** is a perspective view of an example valve.

FIG. **3** is an exploded view showing the valve of FIG. **2**.

FIG. **4** is a cross sectional view along line **4-4** on FIG. **2** with a piston rod in a closed position.

FIG. **5** is a view like FIG. **4** with the piston rod in an open position.

FIG. **6** is a cross sectional view along line **6-6** on FIG. **2** with the piston rod in the closed position.

FIG. **7** is a view like FIG. **6** with the piston rod in the open position.

FIG. **8** is an example injector.

FIG. **9** is a cross sectional view along line **9-9** on FIG. **8**.

FIG. **10** is an example barbed fitting and an example duckbill valve.

FIG. **11** is an example system diagram.

DETAILED DESCRIPTION

In the present description, certain terms have been used for brevity, clarity and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes only and are intended to be broadly construed. The different apparatuses, systems, and methods described herein may be used alone or in combination with other apparatuses, systems, and methods. Various equivalents, alternatives and modifications are possible within the scope of the appended claims.

FIG. **1** is an example beverage dispensing machine **10** that dispenses a custom mixed beverage to an operator. The beverage machine **10** includes at least one valve **12** (described further herein) that receives a base fluid (e.g. a liquid/frozen slush fluid, a carbonated liquid/frozen slush fluid) (see base fluid lines B in FIGS. **5** and **7**) and dispenses a mixed beverage (e.g. a vanilla cherry flavored carbonated

liquid/frozen slush mixed beverage) (see mixed fluid lines M in FIGS. **5** and **7**) comprising the base fluid and an additive fluid (e.g. cherry flavoring syrup, vanilla flavoring syrup) (see additive fluid lines A in FIGS. **5** and **7**). The number of valves **12** included with the beverage machine **10** can vary. Reference is made to the above-incorporated U.S. Pat. No. 6,220,047 for further description of conventional frozen beverage dispensing machines.

FIGS. **2-7** depict an example valve **12**. The valve **12** includes a fitting **13** that couples to the beverage machine **10** (FIG. **1**) and receives the base fluid B from a base fluid source (not shown; e.g. a container enclosed in the beverage machine **10**). The valve **12** has a bore **21** (FIG. **4**) through which the base fluid B flows, and the bore **21** comprises an upstream inlet end **22** that receives the base fluid B, a perimetral surface **24** that defines a plurality of ports **26** through which the additive fluid A is injected to thereby mix with the base fluid B, and a downstream outlet end **23** that dispenses the mixed beverage M. In certain examples, the valve **12** has a channel **28** (FIG. **4**) that surrounds the bore **21** and is configured to convey the additive fluid A from the injector **40** to each of the ports **26**. In certain examples, the valve **12** includes an insert **29** (FIGS. **3-4**) positioned in the bore **21** to define the channel **28**. The valve **12** also includes a pair of o-rings **30** configured to create a fluid tight seal between the insert **29** and the valve **12**.

The valve **12** has an air cylinder piston **14** configured to selectively move a piston rod **15** into and between a closed position (FIGS. **4** and **6**) in which a piston rod **15** blocks/prevents the base fluid B from flowing through the valve **12** and an open position (FIGS. **5** and **7**) in which the piston rod **15** moves to thereby allow the base fluid B to flow through the valve **12**. That is, when the piston rod **15** is in the open position (FIGS. **5** and **7**), the base fluid B flows through the valve **12** from the base fluid source and when the piston rod **15** is in the closed position (FIGS. **4** and **6**), the piston rod **15** prevents the base fluid from flowing through the valve **12**. In certain examples, the valve **12** includes a resilient member **27** positioned at the upstream inlet end **22** and configured to create a fluid tight seal between the piston rod **15** and the bore **21** when the air cylinder piston **14** is in a closed position (FIGS. **4** and **6**). The air cylinder piston **14** is coupled to a gas inlet **16** and a gas outlet **17** (FIGS. **6-7**). The air cylinder piston **14** can be manually operated and/or controlled by a controller **100** (FIG. **11**). The size and shape of the resilient member **27** can vary (e.g. the resilient member **27** is an o-ring). The type and configuration of the air cylinder piston **14** can include commercially available air cylinder pistons available from Bimba (Part No. COL-0017744-A-BR). One having ordinary skill in the art will recognize that other types of devices and/or valves (e.g. electric solenoid, stepper motor) can be used to control the flow of base fluid B through the valve **12**.

The valve **12** includes a baffle **60** (FIG. **4**) positioned in the bore **21** downstream of the injector **40** and configured to redirect the base fluid B and the additive fluid A to thereby further mix the additive fluid A into the base fluid B. The baffle **60** includes radially orientated holes **61** (FIG. **4**) through which the additive fluid A and the base fluid B flow. In certain examples, the baffle **60** is configured redirect the base fluid B and the additive fluid A from an axial flow to a radial flow (FIG. **5**)

The valve **12** includes a deflection member **70** (FIG. **4**) positioned in the bore **21** downstream of the baffle **60** and configured to further mix the additive fluid A into the base fluid B. The deflection member **70** has a center column **71** and a plurality of fins **72** that radially extend from the center column **71**.

The beverage machine **10** includes an injector **40** coupled to the valve **12** and configured to radially inject the additive fluid A into the base fluid B through the plurality of ports **26** as the base fluid B flows through the bore **21** such that the additive fluid A mixes into the base fluid B to form the mixed beverage M (see FIGS. **5** and **7**). That is, the additive fluid A is injected into the base fluid B in a direction that is transverse to the base fluid B as the base fluid B flows through the bore **21**. The additive fluid A can include any number of fluid components (e.g. nutrients, flavoring syrups, acids, sweeteners) (see fluid components lines C in FIG. **7**). For instance, the additive fluid A can be a first fluid component (e.g. cherry flavoring syrup), a second fluid component (e g vanilla flavoring syrup), or a mixed fluid component (e.g. a cherry-vanilla flavoring syrup) formed from the first fluid component and the second fluid component.

The injector **40** includes a manifold **42** (FIG. **6**) that receives the first fluid component and the second fluid component and dispenses one or more of the first fluid component, the second fluid component, and the mixed fluid component. The manifold **42** is configured to convey the first fluid component and the second fluid component parallel to an injector axis **43** (FIG. **6**) The number of fluid components that can be received and dispensed by the manifold **42** can vary, and in the example depicted in FIG. **8**, the manifold **42** can receive up to eight fluid components. The injector **40** includes a plurality of barbed fittings **48** that are removably coupled to the manifold **42**. The barbed fittings **48** receive the fluid components C from fluid component sources (not shown; e.g. a syrup cartridges, a bag-in-box containers) via fluid supply lines **49** (FIG. **1**) which are connected to the barbed fittings **48**. One having ordinary skill in the art will recognize that the fluid components can be conveyed or supplied to the injector **40** via the fluid supply lines **49** by conventional devices and systems, e.g. fluid pumps **112** (FIG. **10**). In certain examples, check valves or duckbill valves **53** (see FIGS. **3**, **6-7**, and **10**) are coupled to each of the barbed fittings **48** and configured to prevent the fluid components from backflowing toward the fluid component sources. In certain examples, the injector **40** has a cover **46** removably coupled to the injector **40** and configured to protect the manifold **42** from debris and contamination.

The injector **40** extends along an injector axis **43**, and the injector **40** has a surface **44** centered about the injector axis **43**. The surface **44** is configured to radially inwardly direct the fluid components C dispensed from the manifold **42** toward the injector axis **43** (FIG. **7**). The shape of the surface **44** can vary, and in the example depicted, the surface is a frustoconical surface.

In certain examples, the manifold **42** is further configured to receive and dispense a gas (e.g. N2, O2, CO2) and the injector **40** is further configured to inject the gas into the valve **12** to thereby clear residual additive fluid A from the valve **12** after the mixed beverage M has been dispensed. That is, the injector **40** includes a gas barbed fitting **50** that is removably coupled to the manifold **42** and the gas barbed fitting **50** receives the gas from a gas source (not shown; e.g. a CO2 gas tank) via a gas supply line **51** (FIG. **1**) which is connected to the gas barbed fitting **50**. In operation, when the gas is dispensed by the manifold **42**, the gas forces or clears the residual additives fluid from the injector **40**, the channel **28**, the plurality of ports **26**, and/or the valve **12**. The

dispense of the gas from the manifold **42** can be manually controlled and/or controlled by a controller **100** (FIG. **11**).

The orientation of the injector **40** relative to the valve **12** can vary. For example, the injector **40** can be configured such that the injector **40** injects the additive fluid A into the base fluid B via a first side **19** (FIGS. **6-7**) of the valve **12** or an opposite, second side **20** (FIGS. **6-7**) of the valve **12**. The injector **40** includes a plug **41** that is coupled to the valve **12** on the side of the valve **12** opposite the side of the valve **12** through which the injector **40** injects the additive fluid A into the base fluid B (e.g. in FIGS. **6-7** the additive fluid A is injected into the base fluid B via the first side **19** of the valve **12** and the plug **41** is coupled to the second side **20** of the valve **12**). The plug **41** is configured to cover or fill any voids/spaces of the valve **12**, and the plug **41** can be removed during maintenance and/or cleaning. The plug **41** also allows an operator to mount the injector **40** and/or the manifold **42** to either side **19**, **20** of the valve **12** to accommodate beverage machines **10** (FIG. **11**) with different clearance or mounting requirements (e.g. the beverage machine **10** is positioned against a wall and the injector **40** can only be coupled to the first side **19** of the valve **12**). In certain examples, the injector **40** includes an o-ring **52** configured to create a fluid tight seal between the injector **40** and the valve **12**.

Referring to FIG. **11**, the beverage machine includes a computer controller **100** in communication with various components of the beverage machine **10** described herein. The controller **100** controls the beverage machine **10** in accordance with inputs received by a user input device **104** positioned on the beverage machine **10** (FIG. **1**). In other examples, the user input device **104** can be remote to the beverage machine **10**. The type and configuration of the user input device **104** and the controller **100** can vary from that which is shown. The user input device **104** can include one or more conventional input devices for inputting operator or user selections to the controller **100**. Exemplary user input devices **104** include touch screens, mechanical buttons, mechanical switches, voice command receivers, tactile command receivers, gesture sensing devices, and/or remove controllers such as personal digital assistant(s) (PDAs), handheld(s), laptop computer(s), and/or the like.

The controller **100** can be located in beverage machine **10** and/or can be located remotely from beverage machine **10**. In some examples, the controller **100** can be configured to communicate via the Internet or any other suitable communication link. Although FIG. **11** shows one controller **100**, there can be more than one controller **100**. Portions of the methods described herein can be carried out by a single controller or by several separate controllers. Each controller can have one or more control sections or control units. In some examples, the controller **100** can include a computing system that includes a processing system, storage system, software, and input/output (I/O) interfaces (e.g. user input device **104**) for communicating with devices described herein and/or with other devices. The processing system can load and execute software from the storage system. The controller **100** may include one or many application modules and one or more processors, which may be communicatively connected. The processing system may comprise a microprocessor and other circuitry that retrieves and executes software from the storage system. Non-limiting examples of the processing system include general purpose central processing units, applications specific processors, and logic devices. The storage system can comprise any storage media readable by the processing system and capable of storing software. The storage system can include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data.

The controller **100** communicates with one or more components of the beverage machine **10** via one or more communication links **108**, which can be a wired or wireless links. The controller **100** is capable of monitoring and/or controlling one or more operational characteristics of the beverage machine **10** and its various subsystems by sending and receiving control signals via the communication links **108**. It should be noted that the extent of connections of the communication link **108** shown herein is for schematic purposes only, and the communication links **108** in fact provides communication between the controller **100** and each of the devices and various subsystems described herein, although not every connection is shown in the drawing for purposes of clarity.

The controller **100** is in communication with the user input device **104**, the air cylinder piston **14**, and the fluid pumps **112** that pump the fluid components to the injector **40**, and the controller configured to control the air cylinder piston **14** and the fluid pumps **112** based on the input received via the user input device **104**. The input received via the user input device **104** can correspond to the custom mixed beverage to be dispensed, and controller **100** is configured to interpret the input received via the user input device **104** and thereby control the air cylinder piston **14** and the fluid pumps **112** such that the custom mixed beverage dispenses from the valve **12**. The controller **100** can also be in communication with flow sensors **116** or other sensors such that the controller **100** controls the air cylinder piston **14** and the fluid pumps **112** based on fluid flow characteristics or machine operation characteristics sensed by the flow sensors **116** or other sensors.

The beverage machine **10** can include a method or method steps of dispensing the mixed beverage M. The method can comprise the steps of: receiving, with a valve **12** having a bore **21** with an upstream inlet end **22**, the base fluid B, wherein the bore **21** has a downstream outlet end **23** and a perimetral surface **24** that defines a plurality of ports **26**; injecting, with an injector **40** coupled to the valve **12**, the additive fluid A through the plurality of ports **26** radially into the base fluid B as the base fluid B flows through the valve **12** such that the additive fluid A mixes with the base fluid B to form the mixed beverage M; and dispensing the mixed beverage M from the downstream end of the bore **21**. The method can also comprise providing a baffle **60** in the bore **21** downstream of the injector **40** to further mix the additive fluid A into the base fluid B and/or providing a deflection member **70** in the bore **21** downstream of the baffle **60** to further mix the additive fluid A into the base fluid B.

The present inventors of the present disclosure have also recognized a problem that the air cylinder piston **14** can occasionally become blocked by frozen particles and/or ice chips from the base fluid source (not shown) such that the valve **12** malfunctions (e.g. remain open, remain closed). Through research and experimentation, the present inventors have discovered that frozen particles and/or ice chips can be cleared from the air cylinder piston **14** by repeatably reciprocating the air cylinder piston **14**, for example in a rapidly successive manner. That is, the air cylinder piston **14** can be repeatably reciprocated by alternating the air flow to and from the gas inlet **16** and gas outlet **17** such that the air cylinder piston **14** rapidly reciprocated between the closed position (FIGS. **4** and **6**) and the open position (FIGS. **5** and **7**) which vibrates/breaks-up the frozen particles and/or ice

chips blocking the valve **12**. The controller **100** can be configured to reciprocate the air cylinder piston **14**, as described above, when a corresponding input in received from the user input device **104** and/or when the controller **100** determines via electronic signals from flow sensors **116** that frozen particles and/or ice chips block the valve **12**. In certain examples, the beverage machine **10** includes the method of dispensing the beverage from the valve **12** including receiving, by way of the controller **100** a signal from the user input device **104** that indicates that the valve **12** blocked and controlling the air cylinder piston **14** such that air cylinder piston **14** reciprocates to unblock the valve **12**.

What is claimed is:

1. A beverage machine comprising:

a valve that receives a base fluid and dispenses a mixed beverage comprising the base fluid and an additive fluid, the valve having a perimetral surface that defines a bore through which the base fluid flows and a channel that surrounds the bore and through which the additive fluid flows to a plurality of ports defined in the perimetral surface through which the additive fluid is radially injected into the bore to thereby mix with the base fluid; and

an injector coupled to the valve and configured to inject the additive fluid into the channel such that the additive fluid flows through the channel and the plurality of ports to thereby mix into the base fluid to form the mixed beverage, wherein the injector has:

an injector axis along which the injector extends;

a surface centered about the injector axis and configured to radially inwardly direct the additive fluid toward the injector axis along which the additive fluid is injected into the channel; and

a manifold configured to receive a plurality of fluid components and dispense the plurality of fluid components, wherein the surface radially inwardly directs the plurality of fluid components toward the injector axis such that the plurality of fluid components mix and form the additive fluid.

2. The beverage machine according to claim **1**, wherein the additive fluid is injected into the base fluid in a direction that is transverse to the base fluid as the base fluid flows through the bore.

3. The beverage machine according to claim **1**, wherein the bore has an upstream end that receives the base fluid and a downstream end that dispenses the mixed beverage; and wherein the valve comprises a baffle positioned in the bore downstream of the injector and configured to redirect the base fluid and the additive fluid to thereby further mix the additive fluid into the base fluid.

4. The beverage machine according to claim **3**, wherein the baffle is configured to redirect the base fluid and the additive fluid from an axial flow to a radial flow.

5. The beverage machine according to claim **3**, wherein the valve further comprises a deflection member positioned in the bore downstream of the baffle and configured to further mix the additive fluid into the base fluid.

6. The beverage machine according to claim **5**, wherein the deflection member comprises a center column and a plurality of fins that radially extend from each other and from the center column.

7. The beverage machine according to claim **1**, wherein the manifold is further configured to receive and dispense a gas, and wherein the injector is further configured to inject the gas into the valve to thereby clear residual additive fluid from the valve.

8. The beverage machine according to claim **1**, wherein the surface is a frustoconical surface.

9. The beverage machine according to claim **1**, wherein the manifold is configured to convey the plurality of fluid components parallel to the injector axis.

10. The beverage machine according to claim **1**, wherein the injector has a cover removably coupled to the injector and configured to protect the manifold from debris and contamination.

11. A method of dispensing a mixed beverage comprising a base fluid and an additive fluid, the method comprising:

receiving, with a valve having a bore with an upstream inlet end, the base fluid, wherein the bore has a downstream end and a perimetral surface that defines a plurality of ports, the valve defines a channel that surrounds the bore and through which the additive fluid flows to the plurality of ports;

injecting, with an injector coupled to the valve, the additive fluid through the plurality of ports radially into the base fluid as the base fluid flows through the valve such that the additive fluid mixes with the base fluid to form the mixed beverage, the injector having:

an injector axis along which the injector extends;

a surface centered about the injector axis and configured to radially inwardly direct the additive fluid toward the injector axis such that the additive fluid is injected into the channel; and

a manifold configured to receive a plurality of fluid components and dispense the plurality of fluid component, wherein the surface radially inwardly directs the plurality of fluid components toward the injector axis such that the plurality of fluid components mix and form the additive fluid; and

dispensing the mixed beverage from the downstream end of the bore.

12. The method according to claim **11**, further comprising:

providing a baffle in the bore downstream of the injector to further mix the additive fluid into the base fluid; and

providing a deflection member in the bore downstream of the baffle to further mix the additive fluid into the base fluid.

13. The method according to claim **11**, wherein the base fluid is a frozen slush fluid, and further comprising:

receiving, with a controller, a signal from an user input device that flow of the frozen slush fluid through the valve is blocked; and

rapidly reciprocating a piston rod, with an air cylinder piston, based on the signal from the user input device into and between a closed position in which the piston rod blocks flow of the frozen slush fluid through the valve and an open position in which the piston rod is moved such that the frozen slush fluid flows through the valve, and wherein rapid reciprocation of the piston rod clears the valve of frozen particles that block flow of the frozen slush fluid through the valve.

14. The method according to claim **11**, further comprising:

sensing, with a flow sensor, absence of flow of the frozen slush fluid through the valve when a piston rod is in the open position; and

determining, with a controller that is in communication with the flow sensor, that frozen particles block flow of the frozen slush fluid through the valve based on signals from the flow sensor; and

rapidly reciprocating a piston rod, with an air cylinder piston, based on the signals from the flow sensor into

and between a closed position in which the piston rod blocks flow of the frozen slush fluid through the valve and an open position in which the piston rod is moved such that the frozen slush fluid flows through the valve, and wherein the rapid reciprocation of the piston rod clears the valve of frozen particles that block flow of the frozen slush fluid through the valve.

15. A beverage machine comprising:

a valve that receives a base fluid and dispenses a mixed beverage comprising the base fluid and an additive fluid, the valve having:

a perimetral surface that defines a bore through which the base fluid flows and a plurality of ports; and

a channel that surrounds the bore and through which the additive fluid flows to the plurality of ports such that the additive fluid is radially injected into the bore to thereby mix with the base fluid; and

an injector coupled to the valve and configured to inject the additive fluid into the channel such that the additive fluid flows through the channel and the plurality of ports, the injector comprises:

an injector axis along which the injector extends;

an interior chamber extending along the injector axis;

a manifold configured to receive a plurality of fluid components and dispense the plurality of fluid component into the interior chamber; and

an interior surface centered about the injector axis and configured to radially inwardly direct the plurality of fluid components dispensed into the interior chamber toward the injector axis such that the plurality of fluid components mix and thereby form the additive fluid.

16. The beverage machine according to claim **15**, wherein the manifold is configured to convey each fluid component of the plurality of fluid components parallel to and radially offset from the injector axis.

17. The beverage machine according to claim **15**, wherein the interior surface is a frustoconical surface.

18. The beverage machine according to claim **17**, wherein the additive fluid is injected into the base fluid in a direction that is transverse to the base fluid as the base fluid flows through the bore.

19. The beverage machine according to claim **16**, wherein the manifold is further configured to receive a gas and dispense the gas into the chamber to thereby clear residual fluid components from the interior chamber and residual additive fluid from the valve.

20. The beverage machine according to claim **19**, wherein the manifold is further configured to convey the gas along the injector axis.

21. The beverage machine according to claim **15**, wherein the base fluid is a frozen slush fluid; and wherein the valve further comprises:

an air cylinder piston that reciprocates a piston rod into and between a closed position in which the piston rod blocks flow of the frozen slush fluid through the valve and an open position in which the piston rod is moved such that the frozen slush fluid flows through the valve;

wherein the air cylinder piston is configured to rapidly reciprocate the piston between the open position and closed position to thereby clear the valve of frozen particles that block the flow of the frozen slush fluid through the valve.

22. The beverage machine according to claim **21**, further comprising:

a flow sensor configured to sense absence of flow of the frozen slush fluid through the valve when the piston rod is in the open position; and

a controller in communication with the flow sensor and the air cylinder piston and configured to control the air control cylinder to rapidly reciprocate the piston rod when the flow sensor senses the absence of flow of the frozen slush fluid through the valve when the piston rod is in the open position.

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