

Description

[0001] This invention relates to a novel form of valve for use in connection with fluids and especially liquids, e.g. water and, in particular, to a method of delivering discrete slugs of fluid.

[0002] Valves are known which produce discrete slugs of water. However, such valves generally operate by switching the fluid flow on and off and they are therefore mechanically complex and expensive to manufacture. They are also expensive to maintain, since the many moving parts are subject to wear and tear. Also in electrically operated valves, the power required for switching on and off can be significant, particularly over long periods of time.

[0003] In the late 1950s and 1960s fluidic valves were known which utilised compressed air to switch the fluid flow. These were often made into logic gates but problems were often encountered with air cleanliness due to blocking of the fine passages. Such valves were used on vibrating machinery where the then standard glass valves were too fragile. At the time, fluidic devices also offered weight and space savings. However the arrival of silicon chip based logic gates with greatly reduced cost, size and weight began the demise of fluidic logic gates. Traditional mechanical or gate valves tend to be more compact, offer a wider flow range and can be provided with a non-return facility. For these reasons fluidic devices have not been explored fully.

[0004] Fluidic devices, with the major dimensions in the order of metres, have been considered for use in water works. However in standard texts on fluid mechanics, for example, there is no mention of fluidic devices. This is probably due to certain perceived major drawbacks, *inter alia*, a lack of non-return facility, a very limited flow range for satisfactory operation, and space requirements.

[0005] We have now found a novel form of valve which overcomes or mitigates the disadvantages of the prior art.

[0006] Generally, the valve of the invention operates by diverting the fluid flow rather than strictly switching flow on and off.

[0007] Thus according to the invention we provide a valve comprising a fluid inlet port connected downstream to a junction, the junction being provided with at least first and second fluid outlet ports, the valve also being provided with means for adjusting the pressure of the fluid flowing through the inlet port, so as to divert the fluid flow at the junction from the first fluid outlet port to the second fluid outlet port.

[0008] It will be readily understood by one skilled in the art that the diversion of the fluid flow from the first fluid outlet port to the second fluid outlet port can also be effected in the opposite direction, that is, diverting the fluid flow from the second fluid outlet port to the first fluid outlet port.

[0009] In a preferred embodiment of the invention a

conduit is connected between the fluid inlet port and the junction. Each of the first and second outlet ports may themselves be provided with respective conduits connecting them to the junction region of the valve. Thus in an especially preferred embodiment of the invention the valve system comprises a Y arrangement, wherein the fluid inlet port is situated at the base of the Y s and conduit and the first and second outlet ports are situated at the head of the Y.

[0010] In a further embodiment of the invention a valve may comprise a plurality of Y arrangements. For example, a three dimensional valve system may comprise a pair of Y arrangements each Y being in a plane which is perpendicular to the other Y. Such a three dimensional valve system may optionally comprise a single inlet port whilst still having a plurality of outlet ports, e.g. four outlet ports. The outlet ports may lie in two pairs each in perpendicular planes. Alternatively, the outlet ports may be ducted such that the ports all lie in the same plane. However, in an especially preferred three dimensional embodiment, each of four outlet ports are arranged as the corner of a square made up by the other outlet ports.

[0011] In the valve of the invention the cusp of the Y arrangement is preferentially wider than the diameter of the inlet port and/or the inlet conduit. Also, preferentially the cusp is situated as close to the inlet port, or as close to the end of the inlet conduit, as possible. The cusp may preferentially be curved and most preferably be concave with respect to the inlet port.

[0012] A side wall of the outlet port, which may, preferentially, return to the switching/control port, can be set well back from the innermost edge of the inlet port. This positioning is also required to enable a wall of the fluid jet to break in response to a pulse at the control port.

[0013] Furthermore, the areas of cross section of the first and second outlet ports are preferentially substantially the same and may be at least equal to the area of cross section of the inlet port. This ensures that all the fluid can flow down the selected outlet port, since a restriction in the outlet port may cause some fluid to flow out through the non-preferred outlet. Preferably, the areas of cross section of the first and second outlet ports are preferentially substantially slightly larger than the area of cross section of the inlet port.

[0014] The means for applying pressure to the fluid flow may vary, *inter alia*, depending upon the size and nature of the valve, the fluid medium, the flow rates, etc. However, for example, the switching can be triggered by fluid pressure, e.g. a gas, such as air; or a liquid, such as water. Smaller valves of the invention may be used to transmit very small volumes of fluid, e.g. microlitres. In such valves the switching may still be triggered by fluid pressure as hereinbefore described. However, in an alternative embodiment of the invention the trigger may be an electronic or an electromechanical trigger. An especially preferred trigger in this case is a piezoelectric trigger.

[0015] When the trigger comprises the use of fluid pressure, the switching can be done with, for example, air or water. In an especially preferred valve of the invention comprising a fluid trigger, the fluid in the trigger is the same as the fluid flowing through the valve. For example, in a water system the trigger can advantageously be a water trigger. Such a system has the added advantage that the trigger can be operated either by a separate supply of e.g. water or by water, for example, taken from the main flow supply of the valve.

[0016] Furthermore, pressure required to trigger the valve can be considerably less than the main flow pressure. Thus only a fraction of the fluid flow may need to be diverted to act as a trigger, whilst any loss of fluid pressure will not be disadvantageous to the trigger mechanism.

[0017] The rapid response and the ability to use different fluid media for triggering the switch enables not only simple switching for example by a cam timer, but also more complex methods such as Computer control in response to music and/or movement.

[0018] Conventionally known valves operate by starting and stopping fluid flow. However, it is a particular advantage of the valve of the present invention that the valve diverts the water flow. Furthermore, the flexibility and speed offered by the valve system of the invention is unlikely to be achievable by starting and stopping a conventional valve due to the longer response time. Furthermore, a multi jet system can be operated from a single valve of the invention connected to a pump. The process of diverting the fluid flow with the valve of the present invention. This process can take a fraction of a second, estimated at from 0.1 to 0.2 seconds, e.g. 0.1 to 0.2 seconds to produce a well defined slug of water. In addition, since the valve of the invention has no moving parts, the valve is silent in operation further facilitating its use in conjunction with, e.g. a musical display.

[0019] Furthermore, as the fluid flow is simply diverted, rather than stopped and started, there are no pressure pulses (e.g. producing a water hammer effect) to affect upstream pumps, pipes etc, therefore the switching occurs rapidly giving a clean slug of water.

[0020] In use, one of the outlet arms of the Y may be used as the issuing jet or nozzle from which a water slug flows. The other outlet arm of the Y may be preferentially connected back to the water tank used to feed the main pump. Larger versions of the device may benefit from having a non-return valve in the tank discharge as the action of a vortex can draw air back into the valve and mix air with the water jet, causing some turbulence/jet break-up. As the water is continually flowing lower pressure, simpler and cheaper pumps can be used. Also, a single pump can be used to feed several devices and the pump does not have to be adjacent to a nozzle which emits a water slug.

[0021] The cross-section of the inlets and outlets may be varied. Thus, they may be circular, square, ellipsoidal, etc in cross-section. In a preferred embodiment, the

junction between the first and second outlets is substantially rectangular in cross-section. Such a feature has the advantage that a vortex may be formed.

[0022] The valve of the invention may generally be used with any fluid, that is, any gas, liquid or flowable solid, e.g. a flowable powder, or any combination of the aforesaid, for example, a combination of a gas and a flowable powder.

[0023] According to a further feature of the invention we provide a system for a garden water feature comprising at least a pump and a valve of the invention.

[0024] We further provide a method of switching fluid flow in a system which comprises the use of as hereinbefore described. In particular, we provide a method which comprises producing a display in which a fluid, e.g. water, can be seen to appear to jump from one position to another which comprises means for creating fluid flow and a valve of the invention. If a three dimensional valve system is used then a water feature may be created in which 'square' slugs of water may be fired, e.g. fore, aft and side to side.

[0025] Because of the very small amounts of energy required to trigger the switch of the valve, the valve of the invention is especially suited for use in connection with medical devices. Thus according to a further feature of the invention we provide a medical device comprising a valve as hereinbefore described.

[0026] A three dimensional valve of the invention can also be used in a device to provide vectored thrust on space craft, aeroplanes, marine craft, etc. At present vectored thrust is usually done by mechanically moving a nozzle through which a high speed fluid is flowing but at least one disadvantage is that the mechanical system has a finite response time. A three dimensional fluidic device has the same response time as the simpler two dimensional version and thus be able to be computer controlled to provide dynamic thrust control for example to attain stationary hover or for rapid manoeuvrability.

[0027] In a further embodiment the valve is used to produce pulses in a chemical plant to promote mixing in a tank, without the need of a mechanical agitator. The valve may also be used in microfluidic reactors where chemical reactions take place in channels etched in glass or silicon, for example. The channels are so fine that surface tension can dominate the flow. Thus the use of the valve to pulse the flow may disrupt the surface tension effect and thus promote the efficiency of a microfluidic device.

[0028] The valve of the invention may comprise any conventionally known material e.g. metal. However, a lightweight and corrosion resistant material is preferred, for example, glass, ceramic or a plastics material. A plastics material is most preferred.

[0029] The invention will now be described by way of example only and with reference to the accompanying drawings in which figure 1 is a plan view of the valve of the invention;

figure 2 is an underneath view of a valve of the invention; and

figure 3 is a schematic representation giving dimensions of one embodiment of a valve of the invention.

[0030] Referring to figures 1 to 3 together, a valve (1) of the invention comprises a plastics casing (1a) an inlet port (2) connected to a downstream inlet conduit (3). The inlet conduit (3) having an upstream end (4) and a distal downstream end (5). The downstream end (5) is connected to a junction region (6).

[0031] The junction region (6) provided with two trigger ports (11 and 12) and fluid outlets (8 and 10). The junction region (6) is connected to the outlets (8 and 10) via the respective conduits (7 and 9). The cusp (17) of the junction region (6) between the outlet conduits (7 and 9) is provided with a concave surface (18) facing the inlet conduit (3).

[0032] Trigger port (11) is connected to a hose (15) via trigger conduit (13). Similarly, trigger port (12) is connected to a hose (16) via trigger conduit (14).

[0033] In use water flows into inlet port (2) and through conduit (3) into the junction (4). Water will flow, for example through conduit (7) to outlet (8). For the valve to operate, water may be passed down hose (15) through conduit (13) and trigger port (11) thereby applying pressure to the fluid flowing into the junction (4) and causing the fluid to be diverted into conduit (9) and outlet port (10).

[0034] The water flow will remain passing through conduit (9) and exiting at outlet (10) until a further pressure pulse is applied at trigger port (12) which then cause the water flow to be diverted again.

[0035] Therefore, depending upon the extent and frequency of the pressure, discrete slugs of water can be created.

[0036] A pulse only is needed at trigger port (11) to divert the flow from conduit (7) and outlet (8) to conduit (9) and outlet (10).

[0037] Once the water is diverted, extra pulses, continuous flow or starting/stopping the flow at trigger port (11) will not have a switching effect.

Claims

1. A valve comprising a fluid inlet port connected downstream to a junction, the junction being provided with at least first and second fluid outlet ports, the valve also being provided with means for adjusting the pressure of the fluid flowing through the inlet port, so as to divert the fluid flow at the junction from the first fluid outlet port to the second fluid outlet port.

2. A valve according to Claim 1 **characterised in that** the inlet port is connected to a fluid passage and the downstream end of the fluid passage is connect-

ed to the first and second fluid outlet ports.

3. A valve according to Claim 2 **characterised in that** each of the first and second outlet ports are themselves be connected to a respective liquid passage.

4. A valve according to Claim 1 **characterised in that** the valve system comprises a Y arrangement wherein the base of the Y is the inlet port and the head of the Y comprises the first and second outlet ports.

5. A valve according to claim 4 **characterised in that** the valve comprises a pair of Y arrangements.

6. A valve according to claim 5 **characterised in that** the pair of Y arrangements are each positioned in planes perpendicular to one another.

7. A valve according to Claim 1 **characterised in that** the means for applying pressure to the fluid flow is triggered by fluid pressure.

8. A valve according to Claim 1 **characterised in that** the junction between the first and second outlets is substantially circular in cross-section.

9. A valve according to Claim 8 **characterised in that** the substantially circular cross section is sufficient to enable a vortex to be formed.

10. A valve according to claim 4 **characterised in that** the diameter of the cusp is greater than the diameter of the inlet port.

11. A system for a garden water feature comprising at least a valve according to claim 1 and a pump.

12. A method of switching fluid flow in a system which comprises the use of a valve according to claim 1.

13. A method according to claim 12 **characterised in that** the system produces a display in which a fluid can be seen to appear to jump from one position to another.

14. A method according to claim 1 **characterised in that** the fluid is a liquid.

15. A method according to claim 1 **characterised in that** the liquid is water.

16. A chemical plant comprising a valve according to claim 1.

17. A thruster comprising a valve according to claim 1.

18. A medical device comprising a valve according to

claim 1.

- 19.** A medical device according to Claim 18 **characterised in that** the trigger is a piezoelectric trigger.

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- 20.** A valve substantially as described with reference to the accompanying examples and drawings.

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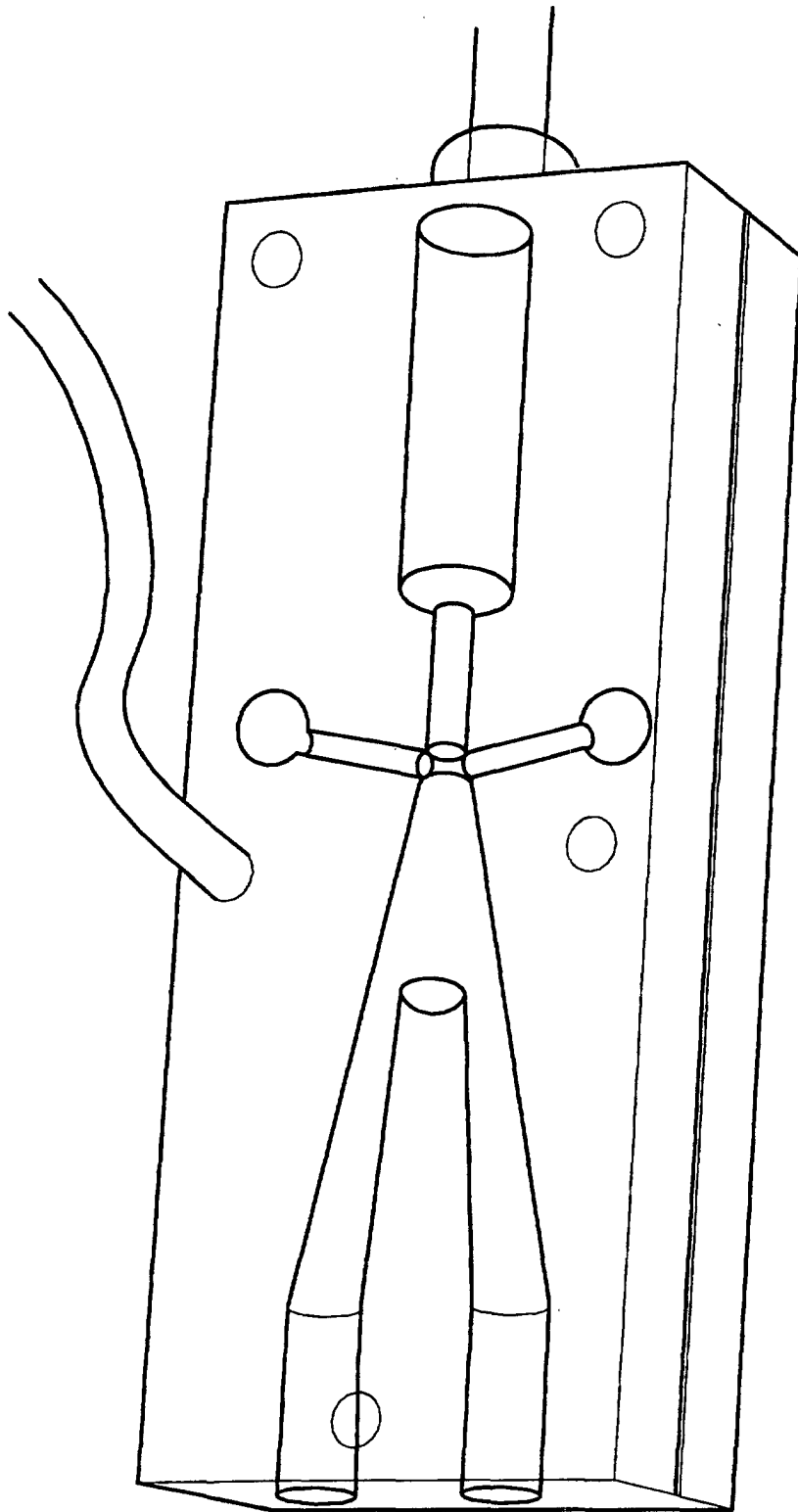


Fig. 1

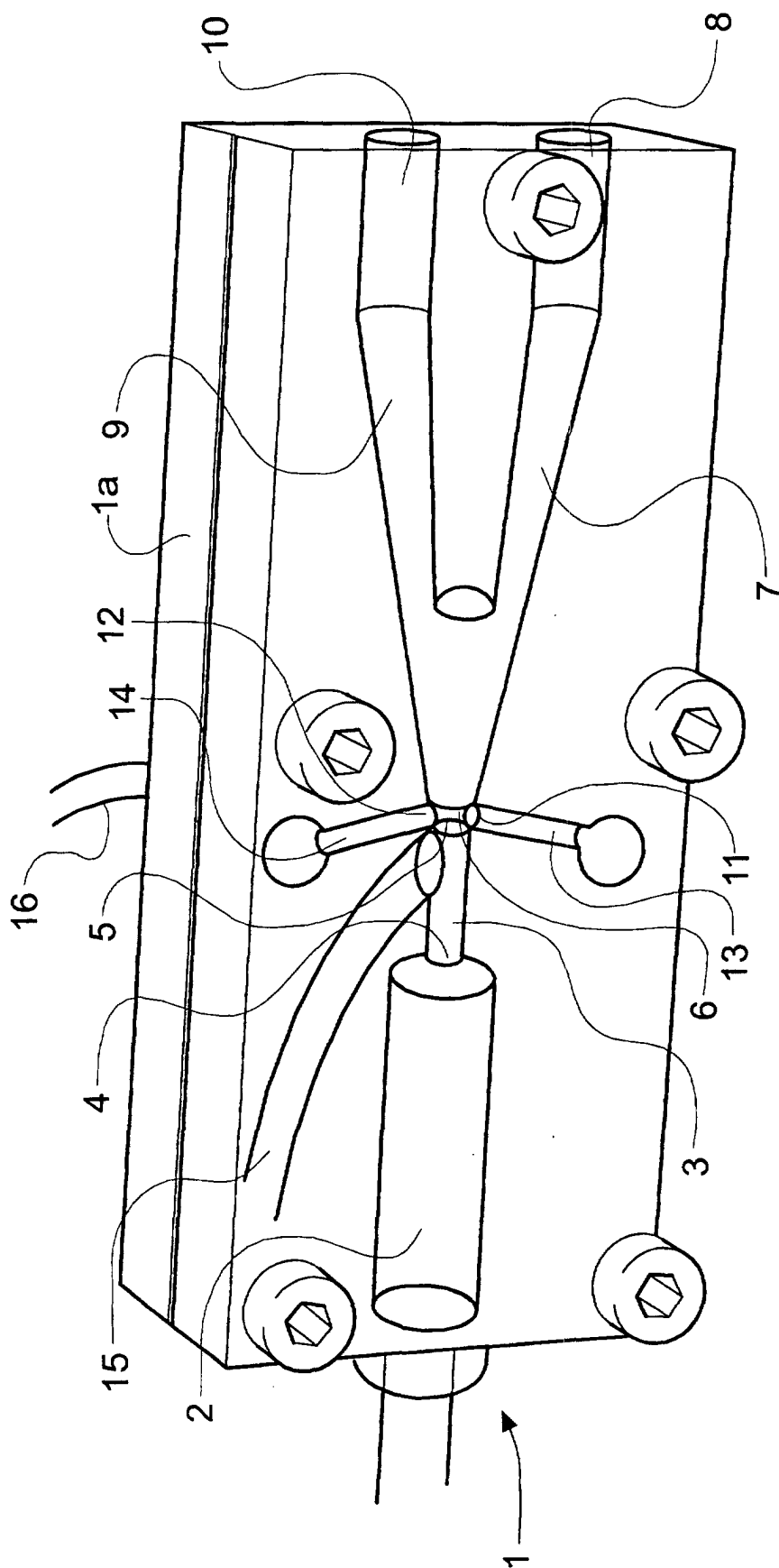


Fig. 2

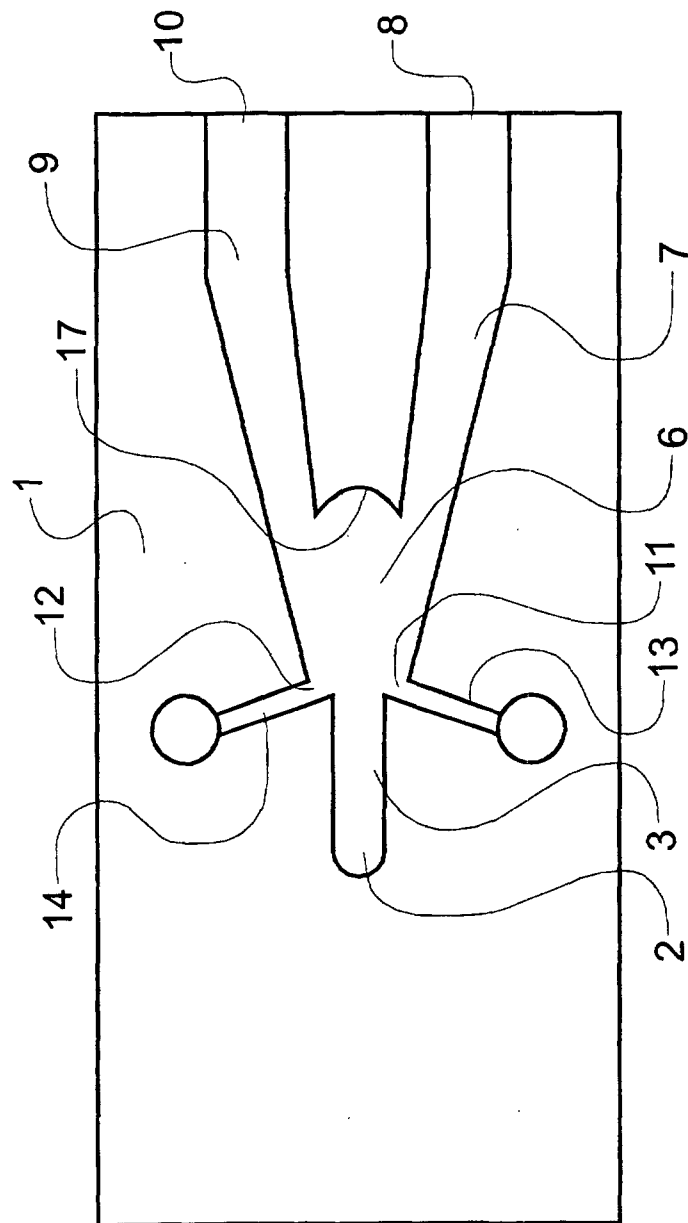


Fig. 3