

VALVE FOR CONTROLLING FLOW OF MATERIAL IN A PIPE

FIELD OF INVENTION

The present invention relates to an apparatus, method and system for controlling flow of material through a pipe using physical force acting on a shuttle that moves in and out of a passage of flow in a pipe. More particularly, the present invention relates to a valve installed at a pipe which valve regulates fluid or fluid-solid mixture flow within said pipe by means of differential pressure or mechanical force acting on a shuttle which restricts or allows flow based on the position of the shuttle within the pipe.

BACKGROUND OF THE INVENTION

Pipe networks with liquids and/or gases sometimes mixed with solids flowing through them often require the control of flow of the material. Current valves used for this application include ball valves, butterfly valves, slide gate valves, knife gate valves and such like.

In transport of sewerage, water, industrial gas, petrochemical or solid waste through pipe networks such valves are used with the primary function of isolating the flow of the material within desired sections of the pipe. By isolating sections of the pipe, the flow of material can be controlled and sequenced to ensure proper function of the whole system.

The current designs of these valves are generally designed to handle large differential pressures across the valve and hence are generally oversized for applications requiring smaller differential pressures across the valve. These valves often require expensive pneumatic cylinders or motors to drive the mechanism that controls the flow in the pipe. They also place space restrictions on installation due to their space requirements for maintenance and replacement of components of the valve.

To compound the cost associated with the above disadvantages when installed below ground level they also require large expensive chambers, often made

of reinforced concrete to be constructed around them to allow for the installation, operation and servicing of these valves. The cost of these chambers often outweighs the cost of the valves and the costs increase exponentially with the installation depth of the valve.

5 Subsea pipelines are usually used to convey fluids such as natural gas, liquid petroleum or even water. Typically, these pipelines require complex valves to regulate flow within them. These valves require huge cost and highly skilled personnel to install and maintain. Further, when a fluid travelling at high speed within a pipe meets a sudden change in direction or velocity, e.g. during a sharp bend or sudden
10 closure of a valve, a phenomena known as a fluid hammer will occur, where the momentum of the fluid is converted to high pressure and shockwaves due to the sudden change. The resultant pressure surge and shockwaves can severely damage piping and related equipment.

Well blowouts are another issue faced in pipe flow control and are prevalent in
15 the oil and gas industry. This usually occurs when high pressures from oil or gas reservoirs are released uncontrollably to the surface due to equipment failure. Blow-out preventers are used to deal with these occurrences, however, when these preventers fail to function, steps need to be taken to cap the blowout to halt further release of oil or gas to the surface. A measure used by drilling engineers to halt a
20 blowout is to 'kill' the well by filling the well with a 'kill fluid' that is heavier than the oil or gas in the reservoir and will prevent any further flow of oil or gas to the surface once the well is filled. Again, this measure is costly and requires personnel to be exposed to the hazards involved in capping the blowout.

EP 1 555 223 A1 discloses a valve primarily used for regulating mass flow in
25 waste suction systems. The invention houses a displaceable valve plate in a valve chamber which is connected to an actuating mechanism at the top. Openings at the sides connect two opposing pipe ends. Air inlets carry secondary transport air into the system and clear debris that remain at the valve plate seat. The system faces several drawbacks, namely, a recess for the valve plate seat causes debris to fall in
30 and be trapped and secondary air transport may not be able to clear debris caught in the recess. Further, the displaceable valve plate is inflexible and would not be able to

completely seal flow should any debris remain trapped in the recess. Also, substantial excavation work is required to install and service the valve.

The present invention is developed to minimize the cost of the valve, allow for easier maintenance as well as to substantially reduce the size of the underground chambers traditionally required to house conventional valves. The underlying principle of the invention can also be used for deep sea applications and mitigating fluid hammer effect. It is also intended to reduce or eliminate risks involved in installing, maintaining, servicing and replacing conventional valves.

The scope of the present invention is to allow for a greater use of this type of valve and to eliminate the cost and space restrictions placed by conventional designed valves.

SUMMARY OF THE INVENTION

The present invention discloses a system for controlling flow of material within a pipe by means of a valve and a valve actuating unit, characterized in that the valve includes a hollow projection secured to the pipe, a shuttle that is contained within the hollow projection and a means to move the shuttle linearly within the hollow projection wherein a part of the shuttle is introducible into the pipe to restrict the flow of material and withdrawable into the hollow projection to allow flow of material within the pipe.

Also, the present invention discloses a system for controlling flow of material within a pipe by means of a valve and an actuation unit characterized in that the valve includes a shuttle movable linearly within a hollow projection by a pressure differential maintained between a chamber within the hollow projection and the pipe to which the hollow projection is attachable.

The present invention further discloses a method of controlling flow of material within an apparatus as hereinbefore described, wherein the method includes maintaining a pressure or head of fluid within the hollow projection, generating differential pressure to withdraw the shuttle into the hollow projection or to extend the shuttle into the body of pipe and allowing or restricting flow of material in the pipe based on the position of said shuttle.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given herein below and accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, wherein:

- 5 Figure 1a shows a valve installed at a pipe with a flow of material travelling within the pipe.

Figure 1b shows fluid supplied to a chamber to partially restrict flow.

Figure 1c shows a fully restricted pipe flow after fluid supply has caused the valve to fully close.

- 10 Figure 1d shows fluid being removed from the chamber to cause the valve to open and allow flow.

Figure 1e shows the valve installed at an upstanding angle other than 90° with regards to the pipe's longitudinal axis.

- 15 Figure 2a shows a variant of the valve using a spring for a 'NORMALLY CLOSED' setting.

Figure 2b shows fluid being removed from the valve that generates a vacuum that overcomes spring force holding a shuttle down and causes the valve to open.

Figure 2c shows a valve that uses a spring to normally close a pipe flow using a shuttle and a winch to allow for flow in the valve.

- 20 Figure 3a shows the valve being used in a deep-water scenario with a head of water at similar pressure with the pipe flow pressure.

Figure 3b shows the angled shape of the shuttle to minimize water hammer effect.

Figure 3c shows the valve stopping the flow of fluid.

Figure 3d shows the valve being opened to allow flow.

- 25 Figures 4a - 4d show how the valve functions.

Figure 5a shows a shuttle with an externally fitted bladder.

Figure 5b shows the expansion of the externally fitted bladder when fluid is supplied into the valve.

- 30 Figure 5c shows a fully expanded bladder that seals any gaps between the shuttle and the pipe.

Figure 5d shows the deflated bladder after fluid is removed from the valve.

Figures 6a - 6d show the workings of a shuttle design with a partial bladder attachment at the downstream side.

Figure 7a shows the top of a shuttle with an externally fitted bladder.

Figure 7b shows the top view of a shuttle contained in a hollow projection with groove and tongue mating.

Figure 7c shows a shuttle with holes for fluid to inflate an externally fitted bladder.

5 Figure 8a & 8b show the top and side views of a shuttle fitted with inflatable side seals in deflated and inflated states respectively.

Figures 9a & 9b show screw threads formed on the top of a shuttle and shuttle with bladder.

10 DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to an apparatus, method and system to control fluid flow through a pipe using differential pressure or mechanical force across a shuttle to move in and out of the passage of fluid flow in a pipe.

15 In the description, the term 'pipe' is used in a general sense to include conduits, tubes, ducts, culverts and channels, wherein material flows along the length of the 'pipe'. Accordingly, the pipe can be of concrete, steel or plastic material.

The various embodiments of the present invention will be described herein in Figures 1a – 9b.

20 A valve (10) of the present invention as shown in Figure 1a comprises of a pipe (12) which can be a conduit such as a tubular pipe, channel, duct or culvert which conveys a flow of material (14), of which the material can be a fluid, examples of which are oil, liquid and gas, or a fluid-solid mixture flow where flow contains solids in fluid. Examples of materials to be conveyed are such as fluids such as oil, liquid and gas and fluid-solid mixtures such as sewerage, solid waste materials and
25 other fluids containing solid materials in them. Specifically, the present invention is intended for use in waste collection systems where air is used to transport waste, water, sewerage, industrial gas and petrochemical supply systems. Connected to the pipe (12) is a hollow projection (16), examples of which are a solid branch pipe or a flexible pipe that leads to the surface of the ground or any other desired surface level
30 and is closed by an impermeable cover, an example of a sealing means (18). The hollow projection (16) houses a shuttle (20) that is locked in position to a stopper

(22) by a clamping means (24), an example of which is a magnet or a clamping device. This position of the shuttle (20) as shown in this figure is defined as the 'OPEN' position as flow in the pipe (12) is at maximum. A spacer (26) with an adjustable height to suit the depth of the pipe (12) is installed and the spacer connects the stopper (22) to the sealing means (18). A chamber (28), defined as a volumetric space within the hollow projection (16) between the sealing means (18) and the shuttle (20), is subject to pressure changes. The stopper (22) is permeable and does not restrict pressure within the chamber (28) but limits the upward movement of the shuttle (20) within the chamber (28).

Figure 1b shows differential pressure generated to move the shuttle (20) downwards. Differential pressure is the pressure difference between the pressures in the pipe (12) and the chamber (28) and can be generated via hydraulic or pneumatic means. Fluid, which can be oil, gas or liquid, is introduced into the chamber (28) by pressure. The source of fluid could be from an externally positioned pressurized conduit or directly from a pump located inside the chamber (28) with an inlet conduit connected to the pump. As the fluid enters and fills the chamber (28) the pressure in the chamber (28) increases as the chamber (28) is filled with fluid and further introduction of fluid into the chamber (28) causes the pressure in the chamber (28) to become greater than pressure of the flow of material (14) in the pipe (12). The force generated by the increased pressure in the chamber (28) acts upon the shuttle (20) and unlocks the shuttle (20) from the 'OPEN' position as shown in Figure 1a by overcoming the resisting force of the magnet (24). As the pressure increases further, the force exerted on the shuttle (20) becomes greater and the shuttle (20) descends linearly along a central axis of the hollow projection (16) into the pipe (12). As the shuttle (20) is projected into the pipe (12) and narrows down the cross-sectional area of the pipe (12), the flow of material (14) in the pipe (12) is reduced.

Pressurized fluid in the chamber pushes the shuttle (20) all the way into the pipe (12), completely obstructing flow of material (14) in the pipe (12), as seen in Figure 1c. This position of the shuttle (20) is defined as the 'CLOSED' position as the flow of material (14) is completely restricted in the pipe (12).

Figure 1d shows fluid being removed from the chamber (28) which causes the pressure in the chamber (28) to become lower than the pressure in the pipe (12). As

the pressure in the pipe (12) is greater than the pressure in the chamber (28), the pressure difference generates a force which pushes the shuttle (20) out of the pipe (12) and causes the shuttle (20) to ascend linearly along the central axis of the hollow projection (16) back into the chamber (28) towards the original 'OPEN' position as shown in Figure 1a. The removal of fluid from the chamber (28) is achieved by means of a pump which evacuates fluid inside the chamber (28). Alternatively the fluid in the chamber (28) can be pumped out by means of a conduit attached to a pump.

In Figure 1e, it is shown that the design of the valve (10) allows for the valve (10) to be installed at an upstanding direction at any angle above a longitudinal axis of the pipe (12). Conventional valves are typically designed with the controlling mechanism being perpendicular to the direction of the flow it is controlling. This can be an issue when there are space constraints. The terminal end of the shuttle (20) is designed so that the dimension of the terminal end corresponds with the cross-section of the pipe (12) to allow the shuttle (20) to close the cross-section of the pipe (12) at angles other than 90°, wherein the angle (θ) is preferably 40° to 90° from the longitudinal axis of the pipe (12). This is helpful in situations where space is constrained and placement of a valve (10) in a particular angle or position is crucial.

Figure 2a shows a variation of the configuration as shown in Figure 1a in that a biasing means (30), an example of which are spring such as coil spring, flat spring or machined spring is located between the shuttle (20) and the stopper (22). This allows for a 'NORMALLY CLOSED' configuration without the need to pressurize the chamber (28) to move the shuttle (20) to the 'CLOSED' position as explained previously, as the biasing means (30), having elastic potential force, pushes the shuttle (20) into the 'CLOSED' position.

Figure 2b shows the valve (10) in an 'OPEN' position. To move the shuttle (20) to the 'OPEN' position, a low pressure is created above the shuttle (20) by evacuating fluid from the chamber (28) which creates a pressure difference whereby the pressure within the pipe (12) is greater than the pressure within the chamber (28) and this pressure difference causes a force to be exerted against the shuttle (20) from the pipe (12) into the chamber (28) which overcomes the spring resistance and

pushes the shuttle upwards and compresses the biasing means (30) and allows flow of material (14) in the pipe (12).

The biasing means (30) and shuttle (20) can be configured so that the shuttle (20) is in a 'NORMALLY CLOSED' or 'NORMALLY OPEN' setting. In a 'NORMALLY
5 'CLOSED' setting, the biasing means (30) exerts an amount of force to keep the shuttle (20) pushed down until it is necessary to raise it to allow flow of material (14). Conversely, in a 'NORMALLY OPEN' setting, the shuttle (20) hangs under the biasing means (30) in the 'OPEN' position which allows flow (14) until it is necessary to lower it by exerting a higher pressure within the chamber (28) which in turn creates a
10 downward force to move the shuttle (20) into the pipe (12) to stop the flow of material (14).

Another variation of the valve (10) is shown in Figure 2c where the shuttle (20) is moved by mechanical means. A biasing means (30) is used to push the shuttle (20) into the 'CLOSED' position. A cable (32) is used to pull the shuttle from the
15 'CLOSED' position to the 'OPEN' position. The valve (10) uses mechanical means, an example of which is a winch (34) to winch the cable (32) and pull the shuttle (20) out of the pipe (12) and into the chamber (28).

Figure 3a further demonstrates the use of this valve (10) for very deep applications where accessibility of the valve (10) for maintenance and repair is needed
20 but depths of liquid or ground or the conditions of the water may not make it a safe or feasible operation. In this case a head of fluid in the chamber (28) is used to move an angled shuttle (36), wherein the fluid may be the same or compatible with fluid flowing in the pipe (12), only requiring a small pressure being applied at the top of the head of fluid in the chamber (28) to move the angled shuttle (36) into the
25 'CLOSED' position. The angled shuttle (36) is designed with a wedge shape that allows for momentum of the fluid flowing in the pipe (12) to be transferred to the head of fluid within the chamber (28) in the direction of the central axis of the hollow projection. Conversely, to move the angled shuttle (36) into an 'OPEN' position a small volume of fluid needs to be pumped out at the top of the chamber (28) to create a
30 reduction of pressure and allow the angled shuttle (36) to travel up.

In Figure 3b, an angled shuttle (36) is lowered into the fluid flowing in the pipe (12). Sudden valve closures during high volume and velocity fluid flow can cause a

fluid hammer effect. To mitigate this, the angled shuttle (36) is gradually lowered into the flow by gradually supplying pressurized fluid into the chamber (28) which creates a downward force pushing the angled shuttle (36) into the pipe (12). Due to the upward force acting on the angled shuttle (36) created by the momentum of moving fluid in the pipe (12), the downward movement of the angled shuttle (36) is resisted. By
5 allowing the momentum of the moving fluid to dissipate into the head of fluid in the chamber (28) while gradually lowering the angled shuttle (36) into the 'CLOSED' position, the adverse effects of the water hammer can be minimized or eliminated.

Figure 3c shows the angled shuttle (36) in the 'CLOSED' position and the fluid
10 flow in the pipe (12) is stopped. With this setup, there is no need for additional dampers or risers to allow flow of fluid in the pipe (12) to be diverted to mitigate the fluid hammer effect. To allow flow within the pipe (12) again, fluid is removed from the chamber (28) as shown in Figure 3d. This causes the pressure within the chamber (28) to become lesser than the pressure in the pipe (12) which therefore creates
15 a force that lifts the angled shuttle (36) up and into the chamber to the 'OPEN' position.

Figures 4a – 4d represent the application of using the shuttle (20) as a means to stop the flow of material (14) by creating a pressure difference across the shuttle (20) with the shuttle (20) always moving away from the area of greater pressure
20 which generates a force that acts upon the shuttle (20). In Figure 4a, the shuttle (20) is in the 'OPEN' position. Figure 4b shows that as fluid is supplied into the chamber (28), the shuttle (20) is pushed downwards due to the force acting on the shuttle by the higher pressure in the chamber (28) over the lower pressure in the pipe (12). In Figure 4c, the downward force due to the higher pressure in the chamber (28) keeps
25 the shuttle (20) in the 'CLOSED' position. As fluid is removed from the chamber (28), as seen in Figure 4d, the pressure in the pipe (12) becomes greater than the pressure in the chamber (28) and the difference in pressure creates a force that moves the shuttle (20) upward.

Figures 5a – 5d show a shuttle with an externally fitted bladder (38). In Figure
30 5a, the pressure in the chamber (28) is lower than the pressure in the pipe (12) and the shuttle with bladder (38) is in the 'OPEN' position with the bladder hugging the shuttle in its unexpanded state due to the pressure difference.

In Figure 5b, fluid under pressure enters the chamber (28) above the shuttle causing a higher pressure to build up in the chamber (28). The pressure from the chamber (28) above the shuttle with bladder (38) is allowed to permeate through the shuttle into the bladder. The fluid permeates through the shuttle and force from the
5 increased pressure acts against the bladder wall. The higher pressure difference creates a force that pushes the shuttle with bladder (38) into the pipe (12) and causes the shuttle with bladder (38) to expand slightly.

In Figure 5c the shuttle with bladder (38) is pushed into the 'CLOSED' position by force created by the higher pressure in the chamber (28) in relation to the pipe
10 (12) with the bladder fully expanded to seal any gaps that may exist between the shuttle body and the pipe (12) wall ensuring an efficient fluid seal between both sides of the pipe (12) separated by the shuttle-bladder arrangement.

Fluid is removed from the chamber (28) by pumping the fluid out as shown in Figure 5d, creating a lower pressure in the chamber (28). This lower pressure difference causes the bladder to shrink as force from the higher pressure in the pipe (12)
15 acts upwards towards the chamber against the bladder, at the same time pushing the shuttle with bladder (38) upwards into the chamber (28) to allow flow of material (14) to be restored in the pipe (12).

Figure 6a - 6d shows a variant of the shuttle which has a half-solid and half-bladder design (40). In this design, only half of the shuttle body is permeable to allow
20 fluid to permeate through to the bladder while another half of the shuttle body is solid. The half-bladder shuttle (40) is oriented so that the solid half faces upstream side of the pipe (12) and bladder half faces the downstream side. This configuration is envisaged to be used when solid materials are being conveyed in the fluid as the solid
25 part of the shuttle on the upstream side will protect the bladder from being punctured by the solid materials in the fluid-solid mixed flow. The method of opening and closing the valve (10) is similar to what is shown in Figures 5a - 5d.

In Figure 6a, the half-bladder shuttle (40) is in the 'OPEN' position with the bladder portion hugging the shuttle as the pressure within the chamber (28) is lesser
30 than the pressure within the pipe (12). In Figure 6b, fluid under pressure enters the chamber (28) and permeates through the shuttle to the bladder half. The increase in pressure creates a force that pushes the half-bladder shuttle (40) down into the pipe

(12) and expands the bladder slightly. In Figure 6c, the pressure in the chamber (28) is sufficiently higher than the pressure in the pipe (12) to move the half-bladder shuttle (40) into the 'CLOSED' position and cause the bladder half to be fully expanded to seal any gaps. Fluid is removed from the chamber (28) as shown in Figure 6d, and the lower pressure within the chamber (28) causes the bladder to shrink. The half-bladder shuttle (40) is raised into the chamber (28) due to force exerted on it by higher pressure in the pipe (12), allowing flow (14) to be restored in the pipe (12).

Figure 7a shows a top view of the shuttle with a hollow section (42). This design is for shuttles with bladders fitted to them. The bladder is fitted circumferentially around the shuttle (20) and is made of materials such as rubber, neoprene, leather and other elastic materials consistent with the spirit of the invention. In the event that the half-bladder shuttle (40) is used and rotation of the shuttle about its vertical axis cannot be allowed, guide grooves (44), an example of means to prevent angular rotation within the chamber, are incorporated into the shuttle where they are mated to tongues (45) formed within the hollow projection (16), shown in Figure 7b. Depending on the situation, the guide grooves (44) can be formed within the hollow projection and tongue (45) formed on the shuttle instead. Figure 7c shows the shuttle with holes (46) around the shuttle body wall that will allow fluid to pass through the shuttle to cause the bladder to expand or shrink depending on the pressure condition within the hollow section of the shuttle and chamber above it. When pressure within the chamber is greater than the pressure within the pipe, the bladder will expand and when the pressure within the chamber is lesser than the pressure within the pipe, the bladder will shrink.

Figure 8a shows the top and side views of a hollow shuttle with inflatable side seals (48). The inflatable side seals (50) are made of materials similar to that of the bladder as described in Figures 5a – 5d. The side seals (50) are withdrawn in recesses formed on surfaces where the shuttle meets the pipe wall. Guide grooves (44) prevent the shuttle with inflatable side seals (48) from rotating within the chamber to ensure proper sealing of the flow. The side seals (50) are in a deflated state and remain withdrawn in the recesses when there is no positive differential pressure supplied into the chamber. Figure 8b shows the top and side view of the same shuttle with inflatable side seals (48) with the side seals (50) which are inflated when positive differential pressure is supplied into the chamber. The side seals (50) ex-

pand to seal any minor gaps that may be present between the shuttle and the pipe wall. The shuttle operates similarly to what is shown in Figures 5a - 5d.

Figures 9a and 9b show screw threads (52) formed on top of the shuttle (20) and shuttle with bladder (38, 40) designs to facilitate removal of the shuttle (20) and shuttle with bladder (38, 40) from a hollow projection. During installation or servicing of the shuttle (20) and shuttle with bladder (38, 40), an extendible t-wrench or a device performing a similar function with a threaded end is screwed onto the screw threads (52) to hold the shuttle (20) or shuttle with bladder (38, 40) as it is inserted into or removed from the hollow projection. When the shuttle (20) or shuttle with bladder (38, 40) is fully inserted or removed, the shuttle (20) or shuttle with bladder (38, 40) is then unscrewed from the extendible t-wrench.

The design of this valve is an improvement over conventional valve installations presently in use. The circular cross-section of the shuttle gives it increased mechanical strength in stopping flow and is more resistant against deformation caused by forces acting against it by material flow and differential pressure as compared to traditional gate or ball valves which uses gates with a relatively thin or flat cross-section.

Furthermore, installation of the valve only requires an opening be made at the top of the main pipe to attach the hollow projection. There are no sudden recesses or angles to interrupt the flow of material in the pipe or cause materials to be trapped. The pipe is a smooth bore from the upstream side to the downstream side. The hollow projection is also a smooth bore from where it meets the main pipe to the opening at the surface and this design allows for various means to move the shuttle to be employed within the chamber of the hollow projection.

By virtue of the design of the valve, the need for any maintenance chamber is eliminated as all installation and servicing can be done from above ground level. This eliminates the need for extraneous machinery or safety ventilation equipment which helps to reduce the cost required to install and maintain the valves. Furthermore, as no extensive soil removal is required, risks involved in these work processes and the use of safety gears can be reduced.

Traditional valves are overdesigned to withstand working pressures of up to 1,000,000 Pa. This requires complex engineering and higher strength materials which usually translates to higher cost of the valve. The valve as described in the present invention can be applied to systems that have lower working pressures, i.e.
5 up to 500,000 Pa and therefore its simplistic design and lack of need for high strength materials require less cost.

The invention can be applied to cases where oil well blowouts occur, where an opening can be made at the side of pipe where oil is gushing out from and a shuttle can be inserted into the opening to halt any more flow of oil from the reservoir.
10 This would be preferable to inserting 'kill fluid' into the oil well, which needs to be removed if the well is to be used again.

CLAIMS

1. A system for controlling flow of material (14) within a pipe (12) by means of a valve (10) and a valve actuating unit, characterized in that the valve (10) includes;
5 a hollow projection (16) secured to the pipe (12);
a shuttle (20) that is contained within the hollow projection (16); and
a means to move the shuttle (20) linearly within the hollow projection (16);
wherein flow-affecting part of the shuttle (20) is introducible into the pipe (12)
to restrict the flow of material (14) and withdrawable into the hollow projection
10 (26) to allow flow of material (14) within the pipe (12).
2. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) is moved linearly within the hollow projection (16) by means of a pressure differential maintained between a chamber (28) and fluid pressure in the pipe (12), wherein the chamber (28) is a volumetric
15 space between a sealing means (18) at the top end of the hollow projection (16) and the shuttle (20).
3. The system for controlling flow of material (14) within a pipe (12) as claimed in Claim 1, wherein the hollow projection (16) is upstanding from any angle above a longitudinal axis of the pipe (12).
- 20 4. The system for controlling flow of material (14) within a pipe (12) as claimed in Claim 3, wherein the hollow projection (16) is aligned at an angle of 40° to 90° from the longitudinal axis of the pipe (12).
5. The system for controlling flow of material (14) within a pipe (12) as claimed in Claim 2, wherein the hollow projection (16) includes a chamber (28) into which
25 chamber (28) fluid is introducible or withdrawable to vary pressure exerted on the shuttle (20) so as to move the shuttle (20) linearly along the central axis of the hollow projection (16).
6. The system for controlling flow of material (14) within a pipe (12) as claimed in Claim 5, wherein the pressure in the chamber (28) is pneumatic.

7. The system for controlling flow of material (14) within a pipe (12) as claimed in Claim 5, wherein the pressure in the chamber (28) is hydraulic.
8. The system for controlling flow (14) of material within a pipe (12) as claimed in Claim 5, wherein pressure within the chamber (28) is increased by pumping fluid into the chamber (28) and pressure within the chamber (28) is reduced by withdrawing fluid from the chamber (28).
9. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) is moved linearly within the hollow projection (16) by means of a winch (34) mounted on top of the hollow projection (16) and is secured to the shuttle (20) by a cable (32);
wherein the shuttle (20) is withdrawn into the hollow projection (16) by winching the cable (32) to facilitate flow of material (14) in the pipe (12) and lowered from the hollow projection (16) by unwinding the cable (32) and mechanical force from a biasing means (30) to block the flow of material (14) in the pipe (12).
10. The system for controlling flow of material (14) within a pipe as claimed in Claim 9, wherein biasing means (30) are springs such as coil spring, flat spring and machined spring.
11. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) has a free terminal end which is congruent with cross-section of the pipe (12) and fits within the hollow projection (16).
12. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) has a free terminal end which includes a bladder portion.
13. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) has a free terminal end which includes a solid portion and a bladder portion.
14. The system for controlling flow of material (14) within a pipe as claimed in Claims 12 and 13, wherein the bladder portion is an expandable bladder whose volume is expandable by increasing pressure within the bladder.

15. The system for controlling flow of material (14) within a pipe as claimed in Claim 13, wherein at least one inflatable side seal (50) is fitted in a recess formed vertically around the external surface of the shuttle (20) or circumferentially around the shuttle (20).
- 5 16. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein terminal end of the shuttle (20) is wedge shaped in order to create a thrust in the direction of the central axis of the hollow projection (16).
17. The system for controlling flow of material (14) within a pipe as claimed in Claims 13, 15 or 16, wherein the shuttle (20) is prevented from rotating along
10 the vertical axis by at least one tongue (45) formed along the vertical inner circumferential surface of the chamber (28) and guide groove (44) formed along the shuttle (20) respectively or at least one tongue (45) formed along the shuttle (20) and guide groove (44) formed along the vertical inner circumferential surface of the chamber (28) respectively.
- 15 18. The system for controlling flow of material (14) within a pipe as claimed in Claim 1, wherein the shuttle (20) is detachably attached via a clasping means (24) to a stopper (22) situated within the chamber (28) wherein the stopper (22) is connected to a sealing means (18) at the top end of the hollow projection (16) via a spacer (26).
- 20 19. The system for controlling flow of material (14) within a pipe as claimed in Claim 18, wherein the clasping means (24) is a magnet.
20. The system for controlling flow of material (14) within a pipe as claimed in Claim 18, wherein the clasping means (24) is a clamping device.
21. The system for controlling flow of material (14) within a pipe as claimed in
25 Claims 12, 13 or 17 wherein the shuttle (20) is removable from the hollow projection (16) and includes screw threads (52) formed on a top end of the shuttle (20) which screw threads (52) are interfaceable to an extendible t-wrench.
22. A system for controlling flow of material (14) within a pipe (12) by means of a valve (10) and an actuation unit characterized in that the valve (10) includes a
30 shuttle (20) movable linearly within a hollow projection (16) by a pressure dif-

ferential maintained between a chamber (28) within the hollow projection (16) and the pipe (12) to which the hollow projection (16) is attachable.

23. A method of controlling flow of material (14) of the system as claimed in Claims 1, 2 or 22, wherein the method includes:

- 5
- i) maintaining a pressure or head of fluid within the hollow projection (16);
 - ii) generating differential pressure to withdraw the shuttle (20) into the hollow projection (16) or to extend the shuttle into the body of pipe (12);
 - iii) allowing or restricting flow of material (14) in the pipe based on the position of said shuttle (20).

10 24. The method of controlling flow of material (14) of the system as claimed in Claim 23, wherein step of generating differential pressure to extend the shuttle into the body of pipe (12) further includes a step of allowing momentum of flow of material (14) in the pipe (12) to dissipate into the head of fluid within the hollow projection (16) to mitigate a fluid hammer effect.