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**DTIC QUALITY INSPECTED 1**

2  
3 PISTON AND CYLINDER

4 ACTUATED POLYMER MIXING VALVE

5  
6 STATEMENT OF GOVERNMENT INTEREST

7 The invention described herein may be manufactured and  
8 used by or for the Government of the United States of  
9 America for Governmental purposes without the payment of any  
10 royalties thereon or therefor.

11  
12 BACKGROUND OF THE INVENTION

13 (1) Field of the Invention

14 The invention relates to mixing valves, and is directed  
15 more particularly to a valve for introducing a polymer into  
16 a stream of water prior to the flowing of the water and  
17 polymer mixture from an underwater vehicle and onto a hull  
18 surface thereof to reduce drag on the vehicle operating  
19 underwater.

20 (2) Description of the Prior Art

21 Drag created by the travel of underwater vehicles,  
22 caused by viscous effects of turbulent flow of water over

1 exterior surfaces of the vehicle, limits the overall  
2 effectiveness and performance of such vehicles.

3 It is known to reduce such drag by delivering a stream  
4 of liquid polymer from inside the vehicle to the external  
5 hull surfaces of the vehicle, the polymer acting to reduce  
6 turbulence, and thereby reduce drag. A system for  
7 delivering polymer for such purpose is disclosed in U.S.  
8 Patent Application Serial No. 08/083,222, filed June 29,  
9 1993, in the names of Pierre J. Corriveau et al.

10 The dispensed polymer, while effective to reduce drag,  
11 dissipates rather rapidly, being washed away by the water  
12 environment of the vehicle. Inasmuch as space is at a  
13 premium in such vehicles, the storage of large volumes of  
14 liquid polymer is not acceptable. Thus, if substantially  
15 pure polymer is dispensed, the time of its effectiveness is  
16 quite limited.

17 It is known that a slurry of water and liquid polymer,  
18 including a very small quantity of polymer in the slurry,  
19 such as 8 to 30 parts per million, is quite effective for  
20 the purpose. In view of this, the use of mixing valves for  
21 mixing together a small amount of polymer and a relatively  
22 large amount of water (taken from the water environment and  
23 therefore requiring no storage room) is known. The polymer

1 is stored under pressure and, upon release, discharges into  
2 a stream of flowing water. It has been found, for example,  
3 that running the water through a venturi and injecting  
4 polymer into the venturi allows the water and polymer to mix  
5 sufficiently to be effective. A spring loaded valve has  
6 been used to close off the polymer. Pressurizing the  
7 polymer opened the valve and reducing the pressured closed  
8 the valve. It has been found, however, that when the  
9 polymer pressure is reduced, a small amount of water  
10 sometimes enters the valve polymer opening, causing the  
11 polymer to solidify at the opening. When this happens, it  
12 is necessary to disassemble the valve to remove the clog.

13 Accordingly, there is a need for a mixing valve which  
14 facilitates shutting off polymer flow while the polymer is  
15 under sufficient pressure to preclude water entry into the  
16 polymer valve opening.

17  
18 SUMMARY OF THE INVENTION

19 It is, therefore, an object of the invention to provide  
20 a valve for introducing liquid polymer into a moving stream  
21 of water, prior to flowing the water and polymer together  
22 onto a hull surface of an underwater vehicle, and which may

1 be closed while the polymer is under pressure, to prevent  
2 further flow of polymer into the water stream.

3 With the above and other objects in view, as will  
4 hereinafter appear, a feature of the invention is the  
5 provision of a valve for introducing polymer into a moving  
6 water stream prior to flowing the water stream, with the  
7 polymer therein, onto a hull surface of an underwater  
8 vehicle. The valve comprises a venturi block having therein  
9 a venturi passageway for flowing water therethrough, a  
10 polymer inlet tube extending through the venturi block and  
11 into the venturi passageway for introducing the polymer into  
12 the water flowing through the venturi passageway. A shut-  
13 off plunger extends through a bore in the venturi block and  
14 is axially aligned with the polymer inlet tube, the plunger  
15 being reciprocally movable in the bore between a first  
16 position in which a head portion of the plunger extends into  
17 and seals closed the polymer inlet tube, and a second  
18 position in which the head portion of the plunger is spaced  
19 from sealing engagement with the polymer inlet tube. A  
20 piston and cylinder assembly is provided for moving the  
21 plunger between the first and second positions.

22 The above and other features of the invention,  
23 including various novel details of construction and

1 combinations of parts, will now be more particularly  
2 described with reference to the accompanying drawings and  
3 pointed out in the claims. It will be understood that the  
4 particular device embodying the invention is shown by way of  
5 illustration only and not as a limitation of the invention.  
6 The principles and features of this invention may be  
7 employed in various and numerous embodiments without  
8 departing from the scope of the invention.

9  
10 BRIEF DESCRIPTION OF THE DRAWINGS

11 Reference is made to the accompanying drawings in which  
12 is shown an illustrative embodiment of the invention, from  
13 which its novel features and advantages will be apparent,  
14 wherein corresponding reference characters indicate  
15 corresponding parts throughout the several views of the  
16 drawings and wherein:

17 FIG. 1 is a generally sectional view of one form of a  
18 valve illustrative of an embodiment of the invention;

19 FIG. 2 is a sectional view taken along line II-II of  
20 FIG. 1;

21 FIG. 3 is similar to FIG. 1, but showing the valve in a  
22 different operational mode;

1           FIG. 4 is a side elevational view of a plunger portion  
2 of the valve of FIG. 3, shown turned 90° to the position in  
3 which it is shown in FIG. 3; and

4           FIG. 5 is a distal end view of the plunger portion of  
5 FIG. 4.

6  
7                           DESCRIPTION OF THE PREFERRED EMBODIMENT

8           Referring to the FIG. 1, it will be seen that an  
9 illustrative valve 10 includes a venturi block 12 having a  
10 venturi passageway 14 extending therethrough for flow of  
11 water from a venturi water entrance 16, through venturi  
12 passageway 14, to a venturi water outlet 18.

13           A polymer inlet tube 20 extends through venturi block  
14 12, substantially normal to an axis 22 of venturi passageway  
15 14 and into venturi passageway 14 for introducing liquid  
16 polymer into the water flowing through venturi passageway  
17 14.

18           A shut-off plunger 24 extends through a bore 26 in  
19 venturi block 12 and is axially aligned with polymer inlet  
20 tube 20. The plunger 24 is reciprocally movable in bore 26  
21 between a first position (FIG. 1) in which a head portion 28  
22 of plunger 24 extends into and seals closed polymer inlet  
23 tube 20, and a second position (FIG. 3) in which head

1 portion 28 of plunger 24 is spaced from sealing engagement  
2 with polymer inlet tube 20.

3 Referring to FIGS. 4 and 5, it will be seen that  
4 plunger head portion 28 may be divided to provide increased  
5 flow area through head portion 28, when such flow is  
6 desired. The head portion 28 is provided with at least one  
7 O-ring seal 30 for effectively sealing off polymer flow from  
8 polymer inlet tube 20, when no flow is desired.

9 Referring again to FIG. 1, it will be seen that the  
10 valve further includes a piston and cylinder assembly 32 for  
11 moving shut-off plunger 24 between the aforesaid first and  
12 second positions. The piston and cylinder assembly 32  
13 includes a cylinder 34 extending substantially parallel to  
14 axis 22 of venturi passageway 14. A piston 36 in cylinder  
15 34 and a piston rod 38 are movable in directions  
16 substantially parallel to the axis of venturi passageway 14.

17 Referring now also to FIG. 2, a slide means 40  
18 interconnects piston 36 and plunger 24 for converting the  
19 movements of piston rod 38 to movements of plunger 24 in  
20 directions normal to venturi passageway 14 to a selected one  
21 of the aforesaid first and second positions. The slide  
22 means 40 includes a slide member 42 fixed to piston rod 38,



1 and a slide block 44 fixed to venturi block 12 and mounting  
2 slide member 42 for sliding in slide block 44 (FIG. 2).

3 A first slide structure, preferably elongated spline-  
4 like projections 46, are disposed on slide member 42, and a  
5 second slide structure, preferably grooves 48, are disposed  
6 in plunger 24. The projections 46 and grooves 48 are  
7 complementary to each other and are interconnected so as to  
8 effect the aforesaid conversion of movements. It will be  
9 apparent that the projection and groove arrangement can be  
10 reversed, such that grooves are disposed in slide member 42  
11 and projections extend from plunger 24.

12 As shown in FIGS. 1 and 3, grooves 48 and projections  
13 46 are complementarily inclined relative to the axis of  
14 piston rod 38. It has been found that an incline of about  
15  $21^{\circ}$  performs satisfactorily.

16 A slide retainer 50 is fixed to cylinder 34 and extends  
17 therefrom, overlying slide member 42. The slide retainer 50  
18 defines a bore 52 through which plunger 24 extends and is  
19 slidably retained therein.

20 In operation, cylinder 34 is pressurized by fluid  
21 entering a cylinder opening 54 and vents out a cylinder  
22 opening 56, enabling piston 36 and piston rod 38 to move  
23 rightwardly, as viewed in FIG. 1, to cause slide member 42

1 to move rightwardly. As inclined elongated projections 46  
2 move rightwardly in grooves 48, shut-off plunger 24 moves  
3 downwardly. The plunger head portion 28 enters polymer  
4 inlet tube 20, against the pressure therein, with o-ring  
5 seal 30 engaging the interior of inlet tube 20 to seal off  
6 the tube and stop the flow of liquid polymer therethrough.

7 When flow of polymer is desired, fluid under pressure  
8 is introduced into cylinder 34 through cylinder opening 56  
9 and cylinder 34 is vented through cylinder opening 54,  
10 causing piston 36 to move leftwardly, as viewed in FIG. 3,  
11 to cause plunger 24 to move upwardly to disengage sealing  
12 ring 30 from tube 20 and to remove head portion 28 from tube  
13 20, sufficiently to permit polymer to flow around head  
14 portion 28 and through a gap 58 (FIGS. 4 and 5) in head  
15 portion 28, and into venturi passageway 14 to mix with a  
16 stream of water flowing therethrough.

17 There is thus provided a valve which admits liquid  
18 polymer under pressure into a venturi passageway to mix with  
19 a stream of water, and which can be closed against the  
20 pressure of the polymer to stop flow of polymer into the  
21 venturi passageway, without water entering the polymer  
22 inlet.

1            Obviously many modifications and variations of the  
2 present invention may become apparent in light of the above  
3 teachings. For example, the valve can be used for mixing of  
4 other materials besides water and polymer, such as mixing of  
5 a two part epoxy. The shape of the flow passages in the  
6 venturi block, as well as the shape of the plunger can be  
7 changed to suit the materials used. It will also be  
8 appreciated that the angle of the grooves and projections  
9 can be reversed such that movement of the piston towards the  
10 plunger would result in movement of the plunger out of the  
11 inlet tube.

12           It will be understood that many additional changes in  
13 the details, materials, steps and arrangement of parts,  
14 which have been herein described and illustrated in order to  
15 explain the nature of the invention, may be made by those  
16 skilled in the art within the principles and scope of the  
17 invention.

2  
3 PISTON AND CYLINDER

4 ACTUATED POLYMER MIXING VALVE

5  
6 ABSTRACT OF THE DISCLOSURE

7 A valve for introducing polymer into a moving water  
8 stream prior to flowing the water stream, with the polymer  
9 therein, onto a hull surface of an underwater vehicle. The  
10 valve comprises a venturi block having therethrough a  
11 venturi passageway for flowing water therethrough, a polymer  
12 inlet tube extending through the venturi block and into the  
13 venturi passageway for introducing the polymer into the  
14 water flowing through the venturi passageway. A shut-off  
15 plunger extends through a bore in the venturi block and is  
16 axially aligned with the polymer inlet tube, the plunger  
17 being reciprocally movable in the bore between a first  
18 position in which a head portion of the plunger extends into  
19 and seals closed the polymer inlet tube, and a second  
20 position in which the head portion of the plunger is spaced  
21 from sealing engagement with said polymer inlet tube. A  
22 piston and cylinder assembly moves the plunger between the  
23 first and second positions.

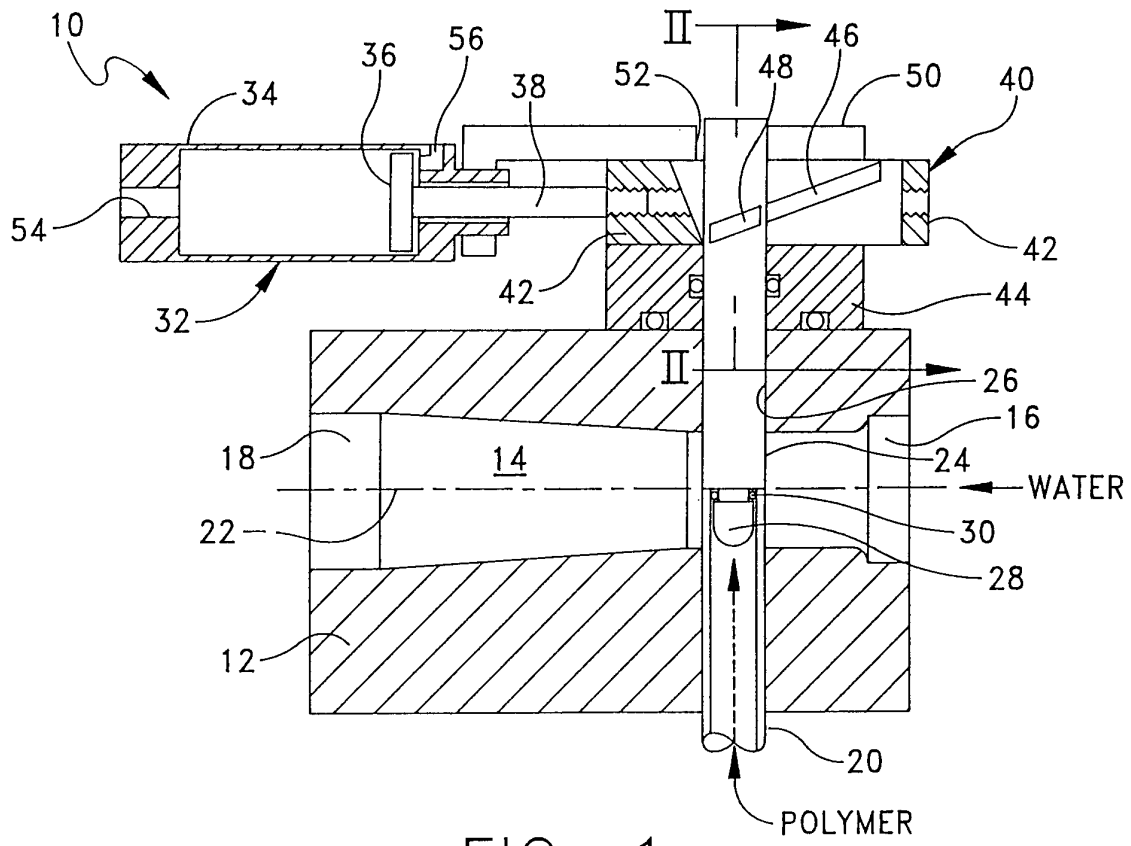


FIG. 1

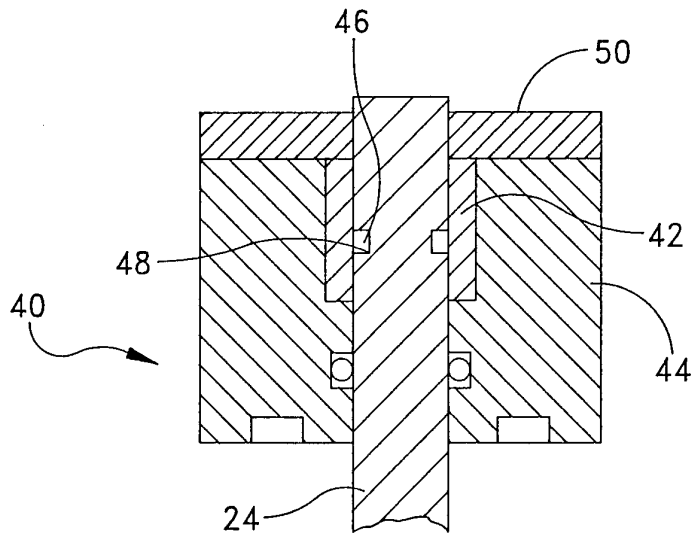


FIG. 2

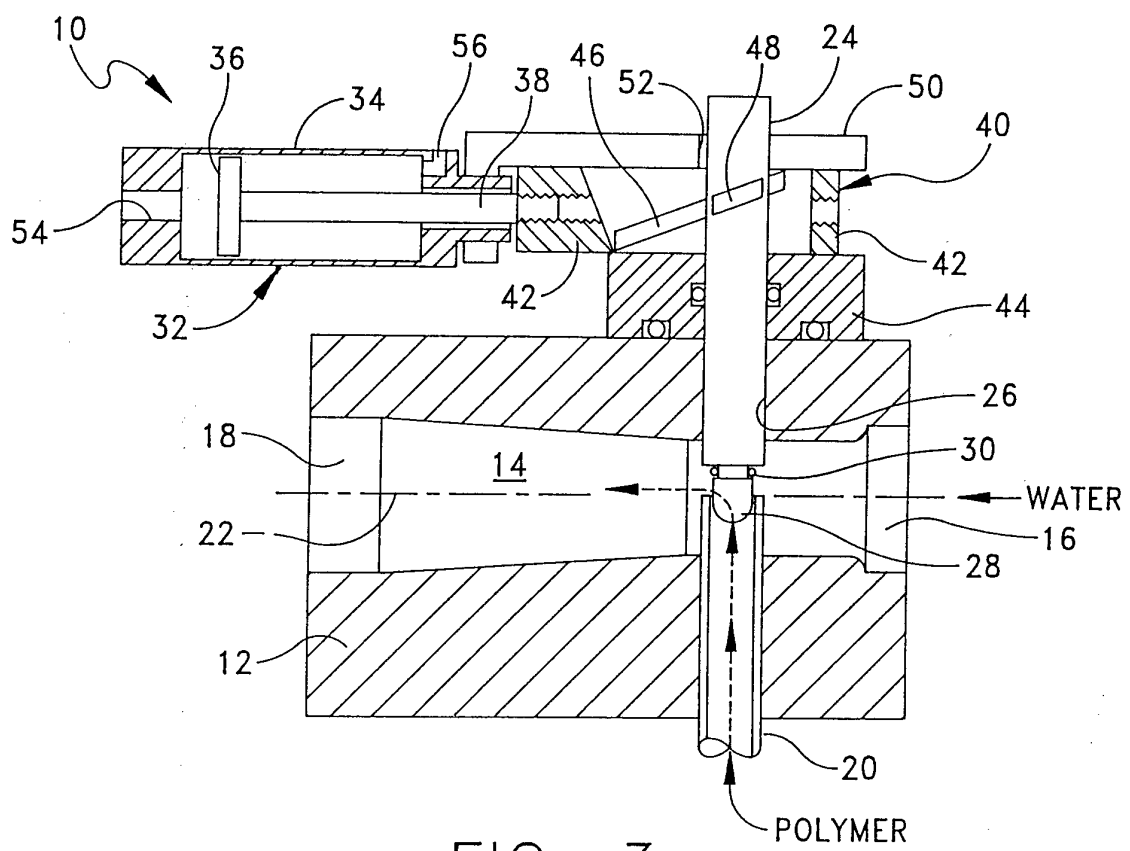


FIG. 3

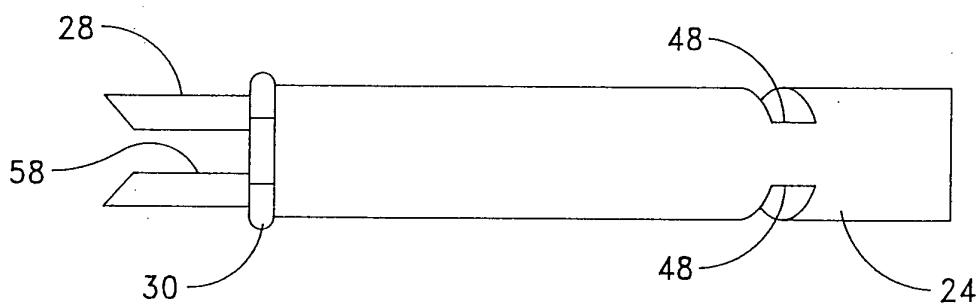


FIG. 4

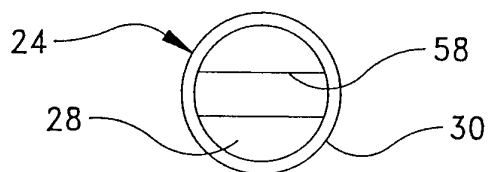


FIG. 5