April 18, 1961 R. S. WADDINGTON ET AL 2,980,033

FLUID HANDLING DEVICES

Filed Feb. 26, 1957 2 Sheets-Sheet 1

Fig. 1.

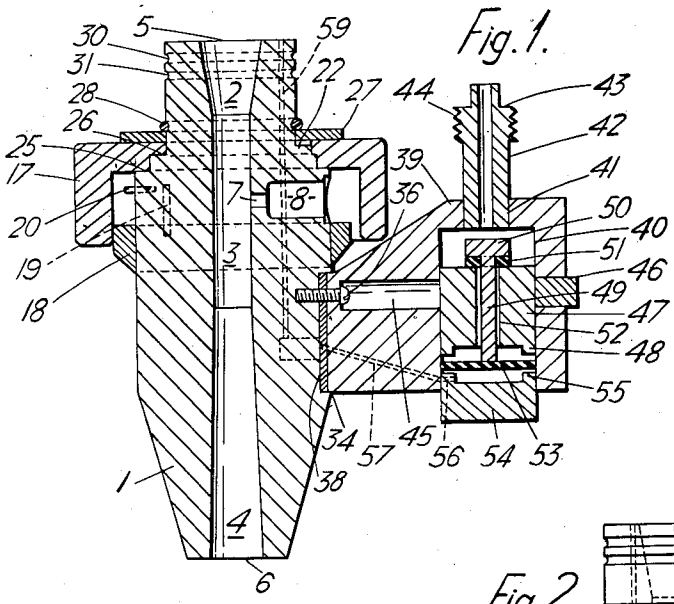


Fig. 2.

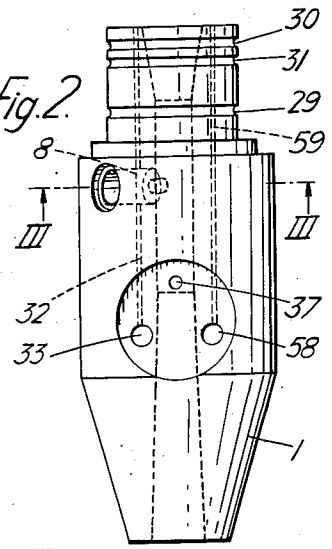


Fig. 3.

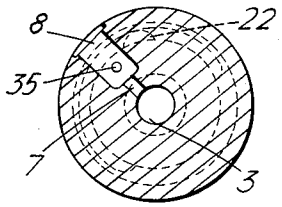
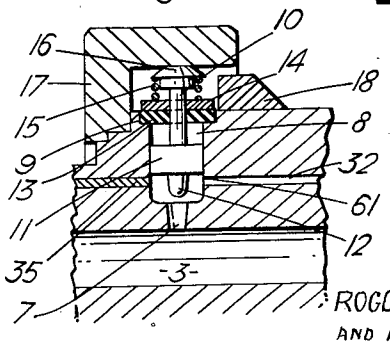


Fig. 4.



Inventors
ROGOR STRANGE WADDINGTON
AND BRUCE DUVAL
By
Linton and Linton
Attorneys

April 18, 1961 R. S. WADDINGTON ET AL 2,980,033

FLUID HANDLING DEVICES

Filed Feb. 26, 1957 2 Sheets-Sheet 2

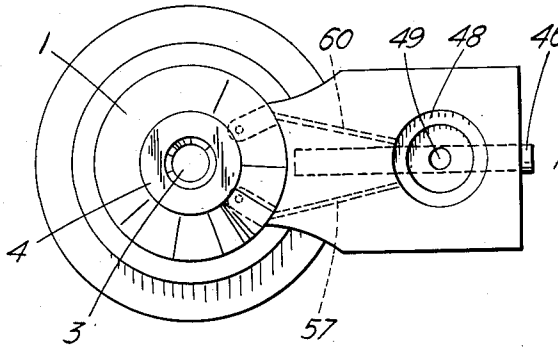


Fig. 5.

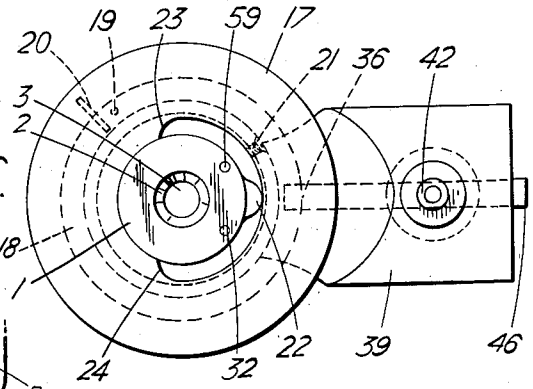


Fig. 6.

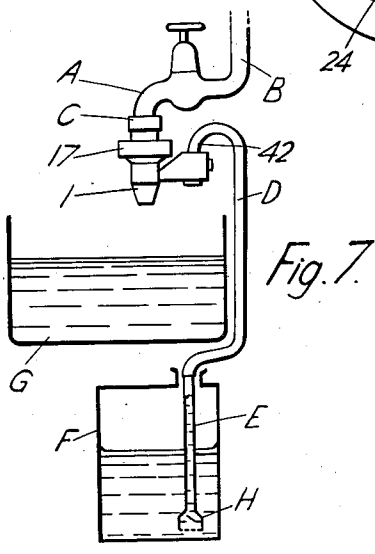


Fig. 7.

Inventors
ROGOR STRANGE WADDINGTON
AND BRUCE DUVAL
By
Linton and Linton
Attorneys

United States Patent Office 2,980,033 Patented Apr. 18, 1961

2,980,033

FLUID HANDLING DEVICES

Rogor Strange Waddington, 6 Magdalene House, Manor Fields, Epsom, England, and Bruce Duval, 39 Cheam Road, Ewell, England

Filed Feb. 26, 1957, Ser. No. 642,502

Claims priority, application Great Britain Feb. 27, 1956

11 Claims. (Cl. 103—262)

The present invention relates to fluid handling means and has as an object the provision of a device which enables fluids to be mixed together in a simple and automatic manner.

It has long been known that a primary-liquid flowing through a venturi having an inlet passage connected with an intermediate point thereof, will draw a stream of secondary-liquid through that inlet passage. Such known forms of apparatus as incorporate such an arangement of venturi and conduit, for example flow meters and laboratory filter pumps, are not however well adapted for general use as mixing apparatus, primarily because (*a*) the proportion of secondary-liquid pumped and mixed with the primary liquid has, with the forms of venturi employed, been very sensitive to the rate of flow of the primary-liquid; (*b*) venturis as previously employed, although they have in some cases been capable of producing a very large pumping effect, have offered a considerable resistance to the flow of the primary-liquid.

It is an object of the present invention to provide an apparatus in which these defects are avoided and which thus constitutes a satisfactory mixing device for use even in establishments where it is virtually impossible to supply primary liquid at a constant rate of flow e.g. where a large number of water supply points are fed from a common elevated cistern.

In accordance with the present invention there is provided apparatus for mixing liquids which apparatus comprises a hollow body part the surface of which is shaped to define a venturi passageway for the passage of primary liquid through said body part, said passageway having an elongated throat section leading from a convergent inlet section to a divergent outlet section, having an included angle of divergence of from 2½° to 7½° (and therefore having its wall surfaces inclined to its axis at from 1¼° to 3¾°), which is terminated by a mixture outlet from said hollow body part and to exhibit, when viewed from the direction of approach to said throat section, an annular surface portion surrounding said throat section having an overall cross-sectional area greater, preferably substantially greater, than the cross-sectional area of the mixture outlet and which annular surface portion consists at least in part of that portion of the surface of the body part which defines the convergent inlet section, said body part being formed with a secondary liquid inlet passage communicating with said throat section preferably at a distance from the junction of said throat section with said inlet section of ⅛ of ⅜ of the length of said throat section. As will be appreciated, part of the surface of the body part, bounds the body part externally and part of said surface bounds the body part internally.

To use the said apparatus for mixing a small proportion of a secondary-liquid with a primary-liquid, a supply of the secondary-liquid is connected with the secondary-liquid passage and the annular surface portion is arranged, by appropriately connecting the body part with

primary-liquid supply means, to lie across a stream of the primary-liquid. As the primary-liquid forces its way through the throat section the secondary-liquid is drawn through the secondary-liquid passage and into the throat section, where it meets the primary-liquid to emerge in admixture therewith from the mixture outlet. This effect is produced by the substantial fall in pressure suffered by the primary-liquid stream as it passes through the venturi passageway.

Among the possible forms of the surface of the body part there may be mentioned the following:

(*a*) The body part is formed with a flat end-surface, from the centre of which the inlet section converges to meet the throat section; in this case the flat end-surface provides a part of the annular surface portion;

(*b*) The body part is formed with a sharp edge at its end, from which edge the inlet section converges to meet the throat section;

(*c*) The body part is formed with an end-surface formation adapted to seat on the end of a primary-liquid supply conduit, the annular surface portion being surrounded by said end-surface formation and the outer part of the surface of the body part being formed with a thread adapted to be engaged by a union nut associated with the conduit or being formed with a shoulder for locating a union nut adapted to engage a thread formed on the conduit;

(*d*) The body part is formed with an internal surface portion which joins the periphery of the annular surface portion, said internal surface portion being adapted to be fitted over the end of a primary liquid supply conduit in screw-threaded or frictional engagement therewith.

In order to illustrate the invention there is given the following description, wherein reference is made to the accompanying drawings, of a preferred embodiment of the mixing device. The said embodiment incorporates a shut-off valve for the secondary liquid as described in our copending application Serial No. 642,503. In the drawings:

Fig. 1 shows in vertical cross-section the embodiment which incorporates a block valve assembly;

Fig. 2 is an elevation of the embodiment taken from the right as seen in Fig. 1, the block valve assembly and parts **17**, **27** and **28** being removed;

Fig. 3 is the cross-section taken along the line III—III of Fig. 2;

Fig. 4 is a vertical cross-section through a part of the device;

Fig. 5 an underneath plan of the embodiment as shown in Fig. 1 parts **53** and **54** being removed;

Fig. 6 is a plan of the embodiment, while

Fig. 7 illustrates a manner is which the embodiment may be put into use.

Referring to Fig. 1, the device shown therein comprises a body part **1** formed with a venturi passageway having an inlet section **2**, an elongated throat section **3** and an outlet section **4** connecting a primary-liquid inlet **5** with a mixture outlet **6**. The diameter of the primary-liquid inlet **5** is 5/16 inch and the diameter of the mixture outlet **6** is 9/32 inch. The inlet section **2** of the venturi passageway has a length of ⅜ inch and an angle of convergence (half conical angle) of 12½°. The elongated throat section **3** has a diameter of 3/16 inch and length of 1 inch, while the outlet section **4** has an angle of divergence (half conical angle) of 2½° and a length of 15/16 inches, giving a total length for the body part and for the venturi passageway of 2 11/16 inches.

Water supply company regulations usually specify that the height of the lower end of a tap connected with the supply mains must be at least 3 inches above the top of the waste outlet from the sink or other fixed receptacle

over which it is installed and that any anti-splash device or other extension connected with the tap must not exceed 3 inches in length. The result of these regulations is to avoid the submergence of the tap or any extension connected thereto below the maximum water level, thereby avoiding any possibility of contaminated water being drawn back into the supply mains when the supply of water is interrupted. In consequence the overall length of the apparatus shown in the drawings is such as to render it acceptable virtually universally.

A secondary-liquid inlet passage 7 of diameter 7/64 inch formed in the wall of the body part and entering the elongated throat section 3 at a distance of 7/8 inch from the primary liquid inlet 5 is provided for leading secondary liquid to the throat section 3. As shown most clearly in Fig. 4 the outer end of the valve chamber is countersunk at 9 and contains a piston assembly (omitted for the sake of clarity from Fig. 1) which piston assembly consists of a stem 10 terminating in a piston 11 having a close fit within the valve chamber and, on the side of the piston opposite from the stem, a component 12 adapted to fill the conduit 7 substantially completely. The component 12 is, in the case shown, formed of soft rubber in order to provide a liquid-tight seal for the conduit 7. It may however be, and preferably is, formed of hard steel or other metal ground to fit the passage closely. The stem part of the valve assembly passes through a rubber washer 13 which rests in the countersunk end of the valve chamber and whose central aperture has a close fit with the stem 10. A metal washer 14 placed over the rubber washer 13 serves to accept the reaction of the lower end of a helical spring 15 the other end of which bears against a small knob 16 of nylon or other low-friction plastic material at the head of the stem. The head 16 bears against the inner cam surface of the skirt of a cam ring 17 which is rotatably mounted upon the body part, the said skirt portion having a cylindrical inner surface which is formed eccentrically with the axis of rotation of the cam ring, thereby causing the piston 11 to be moved within the valve chamber when the cam ring is rotated. Index markings on the cam ring (not shown) enable the ring to be set for specific concentrations of secondary-liquid in the mixture. For limiting the rotation of the cam ring, and thus limiting outward movement of the piston, there is provided a rotatable set-ring 18 which carries a peg 19 adapted to engage a peg 20 which projects from the inner surface of the cam ring. A set-screw 21, which is formed with a cruciform or other specially-shaped recess in its head so that it can only be moved by means of a complementary key is provided for locking the set ring 18 and consequently setting the stop 19 in a position corresponding with the desired maximum outward limit of travel of the piston assembly. Further limiting means for the rotation of the cam ring 17 are provided by a projection 22 formed on the body part, which projection is adapted to engage the ends 23 and 24 of a circular keyway formed in the under surface of the cam ring contiguous with the central aperture thereof. For locating the cam ring in its correct position upon the body part, the body part is formed with shoulders 25 and 26 adapted to co-operate with complementary formations surrounding the central aperture of the cam ring. A metal washer 27 retained in position by a split ring 28 which rests in a complementary groove 29 formed in the outer surface of the body part serves to hold the cam ring against withdrawal. Above the groove 29, the exterior of the body part is provided with a pair of grooves 30 and 31 which serve to assist in forming a strong connection when the device is connected by means of a short length of rubber tubing to the tap with which it is to be used. The external diameter of the body part at this position is 11/16 inch.

For supplying the secondary-liquid to the valve chamber 8, there is provided an internal passageway 32 formed by a long bore from the end of the body part to a small junction chamber 33 bored into the body part from a cylindrically walled flat-bottomed recess 34 formed in the outer surface thereof. The part of the long bore between the upper end of the body part and the valve chamber 8 is then filled throughout its length by means of a rod 35 cemented therein. In this way the passageway 32 is conveniently formed even though neither end is readily accessible for boring.

Secured to the side of the body part 1 with its end portion located within the recess 34 is a block valve assembly secured in position by screw 36 which enters a tapped hole 37 in the body part 1. A fibre gasket 38 placed in the bottom of the recess 34 ensures a fluid-tight connection between the block valve assembly and the body part. The block valve assembly consists of a body part 39 formed with a large bore 40 which lies parallel with the axis of the venturi passageway in the body part 1 and extends from the under-surface of the part 39 to meet a short bore 41 formed co-axially therewith from the top of the part 39. Secured within the short bore 41 is a nipple 42. At its upper end the nipple 42 is provided with a seating surface 43 below which is formed a threaded section 44, this arrangement enabling a secondary-liquid supply tube to be secured by means of a suitable union nut. A horizontal bore 45 formed through the part 39 and passing through the bore 40 gives access during assembly to the screw 36. In the finally assembled device the outer end of the bore 45 is sealed by a plug 46 as shown. Located within the bore 40 is a tightly fitting plug 47 provided with a raised rim 48 at its lower end. A piston valve comprising a stem portion 49 of rounded triangular cross-section, a head portion 50 and a washer 51, has its stem passed in loose sliding relationship through a cylindrical bore 52 formed on the axis of the plug 47. The stem portion 49 of the piston assembly rests upon a rubber diaphragm 53 retained in position by a plug 54 provided with an upper circumferential ridge 55 which seals the lower end of the bore 40. The circumferential ridge 55 is perforated at 56 to provide communication between, on the one hand, the space between the underside of the diaphragm 53 and the upper surface of the plug 54, and on the other hand, a passageway 57 bored through the body part 39 at such an angle as to communicate with a junction chamber 58 formed in the recess in the body part 1. This junction chamber 58 cumminicates via a passageway 59 with the upper end of the body part 1. A further passageway 60 (Fig. 5) is formed through the part 39 to connect the junction chamber 33 with an aperture formed through the rim 48 on the plug 47 and thence to the upper side of the diaphragm 53.

With the apparatus shown in Figs. 1 to 6 connected with a tap or other supply of primary liquid by a short length of rubber tube having its end pushed over the grooves 30 and 31 and the nipple 42 connected with a supply of secondary-liquid, flow of the secondary liquid to the valve chamber 8 is prevented until primary-liquid is passed through the venturi passageway and the pressure of the primary-liquid at the upper end of the apparatus is applied to the underside of the diaphragm 53 via passageway 59, junction chamber 58, passageway 57 and aperture 56. The effect of this pressure is to deform the diaphragm and raise the piston 50 and washer 51 so that secondary liquid can flow through the clearance space between the stem 49 and the wall of the bore 52 to reach the valve chamber 8 via bore 60, junction chamber 33 and bore 32. Assuming that the cam ring 17 and consequently the piston assembly are in the relative positions shown in Fig. 2, the throttling effect of the venturi passageway draws secondary liquid into the stream of primary liquid so that a mixture of primary and secondary liquids emerges from the mixture outlet 6, the actual strength of the mixture depend-

ing upon the precise position of the cam ring **17** and the corresponding position of the piston **11** relative to the orifice **61** with which the bore **32** communicates with the valve chamber **8**. Outward movement of the piston **11** from the position shown in Fig. 2 causes the orifice to become relatively more uncovered and thus to increase the concentration of secondary-liquid in the mixture emerging from mixture outlet **6**, while inward movement results in a more complete covering of the orifice **61** and thus reduces the said concentration. If while the primary-liquid is flowing the cam ring **17** is rotated to push the piston assembly inwardly by reaction of the head **16** thereof, to such an extent that part **12** fills or substantially fills the conduit **7**, the supply of secondary-liquid is interrupted and moreover the complete filling or substantially complete filling of passage **7** by part **12** ensures that no pocket of secondary-liquid is left in contact with the stream of primary-liquid. Consequently, primary-liquid is almost immediately obtained from the mixture outlet **6** in uncontaminated condition.

When the flow of primary-liquid is interrupted its pressure ceases to be applied to the underside of the diaphragm **53**. The washer **51** consequently falls into contact with the upper surface of the plug **47** and thus seals the secondary liquid supply from the valve chamber. If for any reason the outlet **6** is blocked and the primary liquid supply is operated in such a manner as to provide a vacuum effect, secondary-liquid cannot be drawn into the primary liquid supply and cause undesirable contamination.

It will be noted that the block valve assembly, being mounted on the side of the apparatus does not increase the overall length thereof.

When the device shown in Figs. 1 to 6 is connected to a ½ inch water tap supplied with a 20 foot head of water-pressure through ½ inch pipework, a rate of flow is obtained from the mixture outlet which is only 30% less than that obtainable from the water tap before connection of the device. This small reduction in the rate of flow is obtained simultaneously with a high pumping efficiency; for example when supplied with water under a head of only 7 feet the device is capable of lifting water supplied as secondary-liquid through a height of 5 feet.

The ability of the device to give a mixture whose concentration is insensitive to the variations of the rate of flow of the primary-liquid as are likely to be encountered during normal use is illustrated by the following table:

Head of Water Pressure at ½" tap	Arbitrary setting of cam ring	Concentration of mixture in fluid ounces per gallon
9'4"	A	0.35
20'	A	0.60
60'	A	0.77
120'	A	0.80
210'	A	0.70
9'4"	B	0.66
20'	B	0.86
60'	B	0.95
90'	B	1.16
120'	B	1.27
210'	B	1.18

The use of the device is illustrated diagrammatically in Fig. 7 which shows a tap A supplied by a pipe B leading for example from an overhead cistern or water supply mains and having the device attached thereto by means of a rubber connector C. A rubber or other tube D passes from the nipple and joins a copper tube E which dips to the bottom of detergent liquid in a can F placed under the sink G over which the tap A is installed. The lower end of the tube E is fitted with a housing H, adapted to pass through the mouth of the can and containing a filter for the detergent liquid and a non-return valve which ensures that the tube D and the secondary-liquid passageways in the device remain filled with detergent between mixing operations.

It will be appreciated that the specific embodiments of the mixing device provided by the present invention which are described herein are given merely by way of illustration and that various departures may be made therefrom without departing from the scope of the invention claimed.

We claim:

1. Apparatus for mixing liquids which apparatus comprises a hollow body part the surfaces of which are shaped to define a venturi passageway for the passage of primary liquid through said body part, said venturi passageway having an elongated throat section leading from a convergent inlet section to a divergent outlet section which has an included angle of divergence of from 2½° to 7½° and which is terminated by a mixture outlet from said hollow body part and to exhibit, when viewed from the direction of approach to said throat section, an annular surface portion which surrounds said throat section and has an overall cross-sectional area greater than the cross-sectional area of the mixture outlet and which annular surface portion consists at least in part of that portion of the surface of the body part which defines the convergent inlet section, said body part being formed with a secondary liquid inlet passage communicating with said throat section at an intermediate position thereon.

2. Apparatus according to claim 1 in which the body part is formed with a flat end surface from the centre of which the inlet section converges to meet the throat section.

3. Apparatus according to claim 1 in which the body part is formed with an internal surface portion which joins the annular surface portion at the outer periphery thereof and is adapted to be engaged over the end of a primary liquid supply conduit.

4. Apparatus according to claim 1, in which the included angle of divergence of the outlet section is about 5°.

5. Apparatus according to claim 1, in which the included angle of convergence of the inlet section is from 20 to 30°.

6. Apparatus according to claim 1, in which the included angle of convergence of the inlet section is about 25°.

7. Apparatus according to claim 1, in which the inlet section has a length which is at least as great as the transverse dimension of the throat section.

8. Apparatus according to claim 1, in which the outlet section has an axial length which is from two to six times the transverse dimension of the throat section.

9. Apparatus according to claim 1, in which the throat section has a diameter of about 3/16" and the secondary liquid inlet passage has a diameter of about 7/64".

10. Apparatus according to claim 1 in which the secondary liquid inlet passage communicates with the throat section at a position which lies at a distance of from ⅛ to ⅜ of the length of the throat section from the junction of the inlet section and the throat section.

11. Apparatus for mixing a secondary liquid with water from a tap which apparatus comprises a body part provided with a connector operable to engage the tap and formed with a venturi passageway for the passage of water from within the connector through the body part, said venturi passageway having a convergent inlet section leading from within the connector to an elongated throat section whose length and transverse dimensions are in a ratio of at least 3:1 and said throat section communicating with a divergent outlet section in which the boundary surface of the venturi passageway diverges from the axis thereof at from 1¼° to 3¾°, and which is terminated by a mixture outlet from said body part, said body part being formed with a secondary liquid inlet passage com-

municating with said throat section at an intermediate position thereon.

References Cited in the file of this patent

UNITED STATES PATENTS

911,000	Fitzgibbon	Jan. 26, 1909
1,085,348	Ledoux	Jan. 27, 1914
1,311,861	Earl	July 29, 1919
1,321,856	Slater	Nov. 18, 1919
1,748,488	McCabe	Feb. 25, 1930
1,753,662	Merker	Apr. 8, 1930
1,897,492	Ledoux	Feb. 14, 1933
1,937,893	Hutton	Dec. 5, 1933
2,168,363	Pos	Aug. 8, 1939
2,300,642	Booth	Nov. 3, 1942
2,353,759	Ray	July 18, 1944
2,795,460	Bletcher et al.	June 11, 1957
2,797,132	Alpert	June 25, 1957

FOREIGN PATENTS

698,804	Germany	Nov. 18, 1940

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,980,033 April 18, 1961

Rogor Strange Waddington et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 1 and 2, address of first inventor, for "Manor Fields, Epsom, England," read -- Manor Fields, Putney, England, --; in the heading to the printed specification, lines 3 and 4, address of first inventor, for "6 Magdalene House, Manor Fields, Epsom, England," read -- 6 Magdalene House, Manor Fields, Putney, England, --.

Signed and sealed this 24th day of October 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

USCOMM-DC