Nov. 13, 1951 J. D. LANGDON 2,574,488

CROSS CONNECTION ELIMINATOR

Filed Oct. 12, 1945 2 SHEETS--SHEET 1

Fig. 1

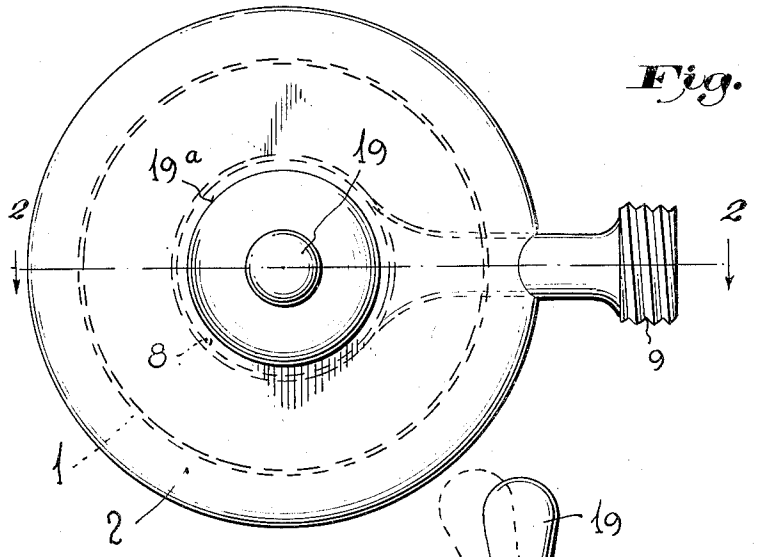
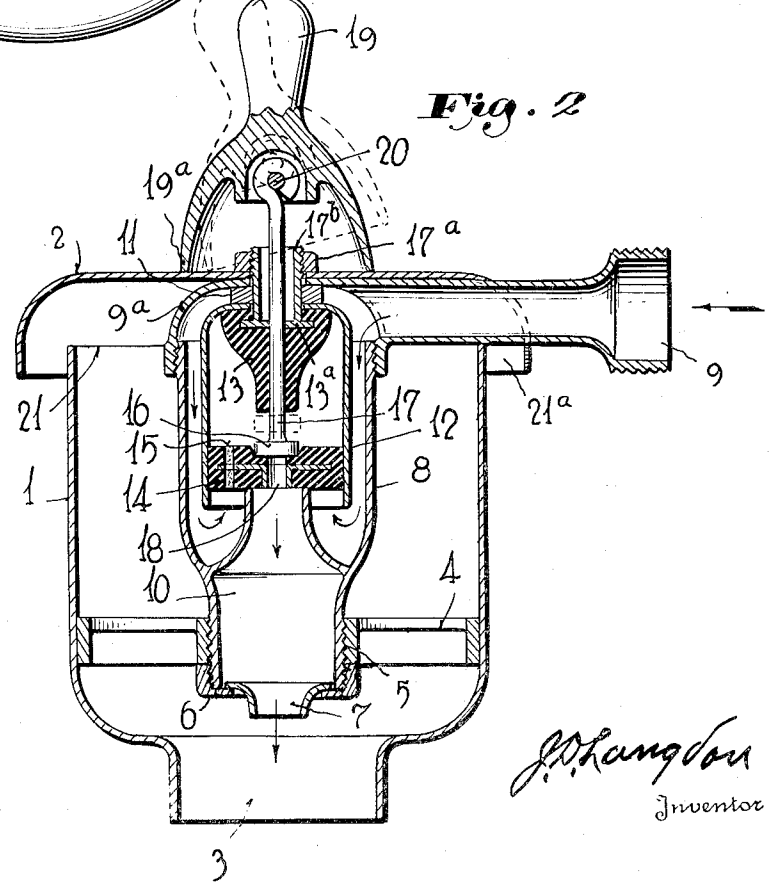


Fig. 2



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Fig. 3

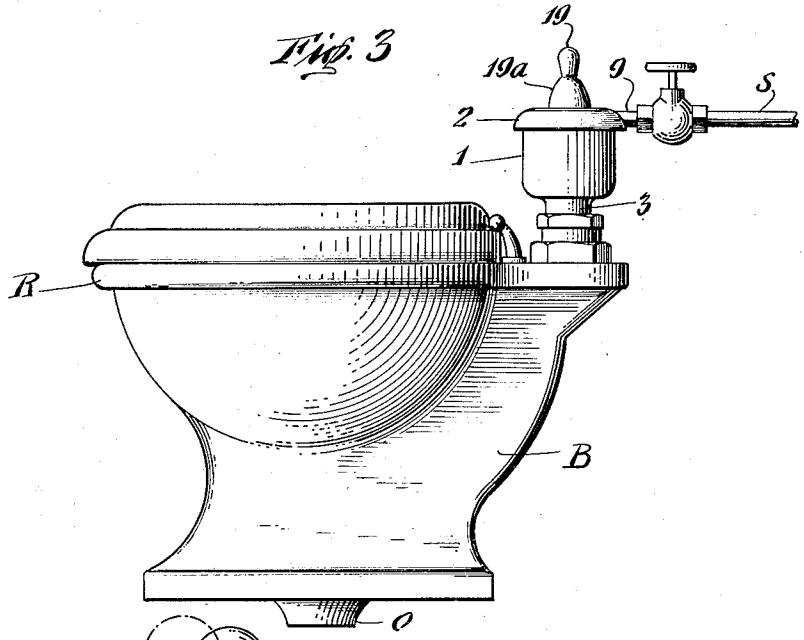
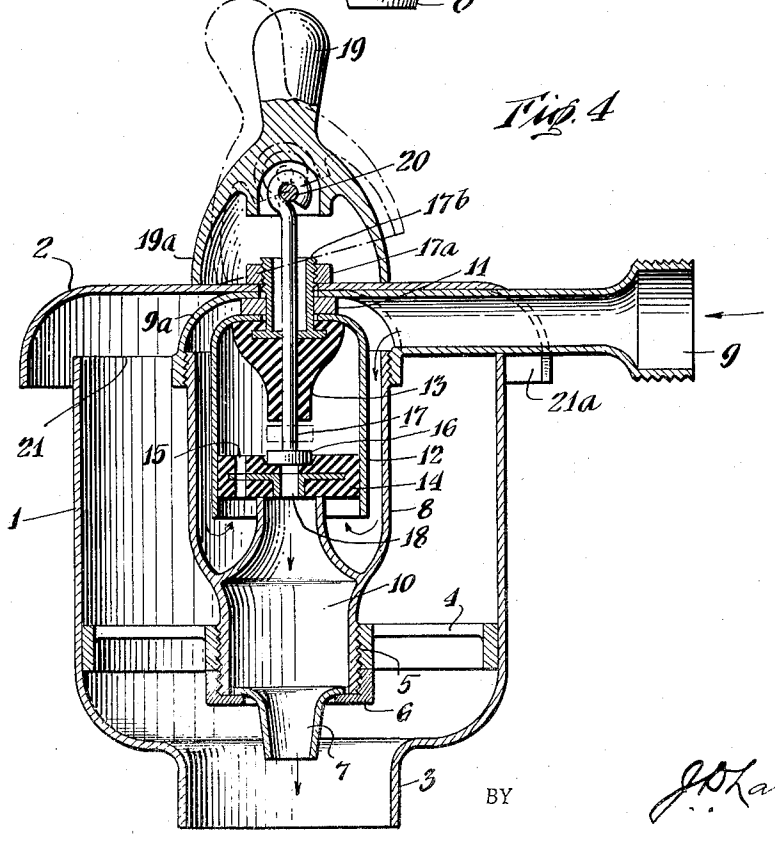


Fig. 4



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2,574,488

CROSS CONNECTION ELIMINATOR

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Application October 12, 1945, Serial No. 621,964

4 Claims. (Cl. 137—93)

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The present invention relates to cross connection eliminators, such as set forth in the Langdon application for patent, Ser. No. 389,436, April 19, 1941, now abandoned, of which this application is a continuation in part.

The primary purpose of this invention is to formulate the approximate proportion of the diameter, i. e., cross sectional area of a valve outlet or nozzle in relation to the cross sectional area, i. e., diameter of the outlet, in order to eliminate the possibility of a cross connection between a valve and a casing encompassing the same as hereinafter described.

A further object is to establish the distance between the planes of the discharge end of the nozzle of a valve encompassed by the outer casing forming the described device and the proximal end of the outlet of the outer casing of the device.

A still further object is to establish the range of proportion between the cross sectional area of the discharge outlet or nozzle of a valve with relation to the cross sectional area of the outlet discharge opening of the casing forming a cross connection eliminator when combined with a valve.

Another object is to teach the effect of moving the discharge end of a valve nozzle within the zone encompassed by the wall of the casing and outlet thereof.

Another object is to teach the effect of various proportions and planes of relationship of the various elements of the present device with respect to the aspirational and inspirational effect produced by atmospheric and liquid pressure.

Other and further objects and purposes will appear as the specification proceeds and the operation of the device is described as illustrated by the drawings.

The accompanying drawings illustrate only one method of reduction to practice, it being specifically understood that the form and proportions of the mechanical element and their organization may be changed within the scope of the claims.

Of the drawings:

Fig. 1 is a plan of the invention looking toward the top showing outer casing 1 in dotted lines thru the bonnet tube, the outline of the casing 8 and its cap also being shown in dotted lines.

Fig. 2 is a sectional detail as at 2—2, Fig. 1.

Fig. 3 shows the device in cross section as at 2—2, Figs. 1 and 2, attached to a toilet bowl having an outlet O.

Fig. 4 represents a similar cross section to that of Fig. 2 with the discharge nozzle 7 of the valve

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8 extended to a point circumscribed by the discharge outlet 3 of casing 1.

The elements illustrating the invention include an outer casing 1 3¼" in diameter having a total area of 8.29 within its inner circumference; a bonnet 2 having a diameter of 4" and a total area of 12.56" within the inner circumference; having an outlet 3 $1\frac{1}{16}$" in diameter having an area of 2.23" within its inner circumference; a bridge formed by a spider-like member 4 disposed and attached within the casing 1 and having a ring-like peripheral support with an inside diameter of 3" and total area of 7.06", there being three spaces defined by an external and an internal supporting ring having supporting arms extending therebetween, the arms are considered to be made of sheet metal $\frac{1}{16}$" thick, each arm being 1" long, the three arms occupying an area of .18". The supporting ring 5 formed in the center of the bridge 4 is threaded to receive the outlet end of the casing of the pressure operated valve 8 which is extended thru the ring 5 and locked in position by the flanged nut 6, having an inwardly extended shoulder which supports a flanged nozzle 7 having a diameter of $\frac{5}{16}$" at the discharge end with an area of .07". The nut 6 has the same outside diameter as the ring 5 namely $1\frac{5}{16}$" and occupies an area of 1.7" in the center of the spider 4 leaving a mean effective passageway area thru the spider 4 more than 20 times greater than the area of the discharge opening of nozzle 7.

The nozzle 7 is removable and any suitable sized nozzle may be substituted to meet the various conditions of pressure and use by changing the volume of liquid delivered into outlet 3 thus controlling the flow of liquid from the casing 1 with relation to the passages 21 and 21*a* to accommodate the movement of atmospheric pressure thru the casing 1 and inner circumference of cap 2 respectively; the greater the volume of liquid delivered into outlet 3, the higher the liquid will rise in any conduit connected to outlet 3 which in itself forms a conduit if extended to do so.

The structure of the pressure operated valve comprises a casing 8 having an inlet 9 formed by an extension of the cap 9*a* the inlet occupying an area of .19" having a diameter of ½"; the cap 9*a* occupies an area of 2.51". The outlet end 10 of the casing of the valve 8 is formed with a valve seat projecting inwardly of the outlet 10 and in axial alignment therewith. A lock nut 11 holds the cylinder 12 firmly in assembled relationship with a packing sleeve 13 forming a flexi-

ble guide in conjunction with a separate guide washer 13*a* which is free to move laterally a distance limited by the size of the opening thru the assembly and guide sleeve 17*b* thru which the stem of the relief valve 17 is disposed. The sleeve 17*b* is secured thru the closed end of the cylinder 12 and extended thru the cap 9*a* and the bonnet 2 which are clamped between the set nut 17*a* and nut 11. The piston 14 has a bypass 15 communicating with the passage thru the casing 8 between the inlet 9 and the outlet 10. The relief valve 16 seats across the port 18 thru the center of the piston 14, a pressure chamber being formed between the head of the cylinder 12 and the piston 14 which normally rests upon the seat of outlet 10. A handle 19 is substantially bell-shaped in form, the rim thereof forming a fulcrum 19*a* surrounding the stem 17 of the relief valve 16 which is pivotally held to the handle 19 by a pin 20 forming a universal joint permitting the handle to rock in any direction and raise the relief valve, the piston 14 is then raised by liquid pressure within the casing 8 of the valve 8; the release of handle 19 permits the relief valve 16 to close the port 18 at which time liquid pressure enters the pressure chamber thru bypass 15 thus closing the valve.

The drawing as of Fig. 2 constitutes an approximate formula for proportioning the various elements and their relative position, such as the size of the various openings provided for the outer casing 1 and the valve 8.

The following recitation and table gives the approximate proportional effective area of each of the passages provided by the invention for atmospheric and liquid pressure:

Outer casing 1, inside diameter 3¼", total area of passage 8.29, less diameter of cap 9*a* $1\frac{3}{16}$", outside diameter having an area of 2.51, less the diameter of inlet 9, ½" having an area of .19" added to area of cap 9*a* equals 2.7" which is the space occupied by the cap and inlet, deducted from the area of the casing 1 leaves a total effective area of 5.59" for the passageway around the valve 8, cap 9*a* and inlet 9.

The cap 2 of casing 1, inside diameter 4", total area 12.56 less the outside diameter of casing 1, 3⅜", occupying an area of 8.87 deducted from 12.56, leaves a total effective area of 3.69 for the passageway formed by the space between the outside of the casing 1 and the inside of casing 1.

The spider or bridge 4 has a mean diameter of 3" with a total area of 7.06" inside of the ring supporting the same within the casing 1 and the outside diameter of the ring 5 and the nut 6, having an outside diameter of $1\frac{5}{16}$", i. e. area of 1.7 deducted from 7.06 leaves an area of 5.36, less the space occupied by the three convergent arms of the bridge 4, each 1" long and $\frac{1}{16}$" thick occupying an area of .18" leaving a mean effective passageway area thru the bridge of 5.18".

The outlet 3 of casing 1 has an inside diameter of $1\frac{1}{16}$" i. e. area of 2.23" mean effective passageway with the discharge end of nozzle 7 disposed on a plane above the margin of the inner end of the discharge outlet 3 of casing 1, as of Fig. 2. When the discharge nozzle 7 is disposed to project within the confines of the outlet 3 of casing 1, as shown in Fig. 4, the diameter of $1\frac{1}{16}$" i. e. area of 2.23" is reduced to 2.09" mean effective passageway area by deducting the outside diameter of $\frac{7}{16}$", i. e. area of .14".

It will be noted that the effective area of all the openings provided for the ingress of atmosphere thru the casing 1 of the device are at least

20 times the area of the discharge nozzle 7, as shown by the following table:

Nozzle 7, effective area .07, 31.8 times smaller than outlet 3.

Nozzle 7, effective area .07, 74 times smaller than bridge passage 4.

Nozzle 7, effective area .07, 79 times smaller than passageway 21.

Nozzle 7, effective area .07, 52 times smaller than passageway 21*a*.

The nozzle 7 need not be more than 2½ times smaller than the outlet 3 if disposed above the inner margin of the proximal end to the outlet 3. It has been proven by actual test in the laboratory that in actual connection with the toilet bowl, nozzle 7 need not be more than 1½ times smaller than the outlet 3 if the end of nozzle 7 is disposed three fourths of its diameter away from the inner margin of the circumference of outlet 3. Furthermore the device as illustrated may be installed in a horizontal position if the level of the outlet 3 is disposed an ample distance above the level of the top of the bowl rim on a plane at least twice the diameter of the nozzle provided an ample space for the passage of atmospheric pressure is provided around the nozzle 7.

It has also been discovered that when the discharge nozzle 7 spaced away from the proximal inner margin of the passageway 3 and the passageway 3 is made with a sharp shoulder surrounding its inner margin, the movement of atmospheric pressure when the valve 8 is subjected to vacuum has a baffle effect which causes a condition of air movement tending to more effectively prevent the rise of liquid in the outlet 3 when the same has been reduced to a minimum diameter i. e. 1½ times larger area than nozzle 7.

Under conditions where the toilet bowl or defecator has its outlet plugged, the back pressure caused thereby may back the water up thru outlet 3 while the valve 8 is running as gravity plus the inspirating effect of liquid flowing thru the nozzle 7 might not carry the water away as fast as delivered into the tailpiece 3*a* connecting the casing 1 to the toilet bowl TB, however the laboratory tests have proved that any dimensions mentioned herein will effectively permit the casing 1 and tailpiece 3*a* to be effectively evacuated under the conditions of a flooded bowl regardless of how quick a vacuum was substituted for a condition of pressure within the valve.

It has also been discovered that the casing 1 can be eliminated entirely if desired when the nozzle 7 is ½" in diameter for example and the tailpiece 3*a* is 2" in diameter and the plane of the discharge end of the nozzle 7 is spaced ½ its diameter away from the proximal margin or beginning of the outlet 3 which is in reality the opening forming the beginning of the tailpiece or conduit between the nozzle 7 and the fixture, bowl or defecator served by the valve 8 whereby liquid is projected across an ample open space from a point clearing the proximal end of a conduit having at least 1½ times the area of the nozzle 7 constituting said ample proportion between the nozzle 7 and proximal terminus of the outlet or conduit 3 or an ample proportion for the nozzle 7 should be at least 8 times less area than the outlet when encompassed and surrounded thereby; ample space permitting communication between atmosphere and the discharge end of the nozzle 7 should be at least 20 times greater than said nozzle.

The aspirating effect of the discharge nozzle 7 acts to entrain air from the atmosphere with the jet of liquid projected into the outlet 3, thus substantially increasing the volume of fluid injected into the fixture at the same velocity as the jet of liquid from the nozzle 7, thus substituting a considerable volume of air for liquid which ordinarily would have to be used to do the work of flushing a bowl or fixture and sweeping the same clean of the solid waste contents. The arrangement shown by Fig. 2 wherein the nozzle 7 terminates prior to entering the outlet or conduit 3 as a greater amount of air is aspirated from atmosphere since the end of the jet of liquid contacts atmospheric pressure prior to the entrainment of air as atmospheric pressure has free access to the jet of liquid prior to the time the same enters the outlet 3 which offers much less resistance to the movement of atmospheric pressure than is the case when the outlet 3 actually surrounds the nozzle 7 encompassed thereby.

U. S. application for Patent Ser. No. 517,727, January 10, 1944, now U. S. Pat. 2,361,694, October 31, 1944, is a continuation in part of Ser. No. 389,436 of which this application is a continuation in part and covers the relationship of the essential elements of the parent patent without reference to the actual mathematical proportions in relationship to the minimum or maximum dimensions of the nozzle, air ports and placement of said elements.

This application is also a continuation in part of the following applications:

Ser. No. 565,353, November 13, 1944, now Patent No. 2,438,507 of March 30, 1948, which covers the cross connection eliminator placed in a substantially horizontal position wherein the pressure operated valve 8 or equivalent and the nozzle 7 or equivalent are encompassed by a toilet bowl, part of which serves in lieu of casing 1 of the parent application, Ser. No. 389,436.

Ser. No. 563,233, April 25, 1944, now abandoned, covers a method of installation which includes the cross connection eliminator in principle, the drawings therefor showing figures wherein the casing 1 or its equivalent is eliminated.

Having described my invention and the construction and operation thereof to enable those versed in the art to formulate and construct the same, the following claims are made:

1. A cross connection eliminator comprising an outer shell encompassing a pressure operated valve having a casing with a discharge nozzle extending therefrom, the casing of the valve being spaced away from the shell by an annular passageway to permit the free movement of atmosphere around the casing and providing a space for the passage of air between said shell and said casing at least 20 times larger in area than the discharge opening in the nozzle providing an outlet for said pressure operated valve, said valve having an inlet adapted to be attached to a source of liquid supply; the space for the passage of air being ample to permit the free evacuation by gravity any liquid accumulated in said shell thru an outlet provided for said shell; said nozzle having its discharge terminus on a plane spaced above the plane of the inner end of the outlet opening

provided for said shell, said nozzle disposed concentric with the last named outlet and adapted to project a jet of liquid thereinto.

2. For combination with a plumbing fixture, a cross connection eliminator comprising an outer shell having an air inlet end and a liquid outlet end and surrounding the body of a fluid pressure control valve having a casing provided with valve inlet means and valve outlet means, the liquid outlet end being of reduced diameter, the inlet end of said outer shell being open to atmosphere, an ample and continuous annular passageway formed between the shell and the valve casing and communicating between the inlet and outlet ends of the shell, the valve outlet forming a nozzle surrounded by the outlet end of the annular passage, between said shell and casing whereby pressure fluid projected from said nozzle will entrain atmosphere and project said pressure fluid and atmosphere thru the outlet of the shell, said nozzle having a discharge terminus on a plane spaced above the plane of the inner end of the reduced liquid outlet of the shell.

3. A device as of claim 1, the outlet area of the reduced liquid outlet being at least one and one half times larger than the area of the discharge nozzle opening.

4. A cross connection eliminator comprising a tubular outer shell having an inlet end open to atmosphere and a liquid outlet end, and circumscribing and defining annular passage means spacing a concentrically disposed valve unit away from the inner wall of the outer shell, said valve unit held in fixed spaced relationship by interconnecting means extended across the annular space between the inner wall of the shell and the outer wall of said valve unit, the valve being provided with an inlet for connecting same to a source of liquid supply, said valve having a discharge nozzle disposed between the inlet end of the shell and said liquid outlet end of said shell, the opening of the nozzle projecting toward the outlet end of said shell, said annular space around said valve constituting ample means for the free passage of air entrained by a jet of liquid projected from said discharge nozzle under pressure whereby air is drawn thru spaces provided between said interconnecting means constituted by narrow arm means extended across said annular space, the jet of liquid combined with the entrained air being projected thru the outlet end of said shell, said annular passage means being of an area greater than the area of the discharge nozzle opening and permitting free ingress of atmosphere from the inlet end of said shell into the nozzle when a subatmospheric condition of pressure exists within said valve, thereby eliminating any cross connection between said nozzle and said liquid outlet end of said shell.

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REFERENCES CITED

The following references are of record in the file of this patent:

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