March 31, 1953 E. P. AGHNIDES 2,633,343

GAS AND LIQUID MIXING DEVICE

Filed Dec. 2, 1948 2 SHEETS—SHEET 1

Fig.1

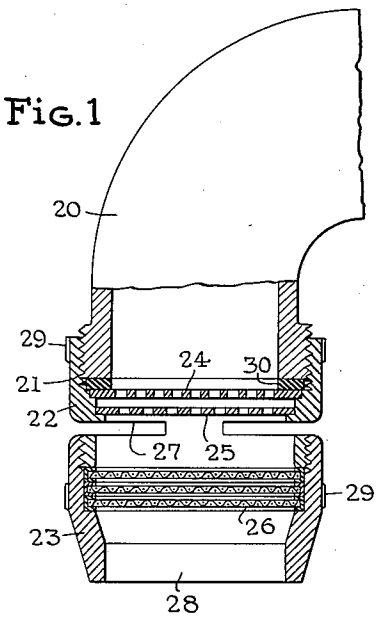


Fig.3

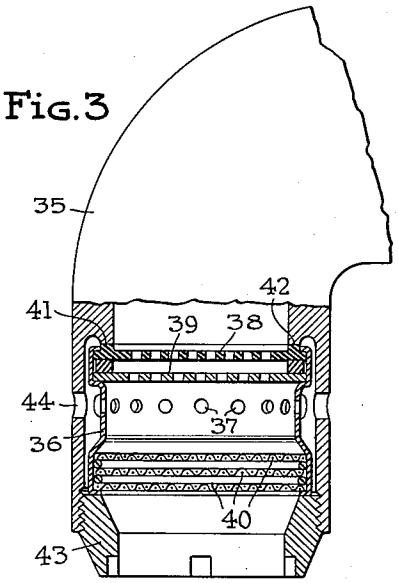


Fig.2

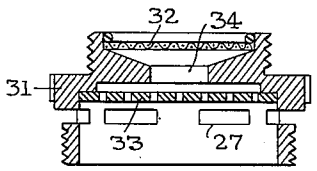


Fig.5

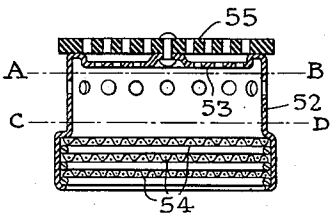


Fig.4

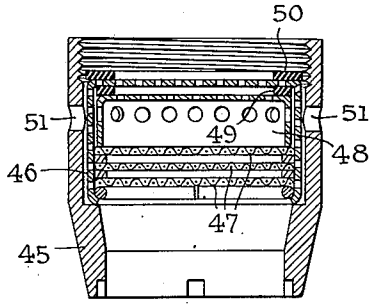
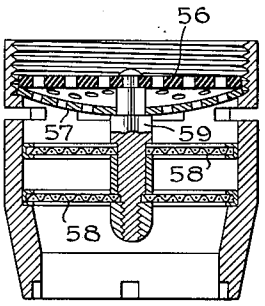


Fig.6



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GAS AND LIQUID MIXING DEVICE

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Fig. 7

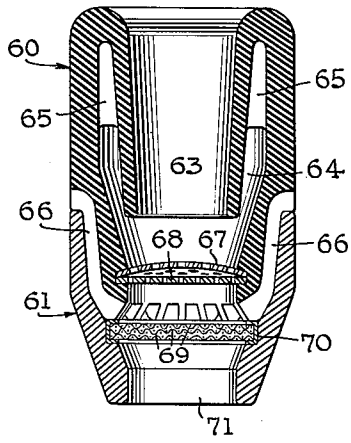


Fig. 8

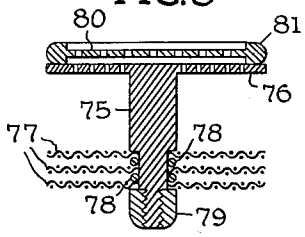


Fig. 11

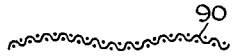


Fig. 12

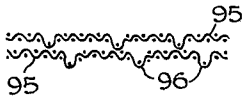


Fig. 9

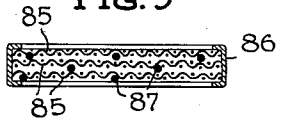


Fig. 13

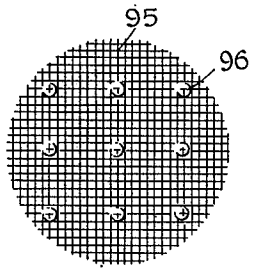
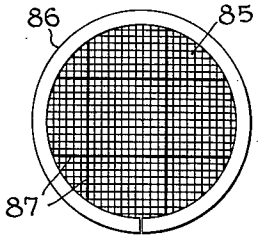


Fig. 10



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UNITED STATES PATENT OFFICE

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GAS AND LIQUID MIXING DEVICE

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Application December 2, 1948, Serial No. 63,110

11 Claims. (Cl. 261—76)

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This invention relates to fluid mixing devices and more particularly to an improved device for producing a stream of liquid containing air bubbles throughout the stream. Such a device applied to a conventional water faucet provides a bubbly stream of water which is soft and light to the touch and which possesses numerous advantages not present in a plain water jet or in a sprayed water jet.

The present invention is an improvement on the devices shown in my Patent 2,210,846, dated August 6, 1940, and in my Patent 2,316,832, dated April 20, 1943.

It is an important object of the present invention to provide an improved unit for mixing air with liquid to produce a bubbly stream.

It is another object of this invention to provide a mixing unit which may be removed from the mixing device as a unit for cleaning, whereby the parts of the unit are maintained in proper relation to each other, and whereby improper reassembly of the mixer parts after cleaning is avoided.

It is another object of this invention to provide a mixing unit which can easily be replaced by a spare unit.

It is another object of this invention to provide a fluid mixing device wherein the member-connecting means engage two or more or all of the members forming the device to reduce the number of parts, to provide for easy assembly and for easy replacement, and for maintenance of proper relationship between the various parts of the device.

It is a further object of this invention to provide an improved mixer having discs and screens of novel construction which properly spaces the discs and screens and which also prevents deformation of the same during handling and cleaning.

Other objects and advantages of the invention will be readily apparent to those skilled in the art from the following description of preferred embodiments illustrated in the accompanying drawings, wherein:

Figure 1 is an elevational view partly in section of a fluid mixing device detachably secured to the spout end of a conventional water faucet.

Figure 2 is an elevational view in section of a modified form of the upper member of the Figure 1 construction for attachment to the spout end of a water faucet having an internal threaded portion.

Figure 3 is an elevational view partly in section of a modified form of mixing unit removably positioned within the spout end of a water faucet.

Figure 4 is a sectional view of a mixing device for attachment to the spout end of a faucet and having a mixing unit removably positioned therein.

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Figure 5 is a sectional view of another form of mixing unit for use in the construction shown in Figure 3 or in the construction shown in Figure 4.

Figure 6 is a sectional view of a modified form of mixing device and mixing unit.

Figure 7 is a sectional view of a mixing device of flexible material adapted for application to an unthreaded water faucet spout.

Figure 8 is a sectional view of a disc and screen unit somewhat similar to that shown in Figure 6.

Figure 9 is a sectional view of a modified three-screen mixing unit for use in the constructions shown in Figures 1, 3, 4, 5 and 7.

Figure 10 is a plan view of one of the screens shown in Figure 9.

Figure 11 is a sectional view showing the curvature of screens which may be used in the constructions of Figures 1, 3, 4, 5 and 7.

Figure 12 is a sectional view showing another form of screen which may be used in the above constructions.

Figure 13 is a plan view of one of the screens illustrated in Figure 12.

Referring now to the drawings for the purposes of illustration, the spout end of a conventional water faucet is indicated by the numeral **20**. The spout **20** is provided with external threads **21** to which member **22** of a mixing device is detachably secured. A member **23** is secured to the member **22** to form a chamber in which the component parts of a mixing unit are placed. The mixing unit includes perforated discs **24** and **25** seated upon shoulders in the member **22** and screens **26** secured between the lower end of member **22** and a shoulder in member **23**. The member **22** or member **23** is provided with slots **27** forming air inlet openings, and the member **23** is provided with a discharge opening **28**. The members **22** and **23** may be provided with knurls **29** to facilitate assembly on and removal from the spout **20**. A sealing washer **30** is provided between the end of spout **20** and the upstream disc **24**.

The modified construction shown in Figure 2 comprises a member **31** which may be substituted for the member **22** of the Figure 1 construction where the mixing device is to be installed upon a spout end having internal rather than external threads. The member **31** carries an upstream perforated disc or screen **32** and a downstream perforated disc **33**, the latter having a press fit. The opening **34** may be enlarged and the screen **32** may be replaced by a perforated disc as in the Figure 1 construction. The mixer device constructions described above may have the upper member **22** or **31** made as large or small as desired to fit any size of faucet spout without changing the size of the lower member **23** or the dis-

charge orifice 28. Likewise, the lower members 23 may be made with various sizes of discharge orifice 28 for use with either upper member 22 or 31. The two-part mixing device construction is thus readily adaptable for various sizes and shapes of faucet spouts and to provide a discharge outlet of the correct size. Another feature of this construction is that a mixing device providing for properly spacing the parts of the mixing unit is provided without requiring more than one reduction of internal diameter and hence allowing a greater discharge orifice diameter for a spout of given diameter.

The mixing device shown in Figure 3 is adapted to be inserted within the outlet end of spout 35 and comprises a tubular shell 36 having a somewhat constricted central portion provided with apertures 37 for the inlet of air. The upper end of the shell 36 is provided with two perforated discs 38 and 39 spaced apart by a suitable washer, the discs and washer being firmly held between the constricted portion of the shell 36 and the upper inturned edge of the shell. The lower portion of the shell 36 is provided with three circular fine-mesh screens 40 spaced from one another by washers. The screens and washers are held together as a unit between the constricted portion of the shell 36 and the lower inturned edge of the shell. The upper disc 38 may have an upstanding annular rim 41 for sealing engagement with a projecting rim 42 formed on the inner surface of the spout 35, and may be formed of resilient or semi-resilient material, such as hard rubber or the like. The upper disc 38 may be of metal and be provided with a separate sealing rim or washer as illustrated, for example, in the Figure 4 modification. The mixing unit is securely held within the spout 35 by a threaded member 43 having a discharge outlet for the bubbly stream produced. The member 43 may have a male thread as shown in Figure 3, or may be provided with a female thread to engage a male thread on the end of spout 35. Suitable notches may be provided in the discharge opening of member 43 to receive a turning tool, such as a coin. Apertures 44 are provided in the spout 35 adjacent the apertures 37 for permitting air to be drawn into the mixing unit. The aperture or apertures 44 may be only at the rear or underside of the spout 35, so there will be no apparent modification of the spout end to the user.

The mixing device shown in Figure 4 includes a one-piece member 45 for attachment to the spout end of a faucet, such as shown in Figure 1, and a mixing unit within the member 45. The mixing unit comprises a cup-shaped shell 46 having a perforated upstream end and having three screens 47 positioned in the lower end thereof. The shell 46 may be stamped from perforated sheet metal or from sheet metal which is then punched or drilled to perforate the upstream end and to provide air inlet apertures in the cylindrical portion thereof. Within the shell 46, an inner inverted cup 48 is positioned between a spacing washer 49 and the screen 47. The upper end of the cup 48 is perforated to provide a jet-forming disc and the sides of the cup 48 may be provided with one or more apertures for the inlet of air. The cup 48 may be formed of a tubular perforated member and a perforated disc engaging the upper end of the tubular member. A sealing washer 50 is provided above the upper end of the member 46 to seal with the end of the faucet spout. The member 45 is provided with air inlet openings 51.

The modified mixing unit shown in Figure 5 includes a cup-shaped shell 52 having a perforated upper end 53 and an inturned lower edge to secure the spaced screens 54 therein. The lower edge of shell 52 obviously may be slotted to permit limited expansion for the removal from and the replacement of screens 54 in the shell 52. A perforated disc 55 is secured to the upper end of the shell 52 by fastening means such as a rivet and may be spaced from the perforated end 53 by the upwardly projecting portions of the shell 52. This unit may be constructed without the three screens 54 for use in conjunction with a multiple screen unit such, for example, as shown in Figure 9 and described hereinafter. The upstream perforated disc 55 is preferably made of resilient material such as rubber so that the peripheral edges of the disc may be raised to facilitate cleaning of the space between the disc 55 and the perforated end 53 of the shell 52. The upper portion of the unit shown in Figure 5, the portion above line A—B, may be made as a unit for use in the device shown in Figure 1 as a substitute for discs 24 and 25. Likewise said portion may be substituted in the Figure 6 construction for discs 56 and 57, the body member of Figure 6 being provided with mixing screens positioned therein. The upper and central portion of the unit shown in Figure 5, the portion above the line C—D, may be made as a unit and used in a body member such as shown in Figure 4 together with a screen unit or units as shown, for example, in Figures 1, 7 and 9.

The mixing unit shown in Figure 6 includes an attaching member generally similar to that shown in Figure 4, and the mixing unit includes a perforated rubber disc 56, a concave perforated disc 57, and screens 58, these parts being assembled and held in spaced relationship by a central stud 59. The peripheral edge of the disc 57 seats upon an internal shoulder in the attaching member. The entire mixing unit is removable from the attaching member for cleaning or for replacement by a spare unit. As in the Figure 5 construction, the edges of the rubber disc 56 may be easily raised to facilitate cleaning of the upstream side of concave disc 57. The disc 56 also serves as a sealing member as the periphery of disc 57 clamps it against the spout end of a faucet, or against the internal rim 42 of the Figure 3 construction when the mixing unit is used within the end of a faucet spout. The concave shape of the disc 57 serves to direct any accumulation of dirt particles toward the center of the disc thereby leaving the majority of the perforations in the disc free from clogging.

The preferred spacing and sizes of the perforated discs and the screens for use in fluid mixing devices for application to water faucets and the like will now be described. The upstream disc and the downstream disc may each have thirty to forty perforations each of eight-tenths to one millimeter in diameter. While an upstream disc is not absolutely essential, its use regulates the flow of liquid to the downstream jet-forming disc and collects dirt in the liquid which might otherwise clog the perforations of the downstream disc. The upstream disc may have larger perforations than the downstream disc but in such case the large perforations should be spaced more than one millimeter from each other, or the upstream disc may have perforations of equal or smaller size than the perforations of the downstream disc and closer to each other. The upstream disc may be provided

with a central imperforate portion to provide for more even distribution of liquid to the downstream disc. The upstream disc perforations should be such as not to materially increase the back pressure due to the attachment of the mixing device to a water faucet since a material restriction to the free flow of liquid through the mixing device, when excessive, will damage the quality of the bubbly jet of liquid produced. It is desirable that the downstream disc produce a plurality of high velocity streamlets of liquid parallel to one another or slightly divergent. The perforated discs may be spaced about one millimeter apart by washers, as shown in the Figures 3 and 4 construction, or by the configuration of the downstream disc as shown in the Figures 5, 6 and 7 construction. The screens are preferably formed of wire mesh woven from wire of about twenty-three hundredths millimeter in diameter, there being twenty-eight to forty wires per inch. The upstream screen is spaced about seven millimeters below the downstream disc, and the screens are spaced from one another a distance of about one millimeter. The discharge outlet opening of the mixing device should be about fifteen to twenty millimeters in diameter for use on the average water supply faucet.

In the modification illustrated in Figure 7, the mixing unit chamber is formed by members 60 and 61. The member 60 preferably formed of resilient material such as rubber, is provided with an inturned inlet neck 63 having a space 64 between it and the outer portion of the member, a plurality of integral webs 65 being provided therein. Liquid under faucet pressure flows into the space 64 to cause the neck 63 to grip the spout end of a faucet. The lower end of member 60 is provided with projecting ribs 66 and the inner surface of member 61 frictionally engages the outer surfaces of the ribs 66. The ribs 66 provide air inlet channels for the admission of air into the chamber containing the mixing unit. The mixing unit comprises a pair of perforated discs 67 and 68 resiliently held in an annular channel in the lower portion of member 60. The disc 67 is preferably of curved cross-section with the convex side facing upstream. The convex surface of the upstream disc will direct dirt toward its periphery and tend to keep the perforations open. The discs 67 and 68 may be secured together as shown, for example, by the construction illustrated in Figures 5 and 6. The mixing unit also includes a group of three fine-mesh screens 69 assembled as a unit with a peripheral rim 70 holding the screens 69 together. The individual screens 69 may be properly spaced from each other by the use of a peripheral rim on each screen as shown in Figure 1, or they may be of special screen material as described hereinafter. The member 61 has an outlet 71 in its lower end, and may be molded of plastic material somewhat harder than the resilient material of member 60.

The mixing unit illustrated in Figure 8 includes a central stud 75 integral with or attached to a perforated disc 76. Fine-mesh screens 77 are supported on the shank of stud 75 and spaced by washers 78, a nut 79 being provided on the lower end of stud 75 to hold the assembly together. The washers 78 may be provided with a few radially projecting arms to prevent a decrease in the spacing between screens 77. The upper perforated disc 80 may be conveniently formed from plastic material or metal and is provided with an integral peripheral rim 81. The rim 81 is adapted to serve as a gasket to seal the mixing unit in a faucet connecting member. An element such as the disc 80 provides in one piece a disc-spacing shoulder or washer, the upstream perforated disc, and the washer sealing the space between the fluid mixing device and the end of the spout.

The screen assembly shown in Figures 9 and 10 comprises three fine-mesh screens 85 held together by a peripheral rim member 86. The screens 85 may be formed of woven wire fabric in which certain spaced wires 87 are of substantially larger diameter than the remaining wires of the fabric. The large diameter wires 87 serve to properly space the screens 85 apart when the screens are assembled on one another. Another method for spacing the screens is illustrated in Figure 11 wherein a single screen 90 is shown. The screen 90 is of fine-mesh woven wire which is corrugated to form a screen having reverse curvature as shown. The screens 90 may be of concave shape similar to the shape of diaphragms 57 and 67 to provide spacing when two concave screens are used together. By assembling a plurality of such screens with the corrugation axis of one screen at an angle to the corrugation axis of the next screen, the screens are properly spaced apart for assembly in the mixing unit such as shown in Figures 1, 3, 4 and 7. A similar method of effecting proper screen spacing is shown in Figures 12 and 13 wherein each screen 95 is formed to have a plurality of depressed areas or nubs 96. The spaced depressed areas 96 on one screen engage flat areas on the adjacent screen to space the screens a proper distance apart.

The operation of my improved mixing device will now be set forth. The member for holding a mixing unit assembly is secured to the spout end of a faucet or pipe by threads as shown in Figures 1, 2, 3, 4 and 6 or by friction as shown in the Figure 7 construction. As liquid passes through the mixing unit, the entering solid stream is divided into a plurality of high velocity streamlets by the pair of perforated discs. The upstream disc functions to prevent dirt from clogging the downstream disc and also to assure a more even distribution of liquid to the downstream disc. The downstream disc then divides the liquid flow into a plurality of high velocity fine streamlets which draw air into the mixing chamber through the air inlets described. The liquid streamlets impinge upon the upstream fine-mesh screen which breaks up the streamlets and intimately mixes the liquid with air. Further mixing is effected by the downstream screens which cause a coherent stream of liquid having a myriad of air particles and small air bubbles entrapped and suspended therein to issue from the discharge outlet. The resulting stream of liquid has a relatively large volume of gas, such as air, intimately mixed therewith, and is white in appearance, soft and light to the touch, and possessed of numerous advantages not found in the usual jet of liquid discharged from a conventional faucet or tap. The bubbly foaming stream may be used to form soap suds rapidly with relatively little soap. The foaming stream clings to objects placed in its path without splashing and facilitates cleaning and rinsing operations. The bubbles swell the stream and increase the contact between the liquid and the object placed under the stream, thereby speeding up cleansing and rinsing operations. As a result, the stream washes in less time and with less liquid. The air bubbles in the foaming stream carry away foreign tastes and odors and restore

oxygen to the liquid. The mixing unit is particularly suitable for use on water faucets, but is also useful in mixing a gas with a liquid, in general, as will be apparent to those skilled in the art.

This invention includes numerous variations and modifications in the embodiments shown and described which may be made without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. A device for producing a stream of liquid containing air bubbles therein comprising in combination: a body member defining a chamber, one end of said member having means for detachably connecting said member to the discharge end of a conduit adapted to deliver liquid under pressure to said chamber, the other end of said member providing an outlet for said chamber for the discharge of a bubbly stream of liquid containing air therein, said member having an inlet for the admission of air into said chamber; jet forming and mixing means positioned within said chamber including a perforated disc and a plurality of fine-mesh screens; and means including a perforated shell engaging the peripheries of said disc and screens for spacing the same with respect to each other and holding said disc and screens together as a unit removable from said chamber.

2. A device for producing a stream of liquid containing air bubbles therein comprising in combination: a conduit adapted to deliver liquid under pressure, said conduit having an air inlet adjacent to its discharge end and having a projecting shoulder on its inner surface spaced upstream of said air inlet; a jet-forming and mixing means removably positioned within the end of said conduit; and a member detachably connected to the end of said conduit for holding said jet-forming and mixing means against said shoulder and having an outlet for the discharge of a bubbly stream of liquid, said jet-forming and mixing means including a plurality of perforate diaphragms and perforate means engaging said diaphragms for holding the same in spaced relationship with respect to said air inlet.

3. A device for producing a coherent stream of water containing air bubbles therein comprising in combination: a body member defining a chamber, one end of said member being adapted to be connected to the discharge end of a conduit adapted to deliver water under pressure to said chamber, the other end of said member providing an outlet for said chamber for the discharge of a stream of water containing air bubbles therein, jet forming and mixing means positioned in said chamber, said mixing means being downstream from said jet forming means, said jet forming means and said mixing means including perforate diaphragms, means connecting all of said perforate diaphragms together into a unit removable from said chamber as a unit, and means defining an air inlet leading to the space between said jet forming means and said mixing means for admitting air into said space.

4. The structure defined by claim 3 in which said jet-forming means includes a pair of perforated discs, the upstream disc of said pair of discs having an integral annular sealing shoulder projecting above the end of said connecting means.

5. The structure defined by claim 3 in which said mixing means includes a plurality of fine-mesh screens of woven wire, a few of the wires in each screen being of larger diameter than the diameter of other wires in said screen, whereby portions of said screens are spaced from each other.

6. The structure defined by claim 3 in which said mixing means includes a plurality of fine-mesh screens of woven wire, one of said screens being provided with depressed portions to space the other portions of adjacent screens from each other.

7. The structure defined by claim 3 in which said mixing means includes a plurality of perforate diaphragms adjacent one another, at least one of said diaphragms having raised portions engaging portions of an adjacent diaphragm to space one perforate diaphragm from the adjacent diaphragm.

8. The structure defined by claim 3 in which the upstream perforate diaphragm is of resilient material having an upstanding annular portion spaced from the periphery of said diaphragm.

9. The structure defined by claim 3 in which said body member defining a chamber includes a projecting shoulder on its inner surface, and includes means engaging the downstream end of said perforate diaphragm unit to hold the upstream end of said unit against said shoulder.

10. The structure defined by claim 3 in which the upstream jet forming diaphragm is of resilient material and in which the perforate diaphragm adjacent to said resilient diaphragm is of substantially rigid material having a raised peripheral portion for engagement with the peripheral portion of said resilient diaphragm, said means connecting said perforate diaphragms together including a central stud engaging and holding said diaphragms in spaced relationship.

11. A device for producing a coherent stream of water containing air bubbles therein comprising in combination: a body member defining a chamber, one end of said member being adapted to be connected to the discharge end of a conduit adapted to deliver water under pressure to said chamber, the other end of said member providing an outlet for said member for the discharge of a stream of water containing air bubbles therein, jet forming and mixing means positioned in said chamber, said mixing means being downstream from said jet forming means, said jet forming means and said mixing means including perforate diaphragms, means holding said perforate diaphragms spaced one from another and connecting said perforate diaphragms together into a unit removable from said chamber as a unit, and means defining an air inlet leading to the space between said jet forming means and said mixing means for admitting air into said space.

ELIE P. AGHNIDES.

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