

[54] **STATIC MIXING DISPENSER AND MIXING METHOD**

[76] Inventor: **Frank E. Ives**, 1862 Ives Avenue, Kent, Wash. 93031

[22] Filed: **Feb. 10, 1971**

[21] Appl. No.: **114,205**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 696,190, Jan. 8, 1968.

[52] U.S. Cl.259/4, 259/DIG. 30

[51] Int. Cl.B01f 15/02

[58] Field of Search.....259/4, 8, 36, 18, 19, 97

[56] **References Cited**

UNITED STATES PATENTS

1,626,487 4/1927 Warren259/4

2,601,018	6/1952	Heyl.....	259/4
3,420,506	1/1969	Gurley.....	259/8
3,223,388	12/1965	Knox.....	259/4
3,051,455	8/1962	Magester.....	259/8

Primary Examiner—Robert W. Jenkins

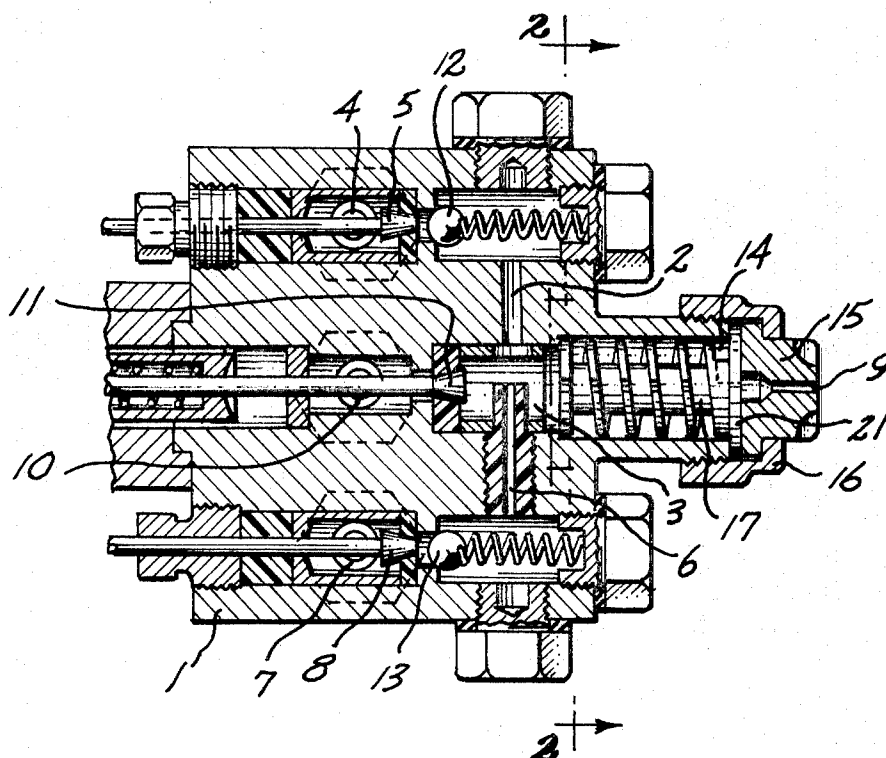
Attorney—Robert W. Beach

[57]

ABSTRACT

In the course of flowing between a supply passage or passages, liquids are mixed by the bulk of the liquid following a helical path defined by a helical feather interrupted at intervals by notches or ports through which crosscurrents flow to intersect the main flow of liquid.

7 Claims, 11 Drawing Figures



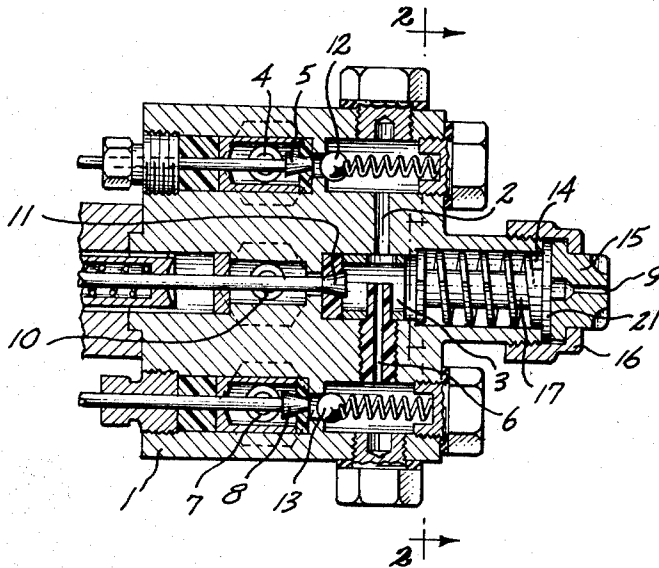


Fig. 1.

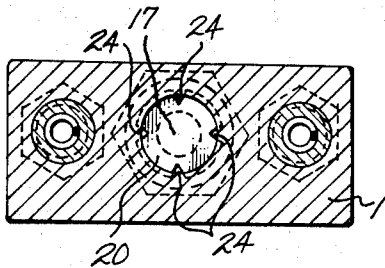


Fig. 2.

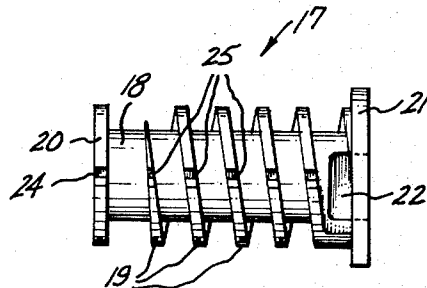


Fig. 3.

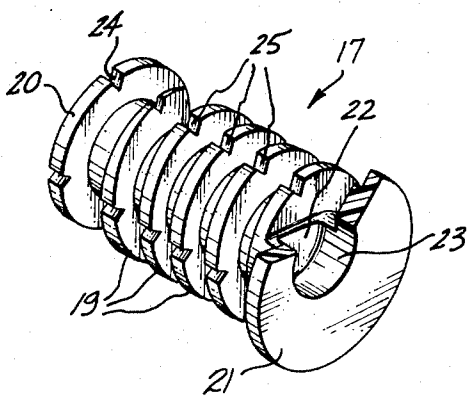


Fig. 5.

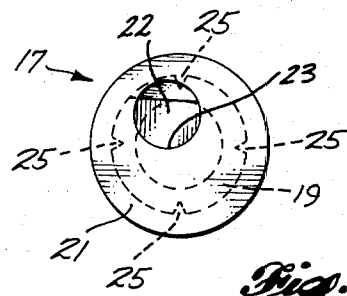


Fig. 4.

INVENTOR,
FRANK E. IVES

BY
Robert W. Beach

ATTORNEY

Fig. 6.

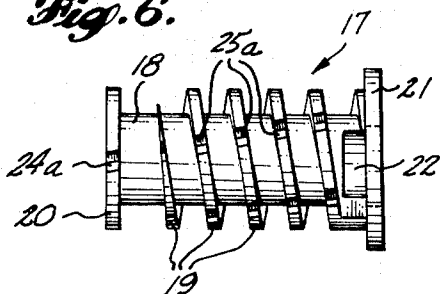


Fig. 7.

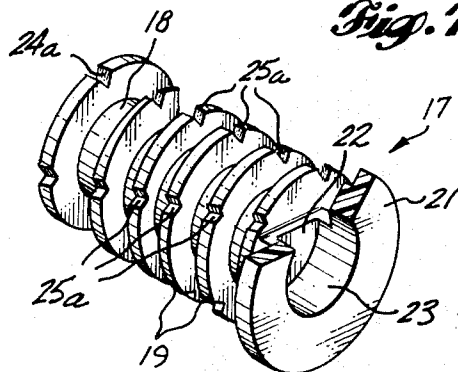


Fig. 10.

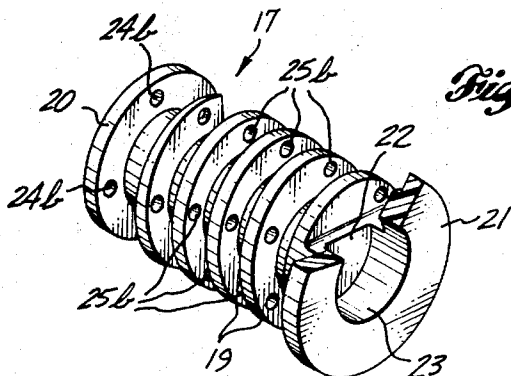
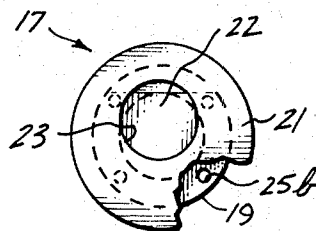


Fig. 9.

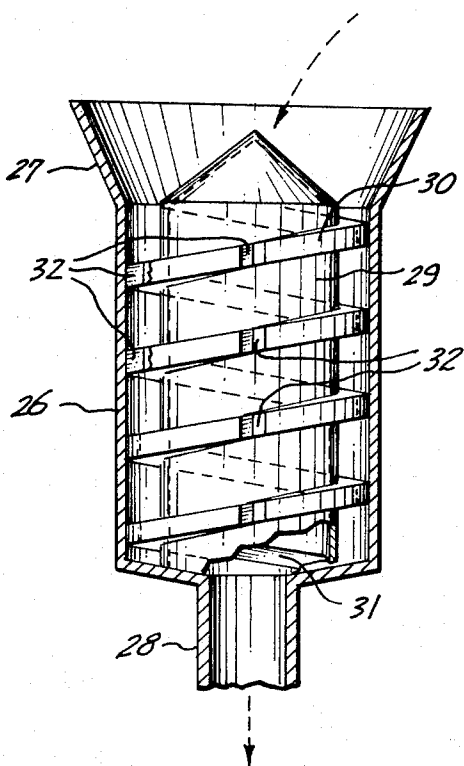


Fig. 11.

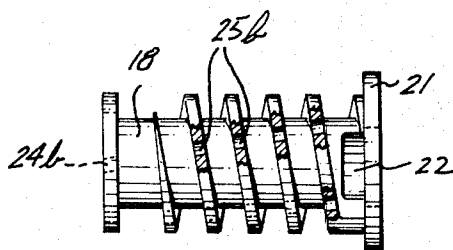


Fig. 8.

INVENTOR
BY FRANK E. IVES
Robert W. Beach
ATTORNEY

STATIC MIXING DISPENSER AND MIXING METHOD

This application is a continuation-in-part of my U.S. Pat. application Ser. No. 696,190, filed Jan. 8, 1968, for Liquid Resin Spray Dispenser.

A principal object of the present invention is to effect thorough and uniform mixing of a plurality of liquids automatically by the use of static structure.

A further object is to effect such mixing quickly and during passage of the liquid through the body of dispensing apparatus.

Another object is to effect such thorough and uniform mixing of a plurality of liquids even though the proportions of the liquids in the mixture are very unequal, and even though the viscosity of the two liquids may be quite different.

It is also an object to effect blending of liquids whether the liquid is forced through the mixer under high pressure or flows through the mixer under comparatively low pressure.

An additional object is to provide such a mixer which is of simple and inexpensive construction, which can be utilized in a variety of sizes, and which can be cleaned readily.

FIG. 1 is a longitudinal section through a spray nozzle body incorporating a dispenser of the present invention, and

FIG. 2 is a transverse section through such nozzle body taken on line 2—2 of FIG. 1.

FIG. 3 is an enlarged side elevation of a principal component of the mixer,

FIG. 4 is an end elevation of such component, and

FIG. 5 is a top perspective of the component having parts broken away.

FIG. 6 is a side elevation of a somewhat modified mixer component, and

FIG. 7 is a top perspective of such component with parts broken away.

FIG. 8 is a side elevation of a still further modified mixer component, parts of which are broken away,

FIG. 9 is an end elevation of such component, having parts broken away, and

FIG. 10 is a top perspective of such component with parts broken away.

FIG. 11 is an elevation of another embodiment of the mixer, having parts broken away.

A particularly desirable application of the present invention is in spray nozzles used to dispense a mixture of liquid resin and catalyst. The mixer is effective to blend quickly a comparatively large proportion of comparatively viscous resin, such as polyester resin, and a comparatively small proportion of comparatively fluid catalyst. The amount of catalyst used, for example, may be approximately 1 percent by weight as much as the resin. In such an application of the present invention it is also important that the mixer be compact so that it can be accommodated within the body 1 of a hand-held spray gun. Such spray gun is generally of the type shown in my copending patent application Ser. No. 696,190 mentioned above.

Within the spray gun body resin flows through an internal duct 2 to one side of the initial mixing chamber 3. Such resin is supplied to the spray gun body through a supply conduit 4, and its flow into the initial mixing chamber is controlled by a valve 5. Catalyst is supplied to the initial mixing chamber 3 through a duct 6 in the

body. Such catalyst is supplied to the body through a conduit 7, and the flow of catalyst into the duct 6 is controlled by a valve 8. The proportions of resin and catalyst supplied to the body through the conduits 4 and 7, respectively, are regulated by supply mechanism (not shown). When it is desired to dispense resin and catalyst mixture through the spray nozzle 9, the valves 5 and 8 are opened simultaneously.

After use, in order to prevent mixed resin and catalyst from setting up in the gun body, including the mixer mechanism, flushing solvent can be supplied to the spray gun body through a conduit 10, flow of which into the initial mixing chamber 3 is controlled by a valve 11. Such valve will be opened when the resin control valve 5 and the catalyst control valve 8 are closed. As a precaution, however, a ball check valve 12 may be provided in the resin passage, and a ball check valve 13 provided in the catalyst passage to seal the resin and catalyst passages respectively from backflow of flushing solvent through such passages beyond these valves.

The mixer of the present invention is interposed between the initial mixing chamber 3 and the spray nozzle 9. Such mixer is housed in the principal mixing chamber 14, the inner end of which communicates with the initial mixing chamber 3, and the outer end of which is closed by the nozzle body 15. Such nozzle body is held in place by an annular cap 16 having a flange engaging the nozzle body and an internal thread mating with an external thread on the spray gun body.

The mixing mechanism of the present invention is static and functions simply by establishing and controlling a mixing flow course of the liquid resin and catalyst mixture during its passage from the initial mixing chamber 3 to the spray nozzle 9. Such course is established and controlled by the mixing flow guide 17, one form of which is illustrated in FIGS. 3, 4 and 5, located in the principal mixing chamber 14. Such mixing flow guide functions to establish the main current or principal flow of the bulk of the liquid mixture along a tortuous course with crosscurrent of such liquid mixture intersecting such main current at intervals along its course.

The flow guide 17 preferably is formed as an insert which can be inserted easily into the principal mixing chamber 14 when the cap 16 and the nozzle body 15 are removed. Such guide includes a core 18 around which extends a helical feather 19 defining the tortuous helical path of flow of the bulk of the liquid mixture between its convolutions. A circumferential flange 20 projects from the inner end of the core, and a larger circumferential flange 21 projects from the outer end of the core.

The external circumference of the feather 19 and the inner flange 20 are substantially the same and are of a size to fit closely within the wall of the principal mixing chamber 14. The exterior circumference of the outer flange 21 is preferably approximately equal to the largest circumference of the nozzle body 15, so that such flange can be clamped between the nozzle body and the end of the spray gun body 1 by the cap 16 when it is screwed into place. The flow guide 17 will be held firmly in the principal mixing chamber in this way.

Entrance passages for flow of liquid mixture from the initial mixing chamber 3 into the principal flow passage of the mixer are provided past the inner flange 20 of the

mixing flow guide, which in the form of guide shown in FIGS. 3, 4 and 5 are a plurality of notches 24 in the circumference of the flange 20 spaced circumferentially around such flange. Passages for crosscurrents at intervals along the principal flow path are provided in the helical feather 19. These passages in the form of guide shown in FIGS. 3, 4 and 5 are axial rows of notches 25 in the periphery of the feather convolutions. A plurality of such rows of notches is preferred.

It is not necessary that the notches 25 be arranged in rows from an operational point of view, but it is easier to cut such notches in rows in manufacturing the guide. Also each row of crosscurrent notches 25 is shown as being in alignment with an entrance notch 24 in the inner flange 20. Four of such rows of notches are shown in FIGS. 3, 4 and 5, spaced equidistantly circumferentially of the guide flange 20 and feather 19.

It is preferred that resin and catalyst flowing into the initial mixing chamber 3 flow in opposite directions substantially in alignment, as indicated in FIG. 1. From this initial mixing chamber the resin and catalyst liquid flows through the entrance passages, formed by the notches 24, as shown best in FIG. 2, to the principal mixing chamber 14. Such liquid enters the annular space encircling the core 18 of the mixing flow guide between the inner flange 20 and the adjacent end of the feather 19. Such liquid will squirt through the small entrance passages 24 with greater or less force and velocity, depending upon the pressure exerted on the liquid resin and catalyst supplied through the supply conduits 4 and 7.

The cross-sectional area of the groove between the convolutions of the feather 19 is much greater than the cross section of each bypass passage formed by a notch 25 across a feather, which short-circuits a feather convolution. The bulk of the liquid mixture will flow comparatively slowly through the tortuous spiral channel defined by the feather 19, while local crosscurrent will flow from one convolution of the principal flow to the next, through the notches 25, to further the mixing action. The spiral channel between the convolutions of the feather 19 forms a comparatively long path of travel for the main current of the liquid into which the crosscurrents passing through the notches 25 are injected at intervals along the spiral course of the main current.

From the discharge end of the helical channel formed by the convolutions of the feather 19, the liquid flows into the outlet pocket 22 communicating with the central discharge aperture 23 in the outer flange 21. From such discharge aperture the thoroughly and uniformly blended liquid is sprayed from the nozzle passage 9. Despite the tortuous character of the path formed by the feather 19 around the mixing guide, the channel between the convolutions of the feather has a cross section sufficiently large so that the resistance to flow of the liquid through the mixer is not substantial.

While the mixing flow guide 17 shown in FIGS. 3, 4 and 5 has the bypass notches 25 in the edge of the feather disposed in axial alignment, it may be preferable to have the bypass notches arranged in skew rows, as illustrated by the notches 25a shown in the mixing flow guide of FIGS. 6 and 7. Such row of notches may be skewed sufficiently relative to the axis of the guide, so that each notch is directed substantially perpendicu-

lar to the convolution of the feather 19 in which it is formed. Also, the row of notches 25a in the peripheral edges of the feather 19 can be aligned with an entrance passage notch 24a in the inner flange 20, which is also a skew notch.

A further alternative type of construction for the bypass passages of the mixing flow guide is shown in FIGS. 8, 9 and 10. In this guide the by-pass passages through the convolutions of the helical feather 19 are apertures 25b. Such apertures are shown as being arranged in a skew row, and an entrance aperture 24b in the inner flange 20 is also arranged in each such row. Such row of apertures can be drilled in the guide from its inner end.

The mixing operation of the guide shown in FIGS. 6 and 7 and of the guide shown in FIGS. 8, 9 and 10 is generally the same as the mixing operation accomplished by the guide shown in FIGS. 3, 4 and 5. In each instance crosscurrents flow through the bypass passages in the feather into the main current flowing through the spiral channel defined by the feather 19 to increase the mixing action locally at spaced locations along the helical path. In each instance the cross-sectional area of a bypass passage through the feather is a small fraction, such as 10 percent to 30 percent of the cross-sectional area of the principal flow channel.

While it is desirable to have the liquid resin and catalyst supplied to the spray gun body 1 through conduits 4 and 7, respectively, under considerable pressure in order to have a strong spray of liquid discharged from the nozzle aperture 9, the mixing action of the mixer of the present invention is not dependent upon the liquid being forced through the mixer under great pressure. In fact, in the mixer shown in FIG. 11 only gravity is relied upon to cause the liquid mixture to flow through the mixer.

The mixer of FIG. 11 can be utilized effectively where liquid resin is simply being poured into a mold. Use of such mixer makes it unnecessary to mix a batch of resin and catalyst thoroughly before it is poured into the mold. Instead the catalyst can simply be mixed with the resin in a preliminary way, and the final blending will be accomplished by pouring the liquid resin mixture through the mixer shown in FIG. 11.

The mixer of FIG. 11 includes a cylindrical casing 26 disposed with its axis upright. The upper end of such casing terminates in a flared lip 27 providing an inlet opening to the mixer for the resin and catalyst liquid mixed in preliminary fashion. The completely blended resin and catalyst liquid is discharged from the mixer through a bottom spout 28 having a cross-sectional area considerably smaller than the cross-sectional area of the casing 26, such as 10 to 20 percent of the casing cross-sectional area.

Within the mixer casing 26 is the mixing flow guide, including a cylindrical core 29 around which extends a helical feather 30. The lower end of the helical channel formed between the convolutions of the feather opens into an outlet pocket 31 in the lower end of the core 29, which communicates with the discharge spout 28. The edges of the convolutions of feather 30 fit snugly in the cavity of the casing 26 and bypass passages between adjacent convolutions of the helical flow channel are formed by notches 32 in the peripheries of the feather convolutions.

To facilitate their formation the bypass notches 32 are arranged in axial rows, but such alignment of the notches is not required. Also, as discussed in connection with FIGS. 8, 9 and 10, the bypass passages of the feather convolutions in the mixer of FIG. 11 could be apertures instead of peripheral notches if desired. The mixing operation accomplished by the mixer of FIG. 11 utilizes the same principle as the mixing operation described in connection with the spray gun mixer. The bulk of the resin and catalyst mixture will flow downward through the casing 26 along the helical channel between the convolutions of the feather 30, while crosscurrents will flow through the notches 32 to mingle with the main current of liquid flowing through the helical channel.

The mixer of the present invention is very easy to clean. As discussed above, the mixing flow guide 17 of the spray gun is held in place in the principal mixing chamber 14 by the cap 16 pressing the nozzle body 15 against the outer flange 21 of the mixer guide, as shown in FIG. 1. To clean the mixer, therefore, it is merely necessary to unscrew the cap 16 and the nozzle body 15, whereupon the mixing flow guide 17 can be withdrawn readily from the chamber 14. Such operation leaves the chamber 14 unobstructed for cleaning, and the principal flow channel of the guide 17 between the convolutions of the feather 19 is exposed for easy cleaning.

Because the mixer of FIG. 11 is normally used in a position with the axis of the casing 26 upright as shown in FIG. 11, it is not necessary to make any provision for holding the mixing flow guide in the casing. Such guide should be provided as a loose part of the mixer, which can be removed from the casing simply by inverting the casing. The interior of the casing is thus left unobstructed for cleaning, and the helical channel between the convolutions of the feather 30 is exposed for cleaning.

I claim:

1. In static mixing mechanism for blending a small amount of relatively fluid liquid uniformly with a relatively large amount of relatively viscous liquid, including a cylindrical core and a helical feather convoluted around the cylindrical core defining a tortuous course for flow of the bulk of the liquid mixture, and bypass passages connecting portions of such tortuous course for flow of crosscurrents between such connected por-

tions of the tortuous course, the improvement comprising an end plate blocking the entrance to such tortuous course and having small entrance passages therethrough offset outwardly a substantial distance from the periphery of the cylindrical core and constituting the sole entrance for the liquids.

2. The mechanism defined in claim 1, in which the small entrance passages are peripheral notches in the end plate.

3. The mechanism defined in claim 1, in which the small entrance passages are apertures through the end plate.

4. the mechanism defined in claim 1, in which the bypass passages in adjacent convolutions are arranged in a row skewed with respect to the axis of the core for forming substantially a helix convoluted in the direction opposite to the direction of convolution of the helical feather.

5. The mechanism defined in claim 1, in which the end plate is a flange on one end of the core and the core area at the end plate is at least as great as the average cross-sectional area of the core.

6. In static mixing mechanism for blending a small amount of relatively fluid liquid uniformly with a relatively large amount of relatively viscous liquid, including a cylindrical core and a helical feather convoluted around the cylindrical core defining a tortuous course for flow of the bulk of the liquid mixture, the improvement comprising bypass peripheral notches in the helical feather, each notch being of a radial depth less than one-half the radial width of the feather and each notch being of a circumferential width at least as small as its radial depth.

7. In the method of blending a mixture of a plurality of liquids, which mixture includes predominantly viscous resin and a proportion of comparatively fluid catalyst, which proportion is a small fraction of the resin by weight, by flowing the bulk of the liquid mixture along a helical course convoluted around a core and at intervals along such helical course injecting into such flow of the liquid mixture bulk cross currents of such mixture, the improvement which comprises supplying the mixture of liquids to the helical course only in the form of a plurality of streams of such mixture introduced to the helical course at locations spaced outwardly from the core around which the helical course is convoluted.

* * * * *

50

55

60

65