Dec. 9, 1969 E. J. KRIZAK ET AL 3,482,822

MIXING DEVICE

Filed Jan. 30, 1968 4 Sheets-Sheet 1

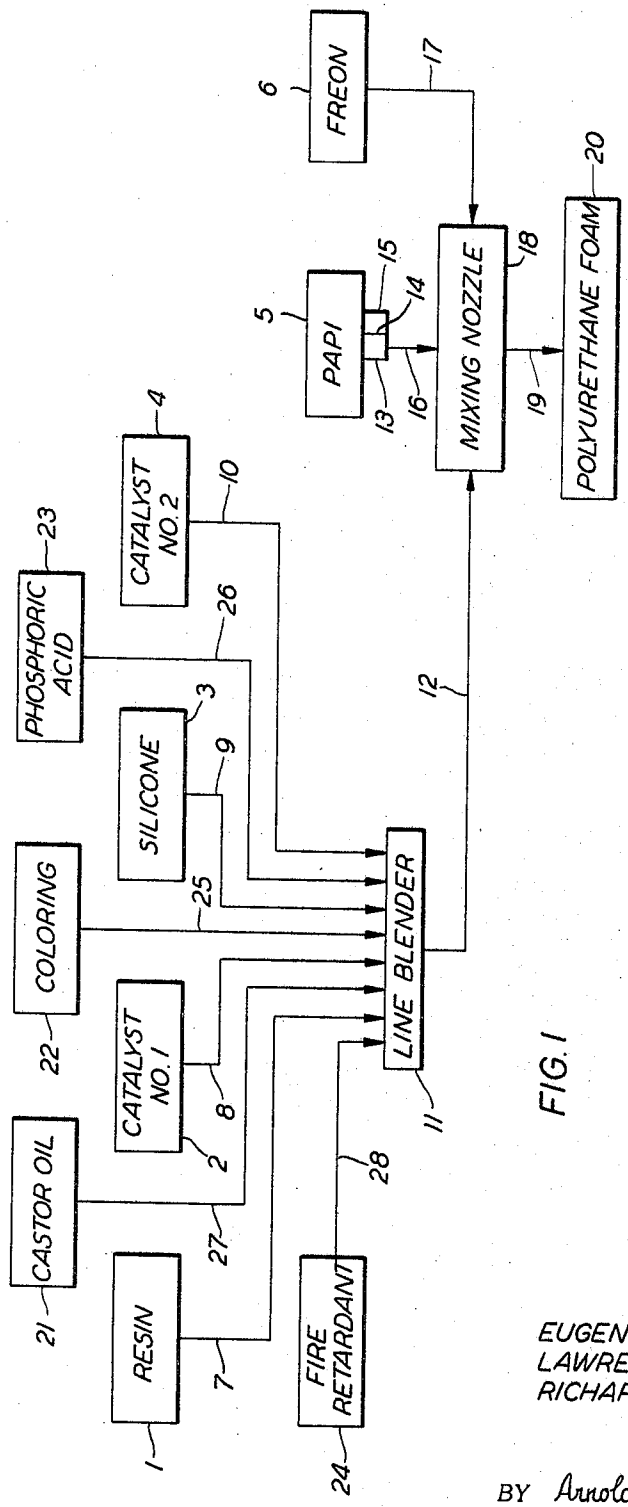


FIG. 1

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MIXING DEVICE

Filed Jan. 30, 1968 4 Sheets-Sheet 2

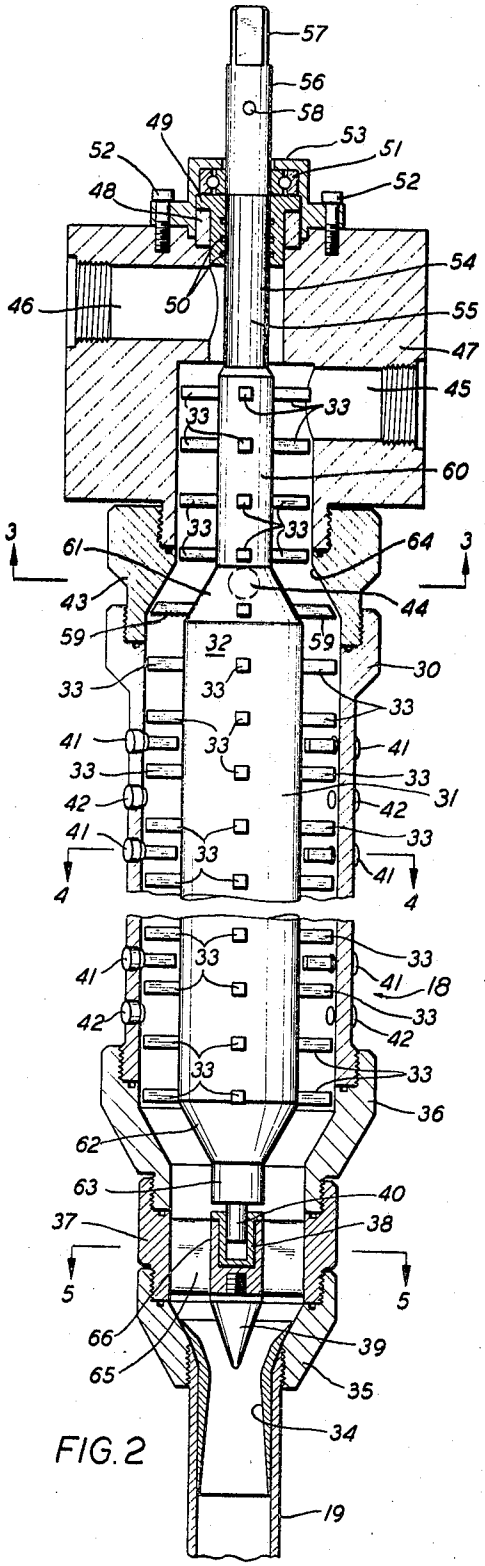


FIG. 2

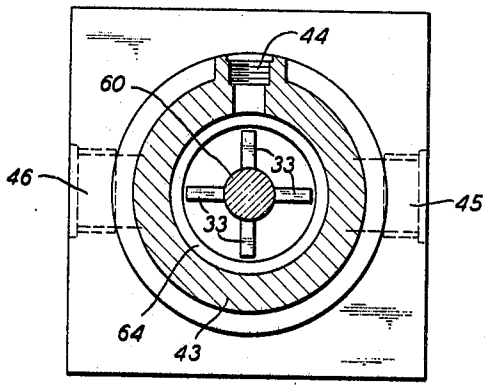


FIG. 3

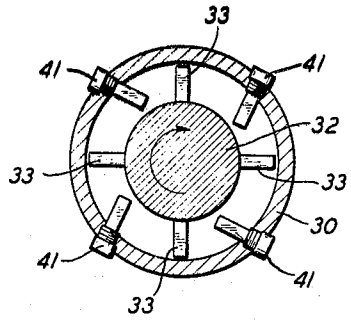


FIG. 4

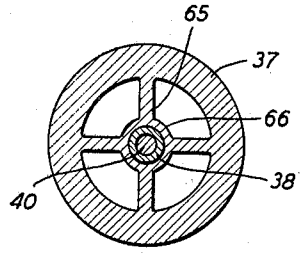


FIG. 5

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MIXING DEVICE

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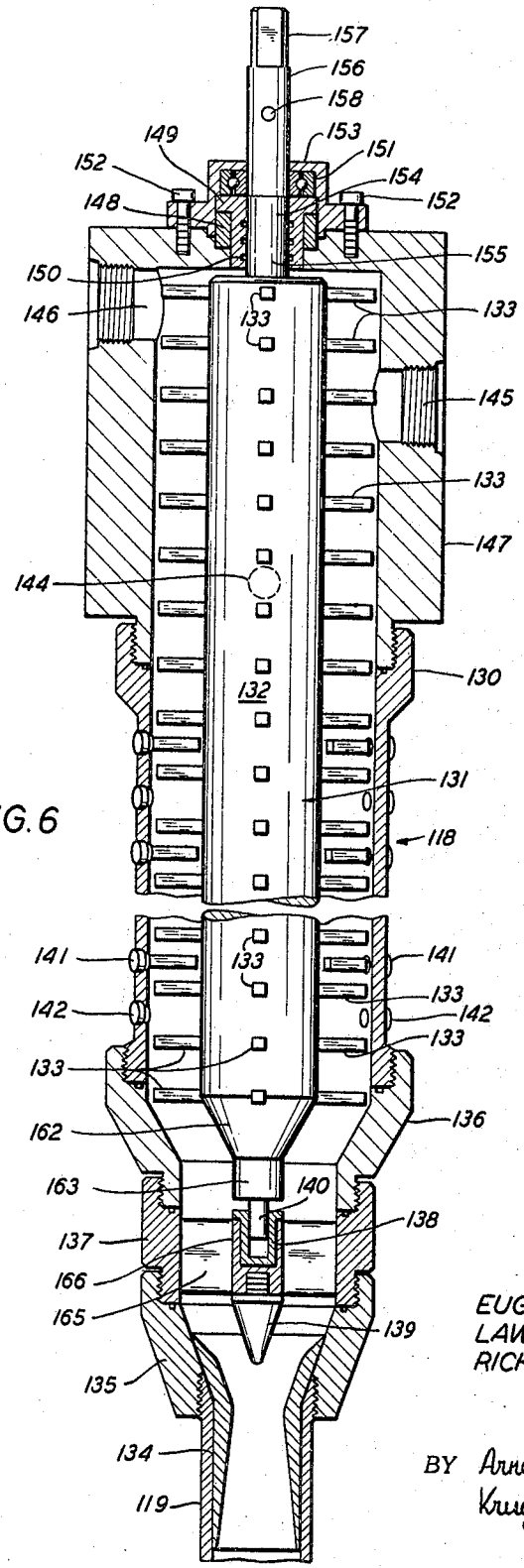


FIG. 6

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MIXING DEVICE

Filed Jan. 30, 1968 4 Sheets-Sheet 4

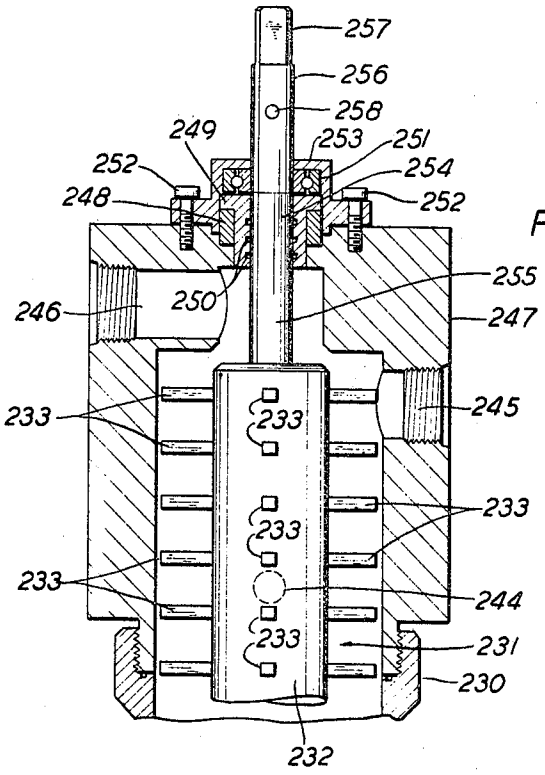


FIG. 7

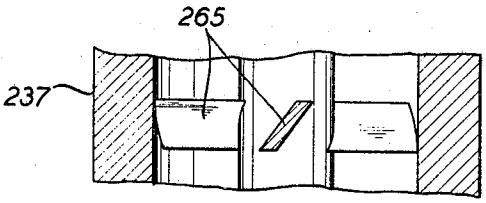


FIG. 9

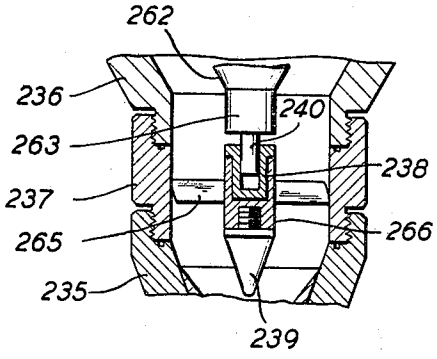


FIG. 8

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3,482,822

MIXING DEVICE

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Filed Jan. 30, 1968, Ser. No. 701,783
Int. Cl. B01f 7/04, 15/06
U.S. Cl. 259—8 23 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for providing a substantially homogeneous mixture of a plurality of immiscible liquids without frothing or vaporizing. The apparatus is preferably composed of a mixer containing a plurality of inwardly directed stationary mixing pins projected toward a rotating whipper, and a venturi-like outlet to restrict outflow and provide a back pressure without producing turbulence. The apparatus also includes provision for combining various liquids including Freon of different temperature in a selected sequence so as to maintain the average temperature at below flash point of the Freon.

BACKGROUND OF THE INVENTION

This invention relates to improved apparatus for producing polyurethane foam and the like, and more particularly relates to improved apparatus for providing a mixture of liquid reactants for producing a substantially isotropic foam.

It is well known to produce urethane foam stock by combining a suitable polyhydroxyl compound, a flowing agent such as nitrogen or Freon, and a polyisocyanate, to produce a cellular material. It is also well known to commingle various catalysts, surfactants, coloring agents, etc., with the basic reactants to control the speed and character of the reaction, and to control the various characteristics of the resulting cellular material.

The resulting cellular material may be made either flexible or rigid, and may be produced with various preselected characteristics. In the case of rigid polyurethane foam material, one of the more critical characteristics in the isotropicity of the "bun," as it is commonly termed, and the degree of isotropicity is, of course, related to the uniformity of the size and distribution of the cells in the solidified foam.

Although polyurethane foam is highly regarded for its insulating capabilities, there are competitive substitutes which are commercially available at a reasonable price. Hence, it is an economic necessity that polyurethane foam stock be produced with a consistently high degree of isotropicity and at a cost which is at least competitive with the price of the substitutes.

Low cost foam is best produced by a one-shot process which involves a continuous flow of the various constituents into a mixer which operates to deposit a continuous stream of reacting liquid at the input side of a tunnel mold which contains the foaming mass until it solidifies. Although some control over the isotropicity of the product may be had during the foaming stage in the tunnel mold, the interaction of the constituents is basically irreversible. Hence, it will be apparent that the quality of the resulting product is primarily dependent on the quality and relative proportions of the various reactants, and the homogeneity of the liquid mixture which is deposited in the tunnel mold.

The overriding difficulty in providing a sufficiently homogeneous mixture to the input side of the tunnel mold, arises from the fact that most of the various constituents are basically immiscible with one another and

that some of the reactants are actually "hostile" to the presence of one or more of the other reactants. Accordingly, various improved mixing devices such as those depicted in U.S. Patents No. 3,181,839, and No. 3,220,801, have been developed for the express purpose of receiving substantially simultaneous and continuous input flows of various different incompatible liquids and, within a very brief moment, churning them physically together before ejecting them in the form of a homogeneous mixture.

Basically all of these mixing devices employ a chamber which receives the various liquid inputs, and which contains a whipper which is immersed in the liquid and which revolves for the purpose of beating the liquids together. The liquids must flow in and out of the mixing device within a relatively brief interval since the reaction between the polyhydroxyl (hereinafter termed the "resin") and the polyisocyanate, tends to commence almost instantaneously, and since it is essential that the liquid mixture leave the mixing device and enter the tunnel mold before any gas bubbles begin to form. Hence, it is obvious that it is necessary to revolve the whipper at a very high speed in order to effectively churn the various immiscible liquids into a homogeneous mixture within the limited time allowed for the mixing stage.

The fact that the whipper must be revolved at such a high speed is, in itself, a disadvantage insofar as the isotropicity of the resulting foam stock is concerned. In the first place, the various constituents tend, for the most part, to be highly viscous and thus there is a strong tendency for the liquid in the receiving or mixing chamber to revolve with the whipper in the manner of a solid mass. Secondly, rotation of the whipper at speeds of the magnitude required for effective homogeneity in itself tends to produce cavitation in the liquid. Since the Freon is injected into the mixing device in liquid form it tends to vaporize with any decrease in pressure and thus this cavitation tends to cause premature foaming in the mixing device which seriously affects the isotropicity of the foam stock.

Another serious defect in the mixing devices presently available is also concerned with the fact that it is essential to maintain the Freon in a completely liquid state until it leaves the mixing device. Hence, it is desirable that the Freon be subjected to a pressure sufficient to keep it liquified as long as it is in the mixing device. Although such a pressure can be established and maintained with the mixing device by various techniques, in the present instance this is preferably achieved by the provision of a restriction in the liquid flow path at the outlet of the mixer of a size sufficient to maintain a liquifying back pressure on the Freon in the mixing device without, at the same time, adversely affecting or reducing the homogeneity or the liquidity of the liquid mixture departing from the mixing device. However, this problem has not been properly considered or dealt with in the designs of the mixing devices presently available, and thus it frequently happens that an abnormally large bubble of Freon will occur in the liquids within the mixing device. In such a case, this will result in voids or cavities within the finished foam stock which is entirely unacceptable.

A further disadvantage in the mixing devices in the prior art is that it has hitherto been impossible from a practical standpoint to provide a whipper which is adequately balanced within the tolerances required for the production of polyurethane foam stock having the required isotropicity. It will be apparent that only a minor imbalance will cause high frequency vibrations when a whipper is revolved at speeds ranging up to 8,000 r.p.m. and greater. Although the mixing devices of the prior art are quite capable of enduring these vibrations without apparent damage, the vibrations tend to promote the for-

mation of bubbles which are quite deleterious to the isotropicity of the resulting foam stock for the reasons hereinbefore given.

Another disadvantage of the mixing devices of the prior art is also due to the relative incompatibility of the various components, at least insofar as the production of polyurethane foam stock is concerned, and involves the fact that the various components must necessarily be introduced into the mixing device at different temperatures. In particular, the resin is usually delivered into the mixing device at a much higher temperature than that of the Freon, and this also tends to cause the Freon to vaporize prematurely within the mixer.

These and other critical disadvantages of the prior art have been effectively overcome with the present invention, and novel apparatus are provided herewith for effectively combining basically immiscible liquids into a homogeneous liquid mixture, and for maintaining the liquidity of such mixture during the intermixing of the components thereof.

SUMMARY OF THE INVENTION

The advantages of the present invention are preferably obtained with a mixer of substantially the general configuration and design present in mixers of the prior art, but preferably including a selected number of pins detachably mounted in the wall of the receiving or mixing chamber and inwardly directed tangentially relative to the whipper body and its direction of rotation. The whipper is preferably composed of an elongated cylindrical body having a diameter along its length such as to provide a substantially uniform spacing betwen the whipper body and the inside surface of the mixing chamber. The whipper is also preferably provided with a plurality of outwardly extending pins perpendicularly mounted on the body of the whipper to beat the surrounding liquid during rotation of the whipper body.

As will hereinafter be explained, the entire whipper unit, including the body, the pins, and all bearing sections, is preferably fashioned as a unit from a single piece or mass of steel, in order that the whipper be provided with a balance which is sufficient for present purposes. Accordingly, the bearing surface of the whipper which is interconnected with a fluid seal, as will hereinafter be described, is preferably provided with a Teflon-impregnated ceramic coating to improve its durability and to thereby greatly extend the useful life of this component.

A further feature of the preferred form of the present invention includes the relocation of the Freon input port downstream of the resin and isocyanate input ports, and the location of the isocyanate input port at a point intermediate of the resin and Freon input ports. As will hereinafter be explained, this relocation of the input ports keeps the Freon in the mixer at a lower temperature and thus reduces the tendency of the Freon to vaporize prematurely in the mixer.

A significant feature of the present invention includes the provision of a flow restriction of a preselected cross section at the exit end of the mixer, and which is adapted to create a back pressure within the mixing chamber to maintain the Freon therein in a liquid state, but which is also preferably adapted to permit liquid flow into the spout without causing or permitting separation of the liquid components of the mixture, and without creating any significant turbulence in the liquid flowing therethrough. Preferably, the flow restriction is substantially in the form of a replaceable venturi as will hereinafter be explained.

These and other features of the present invention will be further described or will become apparent in the following detailed description, wherein reference is made to the figures in the accompanying drawings.

THE DRAWINGS

FIGURE 1 of the drawings is a functional representation of a typical one-shot process for the manufacture of polyurethane foam stock, and illustrates the various components in a typical formulation and the manner and sequence in which such components are intermingled.

FIGURE 2 is a pictorial representation, partly in cross section, of an exemplary embodiment of a mixer constructed to include the various features of the present invention.

FIGURE 3 is a pictorial representation, partly in cross section, of the portion of the apparatus depicted in FIGURE 2 including the liquid input ports.

FIGURE 4 is a pictorial representation, partly in cross section, of another portion of the apparatus depicted in FIGURE 2 and illustrating a preferred arrangement of the stationary pins hereinbefore mentioned.

FIGURE 5 is a cross-sectional representation of another portion of the apparatus depicted in FIGURE 2.

FIGURE 6 is a pictorial representation, partly in cross section, of a modified version of the apparatus depicted in FIGURE 2.

FIGURE 7 is a pictorial representation, partly in cross section, of a modified version of a portion of the apparatus depicted in FIGURE 6.

FIGURE 8 is a pictorial representation, partly in cross-section, of a modified version of another different portion of the apparatus depicted in FIGURE 6.

FIGURE 9 is another pictorial representation, partly in cross section, of a portion of the apparatus depicted in FIGURE 8.

DETAILED DESCRIPTION

Referring now to FIGURE 1, there may be seen a functional representation of ten separate tanks **1–6**, and **21–24**, arranged to hold each of their respective contents separate from each other. In particular, tank **1** may be seen to contain resin, tank **2** to contain a first or No. 1 catalyst, tank **3** to contain silicone and tank **4** to contain a second or No. 2 catalyst. Further, tank **5** is represented as containing the aforementioned polyisocyanate, which will hereinafter be referred to as "PAPI," a registered trademark of The Upjohn Company. Tank **6** is represented as containing Freon, tank **21** as containing castor oil, and tank **22** is represented as containing a suitable dye or coloring agent. Tank **23** is represented as containing phosphoric acid, and tank **24** is represented as containing a suitable fire retardant. The various catalysts and other constituents mentioned herein are well known components, and are named herein merely to illustrate a typical formulation for the production of polyurethane foam.

The basic reactants in the manufacture of polyurethane foam are, as hereinbefore stated, the resin in tank **1**, the PAPI in tank **5**, and the Freon in tank **6**. The other constituents are substantially nonreactant with each other, or with either of the two basic reactants (resin or PAPI) separately. Hence, it has been found to be desirable to first blend together all of the catalysts and other secondary ingredients with the resin, and then to deliver this mixture as a single stream to the point of combination of the PAPI and Freon therewith.

Accordingly, it may be seen that the resin output line **7** is connected to deliver resin to a line blender **11**, and that the catalyst No. 2 output line **8** is also connected to the blender **11**. Further, the silicone output line **9**, the catalyst No. 2 output line **10**, the coloring output line **25**, the phosphoric acid output line **26**, and the fire retardant output line **28**, are also connected to deliver their respective outputs separately to the line blender **11**. As may also be seen, the various components in the line blender **11** are delivered in the manner of a premix through output line **12** to one of the three input ports of the mixing nozzle **18**.

In a conventional production system tank **5** which holds PAPI is preferably provided with three separate output lines in order that more effective control may be had

over the proportionality of the PAPI with respect to the resin. Accordingly, FIGURE 1 may be seen to functionally illustrate how PAPI is delivered from tank **5** in three separate streams which will hereinafter be referred to, respectively, as PAPI–A, PAPI–B and PAPI–C. In particularity, PAPI–A is delivered through output line **13**, PAPI–B through output line **14** and PAPI–C through output line **15**, which all merge into a single PAPI output line **16** connected to a second of the three input ports of the mixing nozzle **18**. The Freon from tank **6** is illustrated as delivered through a separate output Freon output line **17** to the third input port in the mixing nozzle **18**.

It is the function of the mixing nozzle **18** to physically or mechanically blend together the various constituents into a homogeneous liquid mixture, and to deliver this mixture into the input end of a tunnel mold (not depicted) through a conventional spout **19** to produce the polyurethane foam **20** functionally represented in FIGURE 1.

As hereinbefore stated, the proportionality of the various components is a vital factor with respect to the character of the finished product. Accordingly, each of the aforementioned output lines are provided with valves and contain various control equipment whereby their respective throughputs may be regulated as desired. In addition, return lines are usually provided in a system of the type depicted in FIGURE 1. Since these return lines and control equipment are not pertinent to the present invention, however, they have not been specifically illustrated in FIGURE 1 and will not be further discussed herein.

Referring now to FIGURE 2, there may be seen a pictorial representation, partly in cross section, of the various components and functional details of an exemplary form of the mixing nozzle **18** depicted generally in FIGURE 1. More particularly, the mixing nozzle **18** may be seen to include a cylindrical barrel **30** having an upset upper end with internal threads therein for connection with a barrel connector **43**. The lower end of the barrel **30** is provided with external threads for threaded engagement with a barrel adapter **36** which, in turn, is provided with internal threads at one end for receiving the lower end of the barrel **30**, and with external threads at the other end for threaded engagement with a lower bearing mount **37**.

Also represented in FIGURE 2 is an exemplary whipper assembly **31**, which is preferably fabricated as a "one-piece" component from a single piece of steel as will hereinafter be explained, and in the form illustrated in FIGURE 2 is composed of a cylindrical main body **32** with an upper frusto-conical shoulder section **61** tapering to an upper body section **60** of a smaller diameter than that of the main body section **32**, and a lower frusto-conical shoulder section **62** tapering into a lower body section **63** having substantially the same smaller diameter. The upper body section **60** may also be seen to include a further extension comprising a bearing section **54** of slightly smaller diameter, and a shank section **56** terminating in a rectangular end portion **57**. The lower body section **63** may be seen to include a further extension of relatively smaller diameter and functioning as a lower whipper bearing **40** as will hereinafter be explained.

It is desirable that the mixing nozzle **18** be provided with a configuration such that the assembly be "liquid full" at all times during operation. Furthermore, it is desirable that travel time of the liquids through the mixing nozzle be coordinated with the rotation velocity of the whipper assembly **31**, so that the liquids will be adequately intermixed, but so that "overmixing" will not occur. Accordingly, the mixing nozzle **18** of the present invention may, as will hereinafter be explained, have either the configuration illustrated in FIGURE 2 or the configuration illustrated in FIGURE 6, or any other suitable configuration wherein the cross-sectional area of the annular space is substantially uniform between the barrel **30** and head block **47**, etc., wherein the whipper pins **33** are disposed for the purpose of beating and intermixing the surrounding liquids.

Each of the various whipper pins **33** may have a rectangular configuration and is preferably long enough to extend substantially (but not entirely) across the aforementioned annular space about the whipper assembly **31**. Thus, the pins **59**, which are mounted on the upper body shoulder section **61**, are preferably provided with tapered end surfaces parallel with the tapered inside surface **64** of the adjacent barrel connector **43**, in order to provide for minimum clearance therebetween during rotation of the whipper assembly **31**.

As hereinbefore mentioned, the liquid PAPI and resin may be expected to arrive at the mixing nozzle **18** in an extremely viscous state, and thus there is a tendency for the whipper assembly **31** to revolve the adjacent liquids in the manner of a solid mass, rather than to intermix the liquids in the manner sought to be achieved. Accordingly, stationary pins **41** may be disposed, in numbers dependent on the viscosity of the liquids, in suitably located apertures in the wall of the barrel **30** to oppose such revolvement of the liquids and to assist in shearing or mixing thereof during flow through the barrel **30**.

Referring now to FIGURE 4, there may be seen a cross-sectional representation of the barrel **30** and whipper assembly **31**, whereby the stationary pins **41** may be seen to be positioned more or less tangentially with respect to the surface of the main whipper body section **32**. For purposes of illustration, it may be assumed that the whipper assembly **31** represented in FIGURE 4 is rotated in a clockwise manner relative to the barrel **30**, and that the whipper pins **33** accordingly tend to also rotate the liquid inside of the barrel **30** in a clockwise manner. The stationary pins **41**, of course, tend to retard and resist such clockwise rotation of the fluid, as hereinbefore described. However, it may be seen that if the fluid is rotated past the stationary pins **41** at a sufficient velocity, a pressure drop will tend to be created on the downstream sides of the stationary pins **41**. Such a pressure drop is, of course, undesirable since this will tend to cause the Freon to flash in these locations, and thus the stationary pins **41** are preferably mounted in an angular manner relative to the surface of the whipper main body section **32** to permit the fluid to immediately carry away any bubbles which might form behind the stationary pins **41**. In this respect, it should be noted that, at high rotational velocities, the mixing nozzle **18** tends to function somewhat in the manner of a centrifugal separator whereby the heavier of the liquids will tend to move outwardly of the whipper assembly **31**. The tangential arrangement of pins **41** tends to reverse this outward movement, and thus aids intermixing of the liquids for this additional reason.

Referring again to FIGURE 2, it should be noted that the stationary pins **41** depicted therein may be substantially of the same size as the whipper pins **33** and **59** mounted on the whipper assembly **31**, although this is not a feature of the present invention. On the other hand, it should be particularly noted that only a selected number of stationary pins **41** need be used in the depicted assembly, since the number of stationary pins **41** required to effectively oppose liquid rotation will depend upon the viscosity and compatibility of the liquids passing into the cylinder **30**. Accordingly, the cylinder **30** is preferably provided with more than enough ports to accommodate the number of stationary pins **41** which may be required for most liquid mixtures, and thus those ports not required to accommodate a stationary pin **41** should be closed with a plug **42** as shown in FIGURE 2. This is particularly important, since it is necessary not to "overmix" the liquids in the cylinder **30**, so as to avoid causing the liquids

to froth, since this will also adversely affect the isotropicity of the finished polyurethane foam product.

As may also be seen in FIGURE 2, the upper end of the barrel connector **43** contains internal threads for threadedly engaging the external threads on a head block **47** having a PAPI input port **45** on one side thereof and a resin input port **46** on its other side. In addition to functioning as an input manifold for the resin and PAPI, it is a function of the head block **47** to house and support the various bearing and sealing assemblies required to support the upper end of the whipper assembly **31**. In particular, there may be seen a seal bushing **49** disposed snugly but rotatably about the upper whipper bearing section **54** and containing a group of three O-rings **50** of Teflon or synthetic rubber for providing fluid-sealing engagement with the surface of the upper bearing section **54** of the whipper assembly **31**. Also disposed about the whipper shank section **56** is an upper bearing assembly **51**, which may be a conventional ball-bearing assembly, and which is held in position adjacent the seal bushing **49** by a bearing housing **53** attached to the head block **47** by means of bolts **52**. It will be noted that the seal bushing **49** may be provided with a flange to engage a spacing ring **48** located therein to hold the sealing O-rings **50** in a preselected location about the surface of the upper bearing section **54** of the whipper assembly **31**. The spacing ring **48** may be varied in width, whereby the seal rings **50** may be shifted to a different location on the upper bearing section **54**, if this part of the whipper assembly **31** becomes abnormally worn to the extent that effective fluid-sealing engagement therewith becomes difficult. In addition, the upper bearing section **54** is preferably provided with a thin coating of Teflon-impregnated ceramic material **55**, which has been shown by actual usage to provide a very long-lived surface for purposes of the depicted apparatus.

Referring now to FIGURE 3, there may be seen a cross-sectional representation of the portion of the mixing nozzle **18** at a location across the barrel connector **43**, wherein the rectangular or square configuration of the head block **47** may be seen, and where the resin input port **46** may be seen to be disposed on the opposite side of the head block **47** from the PAPI input port **45**. In addition, the Freon input port **44** may be seen to be located in the barrel connector **43**, rather than in the head block **47**, as is the case with the other two liquid input ports.

As hereinbefore explained, the resin and other constituents flowing from the line blender **11** are usually delivered to the mixing nozzle **18** at a warm temperature relative to that of the Freon and PAPI. In many of the systems of the prior art, it is conventional to deliver both the resin and the freon into the mixing nozzle **18** by way of a common input port, or to a different input port at or about substantially the same location along the length of the liquid stream flowing through the mixer. In such a technique, however, the heat of the resin mixture tends to cause the cold liquid Freon to instantaneously vaporize or "flash" as it is commonly termed. For various reasons not pertinent to the present invention, the PAPI is usually delivered into the mixing nozzle **18** at a relatively cold temperature, but it is impractical to combine the Freon with the PAPI for common input to the mixing nozzle **18**, since the Freon does not readily dissolve in the PAPI. Thus, some foam systems have mixing devices of the character depicted in FIGURE 2 which have three or more separate input ports. However, the ports are all closely located in the mixing unit so as to facilitate blending of the components, notwithstanding this increases the likelihood that the Freon will flash upon entering the mixing unit.

In the apparatus depicted in FIGURE 2, the relatively warm resin is delivered through a port **46** which is located relatively high in the head block **47**, and the substantially colder PAPI is received through the PAPI input port **45** in a location lower in the head block **47** and downstream of the resin input port **46**. However, the Freon input port **44** may be seen to be located in the barrel connector **43** below the head block **47** and further downstream from both the other two input ports **45** and **46**. In this manner, the mixture of resin and PAPI reaches the incoming Freon at a much lower temperature than in the case of the mixing nozzles of the prior art, and thus the tendency for the Freon to flash upon entering the mixing nozzle **18** is eliminated or greatly reduced with this arrangement.

It should be especially noted that the arrangement of the input ports **44–46** illustrated in FIGURE 2 provides an additional significant advantage during the periods wherein the foam system suggested in FIGURE 1 is shut down. As hereinbefore stated, it is conventional to reroute the various liquids away from the mixing nozzle **18** and back to their respective tanks, during such shutdown periods. As has also been previously stated, it is substantially impossible to retard or interrupt the reaction once the reactants have been commingled.

It is obvious that it is extremely undesirable that the reaction be permitted to proceed to any substantial extent within the mixing nozzle **18**, and thus it is conventional to immediately direct a flow of solvent into and through one or more of the input ports **44–46** immediately upon the interruption of the flow of the reactants thereto, to flush all active materials out of the mixing nozzle **18**. However, it is generally impossible to completely cleanse the interior of the mixing nozzle **18** in this manner, and a small amount of "stagnant" liquid will usually tend to collect and stand in the upper end of the head block **47** adjacent the seal bushing **49** and lower O-ring **50**. If these liquids react into polyurethane foam or the like, this will clog the seal bushing **49** and burn out the O-rings **50** when the whipper assembly **31** is revolved.

Accordingly, it will be noted that it is the resin input port **46** only which introduces liquid into the mixing nozzle **18** at a location near the seal bushing **49**, and the PAPI input port **45** is located well downstream of the resin input port **46** and seal bushing **49**. Thus, any stagnant liquid in the mixing nozzle **18** will be seen to be composed of only non-reacting substances, and that any commingled liquids are located so as to be carried completely out of the mixing nozzle **18** by the incoming solvent.

Referring again to FIGURE 2, it may be seen that the whipper assembly **31** includes a lower bearing section **40** of relatively small diameter and located on the lower end of the lower whipper body section **63**. The whipper assembly **31** is centrally supported within the cylinder **30** by means of the upper bearing **51** at the upper end of the whipper assembly **31**, and a lower bearing or seal bushing **38** located in the center of a lower bearing mount **37**.

The lower bearing mount **37** may be seen to contain internal threads at its upper end for threaded engagement with the lower end of the barrel adapter **36**, and external threads at its lower end for threaded engagement with the upper end of the spout connector **35**. Referring now to FIGURE 5, it may be seen that the lower bearing mount **37** is depicted as a spider-like component having four ribs **65** which support a central body section **66** containing the lower seal bushing **38**. The spaces between ribs **65** provide passages **67** for liquid flow from the barrel **30** into the spout **19**.

Referring again to the lower portion of FIGURE 2, there may be seen a fairing **39**, which is a generally conical body having a threaded stem inserted in the lower end of the central body section **36** of the lower bearing mount **37** and shaped so as to greatly reduce turbulence and cavitation adjacent the lower surface of this central body section **36** in the liquid flowing into the spout **19**. In addition, there may also be seen a venturi insert **34** slidably inserted in the spout **19** and having an upper flared end section resting on the inside surface of the spout connector **35**. More particularly, the venturi insert **34** has an inwardly

curved venturi-like inner surface providing a restriction in the flow path of the liquid departing the barrel **30**.

As hereinbefore stated, the basic problem with the mixers of the prior art is that the Freon tends to flash in the mixing head barrel **39**. This is quite disadvantageous, since the bubbles produced by such flashing tend to flow with the liquid mixture into the tunnel mold (not depicted) where they continue to grow at a faster rate than the bubbles intended to be generated. These larger premature bubbles are obviously inconsistent in shape and distribution with the bubbles intended to be generated during the foaming process, and thus they adversely affect the isotropicity of the finished polyurethane foam stock.

It is the purpose of the venturi insert **34** to provide a venturi-like restriction, as hereinbefore stated, so as to create a back pressure in the barrel **30** to keep the Freon from flashing or otherwise prematurely vaporizing within the mixing nozzle **18**. The cross-sectional area at the throat or narrowest point in the venturi insert **34** determines the magnitude of the back pressure, and thus the venturi insert **34** is preferably made for easy replacement whereby the back pressure may be varied as desired to compensate for changes in the various production parameters.

Instead of a venturi insert **34** such as illustrated in FIGURE 2, a conventional shutoff valve or stopcock may be used instead to provide an easily adjustable flow restriction, and to eliminate the necessity of detaching the spout connector **35** from the assembly for the purpose of changing the venturi insert **34**. However, a stopcock or shutoff valve, or the like, will inevitably create turbulence in the liquids flowing through the spout **19**, and this turbulence will tend to cause flashing or vaporizing of the Freon. The venturi insert **34**, on the other hand, is specifically designed to produce a flow having little or substantially no turbulence and which, therefore, is much to be preferred for purposes of the present invention.

The whipper assembly **31** may be revolved within the mixing nozzle **18** by any suitable source of power such as a conventional electric motor (not depicted). Accordingly, the shank section **56** of the whipper assembly **31** may be provided with a pin hole **58** and a rectangular end portion **57** for conventional interconnection with the shaft of any suitable electric motor or the like.

It is a feature of the apparatus depicted herein that the spacing between the surfaces of the main whipper body section **32**, the upper body section **60**, and the upper and lower body shoulders **61** and **62**, and the inside surfaces of the barrel **30**, the barrel adapter **36**, and the barrel connector **43**, respectively, be substantially constant.

It will be apparent that when the whipper assembly **31** is revolved, the outer ends of the pins **33** will travel at a greater linear velocity than will the portions of such pins **33** adjacent the main body section **32**. If the pins **33** are of a sufficient length, it will happen that frothing will occur at the outer end portions of such pins **33** simultaneously with incomplete or inadequate mixing adjacent the main body section **32**. Accordingly, it will be apparent that it is desirable that the whipper pins **33** be relatively short so as to minimize the velocity differential along the length of these pins **33**, especially in those instances when the whipper assembly **31** is rotated at high rotational velocities.

If the whipper body is of a uniform diameter along its entire length, it will be apparent that the whipper pins **33** located on the main body section **32** will necessarily be longer than the pins **33** located on the upper body section **60**, and that it will be extremely difficult to rotate a whipper assembly **31** of such configuration without either frothing or inadequate mixing, or both. On the other hand, if the whipper assembly **31** is constructed as depicted in FIGURE 1 wherein the spacing between the barrel **30** and the main body section **32** is at least substantially the same as the spacing between the head block **47** and the upper body section **60**, then the pins **33** will all be of the same relatively shorter length which is less prone to create the unwanted and anomalous situation of causing the Freon adjacent their tips to froth or flash and, at the same time, incompletely commingling the liquids adjacent the surface of the main body section **32** and the upper and lower shoulders **61** and **62** of the whipper assembly **31**.

Referring now to FIGURE 6, there may be seen a modified form of the structure represented illustratively in FIGURE 2, and depicting a different exemplary mixing nozzle **118** having a barrel **130**, barrel adapter **136**, lower bearing mount **137**, spout connector **135**, and spout **119**, all having substantially the configuration and function of the various components corresponding thereto which are depicted in FIGURE 2. Similarly, the barrel **130** may be seen to be provided with lateral apertures containing either plugs **142** or stationary pins **141** angularly and inwardly mounted therein, as hereinbefore described.

The depicted mixing nozzle **118** may be seen also to include a one-piece whipper assembly **131** having a lower configuration similar to the whipper assembly **31** depicted in FIGURE 2. That is, the whipper assembly **131** illustrated in FIGURE 6 may be seen to be provided with a cylindrical main body section **132** of a relatively larger preselected diameter, a lower body section **163** of a smaller diameter, a lower bearing section **140** extending concentrically from the lower body section **163**, and a frustoconical lower shoulder section **162** connecting the surfaces of the main body section **132** to the lower body section **163**.

The lower bearing mount **137** may be seen to be provided with a lower bushing or bearing **138** for rotatably supporting the lower bearing section **140** of the whipper assembly **131**, and a generally conical fairing **139** threadedly connected therebelow. A venturi insert **134** may be seen to be slidably inserted in the spout **119**, and may be further seen to have a flared upper portion supported by the tapered inside surface of the spout connector **135**.

In the apparatus depicted in FIGURE 6, the head block **147** may be seen to be longer than the head block **47** illustrated in FIGURE 2, (although this in itself is not essential to the purposes of the present invention), and to be threadedly connected to the upper end of the barrel **130**. Further, the head block **147** may be seen to be provided with a concentric passageway of the same or substantially the same diameter as the inside diameter of the barrel **130**, and to have a resin input port **146**, a PAPI input port **145** downstream thereof, and a Freon input port **144** further downstream of the PAPI input port **145**, for the reasons which have hereinbefore been explained with respect to FIGURES 2 and 3.

The main body section **132** of the whipper assembly **131** may be seen to extend into the passageway in the head block **147** past the Freon and PAPI input ports **144** and **145**, and preferably to or beyond the resin input port **146**, and to have pins **133** located along substantially the entire length thereof. The upper end of the whipper assembly **131** may be seen to include an upper bearing section **154** preferably coated with a Teflon-impregnated ceramic material **155**, as hereinbefore explained, and a shank section **156** having a rectangular end portion **157** and pin hole **158**, as in the case of the structure illustrated in FIGURE 2.

The head block **147** may be seen to be provided with an upper bearing **151** for rotatably supporting the upper end of the whipper assembly **131**, and an upper bearing housing **153** secured to the top of the head block **147** by conventional bolts **152** for supporting the upper bearing **151** concentrically with respect to the passageway in the head block **147**.

A seal bushing **149** containing one or more seal rings **150** of Teflon or synthetic rubber may be seen to be disposed in the upper bearing housing **153** and rotatably but fluid-tightly located adjacent the upper bearing section **154** of the whipper assembly **131**. A spacing ring

148 may also be provided within the upper bearing housing 153 as explained with respect to the corresponding portions of the structure illustrated in FIGURE 2.

Referring to the upper bearing sections 54 and 154 illustrated in FIGURES 2 and 6, respectively, it should be understood that any relatively hard material may be used thereon as bearing material. For example, these components may be provided with a hard chrome overlay, ground and polished to the proper dimension, instead of the ceramic material hereinbefore described.

It should be noted that it is the function of the O-rings 50 and 150 which are also illustrated in FIGURES 2 and 6, respectively, to provide a fluid-tight seal about the rotating circumference of the upper bearing sections 54 and 154, respectively. It is well known that this is ordinarily impractical, since the O-rings 50 and 150 will ordinarily be destroyed by friction between the upper bearing sections 54 and 154 during high speed rotation of these components. In the apparatus depicted in FIGURES 2 and 6, this problem is avoided and an effective seal is obtained, by having the O-rings 50 and 150 rotatably disposed about the bearing sections 54 and 154, respectively, and by filling the spaces with a suitable low viscosity lubricant having a high degree of lubricity. Such a lubricant may be the material known as "Lubriplate," which is a trademark owned by Fiske Brothers Lubricant Co., of Newark, N.J.

Although it is a feature of the present invention to provide one-piece whipper assemblies 31 and 131, as depicted respectively in FIGURES 2 and 6, it should be understood that these whipper assemblies 31 and 131 may be manufactured in separate sections according to conventional practices if rotational velocities are not normally expected to substantially exceed velocities of 2,000 to 3,000 r.p.m., more or less. It is only when velocities of 5,000 to 6,000 r.p.m. or greater are sought to be obtained, that the advantages provided by a one-piece whipping unit become sufficiently appreciable so as to warrant the expense and difficulty which is inherently attendant in making these components entirely from a single piece of steel (excepting the hard ceramic or chrome coating 55 and 155, of course).

Referring now to FIGURE 7, there may be seen a modified form of the upper portion of the apparatus illustrated in FIGURE 6, including a head block 247 having a resin input port 246, a PAPI input port 245, and a Freon input port 244, and provided with threads for attachment to a barrel 230 as hereinbefore described. In addition, there may be seen an upper bearing 251 for rotatably supporting the upper end of a whipper assembly 231, and an upper bearing housing 253 secured to the top of the head block 247 by bolts 252 for supporting the upper bearing 251 concentrically with respect to the passageway in the head block 247.

A seal bushing 249 containing one or more seal rings 250 of Teflon or synthetic rubber may be provided in the upper bearing housing 253, and located rotatably but fluid-tightly adjacent the upper bearing section 254 of the aforementioned whipper assembly 231, as previously described with respect to FIGURES 2 and 6, and a spacing ring 248 may similarly be provided within the upper bearing housing 253.

As may also be seen in FIGURE 7, the whipper assembly 231 may be constructed as hereinbefore described with respect to FIGURES 2 and 6, except that the main body section 232 abruptly terminates at a location adjacent the upper limit of the PAPI input port 245, and the upper portion of the whipper assembly 231 comprises an upper bearing section 255 of a smaller diameter and extending through the seal bushing 249. The upper bearing section 255 may further be seen to terminate in a shank section 256 having a rectangular end portion 257 and a pin hole 258, as hereinbefore explained.

The significant difference between the structures illustrated in FIGURES 6 and 7 may readily be seen to be the omission of any whipper pins 233 adjacent the resin input port 246. It will thus be apparent that the upper interior of the head block 247, in apparatus constructed as illustrated in FIGURE 7, will be substantially always filled with an unmixed layer or "belt" of resin, and that intermixing of the fluids entering the head block 247 will not occur to any significant extent above the PAPI input port 245. It is undesirable to have any interaction occur between the resin and the PAPI adjacent the seal rings 250 and the seal bushing 249, since this tends to damage the rings 250 and cause leakage. With the resin layer or "blanket" maintained adjacent the rings 250 and seal bushing 249 by the embodiment illustrated in FIGURE 7, however, no such interaction is permitted.

Referring now to FIGURES 8 and 9, there may be seen another modified portion of the structures illustrated in FIGURES 2–6, including a barrel adapter 236, a lower bearing mount 237, and a spout connector 235, all arranged as illustrated so as to support the lower portion of the whipper assembly 231 concentrically relative to the barrel (not depicted). More particularly, the lower body shoulder 262, lower body section 263, and lower bearing section 240 are illustrated as supported by a lower seal bushing 238 mounted in the body section 266 of the lower bearing mount 237. The basic distinction between the structure illustrated in FIGURES 8 and 9, and the corresponding portions of the structures illustrated in FIGURES 2, 5, and 6, may readily be seen to be in the size and arrangement of the ribs 265 which support the body section 266 of the lower bearing mount 237.

As hereinbefore stated, it is a feature of the present invention to provide aforementioned stationary pins 41 and 141 illustrated in FIGURES 2 and 6, in order to retard or prevent rotation of the liquids within the barrel 30 and 130. Although these pins have been quite effective for this purpose, it should be realized that some degree of rotation is inevitable, especially within sections of the mixing nozzle 18 and 118 below the barrel 30 and 130 respectively. Furthermore, the reduction in cross-sectional area tends to accelerate fluid flow below the barrels 30 and 130, and the combined effects of such acceleration and rotation tends to produce a vortex within the liquid flowing through the lower bearing mounts 37 and 137.

As the whirling liquids pass the ribs 65 and 165, cavitation tends to occur behind the upper edges of these ribs producing gaseous nucleation within the liquid. It has been found that this gaseous nucleation can be greatly reduced if the ribs 65 and 165 are reduced in height as may be seen with the ribs 265 illustrated in FIGURES 8 and 9. For example, it has been found that if the ribs 265 are only about three times as high as they are thick, that these ribs 265 create less disturbance and thereby less gaseous nucleation in the liquids, whereby the tendency of these liquids to separate into streaks is substantially reduced in this portion of the mixing assembly.

In addition, however, the tendency for the liquids to revolve while flowing past the lower bearing mounts 37 and 137, and to assume a vortex configuration, inherently establishes for a flow path which is non-parallel to the vertical sides of the ribs 65 and 165, irrespective of how broad these sides may be. Accordingly, the lower bearing mount 237 illustrated in FIGURES 8 and 9 may be seen to be provided with ribs 265 which are pitched so as to conform with the flow path of the whirling liquids, whereby the tendency for gaseous nucleation to occur is further substantially reduced in this portion of the mixing assembly.

It will be noted that the stationary pins 41 and 141 respectively are illustrated in FIGURES 2 and 6 as having rectangular or square configurations. Although such a configuration has been found suitable for present purposes, it should be understood that the ideal pin configuration is substantially dependent on the velocity and

viscosity of the liquids. Accordingly, pins **41** and **141** may have round or diamond-shaped configurations, without such modification constituting a fundamental departure from the concept of the present invention.

Various other modifications may suggest themselves from a consideration of the methods and apparatus described herein and depicted in the drawings. Accordingly, it should be understood that the forms of the present invention described herein and illustrated by the structures and processes depicted in the drawings, are illustrative only and are not intended as limitations on the present invention.

What is claimed is:

1. Apparatus or commingling a plurality of liquids into a substantially homogeneous mixture, said apparatus comprising

a cylindrical tubular member having a plurality of lateral apertures arranged in the wall thereof and each adapted to be closed by a stoppering means,

a whipper means concentrically disposed in said cylindrical tubular means and having on its surface a plurality of perpendicularly outwardly projecting pin-like extensions for shearing and commingling liquids adjacent thereto, and

a preselected number of pin members disposed in at least a portion of said apertures in said cylindrical tubular member and projecting angularly inwardly thereof and generally tangentially toward said whipper means between said pin-like extensions thereof.

2. The apparatus described in claim **1**, wherein said lateral apertures are arranged in a plurality of equally spaced apart longitudinal alignments about the wall of said cylindrical tubular member.

3. The apparatus described in claim **2**, wherein said apparatus further includes

liquid intake means having a central passageway communicating with the interior of said cylindrical tubular member and a plurality of liquid input ports for receiving and separately introducing selected different liquids into said passageway at different locations.

4. The apparatus described in claim **3**, wherein said liquid intake means includes a first port for receiving and for introducing a relatively warmer liquid into said passageway at a first upstream location therein and a second port for receiving and for introducing a relatively colder liquid into said passageway at a second downstream location therein so as to provide a commingled liquid flow at a third location downstream of said second location and colder than said relatively warmer liquid.

5. The apparatus described in claim **4**, wherein said liquid intake means comprises

manifold means having a central passageway and having a first input port for conducting liquid into said passageway at a first location and a second input port generally opposite said first input port for conducting liquid into said passageway at a second different location downstream of said first location, and

a first tubular connector interconnecting the upstream end of said cylindrical tubular member with the downstream side of said manifold means and having a third input port for receiving a third stream of liquid and for commingling said third stream with said first and second streams at a point downstream from said first and second locations.

6. Apparatus for commingling a plurality of liquids into a substantially homogeneous mixture, said apparatus comprising

a cylindrical tubular member,

manifold means having a central passageway having a first input port for conducting a first stream of liquid into said passageway at a first location and a second input port generally opposite said first input port for conducting a second stream of liquid into said passageway at a second different location downstream of said first location,

a first tubular connector interconnecting the upstream end of said cylindrical tubular member with the downstream side of said manifold means and having a third input port for receiving a third stream of liquid and for commingling said third stream with said first and second streams at a point downstream from said first and second locations,

a tubular spout member adapted to discharge a viscous liquid mixture,

a second tubular connector interconnecting the downstream end of said cylindrical tubular member with said tubular spout member and having a tapered inside surface for connecting the inside surfaces of said tubular spout means and said cylindrical tubular member,

a flow restriction means adapted to develop a back pressure in said cylindrical tubular member during liquid flow therethrough, and

a whipper means concentrically disposed in said cylindrical tubular means and said first and second tubular connectors and having a plurality of perpendicularly outwardly projecting pin-like extensions each of substantially equal length and substantially equal rectangular cross-sectional configuration and arranged about said body portion in a plurality of equally spaced apart alignments longitudinal thereof for shearing and commingling intermixed liquid adjacent there.

7. The apparatus described in claim **6**, wherein said flow restriction means has a venturi-like interior configuration.

8. The apparatus described in claim **7**, wherein said tubular spout member has an inside diameter smaller than the inside diameter of said tubular bearing support means, and wherein said flow restriction means is slidably disposed in said spout member and has a flared upstream end.

9. Apparatus for commingling a plurality of liquids into a substantially homogeneous mixture, said apparatus comprising

a cylindrical tubular member having a preselected number of lateral apertures arranged in a preselected number of equally spaced apart longitudinal alignments about the wall thereof and each adapted to be closed by a stoppering means,

manifold means having a central passageway and having a first input port for conducting a first stream of liquid into said passageway at a first location and a second input port generally opposite said first input port for conducting a second stream of liquid into said passageway at a second different location downstream of said first location,

a first tubular connector interconnecting the upstream end of said cylindrical tubular member with the downstream side of said manifold means and having a third input port for receiving a third stream of liquid and for commingling said third stream with said first and second streams at a point downstream from said first and second locations,

tubular bearing support means having a plurality of spaced apart rib portions centrally supporting a bearing support portion,

a second tubular connector interconnecting the downstream end of said cylindrical tubular member with said tubular bearing support means,

a tubular spout member adapted to discharge a viscous liquid mixture,

a tubular spout connection detachably connected to said tubular bearing support means for coupling said spout member thereto downstream of said cylindrical tubular member,

a flow restriction means slidably disposed in said spout member to develop a back pressure in said cylin-

drical tubular member during liquid flow therethrough and having a portion of its inside surface provided with a generally venturi-like configuration,

a generally conically shaped fairing member mounted on the downstream side of the bearing support portion of said tubular bearing support means and extending concentrically into said flow restriction means adjacent said venturi-like portion thereof,

a bearing means disposed centrally in said tubular bearing support means and on the upstream side of said bearing support portion thereof,

bearing and sealing means disposed in said manifold means for stoppering said passageway therein upstream of said first location,

a whipper means concentrically disposed in said cylindrical tubular means and said first and second tubular connectors and having an upper extension rotatably disposed in a fluid-tight manner in said bearing and sealing means and having a lower extension rotatably positioned in said bearing means,

said whipper means also having a cylindrical body portion with a configuration generally establishing a substantially constant spacing along its length between said whipper means and the inside surfaces of said cylindrical tubular means, said first and second tubular connectors and said manifold means, and further having on its surface a plurality of perpendicularly outwardly projecting pin-like extensions each of substantially equal length and substantially equal rectangular cross-sectional configuration and arranged about said body portion in a plurality of equally spaced apart alignments longitudinal thereof for shearing and commingling intermixed liquids adjacent thereto, and

a preselected number of pin members disposed in at least a portion of said apertures in said cylindrical tubular member and projecting inwardly thereof toward and generally tangentially to the body portion of said whipper means between said pin-like extensions thereof.

10. The apparatus described in claim **9**, wherein said whipper means including said body portion, upper and lower extensions, and said pin-like extensions thereof is formed as a single unit from a single coherent mass of material.

11. The apparatus described in claim **10**, wherein a coating of a relatively hard material is disposed on the surface of said upper extension of said whipper means and rotatably within said bearing and sealing means.

12. The apparatus described in claim **11**, wherein said cylindrical tubular member has a larger inside diameter than that of said passageway in said manifold means, and

wherein the spacing between the surface of said whipper means and said manifold means along at least a portion of said passageway therein is substantially the same spacing as that between said whipper means and the inside surface of said cylindrical tubular member.

13. The apparatus described in claim **11**, wherein said material is a Teflon-impregnated ceramic material.

14. The apparatus described in claim **11**, wherein said material is a hard chrome alloy material.

15. Apparatus for commingling a plurality of liquids into a substantially homogeneous mixture, said apparatus comprising

a cylindrical tubular member having a first preselected inside diameter and a preselected number of lateral apertures arranged in a preselected number of equally spacer apart longitudinal alignments about the wall thereof and each adapted to be closed by a stoppering means,

manifold means having a central passageway of a second preselected diameter smaller than said first diameter and having a first input port for conducting a first stream of liquid into said passageway at a first location and a second input port generally opposite said first input port for conducting a second stream of liquid into said passageway at a second different location downstream of said first location,

a first tubular connector interconnecting the upstream end of said cylindrical tubular member with the downstream side of said manifold means and having a tapered inside surface for connecting the inside surfaces of said manifold means and said cylindrical tubular member and a third input port for receiving a third stream of liquid and for commingling said third stream with said first and second streams at a point downstream from said first and second locations,

tubular bearing support means having an inside diameter smaller than said first preselected inside diameter of said cylindrical tubular member and having a plurality of spaced apart rib portions centrally supporting a bearing support portion,

a second tubular connector interconnecting the downstream end of said cylindrical tubular member with said tubular bearing support means and having a tapered inside surface for connecting the inside surfaces of said tubular bearing support means and said cylindrical tubular member,

a tubular spout member adapted to discharge a viscous liquid mixture and having an inside diameter smaller than the inside diameter of said tubular bearing support means,

a tubular spout connection detachably connected to said tubular bearing support means for coupling said spout member thereto downstream of said cylindrical tubular member and having a tapered inside surface for connecting the inside surfaces of said spout member and said tubular bearing support means,

a flow restriction means slidably disposed in said spout member and adapted to develop a back pressure in said cylindrical tubular member during liquid flow therethrough and having a flared upstream and adapted to abut the tapered inside surface of said spout connector and having a portion of its inside surface provided with a generally venturi-like configuration,

a generally conically shaped fairing member mounted on the downstream side of the bearing support portion of said tubular bearing support means and having its apex end extending at least partially into said flow restriction means concentrically relative to the venturi-like portion of the inside surface thereof,

a bearing means disposed centrally in said tubular bearing support means and on the upstream side of said bearing support portion thereof,

bearing and sealing means disposed in said manifold means for stoppering said passageway therein upstream of said first location,

a whipper means concentrically disposed in said cylindrical tubular means and said first and second tubular connectors and having an upper extension with a Teflon-impregnated ceramic surface coating rotatably disposed in a fluid-tight manner in said bearing and sealing means and having a lower extension rotatably positioned in said bearing means,

said whipper means also having a cylindrical body portion with a configuration generally establishing a substantially constant spacing along its length between said whipper means and the inside surfaces of said cylindrical tubular means, said first and second tubular connectors and said manifold means, and further having on its surface a plurality of perpendicularly outwardly projecting pin-like extensions each of substantially equal length and substantially equal rectangular cross-sectional config-

uration and arranged about said body portion in a plurality of equally spaced apart alignments longitudinal thereof for shearing and commingling intermixed liquids adjacent thereto,

said body portion, upper and lower extensions, and said pin-like extensions of said whipper means being formed as a single unit from a single mass of material, and

a preselected number of pin members disposed in at least a portion of said apertures in said cylindrical tubular member and projecting inwardly thereof toward and generally tangentially to the body portion of said whipper means between said pin-like extensions thereof.

16. Apparatus for commingling a plurality of liquids into a substantially homogeneous mixture, said apparatus comprising

a cylindrical tubular member,

liquid intake means having a central passageway communicating with the interior of said cylindrical tubular member and a plurality of liquid input ports for receiving and separately introducing selected different liquids into said passageway at different locations,

a tubular spout member adapted to discharge a viscous liquid mixture,

a connector interconnecting the downstream end of said cylindrical tubular member with said tubular spout member,

a flow restriction means adapted to develop a back pressure in said cylindrical tubular member during liquid flow therethrough, and

a whipper means concentrically disposed in said cylindrical tubular means and said first and second tubular connectors and having a plurality of perpendicularly outwardly projecting pin-like extensions each of substantially equal length and substantially equal rectangular cross-sectional configuration and arranged about said body portion in a plurality of equally spaced apart alignments longitudinal thereof for shearing and commingling intermixed liquid adjacent thereto.

17. The apparatus described in claim **16**, wherein said flow restriction means has a venturi-like interior configuration.

18. The apparatus in claim **17**, wherein said apparatus further comprises

a plurality of pin members disposed in said cylindrical tubular member and projecting inwardly thereof toward said whipper means between said pin-like extensions thereof.

19. The apparatus in claim **18**, wherein said pin members project angularly inward of said cylindrical tubular member and generally tangentially to said whipper means.

20. Apparatus for commingling a plurality of liquids into a substantially homogenous mixture, said apparatus comprising

a cylindrical tubular member,

manifold means having a central passageway and having a first input port for conducting liquid into said passageway at a first location and a second input port generally opposite said first input port for conducting liquid into said passageway at a second different location downstream of said first location,

a first tubular connector interconnecting the upstream end of said cylindrical tubular member with the downstream side of said manifold means and having a third input port for receiving a third stream of liquid and for commingling said third stream with said first and second streams at a point downstream from said first and second locations, and

a rotatable whipper means concentrically located therein.

21. The apparatus described in claim **20**, wherein said apparatus further comprises

a tubular spout member adapted to receive a viscous liquid mixture from said cylindrical tubular member, and

a flow restriction means disposed generally between said spout member and said cylindrical tubular member to develop a back pressure in said cylindrical tubular member during liquid flow therethrough and having a generally venturi-like interior configuration.

22. Apparatus for commingling a plurality of liquids into a substantially homogenous mixture, said apparatus comprising

a cylindrical tubular member adapted to receive said liquids at one end and having a tapering exit end having a progressively reducing cross-sectional area for ejecting said liquids,

a whipper means concentrically disposed in said cylindrical tubular means and having on its surface a plurality of outwardly projecting pin-like members for shearing and thereby commingling said received liquids,

a plurality of stationary pin members mounted in said cylindrical tubular member and projecting toward said whipper means, and

a bearing support means interconnected with said cylindrical tubular member downstream of said tapering exit end thereof and having a whipper support portion support by a plurality of equally spaced apart rib members generally aligned in conformance with the flow path of said liquids discharged through said tapered exit end and each having a height not greater than three times its thickness.

23. The apparatus as described in claim **22**, wherein said whipper and said tapered exit end of said cylindrical tubular member cooperate to accelerate said liquids along a flow path having a generally whirling vortex-like configuration, and

wherein said rib members are tilted relative to said whipper support portion of said bearing support means for alignment generally with said vortex-like flow path of said accelerated liquids.

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