United States Patent [19]

Shano

[11] **3,782,694**

[45] **Jan. 1, 1974**

[54] **APPARATUS AND METHOD FOR MIXING MATERIALS**

[75] Inventor: **Charles L. Shano,** Phoenix, Ariz.

[73] Assignee: **Western Controls Inc.,** Pheonix, Ariz.

[22] Filed: **Sept. 18, 1972**

[21] Appl. No.: **289,821**

[52] **U.S. Cl.** **259/4**

[51] **Int. Cl.** **B01f 15/02**

[58] **Field of Search** ..... 259/4, 18, 36, DIG. 17

[56] **References Cited**

UNITED STATES PATENTS

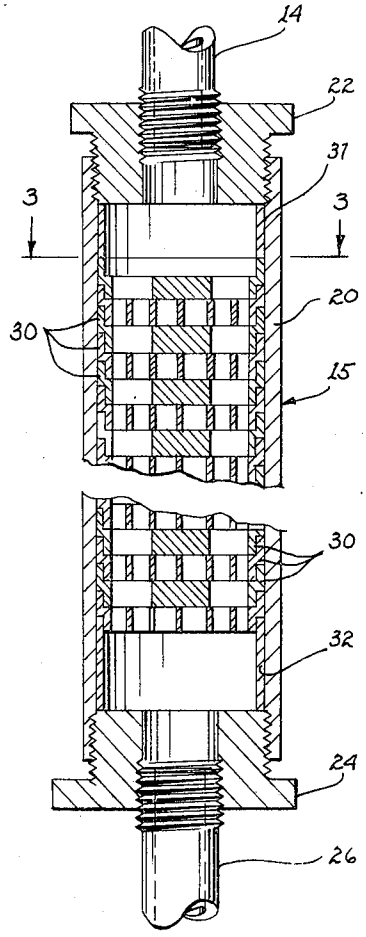
2,890,868	6/1959	Potchen	259/4
3,206,170	9/1965	Schippers	259/4
3,526,391	9/1970	Church	259/4
3,582,048	6/1971	Sarem	259/4
3,623,704	11/1971	Skobel	259/4
3,701,619	10/1972	Appeldoorn	259/4

Primary Examiner—Robert W. Jenkins
Attorney—William C. Cahill et al.

[57] **ABSTRACT**

A method and apparatus is disclosed wherein a material or fluid stream is directed along a longitudinal axis of an elongated segmented tubular member. The stream is divided into halves, and each half is directed against a transverse wall of one of the segments wherein the half streams are again divided into quarter streams while simultaneously directed transversely of the tubular member. The quarter streams are directed through passageways in the segment and are subsequently recombined with each quarter stream being combined with a quarter stream from a different half stream. Simultaneous with the recombination, the newly formed half streams are again directed longitudinally of the tubular member.

6 Claims, 8 Drawing Figures



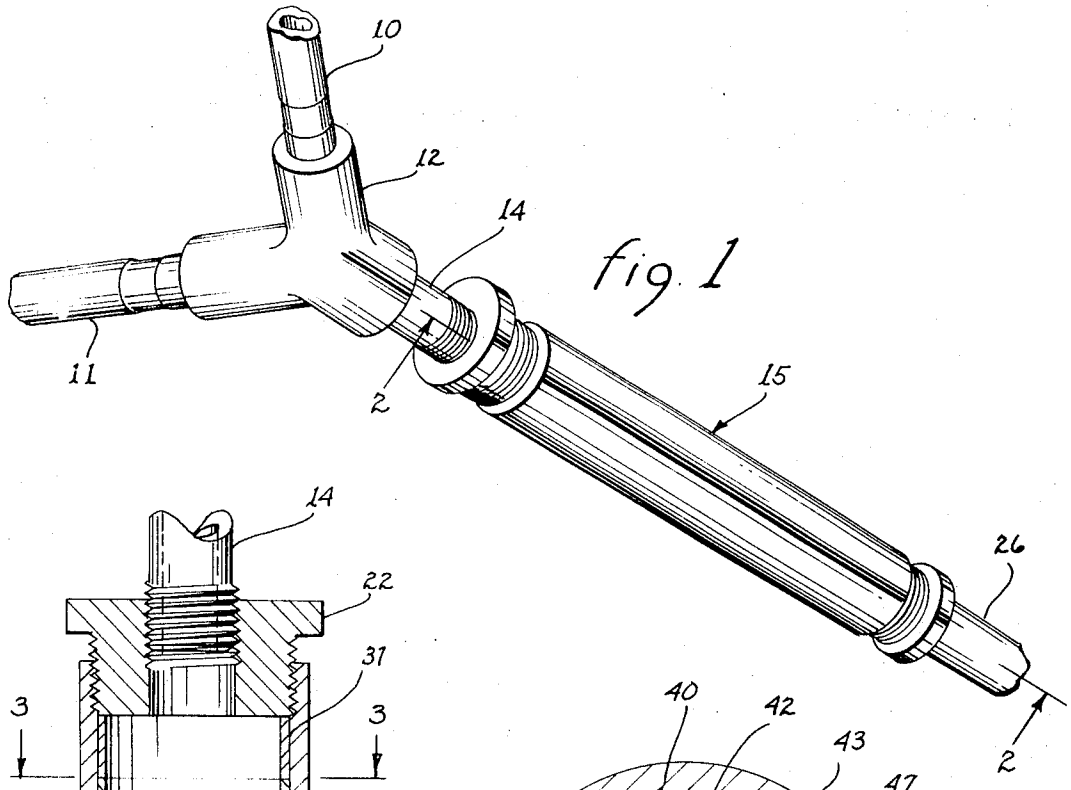


fig. 1

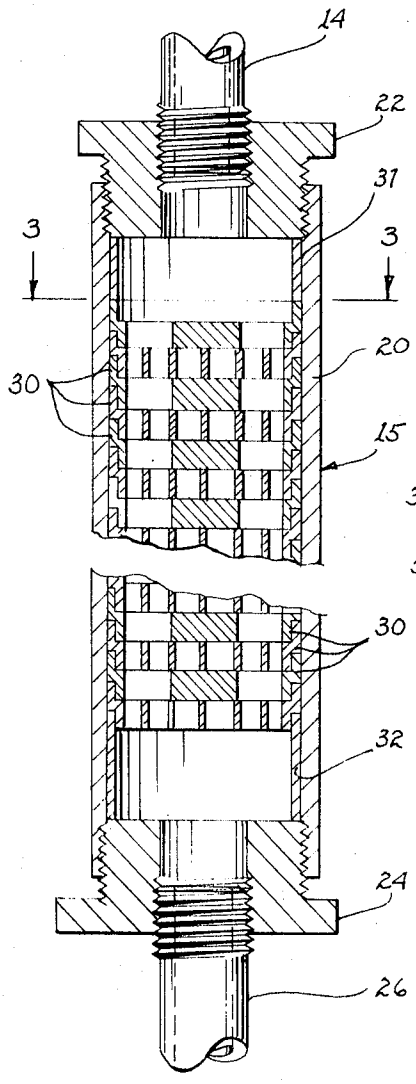


fig. 2

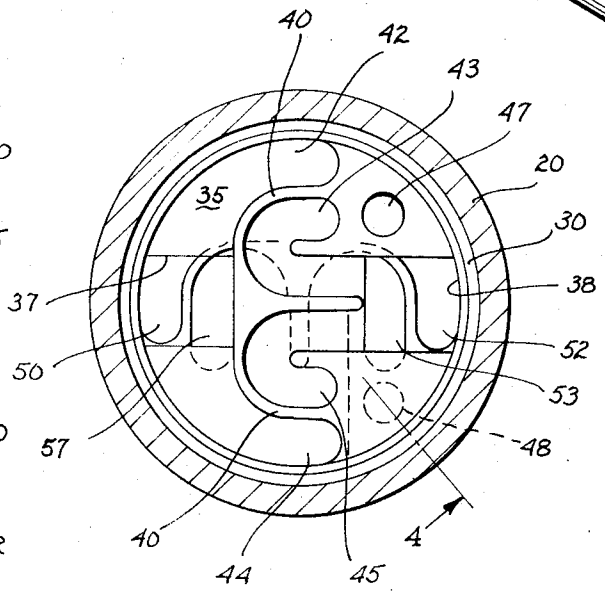


fig. 3

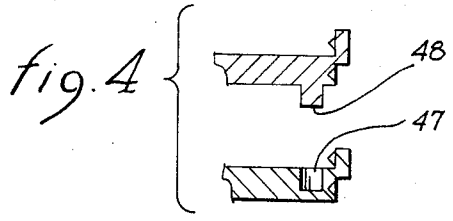


fig. 4

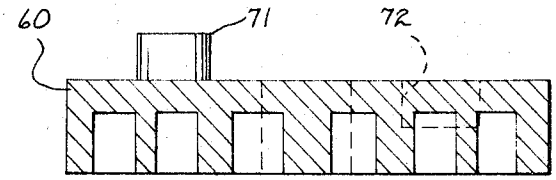


fig. 6

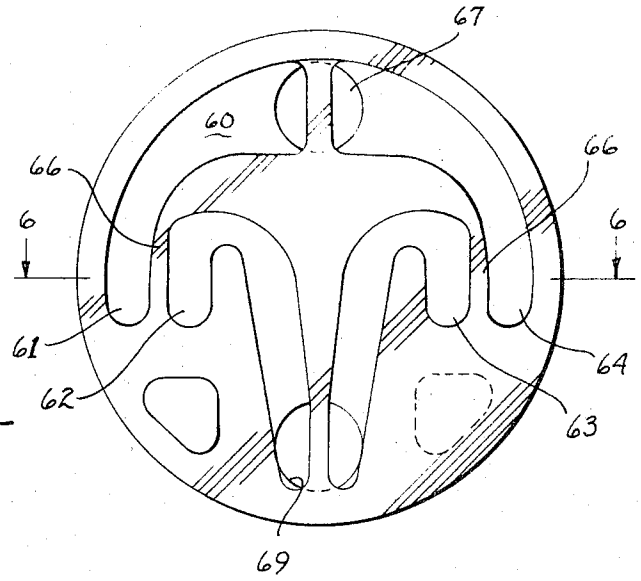


fig. 5

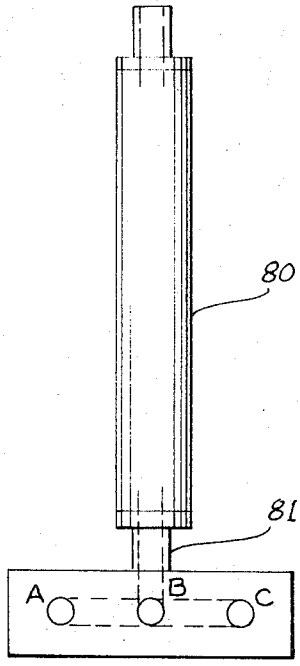


fig. 7

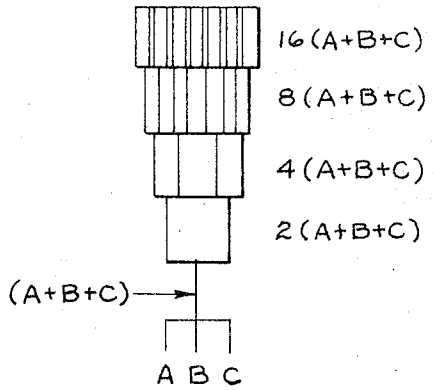


fig. 8

APPARATUS AND METHOD FOR MIXING MATERIALS

The present invention relates to mixing apparatus and methods, and particularly to a method and apparatus for receiving fluid streams, each of a different material, and recombining the streams into a single homogeneous stream.

It is frequently important to insure the homogeneity of a fluid and to mix different fluids to form the homogeneous fluid immediately prior to its utilization. The mixing of such fluids has previously required the use of relatively complex apparatus if complete homogeneity is to be insured; further, the complexity of such apparatus indicates a relatively high cost. Typically, fluids to be recombined are transmitted to a mixing device and, after mixing, are transported to the point of utilization through a cylindrical conduit. The mixing apparatus therefore usually may conveniently take the form of a cylindrical member connected in series with the exit conduit. The material being mixed or the fluids passing through the mixer may require the addition of heat or the mixing process may be exothermic, requiring the removal of heat in the mixer. The surface area of contact between the fluid passing through the mixer is an important function of the ability of the apparatus to conduct heat either from or to the fluid passing therethrough.

It is therefore an object of the present invention to provide a mixing apparatus for receiving a plurality of fluids to be mixed and for mixing the fluids to provide a single homogeneous fluid.

It is another object of the present invention to provide a mixing apparatus that is inexpensive to manufacture while providing an efficient structure to insure thorough mixing of the fluids.

It is still another object of the present invention to provide a mixing apparatus that can readily be disassembled for cleaning and replacing worn parts.

It is still another object of the present invention to provide apparatus for conducting fluids therethrough incorporating a large surface area in contact with the fluid to promote efficient heat transfer.

It is also an object of the present invention to provide a method for mixing fluid streams to provide a single homogeneous fluid stream.

It is a further object of the present invention to provide a method for mixing fluid streams wherein the fluid is divided into smaller streams while the direction of fluid flow is changed from longitudinal to transverse.

These and other objects of the present invention will become apparent to those skilled in the art as the description thereof proceeds.

The present invention may be described by reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of apparatus constructed in accordance with the teachings of the present invention for mixing two fluids.

FIG. 2 is a cross-sectional view of a portion of FIG. 1, taken along line 2—2.

FIG. 3 is a cross-sectional view of FIG. 2, taken along line 3—3.

FIG. 4 is a cross-sectional view of a portion of FIG. 3, taken along line 4—4.

FIG. 5 is a plan view of a modified segment for use in the method and apparatus of the present invention.

FIG. 6 is a cross-sectional view of FIG. 5, taken along line 6—6.

FIG. 7 is a schematic view of the apparatus of the present invention, showing the application of the invention to the mixing of three fluids.

FIG. 8 is a schematic diagram useful for describing the mixing operation of the apparatus of the present invention.

Referring now to FIGS. 1–4, conduits 10 and 11 are each connected to a different source (not shown) of fluid, said fluids to be mixed. The conduits 10 and 11 are connected in any conventional means, such as a Y coupling 12, thus superficially combining the two fluids in conduit 14. Conduit 14 is connected to the apparatus of the present invention 15 which is shown in cross section in FIG. 2. The fluids, superficially mixed in the conduit 14, enter the mixing apparatus 15 longitudinally thereof. The mixing apparatus incorporates a cylindrical housing 20 which is internally threaded at either end to receive end fittings 22 and 24 which, in turn, are connected to an input conduit 14 and an output conduit 26 respectively. The housing 20, in the embodiment chosen for illustration, is cylindrical but it will be obvious to those skilled in the art that a rectangular or other cross section may be used, although with somewhat less efficiency. The housing supports a plurality of segments 30, each segment being identical with the others. The segments are interfitted with each succeeding segment so as to form a fluid-tight segmented cylinder through which the fluids pass, as will be described more fully hereinafter. The interfitted segments 30 may be spaced from the ends of the housing 20 by suitable spacers 31 and 32.

Each of the segments may conveniently be molded of plastic, or, in the event the apparatus is used in a heat exchanging environment, may be of an appropriately formed metal or other high heat conductivity metal.

Referring specifically to FIG. 3, the segment 30 shown therein may be seen to include a transverse wall 35 which, if not provided with openings therethrough, would interrupt the flow of fluid through the segment. However, the transverse wall 35 is provided with two openings 37 and 38 positioned diametric with respect to each other. A dividing partition 40 extends upwardly from the transverse wall 35; the dividing partition 40 forms passageways 42, 43, 44, and 45, each of said passageways extending transversely to the longitudinal axis of the housing 20. Each segment 30 is provided with a detent 47 and an extension 48 (see FIG. 4) wherein each segment, while identical to all other segments, is rotated 90° with respect to the succeeding segment since the extension 48 is positioned 90° about the axis of the housing 20 from the detent in that segment. Therefore, as the segments are "stacked", the extensions 48 prevent the segments from nesting unless they are rotated 90° with respect to each other. The segments are formed so as to stack and "snap" together to form a self-sealing structure that may be used without the housing 20, although the housing 20 adds structural strength to the assembly.

With the 90° orientation of the succeeding segments, it may be seen that the openings 37 and 38 in the transverse wall 35 are oriented with the passageways 50, 51, 52, and 53 of the next succeeding segment. Similarly, the next preceding segment would have its openings oriented with the passageways 42, 43, 44, and 45. In this manner, fluid exiting from the preceding segment

into the segment shown in FIG. 3 would be in the form of two streams flowing longitudinally of the housing **20**, the first of which would flow directly into the segment **30** and be divided by the partition **40** into two streams, one flowing in the passageway **42** and the other flowing in the passageway **43**; the second of the streams entering the segment **30** would be divided by the partition **40** into two streams, one flowing in the passageway **44** and the other flowing in the passageway **45**. That portion of the fluid flowing in channels **42** and **44** is recombined at the opening **37**, while the fluid flowing in channels **43** and **45** is recombined at the opening **38**. The fluid stream entering the housing **20** is therefore first divided into halves, each half flowing through an opening such as that at **37** and **38** on to the second segment. The flow up to this point has been essentially longitudinal but upon passing through the openings **37** and **38** is simultaneously divided by the partition **40** and is directed transversely of the housing **20**. Each half stream is accordingly divided into quarter streams, each quarter stream following one of the passageways **42, 43, 44** and **45**. When the quarter streams travel their respective passageways and reach an opening **37** or **38**, the quarter streams are recombined into half streams; however, each quarter stream is combined with a quarter stream of a different half stream. Simultaneously with the recombination of the quarter streams, the newly formed half streams again flow longitudinally of the housing **20** to the next segment **30**. In this manner, the superficially mixed fluid entering the mixing apparatus **15** from the conduit **14** is first divided into two half streams; each half stream is divided into quarter streams while simultaneously with such division the direction of the quarter streams is changed from longitudinal to transverse. Each quarter stream travels a transverse path to be recombined with a different quarter stream while the direction is simultaneously changed from transverse to longitudinal. The change in direction of the fluid as it passes through the respective segments forces the fluid against the transverse walls of the segments as the fluids changes direction from longitudinal to transverse. This direction change not only enhances the mixing of the fluids but in those instances where the apparatus is used in a heat transferring environment, the direction change and large fluid surface contact area effectively reduces boundary layer insulation to greatly enhance the heat transfer capacity of the apparatus. Further, flow direction can be reversed with equal effectiveness.

Referring now to FIGS. **5** and **6**, a modified segment form is shown. A transverse wall **60** forces fluid streams impinging thereagainst to change from a longitudinal to a transverse direction of flow. Passageways **61, 62, 63,** and **64** receive fluid streams from the preceding segment and direct the streams, after being divided by partition **66**, to openings **67** and **69**. The openings **67** and **69** register with the beginnings of the passageways of the next succeeding segment in a manner described in the preceding embodiment. The successive segments of the embodiment shown in FIGS. **5** and **6** are also rotated 90° with respect to each other through the utilization of an extension **70** and a corresponding detent **72** positioned 90° with respect to each other about the axis of the segment. It may be seen that the embodiment shown in FIGS. **5** and **6** incorporates the same features of the segment shown in FIG. **3** and that only the specific shape has been changed.

Referring now to FIGS. **7** and **8**, a schematic mixer **80** is shown connected to receive three fluid streams A, B, and C, said streams having been superficially mixed by combination with the input conduit **81**. Referring to FIG. **8**, it may be seen that the fluid stream containing the three separate fluids (A + B + C) may be mixed to any desired degree by simply adding additional segments to the mixing apparatus. If only one segment is used, the stream is divided into two streams which may then be recombined; however, if two segments are used, the two streams exiting from the first segment are again divided, thus effectively producing four streams. Similarly, successive segments each effectively double the number of streams that are produced during the mixing of the fluids as it passes through the mixing apparatus. The degree of mixing desired may be determined in accordance with numerous factors, but the apparatus of the present invention will divide and recombine for every segment that is added to the stack of segments. Thus, the precise number of segments required to provide the desired degree of mixing may be determined, thereby permitting unneeded segments to be removed to minimize the fluid pressure required to force the fluid through the mixing apparatus.

I claim:

1. Mixing apparatus for transmitting and mixing fluids comprising:

a. an elongated segmented tubular member, having a longitudinal axis, for connection to a source of fluids to be mixed, said fluids entering and exiting said tubular member parallel to said longitudinal axis;

b. means within said tubular member for dividing a fluid stream entering said tubular member into a plurality of minor streams;

c. each segment of said tubular member including:

1. a transverse wall for intercepting each of said minor streams and directing said minor streams transversely of said tubular member,

2. a dividing partition extending from said transverse wall for dividing each of said minor streams into portions thereof,

3. a plurality of segment exits,

4. a plurality of transversely extending passageways for directing the portions of each minor stream to a different one of said segment exits to be combined at said exits with the portions of a different one of said minor streams;

d. said fluids directed longitudinally from the exits of each segment to the succeeding segment.

2. The combination set forth in claim **1**, wherein said elongated segmented tubular member is cylindrical.

3. The combination set forth in claim **1**, wherein said means for dividing a fluid stream into a plurality of minor streams comprises the first segment of said tubular member to be encountered by said fluid stream entering said tubular member.

4. The combination set forth in claim **1**, wherein said segments are identical and are nested with respect to each other and are rotated 90° with respect to the preceding and succeeding segments.

5. The combination set forth in claim **1**, wherein said segments are interfitted with each preceding segment to provide a seal therebetween and to form said tubular member.

6. A method for mixing different fluid streams to form a single homogeneous fluid stream, comprising the steps of:

a. combining said different fluid streams to form a single fluid stream flowing along a given axis;

b. dividing said single fluid stream into two half streams flowing longitudinally along said axis;

c. dividing each of said half streams into quarter streams while simultaneously changing the direction of said quarter streams to transverse of said axis;

d. combining each quarter stream of one half stream with a quarter stream of another half stream while simultaneously changing the direction of flow to parallel to said axis to form new half streams; and

e. combining said new half streams to form a single stream.

* * * * *