An interfacial surface generator is formed by clamping a flexible tube between a plurality of pairs of angularly disposed elongate elements wherein adjacent pairs of elements are axially displaced about 90° and are of opposite hand.

5 Claims, 7 Drawing Figures
INTERFACIAL SURFACE GENERATOR FORMING APPARATUS

An interfacial surface generator can be prepared by forming a plurality of crimps in a deformable tube such as a metal or glass tube. Such crimps have inwardly extending peaks which are angularly disposed with respect to the axis of the tube and the peaks of opposed crimps generally can be considered to form a cross. Such a mixer can be considered to have two varieties of crimps; a first set which can be arbitrarily designated as right hand and a second set designated as left hand. The crimps are alternating right and left hand and each set of crimps is disposed generally at right angles to the remaining set of crimps. Such a mixer manipulates a stream in such a manner that it is divided, laterally stretched and recombined in such a manner that new interfaces are formed between the stream portions. Such a mixer is disclosed in U.S. Pat. No. 3,358,749. For many applications, it is often desired to mix hardenable chemically reactive materials rapidly such as thermosetting resin components. Frequently it is necessary in mixers handling such hardenable reactive materials that elaborate precautions be taken to prevent hardening of the resinous material within the equipment. Such precautions may involve automated solvent purging and the like.

It would be desirable if there were available an apparatus which would permit the rapid preparation of an interfacial surface generator of low strength materials.

It would also be desirable if there were available an apparatus which would convert low cost, low strength materials into an interfacial surface generator which would permit discarding of the interfacial surface generator after use.

It would further be desirable if there were available an apparatus which would conveniently form flexible tubing into an interfacial surface generator.

These benefits and other advantages in accordance with the present invention are achieved in an apparatus for the preparation of an interfacial surface generator, the apparatus comprising a base, the base having a longitudinal axis, an elongate pressure member affixed to the base and angularly disposed with respect to the longitudinal axis, a second elongate member oppositely disposed from the first longitudinal member, the second elongate member being in spaced relationship to the first member and angularly disposed to the first elongate member and the longitudinal axis, the second elongate member being supported by a first positioning means, the first positioning means selectively positioning the second elongate member adjacent to or remote from the first elongate member, the first and second elongate members forming a first pair of elongate members, a second pair of elongate members axially disposed relative to the first pair of elongate members and similarly supported, with the difference being that a projection of the longitudinal axis of the first pair of elongate members and a projection of the axis of the second pair onto a plane normal to the longitudinal axis of the apparatus provides a pattern which has the general configuration of two overlapping crosses.

Further features and advantages of the present invention will become more apparent from the following specification taken in connection with the drawing wherein:

FIGS. 1, 2 and 3 are schematic representations of three views of elongate elements as employed in the practice of the present invention.

FIG. 4 is an end or axial representation of an apparatus of the invention.

FIG. 5 is a side view of the apparatus of FIG. 4.

FIG. 6 is a schematic representation of an alternate embodiment of the invention.

FIG. 7 is an end view of another alternate embodiment of the invention.

FIGS. 1, 2 and 3 schematically depict three views of elongate pressure elements shown in a position which deform a flexible tube (not shown) passing between adjacent elements into the configuration of a mixer having crimps generally as shown in U.S. Pat. No. 3,358,749. In FIGS. 1 and 2 there are shown three pair of elongate elements, a first pair 11 consisting of a first element 12 and a second element 13. A second elongate element pair 15 is disposed adjacent the pair 11. The pair 15 consists of a first element 16 and a second element 17. A third element pair 19 is disposed adjacent the pair 15 and remote from the pair 19. The element pair 19 comprises an element 21 and a second element 22. In FIGS. 1 and 2 a dotted line represents an axis which is equivalent to the longitudinal axis of a mixer formed by positioning the flexible tube between the various elongate element pairs. FIG. 2 is a view of the arrangement of FIG. 1 as the arrangement of FIG. 1 is rotated 90° to the left.

FIG. 3 is a view of the arrangement of FIG. 1 taken along the axis. Thus, in an axial view a projection of the longitudinal axis of the elements 12, 13, 16 and 17 projected onto a plane normal to the axis forms a pattern of two overlapped crosses, each cross having two adjacent long arms and two adjacent short arms.

FIG. 4 is an end view of an apparatus in accordance with the present invention generally designated by the reference numeral 25. The apparatus 25 comprises an elongate frame or support member 26. The frame has affixed thereto a first support member 28. The support member 29 has affixed thereto an elongate pressure element 29. The pressure element 29 is in generally fixed arrangement relative to the frame 26. Fixed to the support member 28 generally adjacent to the frame is a selective positioning means 31 such as a toggle clamp. The positioning means or clamp 31 has a moveable arm 32 having a first end pivotally affixed about a pivot 33 which is in fixed position relative to the frame 26. The arm 32 has disposed thereon remote from the pivot 33 an elongate pressure element 35. The element 35 is fixed in spaced relationship to the element 29. The elements 35 and 29 are similarly positioned to the elements 12 and 13 of FIGS. 1, 2 and 3. A locking and positioning means or handle 37 in operative combination with the arm 32 selectively permits positioning of the pressure element 35 adjacent the elongate element 29 and remote therefrom. Beneficially, a wide variety of clamping means are employed; however, for many purposes it is often desired to use toggle clamps as they are readily available and relatively inexpensive. A second support means 28A has clamping means 31A adjacent the clamping means 31 and disposed generally in a plane at 90 degrees to the support 28. For clarity of illustration, the end of the arm equivalent to the arm 32 has been omitted.

FIG. 5 is a side view of apparatus 25 showing the location of two clamping means 31 on one side of the
frame 26 and two clamping means 31A on the opposite side of the frame. A flexible tube 38 is grasped by the clamping members and deformed into a mixer of the configuration shown in U.S. Pat. No. 3,358,749.

In FIG. 6 there is shown a schematic plan view of an apparatus in accordance with the invention generally designated by the reference numeral 50. The apparatus 50 has a plurality of first clamping means 51 and a second plurality of clamping means 52 oppositely disposed and interdigitated therewith. The clamping means 51 and 52 are generally similar to the clamping means 31 of FIG. 4. Each of the clamping means supports a pair of elongate pressure elements such as depicted in FIGS. 1, 2 and 3 wherein the configuration of the pressure elements in clamping means 51 are identical and the configuration of the elongate pressure elements in the clamping means 52 are generally identical. The clamping means 51 has a common actuating means or operating handle 64 and the means 52 also has a common operating means 55 which permits the simultaneous opening of the clamping means 51 on actuation of the bar or handle 64 and simultaneous opening of the clamping means 52 on actuation or opening of the bar or handle 55.

In FIG. 7 there is depicted an end view of an apparatus in accordance with the present invention generally designated by the reference numeral 60. The apparatus 60 has an elongate frame member 61. The frame member 61 has a generally channel-shaped configuration. Generally centrally disposed within the frame 61 is a fixed element support 62. Affixed to the element 62 is a first fixed element 63 and a second fixed element 64 generally equivalent to the elements 12 and 17 of FIGS. 1, 2 and 3. A first housing portion 65 having a generally L-shaped configuration is pivotally affixed to one flange of the channel 61 by means of a hinge 66. The hinge 66 permits the housing portion 65 to be pivotally positioned generally adjacent to or away from the fixed elongate element 63. The element 62 has a plurality of elongate element supports 67, one shown; the support 67 carries an elongate pressure element 68 which is oppositely disposed to the elongate element 63. The elements 63 and 68 form a pair of elements generally equivalent to the pair 11 shown in FIGS. 1, 2 and 3. A second housing portion 69 is pivotally affixed to the remaining flange of the channel 61 by means of a hinge 70. Affixed to the second housing portion 69 are a plurality of elongate pressure element supports 71, one shown, carrying an elongate pressure element 72 generally equivalent to the elongate pressure element 16 of FIGS. 1, 2 and 3. The elements 64 and 72 form a second pair of pressure elements. A housing portion restraining means 75 comprises a second lug 76 affixed to the first housing portion 65 at a location remote from the hinge 66, a second lug 77 affixed to the second housing portion 69 remote from the hinge 70 and oppositely disposed to the lug 76 in combination with a bolt 78 and nut 79, providing a means of securing the housing portions 65 and 69 in adjacent relationship and position the elongate elements 68 and 72 in adjacent pairs such as is depicted in FIGS. 1, 2 and 3.

Beneficially, the apparatus 60 may have any desired number of pressure element pairs. The embodiment of FIG. 7 is particularly desirable when flexible tubing is employed which can be deformed with relatively little mechanical force and a great number of crimps can be formed simultaneously by positioning the tube on the fixed elongate pressure elements and pivoting the housing halves 65 and 69 toward each other and fastening the housing halves 65 and 69 together.

Apparatus in accordance with the present invention is found eminently satisfactory for forming interfacial surface generators from a wide variety of flexible tubing and particularly plastic and thin soft copper tubing.

As is apparent from the foregoing specification, the present invention is susceptible of being embodied with various alterations and modifications which may differ particularly from those that have been described in the preceding specification and description; for this reason, it is to be fully understood that all of the foregoing is intended to be merely illustrative and is not to be construed or interpreted as being restrictive or otherwise limiting the present invention.

What is claimed is:

1. An apparatus for the preparation of an interfacial surface generator, the apparatus comprising a base, the base having a longitudinal axis, an elongate pressure member affixed to the base and angularly disposed with respect to the longitudinal axis, a second elongate member oppositely disposed to the first elongate member, the second elongate member being in spaced relationship to the first member and angularly disposed to the first elongate member and the longitudinal axis, the second elongate member being supported by a first positioning means, the first positioning means selectively positioning the second elongate member adjacent to or remote from the first elongate member, the first and second elongate members forming a first pair of elongate members, a second pair of elongate members axially disposed relative to the first pair of elongate members and similarly supported, with the difference that a projection of the longitudinal axes of the first pair of elongate members and a projection of the axes of the second pair onto a plane normal to the longitudinal axis of the apparatus provides a pattern which has the general configuration of two overlapping crosses.

2. The apparatus of claim 1 wherein the positioning means are toggle clamps.

3. The apparatus of claim 1 wherein a plurality of pairs of elongate members of alternating right and left hand configuration are sequentially disposed adjacent the first and second pairs and alternate pairs of elongate members have a generally like configuration.

4. The apparatus of claim 3 wherein a plurality of elongate members of like orientation are supported on a first positioning means and a plurality of elongate members of like configuration are supported on the second positioning means.

5. The apparatus of claim 1 having a thin wall flexible tube passing therethrough and clamped by the elongate member pairs.