June 16, 1959 J. A. POTCHEN 2,890,868

MIXING HEAD

Filed Aug. 1, 1955

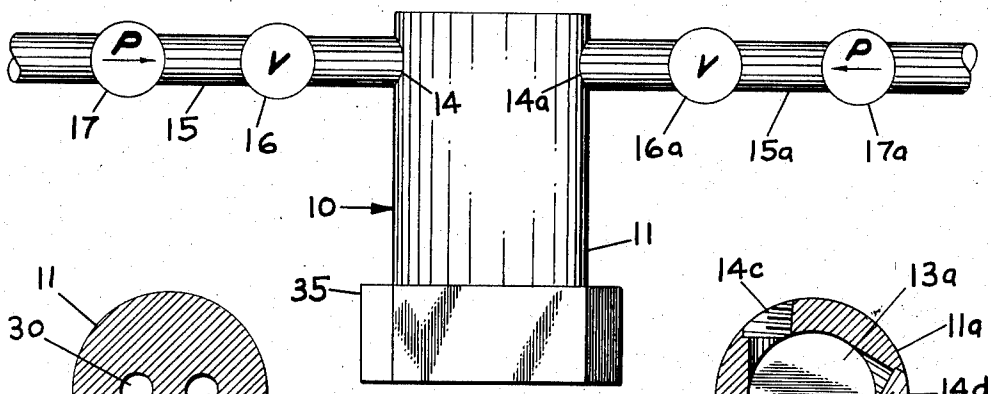


Fig. 1

Fig. 9

Fig. 10

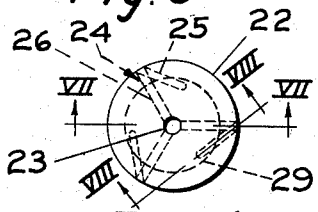


Fig. 4

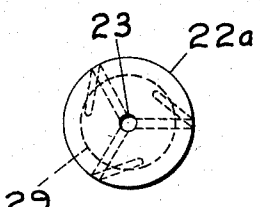


Fig. 6

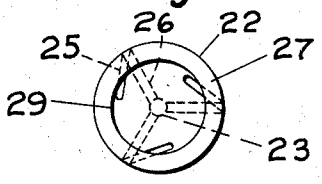


Fig. 5



Fig. 7



Fig. 8

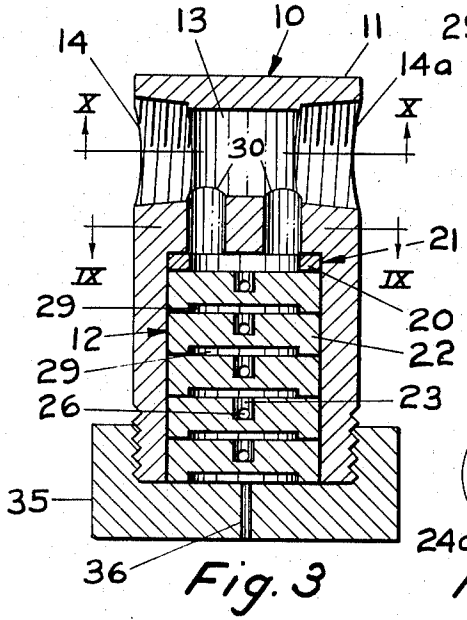


Fig. 3

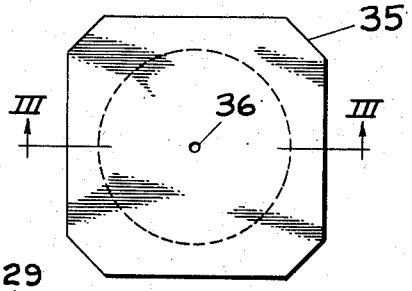


Fig. 2

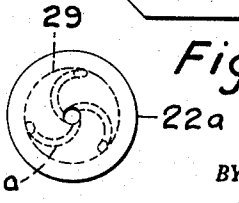


Fig. 11

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MIXING HEAD

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Application August 1, 1955, Serial No. 525,748

6 Claims. (Cl. 259—4)

This invention relates to the mixing of two or more flowable substances and more particularly to a method and a device for effecting such mixing.

The problem of continuously and completely intermixing two or more flowable substances is common to a great many industries. Quite frequently the problem is solved by the batch method in which the substances are placed together and then by agitation or similar mechanical means mixed one into the other until a complete blending of the two substances has been effected.

Where the substances are miscible and both have a low viscosity, such as water, the problem is not particularly serious. Where, however, the substances are immiscible the task of blending presents a difficult problem. Also, where one or both of the substances is characterized by either a high viscosity or high surface tension, the problem becomes a serious one if the desired result is a complete blending to the extent that the individual characteristics of both substances become entirely lost and unidentifiable.

The problem becomes even more acute where the mixing must be done continuously and rapidly. In some cases, a further complication is introduced by the necessity of effecting the mixing either in an inert atmosphere or completely isolated from gaseous contact to prevent chemical reactions or the entry of the gases into the substances.

All of these problems are presented in acute form in the use of the so-called "foaming diisocyanate plastics." In this case the substances are of different viscosity and different surface tension and are not readily miscible. Further, since the chemical reaction producing the foaming action is initiated normally within a matter of seconds after the substances are brought into contact, the complete mixing operation must be carried out rapidly to effect complete blending before the foaming reaction sets in.

Further, it is desirable that the mixing of the substances be carried out in such a manner that no air becomes intermixed into the substances during the mixing and blending operation. Despite the rigid conditions under which the mixing must occur, it is absolutely essential that the mixing of the reactants making up the foaming diisocyanate plastics effect a complete blend so that all characteristics of the individual substances are completely obliterated.

Since, in many cases, the mixed substances form either a mixture which reacts to form foam or hardens very rapidly once intermixed, it is necessary that the mixing equipment be adapted to quick and easy cleaning at the end of each operation. Also, it is normally necessary that the actual mixing be done at the point of ultimate use. Frequently, this is a confined area in which the space limitations become serious.

This invention solves these problems. It provides a compact, rapid means of completely blending two or more flowable substances irrespective of their miscibility,

viscosity or surface tension. It provides a method and means of continually mixing such substances to produce a complete blend. It also is characterized by adaptability to all of the specialized and difficult conditions imposed upon this type of operation.

These and other objects and purposes of this invention will be immediately seen by those acquainted with the problems of blending flowable substances upon reading the following specification and the accompanying drawings.

In the drawings:

Fig. 1 is a side elevation view of a mixer embodying the principles of this invention.

Fig. 2 is a bottom view of the discharge head for the mixer.

Fig. 3 is a central sectional elevation view of the mixer.

Fig. 4 is a plan view of one of the mixing disks or baffles utilized in the mixer.

Fig. 5 is a bottom view of the mixing disk illustrated in Fig. 4.

Fig. 6 is a plan view of a modified form of the mixing disks illustrated in Fig. 4.

Fig. 7 is a sectional elevation view taken along the plane VII—VII of Fig. 4.

Fig. 8 is a sectional elevation view taken along the plane VIII—VIII of Fig. 4.

Fig. 9 is a sectional view taken along the plane IX—IX of Fig. 3.

Fig. 10 is a sectional view taken along the plane X—X of Fig. 3 showing a modified arrangement for the mixer.

Fig. 11 is a plan view of another modification of the disk.

In executing the objects and purposes of this invention, I have provided a mixing head in which two or more flowable substances are brought together and then passed into a chamber from the center of which they are withdrawn in the form of two or more small streams. These streams are introduced into a second chamber in such a manner as to circulate in the form of a whirlpool, thus effecting an intermixing of the substances. The substances are then withdrawn from the center of this whirlpool in the second chamber and divided into two or more separate streams. These streams are again reintroduced into a third chamber to form a whirlpool. This process is repeated until the substances are entirely blended.

In effect, the method of mixing taught by this invention consists of the twisting together of the individual substances followed by the cutting of the twisted substances into separate pieces effected by the formation of the individual streams. The separate pieces are then re-mixed so that the individual pieces of each substance become thoroughly intermixed by twisting them together in the manner of a rope. By repeating this uniting by twisting, cutting and reuniting by twisting the cut-off portions, the substances become completely blended.

Referring specifically to the drawings, the numeral **10** indicates a mixing head having a shell **11**, the upper end of which is closed. The lower portion of the shell is hollow, providing a mixing cavity **12**, connected to a receiving cavity **13** by a pair of passages **30**. In the particular embodiment illustrated in Figs. 1 and 3, the receiving cavity **13** extends diametrically through the head and is threaded on each end to provide a pair of receiving ports **14** and **14*a***. As will be more fully explained hereinafter this is but one of many possible arrangements which may be used to introduce the substances to the mixer.

While this invention is particularly described as having a pair of receiving ports for admitting the flowable

substances, it will be recognized that if more than two substances are involved, additional receiving ports may be provided as is indicated in Fig. 10. In shell **11***a* three receiving ports **14***b*, **14***c* and **14***d* are shown tangentially entering the mixing chamber **13***a*. The mixing cavity **12** can be extended up into the area of the receiving ports with the upper portion of it forming the receiving cavity **13***a* and the passages **30** eliminated.

Again referring to Fig. 1, a pair of supply conduits **15** and **15***a* are connected to the receiving ports **14** and **14***a* respectively. Normally, supply conduits **15** and **15***a* have a control valve **16** and **16***a* respectively and a pump **17** and **17***a* respectively. By means of either the capacity of the pumps **17** and **17***a* or the adjustment of the valves **16** and **16***a* or both, the relative quantities of the substances entering the mixer **10** may be accurately proportioned. While this is one particular method of proportioning the relative volumes of the two substances, others may be employed.

It will be recognized that a pre-mixing operation may be carried out between two of the substances and then the mixed substances introduced together with a third substance to be blended within this mixer. For effecting this pre-mixing of certain of the substances a mixer **10** may be used. Thus, two or more of these mixers may be used in tandem.

A spacer ring **20** bears against the upper end wall **21** of the cavity **12**. The spacer ring **20** creates a receiving chamber at the upper end of the mixing cavity **12** into which the substances may flow from the passages **14**. In a construction in which the passages **14** are eliminated and the receiving cavity **13** is but an extension of the mixing cavity **12**, the ring **20** can be eliminated. However, it is essential that the diameter of the interior cavity of the shell **11** be reduced at this point to form a shoulder against which the upper or first of the mixing disks **22** may be seated.

The wafers or mixing disks **22** are designed to slidably but closely fit within the cavity **12**. The fit should be such that there will be no tendency for the substances to by-pass the disks between their periphery and the walls of the cavity **12**. In the illustrated form of this invention, five mixing disks are utilized. It will be recognized that the number of mixing disks used in the mixer will depend upon the particular characteristics of the substances being mixed and the difficulty with which they are blended. Thus, if the substances are exceedingly difficult to blend, more of the mixing disks may be used whereas if the substances are relatively easy to blend, a lesser number of the mixing disks may be used.

The individual mixing disk has a small, blind chamber or well **23** in the center of its upper face. Extending radially from the well are three channels **24** having a receiving portion **26** and a discharge portion **25**. The receiving portions **26** of these channels extend radially outwardly through the periphery of the disk. The diameter of each channel is such that it has sufficient capacity to pass approximately one-third of the expected flow rate of the material. Each of the channels **24** has a discharge portion **25** communicating with the receiving portion **26** adjacent the periphery of the disk. The discharge portion **25** is inclined downwardly and communicates with the recess **29** in the bottom of the disk. The discharge orifices of the channels **24** are so oriented that they enter the recess **29** tangentially to a theoretical circle adjacent the periphery of the recess. The recess **29** is, in effect, a blind cavity milled into the lower surface of the disk and having a diameter constituting the major portion of the diameter of the disk. The recess **29** is surrounded by a wall **27** which, in effect, spaces the top wall **28** of the recess above the top surface of the next adjacent disk to create the chamber **29**.

The channels preferably are equally spaced and the discharge orifices of the channels in the recess **29** are likewise equally spaced. By extending the channels through the periphery of the disk, both portions are made accessible for cleaning by the insertion of a rod from the periphery of the disk.

It will be recognized that the disks **22***a* may be so designed that the channels **24***a* do not breach the periphery of the disk (Fig. 11). These channels **24***a* are so curved that, while they leave the central well **23** radially, they enter the recess **29** tangentially adjacent its periphery. It is important that the channels discharge tangentially into the recess to create the whirlpool type of movement in the recess.

The channels **24** or **24***a* may communicate tangentially with the central well. Both the radial and tangential arrangements cause effective subdivision of the substances entering the well.

In the particular embodiment illustrated in Fig. 3, five disks **22** are utilized. These disks are enclosed by a discharge head **35**. The head has an internally threaded recess in one face, providing the means of attachment to the shell **11** since, on its lower end, the shell is threaded. The head **35** has, at its center, a discharge orifice **36** through which the blended substances are discharged.

The components of the mixer **10** may be fabricated from any suitable material. Such material must have sufficient strength to withstand the operating pressures of the mixer. They must be inert in the presence of the substances passed through the mixer. An example of one particular material normally suitable for this purpose is brass.

Operation

The substances to be mixed are first brought together in the receiving cavity **13**. Slight mixing may occur in this cavity but normally substances of the type with which this mixer is intended to be used strongly resist intermixing. Consequently, the substances will pass from the receiving cavity to the first mixing disk in completely identifiable form.

After entering the mixing cavity **12**, the substances flow into the central well **23** of the top or first disk **22**. As the substances flow out of the well **23**, they are divided into three separate streams by passing into the individual channels **24**. The substances are discharged from these channels into the first recess or mixing chamber **29**. As the substances enter the recess or mixing chamber **29**, they are caused to spiral within the chamber by reason of their tangential entry. This spiraling tends to mix the substances and to intermix the individual streams by rolling them to some extent about each other in the form of a rope. The substances move inwardly in the chamber **29** in the form of a whirlpool and discharge at the center through the well **23** of the second disk. From this well the mixed substances are again divided into three individual streams upon entering the channels **24** of the second disk. The substances discharge tangentially from the channels **24** of the second disk into the second mixing chamber **29**. Here they are again reunited in a whirlpool with the individual streams twisting about each other. This process is repeated by each mixing disk **22** seated in the mixing cavity **12**.

The result of this arrangement is to treat the substances much in the manner in which a rope is manufactured. The substances are first divided into two more individual streams. These streams are then reunited by twisting them about each other in the form of a rope. This is the action occurring in the first mixing chamber **29**. The reunited and twisted mass is then cut into random sections by its entry into the individual channels **24** of the second disk. This, in effect, is cutting the twisted rope form into short pieces which pieces, when reunited, in the second mixing chamber are arranged in a random pattern. This results in thorough intermixing. This random pattern of pieces is again spiraled in the second mixing chamber to form a rope. It will be seen that the process of dividing and subdividing of the individual substances progresses arithmetically as they pass through

the mixer. This action is continued until the individual characteristics of each separate piece is lost and the substance as a whole has acquired the characteristics of a true blend.

This mixer is specifically designed for the handling of difficult to mix flowable substances. Thus, it is designed to handle substances which are immiscible and which are not readily soluble one within the other. As an example, it is designed to blend such immiscible substances as oil and water or in a paint to blend the pigment, vehicle and carrier to form a blend in which the individual characteristics of each ingredient have become indistinguishable.

This mixer is capable of completely blending such substances irrespective of their lack of solubility, their lack of miscibility and the fact that each substance is characterized by high surface tension and high viscosity. It will be recognized that this mixer is quite capable of mixing a large number of individual, flowable substances and is not limited to the mixing of merely two or three such materials. It may be, in cases where a number of substances are brought together, that the proportional size of the mixer will have to be increased to provide sufficient flow through the mixer. It will be recognized that the overall size of the mixer may be changed to meet the requirements of particular situations. In these cases it may also be necessary to increase the number of individual mixing disks **22** to effect complete blending of the materials. Another modification which will increase the mixer flow capacity is increasing the number of channels in each disk. These, however, are merely multiplications of the principle employed in the mixer illustrated.

The relative diameters of the channels **24** and of the wells **23** may vary within a considerable range and still effect the mixing action. This is true because the mixer effects blending by twisting, separating and random rearrangement of the substances and not upon any turbulence created within the flowing substances as they pass through the channels and orifices. Tests have indicated that the creation of turbulence within substances of this type will not cause mixing such as is produced by this machine. The inability to mix and blend substances of this type by turbulence is established by the fact that when two heavy, saturated, sugar syrups each identified by a distinct coloring were passed at room temperature through a one-sixteenth, internally tapped, three inch long orifice, they failed to mix and were discharged in clearly identifiable individual streams.

These same substances passed through this mixer, utilizing five disks in which the wells **23** were one-eighth inch diameter and the channels **24** were five sixty-fourths inch diameter, the syrups were so completely blended that the individual colors of each syrup had become entirely indistinct. These sugary syrups were passed through the mixer at approximately the rate of one quart per minute under a pressure of from one hundred to three hundred pounds per square inch.

Among other substances which have been successfully blended with this mixer are a polyester resin and a diisocyanate. These substances are not miscible and are resistant to intermixing. Yet a five disk mixer of identical construction as that used for the heavy sugary syrup effected a complete blending of these substances.

It will be recognized from this description that the particular size of the channels **24**, wells **23** and the discharge orifice **36** is not particularly critical. These are chosen to be of sufficient size to permit the substances to be passed through without too great a resistance and at a flow rate which will meet the demand requirements of the particular application.

The lower limit of size of the channels is established by the upper limit of back pressure it is practical to create within the mixer. The upper limit of the channel

size is set by that which will cause sufficient division of the substances to effect a complete blending.

It will be recognized, however, that this, again, is a relative matter inasmuch as a mixer having a certain number of disks, each equipped with a particular diameter of channel, which will not effect complete blending can be made to do so by increasing the number of disks through which the material is passed or the number of channels in each disk. Also, difficulty along this line may be overcome by increasing the number of channels **24** in each disk. These changes are merely matters of routine design adaptation since the basic principles of the method and structure disclosed by this invention are employed.

It is necessary that at least two channels **24** be provided in each mixing disk. However, the number of channels **24** in excess of two is a matter of design choice. Thus, designs having six or more such channels are entirely effective.

Where it is felt desirable, left and right hand disks may be arranged in an alternate pattern to cause the substances to spiral in opposite directions. Preliminary tests on this arrangement have indicated that it does not materially increase the efficiency of the mixer, at least under the circumstances in which the mixer has been presently used. It is thought that some slight rotation of the disks may occur as a result of the passage of the substances through them. This is not believed to have any detrimental effect upon the operation of the mixer. By alternately arranging right and left hand disks this rotation effect may be counteracted.

Since the mixer is useable either as the discharge head or as an insertion in a conduit at the juncture of the conduits for the individual substances, it is adapted to continuous operation. Further, since the substances are confined to a closed chamber during the mixing in which there is no air or other gaseous medium, it is ideally suited to the mixing of substances which must not have contact with gases during the mixing operation.

The mixer may be quickly and easily cleaned by passing a suitable cleaning liquid through it. This may be done by providing an additional inlet port in the receiving cavity through which the cleaning liquid is admissible. This is particularly advantageous in connection with substances which do not require thorough removal at the end of each operational run except in zones where they have been mixed.

It will be recognized that various modifications of this invention may be made such as the alternate use of right and left hand disks or the use of the type of mixing disk illustrated in Fig. 11. The disks may be made integral with the housing in the form of baffles. Each of these modifications, however, will employ the principles of this invention. Accordingly, such modifications are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. A mixer for mixing flowable substances comprising a housing, a disk in said housing defining a first recess on one side thereof, an inlet port communicating with said first recess, a plurality of channels in said disk communicating with said inlet port extending radially to the periphery of said disk and a plurality of channels communicating with said radially extending channels and extending inwardly and terminating adjacent to the periphery of a second recess disposed on the side of said disk opposite to the side containing said inlet port, said second recess having a diameter smaller than the diameter of said disk, and closing means in said housing closing said housing, and port means in said closure means communicating with said second recess.

2. A mixer in accordance with claim 1 wherein said housing encloses a plurality of said disks.

3. A mixer for flowable substances comprising a

housing having a central chamber, an inlet port communicating with one end of said chamber, a disk seated in said chamber and engaging the walls thereof, said disk having a central blind opening in the one face adjacent said inlet port, at least a pair of channels in said disk communicating with said opening and extending outwardly away therefrom, said disk having a recess in its other face, and said channels communicating tangentially with said recess adjacent the periphery thereof.

4. A mixer as recited in claim 3 wherein a plurality of said disks are mounted in said housing and including means for pressing said disks together.

5. A disk element for a mixer for flowable substances comprising a body member having a central blind opening in one face and a recess in the other face, said recess being surrounded by a spacer wall, a pair of channels each communicating at one end with said blind opening, and the others of the ends of said channels communicating tangentially with said recess adjacent said spacer wall.

6. A disk element for a mixer for flowable substances comprising a body member having a central blind opening in one face and a recess in the other face, surrounded by a spacer wall, a first plurality of channels each communicating at one end with said blind opening, said channels extending radially from said blind opening to the periphery of said body member, and a second plurality of channels each at one end communicating with one of said first plurality of channels adjacent the periphery of said body member and at the other end communicating tangentially with said recess.

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