United States Patent

Mosher et al.

[15] **3,704,866**

[45] **Dec. 5, 1972**

[54] **CONTINUOUS MIXER**

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[21] Appl. No.: **41,322**

[52] **U.S. Cl.**.....**259/192**, 259/6

[51] **Int. Cl.**.....**B29f 3/02**, B01f 7/08

[58] **Field of Search**.....259/6, 21, 104, DIG. 2, 192; 18/2 EP

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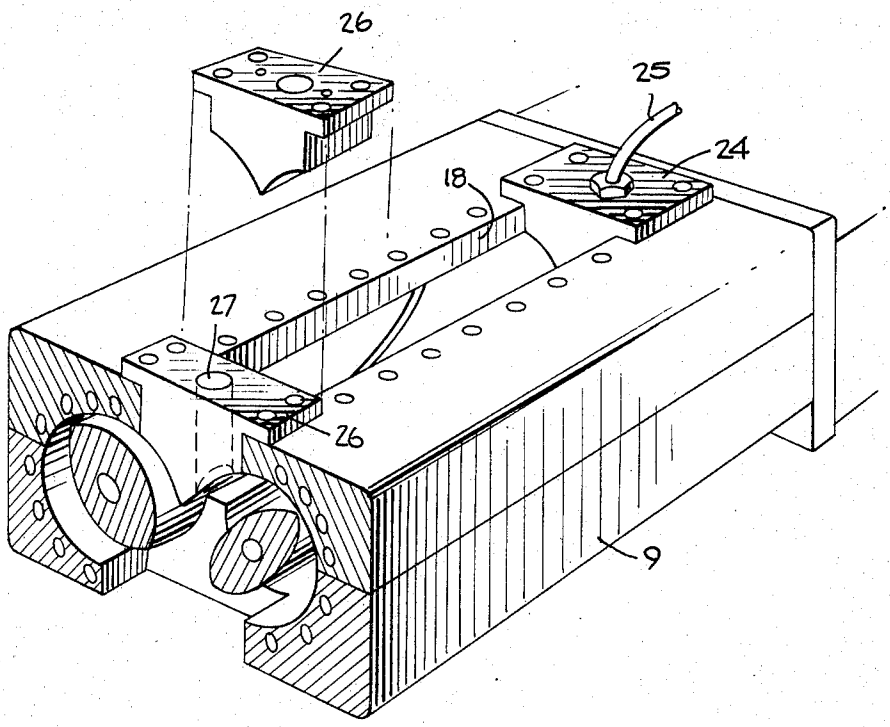
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Assistant Examiner—Alan I. Cantor
Attorney—Kenyon & Kenyon Reilly Carr & Chapin

[57] **ABSTRACT**

A continuous mixer has its barrel forming the rotor chambers upwardly open above these chambers and provided with removable closing sections.

11 Claims, 11 Drawing Figures

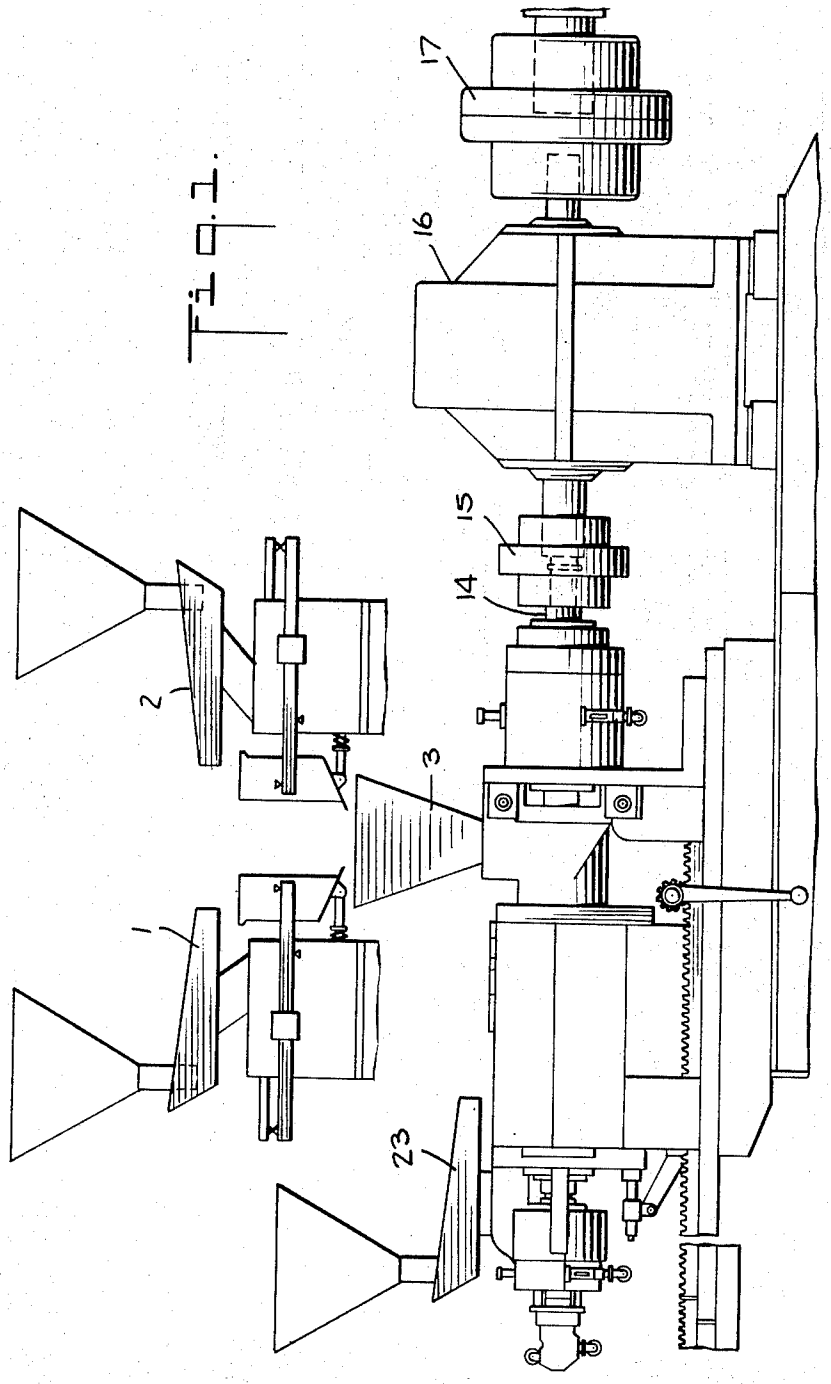


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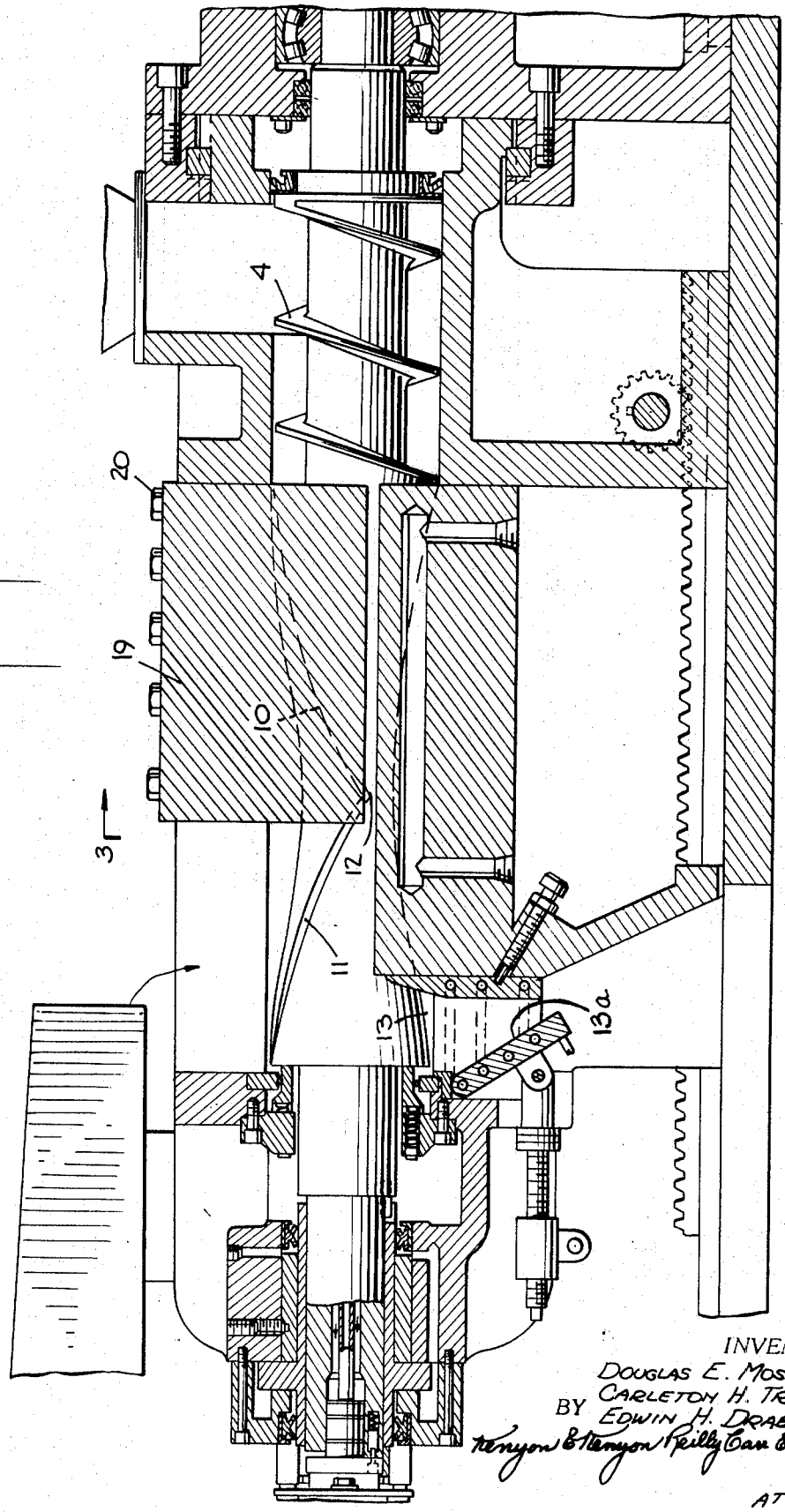
SHEET 1 OF 4

Fig. 1.



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Fig. 2.



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Fig. 3.

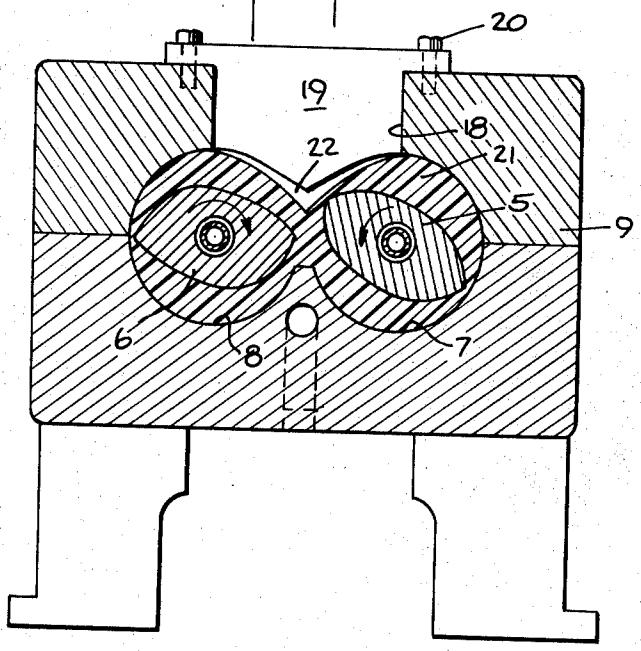


Fig. 6.

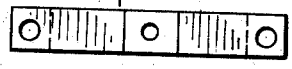


Fig. 7.

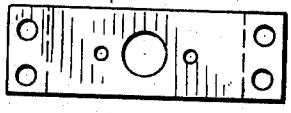


Fig. 8.

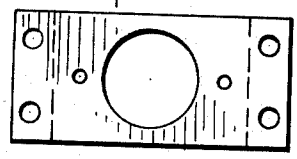


Fig. 9.

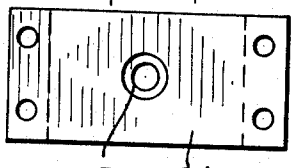


Fig. 10.

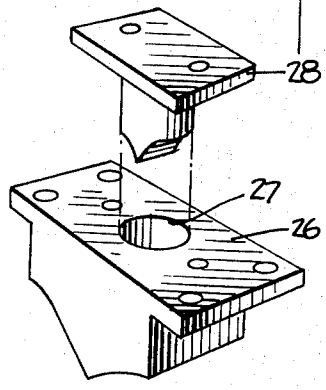
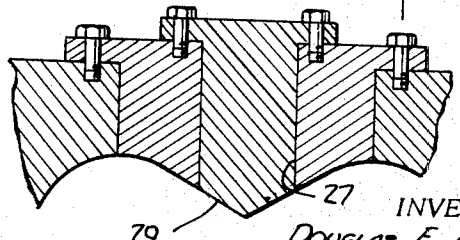


Fig. 11.



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Fig. 4.

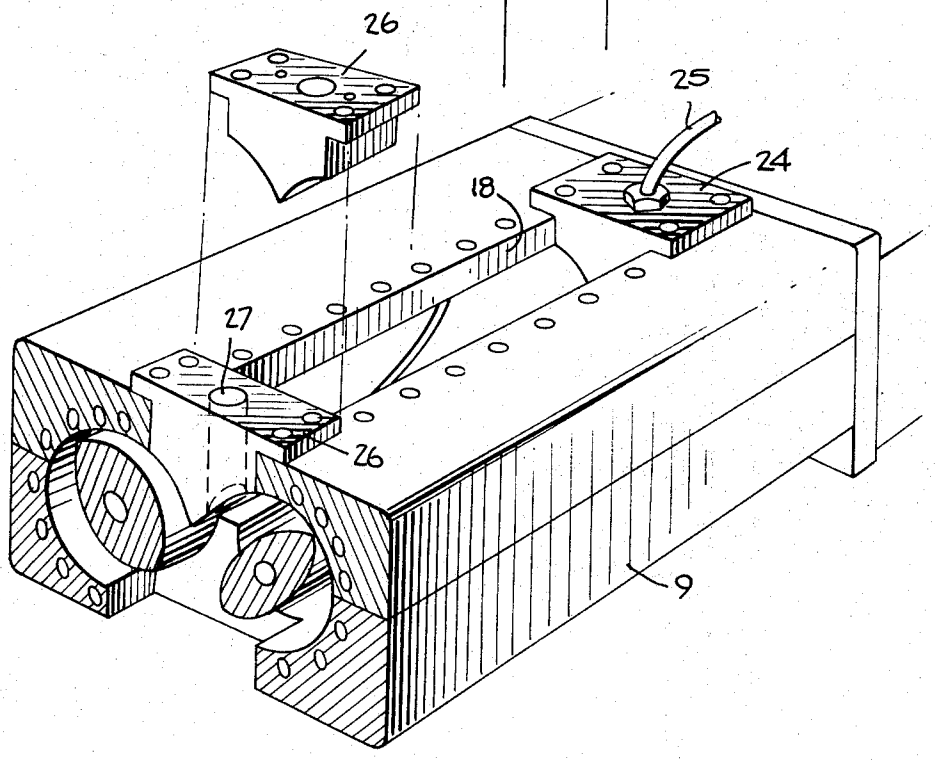
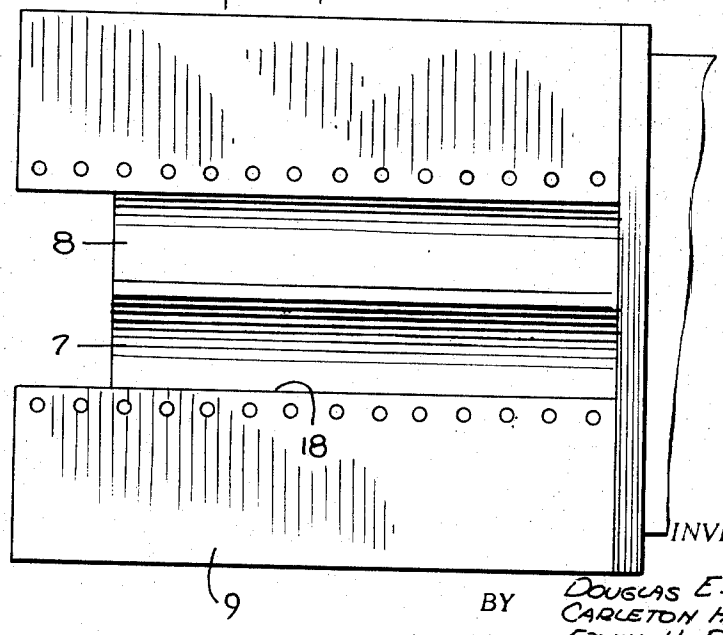


Fig. 5.



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CONTINUOUS MIXER

BACKGROUND OF THE INVENTION

This invention is an improvement on the continuous internal stiff-gel mixer disclosed and claimed by the Ahlefeld Jr. et al U.S. Pat. No. 3,154,808 dated Nov. 3, 1964.

Some prior art U.S. patents indicate that continuous machines they disclose can mix satisfactorily practically everything. However, each type of mixer has its particular uses and limitations. The reader unfamiliar with this art is referred to the Encyclopedia of Chemical Technology. The Interscience Encyclopedia, Inc., New York, NY, 1952, vol. 9, pp. 154–166.

Commercially, the roll mill is disappearing. Its disadvantages are well known. Today most rubber products reinforced with carbon black are mixed in internal mixers of the vaned-rotor type made and sold by the Farrel Division of the USM Corporation, Ansonia, CONN., under that Corporation's registered trademark "Banbury".

This patented mixer, of U.S. Pat. No. 3,154,808, uses rotors having blades with cross sections that are substantially like that of Banbury-type blades, each having a portion that twists from its direction of rotation and a portion that twists in the opposite direction. The length and twist ratios between these oppositely twisting blade portions are such that when the mixer's chambers, in which the rotors operate, contain material to be mixed, the average of the axially directed forces applied to the material by the blades is insufficient to force the material to feed through the mixer. The material is subjected to a typical Banbury-type mixing action but without the pumping action on the material characteristic of the older Banbury-type mixer of the batch type. Movement of material through this continuous mixer is effected by forcing material into its feeding end which forces the material being mixed to move through the mixer with a proportionate amount discharging. This feeding is under the control of the operator and he, therefore, has positive control of the residence time of the material in the mixer. By restraining the discharge of the material the internal mixing pressure is also under control.

Because this patented continuous mixer provides the typical Banbury-type mixing action, except for pumping the material back and forth between the chambers' ends as in the batch type, it was assumed that the material, confined by the chambers' walls, was under the high radial pressures known to exist in the batch type, throughout the length of the materials' controlled travel through the chambers of this unique continuous mixer. Therefore, it was assumed that during the mixing operation any additions of material to the material residing in the chambers would have to be by pressure injection to the chambers through bores in the barrel as is done, for example, when adding oil to rubber being compounded in the batch Banbury-type mixer.

The present invention resulted from the discovery, contrary to the above, that during the operation of the patented continuous mixer, the rotors having the Banbury-type blades and operating in the barrel's chambers, which are parallel cylinders which laterally interconnect or open to each other, when mixing materials having visco-elastic properties, apparently drag the material downwardly from the chambers' walls upper

portions as the rotor blades turn towards each other and downwardly with respect to each other. Apparently, the elastic properties of the viscous material cause it to spring away from the chambers' cylindrical walls where they interjoin above the downwardly rotating rotor blades beneath these portions and throughout zones circumferentially adjacent thereto.

In any event, it was discovered that during the operation of the patented continuous mixer the material being mixed freed itself from upper portions of the chambers' walls after the material had received sufficient mixing action to possess visco-elastic properties, meaning that the material was a viscous elastic substance. Stiff-gels, in general, achieve this property after adequate mixing, examples of such gels being rubbers, elastomers, plastics and the like, keeping in mind that they are heated by the mixing energy they receive.

SUMMARY OF THE INVENTION

Based on the foregoing discovery, the present invention comprises the patented continuous mixer made with its upper barrel portion above the interjoining portions of the two chambers more or less open, instead of completely closed, as shown in the previously identified Ahlefeld Jr. et al patent. The object is to permit the addition of material, including solid material, to the materials being mixed without the added material necessarily going through the entire mixing operation time.

Removable sections are provided to close the upwardly open part of the barrel as required by the mixing operation being practiced. These sections have inner or bottom ends contoured to form with the balance of the chambers' walls the typical contour of the chambers of the patented mixer when the sections are applied to the barrel. The sections must be used to close the chambers open top at the charging end of the mixer, or it must be permanently closed, to the extend necessary to confine the material being mixed while it is exerting the high radial pressures characteristic of the batch Banbury-type mixer, and until the material has received enough mixing energy to have visco-elastic properties. From thereon the top of the barrel may be left more or less open, depending upon the nature of additions to be made to the mixing material and the mixing period when the additions are to be made.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of the mixer of the Ahlefeld Jr. et al patent embodying the improvement of the present invention;

FIG. 2 is a vertical longitudinal section of this mixer;

FIG. 3 is a cross section taken on the line 3—3 in FIG. 2;

FIG. 4 is a partially exploded perspective view of the barrel of the mixer illustrating the removable sections for the barrel's open top;

FIG. 5 is a top view of the barrel looking down through its open top from which the rotors and all of its top closing sections have been removed::

FIGS. 6 to 9 are top views of variously sized top closing sections for the open top of the mixer;

FIG. 10 is an exploded perspective view of one of the sections bored to receive mixing additives with its bore provided with an obturator; and

FIG. 11 is a cross section of the FIG. 10 section installed on the mixer's barrel and the obturator in use.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring to the above drawings, the materials to be mixed are fed continuously or substantially continuously by automatic weighing feeders 1 and 2 of commercially available types, into the hopper 3 of the mixer down through which the materials fall to the screw flights 4 on the rotors 5 and 6 and which operate to stuff the materials under pressure into the charging ends of the laterally interconnecting parallel cylindrical chambers 7 and 8 formed in the barrel 9 of the mixer.

The rotors 5 and 6 each have the Banbury-type cross-sectioned blades each having a portion 10 that twists away from the rotors' direction of rotation and a portion 11 that twists in the opposite direction, the two portions joining to form an apex 12 as shown by FIG. 2. Each rotor has two of these blades arranged 180° apart. The length and twist ratio between the oppositely twisting blade portions 10 and 11 are in each instance such that when the chambers 7 and 8 contain the materials to be mixed, the average of the axially directed forces applied to the materials by the blades is insufficient to force the materials through the chambers and through the transversely extending discharge orifice 13. This orifice is shown by FIG. 2 constructed as disclosed by the previously noted Ahlefeld Jr. et al patent, the swinging wall 13*a* controlling the restraint to the discharging material and therefore the pressure of the material being mixed in the chambers 7 and 8.

As shown by FIG. 1, the rotors, which consume a great deal of power, have outwardly extending shafts 14 connected by a heavy coupling 15 with the heavy duty gear stand 16 receiving rotary power, from a source not shown, through a heavy coupling 17.

As so far described, the illustrated mixer is substantially the same as the mixer of the Ahlefeld Jr. et al patent. Assuming the chambers 7 and 8 to contain previously fed materials, rotation of the rotors in opposite directions so the rotor blades move downwardly towards each other below the upper junctions of the two chambers, causes the materials to receive the typical Banbury-type mixing action but without the pumping back and forth action of the batch type. Movement through the machine is entirely under the control of the operator who controls the automatic machines 1 and 2 to feed at rates providing the mixing time known to provide the proper mixing and which, of course, differs for different materials. The mixed material cannot discharge through the orifice 13 at any rate other than that under the control of the feeders 1 and 2.

The improvement comprises the top opening 18 which, in the illustrated mixer, extends throughout the entire length of the barrel as shown by FIG. 5. That is to say, the barrel is open upwardly throughout its length and for a width extending transversely between vertical planes extending through the axes of the two rotors. This width can be varied to some extent and the length of the top opening need not be for the full length of the barrel as explained below.

For example, materials fed into the hopper 3 as solids must receive a certain amount of mixing energy before plasticizing into a visco-elastic material. Also, from the charging ends of the chambers up to locations at or slightly beyond the apices 12 of the rotor blades the mixing materials exert relatively high radial pressures.

Therefore, in FIG. 2 the open top throughout this zone established by the apices of the rotors, is closed by a top closing section 19 which as shown by FIG. 3 is firmly anchored by cap screws 20 to the top of the barrel 9. As shown also by FIG. 3 the bottom end of this section 19 is contoured as two interjoining cylindrical portions to complete the contour of the cylindrical shapes of the two chambers which join to provide the lateral communications between the chambers. This particular closing section 19 is otherwise solid and massive to resist the high radial forces exerted by the materials as they plasticize under the Banbury-type mixing action of the patented mixer.

As previously described, it has been discovered that after the mixing materials are plasticized and in a visco-elastic condition, ready to receive, usually, further mixing energy for the time fixed by the particular formulation under treatment, the plasticized material 21 is either dragged down or elastically springs away from the chambers' walls where they interjoin above the area where the barrel chambers open to each other and the blade tips move downwardly towards each other and towards the bottoms of the chambers. As indicated by FIG. 3, an actual space 22 is formed where the material forwardly in the feeding direction of the materials from the junctions between the oppositely twisting blade portions is free from contact with the chambers' walls. This space is formed as the material becomes plastic and elastic, although the material is elsewhere exerting the high radial pressures against the chambers' walls to give the Banbury-type mixing action. Throughout this zone removable sections may be used.

As indicated by FIG. 2, the balance of the barrel to its discharge end can be left open without any upward movement of the plasticized materials receiving the additional mixing energy usually required by the specifications of their mixing treatment. As indicated by FIGS. 1 and 2, a third automatic feeder 23 may be used here to make any type of addition desired to the mixing plastic mass feeding at the rate controlled entirely by the controllable feeders 1 and 2. Such material might, for example, be fiberglass which it is desired to add to the mix at a late period to avoid undue fragmentation of the fiber particles. Fiberglass is, of course, but one example of many types of materials both solid and liquid which can be added to the mixing material. The material appears to be drawn downwardly by the downwardly rotation blade portions of the rotors as contrasted to being forced upwardly as it would if the rotor blades acted as screws, for example, like the screws of the screw-type continuous mixer of the Fuller U.S. Pat. No. 2,615,199, dated Oct. 28, 1952.

Ordinarily, it is not considered desirable to leave the barrel top open so extensively as is shown by FIG. 2. The great flexibility permitted by the present invention is high-lighted by FIGS. 4 to 11 as follows:

First, referring to FIG. 4, this shows the relatively long solid top section 19 removed. At the far righthand end a relatively short section 24 is shown in place and having an inlet connection 25 which, although not shown in FIG. 4, extends downwardly through the section 24 so as to open into the chambers at the apex

formed by the two cylindrical sections of this section **24** which complete the cylindrical interjoining contours of the chambers **7** and **8** at that end when the section is in position. A top view of this section is shown by FIG. **9**. This section **24** may be used for the introduction of liquid, for example oil, under a pressure exceeding that of the materials which at this entrance end of the chambers are receiving their initial mixing action. Although shown open in FIG. **4**, the balance of the open top of the barrel **9** may be closed by a section corresponding to the section **19** in FIG. **2** but, of course, of the greater length required for complete closing. In this case, the mixer would operate the same as does the mixer of the Ahlefeld Jr. et al patent and would, in fact, embody all of the features of that patented mixer. Incidentally, although the barrel **9** in the present invention is shown as having a rectangular shape as contrasted to the rounded shape shown by the Ahlefeld Jr. et al patent, this is a matter of design only.

FIG. **4** shows the possibility of using a section **26** adjacent to the discharge end of the machine having a vertical through bore **27** of a relatively large diameter and through which solids such as fiberglass or other materials may be introduced to the chambers at atmospheric pressure due to the existence of the space **22** at that end of the machine where the materials have become plasticized thoroughly. As shown by FIG. **10**, this section **26** is provided with an obturator **28** which may be used to completely close its bore **27** when the latter's use is not desired. The obturator has a bottom end **29** which completes the internal contour normal to the patented mixer. It is to be understood that the balance of the barrel's open top would be closed by a suitable section back to the charging ends of the chambers.

Various sections shown by **6** to **8** are representative of the shapes and dimensions which may also be used in conjunction with fully closing sections for various operations.

In general, any section used to close the open top **18** of the barrel **9**, that is positioned between a location insufficiently beyond the apices **12** of the rotor blades and the inlet ends of the chambers to enjoy the peculiar action previously described, must resist high radial pressures exerted by the materials caused by the inherent action of the patented continuous mixer and also by any unplasticized materials. Such sections must, therefore, be either solid or designed for the introduction of materials under pressures exceeding those existing in the chambers throughout that zone. The introduction of liquids under pressure is easy to comprehend. However, even solids may be introduced provided they are stuffed into the chambers through a bored section at pressures exceeding those existing within the chambers. Safely beyond the rotor apices towards the discharge end of the mixer almost any desired type of section with bores of varying sizes may be used or sections may be entirely eliminated, depending on the mixing specifications for the formation of the mixing materials.

When the mixer of the present invention is initially starting from a cold or uncharged condition there is a period of time during which the mixer discharges relatively unplasticized materials. During this start-up period the materials exert high radial pressures throughout the lengths of the chambers and any insert used having any sized bore must be closed by an obturator such as the one shown by FIGS. **10** and **11**. The entire open top must be otherwise fully closed. As the mixer, with time, assumes its operating condition, these obturators may be removed as required for the insertion of additional materials subject to the restrictions described hereinabove.

With the mixer having at least a portion of its barrel open over the interconnecting portions of the barrel's chambers formed by one or more of the removable sections, as described, in the zone where the unique separation of the mixing material from the upper interjoining chamber portions occurs, great flexibility as to additions is made possible, both as to the character of these additions and as to their time of addition.

What is claimed is:

1. A continuous internal mixer comprising a barrel forming two laterally interconnecting substantially cylindrical and mutually parallel chambers having at one end a common discharge orifice, bladed rotors located in said chambers, means for receiving the material to be mixed and stuffing it under pressure into said chambers at a location spaced from said discharge orifice, means for rotating said rotors, each of said rotors having a blade with a cross section that is substantially like that of a Banbury-type blade and having a portion that twists away from its direction of rotation and a portion that twists in the opposite direction, the length and twist ratio between said oppositely twisting portions of said blade being such that when said chambers contain said material the average of the axially directed forces applied to the latter by said blades is insufficient to force the material through said orifice, whereby the overall axial travel of said material through said chambers is dependent on the rate at which it is received by the first named means, wherein the improvement comprises a portion of said barrel over the interconnecting portions of said chambers and said rotors being formed by one or more removable sections.

2. The mixer of claim **1** in which at least one of said sections is located in a zone extending forwardly from the junctions of the oppositely twisting portions of said blades.

3. The mixer of claim **1** in which at least one of said sections has a bore formed therethrough opening from the outside of this section to its inside.

4. The mixer of claim **1** in which at least one of said sections has a bore formed therethrough opening from the outside of this section to its inside, and a removable obturator for said bore.

5. The mixer of claim **1** in which said barrel portion is formed for substantially the lengths of said rotors by a plurality of said sections and the latter are individually removable.

6. The mixer of claim **1** in which the inside contour of said one or more sections is shaped to form the upper parts on the laterally interconnecting portions of said chambers.

7. The mixer of claim **6** in which at least one of said one or more sections is located within a zone extending forwardly from the junctions of the oppositely twisting blades of said rotors.

8. The mixer of claim 7 in which said one of said sections has a bore formed therethrough opening from the outside of this section to its inside.

9. A continuous internal mixer comprising a barrel forming two laterally interconnecting substantially cylindrical and mutually parallel chambers having interspaced charging and discharging ends, means for moving material through said chambers, said barrel having a top opening above the interjoining portions of said chambers, rotors extending through said chambers and having blades with cross sections substantially like that of a Banbury-type blade and having at least portions below said opening, and means for rotating said rotors so their blades move downwardly towards each other below the upper junctions of said chambers, said blades being constructed to impart mixing energy to material under radial pressure while this material moves through said chambers under said opening, the latter having a maximum transverse width extending transversely between vertical planes extending through the axes of said two rotors.

10. The mixer of claim 9 in which at least one removable top closing section is provided to at least partly close said opening, said section having a bottom contoured as two interjoining cylindrical portions which complete the cylindrical shapes of said two chambers where said section is used.

11. The mixer of claim 10 in which said removable section has a bore formed therethrough, opening from the outside of this section to its inside, and a removable obturator for said bore.

* * * * *