United States Patent

Aletti

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[54] CONTINUOUS MIXER

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**259/7,** 18/2 ES, 18/12 SA, 18/12 SB, 18/12 SE, 18/12 SN, 259/9, 259/43, 259/97

[51] **Int. Cl.**.....**B01f 7/24,** B01f 7/08

[58] **Field of Search**.....259/2, 17, 35, 59, 93, DIG. 3, 259/DIG. 4, DIG. 6, DIG. 10, DIG. 11, DIG. 13, 9, 10, 45, 46, 109, 110

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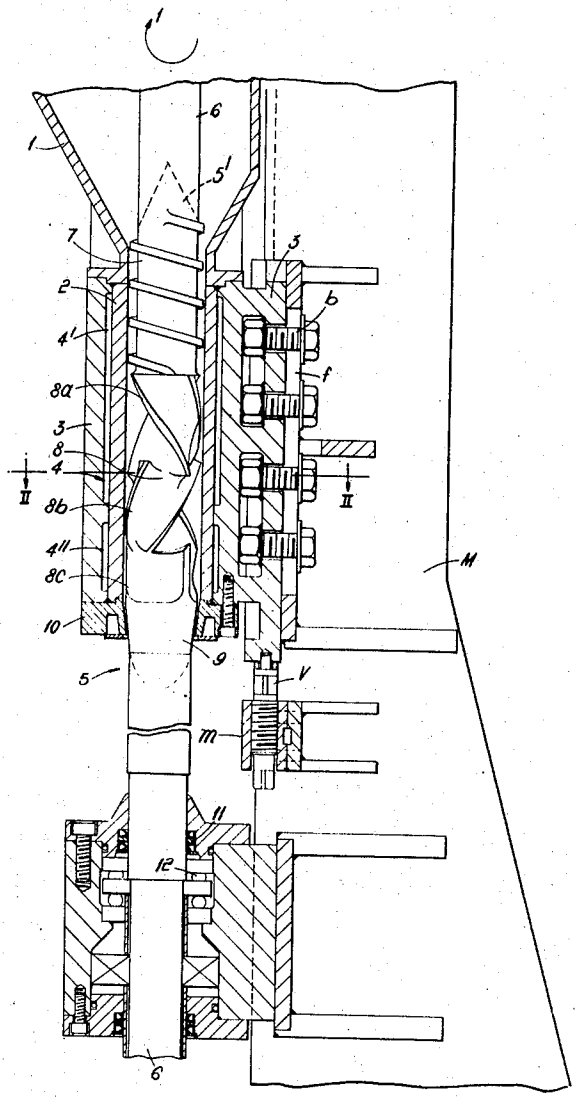
[57] **ABSTRACT**

A mixer for use particularly in the dispersion of powders in gelatinous masses and for the handling of the resultant mixtures, applicable especially to the rubber and plastics industries in general, in which a single mixing chamber is used together with a single rotor consisting of a number of sections inside said chamber.

10 Claims, 5 Drawing Figures



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SHEET 1 OF 3

Fig. 1

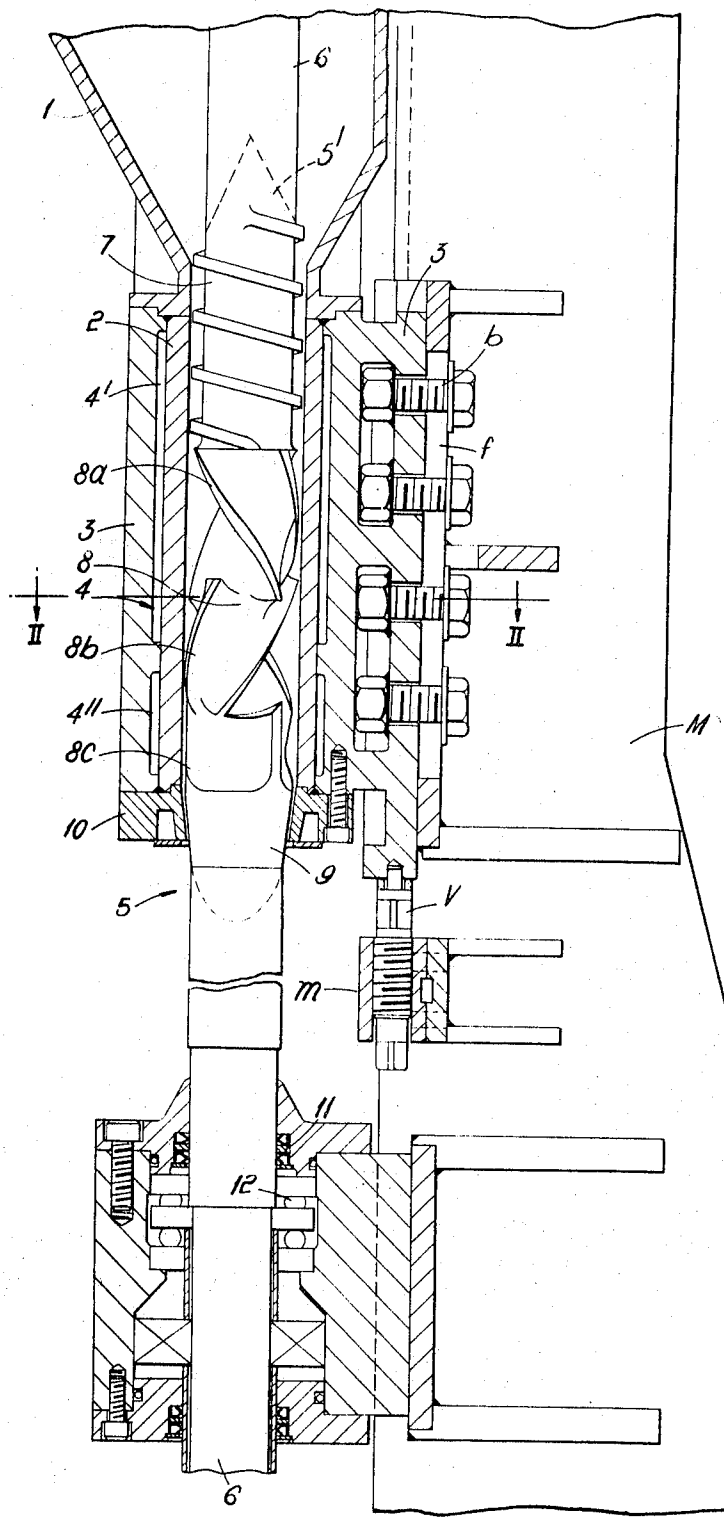

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Fig.2

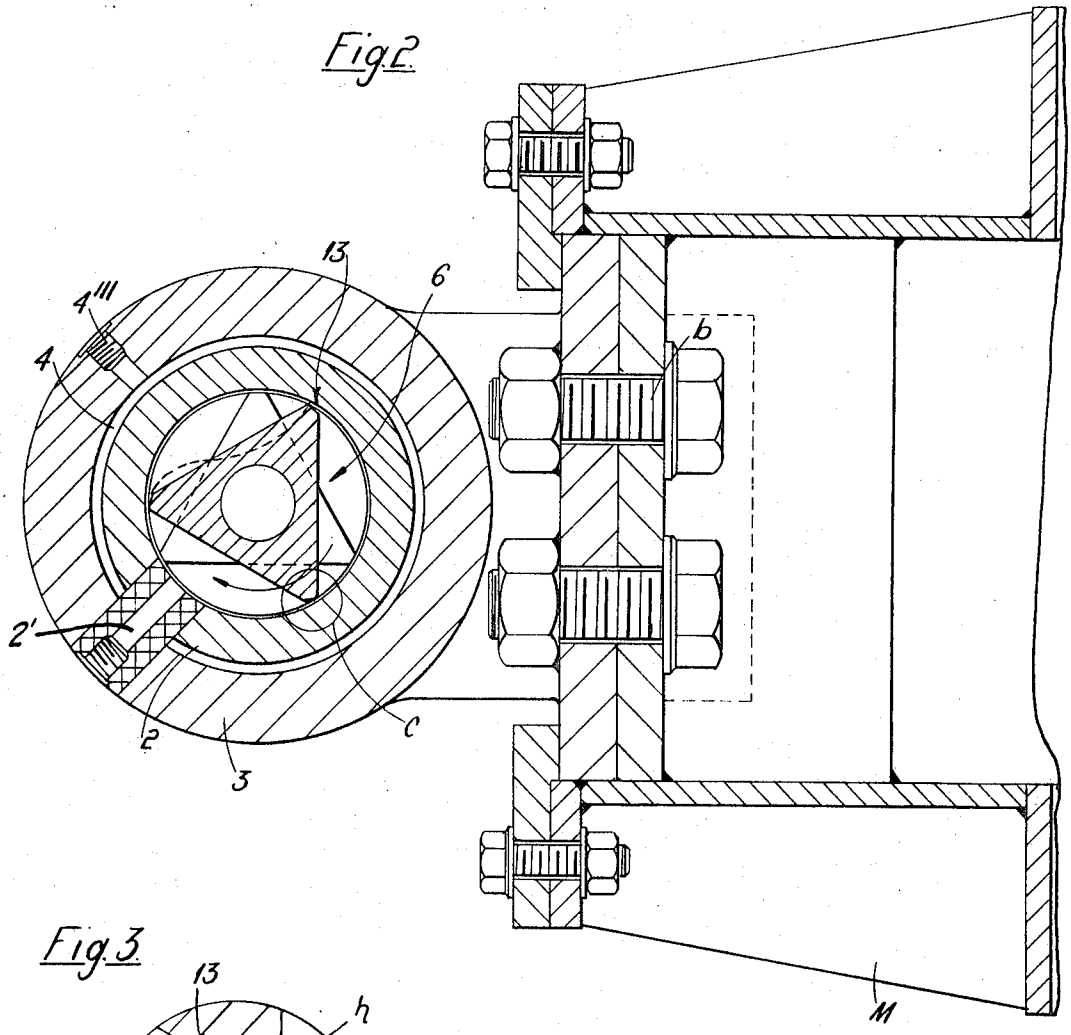


Fig.3

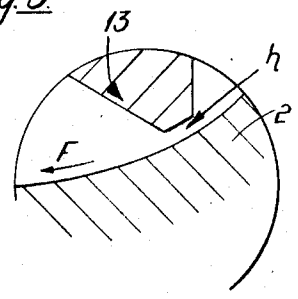
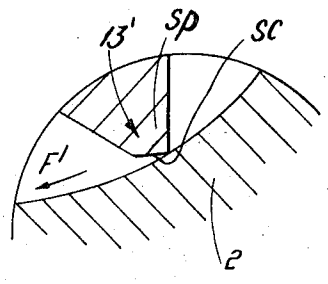


Fig.4



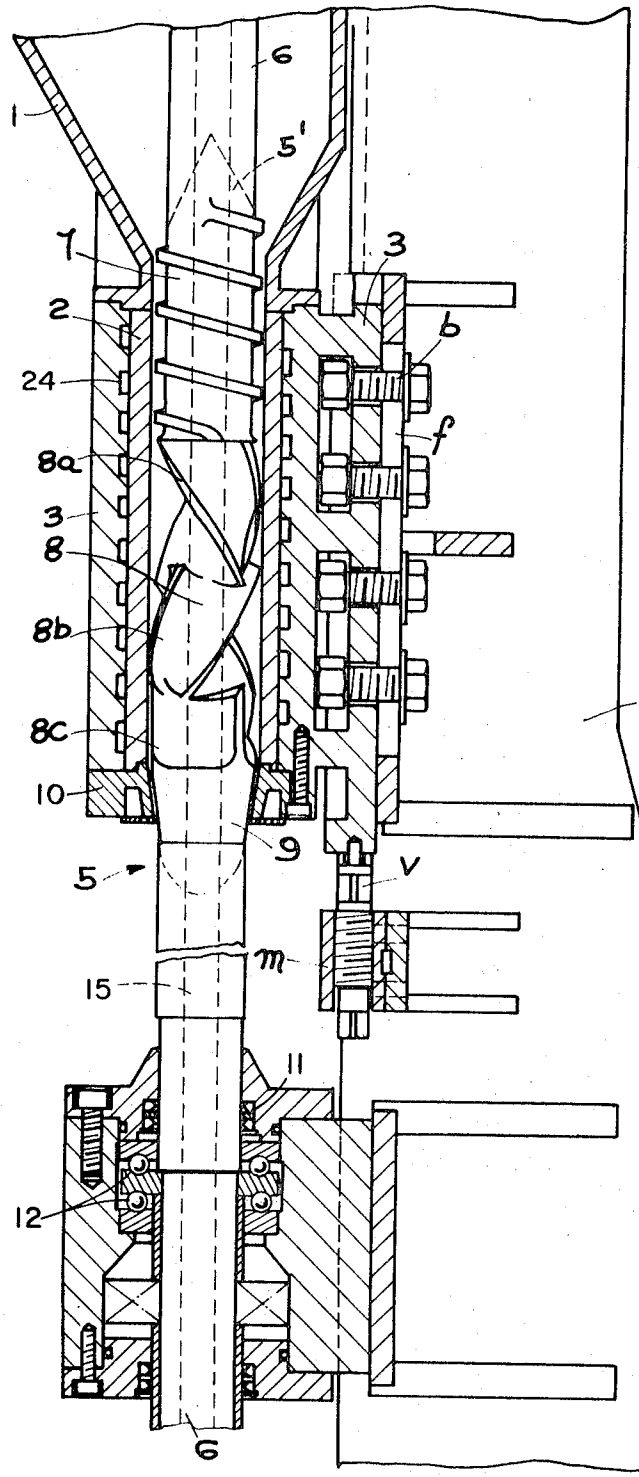


FIG. 5

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CONTINUOUS MIXER

BACKGROUND OF THE INVENTION

This invention relates to a continuous extended surface mixer which is particularly suitable for application to the rubber, plastic, soap, edible flour product and other industries, for use in the dispersion of powders in gelatinous masses and for the handling of the resultant mixtures.

Many types of mixtures are known in this field which are capable of being used with good results for the above mentioned applications. Essentially these are required to perform a double function, this being to carry out macroscopic mixing of the ingredients fed to it and to obtain a fine dispersion of a certain type of these ingredients, generally a powder, in others which may be extremely viscous pastes or relatively viscous liquids. Because of the particular development of their field of application the mixers in question are objects of continuous and deep study with the purpose of ever improving their use and efficiency both from the point of view of process quality and productive output.

This invention adds a valid contribution to these studies by providing a mixer with improved characteristics from both the aspects mentioned, in that it is able on the one hand to give continuous production and on the other hand to provide improved processing of the mixtures.

SUMMARY OF THE INVENTION

This mixer comprises a substantially cylindrical mixing chamber and a single rotor coaxial with said chamber and rotating in it, formed from three continuous sections for feeding, mixing and discharge respectively, of which the mixing (intermediate) section is formed from two opposing screw parts and a prismatic part, having substantially equal polygonal sections.

The invention will be described in detail by way of example with reference to the accompanying drawings which illustrate one preferred embodiment and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of the essential parts of the mixer according to the invention through the axis of its rotor;

FIG. 2 is a transverse section through the line II—II of FIG. 1;

FIG. 3 shows one embodiment of the detail enclosed by the circle C of FIG. 2;

FIG. 4 shows an alternative embodiment of said detail; and

FIG. 5 is a sectional view, similar to FIG. 1, showing an alternative embodiment of the rotor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings the mixer illustrated comprises a feed hopper 1, a cylindrical or slightly conical chamber 2 with vertical axis surrounded by an external shell 3 which forms an interspace 4 for the circulation of a means of heat exchange and a rotor 5 arranged so that a large part of its length is inside the chamber 2 and having its axis coincident with that of said chamber. The rotor 5 consists of a single elongated body of steel comprising cylindrical extremities 6, at least one of which is supported, and a central working part. The working part comprises a feed screw conveyor 7 which functions as an element for feeding and dosing the material, a mixing section 8 formed from two opposing screw parts 8*a* and 8*b* and a third prismatic part 8*c*, and finally a discharge section 9 in the form of an inverted truncated cone. The chamber 2 terminates at its lower end with a discharge ring 10 shaped conically internally with an angle different from that of the discharge section 9 of the rotor 5 which is arranged inside it. The interspace 4 is divided into two sections 4′ and 4″ fed by way of holes 4‴ with the purpose of permitting better temperature control inside the mixing chamber.

The chamber 2 is fixed to the framework M of the machine in such a way that small variations in its axial position are possible. In the drawing this type of assembly, which can be carried out in practice in a number of different ways, is shown diagrammatically as a fixing by means of bolts *b* through a continuous slot *f* of the framework M. The chamber rests on a plurality of screws *v* (only one of which is illustrated in FIG. 1) carried by internal threads *m* of the framework M so that the axial position of the chamber 2 can be exactly adjusted and its axis maintained vertical. By rotating these screws together the level of the chamber 2 is varied and as the position of the rotor 5 remains fixed, as will be seen hereinafter, a relative axial movement between these parts of the mixer takes place. This permits the width of the annular cavity which separates the discharge ring 10 of the chamber 2 from the discharge section 9 of the rotor 5 to be modified whenever this is necessary for adaptation to the individual process runs.

The screw system *v* described can obviously be substituted, in a type of mixer according to the invention having more advanced characteristics than that diagrammatically described, by a hydraulic system of more comfortable and reliable operation. This system could thus be employed not only now and again, between one operation of the machine and another or between one stage of the operation and another, but even during the progress of each individual operation, in order to vary the discharge section and thus permit the regulation of one of the process variables. An analogous result could also be obtained by means of motorization of the screw system described and illustrated.

It is important to note the fact that the mobility of level of the chamber 2 renders the cleaning of the machine easy. In fact by removing the hopper 1 and the discharge ring 10, the whole body of the mixer can be raised so uncovering the mixing and feed screw conveyor sections for cleaning. The chamber 2 can then be easily cleaned as can the other parts of the mixer.

Lateral holes 2′ are provided in the chamber 2 at different heights with the purpose of permitting the introduction into the mixing chamber of elements for measuring the process variables, in particular temperature and pressure. Said holes 2′ or similar holes of suitable size can be used for the introduction of additional materials of any type into the mixing chamber 2.

In FIG. 1 the rotor 5 is shown rotably supported at its lower end in a support comprising radial bearings 11 and thrust bearings 12. At its upper end the rotor can be supported by a radial bearing (not shown) or can terminate (as indicated by the broken lines 5′) without further support.

The rotor is driven at one of its ends by any suitable known system either at fixed or variable velocity according to requirements. It is not considered necessary to illustrate any of these systems in detail in the figures, neither does it serve any purpose to describe one here.

Examining in greater detail the characteristics of the rotor 5 it is seen that the feed screw conveyor 7 is shown formed with a square section. This section could however be slightly trapezoid without negative consequences. It is however important that the feed capacity of the screw is in line with the general characteristics of the mixer.

The section of the screw zones 8*a*, 8*b* and 8*c*, clearly shown in FIG. 2, are in the form of an equilateral triangle, with the corners 13 bevelled. By making the bevels 13 with a circumference concentric with the external chamber 2, the width of the gap *h* will be constant, as in the case of FIG. 3. The direction of rotation indicated by the arrow F is fixed only by the necessity for the screw 7 to push the material into the chamber, in that the section itself does not have an inherent direction of rotation. The upper screw zone 8*a* has to push the material downwards while the lower zone 8*b* has to force it upwards so as to remix the material. Alternatively the gap *h* can be made of variable width by making bevels 13′ formed from a flat wall *sp* and a curved part *sc* with its center of curvature displaced from the axis of the rotor, as shown in FIG. 4. In this case the direction of rotation has to be that indicated by the arrow F′. It is also possible to form the parts 8*a* and 8 *b* of the

rotor with triangular sections having cylindrical bevels **13** concentric with the axis and the part **8c** of triangular section having flat and curved bevels **13'**.

The bevels **13** and **13'** consist of surfaces parallel to the axis of the machine when the chamber **2** is cylindrical. When the chamber **2** is slightly conical the bevels can also be shaped with conical or inclined surfaces which among other things will allow the width of the gap *h* to vary as a function of the reciprocal axial position of the chamber **2** and the rotor **5**.

The rotor **5** is preferably made with an axial bore **15** to allow the circulation of a heat exchange fluid. The method of effecting this is technically well known and there is no need to illustrate it. For this reason and for simplicity it has not been shown on the drawings.

The operation of the mixer can be described briefly: The materials to be mixed are loaded into the hopper **1** in suitable forms and quantities. The screw conveyor of the rotor **7** feeds them into the chamber **2** and thrusts them downwards into the mixing zone formed by the two triangular screw parts **8a** and **8b** of the rotor, the first part of which forces the material downwards and the second upwards, so as to create ideal conditions for an efficient and intimate mixing. The material then passes into the zone corresponding to the part **8c** by the thrust of the fresh material, created by the screw conveyor **7**, then through the discharge zone between the discharge section **9** and the rotor **5** and the discharge ring **10**, to the outside of the machine. Along the whole of the length of the chamber **2** the material being handled is subjected to temperature and pressures which are adjusted by varying the temperature of the heat exchange fluids circulating in the interspaces **4'** and **4''** and inside the rotor **5** respectively, and by varying the relative level between the chamber **2** and the rotor **5** and the rotational speed of the rotor. The extent and influence of the individual adjustments will vary according to the material and processes being operated, according to rules easily determinable by specialists.

At the beginning of operation there will be a transitory period during which the mixing chamber is filled. After this the operation will proceed continuously according to substantially constant laws.

The mixer according to the invention gives considerable advantages over conventional ones. Its particular characteristics are its extreme structural simplicity, the vertical flow of the material and the high intensity os mixing and dispersion which can be obtained by it.

With regard to the simplicity of structure of the mixer it will be seen for example that axial discharge of the product allows the complicated systems usually necessary for rendering the mixing chamber tight to be eliminated. Another important characteristic is the extended surface per unit of volume of material being processed, this permitting a high degree of heat exchange between the walls of the mixing chamber central rotor and material, so facilitating temperature control of material. The operation of the machine is continuous and this constitutes an unquestionable and substantial factor of progress to which must be added the ease, simplicity and reliability of operation and adjustment, ease of cleaning and compactness of the structure.

The described embodiment of the mixer according to the invention, being by way of example only, can undergo variations and modifications of various kinds without leaving the field of protection of the invention. To give some examples the rotor **5** can be supported at its upper part rather than its lower part by using an upper support furnished with thrust bearings. The shape of the section of the parts **8** of the rotor can also be varied by making the sides of the triangle which form it curved for example. Similarly the crests of the screws of the rotor, which are discontinuous in the representation shown in the drawings, can be made continuous wholly or partly. The interspace sections can be more than two or the interspaces can be substituted by spirals **24** which can be filled either with heat exchange fluid or electrical heating coil means. It has already been said that the assembly of the mixing chamber on the framework of the mixer can be made in a different manner. It can be added that the chamber itself and its shell can be made in two halves in order to facilitate cleaning and removal of the chamber.

Finally it should be noted that although the mixer according to the invention derives important advantages from the vertical arrangement of its parts it can also be built horizontally, so conserving all those advantages which do not depend on the principal position of the machine.

Although the machine is here claimed and described as a complete machine in itself it will be evident to specialists in the field that it can also form the central part of an extruder or an injection press. The invention also applies to this particular application.

I claim:

1. A mixer for use particularly in the dispersion of powders in gelatinous masses and for the handling of the resultant mixtures, applicable especially to the rubber and plastics industries in general, comprising a substantially cylindrical mixing chamber having a smooth inner surface and a single rotor coaxial with said chamber and rotating therein, said rotor having three continuous sections for feeding, mixing and discharge, respectively, of which the mixing section is formed from two opposing screw parts and a prismatic part, said screw parts being generated by the rotation, in opposite directions along the rotor axis, of a plane polygonal section equal to that of said prismatic part.

2. A mixer as claimed in claim **1**, in which the feed section of the rotor comprises a screw conveyor and the discharge section comprises an inverted truncated cone, further comprising a feed hopper secured to the feed end of said chamber, said rotor being arranged inside the mixing chamber in such a way that the feed section projects outwards from the chamber to penetrate into said feed hopper, and a discharge ring on the discharge end of said chamber having its internal wall in the shape of a truncated cone with a taper different from that of the discharge section of the rotor.

3. A mixer as claimed in claim **2**, further comprising means to adjust the discharge area formed between the discharge ring of the mixing chamber and the discharge section of the rotor by relative axial movement of the parts forming said area.

4. A mixer as claimed in claim **3**, in which the mixing chamber further comprises interspaces for circulation therein of a heat exchange fluid, means to circulate said fluid inside the rotor and inside the discharge section of the chamber.

5. A mixer as claimed in claim **1**, further comprising means for relatively moving the rotor and mixing chamber along a common axis and in which the material feed and discharge are simultaneous and continuous.

6. A mixer as claimed in claim **1**, further comprising closable holes in said chamber which permit the introduction into the chamber of members for sensing the parameters of the operational process and/or of process material.

7. A mixer as claimed in claim **1**, in which the mixing chamber and the rotor are cylindrical.

8. A mixer as claimed in claim **1**, in which the mixing chamber and the rotor are slightly conical.

9. A mixer as claimed in claim **1**, in which the feed section of the rotor comprises a screw conveyor while the discharge section comprises an inverted truncated cone and the mixing section has a triangle as the cross-section of its screw and prismatic parts.

10. A mixer as claimed in claim **9**, in which the corners of the triangle of said section are bevelled according to a circumference concentric with the axis of the mixing chamber and rotor.

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