May 30, 1950

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APPARATUS FOR GRINDING, MIXING, AND KNEADING MATERIALS

2,509,379

Filed June 24, 1948

2 Sheets-Sheet 1

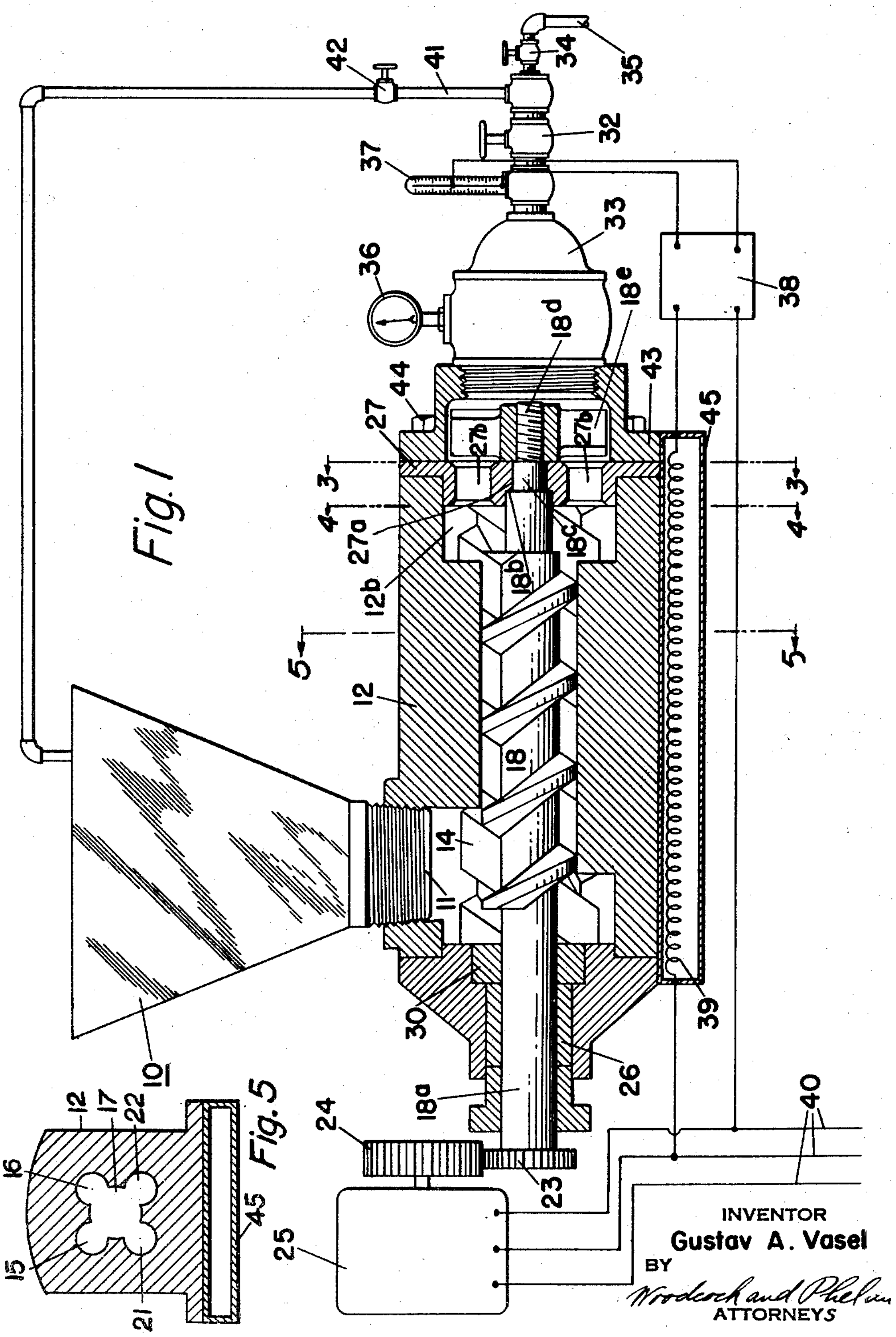

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Fig. 2

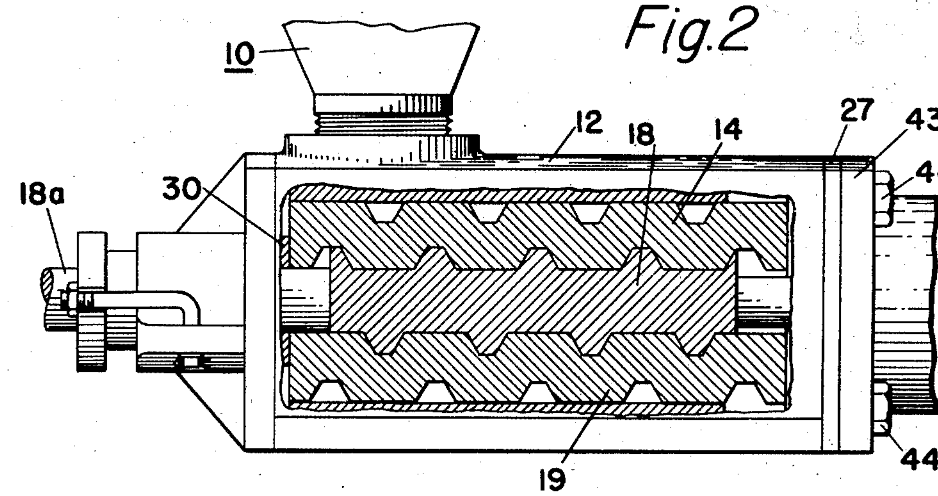


Fig. 3

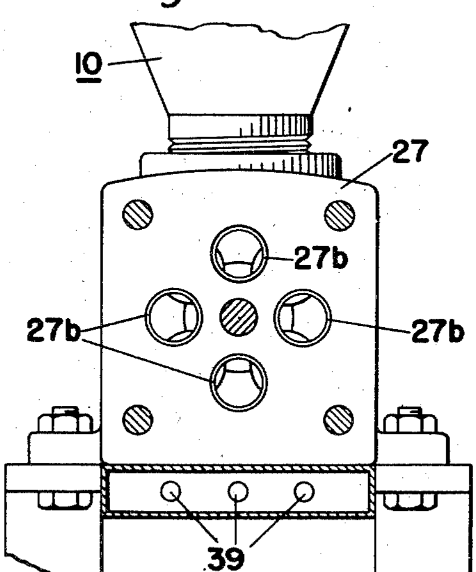
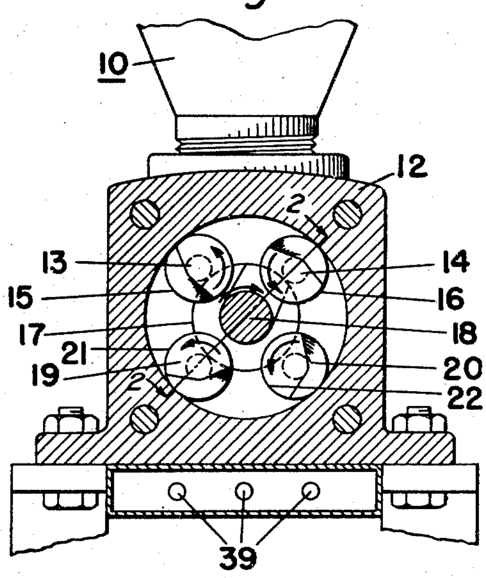


Fig. 4



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APPARATUS FOR GRINDING, MIXING, AND KNEADING MATERIALS

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Application June 24, 1948, Serial No. 34,865

5 Claims. (Cl. 241—66)

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This invention relates to methods and apparatus for mixing wet and dry materials such as a liquid vehicle and solids such as pigments, etc., and has for an object the provision of a system and apparatus for producing a combined grinding, kneading and mixing action of high efficiency for an end product of great uniformity.

The invention has been found particularly applicable to the dispersion of a pigment into a vehicle to produce materials such as paints and inks; and to the dispersion and mixing of foodstuffs such as margarin, peanut butter, etc. Heretofore, adequate mixing and grinding of such products has involved several independent operations and considerable complex equipment. For example, preparation of paint has required the use of several pieces of apparatus which are heavy, bulky and expensive. Pigment received in dry form was delivered to dough mixers where the dry material was put into the vehicle and mechanically stirred until the particles were considered adequately wetted. The mass was then delivered to grinding mechanism such as roller mills. Thereafter, the mixture passed through a homogenizer or again through the dough mixer. The entire operation was relatively lengthy, from ten to ninety hours being required for adequate treatment in a ball mill or roller mill.

In carrying out the present invention in one form thereof, a mixture of dry material, together with liquid material such as one or more vehicles, is introduced into a zone wherein there is a grinding, kneading and mixing action along a spiral path with forcible ejection of the material from the mixing zone. More particularly, the mixture is fed between a pair of blades or idlers each having a spiral thread thereon meshing with spiral threads on a centrally disposed rotor. The complementary threads are preferably provided so that the material is ground between contacting portions and, at the same time, kneaded for thorough dispersion of the material. Flow-producing means beyond the mixing area driven by the rotor and having a controlled or predetermined capacity receives the ejected material and conveys it away at a predetermined rate to control the pressure effective in the mixing area. There is a reduction of agglomerates and aggregates which means reduction in particle size so that in the end product there is a maximum degree of fineness. The combined wiping, rubbing and grinding action results in a homogeneous mixture as the end product.

For further objects and advantages of the invention, reference is to be had to the accompanying drawings in which:

Fig. 1 is in part a sectional view of an apparatus embodying the invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 4;

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Fig. 3 is a section taken on the line 3—3 of Fig. 1;

Fig. 4 is a section taken on the line 4—4 of Fig. 1; and

Fig. 5 is a section taken on the line 5—5 of Fig. 1, with certain parts omitted.

Referring to the drawings, the invention in one form has been shown applied to a grinding, kneading and mixing apparatus in which material is fed from a hopper 10 through an inlet opening 11 of a casing or housing 12. The material flows into the mixing area between a pair of blades 13 and 14 disposed in openings 15 and 16 spaced radially outward from a central cylindrical opening 17 having disposed therein a central rotor 18. Similar blades 19 and 20 are provided in radially spaced openings 21 and 22. The five openings 15, 16, 17, 21 and 22 are all cylindrical and extend substantially the full length of the casing 12. The rotor and each of the blades closely fits its cylindrical opening. Each blade meshes with and is complementary to the rotor 18 disposed within the central opening 17. The rotor 18 is provided with an extension 18*a* having on the end thereof a gear 23 meshing with a driving gear 24 carried by the shaft of a motor 25. A packed bearing 26 is provided for extension 18*a*, while at the opposite end of the rotor 18 a bearing plate 27 is provided. The bearing plate 27 has a reentrant opening 27*a* into which the end of rotor 18 extends, a shoulder 18*b* being provided to abut a complementary shoulder of the plate 27. A portion 18*c* of the rotor 18 of reduced diameter extends to the face of the plate 27 and is there further reduced in diameter and threaded at 18*d* to receive the flow-producing propeller 18*e*. The rotor end portion 18*c* is of such length that the rotor 18 may turn freely but is retained in fixed axial relation with member 27 when the propeller 18*e* is screwed tightly against the shoulder at the end of the threaded portion 18*d*. The plate 27 then receives axial forces from the rotor through the propeller 18*e*.

The helical member on rotor 18 may be a single righthand thread or blade of relatively large pitch. It meshes with cooperating threads on the blades 13, 14, 19 and 20. The axial length of the blade on rotor 18 is considerably less than the axial length of blades 13, 14, 19, and 20. As viewed in Fig. 4, the direction of rotation of rotor 18 is clockwise, thus forcing the mixed material from the grinding-mixing area into the chamber 12*b*. Each blade driven by rotor 18 abuts against the bearing plate 27. As indicated, the plate 27 (of any suitable bearing material such as bronze) is provided with a plurality of openings 27*b*, Fig. 3, angularly disposed intermediate the radially spaced blades for exit of material into an outlet chamber 33 and thence to an outlet system (shown in Fig. 1, reduced in scale beyond chamber 33). The plate 27 is held in place by the housing 43 for chamber 31 which is secured to the casing 12 by a plurality of bolts 44.

The propeller 18e positioned adjacent the plate 27 and in chamber 31 preferably is of such dimension and configuration that it has greater fluid-moving capacity than the rotor 18 and blades 13, 14, 19 and 20. In such preferred form the mixture is removed from the chamber 12b so that rotor 18 and its complementary blades will not be required to operate under back pressure. As a result, the rotor and blades run relatively free, thus eliminating friction heating of the device and the mixture occasioned by grinding and mixing at elevated pressures. Such heating is objectionable in mixing of certain products.

In other operations, the back pressure may be controlled by proper selection of the size and configuration of the propeller 18e. In any event, the pressure in the working area may be controlled and at the same time an output pressure maintained to convey the mixture to the site of further operations (packaging, etc.) without the need of additional pumping or conveying equipment.

The thread or blade on rotor 18 and the pitch of the propeller are opposite in sense to the threads on the end 18d of the rotor 18. The force created by working against the mixture serves tightly to screw the propeller onto the end of the rotor to maintain the fixed axial relationship with respect to the bearing plate 27.

The pressure in the output is indicated by a pressure gage 36. The mixing may be at elevated temperatures, if desired, and under any suitable control as indicated by a contact-making thermometer 37 which makes and breaks energizing circuits for relay apparatus 38 for control of the energization of a heater coil 39 connected to supply lines 40. Under similar control, a fluid may be circulated in a heat-transfer system associated with the device either to increase or decrease the temperature of the material independent of the working pressure.

It is desirable in certain applications to recycle a fraction of the material being mixed, and for this purpose a return line 41 having a control valve 42 may be utilized. By partially closing the valve 34 to increase the pressure behind it, material may be made to flow through line 41 and into the hopper 10.

The apparatus as a whole is of relatively low cost, simple in operation and yet produces combined grinding, mixing, kneading and dispersing actions which rapidly and efficiently produce an intimate mixture of solid materials with liquid materials. The system is such that products may be mixed in the single apparatus and in accordance with the process above described without need for preliminary treatment in ball mills, homogenizers and the like. The invention is applicable to a plurality of materials, particularly where there is product-appreciation or enhancement of value of the product by reason of the intimacy of the mixture of the solid materials with the liquid components.

While four blades or spirally-threaded grinding elements driven by the rotor have been disclosed, it is to be understood that advantages will be secured with systems using two or more such blades where their orientation about the rotor is such that the radial forces on the rotor are substantially balanced to permit relatively high speed operation.

The material to be mixed or ground may be moved from the hopper 10, as by gravity, or if desired by spiral feed means. It enters the mixer in an open free space which extends between the two upper blades 13 and 14, and enters into the grooves between the threads thereof. It is divided, a part being pushed along each of the grooves, but each part joining and uniting with the other as the groove intersects the threaded centrally located member 18. The mixture is ground between metallic surfaces in sliding engagement. The driving member 18 tends to move to the left and the driven blades to the right. The plate 27 restrains axial movement of the rotor and blades thereby causing considerable force to be exerted on the contact faces of the thread and grooves. Grinding action takes place between the contact faces of the spiral thread on the central rotor blade 18 and complementary spiral grooves on the blades 13, 14, 19 and 20.

The cylindrical openings 15, 16, 21 and 22 are so disposed with respect to the central opening 18 that considerable rolling action takes place between the crest of each of the outer blades and the axial space between the spiral thread on the central blade 18. Additional grinding and wiping action takes place between the crests of each of the outer blades and the walls of their respective chambers. The mixing, kneading, wiping and grinding action continues throughout the length of the casing 12. The flow of the mixture from the grinding area is controlled by propeller 18e, thus the pressure in the reentrant opening 12b, through which the radially spaced blades extend, also is controlled.

The apparatus is relatively small in size, compact, and is of but few moving parts. By way of example, in one modification of the mixer the housing was approximately 4" square and 12" long; the central opening approximately 1.75" in diameter, and the blades, 1" in diameter. The rotor was driven at a speed of 3600 R. P. M. by a motor of 7.5 H. P.

It is emphasized that not only is there provided, in accordance with the present invention, a new form of mixing device, but also in accordance with the method and the mode of operation of the new device there is product improvement due to the more complete dispersion of the solid materials and the liquid materials. By locating the idlers or blades 13 and 14 on oposite sides of the inlet 11, the material to be treated divides between the two spiral channels and moves forward in divided spiral paths which, because intersecting with the central drive roller, again divides and is distributed circumferentially of the mixer. There is avoided direct travel of the material along single spirals. Instead, the material divides among the spirals and is rotated around the central driving rotor and is constantly sub-divided between the driven blades.

Where the kneading and mixing and dispersing actions are to be conducted under a minimum of pressure, the propeller 18e performs the important function of moving the material forward through the outlet with a resultant reduction of pressure on the material as it passes through the spiral rotor and cooperating blades. This means that the friction on the moving parts as materials are dispersed, ground and mixed is reduced and less heat is generated. The mixing process may, therefore, be conducted at lower temperatures without the provision of additional cooling means which, as previously noted, can be substituted for the heater 39 shown in Fig. 1.

The propeller 18e rotating in the discharge chamber performs the additional function of added mixing by reason of its rotation through the mass as it is discharged from the driving rotor and the cooperating blades. The pitch of the blades of the propeller assists in moving the material forward (though in special cases the pitch could be reversed), the resultant thrust from the propeller makes it possible to eliminate ball bearings. This means that cleaning is greatly facilitated which is not only particularly important with reference to food products, but is an advantage from the standpoint of economy and time devoted to cleaning the device when used in any mixing operation. The bearing plate 27, neutralizing all axial forces in the system, is of reasonably simple shape, and yet performs a plurality of functions. It maintains the idlers or mixing blades in place and takes the thrust of the driving rotor by way of the hub of the propeller 18e which is threaded on the end of the rotor 18 and disposed in abutting relation with the central part of the plate 27. Finally, the particular arrangement of driving rotor and mixing blades results in a relatively fast movement of the materials in circumferential and axially spiraling paths in which there is substantial turbulence created for most efficient mixing without the induction of air due to the turbulence occurring within the mixing cylinders in which the spiral elements are disposed. Induction of air is also lacking in the discharge chamber in which the propeller 18e is disposed, since the material fills the discharge chamber completely.

While a preferred form of the invention has been illustrated, it is to be understood that modifications may be made within the scope of the appended claims.

What is claimed is:

1. In a continuous mixer a casing having four elongated chambers extending radially from and parallel to a central chamber, spiral blades in each of said four chambers, a rotor in said central chamber meshing with each of said blades, driving means for rotating said rotor and said blades, said casing having an opening intermediate a pair of said blades for feeding material thereinto for divided spiral flow, said casing being provided with an exit axially extending from said blades, a bearing plate disposed at said exit having openings therein and bearing portions on one side thereof engaging said rotor and said blades, and fluid-moving means secured to said rotor and bearing on a side of said plate opposite said bearing portions to maintain in axially fixed position said rotor and said blades.

2. A continuous mixer comprising a casing having a central chamber, a spiral rotor extending through the length of said chamber, means for driving said rotor, a plurality of openings radially spaced from said central chamber, a spiral blade within each of said radially spaced openings and meshing with said centrally disposed rotor, said casing having an inlet for flow of material thereinto, a bearing plate disposed at one end of said central chamber having openings therein for discharge of material after it has been subjected to a wiping and rubbing action by said meshing blades, a propeller to receive and move said materials away from said rotor and said blades, said propeller having greater fluid-moving capacity than said rotor and said blades, and means controlling the temperature of said mixer independent of the working pressure.

3. Apparatus for milling and mixing the combination of wet and dry materials which comprises a rotor with a helical thread of relatively large pitch, a thrust plate, one end of said rotor extending through said thrust plate, fluid-moving means fastened to the extended end of said rotor and adjacent said thrust plate, means for driving said rotor, said fluid-moving means bearing against one side of said thrust plate to transmit thereto the axial thrust developed upon rotation of said rotor, a plurality of threaded idlers symmetrically disposed about and held in mesh with said rotor abutting said thrust plate and neutralizing said axial thrust on said rotor, means for introducing said materials into said apparatus at the end opposite said thrust plate, and a flow channel for receiving said material from said fluid-moving means.

4. In an apparatus utilizing intermeshing threaded members for milling and grinding a mixture of wet and dry materials, the combination of a driven rotor having a central portion threaded with relatively large pitch and an extended end portion threaded opposite in sense to said central portion, a thrust plate centrally apertured to receive and support an end portion of the rotor, idlers symmetrically disposed about said driven rotor meshing with said intermediate portion and driven thereby, said idlers bearing against one side of said thrust plate and in cooperation with said rotor milling said mixture while conveying it toward said thrust plate, a propeller threaded on the extended end of said rotor and bearing against an opposite side of said thrust plate to thus neutralize axial forces developed when said material is introduced into said apparatus, said propeller having a predetermined capacity with respect to the capacity of said idlers and said rotor thereby to control the back pressure on said material in the grinding and milling operation.

5. In an apparatus for producing uniform dispersion of a mixture of liquids and solids comprising a rotor having threads of relatively large pitch throughout a central portion thereof and an end threaded with the pitch opposite to that of said central portion, a housing having a central cylinder within which said rotor is disposed, said housing having a plurality of cylinders intersecting with said central cylinder, idlers disposed within each of said intersecting cylinders and each having threaded central portions meshing with said intermediate portion of said rotor, said housing having a discharge chamber for receiving material discharged from said rotor and its idlers, a thrust plate within said discharge chamber having openings for discharge of material therethrough and having a hub portion engaging a shoulder on said rotor and having bearing surfaces engaging the ends of said idlers, means threaded to said end of said rotor for engaging said thrust plate on the side remote from said shoulder whereby axial forces developed by said rotor and said idlers tend to neutralize each other by applying said axial forces oppositely to said thrust plate, means for rotating said rotor and said idlers for forced flow of said mixture through each spiral path formed between said threaded portions and its associated cylinder, said forced flow developing a grinding and kead-

ing action under a gradually increasing pressure axially of said cylinders, and a propeller driven by said rotor within said discharge chamber having the pitch of the blades thereof in a direction to assist movement of said mixture away from said cylinders thereby to reduce the pressure within said cylinders.

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