April 4, 1950 S. L. GOODCHILD 2,502,563

MIXING MACHINE

Filed Nov. 28, 1945 4 Sheets-Sheet 1

Fig. 1

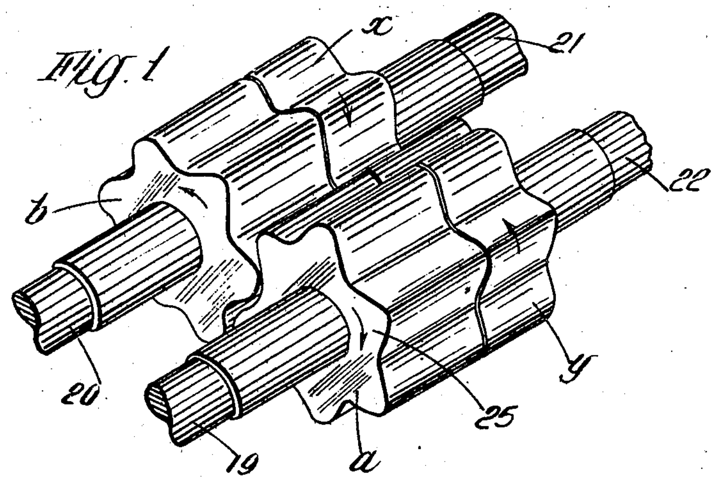
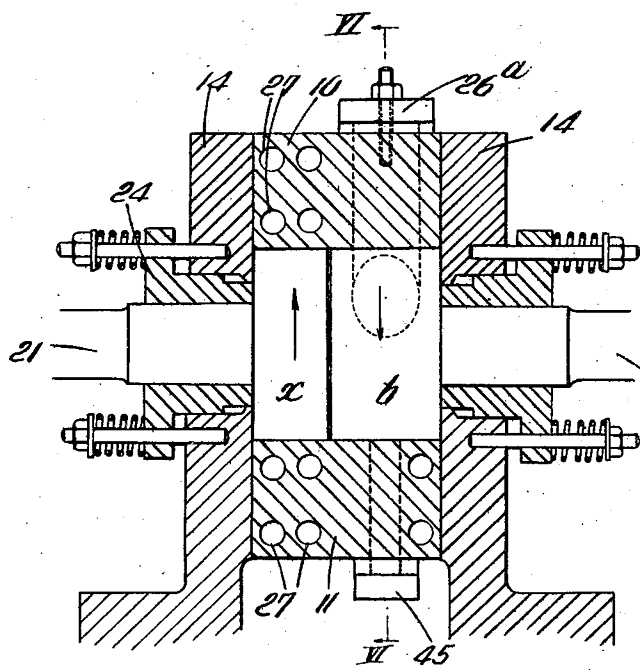


Fig. 5.



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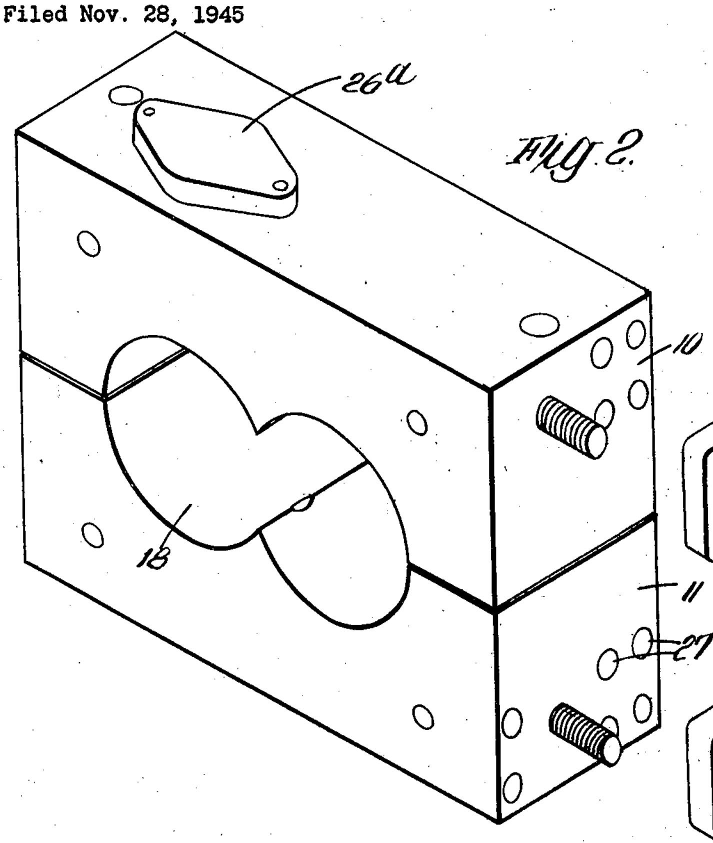
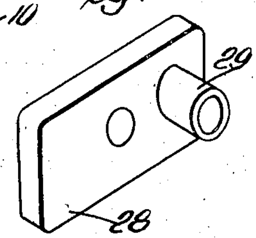


Fig. 2.

Fig. 7.



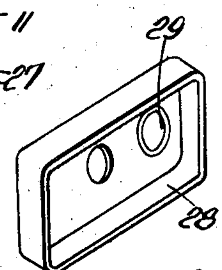
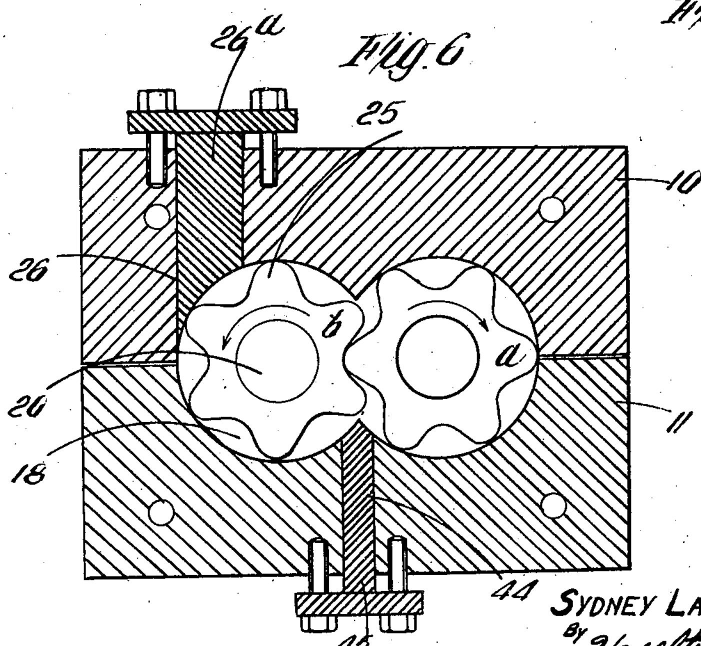


Fig. 8.

Fig. 6



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MIXING MACHINE

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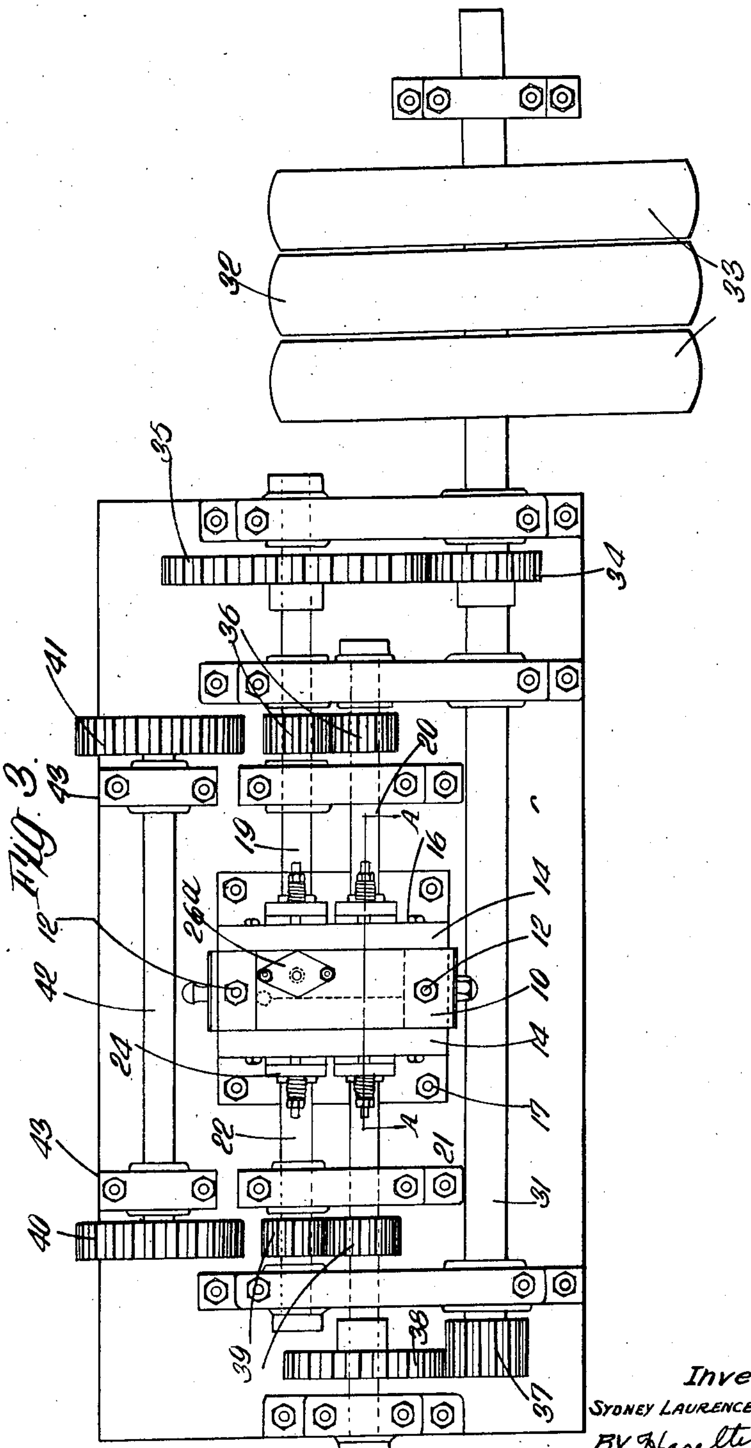

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MIXING MACHINE

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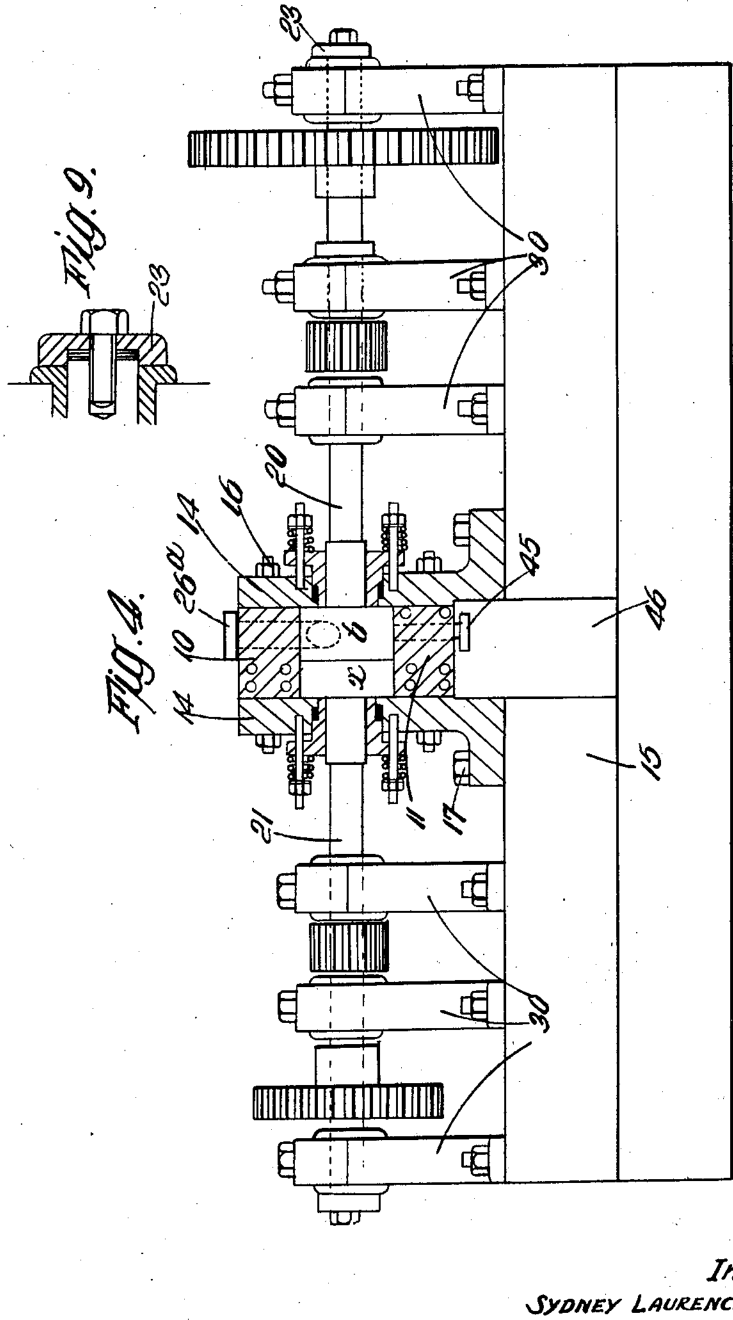

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2,502,563

MIXING MACHINE

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8 Claims. (Cl. 259—104)

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This invention relates to machines for mixing and kneading plastic masses and more particularly for incorporating and dispersing pigments into oils, resins, varnishes, cellulose and other plastics and subsequently reducing the pigmented plastic thus formed with solvents, paint media, etc. into a uniform flowable paste or liquid. Of known machines of this kind, kneaders or internal mixers of the Werner Pfleiderer or Banbury type have had a certain amount of success but these machines suffer from the following disadvantages:

1. The volume of material for mixing action in the stiff state is critical.
2. The material mixed tends to be thrown out of the mixing chamber needing hydraulic rams, etc. to return it.
3. The mixing action is not entirely positive if the charge is sticky, and when solvent is added to reduce the mass, the charge slips and prolonged mixing is required to incorporate the solvent.
4. When being reduced with solvent, the mass sticks to the sides of the vessel and the back of the rotors, and it is difficult to produce a uniform smooth paste with good dispersion of the pigment.

Most success has been obtained in the dispersion of pigments into cellulose plastics, but to reduce the plastic for use it is usual, in order to overcome the above difficulties, to empty the charge and sheet the pigmented plastic over roller mills, to dry this sheet free of solvent, and then to break it up into chips. These chips are subsequently dissolved in a vortex mixer in solvents, and it will thus be seen that several machines and stages are required. In the case of concentrated plastics of pigment in oil, varnish or synthetic resin, no quick and easy method of reducing the paste without flocculation of the pigment exists.

The principal object of the present invention is to provide an apparatus for the production of flowable pastes or liquids from pigment and media without the difficulties described above, and which makes available paints and compositions of high pigment content and good gloss and dispersion.

According to the invention, a machine for the purpose specified comprises a mixing chamber and one or more members which are adapted for rotation therein in such manner that the material under treatment is positively mixed and kneaded while each of the surfaces of said rotatable members and of said chamber which contacts the material under treatment, is contacted, wiped or narrowly cleared by one or other of the remainder of said surfaces.

According to the preferred embodiment, the

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machine comprises a closed chamber of a shape equivalent to two parallel, intersecting cylinders within which are disposed, with a narrow clearance, two pairs of oppositely rotatable, intermeshing rotors, the rotors of each pair being located one in each part-cylindrical portion of the chamber and being of such shape that the periphery of one is contacted, wiped, or narrowly cleared by the periphery of the other. The pairs of rotors desirably rotate at different speeds since such differential movement assists homogeneous mixing. In this case, the rotors have a lateral width inversely proportional to the speed at which they are rotated, in order that the two pairs of rotors shall have the same displacement. The rotor teeth consist of epi- and hypocycloidal curves.

According to another embodiment, a chamber as above described contains only one pair of intermeshing rotors which are, however, less wide than the chamber so that the charge is exuded laterally into a free space. To ensure that the two sides of the chamber are contacted and wiped, and the whole charge worked upon, the rotors are adapted to be given a to and fro lateral action within the chamber. The rotor teeth are helical and, as in the previous embodiments, are of epi- and hypocycloidal form and their direction of rotation can be reversed in synchronism with the reversal of the lateral stroke.

According to yet another embodiment, the chamber is rotatable and consists of a cylinder, the inner periphery of which is toothed, with epi- and hypocycloidal teeth. An inner rotor with a small number of teeth engages the teeth of the chamber and a crescent-shaped abutment fills the space not covered by the path of the teeth. As in the previous embodiment, the internal rotor is less wide than the cylinder in order to give the charge a path to the suction side of the mixing cycle and is given a similar lateral action.

In any of the embodiments, above described, some of the rotor teeth may be omitted, the rotors being circular at these points and in contact. The remaining teeth and valleys in the mating rotors would have to mate at appropriate points of their revolutions.

The preferred embodiment of the invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of the rotors,

Figure 2 is a perspective view of the mixing chamber in which the rotors are adapted to work,

Figure 3 is a plan view of the complete machine,

Figure 4 is a side elevation corresponding to Figure 3, partly in section on the line A—A,

Figure 5 is an enlarged section on the line A—A of Figure 3,

Figure 6 is a section on the line VI—VI of Figure 5, and,

Figures 7, 8 and 9 are detail views.

The mixing chamber consists of upper and lower members 10 and 11 secured together by means of vertical bolts 12, and side members 14 which are secured to members 10 and 11 by means of horizontal bolts 16 and to the foundation 15 by means of foot bolts 17. The chamber 18 thus formed is in the shape of two intersecting cylinders as shown more particularly in Figures 2 and 6. Two pairs of rotors *a*, *b*, and *x*, *y* are located within the chamber 18, the pair *ab* being driven in the opposite direction to the pair *xy*. As shown, *a* and *x* are being driven in the clockwise direction, while *b* and *y* are being driven in the counter clockwise direction, but such relative directions of rotation may be reversed as explained hereinafter. Rotors *a* and *b* are secured to parallel shafts 19 and 20, and rotors *x* and *y* are secured to parallel shafts 21 and 22. Side play in the shafts 19—22 is limited by thrust bearings 23 which bear against the side face of the outer bearing on each rotor shaft. Combined bearings and spring-loaded glands 24 tend to force the rotors together, the outer diameter of the glands being sealed with packing, but are resisted by the bearings 23 so that in practice there is a small lateral clearance between the rotors. The rotors are of such shape that the whole of the periphery of one is contacted, wiped or narrowly cleared by the periphery of the mating rotor, and as shown the rotors are formed with six teeth 25 consisting of epicycloidal and hypocycloidal curves. Other numbers of teeth may be employed. Generally, the clearance between the rotors, and between the rotors and the wall of the chamber, is of the order of a few thousandths of an inch, but for big machines or for operating on special plastics, clearances of up to the order of a quarter of an inch between the rotors may be employed. It will thus be appreciated that no sticky masses can permanently adhere to the rotors or to the wall of the mixing chamber.

Material is fed to the chamber through an opening 26 normally closed by a removable charge plug 26*a* and enters the chamber substantially at a tangent to the rotor *b* so that the material is drawn in when *b* is rotating anticlockwise. The material is then carried downwards around rotor *b* until it reaches the zone immediately below the line along which the rotors *a* and *b* intermesh. Here the material is kneaded and forced to pass laterally along the teeth of rotors *ab* to the rear pair of rotors *xy* which, rotating in the opposite direction, pass it upwardly round the rotor spaces to a zone immediately above the line along which rotors *xy* intermesh, whence it is forced laterally into the spaces of the front rotors *ab*, thus completing a mixing cycle. Once the charge has been introduced, it will be appreciated that the relative rotation of the pairs of rotors may be reversed one or more times during the mixing operation to ensure homogeneous mixing. The two pairs of rotors preferably rotate at different speeds, thus giving differential movement to aid homogeneous mixing, and in this case, to ensure that the two sets of rotors shall have the same displacement, the rotors have a lateral width inversely proportional to their rotational speeds. Thus, in the embodiment shown, rotors *xy* rotate at a higher speed than rotors *ab*.

Tubular channels 27 are formed in the members 10 and 11 for the passage of a cooling medium, usually water. The supply and return of the cooling medium is effected through cover plates 28 having a single water inlet 29.

Shafts 19 to 22 are supported in suitable bearings 30 and when the machine is mixing, said shafts are normally driven from the common shaft 31 by means of the fast pulley 32. The provision of two loose pulleys 33 and crossed and open belts (not shown) allows for a main drive in either direction. Shafts 19 and 20 with their associated rotors *ab* are driven from the shaft 31 by means of the spur wheels 34 and 35 and pinions 36, while shafts 21 and 22 with their associated rotors *xy* are driven from the shaft 31 by means of the spur wheels 37 and 38 and pinions 39. It will thus be seen that the pairs of rotors *ab* and *xy* are driven in opposite rotational directions by the common shaft 31. While the mixing chamber is being charged, the rotors are driven in the direction shown in Figure 1, but during the mixing operation, the directions of rotation can be changed intermittently by reversing the direction of rotation of shaft 31 by slipping in either the crossed or open belt as the case may be.

At the completion of the mixing operation, when it is required to empty the mixing chamber, shaft 31 is pushed horizontally to the left thus throwing spur wheels 34 and 35 out of engagement while retaining engagement between spur wheels 37 and 38 as will be seen from Figure 3. Gear wheels 40 and 41 carried by layshaft 42 are then brought into engagement with the driving pinions 39 and 36 respectively, thus reversing the direction of rotation of the rotors *ab*. The bearings 43 for layshaft 42 are mounted on slides so that wheels 40 and 41 can be thrown completely out of engagement with the pinions when not required for emptying. When set for emptying, rotors *b* and *x* should rotate in an anticlockwise direction and rotors *a* and *y* in a clockwise direction, thus forming in effect a gear type pump which will force out the contents through the discharge orifice 44 normally closed by plug 45. It will thus be understood that the wheels 40 and 41 will be brought in while shaft 31 is rotating in the direction such that the rotors are rotating in the opposite directions to those shown in Figure 1.

The machine may be thoroughly cleaned by slacking off the retaining springs and sliding glands 24 clear on to the reduced portions of the shafts 19—22. The sides 14 of the mixing chamber may then be slid to left and right by removing the horizontal bolts 16 and the foot bolts 17. By removing vertical bolts 12 the two halves 10 and 11 of the rotor housing may be taken apart and thoroughly cleaned. The upper half may be removed directly, the lower half then being dropped into the well 46 and brought forward.

The faces between the two pairs of rotors may be cleaned by slightly separating the rotors laterally. The rotors themselves are not removed from the machine for cleaning, as they are completely exposed once the rotor casing and sides have been removed.

It will be appreciated that as the movement of the charge is positive, kneading and mixing will take place even though the free space in the machine is only partly occupied, and that the machine need only be partly loaded with pigment and media to give a stiff plastic, with the result that space is available for the addition of solvent or more medium for reducing purposes. The machine will therefore operate effectively at all stages.

The rotors as shown are all of the same diameter and have the same number of teeth but I do not wish to limit myself to this arrangement and the mating rotors may have different numbers of teeth, and the pairs may differ from each other in diameter and/or number of teeth provided that, relative speeds of rotation and width considered, the volumetric displacement of each pair of rotors is substantially the same and that the point of kneading displacement is approximately laterally opposite the suction zone of the other pair of rotors.

The machine according to the present invention has several advantages over known machines. Thus, paints of high gloss can be produced more easily than hitherto due to the good dispersion in the heavy plastic effected. Again, as the working surfaces are self-wiping, it is possible to clean the machine easily by running it after discharge with a quantity of solvent.

I have ascertained that the machine operates most effectively with pigments consisting of agglomerates of finely divided particles in preference to pigments of an abrasive or coarse structure. Suitable pigments include zinc oxide, carbon black, titanium dioxide, chrome yellow, antimony oxide and lakes.

The machine may be used for emulsification of viscous or gel-like substances with aqueous media. This operation is difficult in existing mixers because of slipping of the semi-solid mass in the mobile aqueous media. In further amplification of the second embodiment the machine comprises a closed mixing chamber similar to that of the preferred embodiment consisting of members **10, 11, 12, 14, 15, 16, 17**, Figs. 2, 3 and 6. This chamber contains one pair of intermeshing rotors which are of epicycloidal and hypocycloidal construction, of helical form, and are less wide than the chamber. The charge being worked is forced axially along the teeth into a free space at the end of the rotors. To ensure that each side of the mixing chamber and rotors be wiped and the whole charge worked upon a lateral action is imparted to the rotors. This action is produced by cams acting on each rotor shaft. Rotors and cams are driven through gearing by a reversible electric motor. The cams are arranged to provide a dwell at the end of each stroke and in addition to operate a switch which first stops and then reverses the drive.

I claim:

1. A mixing device for the purpose described comprising a closed mixing chamber of a shape equivalent to two parallel intersecting cylinders, inlet and outlet means in said chamber and two oppositely rotatable pairs of intermeshing toothed rotors, said rotors being disposed one of each pair in each part-cylindrical portion of the chamber with a narrow clearance between said rotors and respective cylinder walls and said rotors being so shaped that the entire periphery of one rotor of each pair is narrowly cleared in motion by the entire periphery of the other rotor of the pair.

2. A mixing device for the purpose described comprising a closed mixing chamber of a shape equivalent to two parallel intersecting cylinders, inlet and outlet means in said chamber, two oppositely rotatable pairs of intermeshing toothed rotors, and means for rotating said pairs of rotors at different speeds, said rotors being disposed one

of each pair in each part-cylindrical portion of the chamber with a narrow clearance between said rotors and respective cylinder walls, so shaped that the entire periphery of one rotor of each pair is narrowly cleared in motion by the entire periphery of the other rotor of the pair and each pair of rotors having a lateral width inversely proportional to the rotational speed of the rotors.

3. A mixing device for the purpose described comprising a closed mixing chamber of a shape equivalent to two parallel intersecting cylinders, inlet and outlet means in said chamber, two oppositely rotatable pairs of intermeshing toothed rotors, said teeth on said rotors consisting of epi- and hypocycloidal curves, and means for rotating said pairs of rotors at different speeds, said rotors being disposed one of each pair in each part-cylindrical portion of the chamber with a narrow clearance in between said rotors and respective cylinder walls, and said rotors being so shaped that the periphery of one rotor of each pair is narrowly cleared by the periphery of the other rotor of the pair, the lateral width of each pair of rotors being inversely proportional to the respective rotational speeds.

4. A mixing device for the purpose described comprising a closed mixing chamber of a shape equivalent to two parallel intersecting cylinders, inlet and outlet means in said chamber, two oppositely rotatable pairs of intermeshing toothed rotors, said teeth on said rotors consisting of epi- and hypocycloidal curves, and a common driving shaft for driving said pairs of rotors at different speeds, said rotors being disposed one of each pair in each part-cylindrical portion of the chamber with a narrow clearance in between said rotors and respective cylinder walls, and said rotors being so shaped that the periphery of one rotor of each pair is narrowly cleared by the periphery of the other rotor of the pair, the lateral width of each pair of rotors being inversely proportional to the respective rotational speeds.

5. A mixing machine according to claim 4 further comprising additional means for reversing the direction of rotation of one pair of rotors and means for bringing said reversing means into operation when said driving shaft is rendered inoperative with respect to said pair of rotors.

6. A mixing machine according to claim 4 further comprising means for rotating the common driving shaft in either direction.

7. A mixing device according to claim 1 further comprising a discharge means in said chamber located in a position immediately below the line along which the rotors intermesh.

8. A device according to claim 1 wherein the said inlet is arranged on one side of the chamber so that the material, on entry, contacts a toothed rotor at a substantial tangent.

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