

Dec. 3, 1957

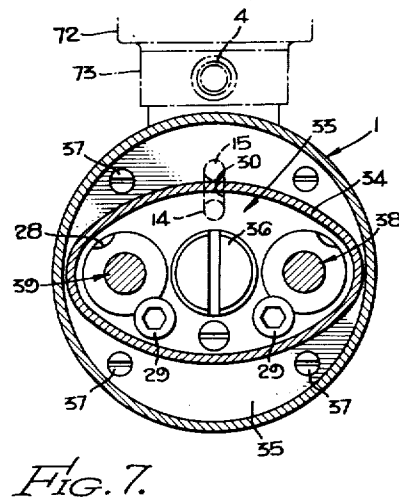
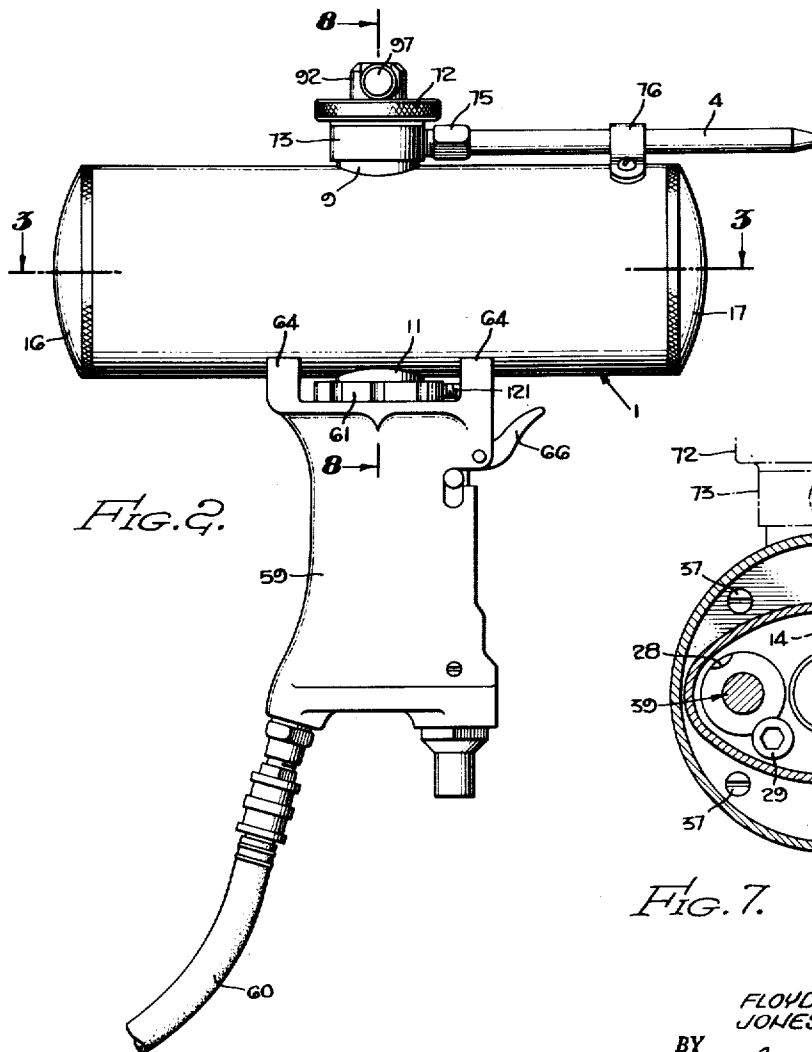
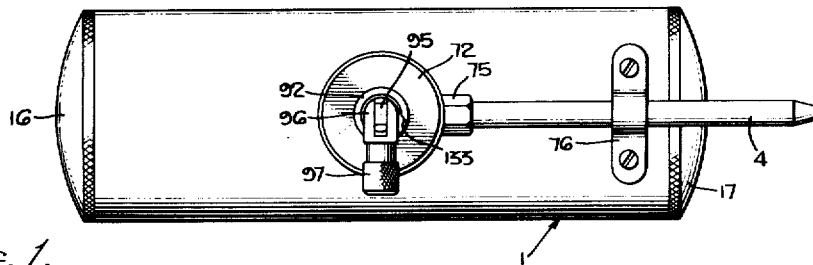
F. E. SNOW ET AL

2,814,827

APPLICATOR AND MIXER FOR VISCOUS MATERIALS

Filed July 28, 1952

14 Sheets-Sheet 1



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14 Sheets-Sheet 2

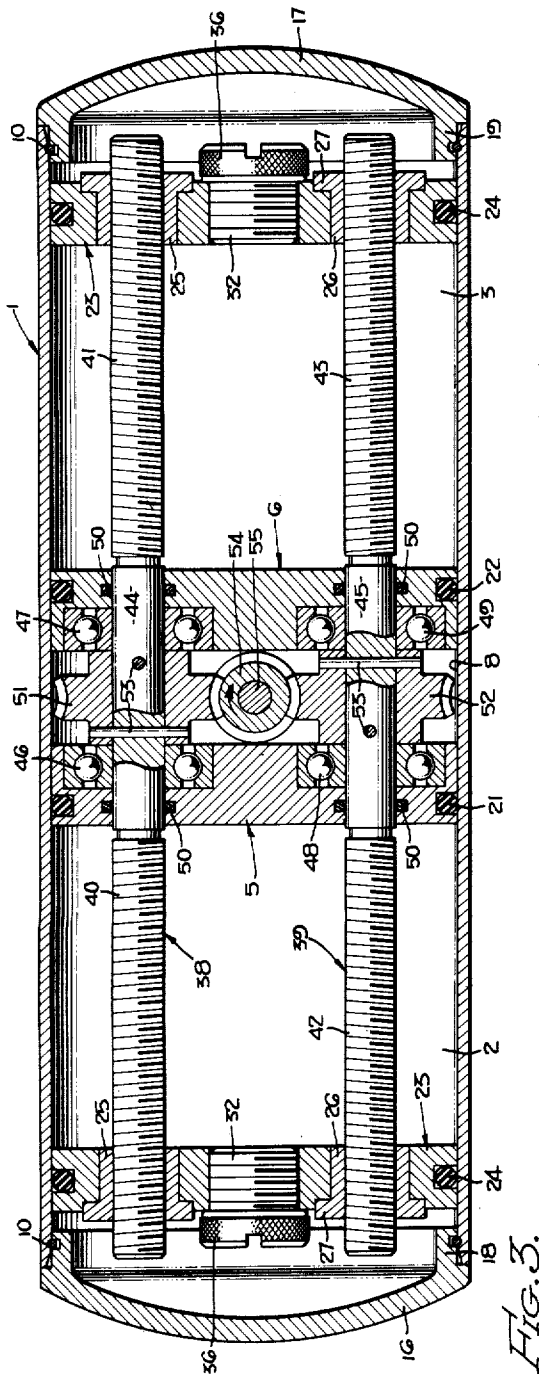


FIG. 3.

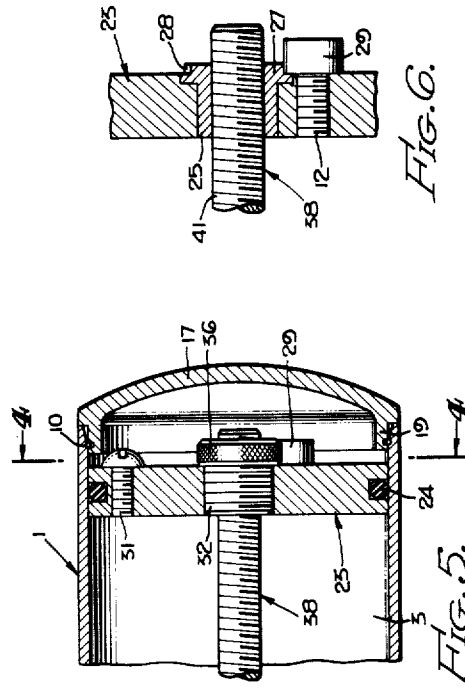


FIG. 5.

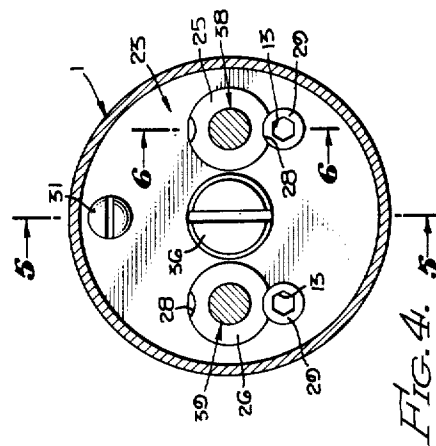


FIG. 4.

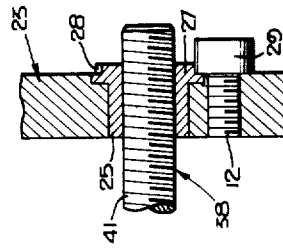


FIG. 6.

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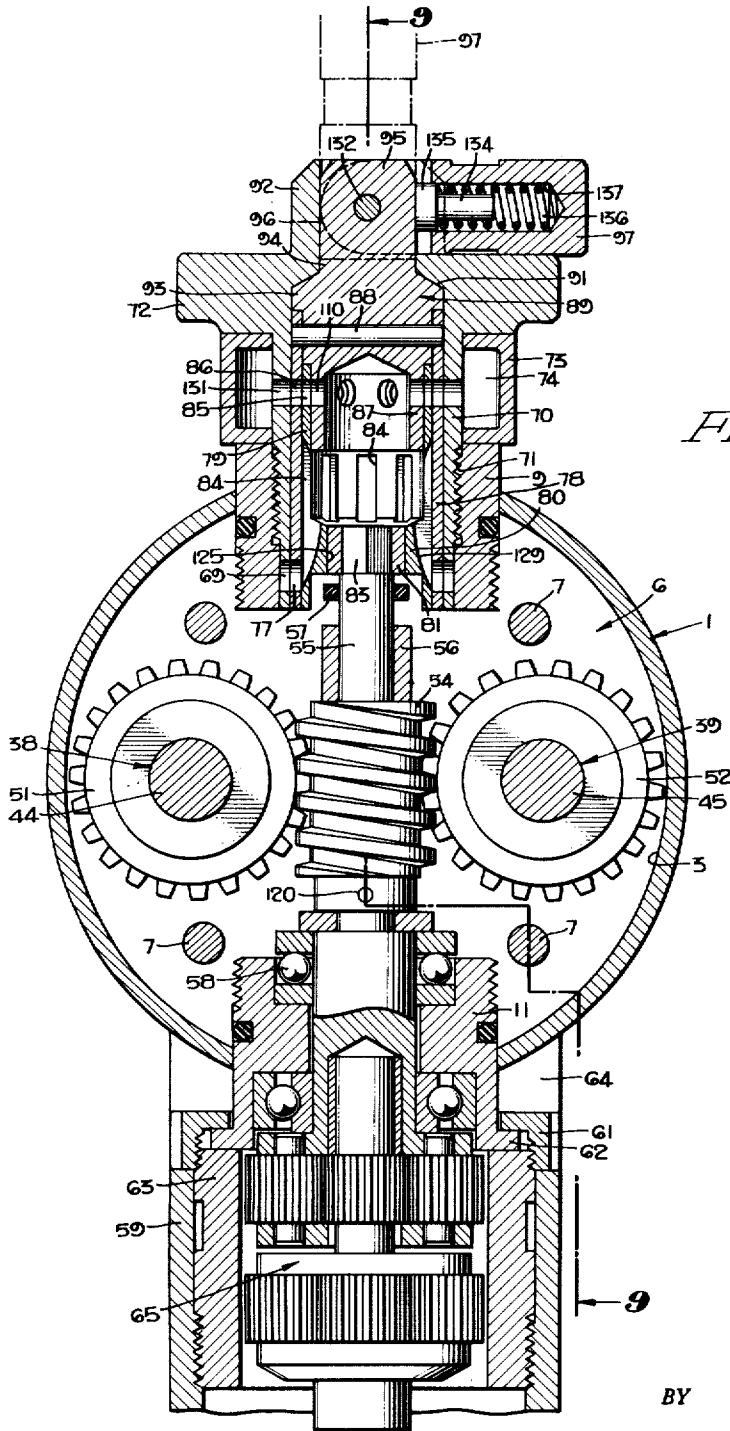


FIG. 8.

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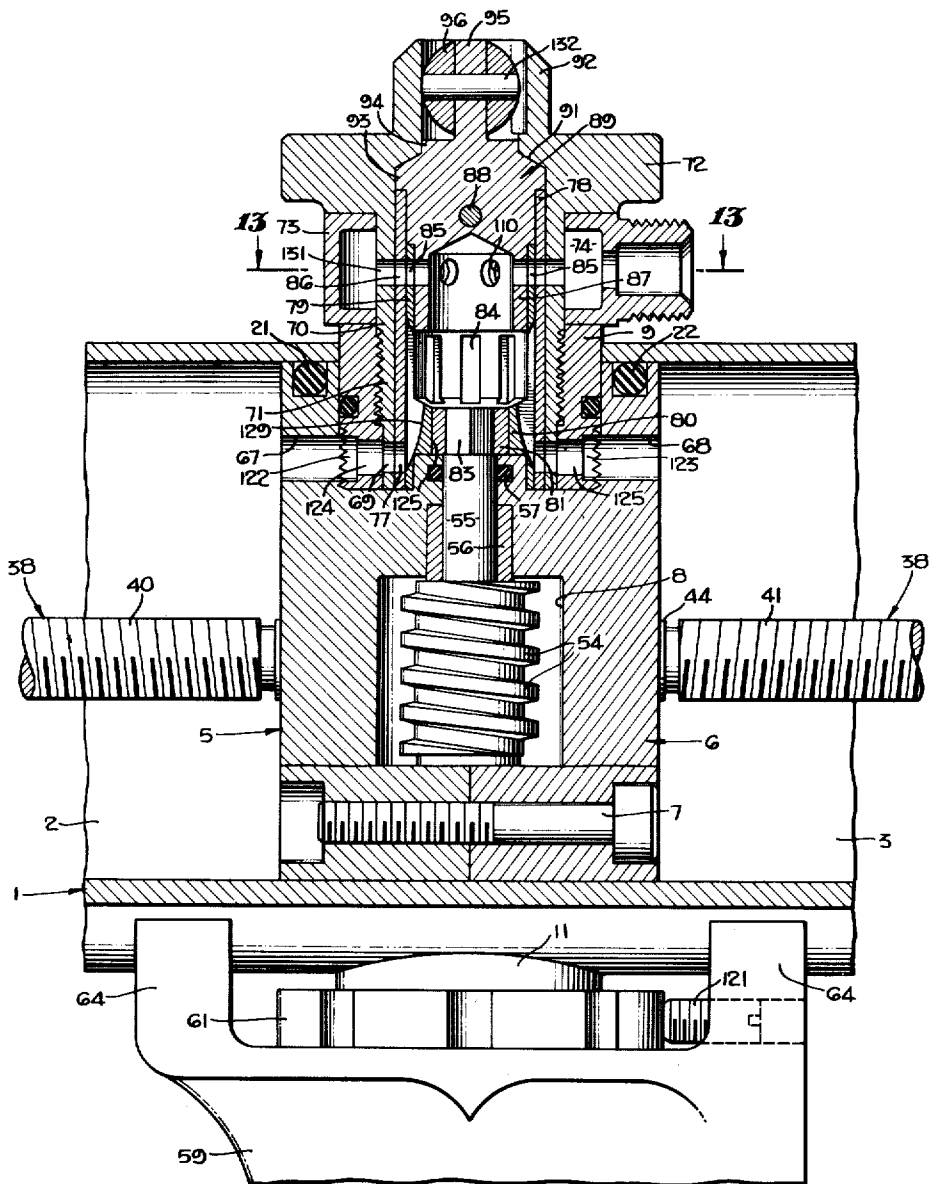


Fig. 9.

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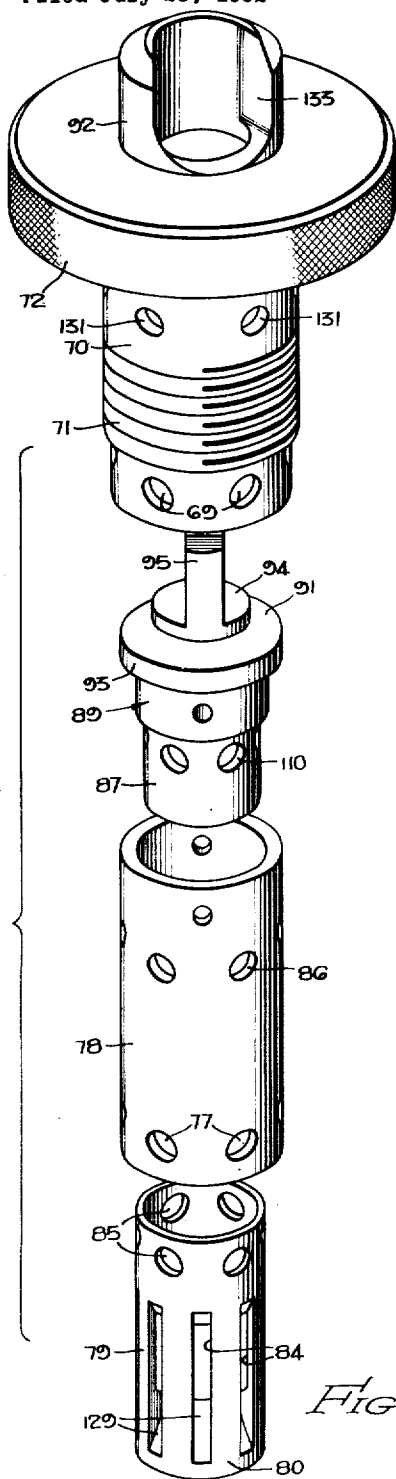


FIG. 10.

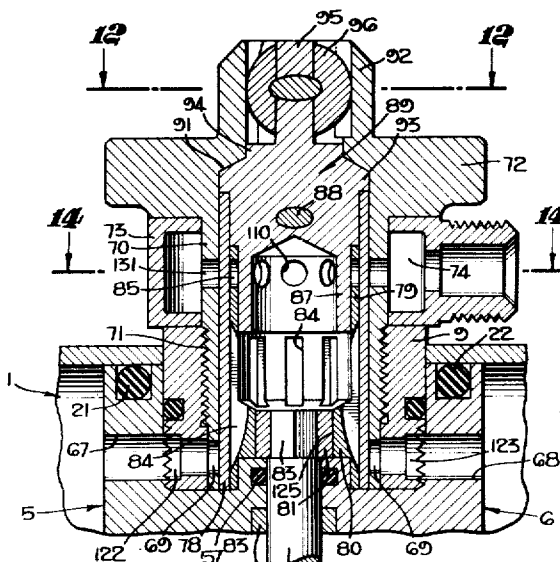


FIG. 11.

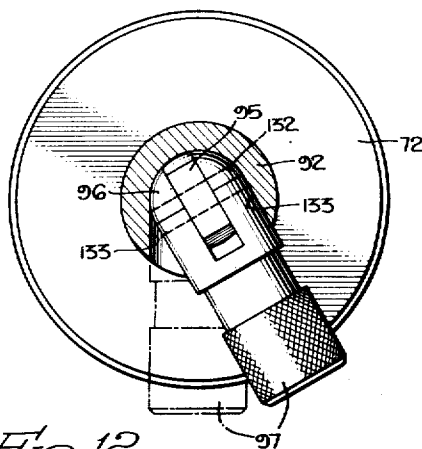


FIG. 12.

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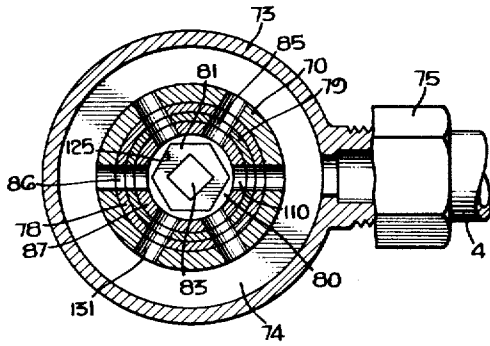


FIG. 13.

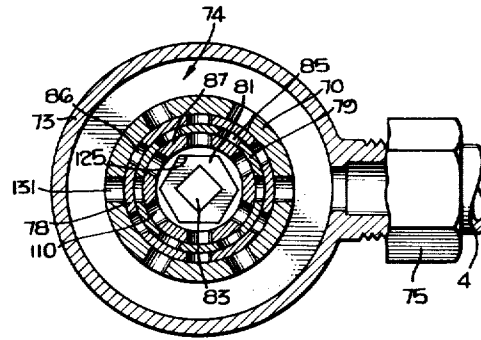


FIG. 14.

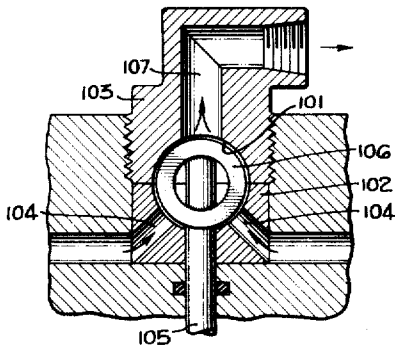


FIG. 15.

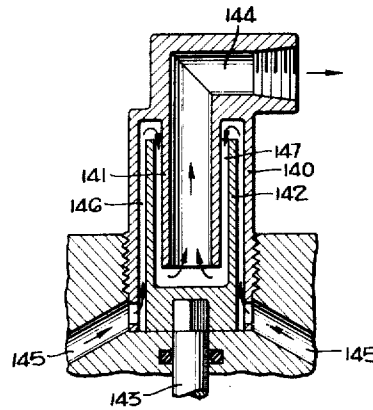


FIG. 16.

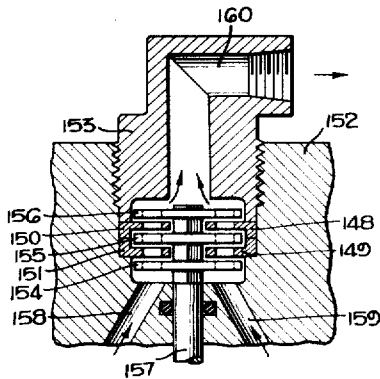


FIG. 17.

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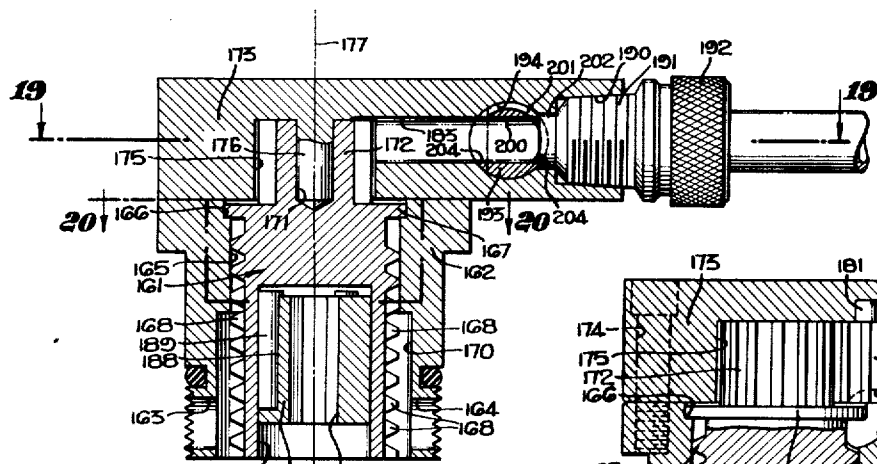


FIG. 18.

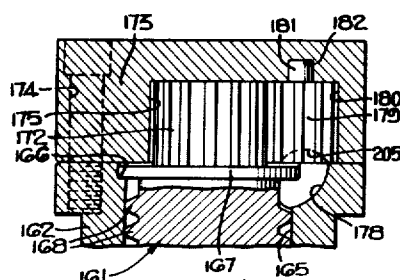


FIG. 21.

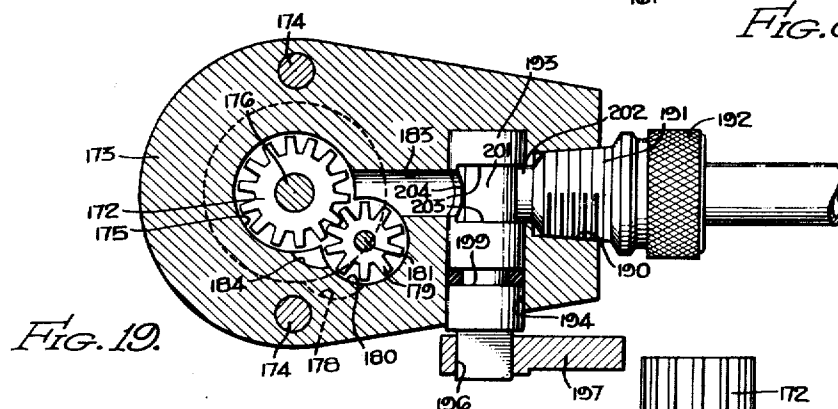


FIG. 19.

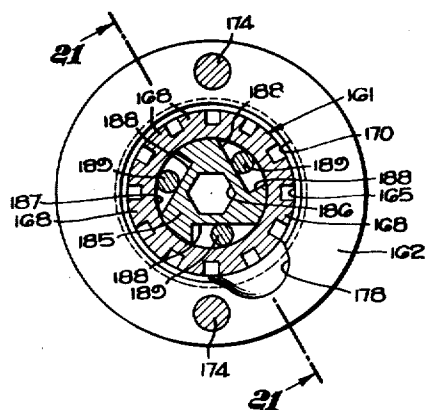


FIG. 20.

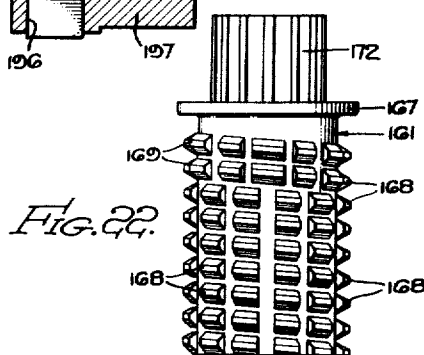


FIG. 22.

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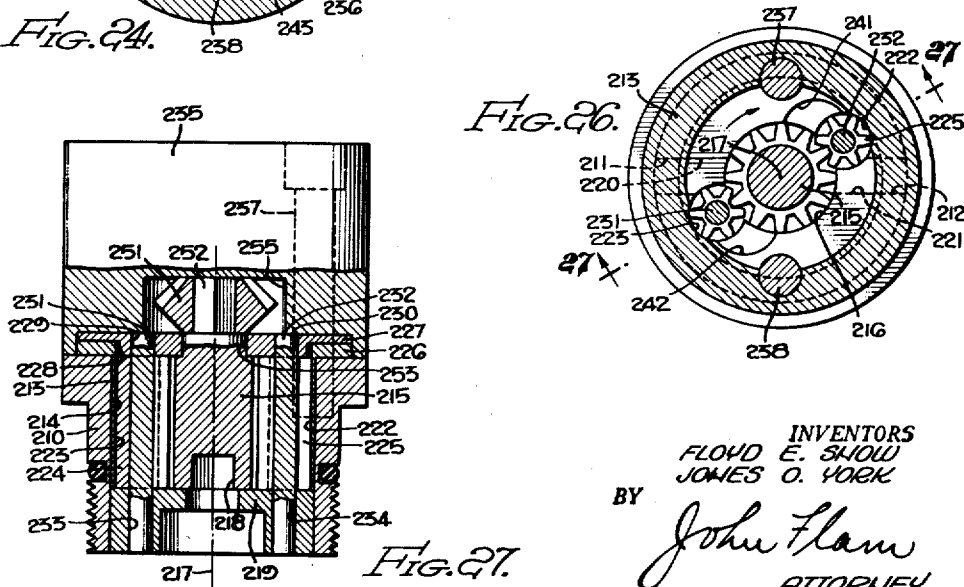
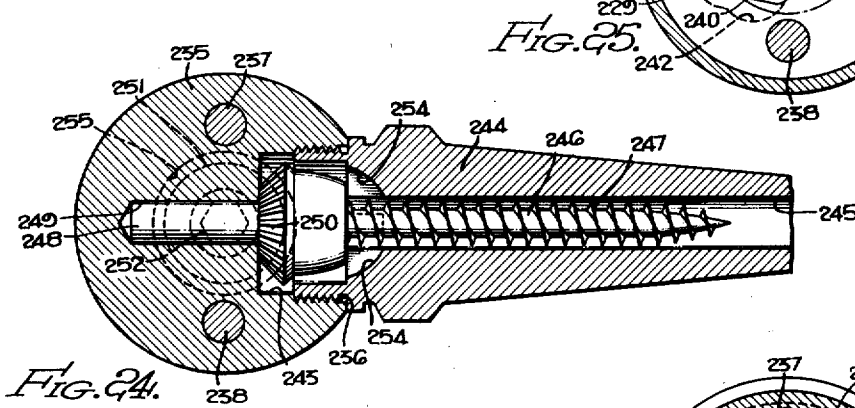
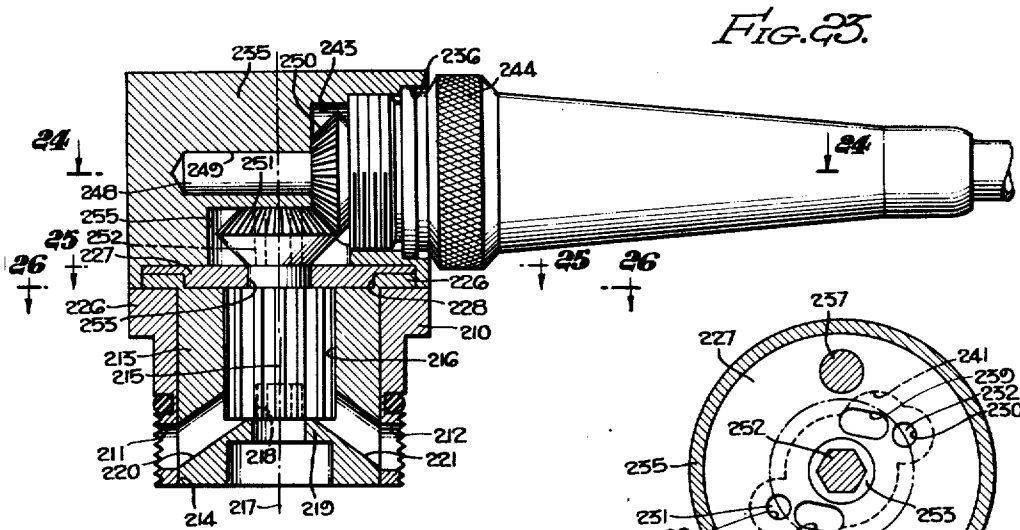
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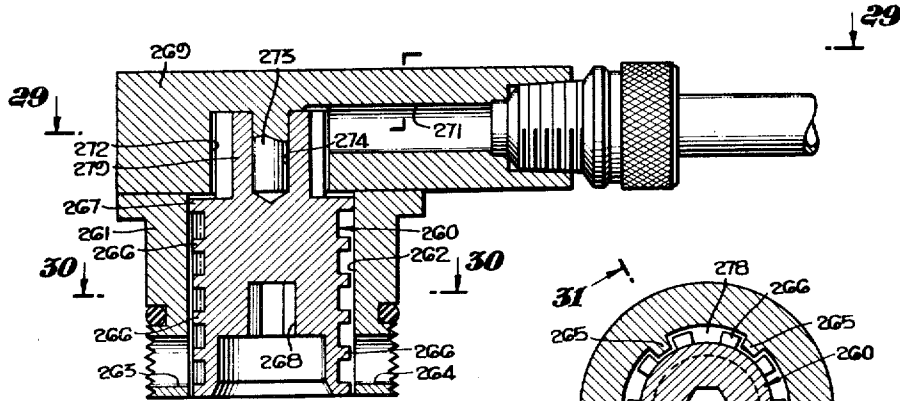


FIG. 28.

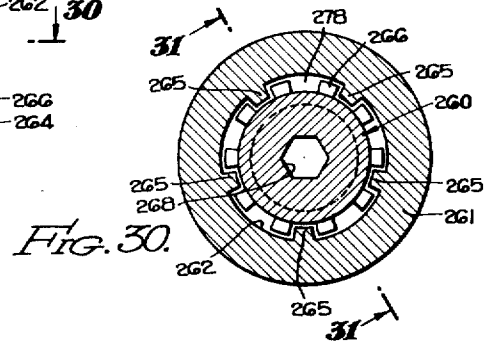


FIG. 30.

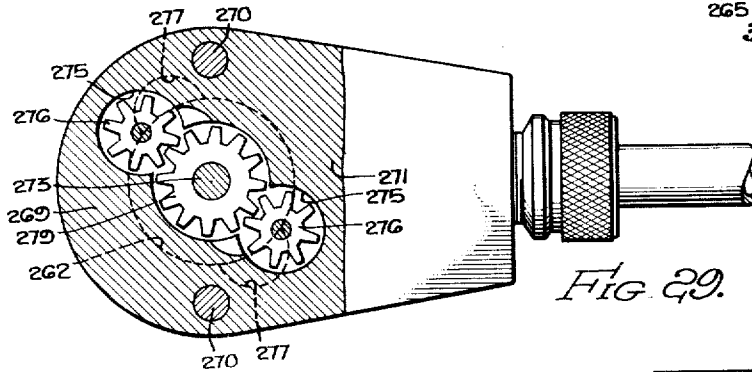


FIG. 29.

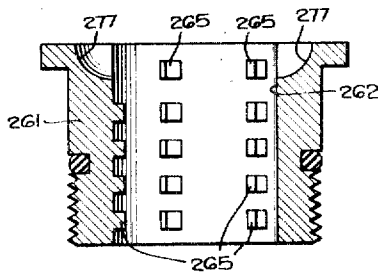


FIG. 31.

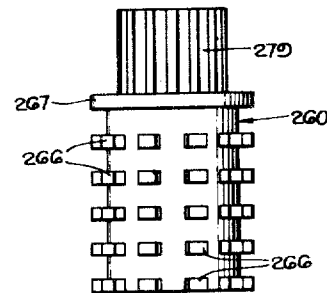


FIG. 32.

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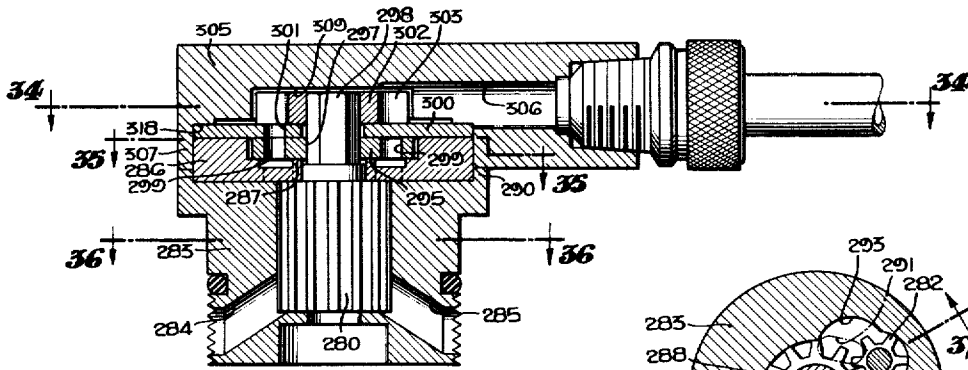


Fig. 33.

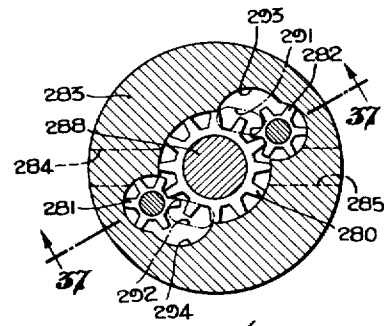


Fig. 36.

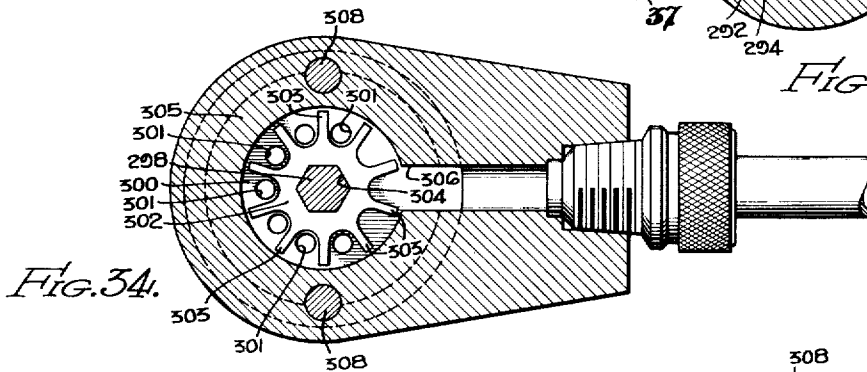


Fig. 34.

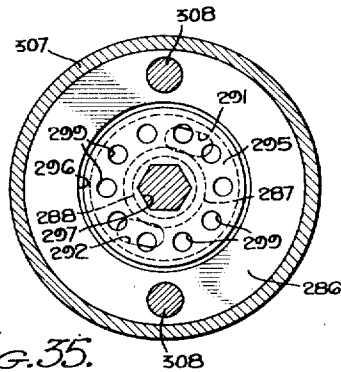


Fig. 35.

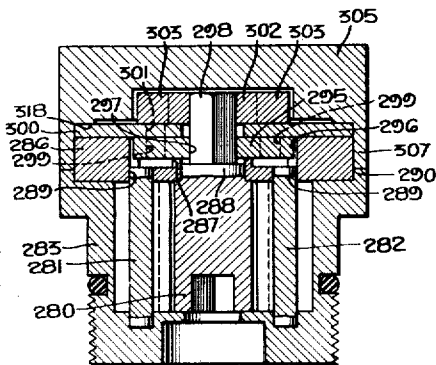


Fig. 37.

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FIG. 38.

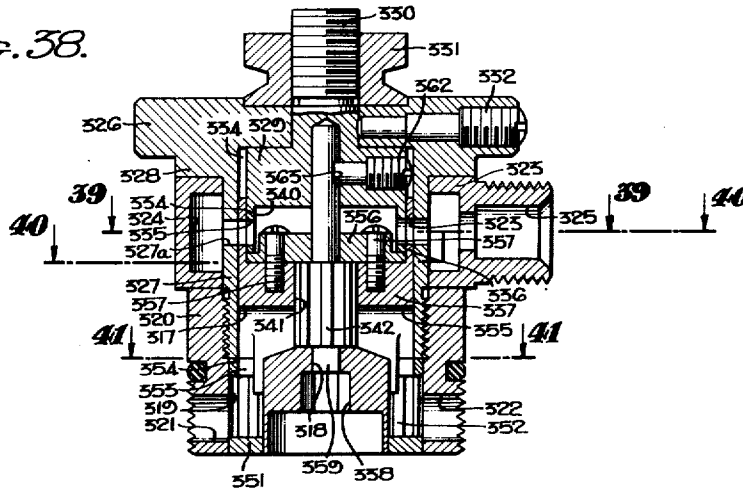


FIG. 39.

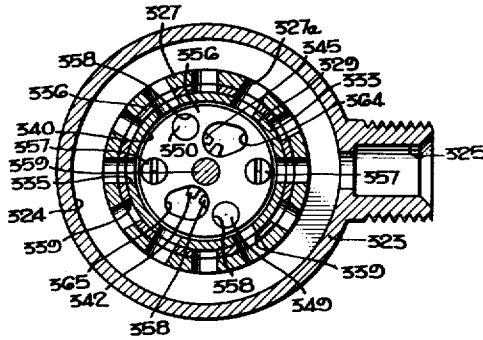


FIG. 40.

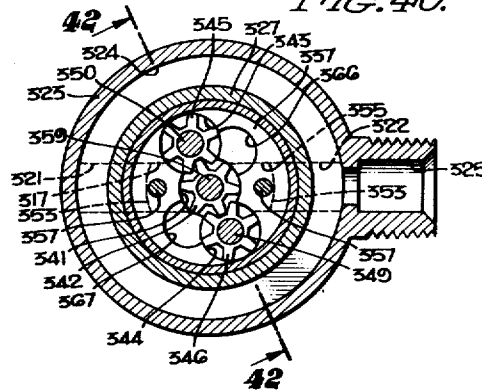


FIG. 42.

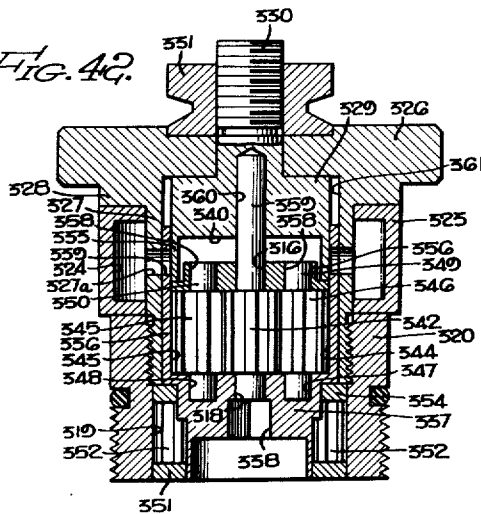
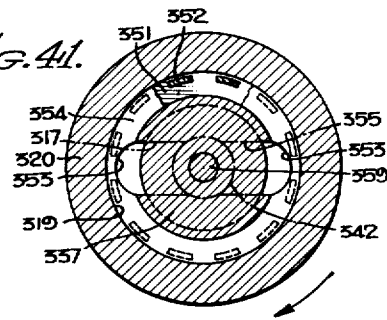


FIG. 41.



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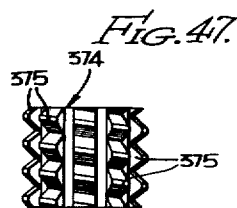
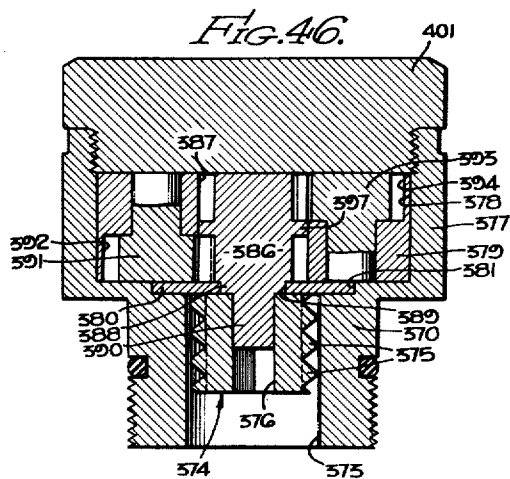
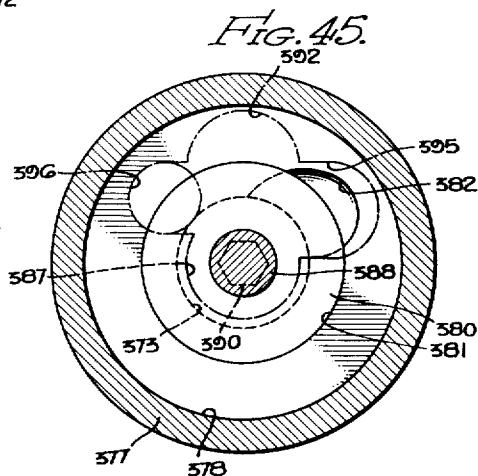
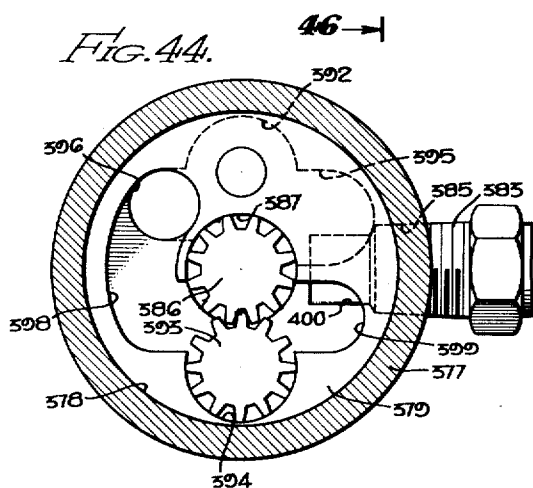
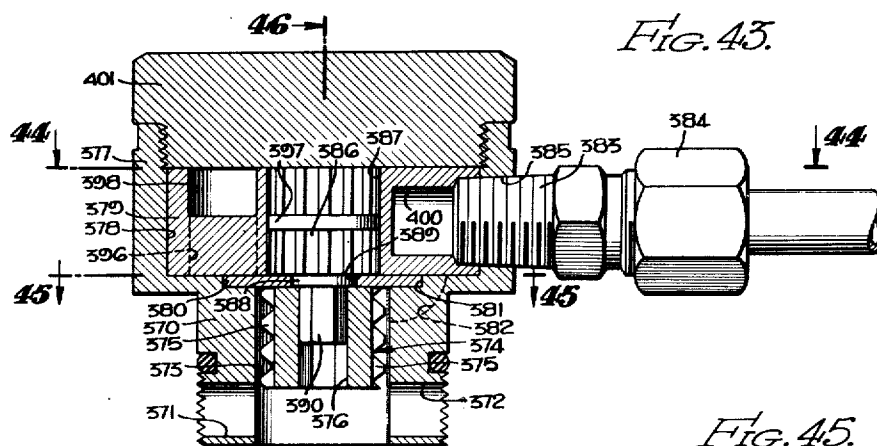
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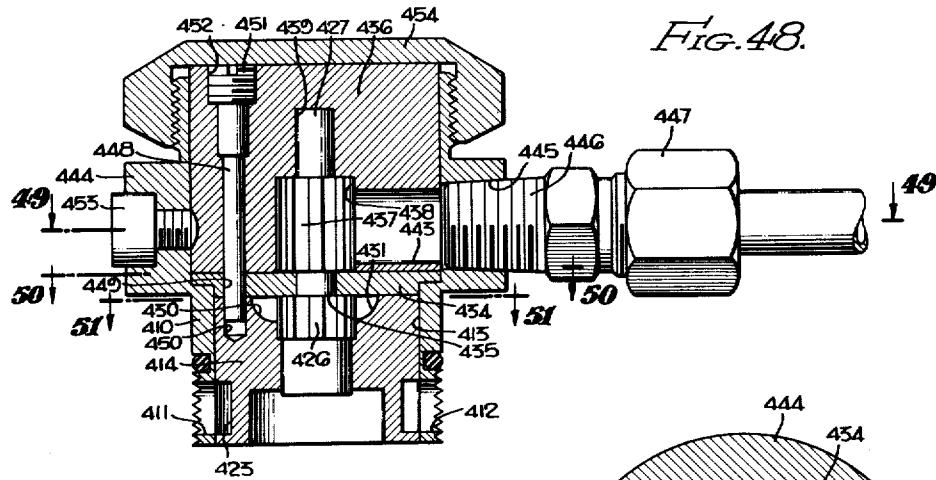


FIG. 48.

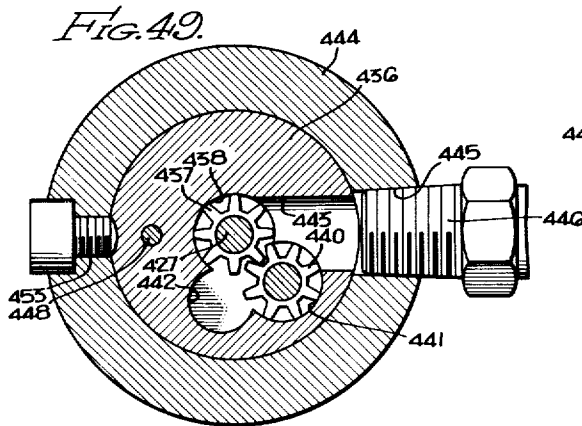


FIG. 49.

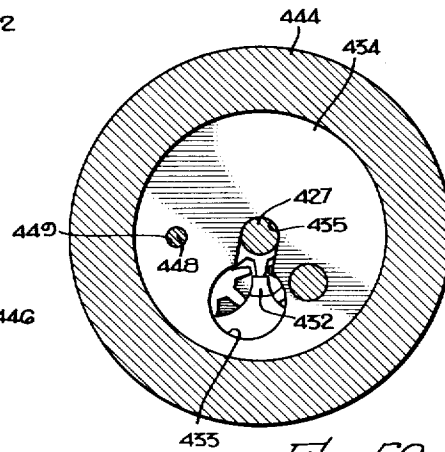


FIG. 50.

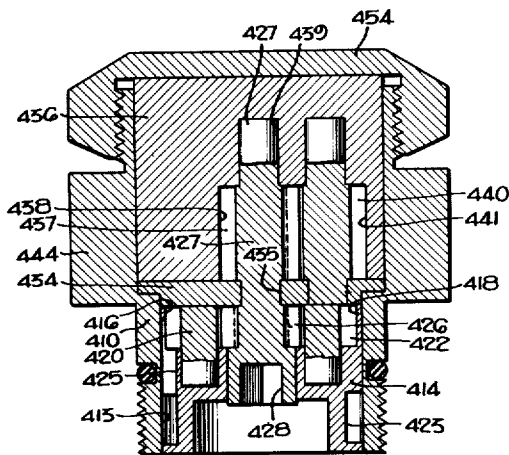


FIG. 52.

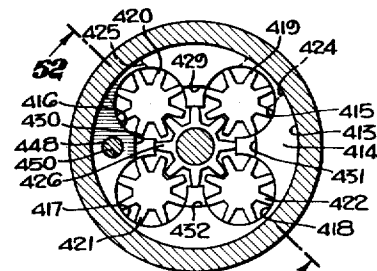


FIG. 51.

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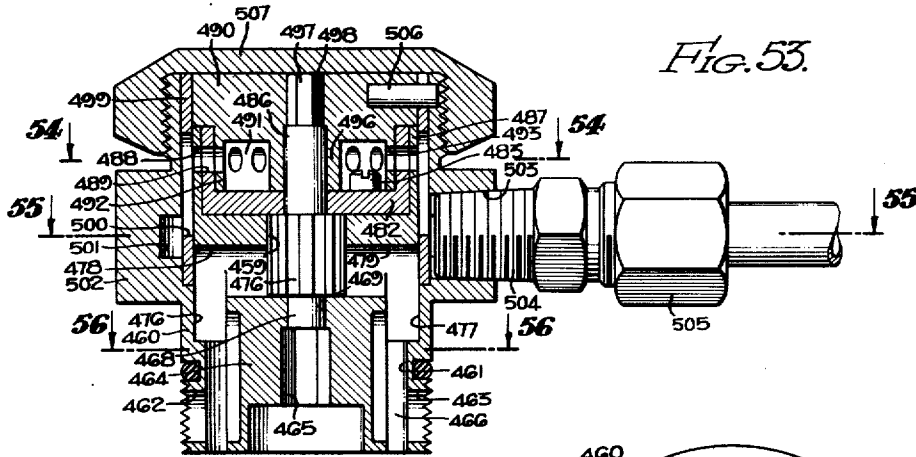


FIG. 53.

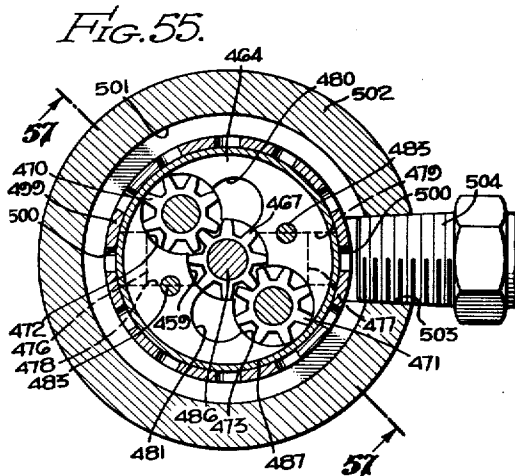


FIG. 55.

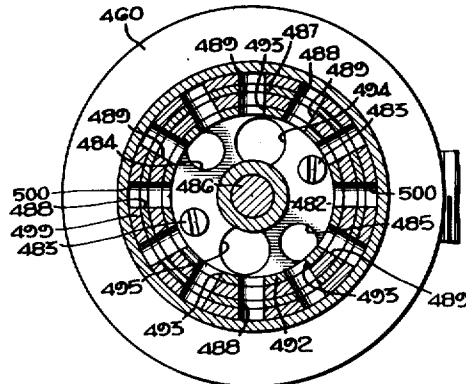


FIG. 54.

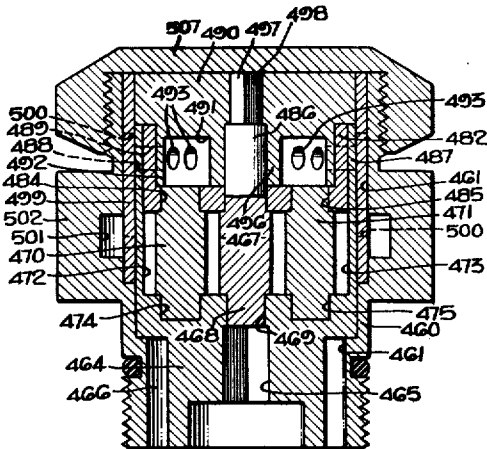


FIG. 57.

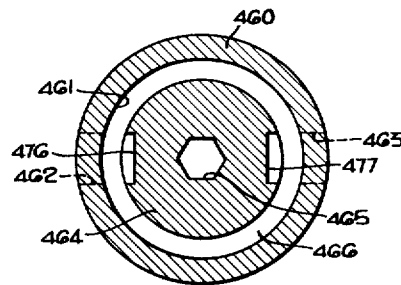


FIG. 56.

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APPLICATOR AND MIXER FOR VISCOUS MATERIALS

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Application July 28, 1952, Serial No. 301,174

9 Claims. (Cl. 18—2)

This invention relates to the application of viscous compounds or mixtures, such as rubber-like sealing compounds.

It is often essential to flow compounds of this character over localities where surfaces are in contact, as, for example, around the flange of a cover plate for airplane gasoline tanks.

Such compounds are also used around bolts and nuts. The compound usually includes rubber-like, tacky material that hardens on exposure to air.

The individual constituents of such a mixture are a rubber material and a catalyzer. When mixed, setting takes place at a slow rate.

In order efficiently to utilize such compounds, they should accordingly be mixed at the time they are to be applied; for, otherwise, setting of the mixture would render them incapable of use.

It is one of the objects of this invention to provide a compact and inexpensive mixer and applicator that performs the essential function of intimate intermixture of the constituent elements at the time the compound is to be used.

It is another object of this invention to provide a structure for the mixer that effectively and intimately associates the catalyzer and rubber material, preferably by a rubbing, as well as a cutting, or comminuting action.

It is still another object of this invention to facilitate the cleaning of the parts, as by ready and rapid removal of these parts. This feature is particularly important, since the materials treated are sticky or gummy.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose, there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a plan view of an apparatus incorporating the invention;

Fig. 2 is a side elevation thereof;

Fig. 3 is an enlarged sectional view, taken along a plane corresponding to line 3—3 of Fig. 2;

Fig. 4 is a sectional view, taken along a plane corresponding to line 4—4 of Fig. 5;

Fig. 5 is a sectional view, taken along a plane corresponding to line 5—5 of Fig. 4;

Fig. 6 is a fragmentary enlarged sectional view, taken along a plane corresponding to line 6—6 of Fig. 4;

Fig. 7 is a sectional view, similar to Fig. 4, of a modified form of the invention;

Fig. 8 is an enlarged vertical sectional view, taken along a plane corresponding to line 8—8 of Fig. 2;

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Fig. 9 is a vertical sectional view, taken along a plane corresponding to line 9—9 of Fig. 8;

Fig. 10 is an exploded view of the mixing mechanism;

Fig. 11 is a fragmentary view, similar to Fig. 9, but illustrating another position of the apparatus;

Fig. 12 is a sectional view, taken along a plane corresponding to line 12—12 of Fig. 11;

Fig. 13 is a sectional view, taken along a plane corresponding to line 13—13 of Fig. 9;

Fig. 14 is a sectional view, taken along a plane corresponding to line 14—14 of Fig. 11;

Figs. 15, 16, and 17 are fragmentary sectional views, similar to Fig. 9, of modified forms of the invention;

Fig. 18 is an enlarged sectional view of another modified form of this invention;

Figs. 19 and 20 are sectional views, taken along the planes indicated by lines 19—19 and 20—20, respectively, of Fig. 18;

Fig. 21 is a fragmentary sectional view, taken along the plane indicated by line 21—21 of Fig. 20;

Fig. 22 is an elevation of a part of the mechanism illustrated in Fig. 18;

Fig. 23 is an enlarged sectional view, illustrating another modified form of this invention;

Figs. 24, 25, and 26 are sectional views, taken along planes indicated by lines 24—24, 25—25, and 26—26, respectively, of Fig. 23;

Fig. 27 is a view partly in section, taken along a plane indicated by line 27—27 of Fig. 26;

Fig. 28 is an enlarged vertical sectional view, illustrating another modified form of this invention;

Fig. 29 is a view, partly in section, taken along a plane indicated by line 29—29 of Fig. 28;

Fig. 30 is a sectional view, taken along a plane indicated by line 30—30 of Fig. 28;

Fig. 31 is a sectional view, taken along a plane corresponding to line 31—31 of Fig. 30;

Fig. 32 is an elevation of part of the mechanism illustrated in Fig. 28;

Fig. 33 is an enlarged vertical sectional view of still another modified form of this invention;

Figs. 34, 35, and 36 are sectional views, taken along planes indicated by lines 34—34, 35—35, and 36—36, respectively, of Fig. 33;

Fig. 37 is a sectional view, taken along the plane indicated by line 37—37 of Fig. 36;

Fig. 38 is an enlarged vertical sectional view, illustrating still another modified form of this invention;

Figs. 39, 40, and 41 are sectional views, taken along planes indicated by lines 39—39, 40—40, and 41—41, respectively, of Fig. 38;

Fig. 42 is a sectional view, taken along the plane indicated by line 42—42 of Fig. 40;

Fig. 43 is an enlarged vertical sectional view, illustrating still another modified form of this invention;

Figs. 44, 45, and 46 are sectional views, taken along planes indicated by lines 44—44, 45—45, and 46—46, respectively, of Fig. 43;

Fig. 47 is an elevation of a part of the mechanism illustrated in Fig. 43;

Fig. 48 is an enlarged vertical sectional view of still another modified form of this invention;

Figs. 49, 50, and 51 are sectional views, taken along planes indicated by line 49—49, 50—50, and 51—51 of Fig. 48;

Fig. 52 is a sectional view, taken along the plane indicated by line 52—52 of Fig. 51;

Fig. 53 is an enlarged vertical sectional view of still another modified form of this invention;

Figs. 54, 55, and 56 are sectional views, taken along

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planes corresponding to lines 54—54, 55—55, and 56—56 of Fig. 53; and

Fig. 57 is a sectional view, taken along the plane indicated by line 57—57 of Fig. 55.

The device, as shown in Figs. 1 and 2, includes a barrel 1 of generally hollow cylindrical configuration. This barrel is divided into two cylinder spaces 2 and 3 (Fig. 3) into which the two constituent materials (such as a catalyst and a rubber material) may be placed for ultimate discharge, under pressure exerted in these spaces, through a spout structure 4 (Figs. 1 and 2) mounted on the barrel 1. The intermingling of the materials prior to discharge is effected in a manner to be hereinafter described.

In order to form the cylinder spaces 2 and 3, use is made of an intermediate wall structure comprising the mating halves 5 and 6 (Figs. 8, 9, and 11). These halves are of generally cylindrical configuration to fit the interior of the cylinder barrel 1. They are provided with appropriate mating recesses to define apertures for bearings, etc., all as hereinafter described. The halves 5 and 6 are held together by four screws 7 (Figs. 8 and 9). As shown most clearly in Fig. 9, O-rings 21 and 22 are provided in grooves formed in the peripheries of these halves so as to isolate the cylinder spaces 2 and 3 from each other.

The opposite ends of the inner bore of barrel 1 are each provided with an outward taper for the accommodation of the cover members 16 and 17 (Figs. 1, 2, 3, and 5). These cover members are provided with the flanges 18, 19, respectively telescoping into the ends of the barrel 1 and fastened thereto as by snap rings 10.

Halves 5 and 6 cooperate to define a space 8 in which appropriate mechanism is located for the operation of piston structures in the cylindrical spaces 2 and 3. This mechanism will be described hereinafter.

A threaded bushing 9 (Figs. 2, 8, 9 and 11) is accommodated in a threaded aperture formed by the halves 5 and 6, and is bottomed therein. The axis of this bushing is transverse to the axis of barrel 1. It passes radially into the barrel through a radial aperture, and thus serves to restrain relative axial movement between the barrel 1 and the structure 5—6. It also serves as a main support for the disintegrating and mixing elements.

A similar bushing 11 (Fig. 8) extends coaxially with the bushing 9, at the lower side of the barrel 1, and is similarly threaded into an appropriate threaded aperture formed by the halves 5 and 6. The bushing 11 is bottomed in this threaded aperture.

Two identical piston structures, respectively in the cylinder spaces 2 and 3, are provided for urging the material from these two spaces 2 and 3 through the chopper and mixer mechanism supported by the bushing 9.

These piston structures are shown to best advantage in Figs. 3, 4, 5, and 6.

Each piston structure includes a cylindrical piston proper 23, carrying a sealing O-ring 24 located in a groove in the periphery of the piston. A pair of spaced nuts 25 and 26, having exterior cylindrical surfaces, are telescoped within appropriate apertures in the piston 23. Flanges 27 on these nuts extend partially into counterbores of these apertures. The peripheries of the flanges, as shown most clearly in Figs. 4 and 6, are each provided with a pair of arcuate recesses 28 at diametrically opposite places of the flange. These recesses form plane surfaces coplanar with the end surfaces of the piston 23. Engaging one of these recesses is the cylindrical head 29 of screw 12, threaded in an aperture adjacent the nut 26. This head 29 has a hexagonal recess 13 (Fig. 4) to permit removal and replacement of the screw. In this way, the nuts are prevented from rotating, and they are also restrained against axial movement with respect to the piston 23. The two recesses of each nut 26 make it possible to adjust the angular positions of the nuts by half revolutions.

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In order to gain access to the spaces 2 and 3, removable threaded plugs 32 are provided in each of the pistons 23. Knurled and slotted head 36 is provided for manual manipulation.

Thus, to gain access to the spaces 2 and 3 to insert ingredients to be mixed, the covers 16 and 17, as well as the plugs 32, may be removed.

For moving the pistons 23 simultaneously toward the wall 5—6, use is made of a pair of lead screws 38 and 39. These lead screws respectively have two threaded sections 40, 41 and 42, 43. The sections 40 and 41 are of opposite threads, as are the sections 42 and 43. Accordingly, simultaneous rotation of the lead screws will move the pistons 23 toward each other. The rate at which the materials in cylinder spaces 2 and 3 are urged into the bushing 9 is dependent upon the relative pitches of sections 40, 41 and 42, 43. Thus, if the materials are to be delivered in equal amounts, the pitches are equal. Assuming that the material in the left-hand chamber 2 is to be delivered at a faster rate than the material in chamber 3, then, in that event, the pitches of the threaded sections 40 and 42 are made correspondingly greater. Obviously, in this manner any desired ratio of ingredients may be secured.

Another way to adjust the ratio is indicated diagrammatically in Fig. 7. In this instance, the piston 33 has an area less than that of barrel 1. For example, it may be of elliptical cross section, fitting closely within an elliptical insert 34 in barrel 1. This insert has a flange 35 attached to one side of the wall 5—6 (Figs. 3 and 9), as by screws 37. The flange 35 is provided with a groove 30 communicating, at its inner end 14, with the cylinder space formed by insert 34. The outer end 15 of the groove 30 communicates with the mixer mechanism hereinafter to be described.

The lead screws 38 and 39 (Fig. 3) are each provided with a cylindrical shaft portion 44 or 45, located intermediate the threaded sections. These shaft portions are appropriately supported in radial and thrust bearing structures 46, 47, 48, and 49, located in recesses in the wall halves 5 and 6 (Fig. 3) and opening into the space 8. Appropriate O-rings 50 surround the shaft portions 44 and 45, and are located in grooves formed in the halves 5 and 6.

In order to rotate the lead screws 38 and 39, these lead screws are provided with worm wheels 51 and 52 (see, also, Fig. 8). These worm wheels may be appropriately joined to the shaft portions 44 and 45 as by the aid of the cross pins 53.

A common driving worm 54 engages both of the worm wheels 51 and 52. This worm is located in the space 3, and is mounted on a shaft 55 coaxial with bushings 9 and 11. Shaft 55 is journaled at its upper end in a bushing 56 (Figs. 8, 9, and 11) located in a recess formed by the halves 5 and 6. An O-ring 57 is disposed around the upper end of the shaft 55, and in a groove formed by the two halves 5 and 6.

The worm 54 is shown as coupled to the shaft 55 as by the aid of a cross pin 120 (Fig. 8). The lower threaded bushing provides a rotary thrust bearing support 58 (Fig. 8) for the shaft. This shaft is appropriately driven by an air motor mechanism encased in a hollow handle or housing 59 (Figs. 2, 8, and 9). Air may be supplied to the air motor in the housing 59 by the aid of an air hose 60. The housing 59 is arranged to be held appropriately in place by the aid of a nut structure 61 that has a flange overlapping the lower flange 62 of the bushing 11. It is threaded on a member 63 held in the housing 59. The housing 59 is provided with saddle portions 64 (Figs. 2 and 9) adapted to engage the lower side of the barrel 1. As the nut structure 61 is rotated, these saddle members 64 are urged upwardly into contact with the barrel 1. A set screw 121 extends through one of these saddle members to lock nut 61 against inadvertent rotation.

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Interposed between the air motor in the housing 59 and the worm shaft 55 is a planetary reduction gearing 65 (Fig. 8), and which is enclosed in member 63. Since this reduction gearing forms no part of the present invention, further description is unnecessary. It is sufficient to note that the rotation of the air motor is controlled by a trigger 66 (Fig. 2) which may be optionally operated to cause the air motor to rotate in either direction or to stop the air motor. In this way, the pistons 23 may be caused to move in either direction for the mixing operation, as well as for the retraction of the pistons 23 for the purpose of reloading the barrel 1.

The pistons 23 urge the materials to be mixed through appropriate ports formed in the wall halves 5 and 6. As shown most clearly in Fig. 9, wall half 5 has a port 67 communicating with space 2, and wall half 6 has a corresponding port 68 communicating with space 3. These are arranged diametrically opposite each other with respect to the bushing 9. This bushing is also appropriately apertured for the passage of the materials.

Thus, bushing 9 has diametrically opposite ports 122 and 123 aligned respectively with ports 67 and 68 (Fig. 9). These ports are in communication, respectively, with ports 124 and 125 in bushing 9, said ports 124 and 125 having a substantial angular extent about the axis of the bushing.

The materials passing through the ports 67, 68, 122, and 123 can pass through a series of apertures 69 located in the end of a hollow body member 70 (Figs. 8, 9, 10, and 11). This hollow body member 70 has a threaded portion 71 engaging the corresponding internal threads in the bushing 9. This body member is provided with a flanged head 72 which may be knurled (Figs. 2 and 10) for manual assembly with the plug 9.

Interposed between the lower surface of the head 72 and the top of the plug 9 is a collector member 73 (Figs. 2, 8, 9, 11, 13, and 14). This collector member, as will be hereinafter described, provides an annular mixing chamber 74 into which the materials are urged under pressure.

This chamber 74 is placed in communication with the nozzle 4, as by the aid of the coupling 75 (Figs. 1, 2, 13, and 14). This coupling is omitted in Figs. 8 and 9. The nozzle 4 thus receives the discharged intermixed materials. This nozzle may further be supported by the aid of a standard 76 (Figs. 1 and 2) mounted on top of the barrel 1.

As shown most clearly in Figs. 8, 9, and 11, the body 70 is coaxial with the shaft 55.

The materials to be mixed enter by way of ports 67 and 68, and the apertures 69, past another group of apertures 77 (Figs. 8, 9, and 10) in the lower end of a sleeve 78. This sleeve 78 telescopes within the body 70. It is angularly adjustable in order to close the apertures 69 (Fig. 11) or to place these apertures in register with the apertures in sleeve 78 (Fig. 8).

A chopper sleeve member 79 (Figs. 8, 9, 10, 11, 13, and 14) telescopes within the upper end of the sleeve 78, and is shown as integral with a lower end wall 80 (Figs. 8, 9, 11, 13, and 14). This wall 80 has a non-circular aperture 125 (such as of hexagonal form), press-fitted over a hexagonal hub 81. This hub 81 has a square aperture telescoping over a corresponding non-circular end 83 of the shaft 55. Accordingly, rotation of shaft 55 causes rotation of the chopping sleeve 79.

A series of slots 84 (Figs. 8, 9, 10, and 11) extend longitudinally through the chopping sleeve 79. These slots are narrow along the length of sleeve 79, and present cutting edges that cooperate with the edges of apertures 77 of the shut-off sleeve 78 (Fig. 9) as shaft 55 rotates. The chopped material passes through the slots into the interior of chopping sleeve 79. At the lower portions of the slots there are curved bottom walls 129 serving as sloping guides for the passage of the chopped material into the interior of sleeve 79.

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Egress from the interior of chopping sleeve 79 is effected through a series of apertures 85 at the upper end of this sleeve (Figs. 8, 9, 10, 11, 13, and 14).

The upper end of the shut-off sleeve 78 is provided with a series of apertures 86 which can be made to register with the corresponding apertures 85 of chopper sleeve 79, or placed out of registry therewith. Fig. 13 illustrates the apertures in alignment, and Fig. 14 illustrates these apertures out of alignment. While the sleeve 78 is in the position of Figs. 8 and 13, flow of material into and out of the interior of the chopper sleeve 79 is permitted; and this material is forced by the pressure in cylinder spaces 2 and 3 into the sleeve 79 and outwardly through apertures 85. When the shut-off sleeve 78 is moved to the position of Fig. 14, the flow of material to the interior of sleeve 79 is prevented.

A supplemental shut-off sleeve 87, angularly movable with the sleeve 78, telescopes within the upper end of the rotating chopper member 79. This sleeve valve is provided with a series of apertures 110 that can be moved into registry with outlet apertures 131 of the body 70 (Fig. 13). When sleeves 78 and 87 are angularly adjusted to a proper position, as indicated in Fig. 13, the materials can proceed through the ports 67, 68, apertures 69 and 77, through slots 84, into sleeve 79, and then radially outwardly through the apertures 110 in member 87 to be further chopped by the chopper sleeve 79 and urged through the openings 86 of the sleeve valve 78, and finally through the openings 131 into the annular collecting chamber 74 of the collector 73.

Chopping occurs between the stationary member 87, as well as the sleeve member 78, by the interposition and rotation of the chopper sleeve 79. While pressure is exerted upon the material in the cylinder chambers 2 and 3, the material follows the path hereinbefore described, and is comminuted by the coaction of the edges of the slots 84 of the chopper sleeve 79 with the edges of apertures 77, the shut-off sleeve 78, as well as by the coaction between apertures 85 in sleeve 79 and apertures 110 and 86 of the shut-off sleeves 78 and 87. The mixing action is also augmented due to the fact that the materials are smeared by rubbing in the small clearance between the sleeves 78, 79, and 87.

The effect of this chopping and smearing action is that small particules of the materials are delivered into the chamber 74. These particles have thus been intimately intermixed by the combined effect of pressure, rubbing, and chopping that takes place within and through the sleeves 78, 87, and 79.

The sleeve valve 78 is attached, as by a cross pin 88, to a head 89 (Figs. 8, 9, 10, and 11). This head has a flange 93 contacting the upper edge of sleeve 78. The inner sleeve 87 is formed integrally with the head 89. At the upper end of the head 89, there is a conical shoulder 91 contacting a corresponding interior conical surface formed in head 72. In this way, axial movement of member 89 is restricted.

Head 72 is provided with an interrupted hollow cylinder 92 into which the upper cylindrical portion 94 of the head 89 projects. An ear 95 is integrally formed with portion 94. A handle 97 for adjusting the sleeve valves 78 and 87 is pivoted on this ear 95, as by a pin 132 passing through the clevis 96 formed at the end of handle 97. In the full-line position of Fig. 8, the handle has a limited angular movement defined by the side surfaces 133 (Figs. 10 and 12) of the hollow cylinder 92. This angular range corresponds to open or closed position of shut-off sleeves 78 and 87. By movement of the handle 97 to the upright position shown in phantom lines in Fig. 8, the head 89 can be readily disassembled from the member 72.

For resiliently maintaining the handle 97 in either the active position or the upright position (shown in phantom in Fig. 8), use is made of a plunger 134 having a

head 135 urged inwardly toward ear 95 by a compression spring 136. This compression spring is accommodated in a cylindrical recess 137 of handle 97. The head 135 is guided by this recess.

In the full-line position of Fig. 8, the head 135 contacts one of the edges of ear 95. In the phantom line position, the head 135 engages the top surface of the ear.

The lead screws 38 and 39 are rotated to bring the pistons 23 toward each other by the rotation of shaft 55 in a clockwise direction, as viewed in Fig. 3. Accordingly, the friction between the cylindrical surfaces of chopper sleeve 79 and the sleeve valves 78 and 87 (when sealing compound is contained between these surfaces) is such as to move the handle member 97 to the dot-and-dash position of Fig. 12. In this position, the sleeve valves are in open position, permitting the discharge of the comminuted mixture into the mixing chamber 74. However, manual movement of the handle 97 in a counterclockwise direction will close the apertures.

In operation, the materials to be mixed, such as the catalyzer and the rubber compound, are placed within the cylindrical spaces 2 and 3 through the piston openings normally closed by plugs 32. When it is desired to extrude a mixed compound through the nozzle 4, the trigger 66 is operated to rotate the transmission in the proper direction for forcing the materials from the cylinder spaces 2 and 3 into the interior of the chopper sleeve 79 via openings 69 and 77 and slots 84. The intermixed materials are then forced through the openings 110 in the sleeve 87, and are further chopped by shearing action of the edges of the relatively rotating apertures 110, 84, and 86, and smeared between the surfaces of sleeves 87, 79, and 78. They finally are urged by pressure into the collecting chamber 74 and thence to the nozzle 4.

This method of mixing is particularly effective for the tacky compound, as the chopper serves to separate the intermingled materials into small pieces which are then further intimately associated in the space between the surfaces of sleeves 87, 79, and 78. For practical purposes, the rate of rotation of the chopper 79, imparted to it by shaft 55, is of the order of 50 to 100 revolutions per minute.

In the form shown in Fig. 15, the mixing chamber is formed by a spherical surface 101 and defined by the aid of the inlet member 102 and an outlet member 103. Inlet ports 104 lead to the cylinder spaces of barrel 1. An agitator shaft 105 carries an annular agitator 106. For proper mixing, the shaft 105 is rotated at about two hundred revolutions per minute. The beating action of the agitator 106 serves effectively to cut and intermingle the constituent parts, which ultimately pass through the outlet port 107. The shaft 105 must be quite rapidly rotated to produce the proper mixing action.

In the form shown in Fig. 16, there are a pair of stationary concentric cylindrical members or sleeves 140 and 141. Interposed between these two cylindrical members is a rotary tubular member 142 mounted upon the shaft 143. Narrow annular spaces are formed between these three cylindrical members. The inner cylindrical member 140 is hollow, and connects to the outlet port 144.

The inlet ports 145 from the cylinder spaces of barrel 1 communicate with the lower end of the outer annular space 146. The inner annular space 147 and space 146 are in communication at the top of the structure.

The relative rotary motion of the surfaces of the members 140, 141, and 142 produces a kneading or smearing action which is effective in the intermingling of the constituent elements. In this instance, somewhat more power is required to operate the device, as there is a substantial friction encountered in this kneading or smearing action. The course of the material is first of all urged upwardly through the annular passage 146, then downwardly through the annular passage 147, and finally upwardly

through the innermost hollow cylindrical member 141. The annular spaces 146 and 147 are purposely made relatively narrow in order effectively to provide the kneading action.

In the form shown in Fig. 17, a pair of stationary apertured discs 148 and 149 are held in spaced relation by the aid of their contacting flanges 150 and 151. The flange 150 rests upon an appropriate shoulder in the body member 152. The flanges are held in close contact by the externally threaded outlet member 153.

Three discs 154, 155, and 156 are held in axially spaced relation at the end of a rotary agitator shaft 157. The end discs 154 and 146 are disposed respectively below the disc 149 and above the disc 148. The intermediate rotary disc 155 is disposed between the two stationary discs 148 and 149. Each of the discs 148, 149, 154, 155, and 156 is provided with a series of through apertures arranged near the circumference of the discs. The apertures in the central disc 155 are staggered with respect to the apertures in the outer discs 154 and 156. All of the discs are relatively closely spaced to each other to provide only a small amount of clearance. At no instance can material flow through more than two discs, due to the staggered apertures. Thus, smearing is effected between the flat surfaces of the discs.

The inlet ports 158 and 159, as before, lead to the cylinder spaces, and extend beneath the lowermost rotary disc 154. The member 153 provides the outlet port 160.

In the form of the mixer illustrated in Figs. 18 to 22, intermixture of the rubber material and catalyzer is accomplished by a rotating interrupted threaded chopping member 161.

A hollow body member 162 is accommodated in the threaded aperture formed by the halves 5 and 6 in place of the bushing 9. The body member 162 has at its lower end inlet ports 163 and 164 cooperable with the ports 67 and 68 of the halves 5 and 6 respectively. The body member has a through axial bore 165 that accommodates the chopping member 161. An annular flange 166 is formed at the upper end of the body member cooperable with a flange 167 of the chopper member for limiting downward movement of the chopper member 161 with respect to the body member 162. Projections 168 of the chopping member 161 are provided in the form of peripherally interrupted flanges arranged in this instance spirally as interrupted threads. The projections are not all axially aligned. Accordingly, the flow of the materials is caused to follow a path having substantial changes in directions whereby the materials are thoroughly intermixed.

The bore 165 of the body member has only slight clearance with respect to the upper turns of the helically arranged projections 168. Flow of the material is then made to progress through the spaces between the projections 168. While the projections are arranged helically, they are in left-handed arrangement. Accordingly, angular rotation of the chopping member 161 in a clockwise direction as viewed from above does not aid in the ultimate upward flow of the material. While upward flow is permitted by the spacing between the projections, the helically arranged projections 168 produce a churning action.

At the lower portion of the body member 162, the bore 170 is enlarged to provide an annular space facilitating entry of the material into the body member 162 through the ports 163 and 164. The material is thus easily permitted to come in intimate contact with the projections 168 of the chopping member 161.

The chopping member 161 carries a spur gear 172 extending above the body member 162. A cap member 173 provides an appropriate recess 175 for accommodating the gear 172. The cap 173 closes the body member 162 and is secured by the aid of bolts 174. This cap member has an integrally formed downwardly extending pin projection 176 accommodated within a corresponding bore

171 of the gear 172. The pin 176, together with the closely fitting bore 165, guides the chopping member 161 for rotation about its longitudinal axis 177.

As shown most clearly in Figs. 19, 20, and 21, a groove 178 at the upper end of the body member 162 forms the outlet passageway from the body member 162. This groove 178 forms a path leading around the flange 167 to a recess 205 (Fig. 21) in the cap 173.

A gear 179 is accommodated in an arcuate recess 180 of the cap member 173 that communicates with the recess 175 for the gear 172. The gear member 179 has a shaft extension 181 fitting in an appropriate recess 182 of the cap member 173 for guiding the gear member for rotation. This gear member 179 is in engagement with the gear 172, and is rotated thereby.

The passage forming grooves 178 and 205 are in communication with the bottom of the gear 179. An outlet passage 183 in the cap 173 communicates with the upper portions of both gear recesses 175 and 180, as shown in Figs. 18 and 19.

Assuming a clockwise rotation of the chopping member 161, as viewed in Fig. 19, the gear member 179 is caused to rotate in a counterclockwise direction. The material passing from the body member 162 and into the cap 173 by the aid of the grooves 178 and 205 enters the spaces between the teeth of the gear member 179 and is carried arcuately and upwardly in the gear recess 180. The outlet passage 183, communicating with the upper portion of recess 180, receives that portion of the material in recess 180 that is at the higher level, and such portion may then pass outwardly of the mixing member. Another portion of the material in recess 180 that is at the lower level therein is brought into contact with the teeth of the driving gear 172, and may pass to an intermediate collection point formed by a recess 184 (Fig. 19) communicating with the upper portions of the gear recesses 175 and 180. From this collection point, some material may be urged again around the gear recess 180. Another part of the material in the recess 184 is carried by the gear 172 clockwise about its recess 175 and thence to the outlet passage 183. The material thereby becomes further intermixed.

The gear members 172 and 179 act as a pump that aids the flow of material through the device. Accordingly, a high rate of flow can be achieved without requiring the pistons 23 to develop an extremely high pressure in the cylindrical spaces 2 and 3, which might otherwise be of the order of several hundred pounds per square inch. An improved operation is thus achieved. The gears furthermore cause a substantial intermixture of the material by engagement of the teeth of the gear members 171 and 179, as well as by smearing action.

Since the projections 168 of the chopper member 161 are arranged helically, but in left-handed arrangement, a reversal of the air motor mechanism might induce a flow of material outwardly of the passage 183 without the application of pressure by the pistons 23. It is thus important that the mixer be inoperative while the pistons 23 are retracted, such as for refilling the chambers 2 and 3. A one-way drive for the chopping member 161 ensures against such undesired flow. For this purpose, a clutch member 185 is provided that has an appropriate non-circular recess 186 for coupling the shaft 55. This clutch member 185 is accommodated in an axial recess 187 in the bottom of the chopping member 161. The member 185 has a series of angularly spaced, longitudinally extending slots 188 facing the bore 187. Each of these slots 188 is of maximum depth, or minimum distance from the axis of rotation at the clockwise-most portion of the slots, and is of continuously decreasing depth or increasing radial distance in the counterclockwise direction of the slots 188. The slots 188 thus form wedge-shaped spaces with the bore 187.

Accommodated within the slots 188 respectively are rolling elements 189, the diameters of which are such that they may be accommodated at the clockwise-most por-

tion of the slots 188 without contacting the wall forming the bore 187 of the chopping member 161. Upon clockwise rotation of the clutch member 185 in the position illustrated in Fig. 20, the rolling elements are urged toward the counterclockwise-most position of the slots 188, bringing the rolling elements 189 into engagement with the wall forming the bore 187. Accordingly, upon clockwise rotation of the clutch member 185, the rolling elements 189 become firmly wedged to couple the chopping member 161 for rotation with the clutch member 185. Upon reversal of the air motor mechanism, the clutch member 185 is caused to rotate in a counterclockwise direction, as viewed in Fig. 20. Accordingly, the rolling elements 189 are urged to the deep end of the slots 188, thereby unclutching the chopping member 161 from the mechanism. Reversed rotation of the chopping member 161 is thus prevented.

The cap member 173 has an interiorly threaded portion 190 in alignment with the outlet port 183, for cooperation with a threaded extension 191 of a coupling member 192 for the nozzle 4.

For controlling the flow of material through the mixing mechanism, a plug valve 193 cooperates with the outlet passage 183. This plug 193 is substantially of cylindrical form and is accommodated in a cylindrical recess 194 intersecting the outlet passage 183 at right angles thereto. This recess 194, opening on one side of the cap member 173, permits insertion of the plug 193. The plug 193 has a non-circular end 195 engaged by a corresponding aperture 196 of an operator 197. A resilient O-ring 198 accommodated in an appropriate groove 199 in the plug 193 prevents outward flow of material along the closure 193.

As shown most clearly in Fig. 18, the plug 193 has a through transverse port 200 that may be aligned with the outlet passage 183 for uninterrupted flow through the device. For limiting movement of the plug 193 and for maintaining it in assembled relationship with the cap 173, an arcuate slot 201 extends partially around the outside of the plug 193. The threaded extension 191 has a reduced cylindrical portion 202 that extends within the slot 201. This cylindrical projection 202 has a diameter corresponding to the axial distance between the opposed axially spaced walls 203 of the recess 201. Accordingly, when the apparatus is in assembled position, the plug 193 is prevented from moving axially in the recess 194. This ensures proper alignment of the outlet passage 183 with the through port 200. Furthermore, the projection 202 limits angular adjustment of the plug 193 by engagement with the arcuately spaced end walls 204 of the recess 201. As illustrated in Fig. 18, the projection 202 is engaged by one end wall of the recess, corresponding to counterclockwise-most adjustment of the plug 193. This end wall is so located that it corresponds precisely to accurate alignment of the port 200 with the outlet passage 183. Clockwise rotation of the plug 193, from the position illustrated in Fig. 18, is limited by the other end wall of the recess and ensures against unintentional movement of the closure 193 beyond fully closed position.

In the form illustrated in Figs. 23 to 27, a body member 210 cooperates with the halves 5 and 6. The body member 210 provides inlet ports 211 and 212 at opposite sides of the body member. A sleeve member 213 is inserted in a longitudinal bore 214 of the body member, and mounts a gear pump structure that not only causes intimate intermixture of the rubber material and catalyzer, but reduces the pressure required to be developed by the pistons 23. A main driving gear 215 of the gear pump is accommodated in an axial recess 216 in the sleeve 213 and is therein guided for angular rotation about an axis 217. This gear has in its lower end a non-circular recess 218 cooperable with the shaft of the air motor. The sleeve 213 has an annular, inwardly directed flange 219 that provides a seat for the main gear 215 and

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permits access of the air motor shaft to the non-circular recess 218.

The sleeve 213 has inclined ports 220 and 221 aligned with the inlet ports 211 and 212 of the body member 210. The ports 220 and 221 communicate with the axial bore 216 housing the main gear at places in the bore 216, communicating not only with the sides of the gear 215 but with the bottom thereof (Fig. 23).

As shown most clearly in Figs. 26 and 27, the sleeve 213 also has longitudinally extending arcuate recesses 222 and 223 communicating with the recess 216 of the main gear 215. These recesses 222 and 223 are on diametrically opposite sides of the axis 217 of gear 215. In the recesses are driven gears 224 and 225 in engagement with the main gear 215. The ports 220 and 221 are so located, as illustrated in Fig. 26, that they communicate not only with the main gear recess 216, but also with these recesses 222 and 223 respectively. Accordingly, the gears 224 and 225 cooperate with the main gear 215 to form gear pumps interposed in the paths of the material for aiding in the flow of the material that enters the ports 211 and 212 respectively. The gear structures also cause intimate intermixture of the material, since material entering the port 212 is carried into contact with the material entering through port 211 by the rotating structure, etc.

The sleeve 213 has at its upper end an annular flange 226 engaged by the main body member 210 to limit downward movement of the sleeve 213 in the bore 214. A flanged plate 227 (Figs. 23 and 25) has a reduced portion accommodated within an annular recess 228 of the flange 226. This plate, as illustrated most clearly in Fig. 27, has apertures 229 and 230 piloting shaft extensions 231 and 232 of the gears 224 and 225, respectively. The sleeve 213 furthermore has apertures 233 and 234 piloting shaft extensions at the other ends of the gears 224 and 225, respectively. The apertures 229 and 230 of the plate 227 and the apertures 233 and 234 of the sleeve 213 serve accurately to mount the gears 224 and 225 for rotation.

A cap member 235, forming the outlet 236 of the mixer mechanism, is secured to the main body member 210 by the aid of bolts 237 and 238. These bolts extend through appropriate apertures in the plate 227 and the flange 226 of the sleeve 213 for providing accurate alignment of the members. The bolts 237 and 238 are engaged by interrupted threads provided by the main body member 210.

The cap 235 provides a bore or chamber 255 (Fig. 23) adapted to form a part of the passage for the material. This chamber 255 opens on the lower side of the cap 235 and is in substantial alignment with the recess 216 for the main gear. Communication is established between the bore 216, recesses 222 and 223 for the gear members 224 and 225 to the chamber 255 by the aid of appropriate apertures 239 and 240 (Fig. 25) through the plate 227.

Arcuate recesses 241 and 242 formed in the upper part of sleeve 213 (see dotted lines in Fig. 23; and also see Fig. 26) are in registry with the apertures 239 and 240 to facilitate the flow from the gear pump into the chamber 255. An outlet chamber 243 (Fig. 23), in communication at its lower end with the chamber 255, communicates at the other end with the interior of a coupling member 244 threadedly accommodated in the cap member 235.

The coupling member 244, as shown most clearly in Fig. 24, provides a cylindrical outlet passage 245 communicating with the nozzle 4. In this passage 245 is a screw pump member 246 designed to aid in the flow of material through the mixer. This member has helically arranged threads that, upon rotation of the member 246, urges the material outwardly of the passage 245. This pump member 246 has a shaft extension 248 piloted in a recess 249 of the cap member 235.

For rotating the pump member 246, a bevel gear construction is provided (Figs. 23 and 24). One bevel gear

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250 is carried by the shaft 248 of the pump 246 and is located in the outlet chamber 243. This bevel gear 250 is engaged by another bevel gear 251 in the chamber 238. The bevel gear 251 is mounted on a non-circular shaft extension 252 of the main gear 215 (see, also, Fig. 25). This shaft extension 252 extends into the chamber 255 through an appropriate aperture 253 of the plate 227. Appropriate slots 254, spaced 90° apart, are provided in the connector member 244 to facilitate flow of material into intimate engagement with the pump member 246.

Upon clockwise rotation of the main gear 215 by the air motor mechanism, as viewed in Figs. 24, 25, and 26, the threads 247 are arranged to aid the flow of material upon rotation of the pump member 246.

The bevel gear construction 250, 251 not only serves as the transmission mechanism for the pump 246, but aids the gear pump structures 215, 224, 225 in effecting intimate intermixture of the material.

The form of the invention illustrated in Figs. 28 to 31 is similar to the form illustrated in Figs. 18 to 22. It utilizes both a rotary chopping member 260 and a gear pump construction. The gear pump causes intimate intermixture and reduces the pressure required to be produced by the pistons 23.

A main body member 261 is threadedly accommodated in the halves 5 and 6. The main body member 261 has an axial aperture 262 guidingly receiving the chopping member 260. Inlet ports 263 and 264 are provided on opposite sides of the body member 261 for feeding the material into the aperture 262.

In the present instance, the main body member 261 has a plurality of longitudinally spaced series of angularly spaced projections 265 (Figs. 30 and 31) cooperating with a corresponding plurality of longitudinally spaced series of angularly spaced projections 266 of the chopping member 260. The chopping member 260 can be telescoped into the body member 261 by angularly displacing the projections 265 and 266 of the members 261 and 260, respectively, before the parts are moved axially together. Such angular position is shown most clearly in Fig. 30. A flange 267 at the upper portion of the chopping member 260 is disposed above the uppermost series of projections 265 of the body member 261. In such assembled position, the series of projections 266 of the rotary chopping member 260 are longitudinally spaced from the series of projections 265 of the body member 261. Accordingly, when the chopping member is so located, it may be rotated with the body member 261, the projections 266 longitudinally interleaving with the projections 265 of the body member 261.

The material entering the aperture 262 of the main body member 261 under pressure through the inlets 263 and 264 must move around the relatively rotating projections, thereby causing mixing of the material. As shown most clearly in Fig. 30, there are only five projections 265 in each series of projections of the main body member 261. There are ten projections in each series of projections of the chopping member 260. Accordingly, for any angular position of the chopping member 260 in the main body member 261, there are five substantially uninterrupted longitudinal paths for the material that is mixed. Such paths are illustrated by the reference character 278, for instance. Such uninterrupted paths 278 are not undisturbed, since the projections 265 of the main body member soon cross such paths upon rotation of the chopping member. Other distinct through longitudinal passages are then formed. The interleaving projections thus completely mix the different materials entering through the ports 263 and 264.

For rotating the chopping member 261, an appropriate non-circular aperture 268 is provided in the bottom thereof for engagement with the non-circular extension of the air motor shaft.

A cap member 269, secured to the main body member 261 by the aid of bolts 270, provides the outlet pas-

sageway 271 for the material. The cap member 269 has a recess 272 accommodating a gear member 279 integrally joined to the top of the chopping member 260. An integrally depending pin 273 of the cap 269 is accommodated in a corresponding axial recess 274 of the gear 279 for guiding the chopping member 260 and gear member 279 for angular movement.

As shown most clearly in Fig. 29, the cap member 269 has a pair of arcuate recesses 275 communicating with the gear recess 272 on diametrically opposite portions thereof. These recesses 275 accommodate gear structures 276 that are rotated by engagement with the gear-toothed projection 279. These gears operate as pumps interposed in the passageway for the material, and greatly assist in the flow of material through the mixer. Material from the chopping chamber 262 can pass to the gear structures by the aid of slots 277 in the main body member 261. These gear structures, in addition to pumping the material into the outlet passage 271, also serve further to produce an intimate intermixture of the materials.

In the form illustrated in Figs. 33 to 37, a main gear 280 is provided with associated gear structures 281 and 282 (Fig. 36), such as described in connection with the form illustrated in Figs. 23 to 27. These gear structures mix the material and reduce the pressure required to be developed by the pistons 23.

The main body member 283 in the present instance provides suitable longitudinally extending arcuate recesses for the gear structures 280, 281, 282, and provides the inlet openings 284 and 285 leading to these recesses. A plate 286 provides suitable bearings for shaft projections of all the gear members 280, 281, 282. For this purpose, the plate 286 has an apertured boss 287 receiving a cylindrical portion 288 integrally formed on the central gear 280. Recesses 289 (Fig. 37) receive the shaft extensions of the gear structures 281, 282.

An upwardly extending flange 290, formed on the body member 283, receives the plate 286. The material from the gear-toothed structure is permitted to pass centrally of the plate 286 by the aid of apertures 291 and 292, shown in phantom lines in Figs. 35 and 36. These plate apertures 291 and 292 register with appropriate passageways 293 and 294, respectively, of the main body member 283. These passageways 293 and 294 extend longitudinally of the body member 283. A small rotatable plate 295, shown most clearly in Fig. 35, is accommodated with a slight peripheral clearance in an annular recess 296 of the plate 286. The plate is carried by the main gear 280 for rotation therewith. For this purpose, the plate 295 has a non-circular aperture 297 telescoping over a corresponding non-circular shaft extension 298 formed integrally on the main gear 280.

The plate 295, as illustrated most clearly in Fig. 35, has a plurality of angularly spaced through apertures 299, through which the material may pass. The material may most easily enter the apertures 299 when they are brought into registry with the aligned recesses 291—293, or 292—294. A stationary plate 300 cooperates with the rotary plate 295 to aid in mixing the material, and has a series of angularly spaced through ports 301 that intermittently register with ports 299 of the rotating plate 295. Accordingly, the material may pass longitudinally through the plates 295 and 300 through paths that are continuously being changed and interrupted.

A rotatable cutter 302, superimposed on the stationary plate 300, produces a further chopping of the material. This cutter 302 is in the form of a vane structure, vanes 303 extending radially beyond the apertures 301 to insure that all of the material passing through the apertures 301 receive the benefit of the cutting action of the cutter member 302. For rotating the cutter 302 for cooperation with the stationary apertured plate 300, it is provided with a

non-circular aperture telescoped over projection 298 of the gear member 280.

A cap member 305 cooperates with the body member 382 to provide an annular chamber for the mechanism above the gear pump structure. For this purpose, it has an annular flange 307 abutting the flange 290 of the body member. The cap member has a recess 309 accommodating the cutter 302. A shoulder 318 is formed inwardly of the flange 307. The stationary plate 300 is received within the flange 307 of the cap 305, and rests against the shoulder 318. The flange 307 telescopes over a portion of the bearing plate 286.

An outlet passageway 306 is provided in the cap member 305 that extends into the cutter recess 309. This outlet passageway 306 extends substantially radially of the annular chamber for the cutting mechanism.

For securing the cap 305 to the body member 283, a pair of bolts 308 pass longitudinally through the cap member 305 into appropriate threaded apertures of the main body member 283. These bolts also pass through the stationary plate 300 and bearing plates 286, determining proper alignment thereof.

Contact of all of the material intended to be mixed, with the cutter 302 is ensured by providing the apertures 301 of the stationary plate 300 at only a portion of the periphery thereof. Thus, that portion of the plate 300 that is nearest the outlet passage 306 is devoid of apertures. Accordingly, none of the material can pass directly from an aperture 301 to the outlet 306, but must be urged into the outlet 306 by the cutter 302.

In the form illustrated in Figs. 38 to 41, another form of a mixer utilizing a gear pump construction is illustrated. A main body member 320 serves as the main housing for the mixing apparatus and is threadedly accommodated in the halves 5 and 6. The main body member has radially extending inlet ports 321 and 322 that establish communication to a through axial bore 319 of the body member. A cap member 326, having an annular flange 327, cooperates with the body member 320 to define a housing. The lower end of flange 327 is threadedly received in the upper portion of the bore 319 of the body member 320. A rotary member 337 is telescopically received in the flange 327 of the cap 326. This rotary member mounts a gear construction through which the material must pass.

As illustrated in Fig. 40, the rotary member 337 has a cylindrical recess 341 centrally thereof, opening upwardly of the rotary member, accommodating a non-rotary gear 342. On opposite sides of the central recess 341, and similarly opening upwardly of the rotary member 337, are arcuate slots 343 and 344 that intersect the cylindrical bore 341. Inserted in these arcuate slots 343 and 344 are rotary gear structures 345 and 346, as shown in Fig. 42, that are in engagement with the central gear 342. The rotary member 337 provides piloting recesses 347 and 348 for the lower ends of shafts 349 and 350 of the gear structures 346 and 345, respectively. The rotary member 337 also has a cylindrical recess 318 receiving the lower end of the shaft 359 of the non-rotary gear 342.

An annular cage 352 is carried on the lower portion of the rotary member 337 and has angularly spaced, longitudinally extending slots between upper and lower flanges 354 and 351 of the cage 352, respectively. The cage 352 defines an inner annular space surrounding the lower portion of the rotary member 337. The material from the inlet ports 321 and 322 passes into the cage, the cage producing an initial mixing. A pair of arcuate slots 353 is formed in the upper flange 354, as shown most clearly in Figs. 38 and 41, at diametrically opposite sides thereof. These arcuate slots are in registry with radially extending passageways 355 and 317 in the rotary member 337. Accordingly, the material from the inside of the cage 352 can pass upwardly into these passageways 355 and 317, via slots 353.

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As shown by the dotted lines in Fig. 40, the passageway 317 intersects the arcuate recess 343 for the gear structure 345 and the cylindrical recess 341 for the main gear 342. The passageway 355, however, intersects the arcuate slot 344 for the gear 346, as well as the cylindrical recess 341 opposite the passageway 317.

A plate 356 is secured to the rotary member 337 by the aid of screws 357. As shown most clearly in Figs. 39 and 42, this plate provides piloting recesses 358 for the upper ends of the shafts 349 and 350 of the rotary gear structures 345 and 346. The plate also has a central cylindrical aperture 316 piloting the upper elongate extension of the shaft 359 of the non-rotary gear structure 342.

The material entering the gear structures through passageways 317 and 355 can pass upwardly of the rotary member 337 by the aid of appropriate ports 364 and 365 (Fig. 39) of the plate 356 that register with arcuate recesses 366 and 367 (Fig. 40) in the rotary structure 337. These recesses are at the upper portion of the rotary member 337, and receive the material after being acted upon by the gear structures.

The rotary member 337 is rotated by the aid of a non-circular recess 338 in the bottom of the member 337. Assuming, for the present, that the central gear 342 is held against rotation, then a clockwise direction of rotation of the rotary member 337, as viewed in Fig. 40, will impart a planetary motion to the gear structures 345 and 346. The material entering the passageway 317 will then be carried arcuately around the passageway 343 and upwardly therein. The material then passes into the recess 366. Similarly, the material entering the passageway 355 is carried arcuately around the recess 344 by the gear 346 and finally to the recess 367. Some of the material from the passageway 317 may be diverted from the arcuate slot 343 by the stationary gear 342. Similarly, some of the material from the passageway 355 may be diverted from the arcuate slot 344 by the gear structure 342. A thorough mixing is thus produced. Also, as in the previous forms, the gear structures act as a pair of tandem pumps, whereby the pressure required to be developed by the pistons 23 can be materially reduced.

A collector member 323 has an annular recess 324 receiving the material that has been acted upon by the gear structures. The material in the recess 324 can pass to the nozzle structure by the aid of a radially extending outlet passageway 325 formed on the collector member. The collector member 323 is held in assembled relationship against the top of the main body structure 320 by the aid of an annular flange 328 in the cap member 326 that engages the upper portion of the collector 323.

A stationary member 329 is carried by the cap member 326, as by the aid of a threaded extension 330 projecting through the cap 326 and engaged by a lock nut 331. The stationary member 329 has an annular flange 333 spaced inwardly of the flange 327 of the member 326. It forms an annular space 334 between the flanges. The flange 333 of the inner stationary member 329 forms a chamber 340 receiving the material from the gear structure and passing through the plate 356.

The material can pass outwardly of the flanges 333 and 327 by the aid of a series of radially extending apertures 327a and 335 in the flanges 327 and 333, respectively. These radial ports are in pre-set alignment with each other, as by the aid of a set screw 332 carried by the outer member 326 and engaging the extension 330 of the inner flange member 329. The annular recess 324 of the collector member 323 is in communication with the ports 327a of the outer flange 327.

To produce a further admixture of the material, a cutting and smearing action is achieved by an upwardly extending annular flange 336 integrally formed on the rotary member 337 that extends into the annular space 334. As shown most clearly in Fig. 39, this flange 336

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has a series of angularly spaced ports 339 that intermittently register with the ports 327a and 335 of the inner and outer stationary flanges 333 and 327, respectively.

For holding the central gear structure 342 against rotation, a set screw 362, carried by the inner non-rotary member 329, engages a flat portion 363 of the upper elongate extension of the shaft 359.

In the form illustrated in Figs. 43 to 47, a main body member 370 is threaded at its lower end for cooperation with the halves 5 and 6 as before. The main body member 370 has inlet ports 371 and 372 for the material. These inlet ports 371 and 372 communicate with an axial bore 373 of the main body member, forming a mixing chamber.

In this chamber 373 is a rotary chopping member 374 (Fig. 47) formed by a series of helically arranged interrupted threads or projections 375. The rotary chopping member 374 has a through non-cylindrical bore 376 engageable with the shaft of the air motor, or the like. The spaced projections 375 cooperate with the wall forming the bore 373 to define irregular paths of the material, for mixing.

The interrupted turns forming the projections 375 are left-handed, whereby the material is not thereby aided in its ultimate upward movement. The chopper member 374 provides a slightly reverse movement of the material and produces a churning effect of the material as it passes upwardly thereof, improving the mixing of the material.

The axial bore 373, in which the chopper member 374 extends, is closed by a disc 380 accommodated in a circular recess 381 of the main body member 370.

For permitting passage of the material upwardly from the chamber 373 of the body member 370, a slot 382 (Figs. 43 and 45) is provided. This slot 382 defines a passageway between the upper portion of the mixing chamber 373 to the upper surface of the body member 370, the slot 382 leading around the disc or plate 380.

The main body member 370 has an upwardly extending annular flange 377 forming a circular recess 378 in which a gear pump structure is accommodated. The flange 377 has an interiorly threaded through transverse aperture 385 forming the outlet from the body member.

In the annular recess 378 is disposed a stationary passage-forming member 379 (Fig. 44) that guides the material from the mixing chamber 373 to the outlet 385. This passage-forming member 379 defines communicating lower and upper passageways, respectively, in the lower and upper surfaces of member 379. The inlet to the lower passageway is formed by a recess 395 registering with the slot 382 of the main body member 370. This recess 395 has a depth corresponding to about half the thickness of the member 379, and opens downwardly thereof. The outlet from the lower passageway is formed by a through longitudinal aperture 396 in the member 379 that is angularly spaced from the inlet recess 395.

A through axially extending bore 387 in the member 379 intersects the inlet recess 395 and outlet aperture 396 at one side thereof; an arcuate recess 392 in member 379 (see Fig. 46), facing downwardly of the passage-forming member 379, also intersects the inlet recess 395 and outlet 396 opposite the bore 387. The bore 387 and recess 395 intersect each other, and form the central portion of the lower passageway. The outline of the lower passageway formed in the member 379 is shown in phantom lines in Fig. 45. The arcuate recess 392 guidingly receives a spur gear 391 (Fig. 46), and the through bore 387 guidingly receives a main gear structure 386. These gear structures 391, 386 are in engagement and form a gear pump interposed in the lower passageway. The main gear 386 has an annular flange 388 below the member 379 that is received by a circular recess 389 of the disc 380.

An upper passageway is formed by the stationary member 379. The inlet to the upper passageway is formed by the through bore 396. An arcuate recess 398

(Figs. 43 and 44) communicates with the aperture 396. The depth of the entire upper passageway corresponds to the depth of the recess 398, as indicated in Fig. 43. The outlet from the upper passageway is formed by an arcuate recess 399.

As illustrated most clearly in Fig. 44, the central longitudinal bore 387 communicates with the arcuate recess 398 and the outlet recess 399 at one side thereof; an arcuate recess 394 in the member 379, facing upwardly of the member 379, also intersects the arcuate recess 398 and outlet recess 399 opposite the bore 387. The axial or central bore 387 and recess 394 communicate with each other, and form the central portion of the upper passageway.

The arcuate recess 394 accommodates a spur gear 393 (see, also, Fig. 46) that is in engagement with the gear structure 386. Accordingly, the gear structures 393, 386 provide a gear pump structure extending across the upper passageway, and in series relationship with the pump structure in the lower passageway.

The gear structure 386 has an annular flange 397 (Figs. 44 and 46) intermediate its length for preventing undesired passage of the material along the length of the gear, and restricting flow of material between the lower and upper passages to the longitudinal aperture 396.

Communicating with the outlet recess 399 is an outlet chamber 400 accommodating the end of a threaded projection 383 of a coupling member 384. The passage-forming member 379 is maintained in a definite angular position corresponding to registry between the slot 382 and the inlet port 395 by engagement of the passage-forming member 379 with the threaded projection 383 of the coupling member.

A non-circular projection 390 of the gear structure 386 is received in the non-circular bore 376 of the mixing member 374. Accordingly, upon rotation of the mixing member 374, the gear structure 386 is rotated. The spur gears 391 and 393, being in engagement with the gear structure 386, are caused to rotate in their recesses.

Assuming a clockwise direction of rotation of the gear structure 386, as illustrated in Figs. 44 and 45, it is apparent that the material is carried about the gear accommodating recesses. Substantial smearing action is produced, as well as admixture by virtue of the interengagement of the gear structures.

The material enters the inlets 371 and 372, passes around the mixing member 374 in the chamber 373, upwardly in the arcuate slot 382. The material then enters the lower passageway of the member 379 at the recess 395 registering with the slot 382, then around the recesses 392 and 387 by the gears 391 and 396, then to the through aperture 396. The material then enters the upper passageway at the arcuate recess 398, and is carried around the recesses 394 and 387 by the gears 393 and 386. The material then enters the outlet chamber 400 via the outlet recess 399.

A threaded cap member 401 is received by the flange 377 and closes the annular chamber 387. The cap member 401 may be provided with a knurled periphery to facilitate its assembly.

In the form illustrated in Figs. 48 to 52, a main body member 410 is threaded at its lower end for reception by the halves 5 and 6. The main body member 410 has inlet ports 411 and 412 feeding material to a through longitudinal bore 413 of the body member 410. In the lower portion of the bore 413 is inserted a non-rotary gear housing member 414. The housing 414 is held against rotation in a manner to be described more fully hereinafter. The housing member 414 has four angularly spaced arcuate recesses 415, 416, 417, and 418, which open in the upper surface of this member. These recesses accommodate spur gears 419, 420, 421, and 422, forming a part of a multiple gear pump construction (Fig. 51). The gear pump mixes the material and re-

duces the pressure required to be developed by the pistons 23.

As shown most clearly in Figs. 51 and 52, the housing member 414 also has two angularly spaced, longitudinally extending recesses 424 and 425 at the outer portion thereof, communicating with an annular recess 423 (Fig. 52), that registers with the inlets 411, 412. These recesses 424 and 425 communicate with two of the gear tooth recesses 415 and 416. Accordingly, the material entering through the inlets 411 and 412 is in communication with the outermost portion of the gear-toothed structures 419 and 420.

Centrally of the housing member 414 is a lower main driving gear 426 meshing with all of the outer gear structures 419, 420, 421, and 422. This gear structure 426 has a shaft 427 extending through the non-rotary member 414. The lower end of the shaft 427 is provided with a non-circular recess 428 for engagement with the shaft of the air motor mechanism.

As shown most clearly in Fig. 51, a plurality of arcuate recesses 429, 430, 431, and 432 are provided in the upper face of the housing member 414. These recesses 429, 430, 431, and 432 form intermediate passages for the material as it progresses through the gear structures. Each of the recesses communicates with the main gear 426, as well as with two adjacent gear structures.

Assuming a clockwise direction of rotation of the main gear structure 426, all of the supplemental gears 419, 420, 421, and 422 are rotated in counterclockwise directions. The material entering the gear structures through the inlet slots 424 and 425 of the housing member 414 is carried by the gear structures 419 and 420 to the recesses 429 and 430, respectively. Considering, for instance, the gear structure 419 in cooperation with the main gear structure 426, it is apparent that these intermeshing gears act to move the material from the recess 429 to the next clockwise recess 431. The gear structure 420 similarly cooperates with the main gear 426 to move the material from the recess 430 to the recess 429. The gear structures 421 and 422 similarly operate. Furthermore, each of the gear structures 419, 420, 421, and 422 urges some of the material in the recesses 429, 430, 431, and 432 about their arcuate cylindrical surfaces. Thus, for instance, the gear structure 420 urges some of the material in the recess 429 around the cylindrical wall of recess 416 of the gear 420. The other gear structures 419, 421, and 422 similarly operate.

Extremely thorough intermixture of material is achieved by the gear construction.

As illustrated most clearly in Fig. 50, the mixed material is ultimately permitted to move upwardly of the non-rotary member 414 through an aperture 433 in a shaft-guiding stationary plate 434. This recess 433 is substantially in juxtaposed relationship with the recess 432. The stationary plate 434 has a through aperture 435 (Fig. 50) guidingly receiving the shaft 427 of the main gear structure, and communicating with the recess 433. The shaft 427 can be positioned in the plate aperture 435 by first inserting the main gear structure 426 through the recess 433, and then moving the structure laterally into the aperture 435.

A second non-rotary member 436 is telescopically received by the main body member 410, and houses a gear pump structure for urging the material outwardly of the mixing mechanism. The upper non-rotary member 436 receives an upper main gear 437 (Figs. 48 and 52) secured to the shaft 427. For this purpose, the upper non-rotary member 436 has an axial recess 438 accommodating the upper main gear structure 437. It also has a recess 439 piloting the end of the shaft 427.

As shown most clearly in Figs. 49 and 52, the upper non-rotary member 436 also carries a second gear structure 440 in an arcuate recess 441. The gear 440 is adapted to be rotated by interengagement with the upper main gear 437. The upper non-rotary member 436

has a port 442 leading to the upper gear structure and in registry with the bearing plate recess 433. This recess 442 brings the material into contact with the gears 437 and 440 on one side thereof. The gears 437 and 440 urge the material around their respective recesses 438 and 441 to an outlet passage 443 provided in the upper non-rotary member 436 on that side of the gear structure opposite the port 442. Substantial smearing of the material there takes place.

The main body member 410 has a central flange 444 that is provided with a threaded outlet port 445 aligned with the outlet passageway 443 and receiving a threaded extension 446 of a coupling member 447.

For maintaining the parts in alignment, a keying pin 448 extends longitudinally through the upper non-rotary member 436 and passes eccentrically through an aperture 449 in the bearing plate 434 and into a piloting recess 450 of the lower non-rotary member 414. This key 448 is positioned by the aid of a slotted threaded head 451 thereon. This head 451 is received by a threaded recess 452 in the upper portion of the upper non-rotary member 436. A set screw 453, extending radially of the main body member 410 through the flange 444, engages the upper non-rotary member 436 to provide accurate alignment of the outlet passage 443 with the outlet port 445 of the main body member 410.

A cap 454 is threadedly received by the upper portion of the main body member 410 for closing the structure.

In the form illustrated in Figs. 53 to 57, an arrangement is provided that is somewhat similar to the form illustrated in Figs. 38 to 42. The present form utilizes a series of apertured sleeves and flanges that are relatively rotatable. It also utilizes a gear pump construction to mix the material and reduce the pressure required to be developed by the pistons 23.

A main body member 460 is threaded at its lower end for reception by the halves 5 and 6. This main body member 460 has a longitudinal bore 461 in which the grinding and mixing mechanism is received. The material is admitted to the bore 461 by inlet ports 462 and 463. A rotary member 464 is received in the bore 461. It has an appropriate non-cylindrical recess 465 by which it is rotated. The rotary member 464 has a substantial clearance with respect to the bore 461 at the inlet openings 462 and 463 (Fig. 57). Accordingly, an annular space 466 is formed that communicates with the inlet openings 462 and 463.

A non-rotary main gear 467 is supported in a recess 459 (Figs. 53 and 55) in the rotary member 464 substantially axially thereof, and opening in the upper face of member 464. This main gear 467 has a lower shaft extension 468 piloted in a cylindrical recess 469 of the rotary member. Associated with the main gear member 467 are a pair of rotary gear structures 470 and 471 (Figs. 55 and 57) that are supported in appropriate recesses 472 and 473 of the rotary member 464. These rotary gear structures are in engagement with the main gear 467 on opposite sides thereof. Recesses 474 and 475 in rotary member 464 receive shaft extensions of the rotary gear structures 470 and 471.

The material from the inlets 462 and 463 is brought into the recesses of the gear structures by the aid of a pair of longitudinally extending slots 476 and 477 (Figs. 53 and 56) on diametrically opposite sides of the rotary member 464. A pair of radially extending slots 478 and 479, as shown most clearly in Fig. 53, communicate with the slots 476 and 477, respectively, at one end. The transverse passageway 478 opens into the recesses 472 and 459 of the gear structure 470 and main gear 467. The transverse passageway 479 opens into the recess 473 for the gear 471, as well as the main gear recess 459 opposite the passageway 478. Longitudinally extending outlet passageways 480 and 481, opening upwardly of the rotary member 464 (Fig. 55), are angularly displaced from the inlet passages 478 and 479,

and receive the material urged therein by the gear structures 470 and 471, respectively.

The main gear 467 is prevented from rotating by a structure to be hereinafter described. Assuming a clockwise rotation of the rotary member 464, it is apparent that the gear structures 470 and 471 carry the material about their respective recesses 472, 473 from the passageways 478 and 479 into the outlet passages 480 and 481. The main gear 467, being stationary (Fig. 55), diverts some of the material in the passage 478 from the gear structure 470 and urges it, instead, into the passageway 481. The main gear structure 467 in a similar manner diverts some of the material from the transverse passage 479 from the gear 471 and, instead, into the passageway 480. A substantial intermixture of the material is thus effected.

A cup member 482 (Fig. 57) is secured to the rotary member 464 by the aid of screws 483 (Figs. 54 and 55), and provides piloting recesses 484 and 485 (Fig. 57) for the upper ends of the rotary gear structures 470 and 471. An upper shaft extension 486 of the main gear 467 also passes through the cup 482. The rotary member 464 has an upwardly extending annular flange 487 (Figs. 54 and 57) that is provided with angularly spaced apertures 488 (Fig. 54). The cup 482, rotatable with the member 464, has equiangularly spaced apertures 489 in its flange that are continuously in alignment with the apertures 488 of the rotatable member 464.

A stationary flange member 490 cooperates with the cup 482 to define an upper annular chamber 491. For this purpose, the stationary member 490 has a depending flange 492 telescopically received by the cup member 482. This flange 492 has a series of equiangularly spaced through apertures 493 that intermittently register with the apertures 488 and 489 of the rotating members 464 and 482.

Fig. 54 illustrates a position in which the ports 488, 489, and 493 are in registry. The material from the gear structure passes into the chamber 491 through apertures 494 and 495 (Fig. 54) in the bottom of the cup 482 that are in registry with the outlet passages 480 and 481 (Fig. 55) of the rotating member 461, respectively. The material thus may pass outwardly of the chamber through the ports 488, 489, and 493 when they are in partial or total registry.

The stationary flange member 490 has a sleeve 496 telescopically accommodating the cylindrical shaft extension 486 of the main gear 467. The shaft extension 486 has a non-circular or hexagonal portion 497 accommodated in a corresponding recess 498 of the stationary flange member 490. The flange member 490 is held stationary by means to be hereinafter described. Accordingly, the main gear structure, by the non-circular recess 498 and corresponding non-circular portion 497, is held against rotation. Rotation of the member 464 thus causes the planetary movement of the gears 470 and 471.

Telescopically received in the main body member 460 and surrounding the rotatable flange 487 is a non-rotary cutter member 499 (Fig. 53) in the form of a sleeve. This cutter member 499 has a series of angularly spaced, longitudinally extending holes 500 that intermittently register with the apertures 488 of the rotary flange 487. The material entering the sleeve slots 500 may then pass downwardly of the non-rotary cutter member 499 into an annular collecting recess or channel 501 provided in a flange 502 of the main body member 460. The flange 502 has an interiorly threaded aperture 503 forming the outlet from the mixing mechanism. A threaded projection 504 of a coupling member 505 is received in this outlet 503.

For holding the stationary flange member 490, cutter member 499, and main gear 467 against rotation, a pin 506 is provided that extends transversely through the cutter 499 and at one end into the non-rotary flange

member 490. At the other end the pin 506 is accommodated in an aperture provided in the main body member 460. A cap 507 closes the upper end of the main body member 460.

The mixer structures shown in Figs. 15, 18 to 20, 28 to 32 and 43 to 47 are disclosed and claimed in a divisional application Serial No. 677,173, filed July 15, 1957, and entitled Applicator and Mixer for Viscous Materials.

The mixer structures shown in Figs. 1 to 15, 33 to 37, 38 to 41 and 53 to 57 are disclosed and claimed in a divisional application Serial No. 677,172, filed July 12, 1957, and entitled Applicator and Mixer for Viscous Materials.

The mixer structures shown in Figs. 15, 23 to 27 and 48 to 52 are disclosed and claimed in a divisional application Serial No. 677,171, filed July 8, 1957, and entitled Applicator and Mixer for Viscous Materials.

The inventors claim:

1. In apparatus for mixing viscous materials: a barrel; means forming a wall intermediate the ends of the barrel; piston structures on opposite sides of the wall; a pair of lead screws, each lead screw connected to both pistons in such manner that rotation of the lead screws in one direction will move the pistons toward the wall, and rotation of the lead screws in the opposite direction will move the pistons away from the wall; power means for simultaneously rotating the lead screws; a rotary mixer having an inlet communicating through the wall with the spaces on opposite sides of the wall, as well as an outlet; and means for admitting constituent materials into the spaces between the wall and the piston structures.

2. In a device of the character described: means forming a pair of coaxial cylinders; a wall separating the cylinders; pistons respectively in the cylinders; rotary power means carried by the wall for simultaneously moving the pistons toward the wall; said wall having ports respectively communicating with the cylinder spaces; and a rotary mixer mounted on the wall and having an inlet communicating with the ports.

3. In a device of the character described: means forming a cylinder space; a piston operating in the space; a pair of nuts extending into apertures in the piston; lead screws engaging the nuts; each of said nuts having an arcuate recess adjacent the periphery of the nut; and means for restraining each of said nuts against angular movement, including a screw having a head engaging said recess.

4. In a device of the character described: a barrel; means forming a wall intermediate the ends of the barrel; piston structures on opposite sides of the wall; a hollow insert in one of the spaces defined by the wall and forming a cylinder, one of said piston structures being movable within said insert; means for simultaneously moving both structures toward or from the wall; and a rotary mixer having an inlet communicating with the spaces on opposite sides of the wall, as well as an outlet.

5. In a device of the character described: means forming a pair of coaxial cylinders; a wall separating the cylinders; pistons respectively in the cylinders; rotary means carried by the wall for simultaneously moving the pistons toward the wall; said wall having ports respectively communicating with the cylinder spaces; a rotary mixer mounted on the wall and having an inlet communicating with the ports; and means connecting said rotary mixer to said rotary means.

6. In a mixer structure: means forming a pair of co-

axial cylinders; a wall separating the cylinders; a pair of lead screws each extending through the wall and into the cylinders; a piston in each of the cylinders, and in engagement with corresponding ends of the lead screws; the pitch of the lead screws being opposite at opposite ends thereof; rotary means carried in the wall for rotating said lead screws; and passage forming means for conducting material from the cylinders through the wall.

7. In a mixer structure: a body having means forming a mixing chamber; a rotary mixer in the chamber; means cooperating with opposite sides of the body, forming separate reservoir spaces for constituents to be mixed; a pair of passage-forming means in the body for passing constituent materials from said spaces to said chamber; a wall for each reservoir space and movable toward the body for displacing the constituents for passing them in metered rates to said chamber; and means for operating said rotary mixer and for simultaneously moving said walls toward said body.

8. In portable apparatus for mixing viscous materials: an elongate cylinder; a wall located centrally of the cylinder and dividing the cylinder into two reservoir spaces on opposite sides of the wall for two constituent materials; pistons for the cylinder spaces respectively; means forming a mixing chamber at the wall; means forming a pair of inlet passages for the mixing chamber and respectively opening through the wall on opposite sides thereof for communication with the respective cylinder spaces; a rotary mixer in the mixing chamber; a grip secured centrally to the exterior of the cylinder; and means for moving the pistons toward the wall and for rotating said mixer.

9. In a device of the character described: means forming a pair of coaxial cylinders; a wall separating the cylinders; a piston for each cylinder; a nut for each piston and extending into an aperture of the piston; a lead screw having threads of opposite pitch at opposite ends cooperating respectively with the nuts, each of the nuts having an arcuate recess adjacent the periphery of the nut; and means for restraining each of the nuts against angular movement, including a screw having a head engaging said recess.

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