

July 10, 1934.

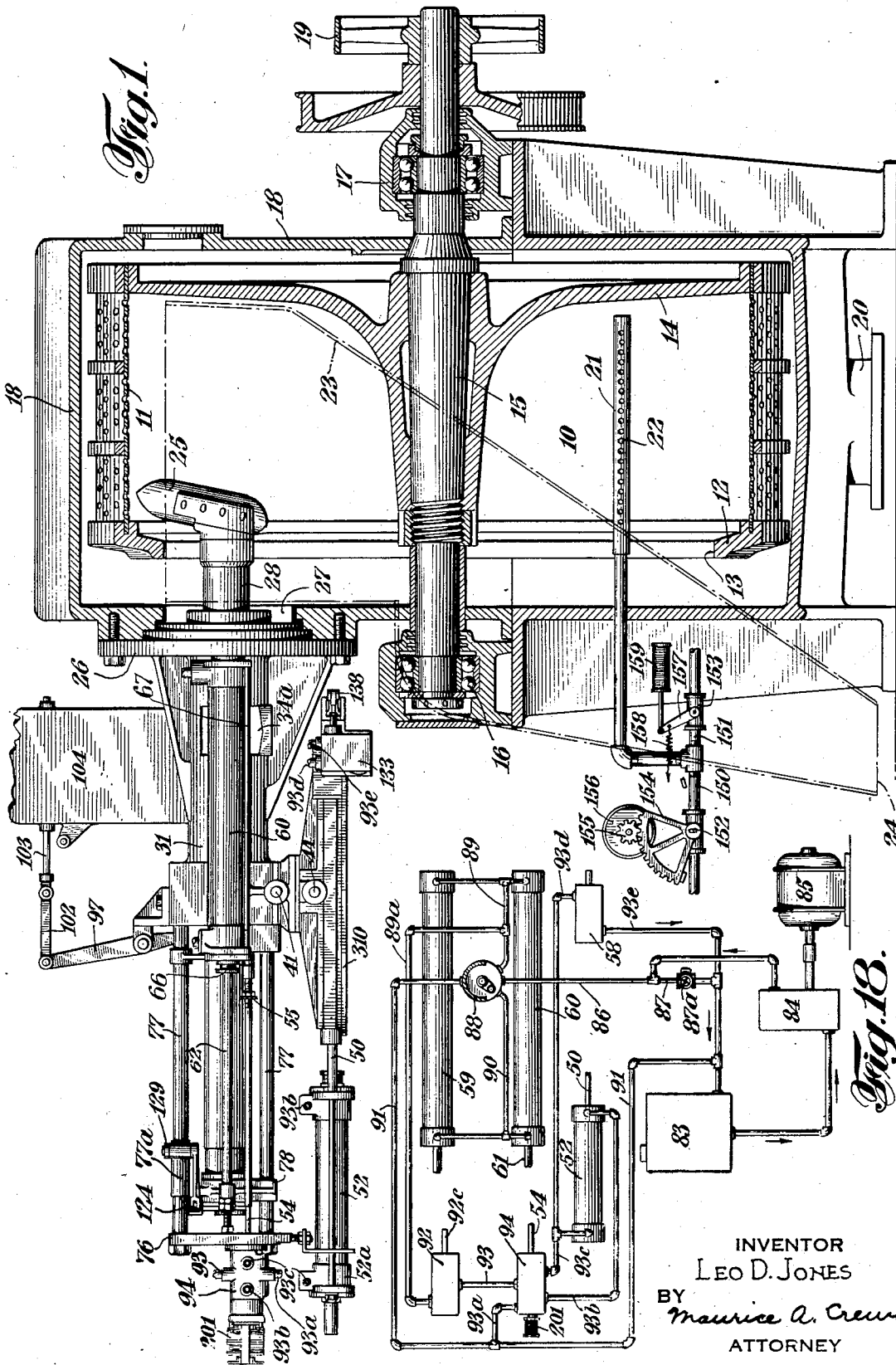
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1,965,840

CENTRIFUGAL MACHINE

Filed Nov. 17, 1932

11 Sheets-Sheet 1



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Fig. 2.

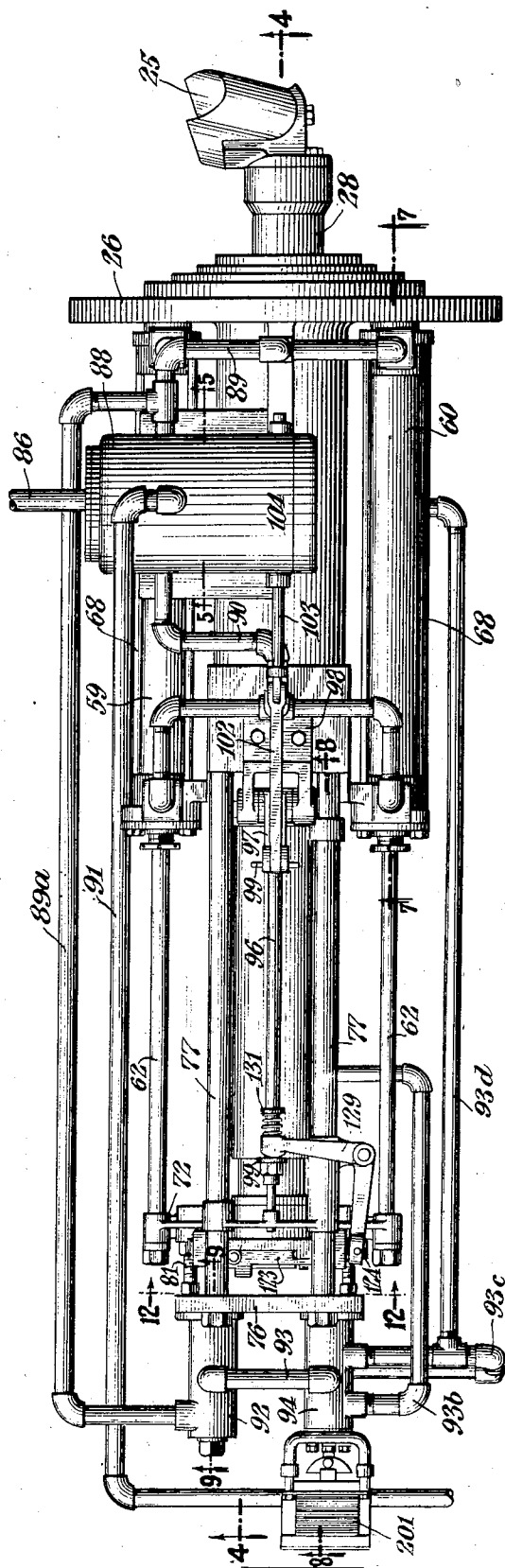


Fig. 7.

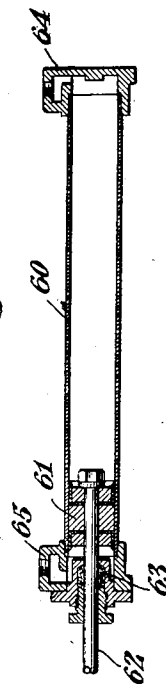
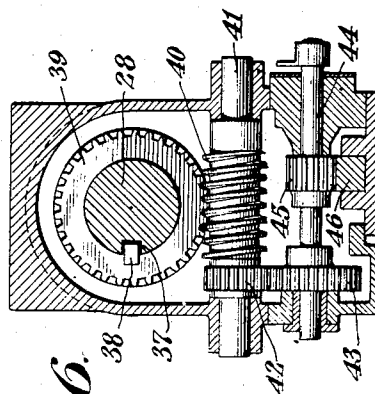


Fig. 6.



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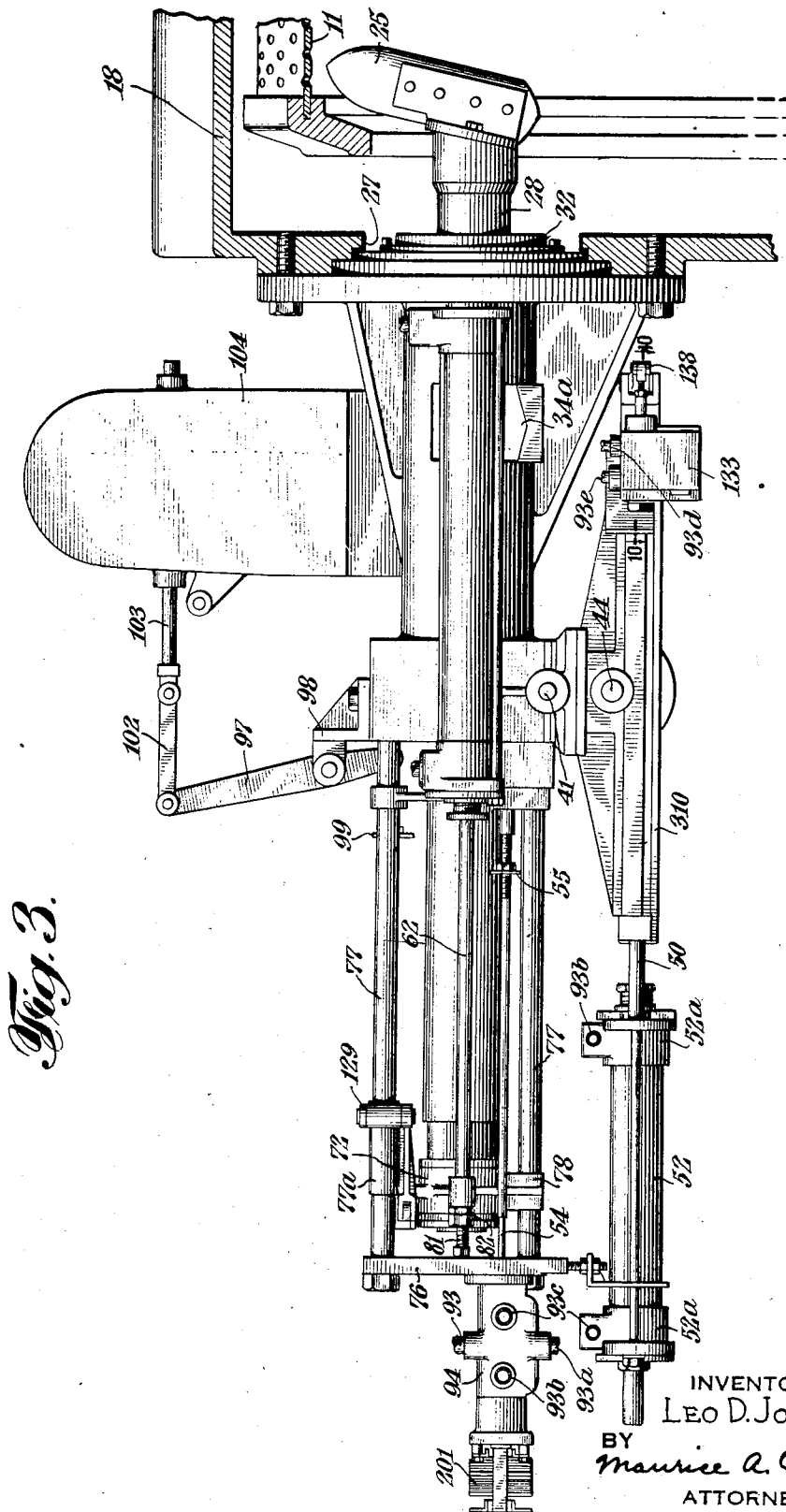
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11 Sheets-Sheet 3



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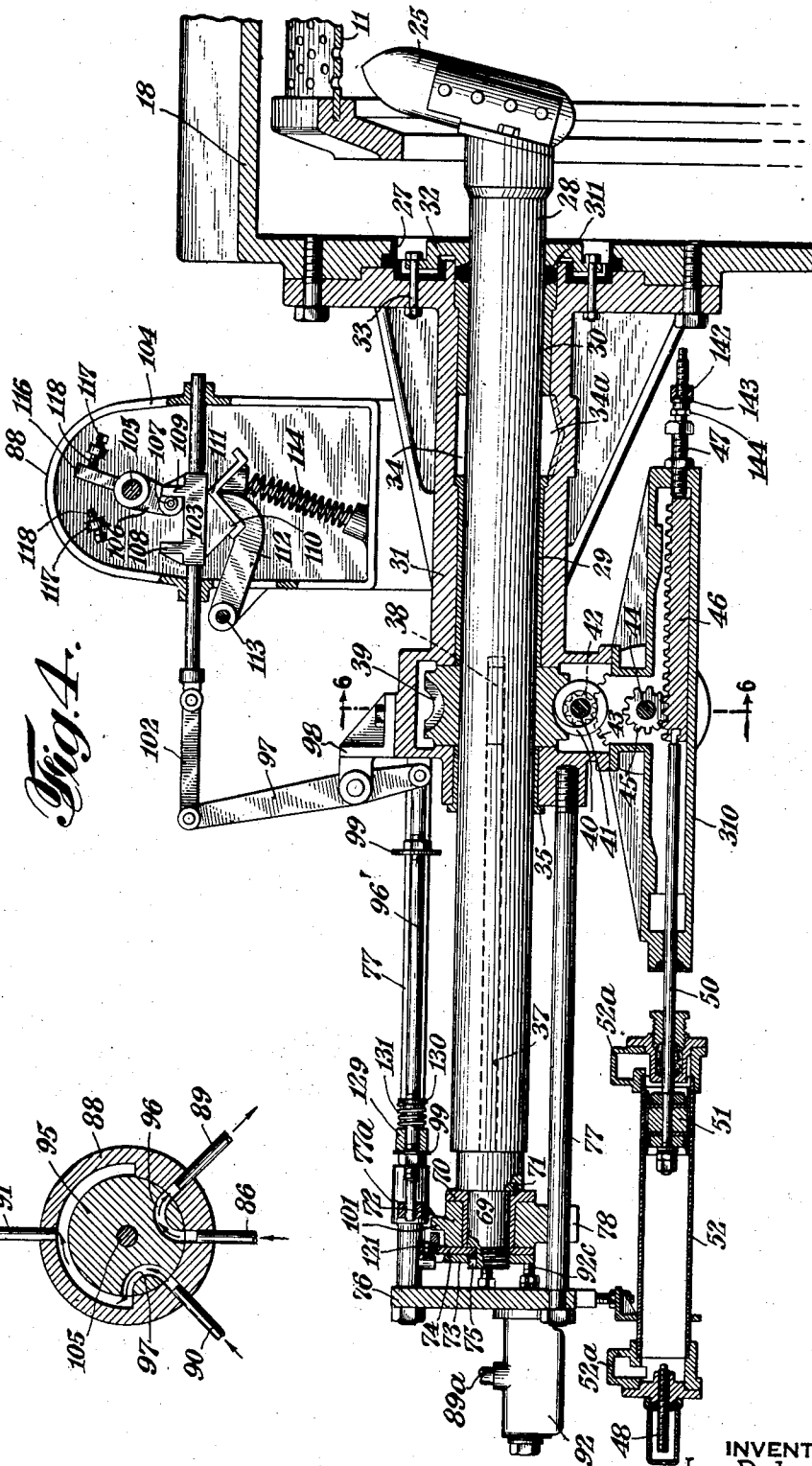


Fig. 4.

Fig. 5.

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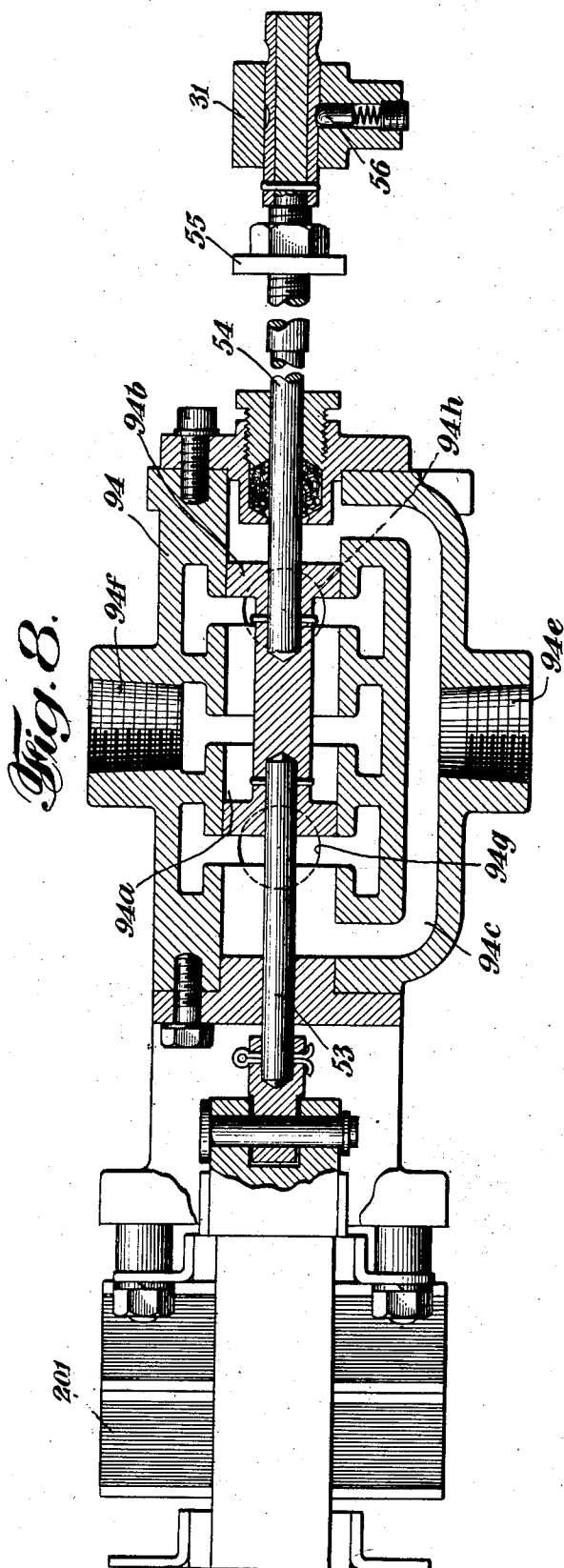
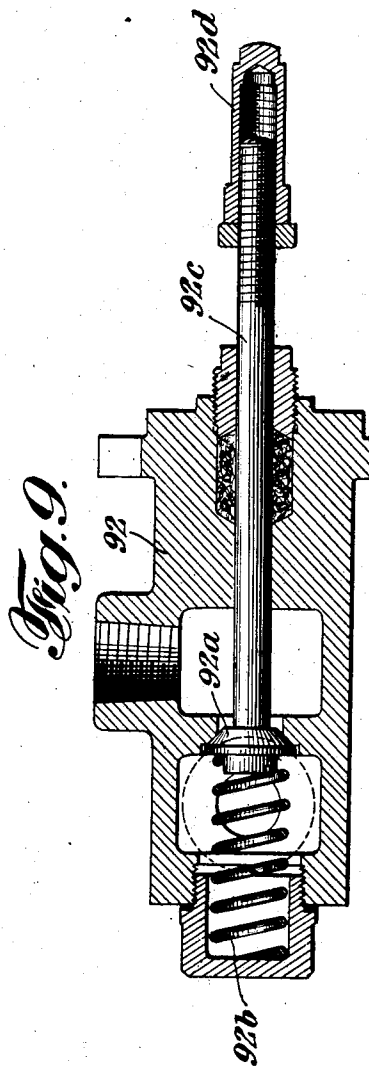
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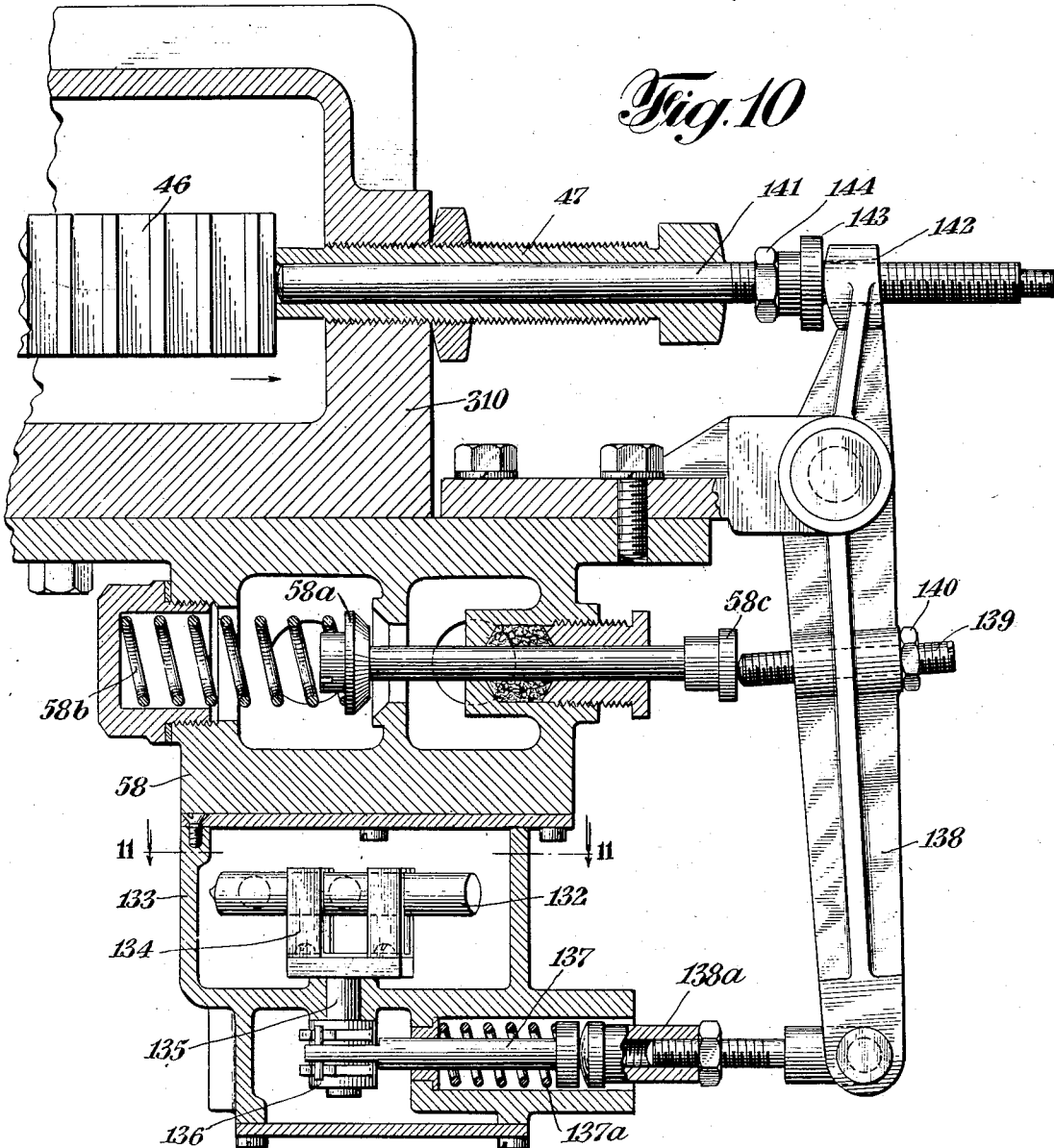
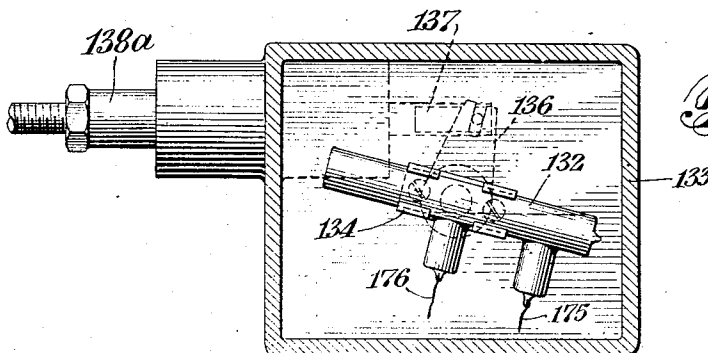
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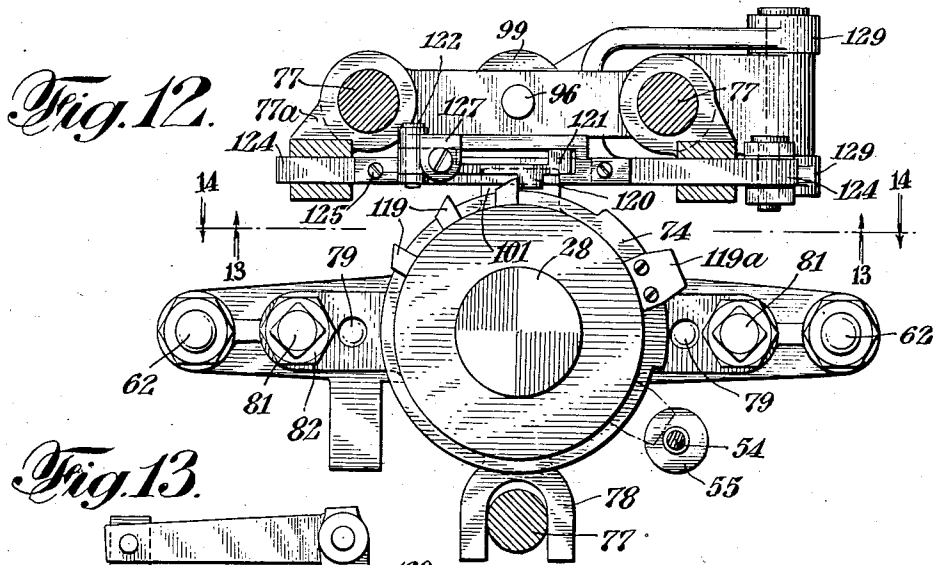
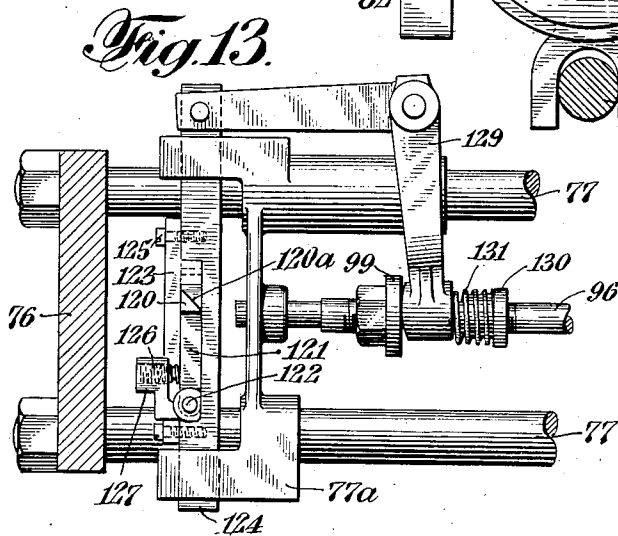
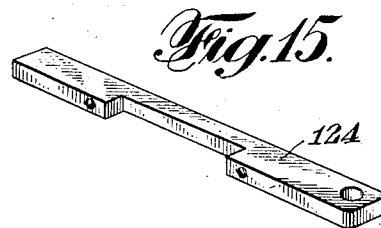
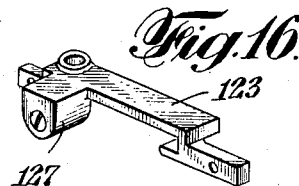
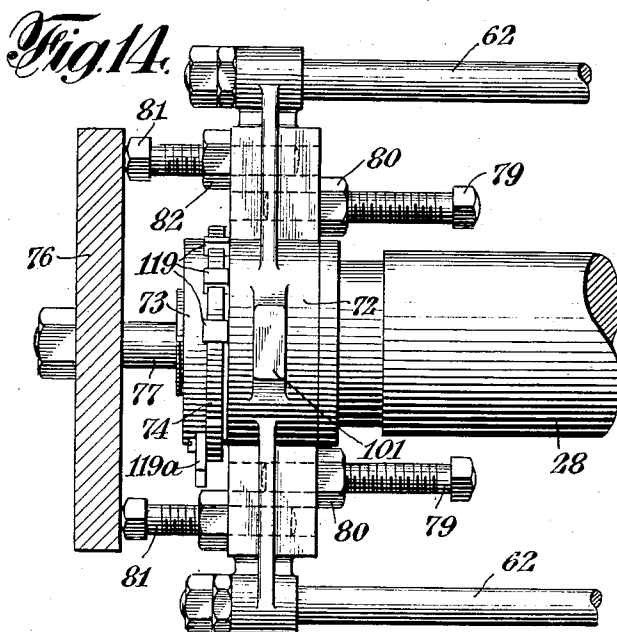
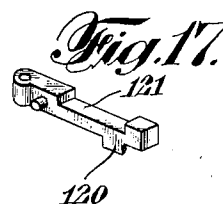
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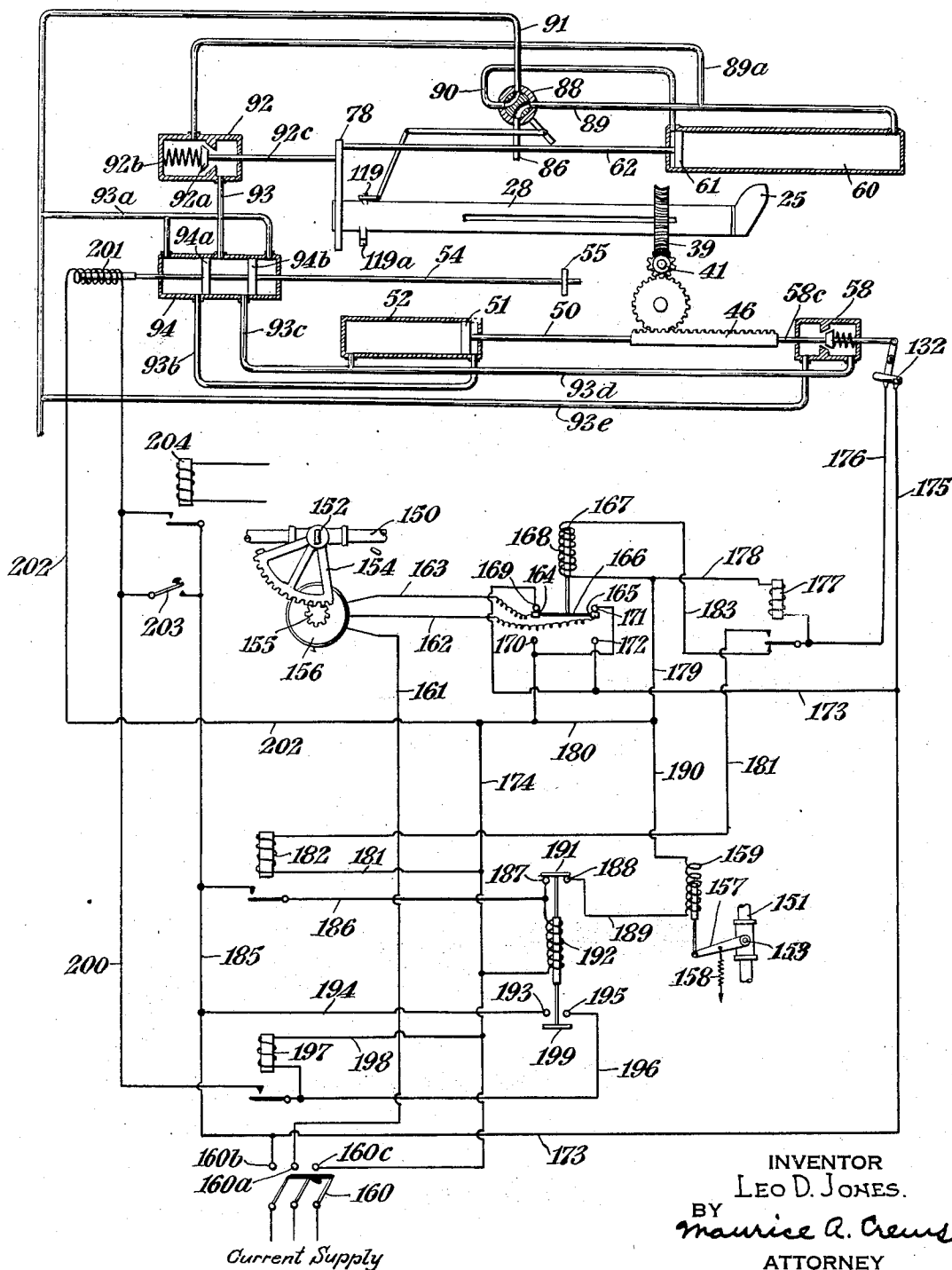
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Fig. 19.



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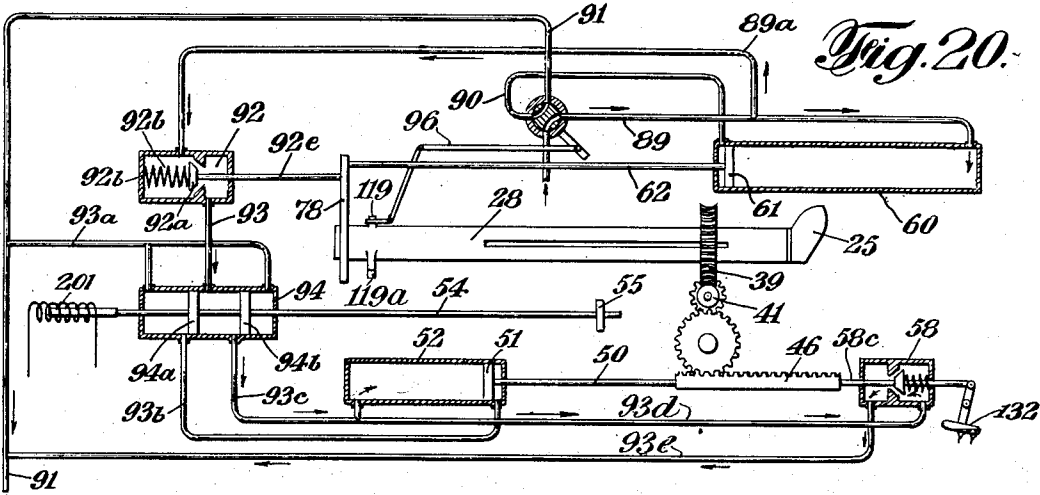
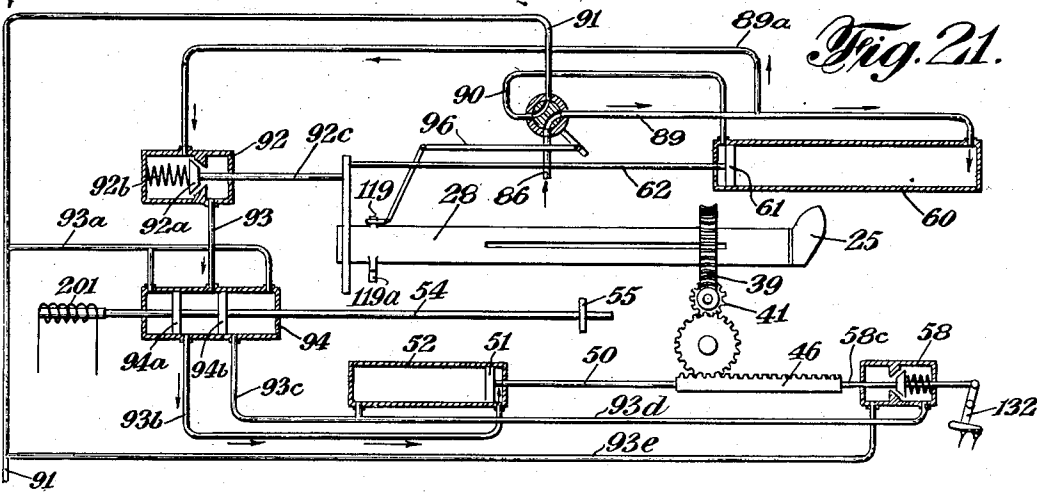
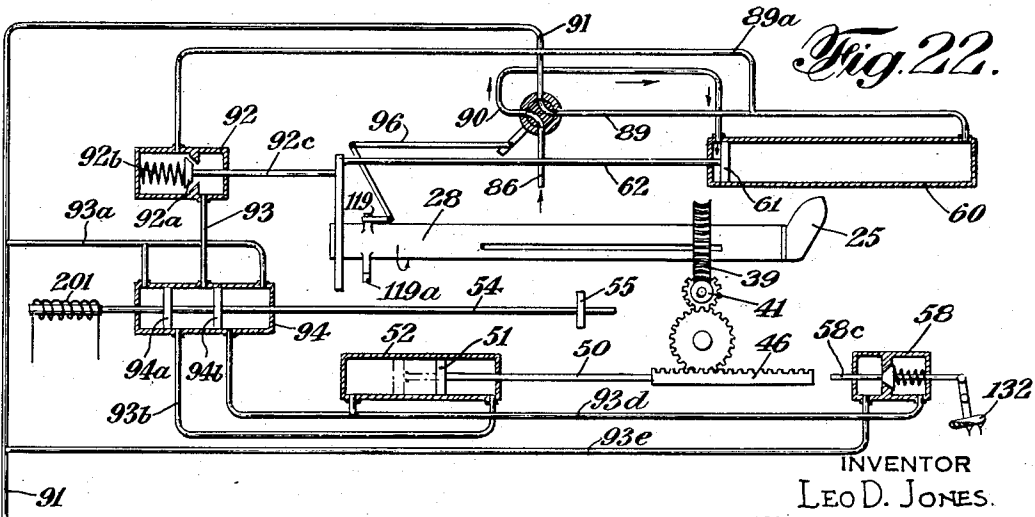
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Fig. 23

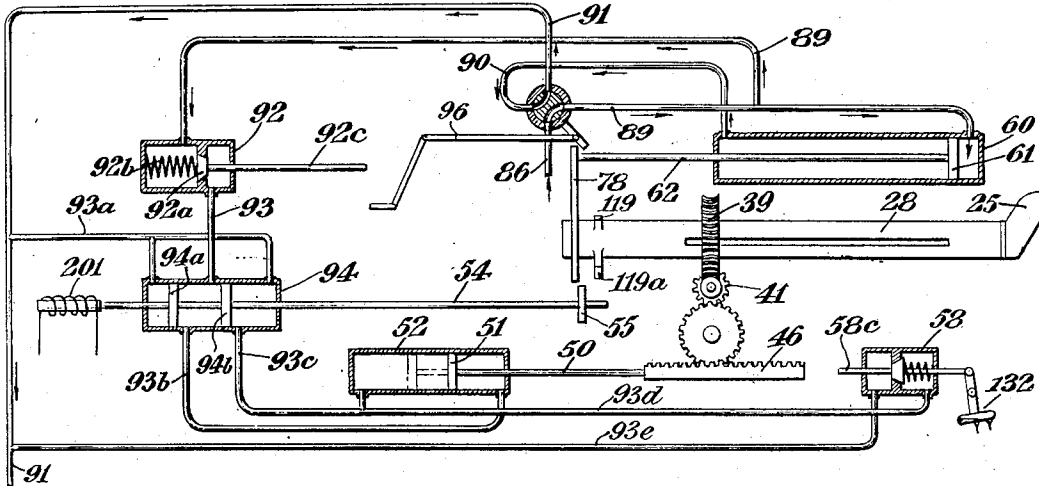


Fig. 24

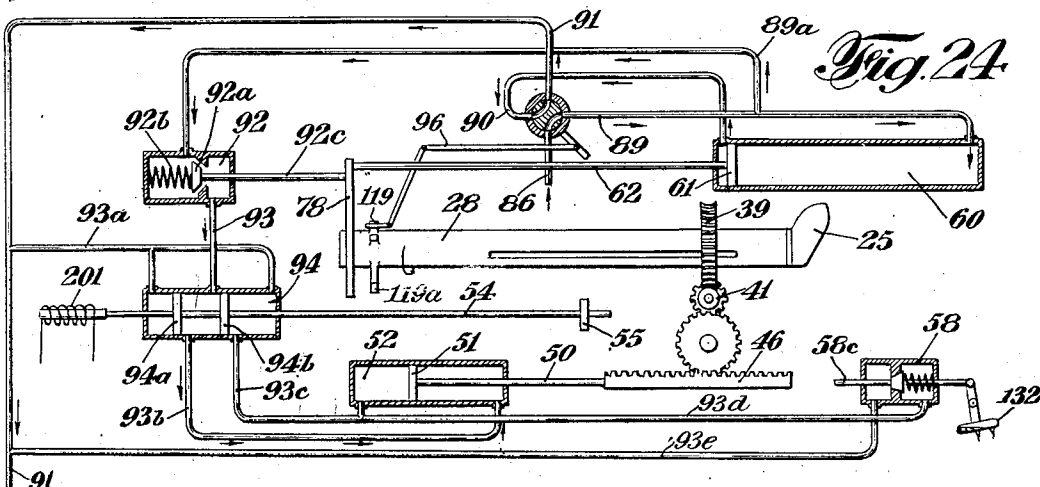
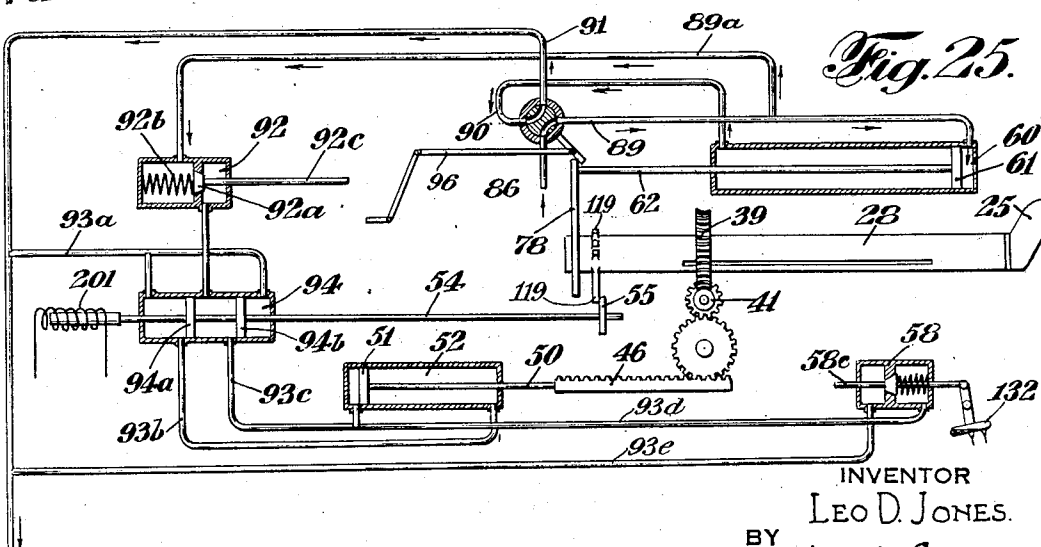


Fig. 25.



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Fig. 26.

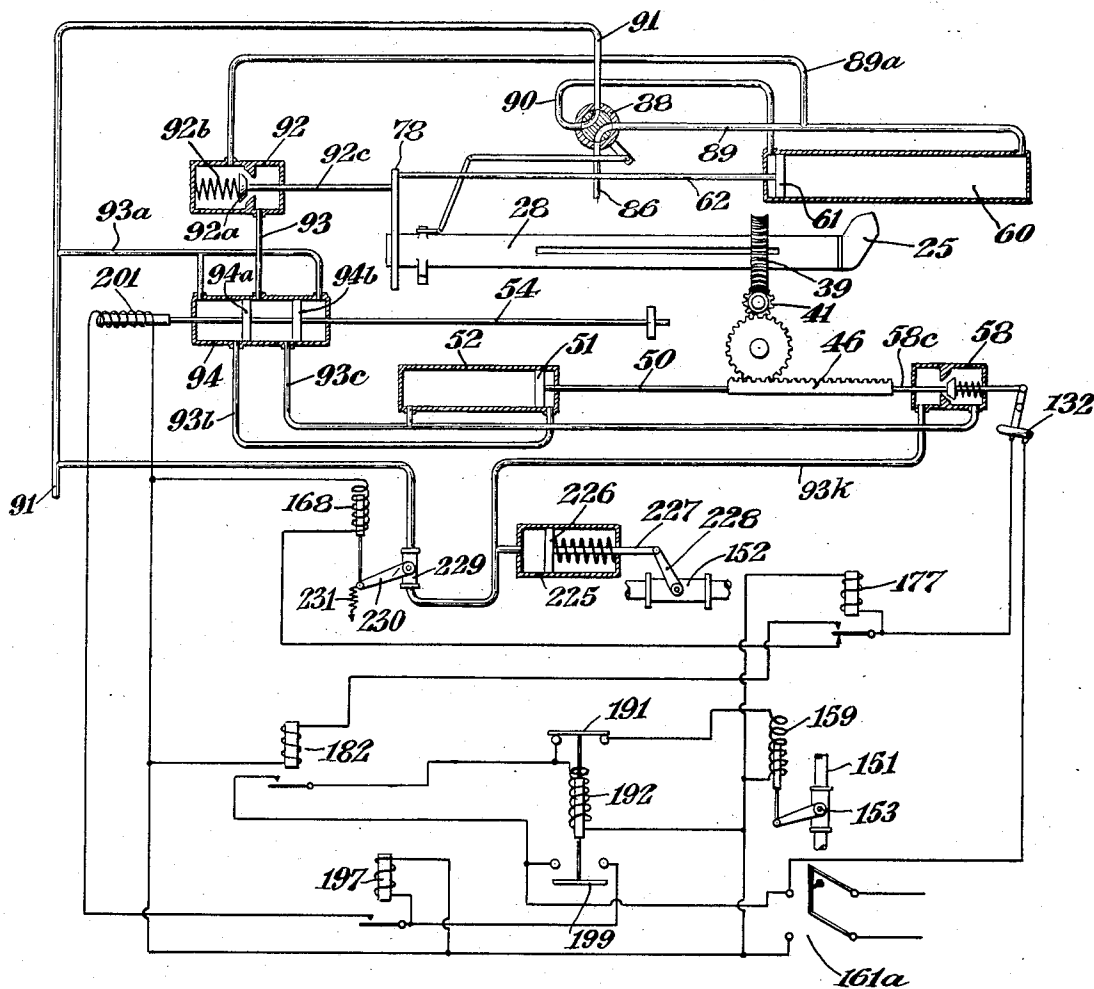
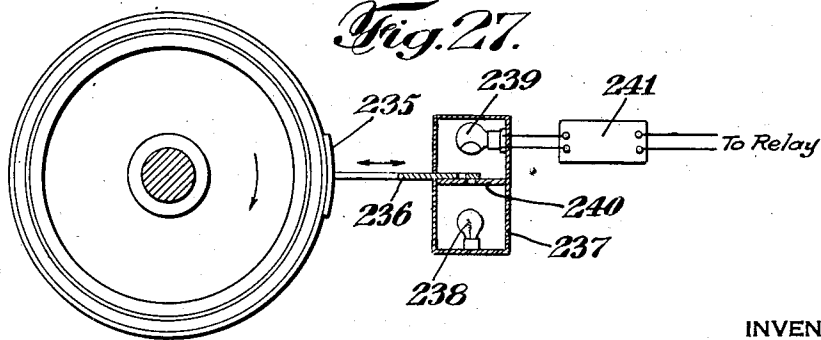


Fig. 27.



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL MACHINE

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Application November 17, 1932, Serial No. 643,022

23 Claims. (Cl. 210—70)

This invention relates to centrifugal machines and particularly to mechanism for dislodging or unloading from the rotor thereof solids collected therein as a result of separating solids from liquids centrifugally.

In the separation of solids from liquids centrifugally the removal from the rotor of the solids from which liquid has been separated, in such a manner that the separating operation may be subject to a minimum interruption is a difficult problem and even though apparatus may be found that is satisfactory with some materials, that apparatus will frequently not be satisfactory with other materials. Efforts have been made to provide apparatus capable of removing solids continuously from centrifugal rotors but such apparatus is subject to similar defects.

It has been proposed to provide a dislodging or cutting tool for removing solids from centrifugal rotors during the rotation thereof, but devices that have been proposed require extensive and careful control by the operator and they are likely to injure the rotor without effecting the desired removal of solids therefrom. It has been proposed to employ a dislodging or cutting tool that is provided with belt driven operating and reversing mechanism, but such devices require considerable skill and attention on the part of the operator. Thus, the inertia of the moving parts frequently carries the tool past the points at which it should come to rest and leads to injury or destruction of the rotor or the tool as a result of unintended and unavoidable contact of these members with each other. This is particularly likely to occur in cases in which the tool is erroneously believed to be acting upon the bowl cake. In other cases, when acting upon cake, the tool movement is not carried far enough and removal of cake is incomplete. Attempts to limit tool movement in such devices by stops may cause either binding or shocks difficult to absorb.

A feature of this invention is that a tool is employed which effects dislodgment of the solids collected in a centrifugal rotor quickly without materially reducing the speed of rotation of the rotor or stopping it, and the tool is provided with operating mechanism whereby it is operated automatically to effect the desired removal of solids from the rotor without danger of injury to the rotor. Thus, features of this invention are that the means for moving the tool is free of inertia that will tend to carry the tool into engagement with the rotor; that the tool is prevented from moving into engagement with the rotor by stops that do not cause binding or wedging when they

come into operation; that the operating mechanism carries the tool back and forth along the cylindrical interior surface of the solids in the rotor and automatically reverses such motion of the tool before it comes into engagement with the rotor; that the depth of cut made by the tool is automatically controlled and the means for adjusting the tool for successive cuts is provided with effective stops that cannot produce wedging or binding; that in the automatic reversal of the motion of the tool, the reversal of the force upon it is full and complete and automatic; that the movement of the tool back and forth across the bed of solids in the rotor is automatically controlled; and that the automatic mechanism can be so controlled as to bring the tool to rest in a desired position at the end of each dislodging operation.

Another feature of this invention is that means are provided for automatically producing the following cycle of operation of the centrifugal:

Liquid mixture is supplied to the centrifugal through a predetermined period and is then shut off; the deposit in the rotor is centrifugally dried for a second predetermined period; wash water is supplied to the centrifugal through a third predetermined period and is then shut off; the deposit is again centrifugally dried through a fourth predetermined period; the dislodging tool is started and caused to operate to remove the deposit from the rotor and its operation is thereafter stopped and liquid mixture is again supplied to the centrifugal to begin another cycle.

A further feature is that means are provided for automatically terminating the supply of liquid mixture and starting the operation of the dislodging tool should unevenness develop in the layer of solids in the separator during the period of supply of liquid mixture thereby causing vibration of the centrifugal.

Other objects, novel features and advantages of this invention will be apparent from the following specification and accompanying drawings, wherein:

Fig. 1 is a view, partly in section, of a centrifugal machine embodying the invention;

Fig. 2 is a plan view of the tool operating mechanism shown in Fig. 1;

Fig. 3 is an enlarged fragmentary view similar to Fig. 1;

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

Fig. 5 is a partial section on the line 5—5 of Fig. 2;

Fig. 6 is a partial section on the line 6—6 of Fig. 4;

Fig. 7 is a partial section on the line 7—7 of Fig. 2;

Fig. 8 is an enlarged section on the line 8—8 of Fig. 2;

Fig. 9 is an enlarged section on the line 9—9 of Fig. 2;

Fig. 10 is an enlarged section on the line 10—10 of Fig. 3;

Fig. 11 is a section on the line 11—11 of Fig. 10;

Fig. 12 is a section on the line 12—12 of Fig. 2;

Fig. 13 is a section on the line 13—13 of Fig. 12;

Fig. 14 is a section on the line 14—14 of Fig. 12;

Figs. 15, 16 and 17 are perspective views of individual parts;

Fig. 18 is a piping diagram;

Fig. 19 is a combined piping and wiring diagram;

Figs. 20, 21, 22, 23, 24 and 25 are diagrammatic views of successive steps in the cycle of operation of the machine;

Fig. 26 is a combined piping and wiring diagram of a modified form of the invention; and

Fig. 27 is a diagrammatic section of a control member.

While apparatus embodying my invention is subject to various modifications the following detailed description of the embodiment shown in the drawings will assist in an understanding of the invention and additional features will appear therefrom.

A centrifugal rotor 10, comprising a wall 11, which may be of cylindrical or other suitable form and which may be perforated or impermeable, an end wall 12 provided with an opening 13 and an end wall 14, is mounted upon shaft 15 carried in bearings 16 and 17 which are supported by a housing 18 which encloses the rotor. The shaft, and the attached rotor may be rotated in any suitable manner as by a pulley 19. In case the rotor is perforated, liquid separated centrifugally from the solids is collected in the housing 18 and withdrawn therefrom through outlet 20. The mixture which is to be separated is supplied in any suitable manner to the rotor 10 as by means of pipe 21 having discharge holes 22. After a cake of solids of suitable radial depth is formed in the rotor by straining or by sedimentation or by both such operations, and after supply of mixture to the rotor is discontinued, and after any time interval that may be desirable to effect further separation of liquid from the solids, the solids are dislodged from the rotor as hereinafter described during the rotation of the rotor, and the dislodged solids fall into a hopper, the position of which is generally indicated by the lines 23, the hopper extending through a suitable opening in casing 18 and having an outlet 24 for the solids.

The means for supporting and moving the dislodging or cutting tool 25 may be mounted in any manner, in proper relation to rotor 11, as by bolting the flange or base plate 26 thereof in position over the opening 27 in the housing 18. Tool 25 is attached to and supported by the tool-operating bar or member 28 and this member is mounted for reciprocation and rotation in bearings 29 and 30 carried by a frame 31 which is connected to the flange or base plate 26. Bearing 30 is provided at the end thereof adjacent the rotor with a stuffing box that prevents entrance into the bearing of foreign materials such as liquids and solids introduced into rotor 11, said stuffing box comprising packing 311 that is compressed by compression member 32 upon tightening of bolts 33. Between bearings 29 and 30 the frame 31 is

spaced from bar 28 to provide a space 34 around bar 28. It is also provided with openings 34a communicating with this space, through which foreign material entering bearing 30 is discharged, in order that it may not enter bearing 29. In the construction shown, frame 31 is provided with a third bearing 35 for bar 28.

In the construction shown in the drawings the cutting edge of tool 25 is moved from and toward the inner surface of rotor 11 by rotation of bar 28. During the formation of a cake of solids in the rotor, tool 25 is maintained, by suitable rotation of bar 28, in a position in which it will not engage the surface of the cake. After a cake of sufficient depth has been formed bar 28 is rotated, to carry the cutting edge of the tool toward the inner surface of rotor 11. For this purpose bar 28 is provided with a keyway 37 in which a key 38 is fitted, this key being connected to worm-wheel 39 housed in frame 31 between bearings 29 and 35. Shaft 41 is mounted in frame 31 for rotation and carries a worm 40 engaging worm-wheel 39. Shaft 41 is also provided with gear 42 which is engaged by gear 43 mounted on shaft 44 to which is secured gear 45 which in turn engages rack 46. Rack 46 slides within auxiliary housing 310 and rod 50 is secured to rack 46. The rod 50 passes through one end of auxiliary housing 310 and carries on its end a piston 51 that is located within hydraulic cylinder 52.

The cylinder 52 is supported by the plate 76, later to be described, and is provided with heads 52a having ports through which liquid is supplied to and discharged from the ends of the cylinder. The extent of reciprocation of the rack 46 and consequently the extent of rotation of the bar 28 is limited by adjustable stops 47 and 48 carried respectively by the auxiliary casing 310 and one head 52a of the cylinder 52 which stops are arranged to be engaged respectively by the rack 46 and the piston 51. Liquid under pressure is supplied to the cylinder 52 by means later to be described for causing reciprocation of the piston 51 to effect rotation of the bar 28 through the gears previously described.

For the purpose of carrying cutting tool 25 back and forth across the cake in rotor 11 in a direction parallel to the axis of the rotor, hydraulic means is provided. In the construction shown this means comprises hydraulic cylinders 59 and 60 within which are located pistons 61 provided with piston rods 62 which extend through stuffing boxes 63. In the construction shown, cylinders 59 and 60 are respectively provided with heads 64 that abut against flange or plate 26 of frame 31 and heads 65 that carry stuffing boxes 63. Heads 65 are provided with ears 66 which are attached by means of bolts 67 to portions of frame 31. To assist in holding cylinders 59 and 60 in position and to hold the heads on the cylinder walls, long bolts 68 pass through cylinder heads 65 and through cylinder heads 64 and are threaded into flange or base plate 26.

Tool-operating bar 28 is formed with a portion 69 that is of reduced diameter and a bushing 70 fits thereon and rests against the resulting shoulder and is prevented from rotating on bar 28 by pin 71. Yoke 72 is provided with an opening within which bushing 70 rotates, and nut 73 acts to hold yoke 72 in place on bushing 70. A plate 74 lies between nut 73 and yoke 72 and has a tongue extending into slot 75 in bar 28 so that rotation of bar 28 will not cause unscrew-

ing of nut 73. The outer ends of piston rods 62 are secured in yoke 72 as shown in Fig. 2 and motion of pistons 61 is thereby imparted to rod 28 to effect movement of the tool across the face of the cake in rotor 11. Plate 76, which is triangular in the construction shown is held in fixed position with respect to frame 31 by being bolted to the three rods 77 that are threaded into frame 31. As shown in Fig. 4, yoke 72 is provided with a downward extension 78 having an opening that accommodates the lowermost of rods 77, yoke 72 being thereby held against rotation in the event that rotation of bar 28 tends to cause rotation of yoke 72.

Stop bolts 79 (Fig. 14) are carried by yoke 72 and their inner ends engage the end of casting 31 to limit the movement of bar 28 into the rotor (to the right in Fig. 4). These bolts are threaded into yoke 72 in order that their position thereon may be adjusted, and are held in adjusted position with respect to bar 28 by lock nuts 80. Stop bolts 81 are carried by yoke 72 and their outer ends engage plate 76 to limit the outward movement of bar 28 (movement of bar 28 to the left in Fig. 4) the bolts being threaded into yoke 72 for adjustment and being held in adjusted position by lock nuts 82.

From the foregoing it will be apparent that by admitting liquid under pressure alternately to opposite ends of cylinders 59 and 60, tool 25 will be moved back and forth across the cake in rotor 11, and that the engagement of stops 79 with casting 31 will adjustably limit the extent of such movement in one direction while engagement of stops 81 with plate 76 will adjustably limit that movement in the other direction, and that bar 28 may be rotated to adjust the distance of the cutting edge of the tool from the inner surface of the rotor without imparting rotation to any part of the hydraulic tool-reciprocating mechanism. Worm-wheel 39, which rotates bar 28, is so located intermediate the ends of bar 28 that keyway 37 never passes within or through packing 311 or into a position in which material treated in the rotor might lodge within that keyway.

Mechanism is provided whereby predetermined reciprocation or rotation of tool-bar 28 will cause a discontinuance of supply of liquid under pressure causing the motion toward the end of any cylinder and initiation of such supply to any other end of one of the cylinders, and cause a corresponding motion of the tool-bar 28 according to the particular step in the cycle. And, such mechanism effects a complete and rapid change, the supply to any end of the cylinders being suddenly and completely discontinued and motion promptly halted.

The circulating system for the operating liquid is shown in Fig. 18. A supply of liquid, preferably oil, is maintained in tank 83, and pump 84 driven by motor 85 delivers the liquid under pressure into supply pipe 86 which delivers the liquid under pressure to four-way-valve 88. From four-way-valve 88, pipes 89 communicate with one end of cylinders 59 and 60 and pipes 90 communicate with the other end of those cylinders and pipe 91 leads back to supply tank 83. Liquid supplied under pressure by pump 84 that is in excess of that required for proper operation is returned to tank 83 by pipe 87 in which pressure relief valve 87a is positioned. From the pipes 89, a pipe 89a leads to a valve 92 comprising a casing having inlet and outlet chambers connected by a port formed with a seat for

a valve head 92a which is maintained on its seat by spring 92b. The valve head 92a is provided with a stem 92c which projects beyond the casing and is provided with an adjustable thimble 92d. The valve is supported by the plate 76 and the thimble 92d is arranged to be engaged by the yoke 72. A pipe 93 leads from the valve 92 to a valve 94 having three outlets from which lead pipes 93a, 93b and 93c. The valve 94 is supported by the plate 76 and comprises a casing having a central cylindrical chamber 94a in which is provided a reciprocating piston 94b (Fig. 8). A conduit 94c connects the ends of the cylinders with the discharge port 94e connected with pipe 93a. The pipe 93 communicates with the inlet port 94f which in turn communicates with the central portion of the cylinder 94a. The outlet ports 94g and 94h communicate with pipes 93b and 93c and also communicate with the chamber 94a. The piston 94b is recessed centrally so that in one position it provides communication between the inlet port and one outlet port and in another position provides communication between the inlet port and the other outlet port. When either outlet port is in communication with the inlet port, the other outlet port is in communication with the conduit 94c.

A rod 53 is connected at one end to the piston 94b and at the other end to the armature of a solenoid 201. A second rod 54 is connected at the other end to this piston and extends parallel to the bar 28 and has its other end supported by frame 31. A collar 55 is adjustably mounted on the rod 54 and is adapted to be engaged by a lug 119a later to be described and carried by the bar 28. A spring actuated latch member 56 cooperates with the free end of the rod 54 to hold the piston 94b in either of its two positions.

The pipe 93a leads to the discharge pipe 91 and the pipe 93b leads to the right hand head 52a of the cylinder 52. The pipe 93c leads to the left hand head 52a of the cylinder 52 and a branch 93d leads to a valve 58 supported by the auxiliary casing 310. The valve 58 comprises a casing having inlet and outlet chambers connected by a port formed with a seat for a valve head 58a which is maintained on its seat by spring 58b. The valve head 58a is provided with a stem 58c which projects beyond the casing. A pipe 93e leads from the valve 58 to the discharge pipe 91.

The internal construction of valve 88 appears in Fig. 5. Provided valve 92 is closed when movable member 95 of valve 88 is in the position shown in Fig. 5, liquid under pressure will pass from pipe 86 through passage 96 into pipes 89 and to the right hand ends of cylinders 59 and 60 and liquid will escape from the left hand ends of those cylinders through pipes 90 and through passage 97 of movable member 95 into return pipe 91. Shifting of movable member 95 counterclockwise until passage 96 leads from pipes 89 to return pipe 91 and passage 97 leads from supply pipe 86 to pipes 90 will cause liquid under pressure to be supplied to the left-hand ends of those cylinders and permit liquid to be discharged from the right-hand end of those cylinders into return pipe 91. Automatic mechanism is hereinafter described for effecting movement of movable member 95 back and forth from one of the adjustments above described to the other.

The automatic reversing mechanism comprises rod 96', (Fig. 4) one end of which is supported for sliding in a frame 77a supported by two of

the rods 77 and the other end of which is supported by a pivot on rocker arm 97 which is pivoted to bracket 98 carried by frame 31. Contact collars 99 are threaded upon rod 96 in order that their position thereon may be adjusted. Pivoted to the opposite end of rocker arm 97 is link 102 that is pivotally connected to one end of valve-operating bar 103 supported for sliding in auxiliary frame 104 that is mounted upon frame 31. Movable member 95 of four-way-valve 88 is attached to shaft 105 to which is secured arm 106 carrying roller 107. Rod 103 is provided with arms 108 and 109 for cooperating with roller 107 to swing arm 106 and rotate movable member 95 of valve 88. Rod 103 is provided with a projection 110 which cooperates with a projection 111 on lever 112 that is pivoted at 113 and pressed upwardly by spring 114. These parts are shown in Figs. 1 and 4 in the position in which they lie when tool 25 is at rest and valve 88 is in the setting shown in Fig. 5. Arm 106 is provided with an extension 116 that engages cushioning stops at the limiting positions of arm 106. These stops may be of any suitable construction but are shown in the drawings simply as lugs 117 in which are adjustably threaded the screws 118 that engage extension 116.

The ring 74 (Fig. 12) is provided with a plurality of similar lugs 119 and is also provided with a lug 119a. The lugs 119 are adapted to engage a lug 120 extending downwardly from an arm 121 which is pivoted at one end by a pin 122 to a member 123 which in turn is attached to a bar 124 by bolts 125. A spring 126 contained within a housing 127 on the member 123 tends to maintain the arm 121 in the position shown in Fig. 13 with the lug 120 in the path of lugs 119. The bar 124 is slidably supported by frame 77a and is attached at one end to one arm of a bell crank lever 129 also supported by the frame. The other end of the bell crank lever 129 is forked and surrounds the bar 96'. The left-hand collar 99 on the bar 96 is arranged to be engaged by the forked arm of the bell crank lever and an additional collar 130 and spring 131 are provided to take up slack motion.

Clockwise rotation of the bar 28 and ring 74 from the position shown in Fig. 12 causes the first lug 119 to pull the arm 121 to the right, thereby sliding bar 124 to the right to turn bell crank lever 129 and move the rod 96 to the left from the position shown in Fig. 4. Such movement of the bar 96 causes bar 103 to move to the right until the apex of projection 110 snaps over the apex of projection 111 and then a quick and complete movement of the rod 103 to the right occurs as projection 110 rides down the right hand slope of projection 111 due to the action of the spring 114 and the engagement of the arm 108 with roller 107 causes valve member 95 to be given a quick and complete counter-clockwise movement from the position shown in Fig. 5, to put the supply pipe 86 into communication with the pipe 89. Thereupon oil is caused to flow into the left hand ends of the cylinder 60 to move the bar 28 to the right. As the bar 28 approaches the limit of its movement to the right, lug 101 will engage stop 99 at the right hand of bar 96' and cause bar 103 to move to the left back into the position shown in Fig. 4, thereby returning the valve 88 to the position shown in Fig. 5. Thereupon, the valve 92 being closed and the valve 94 properly set, oil will be supplied to the right hand end of the cylinder 60 and the bar

28 will be returned to the position shown in Fig. 4. When the bar 28 is returned to the position shown in Fig. 4, the bar 28 is again rotated sufficiently to cause the next lug 119 to again actuate the valve reversing mechanism and the above described cycle is repeated. Rotation of the bar 28 is effected by movement of the rack 46 through the medium of gears 41, 42, 43 and 45, the rack 46 being actuated by the piston 51 which in turn is actuated by oil supplied to the cylinder 52, the supply of oil being controlled by the valve 92 which is opened by the bar 28 when returned to the position shown in Fig. 4. The bar 28 is thus caused to reciprocate and prior to each stroke the bar is rotated slightly to advance the cutting edge of the tool 25 toward the rotor. Continued rotation of the bar 28 brings the lug 119a into alignment with the stop collar 55 mounted on the connecting rod 54. Engagement of the lug 119a with the collar 55 operates the valve 94 and causes reverse rotation of the bar, when it has returned to position shown in Fig. 4, to move the cutting edge of the tool 25 away from the rotor. The lug 120 is provided with a cam face 120a which is engaged by the lugs 119 upon counterclockwise rotation of the bar 28. When the lugs engage the face 120a the arm 121 swings outwardly to permit the lugs to pass.

A mercoid switch 132 is contained within a housing 133 supported by the valve 58 (see Fig. 10). The switch is carried by a rotatable member 134 provided with a shaft 135 mounted in a wall of the housing 133. An arm 136 is attached to the shaft 135 and at its outer end is connected to the end of a plunger 137 around which is arranged a spring 137a for moving plunger to the right. The other end of the plunger is engaged by an adjustable push rod 138a connected to a lever 138 pivotally supported by a bracket attached to the valve 58. A bolt 139 is threaded through the lever 138 and is adapted to engage the end of stem 58c of the valve 58. A lock nut 140 is provided to hold the bolt 139 in adjusted position. A rod 141 is slidably mounted in the stop bolt 47 and projects into the casing 310 into position to be engaged by the end of rack 46. The rod 141 projects through an eye 142 in the lever 138 and is provided with a collar 143 threaded thereon. The collar 143 is adjustable on the rod 141 and a lock nut 144 is provided for holding the collar 143 in adjusted position. Movement of the rod 141 to the right causes the lever 138 to swing, thereby opening the valve 58 and rotating the mercoid switch from the position shown in Fig. 11 in which the switch is open to a position in which the switch is closed.

A supply pipe 150 for the mixture to be separated and a water supply pipe 151 communicate with the pipe 21. The pipe 150 is controlled by a valve 152 and the pipe 151 is controlled by a valve 153. The valve 152 is provided with a quadrant 154 which meshes with a pinion 155 mounted on the shaft of a torque motor 156. The valve 153 is provided with an arm 157 which is connected by suitable linkage with the armature of a solenoid 159. A spring 158 tends to hold the valve in closed position.

The torque motor 156 is connected with a three phase power line through a switch 160. The wire 161 leads directly from the motor to one terminal 160a of the switch 160. The wires 162 and 163 lead from the motor to contacts 164 and 165 at the end of an insulated bar 166 supported by the armature 167 of a solenoid 68. The contacts 164 and 165 are adapted to engage respectively either

rack 46 to the left also actuates gears 45, 43, 42 and 41 to rotate the bar 28 to bring the tool 25 into cutting position. Rotation of the bar 28 causes the first lug 119 to move the bar 124 thereby actuating the bell crank lever 129 to pull the rod 96 to the left and actuate valve 88 to turn the same into position in which the pipe 86 is connected to the pipe 90 and shutting off flow to cylinder 52 to stop rotation of bar 28. Oil thereupon flows into the left hand end of the cylinder 60 and causes the piston 61 to move to the right, thereby moving the bar 28 into the rotor. The oil from cylinder 60 discharges through pipe 89 and valve 88, into pipe 91. As the bar 28 moves inwardly the plate 78 moves out of engagement with the thimble 93c, thereby permitting valve 92 to close (Fig. 23), to prevent flow to cylinder 52. As the bar 28 reaches the limit of its stroke the lug 101 engages the right hand collar 99 to move the rod 96' to the right, thereby tripping the actuating mechanism of valve 88 and returning the same to the position in which the pipe 86 communicates with a pipe 89 (Fig. 23). As the valve 92 is now closed oil passes through the pipe 89 into the right hand end of the cylinder 60 and moves the piston 61 to the left. Oil is discharged from the left hand end of the cylinder 60 through the pipe 90 and valve 86 into the discharge pipe 91. When the bar 88 approaches the left hand end of its stroke the plate 78 again engages the stem of valve 92, thereby opening the same and permitting oil to flow through the valve 92, pipe 93, valve 94, pipe 93b and into the right hand end of cylinder 50, thereby moving the piston 51 further to the left. Movement of the piston causes further rotation of the bar 28 and the engagement of the second lug 119 with the lug 120 to slide the bar 128 thereby again actuating bell crank lever 129 and rod 96 to reverse the position of valve 88 and repeat the cycle just outlined. The third actuation of the piston 51 brings it to the limit of its movement and the third rotational step of the bar 28 brings the lug 119a into position to engage the collar 55 on rod 54 on its next movement to the right (Fig. 25). Engagement of the lug 119a with the collar 55 returns the piston to the position shown in Fig. 25. On the next return of the bar 28 to its left hand position the valve 92 is again opened and oil will now flow through this valve, pipe 93, valve 94 and into the left hand end of cylinder 50, thereby forcing the piston 51 to the right. The rack 46 moves to the right with the piston and causes reverse rotation of the bar to its original position, opens valve 58 and actuates mercoird switch 132 to close the same. Actuation of the mercoird switch 132 closes the circuits through the solenoid 168 and the relay 177, thereby energizing the torque motor 156 to again open the valve 152 from which point the cycle above described will be repeated.

The operation of the machine thus involves the initial opening of the valve 152 by the energization of the motor 156 through the contacts 164, 165 to admit the feed of liquid mixture to the bowl through the openings 22 in the feed pipe 21. After this feed has continued for a suitable period, the armature of the relay 177 will be actuated and the valve 152 will be moved to closed position. A drying period now ensues during the continued rotation of the rotor and at the end of such drying period the slow-acting relay 182 effects a movement of its armature and an opening of the valve 153 to admit wash water to the cylinder. The feed of water through

this valve is maintained until the armature of slow-acting relay 192 has disengaged the bridge 191 from contacts 187 to permit the return of valve 153 to closed position. The washed cake is then dried during the lag incident to the operation of slow-acting relay 197. The operation of relay 197 energizes the solenoid 201 to move the piston 94b, 94a into the left hand position, in which communication is established between pipe 93 and the right hand end of cylinder 52 to move piston 51 to the left as indicated in full lines in Figure 22.

Movement of the piston 51 in this manner causes a partial rotation of the tool 25. Such movement also permits closure of the valve 58 and actuates switch 132 to open the circuit including relay 177 to permit successive de-energizing of solenoids 182, 192, 197 and 201 and opening of circuits controlled thereby. Rotation of bar 28 also operates through the first lug 119, bar 124 and bell-crank 129 to turn the valve 88 into a position in which fluid is admitted to the left hand end of cylinder 60, as illustrated in Fig. 23. As the bar 28 moves inwardly, the plate 78 allows valve 92 to close, thereby precluding further flow of motive fluid to the right hand end of cylinder 52 and limiting the stroke of piston 51 to the full line position of Fig. 22.

At the end of the inward stroke of the tool the lug 101, (Fig. 4), trips the actuating mechanism of the valve 88 to reverse its position and effect a return stroke of the bar 28. As this bar returns it again opens the valve 92 by reason of the abutment of plate 78 thereagainst, allowing fluid to be again admitted to the right hand end of cylinder 52. Further rotation of bar 28 incident to such movement operates through the second lug 119 to again reverse the valve 88 and a second forward stroke of the tool ensues. A third stroke is also initiated as above described. The third movement of bar 28 to the right causes abutment of lug 119a with collar 55, thereby reversing the position of the valve 94 and allowing oil to be admitted to the left hand end of cylinder 50 to move the piston 51 to the right to return the tool 25 to its original angular position, upon the completion of its reciprocating stroke to the left and the consequent opening of the valve 92. The switch 132 is also moved to closed position by means of the rack 46 which is moved to the right by such movement, and the cycle is thereupon repeated.

In Fig. 26 a modified form of the control mechanism is disclosed. In this modification the valve 152 is actuated hydraulically instead of electrically. The outlet from valve 58 is connected by pipe 93k with one end of a cylinder 225 in which is mounted a spring pressed piston 226 which is connected by a link 227 with the actuating arm 228 of the valve 152. The pipe 93k communicates through a valve 229 with the discharge pipe 91. The valve 229 has an operating handle 230 which is connected to the armature of solenoid 168. Upon closure of the switch 161a, a circuit is closed through solenoid 168 which is energized to close valve 229 thereby causing oil to flow into the cylinder 225 under pressure, force back the piston 226 and open the valve 152. After a predetermined period of time the slow operating relay 177 actuates its armature to break the circuit through the solenoid 168 and permit the spring 231 to return the arm 230 to valve open position, thereby permitting oil in the valve to escape and the spring to return the piston to original position, thereby closing the valve 150. From this point on the

the contacts 169 and 171 or the contacts 170 and 172. Contacts 169 and 172 are connected through wire 173 with the terminal 160b of the switch 160 and contacts 170 and 171 are connected by wire 174 with the terminal 160c of the switch. One terminal of the mercoird switch 132 is connected through the wire 175 with the wire 173 and its other terminal is connected through the wire 176 with the armature and winding of a slow acting relay 177 which is connected through wires 178, 179 and 180 with wire 174. The inner contact for the armature of relay 177 is connected by wire 181 through the field winding of relay 182 with wire 174. The outer contact of relay 177 is connected by wire 183 through the field winding of solenoid 167 with wire 179. Terminal of switch 160b is connected by wire 185 with the contacts of relay 182. The armature of relay 182 is connected by wire 186 with a contact 187. A contact 188 is connected by wire 189 with the field winding of the solenoid 159 which in turn is connected by wire 190 with wire 180. The contacts 187 and 188 are bridged by a conductor 191 carried by the armature of a solenoid 192, the field winding of which is connected to the wire 186 and also to the wire 174. A contact 193 is connected by a wire 194 with the wire 185 and a contact 195 is connected by wire 196 with the armature and field winding of a relay 197, the field winding being connected by a wire 198 with the wire 174. A conductor 199 carried by the armature of the solenoid 192 is adapted to bridge the contacts 193 and 195. The contact of relay 197 is connected by wire 200 with the field winding of solenoid 201 which in turn is connected by wire 202 with wire 174. A manually operable switch 203 is provided between wire 185 and wire 200. The armature of a relay 204 is connected to the wire 185 and the contact for this relay is connected to the wire 200. The field winding of the relay 204 is connected through relays not shown with the photo-electric cell 205 shown in Fig. 27.

Figs. 1 to 17 show the above described apparatus at rest, the bar 28 being arranged in the position shown in Fig. 4, the valve 88 being in the position shown in Fig. 5, the valves 150 and 151 being closed, the switch 160 being open and the various switches, relays of the electric circuit and the valves of the oil circuit being in the positions shown in Fig. 19.

With the rotor of the separator operating at proper speed the switch 160 is closed to start the cycle of operations of the device. The movable contacts 164 and 165 being in engagement with the stationary contacts 170 and 172, current is supplied to the torque motor in such way as to tend to move the valve 152 into closed position but as the valve is already closed there is no change in the position thereof. Current passes through the mercoird switch 132, the armature and outer contact of relay 177, and field winding of solenoid 167. Energization of the solenoid causes actuation of its armature to lift contacts 164 and 165 away from contacts 170 and 172 and bring contacts 164 and 165 into engagement with contacts 169 and 171. Thereupon, the motor 156 is oppositely energized and turns the valve 150 into open position, thereby permitting flow of liquid mixture through the pipe 21 into the rotor of the separator. Simultaneously with the closing of the circuit just described a second circuit is closed through the field winding of relay 177. The relay 177 is slow acting and is so timed that after a predetermined period it moves its armature out of engagement with the outer contact and into

engagement with the inner contact, thus opening the circuit through the field winding of solenoid 167 and closing another circuit through field winding of solenoid 182. The solenoid 167 is thereby de-energized and its armature drops down to return the contacts 164 and 165 into engagement with contacts 170 and 172, thereupon the motor 156 is reversed to close the valve 152. The relay 182 is slow acting and is so timed that it does not actuate its armature for a predetermined period, during which period the cake deposited on the interior of the rotor is dried. Engagement of the armature of relay 182 with its contact closes a circuit through contact 187, bridge 191, contact 188 and field winding of solenoid 159. The solenoid 159 is thereby energized and its armature is pulled against the action of the spring 158 to open valve 153, thereby supplying wash water through the pipe 21 to the rotor. Also a circuit is simultaneously closed through the field winding of solenoid 192. The solenoid 192 is slow acting and is properly timed to operate after a predetermined period, during which the wash water is supplied to the rotor. Lifting of the armature of relay 192 disengages the bridge 191 from the contacts 187 and 188 thereby opening the circuit through the solenoid 159 to de-energize the same and permit the spring 158 to return the valve 153 to closed position. At the same time, the bridge 199 is brought into engagement with the contacts 193 and 195 thereby closing a circuit through the field winding of relay 197. The relay 197 is slow acting and is timed to operate only after a predetermined period during which the washed cake in the rotor is again dried. Lifting of the armature of the relay 197 closes a circuit through the field winding of solenoid 201. Energization of the solenoid 201 causes the same to move its armature to the left, thereby actuating the piston 94b of the valve 94.

Before actuation of the piston 94b, the valve 94 was so set that oil was flowing from pipe 86 through valve 88, pipe 89a, valve 92, pipe 93, valve 94, pipe 93c, valve 58 and pipe 93e to pipe 91, the valve 92 being held open by engagement of the plate 78 with the thimble 92d and the valve 58 being held open by engagement of the rack 46 with the stem 58c (Fig. 20). Energization of the solenoid 201 moves the piston 94b into the position shown in Fig. 21, thus closing off pipes 93c from pipe 93 and putting pipe 93b into communication with pipe 93. Oil thereupon flows into the right hand end of cylinder 52 and moves piston 51 to the left, (Fig. 22), the oil already in the cylinder being discharged, through pipe 93c, valve 94 and pipe 93a into pipe 91. Movement of the piston 51 to the left draws the rack 46 to the left, thereby permitting valve 58 to close and actuating the mercoird switch 132 to open the circuit of which it is a part, thereby de-energizing relay 177 and permitting its armature to move from engagement with the inner contact into engagement with the outer contact, thereby opening the circuit through solenoid 182. De-energization of solenoid 182 permits its armature to become disengaged from its contact, thereby opening the circuit through solenoid 192. De-energization of solenoid 192 permits its armature to drop to disengage the bridge 199 from the contacts 193 and 195, thereby opening the circuit through solenoid 197. De-energization of solenoid 197 permits its armature to move out of engagement with its contact, thereby opening the circuit through solenoid 201 and de-energizing the same. Movement of the 150

operation is identical with the control system previously described.

In Fig. 27 there is disclosed an automatic control for setting in operation the discharging mechanism should the rotor become unbalanced due to an uneven layer of deposit. A plate 236 is linked to the frame of the centrifugal and leads into a housing 237. The housing is mounted on an independent foundation. In one end of the housing there is provided a source of light 238 and in the other end of the housing there is provided a photo-electric cell 239. Between the source 238 and the photo-electric cell 239 there is provided a partition 240 having an aperture. The plate 236 also has an aperture, the arrangement of these apertures being such that normally they are out of register. However, should the centrifugal begin to vibrate due to an unbalanced condition, the plate 236 will be moved sufficiently to bring its aperture into register with the aperture in the partition 240 thereby permitting light to pass from the source 238 to the photo-electric cell 239. The photo-electric cell 239 is connected to a relay 241 which in turn is connected to the field winding of solenoid 204. When light falls on the photo-electric cell 239 the solenoid 204 is energized, thereby causing its armature to be moved into engagement with its contact and closing the circuit through solenoid 201 to set the discharge mechanism in operation.

The switch 203 may be manually operated at any time to set in operation the discharging mechanism. Actuation of this switch closes the circuit through the solenoid 201 to effect actuation of the control member 94b of the valve 94.

Modifications may be obvious to those skilled in the art and I do not therefore wish to be limited except by the scope of my sub-joined claims as interpreted in the light of the generic spirit of my invention.

What I claim is:

1. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, means for effecting reciprocation and rotation of said holder, means controlled by linear and rotary movement of said holder for determining the direction of linear movement, and means actuated by linear movement of said holder for controlling the rotation thereof.

2. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, means for effecting linear and rotary movement of said holder, means actuated by said holder at the end of its inward stroke for reversing its direction of movement, means actuated by said holder at the end of its outward stroke for effecting rotation of said holder, and means actuated by rotation of said holder for reversing the direction of linear movement of said holder.

3. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for effecting reciprocation of said holder, a valve for controlling the direction of linear movement of said holder, means actuated by said holder for effecting rotation thereof at one end of its stroke, means actuated by rotation of said holder to effect actuation of said valve to cause reverse linear movement of said holder and means actuated by said holder at the end of its reverse stroke to reverse said valve.

4. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, means for effecting linear and rotary movement of said holder, means actuated by

said holder at one end of its stroke to reverse the direction of linear movement of the holder, means actuated by said holder at the opposite end of its stroke for effecting rotary movement of said holder, means actuated by rotary movement of said holder for effecting linear movement of the holder in the first direction, and means actuated by said holder after a predetermined number of strokes for rendering inoperative said first named means.

5. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, means for effecting linear and rotary movement of said holder, means actuated by said holder at one end of its stroke to reverse the direction of linear movement of the holder, means actuated by said holder at the opposite end of its stroke for effecting rotary movement of said holder, means actuated by rotary movement of said holder for effecting linear movement of the holder in the first direction, and means for periodically supplying to said rotor a supply of mixture to be treated.

6. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, means for effecting linear and rotary movement of said holder, means actuated by said holder at one end of its stroke to reverse the direction of linear movement of the holder, means actuated by said holder at the opposite end of its stroke for effecting rotary movement of said holder, means actuated by rotary movement of said holder for effecting linear movement of the holder in the first direction, means for supplying liquid to be treated to said rotor periodically and over a predetermined period, and means for subsequently supplying wash water to said rotor after a predetermined interval and for a predetermined period.

7. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for effecting reciprocation of said holder, a valve for controlling the direction of movement of said holder, means controlled by said holder for rotating the same at the outward end of its stroke, means operable by rotation of said holder to actuate said valve to cause inward movement of the holder, and means operable by inward movement of said holder to actuate said valve to cause reverse movement of the holder.

8. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for effecting reciprocation of said holder, a valve for controlling the direction of movement of said holder, hydraulic means for rotating said holder, a second valve for controlling the direction of rotation of said holder, automatic means for actuating said second valve, means actuable by said holder for controlling flow through said second valve, means operable by rotation of said holder to actuate said first valve to cause inward movement of the holder, means operable by inward movement of said holder to actuate said first valve to cause reverse movement of said holder, and means operable by said holder after predetermined rotation thereof for reversing said second valve.

9. In combination, a rotor, a tool holder, hydraulic means for rotating said tool holder and reciprocating the same axially of said rotor, valve means for rendering said hydraulic means operative or inoperative, a pipe extending into said rotor, a valve for connecting said pipe with

- a supply of mixture to be treated, a second valve for connecting said pipe with a supply of wash water, automatic means for opening said first valve and closing the same after a predetermined period, opening said second valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said valve means to render said hydraulic means operative, and means operable by said holder after a predetermined number of strokes for actuating said valve means to render said hydraulic means inoperative.
10. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means operable by reciprocation of said holder for controlling said first hydraulic means, and valve means operable by rotation and reciprocation of said holder for controlling said second hydraulic means.
11. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means for rendering said hydraulic means operative or inoperative, valve means operable by reciprocation of said holder for controlling said first hydraulic means, valve means operable by rotation and reciprocation of said holder for controlling said second hydraulic means, a pipe extending into said rotor, a valve connecting said pipe with a supply of mixture to be treated, a second valve connecting said pipe with a supply of wash water, automatic means for opening the first valve and closing the same after a predetermined period, opening the second valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said first named valve means for rendering said hydraulic means operative.
12. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means for rendering said hydraulic means operative or inoperative, valve means operable by reciprocation of said holder for controlling said first hydraulic means, valve means operable by rotation and reciprocation of said holder for controlling said second hydraulic means, a pipe extending into said rotor, a valve connecting said pipe with a supply of mixture to be treated, a second valve connecting said pipe with a supply of wash water, automatic means for opening the first valve and closing the same after a predetermined period, opening the second valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said first named valve means for rendering said hydraulic means operative, and means operable by said holder after a predetermined number of strokes for actuating said valve means to render said hydraulic means operative.
13. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for reciprocating said holder, a valve for controlling the direction of movement of said holder, hydraulic means for rotating said holder, a second valve for controlling the direction of rotation of said holder, means for actuating said second valve, a third valve actuatable by said holder for controlling flow through said first and second valves, means operable by rotation of said holder to actuate said first valve to cause inward movement of the holder, means operable by inward movement of said holder to actuate said first valve to cause outward movement of said holder, and means operable by said holder after predetermined rotation thereof for reversing said second valve.
14. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for reciprocating said holder, a valve for controlling the direction of movement of said holder, hydraulic means for rotating said holder, a second valve for controlling the direction of rotation of said holder, means for actuating said second valve, a self-closing valve for controlling flow through said first and second valves, means carried by said holder for opening said last named valve at the end of an outward stroke, means operable by rotation of said holder to actuate said first valve to cause inward movement of the holder, means operable by inward movement of said holder to actuate said first valve to cause reverse movement of said holder, and means operable by said holder after predetermined rotation thereof for reversing said second valve.
15. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means controlled by reciprocation and rotation of said holder for determining the direction of reciprocation thereof, valve means for controlling the direction of rotation of said holder, means controlled by said holder for rendering said first hydraulic means operative or inoperative, and valve means actuatable by said holder after a predetermined number of strokes to render said second hydraulic means operative.
16. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, valve means for controlling the direction of rotation, valve means controlled by reciprocation of said holder for rendering both said hydraulic means operative or inoperative, means to actuate said second valve means to produce rotation of said holder in one direction, and means actuatable by said holder after a predetermined number of strokes for reversing said valve means.
17. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, valve means controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, valve means for determining the direction of rotation of said holder, valve means controlled by said holder for alternately rendering each of said hydraulic means operative and the other hydraulic means inoperative, means for actuating said second valve means for causing rotation of said holder in one direction, and means actuated by the holder after a predetermined number of strokes for reversing said second valve means.
18. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially

of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, a valve controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, a second valve for determining the direction of rotation of said holder, a third valve controlled by said holder for preventing flow through either said first or second valve, means for actuating said second valve to cause rotation of said holder in one direction, means actuated by said holder after a predetermined number of strokes for reversing said second valve and a fourth valve controlled by said first hydraulic means for by-passing the actuating fluid around both said hydraulic means.

19. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, a valve controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, a second valve for determining the direction of rotation of said holder, a third valve controlled by said holder for preventing flow through either said first or second valve, means actuated by said holder after a predetermined number of strokes for reversing said second valve, a fourth valve controlled by said first hydraulic means for by-passing the actuating fluid around both said hydraulic means, a pipe extending into said rotor, a fifth valve connecting said pipe with a supply of mixture to be treated, a sixth valve connecting said pipe with a supply of wash water, and automatic means for opening said fifth valve and closing the same after a predetermined period, opening the sixth valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said second valve to cause rotation of said holder from a position of rest.

20. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, a valve controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, a second valve for determining the direction of rotation of said holder, a third valve controlled by said holder for preventing flow through either said first or second valve, means actuated by said holder after a predetermined number of strokes for reversing said second valve, a fourth valve controlled by said first hydraulic means for by-passing the actuating fluid around both said hydraulic means, a pipe extending into said rotor, a fifth valve connecting said pipe with a supply of mixture to be treated, a sixth valve connecting said pipe with a supply of wash-water, automatic means for opening said fifth valve and closing the same after a predetermined period, opening the sixth valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said second valve to cause rotation of said holder from a position of rest, and means responsive to vibration of said rotor for actuating said second valve.

21. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said

holder, hydraulic means for reciprocating said holder, a valve controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, a second valve for determining the direction of rotation of said holder, a third valve controlled by said holder for preventing flow through either said first or second valve, means actuated by said holder after a predetermined number of strokes for reversing said second valve, a fourth valve controlled by said first hydraulic means for by-passing the actuating fluid around both said hydraulic means, a pipe extending into said rotor, a fifth valve connecting said pipe with a supply of mixture to be treated, a sixth valve connecting said pipe with a supply of wash-water, electrical means for opening said fifth valve and closing the same after a predetermined period, opening the sixth valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said second valve to cause rotation of said holder from a position of rest, and a switch controlled by said first hydraulic means for effecting energization and de-energization of said electrical means.

22. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, a valve controlled by reciprocation and rotation of said holder for determining the direction of reciprocation, a second valve for determining the direction of rotation of said holder, a third valve controlled by said holder for preventing flow through either said first or second valve, means actuated by said holder after a predetermined number of strokes for reversing said second valve, a fourth valve controlled by said first hydraulic means for by-passing the actuating fluid around both said hydraulic means, a pipe extending into said rotor, a fifth valve connecting said pipe with a supply of mixture to be treated, a sixth valve connecting said pipe with a supply of wash-water, electrical means for opening said fifth valve and closing the same after a predetermined period, opening the sixth valve after a second predetermined period and closing the same after a third predetermined period and after a fourth predetermined period actuating said second valve to cause rotation of said holder from a position of rest, a switch controlled by said first hydraulic means for effecting energization and de-energization of said electrical means, and means responsive to the vibration of said rotor for energizing the means for actuating said second valve.

23. In combination, a rotor, a tool holder mounted for rotation and reciprocation axially of said rotor, hydraulic means for rotating said holder, hydraulic means for reciprocating said holder, a valve for determining the direction of reciprocation, lugs carried by said holder, a slide engageable by said lugs, linkage between said slide and valve for actuating the latter upon movement of the former, means for actuating said linkage to reverse said valve on reciprocation of said holder, a second valve for determining the direction of rotation of said holder, and means for reversing said second valve after a predetermined number of strokes of said holder.

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