Aug. 26, 1969 B. A. LOOMANS ET AL 3,463,459

AUTOMATICALLY OPERATED DOOR MECHANISM FOR A MIXER, KNEADER, REACTOR OR LIKE MACHINE

Filed Feb. 12, 1968 3 Sheets-Sheet 1

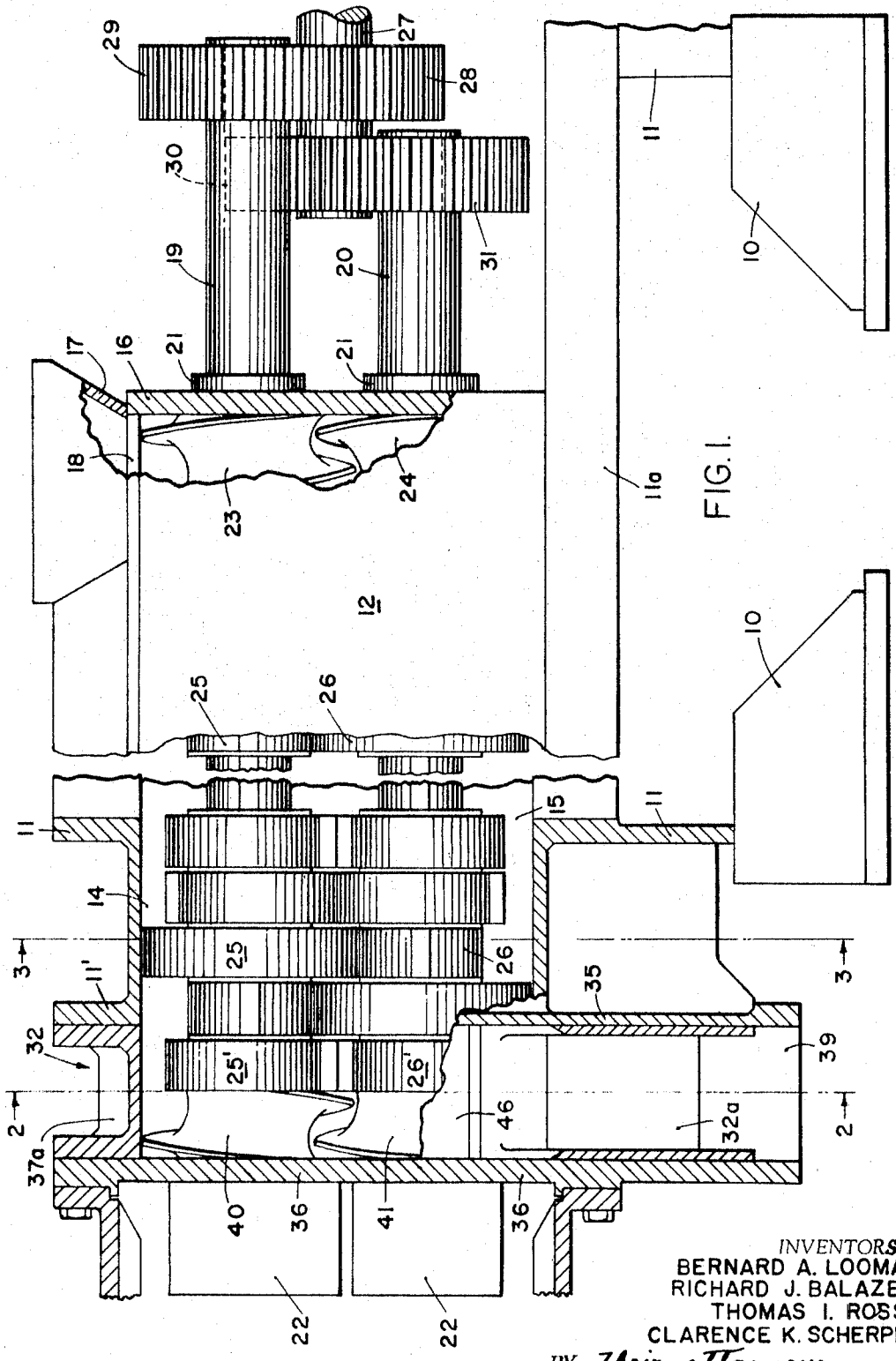

FIG. 1.

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Filed Feb. 12, 1968 3 Sheets-Sheet 2

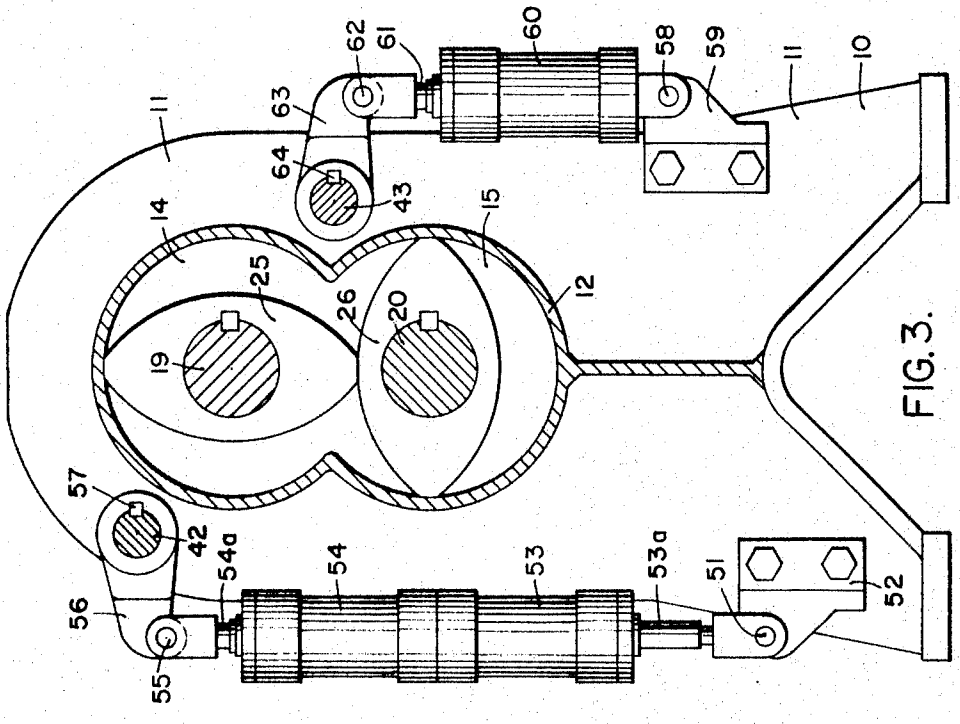

FIG. 3.

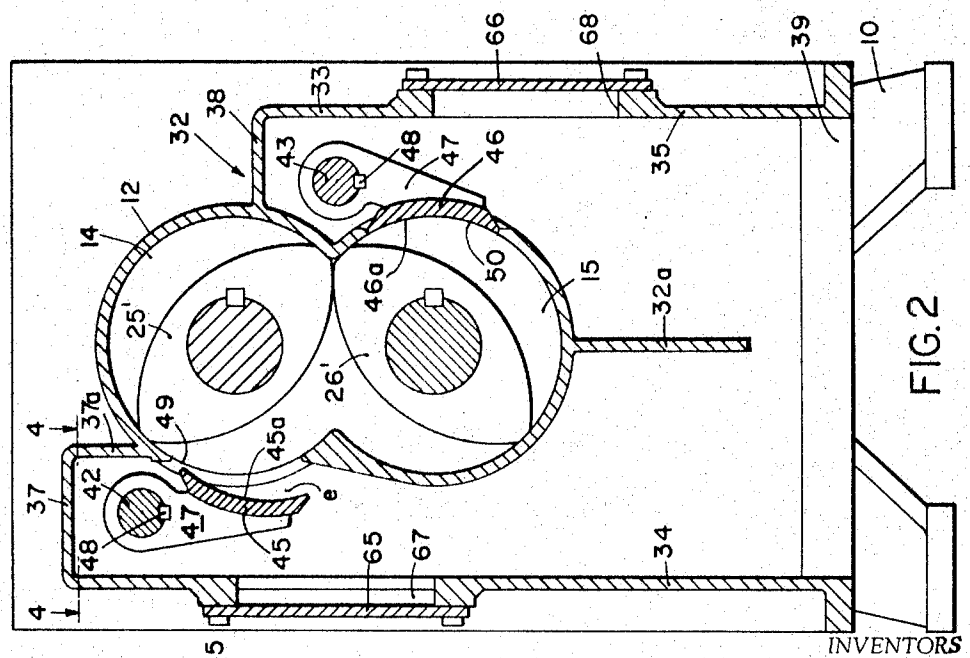

FIG. 2.

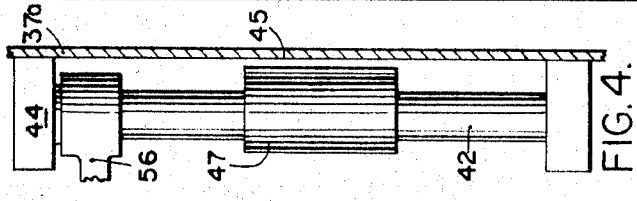

FIG. 4.

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Filed Feb. 12, 1968 3 Sheets-Sheet 3

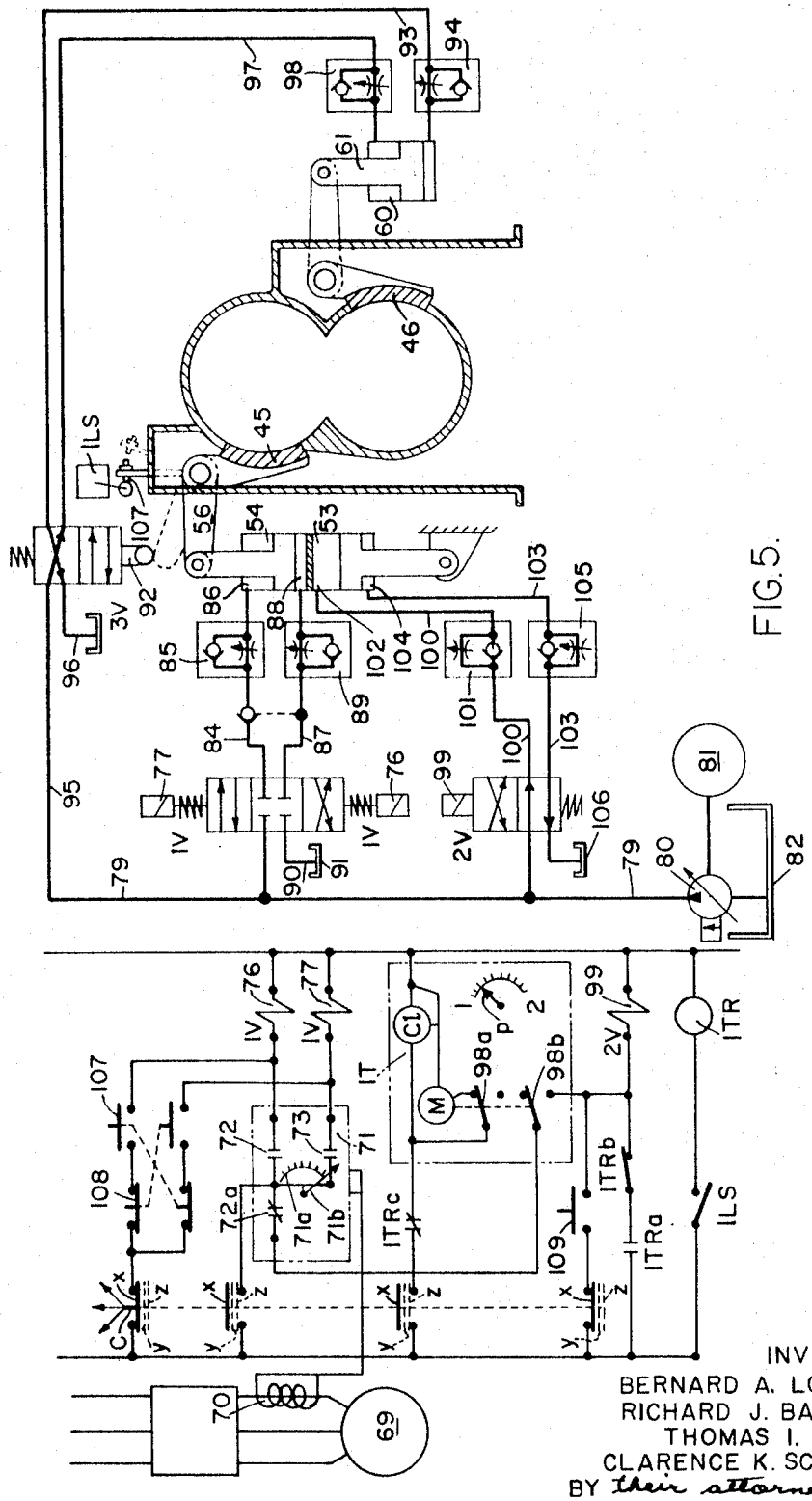

FIG. 5.

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3,463,459

AUTOMATICALLY OPERATED DOOR MECHANISM FOR A MIXER, KNEADER, REACTOR OR LIKE MACHINE

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Int. Cl. B01f 15/02
U.S. Cl. 259—41 15 Claims

ABSTRACT OF THE DISCLOSURE

A continous mixer having housing means in the configuration of intersecting cylinders and a plurality of parallel shafts extending axially in the housing, radially aligned interwiping mixing paddles on the shafts shaped to also wipe the walls of the housing upon rotation of the shafts, doors for the housing curved to be wiped by the paddles when in closed position, one of the doors being normally maintained in at least partly open position to permit the passage of material out the door while the other is normally maintained in closed position, a control circuit for varying the position of the partly open door according to the power required to drive the shafts in the same direction of rotation and at the same speed, a control for periodically moving the partly open door to closed position to permit a paddle to wipe the door and remove any accumulation of material thereon, and a control for opening the normally closed door when the normally partly open door is substantially fully opened.

One of the prime objects of the invention is to provide a mixer having a discharge door assembly including one normally partly open gate or door configured to be wiped by a mixing element which is controlled in a manner so that it is periodically closed to permit the mixing element to wipe the door.

Another object of the invention is to provide a door of the character disclosed which is retained in a partially open position and regulates the flow of material being discharged from a continuously operating mixer, and which automatically reacts to an emergency situation to open fully to empty the mixer of material.

Still another object of the invention is to provide a door assembly including an upper gate and a lower gate, the bottom gate or door being normally closed and openable automatically in an emergency situation responsive to opening of the upper gate or door to assist the upper door in emptying the mixer.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawings, in which:

FIGURE 1 is a fragmentary, sectional elevational view through the mixer of the invention, with the midportion of the mixer being broken away and omitted from the view for the sake of convenience;

FIGURE 2 is a transverse sectional view through the discharge end of the mixer, taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a similar transverse sectional view taken through the mixer on the line 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary, sectional top plan view taken on the line 4—4 of FIGURE 2;

FIGURE 5 shows a typical electrohydraulic control system for the door assembly.

Referring now more particularly to the accompanying drawings, wherein a preferred embodiment of the invention only is illustrated, the mixer includes end base members **10** mounting frame portions **11** on which the bed **11***a* of a horizontally disposed mixer housing generally designated **12** is supported as shown. It is to be understood that the mixer which will be described is a continuous mixer of the character disclosed in Loomans et al., U.S. Patent No. 3,195,868 and in a similar manner includes the figure 8-shaped housing **12** which defines communicating upper and lower intersecting, cylindrical chambers **14** and **15**. While the drawings do not indicate it, usually a jacket is provided around the casing **12** to hold a cooling or heating medium in the manner disclosed in the patent mentioned. As FIGURE 1 indicates, the charge end of the barrel or housing **12** is closed by an end plate **16**, and a material supply hopper **17** may be provided for moving material into the casing **12** through a material supply opening **18**.

Extending axially through each of the chambers **14** and **15** in a concentric manner are upper and lower mixer shafts **19** and **20**, respectively, which may be journaled in suitable bearings **21** at the charge end of the housing **12**, and **22** at the discharge end. Keyed on the front ends of shafts **19** and **20** as in the aforementioned patent are worm sleeves **23** and **24** which serve to advance the material from the charge end of the housing **12** toward the opposite end thereof, and also keyed on the shafts **19** and **20** are pairs of radially interengaging and interwiping upper and lower paddles **25** and **26**, respectively, which wipe the walls of the figure 8-shaped housing **12** as well as one another.

As the drawings indicate, each of the paddles **25** and **26** is of generally lenticular shape and each pair of mating paddles **25** and **26** is disposed with the major axis of one paddle at right angles with respect to the major axis of the other paddle, as illustrated particularly in FIGURE 3. The paddles **25** and **26** may be helically pitched in a direction to move the material from the charge end of the mixer housing **12** toward the discharge end and staggered helically so that they collectively also form worms moving the material toward the discharge end of the housing **12**. The continuous spiral feed screws **23** and **24** in cross section have the same configuration as the paddles **25** and **26** and consequently their respective crests also wipe the walls of the chambers **14** and **15** clean. The flanks and crests of each spiral feed screw are thus also wiped clean by the flanks and crests of the other spiral feed screw in the same manner as are the flanks and crests of the paddles **25** and **26**. The feed screw sections **23** and **24** are preferably pitched to provide a more rapid throughput of material than the pairs of paddles **25** and **26** would provide, and insure the desired rate of throughput. With low viscosity materials supplied under pressure by a metering device, it may be desirable to replace the worm sections **23** and **24** with pairs of paddles **25** and **26**, and this may also be advisable when certain chemical reactions are occurring in the mixer. The shafts **19** and **20** are driven in the same direction of rotation and at the same speed by a drive shaft **27** mounting a gear **28** in mesh with a gear **29** on the shaft **19**, and a gear **30** in mesh with a gear **31** on the mixer shaft **20**.

THE DISCHARGE HOUSING

At the discharge end of the housing a discharge housing assembly generally indicated by the numeral **32** is connected to an end support wall portion **11'** and includes a discharge casing surrounding the discharge end of mixer housing **12** having side walls **33** and **34** (FIGURE 2), end walls **35** and **36**, and stepped top wall sections **37** and **38** which join to the mixer housing **12**, the wall **37** being

joined to the upper portion of mixer housing **12** by a wall **37***a*. The end wall **36** of discharge housing **32** closes the end of mixer housing **12** as well. As FIGURE 1 indicates, the discharge housing assembly **32** is open at its lower end as at **39** and discharges to any suitable collecting or conveying device, dependent upon the mixing operation or reaction being carried on in the mixer housing **12**. A divider plate **32***a* depends from the end of mixer casing **12**.

THE DISCHARGE GATE ASSEMBLY

As FIGURE 1 also illustrates, the portion of mixer casing **12** which extends into the discharge housing **32** houses an end pair of paddle members **25'** and **26'** and reversely pitched, helical worm or screw sections **40** and **41** fixed on the shafts **19** and **20** which are pitched to advance material in a direction toward the charge end of the machine in opposition to the flow of material therein. Provided within the discharge housing **32** are an upper rock shaft **42** and a lower rock shaft **43**, disposed adjacent and parallel to opposite sides of the mixer casing **12**. The shafts **42** and **43** are journaled in bearings **44** which may be affixed to the casing or barrel **12** and mount discharge doors or gates **45** and **46**, respectively, on arms **47** which are keyed to the rock shafts **42** and **43** as at **48**. As FIGURE 2 particularly indicates, the gates **45** and **46** have curvilinear inner surfaces as at **45***a* and **46***a* to conform to the curvilinear configuration of the casing **12** and, when in the closed position in which they are shown in FIGURE 2, effectively seal the oppositely disposed side discharge openings **49** and **50** provided in the casing **12**. Pivotally mounted as at **51** on a bracket **52** secured to the end frame member **11** is the piston rod **53***a* of a hydraulic cylinder **53** which carries a cylinder **54** having a piston rod **54***a* pivotally connected as at **55** to an arm **56** which is keyed to the rock shaft **42** as at **57**. Also pivotally mounted as at **58** on a bracket **59** secured on the opposite side of end member **11** is a hydraulic cylinder **60** which has its piston rod **61** pivotally connected as at **62** to an arm **63** keyed to the rock shaft **43** as at **64**. As will later become clear, piston rod **53***a* is normally fully extended to hold cylinder **54** in a position that allows it to open and close gate **45**, the piston rod **54***a* is held in a normally partly extended or open position to provide a gate which is open to the extent *e* in FIGURE 2, and the piston rod **61** is normally in the retracted position in which it is shown in FIGURE 3 and holds the gate or door **46** in the closed position in which it is shown in FIGURE 2. Access doors **65** and **66** are releasably secured over openings **67** and **68** in walls **34** and **35**, respectively, as shown in FIGURE 2, for the sake of convenience.

THE ELECTROHYDRAULIC CIRCUIT

At the left in FIGURE 5 is an electrical circuit and at the right a hydraulic circuit which is controlled by the electrical circuit in a manner to be described. The drive motor for driving shaft **27**, and through it shafts **19** and **20**, is shown at **69** in the electrical circuit connected through a current transformer **70** to an optical meter relay **71** with an indicating pointer contact **71***b* and separately adjustable high and low contacts **72** and **73**, the so-called high contacts **72** being normally open as shown and the contacts **73** being also normally open. The meter relay employed is one which is currently available on the market and may comprise the type 195 meter relay sold by General Electric Company. Such meters conventionally include the indicating pointer, which is movable relative to a scale according to the current being drawn and which opens and closes the low and high relay contacts **73** and **72**, respectively, at the limits of its travel in the usual manner. Preferably, the so-called high and low contacts **72** and **73** are carried by settable points whose position also can be varied relative to the scale to "set" different limits.

Also connected in the electrical circuit adjacent the meter relay generally designated **71** is a motor driven timer generally designated IT. Such timers are also currently available on the market and may comprise the series **305B** general purpose reset timer manufactured by Automatic Timing & Controls, Inc., King of Prussia, Pa., U.S. The time delay device IT is operative to provide a definite timed period during which the door **45** is normally partly open. A valve IV for controlling the open position of door **45** under normal circumstances has a solenoid **76** which, when energized, operates to further open door **45**. The valve IV also has a solenoid **77** which, when energized, operates to pass fluid to cylinder **54** to move the door **45** to a more closed position. At the right end of FIGURE 5 in the hydraulic diagram, hydraulic fluid under pressure is shown as supplied to the valve IV through a hydraulic line **79** by a hydraulic power unit comprising a pump **80** driven by a motor **81**, pump being connected to a reservoir **82**. From valve IV a hydraulic fluid supply line **84** leads through a flow control valve **85** to the gate-closing side **86** of the hydraulic cylinder **54**. Similarly, a hydraulic fluid line **87** leads from the gate-opening side **88** of the cylinder **54** through a flow control valve **89** back to control valve IV. Hydraulic line **90** connects the valve IV with reservoir **82**.

Dependent on the particular setting of relay contacts **72** and **73** with respect to the meter scale **71***a*, control valve IV will maintain the piston rod **54***a* of cylinder **54** in a partly raised position and the door **45** in a partly open position so long as the power required to drive shafts **19** and **20** is normal. When the mixer shafts **19** and **20** are being driven normally under a normal power load, the pointer **71***b* of meter **71** will be disposed approximately midway between the relay contacts **72** and **73**. When the pointer swings over to the high contacts **72**, however, indicating that an undue amount of power is being utilized to drive shafts **19** and **20**, contacts **72** are closed and solenoid **76** is energized to pass fluid through line **87** to move the door **45** to a more open position. At this time, of course, solenoid **77** is deenergized. Conversely, when practically no power is being utilized to drive shafts **19** and **20**, as at a time when the machine is starting up, the low side contacts **73** will be closed, due to the presence of the meter indicator pointer **71***b* at the contacts **73**, and solenoid **77** will be energized to pass hydraulic fluid through line **84** to the cylinder **54** and move the door or gate **45** to a more closed position. At this time solenoid **76** is, of course, deenergized and hydraulic fluid is free to exit through hydraulic line **87**.

The hydraulic cylinder **54** is actuated to completely open the door or gate **45** in an emergency situation when an abnormally high current is required to drive shaft **27** and, when this occurs, the arm **56** depresses the spring returned operating plunger **92** of a hydraulic valve **3V** which is operated to move fluid through a line **93** and flow control valve **94** to operate cylinder **60** and open door **46**. Hydraulic fluid is supplied to the control valve **3V** through a hydraulic line **95** communicating with line **79** and the valve **3V** has a reservoir line **96**. A similar line **97** leads through a flow control valve **98** to the opposite side of the cylinder **60**. The valve **3V** normally maintains the door **46** closed and it is only when plunger **92** is depressed that hydraulic fluid is fed by the valve **3V** through hydraulic line **93** to raise the piston rod **61** of hydraulic cylinder **60** and completely open the gate or door **46**. This occurs only at a time when the gate or door **45** is already fully opened and serves to permit the extremely fast exit of material from the mixer in an emergency situation. Such a situation might occur, for instance, in a polymerization reaction to empty the machine rapidly if the reaction gets out of control temperature-wise.

Except when meter contacts **72***a* are opened (which occurs when pointer **71***b* closes "high" limit contacts **72**), the timer IT operates to periodically close the top gate **45** so that it may be intermittently wiped by the pair of

paddles 25', 26' and reverse screw sections 40 and 41, it being understood that reverse worm sections 40 and 41 in cross section have the same configuration as the paddles 25 and 26 to perform the wiping function in the same manner. The timer IT has a motor M driving a spring returned timer pointer *p* which moves from a preset position 1 governing the time period through a rotary path to a second position 2 to open a switch 98*a*. The motor M is coupled to the pointer by a clutch C1 which releases when contacts ITR*c* are opened so that the pointer can return as will later appear. When the motor M of timer IT times out by opening switch 98*a*, the companion timer switch 98*b* is closed and the solenoid 99 of spring returned control valve 2V is energized so that hydraulic fluid is fed through a hydraulic line 103 and a flow control valve 105 to the door closing side 104 of cylinder 53. A hydraulic line 100 leads from the opposite, door opening side 102 of cylinder 53 through a flow control valve 101 back to the control valve 2V. Control valve 2V is provided with the usual reservoir line 106 which communicates with the reservoir 82.

As FIGURE 5 indicates, a switch actuator 107 provided on the arm 56 moves into engagement with the actuator arm of a switch ILS when arm 56 on which it is mounted is pivoted downwardly to dispose door 45 in closed position. Thus, when the gate or door 45 is moved to fully closed position by the cylinder 53, the movement is sensed by limit switch ILS. Connected in circuit with the limit switch ILS is a timing relay ITR which has relay contacts ITR*a* with associated timing contacts ITR*b* and contacts ITR*c*, as shown. When the contacts ITR*c* are opened by relay ITR, the pointer *p* of timer IT is freed so that it may return (reset) to original position. Simultaneously, the contacts ITR*a* close to hold solenoid 99 energized after timer IT contacts 98*b* reset to their open position. The pneumatic timing contacts ITR*b* hold solenoid 99 energized for a time period of approximately one second or whatever time is required to insure that the interior surface 45*a* of door 45 is cleaned. When the timing contacts ITR*b* of relay ITR open, solenoid 99 is deenergized and valve 2V is free to return to original position. Cylinder 53 is thereby returned to original position, the gate 45 is opened to a position again governed by the control valve IV, limit switch ILS is released, and timer ITR is reset by the opening of limit switch contacts ILS. When the pointer *p* of timer IT is returned to its original position, contacts 98*a* and 98*b* close and open, respectively, contacts ITR*c* reclose when timer ITR resets, and the clutch solenoid C of timer IT is energized at this time to recoupled the timer pointer *p* to motor M so that the cycle repeats.

It is to be noted that when the timer IT times out and the door 45 is closed for cleaning, the complete cylinder 54 is carried along downwardly with its piston position unchanged. Later, when cylinder 53 reopens the gate 45, the gate or door 45 will return to the same "control" position. The flow control valves 101 and 105 for cylinder 53 are set to provide relatively fast movement so that the closing of gate 45 will not last long enough to raise the motor load and upset the control position of cylinder 54.

As the control circuit indicates, both manual and automatic control of the upper gate or door 45 is provided. With the control selector switch C at "hand" (the position *x* of the bridge members shown in solid lines), the top door 45 is controlled by watching the motor load indicator pointer of meter 72 and pressing the "open" or "close" push button 107 or 108, respectively, to position the door 45 as desired. Manual gate operation will be used during start-up to position the gate 45 to a predetermined amount of material is present in the machine. When quick-close button 109 can be used to close the top gate 45 quickly for cleaning. When the button 109 is released, the gate 45 will return to its previously positioned opening. The "off" position of the control bridge members is indicated at *y* and the "automatic" position at *z*.

In operation, both gates 45 and 46 are initially closed, of course, until the machine is charged and a predetermined amount of material present in the machine. When this occurs the amount of current required to rotate shafts 19 and 20 will increase and control valve IV will be operated through energization of solenoid 76 to open the gate 45 to a predetermined open position in which it is normally maintained, as shown in FIGURE 2. Thereafter, as long as normal flow conditions are maintained in the mixer and normal current is required to operate shafts 19 and 20, valve 45 will be retained in this normally open position except that it will periodically be closed by the timer IT operating through valve 2V. The gate 45 is closed under these conditions for a sufficient period of time for the top gate 45 inner surface to be wiped clean. Only in an emergency situation will door 45 be completely opened, and at this time the bottom door 46 will also be completely opened for the period of time during which the unusually high current is required to revolve shafts 19 and 20. When the high current situation is relieved by emptying of the material rapidly through both gates 45 and 46, the gate 45 will return to a partially open position while gate 46 returns to closed position.

We claim:

1. In a mixer, kneader, reactor or like machine: housing means in the configuration of intersecting sylinders; a plurality of parallel shafts extending axially in said housing means and having interwiping material agitating means thereon shaped to also wipe the walls of said housing means upon rotation of said shafts; means for driving said shafts in the same direction of rotation and at the same speed; door means in said housing means configured to be wiped by said agitating means when in closed position; means normally holding said door means in a position removed from closed position to permit the passage of material through said door means; and means for periodically moving said door means to closed position to permit said agitating means to wipe said door means and remove any accumulation of material therefrom.

2. The combination defined in claim 1 in which electrically controlled motor means drives said shafts; said door means is mounted to move to various positions in which it varies the amount of material passed; and control means is provided for varying the position of said door means according to the power required to drive said shafts.

3. The combination defined in claim 2 in which said door means is moved away from said housing means upon an increase in the power required.

4. The combination defined in claim 1 in which said agitating means comprises radially aligned, generally lenticular paddles on said shafts, the interwiping paddles being angularly displaced 180°.

5. The combination defined in claim 4 in which said paddles are helically disposed to feed material toward one end of said housing means; and reverse-hand worm means on said shafts at said end feed material in an opposite direction; there being discharge casing means leading from said housing means at the juncture of said worm means and paddle means and housing said door means.

6. The combination defined in claim 1 in which said door means is provided in the upper part of said housing means and a second door means is provided in the lower part of said housing means; said second door means being normally in closed position; and control means for opening said second door means when said first door means reaches a fully open position.

7. The combination defined in claim 6 in which electrically controlled hydraulic rams separately move said door means and second door means to open and closed positions.

8. The combination of claim 7 in which said housing

means is in the configuration of an upright figure 8 and the door means and second door means are on opposite sides of the housing means.

9. In a mixer, kneader, reactor or like machine: housing means; shaft means extending axially in said housing means and having material agitating means thereon; means for driving said shaft means; door means in said housing means configured to be wiped by said agitating means when in closed position; means normally holding said door means in a position removed from closed position to permit the passage of material through said door means; and means for periodically moving said door means to closed position to permit said agitating means to wipe said door means and remove an accumulation of material therefrom.

10. In a mixer, kneader, reactor or like machine: housing means; shaft means extending axially in said housing means and having material agitating means thereon; means for driving said shaft means; gate means for said housing means for controlling the discharge of material therefrom; means for sensing the amount of current required to operate the shaft means; and means for moving the gate means away from the housing means to increase the outflow therefrom when said sensing means senses that the current requirement is greater than a predetermined requirement.

11. The combination defined in claim 10 in which the sensing means includes contacts set at high and low power requirement limits.

12. In a mixer, kneader, reactor or like machine: longitudinally extending housing means; shaft means extending axially in said housing means and having mixing element means thereon; means for driving said shaft means; upper gate means in one end of said housing means; means normally holding said upper gate means in a position removed from closed position to permit the passage of material through said upper gate means; lower gate means for said end of the housing means; and control means operable in response to said upper gate means reaching a predetermined position removed from closed position to open said lower gate means.

13. In a mixer, kneader, reactor or like machine, housing means; shaft means extending axially in said housing means and having material agitating means thereon; means for driving said shaft means; discharge door means in said housing means; means normally holding said door means in a position removed from closed position to permit the passage of material through said door means; means for sensing the amount of power required to drive said shaft means; and means for holding said door means in an open position when said power requirement increases.

14. In a mixer, kneader, reactor or like machine: housing means; shaft means extending axially in said housing means incorporating mixing element means thereon; means for driving said shaft means; door means in said housing means configured to be wiped by said agitating means when in closed position; and means for automatically periodically moving said door means from an open to closed position, and returning said door means, to permit said agitating means to wipe said door means and remove any accumulation of material therefrom.

15. The combination defined in claim 14 in which a first fluid pressure operated cylinder moves said door means to more open or more closed positions dependent on the power required to drive said shaft means; and said means for automatically periodically moving said door means includes a second fluid pressure operated cylinder means carrying said first fluid pressure operated cylinder means.

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ROBERT W. JENKINS, Primary Examiner

U.S. Cl. X.R.

259—6