Dec. 20, 1955 J. HERTRICH 2,727,630

CENTRIFUGAL LOADING CONTROLS

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Fig. 2.

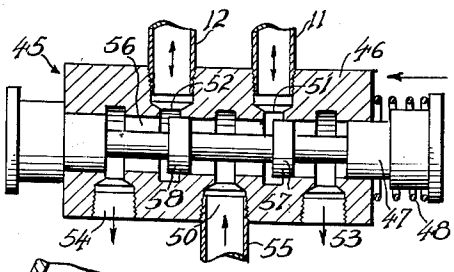

Fig. 1.

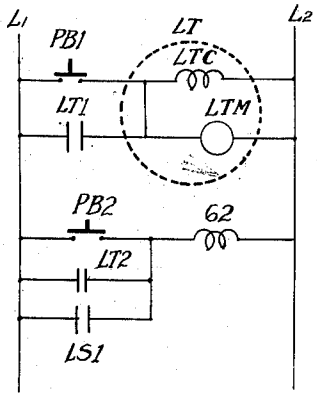

Fig. 3.

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CENTRIFUGAL LOADING CONTROLS

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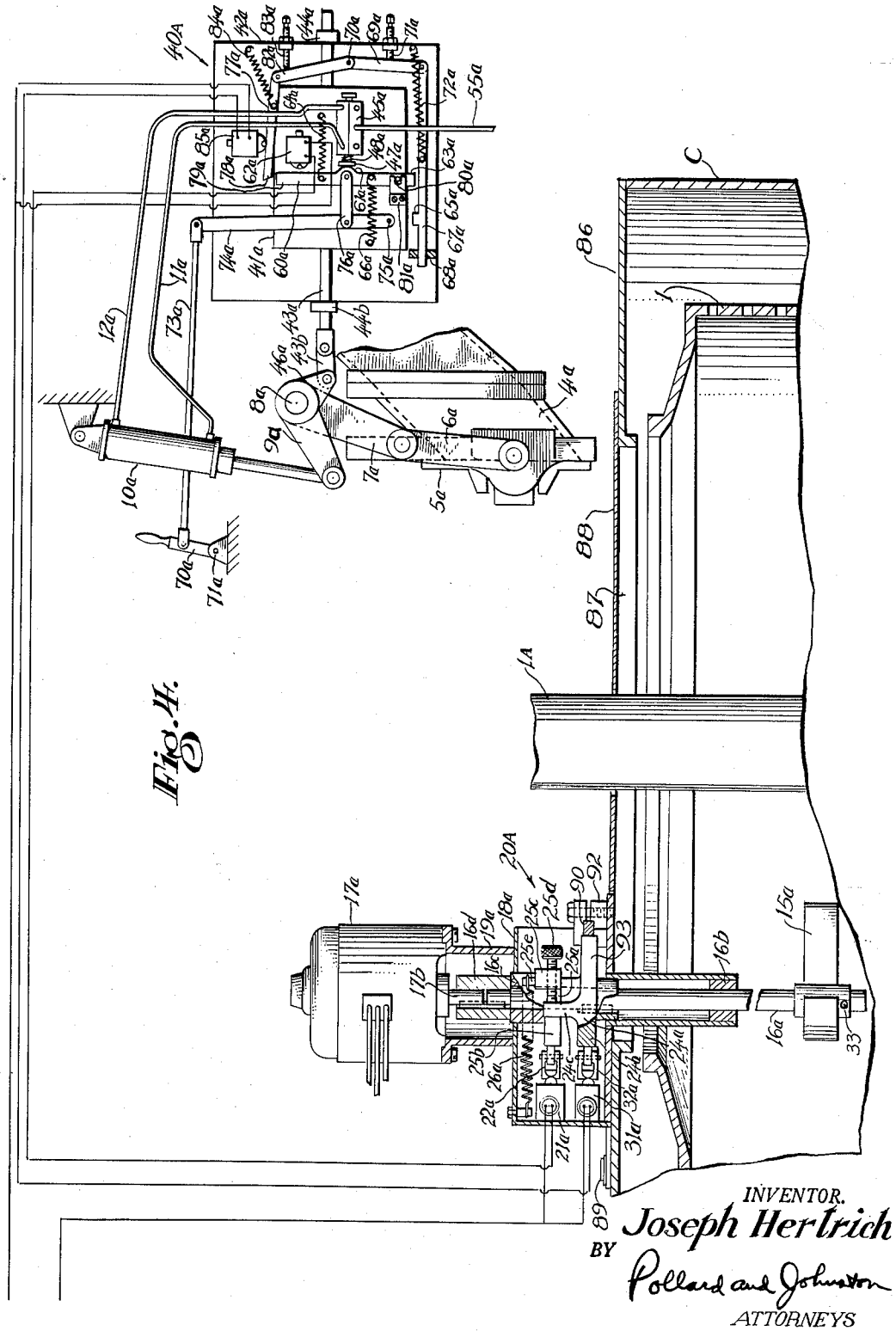

Fig. 4.

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CENTRIFUGAL LOADING CONTROLS

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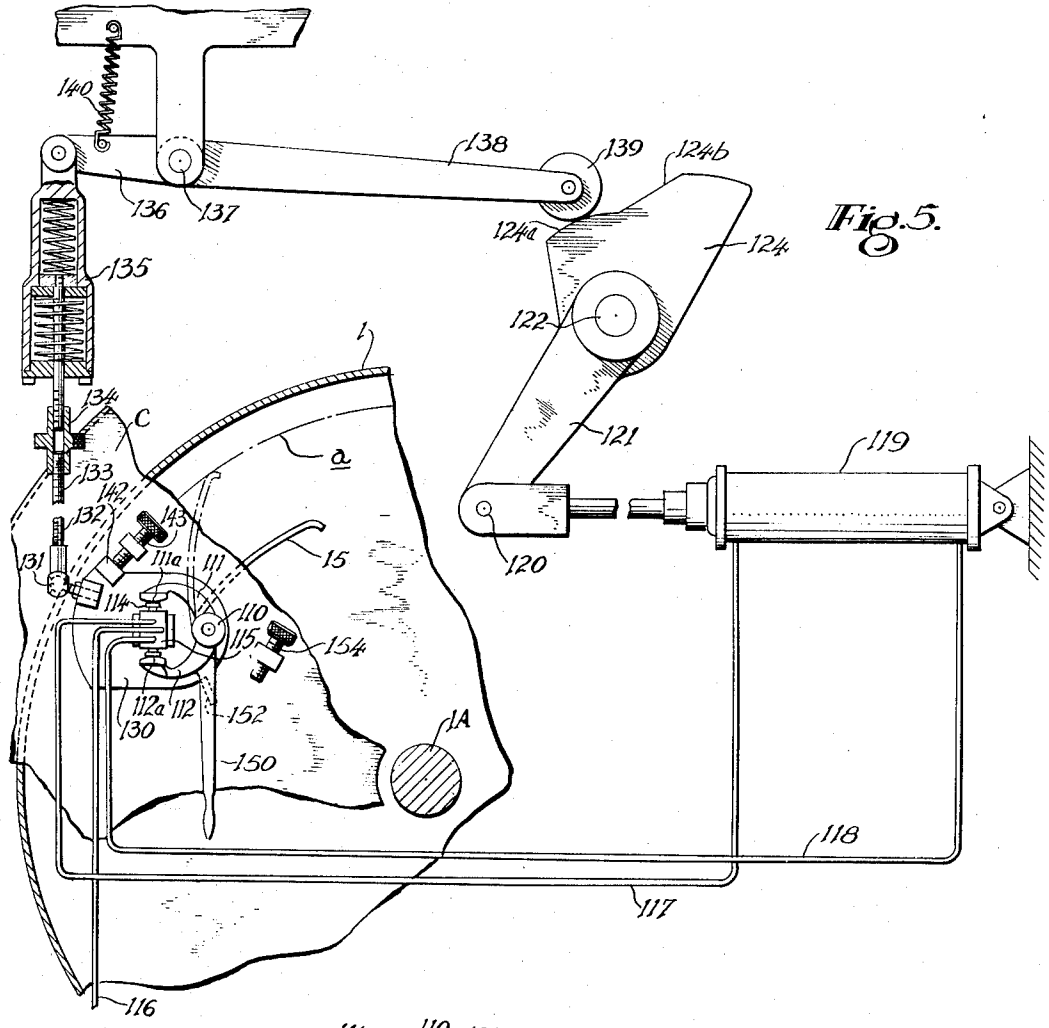

Fig. 5.

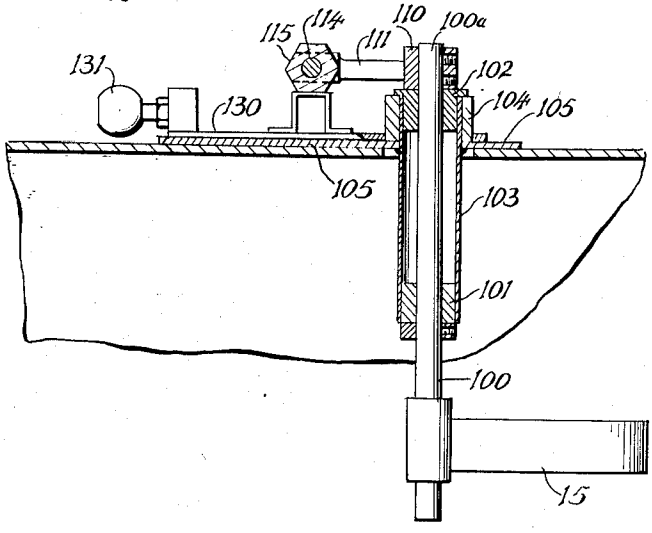

Fig. 6.

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CENTRIFUGAL LOADING CONTROLS

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Fig. 8.

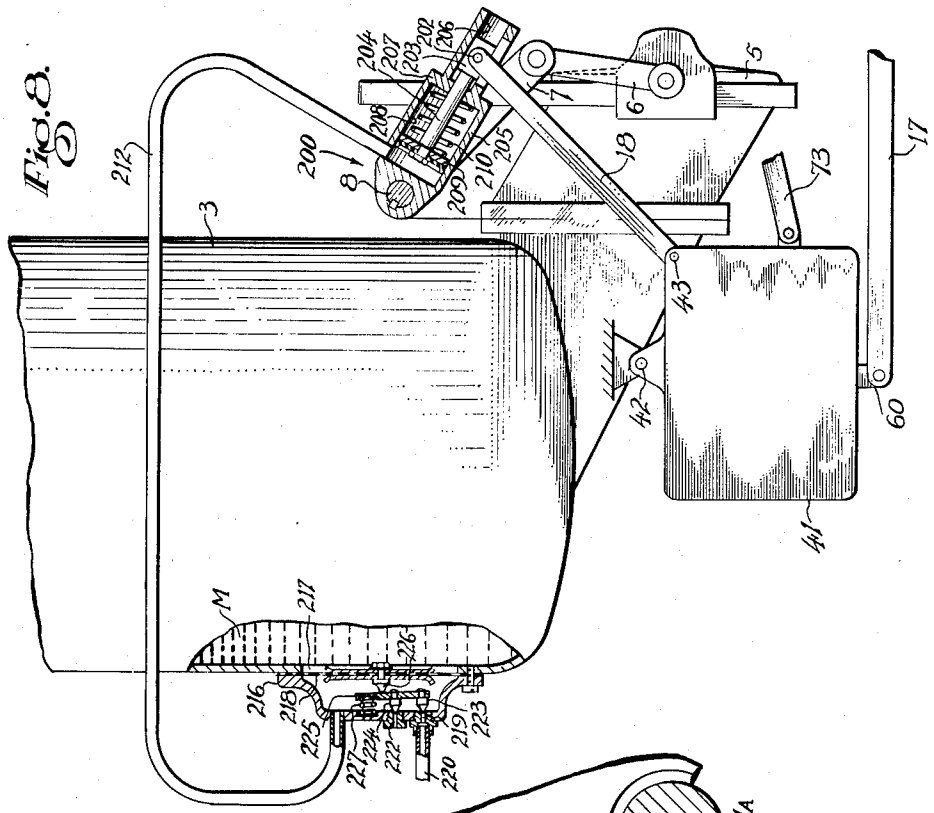
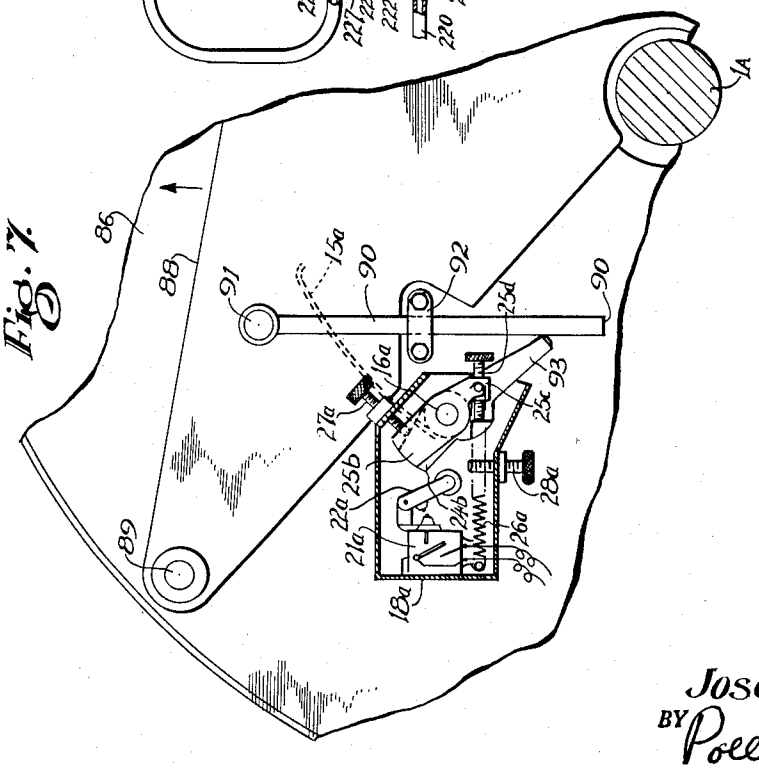


Fig. 7.



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2,727,630

CENTRIFUGAL LOADING CONTROLS

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Application December 12, 1951, Serial No. 261,258

35 Claims. (Cl. 210—68)

This invention relates to new and improved loading control mechanisms useful especially for regulating the introduction of charge materials into heavy cyclical centrifugal machines of the type used in the manufacture and the refining of sugar. It is particularly valuable for either the automatic control or the completely automatic performance of centrifugal loading operations.

Inaccurate loading is a common and very costly fault in sugar centrifugal work. The centrifugal baskets should be loaded to their full capacity in order to maintain high production, yet this often results in overloading and losses of charge material containing crystallized sugar into the channels provided for collecting impure syrup. Though less noticeably, losses and inefficiencies result also from any considerable variations of the volume of charge material introduced into the basket in the successive centrifugal cycles, for these variations affect the thickness of the basket charges and the effectiveness of the centrifugal purging, washing and drying actions applied to each charge.

The labor requirements for loading operations also present problems in existing practice. The work imposes strains upon centrifugal operators, and in order to maintain satisfactory results a high degree of skill and attentiveness as well as physical endurance are needed.

It has been proposed heretofore to save labor by means of various automatic mechanisms which, in general, are adapted to initiate loading automatically, to hold a loading gate open at a set position as the basket becomes filled, and to close the gate either after a preset period of time or when the basket charge has reached a certain final thickness. These known mechanisms are not able to keep basket charges uniform, especially in sugar centrifugal work. In that work the charge material undergoes changes of fluidity during the processing of a given batch or run of massecuite or magma, by reason of temperature changes or continued crystallization or the settling of crystals from syrup, and no two batches or runs have quite the same flow qualities. If the loading period is timed, the flow rate of the material determines the charge volume, rather than the control mechanism. If the control mechanism responds merely to the final charge thickness, the charges still vary because substantially more or less charge material enters the basket after this response, depending upon the fluidity of the material and the distance between the loading gate and the basket.

These problems, if not the complexity or unreliability of the mechanisms heretofore proposed, have resulted in continued reliance on manually controlled loading operations, both in sugar industries and in other fields of use of heavy cyclical centrifugal machines. For lack of satisfactory loading control mechanisms, among other things, industry has continued to lack a satisfactory completely automatic machine of this nature.

The principal object of this invention is to provide loading control mechanisms for heavy cyclical centrifugal machines or the like which accurately regulate the successive

loading operations and thus avoid important losses and inefficiencies suffered in present practice.

Another object of the invention is to provide loading control mechanisms which enable the substantially uniform charging of baskets in successive centrifugal cycles even though changes occur in the fluidity of the charge material, and in the use of which the distance between the loading gate and the centrifugal basket has a negligible influence.

Another object of the invention is to provide loading control mechanisms which enable centrifugal loading operations to be performed safely under mechanical regulation while the baskets are being accelerated in speed, so that no time need be lost in loading by reason of the use of these mechanisms.

Still another object is to provide commercially practical mechanisms which free the operators of centrifugal machines from the physical strains attendant to loading operations, and which reduce or eliminate the influence of the operator's attentiveness and skill upon the efficiency obtained in centrifugal work.

A further object of the invention is to provide loading control mechanisms which bring about savings of labor costs, as well as increased efficiency, in centrifugal operations; and, still further, to provide such loading control mechanisms whereby all the steps incident to centrifugal loading operations can be performed automatically in a highly reliable and efficient manner.

A still further object is to provide centrifugal loading control mechanisms which automatically take account of changes in the hydrostatic head or depth of charge material in a supply tank from which the material is delivered into centrifugal machines, so that differences in flow rate which result from such changes will not objectionably influence the uniformity of loading operations.

Among other objects of this invention are: To provide loading control mechanisms which can be applied to any existing heavy centrifugal installation with little mechanical alteration of the installation; to provide such mechanisms which are useful for the controlled loading of many different types or grades of charge material, and under any desired process conditions; and to provide such mechanisms which have simple and easily accessible adjustments for adapting the operation of the mechanism to the processing requirements of any material for which it may be used.

According to this invention the loading gate serving a centrifugal machine is provided with a power operated gate closing means, which preferably is a single gate operating motor, such as an air cylinder, serving both to open and to close the gate; the centrifugal is provided with a charge measuring device that is changed in its position or condition of actuation as the volume of a basket charge increases in the course of a loading operation; and a progressive automatic coordination of the operation of these elements is brought about by means of a control mechanism that responds progressively to charge induced movements of the measuring device and in turn actuates the gate closing means progressively so as to bring the gate from open position to progressive closing positions corresponding to progressive positions of the measuring device.

A mechanism of this character makes use of suitable control means adapted to be moved progressively in response to movements of the charge measuring device, together with actuating means for the gate motor that respond progressively to movements of such control means. The gate closing action of the motor can be controlled in definite correlation to the position of the measuring device by the provision of further means for progressively biasing the motor actuating means, or the control means to which it responds, to a motor inactivating position in response to closing movements of the gate itself.

The invention further provides control mechanisms of the nature described which bring the loading gate to a pinched or largely closed position as the basket charge approaches a desired final volume, and which then act quickly to complete the closing of the gate by uninterrupted action of the gate motor.

In this way, the mechanism is able to determine quite accurately the final volume of the charge, for the loading gate moves to pinched position in definite relation to the building up of the charge, and the limited amount of material that can flow through the gate as it closes finally from the pinched position need not be enough to cause an objectionable deviation from the desired final charge volume. Rapid loading can also be assured, since the control mechanism can actuate the gate motor to open as well as to close the gate and can be set to cause any desired degree of gate opening at the outset of a loading operation and to hold the gate at this degree of opening until the basket charge reaches a desired thickness at which it will initiate the progressive gate closing action. This selectivity of the loading rate is important not only as a time saver but also to the usefulness of a given apparatus for a wide variety of charge materials.

The charge measuring device most conveniently used is a finger or charge feeler that bears against and rides over the inside face of the charge being formed in the rotating basket. The control mechanism can have a variety of forms and various means of interconnection with the other elements; among them, electrical, electro-pneumatic and direct mechanical connections. While a step by step action of this mechanism can be provided, the invention also provides progressively acting mechanisms having a continuing servomotor action that enhances the sensitivity and reliability of the loading control. In these, any movement of the charge feeler induced by an increase of the charge volume may position control elements so as to cause a gate closing action of the gate motor, and the resulting gate closing movement brings about a counteraction of the change of feeler position so as to keep the gate open, though closing gradually as the charge builds up, until at a desired charge volume the gate reaches a final degree of opening from which it is closed quickly to terminate the loading operation.

In any embodiments of the invention the movement of the charge measuring device to an active or charge feeling position may be coordinated with actuation of the gate motor to open the loading gate.

According to another feature of the invention, the control mechanisms are provided with simple and easily accessible means of adjustment by which they may be adapted to the processing needs of any charge material or to any centrifugal installation for which they may be used.

One such adjustment may be provided for setting the "final gate opening," by which is meant the pinched or narrowly opened position from which the gate is closed completely to terminate a loading operation. This adjustment permits easy correction of any tendency to overload or underload the centrifugal in handling a particular type of charge material.

Another adjustment may be provided for setting the final charge volume to be produced in each loading operation, this setting being selected according to the nature of the charge material to be treated and the treatment it is to receive in the centrifugal.

Still another adjustment may be provided for setting the "initial gate opening," i. e., the distance or width to which the gate is opened at the outset of each loading operation, so that any desired rate of loading may be obtained. Further, the mechanism may include an adjustment for the "initial charge volume," i. e., the charge volume at which partial closing or pinching movement of the gate is to begin. This factor can be determined by the settings made for "final charge volume" and "initial gate opening."

The invention comprehends embodiments adapted for manual attendance, i. e., for the manual initiation of each loading operation followed by the automatic conduct and termination of the loading under the control of the mechanism, in which all the required control and adjustment functions may be integrated into a compact mechanical unit that can be mounted readily at the centrifugal machine with only a simple connection between it and a gate operating motor.

In other embodiments of the invention, which are suitable for either manual or automatic initiation of loading operations, an electrically operated motor device such as a torque motor may be employed for moving a charge feeler into working position, and this movement may bring about the actuation of the gate motor in gate opening direction. In such embodiments it is desirable to have the electrical parts located away from the vapors, dust, etc., commonly to be found at the curb of a centrifugal machine.

According to a particularly advantageous combination, a compact control in the nature of a "servo-motor," comprising electrical, pneumatic and mechanical elements, is provided for mounting near to and in connection with the loading gate and the gate motor of a centrifugal installation, while another compact unit integrating the measuring and adjustment functions of the mechanism is mounted on or adjacent to the centrifugal curb in suitable connection with the charge feeler and the servo-motor control, so that upon actuation of that control to open the gate resulting gate and control movements will place the charge feeler in working position; while later movements of the feeler induced by the increasing charge in the centrifugal basket will act through the control to close the gate in the desired progressive manner.

According to a further feature of this invention, the action of the loading control mechanism is modified automatically in accordance with changes of the hydrostatic head or level of charge material awaiting delivery through the loading gate, so that variations of flow rate which result from such changes need not be observed by an operator nor compensated by manual adjustments of the mechanism in order to maintain highly efficient loading operations at all times. While various devices may be employed in this combination, a preferred embodiment makes use of pressure responsive means connected with the loading control mechanism and with the tank holding the charge material, which respond to changes of the hydrostatic head of material in the tank and adjust the setting of the loading control proportionately so as to increase the initial gate opening as the level of material in the holding tank falls, and so as to decrease it upon a rise of that level.

Other objects, features and advantages of the invention will appear from the following detailed description and the accompanying drawings of illustrative embodiments thereof.

In the drawings:

Fig. 1 is a diagrammatic assembly view of a cyclical centrifugal installation provided with an automatic loading control mechanism according to a preferred embodiment of the invention;

Fig. 2 is a diagrammatic longitudinal cross-section of an air control valve used in the embodiment of Fig. 1;

Fig. 3 is an elementary wiring diagram suitable for the electrical elements of the same embodiment;

Fig. 4 is a diagrammatic assembly view of another embodiment of the invention.

Fig. 5 is a diagrammatic assembly view of a third embodiment of the invention adapted for the integrated control of functions of the loading control mechanism in a manually activated unit located at the curb of the centrifugal machine;

Fig. 6 is a vertical cross-section through part of the control mechanism of Fig. 5; and

Fig. 7 is a fragmentary plan view, partly in horizontal

cross-section, showing parts of the control mechanism of the second embodiment combined with means for rendering the loading gate inoperable when a sliding cover element of the centrifugal curb is in closed position; and

Fig. 8 is a diagrammatic elevational view, partly in vertical cross-section, showing the combination of the first-mentioned embodiment with means for automatically modifying the action of the loading control mechanism in response to changes of the pressure head of charge material awaiting delivery into the centrifugal machine.

Referring first to Fig. 1, this diagram is a composite of elements shown in plan view at the right hand side of the figure and other elements shown in elevation at the left hand side of the figure. At the right hand side, **1** denotes a portion of the side wall of a filtering centrifugal basket of the type used in the processing of sugar. A portion of an annular basket charge, say of sugar, or other granular solids, is indicated at **2**. The inner surface of the complete charge is indicated at **2***b*, while broken line **2***a* indicates a position through which the charge surface progresses inward in the course of a loading operation.

At the left hand side of Fig. 1, **3** is a portion of a tank holding charge material to be delivered into the centrifugal basket **1**. The material flows from this tank through loading spout **4** and thence into the basket when a loading gate **5**, of any suitable construction, is moved away from its position closing the spout outlet. Gate **5** is connected by suitable linkage, including link **6**, arm **7**, gate operating shaft **8** and arm **9**, with the reciprocatory plunger of an air cylinder **10** which serves as a motor both for opening and for closing the loading gate.

It will be evident that when air under suitable pressure is admitted into the upper part of cylinder **10** through conduit **11**, the arms **9** and **7** on shaft **8** are rocked counterclockwise so as to lift gate **5** to an open position at which charge material in tank **3** will flow under gravity into basket **1**; while admission of the air pressure through conduit **12** into the lower end of cylinder **10**, conduit **11** then being suitably vented, brings about a closing movement of the loading gate.

What has been described immediately above is well known in the art. It also is well known that the opening of the loading gate should take place after the basket of the cooperating centrifugal has been emptied and brought to a low speed of rotation sufficient to cause the formation of an even annular wall of the inflowing charge material under the centrifugal force imparted to it by the basket rotation. Further, it will be understood that the formation of a complete charge in the basket requires a considerable period of inflow of the charge material, say 10 to 30 seconds, more or less, depending upon the volume of the charge to be treated, the size and extent of opening of the loading gate, and the flow rate of the charge material.

As the charge material flows into the basket, the annular charge being formed therein increases gradually in thickness until it reaches a final thickness corresponding to the desired charge volume, at which point the loading gate should be closed. This progressive building up of the charge is susceptible to measurement in various ways. A particularly simple yet effective way of measuring it, as well known, is to use a charge feeler that slides on and is moved inward by the rotating inner surface of the increasing charge. Such a charge feeler is illustrated at **15** in Fig. 1. This feeler is carried by and swings with a shaft **16** which may be mounted by an suitable bearing and bracket arrangement on or adjacent to the usual stationary curb (not shown) of the centrifugal machine.

In combination with the elements just described, Fig. 1 shows a loading control mechanism comprising two coordinated assembly units **20** and **40** which are interconnected by suitable link means at **17**. Unit **20** includes the feeler shaft **16** and charge feeler **15**, and serves to integrate the charge measuring and adjustment functions of the control mechanism. Unit **40** includes a reciprocable support **41**, here having the form of a control box mounted for rocking movement on a fixed pivot **42** located in suitable relation to the gate operating mechanism. This support is connected for forward and backward movements with opening and closing movements of the loading gate **5**. For example, a link **18** has a pivotal connection at **43** with support **40** and another pivotal connection at **44** with the gate operating arm **7** on shaft **8**.

The reciprocable support or control box **41** carries a gate motor control device **45**, the nature of which is suitably adpated to that of the gate operating motor. In the embodiment shown, device **45** is an air valve having a relatively fixed element or valve body **46** fastened to support **41** and a relatively movable element or valve plunger **47**. The movable element is normally biased by compression spring **48** to a gate opening position but is movable backward from that position, first to a gate inactivating position and then to a gate closing position at the backward limit of its movement.

Various known forms of air valves are suitable for this purpose. The one shown, as seen in Fig. 2, has formed in valve body **46**: a central port **50** for connection with a compressed air supply line **55**; laterally offset ports **51** and **52** for connection, respectively, with the air conduits **11** and **12** of cylinder **10**; and vent ports **53** and **54** near opposite ends of the valve body. The body has a long axial chamber **56** formed with five annular air passages communicating with the respective air ports, and the plunger **47** extends through this chamber and carries therein spaced sealing pistons **57** and **58**. Piston **57** controls the air flow into and from conduit **11**, and piston **58** controls the air flow into and from conduit **12**. At the gate opening position of the valve, air entering port **50** passes through port **51** into conduit **11**, while conduit **12** is vented through communicating ports **52** and **54**. At the deenergizing or gate inactivating position (an intermediate position of the plunger), pistons **57** and **58** seal off ports **51** and **52** and prevent any passage of air through the valve. At the gate closing position, air from line **55** passes through ports **50** and **52** into conduit **12**, while conduit **11** is vented through communicating ports **51** and **53**.

The several operative positions of the motor control device or air valve **45** are determined by the positioning of a control member **60** which is arranged over the base of the reciprocable support **41** so as to be carried with the support in its forward and backward movements, yet is movable relative to the support in order to position the movable valve element. Member **60** in this embodiment has the form of a bar, a mid-portion of which, at its backward side, engages the forward end of the valve plunger **47**.

The lower end of control member **60** projects downward from the support or control box **41** for pivotal connection at **61** with one end of the interconnecting link **17**. That link extends forward from unit **40** for pivotal connection, as at **19**, with a lever arm **21** on the feeler shaft **16** of unit **20**. The upper end of member bar **60** is arranged to be positioned by a motor device **62** which is fixed to the support **41**. This motor device conveniently may be an electrically operated solenoid having a plunger **63** in position to thrust the bar forward when the solenoid is energized.

A tension spring **64** is fixed to a backward part of support **41** and to an upper part of member **60** so as to bias member **60** and valve **45** to gate closing position whenever the motor device **62** is deenergized. This spring is strong enough to overcome the force of the valve spring **48**. Another tension spring **66** is fixed to a forward part of support **41** and to a lower part of control member **60**, so as yieldably to connect member **60** and unit **20** for movements with support **41** in response to movements of the loading gate **5**.

The control member 60 is held in a stable working position, relative to plungers 47 and 63 and tension springs 64 and 66, by means of a transverse slot 67 in the mid-portion of member 60, which slot engages over a pin 68 fixed to the free end of a reciprocable shaft 69. Shaft 69 fits slidably within a guide 70 fixed to the base of support 41 and also in a guide groove or slot 71 formed in a side flange of the support. The backward end of guide 70 engages the mid-portion of control member 60 at its forward side and keeps this member from moving forward out of working position. The control member, however, remains freely movable relative to the centralizing pin 68 for the automatic operation of the control mechanism.

The shaft 69 is made reciprocable and has its forward end connected with a manual operating lever 72 through suitable linkage 73, so that the control mechanism can be operated by hand to bring about opening and closing movements of the loading gate. A stable normal position of the shaft and pin 68 is maintained, notwithstanding vibrations to which the mechanism may be subjected in use, by means of a compression spring 74 which surrounds shaft 69 between the guides 70 and 71 and bears against collars 75 and 76 also surrounding this shaft. These collars in turn are seated against respective pins 77 and 78 fixed to the shaft 69 adjacent to the guides 70 and 71, respectively. It results that a force sufficient to overcome the compression of spring 74 is necessary in order to slide shaft 69 either backward or forward in the guides. Such a force can be applied by rocking lever 72 in either direction about its fixed pivot 72*a*. When lever 72 is pushed backward, pin 78 thrusts collar 76 backward against the compression of spring 74, and the centralizing pin 68 thus can be moved backward until it has engaged the backward end of slot 67 and has moved member 60 and plunger 47 against the tension of spring 66 to either the gate inactivating position or the gate closing position, as desired. On the other hand, if control member 60 and plunger 47 are already at gate closing position, pin 68 can be moved forward so as to dispose them at gate inactivating or gate opening position, by pulling forward on lever 72. In this case, spring 74 is compressed by action of pin 77 on collar 75, and pin 68 acts on the forward end of slot 67 to position the control member and air valve.

In the idle position of shaft 69 and lever 72, control member 60 can move backward and forward relative to pin 68 and also can undergo rocking movements about this pin. The extent of its rocking movements relative to support 41 may be limited by suitable means such as stop pins 80 and 81 fixed to a lower portion of the support for engagement with a lower part of member 60.

The functions embodied in unit 40 may now be described further:

If solenoid 62 is deenergized, its plunger 63 exerts no pressure on member 60, and spring 64 then holds member 60 and air valve 45 in gate closing position; i. e., compressed air from line 55 passes through the valve into conduit 12, and conduit 11 is vented through the valve, so that cylinder 10 moves or holds the loading gate to closed position.

When solenoid 62 is energized, plunger 63 thrusts the upper end of member 60 forward against the tension of spring 64, and if the lower end of this member is then being held in a forward position by spring 66 or link 17, the control member and air valve are disposed in gate opening position. The compressed air from line 55 now passes into conduit 11, and conduit 12 is vented, so that cylinder 10 starts moving the loading gate to open position. As the gate moves open, its operating arm 7 acts through link 18 to rock support 41 forward on pivot 42. Control member 60 and link 17 move forward with the support, thus allowing solenoid 62 to keep member 60 and valve 45 in gate opening position, unless and until a limit or restriction is imposed against their forward movement. Thus the gate could be moved and held as far open as possible, with air pressure continuing to be applied through conduit 11, until it were desired to close the loading gate, at which point control member 60 and air valve 45 could be disposed in gate closing position by deenergizing solenoid 62, thereby causing spring 64 to move them to that position, or by thrusting backward on hand lever 72.

On the other hand, the operating positions of the control mechanism can also be determined by the positioning of the lower end of control member 60: If, while the gate is opening, a resistance is applied through link 17 to limit the forward movement of member 60 with support 41, a further increment of forward movement of the support causes a relative backward movement of the lower end of member 60 to dispose this member and the air valve in gate inactivating position. The air valve then seals off both of conduits 11 and 12, so that the air cylinder 10 holds the loading gate in whatever position it occupied at the moment of the shifting of member 60.

Moreover, if the lower end of member 60 is now given a backward movement by action transmitted through link 17, it will dispose the air valve in gate closing position and cause the air cylinder 10 to start closing movement of the gate. But a corresponding backward movement of support 41, which then results through gate arm 7 and link 18, will again dispose member 60 and the air valve in gate inactivating position, unless a further backward movement of link 17 and the lower end of member 60 has occurred meanwhile through further action on link 17 .

It will be evident, therefore, that the opening of the loading gate can be brought about automatically or by remote control through the energization of motor device 62; that the resulting forward movement of unit 40 produces a corresponding forward movement of link 17 which, through lever arm 21 and shaft 16 of unit 20, will serve for the outward movement of feeler finger 15 to a working position in desired relation to basket wall 1, as the loading gate moves open; that by limiting the forward movement of link 17 the extent of the "initial gate opening" can be predetermined, the gate motor being inactivated to hold the gate at the selected extent or width of full opening when the limit is reached; and that the closing movement of the gate can be brought about progressively through progressive backward movement of the lower end of member 60, in direct proportion to that movement. Further, it will be evident that the progressive inward movement of charge feeler 15, as induced by a progressively increasing charge in the centrifugal basket 1, can act through shaft 16, lever arm 21 and link 17 to cause progressive backward movement of the lower end of control member 60 and, in this way, to cause closing movements of the loading gate proportionate to the increasing thickness of the basket charge; i. e., proportionate to the inward movement of the charge measuring device 15.

The ratio of increments of closing movement of gate to increments of inward movement of feeler 15 is dependent upon lever ratios existing in the connections between these elements. By suitable selection or adjustment of these ratios the loading gate may be caused to close in any desired relation to the inward movement of the feeler. For example, lever arm 21 may be formed with a series of spaced openings 22, any of which may be chosen to receive the pivot pin 19 on the forward end of link 17 so as to select a desired ratio for the movements of the feeler and the gate.

Referring more particularly to the construction of unit 20, it will be seen from Fig. 1 that lever arm 21 is not fixed directly to feeler shaft 16 but is connected for rotation with this shaft and the feeler through an underlying rotary member 23 and still another underlying lever arm 24 which is fixed to shaft 16. Lever arm 24

has a yieldable and adjustable connection with member 23 through a tension spring 25 interconnecting these elements and an adjustable set screw or stop element 26 which is threaded in arm 24 and bears against abutment 23*a* formed on member 23. Member 23 in turn has a yieldable and adjustable connection with lever arm 21 through a tension spring 27 interconnecting these elements and an adjustable set screw or stop element 28 which is threaded in arm 21 and bears against an arm or abutment 23*b* on member 23. The connections between parts 21, 23 and 24 cause these parts as well as shaft 16 and feeler 15 to move together about the axis of shaft 16. Being yieldable, however, these connections prevent damage to the mechanism in the event of any obstruction of the feeler movement or of the movement of arm 21. Further, the adjustable stop elements 26 and 28 provide for desirable adjustments of certain loading conditions; and the adjustable control of another loading condition is obtained by means of a set screw or stop element 29 which is adjustably threaded in a fixed bracket 30 in position to be engaged by an abutment 23*c* on member 23 when the loading gate 5 has been moved open to a desired degree of initial gate opening.

It will be evident that the forward movement of unit 40 and link 17, which occurs with opening movement of the loading gate, causes lever arm 21 and member 23 to move counter-clockwise about the axis of shaft 16 until abutment 23*c* engages against stop element 29. When that occurs, the feeler 15 ceases to move outward and the link 17 and lower end of control member 60 cease to move forward with support 41, whereupon the control member and air valve are shifted to gate inactivating position and the initial opening of the loading gate is discontinued. The extent or height of the initial gate opening thus obtained is readily adjustable at the curb of the centrifugal machine by simple adjustment of the position of stop element 29.

While the progressive gate closing action of the control mechanism can be allowed to continue until the loading gate has been brought to a completely closed position, to continue it so far is generally not necessary. A faster loading operation can be obtained by causing the control mechanism to close the gate progressively, in accordance with inward movement of the charge feeler, until the loading gate has reached a desired pinched or largely closed position, and then to move the gate quickly to its completely closed position. In the embodiment of Fig. 1 a relatively fixed limit switch 31 having a movable switch arm 32 cooperates with a switch operating cam 23*d* on member 23 to bring about the quick final closing of the gate.

The limit switch 31 has contacts LS1 connected electrically in a control circuit leading to the gate opening solenoid 62, as diagrammed in Fig. 3. There may be other circuit connections to the same solenoid, to be closed when starting a loading operation as described hereinafter, but the limit switch 31 is employed so as to hold the solenoid in energized condition in the course of each loading operation. It does this, as the drawing makes clear, through the action of cam 23*d* which moves arm 32 and limit switch 31 to circuit closing position as member 23 turns counter-clockwise with opening movement of the loading gate. The circuit thus established is held by the limit switch while the charge 2 is building up in the basket 1, and until the inward movement of feeler 15 has moved cam 23*d* clockwise to a position releasing arm 32 and thus causing the limit switch contacts to open. At that moment solenoid 62 is deenergized, and control member 60 and air valve 45 are immediately shifted to gate closing position so as to close the loading gate quickly without further dependence upon the position of the charge feeler. The position of the member 23 at the moment of final gate closing is consequently always fixed by reason of the fixed position of limit switch 31.

The adjustable stop element 26 provides for any desired adjustment of the relative position of feeler 15 and member 23, without affecting any of the other adjustments or functions of the control mechanism. This adjustment determines the position to be occupied by the feeler at the moment the limit switch 31 trips, causing quick closing of the gate, hence, the thickness to which the incoming charge will build up before the gate is closed completely, that is, the final charge thickness.

The adjustable stop element 28, provides for relative adjustment between the lever arm 21 and the member 23. This adjustment determines the position of the gate at the moment quick closing starts, that is, the pinched loading gate position, or the height of the "final gate opening" at which the quick closing action will occur.

As seen before, the adjustable stop element 29 determines the "initial gate opening." More specifically, this element 29 controls the difference between the "initial gate opening" and the "final gate opening," so that the adjustment of the initial gate opening is equivalent to the sum of the adjustments of stop elements 29 and 28. This means that for a given setting of 29 the "initial gate opening" will change whenever the "final gate opening" is changed and by the same amount.

The adjustable stop element 29 also controls the initial position of the feeler 15, that is, the position occupied by the feeler at the limit of the gate opening movement; hence the initial charge thickness, that is the thickness to which an incoming charge in the basket 1 must build up before the charge begins to act upon feeler 15 and thus, to cause closing movement of the loading gate. For practical purposes, it is generally desirable that the gate be held at the full initial opening until the charge has reached a thickness of at least several inches.

The feeler 15 moves at a rate proportional to the gate movement, so that for a greater "initial gate opening" the "initial charge thickness" is smaller. The ratio between movement of gate and feeler 15 and consequently the ratio between "initial gate opening" and "initial charge thickness" can be changed by inserting pin 19 of link 17 into different holes 22 of lever 21.

Fig. 3 shows an elementary control circuit suitable for the initiation of each loading operation either by remote manual actuation of the described mechanism or by automatically timed actuation thereof.

For remote manual actuation, a pushbutton PB2 may be located at any desired position with its contacts connected respectively to one side of the coil of solenoid 62 and to current supply line L1, the other side of the solenoid coil being connected to current supply line L2. The limit switch 31 has contacts LS1 connected in a circuit bridging the pushbutton contacts. Thus, the pushbutton may be closed manually and held closed until movements of gate 5, unit 40 and unit 20 have resulted in the closing of contacts LS1, whereupon the pushbutton may be released and the control mechanism will proceed to complete a loading operation.

Automatic initiation of the loading may be obtained by the use of an electrical timer of any suitable construction, as diagrammed at LT in Fig. 3. The timer typically comprises a clutch actuating coil LTC, a motor LTM and normally open contacts LT1 and LT2; contacts LT1 being closed by action of the timer when its clutch and motor are energized, and contacts LT2 being closed at some predetermined interval thereafter, depending upon the setting selected for the timer mechanism. Such a loading timer may be part of a more comprehensive timing control system used for controlling functions of the centrifugal machine other than the loading operation, or it may be energized independently of other controls. In either event, contacts such as those of switch PB1 may be closed to start the action of the loading timer, which may be continued in action by holding its own energizing

circuit through contacts LT1. After expiration of the time interval set on the timer mechanism, the timer will close contacts LT2 in a circuit between solenoid 62 and line L1, thus energizing the solenoid to cause the opening of the loading gate and other coordinated movements of the loading control mechanism as described above.

The operation of the first embodiment may be explained further as follows: At all stages of the operating cycle of the centrifugal machine, except the loading stage, the loading gate 5 is in closed position, the charge feeler 15 rests at an extreme inward position out of contact with any charge in the basket, and the control member 60 and air valve 45 are in gate closing position, solenoid 62 being deenergized. The basket 1 being empty and having been brought to a low speed suitable for loading, solenoid 62 is then energized in any of the ways above mentioned.

Of course, in cases of emergency or abnormal conditions, a manually controlled loading operation can be brought about easily by manipulation of lever 72. But automatically controlled loading is normally desired; so solenoid 62 is energized, and the mechanism then proceeds to bring about a complete and precisely controlled loading operation, quite automatically.

First, member 60 and the air valve 45 are shifted to gate opening position by the action of solenoid 62, and air cylinder 10 proceeds to move the gate in opening direction. At the same time, unit 40 and link 17 are moved forward and unit 20 is moved counter-clockwise about the axis of shaft 16 so as to move the charge feeler 15 outward into working position, to close limit switch 31, which holds closed the energizing circuit of solenoid 62, and finally, when the gate is at the desired degree of full or initial opening, to engage abutment 23c with stop element 29 so that a slight additional forward movement of support 41 will dispose member 60 and air valve 45 at gate inactivating position.

The opening of the gate, of course, admits charge material into the basket, and this inflowing material builds up into an annular charge of progressively increasing thickness. When the inner surface of the increasing charge has reached the feeler, say at line 2a in Fig. 1, feeler 15 begins to be moved inward. As it moves inward, unit 20 is turned clockwise about the axis of shaft 16, and control member 60 is thrust backward at its lower end by link 17 to shift the air valve from gate inactivating position to gate closing position. The loading gate 5 then starts to close under the force of air pressure admitted through conduit 12 into cylinder 10.

As the gate closes, however, it produces a backward movement of support 41 and valve 45 to counteract the charge induced movement of link 17 and member 60, thus biasing member 60 and the air valve inactivating position. Further inward movement of the feeler, induced by further building up of the charge, causes a further movement of the control member in gate closing direction, to be counteracted in turn by the further gate closing movement, until the charge has reached approximately the desired final thickness and the gate 5 has a pinched position from which it can be closed quickly without allowing an objectionable surplus of charge material to enter the basket.

At that moment, the limit switch cam 23d moves clear of limit switch arm 32, and contacts LS1 then open to deenergize solenoid 62 and cause control member 60 and air valve 45 to be disposed and held in gate closing position. The gate then moves quickly to its completely closed position. At the same time, finger 15 is moved further inward to a position where it will not obstruct the rotation of the charged basket as the centrifugal machine proceeds on its operating cycle.

The embodiment of the invention shown in Figs. 4 and 7 has several features in common with that of Fig. 1. It differs, however, in the form, arrangement and operation of parts of the controls and in that the loading gate is closed step by step in response to charge-induced movements of a charge measuring device, instead of in continuous response thereto as in Fig. 1. Further, this device is moved to working position by its own motor. Only electrical connections exist between a charge feeler assembly 20A, adjacent the curb C of the centrifugal, and a control assembly 40A which is connected mechanically with the loading gate. The loading gate has an "open" position, a "pinched" position and a closed position, and in closing it is moved rapidly from open to pinched position after most of the charge has been formed and is again moved rapidly from pinched position to closed position when the charge is at the desired final volume.

In Fig. 4 the arrangement of the loading spout 4a, the loading gate 5a and the gate operating mechanism, including link 6a, arm 7a, shaft 8a, arm 9a and air cylinder 10a, is similar to the arrangement of Fig. 1. As illustrated, however, downward movement of the air cylinder piston and arm 9a serves to close the loading gate, and upward movement thereof serves to open the gate; so the gate opening air line 11a is connected with the lower end of the cylinder and the gate closing air line 12a is connected with its upper end.

These air lines extend from ports of an air control valve 45a which is mounted on a slidable support 41a forming part of assembly 40A. Valve 45a is connected with a source of compressed air through air line 55a. It has a plunger 47a normally biased to gate opening position by a compression spring 48a, and in construction and operation it may be like the air valve described in connection with Fig. 1.

The operating positions of the air valve are again governed by the positioning of a movable control member 60a which is arranged over the face of support 41a so as to be movable with this support yet to undergo relative movements by which an abutment 61a at one side of member 60a will dispose the valve elements in gate opening, gate inactivating or gate closing position. The support also carries a solenoid 62a in position to engage the upper end of member 60a and thrust this member away from the valve body when energized. A tension spring 64a extending between the upper part of member 60a and an anchor on support 41a serves to bias the control member and valve plunger toward gate closing position. A second tension spring 66a, anchored to the support and to the lower part of member 60a, acts in a direction opposite to spring 64a and normally holds a stop pin 80a on said lower part against an abutment 81a fixed to the movable slide.

It will be evident that when solenoid 62a is energized member 60a may be thrust away from the valve body against the tension of spring 64a so as to dispose the valve in gate opening position, air pressure then passing through line 11a; while when deenergized solenoid 62a allows spring 64a to dispose the control member and valve body in gate closing position, in which air pressure passes through line 12a into the lower end of cylinder 10a. On the other hand, when solenoid 62a is energized, member 60a and the air valve nevertheless may be disposed in gate inactivating position or gate closing position by forcing the lower part of the control member toward the valve body against the tension of spring 66a.

Furthermore, any desired position of the control member and air valve may be established by the manual operation of a hand lever 70a which is fulcrumed at 71a and is connected with the mid-portion of control mmber 60a through link 73a, arm 74a pivoted at 75a to the slidable support, and link 76a. This manual operating mechanism serves the same functions as the mechanism connected with lever 72 in the embodiment of Fig. 1.

The support 41a is mounted for sliding movement in a fixed housing 42a by means of a rod 43a which carries the support and extends slidably through bearings 44a and 44b on opposite side walls of the housing. The for-

ward end of rod 43a is coupled pivotally to a link 43b which in turn is pivoted to an arm 46a fixed to the gate operating shaft 8a. This connection is such that opening and closing movements of the loading gate 5a produce proportional forward and backward sliding movements, respectively, of support 41a. These movements are utilized for positioning the control member and air valve as follows:

The lower end 63a of member 60a moves forward with support 41a, as the loading gate opens, in a path in which it will engage an abutment 65a on an adjustably positioned arm 67a. The forward end of this arm slidably engages a guide 68a fixed to the housing. Its backward end is pivoted to an arm 69a which in turn is pivoted to the fixed housing at 70a. An adjustable stop or set screw 71a is mounted on the backward side wall of the housing so as to engage arm 69a and determine the working position of the abutment 65a, this position being yieldably maintained by a tension spring 72a which is anchored to arm 67a and the housing structure so as to keep arm 69a in engagement with the stop element. The abutment 65a thus constitutes an adjustable means for determining the "initial opening" of the loading gate. When solenoid 62a is energized to dispose control member 60a and air valve 45a in gate opening position, the loading gate opens and at the same time support 41a moves forward. These movements continue until end 63a of the control member has engaged the preset abutment 65a, whereupon the control member and air valve are disposed at gate inactivating position. The loading gate then ceases its opening movement, at a position determined by the setting of abutment 65a.

In the initial gate closing operation, which follows when solenoid 62a is deenergized, any desired "pinched" position of the loading gate is established, through backward movement of the slide support 41a, by means of an arm 77a which presents an abutment 78a in the path of movement of the upper end 79a of control member 60a. Arm 77a is pivoted at its backward end to an arm 82a which in turn is fulcrumed on fixed pivot 70a. An adjustable stop or set screw 83a, mounted on the housing side wall, and a tension spring 84a extending between arm 77a and the housing structure, serve to position abutment 78a in the manner described with reference to abutment 65a. In this instance, however, spring 84a tends to swing arm 77a upwardly and out of the path of the control member, and a solenoid 85a is mounted on the housing in position to counteract the spring action and hold abutment 78a in that path when this solenoid is energized. Accordingly, the energization of solenoid 85a in conjunction with opening movement of the loading gate will cause abutment 78a to be disposed in the path of backward movement of the control member; and when gate closing action occurs, the concomitant backward movement of support 41a and member 60a brings the upper end of member 60a into engagement with abutment 78a, whereupon a further increment of gate closing movement shifts the air valve 45 relative to member 60a so as to dispose these elements at gate inactivating position. Thus the "final opening" or pinched position of the loading gate is determined by the adjustable setting of abutment 78a.

Further, when it is time to complete the closing of the loading gate this may be accomplished automatically by deenergizing solenoid 85a (solenoid 62a having been previously deenergized). Spring 84a thereupon shifts arm 77a and abutment 78a out of engagement with the control member and allows spring 64a to dispose this member and the air valve at gate closing position.

The conditions of actuation of the solenoids of control assembly 40A are determined by the charge feeler assembly 20A. Two limit switches 21a and 31a are associated with that assembly; switch 21a being connected in a control circuit leading to solenoid 62a, and the other limit switch being in a circuit to solenoid 85a. The limit switches have arms 22a and 32a, respectively, which normally hold their respective contacts open but are moved to close the respective solenoid circuits as described below.

Assembly 20A includes a charge feeler 15a adjustably mounted on a shaft 16a which extends vertically through two spaced bearings 16b and 16c. One bearing is fixed to the top of curb C and the other is fixed above it to a bracket or housing 18a. A torque motor 17a is mounted on a support 19a extending from this housing. The torque motor shaft 17b is keyed to a coupling 16d which is also keyed to the upper end of feeler shaft 16a, so that the charge feeler and the torque motor move together. When the torque motor is energized it acts in a counterclockwise direction, as viewed from the top of Fig. 4, to move feeler 15a outward into working position. The torque then exerted, however, is so limited that the pressure of charge material against the feeler, as a charge builds up in the centrifugal basket 1, is able readily to overcome this torque and move the feeler inward.

Below bearing 16c two control elements 24a and 25a are mounted on shaft 16a. The first is keyed to the shaft opposite limit switch arm 32a and comprises a radially protruding cam 24b for operation of this switch arm and an upwardly projecting abutment 24c. The second is loose on the shaft, above element 24a, and comprises a radially protruding cam 25b for operation of limit switch arm 22a. Element 25a also has a radial arm 25c in which a stop element or set screw 25d is threaded for engagement with the abutment 24c on element 24a.

A pin 25e on arm 25c serves as the anchor for one end of a tension spring 26a, the other end of which is anchored to the frame 18a so that the feeler shaft assembly is biased clockwise by this spring. Whenever the torque motor is inactive, spring 26 moves the assembly to dispose feeler 15a and the switch cams 24b and 25b in an idle position.

As seen in Fig. 7, the extreme inward or idle position of the feeler is determined by a stop element 27a adjustably fixed in housing 18a so as to engage a side of cam 24b at any desired limit of its clockwise movement. The initial outward or working position of the feeler is determined similarly by a stop element 28a which is adjustably fixed in another part of housing 18a so as to engage a side of cam 25b at any desired limit of the counterclockwise movement of the feeler shaft assembly.

It will now be evident that an automatic centrifugal loading operation may be started, in the use of this second embodiment, merely by energizing torque motor 17a. The motor then turns the feeler shaft assembly counterclockwise against spring 26a until the feeler reaches an initial working position determined by stop element 28a and in the course of this movement, cam 24b acts first upon arm 32a to close limit switch 31a, and shortly afterward cam 25b acts upon arm 22a to close limit switch 21a. The solenoids 85a and 62a thus are energized so as to urge arm 77a and abutment 78a toward their working position and to thrust forward the upper end of control member 60a. Air valve 45a now admits compressed air into the lower end of cylinder 10a; loading gate 5a starts opening movement; and arm 77a moves to its working position.

When the charge feeler has arrived at the desired outward position its movement is stopped by stop element 28a, but the motor 17a continues to be energized and to keep the two limit switches closed.

When the loading gate has reached the predetermined open position its motion is stopped by the action of abutment 65a as already described.

Meanwhile, charge material flowing into the centrifugal basket forms therein an annular charge wall of progressively increasing thickness; and after the inner surface of this will reaches the feeler 15a, it moves the feeler inward as the charge increases, thus turning the feeler shaft assembly clockwise against the motor torque. At an

inward feeler position determined by the setting of adjustable stop element 25*d*, cam 25*b* releases switch arm 22*a*, whereupon the contacts of limit switch 21*a* are opened and solenoid 62*a* is deenergized. The control member 60*a* and air valve 45*a* are thus disposed at gate closing position, and compressed air flows into the upper end of cylinder 10*a* to move the loading gate in closing direction. As the gate so moves the support 41*a* slides backward, and at a desired "pinched" position of the gate abutment 78*a* stops the upper end of the control member so as to dispose this member and the air valve at gate inactivating position.

The gate now stays at the desired "pinched" position, allowing only a relatively small stream of charge material to enter the basket, until the charge induced movement of feeler 15*a* has caused cam 24*b* to release switch arm 32*a*. At that moment the contacts of limit switch 31*a* open, whereupon solenoid 85*a* is deenergized, spring 84*a* lifts abutment 78*a* out of the path of control member 60*a*, and spring 64*a* moves the control member again to gate closing position. The loading gate then moves quickly to its completely closed position, and a complete charge of the desired volume is obtained in the centrifugal basket.

The position of the feeler 15*a* at that moment, which determines the final charge thickness in the basket, is adjusted by means of the set screw 33 which holds the hub of the feeler at any desired position on shaft 16*a*.

After the completion of the charging operation torque motor 17*a* preferably is deenergized so that spring 26*a* will move the feeler shaft assembly farther clockwise to the idle position determined by stop element 27*a*, at which position feeler 15*a* is spaced inward from the inner surface of the rotating basket charge.

A third embodiment of this invention will now be described with reference to Figs. 5 and 6 of the drawings. In this embodiment the centrifugal basket 1 on shaft 1A is associated with a charge feeler 15, and a unified control mechanism located at curb C is connected mechanically for movements with the feeler and with the operating mechanism of the loading gate. The operation of this loading control mechanism is initiated manually, whereupon the mechanism proceeds to control and complete a loading operation in substantially the manner described in connection with Fig. 1.

As seen in Fig. 6, feeler 15 is mounted on feeler shaft 100 which extends vertically through spaced bearings 101 and 102 in opposite ends of a supporting tube 103 which depends from a hub 104 fixed over the curb top. Hub 104 is fixed to base plate 105. The upper end 100*a* of shaft 100 carries a control member 110 which is fixed to the shaft and has two arms 111 and 112 extending horizontally over the base plate in the form of a fork or yoke which terminates in spaced, oppositely facing rounded ends 111*a* and 112*a*. These rounded yoke ends bear against the opposite ends of a valve plunger 114 which is the movable element of an air control valve 115 similar to valve 45 of the first embodiment. The body of valve 115 is mounted on a movable support 130 which overlies base plate 105 and embraces hub 104 so as to be reciprocable thereon about the axis of shaft 100.

The air valve 115 has a compressed air supply line 116 and air lines 117 and 118 which lead respectively to opposite ends of air cylinder 119. The piston of this air cylinder is connected pivotally at 120 with arm 121 fixed to a gate operating shaft 122, this shaft being connected with a loading gate in any suitable manner such as that of Fig. 1 or that of Fig. 4. It suffices here to state that when control member 110 is shifted counterclockwise relative to support 130, it disposes valve plunger 114 at gate opening position so as to admit compressed air from line 116 through line 117 into the backward end of cylinder 119, thereby causing the loading gate to open; and when the control member and valve body shift relatively in the opposite direction, the valve is disposed at gate closing position and compressed air passes through line 118 into the forward end of cylinder 119, thereby closing the loading gate.

Opening and closing movements of the loading gate bring about concomitant movements of the control mechanism through suitable mechanical connections between the movable support 130 and a control cam 124 which is fixed to turn with the gate operating shaft 122. For ease of illustration, these connections are shown as if they existed in a single plane, although the connection to support 130 typically would extend horizontally from this support and the cam 124 typically would move in a vertical plane. Support 130 has a spherical coupling at 131 with a rod 132 which is suitably connected for movement to and fro with movements of a vertical connecting rod 133. This rod in turn is connected through an adjustable coupling 134 and a spring coupling 135 to one arm 136 of a lever which is fulcrumed on a fixed pivot 137 between its arms, and which carries on its other arm 138 a cam roller 139 held against the face of cam 124. A spring 140 yieldably holds the cam roller against the cam.

In addition to part of coupling 131 the movable support 130 carries nearby an abutment 142 in position to engage a fixed yet adjustable stop element 143 at a desired limit of clockwise movement of the support.

The movable control member 110 is integral or joined with a hand lever 150 which extends forward from the feeler shaft for convenient operation by an attendant of the centrifugal machine. An abutment 152 is fixed to this lever in position to engage a relatively fixed yet adjustable stop 154 at a desired limit of counterclockwise movement of control member with support 130.

The operation of this third embodiment of the invention is as follows:

As shown in full lines in Fig. 5, the charge feeler 15 is in an idle or extreme inward position, the loading gate (not shown) is closed, and cam roller 139 rests on a lower face 124*a* of cam 124.

In order to initiate a loading operation, the attendant of the machine grasps hand lever 150 and easily moves it counterclockwise, thereby disposing the yoke-like control member and valve plunger 114 at gate opening position so that compressed air passes through line 117 and moves the air cylinder to open the loading gate. As the gate moves open, cam roller 139 and arm 138 are lifted by the rising face 124*b* of cam 124, and through the linkage extending to support 130 this movable support is turned proportionately about the axis of hub 104. The support thus follows the hand lever, and as long as the hand lever continues to be moved ahead of the support, the gate continues to open. If the hand lever movement is stopped, the gate stops opening at a corresponding position; and if the hand lever movement is reversed, the gate closes correspondingly.

Normally, however, the hand lever is moved counterclockwise until it reaches a predetermined limiting position at which the desired initial gate opening is obtained, and this movement also turns shaft 100 so as to dispose feeler 15 in a desired initial working position as illustrated by broken lines in Fig. 5. The initial gate opening and the initial feeler position are predetermined and kept uniform in successive loading operations by the setting of stop element 154, since abutment 152 engages this stop element after a predetermined hand lever movement, whereupon a slight further movement of the gate and support 130 causes yoke end 112*a* to dispose the air valve 115 at gate inactivating position.

The open loading gate is now delivering charge material into basket 1, and when the thickness of the growing charge reaches line *a*, the charge surface begins moving feeler 15 inward. As the feeler moves inward it turns shaft 100 and control member 110 in clockwise direction and thus shifts the control member and air valve plunger to gate closing position, air pressure then passing through line 118 into the gate closing end of cylinder 119. The gate now starts closing, but as it moves in closing direc-

tion a corresponding backward (clockwise) movement of support 130 is produced through the action of cam 124 and elements 131 to 140, inclusive. This backward movement in turn disposes the control member and air valve at gate inactivating position, for the valve plunger 114 is easily slidable in the valve body and the valve elements will shift to that position before they can transmit hrough member 110 enough force to overcome the friction of shaft 100 in bearings 101 and 102. Meanwhile, however, the feeler is still being moved inward; so it acts continuously to bias the control member and air valve to gate closing position, while being counteracted continually by further gate closing movements which bias these elements to gate inactivating position. It results that the closing movement of the loading gate is brought about in continuous response to the charge induced movement of the charge feeler, and in a definite relation to that movement which is determined by the operating connections between gate shaft 122 and support 130.

As already explained, however, the charge finally reaches a desired thickness at which the loading should end quickly without further progressive action of the control mechanism. This point is determined by the setting of stop element 143. When abutment 142 engages this stop element the support 130 cannot move farther in clockwise direction, and any further inward movement of feeler 15 then disposes control member 110 definitely at gate closing position and the gate quickly completes its closing movement.

It will be understood that a direct mechanical connection could be applied instead of a cam between arm 138 and an arm on gate shaft 122. In that event the spring coupling 135 would permit overtravel in the linkage between the movable support 130 and the gate mechanism. A cam connection of the type illustrated may be advantageous, however, in that any desired relationship between the travel of the charge feeler 15 and the travel of the loading gate can be obtained by suitable formation of the cam used at 124. In this way the action of the loading control mechanism can be easily modified so as to conform with special requirements of any particular type of charge material to be loaded and treated in the centrifugal machine.

By adjusting the position of stop element 154, the initial gate opening and the initial position of feeler 15 may be selected as desired. The initial feeler position may be adjusted independently by changing the angular relation of the feeler or of feeler shaft 100 to control member 110. By adjusting the position of stop element 143 the final thickness of the basket charge may be selected as desired. By adjusting the coupling 134 on connecting rod 133 the "pinched" position or "final opening" of the loading gate may be selected as desired. Thus it is evident that the third embodiment of this invention provides for adjustments and for a progressive manner of operation quite similar to those provided for in the embodiment of Fig. 1.

A further feature of this invention consists in a combination which prevents the opening of the loading gate through automatic operation of the loading control mechanism unless a movable cover for the centrifugal curb top is in open position. Further, an inadvertent closing of the curb cover in the course of a loading operation will interrupt the loading by closing the loading gate. To this end, the movable curb cover is provided with means which cooperate with parts of the loading control mechanism to hold this mechanism in gate closing position whenever the curb cover is closed, and which release the cooperating parts for normal operation when the curb cover is open.

Such a combination is illustrated in Figs. 4 and 7, as applied in the second embodiment above described. The curb top at 86 has a central opening 87 around basket spindle 1A, and a cover element 88 is slidable about a fixed pivot 89 so as to open and close the top opening. A control rod 90 is pivoted to cover 88 at 91, this rod extending forward from its pivot in slidable engagement with a guide bracket 92. When cover 88 is closed, as seen in Fig. 7, the forward end portion of rod 90 lies in the path of turning movement of a tail piece 93 extending radially from control element 24*a*. The relative locations of rod 90 and tail piece 93 are such that the rod is retracted from the path of the tail piece when cover 88 is open; but when the cover is closed rod 90 blocks counterclockwise movement of the feeler shaft assembly, thus preventing actuation of the loading gate through cam 25*b* and limit switch 21*a*. Even though the torque motor is energized, the feeler shaft assembly cannot move to active position as long as the closed curb cover holds rod 90 across the path of tail piece 93; so solenoid 62*a* is never energized and the automatic control mechanism never opens the loading gate as long as the curb cover is closed. Although opening of the curb cover removes rod 90 from the path of tail piece 93, it will be evident that end 94 of this rod will engage the tail piece and thrust the feeler shaft assembly clockwise to its idle position if the curb cover is closed while the loading control mechanism is active.

According to a further feature of this invention, the loading control mechanism is provided with structures which act automatically to vary the extent of opening of the loading gate, in different loading operations, so as to compensate for changes in the level or pressure head of the supply of charge material from which the centrifugal machine is loaded in these operations. Such changes influence the velocity of flow through the gate orifice, and these further structures are adapted to control the gate opening so that the charge material will flow at approximately the same volumetric rate over long periods of centrifugal operation, notwithstanding major changes of level in the holding tank serving the centrifugal machine. To achieve this result, the height of the gate opening obtained at any position of the charge feeler is made smaller for loading operations occurring when the charge material flows out under a higher level and pressure head, than it is when the level of the charge material is reduced.

There are various ways of obtaining this function with the new loading control mechanisms. For example, suitable stop elements in embodiments already described can be turned progressively, by hand or by any suitable progressive or step-by-step mechanism, at a rate correlated to the rate of change of the level of charge material in the holding tank. On the other hand, a preferred manner of obtaining this function is illustrated in Fig. 8 of the drawings, which shows parts of the embodiment of Figs. 1 to 3 in combination with a level-compensating mechanism which responds directly to the hydrostatic pressure of material in the holding tank 3 and adjusts proportionately a connecting linkage that governs the ratio of the travel of loading gate 5 to the travel of the charge feeler 15 (Fig. 1).

Fig. 8 shows in outline the movable control box or support 41 with control member 60 projecting from this box for connection through link 17 with the feeler shaft assembly of unit 20 (Fig. 1). The loading gate 5 is again operated through link 6, arm 7 and gate operating shaft 8. Gate movements are again transmitted to support 41 through link 18 pivoted at one end, at 43, to the control box; but instead of being fixed to arm 7 as at 44 in Fig. 1, the other end of this link is coupled for movement with the gate operating mechanism through a variable positioning device 200 which serves to vary automatically the effective length of the connecting link, as follows:

The forward end of link 18 is pivotally connected at 202 to the head 203 of a plunger 204 which is reciprocable within a hollow body member 205. The plunger head is guided in passage 206 of the body member, while the stem of the plunger extends through body wall 207

into a piston chamber 208 where it carries piston 209 on its inner end. The body member 205 is keyed to gate operating shaft 8 so that it moves in the same sense as arm 7, thus moving link 18 and support 41 in proportion to the movement of gate 5.

The lever ratio existing at any movement, however, depends upon the position of head 203 in passage 206, and this position is determined according to the pressure head of material in tank 3 in the following manner:

A compression spring 210 within chamber 208 biases piston 209 toward shaft 8, thus tending to shorten the lever arm between gate 5 and support 41 under a force which varies with the degree of compression of the spring. A compressed air line 212 enters the base of the piston chamber to apply therein a fluid pressure counterbalancing the spring pressure. This air line extends from an air chamber 216 which is fixed over an opening 217 in tank 3 and is separated from charge material in this tank by a flexible diaphragm 218. A restricted orifice 219 enters chamber 216 from a compressed air line 220 containing air under a pressure at least equal to the maximum pressure asserted on diaphragm 218 by material in the tank. Another restricted orifice 222 is provided for venting pressure from chamber 216. The air flow through these orifices is controlled by needle valves 223 and 224, respectively, both of which are carried on the outer side of a floating valve member 225. The inner side of this valve member bears against a stem 226 on diaphragm 218, being thrust against this stem by a compression spring 227 which has enough strength to open or close either needle valve.

It results that the air pressure in chamber 216, hence the pressure transmitted through line 212 into piston chamber 208, is always in balance with the pressure exerted by charge material against the diaphragm. When tank 3 is filled with charge material the outward pressure of this material acts through stem 226 to rock member 225 against spring 227 so as to open needle valve 223 and hold valve 224 closed, thus allowing the air pressure to counterbalance the material pressure. The diaphragm then moves inward until both needle valves are closed. As material is withdrawn from tank 3, however, an overpressure developing in chamber 216 will move the diaphragm and stem 226 inward, whereupon spring 227 rocks member 225 inward so as to keep valve 223 closed yet to open valve 224, until a pressure balance again closes both needle valves.

Thus the air pressure acting on piston 209 always corresponds to the pressure of charge material in tank 3, and this air pressure positions the plunger head 203 and link 18 at a corresponding distance from the axis of the gate operating shaft 208. Accordingly, when the charge material is at a high level, link 18 operates on a larger lever arm than when the level of charge material is lower, and the gate opening produced by the loading control mechanism is therefor smaller in the case of a high level and larger in the case of a lower level. In this way the level compensating mechanism can so vary the connecting linkage in the loading control mechanism that a substantially uniform rate of flow of charge material through the loading gate will be maintained in all loading operations, notwithstanding the accompanying changes of level in the holding tank.

It will be understood that the foregoing detailed description and the accompanying drawings are intended to exemplify the invention and that the new parts, improvements and combinations herein disclosed may be embodied in various other forms and arrangements of apparatus without departing from the substance of the disclosure or the intended scope of the appended claims.

I claim:

1. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge measuring device positionable by charge material in the basket, means for energizing the gate motor including independently movable control elements having gate opening, gate closing and motor deenergizing relative positions, means for positioning one of said elements according to positions of said gate and means moved independently of said gate for positioning another of said elements according to positions of said device, means for concomitantly activating said charge measuring device and biasing said elements to gate opening position, said first mentioned positioning means being responsive to charge induced movements of said device to bias said elements to gate closing position, and said independent positioning means being moved progressively with closing movements of the gate so as to counteract the last recited means and bias said elements to motor deenergizing position so that progressive closing positions of the gate are determined by positions of said device.

2. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge measuring device positionable by charge material in the basket, gate motor energizing means including independently movable control elements having gate opening, gate closing and motor deenergizing relative positions, a shiftable member controlling the position of one of said elements, means for concomitantly activating said measuring device and positioning said member and said one element so as to dispose said elements in gate opening position, means responsive to charge induced movements of said device for shifting said member and said one element so as to dispose said elements in gate closing position, and means moved independently of said device in response to closing movement of the gate for displacing another of said elements relative to said one element so as to counteract said shifting means and dispose said elements in said motor deenergizing position.

3. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge measuring device positionable by charge material in the basket, gate motor energizing means including independently movable control elements having gate opening, gate closing and motor deenergizing relative positions, a shiftable member controlling the position of one of said elements, means for concomitantly activating said measuring device and positioning said member and said one element so as to dispose said elements in gate opening position, means responsive to charge induced movements of said device for shifting said member and said one element so as to dispose said elements in gate closing position, means moved independently of said device in response to closing movement of the gate for displacing another of said elements relative to said one element so as to counteract said shifting means and dispose said elements in said motor deenergizing position, and means for rendering said independently moved means ineffective at a predetermined pinched position of the closing gate.

4. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge feeler movable when in working position by an increasing charge in the basket, gate motor energizing means including independently movable control elements having gate opening, gate closing and motor deenergizing relative positions, a movable support carrying one of said elements, a control member carried with but shiftable relative to said support to position another of said elements, means for displacing said support and said one element in proportion to movement of the loading gate, concomitantly operative means respectively for shifting said control member and said other element relative to said support to dispose said ele-

ments in gate opening position and for placing said feeler in working position, and means responsive to a charge induced movement of said feeler for shifting said member and said other element relative to said support so as to dispose said elements in gate closing position, the action of said displacing means upon a gate closing movement serving to counteract the last recited means so as to bias said elements to motor deenergizing position pending a further charge induced movement of the feeler.

5. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a movable support, a gate motor energizer on said support comprising relatively fixed and relatively movable elements having gate opening, gate closing and deenergizing positions, a member carried by but shiftable relative to said support to position said movable elements, a charge feeler movable when in working position by an increasing charge in the basket, means for displacing said support with movements of the gate, concomitantly operative means respectively for shifting said member so as to dispose said energizer in gate opening position and for moving said feeler outward to working position, means responsive to inward movement of said feeler for shifting said member to dispose said energizer in gate closing position, and means active upon a displacement of said support by gate closing movement to reposition said member so as to dispose said energizer in deenergizing position pending further inward movement of said feeler.

6. In a loading control mechanism as described in claim 5, means including a limit device operative upon a predetermined displacement of said support with gate opening movement to shift said member so as to dispose said energizer in deenergizing position, and means for adjusting the position of said limit device so as to select any of various degrees of initial gate opening.

7. In a loading control mechanism as described in claim 5, means including a limit device operative at a predetermined inward position of the feeler to render ineffective said repositioning means and position said member to hold said energizer in gate closing position.

8. In a loading control mechanism as described in claim 5, means including a limit device operative at a predetermined inward position of the feeler to render ineffective said repositioning means and position said member to hold said energizer in gate closing position, and means for adjusting the relative positions of said limit device and the feeler so as to select any of various final thicknesses for the basket charge.

9. In a loading control mechanism as described in claim 5, manual operating means connected with said member and extending to a position accessible to an attendant of the installation for shifting said member to dispose said energizer in any desired position independently of the positions of other parts of the mechanism.

10. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a movable support, a motor control on said support comprising a relatively movable element having gate opening, gate closing and deenergizing positions, a member carried with but shiftable relative to said support to position said movable control element, a charge feeler movable inward when in working position by an increasing charge in the basket, means for displacing said support with movements of the loading gate, means including a motor device on said support for shifting said member to dispose said element in gate opening position, means for interconnecting said member and said feeler so that displacement of said support and said member with gate opening movement moves the feeler outward to working position, and so that an inward feeler movement will shift said member to dispose said element in gate closing position, and means responsive to displacement of said support with gate closing movement to bias said member so as to dispose said element in deenergizing position pending further inward movement of the feeler.

11. In a loading control mechanism as described in claim 10, means including a limit switch and a switch operator moved with said interconnecting means for inactivating said motor device and positioning said member to hold said control element in gate closing position at a predetermined inward position of the feeler movement.

12. A loading control mechanism as described in claim 11, and means for adjusting the relative positions of said switch operator and said interconnecting means so as to select any desired final opening for the loading gate.

13. A loading control mechanism as described in claim 11, and means for adjusting the relative positions of said switch operator and said feeler so as to select any desired final thickness for the basket charge.

14. In a loading control mechanism as described in claim 11, an abutment member moved with said interconnecting means, a relatively fixed stop engaged by said abutment member after a predetermined displacement of said support with gate opening movement to position said member and thereby said control elements in deenergizing position, and means for adjusting the position of said stop so as to select any desired maximum opening for the loading gate.

15. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a large tank for holding charge material having a loading gate for discharging such material under gravity flow into the basket, and means for closing the gate, a charge measuring device positionable by a charge forming in the basket, control means moved progressively in response to charge induced movements of said device, actuating means for said gate closing means progressively responsive to movements of said control means, means progressively responsive to closing movements of the gate for inactivating said gate closing means, so as to close the gate progressively according to progressive movement of said device, and means operative progressively to change the relative working positions of the loading gate and said measuring device in correspondence to changes in the head and discharge rate of material in said tank.

16. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a large tank for holding charge material having a loading gate for delivering such material under gravity flow into the basket, and a gate operating air cylinder, the combination of a movable support, linkage to connect said support for movement with the gate, an air valve on said support for controlling said cylinder comprising a movable element having gate opening, gate closing and gate inactivating positions, a member carried with but shiftable relative to said support to position the movable valve element, a charge feeler movable inward when in working position by an increasing charge in the basket, a motor device on said support for shifting said member to dispose said valve in gate opening position, means for interconnecting said member and said feeler so that displacement of said support and said member with gate opening movement moves the feeler outward to working position, and so that an inward feeler movement will shift said member to dispose said valve in gate closing position, means responsive to displacement of said support with gate closing movement to bias said member so as to dispose said valve in gate inactivating position pending further inward movement of the feeler, whereby the gate is closed progressively in definite relationship to positions of the feeler, and means responsive to changes of the pressure of charge material in said tank for adjusting said linkage so as to change the relative working positions of the gate and the feeler.

17. In a loading control mechanism for a cyclical cen-

trifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating fluid pressure cylinder, the combination of a movable support, a fluid valve on said support for energizing said cylinder comprising relatively fixed and relatively movable elements having gate opening, gate closing and deenergizing positions, a member carried by but shiftable relative to said support to position the movable valve element, a charge feeler movable when in working position by an increasing charge in the basket, means for displacing said support with movements of the gate, a manual operating device having connections with said feeler and with said member for moving the feeler outward to working position and simultaneously shifting said member to dispose said valve in gate opening position, said connections being responsive to inward movements of said feeler to shift said member so as to dispose said valve in gate closing position.

18. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating fluid pressure cylinder, the combination of a movable support, a fluid valve on said support for energizing said cylinder comprising a relatively fixed and relatively movable elements having gate opening, gate closing and deenergizing positions, a member carried by but shiftable relative to said support to position the movable valve element, means normally biasing said member toward a position disposing said valve in gate closing position, a charge feeler movable when in working position by an increasing charge in the basket, means for displacing said support with movements of the gate, a yielding motor connected with said feeler for moving it outward to working position, a motor device on said support for shifting said member against said biasing means so as to dispose said valve in gate opening position, switch means activated as the feeler moves outward for energizing said motor device, a limit device operative upon a predetermined displacement of said support with gate opening movement to shift said member so as to dispose said valve in deenergizing position, said switch means being responsive to a predetermined inward movement of said feeler to deenergize said motor device, limit means operative upon a predetermined displacement of said support with gate closing movement to shift said member so as to dispose said valve in deenergizing position, and means responsive to a further inward movement of the feeler to inactivate said limit means.

19. In a loading control mechanism for a cyclical centrifugal installation, a support adapted to be mounted at the installation for movement to and fro on its mounting, an air valve carried by the support comprising relatively fixed and relatively movable elements having gate opening, gate closing and gate inactivating positions, a control member carried with and shiftable relative to said support to position the movable valve element, the support having means by which to connect it for forward and backward movements with opening and closing movements of a loading gate, and means carried with said support and adapted to cooperate with a movable basket charge feeler for positioning said control member to establish said valve positions.

20. A loading control mechanism as described in claim 19, said positioning means including an element movable to dispose said member and said valve in gate opening position, means operable to dispose the same in gate inactivating position at a limiting forward position of said support, means operable by movement of such feeler to shift said member so as to dispose it and said valve in gate closing position, and means operable upon backward movement of said support to redispose said member and said valve in gate inactivating position.

21. A loading control mechanism as described in claim 19, said positioning means including a motor device on said support operative when energized to dispose said member and said valve in gate opening position.

22. A loading control mechanism as described in claim 19, said positioning means including a relatively fixed stop acting at a limiting forward position of said support to shift said member so as to dispose it and said valve in gate inactivating position.

23. In a loading control mechanism for a cyclical centrifugal installation including a rotary centrifugal basket, a loading gate, a gate operating motor and a charge feeler movable by an increasing basket charge, a motor control device, a reciprocable support carrying said device and adapted to be connected for forward and backward movements with opening and closing movements of the gate, a control member carried with and shiftable relative to said support for disposing said control device in gate opening, gate inactivating and gate closing positions, means for moving said member and device to gate opening position, means including a limit element to be located in a relatively fixed position for moving said member and device from gate opening to gate inactivating position after a predetermined forward movement of said support, means actuatable by charge induced movement of the feeler to dispose said member and device in gate closing position, said member having connections responsive to backward movement of said support to shift said member and device to gate inactivating position, and means including another limit element to be located in a relatively fixed position for holding said member and device to gate closing position after a predetermined movement of the feeler.

24. A loading control mechanism as described in claim 23, and means for adjusting the working position of the first-mentioned limit element so as to select any desired maximum opening for the loading gate.

25. A loading control mechanism as described in claim 23, and means for adjusting the relative positions of the last-mentioned means and the feeler so as to select any desired final thickness for the basket charge.

26. A loading control mechanism as described in claim 23, and means for adjusting the relative positions of said actuatable means and the feeler so as to select any desired ratio of feeler movement to gate closing movement.

27. A loading control mechanism as described in claim 23, and means for adjusting the working positions of the last-mentioned means so as to select any desired final opening for the loading gate.

28. In a loading control mechanism for a cyclical centrifugal installation or the like, a reciprocable support, linkage to connect it for forward and backward movements with opening and closing movements of a loading gate, an air valve mounted on the support having outlets to be connected with opposite ends of a gate operating air cylinder and having a valve element biased to a gate opening position but movable backward to a gate inactivating position and thence to a gate closing position, a control bar shiftable over said support and controlling the positions of said valve element, an intermediate portion of said bar engaging said valve element, a reciprocable motor device on said support to position a portion of said control bar at one side of said valve element, and link means to position a portion of said bar at the opposite side of said valve element according to the position of a charge measuring device.

29. A loading control mechanism as described in claim 28, and a charge measuring device comprising a feeler finger movable outward to a working position and thence inward by an increasing volume of a charge to be measured, a rotatable shaft carrying the feeler, and a lever arm on said shaft connected for movements therewith and with said link means.

30. A loading control mechanism as described in claim 29, having a limit switch adjacent said shaft for controlling said motor device and an element mounted on and movable with said shaft to operate said limit switch.

31. A loading control mechanism as described in claim 30, said limit switch operator being loosely mounted on said shaft and having a lever arm adjacent the first-mentioned lever arm, and yieldable interconnecting means for said lever arms including means for adjusting their relative positions.

32. A loading control mechanism as described in claim 30, said lever arm and said limit switch operator each being loosely mounted on said shaft, a lever arm on said operator adjacent the first-mentioned lever arm, yieldable interconnecting means for said lever arms including means for adjusting their relative position, another lever arm carried by said shaft adjacent said limit switch operator, and yieldable interconnecting means for said other lever arm and said limit switch operator including means for adjusting their relative position.

33. A loading control mechanism as described in claim 30, comprising an abutment on said limit switch operator, and a relatively fixed stop for engaging said abutment to stop movement of said link means with said support after a predetermined forward movement of said support.

34. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge measuring device positionable by charge material in the basket, independently movable cooperating control elements having an inactive relative position and a gate closing relative position for energizing said motor to close said gate, means responsive to charge induced movement of said device for moving one of said elements so as to dispose said elements in said gate closing position, and means moved independently of said device in response to closing movement of said gate for moving another of said elements so as to dispose said elements in said inactive position, so that the closing movement of said gate induced by said motor energizing elements occurs progressively in accordance with the progressive building up of a charge in said basket.

35. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a loading gate for delivering charge material into the basket and a gate operating motor, the combination of a charge measuring device positionable by charge material in the basket, independently movable cooperating control elements having an inactive relative position and a gate closing relative position for energizing said motor to close said gate, means responsive to charge induced movement of said device for moving one of said elements so as to dispose said elements in said gate closing position, and means moved independently of said device in response to closing movement of said gate for moving another of said elements so as to dispose said elements in said inactive position, so that the closing movement of said gate induced by said motor energizing elements occurs progressively in accordance with the progressive building up of a charge in said basket, said mechanism including means operative upon movement of said device beyond a predetermined position at which the basket charge is nearly at a desired final volume to render said independently moved means ineffective so as to maintain said elements in gate closing position and thus cause quick movement of the gate from a pinched yet still open position to a completely closed position.

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