Feb. 26, 1963 R. C. GOODWIN 3,079,046

SPOUT COMPENSATING LOADING GATE CONTROL

Filed Jan. 25, 1960 3 Sheets-Sheet 1

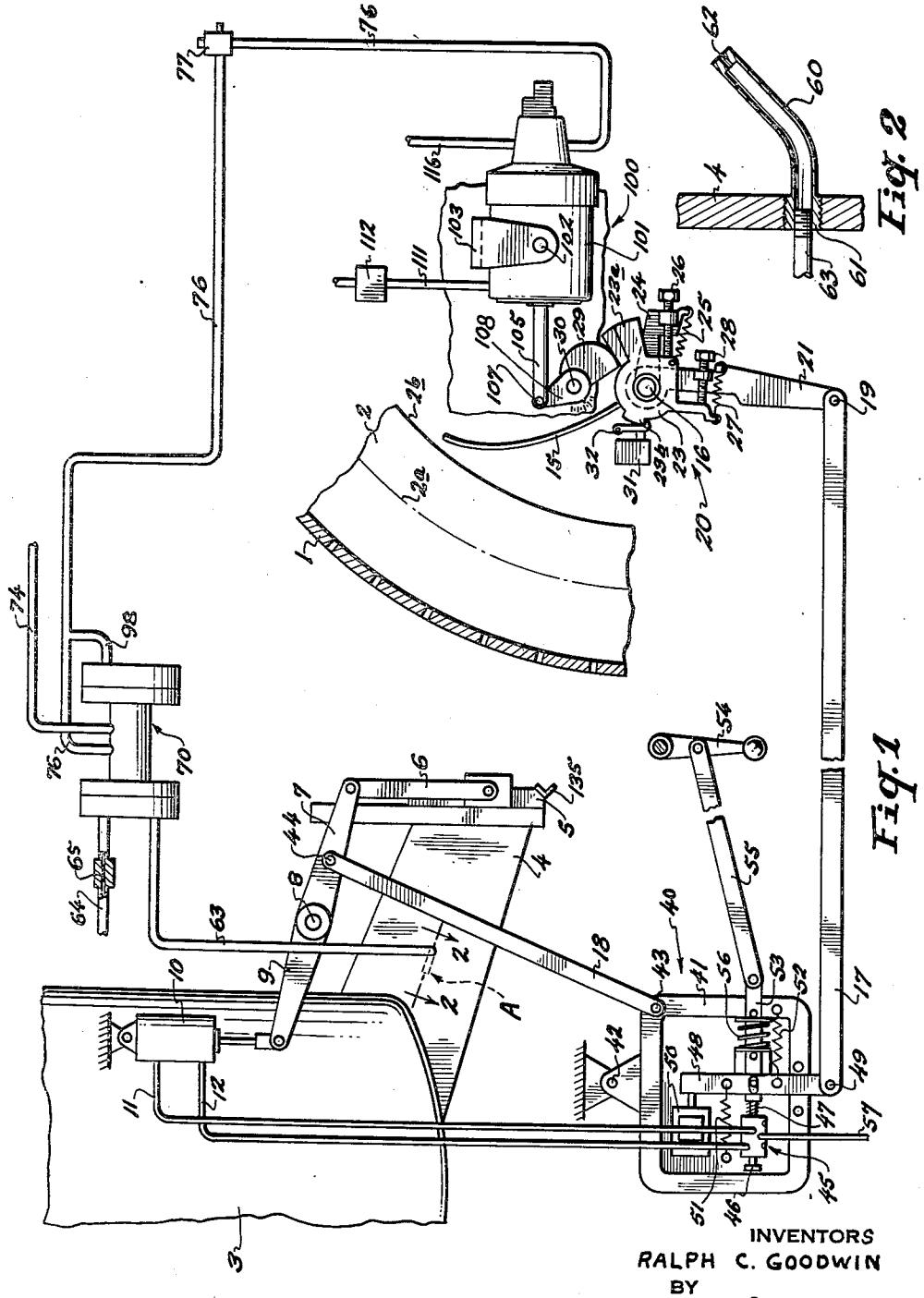


Fig. 1

Fig. 2

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SPOUT COMPENSATING LOADING GATE CONTROL

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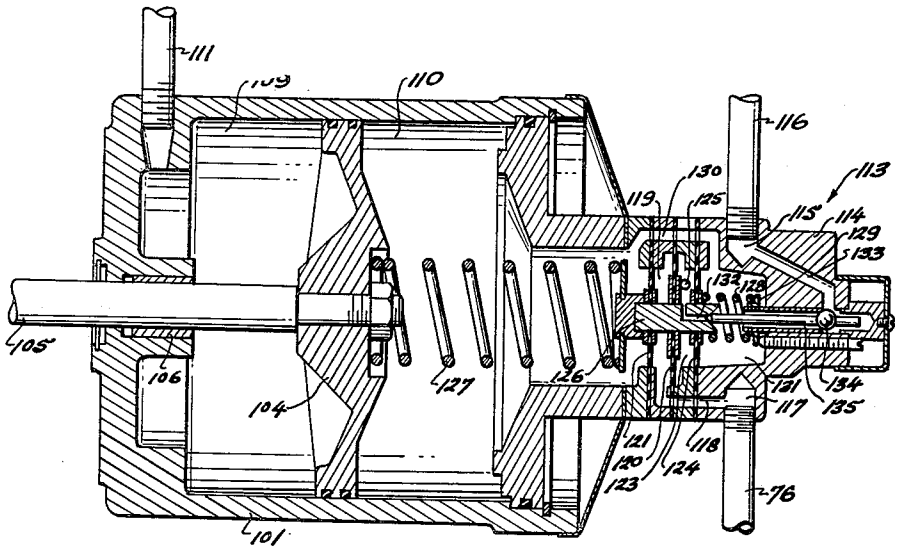


Fig. 4

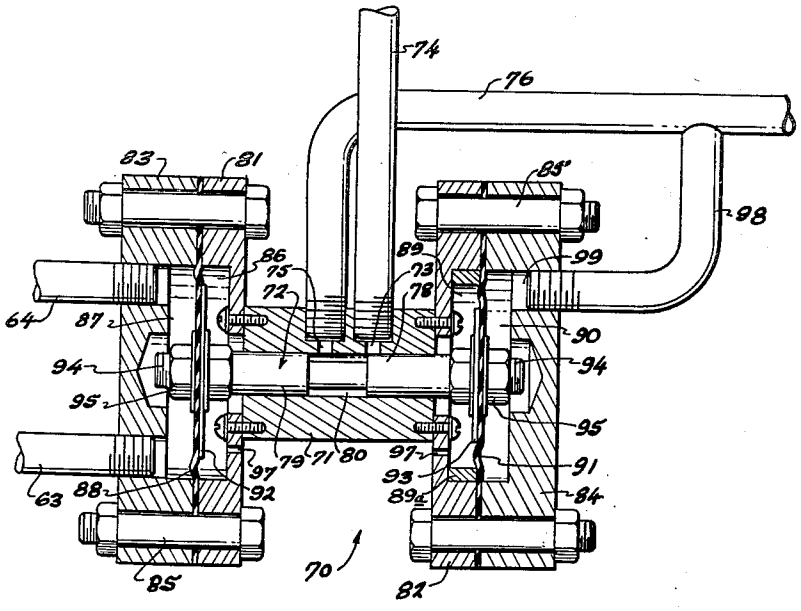


Fig. 3

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SPOUT COMPENSATING LOADING GATE CONTROL

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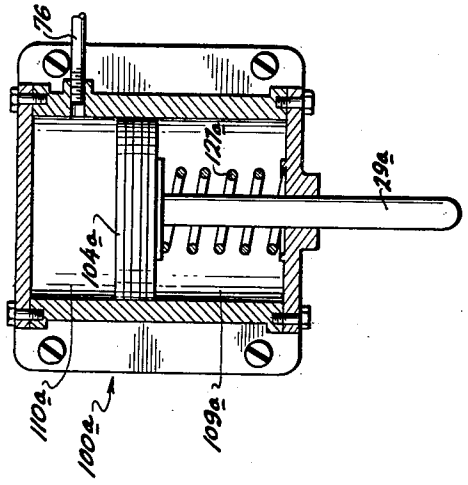


Fig. 6

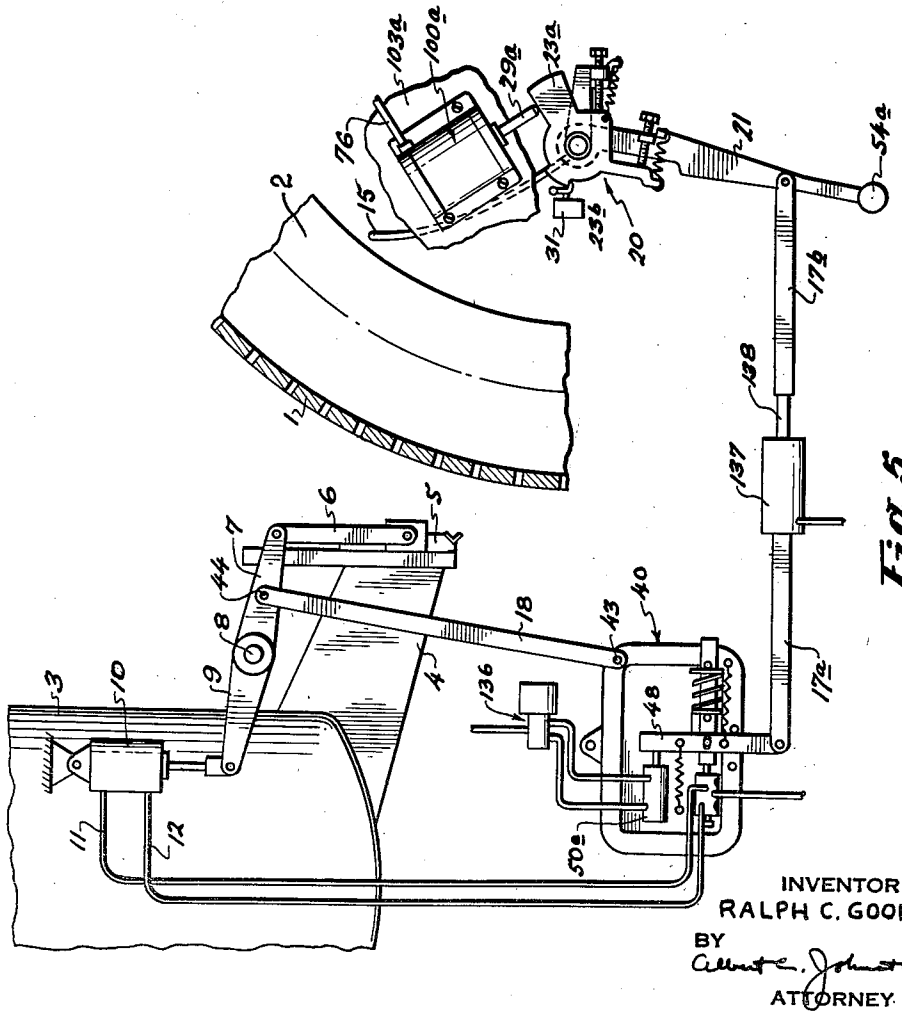


Fig. 5

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3,079,046

SPOUT COMPENSATING LOADING GATE CONTROL

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Filed Jan. 25, 1960, Ser. No. 4,427
16 Claims. (Cl. 222—52)

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.

Various automatic mechanisms have been proposed heretofore for controlling or regulating the introduction of charge materials into heavy cyclical centrifugal machines of the type used in the manufacture and the refining of sugar, such mechanisms, in general, being 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 connection with the loading of sugar centrifugals, in that 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 settling of crystals from syrup, and no two batches or runs have quite the same flow qualities. If the period during which the loading gate is held in its open position is determined on the basis of a preset time, the flow rate of the material through the open gate determines the change volume, rather than the control mechanism. On the other hand, if the control mechanism operates merely in response to the final charge thickness, the charges may 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.

In more recently developed centrifugal loading control mechanism, for example, as disclosed in United States Letters Patent No. 2,727,630, issued December 20, 1955, to Joseph Hertrich, the loading gate serving a centrifugal machine is provided with a power operated gate closing means 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 a maximum open position to progressive closing positions corresponding to progressive positions of the measuring device until the gate reaches a pinched or largely closed position as the basket charge approaches a desired final volume, whereupon the gate closing means acts quickly to complete the closing of the gate so that 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. The charge measuring device of a centrifugal loading control mechanism as disclosed in the above identified patent has provisions for manually adjusting the maximum opening of the loading gate and the thickness of the charge in the basket at the moment when progressive closing of the gate commences; the final thickness or volume of the material charge in the centrifugal basket; and the pinched or largely closed position of the loading gate, that is, the position of the gate when progressive closing thereof is concluded and quick final closing of the gate occurs. By reason of the foregoing manual adjustments, the described centrifugal loading control mechanisms can be adapted to control the loading of various charge materials into the associated centrifugal, and to cause such loading to be efficiently conducted so long as the flow properties of the charge material are known in advance and do not vary considerably during the loading operations so that suitable adjustments can be effected in the control mechanism based upon the known properties of the charge material. Since the flow rate through the loading gate will vary with changes of the hydrostatic head or level of charge material awaiting delivery through the loading gate, one of the centrifugal loading control mechanisms disclosed in the above identified patent includes pressure responsive means connected with the loading control mechanism and with the tank holding the charge material and which respond to changes of the hydrostatic head of material in the tank to adjust the relationship of the loading control mechanism to the position of the loading gate so as to increase the opening of the gate at any stage of the loading operation as the level of material in the tank falls, and so as to decrease the gate opening upon a rise of that level. Thus, the described mechanism seeks to maintain efficient loading operations at all times, that is, to maintain the greatest possible flow rate through the open gate for achieving loading of the centrifugal in the least possible time, by compensating automatically for changes in the flow rate that would result from changes in the hydrostatic head or level of the charge material awaiting delivery, without requiring the use of the previously mentioned manual adjustments.

However, as previously mentioned, 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, so that, even if the opening of the gate is automatically varied in accordance with changes in the hydrostatic head or level of charge material awaiting delivery through the loading gate, the flow rate through the gate may still vary substantially by reason of such changes of fluidity.

Moreover, where mechanisms of the same constructions must serve for loading charge materials differing greatly in viscosity, such as, a very thin or soupy massecuite at one time and a heavy, highly viscous massecuite at another time, a given extent of initial opening of the loading gate may allow the massecuite to spout over the basket in one case but still be insufficient for efficient loading of the basket in the other case.

By reason of the above mentioned deficiencies, the existing automatic loading control mechanisms are incapable of simulating the efficient loading conditions attained by a proficient operator exercising manual control over the opening of the loading gate. When the gate is under manual control, it is the usual practice to open the gate an initial amount so as to permit the flow of charge material to be established. The operator then determines the character of the established flow by observation of the latter, and then further opens the gate to the position which experience has taught is the optimum for the observed flow conditions.

Accordingly, it is a principal object of this invention to provide automatic loading control mechanism for heavy cyclical centrifugal machines or the like which are capable of simulating the optimum loading conditions achieved with manual control by a proficient operator.

Another object is to provide loading control mecha-

nisms for heavy cyclical centrifugal machines or the like which accurately regulate the successive loading operations and which enable the substantially uniform charging of cyclical centrifugal machines in successive loading cycles notwithstanding changes occurring in the fluidity of the charge material or in the hydrostatic head or depth of charge material in the supply tank from which the material is delivered into the centrifugal machines, thereby to avoid uncontrolled differences in flow rate as a result of such changes which would objectionably influence the uniformity of loading operations.

Another object is to provide loading control mechanisms of the described character which are not adversely influenced by only temporary or localized changes in the viscosity or fluidity of the charge material in the supply tank, for example, by the tendency of the massecuite to settle against the gate plate between loading cycles and thereby form a slight partial plug that has to ooze out of the gate when the laater is initially opened before normal flow is established.

Among other objects of this invention are: to provide loading control mechanisms which are automatically adjusted so as to avoid uncontrolled changes in the flow rate through the gate as a result of changes in the viscosity or fluidity of the charge material or changes in the hydrostatic head or depth of charge material in the supply tank, or a combination of such changes, and 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.

In accordance with an aspect of this invention, the control of the opening of the loading gate is modified or compensated in accordance with the pressure condition existing in the spout of the supply tank or mixer so that, when the gate is closed, such pressure condition represents the hydrostatic head in the supply tank and determines the extent of the initial opening of the gate at the commencement of a loading operation, and, when the gate is opened, the pressure condition existing in the stream of the charge material flowing through the spout causes further opening of the gate to a maximum extent primarily dependent upon the viscosity of the charge material in order to obtain a controlled flow rate of the charge material into the centrifugal machine or the like.

In a preferred embodiment of the invention, a centrifugal loading control mechanism of the kind disclosed in the above identified United States Letters Patent No. 2,727,630, which includes a power operated gate opening and closing means for the loading gate serving a centrifugal machine, 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 control mechanism which brings about the progressive automatic coordination of the operation of the power operated gate closing and opening means and of the charge measuring device and which responds progressively to charge induced movement of the measuring device and in turn actuates the gate closing means progressively so as to bring the gate from a maximum or initial open position to progressive closing positions corresponding to progressive positions of the measuring device, and which has an adjustable stop element as a part of its charge measuring device for varying the initial open position of the gate, is further provided with means located in the spout leading to the loading gate for sensing the pressure condition existing in the charge material in the spout, and with means responding to the sensed pressure condition to automatically actuate such adjustable stop element in order to maintain a controlled flow rate irrespective of changes in the fluidity of the charge material or changes in the hydrostatic head of the charge material awaiting delivery through the loading gate.

A further object of the invention is to provide an arrangement for sensing the pressure within the spout of the supply tank or mixer by means of a pipe probe opening into the spout, while avoiding plugging of the pipe probe by the charge material so that the probe will continue to reliably sense the pressure within the spout for the purpose of compensating the operation of the loading gate control mechanism.

In accordance with another aspect of this invention, the pipe probe is purged by a flow of water from a restricted flow source in order to avoid plugging of the pipe probe by the charge material, and the pressure condition in the spout is transmitted through the water filling the pipe probe and actuates a valve device establishing a corresponding pneumatic signal which controls the positioning of a pneumatically operated device connected to the adjustable stop element of the charge measuring device. Thus, the stop element of the charge measuring device is continuously adjusted in accordance with the pressure condition in the spout for varying the initial and maximum open positions of the gate, and the force available for adjusting the stop element, or for maintaining the latter in an adjusted position, may be independent of the pressure condition sensed in the spout of the loading tank by reason of the force amplification possibilities inherent in the valve device, which converts the water pressure signal into a pneumatic signal, and in the pneumatically operated positioning device controlled by such pneumatic signal.

A further feature of the invention is the provision of a deflector baffle along the lower edge of the plate of a loading gate having a control mechanism which is compensated in accordance with the pressure condition in the spout of the supply tank, with such baffle acting to deflect the stream of charge material downwardly into the basket of the centrifugal particularly when the gate opening is small in response to a high hydrostatic head of soupy or highly fluid charge material in the supply tank which would otherwise produce a flat trajectory of charge material pouring from the gate and splashing over the curb of the centrifugal.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of illustrative embodiments thereof which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

FIG. 1 is a diagrammatic assembly view of a cyclical centrifugal installation provided with an automatic loading control mechanism having compensating means responsive to the pressure in the spout of the supply tank in accordance with the invention;

FIG. 2 is an enlarged sectional view taken along line 2—2 of FIG. 1 and showing a pipe probe used for sensing the pressure in the spout;

FIG. 3 is an axial sectional view of a valve device included in the compensating means of FIG. 1;

FIG. 4 is an axial sectional view of a pneumatically operated positioning device also included in the compensating means of FIG. 1;

FIG. 5 is a view similar to that of FIG. 1, but showing another embodiment of the invention; and

FIG. 6 is an axial sectional view of a pneumatically operated positioning device included in the embodiment of FIG. 5.

Referring to the drawings in detail, and initially to FIG. 1 thereof, it will be seen that this diagrammatic view 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, the reference numeral 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, for example, of sugar or other granular solids, is indicated at **2**. The inner surface of the complete charge is indicated at **2b**, while broken line **2a** 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, there is shown a portion of a supply tank or mixer **3** holding charge material to be delivered into the centrifugal basket **1**. The material flows from this tank through a 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 a 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 a conduit **11**, the arms **9** and **7** on shaft **8** are rocked counter-clockwise, as viewed in FIG. 1, so as to lift gate **5** to an open position, and thereby to permit charge material in tank **3** to flow under the influence of gravity through the outlet of spout **4** into basket **1**; while the admission of air under pressure through a conduit **12** into the lower end of cylinder **10**, conduit **11** then being suitably vented, brings about a closing movement of loading gate **5**.

It is well known that the opening of loading gate **5** should take place after the basket **1** of the cooperating centrifugal machine 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, for example, 10 to 30 seconds, more or less, depending upon the volume of the charge to be treated in the centrifugal, 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 wall of charge material being formed in the basket increases gradually in radial 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 the thickness of the charge in the centrifugal basket, as is 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 and is carried by, and swings with, a shaft **16** mounted by a suitable bearing and bracket arrangement on or adjacent to the usual stationary curb (not shown) of the centrifugal machine.

The arrangement embodying the present invention for modifying the extent of opening of loading gate **5** in accordance with the flow rate of the charge material through spout **4** is particularly suited for use with a centrifugal loading control mechanism of the kind disclosed in United States Letters Patent No. 2,727,630, issued December 20, 1955, to Joseph Hertrich, and which, as shown in FIG. 1 of the drawings, comprises two coordinated assembly units **20** and **40** interconnected by suitable link means **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** rockably mounted on a fixed pivot **42** located in suitable relation to the gate operating mechanism. A link **18** is pivotally connected, at **43**, with support **41** and, at **44**, with the gate operating

arm **7** on shaft **8**, so that support **41** moves forwardly and rearwardly about pivot **42** in response to opening and closing movements of loading gate **5**.

As is described in greater detail in the above identified patent, reciprocable support **41** carries an air valve **45** for controlling the supply of compressed air to the gate operating motor or air cylinder **10** and having a plunger **46** normally biased, by a compression spring **47**, to a gate opening position, but which is movable backward from that gate opening position, first to a gate inactivating position and then to a gate closing position at the backward limit of such movement.

The several operative positions of air valve **45** are determined by the positioning of a control member **48** which is arranged for movement with the reciprocable support **41**, so as to be carried with the support in the forward and backward movements of the latter, and yet is movable relative to the support **41** in order to position the valve plunger **46**.

The lower end of control member **48** projects downward from support **41** for pivotal connection, at **49**, with one end of the interconnecting link **17**. Link **17** extends 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 control member **48** is arranged to be positioned by the armature or plunger of a solenoid **50** which is fixed to support **41** so that control member **48** is thrust forwardly when the solenoid is energized.

A tension spring **51** is connected between support **41** and an upper part of control member **48** so as to bias the latter in the direction for moving valve **45** to its gate closing position whenever solenoid **50** is deenergized, and this spring **51** is strong enough to overcome the force of valve spring **47**. Another tension spring **52** is connected between the lower part of control member **48** and support **41** so as to yieldably connect control member **48** and unit **20** for movements with support **41** in response to movements of loading gate **5**.

Control member **48** is held in a stable working position relative to valve plunger **46**, the armature of solenoid **50** and tension springs **51** and **52**, by means of a pin and slot connection with a reciprocable shaft **53** carried by support **41**. The forward end of shaft **53** is connected with a manually operated lever **54** through suitable linkage **55**, 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 shaft **53** is maintained by means of a compression spring **56** which surrounds shaft **53** and bears, at its opposite ends, against collars on the shaft engageable with pins on shaft **53** and parts of support **41** so that a force sufficient to overcome the compression of spring **56** must be applied by way of the lever **54** in order to slide shaft **53** either backward or forward relative to support **41**.

By reason of the pin and slot connection between control member **48** and shaft **53**, the control member is free to undergo its pivotal control movement relative to support **41** so long as shaft **53** is in its normal position determined by spring **56**. However, shaft **53** can be manually moved to an extent exceeding the lost motion provided by such pin and slot connection thereby to effect manually induced movements of control member **48** for actuating the plunger of valve **45** to and from any of its operating positions, that is, its gate closing, gate inactivating and gate opening positions.

The operation of unit **40** will now be summarized:

If solenoid **50** is deenergized, spring **51** holds control member **48** and air valve **45** in gate closing position, so that compressed air from a line **57** passes through valve **45** into conduit **12**, while conduit **11** is vented through the valve, whereby air cylinder **10** moves loading gate **5** to its closed position or hold the gate in that position.

When solenoid **50** is energized, its armature thrusts the upper end of control member **48** forward against the tension of spring **51** and, if the lower end of control

member 48 is then being held in a forward position by spring 52 or link 17, control member 48 and air valve 45 are disposed in gate opening position. The compressed air from line 57 now passes into conduit 11, while conduit 12 is vented, so that cylinder 10 starts moving loading gate 5 to its open position. As the gate moves open, its operating arm 7 acts through link 18 to rock support 41 forward about its pivot 42. Control member 48 and link 17 move forward with support 41, thus allowing solenoid 50 to keep control member 48 and valve 45 in gate opening position, unless and until a limit or restriction is imposed against the forward movement of link 17 and hence of control member 48.

If, while the gate is opening, a resistance is applied through link 17 to limit the forward movement of member 48 with support 41, a further increment of forward movement of the support causes a relative backward movement of the lower end of member 48 to dispose this member and air valve 45 in gate inactivating position. The air valve 45 then seals off both conduits 11 and 12, so that air cylinder 10 holds the loading gate in whatever position it occupied at the moment of such shifting or relative backward movement of control member 48. Moreover, if the lower end of control member 48 is now given a further backward movement relative to support 41 by action transmitted through link 17, it will dispose the air valve 45 in gate closing position and cause air cylinder 10 to start closing movement of the gate. However, a corresponding backward movement of support 41 accompanies the closing movement of the loading gate and will again dispose member 48 and air valve 45 in gate inactivating position with respect to the pivoted support, unless a further backward movement of link 17 and the lower end of member 48 has occurred meanwhile through further action on link 17.

It will be evident, therefore, that the opening of the loading gate and 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 cause the outward movement of feeler 15 to a working position in desired relation to basket wall 1; that by limiting the forward movement of link 17 the extent of the "initial gate opening" can be predetermined, the gate motor 10 being inactivated to hold the gate at the selected extent of the initial opening when such 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 control member 48, in direct proportion to that movement. Further, it will be evident that the progressive inward movement of 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 48 and, in this way, to cause closing movements of the loading gate proportional to the increasing thickness of the basket charge.

Referring more particularly to the construction of unit 20 of the existing centrifugal loading control mechanism, 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 feeler 15 through a rotary member 23 and an 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 an abutment 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 abutment on member 23. The above described connections between parts 21, 23 and 24 cause these parts as well as shaft 16 and feeler 15 to tend to move together about the axis of shaft 16. However, being yieldable, these connections prevent damage to the mechanism in the event of any obstruction of the feeler movement or of the movement of arm 21.

The unit 20 further includes an adjustable stop element 29, which, in the embodiment of the invention illustrated in FIG. 1, is in the form of a radial cam having a spiral-shaped periphery and which is fixed to a rotatable shaft 30 in a position to be engaged by an abutment 23*a* on member 23 when the loading gate 5 has been moved to an initial gate opening.

Unit 20 also preferably includes a relatively fixed limit switch 31 having a movable switch arm 32 which cooperates with a switch operating lobe 23*b* on member 23 to bring about quick closing of the gate in the manner briefly described hereinafter. The limit switch 31 has contacts connected electrically in a control circuit leading to solenoid 50, and is employed so as to hold the solenoid in energized condition in the course of each loading operation.

The operation of unit 20 of the illustrated existing centrifugal loading control mechanism is briefly summarized as follows:

It will be evident that forward movement of unit 40 and link 17 in response to opening movement of loading gate 5 causes lever arm 21 and member 23 to move counter-clockwise about the axis of shaft 16 until abutment 23*a* on member 23 engages against the adjustable stop element 29. When that occurs, feeler 15 ceases to move outward and link 17 and the lower end of control member 48 cease to move forward with support 41 whereupon control member 48 and air valve 45 are shifted to gate inactivating position and further opening of the loading gate is discontinued. Thus, adjustable stop element 29 determines the extent or height of the initial gate opening.

The adjustable stop element 29 also acts, along with the stop 26, to control the initial position of feeler 15, that is, the position occupied by the feeler at the limit of the gate opening movement and, hence, the thickness to which an incoming charge in basket 1 must build up before the charge begins to act upon feeler 15 for moving the latter inward away from the basket wall.

When feeler 15 is moved inward by the charge building up within the centrifugal basket, shaft 16 and lever arm 24 are turned clockwise, as viewed in FIG. 1, and the engagement of stop 26 with the abutment of member 23 causes similar turning movement of the latter which is communicated to lever 21 by way of spring 27. Such turning of arm 21 acts through link 17 on control member 48 to move the latter and air valve 45 to gate closing position. Since feeler 15 is moved progressively inward by the charge, link 17 continues to act in the backward direction on control member 48 so that, as previously described, the closing movements of loading gate 5 are proportionate to the increasing thickness of the basket charge.

Such progressive closing movement of the gate in accordance with inward movement of feeler 15 continues until the loading gate has reached a desired pinched or largely closed position, whereupon switch operating lobe 23*b* of member 23, which moves arm 32 and limit switch 31 to circuit closing position as member 23 turns in response to opening movement of the loading gate, is moved to a position releasing arm 32 and thus causing the contacts of limit switch 31 to open. At that moment, solenoid 50 is denergized, and control member 48 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 feeler 15. Although the position of member 23 at the moment of final gate closing is always fixed by reason of the fixed position of limit switch 31, adjustable stop element 26 provides for any desired adjustment of the relative position of feeler 15 and member 23 and thereby determines the position to be occupied by feeler 15 at the moment when limit switch 31

strips for causing quick closing of the gate. Hence, adjustable stop element **26** determines the thickness to which the incoming charge will build up on the wall of basket **1**, that is, the final charge thickness, before the gate is closed completely.

The adjustable stop element **28** provides for relative adjustment between lever arm **21** and member **23** and thereby determines the position of loading gate **5** 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.

In the above described existing centrifugal loading control mechanism, the adjustable stop element **29**, which is shown in FIG. 1 in the form of a radial cam, may be manually adjusted before the commencement of loading operations in order to vary the initial opening of loading gate **5**. Thus, assuming that the charge material in tank **3** has a uniform or constant fluidity and a constant hydrostatic head, then the flow rate of the charge material into basket **1** will be largely determined by the setting of stop element **29**.

However, as is well known, 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. Further, as charge material is progressively removed from tank **3**, the hydrostatic head or level of charge material awaiting delivery to the centrifugal progressively decreases, and such changes in fluidity of the charge material and in the hydrostatic head or level of the charge material serve to vary the flow rate for each opening of the loading gate. If the opening and closing of the loading gate are responsive only to the build-up of charge material in the basket, such variations in the flow rate objectionably influence the uniformity of loading operations. With the described existing centrifugal loading control mechanism, the desired uniformity of the loading operations can be obtained only through manual adjustment of stop element **29** during the course of the loading operations, but this requires supervision of the loading operations by skilled personnel and detracts from the desired automatic operation of the loading control mechanism.

In accordance with the present invention, adjustable stop element **29** is automatically actuated so that, if the flow rate is relatively small, by reason of a highly viscous charge material or a relatively small hydrostatic head of the charge material in tank **3**, stop element **29** is adjusted in the direction for increasing the opening of gate **5**, whereas, if the flow rate is relatively large, by reason of a soupy or highly fluid charge material or a large hydrostatic head of such charge material in tank **3**, stop element **29** is adjusted in the opposite direction for decreasing the extent of the gate opening.

Such automatic actuation of stop element **29** is made responsive to a pressure condition sensed at a suitable point A in spout **4**, with the sensed pressure being the static head at point A when there is no flow through the spout, for example, as a result of complete closing of the gate, and with the sensed pressure being a combination of the static head and velocity head at point A when gate **5** is opened and there is a flow of charge material through spout **4**.

It will be apparent that, when there is no flow through spout **4**, the pressure sensed at point A is determined exclusively by the hydrostatic head of charge material in supply tank **3**. However, when gate **5** is opened and the charge material flows through spout **4**, the static head at point A is reduced by reason of the conversion of a part of the static head into a velocity head, and the combination of the static head and velocity head is always less than the pressure sensed at point A with the gate closed by reason of the losses involved in the conversion of static head into velocity head, such losses being due to friction resisting the flow of charge material through spout **4** and the restriction of the flow from tank **3** into the spout. Thus, the static pressure at point A decreases as the hydrostatic head of charge material in tank **3** decreases, and, when there is a flow of charge material through spout **4**, the combined pressure at point A further decreases by an amount depending primarily upon the viscosity of the charge material.

As shown in FIGS. 1 and 2, the pressure at point A in spout **4** is preferably sensed by a pipe probe **60** which is formed of a length of bent tubing and has a threaded bushing **61** on one end received in a suitably tapped opening in the side of spout **4**. The free end of pipe probe **60** has a plug therein formed with a small opening or hole **62**. The pipe probe **60** is preferably turned so that the opening **62** faces more or less toward the end of spout **4** communicating with supply tank **3** and therefore senses a velocity head resulting from the flow of charge material through the spout as well as the static head in the spout at point A. Since the drop in the sensed pressure due to the friction of fluid flow, that is, the pressure loss due to viscosity, increases along spout **4** from the end adjacent tank **3** to the end carring gate **5**, it is apparent that the sensitivities to changes in the hydrostatic head of charge material in tank **3** and to changes in the viscosity of the charge material flowing through spout **4**, respectively, may be relatively adjusted by locating pipe probe **60** either closer to, or further away from, the end of spout **4** adjacent tank **3**.

It is also to be understood that rotation of the probe greatly affects the sensitivity thereof to the velocity head component. Thus, when opening **62** faces directly upstream, the probe **60** senses the whole velocity head component, whereas, when opening **62** faces at right angles to the direction of flow, the probe picks up none of the velocity head and, when the opening of the probe faces downstream, the velocity head component is negative, that is, subtracted from the static head sensed by the probe.

In the illustrated embodiment of the invention, the pressure at point A in spout **4** sensed by pipe probe **60** actuates a valve device **70** (FIGS. 1 and 3) which establishes a corresponding pneumatic signal controlling a pneumatically operated positioning device **100** (FIGS. 1 and 4). The positioning device **100** is connected to the shaft **30** of the cam-shaped stop element **29** and is effective to dispose the latter in an angular position determining the initial or maximum opening of gate **5** which corresponds to the pressure sensed by pipe probe **60**.

Referring to FIG. 3 in detail, it will be seen that the valve device **70** may include a valve body **71** having an axially extending bore in which a valve plunger **72** is axially movable. The valve body **71** has a port **73** for connection with a regulated compressed air supply line **74**, and an outlet port **75** which is spaced from the port **73** in the axial direction of body **71** and which is intended for connection to a line or conduit **76** transmitting the pneumatic signal from valve device **70** to the positioning device **100** and having a controllable air bleed **77** extending therefrom (FIG. 1).

The plunger **72** of valve device **70** has spaced sealing pistons **78** and **79** defining an annular space **80** therebetween, and the sealing piston **78** is axially disposed on the plunger to more or less cover port **73**, depending upon the position of the plunger, for thereby controlling the rate at which compressed air can flow from port **73**, through annular space **80** into port **75**. It is apparent that the air pressure or pneumatic signal transmitted through line **76** to positioning device **100** depends upon the rate at which the regulated compressed air supplied to valve device **70** is permitted to flow from port **73** to port **75**. Thus, when plunger **72** is displaced toward the right, as viewed in FIG. 3, so that piston **78** progressively uncovers port **73**, the pneumatic signal or air pressure in line **76** is correspondingly increased, whereas,

when plunger 72 is displaced toward the left to progressively close port 73, the magnitude of the pneumatic signal is correspondingly reduced and the air bleed 77 permits the pneumatic signal in line 76 to drop rapidly in response to such displacement of plunger 72 toward the left.

In order to position valve plunger 72 in accordance with the pressure sensed by pipe probe 60, valve device 70 further includes heads 81 and 82 at the opposite ends of valve body 71 and having covers 83 and 84 secured thereto, for example, by bolts 85. The confronting faces of head 81 and cover 83 are formed with mating recesses which form chambers 86 and 87, respectively, and a flexible diaphragm 88 separates chambers 86 and 87 and is clamped, at its periphery, between the confronting faces of head 81 and 83. Similarly, the confronting faces of head 82 and cover 84 are formed with mating recesses defining chambers 89 and 90, respectively, which are separated by a flexible diaphragm 91 having its periphery clamped between head 82 and cover 84. The diaphragms 88 and 91 have back-up discs 92 and 93 secured thereto by central bolts 94 and related nuts 95, and the heads of the bolts 94 bear against the adjacent ends of valve plunger 72. The ratio of the effective areas of diaphragms 88 and 91 is determined by the inner diameter of a replaceable ring 89*a* fitted in chamber 89 to establish the effective bore of that chamber, and also by the diameter of the back-up disc 93 associated with the diaphragm 91.

The chambers 86 and 89 are preferably vented to the atmosphere, as at 97, so that the movements of diaphragms 88 and 91 are not resisted by air trapped within such chambers. The pressure sensed by pipe probe 60 is transmitted to chamber 87, in the manner hereinafter described in detail, to act against diaphragm 88, and thereby tend to move plunger 72 toward the right, as viewed in FIG. 3. The pneumatic signal or air pressure in line 76 is fed to chamber 90, for example, by way of a line 98 branching off from line 76 and opening into chamber 90 through a port 99 in cover 84, so that the pneumatic signal or air pressure acts in chamber 90 against diaphragm 91 and tends to move valve plunger 72 toward the left, as viewed in FIG. 3. Thus, valve plunger 72 always seeks a position where the force due to the pressure sensed by probe 60 and transmitted to chamber 87 is equal to the force due to the pneumatic signal which is transmitted to the chamber 90. It is apparent that any change in the sensed pressure transmitted to chamber 87 causes a displacement of valve plunger 72 in one direction or the other until the pneumatic signal or air pressure in line 76 corresponds to the changed sensed pressure. Further, by suitably selecting the inner diameter of ring 89*a* in chamber 89 and the diameter of back-up disc 93, it is possible to vary the ratio of the pneumatic signal established in line 76 and the corresponding sensed pressure transmitted to chamber 87.

In order to avoid plugging or clogging of pipe probe 60 by the charge material in supply tank 3, a purging flow of water is preferably maintained through opening 62 of pipe probe 60 into spout 4, and the pressure sensed at point A in spout 4 is then transmitted through such water to chamber 87 of valve device 70. For this purpose, bushing 61 of pipe probe 60 is connected to a line 63 which opens into chamber 87, and a flow of water is supplied from a source of regulated pressure through a pipe 64 which also opens into chamber 87 and which has a restriction 65 interposed therein in order to ensure a slow flow of water through pipe 64, chamber 87 and pipe 63 for keeping clear the opening of pipe probe 60. The restriction 65 also ensures that the pressure acting in chamber 87 will be that transmitted from pipe probe 60 rather than the regulated pressure supplied to pipe 64, and it is only necessary that the regulated pressure should be greater than the maximum pressure that may be sensed by probe 60. Since pipe probe 60, pipe 63 and chamber 87 are continuously filled with water, it is apparent that any change in the pressure sensed at the opening 62 of the pipe probe is transmitted through the water to chamber 87 for action against diaphragm 88.

The pneumatically operated positioning device 100 controlled by the pneumatic signal fed thereto from valve device 70 by way of line 76 is effective to dispose stop element 29 in a position corresponding to the pneumatic signal, and may be of a type that moves the stop element to its adjusted position or maintains the stop element in the adjusted position with a force that is independent of the magnitude of the pneumatic signal. A suitable commercially available positioning device is that known as a "Cylinder Conomotor" which is produced by the Conoflow Corporation of Philadelphia, Pennsylvania. Such a device generally includes a cylinder 101 pivotally mounted, at 102, on a bracket 103 which is secured to the frame or base of charge measuring unit 20 (FIG. 1). Cylinder 101 contains a reciprocable piston 104 (FIG. 4) which has a stem 105 extending axially therefrom through a packing 106 in the end of cylinder 101. The free or outer end of stem 105 is pivotally connected, as at 107, to a radial arm 108 which is fixed to shaft 30 carrying the adjustable stop element or cam 29 (FIG. 1). If desired, radical arm 108 may have a suitable index projecting therefrom and cooperating with a numerical or other scale on the frame or base of unit 20 for indicating the setting or adjustment of cam 29.

Piston 104 devides the interior of cylinder 101 into two chambers 109 and 110, respectively, and a cushion loading air pressure is supplied to chamber 109 through a line 111 having a cushion loading regulator 112 interposed therein (FIG. 4). The other chamber 110 is automatically loaded through a positioner 113 to any pressure required to hold stem 105 in the position corresponding to the magnitude of the pneumatic signal transmitted by line 76.

As shown in FIG. 4, the positioner 113 may include a body 114 mounted on the head of cylinder 101 and having a port 115 for connection to a line 116 through which a filtered supply of compressed air is supplied to the positioner at a suitably regulated pressure. The body 114 further has a port 117 for connection to line 76 transmitting the pneumatic signal, and the port 117 communicates, by way of a passage 118, with a chamber 119 defined between flexible diaphragms 120 and 121 having relatively large and small areas, respectively. Another chamber 123 is defined between a flexible diaphragm 124, preferably having the same area as the relatively small diaphragm 121, and the side of diaphragm 120 remote from chamber 119, and chamber 123 is in communication with the atmosphere by way of a vent 125.

The three diaphragms 120, 121 and 124 are all secured to a plunger 126, and a range spring 127 is interposed between piston 104 and a carrier on plunger 126 to urge the latter in one direction, that is, toward the right as viewed in FIG. 4, while a suppression spring 128 is axially interposed between plunger 126 and an adjustable abutment 129 to urge the plunger 126 in the opposite direction. Chamber 110 in cylinder 101 is in communication, by way of a passage 130, with a space 131 accommodating suppression spring 128, and space 131 is adapted to communicate with the atmosphere through a passage 132 in plunger 126 extending between chamber 123 and a valve seat at the end of plunger 126 in space 131. The space 131 is also adapted to communicate with the port 115 receiving the compressed air supply through a passage 133 terminating in a valve seat.

In order to control the communication of space 131 with either the atmosphere or the compressed air supply, the positioner 113 further includes a ball valve member 134 engageable with the seat in passage 133 and having an elongated stem 135 which is engageable, at its free

end, with the seat at the end of plunger **126** in space **131** to simultaneously close passage **132** of the plunger and to transmit the movement of plunger **126** to valve member **134** in the direction for unseating the latter.

It will be apparent that, when plunger **126** is moved toward the right, as viewed in FIG. 4, stem **135** closes passage **132** and is moved by the plunger to unseat valve member **134** so that the compresesd air supplied through the line **116** is then admitted to space **131** and passes from the latter through passage **130** to the chamber **110** in cylinder **101**, thereby to displace piston **104** toward the left against the cushion loading pressure in chamber **109**. On the other hand, when plunger **126** is moved toward the left, as viewed in FIG. 4, ball valve member **134** is engaged against its seat in passage **133** by the pressure of the supplied compressed air, and the plunger **126** moves away from the end of stem **135**, thereby opening space **131** to the atmosphere by way of passage **132**, chamber **123** and vent **125**.

In the positioner **113**, the force exerted on plunger **126** as a result of the action of the pneumatic signal pressure in chamber **119** against the diaphragms **120** and **121** of unequal area, and the force of the range spring **127** are balanced by the oppositely directed force of the suppression spring **128**. When these forces are in balance, a small pilot flow past valve member **134** ensures instantaneous response to any change in the pneumatic signal pressure fed to chamber **119**. An increase in the pneumatic signal temporarily moves the assembly of the diaphragms and plunger **126** toward the right, as viewed in FIG. 4, and thereby opens valve member **134** to permit an increase in the pressure within space **131** and chamber **110** of cylinder **101** so that, as previously described, piston **104** moves toward the left and thereby decreases the force of range spring **127**. When the movement of piston **104** disposes stem **105** in the axial position corresponding to the pneumatic signal fed to chamber **119**, the forces exerted by the pneumatic signal acting in chamber **119** and by the springs **127** and **128** are again in balance. Conversely, upon a decrease in the pneumatic signal fed to chamber **119**, the disturbed balance of forces results in movement of plunger **126** toward the left, as viewed in FIG. 4, to open the exhaust from space **131** and thereby reduce the pressure in chamber **110** so that the cushion loading pressure in chamber **109** then moves piston **104** toward the right until the increased force exerted by range spring **127** and the force resulting from the reduced pneumatic signal acting in chamber **119** are again balanced by the force of suppression spring **128**.

From the above, it is apparent that the position of stem **105** always corresponds to the magnitude of the pneumatic signal transmitted by way of line **76**, and that the pressure available for adjusting the position of stem **105** or for holding the latter in an adjusted position may be the full supply pressure in line **116** and is independent of the pneumatic signal.

The stop element or cam **29** is arranged to increase the amount of opening of gate **5** that is permitted when stem **105** is retracted or moved toward the right, as viewed in FIG. 4, in response to a reduced pneumatic signal. Conversely, cam **29** is adjusted to decrease the amount of opening of the gate that is permitted when stem **105** is extended or moved toward the left, as viewed in FIG. 4, in response to an increased pneumatic signal.

Although the above described pneumatically operated positioning device **100** is particularly suited for controlling the positioning of adjustable stop element or cam **29** of charge measuring unit **20**, it is apparent that other devices may be used for adjusting the amount of opening of the gate that is permitted in accordance with the magnitude of the pneumatic signal transmitted by way of line **76**.

Thus, as shown in FIGS. 5 and 6 of the drawings, wherein all parts corresponding to those previously described with reference to FIGS. 1 to 4 are identified by the same numerals, the pneumatically operated positioning device **100** and the cam **29** actuated thereby are replaced by a simple single-acting, spring-loaded cylinder **100***a* having a piston **104***a* axially slidable therein and dividing the interior of the cylinder into compartments **109***a* and **110***a*. A stem or plunger **29***a* extends axially from piston **104***a* and projects through one end wall of cylinder **100***a*, and a helical compression spring **127***a* is disposed within compartment **109***a* and acts against piston **104***a* to urge the latter in the direction for retracting the plunger **29***a*. The pneumatic signal transmitted by line **76** is made to act in compartment **110***a* of cylinder **100***a* by suitably connecting line **76** to the cylinder so that, at any time, the position of plunger **29***a* is determined by the balancing of the opposed forces exerted on piston **104***a* by the spring **127***a* and by the pressure of the pneumatic signal in compartment **110***a*, respectively. If the cylinder **100***a* has a relatively short stroke and large diameter, the positioning of its plunger **29***a* in response to changes in the pneumatic signal fed by line **76** to compartment **110***a* will be suitably accurate, and the plunger **29***a* can then act directly as an adjustable stop element for the abutment **23***a* of the charge measuring unit **20**. In order to make it possible for the plunger **29***a* to act directly as an adjustable stop element, the cylinder **100***a* is fixedly mounted on the frame or support **103***a* of unit **20** with the plunger **29***a* extending tangentially to the path of movement of abutment **23***a* and projecting into such path. Thus, when there is a decrease in the pneumatic signal fed to cylinder **100***a* by line **76**, the consequent retraction of plunger **29***a* acting as an adjustable stop element for abutment **23***a* permits further opening of gate **5**, whereas an increase in the pressure of the pneumatic signal causes extension of plunger **29***a* and decreases the permitted extent of opening of the gate.

Reference to FIG. 5 will show that an automatic loading control mechanism embodying the invention may include a handle **54***a* extending from lever arm **21** of the charge measuring unit **20** for effecting manual control over the loading operation, with such handle **54***a* replacing the relatively more complicated manual control arrangement provided by the lever **54** which is connected through linkage **55** with shaft **53** of unit **40** in FIG. 1.

It is also to be noted that the solenoid **50** of FIG. 1 may be replaced by an air cylinder **50***a* (FIG. 5) having its plunger operating in the same way as the armature of the replaced solenoid, and with the supplying of air to cylinder **50***a* being under the control of a solenoid operated valve diagrammatically illustrated at **136** and having its energizing circuit controlled by switch **31**.

Further, in the modification shown in FIG. 5, the link between lever arm **21** and lever **48** is divided into two parts **17***a* and **17***b* respectively connected to a pressure fluid operated expansion cylinder **137** and to the plunger **138** of the latter. The cylinder **137** is of the single acting, spring-loaded type having two positions in which plunger **138** is fully extended and fully retracted, respectively. During loading of the basket, plunger **138** is fully extended, and the link **17***a* and **17***b* has an effective length equivalent to that of the link **17** in the first described embodiment. At the conclusion of the loading operation, plunger **138** is retracted in order to rotate feeler **15** away from the annular basket charge **2** so that the feeler will not ride against the inner wall surface of the charge during centrifuging of the charge, thereby to extend the useful life of the feeler.

The above described arrangements embodying the invention for modifying the operation of the centrifugal loading control mechanism in accordance with a pressure sensed at point A in spout **4** operate as follows:

When gate **5** is closed prior to the commencement of a loading cycle, pipe probe **60** senses the static pressure due to the hydrostatic head of charge material in supply tank **3**, and this sensed pressure causes a corresponding

positioning of adjustable stop element **29** or **29***a*, by way of valve device **70** and positioning device **100** or **100***a*, to limit the initial opening of gate **5** to an extent which is slightly smaller than the optimum for even the most soupy, or at least viscous massecuite and that particular hydrostatic head.

When the loading cycle is initiated, gate **5** initially opens to the extent permitted by the above mentioned initial adjustment of stop element **29** or **29***a* and, as the charge material flows through spout **4**, the combined static head and velocity head sensed by probe **60** is less than the originally sensed static head, with the magnitude of this pressure drop depending primarily upon the viscosity of the charge material, as previously described. The reduced pressure sensed by probe **60** during flow of the charge material through spout **4** results in a correspondingly reduced pneumatic signal fed by line **76** to positioning device **100** or **100***a* which readjusts stop element **29** or **29***a* in accordance with the changed pneumatic signal in order to allow gate **5** to open further to the maximum opening which is the optimum for the actual viscosity of the charge material then flowing through the spout under that particular hydrostatic head. Changes in the viscosity of the massecuite or other charge material during the loading interval are sensed as pressure changes at the probe **60**, as are changes in the hydrostatic head of charge material in supply tank **3**, and the maximum gate opening is adjusted accordingly.

Thus, during successive loading cycles, the position of adjustable stop element **29** or **29***a* is varied as required to maintain optimum loading conditions, even though the hydrostatic head of charge material in tank **3** is progressively reduced and the viscosity of the charge material may vary over a wide range.

It will be seen from the above that the automatic loading control mechanism embodying the invention substantially simulates the characteristics of a loading operation under the manual control of a proficient operator in that the gate is opened initially to a relatively small extent to permit establishment of a flow of charge material, and the gate is thereafter opened further in accordance with the conditions of such flow.

Since the setting of adjustable stop member **29** or **29***a* at the beginning of each loading cycle, that is, when gate **5** is closed, is dependent only upon the hydrostatic head of charge material in tank **3**, and since the pressure sensed by pipe probe **60** is reduced to modify the setting of the adjustable stop element in accordance with the viscosity of the charge material only in response to an actual flow of charge material through spout **4**, it is apparent that a false indication or resetting of stop element **29** or **29***a* cannot result from the partial plugging of the gate by reason of the settling of the massecuite against the gate plate between loading cycles. If such partial plugging occurs, the pressure sensed by pipe probe **60** remains at the value dependent upon the hydrostatic head of charge material in the supply tank until the plug has had an opportunity to ooze out of the opened gate and thereby permit the establishment of the normal flow dependent upon the actual viscosity of the charge material.

Although the flow of water maintained through opening **62** of pipe probe **60** is primarily for the purpose of preventing clogging of the pipe probe by the charge material, it has been found that this purging flow of water which is admitted to the spout through the pipe probe has the further advantage of lubricating the charge material if the latter becomes very viscous, and thereby tends to avoid plugging of the spout by the charge material when there is a fairly long interval between successive loading operations.

Although the automatic control of the opening of gate **5** as described above maintains optimum loading conditions notwithstanding changes in the hydrostatic head of charge material in the supply tank or the viscosity of the charge material, it has been found that, when the gate opening is relatively small, for example, in response to the sensing of a pressure by pipe probe **60** which corresponds to a full supply tank of charge material having a very low viscosity, the small gate opening actually tends to raise the trajectory of the stream of charge material issuing from the gate so that, even though the rate of flow of change material is still maintained uniform to avoid overloading of the basket, there is still the possibility that the raised trajectory of the stream of charge material will cause the latter to splash upon the curb of the centrifugal. In order to avoid this condition, a downwardly inclined deflector baffle **135** (FIG. 1) may be secured to the lower edge of gate **5**. The deflector baffle **135** is effective to downwardly deflect the small streams of very fluid charge material that would otherwise issue almost horizontally from the gate when loading the centrifugal from a full supply tank.

Although particular embodiments of the invention have been described in detail herein with reference to the accompanying drawings, it is to be noted that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged by pouring under gravity from the outlet end of the spout into the basket, a gate at the outlet end of the spout, and gate operating means for opening and closing the gate; the combination of means responsive to the pressure head of the stream of said material flowing in the spout when the gate is open for sensing the friction head loss in said stream, and means modifying the operation of said gate operating means in accordance with changes in the sensed friction head loss to vary the extent of opening of the gate in the direction for maintaining a controlled flow rate of charge material into the basket during successive loading cycles.

2. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pressure signal supplied thereto, means responsive to the pressure head of the stream of the charge material flowing in the spout when the gate is open for sensing the friction head loss in said stream, and means for supplying a pressure signal to said positioning means in accordance with said sensed friction head loss, thereby to cause said positioning means to adjust the stop means for limiting the opening movement of the gate to an extent tending to maintain a controlled flow rate of charge material into the basket during successive loading cycles.

3. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pneumatic signal supplied thereto, responsive to the pressure head

of the stream of the charge material flowing in the spout when the gate is open for sensing the friction head loss in said stream, and means actuated by the sensed friction head loss and effective to establish a corresponding controlling pneumatic signal which is supplied to said positioning means for controlling the latter so that the stop means is adjusted by said positioning means for limiting the opening movement of the gate to an extent tending to maintain a controlled flow rate of charge material into the basket during successive loading cycles.

4. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pressure signal supplied thereto, a pressure sensing probe disposed in the spout within the stream of charge material flowing through the spout when the gate is open for sensing the friction head loss in said stream, and means operated by the friction head loss sensed by the probe and establishing a corresponding pressure signal supplied to said positioning means for controlling the latter in a manner to cause said positioning means to adjust the stop means for limiting the opening movement of the gate to an extent tending to maintain a controlled flow rate of charge material into the basket.

5. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pressure signal supplied thereto, a pressure sensing probe disposed in said spout within the stream of charge material flowing through the spout when the gate is open and facing at least partially against the direction of flow of said stream for sensing the friction head loss in said stream, and means operated by the friction head loss sensed by said probe and establishing a corresponding pressure signal supplied to said positioning means for controlling the latter in a manner to cause said positioning means to adjust the stop means for limiting the opening movement of the gate to an extent tending to maintain a controlled flow rate of charge material into the basket.

6. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pressure signal supplied thereto, a pipe probe having an opening in the spout within the stream of charge material flowing through the spout when the gate is open for sensing the friction head loss in said stream, means supplying water to said pipe probe to flow through said opening of the latter for preventing clogging of said opening by the charge material, and means connected to said water supplying means and sensitive to the sensed friction head loss transmitted through the water from said opening of the pipe probe to establish a corresponding pressure signal supplied to said positioning means for controlling the latter.

7. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for automatically opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure fluid operated positioning means for adjusting the stop means in accordance with a controlling pneumatic signal supplied thereto, means located in the spout responsive to the pressure head of a stream of the charge material flowing through the spout when the gate is open for sensing the friction head loss in said stream, a valve device for regulating the pneumatic signal supplied to said positioning means and including a movable valve member which determines the magnitude of said pneumatic signal in accordance with the position of said movable valve member, and actuating means for said valve member urging the latter in opposite directions in response to the friction head loss sensed in the spout and the pneumatic signal, respectively, so that said valve member is always disposed at a position where the effects of said sensed friction head loss and said pneumatic signal are balanced.

8. In a loading control mechanism for a cyclical centrifugal installation, the combination as in claim 7; wherein said means for sensing the friction head loss in the stream of charge material includes a pipe opening into the spout and a restriction for supplying water at a restricted rate of flow through the said pipe to sense the head applied by material at the pipe opening and to prevent clogging of the opening by charge material, said pipe being connected to said actuating means so that said valve device is actuated in accordance with the sensed friction head loss transmitted through the water in said pipe.

9. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a flowable charge material the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged into the basket, a gate at the outlet of the spout, and gate operating means for opening and closing the gate; the combination of means responsive to the pressure head of a stream of charge material flowing through the spout when the gate is open for sensing the friction head loss in said stream, means establishing a pneumatic signal corresponding to said friction head loss sensed in the spout, adjustable stop means for limiting the extent of the opening of the gate by said gate operating means, pressure fluid operated means connected to said stop means for adjusting the latter, and positioner means controlling the supply of pressure fluid to said means for adjusting said stop means in accordance with said pneumatic signal in order to correlate the adjustment of the stop means with the magniture of the pneumatic signal.

10. In a loading control mechanism, the combination as in claim 9; wherein said means for adjusting said stop means includes a cylinder having a piston reciprocable therein and connected to said adjustable stop means, and said positioner means controls the supply of pressure fluid to said cylinder to positively dispose said piston at a location in the cylinder corresponding to the magnitude of the pneumatic signal received by said positioner means.

11. In a control mechanism for a charging device including a tank for holding a flowable charge material, the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged by pouring under gravity from the outlet end of the spout, a gate at the outlet end of the spout and gate operating means for opening and closing the gate; the

combination of pressure sensing means disposed in the spout upstream of the gate for sensing the static head of the charge material in the spout when the gate is closed and for sensing the loss of head caused by the frictional resistance to the flow of material in the spout when the gate is opened, and means modifying the operation of said gate operating means in accordance with changes in the head sensed by said sensing means such that the gate is initially opened to an extent dependent upon the magnitude of the static head sensed with the gate in the closed position and, after flow of the charge material through the spout is established, the gate is further opened to an extent dependent upon the magnitude of the head loss sensed with the gate in its initially opened position.

12. In a control mechanism for a charging device including a tank for holding a flowable charge material, the fluidity of which is susceptible to variations, having a spout through which the charge material is to be discharged, a gate at the outlet of the spout and gate operating means for opening and closing the gate and having adjustable stop means for limiting the opening movement of the gate; the combination of pressure sensing means disposed in the spout for sensing the static head of the charge material in the spout when the gate is closed and for sensing the loss of head caused by the frictional resistance to the flow of material in the spout when the gate is opened, and means responsive to the said sensing means to vary the position of said adjustable stop means in accordance with the sensed heads so that the gate is initially opened to an extent dependent upon the magnitude of the static head sensed with the gate in the closed position and, after flow of the charge material through the spout is established, the gate is further opened to an extent dependent upon the magnitude of the head loss sensed with the gate in its initially opened position.

13. In a loading control mechanism for a cyclical centrifugal installation including a rotary basket, a tank for holding a mass of a charge material, that flows by gravity with a fluidity susceptible to variations, said tank having a spout for delivering a stream of said charge material into the basket, a gate at the outlet of the spout and gate operating means for opening and closing the gate, the combination of a charge measuring device movable inward toward the center of the basket from a working position spaced from the inner wall of the basket by an increasing charge building up on said inner wall, control mechanism operable to effect simultaneous outward movement of the charge measuring device to said working position and actuation of said gate operating means for gate opening movement, an adjustable stop element coacting with a part of said mechanism to inactivate said gate operating means and limit the opening movement of the gate, means disposed in said spout for sensing the static head of said mass when the gate is closed and for sensing the loss of head in said spout caused by frictional resistance to the flow of said material through the spout when the gate is opened, and means responsive to pressure signals delivered by said sensing means to vary the position of the said adjustable stop element in accordance with changes of the head sensed by said sensing means in such manner that said stop element is given by the magnitude of said sensed head, first, an initial position corresponding to an extent of initial gate opening movement desired for said static head and thereafter, when said gate is opened, an adjusted position corresponding to the full extent of gate opening movement desired for the condition of fluidity indicated by said loss of head, said control mechanism including means responsive to inward movement of said charge measuring device from said working position to actuate said gate operating means progressively for gate closing movement, and finally to close said gate, independently of the position of said stop element.

14. In combination with a tank for holding a mass of a charge material that flows by gravity with a fluidity susceptible to variations, said tank having a spout through which a stream of said material is to be discharged from the tank by pouring under gravity from the outlet end of the spout, and a gate at the outlet end of said spout for regulating the flow of said material through the spout, a pipe containing a liquid and having a liquid-containing end portion disposed in said spout upstream of said gate in the path of the flow of said material in the spout when the gate is open, the liquid in said pipe being continually subject to a pressure that varies in magnitude with variations of the head of the material in said spout contacting said end portion, and means responsive to resulting variations in the magnitude of the pressure of said liquid for generating control signals of corresponding magnitude.

15. In combination with a tank for holding a mass of charge material that flows by gravity with a fluidity susceptible to variations, said tank having a spout through which a stream of said material is to be discharged from the tank by pouring under gravity from the outlet end of the spout, and a gate at the outlet end of said spout for regulating the flow of said material through the spout, a pipe containing a liquid and having a liquid-containing end portion disposed in said spout upstream of said gate in the path of the flow of said material in the spout when the gate is open, the liquid in said pipe being continually subject to a pressure that varies in magnitude with variations of the head of the material in said spout contacting said end portion, and means responsive to resulting variations in the magnitude of the pressure of said liquid for generating control signals of corresponding magnitude, said end portion comprising an open end of said pipe located inside said spout, and means for maintaining continuously through said pipe and through said open end into the material in said spout a restricted flow of said liquid under a predetermined feed pressure.

16. In combination with a tank for holding a mass of a charge material that flows by gravity with a fluidity susceptible to variations, said tank having a spout through which a stream of said material is to be discharged from the tank by pouring under gravity from the outlet end of the spout, and a gate at the outlet end of said spout for regulating the flow of said material through the spout, a pipe containing a liquid and having a liquid-containing end portion disposed in said spout upstream of said gate in the path of the flow of said material in the spout when the gate is open, the liquid in said pipe being continually subject to a pressure that varies in magnitude with variations of the head of the material in said spout contacting said end portion, and means responsive to resulting variations in the magnitude of the pressure of said liquid for generating control signals of corresponding magnitude, said end portion comprising an open end of said pipe located inside said spout, and means for maintaining continuously through said pipe and through said open end into the material in said spout a restricted flow of said liquid under a predetermined feed pressure, said open end facing upstream in said path.

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CERTIFICATE OF CORRECTION

Patent No. 3,079,046 February 26, 1963

Ralph C. Goodwin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 35, for "change" read -- charge --; column 3, line 19, for "laater" read -- latter --; column 9, line 1, for "strips" read -- trips --; column 12, line 19, before "at" insert -- as --; line 27, for "radical" read -- radial --; line 31, for "devides" read -- divides --; column 13, line 8, for "compresesd" read -- compressed --; column 16, line 7, for "change" read -- charge --; line 75, before "responsive" insert -- means --.

Signed and sealed this 1st day of October 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents