

March 4, 1947.

E. E. HARPER

2,416,994

AUTOMATIC CONTROL FOR GRAVIMETRIC FEEDERS BY THE WEIGHT  
OF THE MATERIAL IN THE SUPPLY CONTAINER

Filed April 6, 1944

2 Sheets-Sheet 1

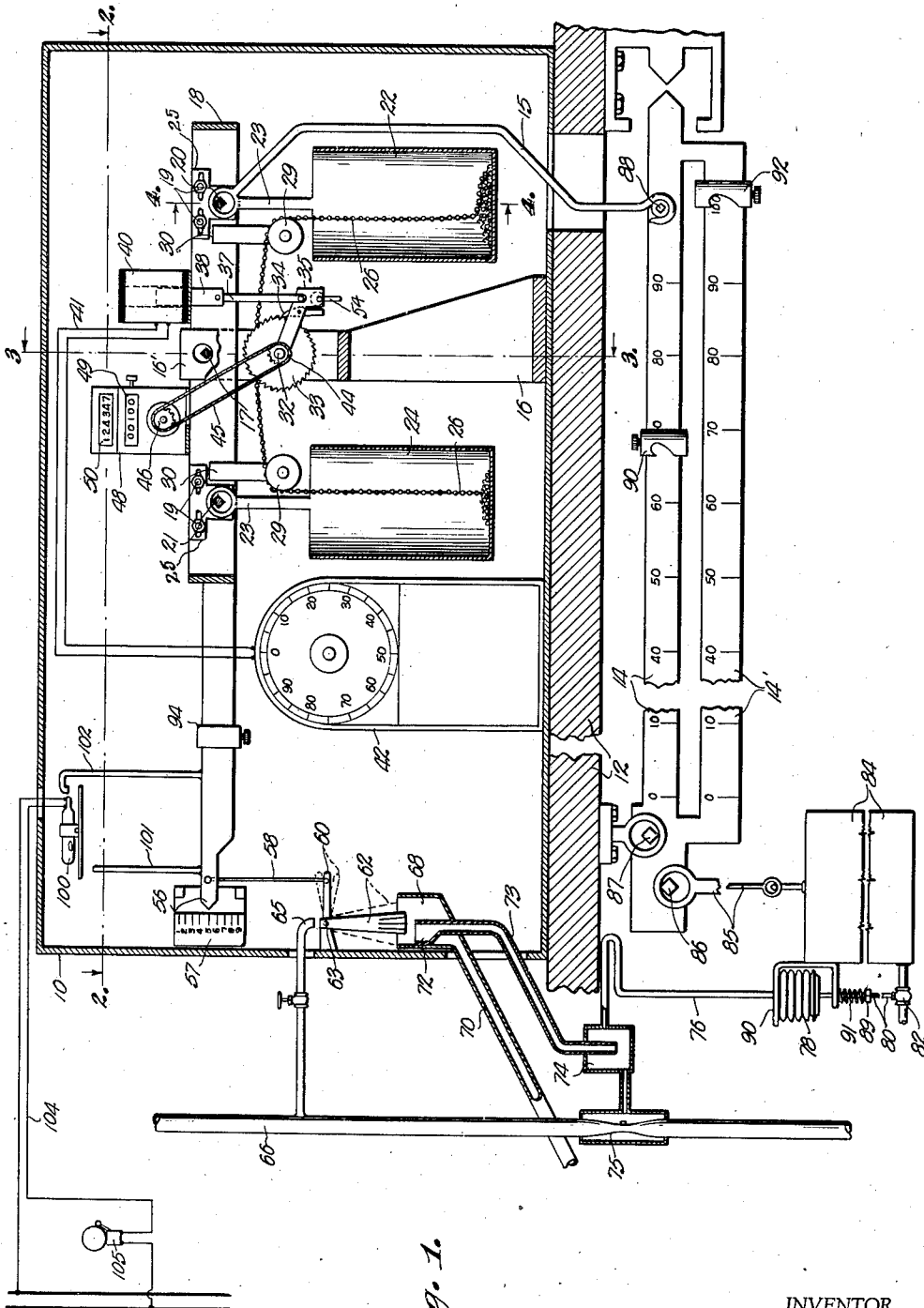


Fig. 1.

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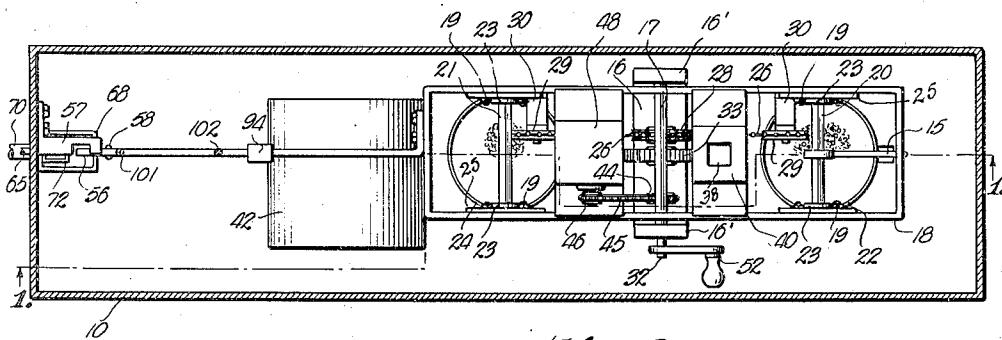


*Fig. 2.*

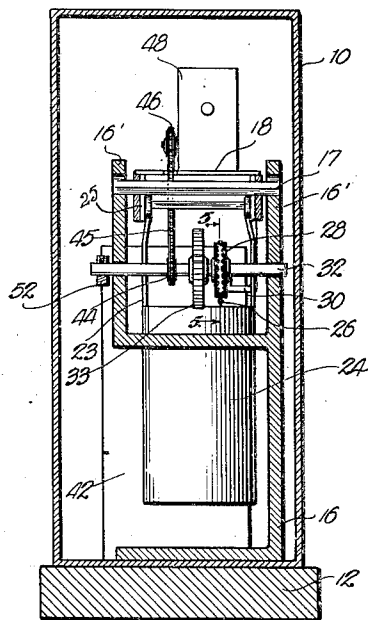


*Fig. 3.*

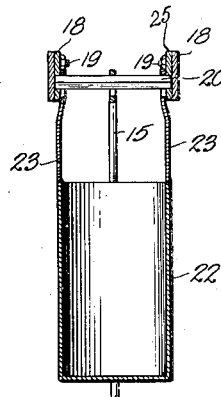


Fig. 4.

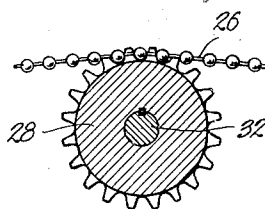


*Fig. 5.*

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## UNITED STATES PATENT OFFICE

2,416,994

AUTOMATIC CONTROL FOR GRAVIMETRIC  
FEEDERS BY THE WEIGHT OF THE MATERIAL IN THE SUPPLY CONTAINERElmer E. Harper, Monrovia, Calif.; Esther Pardee  
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9 Claims. (Cl. 222—58)

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The present invention has reference to improvements in control apparatus for automatic measuring mechanism, such as mechanism for feeding or discharging predetermined quantities or amounts of material for a given purpose, as in the adding of chemicals to water in water purification systems.

An underlying purpose of the invention is to devise improved feeding apparatus which will operate to feed or discharge properly predetermined amounts of the material over a given period of time and also preserve a substantially uniform rate of feeding action during that period.

One primary object of the invention therefore is to provide a novel control method which consists in balancing a load of the material on scales mechanism and, while imparting an unbalancing action thereto as by means of a continuous succession of impulses in such a manner as to unbalance the load on the scales, also transmitting at the same time a succession of control impulses to the feeding means of a character adapted to offset the unbalancing effect of the scales mechanism.

As one means for accomplishing such purpose I provide control means which operates by a measured movement and transfer of weight matter or substance and causing successive transferred portions of such weight matter to affect proportionately the balance of the scales mechanism on which the material to be handled is loaded, and likewise utilizing the same unbalancing effect of such transferred portions of the weight matter to correct the feeding or discharge rate of the material.

In providing apparatus of this character I have devised one form of construction which is suitable for the purpose of the invention, in which a type of weight material such as chain linkage or the like is caused to travel at a given rate, and the weight of successive portions of the chain material is transmitted and applied as a change factor in the unbalancing of the scales mechanism, and the said chain travel is further utilized as a correcting factor for modifying the feed or discharge rate of the material.

One other special and important object of the present invention is to provide an independent or self-contained form of control unit containing all the necessary elements of construction for effecting the required control functions, and assembled in such compact relation as to be readily and conveniently applied as an accessory to standard scale appliances without requiring any change

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in the latter other than the attachment of said unit in proper control relation thereto.

With the foregoing general objects, as well as minor features of improvement, in view, as will appear in the following detail specification, the invention will now be described by reference to the accompanying drawings, exemplifying a suitable construction of apparatus for embodying the proposed improvements, after which those features and combinations deemed to be novel and patentable will be particularly set forth and claimed.

In the drawings:

Figure 1 is a view in sectional elevation illustrating an apparatus constructed in accordance with said view representing a section taken on the line 1—1 of Figure 2;

Figure 2 is a sectional plan view, and represents a section taken on the line 2—2 of Figure 1;

Figure 3 is a transverse sectional view, and represents a section taken on the line 3—3 of Figure 1;

Figure 4 is a transverse sectional view through one of the chain-weight suspension means taken in the plane of its suspension pivot; and

Figure 5 is a sectional detail of the chain-weight feed wheel, being a section taken on the line 5—5 of Figure 3.

Referring now to the accompanying drawings in detail, the control mechanism comprising the essential features of the present invention is designed to be embodied in a control unit which may be assembled in a form of cabinet 10 adapted to be set up in the required position, as by being mounted on a supporting member 12, which may be part of the framework of a scales, and in such relation thereto as to facilitate connection of the control mechanism to the beam 14 of the scales, as by means of a suitable connecting link 15.

The mechanism within the cabinet comprises a bracket or support 16 having upper bearing portions 16' for the mounting of a transverse pivot bar or fulcrum 17 of a weight control beam 18, and at appropriate distances from said fulcrum or axis 17 of the beam 18 the latter is also provided with adjustable pivot elements 20 and 21 for the support of hanger arms 23 carrying a pair of chain buckets 22 and 24—see Figures 1 and 3. The pivot elements 20 and 21 are made adjustable by being mounted on slotted plate members 25 which are shiftable longitudinally along the beam 18 (see 19, Figure 4), the drawing

showing said pivot elements adjusted in equi-

distant relation to the central fulcrum 17, and the upper end of the aforesaid link 15 connected to the pivot element supporting the chain bucket 22.

The pivoted buckets 22 and 24 are for the purpose of receiving and supporting from the pivot points 20 and 21 the opposite end portions of a chain 26 of a uniform construction and weight, as this chain is transferred from one bucket to the other by means of a suitable drum or pulley 28 in opposite directions over guide pulleys 29 journaled in hangers 30 which are attached to the beam 18 over the respective buckets. The pulley 28 is secured to a transverse shaft 32 journaled in the bearings 16' and provided with a ratchet wheel 33 secured to the shaft and actuated by a pawl 34 mounted on a pawl-carrier 35 which is pivotally supported by said shaft and provided with a link 37 connecting said carrier with the core element 38 of a solenoid unit 40, as clearly shown in Figure 1. This solenoid unit is in an electric circuit 41 which includes a conventional form of timer unit 42 for actuation of said solenoid and the ratchet mechanism at a given rate, and thereby at the same uniform rate rotating said pulley 28 for driving and transferring the chain 26 from the bucket 22 to the bucket 24.

A gear 44 on the shaft 32 is provided with a flexible drive connection 45 to a gear 46 or the like whereby a conventional counter device or register 48 is also operated in unison with the chain transferring mechanism just described—said device 48 being preferably constructed to register both batch readings 49 and also total or cumulative readings as indicated at 50.

The shaft 32 is further provided with a crank and handle 52 for reversing the chain transferring operation by hand, in order to transfer the chain 26 from the bucket 24 back to the bucket 22 at the end of each batch count—a cam device 54 being mounted on the pawl-carrier 35 in position to throw the pawl 34 out of engagement with the wheel 32, to permit such reversal of the chain drive.

Various types of control mechanism and connections may be provided between the weight control beam and the feeding means which will be responsive to the movements of said beam, and one such arrangement and construction may be briefly described as follows. The weight control beam 18 may carry a pointer 56 operating along a suitable scale 57 indicating beam deflections, and this tip end of the control beam may be further provided with a suitable connection 58 to an operating arm 60 attached to what may be termed a flow-control pendulum 62 which is suspended from a fixed pivot 63 in the path of a flow of water or other liquid discharging from a pipe 65 leading from any suitable liquid supply pipe 66. The lower portion of the pendulum 62 may be fluted or otherwise shaped so as to spread the liquid or water flow into somewhat fan contour at the entrance 68 to a waste pipe 70, which entrance portion of the waste pipe encloses the mouth portion 72 of an air-choke tube 73 leading to an air trap chamber 74, which in turn is connected with a water jet device 75 forming part of the supply line 66. The chamber 74 is also provided with a flexible tube connection 76 with a Siphon bellows device 78 having an operative connection 80 with a suitable valve 82 or other feed regulating device which controls the discharge of the material. This material, in the example illustrated, is as-

sumed to be a liquid contained in a receptacle 84 suspended by means of a supporting connection 85 from a pivotal point 86 on the scale beam 14, and on the opposite side of the scales fulcrum 37 from that having the pivot point 83 where connection is made with the link 15 already referred to.

The bellows device 78 may be supported by a fixed frame or bracket 90 attached to said receptacle 84 as shown; and between this bracket and an adjustable nut 89 on the operating connection 80 is mounted a coil spring 91 for the purpose of maintaining the valve 82 normally in closed position, as regards any discharge of liquid from the receptacle 84. This is the relationship of the control mechanism corresponding to such limited flow of water admitted to the choke tube 73 as will produce no more than a negligible or inoperative vacuum in the flexible tube 76 and bellows device 78.

The arrangement of the pendulum 62 and its connection to the control beam 18 are such that a deflection of the beam, in response to the chain-transferring action, will permit the pendulum to swing into a position for diverting a greater or less portion of the water flow into the mouth of the choke tube 73; i. e., as some of the chain 26 is transferred to the bucket 24, the tip of the control beam is depressed, allowing the pendulum to swing to the left in Figure 1, thereby increasing the liquid flow through the tube 73 and thus to a degree choking the air flow therethrough and resulting in more air being withdrawn from the tube 76 and bellows device 78 and hence an opening movement of the valve 82 to feed more of the material from the receptacle 84. On the other hand, as the load on the scales, represented by said receptacle and its contents, is decreased due to said feeding and discharge of a portion of its contents, and the beam 18 is swung in the opposite direction, the pendulum 62 will likewise undergo a reverse movement (or to the right in Figure 1), thereby diminishing the liquid flow through the tube 73 so that the air flow therethrough is correspondingly increased, resulting in less air being withdrawn from the tube 76 and bellows 78—i. e., a diminishing vacuum action, and hence an automatic closing movement of the valve takes place to reduce or shut off the discharge of material from the receptacle 84.

One method of operation, with apparatus arranged as above described, may be carried out as follows.

The receptacle 84, which has been balanced on the scales mechanism by means of tare weight 90, is filled with the liquid material to be measured and again balanced by means of the poise 92 on the scale bar 14' of the beam 14, and the said poise then secured in this balanced relation. The scale beam 14 and the weight control beam 18 are then connected by means of the link 15.

At the start of an operating cycle, a quantity of suitable chain 26 of known length and of a weight equal to one-half the weight of the poise element 92, is carried in the bucket 22 and the entire system is brought in balance by means of the poise element 94 on the control beam 18; and the counter or register 48 is adjusted to 0 (or zero) reading. With such operating conditions it will be apparent that if a length of transferable chain (say 100 ft. and weighing 1 lb.) be transferred from bucket 22 to bucket 24 (and said buckets supported in equidistant relation to the beam fulcrum 17), then the lift exerted through the link 15 will just balance the weight

of the poise 92, or have the same effect as if said poise had been shifted to zero reading on the scale bar 14'. This transfer of the chain over to bucket 24 is effected automatically and progressively by the operation of the timer unit 42 and the described connections to the chain feeding drum or pulley 28, said timer device being adjustable for operation over a wide range as to time and therefore adapted to be set to operate said connections at any desired and exactly predetermined and controlled rate. As an example, if 10 ft. of chain weighing  $\frac{1}{10}$  lb. be transferred in one hour, this would be equivalent in effect to a change of  $\frac{1}{10}$  lb. in the lift exerted by link 15 on the scale beam 14 and correspond to a shift of the poise 92 to read 10 lb. less on the scale bar 14'; i. e., would represent an unloading of  $\frac{1}{10}$  of the load of material in the receptacle 84, or 10 lb. on the scale illustrated, within a period of one hour.

Since the transfer of any portion of the chain in the manner just described immediately unbalances the system and therefore depresses the tip of the control beam 18, this varies the position of the flow-control pendulum 62 in such a way as to cause more of the water flow to be diverted into the mouth of the choke tube 73 and correspondingly throttles the air flow there-through, so that a correspondingly increased vacuum effect is produced in the trap chamber 74 and transmitted therefrom by the tube 76 to the bellows device 78. This device 78 in turn opens the valve 82 just the required extent for establishing a liquid discharge from the receptacle 84 at a rate which will be in exact proportion to the rate at which the chain 26 is being transferred.

When the contents of the receptacle 84 have been completely discharged, a new cycle of operation is started by refilling the receptacle, transferring the chain 26 back to the bucket 22 by operation of the handle 52 until the counter 48 again registers zero, and then again balancing the load on the scale beam 14 by means of the poise 92, and restarting the operation of the timer device 42.

With the poise 92 showing the weight of the load at the start of the cycle, the counter device will register amounts indicating the exact weight of material which has been delivered at any given time in the cycle.

As has already been indicated, different types of control mechanism and connections may be employed in lieu of the flow-control pendulum and its connections to the feeding means represented by the valve 82—depending upon operating conditions and the nature of the materials to be handled; for example, my Patent #2,080,267, dated May 11, 1937, illustrates an alternative means of a flow-responsive type and suitable for use in controlling the flow of fluids; and the types of apparatus illustrated in Patents #2,100,315 and #2,100,316, dated November 30, 1937, are applicable for the feeding of dry materials from a container on scales, it being understood that the container for the material may be mounted either on a simple scale beam as herein illustrated, or on platform or hopper scales mechanism as is quite common practice for heavy loads of the material. It may also be stated that it would be entirely practicable to employ, in lieu of the timer unit, any suitable speed changer device, such as that shown in U. S. Patent #2,215,040, dated October 22, 1940, for controlling the speed at which the chain is transferred in the measuring operation.

As a precaution in case of faulty operation, resulting in excessive movements of the weight control beam 18, a conventional switch device 100 may be provided, and located in position for engagement by trip arms 101—102 carried by the control beam, as illustrated in Figure 1, which switch element is included in an electric circuit 104 that may be provided with an alarm 105, or if desired a safety relay device or the like for interruption of the operation in the event of such excessive movement, as will be readily understood.

The only definite essential as to the type of chain used is that the same be fairly uniform in weight throughout, and any required length or weight may be used, and by an adjustment of one of the pivots 20, 21, variations in the weight of chain lengths may be properly compensated for; and this adjustment may be further utilized for governing (within a reasonable range) the change in load transmitted through the link connection 15 to the scale beam 14, which makes it possible to use a comparatively light weight chain instead of the heavy poise commonly required on scales of large capacity.

As an alternative mode of operation the system may be adjusted to balance the load in the receptacle 84 by means of the chain in bucket 22 and without the use of the poise 92 on the scale bar 14', with which arrangement the counter may be set so as to indicate always the exact load remaining in the receptacle. In carrying out such operation the poise 92 may be kept at zero, or used merely as a means of checking the accuracy of the chain weight; or if desired in some cases, both the scale bar 14' of the scale beam and said poise 92 may be dispensed with altogether.

A further important and outstanding feature of the present invention is the provision of a control unit which can be constructed as a separate compact and self-contained assembly adapted to be readily and conveniently attached in operative relation (as by means of the link 15) to practically any standard beam scale, under a wide variety of conditions, without any change or re-designing of the scales or any interference with the ordinary normal use of the beam scale when necessary, since the control unit may be instantly disconnected from the main scale mechanism at any time.

As further features of advantage over prior control apparatus of this character it is to be noted that in addition to the simplicity of the present improved apparatus and the elimination of any elaborate refinements in construction, the use of a comparatively long chain provides a much more accurate method of registering weight measurements as compared with graduations on a scale beam which, under normal conditions, can seldom average more than 30 inches in length. For example, the counter may readily be geared to register a loss in weight (from the receptacle) of say,  $\frac{1}{100}$  or even  $\frac{1}{1000}$  lb. as compared with readings scarcely closer than  $\frac{1}{4}$  lb. on beam scales of 100 lb. capacity, and 2 to 5 lb. on beam scales of 1000 lb. capacity.

The improved construction is also adapted to register counter readings indicating either the weight of material remaining in the receptacle, or the weight of material which has been delivered therefrom; and obviously it would be within the scope of the invention to make still further provision for registering both readings as just indicated, in addition to cumulative readings cov-

ering any desired period of time of operation. It is also apparent that the timer unit may be located at any desired point, separate from the other mechanism of the control assembly, and that other duplicate counter devices (connected electrically with the first) may be provided if necessary at other remote points.

While the apparatus as herein illustrated employs bucket-supporting pivots 20 and 21 on opposite sides of the fulcrum 17 of the control beam 18, it is of course feasible to locate said pivots in operative relationship at the same side of the said fulcrum point; it is even possible to dispense with said control beam altogether, and install the other elements or accessories in operative relationship to a suitable extension of the main scale beam as an alternative form of the construction. Moreover, while I have herein described the improvements as related and applied to weighing mechanism of the scale beam type, it is also feasible to connect and assemble the improved control mechanism in operative relation to many types of dial scale. I therefore desire not to limit the scope of the invention to merely those particular forms of construction and application herein illustrated, but claim such broader scope for my improvements as will be found embraced within the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by said scales mechanism in balanced relation thereon, feeding means for discharging material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, weight material carried by said control beam and comprising a series of substantially uniform weight units shiftable as separately effective weight increments relatively to said beam, means operating at a given controlled rate for consecutively transposing uniform equal portions of said weight material between given selected points on said beam without any shifting movement of the remaining portions of said weight material between said given points, thereby unbalancing the beam and imparting a corresponding unbalancing action to said scales mechanism, and also means responsive to the movements of said control beam for correspondingly regulating the operation of said feeding means.

2. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by the scales mechanism in balanced relation thereon, feeding means for feeding the material from said container, and a control structure comprising a balanced control beam connected with the scales mechanism, weight material carried by said beam and comprising a series of substantially uniform weight units shiftable as separately effective weight increments relatively to said beam, means operating at a given controlled rate to shift uniform equal portions of said weight material into different supported positions on said beam without any shifting movement of the remaining portions of said weight material between said given points, thereby unbalancing the beam and imparting a corresponding unbalancing action to said scales mechanism, and control connections actuated by the movements of said control beam for correspondingly regulating the operation of said feeding means.

3. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by the scales mechanism in balanced relation thereon, feeding means for dispensing material from said container, and a control structure comprising a balanced control beam connected with the scales mechanism, weight material carried by said control beam and comprising a flexible strand supported from two different points on said beam, means operating at a given controlled rate to impart longitudinal shifting movements to said strand for progressively transferring the weight of said weight material from one to the other of said points and thereby unbalancing the beam and correspondingly unbalancing said scales mechanism, and control connections actuated by the movements of said control beam for correspondingly regulating the operation of said feeding means.

4. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by said scales mechanism in balanced relation thereon, feeding means for feeding material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, weight receptacles pivotally supported from the control beam equidistant from and on opposite sides of its fulcrum, a flexible strand of weight material supported for movement endwise between said receptacles, means operating at a given controlled rate to impart longitudinal movement to said strand for progressively transferring the weight of said weight material from one to the other of said receptacles and thereby unbalancing the beam and correspondingly unbalancing the scales mechanism, and control connections actuated by the movements of the control beam for correspondingly regulating the operation of said feeding means.

5. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by said scales mechanism in balanced relation thereon, feeding means for dispensing material from said container, and a control structure comprising a balanced control beam provided with weight receptacles pivotally supported from the beam equidistant from and on opposite sides of its fulcrum point, a flexible strand of weight material supported for movement endwise between said receptacles, means operating at a given controlled rate to impart longitudinal movement to said strand for progressively transferring the weight of said material from one to the other of said receptacles and thereby unbalancing said control beam, a link connecting the pivotal point of one of said receptacles and said scales mechanism whereby the latter is subjected to a corresponding unbalancing action, and control connections actuated by the movements of said control beam for correspondingly regulating the operation of said feeding means.

6. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by the scales mechanism in balanced relation thereon, feeding means for dispensing material from said container, and a control structure comprising a balanced control beam connected with the scales mechanism, a flexible strand of weight material supported from two different points on said control beam, means op-

erating at a given controlled rate to impart longitudinal shifting movements to said strand for progressively shifting the weight of said weight material from one to the other of said supporting points and thereby unbalancing said beam and correspondingly unbalancing the scales mechanism, counter means for automatically registering and recording the movements of said strand shifting means, and control connections actuated by the movements of said control beam for correspondingly regulating the operation of said feeding means.

7. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported by said scales mechanism in balanced relation thereon, feeding means for dispensing material from said container, and a control structure comprising a balanced control beam connected with the scales mechanism, weight receptacles provided with adjustable pivots for pivotally suspending the receptacles from said beam at variable distances from the fulcrum point of the beam, a flexible strand of weight material supported for endwise movement between said receptacles, means operating at given controlled rate for progressively transferring said strand endwise from one to the other of said receptacles and thereby effecting an unbalancing of both said beam and said scales mechanism, and control connections responsive to the movements of said control beam for regulating the operation of said feeding means.

8. A selfcontained control unit for automatically controlling the operation of gravimetric feeding devices comprising, a balanced control beam, weight material carried by said beam and comprising a series of substantially uniform weight units shiftable as separately effective weight increments relatively to said beam, means operating at a given controlled rate for consecutively transposing uniform equal portions of said weight material between two given points on said

beam without any shifting movement of the remaining portions of said weight material between said given points and thereby unbalancing the beam, means for transmitting said unbalancing action to the scales mechanism of the gravimetric feeding device, and connections responsive to the movements of said control beam for imparting corresponding regulating movements to the material-feeding means of the gravimetric feeding device.

9. A selfcontained control unit for automatically controlling the operation of gravimetric feeding devices having material-feeding means comprising, a balanced control beam, weight supporting receptacles provided with pivots for pivotally suspending the receptacles from said control beam in spaced relation to the fulcrum point of the beam, a flexible strand of weight material carried for endwise movement between said receptacles, means operating at a given controlled rate for progressively transferring said strand endwise from one to the other of said receptacles and thereby effecting unbalancing movements of said control beam, one of the pivots for said receptacles being mounted for adjustment along the control beam and provided with a connection for transmitting said unbalancing action to the scales mechanism of the gravimetric feeding device, and means responsive to the movement of said control beam for transmitting a corresponding regulating movement to the material-feeding means of the gravimetric feeding device.

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