April 25, 1950 E. E. HARPER 2,505,491

CONTROL MECHANISM FOR GRAVIMETRIC FEEDERS

Filed May 17, 1944 2 Sheets-Sheet 1

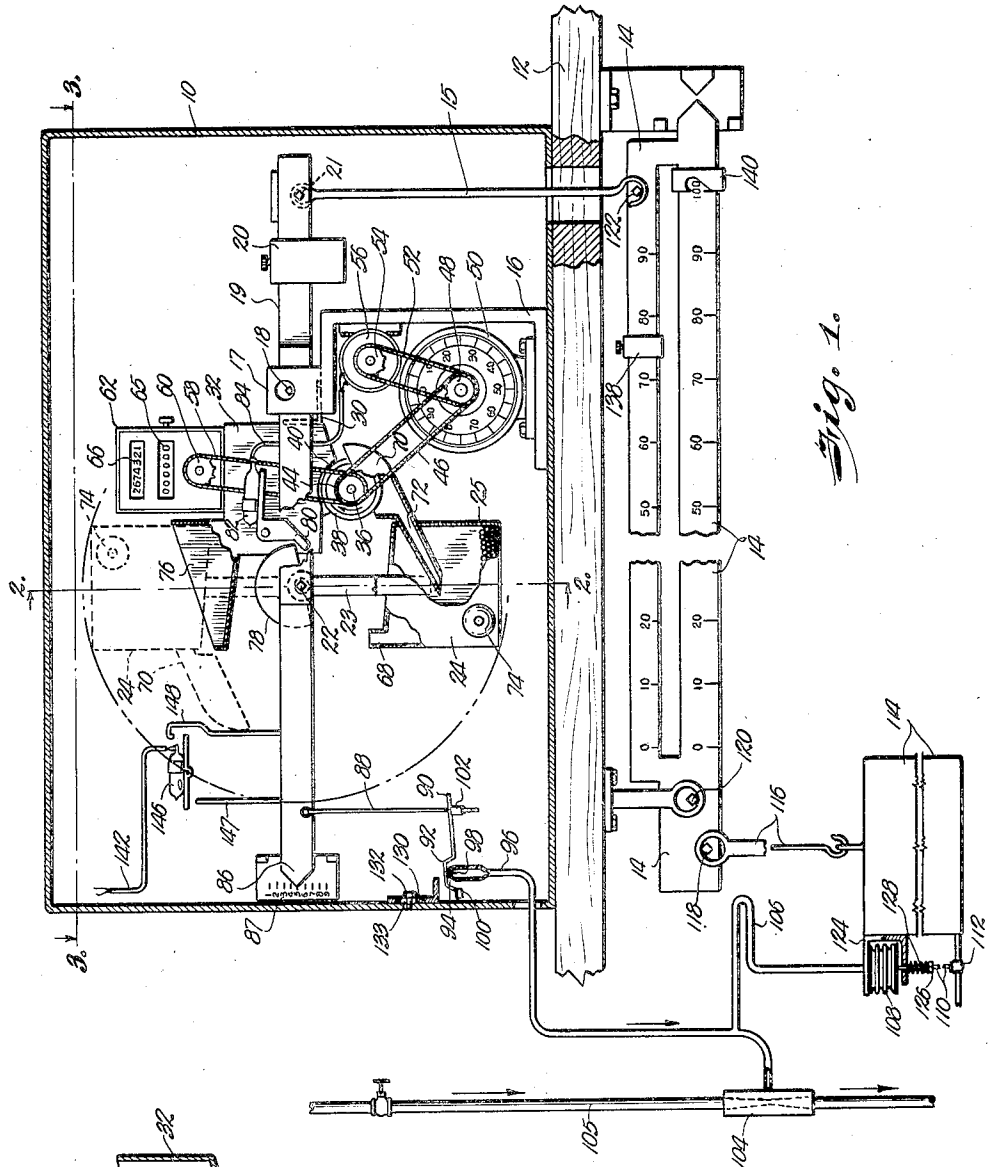


Fig. 1.

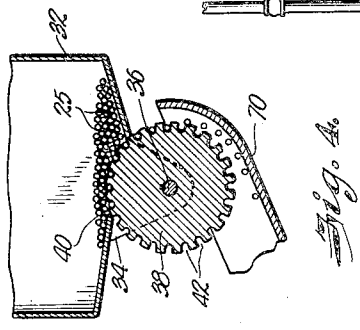


Fig. 4.

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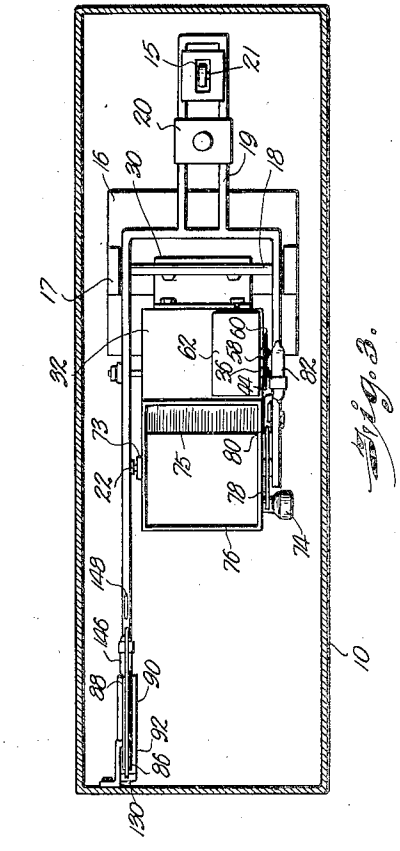


Fig. 3.

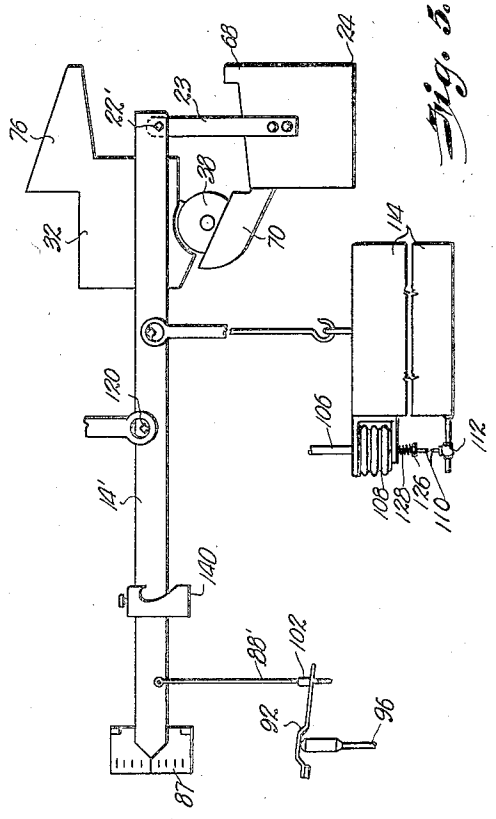


Fig. 5.

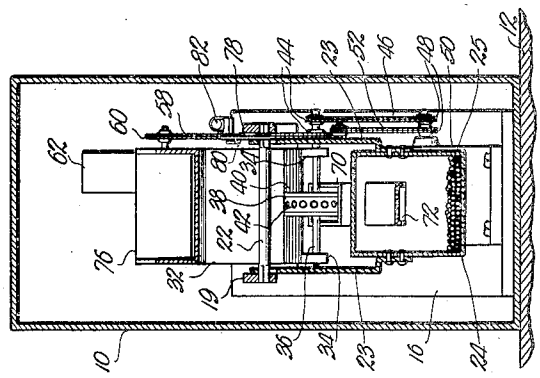


Fig. 2.

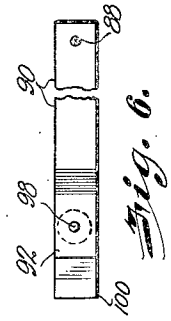


Fig. 6.

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Patented Apr. 25, 1950 2,505,491

UNITED STATES PATENT OFFICE

2,505,491

CONTROL MECHANISM FOR GRAVIMETRIC FEEDERS

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Application May 17, 1944, Serial No. 535,975

8 Claims. (Cl. 222—55)

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The present invention pertains to automatic measuring apparatus of the type operating to feed or discharge predetermined or measured amounts of a material for a given purpose, as is required for example in the handling of chemical materials in water purification operations, and the primary object of the invention relates to the provision of novel control means for the automatic measuring means of this class of apparatus.

A fundamental object of my invention, therefore, is to devise an improved material feeding mechanism in which is incorporated a novel type of control means for insuring the feed or discharge of accurately predetermined amounts of the material over given periods of time as well as to insure a proper uniform rate of the feeding action throughout each period of operation.

For this purpose I have devised a novel control construction which operates by means of a periodic transfer of weight matter and applying the successively transferred portions of such weight matter in such a manner as to proportionately affect the balance of the scales mechanism on which the material to be handled has been loaded and initially balanced, and also making further use of this unbalancing action for the purpose of producing a proportionate correction of the feeding or discharge rate of said material.

As an example of such a construction I provide a control apparatus in which a type of weight material such as granular or shotlike material is fed or transferred at a given rate, and the weight of the successively fed or transferred amounts of said shot or granular material is applied as a change factor in the unbalancing of the scales mechanism and simultaneously applied as a corrective factor for proportionately modifying the feed or discharge rate of the primary material which is being handled.

It is a further object of my invention to provide a control apparatus of the character stated which is also adapted to be embodied in the form of an independent or selfcontained type of control unit comprising all the essential elements of construction for effecting the required control functions and in such compact form as to serve as an accessory adapted for convenient application to standard scale appliances without any material modification thereof.

With the foregoing general objects in view the invention will now be described in detail by reference to the accompanying drawings illustrating practical forms of apparatus for embodying the essential features of my improvements, after which those features and combinations deemed

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to be particularly novel and patentable will be duly set forth and claimed.

In the drawings:

Figure 1 is a view in sectional elevation illustrating and embodying the present improved control system and representing a section taken on the line 1—1 of Figure 2;

Figure 2 is a transverse sectional elevation, representing a section taken on the line 2—2 of Figure 1;

Figure 3 is a sectional plan view and represents a section taken on the line 3—3 of Figure 2;

Figure 4 is an enlarged sectional detail view of a part of the shot-feeding mechanism;

Figure 5 is a diagrammatic view illustrating a modified form of the apparatus; and

Figure 6 is an enlarged plan view of the air choke valve element.

Referring now to the accompanying drawings in detail, the control mechanism forming the subject matter of the present invention is of a character designed to be embodied in the form of a control unit such as may be assembled in a cabinet structure 10 suitable for mounting in operative relation to a scales mechanism, as by being mounted on a supporting member 12, such as the framework of a scales, and in such position as to facilitate the connection of the control mechanism to the beam 14 of the scales, as by means of a suitable form of connecting link 15. In these respects the present invention resembles the subject matter of my Patent No. 2,416,994, dated March 7, 1947, relating to control mechanism designed to function in a manner very similar to the control operation of the construction herein described.

For the support of the control mechanism inside the cabinet 10, I provide an angular type of bracket structure 16, the upper end of which is formed with a bearing structure 17 for a transverse pivot bar or fulcrum 18 carrying a weight control beam 19. At one side of this fulcrum the beam 19 is provided with an adjustable poise or balancing weight 20 and also an adjustable pivot 21 for the connecting link 15; and at the other side of its fulcrum 18 the beam is provided with a pivot bar 22 for a pair of hanger arms 23 supporting a bucket 24 for receiving the shot weight material 25 when the same is fed or discharged by the method about to be described.

At the top of the bracket 16 is secured another bracket element 30 for the fixed support of a magazine or container 32 for the storage of a supply of said shot weight material 25. The bottom of this container is provided with suitable

bracket projections 34 for journaling a shaft 36 carrying a shot feeding wheel 38 in such a position that a portion of the periphery of said wheel projects within an opening 40 in the container bottom, as illustrated in Figure 4. The periphery of the wheel 38 is provided with one or more rows of recesses or pockets 42—each preferably of a size suitable for accommodating a single grain of the shot material 25.

The shaft 36 is provided with a pair of sprocket wheels 44, one of which is driven by a chain 46 from one of a pair of sprocket wheels 48 on a speed changer device 50 (of a type such as is shown in my Patent No. 2,219,040, dated October 22, 1940), the other sprocket wheel 48 being driven by a chain 52 from a sprocket 54 actuated by a suitable motor 56. The motor and speed changer are conveniently mounted within the bracket structure 16, as shown in Figure 1, the function of said speed changer device being to control the speed of rotation of the feed wheel 38 within any desired limits.

The other sprocket wheel 44 on the shaft 36 drives a sprocket chain 58 and sprocket wheel 60 which actuates a conventional counter device or register 62 which is mounted on top of the container 32 and is preferably of a type to register both batch readings 65 and also total or cumulative readings as indicated at 66.

The shot bucket 24 is closed with the exception of an upper discharge spout 68 and a shot receiving funnel 70, one end of which is shaped to embrace a portion of the periphery of the shot feed wheel 38, the remainder of the funnel being shaped as a chute 72 which is attached to the upper portion of the bucket and projects down into about the center of the bucket.

At the end of each cycle of operation, the bucket 24 is adapted to be swung, by means of a handle 74, upwardly into inverted position, as illustrated by the dotted lines in Figure 1, for the purpose of emptying the shot back into the container 32 through a top opening 75, said container being formed with a hopper-like extension 76 shaped to receive and enclose the top of the inverted bucket and thereby guard against the loss by spilling of any of the shot material as the latter pours out of the spout 68 and through the opening 75 back into the container 32.

Provision is also made to insure that the shot feeding operation is stopped during the time required for emptying the bucket 24, by means of a cam device 78 connected to one of the bucket arms 23, which cam device operates in the inverted position of the bucket to engage one end of a pivoted arm 80 carrying a conventional cut-out switch 82 in an electric circuit 84 and operative to open the motor circuit and thus stop the drive to the feed wheel 38.

Various types of control mechanism and connections may be provided between the weight control beam and the feeding means (of the primary material) which will be responsive to the unbalancing action of said beam, and one preferred arrangement and construction may be briefly described as follows.

The control beam 19 may carry a pointer 85 operating along a suitable scale 87 indicative of beam deflections; and this tip end of the control beam may be further provided with a suitable connection 88 to an arm 90 of a rocker valve of thin metal or the like, the body portion 92 of which is formed into inverted cup or hood shape for flatwise engagement (when in valve closing position) with the mouth of a thin-edged air orifice element 94 mounted at the entrance to an air choke tube 96. A pin 98 secured to the center of the body portion 92 of the valve serves to maintain the same in approximately central position over the orifice 94, and a small mass 100 of weight material (such as solder) may be applied to the opposite side of said body from the arm 90 to insure bringing the center of gravity of the valve structure below said orifice and thereby obtain efficient automatic valve closing action on lowering movement of the connection 88 in response to the control operation of the beam 19. Preferably the arm 90 of the valve rests upon a nut 102 which is adjustably mounted upon said link connection 88, although a reverse arrangement of said valve and nut may be used, as hereinafter illustrated.

The air choke tube 96 communicates with a water jet device 104 included as part of a water supply line 105, and also with a flexible tube 106 which connects with a Sylphon type of bellows device 108 having an operative connection 110 with a suitable valve 112 or other equivalent feed regulating device adapted to control the discharge of the primary material which, in the present instance, is assumed to be a liquid contained in a receptacle 114 suspended by means of a supporting connection 116 from a pivotal point 118 on the scale beam 14 and on the opposite side of the scale fulcrum 120 from that having the pivot point 122 where connection is made with the link 15 already referred to. The bellows device 108 may be supported by a fixed frame or bracket 124 attached to said receptacle 114, as illustrated; and between this bracket and an adjustable nut 126 on the operating connection 110 is mounted a coil spring 128 for the purpose of maintaining the valve 112 normally in closed position, as regards any discharge of liquid from the receptacle. This is the relationship corresponding to such a position of the valve 92 as will allow no more than a negligible or inoperative vacuum to be produced in the flexible tube 106 and the bellows device 108.

The arrangement of the valve 92 and its connection to the control beam 19 are such that a deflection of the beam in response to the shot feeding action will permit the valve 92 to settle into more nearly closed position, which has the effect of choking the flow of air through the tube 96 and to that extent resulting in more air being withdrawn from the tube 106 and bellows device 108, and hence producing an opening movement of the valve 112 to feed more of the liquid material from the receptacle 114. On the other hand, as the load on the scales, represented by said receptacle 114 and its contents, is decreased, due to said feeding and discharge of a portion of said contents, so that the beam 19 is caused to swing in the opposite direction, the valve 92 will likewise undergo a reverse or lifting movement, tilting it upon the orifice 94 and to that extent opening said orifice and allowing more air to be admitted to the tube 96, with the effect of diminishing the amount of air withdrawn from the tube 106 and bellows device, i. e., a diminishing vacuum action, which permits an automatic closing movement of the valve 112 to reduce or shut off the discharge of material from the receptacle 114.

A stop bracket 130 may be adjustably supported by means of a screw 132 or the like, engaging a slot 133 in said bracket, in overhanging relation to the valve 92 and a sufficient distance therefrom for permitting all normal operative movements of the valve while preventing any casual

displacement of the same from its position on the orifice element 94 (see Figure 1).

In preparing the apparatus for operation, a supply of granular or shot material 25 (which may be plain lead shot or, if preferred, steel or bronze balls) is placed in the storage container 32. The size of this shot depends upon the requirements to be met by each apparatus; for example, a size may be selected and the pivot 15 so adjusted that, say 100-shot (when supported in the bucket 24) will offset a weight-change of 1 lb. in the receptacle 114, and hence each grain of shot will balance 1/100 lb. in said receptacle and the batch counter reading 64 of the counter device 62 will register a loss of weight from said receptacle of 1/100 lb. for each grain of shot discharged by the shot feed wheel 38 into the bucket 24. From this it will be seen that the principle of the operation is to provide an appropriate number of weight units sufficient for counterbalancing the scale load, and means for successively applying the unbalancing force of those weight units, at a predetermined and controlled rate, and to utilize the resultant unbalancing action in turn as the means for the automatic regulation or control of the feeding rate of the material. In such an operation the sensitiveness of the control action is limited only by the sensitiveness of the control beam balance and the minuteness of the subdivision of the load into weight control units as represented by the number of such units utilized for counterbalancing the load. As a matter of fact it may be pointed out that high grade scales are sensitive to changes in weight much smaller than provided for by the graduations on the limited length of scale beam; and the improved method of the present invention therefore, because of the minute subdivision of weights used, enables the range of operation to be extended (even with present standard scales apparatus) to embrace and cover the requirements as to very sensitive weighing, involved in the operation of gravimetric feeders.

The receptacle 114 may be suspended on a simple beam as shown, or may of course be supported on hopper or platform scales of any capacity, and is balanced empty by the tare weight 138, the motor 56 meanwhile being idle and the shot bucket 24 being entirely empty. Thus the entire system is initially in balance. The receptacle 114 is next filled and the system rebalanced by means of the poise 140 on the scale bar 14' of the beam 14, and the said poise then secured in this balanced position (indicating the net weight of the contents of the receptacle 114).

With the scale system in balance, and the water jet device 104 put in operation, the air control valve 92 will be open wide enough to admit sufficient air to prevent development of a vacuum action in the connections to the bellows device 108 strong enough to operate the valve 112.

On starting the motor 56 the drive through the speed changer 58 operates the shot feed wheel 38 to discharge the shot from the container 32 into the bucket 24 at a known and controlled rate as determined by the adjustment of said speed changer unit 50. The addition of this weight (due to said flow of shot material) slightly unbalances the control beam and tends to lower its tip end and thus allow a settling of the air control valve 92 down into more nearly closed position upon the orifice 94 and to that extent choke the air flow therethrough and intensifying the vacuum action

produced in connections to the bellows device, which transmits an opening movement to the valve 112. After a short interval of operation a condition of equilibrium is established, due to the unbalancing action referred to being exactly offset, or counterbalanced, by the rate of discharge of the material from the receptacle 114; in other words, the control of the feeding action thus produced is just to the required extent necessary for establishing a liquid discharge from the receptacle at a rate which will be in exact proportion to the rate at which the shot is being discharged from the storage container 32 into the bucket 24; and in the establishment of this feeding rate the valve 92 is so adjusted by means of its nut 26 that in the normal operation of the control mechanism the control beam 19 will remain practically continuously in a horizontal position.

The foregoing balanced operation will continue until all the material has been discharged from the receptacle 114, and if the attendant does not interrupt the shot-feeding operation and refill said receptacle for the starting of another cycle, the continued shot flow will unbalance the control beam sufficiently to operate an alarm circuit 142 having a conventional switch device 146 located in position for engagement by trip arms 147 and 148 carried by the control beam, as illustrated in Figure 1. This electric circuit may also, if desired, include safety relays or the like for shutting down the operation entirely; and faulty operation, such as interruption of the shot-feeding action or failure of either of the valves 92 or 112 to function properly, will quickly unbalance the system and thereby cause operation of the alarm, in a manner similar to that referred to in my aforesaid copending application.

The counter device 62 is manually reset at the beginning of each new cycle, so that the batch reading will register zero; and the gear drive from the shot feed wheel is arranged to produce counter readings in pounds and decimals thereof corresponding to the exact weight of material discharged from the receptacle 114 from the beginning of the cycle, the readings 66 showing total or cumulative amounts in the usual manner.

A special advantage which characterizes the use of shot or granular material as the weight material required for the control operation is the availability of such granular form of material in commercial quantities in very uniform sizes; as, for example, in ground balls of the type used in ball bearings and manufactured to very close tolerances. However, for a very wide range of operations I have found that ordinary lead shot will function very satisfactorily and with sufficient accuracy for many purposes; for example, a size of shot averaging upwards of seven thousand shot grains per pound is entirely practical and satisfactory for a great many applications.

Another peculiar advantage attending the use of the shot material is the fact that it promotes scale sensitivity due to the continual slight jarring action imparted to the control system by the impact of the falling shot grains as they drop into the bucket; this has the effect of keeping the scale system "alive," as the expression goes, being comparable to the benefits aimed at in the use of vibratory mechanism in connection with scale mechanism for promoting a freer and more sensitive scale action.

The use of the special type of air control valve

92 in connection with the weight control beam is also particularly effective for the required control function, due to its simplicity and being of so sensitive a type as to require only a negligible amount of force for its operation, and thereby imposing no objectionable load on the beam such as would materially obstruct its movements or operation. Moreover the design of said valve and its control connections is adapted for ready adjustment, and also for operation in either direction with the same result, thus rendering it suitable for different forms of installation.

It is also pointed out that other types of control mechanism and connections may be employed in lieu of said valve 92 and its connections to the feeding means, depending upon operating conditions and the character of materials to be handled, my Patents Nos. 2,080,267, 2,100,315 and 2,100,316 showing examples of such varying requirements and forms of mechanism suitable therefor.

One special advantage of the present type of control construction is its embodiment in the form of a control unit (as in my aforesaid prior patent) which can be constructed as a separate and independent or selfcontained assembly adapted to be quickly and conveniently attached as an accessory to practically any standard beam scale, without any change or redesign of the latter or interference with the ordinary normal use thereof, as required.

However, I have illustrated in Figure 5 of the drawings an alternative form of construction wherein the control beam as a separate element may be dispensed with altogether by combining the control feature in direct operative relation to the scale beam 14' itself. Thus, the shot feeding means can be located in position for discharging the shot into the bucket 24 as suspended from a pivot 22' mounted on an extended portion of said beam 14'; and instead of the link 15, this can be replaced by a control link 38' connected to the valve 92 in such operative relation as to actuate the valve in the opposite direction from that already described, but causing the valve to carry out the same air control function, by its rocking movement upon the orifice 94, as will be readily understood. The fact that all driving mechanism, counter devices, etc., are mounted entirely independent of the control beam, in this modified form as well as in the previously described form of the apparatus, is also of especial advantage, in the interests of sensitivity of scale action, as well as simplicity of construction.

From the foregoing it will therefore be apparent that I have devised a highly practical form of construction and arrangement for fulfilling the desired objects of my invention; and while I have herein illustrated and described what I have found to represent very satisfactory and efficient forms of apparatus, etc., for embodying my improvements, I desire to be understood as expressly reserving the right to make whatever changes or modifications may fairly be deemed to fall within the spirit and scope of my invention as defined by the appended claims.

Having described my invention, what I claim is:

1. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported in balanced relation on said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, a weight container supported by said control beam, means for discharging into said container a series of separate and substantially equal weight units for imposing a continuous succession of additive unbalancing impulses on said scales mechanism at a predetermined and controlled rate, and means actuated by movements of said control beam for transmitting coordinative impulses regulative of the feeding means for offsetting said unbalancing effect on the scales mechanism.

2. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported in balanced relation on said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, a weight container supported by said control beam, an independently supported supply of homogeneous granular material comprised of separate and substantially equal weight particles, means for progressively discharging said granular material into said weight container for imposing a continuous succession of additive unbalancing impulses on said scales mechanism at a predetermined and controlled rate, and means responsive to movements of said control beam for imparting coordinate impulses regulative of the feeding means to offset said unbalancing effect on the scales mechanism.

3. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported in balanced relation on said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, a weight container movably supported by said control beam, an independently supported supply of homogeneous granular weight material, means operating at a predetermined and controlled rate for progressively feeding separate weight particles from said supply of granular material into said weight container and thereby imposing a continuous succession of additive unbalancing impulses on said scales mechanism, and means actuated by movements of said control beam for transmitting coordinate impulses regulative of said first feeding means to offset said unbalancing effect on said scales mechanism, said weight container being movable into position for dumping its contents back into said supply of granular material.

4. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a receptacle for the supply of material supported in balanced relation to said scales mechanism, feeding means for discharging material from said receptacle, and a control structure comprising a balanced control beam connected with said scales mechanism, a weight container supported by said control beam, an independently supported supply of weight material mounted in discharge relation to said container, means for progressively feeding said weight material into said container for imposing a continuous succession of additive unbalancing impules on said scales mechanism at a predetermined and controlled rate, means acting in unison with the operation of said last mentioned means for correspondingly regulating the operation of said first feeding means to offset

said unbalancing effect on the scales mechanism, said weight container being movable into position for dumping its contents back into said receptacle, and means operating in the dumping position of said container for interrupting the operation of said weight material feeding means.

5. A selfcontained control unit for automatically controlling the operation of gravimetric feeding devices comprising, a balanced control beam having adjustable means of connection with the feeding device, means operating at a given controlled rate for progressively loading said control beam at a single point with a series of separate and substantially equal weight units for transmitting through said connection a succession of additive unbalancing impulses to the scales mechanism of the gravimetric feeding device, and connections responsive to movements of said control beam and operative to impart corresponding regulating movements to the material feeding means of the gravimetric feeding device.

6. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for material supported in balanced relation to said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, means for applying the successive impacts of falling mass particles of uniform average weight for imposing a continuous succession of additive unbalancing impulses on said scales mechanism at a predetermined and controlled rate, and means responsive to movements of said control beam for correspondingly regulating the operation of said feeding means and thereby preserving the balance of said scales mechanism.

7. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for the material supported in balanced relation to said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism and actuated by the fluctuations thereof, means for applying to said control beam a continuous succession of combined weight increments and jarring impulses operative to produce unbalancing movement of said control beam at a predetermined and controlled rate, and means responsive to movements of said control beam for correspondingly regulating the operation of said feeding means and thereby preserving the balance of said scales mechanism.

8. Apparatus for the gravimetric feeding of material comprising, in combination with scales mechanism, a container for material supported in balanced relation to said scales mechanism, feeding means for effecting discharge of material from said container, and a control structure comprising a balanced control beam connected with said scales mechanism, means for applying the successive impacts of falling mass particles for imposing a continuous succession of additive unbalancing impulses on said scales mechanism at a predetermined and controlled rate, and means responsive to movements of said control beam for correspondingly regulating the operation of said feeding means and thereby preserving the balance of said scales mechanism.

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