(No Model.) 2 Sheets—Sheet 1.

F. H. RICHARDS.

AUTOMATIC WEIGHING MACHINE.

No. 548,843. Patented Oct. 29, 1895.

Fig. 1.

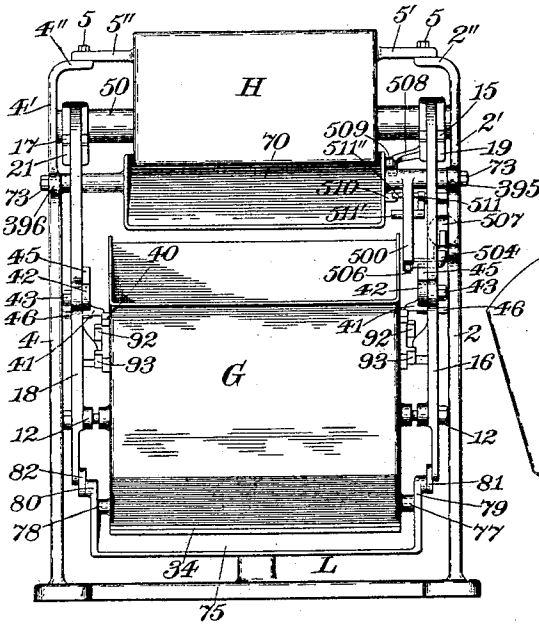


Fig. 2.

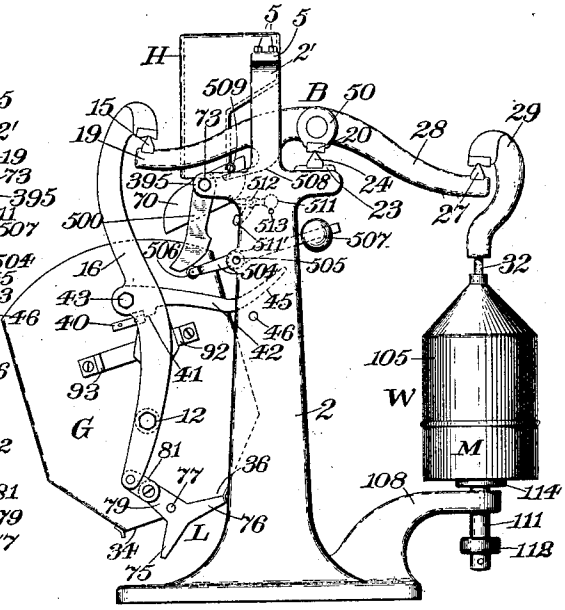


Fig. 3.

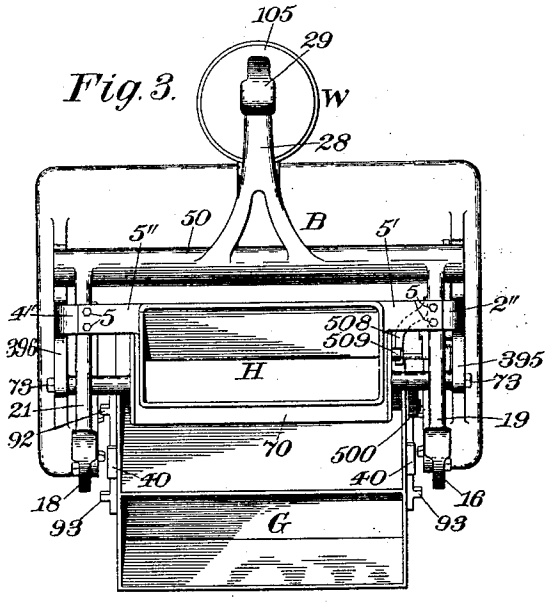
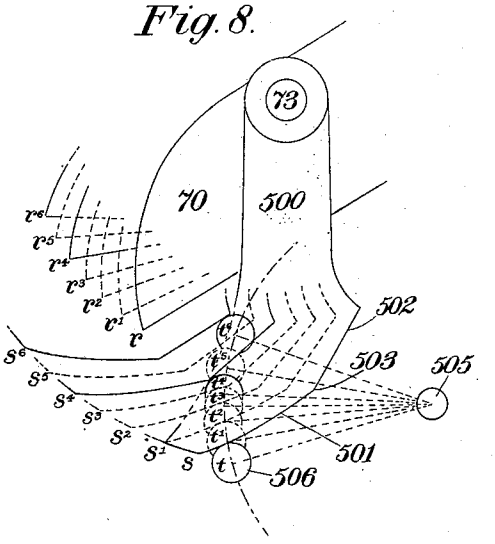


Fig. 8.



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(No Model.) 2 Sheets—Sheet 2.

F. H. RICHARDS.

AUTOMATIC WEIGHING MACHINE.

No. 548,843. Patented Oct. 29, 1895.

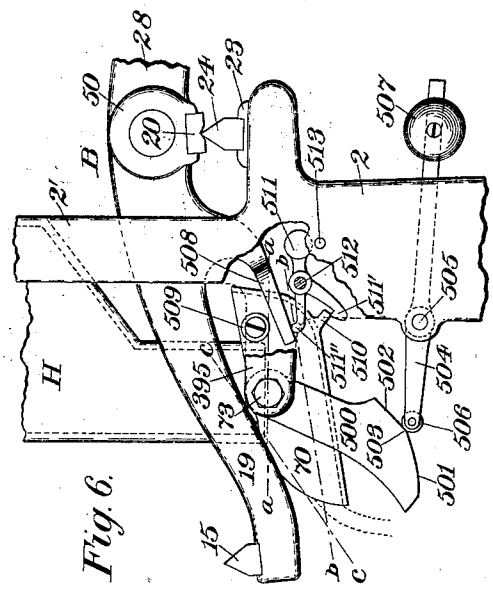

Fig. 6.

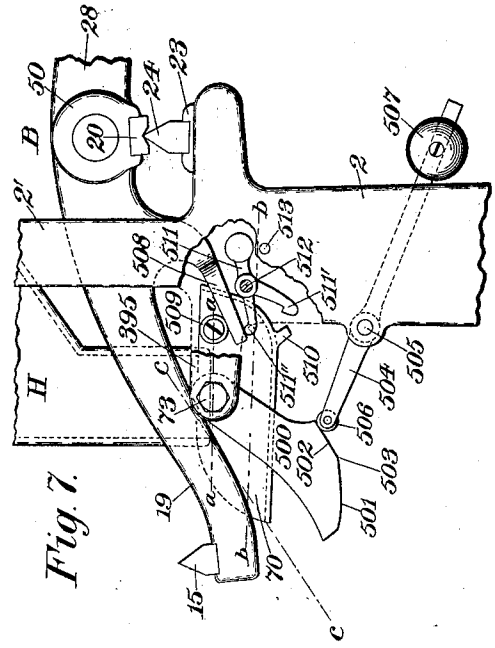

Fig. 7.

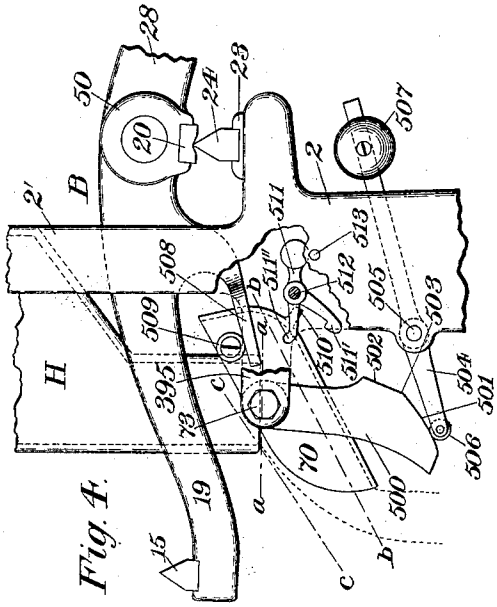

Fig. 4.

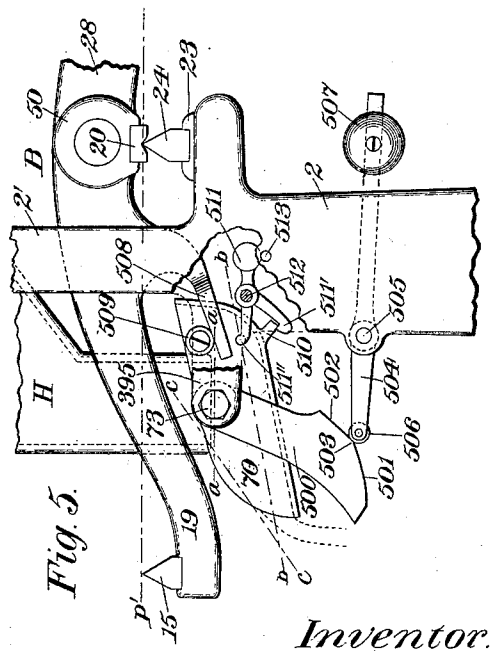

Fig. 5.

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UNITED STATES PATENT OFFICE.

FRANCIS H. RICHARDS, OF HARTFORD, CONNECTICUT.

AUTOMATIC WEIGHING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 548,843, dated October 29, 1895.

Application filed March 13, 1895. Serial No. 541,551. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS H. RICHARDS, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Automatic Weighing-Machines, of which the following is a specification.

This invention relates to weighing-machines, and has for its object to furnish an automatic weighing-machine having an improved valve mechanism in which the force required for effecting the closing movements of the valve may be applied to the valve in a peculiar ratio of decreasing efficiency for properly reducing the supply-stream at the required point in the operation of loading the bucket of the machine.

My present invention is also in the nature of an improvement on the invention described and claimed in my prior patent, No. 535,727, granted March 12, 1895, wherein the valve mechanism is illustrated and described as operated partly from and by the scale-beam and partly by the force of the supply-stream. The valve mechanism of the present application, however, is differentiated from that of said patent by and will hereinafter be described as being actuated principally by means independent of the scale-beam and partly by the force of the supply-stream, and the descent of the scale-beam will also be described as being, during the poising period, unhampered by the movements or by the inertia of a heavily-weighted valve and as being normally both more rapid and more sensitive inoperation than the corresponding movements of the valve mechanisms of weighing-machines ordinarily used.

A further object of my present improvements is, therefore, to furnish a valve mechanism in which the operation thereof will not retard the descent of the scale-beam at any point during the poising period, and will thereby permit a more rapid operation of the weighing-machine, since the speed of movement of the scale-beam upon the return of the bucket is practically a constant factor in all apparatuses of this class which are capable of perfect operation automatically, and the capacity of the machine is substantially dependent upon the elapsed time interval between the beginning of the opening of the valve and the opening of the bucket when the valve is closed and the stream is shut off.

A further object of my invention is to provide, in connection with the valve mechanism, a permissively-operative valve-closing actuator carried independently of and movable relatively to the scale-beam and controlled by the descent of the beam for effecting the reduction and cut-off of the flow of the stream without retarding this descending movement, and also to multiply the descending movement of the beam during the early stages thereof by adding to the force exerted upon the beam by the descent of the bucket the force exerted by the actuator for closing the valve, and to thereby cause a relatively-rapid descending movement of the beam during the first portion of such movement, and also for relieving the beam of the added force of the actuator during the poising period, and for subsequently effecting the cut-off of the stream by said actuator and adding to the effective bucket-opening force of the loaded bucket the valve-closing force of said actuator and the impact of said force of the actuator upon the beam in the direction of the descent of the beam.

For the purpose of illustrating the particular nature and mode of operation of my present improvements I have shown the same applied to a double-bucket weighing-machine, the principal features of which are shown and described in prior Letters Patent of the United States granted to myself and others, which well-known features are for convenience herein described.

In the drawings accompanying and forming part of this specification, Figure 1 is a front elevation of an automatic weighing-machine embodying my present improvements. Fig. 2 is a side elevation of the same as seen from the right hand in Fig. 1. Fig. 3 is a plan of the same. Figs. 4, 5, 6, and 7 are enlarged detail sectional side elevations of the valve mechanism and adjacent parts, portions of the apparatus being removed to more clearly show the construction, and these views illustrate the operation of said valve mechanism by showing the parts thereof in successive stages of their movements. Fig. 8 is a diagrammatic view illustrating series of success-

ive corresponding positions of the valve, the valve-actuating cam, and the valve-actuator.

Similar characters designate the same parts in all the figures.

The framework for carrying the operative parts of the machine usually and as shown in the drawings comprises two side frames or uprights 2 and 4, having vertical extensions 2′ and 4′, upon which a supply-chute H is shown secured by means of bolts 5, passing through projecting arms 5′ and 5″, extending from said chute, and through lateral arms or brackets 2″ and 4″ of the side frames.

A double-chambered bucket G is shown journaled at 12 in bearings formed in hangers 16 and 18, suspended by V-shaped bearings on pivots or knife-edges 15 and 17, respectively, of the principal arms 19 and 21 of a scale-beam B.

It will be understood that when reference is made herein to the movement of the scale-beam the movement of the bucket-supporting arms 16 and 18 is meant, this coinciding, of course, with that of the bucket itself.

The beam B has V-shaped bearings at each end of the usual hollow shaft 50 thereof, only one of said bearings being shown herein. Said bearings rest on pivots or knife-edges suitably supported, as by bearings of the framework. One of said knife-edges is shown at 24 and its bearing at 23. An arm 28 is also shown herein as extending oppositely to the arms 19 and 21 and rearwardly from the scale-beam shaft 50 and as provided with the usual pivot or knife-edge 27, on which a main weight, such as W, (also designated as the "main counterweight" or "beam-counterweight,") is suspended by a hook 29. This counterweight is preferably made up of a lower main weight M, which should have a mass sufficient to balance the unloaded bucket, and a cylindrical cover 105, fitted to slide up and down on a suspension-rod 32 and containing suitable load-weights.

The construction and mode of operation of this counterpoise-weight are fully set forth in my prior Letters Patent, No. 442,720, granted December 16, 1890, to which reference may be had for a more particular description thereof. The stop shown herein, however, for limiting the vertical movement of the counterweight is of a simple type, comprising, preferably, an upper stop-face 114 and a lower stop-collar 112, mounted upon a rod 111, which extends through an opening in a bracket 108.

The bucket G, of the usual double-chambered type and having the discharge-spouts 34 and 36, is shown journaled at 12, as before stated, and the oscillation of said bucket is limited by suitable stops on each side thereof of any of the well-known kinds, the pair on the right being designated 92 and 93, respectively. The spouts 34 and 36 are alternately closed by a bucket-closer, such as L, which is pivotally supported upon said bucket, and is operated by a suitable connection with the hangers thereof. The closer herein shown comprises two oppositely-disposed plates or closers proper 75 and 76, pivoted to the bucket G, upon each side thereof, at 77 and 78, respectively. To the upper ends of the arms 79 and 80 of the closers the lower ends of links 81 and 82 are shown as pivoted, and the opposite ends of these links are also shown as pivoted to the lower ends of the hangers 16 and 18. The construction and mode of operation of this form of bucket-closer are more fully shown and described in detail in my prior patent, No. 442,713, granted December 16, 1890, to which reference may be had.

For retaining the bucket in its forward and backward positions, respectively, I preferably employ the bucket-latch described in my prior Letters Patent, No. 447,354, granted March 3, 1891, but in connection with fixed stops upon the side frames. The detent apparatus is shown in the drawings as comprising the bucket latches or levers 42, which are pivoted at 43 to the hangers 16 and 18, and the projecting ends 45 of which engage with fixed stops 46 upon the side frames. The arms 42 are shown as carrying suitable detent-catches 41, adapted to engage with stops 40, which are secured to the sides of the bucket in the usual manner. The rearward ends 45 of the levers 42 are preferably of segmental form, being substantially concentric with the bucket-supporting knife-edges when the beam is at the poising-point.

In weighing-machines as heretofore constructed it has been customary to control the shutting off of the supply-stream by means of at least two valves, usually successively operated—that is to say, by means of a reducing-valve that gradually cuts down or reduces the volume of the flow to a drip-stream of any predetermined size, and by the subsequent action of a cut-off valve the movement of which follows either immediately or after a predetermined interval the movement of the reducing-valve and serves to shut off the stream entirely.

In my prior patent, No. 535,727, granted March 12, 1895, I have shown and described a valve mechanism by means of which I am enabled to practically combine in one valve the functions of both the reducing-valve and the cut-off valve heretofore usually constructed as independent but co-operating elements of the valve mechanism, and while this type of valve need not necessarily be employed substantially such a valve will now be described, in connection with means for effecting the operation thereof by an actuator mounted independently of the scale-beam and adapted to apply to the valve during the reducing and cut-off movements thereof successively-varying forces substantially proportionate to the progressively-varying distance at successive points in the descent of the bucket between the preponderating loads in advance of the axis of the valve at successive points in the closing movement thereof and the balanced or neu-

tral load upon said valve when the stream is shut off.

By means of a single valve operated in the manner described the construction and operation of the valve mechanism are not only simplified, but from the combination of the reducing and cut-off functions and by reason of the peculiar manner in which it becomes necessary to hang the valve a third function is obtained, which is not inherent in or obtainable from either a reducing-valve or a cut-off valve as ordinarily constructed or from the combined action of the two separate devices, and, moreover, the movements of the valve are effected by means separate from the scale-beam and organized to give the scale-beam an impetus and to impart thereto a multiplied movement at the beginning of the descent thereof and to gradually withdraw the added beam-poising force from the beam during the descent of the bucket and to entirely withdraw this added force at the beginning of the poising of the beam, so that during the poising period the bucket will be entirely relieved from the action of any extraneous force, which might tend to vitiate the accuracy of the weighing operation, said valve-operating means being also organized to give the scale-beam an additional impetus upon the final completion of a load in the bucket and to thereby aid in the release of the bucket-closer and thereby insure the positive opening of the bucket upon the completion of the load.

In the drawings my improved valve is designated by 70 and is shown as pivoted at 73 within arms or brackets 395 and 396, formed upon the side frames 2 and 4 of the machine, so that the axis of movement of the valve will pass through the stream of material issuing from the chute of the machine and supported by the valve when this is closed. This valve 70 is also shown as in the nature of a pan for supporting the material issuing from the chute and is preferably balanced upon its axial line, so that it will have no material tendency in itself to oscillate in either the one or the other direction; but I may employ a valve of a form or type other than illustrated herein. The actuating-lever for the valve is shown herein at 500 as a depending arm integral with or rigidly secured to said valve and provided with a cam-surface at its under rear side formed by two cam faces, one of which 501 constitutes the reducing cam-face and the other 502 the cut-off cam-face, the point or face at the intersection of those two cam-surfaces or merging of the same into each other constituting the poising-point or poising-face 503.

As a means for actuating the valve 70 a lever 504 is shown as pivoted at 505 to the frame 2 and as having at its forward end a friction-roller 506, adapted to engage the cam-surfaces 501 and 502 of the cam-lever 500 and to oscillate said lever and thereby the valve itself. This lever 504 forms an oscillating actuator, and is also shown as weighted at its rear end, the force of said lever being sufficient to cause the closing of the valve against the flow of the outcoming stream from the chute H, and hence the means for effecting the closing movements of the valve is shown herein as a self-active or gravity actuator and which exerts a valve-closing pressure on and transversely of the cam-surface of the cam 500. The weight 507 upon the lever 504 will preferably be adjustable, so as to provide for any variation in the working conditions under which the machine is operated.

For actuating the valve to return the same to its open position after the bucket-closer has been released and the load discharged the scale-beam is shown herein as provided with an arm 508, set substantially radial to the axis of the beam, and the valve is shown as provided with a friction-roller 509, secured to the valve adjacent to the rear end thereof and in such a position that the arm 508 will lie under the same and engage this roller to raise said rear end of the valve and thereby open the same. The roller 509 is usually and preferably so disposed relatively to the radial line connecting the axis of the beam and the axis of the valve as to work through about equal arcs upon opposite sides of this radial line, and, as said roller constitutes the means which serves to transmit to the scale-beam the added force or impetus of the valve-actuator during the descent of the beam prior to the poising thereof and during the descent of the beam subsequent to the poising thereof and beginning with the commencement of the cut-off action of the valve, it follows that said roller will bear down upon the scale-beam with a substantially uniform force, and hence will not materially increase or decrease, by a change of leverage, the force applied by such impetus to the scale-beam, and hence, also, will not become a poise-vitiating factor in the operation, as the ratio of the force transmitted to the scale-beam by the valve-actuator will remain practically unchanged, regardless of the amount of force so transmitted.

In order to check the closing movement of the valve during the drip period, the valve 70 is shown herein as provided adjacent to its rear under side with a stop-arm 510, movable in the path of a swinging detent 511′, forming part of a suitable holding device 511, which is shown pivotally mounted upon a pin 512 upon the side frame 2 of the machine. This holding device is also shown as weighted at its rear end, so as to preponderate in the rear of its pivot, a stop 513 being shown as disposed upon the side frame 2 beneath the weighted end of this holding device, so as to limit the movement thereof in downward direction in the rear of its pivot. This holding device is also shown as having an arm 511″ in advance of its pivot and in the path of the tripping-arm 508 of the scale-beam and adapted to be engaged by said tripping-arm to thereby swing the holding device upon its

pivot and release the detent 511′ at the end of the poising period.

With the parts in the position shown in Figs. 2 and 4 it will be evident that during the early stages of the making of the load an excessively large stream will be permitted to flow from the chute through the valve and into the bucket and that the greater portion of the load will be made up in a very short time. The beam will then begin to descend and will continue in its descent until it reaches the poising-line *p′* in Fig. 5, when the stop-arm 510 of the valve will be engaged by the detent 511′, and the valve will then be held against further movement until the end of the poising period. By the first movement of the scale-beam—that is, its reducing movement—the valve 70 has been oscillated upon its axis until the front thereof has been thrown forward along the line of the supply-chute and nearer to the line of the normal angle of repose of the material issuing from the spout or chute, which line, in the case of some materials, will coincide substantially with the dotted line *c c*, Figs. 4, 5, 6, and 7. As here shown, this line is assumed to be that of the normal angle of repose of wheat.

It will be observed by reference to Figs. 5 and 6 that during the poising period, when the valve is locked in position by the detent 511′, the tripping-arm 508 of the beam will have a limited range of downward movement entirely unaffected by the weight of the valve or the force of the valve-actuator, and that during this period the only forces acting upon the beam to cause the descent of the same are the weight of the partially-loaded bucket, the momentum thereof, and the impact of the drip-steam issuing from and over the forward edge of the valve, and hence during the poising period, when the valve is locked in position, the additional volume of grain to make up the complete load will be delivered into the bucket while the beam is entirely unaffected by the action of an extraneous force, thus insuring the accuracy of the weighing operation.

At the end of the poising period, the beam-arm 508 has reached the limit of that downward range of free movement which is unaffected by the force of the valve and the valve-actuator, which range of movement is shown in Figs. 5 and 6 as the space or arc included between the lower side of the friction-roller 509 and the upper side of the stop 511″. When these parts are in the positions respectively shown in said figures, this beam-arm strikes the stop 511″ and, forcing the same downward, releases the detent 511′ and permits the closure of the valve to cut off the stream. During this movement of the valve, caused by the overpoising of the beam, the rear end of said valve will be carried farther down and the blade or bottom plate thereof brought into a horizontal position, the forward end thereof being at the same time carried farther toward and beyond the line *c c* of the angle of repose of the material, thus cutting off the supply entirely.

It will be observed that during the descent of the beam the valve forms a chute for the supply-stream and that at the end of the movement thereof said valve forms a support for the mass of material cut off thereby. In addition, however, to reducing and cutting off the flow of the stream by projecting the front end of the valve toward and beyond the line of the angle of repose of the outflowing material, an additional means for checking and stopping said flow is obtained by the oscillation of the valve upon its axis and the subsequent shifting of the positions of the various particles or masses of material between the lower edge of the chute and the blade or bottom plate of the valve, and thereby, of course, the vertical shifting of the flow-line of the stream with respect to the line of the normal angle of repose of the material. The force of said shifting movement is not noticeably exerted upon the stream or mass contained within the walls of the lower portion of the chute, nor is it appreciable in the lower stratum or layer of material lying immediately upon the bottom of the valve; but in the zone between the lines *a a* and *b b*, Figs. 4, 5, 6, and 7, the shifting of said particles or masses is most marked, and the effect of said shifting movement constitutes one important factor in controlling the flow of the supply-stream by this type of valve and which is auxiliary to the control of the flow by the forward movement of the valve. The resultant effect is a constantly-increasing variable, tending to constantly reduce the preponderation of the weighted valve in advance of its axis of movement, and thereby tending to bring the valve, with its load, to a balanced position.

It will be seen that the axis of the valve movement is shown as a fixed line with respect to the mass of material supported upon the valve, and that as the valve itself rotates about said axis that portion of the sustained stream will have a shifting movement with respect to said axis and with respect, also, to the mouth of the chute and the blade or bottom plate of the valve. Each grain or piece of that portion of the sustained stream will tend to rotate or oscillate upon an arc of a circle struck from the axis of the valve, and the farther the distance of the particle from said axis the greater will be the arc of movement of said piece or grain, the particles of the mass nearest the extreme front and rear ends of the valve having, of course, the greatest vertical movement. The shifting particles to the rear of the valve-axis have a descending movement during the fall of the scale-beam, and consequently the mass behind said axis is correspondingly loosened up during the closing movement of the valve, while those particles of the mass forward of said axis rise during the closing of the valve and tend to bank up upon the forward portion of the valve bottom or pan and between

it and the lower edge of the supply-chute the oscillation of the valve under pressure of the sustained column and of the valve-actuator, tending to force the grains or pieces of material back into the chute and over and beyond the axis of the valve movement. The greater part of the weight of the sustained column, therefore, shifts to the rear of the valve and serves to act as an additional force upon the rear of said valve to aid the actuator in closing the same. A most important result, however, of the rotary shifting of the particles of the column sustained between the valve-bottom and the mouth of the supply-chute is to force said pieces or grains upward and backward away from the forward end or mouth of the valve, and thereby cut off the flow of the stream entirely before the front end of the valve reaches the line of the normal angle of repose of the material issuing from the chute. It will therefore be evident that the shutting off of the flow is not a true "cut-off" of the stream in the sense to which this term has been usually understood when applied to automatic weighing-machines, but that each shut-off of the valve in advance of the actual arrival of the front edge of the valve at the line of such angle of repose is due mainly to the lateral rearward shifting movement of the mass sustained upon the forward portion of the valve. This non-progressive movement is obviously due partly to the bodily shifting of the mass sustained upon the bottom of the valve and partly to the forcing of such mass backward, away from said line by the combined upward movement of the forward portion of the valve and of the mass thereon and by the downward movement of the stream contained in and issuing from the chute. The opposition of these two forces tends to produce a lateral displacement of the mass at the meeting point of the forces, and said lateral displacement will of course occur principally in the direction of the least resistance. In this case there is a relatively-great resistance at the front end of the valve due to the rising thereof and the banking of the material thereon, while there is very little resistance at the rear of the valve, owing to the descent thereof. Moreover, there is a natural flow or current from the chute to the rear of the valve when said rear portion descends, and hence there is a further tendency for the granular material forward of the valve-axis to shift to the rear and move with the current of grain flowing onto the rearward part of the valve from the chute.

As will be seen from Figs. 4, 5, and 6, the force tending to carry the particles sustained upon the front end of the valve toward the rear of said valve is a gradually decreasing one from said front end, where the arc of movement is greatest and the tendency to compression of the particles correspondingly great. Said force of compression decreases, owing to the shortening of the successive arcs of movement of successive points of the valve, until the axial center of the valve is reached, when said force disappears, and from this point to the extreme rear of the valve, there is a gradually-increasing force of dispersion or separation of the particles sustained.

It will be seen from the foregoing that the resistance opposed to the rearward movement of the sustained column is also avariable, which constantly decreases from the front to the rear of the valve, and that therefore a path of movement being thus provided for the banked-up mass on the front of the valve the particles of said mass will tend to move toward the rear of said valve and will follow said path of gradually-decreasing resistance, and will, moreover, have their movements accelerated, by the current setting in toward the rear of the valve from the chute, whereby as fast as the mass accumulates upon the front end of the valve it will tend to move to the rear, and thereby attain one of the results intended to be secured by the construction and organization of the valve mechanism described—viz., to entirely cut off the flow of the stream before the front end of the valve meets the line of the normal angle of repose of the material issuing from the spout, and therefore in advance of a cut-off effected my means of a valve the path of movement of which is in a line substantially parallel with its ultimate cut-off position.

Form Figs. 5 and 7 it will be evident that the upward and rearward shiftings of the mass upon the forward end of the valve are greatest from the poising position of the beam and valve mechanism to the overpoise position, as during said period the position of the bottom of the valve with respect to a horizontal line quickly changes until the angle of inclination reaches zero. As during this period the position of the front end of the valve rapidly changes and approaches the line of the angle of repose, a correspondingly-increasing force is applied to sustain the forward half or portion of the column of material and carry it toward the rear of the valve, thereby assuring a correspondingly early and rapid final cut-off movement of the valve.

From the foregoing description of the peculiar variations of the several forces and resistances during the operation of the valve it will be clear that the aggregate force required to be exerted on the valve for actuating the same with the required ratio of power during its closing stroke and to actuate the beam and valve conjointly for reducing the supply-stream during said stroke cannot be obtained from a weighted arm having its center of gravity moving in any one given arc, for the reason that no such organization will coincide with that ratio of variation which is necessary for effecting these operations. It is therefore one of the chief objects of my present invention to furnish a valve mechanism having means—to wit, a valve and beam actuating cam—whereby the required ratio of variation

may be obtained in the force applied to these members for operating the same.

As has been before stated, the valve 70 is normally substantially balanced upon its axis 73 so as to have no material movement, due to the preponderation of the valve, either in advance of or in the rear of such axis. It will be evident, therefore, that the movements of the valve will be controlled by the valve-cam and the valve-actuator when the operation of such actuator for the purpose of closing the valve is permitted by the scale-beam.

It will be obvious that by the engagement of the beam-arm or actuator-releasing arm 508 against the under side of the friction roller or stop 509 adjacent to the rear end of the valve the valve will be positively held open so long as the counterpoise-weight W is effected to hold down the rear end of the beam-arm 28.

When a sufficient load has been delivered into the bucket to cause the beam to begin to descend from the position shown in Fig. 4, it will be apparent that the counterpoise W will no longer be effective to maintain the actuator-releasing arm 508 as a relatively-fixed abutment, preventing the closing of the valve, and that as the beam begins to descend the actuator-releasing arm will permit the valve-actuator to become effective, when said actuator will cause its friction-roller 506 to begin to ride up the reducing cam-face 501 of the valve-cam 500, and will thereby effect the projection of the forward end of the bottom plate of the valve forward and nearer to the line of the normal angle of repose of the outflowing material issuing from the chute. It will be observed that this reducing cam-face has the forward end thereof defined by a curve of a smaller radius than that of the arc or line defining the rearward or major portion of this cam-face, so that as the loaded bucket begins to descend relatively the greatest force will first be applied by the valve-actuator as a means for producing a closing or reducing movement of the valve to the position shown in Fig. 5 and with a gradually-decreasing velocity. The successive subsequent exertions of this force upon the valve will be successively reduced, owing to the peculiar ratio of decreasing efficiency of the cam-surface.

By reference to Fig. 8 it will be noticed that when the actuating-roll 506 is in the position shown at t and the valve-cam and the valve are in the positions designated, respectively, by s and r the point of engagement of the actuating-roll 506 with the reducing cam-face 501 of the cam will be at the greatest possible distance from the axis of movement 73 of the valve, and hence as the force exerted by the valve-actuator is through an arc having the pivot 505 as a center the first movement of the actuator for closing the valve will be exerted with the greatest possible effect—that is, with the maximum leverage. It will also be evident that as the movements of the actuator, the cam, and the valve are continued throughout the respective successive positions thereof between the beginning and the end of the closing movement a gradually-decreasing force will be applied to the valve for closing the same through the cam pivoted to this valve. Therefore the force exerted upon the reducing-face of the cam (this face having been constructed of a graduated curvature suitable therefor) will be a gradually and continuously decreasing variable, and the minimum limit of this force will occur and this minimum force will be exerted at the moment preceding that in which the valve is locked by the detent 511′ in the drip position shown in Fig. 5. At this moment the actuating-roll, the cam, and the valve are in the positions illustrated, respectively, at t^4, s^4, and r^4, and the leverage exerted upon the valve by the cam swinging about the axis of the valve movement will be exerted at the moment prior to the locking of the parts, as described, through a distance approximately as much less than the maximum length of leverage as the distance corresponding to the arc through which the actuating-roll has traveled during the poising period.

As the actuator is preferably so organized and disposed relatively to the valve-cam that the several points in the actuator or actuating-lever will travel through about equal arcs upon each side of a horizontal line drawn through the axis of movement of said actuating-lever in moving from one extreme position of said lever to the opposite extreme position thereof, it will be apparent that a substantially-constant force will be applied to the cam-surfaces by the actuating-roll for the purpose of operating the cam-valve. As this force is thus maintained substantially constant, it will be evident that substantially the only variable factors will be the inclination of the cam-face at any point thereof and the length of the lever having the valve-axis as its pivotal point—that is to say, the effective length of the valve-cam lever—and that therefore the cam-surface will have a variable efficiency progressively decreasing in a peculiar variable ratio during the reducing movement.

As the valve turns upon its axis in closing, it will be evident that, as before described, the preponderation thereof in advance of its axis will gradually decrease, and this decrease will take place with and vary directly as the variation of the effective leverage of the valve-cam or valve-cam lever. Hence at the corresponding successive points designated, respectively, by t, t', t^2, t^3, t^4, t^5, and t^6, and s, s', s^2, s^3, s^4, s^5, and s^6 the successive reductions in the power applied due to the successive reductions in the effective length of the valve-cam lever will have their complements in the successive reductions in the preponderation of the loaded valve in advance of its axis at the corresponding successive points in the valve movement designated, respectively, by r, r', r^2, r^3, r^4, r^5, and r^6. This will

be evident by reference to Fig. 8 when taken in connection with Figs. 4, 5, 6, and 7, for, as the valve oscillates in closing the particles of the mass sustained upon the bottom plate thereof will shift, as hereinbefore described, and move toward the rear end of the valve, while at the same time the current will set in toward the rear end of the valve from the supply-chute and will tend to bring the weight of the sustained mass which is in the rear of the valve-axis nearer to that in advance of said axis and the momentum of the outflowing material and the constantly-increasing force of the same will also constantly and progressively tend to establish a condition of equilibrium.

As the preponderation of the valve in advance of its axis is gradually and progressively reduced and as the weighted valve approximates more nearly to a state of equilibrium, it will be obvious that the power required to oscillate said valve to close the same will also decrease and in substantially equal ratio, so that as the actuating-roll, the valve-cam, and the valve approach the limit of the reducing movement thereof in closing the valve the auxiliary force applied to the scale-beam by the actuator through the action of the friction-roller 509 upon the actuator-releasing arm 508 will be gradually removed. Moreover, the cam-surface of the valve-cam is so formed that not only is it a progressively-decreasing leverage exerted upon the valve, but this cam-surface also has a peculiar ratio of decreasing efficiency in substantial correspondence with the peculiar ratio of preponderation in advance of its axes, which is exhibited by the valve during its closing movement. In this connection the term "reducing movement," it should be stated, refers to the movement of the parts during the period beginning with the commencement of the descent of the scale-beam and ending with the locking of the valve in the drip position shown in Fig. 5. At the end of the reducing movement the valve is locked in the drip position by the engagement of the stop 510 with the detent 511′, and the subsequent descent of the scale-beam will be entirely independent of the auxiliary force of the valve-actuator, and as at the moment of locking of the valve in this drip position the beam is in the poising position and is just beginning to descend below the poising-line p' it will be apparent that the beam will be entirely relieved from the action of any extraneous poise-vitiating force.

In the descent of the beam from the position shown in Fig. 5 to that illustrated in Fig. 6, which I term the "neutral" movement of the scale-beam, the friction-roller 509 will maintain a fixed position relatively to the chute and the frame of the machine and the actuator-releasing arm or tripping-arm 508 will move independently of said friction-roller until it comes in contact with the arm 511″ of the valve-holding device 511, when the detent 511′ will be released and the valve permitted to swing shut. At this time the scale-beam has reached its overpoise position and the actuating-roll 506, acting against the cut-off face 502 of the valve-cam, quickly causes the projection of the forward end of the valve beyond the line of the normal angle of repose of the material flowing from the chute and the supply is cut off. In this closing movement of the valve the force exerted by the actuator throws the stop or friction-roller 509 sharply against the auxiliary beam-arm 508 and gives the scale-beam an added impetus to accelerate the descent thereof, thereby forming a positive means for causing the release of the bucket-latch 42 by bringing the arm 45 thereof suddenly against the fixed stop 46.

Referring again to Fig. 8, it will be noticed that at the end of the reducing movement the actuating-roll is shown as having passed completely off of the reducing-face of the cam and as lying just in the rear of the poising-point 503, or point of intersection of the reducing and cut-off faces of said cam, so that the actuating-roll will engage the cam at the forward end of the said cut-off face. This cut-off face lies at such an angle relatively to the actuating-roll 506 and the valve-axis that it offers, practically, no resistance to the actuator when the valve is released from the detent 511′, as the cut-off face at the beginning of the cut-off movement (shown in Fig. 6) lies at but a slight angle to the line connecting the valve-axis and the point of application of force, and hence does not present itself as a substantially-fixed abutment in the line in which the force is applied and intermediate of said valve-axis and the actuating-roll, as would be the case if the cut-off face were in direction a continuation of the reducing-face. Hence the cut-off-cam face has an increased efficiency over the reducing-cam face, and in consequence a very great increase of efficiency in the operation of the actuator is obtained at the moment of beginning of the cut-off action, so that the force of the actuator will be exerted to the best possible advantage and in a direction such as will prevent the retardation of this final or cut-off valve movement.

From the foregoing it will be clear that the present improvements comprise in part and in combination with a supply-chute and with a scale-beam a valve for controlling the supply-stream from the chute, a valve-cam operative in unison with the valve for effecting the closure of the valve and having a stream-reducing cam-face of decreasing efficiency, and a valve-actuator in position and adapted for exerting a continued valve-closing thrust or pressure on the cam-face in a direction for closing the valve. In the preferred form thereof, hereinbefore described, this cam-face is of progressively-decreasing efficiency, and also comprises a reducing-cam face of decreasing efficiency, combined with a cut-off face of relatively-greater efficiency. It will also be clear that my improvements comprise in part

and in combination with the chute the scale-beam and the valve, a valve-cam operative in unison with the valve for effecting the closure of the valve and furnished with a cam-face positioned and adapted to permit the exertion of a decreasing leverage upon the valve during the closing movement thereof, and a valve-actuator in position and adapted for exerting a continued valve-closing thrust or pressure on the cam-face in a direction for closing the valve. Moreover, it will be apparent that my invention comprises in part and in combination with the chute and with the scale-beam a valve under said chute and adapted to form alternately a chute and a support for the supply-stream and having its axis of movement passing through that portion of the supply-stream which is sustained by the valve, and also having an arc of movement at each side of its axis center, a cam carried by the valve, and a valve-actuator pivoted independently of the scale-beam and releasable thereby and in operative connection with the valve-cam, and adapted upon its release by the scale-beam to exert a continued pressure upon the valve to effect the closing movement thereof. The return of the valve to its open position upon the discharge of the load in the bucket is shown herein as effected by the auxiliary beam-arm 508 engaging the under side of the friction-roller 509, and thereby oscillating the valve to open the same; but it is obvious that any other suitable connecting devices which will be operable to open the valve upon the discharge of the load may be employed.

By means of a valve-cam having its valve-face organized in substantially the manner described relatively to the actuating means therefor the force applied for effecting the closing movement of the valve will be modified at successive points in such movement substantially in accordance with the modifications in the valve-load which is to be moved, and by means of a self-active or gravity actuator—such, for instance, as that hereinbefore described—the scale-beam is entirely relieved of any active or positive valve-closing function. By means, also, of the peculiar described construction of the valve and the peculiar organization of the same with the spout or chute and with the valve-operating means, and by means, also, of the valve-actuating devices carried independently of the scale-beam and organized to exert upon the valve before closing the same a force directly proportionate to the load carried upon the valve at successive points in its closing movement, and the amount of which load is constantly and progressively varied during the closing of the valve by the shifting of the particles of the sustained mass and by the current to the rear of the valve from the chute, I am enabled to furnish a weighing-machine of this class with a relatively-large valve adapted to permit the flow of a relatively-large supply-stream and controllable with a relatively-small amount of power exerted by a permissively-operative actuator, which is releasable by the scale-beam, and I am also enabled to control with a relatively-small and progressively-graduated amount of power a single relatively-large valve performing the functions of both reducing the stream and shutting it off entirely. Moreover, by this construction and organization it is not necessary that the grains or pieces of material being weighed should be absolutely or even relatively uniform in size, as there is no delicate mechanism to be clogged, and lumpy and irregular materials of different kinds—such as the small sizes of anthracite coal, meal, feed, &c., the particles or pieces of which are normally of relatively-small size, but which frequently contain pieces or masses of relatively-large size—may be weighed with facility and precision and in relatively-small quantities and with a speed of operation very much greater than that of a machine embodying a valve of the class specified and having its actuating means mounted directly upon the scale-beam, all of which I have practically ascertained by experiments with a full-sized working machine which I have completed and put in operation and made according to my present invention.

Having thus described my invention, I claim—

1. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve for controlling the supply-stream from said chute; a cam operative in unison with the valve, for effecting the closure of said valve, and having a stream-reducing cam-face of decreasing efficiency; and a valve-actuator carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam-face, in a direction for closing the valve.

2. In an automatic weighing-machine, the combination with a supply-chute; of a valve for controlling the supply-stream from said chute; a valve-closing cam operative in unison with the valve, and having a cam-face of decreasing efficiency combined with a cut-off cam-face of relatively-greater efficiency; and a valve-closing actuator in position and adapted for exerting a continued valve-closing pressure on, and transversely of, said cam-faces to thereby close the valve.

3. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of the valve for controlling the supply-stream from said chute; a cam operative in unison with the valve for effecting the closure of said valve, and having a reducing-cam-face of decreasing efficiency, combined with a cut-off cam-face of relatively-greater efficiency; and a valve-actuator carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on the reducing and cut-off faces of said cam, in a direction for closing the valve.

4. In an automatic weighing-machine, the combination with a supply-chute; of a valve

for controlling the supply-stream from said chute; a valve-closing cam having the cam-surface thereof in position and adapted for permitting the exertion of a decreasing leverage upon the valve by the cam during the closing movement of the valve; and a valve-closing actuator in position and adapted for exerting a valve-closing pressure on, and transversely of, said cam-surface to thereby close the valve.

5. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve for controlling the supply-stream from said chute; a cam operative in unison with the valve, for effecting the closure of said valve, and having a cam surface in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve by the cam, during the closing movement of the valve; and a valve-actuator carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam surface, in a direction for closing the valve.

6. In an automatic weighing-machine, the combination with a supply-chute; of a valve for controlling the supply-stream from said chute; and a self-active valve-closing actuator independent of the valve, and in position and adapted for exerting a continued valve-closing pressure on the valve to thereby close the same.

7. In an automatic weighing-machine, the combination with a supply-chute; of a valve for controlling the supply-stream from said chute; a valve-closing cam having the cam-surface thereof in position and adapted for coacting with a self-active valve-closing actuator; and a self-active valve-closing actuator in position and adapted for exerting a continued pressure on said cam-surface to thereby close the valve.

8. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve for controlling the supply-stream from said chute; a cam operative in unison with the valve, for effecting the closure of said valve, and having a stream-reducing cam-face of progressively-decreasing efficiency; and a self-active valve-actuator in position and adapted for exerting a continued pressure on said cam-face, in a direction for closing the valve.

9. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve for controlling the supply-stream from said chute; a cam operative in unison with the valve for effecting the closure of said valve, and having a stream-reducing cam-face of progressively-decreasing efficiency; and a self-active valve-actuator in position and adapted for exerting a continued valve-closing thrust on said cam-face in a direction for closing the valve.

10. In an automatic weighing-machine, the combination with a supply-chute, and with a scale-beam; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve; a cam, operative in unison with the valve, for effecting the closure of the valve, and having a cam surface in position and adapted to permit the exertion of a decreasing leverage upon the valve, by the cam, during the closing movement of the valve; and a valve-actuator, in position and adapted for exerting a continued pressure on said cam surface, in a direction for closing the valve; whereby, upon the descent of the scale-beam, opposite non-progressive shifting movements are imparted to the sustained mass, at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve, in advance of its axis, is progressively decreased, during the closing movement; and the final cut-off of the flow is effected prior to the actual closure of the valve, substantially as and for the purposes set forth.

11. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve; a cam operative in unison with the valve, for effecting the closure of the valve, and having reducing and cut-off faces in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve, by the cam, during the closing movement of the valve; and a valve-actuator, in position and adapted for exerting a continued pressure upon said reducing and cut-off cam-faces, in a direction for closing the valve; whereby, upon the descent of the scale-beam, opposite non-progressive shifting movements are imparted to the sustained mass, at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve, in advance of its axis, is progressively decreased during the closing movement; and the final cut-off is effected, prior to the actual closure of the valve, substantially as and for the purposes set forth.

12. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve; a cam operative in unison with the valve, for effecting the closure of the valve, and having a cam surface in position and adapted to permit the exertion of a decreasing leverage upon the valve, by the cam, during the closing movement of the valve; and a valve-actuator carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam face, in a direction for closing the valve; whereby, upon the descent of the scale-beam, opposite non-progressive

shifting movements are imparted to the sustained mass, at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve, in advance of its axis, is progressively decreased during the closing movement, and the final cut-off of the flow is effected prior to the actual closure of the valve, substantially as and for the purpose set forth.

13. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve; a cam operative in unison with the valve, for effecting the closure of the valve, and having a cam surface in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve by the cam, during the closing movement of the valve; and an oscillating valve-actuator, carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam surface, in a direction for closing the valve: whereby, upon the descent of the scale-beam, opposite non-progressive, shifting movements are imparted to the sustained mass, at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve, in advance of its axis, is progressively decreased during the closing movement; and the final cut-off of the flow is effected prior to the actual closure of the valve, substantially as and for the purpose set forth.

14. In an automatic weighing-machine, the combination with a supply-chute and with a scale-beam; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve; a cam operative in unison with valve, for effecting the closure of the valve, and having reducing and cut-off faces in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve, by the cam, during the closing movement of the valve; and an oscillating valve-actuator, carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam-faces in a direction for closing the valve: whereby, upon the descent of the scale-beam, opposite non-progressive shifting movements are imparted to the sustained mass at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve, in advance of its axis is progressively decreased during the closing movement; and the final cut-off of the flow is effected prior to the actual closure of the valve, substantially as and for the purpose set forth.

15. In an automatic weighing-machine, the combination with a supply-chute, and with a scale-beam having an auxiliary or actuator-releasing arm; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve, and also having a stop in the rear of its axis in position and adapted to be supported by said auxiliary-beam-arm while the scale-beam is counterpoised; a cam operative in unison with the valve, for effecting the closure of the valve, and having a cam surface in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve by the cam, during the closing movement of the valve; and a permissively-operable valve-actuator carried independently of but operative upon the descent of the scale-beam, and in position and adapted for exerting a continued pressure on said cam surface, in a direction for closing the valve, when said actuator is released: whereby opposite non-progressive shifting movements are imparted to the sustained mass at opposite sides of the valve-axis, and the reduction of the volume of the stream is correspondingly accelerated, and the preponderation of the valve in advance of its axis is progressively decreased, during the closing movement; and the cut-off of the flow is effected prior to the actual closure of the valve substantially as and for purposes set forth.

16. In an automatic weighing-machine, the combination with a supply-chute, and with a scale-beam having an auxiliary arm for engaging the valve-supporting stop and for tripping the valve-holding device at the end of the drip-period; of a valve under said supply-chute, and having its axis of movement passing through that portion of the mass which is sustained by the valve, and also having a valve-supporting stop and a valve-locking stop both located in the rear of its axis; a cam operative in unison with the valve for effecting the closure of the valve, and having reducing and cut-off cam-faces in position and adapted to permit the exertion of a progressively-decreasing leverage upon the valve by the cam during the closing movement of the valve; a valve-holding device for engaging the valve-locking stop at the beginning of the drip-period, and releasable by the auxiliary beam-arm at the end of the drip-period; and an oscillating valve-actuator carried independently of the scale-beam, and in position and adapted for exerting a continued pressure on said cam-faces in a direction for closing the valve, and adapted also upon the release of the valve-supporting stop by the descent of the scale-beam to impart first a reducing movement and subsequently and upon the unlocking of the valve at the end of the drip-period a cut-off movement to the valve; whereby, upon the descent of the scale-beam, opposite non-progressive shifting movements are imparted to the sustained mass at opposite sides of the valve-axis, and the reduction of the volume

of the stream is correspondingly accelerated, and the preponderation of the valve in advance of its axis is progressively decreased during the closing movement, and the final cut-off of the flow is effected prior to the actual closure of the valve; and whereby also the force of the actuator aids the descent of the scale-beam during the reducing and cut-off movements of the valve, substantially as and for the purposes set forth.

FRANCIS H. RICHARDS.

Witnesses:
FRED. J. DOLE,
F. N. CHASE.