

June 16, 1964

M. M. BRENNER

3,137,357

ELECTRO-MECHANICAL SYSTEM

Filed Oct. 3, 1961

3 Sheets-Sheet 1

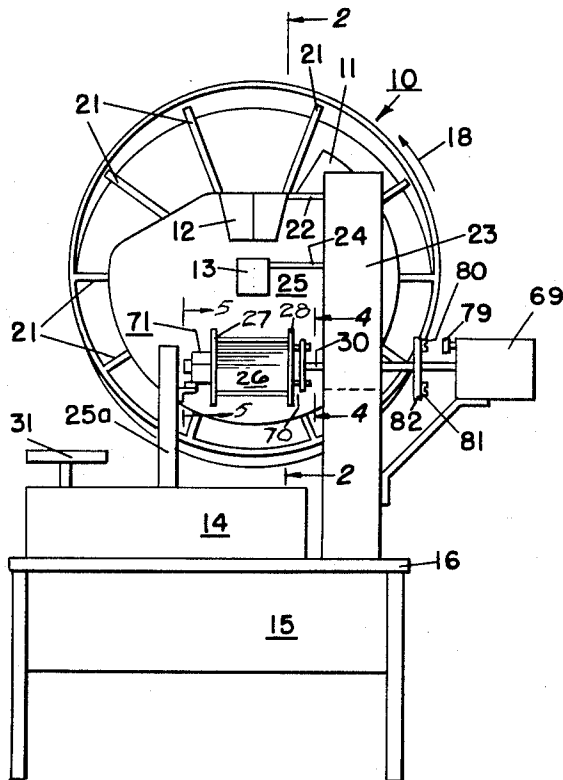


Fig. 1

Fig. 4

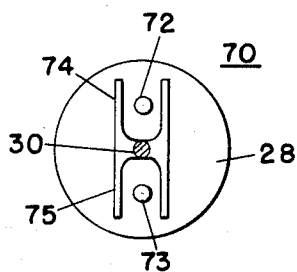


Fig. 5

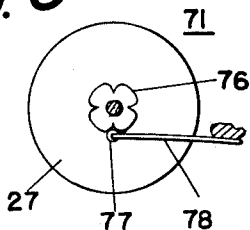
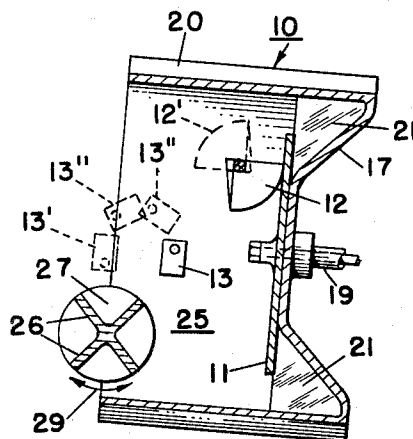


Fig. 2



INVENTOR
MILLARD M. BRENNER

BY *Alfred Stapler*
ATTORNEY

June 16, 1964

M. M. BRENNER

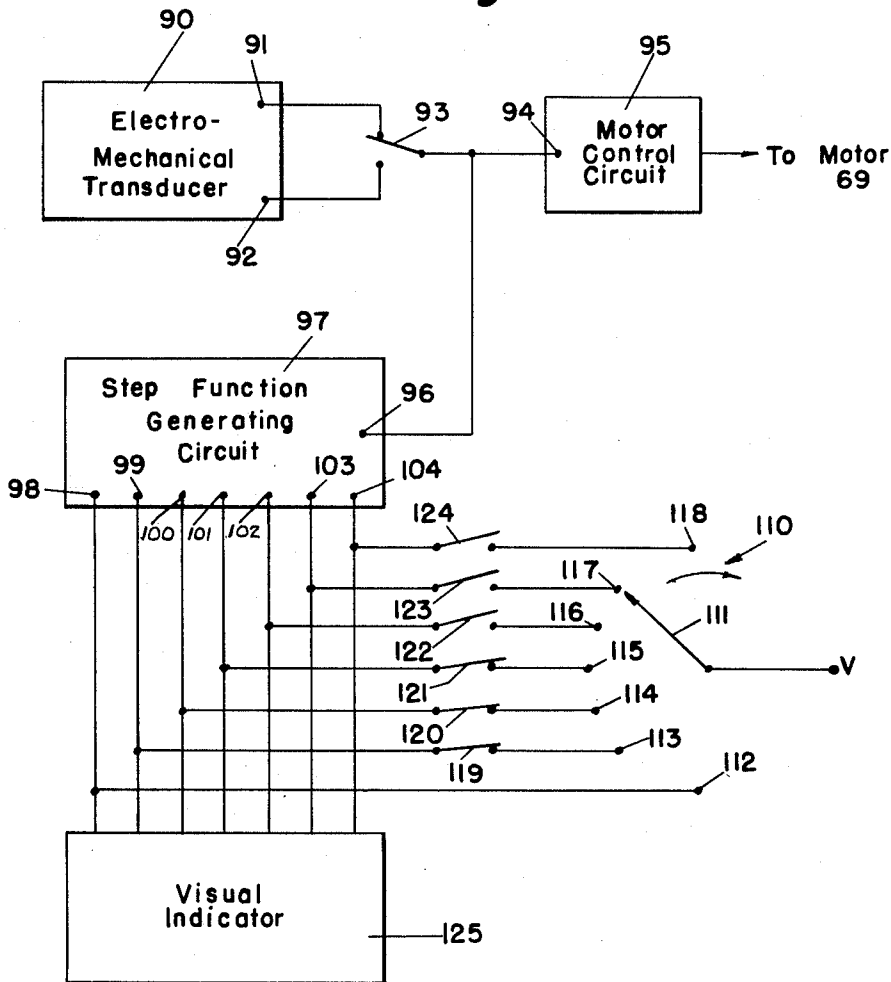
3,137,357

ELECTRO-MECHANICAL SYSTEM

Filed Oct. 3, 1961

3 Sheets-Sheet 3

Fig. 6



INVENTOR.
MILLARD M. BRENNER

BY

Alfred Gayley
ATTORNEY

1

3,137,357

ELECTRO-MECHANICAL SYSTEM

Millard M. Brenner, Radnor, Pa., assignor to General Atronics Corporation, Bala-Cynwyd, Pa., a corporation of Pennsylvania

Filed Oct. 3, 1961, Ser. No. 142,713

16 Claims. (Cl. 177-50)

This invention relates to improved apparatus for automatically dispensing, from a large quantity of similar items, batches consisting of predetermined numbers of these items.

In modern manufacturing and assembly operations it is often necessary to subdivide a large quantity of similar items into smaller batches, each consisting of a specified number of separate items. This need arises, for example, in preparing nuts, bolts, or the like for merchandising in packages each containing a specified number of such items.

Various types of machinery have been proposed for filling packages with specified numbers of such items but none of these have proven completely satisfactory. More particularly this machinery was either too slow, or too inaccurate, or not adapted for convenient change-over for processing items of different shapes and sizes. These shortcomings have proved to be so serious that, in practice, manual counting and batching procedures are still in common usage even in applications in which very large quantities of items have to be counted.

Accordingly, the primary object of the invention is to provide improved automatic machinery for dispensing batches of substantially equal numbers of similar items from a larger group of such items.

Another object of the invention is to provide automatic machinery which is able to perform the desired dispensing operation with exceptional accuracy.

Still another object is to provide such machinery which is able to perform said dispensing operation with exceptional rapidity.

A still further object is to provide such machinery which which can be adjusted simply to process items of widely different shapes and/or weights.

The foregoing objects and others which will appear are achieved by means of apparatus which fills an open-top container to overflowing with the items to be separated into batches, jolts this container to dislodge overflow items, weighs the items remaining in the container and accepts them if their weight is within certain limits while rejecting them and subjecting them to repeated processing if it is not.

For further details reference is made to the discussion which follows and the accompanying illustrative drawings wherein

FIGURE 1 is a front elevation of an embodiment of the invention,

FIGURE 2 is a cross-sectional view of portions of the embodiment of FIGURE 1 taken along the section line 2-2 in FIGURE 1,

FIGURE 3 shows, partly in block and partly in schematic diagram form, certain apparatus which is primarily electrical in nature and which controls certain functions in the embodiment of FIGURE 1,

FIGURES 4 and 5 show certain details of the apparatus of FIGURE 1, and

FIGURE 6 shows another form of the apparatus shown in FIGURE 3 for controlling the apparatus of FIGURE 1.

In all these figures identical reference numerals are used to designate identical parts.

The over-all organization of an embodiment of my invention is shown in FIGURE 1, to which reference may now be had. The principal components of this embodi-

2

ment are a rotatable hopper 10, a plate 11, two cups 12 and 13, a balance 14 and control apparatus 15. All of these principal components, together with certain accessory components described below, are mounted on a stand 16.

The hopper 10 is a cylinder lying on its side, with one end open and the other closed. The closed end wall 17 of the cylinder is shaped like a frustum of a cone reentrant into the cylinder (see FIGURE 2). The hopper is mounted for rotation in the direction of arrow 18 in FIGURE 1 on the axially positioned shaft 19 shown in FIGURE 2. At the closed rear end of hopper 10, between its reentrant rear wall 17 and its side wall 20, there are radial vanes 21 having front edges all lying in the same plane as the most deeply reentrant part of rear wall 17. These vanes 21 form platforms which, in the course of rotation of hopper 10, lift items deposited in the bottom of the hopper to the top of the hopper. Plate 11, which is stationary and abuts against the reentrant hopper wall 17 and the front edges of vanes 21, has everywhere but at the top of the hopper, a radius greater than the most deeply recessed portion of wall 17, thereby restraining the items lifted by vanes 21 from sliding off the inclined planes between these vanes before reaching the top of the hopper. Plate 11 is so dimensioned near the bottom of hopper 10 as to permit items deposited in the bottom of the hopper to slide under the bottom edge of this plate from the open end of the hopper into the spaces between vanes 21 at its closed end. To facilitate this sliding motion, the hopper is preferably tilted so that its closed end is somewhat lower than its open end.

Flush with the top edge of plate 11 is one edge of an open-top cup 12. This cup is mounted so that it can be tilted away from plate 11 and overturned, thereby bringing it into the position shown in broken lines at 12' in FIGURE 2. For this purpose cup 12 is mounted on a shaft 22 which is attached, at the other end, to a supporting and driving structure 23 described more fully herein-after.

Directly below the overturned position 12' of cup 12 is cup 13, which is also open at the top and smaller than cup 12. Cup 13 can also be tilted and overturned to bring it into the position shown in broken lines at 13' in FIGURE 2. This cup may follow an arcuate path between positions 13 and 13', two intermediate positions of the cup along this path being shown in broken lines at 13'' and 13''', respectively, in FIGURE 2. For displacement as described above, cup 13 is mounted on shaft 24, whose other end is also attached to structure 23. The mounting of cup 13 on shaft 24 is preferably such as to permit easy interchange of cups of different sizes and configurations.

Directly below the overturned position 13' of cup 13 is one scale pan of balance 14. This scale pan, whose parts are collectively designated by reference numeral 25 in the drawings, is mounted on one end of the balance arm (not shown) of balance 14 by means of support 25a and consists of four vanes 26 radiating out from a common horizontal axis like the paddles of a paddle wheel, and two vertical discs 27 and 28 attached to opposite ends of these vanes. The intersection of any two adjoining vanes 26 forms a U-shaped trough bounded by segments of the discs 27 and 28. As shown by the two-headed arrow 29 in FIGURE 2, the vanes 26 and discs 27 and 28 are rotatable about their common axis in either direction. More-over apparatus is provided, represented in FIGURE 1 by shaft 30, coupling scale pan 25 via structure 23 to motor 69 for rotating these vanes in steps of one-quarter turn each in either direction in such a way that one V-shaped trough is brought into position opening upwardly toward the inverted position 13' of cup 13 at the end of each rotational step.

The other pan of balance 14, identified by reference numeral 31 in the drawings, which is mounted on the other end of the balance arm of balance 14, may be of any conventional form suitable for being loaded with a quantity of the items to be batched equal to the capacity of cup 13 for such items or a weight equivalent to this quantity.

The apparatus described up to this point is used as follows. Scale pan 31 is loaded with one batch of the items to be processed and the capacity of cup 13 is adjusted until, on the average, it is just able to hold such a batch. This adjustment can be made either by interchanging cups of different sizes or by adjusting the position of the bottom of cup 13 which may be provided, for this purpose, with adjusting means of any conventional form or combination of both. This adjusting means is preferably calibrated to permit ready reproduction of any particular adjustment. The bottom of hopper 10 is loaded with a quantity of the items to be processed which is much larger than one batch and the hopper is then set into rotary motion whereby it lifts said items up to the top of the hopper by means of vanes 21. These items are discharged over the top edge of plate 11 into the cup 12 whose rear lip is initially positioned abutting this top edge. Next cup 12 is overturned into position 12' and its contents thereby discharged over the open top of cup 13, which is then in position beneath overturned cup 12. Next cup 13 is subjected to a sharp jolt which dislodges from cup 13 any items in excess of its capacity. This jolt may be administered by any one of a variety of devices. For example, a rotating cam having a sharp discontinuity in its periphery may be used to impart to the end of shaft 24, attached to structure 23, a sudden displacement upon passage of said discontinuity past said shaft end.

Next cup 13 is inverted into the position 13' shown in FIGURE 2 and its contents thereby discharged into the V-shaped trough of scale pan 25 positioned directly beneath overturned cup 13. Balance 14 compares the weight of the items in scale pan 25 with that of the items in scale pan 31. If this comparison shows that the former differs from the latter by less than certain predetermined amounts, then pan 25 is rotated to discharge its contents away from hopper 10 (this corresponds to counterclockwise rotation of pan 25 in FIGURE 2). Otherwise, pan 25 is rotated in the opposite direction to discharge its contents back into hopper 10 (this corresponds to clockwise rotation of pan 25 in FIGURE 2). The downward tilt of the rear end of hopper 10, coaxing with its rotation, causes the items discharged back into the hopper to slide gradually back into the region between vanes 21 where they are again lifted up for recycling through the machinery.

Except for the rotation of scale pan 25, all of the mechanical operations described heretofore may be powered and controlled by known forms of machinery. More particularly, either separate, suitably coordinated electrical motors, or a single motor with separate power take-offs, may be used to impart to hopper 10 and cups 12 and 13 the respective motions described above. These motors, or power take-offs, may be situated within structure 23 where they act in conventional manner on shaft 19 and on the ends of shafts 22 and 24 attached to said structure. The speed of rotation of hopper 10 should be such that cup 12 is filled between successive discharges into cup 13, preferably to a degree permitting overflow of cup 13. The remaining operations are preferably performed as rapidly, and in as rapid a sequence, as permitted by the mechanical capabilities of the equipment.

The apparatus which determines when and in which direction scale pan 25 is rotated is shown diagrammatically at 15 in FIGURE 1 and one form of this apparatus is shown in detail in FIGURE 3 to which reference may now be had.

Apparatus 15 includes an electro-mechanical transducer 40, a source 41 of a plurality of reference voltages, a voltage comparator 42, two manually operable six-position selector switches 43 and 44, four magnetically operable single-pole, double-throw switches, or relays 45 through 48 and a magnetically operable six-position stepping switch or relay 49.

Electromagnetic windings 51 through 53 are provided for operating the various relays referred to above. More particularly winding 51 operates simultaneously the armatures 45a, 46a and 48a of all three relays 45, 46 and 48, which may be mechanically ganged for this purpose. Winding 52 operates the armature 47a of relay 47 and winding 53 operates the armature 49a of stepping relay 49.

Relay control circuits 55 are provided for energizing the above-mentioned windings as described in more detail hereinafter.

All the relay armatures are shown in FIGURE 3 in the positions which they occupy when their operating windings are unenergized.

The transducer 40 may be a conventional differential transformer having a movable core connected to an element of scale 14 in FIGURE 1 which is displaced in proportion to the weight unbalance between scale pans 25 and 31. This transducer has two output terminals 56 and 57 and is calibrated so as to produce, between each of said output terminals and ground, a potential of zero magnitude when the numbers of items in scale pans 25 and 31, as represented by their respective weights, are equal. When these numbers are unequal, the potentials developed at output terminals 56 and 57 depart from zero. More particularly for each additional item by which the number in pan 25 exceeds that in pan 31 the potential at terminal 56 increases by one unit in a positive direction. On the other hand, for each additional item by which the number in pan 25 falls below that in pan 31 the potential at terminal 57 increases by one unit, also in a positive direction.

Since, as previously explained, the number of items in scale pan 31 equals the desired number of items in each batch, the number of units of positive potential produced at terminal 56 of transducer 40 indicates by how many items a given batch delivered by cup 13 into scale pan 25 exceeds this desired number. Similarly the number of units of positive potential produced at terminal 57 indicates by how many items such a batch falls short of the desired number.

Reference voltage source 41 has six terminals 58 through 63. This source produces, at terminal 58, a positive potential equal to one-half of one of the above-mentioned units of positive potential produced at either of terminals 56 or 57 of transducer 40. At consecutively higher numbered output terminals, source 41 produces increasingly higher positive potentials, each exceeding the next lower one by one of the units referred to above. The magnitudes of these potentials, expressed in said units, are shown in FIGURE 3 adjoining the terminals at which they are produced. Source 41 and transducer 40 are preferably excited from the same power source so that a change in voltage or in performance of the power source will affect both 41 and 40 equally and produce no error.

Connected to the six different terminals 58 to 63 are the six different stationary contacts, respectively, of each of manual switches 43 and 44 and stepping relay 49. The movable contact 43a of switch 43 is connected to one stationary contact 48b of relay 48 while the movable contact 44a of switch 44 is connected to the other stationary contact 48c of relay 48. The armature 48a of relay 48 and the armature 49a of stepping relay 49 are connected to the different stationary contacts 47b and 47c, respectively, of relay 47 and the armature 47a of said relay 47 is connected, in turn, to input terminal 64 of voltage com-

parator 42. The second input terminal 65 of comparator 42 is connected to one stationary contact 45b and 46b of each of relays 45 and 46. The other stationary contacts 45c and 46c of these relays are both connected to ground. Finally the output terminal 66 of comparator 42 is connected to the input terminal 67 of relay control circuits 55. In addition an electrical counting circuit 68 is provided for energization by relay control circuits 55 as hereinafter explained.

Comparator 42 may be any one of a variety of conventional circuits responsive to the application of potentials to its input terminals 64 and 65 to produce distinctively different signals at output terminal 66 depending on which applied signal is more positive. The relay control circuits 55 are responsive to these different signals from comparator 42 in a manner described hereafter.

The apparatus of FIGURE 3 functions as follows, in recurrent cycles coordinated with successive discharges of cup 13 into pan 25 in FIGURE 1. When a batch of items is delivered by cup 13 into scale pan 25 of FIGURE 1, the relays are all set in the positions shown in FIGURE 3. As a result there will be delivered to input terminal 64 of comparator 42 from terminal 58 of reference source 41 a positive voltage of one-half unit magnitude. To input terminal 65, on the other hand, there will be delivered a potential which is less positive than that at terminal 64 if the batch of items in scale pan 25 consists of the same or a lesser number of items than the quantity in scale pan 31 of FIGURE 1. On the other hand, the potential at terminal 65 will be more positive than that at terminal 64 if the batch in pan 25 consists of a number of items greater than that in pan 31. If the former condition prevails, the output from comparator 42 will be such as to cause relay control circuits 55 to energize winding 51, with the result that armatures 45a, 46a and 48a will be displaced from the position shown in FIGURE 3 and brought into contact with stationary contacts 45c, 46b and 48b of relays 45, 46 and 48, respectively. Moreover this energized condition of winding 51 will then be maintained for the rest of the cycle of apparatus 15. On the other hand, if the latter of the above conditions prevails, then the output signal from comparator 42 will be such that control circuits 55 leave winding 51 unenergized during the rest of the cycle. In that case the connections of armatures 45a, 46a and 48a will remain as shown in FIGURE 3.

In either case relay control circuits 55 next energize winding 52, thereby causing armature 47a of relay 47 to make contact with stationary contact 47b.

In this way either movable contact 43a of switch 43, or movable contact 44a of switch 44—depending upon the prior energization or non-energization of winding 51, as previously discussed—will be connected to voltage comparator input terminal 64. The magnitude of the voltage applied to said input terminal in this manner will depend upon the prior manual adjustment of the particular movable contact to which connection has been made. For the adjustments shown in FIGURE 3, by way of example, a voltage of $3\frac{1}{2}$ units would be applied if connection is made to contact 43a and a voltage of $2\frac{1}{2}$ units if connection is made to contact 44a.

In either case, if the voltage applied to terminal 64 at this stage in the cycle is less than the voltage applied to terminal 65 of comparator 42, this indicates that the number of items in scale pan 25 differs from that in pan 31 by more than the desired amount and is therefore outside the prescribed tolerance limits. The output signal produced by comparator 42 under these circumstances is such as to cause relay control circuits 55 to start rotation of electric motor 69, mounted on the free end of shaft 30 in FIGURE 1, in such a direction as to rotate scale pan 25 in the clockwise direction of arrow 29 in FIGURE 2.

In a manner discussed in more detail later this rotation is stopped after one-quarter turn of pan 25, thereby leaving that one of its V-shaped troughs containing the batch of items which produced the immediately preceding rota-

tion in a position in which these items are discharged back into hopper 10. At the same time another trough of scale pan 25 is brought into position facing upwardly and ready to receive the contents of cup 13 when this cup is again overturned into position 13'.

On the other hand, if the voltage applied to terminal 64 at the above-mentioned stage in the cycle is greater than that applied to terminal 65, this indicates that the number of items in scale pan 25 is within the prescribed tolerance limits. In that case the signal supplied from comparator 42 to relay control circuits 55 is such that these circuits de-energize winding 52 and immediately thereafter energize winding 53, thereby restoring armature 47a to contact with stationary contact 47c of relay 47 and causing armature 49a of stepping relay 49 to begin stepping upwardly into contact with successive stationary contacts of this relay until the voltage applied to terminal 64 from these contacts again exceeds that applied to terminal 65. At that point winding 53 is also de-energized by relay control circuits 55 and rotation of motor 69 initiated again, but this time in such a direction as to rotate scale pan 25 in the counter-clockwise direction of arrow 29 in FIGURE 2. This rotation is again stopped after one-quarter turn, thereby leaving pan 25 in a position to discharge its contents away from hopper 10 and preferably into the container (not shown) in which the items in question are to be packaged.

Each of the pulses which are supplied from control circuits 55 to winding 53 in order to cause the armature 49a to step from one stationary contact of relay 49 to the next is also supplied to counter 68 where a total corresponding to the number of such pulses is registered. The indication thus provided of the number by which the number of items in each batch differs from the desired number can be used to adjust the quantity in the batch, preferably after discharge from scale pan 25, to be exactly equal to the desired quantity. This adjustment can be made either manually, or automatically.

Following discharge of the contents of pan 25 either into or away from hopper 10 the relays in FIGURE 3 are all reset to the connections shown in FIGURE 3, after which apparatus 15 is ready for its next cycle.

It will be recognized from the foregoing that the discharge of the contents of scale pan 25 either into, or away from hopper 10 depends upon the relative magnitudes of the voltages supplied to voltage comparator terminals 64 and 65.

Since, if the number of items in pan 25 exceeds that in pan 31, switch 44 is connected to voltage comparator terminal 64, the setting of this switch 44 establishes the upper limit for the number of items in those batches which are discharged away from the hopper. On the other hand, the setting of switch 43 establishes the lower limit for the number of items in such batches. More particularly, connection of the movable contact of each switch to terminal 58 of reference voltage source 41 establishes the corresponding limit at zero, while connection of this contact to progressively higher numbered terminals of said source increases the limit by one item at a time.

Preferably each operating cycle of the apparatus of FIGURE 3 starts as soon after discharge of cup 13 into scale pan 25 as said pan has had an opportunity to become stabilized in the position corresponding to the relative weights in it and in pan 31. This start may be controlled by any conventional time delay means sensitive to the operation of that portion of the machinery of FIGURE 1 which causes said discharge of cup 13 into pan 25. The timing of the various operations within each cycle may be controlled by conventional sequential timing means incorporated within relay control circuits 55.

Since, in the apparatus described above, the weight of each batch of items in scale pan 25 is relied upon to indicate the number of items in the batch and since, in practical situations even ostensibly similar items are not always precisely equal in weight, it is sometimes desir-

able to limit the capacity of cup 13 (FIGURES 1 and 2), which determines the size of the batch, in such a way that, even if all the items in a given batch are at the same extreme limit of their weight tolerances, the total weight of the batch still does not differ by more than the average weight of one-half item from the weight which the same batch would have if all the items in it were of precisely average weight.

If this precaution is not observed, then it is possible for the weight of a given batch in scale pan 25 of FIGURES 1 and 2 to be outside the limits established therefor by switches 43 and 44 even though the number of items in the batch is within these limits. The converse may also occur, that is the weight may be within limits, while the number is not. In the former case the batch in question will be discharged back into hopper 10 of FIGURES 1 and 2 even though it should have been discharged away from the hopper, thereby reducing the rate of delivery of batches which are within limits. In the latter case, batches which are not within limits will be discharged away from hopper 10 and the accuracy of the apparatus thereby impaired. Both of these possibilities can be precluded by adjusting the capacity of cup 13 in the manner discussed above.

In the apparatus of FIGURES 1 and 2 shaft 30 must be able to rotate scale pan 25 in either direction as shown by arrow 29 in FIGURE 2. Yet pan 25 should also be freely movable in a vertical direction in order to function effectively as a part of the weighing mechanism of balance 14. In order to permit both of these motions to take place, without undue increase in the dead weight of scale pan 25, the apparatus of FIGURE 1 is preferably provided with a special coupling 70 between shaft 30 and scale pan 25 and a special detent 71 on the side of scale pan 25 opposite to that on which this pan is coupled to shaft 30.

The coupling 70, which is shown in FIGURE 4 separately from the remainder of the machinery of FIGURE 1 and to a somewhat larger scale than in FIGURE 1, includes two pins 72 and 73 protruding from the outer surface of disc 28 and symmetrically positioned on opposite sides of the axis of rotation of scale pan 25. These pins 72 and 73 are loosely confined between pairs 74 and 75 of spaced, parallel rails, respectively. Each pair of rails is shaped generally like the tines of a tuning fork. The junction of the pairs of rails 74 and 75 is mounted on the end of shaft 30 nearest disc 28. The spacing between the rails of each pair is sufficiently greater than the diameter of the pin confined between them so that each pin is able to move up and down in the space between rails to the extent required to enable the balance 14 to perform its weighing function. Since the balance normally operates in a nearly balanced condition, the range of motion required is not great, being generally only a small fraction of an inch.

The detent 71, which is shown in FIGURE 5 separately from the remainder of the mechanism of FIGURE 1 and also to a somewhat larger scale than in FIGURE 1, serves the purpose of centering pins 72 and 73 in the spaces between the respective pairs of rails 74 and 75. This prevents the pins from bearing against the rails during weighing, which would interfere with the precision of the weighing operation. Detent 71 comprises a circular disc 76 mounted on the outside surface of disc 27 for rotation together with disc 27 about the axis of pan 25. Disc 76 has four V-shaped notches indented at equal intervals about its periphery. A wheel 77, of such diameter as to fit partially into each notch, is mounted on a spring 78 attached to the supporting structure 25a for scale pan 25 in any conventional manner (not shown) so as to urge wheel 77 against the periphery of disc 76. Because of its spring mounting wheel 77 tends to center itself within any given notch in disc 76 after being brought near alignment with this notch. The parts of coupling 70 of FIGURES 1 and 4 and of detent 71 of FIGURES

1 and 5 are so aligned with respect to each other that, whenever rotation of shaft 30 brings a V-shaped trough formed by any two vanes 21 of scale pan 25 into an approximately upwardly-facing position, wheel 77 will be sufficiently close to a notch in the periphery of disc 76 to slip into this notch and thereby center pins 72 and 73 within the spaces between pairs of rails 74 and 75. In addition, by its tendency to remain centered within each such notch, wheel 77 also tends to restrain scale pan 25 from further rotary motion.

It has previously been explained how motor 69 in FIGURE 1 is set into motion to rotate scale pan 25. To stop this rotation when the scale pan has been rotated through approximately one-quarter turn at a time in the appropriate direction, there is provided a magnetic switch 79 shown mounted directly on motor 69 in FIGURE 1 which is opened by passage of either one of magnets 80 and 81, which are mounted in diametrically opposite locations on a plate 82 coupled to shaft 30 for rotation coaxially with this shaft at twice the rate of rotation of motor 69. Opening of switch 79 open-circuits the field of motor 69, thereby interrupting the rotation of this motor. By appropriate peripheral positioning of magnets 80 and 81 relative to the notches in the detent mechanism 71 of FIGURES 1 and 5, this interruption of motor rotation is made to occur when wheel 77 of detent 71 is sufficiently close to one of the notches in disc 76 to perform its centering function, as previously explained. The magnetically generated switch system described above is preferred for long-life, but the same function can obviously be performed by a mechanically operated switch, with a cam wheel substituted for the magnets 80, 81.

Another form which the control apparatus 15 of FIGURE 1 may take is illustrated in FIGURE 6, to which reference may now be had.

In this form the apparatus in question comprises a transducer 90, which may be similar to transducer 40 in FIGURE 3. More particularly transducer 90 produces at output terminals 91 and 92 a potential equal to zero when the numbers of items in scale pans 25 and 31 are equal. When there are more items in pan 25 than in pan 31, transducer 90 produces at terminal 91 a number of units of positive potential equal to the difference in numbers of items. On the other hand, when there are fewer items in pan 25 than in pan 31, then transducer 90 produces at terminal 92 a number of units of positive potential equal to said difference.

A manually operable switch 93 connects either terminal 91 or terminal 92 to input terminal 94 of control circuit 95.

Also connected to this input terminal 94 is the output terminal 96 of a circuit 97 which is responsive to the application of a potential V to its several input terminals 98 through 104 in succession to produce at output terminal 96 a series of different potentials, starting with a positive potential of one-half unit magnitude upon application of said potential V to terminal 98, and becoming progressively more negative, in steps of one unit of potential each, upon application of said potential V to successively higher numbered input terminals of circuit 97. Circuit 97 may take any of a variety of forms. For example, it may consist of a plurality of appropriate voltage sources, connectible through individual relays to output terminal 96, the different relays being closed, in succession, by application of said voltage V to the appropriate input terminals 98 through 104. Alternatively, circuit 97 may comprise a current source supplying substantially constant current to a series-connected chain of resistors, respectively shunted by individual relays. Different ones of these relays are opened and locked open by application of the potential V to different ones of the input terminals. The series-connected resistors are coupled to output terminal 96 in such a way that, as more and more relays are

opened, the potential at the output terminal changes in the required steps.

The required potential *V* is applied to the different input terminals of circuit 97 by means of a rotating switch 110 to whose rotating arm 111 (shown rotating clockwise in FIGURE 6) this potential *V* is applied from a suitable source of such potential (not shown). As rotating arm 111 contacts in succession the stationary contacts 112 through 113 of switch 110, said potential is applied to the different input terminals of circuit 97 in the required sequence. It will be noted that contact 112 is connected to terminal 98 permanently so that, during each revolution of switch 110, one-half unit of positive potential will be produced by circuit 97. On the other hand, contacts 113 through 118 are connected to their corresponding input terminals through manually operable switches 119 through 124, respectively. By opening one or more of these switches the production of selected ones of the other output potentials, which circuit 97 is capable of producing, can be prevented.

Rotating arm 111 on switch 110 is caused to make one complete revolution during each cycle of the equipment of FIGURES 1 and 2. This may be readily accomplished by coupling its rotating arm to the prime mover imparting to said equipment the motions described with reference to FIGURES 1 and 2. The stationary contacts 112 through 118 are so disposed along the path of arm 111 that, during each revolution of said arm, it makes contact with the lowest-numbered stationary contact, namely contact 112, shortly after the discharge of the contents of cup 13 into scale pan 25 in FIGURE 1 which occurs during the corresponding cycle of the equipment of FIGURES 1 and 2. Contact with the highest numbered stationary contact is made, during the same revolution, prior to the next succeeding discharge of cup 13.

Assume now that the various manually operable switches 93 and 119 through 124 in FIGURE 6 are set in the positions shown in that figure, i.e. with switch 93 connecting terminal 94 to terminal 91, switches 119, 120 and 121 closed and switches 122, 123 and 124 open. As rotating arm 111 then contacts the stationary contacts 112 through 118 in succession, there will be produced at output terminal 96 of circuit 97 a series of potential steps, starting with a positive potential of one-half unit upon contact with stationary contact 112, and ending with a negative potential of two and one-half units upon contact with stationary contact 118. If the number of items previously discharged into scale pan 25 is less than that in scale pan 31, then the potential produced by transducer 90 at terminal 91 will be negative, and the combined potential applied to input terminal 94 of circuit 95, which is the sum of said potential produced at terminal 91 and that produced at output terminal 96 of circuit 97, will also be negative when arm 111 contacts contact 112. Under these circumstances circuit 95 produces an output which energizes motor 69 in FIGURE 1 to rotate scale pan 25 in such a direction as to discharge its contents back into hopper 10. On the other hand, if the number of items in pan 25 is equal to or greater than that in pan 31, then the combined potential applied to terminal 94 from transducer 90 and circuit 97 is positive when arm 111 contacts switch 112. In that case, circuit 95 does not initiate rotation of motor 69 in either direction. As rotating arm 111 next contacts stationary contacts 113, 114 and 115, in succession, the combined potential applied to terminal 94 changes in a negative direction in three successive steps of one unit each. Subsequent contacting of contacts 116, 117 and 118, on the other hand, produces no further change in said combined potential, due to the fact that switches 122, 123 and 124 are all open. If the number of items in scale pan 25 exceeds that in pan 31 by three units, or more, then the combined potential applied to terminal 94 will be positive throughout the passage of arm 111 past all the contacts 112 through 118. Under these circumstances, circuit 95 will produce, at the conclusion of this

passage, an output which causes motor 69 in FIGURE 1 to rotate in a direction to discharge the contents of scale pan 25 back into hopper 10. On the other hand, if the number of items in pan 25 exceeds that in pan 31 by two or less, then said combined potential becomes negative at some point during said passage. Circuit 95 responds to this to produce an output causing motor 69 to rotate in a direction to discharge the contents of pan 25 away from hopper 10. Thus, with the switch settings shown in FIGURE 6, the items in pan 25 will be accepted (i.e. discharged away from hopper 10) if they equal in number those in pan 31 or if they exceed those in pan 31 by one or two. Any other number of items will be rejected (i.e. discharged back into hopper 10).

Other adjustments of switches 119 through 124 place different limits on the acceptable number of items in pan 25. In particular, opening of all the switches sets the limit at a number of items exactly equal to those in pan 31, while closing of successively higher numbered switches raises the acceptable limit by one item per switch. On the other hand, reversal of switch 93, so as to connect to terminal 94 of circuit 95 output terminal 92 of transducer 90 rather than output terminal 91, results in acceptance, subject to the adjustable limits imposed by switches 119 through 124, of numbers of items in scale pan 25 which fall below those in pan 31.

Circuit 95 may take any one of a variety of known forms, consisting of a suitable arrangement of voltage sensitive circuits, such as relays, or transistor switching circuits, responsive both to the application of positive and negative potentials to terminal 94 and to the contacting of the different contacts 112 through 118 by rotating switch arm 111 to produce the results described above.

In addition to the components described above the apparatus of FIGURE 6 may also comprise a visual indicator 125, which may be of any conventional form capable of indicating the disposition of the contents of scale pan 25 during a given cycle of the machinery of FIGURE 1. As has been explained previously, different combinations of control signals are provided by switches 111 and 93 and control circuit 95 depending upon the relationship between the numbers of items in scale pans 25 and 31 during any one cycle of the equipment. These various combinations may be utilized in visual indicator 125 to energize different signal lamps, thereby indicating whether any given batch of items in scale pan 25 is within or without the tolerance limits established by the settings of switches 93 and 119 through 124 and, if within limits, what the numerical difference is between said batch in pan 25 and the number of items in pan 31.

Various other modifications will readily occur to those skilled in the art without departing from the inventive concept. For example, if the equipment is to be conveniently usable to process items of different weights at different times, provisions should be made whereby the sensitivity of either the balance itself, or the electro-mechanical transducer responsive to balance deflection, or both, can be adjusted so that, regardless of the weight of the individual items the addition of one item to either scale pan will always produce the same amount of change in the output potential of the deflection responsive transducers 40 in FIGURE 3 and 90 in FIGURE 6.

The system described above may also be used to dispense accurately large quantities of items by making up the large quantity from many small sized batches. For this purpose each small batch is preferably controlled in size so that extreme weight tolerances in the same direction in all items total no more than the average weight of one-half item.

To perform the above type operation a predetermining counter is added to the system, which opens a switch contact and stops operation when the number of accepted batches reaches a certain total. For example, if the desired quantity consists of ten thousand items and each batch consists of twenty items, plus or minus a few, the

quantity of ten thousand will be approximated in five hundred batches. This is the number to which the predetermining counter is set. The quantity by which each batch differs from its nominal (twenty in this illustrative case) is registered on a second counter of the accumulating type. The predetermining counter stops the operation when the required number of batches has been accepted, and the accumulating counter indicates the number of items which must be manually removed or added to make the lot exact.

A preferred embodiment of the above is one wherein the average departure of each batch from nominal is zero, that is, there is an equal chance for a positive or negative error. In this case the number of items which need be added or subtracted is, on the average, minimized.

Accordingly I desire the scope of the invention to be limited only by the appended claims.

I claim:

1. A system for assembling a predetermined quantity of similar items comprising: means for gathering a quantity of said items greater than said predetermined quantity; means for delivering into a container having a capacity substantially equal to said predetermined quantity so many of said gathered items as fit into said container; means for comparing the weight of said items delivered into said container with a weight equal to that of said predetermined quantity of said items; and means responsive to said comparison to determine the disposition of said delivered items.

2. A system for assembling a predetermined quantity of similar items comprising: an open-top container having a capacity for said items substantially equal to said predetermined quantity; means for discharging over said open top a quantity of said items in excess of said capacity of said container; means for agitating said container to dislodge items above said open top; means for overturning said container; means for receiving the contents of said overturned container; means for comparing the weight of said received contents with a weight equal to that of said predetermined quantity of said items; and means responsive to said comparison to determine the disposition of said received contents.

3. A system for assembling a predetermined quantity of similar items comprising: a generally cylindrical hopper lying on its side, said cylinder being open at one end and closed at the other and having compartments open toward the interior of said hopper formed integral with said closed end for lifting items from the bottom to the top of said hopper during rotation of said hopper about its axis; barrier means partially obstructing the openings in all of said compartments except the one at the top of said hopper; a first container positioned to receive items falling out of any said compartment at the top of said hopper, said first container having a capacity for said items in excess of said predetermined quantity; means for delivering into a second container having a capacity substantially equal to said predetermined quantity so many of the items in said first container as fit into said second container; means for comparing the weight of said delivered items with a weight substantially equal to that of said predetermined quantity of said items; and means responsive to said comparison to determine the disposition of said items.

4. The apparatus of claim 3 further characterized in that at least the bottom portion of the side wall of said hopper slopes downwardly toward said closed end of said hopper so that items deposited in the bottom of said hopper are caused to slide toward said closed end during rotation of said hopper.

5. A system for assembling a predetermined quantity of similar items comprising: a generally cylindrical hopper lying on its side and having radial partitions extending into the interior of said hopper from one end wall thereof, said partitions defining compartments open toward said interior, and said end wall having an annular

portion sloping inwardly toward said interior; means for rotating said hopper about its axis; means for preventing items within said compartments from sliding out of said compartments along said sloping end wall portion except when any of said compartments is positioned at the top of said hopper; a first container positioned to receive items sliding out of any said compartment positioned at the top of said hopper, said container having a capacity for said items in excess of said predetermined quantity; means for delivering into a second container having a capacity substantially equal to said predetermined quantity so many of the items in said first container as fit into said second container; means for comparing the weight of said items delivered into said second container with a weight substantially equal to that of said predetermined quantity of said items; and means responsive to said comparison to determine the disposition of said items.

6. A system for assembling a predetermined quantity of similar items comprising: means for gathering a quantity of said items greater than said predetermined quantity; means for delivering into a container having a capacity substantially equal to said predetermined quantity so many of said gathered items as fit into said container; means for discharging said delivered items from said container into one pan of a scale, the other pan of said scale being weighted with a quantity of said items equal to said predetermined quantity; and means responsive to the relationship between the weights in said scale pans to determine the disposition of said items in said one scale pan.

7. A system for assembling a predetermined quantity of similar items comprising: means for gathering a quantity of said items greater than said predetermined quantity; means for delivering into a container having a capacity substantially equal to said predetermined quantity so many of said gathered items as fit into said container; means for discharging said delivered items from said container into one pan of a scale, the other pan of said scale being weighted with a quantity of said items equal to said predetermined quantity; means for sensing any discrepancy between the weights in said pans, and means responsive to a sensed discrepancy in excess of a predetermined maximum to discharge said items in said one pan in a given direction while being responsive to a sensed discrepancy below said maximum to discharge said items in said one pan in a different direction.

8. A system for assembling a predetermined quantity of similar items comprising: means for gathering a quantity of said items greater than said predetermined quantity; means for delivering into a container having a capacity substantially equal to said predetermined quantity so many of said gathered items as fit into said container; means for discharging said delivered items from said container into one pan of a scale, the other pan of said scale being weighted with a quantity of said items equal to said predetermined quantity; means for sensing any discrepancy between the weights in said pans, said sensing means comprising a transducer coupled to said scale and productive of discretely different values of electrical potential in response to unbalances of said scale corresponding to weighting of said one pan with different numbers of said items, and means for comparing said produced potential with at least one reference potential having a value different from that of any of said discrete values; and means responsive to a sensed discrepancy in excess of a predetermined maximum to discharge said items in said one pan in a given direction while being responsive to a sensed discrepancy below said maximum to discharge said items in said one pan in a different direction.

9. The apparatus of claim 8 further characterized in that said potential comparing means comprises a source of plural reference potentials having values intermediate different ones of said discrete potential values, and means

13

for comparing said last named potential with at least one of said plural reference potentials.

10. The apparatus of claim 9 further characterized in that said means for comparing reference and produced potentials comprises means for comparing said produced potentials in succession with different ones of said plural reference voltages.

11. In a system for assembling a predetermined quantity of similar items whose weights are subject to departures within given tolerance limits from an average value: a container open at the top and having a capacity for a number of said items such that if each item of said number is at the same extreme limit of its individual weight tolerance the total weight of said number of items differs from the weight of an equal number of items of average weight by less than one-half the weight of one said item of average weight; means for discharging over said open top a quantity of said items exceeding said capacity; means for agitating said container to dislodge items above said open top; and means for overturning said container along an arcuate path.

12. A system for assembling a predetermined quantity of similar items comprising: means for gathering a quantity of said items greater than said predetermined quantity; means for delivering into a container having a capacity substantially equal to said predetermined quantity so many of said gathered items as fit into said container; means for discharging said delivered items from said container into one pan of a scale, said one pan being rotatable about a generally horizontal axis to discharge the items in said pan in either of two opposite directions, and the other pan of said scale being weighted with a quantity of said items equal to said predetermined quantity; and means responsive to the relationship between the weights in said scale pans to rotate said one scale pan in one or the other of said opposite directions.

14

13. The system of claim 12 further comprising a hopper for delivering items to said gathering means and characterized in that said one scale pan is positioned with respect to said hopper to discharge its contents into said hopper upon rotation in one of said directions and away from said hopper upon rotation in the other of said directions.

14. The apparatus of claim 13 further comprising a motor for producing rotation of said pan in either of said directions and means coupling said motor to said pan, said coupling means permitting a substantial range of free play between said motor and said pan, and detent means for substantially centering said pan within said range.

15. The system of claim 7 further characterized by the provision of means for sensing the number of discharges of said pan in said different direction only.

16. The system of claim 15 further characterized by the provision of means for interrupting the operation of said system after a predetermined number of said discharges in said different direction.

References Cited in the file of this patent

UNITED STATES PATENTS

7,503	Bramble	July 16, 1850
354,423	Kelly et al.	Dec. 14, 1886
628,926	Delaet	July 18, 1899
1,738,634	Bryant	Dec. 10, 1929
2,099,893	Jones	Nov. 23, 1937
2,616,652	Rose et al.	Nov. 4, 1952
2,851,063	Leinhart	Sept. 9, 1958
2,988,247	Garrett	June 13, 1961

FOREIGN PATENTS

839,626	Great Britain	June 29, 1960
---------	---------------	---------------