

Dec. 16, 1969

K. E. DAVIES

3,484,813

CONTAINER FILLING APPARATUS WITH AUTOMATIC CHECKWEIGHER

Filed Nov. 7, 1967

8 Sheets-Sheet 1

Fig. 1.

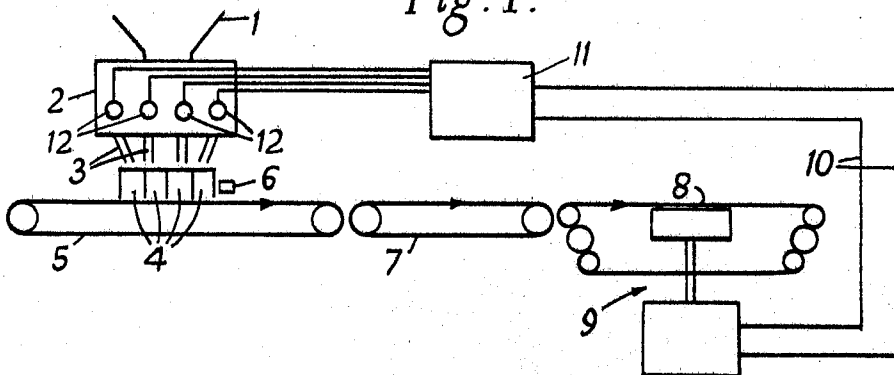
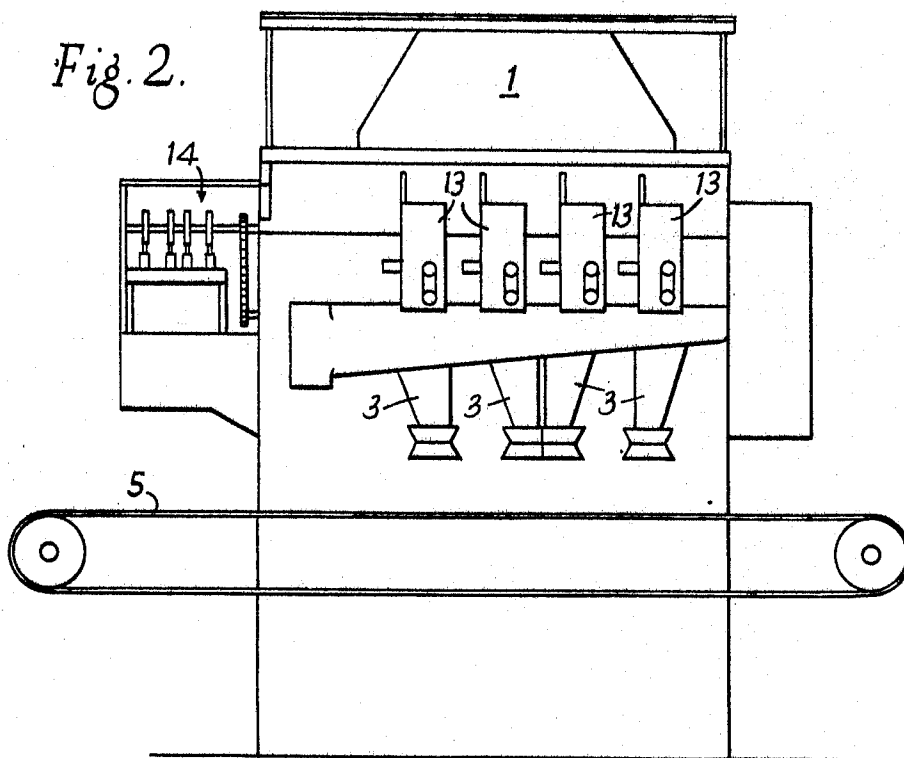


Fig. 2.



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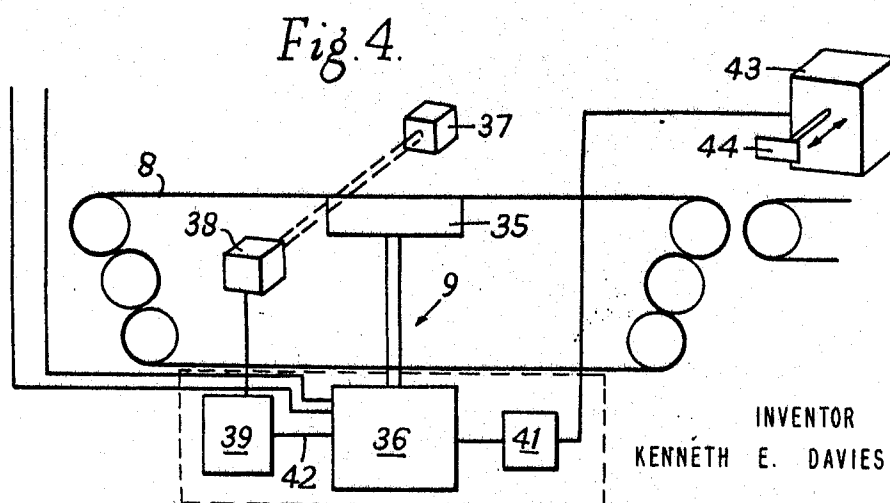
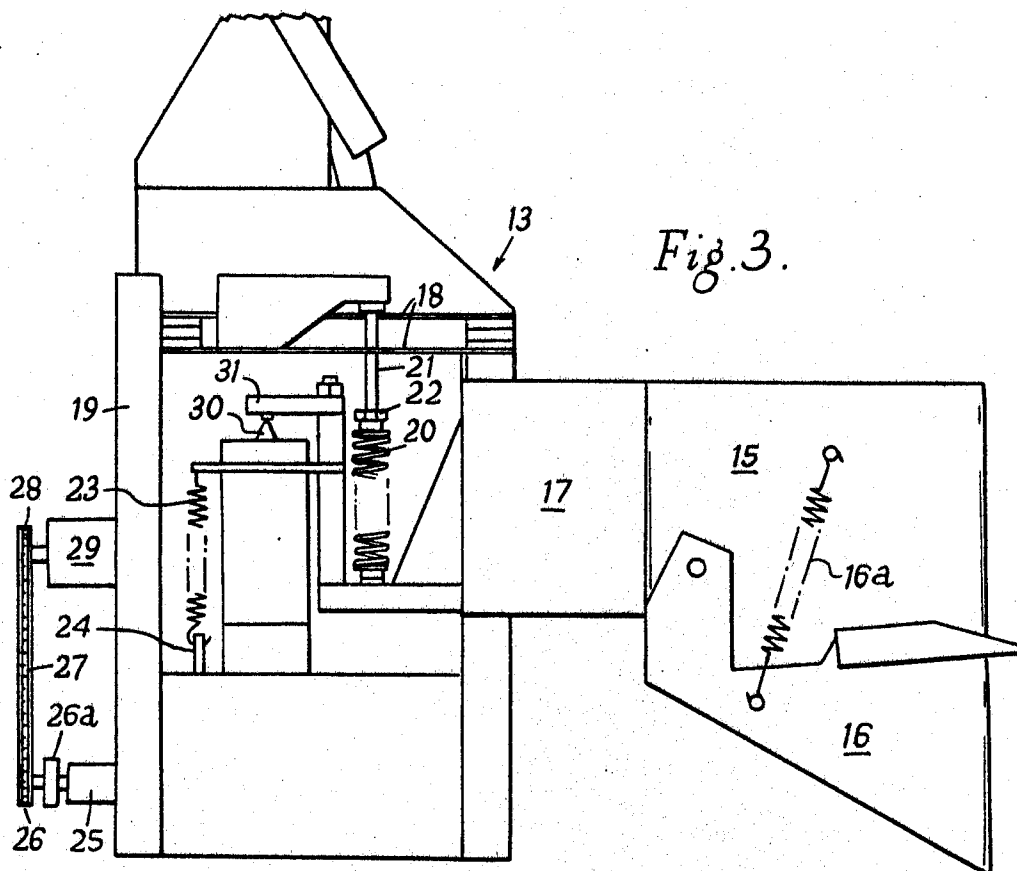
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CONTAINER FILLING APPARATUS WITH AUTOMATIC CHECKWEIGHER

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8 Sheets-Sheet 2



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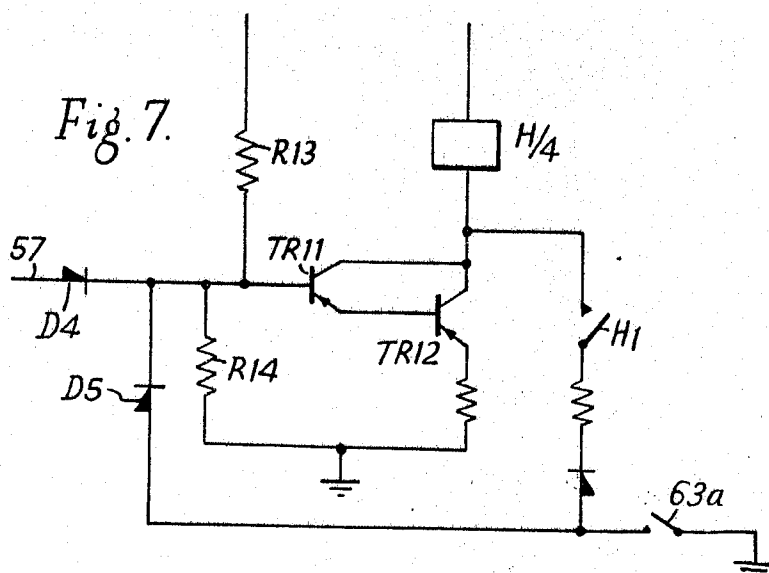
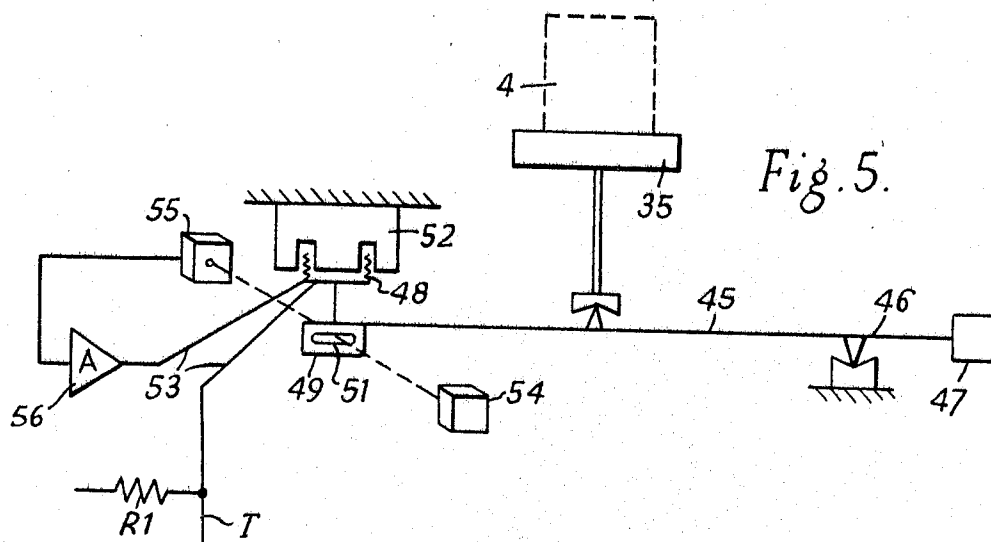
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8 Sheets-Sheet 3



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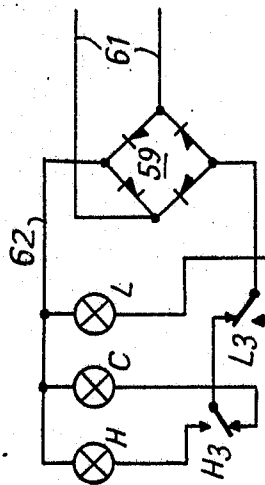
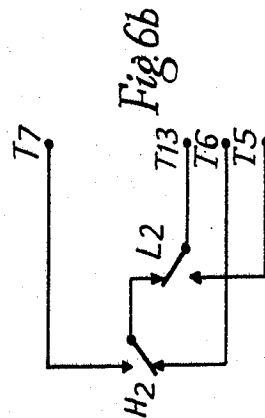
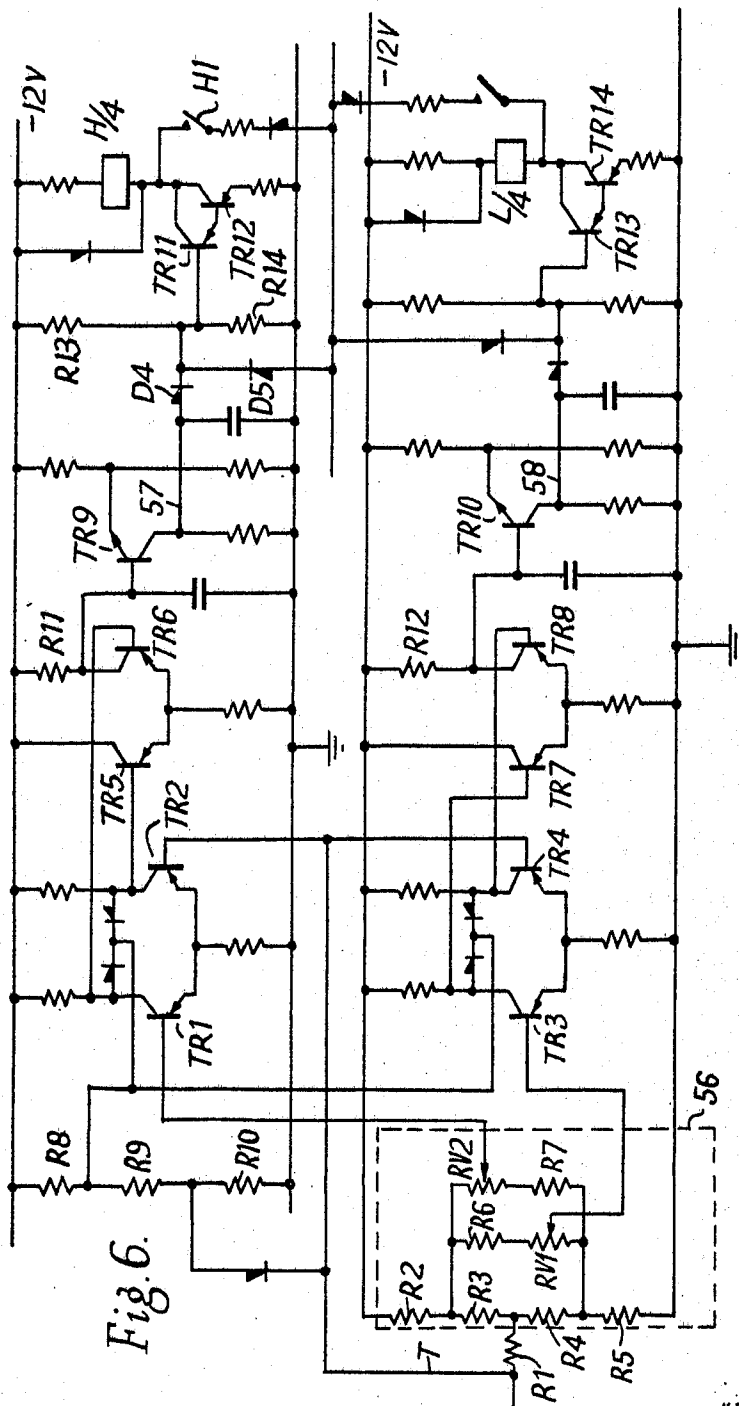
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8 Sheets-Sheet 4



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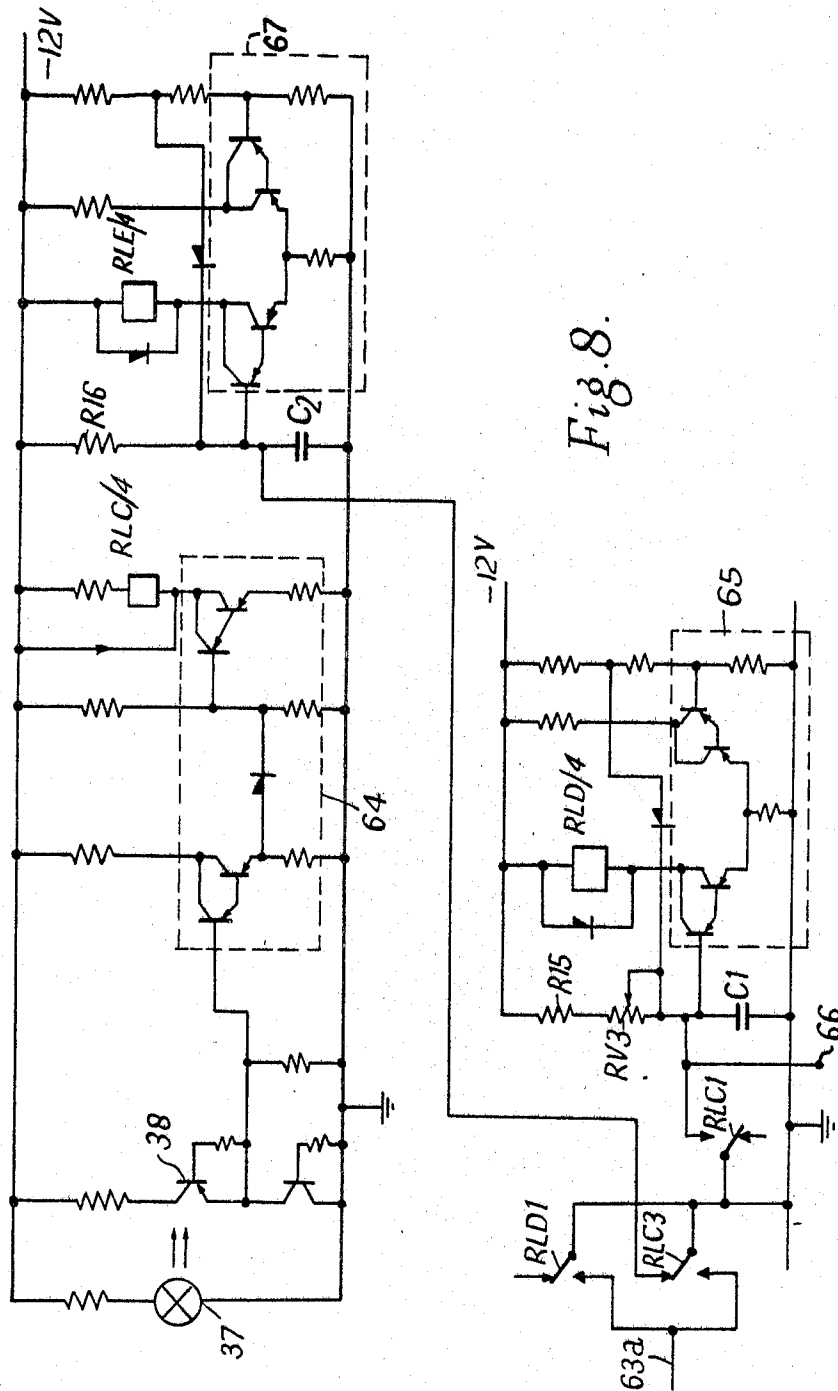


Fig. 8.

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8 Sheets-Sheet 6

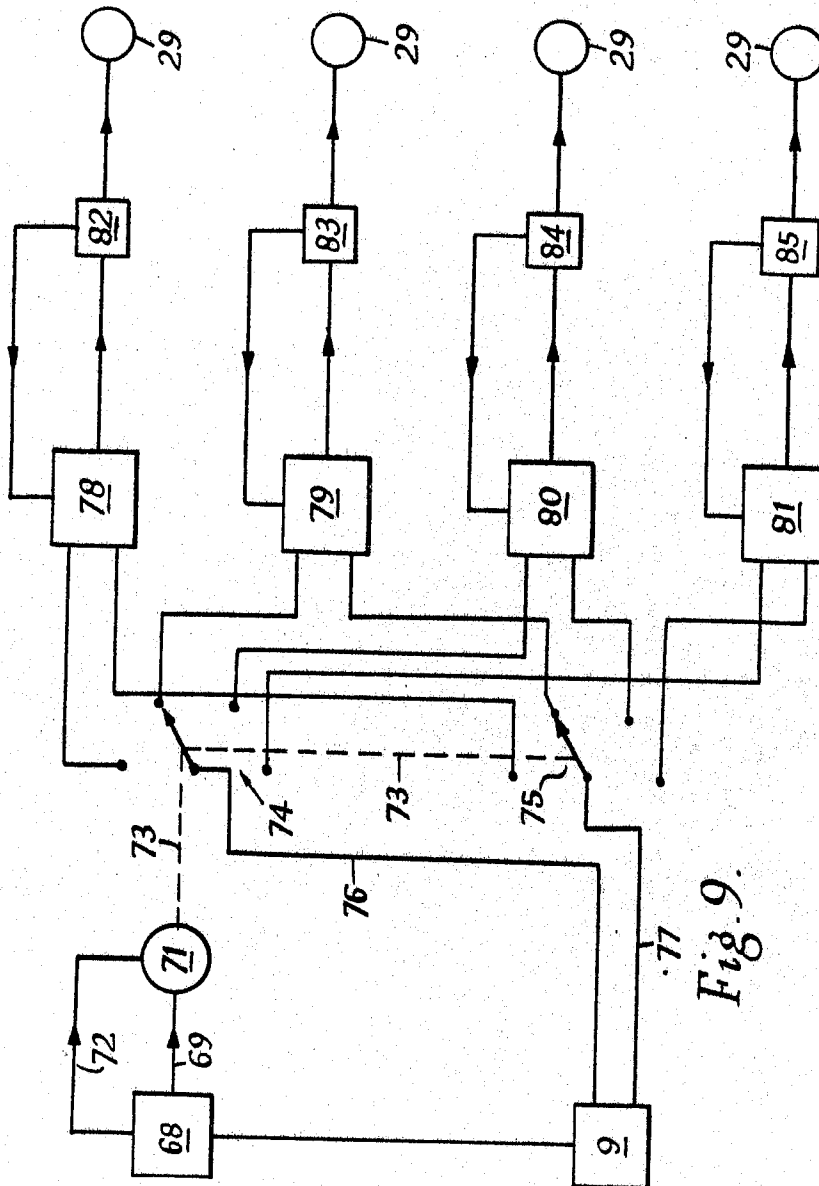


Fig. 9.

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8 Sheets-Sheet 7

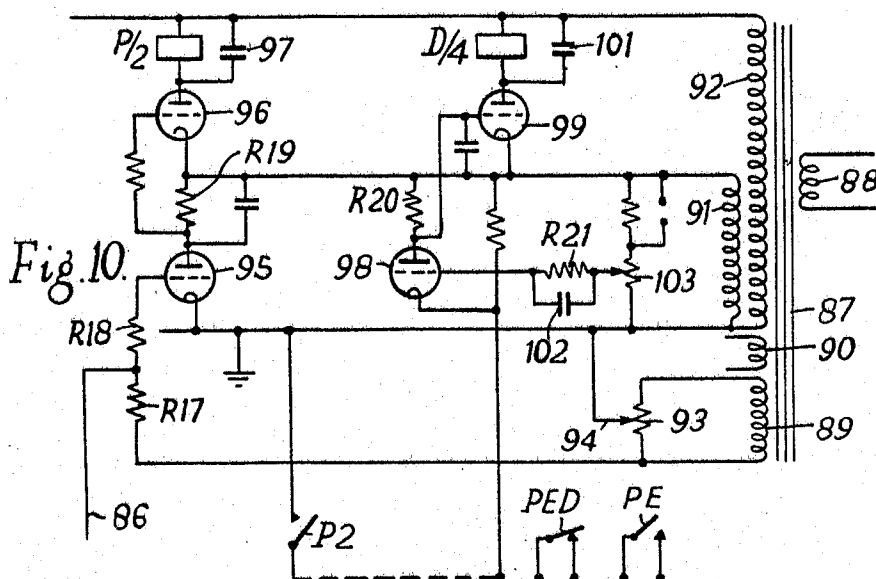
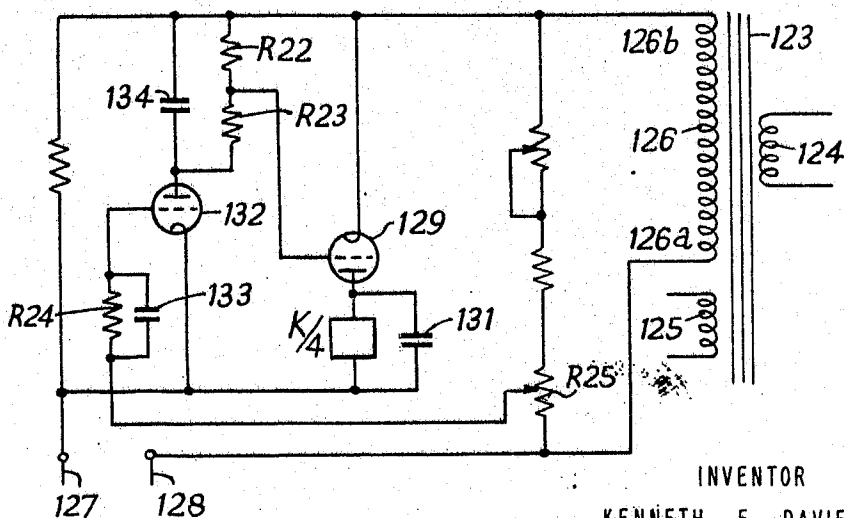


Fig. 12.



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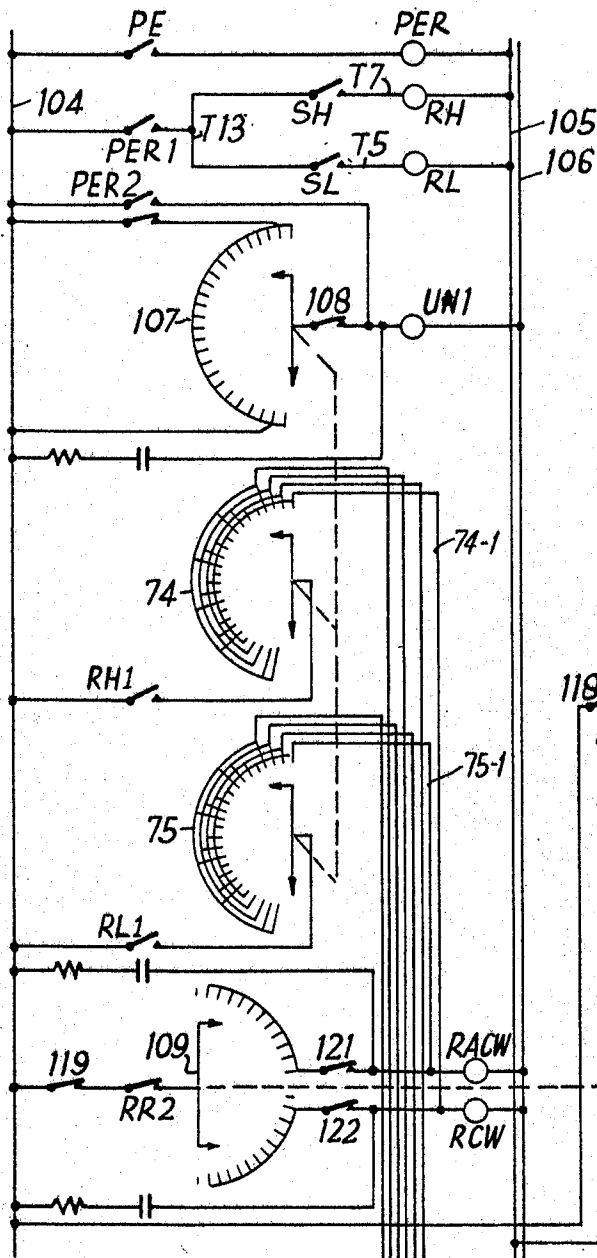
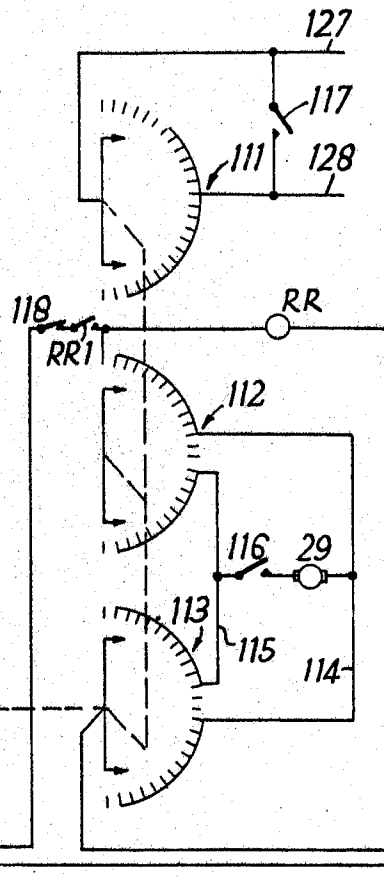


Fig. 11.



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CONTAINER FILLING APPARATUS WITH AUTOMATIC CHECKWEIGHER

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U.S. Cl. 177—50

16 Claims

ABSTRACT OF THE DISCLOSURE

Container filling apparatus having filling heads simultaneously filling a group of containers with a preset weight of material, including detector means responsive to passage of each container, a differentiator responsive to the detector means to differentiate between spacings of single conveyor fed containers and spacings between conveyor fed groups of containers, a checkweigher giving an output when an underweight container is weighed, a memory store for a filling head, distributor means responsive to the detector means, synchronized by the differentiator means arranged to apply to the memory store outputs from the checkweigher and corrector means responsive to said memory store to adjust the settings of said filling head.

The invention relates to container filling apparatus of the kind in which a plurality of filling heads simultaneously fill respective members of a group of containers with a preset weight of material. If the containers are sold on the basis of the quantity of material they contain it is of utmost importance to ensure that no container is delivered with less than the predetermined weight of material therein. It is customary to use a checkweigher to weigh the filled containers and reject those which are underweight. For reasons of economy it is also important to ensure that the weight of material supplied to the containers does not exceed the lower permissible limit by too much.

It is found that there are inevitably fluctuations in the weight of material delivered by a preset filling head and it is an object of the invention to provide in apparatus of the kind referred to, means for automatically correcting such fluctuations by varying the setting of the filling heads in accordance with the weight of the containers as measured by the checkweigher and thereby reduce the proportion of rejected containers while still maintaining the weight delivered within acceptable limits.

According to the invention apparatus for filling containers with a predetermined weight of material comprises a plurality of filling heads which simultaneously fill respective members of a group of containers with a preset weight of the material, successive groups of containers being filled by the filling heads in turn; conveyor means for conveying the containers in succession, the spacing between successive containers of a group hereinafter called the first spacing, being different from the spacing between the last container of one group and the first container of the next group, hereinafter called the second spacing; detector means responsive to the passage of each container; differentiator means sensitive to the response of the detector means to differentiate between the first and second spacings; a checkweigher which weighs the filled containers in succession and gives an output at least when an underweight container is weighed; distributor means driven in response to the detector means and synchronized by the differentiator means; a memory store associated with a particular filling head, the distributor being arranged to apply to the memory store outputs from the checkweigher responsive to the weighing of the particular members of successive groups of containers

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filled by said particular filling heads; and corrector means responsive to the information stored in the memory store to adjust the setting of said particular filling head and thereby correct for variation in the weight of containers filled by said particular filling head from the desired weight. The apparatus is suitable for use in conjunction with a system using any number of filling heads more than one.

A particularly acute problem in providing an automatic weight control system in apparatus of the kind referred to is a difficulty in associating the container for which the checkweigher is giving an indication with the filling head which filled it. The invention overcomes this problem by synchronizing the distributor means by the differentiator means in accordance with the passage of the different groups of containers. Preferably the distributor comprises a uniselector rotary switch having a synchronizing bank of contacts and a distributing bank of contacts, the wipers of the two banks being coupled to be rotatable together in steps continuously in the same sense in response to pulses applied to an operating solenoid thereof, the solenoid being normally pulsed by the detector means once in response to the passage along the conveyor of each container, every n th (where n is the number of filling heads) contact on the synchronizing bank being isolated and the remaining contacts thereof being connected together through a normally open synchronizing switch to a source of energizing potential for the solenoid, the synchronizing switch being closed by the differentiator means once every time said second spacing is detected and the arrangement being such that if, when the synchronizing switch is closed, the wiper of the synchronizing bank makes contact with one of said remaining contacts, a circuit is completed through the solenoid which thereby drives the wiper until it makes contact with an isolated contact, the wiper of the distributor bank being connected to receive outputs from the checkweigher and contacts thereof being connected to the memory store to ensure appropriate distribution of said outputs.

It is envisaged that only one memory store may be provided and that each filling head may be checked in turn over a run of say, twenty-four fillings. While a filling head is being checked the distributor feeds to the store only information appropriate to the weights of containers filled by that head. At the end of a run any necessary correction may be effected in accordance with the accumulated count of errors in the memory store. For example, the arrangement may be such that the checkweigher issues output signals to the distributor only when an underweight container is detected. If, at the end of a run of twenty-four weighings of containers filled by the particular filling head no signals have been received, a signal would be issued by the memory store to reduce the weight delivered by the filling head by an increment. On the other hand, a signal would be issued by the memory store to increase the weight delivered on receipt of an underweight signal from the checkweigher. For the next twenty-four groups the distributor would apply to the memory store weight signals appropriate to another filling head, and so on.

However, it is preferred at present to provide a memory store and associated corrector means for each filling head, the distributor being arranged to distribute to each memory store in turn, in accordance with detection of the passage of successive containers, output signals from the checkweigher responsive to the weighing of the appropriate containers.

Furthermore, it is preferred that the checkweigher gives a first output if the container being weighed is underweight and a second output if the container being weighed is overweight, said first and second outputs appropriate

to containers filled by said particular filling head being applied to the memory store and stored therein, the memory store being arranged to give a first correction output to the corrector means if the accumulated total of said first output exceeds a predetermined limit and a second correction output to the corrector means if the accumulated total of said second outputs exceeds a second predetermined limit. It is possible to arrange that the count in the memory store for over-weight signals and under-weight signals is absolute, but it is preferred to provide that an over-weight signal is counter-balanced by a succeeding under-weight signal so that it is the relative accumulated total which is effective.

Preferably the/or each memory store comprises a uniselector rotary switch having an analyzing bank of contacts with a wiper which is rotatable in either direction from a zero position in response respectively to pulses applied to two uniselector solenoids, one solenoid being pulsed by said first outputs from the checkweigher and the other solenoid being pulsed by said second outputs from the checkweigher, the first p contacts of the analyzing bank from the zero position in the direction taken in response to pulsing of said one solenoid being isolated and the first q contacts of the analyzing bank from the zero position in the direction taken in response to pulsing of said other solenoid being isolated, where p and q are respectively said first and second limits, and the remaining contacts of the analyzing bank are connected together and arranged so that contact of the wiper with one of them completes a circuit to the correcting means to initiate correction, the sense of the correction being determined by two sense-determining banks of contacts on said uniselector arranged to determine the polarity of an operating voltage applied to the correcting means in accordance with the sense of rotation from the zero position of the wipers.

Preferably a resetting bank of contacts is provided on said uniselector to reset the wipers to the zero position once the correction has been effected, the correcting means being connected to energize the resetting bank on completion of the correction.

Preferably the correcting means comprises a reversible servo-motor coupled to the resetting adjustment on the filling head and a timing circuit connected to respond to the completion of said circuit by the wiper of the analyzing bank and to energize the servo-motor for a predetermined time thereafter, the sense of energizing potential applied to the servo-motor being determined by the sense-determining banks.

RELATED ART

The closest patents found are the U.S. Patents Nos. 2,634,080; 2,634,081; 2,634,082 and 2,678,185 which disclose the general nature of the weighing machine described herein. See also U.S. Patent 2,610,052.

With the foregoing objects in view, the invention comprises certain constructions hereinafter described and then particularly pointed out in the claims and a preferred embodiment of the invention is illustrated in the accompanying drawings, in which:

FIGURE 1 is a schematic diagram of the apparatus as a whole;

FIGURE 2 is a front elevation of the filling machine of FIGURE 1;

FIGURE 3 is a side elevation of a filling head of the filling machine;

FIGURE 4 is a schematic diagram of the checkweigher of FIGURE 1;

FIGURE 5 is a schematic diagram of the weighing head of the checkweigher;

FIGURE 6 is a circuit diagram of the discriminator unit of the checkweigher;

FIGURES 6a and 6b are circuit diagrams indicating output connections of the discriminator unit;

FIGURE 7 is a circuit diagram of the sampling control circuit of the discriminator;

FIGURE 8 is a circuit diagram of the photoelectric output unit;

FIGURE 9 is a block schematic diagram of the control unit;

FIGURE 10 is a circuit diagram of the photoelectric and differentiator unit;

FIGURE 11 is a circuit diagram of the distributor and one memory store; and

FIGURE 12 is a circuit diagram of the servo-motor control timer.

Referring to the drawings in detail and in particular to FIGURE 1, there is shown in schematic form a means for filling cartons with breakfast cereal and checking the weights thereof. A hopper 1 of cereal feeds a filling machine 2 which has four chutes 3 arranged to fill four respective cartons at a time. Four cartons are shown at 4 in their respective positions for filling, being supported on a conveyor 5 which is moving in a direction indicated by the arrow and being held stationary against the action of the conveyor by a stop 6. When the four cartons are filled the stop 6 is withdrawn and the cartons are conveyed forward by the conveyor 5 onto a further conveyor 7 which in turn feeds the cartons to another conveyor 8. Conveyors 5 and 8 are moving at a speed of about 100 feet per minute whereas conveyor 7 is a slow speed conveyor moving at about 40 feet per minute. The cartons are each about 6" wide (in the direction of the conveyors) and the arrangement is such that during normal operation the cartons are spaced on conveyor 8 so that the spacing between cartons of the same group is about 10 inches whereas the spacing between the last carton of one group and the first carton of the next group is at least 15 inches.

Conveyor 8 constitutes part of a checkweigher 9 which weighs each carton and deflects any under-weight cartons from the path of the conveyor stream. The checkweigher 9 is capable of determining whether a carton is over-weight, of the correct weight or under-weight. Each carton falls in one of these categories and as it is weighed a signal is passed over one of two lines 10 if it is over-weight and over the other line 10 if it is under-weight to a control unit 11 which serves the function of correlating the information passed from the checkweigher and making appropriate adjustments to the settings of four weight controls 12 on the filling machine. In this way a trend of heavy weights or light weights associated with any one carton of the group of four can be detected and automatically corrected by the control unit 11. The various integers of the system will be described in greater detail hereinafter.

FILLING MACHINE

The filling machine operates by feeding cereal into four filling heads each having weighing receptacle which forms part of a weighing balance and each balance controls a respective pneumatic trip valve which shuts off the flow to the receptacle when the weight in the receptacle is sufficient.

FIGURE 2 shows the hopper 1 which feeds, by means of vibratory feeding devices, four filling heads 13. A cam timing device 14 runs continuously at constant speed and ensures the proper co-ordination of the different functions of the machine. In FIGURE 3 is shown in greater detail one of the filling heads 13 showing in side elevation such a filling head, isolated from the machine. The weighing receptacle, shown at 15, has a closure member 16 at its base which is retained in the closed position by a spring 16a, being opened once in each cycle of operation to discharge its load into an empty carton in response to the cam timing device 14 by means of a solenoid (not shown). The receptacle 15 is fed from the top by a vibratory feeder (not shown) which takes its supply from the hopper 1.

Receptacle 15 is mounted on a frame 17 which is mounted with respect to the rest of the filling head by means of two leaf springs 18, each leaf spring being clamped at one end to the frame 17 and at the other end to the body 19 of the filling head. A coil spring 20 is mounted at one end on a rod 21 which is threaded and mounted in the body 19, the other end of spring 20 being mounted on an extension of the frame 17 and the arrangement being such that the action of the coil spring opposes to some extent the action of the leaf springs 18. Adjustment of the tension of spring 20 is effected by a knurled nut 22 on the threaded rod 21. Normal adjustment of nut 22 effects a coarse adjustment of the balance position of the weighing receptacle. A finer adjustment may be effected by a smaller coil spring 23 which is effectively mounted in parallel with coil spring 20 but which is adjusted by rotation of a rod 24 through the intermediary of bevel reduction gearing (not shown) in response to the rotation of the control 25. Control 25 is coupled, through a friction clutch 26a to a sprocket 26 which is driven by a chain 27 linked to a sprocket 28 on the output shaft of a reversible servo-motor 29.

The position of the frame structure 17 with respect to the body of the filling head is sensed by a pneumatic detector arrangement which applies air under pressure to a fine nozzle 30 fixed with respect to the body 19 and of which the effective aperture is varied by a stop 31 fixed on the frame structure 17 and against which the air from the nozzle 30 is directed. As the cereal is loaded into the receptacle 15 the balance alters, bringing the stop 31 nearer the nozzle and the air pressure in the system supplying the nozzle 30 rises. This air pressure is applied to a second, similar, pneumatic system which trips a closure member (not shown) over the feed for the receptacle. Thus the feed to the receptacle is cut off when the weight reaches a predetermined value. The actual weight, at which cut off is achieved, is adjustable by energization of servo-motor 29 in the appropriate sense.

In a filling cycle, the filling machine is presented by conveyor 5 with a group of four empty cartons, the four receptacles 15 being filled to the appropriate weights determined by the positions of controls 25 and the cam mechanism then opens all the receptacles simultaneously so that the four cartons of the group are simultaneously loaded. The stop 6 is then withdrawn and the cartons allowed to proceed as a group to the checkweigher 9.

CHECKWEIGHER

FIGURE 4 is a schematic diagram of the checkweigher 9 and shows the conveyor 8 thereof onto which cartons are fed by conveyor 7 (FIGURE 1). Conveyor 8 is in the form of spaced parallel bands which move together and which are adapted to convey each carton over a weighing platform 35 so that the weight of the carton is taken by the platform as it passes. Platform 35 is coupled to a weighing head 36 which acts on a force-balance weighing principle so that the movement of platform 35 in weighing the cartons is minimal. In passing over the platform the cartons break a light beam from a lamp 37 to a photoelectric cell 38 and said cell issues a position signal to a programming unit 39 which ensures that the carton is in the correct position when the weight indication from the weighing head is taken. The weighing head gives an output voltage which is proportional to the weight of the carton and this is applied to a discriminator unit 41 which, when in receipt of a sample signal over a lead 42 from programming unit 39, issues an output signal to a reject actuator 43 placed at the end of conveyor 8. If the carton is below standard weight the signal from the discriminator unit is such as to cause the reject actuator 43 to project an arm 44 as the carton proceeds to the next conveyor of the chain and thereby deflects that particular carton from the normal output of the machine. Although the discriminator unit is capable

of discriminating between heavy, correct and light carton weights, only the lightweight cartons are rejected. As will appear hereinafter, however, the other information is utilized in the automatic weight regulation system.

FIGURE 5 is a schematic diagram of the weighing head 36. The weight on platform 35 is applied to one side of a balance beam 45 pivoted on a knife edge 46 and having a counterweight 47. On the end of beam 45 remote from counterweight 47 there is provided a mount which carries a coil 48 and a mask 49 defining a transparent aperture 51. The coil 48 is arranged to move in the field of a permanent magnet 52 and current applied thereto by leads 53 provides a balancing force capable of maintaining the position of the beam substantially constant despite loading thereof. Divergence of the beam from the balance position is detected by variation of a light beam which is directed from a lamp 54 to a photo-transistor 55. The output from the photo-transistor is applied to an amplifier 56 which gives a correcting current over leads 53 to coil 48, the correcting current being of such polarity as to restore the beam to its normal position. The magnitude of the current passing through the coil necessary to maintain the beam in its normal position is a direct measure of the weight on platform 35. This balancing current is applied to a resistor R1 and the potential across the resistor resulting therefrom is applied to the discriminator unit.

The circuit diagram of the discriminator unit is shown in FIGURE 6. One end of resistor R1 is connected to the coil 48, FIGURE 5, and the other end to a reference potential point which is the mid-point of a potential divider constituted by resistors R2 to R5. The reference potential at the end of resistor R1 is -6 volts and a variation of correction current in coil 48 of -30 milliamps to +30 milliamps gives a voltage range at input terminal T of from -2.4 volts to -9.6 volts. There are provided two differential amplifiers constituted respectively by transistors TR1, TR2, and TR3, TR4. The potential appearing at terminal T is applied to the bases of transistors TR2 and TR4 and the other input for each differential amplifier is taken from a reference supply circuit 56. The potential divider constituted by resistors R2 and R5 is tapped by two further, parallel, potential divider circuits constituted respectively by resistors R6, RV1, R7, RV2. The potential appearing at the tap of variable resistor RV1 is applied to the base of transistor TR3 and that appearing at the tap of variable resistor V2 is applied to the base of transistor TR1. These potentials are reference potentials and are adjusted to the desired values by varying resistors RV1 and RV2.

A potential divider constituted by resistors R8 to R10 is provided to supply clamping potentials for use in maintaining the potentials at the collectors of transistors TR1 to TR4 and the potential at terminal T to desired limits.

Following each differential amplifier TR1, TR2 and TR3, TR4 there is provided a further differential amplifier TR5, TR6 and TR7, TR8 respectively. Each of these latter amplifiers has only one output and it is to be noted that the connections between the respective amplifiers are similar except in that the output from collector TR1 is applied to the base of transistor TR6, this being the transistor having the collector load, whereas in the other amplifier pair the input to the base of the transistor TR8, which is the transistor having the collector load, is derived from the collector of transistor TR4. Thus, if the input potential at terminal T is such as to make transistors TR2 and TR4 conduct there will be a rise in potential across resistor R11 but a fall in potential across resistor R12. The collector potentials of transistors TR6 and TR8 are applied respectively to further, NPN, transistors TR9 and TR10. These latter transistors are arranged to conduct if the potentials applied to their bases are sufficiently positive and in that

event to give an output potential at points 57 and 58 respectively of approximately -8.5 volts.

In operation, the reference supply circuit 56 is set so that the reference potential applied to transistor TR1 is approximately -6.05 volts and that applied to transistor TR2 is approximately -5.95 volts. If the input potential at terminal T is less negative than -5.95 volts, indicating a carton weight of less than the predetermined minimum, an output voltage (-8.5 volts) will be obtained at point 58 whereas point 57 will be at ground potential. If the input voltage at terminal T lies between -5.95 and -6.05 volts the potential at points 57 and 58 will both be grounded. If the input potential at terminal T is more negative than -6.05 volts then an output will be obtained from transistor TR9 to give a potential at point 57 of -8.5 volts whereas the potential at point 58 will be zero. This condition indicates that the carton being weighed is heavier than the predetermined limit.

The potentials appearing at points 57 and 58 are applied through clamping circuits to be described in greater detail hereinafter, to amplifiers constituted respectively by transistors TR11, TR12 and TR13, TR14, which, if an output voltage is obtained at point 57 or 58 respectively, energizes an associated relay H/4 and L/4 respectively. If the carton is heavy the relay H/4 is energized and if the carton is light the relay L/4 is energized. If the weight is within the predetermined limits neither relay is energized. Each relay has four contacts and in FIGURES 6a and 6b there are shown two circuits utilizing respectively two contacts of each relay. FIGURE 6a shows an indicator lamp arrangement, the lamps H, C and L being mounted on a display panel and being illuminated respectively when a packet is heavy, correct or light in weight. A full-wave rectifier 59 is connected to the main supply 61 and one terminal 62 of its output is connected in parallel to the lamps. Contacts H3, and L3 of relays H/4 and L/4 respectively are shown both in their unenergized positions, indicating a correct weight.

In FIGURE 6b relay contacts L2 and H2 are shown again in their unenergized positions and the arrangement is effective to connect terminal T13 to one of three further terminals T5, T6 and T7 respectively when the carton weight is light, correct or heavy. The circuit for utilizing these contacts will be described hereinafter.

In order to avoid errors in weighing due to an output being taken from the weighing head when the carton is in the wrong position it is necessary to provide a sampling circuit which governs when the reading is to be taken. FIGURE 7 is a circuit diagram showing the sampling control circuit for the "heavy" amplifier. It is to be understood that the sampling circuit for the other amplifier is precisely the same. The potential appearing at point 57 is applied through a diode D4 to the junction of two resistors R13 and R14 which constitute a potential divider, the potential at the junction of which is normally maintained at approximately -4.8 volts. In order for switching circuit TR11, TR12 to energize relay H/4 it is necessary that the potential at the base of transistor TR11 be at least as negative as -3.7 volts. A diode D5 is connected to the junction of resistors R13 and R14 and is able to be connected to ground by a relay contact 63. Whenever contact 63 is closed the potential at the junction of R13 and R14 is zero and any energizing potential from terminal 57 will not be effective to energize relay H/4. Contact 63 is opened only during the time at which it is determined that the balance prevails for the weighing head. This is determined by a circuit in the programming unit 39 (FIGURE 4), which circuit energizes a relay to open contacts 63 only for a predetermined duration after the beam of light from lamp 37 to photocell 38 is interrupted. The timing circuit will be described in greater detail hereinafter with reference to FIGURE 8.

During the sampling period, when contacts 63 are open, the junction between resistors R13 and R14 is allowed to rise to its rest potential of -4.8 volts if point 57 is not

grounded. In other words, if the amplifier is giving an output of -8.5 volts at point 57 then a switching potential will be applied to transistor TR11 and the relay H/4 will be energized. A self-holding contact H1 is provided on the relay for ensuring that, if the relay is energized, it is held in the energized condition on closing of contacts 63.

FIGURE 8 is a circuit diagram of the photoelectric arrangement for sensing the positions of the cartons and the timing device for appropriate timing of the opening of contacts 63. Lamp 37 directs light onto a phototransistor 38 and the change in potential appearing across transistor 38 when the light beam is broken by a carton present at the weighing platform 35, FIGURE 5, is applied to an amplifying and switching circuit 64 which, when the light beam is broken, de-energizes a relay RLC/4. Contacts RLC1 and RLC3 of relay RLC/4 are shown in the conditions they assume when the relay is de-energized. A resistor-capacitor circuit constituted by a fixed resistor R15, a variable resistor RV3 and a condenser C1 is connected across the supply terminals for the circuit but the condenser is normally (while relay RLC/4 is energized) prevented from charging by being short-circuited through contacts RLC3. On de-energization of the relay RLC/4 contacts RLC3 assume the condition shown and the condenser C1 is allowed to charge. Also, contacts RLC1 change to the condition shown and remove the ground connection from lead 63a (see FIGURE 7) so that the sampling period begins. A differential switching amplifier 65 is arranged to receive the potential across the condenser C1 as one input and to energize a load relay RLD/4 when the potential across the condenser has reached a predetermined value. One of the contacts of relay RLD/4 is contact RLD1 and on energization of the relay this contact changes from the position shown and re-establishes ground potential on line 63a, thereby terminating the sampling period. An output terminal 66 is connected to the junction of resistor RV3 and condenser C1 and the connection to this terminal will be described hereinafter.

If a carton is under-weight it is necessary to reject it and the rejection actuator 43 (FIGURE 4) must be operated when the carton is adjacent the arm 44 and therefore a time delay must be allowed between the re-making of the photo-electric beam as the carton passes on and the actuation of the rejection mechanism. This time delay is afforded by a further resistor-capacitor network constituted by a resistor R16 and a condenser C2 connected across the supply terminals. The junction between the resistor and the condenser is connected to one terminal of switch contacts RLC1 which are arranged so that when relay RLC/4 is de-energized, contacts RLC1 short-circuit condenser C2. When the light beam is re-made the contacts RLC1 change over and condenser C2 is allowed to charge. A differential switching amplifier 67 receives as one input the potential across condenser C2 and energizes a relay RLE/4 when this potential reaches a predetermined value. A contact (not shown) of RLE/4 is arranged in a series circuit with a normally open contact of relay L/4 (FIGURE 6) and a solenoid rejector actuator 43, the arrangement being such that if the discriminator indicates, by closure of the switch contacts of relay L/4 that the carton is light, then the solenoid 43, is energized and actuator arm 44 is projected to deflect the carton at the time when it passes the arm.

CONTROL UNIT

As was mentioned above, the control unit 11 is effective to act on information received from the checkweigher 9 to make automatic correction to the weight adjustment for the four respective weight controls 12 (FIGURE 1). The function of the control unit is to determine, first of all, which of the four filling heads 13 are associated with the individual weight signals issued by the discriminator (FIGURE 6). The control unit 11 then analyzes the weights given by each of the four filling heads 13 and

determines whether a correction should be made and if so the nature of the required correction. Any necessary correction is effected by means of energizing signals issued to the different servo-motors 29 (FIGURE 3). Firstly, consider the problem in associating a particular weighing with the filling head responsible for filling the carton. The filling machine issues the filled cartons in groups of four and the cartons are conveyed one behind the other in line on the conveyor. It might be thought that determination of the filling head appropriate to a particular carton would be merely a matter of establishing a continuous count of the cartons which, once synchronized, would continue to be correct thereafter. However, the solution is not as simple as that because facilities must be available for removing or adding individual cartons from or to the conveyor should the necessity arise and secondly a transient circuit failure could give rise to a carton being missed in the count. If either of these eventualities happens the continuous running count would be out of synchronization indefinitely, there being no automatic means for recognizing and correcting such a fault. Under these circumstances the automatic control for a particular filling head would respond to the weights of cartons from another head and the resulting errors would be manifold.

The problem of distinguishing respective cartons is solved in this apparatus by ensuring that the cartons of each group are spaced uniformly and that the spacing between the last carton of one group and the first carton of the next is appreciably greater than the spacing between the cartons of one group. The output of the photoelectric sensing device using photocell 38 is applied to a timing device which is sensitive to differentiate between the spacing between successive cartons of one group and the spacing between cartons of different groups. Effectively, therefore, it is possible to arrange that the extent of the count required by the apparatus is limited to four and the count is synchronized on the passage of each group. This means that although an individual error cannot be avoided if a carton is removed or added, or if a carton is missed in the count, this error is not carried forward indefinitely but is corrected by synchronization with the next group.

FIGURE 9 is a block schematic diagram of the control unit 11, FIGURE 4. The checkweigher is shown at 9 and there is a connection between the output of the photocell 38 of the checkweigher and a synchronizing circuit 68. Circuit 68 issues a pulse over a line 69 to a selector drive mechanism 71 on the passage past the photocell 38 of each carton. In addition, the circuit 68 issues a synchronizing pulse over a line 72 when there is detected a delay between pulses characteristic of the gap between successive groups of cartons. Mechanism 71 is a uni-selector type of mechanism which responds to each pulse to drive a pair of rotary switches to the next switch position, the mechanical linkages for the two switches being indicated at 73. The two rotary switches are indicated at 74 and 75 respectively and are arranged as distributor switches, the wiper arm of switch 74 being connected to a lead 76 to which is applied a potential in response to a heavy carton and the wiper arm of switch 75 being connected to a lead 77 to which is applied a potential in response to a light carton.

There are provided four memory stores 78, 79, 80 and 81, each having two inputs, one connected to one terminal of switch 74 and the other connected to the corresponding terminal of switch 75. As the distributor switches are rotated one step at a time in response to the passage of the cartons the stores are connected in turn to leads 76 and 77. Each store corresponds to a respective filling head 13 on the filling machine and is arranged to perform an analysis of the weights of the cartons filled by that head. If the analysis indicates that there is a trend for the head to be too liberal or too stringent in dispensing the cereal a signal is issued to a respective timer (82 to 85) which delivers energizing current for an associated servo-motor

29. The timers are effective to control the application of energizing current for a predetermined time. After the predetermined time the servo-motor is stopped and a reset signal is passed to the memory store to erase the existing trend information.

FIGURE 10 is a circuit diagram of the photocell responsive unit incorporating the synchronizing circuit 68 of FIGURE 9. The input to the circuit is taken from a lead 86 which is connected to terminal 66 (FIGURE 8). The effect of the re-making of the light beam by passage of a carton is to ground the lead 86. The synchronizing circuit has a power supply transformer 87 with a primary winding 88 connected across the main supply and four secondary windings 89, 90, 91 and 92, these giving respective output voltages of 60 volts, 6 volts (for heater supplies), 40 volts and 230 volts. A potential divider 93 is connected across winding 89 and has a tap 94 connected to ground, variation of the tapping point effecting a variation of the reference level of the alternating voltage taken from winding 89. One end of winding 89 is connected through two resistors R17, R18 to the grid of a triode 95, the arrangement being such that normally, without lead 86 being grounded, the bias applied to the grid of triode 95 is sufficient, during positive half-cycles of the input voltage, to allow triode 95 to conduct. The re-making of the light beam to photocell 38 has the effect of grounding the lead 86 and this causes triode 95 to cut off, or at least substantially reduces its conduction time per cycle.

Triode 95 has an anode load R19 which constitutes a source of biasing potential for a further triode 96 which has, as its anode load, a relay P/2. The effect of grounding lead 86 is to cause a reduction in the potential drop across R19 and thereby allow valve 96 to conduct and energize relay P/2. Relay P/2 is maintained in its energized condition during negative half-cycles of the supply voltage by a condenser 97 connected thereacross. When the light beam to photocell 38 is interrupted, triode 95 is allowed to conduct again, triode 96 is cut off and relay P/2 is de-energized. Therefore, relay P/2 is energized and de-energized in sympathy with the re-making and breaking of the light beam to photocell 38.

One of the contacts of relay P/2 is shown at P2 and is closed when the relay is energized. Through an external link this contact connects the cathode of a triode 98 with ground when it is closed. Thus, when relay P/2 is deenergized the connection between the cathode of the triode 98 and ground is broken and if the valve were conducting it is now cut off. An anode load resistor R20 for triode 98 constitutes an input bias source for the grid of a further triode 99. When valve 98 is not conducting the bias arrangement is such that triode 99 is allowed to conduct. Valve 99 has, as an anode load, a further relay D/4 which has a parallel condenser 101 to prevent de-energization of the relay during negative half-cycles of the supply voltage. One of the contacts of relay D/4 is PED which is closed when the relay is de-energized. Therefore, it will be seen that removing the grounding of lead 86 by breaking the light beam de-energizes relay P/2, removes ground from the cathode of triode 98, and ensures that relay D/4 is energized and contact PED is opened.

When ground potential is applied to lead 86 by the re-making of the light beam to photocell 38 relay P/2 is energized and relay contacts P2 remake. This grounds the cathode of triode 98 and provides suitable conditions under which the triode can conduct. However, the grid of triode 98 is connected, through a long time-constant resistance-capacitance circuit constituted by resistor R21 and condenser 102, to the tap of a potential divider 103 connected across winding 91. The effect of this arrangement is to provide a delayed action in the provision by triode 98 of sufficient anode current to cut off the triode 99. Thus, when the light beam to photocell 38 is re-made there is a predetermined delay before relay D/4 is de-

energized and contacts PED are closed. When the next carton breaks the light beam the ground connection for the cathode of triode 98 is again removed and the time delay is so arranged that the time lag between the remaking and breaking of the light beam by successive cartons in a group is not sufficient to allow relay D/4 to become de-energized whereas the gap between the remaking and breaking of the light beam by the last carton of one group and the first carton of the next is long enough to allow relay D/4 to become de-energized. Therefore, the effect is that contacts PED are, during normal operation, closed only when the space between successive groups of cartons passes the photocell. On the other hand, further contacts of relay P/2 are shown at PE and these are closed every time the light beam is re-made on passage of a carton. Having reference to FIGURE 9 the pulses on line 69 can be regarded as the closure of contacts PE and the synchronizing pulses on line 72 as closure of contacts PED.

FIGURE 11 is a circuit diagram of the interconnections of the distributor switches 74, 75 and one of the memory stores associated with one of the filling heads 13 of the filling machine. A supply circuit (not shown) gives a positive supply potential on line 104 and a negative potential with respect thereto of -12 volts on line 105 and of -50 volts on line 106. Connections are made so that contacts PE (FIGURE 10) of relay P/2 are connected in series with a slave relay PER across the 12 volt supply lines. One of the contacts of relay PER is shown at PER2 and is open when the relay is de-energized, this contact being connected to energize a uniselector drive solenoid UN1. Solenoid UN1 drives the wipers of a uniselector having three banks, one being a synchronizing bank 107 and the others being distributor banks 74 and 75. The uniselector wipers are capable of rotating continuously around the semi-circular banks in an anticlockwise direction, continuity of operation being ensured by the wiper arms having two opposed contact parts. The banks used are provided with 25 contacts each, and in order to render them effectively 24 contact banks contacts numbers 24 and 25 are bridged. Since contacts PER2 are energized once in response to each carton passing the light beam the uniselector contacts are swept at the rate of one per carton.

The distributor banks 74 and 75 are arranged so that the contacts are connected together in four groups, each group comprising every fourth contact taken at a phasing appropriate to the particular group. Each group of contacts is connected as one of two inputs to a respective memory store. There are four memory stores, one corresponding to each filling head of the filling machine. The first memory store has two inputs taken respectively from the first group (contacts 1, 5, etc.) of bank 74 and the first group (contacts 1, 5, etc.) of bank 75. The second memory store has two inputs taken respectively from the second groups of each bank 74, 75, and so on. It will be seen that as the contact arms of the distributor banks move step by step around the banks they will be connected in turn to respective input leads of the different memory stores. Information concerning the weight of a carton as determined by the checkweigher is applied to the wiper arms in the form of a potential and this information is correlated by the distributor switches so that each memory store contains information appropriate to only its respective filling head.

As was mentioned above, it is important to ensure that the distributor switches are synchronized appropriately with the groups of cartons so that any errors appearing are not carried forward indefinitely in terms of application of weight information to the wrong memory stores. Synchronization is effected by the synchronizing bank 107 in which every fourth contact (1, 5, etc.) is isolated, whereas all other contacts are connected together. The connected contacts of this bank are connected to line 104 through contact PED (FIGURE 10)

which are closed only when a gap indicating a space between successive groups is detected. The wiper arm of bank 107 is connected through a normally closed uniselector interrupter switch 108 and therefore, if the wiper arm is not in contact with one of the isolated contacts (1, 5, etc.) when contacts PED are closed the effect will be that solenoid UN1 is energized and the wiper will be driven around until it makes contact with an isolated contact. The wipers of banks 74 and 75 are therefore also moved until they make contact with a contact of the first group. This ensures that the next weight information is passed to the memory store associated with the filling head which fills the first carton of each group.

A further contact of relay PER is shown at PER1 in series between lines 104 and 105 with two parallel paths, one of which contains a switch SH and a relay RH and the other of which contains a switch SL and a relay RL. This is a schematic way of illustrating the interconnection with the weight information circuit shown in FIGURE 6b. Switches SH and SL which are closed when the weight indicated by the checkweigher is respectively high or low are the equivalent to making direct connections between points T5, T7 and T13 in FIGURES 6b and 11. The consequence is that while relay PER is energized an energizing current is applied to relay RH if the checkweigher indicates that the particular carton is too heavy and an energizing current is applied to RL if the checkweigher indicates that the carton is too light. Contacts of relays RH and RL are shown at RH1 and RL1 respectively as connecting the wiper arms of distributor banks 74 and 75 to the line 104. Thus, if the carton is heavy a potential is applied to the wiper arm of bank 74 and if the carton is light a potential is applied to the wiper arm of bank 75.

Each of the four memory stores is exactly the same and for the sake of convenience only 78, FIGURES 9 and 11, associated with the first weighing head (i.e. the head which fills the first carton of each group) will be described in detail. The memory store comprises a four-bank uniselector the wiper arms of which are capable of being driven clockwise or anticlockwise by solenoids RCW and RACW respectively. The lead 74-1 from the first group of contacts of bank 74 is connected to solenoid RCW and that 75-1 of the first group of contacts of bank 75 is connected to solenoid RACW. Therefore, if a carton of the first group is heavy a potential will be applied to the wiper of bank 74 and thence to solenoid RCW which will rotate the wipers of the memory store uniselector by one contact position in a clockwise direction. If the first carton of the next group is also heavy the wipers of the memory store uniselector will be rotated another contact position in a clockwise direction and so on. If, however, the first carton of a group is light then energizing potential will be applied via the wiper arm of bank 75 to solenoid RACW and the wiper arms of the memory store uniselector FIGURE 11 will be rotated in anticlockwise direction by one step.

Of the four banks of the memory store uniselector, one, 109, is a resetting bank, a second, 111, is an analyzing bank, and the remaining two, 112, and 113, are sense-determining banks. In the configuration shown in FIGURE 11, bank 111 is arranged to ensure that correction is made to the appropriate filling head of the filling machine if (a) an accumulated trend of six heavy cartons is detected or (b) an accumulated trend of two light cartons is detected. This is achieved by isolating, in bank 111, the first six contacts which are swept in the clockwise direction from the neutral position and the first two contacts which are swept in the anticlockwise direction from the neutral position. All the remaining contacts are connected together and the arrangement is such that if the wiper arm makes contact with any of these remaining contacts a signal is passed thereby to a timer FIGURE 11 (to be described more fully hereinafter) which initiates correction of the filling head adjustment by energizing the appropriate servo-motor 29, FIGURE 3, for a predeter-

mined time. It is to be noted that the detection of a trend of heavy or light cartons is accumulative, the registration of, for example, a heavy carton being counteracted if there is subsequently detected a light carton.

Once it has been determined by bank 111 that a correction is necessary the sense of the correction must be determined and this is the purpose of banks 112 and 113. The energizing circuit for the reversible servo-motor 29 of the appropriate filling held includes the two banks 112 and 113 and is arranged as shown in FIGURE 11. If the wipers of banks 112 and 113 are driven in a clockwise direction then a positive potential is applied to a line 114 and a negative potential to a line 115. If the wipers are driven in an anticlockwise direction the potentials on lines 114 and 115 are reversed. The sense of rotation of the wipers depends on the accumulated trend of the heavy or light cartons and the arrangement is such that the corresponding sense of polarity connections to lines 114 and 115 is appropriate to the correction of such a weight trend. Servo-motor 29 is not energized until switch contacts 116 are closed and these are closed for a predetermined time under the control of the timer.

When the operation of the timer is initiated contacts 117 thereof close to lock the timer on, contacts 118 thereof open and de-energize a relay RR which until then is held energized through contacts 118 and RR1, and a contact 119 of the timer opens. De-energization of relay RR closes contacts RR2 thereof and prepares the resetting bank 109 for operation. When the timer operation ceases its contacts 117 and 119 revert to their former conditions with the result that resetting potential is applied from line 104 through switches 119, RR2 and the wiper of bank 109 to solenoids RCW or RACW in accordance with the final position of the wiper. Interrupter switches for the anticlockwise and clockwise solenoids 121 and 122 are provided and the arrangement is such that the wipers are stepped back to their normal position in which on bank 109 they make contact with the isolated zero contact. At this time the wiper of bank 112 makes contact with the zero connector which is arranged to energize relay RR so that the system is prepared for registering the next trend.

FIGURE 12 is a circuit diagram of the timer which determines the length of time for which the servo-motors 29 are operated in response to direction from the appropriate memory store. One timer circuit is provided for each memory store. The timer has an input transformer 123 which has a primary winding 124 connected to receive the main supply and two secondary windings 125 giving 6 volts (for heater supplies) and 126 giving approximately 230 volts. Input leads 127 and 128 are connected to correspondingly marked leads in FIGURE 11 from bank 111 of the memory store. Connecting together leads 127 and 128 has the effect of connecting one terminal of a relay K/4 to the lower end (126a) of winding 126. Relay K/4 is connected in series with a triode 129 which has its cathode connected to the upper end (126b) of winding 126. Thus, the effect of connecting leads 127 and 128 together is to apply operating potential to the circuit of triode 129 and this valve conducts during the negative half-cycles of the supply voltage (when the potential at point 126b is negative with respect to that at 126a). Relay K/4 is thereby energized and is held energized during the positive half-cycles of the supply voltage by a condenser 131 connected thereacross. Relay K/4 is the relay having contacts 116 to 119 described with reference to FIGURE 11.

Connection together of leads 127 and 128 also has the effect of connecting the cathode of a further triode 132, FIGURE 12, to point 126a and, since the anode supply of this triode is connected through resistors R22, R23 to point 126b, conditions are set up in which conduction of triode 132 is possible. However, the grid circuit of triode 132 contains a resistor-capacitor combination of long time-constant, this being constituted by resistor R24

and condenser 133. This combination is provided with suitable biasing potential from a potential divider R25 and prevents triode 132 from passing an appreciable current in the anode circuit for a predetermined time. Once condenser 133 is charged sufficiently, the triode 132 is allowed to conduct and passes current through resistors R22 and R23 which is sufficient to bias the grid of triode 129, which is connected to the junction of resistors R22 and R23, so that triode 129 is cut off. The biasing potential is maintained during the negative half-cycles of the supply voltage by a condenser 134 connected across resistors R22 and R23. When the valve 129 is cut off, relay K/4 is de-energized and the contacts thereof revert to their former conditions. The effect is therefore, that on connection of leads 127 and 128 relay K/4 is immediately energized and is de-energized after a time determined by the time constant of resistor R24 and condenser 133. The delay is adjustable by varying the potential divider R25 and is arranged to be sufficient for energizing the servo-motor 29 for such a time as to allow adjustment of the filling head by a suitable increment which is determined empirically.

The invention is not to be restricted to the precise details of construction shown since various changes and modifications may be made therein without departing from the scope of the invention or sacrificing the advantages to be derived from its use. For example, the timing and delay circuits described with reference to FIGURES 10 and 12 may be of any suitable type provided they have the broad functions described. It may be preferred that these units be transistorized.

Furthermore, the correction action may be set to respond to any desired trend—six heavy weight, or 1 light instead of two light, for example. If desired, signals indicative of a correct weight may be derived from the discriminator and used in the control circuit by adding them to the heavy weight signals and treating them in all respects as if they indicated heavy weights. Under proper operating conditions this would establish artificially a correcting trend biased permanently towards lightening the weights dispensed, this trend being counteracted by reverse correction of the filling head when one or two light weight cartons are actually detected. Such a system would tend to maintain the dispensed weights only marginally above the lower limit. Such a principle could be applied to the system described in detail with reference to the drawings or to the system described in which only one memory store, switched in turn between filling heads, is used.

What is claimed is:

1. Apparatus for filling containers with a predetermined weight of material comprising:
 - (a) a plurality of filling heads for simultaneously filling respective members of a group of containers with a preset weight of the material, successive groups of containers being filled by the filling heads in turn;
 - (b) conveyor means for conveying the containers in succession, the spacing between successive containers of a group, hereinafter called the first spacing, being different from the spacing between the last container of one group and the first container of the next group, hereinafter called the second spacing;
 - (c) detector means responsive to the passage of each container;
 - (d) differentiator means sensitive to the response of the detector means to differentiate between said first and second spacings;
 - (e) a checkweigher for weighing the filled containers in succession providing an output at least when an under-weight container is weighed;
 - (f) distributor means driven in response to said detector means and synchronized by said differentiator means;
 - (g) a memory store associated with a particular filling head, said distributor being arranged to apply to said memory store outputs from the checkweigher respon-

sive to the weighing of the particular members of successive groups of containers filled by said particular filling head; and

- (h) corrector means responsive to information stored in said memory store to adjust the setting of said particular filling head and thereby correct for variation in the weight of containers filled by said particular filling head from the desired weight.

2. Apparatus for filling containers as set forth in claim 1, wherein:

- (a) said distributor comprises a uniselector rotary switch including a synchronizing bank of contacts and a distributing bank of contacts;
- (b) each of said two banks having wipers coupled to be rotatable together in steps continuously in the same sense in response to pulses applied to an operating solenoid thereof;
- (c) said solenoid being normally pulsed by the detector means, once in response to the passage along the conveyor of each container, every n th (where n is the number of filling heads) contact on said synchronizing bank being isolated and the remaining contacts thereof being connected together through a normally open synchronizing switch to a source of energizing potential for the solenoid;
- (d) said synchronizing switch being closed by said differentiator means once every time said second spacing is detected, said arrangement being such that if, when the synchronizing switch is closed, the wiper of the synchronizing bank makes contact with one of said remaining contacts, a circuit is completed through said solenoid to drive the wiper until it makes contact with an isolated contact; and
- (e) said wiper of the distributor bank being connected to receive outputs from said checkweigher and contacts thereof being connected to the memory store to ensure appropriate distribution of said outputs.

3. Apparatus for filling containers as set forth in claim 1, wherein:

- (a) a memory store and associated corrector means are provided for each filling head; and
- (b) said distributor being arranged to distribute to each memory store, in turn, in accordance with detection of the passage of successive containers output signals from said checkweigher responsive to the weighing of the appropriate containers.

4. Apparatus as claimed in claim 1, wherein:

- (a) said checkweigher gives a first output if the container being weighed is under weight and a second output if the container being weighed is over-weight;
- (b) said first and second outputs, appropriate to containers filled by said particular filling head, being applied to the memory store to be stored therein; and
- (c) said memory store being arranged to give a first correction output to the corrector means if the accumulated total of said first outputs exceeds a predetermined limit and a second correction output to said corrector means if the accumulated total of said second outputs exceeds a second predetermined limit.

5. Apparatus for filling containers with a predetermined weight of material comprising:

- (a) a plurality of filling heads for simultaneously filling respective members of a group of containers with a preset weight of the material, successive groups of containers being filled by the filling heads in turn;
- (b) conveyor means for conveying the containers in succession, the spacing between successive containers of a group, hereinafter called the first spacing, being different from the spacing between the last container of one group and the first container of the next group, hereinafter called the second spacing;
- (c) detector means responsive to the passage of each container;
- (d) differentiator means sensitive to the response of the

detector means to differentiate between said first and second spacings;

- (e) a checkweigher for weighing the filled containers in succession providing an output at least when an under-weight container is weighed;
- (f) distributor means driven in response to said detector means and synchronized by said differentiator means;
- (g) a memory store associated with a particular filling head, said distributor being arranged to apply to said memory store outputs from the checkweigher responsive to the weighing of the particular members of successive groups of containers filled by said particular filling head; and
- (h) corrector means responsive to information stored in said memory store to adjust the setting of said particular filling head and thereby correct for variation in the weight of containers filled by said particular filling head from the desired weight;
- (i) said checkweigher giving a first output if the container being weighed is under-weight and a second output if the container being weighed is over-weight, said first and second outputs appropriate to containers filled by said particular filling head being applied to the memory store and stored therein;
- (j) said memory store being arranged to give a first correction output to the corrector means if the accumulated total of said first outputs exceeds a predetermined limit and a second correction output to said corrector means if the accumulated total of said second outputs exceeds a second predetermined limit.

6. Apparatus as claimed in claim 5 wherein said first predetermined limit is two and said second predetermined limit is six.

7. Apparatus as claimed in claim 5 wherein:

- (a) the memory store comprises a uniselector rotary switch including an analyzing bank of contacts and a wiper rotatable in either direction from a zero position in response respectively to pulses applied to two uniselector solenoids, one solenoid being pulsed by said first outputs from the checkweigher and the other solenoid being pulsed by said second outputs from the checkweigher;
- (b) the first p contacts of the analyzing bank from the zero position in the direction taken in response to pulsing of said one solenoid being isolated;
- (c) and first q contacts of the analyzing banks from the zero position in the direction taken in response to pulsing of said other solenoid being isolated where p and q are respectively said first and second limits;
- (d) and said remaining contacts of the analyzing being connected together and arranged so that contact of the wiper with one of them completes a circuit to said correcting means, to initiate correction; and
- (e) the sense of the correction being determined by two sense-determining banks of contacts on said uniselector arranged to determine the polarity of an operating voltage applied to the correcting means in accordance with the sense of rotation from the zero position of the wipers.

8. Apparatus for filling containers with a predetermined weight of material comprising:

- (a) a plurality of filling heads for simultaneously filling respective members of a group of containers with a preset weight of the material, successive groups of containers being filled by the filling heads in turn;
- (b) conveyor means for conveying the containers in succession, the spacing between successive containers of a group, hereinafter called the first spacing, being different from the spacing between the last container of one group and the first container of the next group, hereinafter called the second spacing;
- (c) detector means responsive to the passage of each container;
- (d) differentiator means sensitive to the response of the

- detector means to differentiate between the first and second spacings;
- (e) a checkweigher for weighing the filled containers in succession and providing an output at least when an under-weight container is weighed;
- (f) distributor means driven in response to the detector means and synchronized by the differentiator means;
- (g) a memory store associated with a particular filling head, the distributor being arranged to apply to the memory store outputs from the checkweigher responsive to the weighing of the particular member of successive groups of containers filled by said particular filling head;
- (h) corrector means responsive to the information stored in the memory store to adjust the setting of said particular filling head and thereby correct for variation in the weight of containers filled by said particular filling head from the desired weight; and
- (i) said memory store comprising a uniselector rotary switch having an analyzing bank of contacts and a wiper rotatable in either direction from a zero position.
9. Apparatus as claimed in claim 8 wherein:
- (a) a resetting bank of contacts is provided on said uniselector to reset the wipers to zero position once the correction has been effected and said correcting means being connected to energize the resetting bank on completion of the correction.
10. Apparatus as claimed in claim 8 wherein:
- (a) said correcting means comprises a reversible servo-motor coupled to the resetting adjustment on the filling head; and
- (b) a timing circuit connected to respond to the completion of said circuit by the wiper of the analyzing bank and to energize the servo-motor for a predetermined time thereafter, the sense of energizing potential applied to the servo-motor being determined by the sense-determining banks.
11. Apparatus as claimed in claim 8, wherein:
- (a) a memory store and associated corrector means are provided for each filling head, the distributor being arranged to distribute to each memory store in turn, in accordance with detection of the passage of successive containers; and
- (b) said checkweigher providing output signals responsive to the weighing of the appropriate containers.
12. Apparatus as claimed in claim 1, wherein:
- (a) said second spacing is larger than said first spacing;
- (b) said detector means comprising a lamp and photocell circuit providing an output pulse while the light beam from the lamp to the photocell is broken by a container;
- (c) said differentiator means comprising a delay circuit providing an output impulse only if a predetermined delay elapses between the re-making of the light beam and the subsequent breaking of the light beam; and
- (d) said predetermined delay being arranged to be longer than said first spacing and shorter than said second spacing.
13. Apparatus as claimed in claim 1, wherein:
- (a) a memory store and associated corrector means are provided for each filling head;
- (b) said checkweigher being arranged to give a first output if the container being weighed is under-weight and a second output if the container being weighed is over-weight;
- (c) each memory store comprising a uniselector switch having an analyzing bank of contacts and a wiper rotatable in either direction from a zero position in response respectively to pulses applied to first and second uniselector solenoids, the first p contacts of the analyzing bank from the zero position in the

- direction taken in response to pulsing of said first solenoid being isolated;
- (d) the first contacts of the analyzing bank from the zero position in the direction taken in response to pulsing of said second solenoid being isolated, where p and q are predetermined limits;
- (e) the remaining contacts of the analyzing bank being connected together and arranged so that contact of the wiper with one of them completes a circuit to the correcting means to initiate correction;
- (f) two sense-determining banks of contacts on said uniselector arranged to determine the polarity of an operating voltage applied to the correcting means in accordance with the sense of rotation from the zero position of the wipers to determine the sense of the correction;
- (g) said distributor comprising a further uniselector rotary switch having a synchronizing bank of contacts and first and second distributing banks of contacts, the wipers of the three banks being coupled to be rotatable together in steps continuously in the same sense in response to pulses applied to an operating solenoid thereof;
- (h) the solenoid being normally pulsed by the detector means once in response to the passage along the conveyor every n th (where n is the number of filling heads) contact on the synchronizing bank being isolated and the remaining contacts thereof being connected together through a normally open synchronizing to a source of energizing potential for the solenoid;
- (i) the synchronizing switch being closed by the differentiator means once every time said second spacing is detected and the arrangement being such that, if, when the synchronizing switch is closed, the wiper of the synchronizing bank makes contact with one of said remaining contacts a circuit is completed through the solenoid which thereby drives the wiper until it makes contact with an isolated contact;
- (j) the wiper of the first distributing bank being connected to receive said first outputs from the checkweigher and appropriate contacts thereof being connected to respective first uniselector solenoids of the memory stores; and
- (k) the wiper of the second distributing bank being connected to receive said second outputs from the checkweigher, appropriate contacts thereof being connected to respective second uniselector solenoids of the memory stores.
14. Apparatus as claimed in claim 13, wherein:
- (a) a resetting bank of contacts is provided on said uniselector to reset the wipers to the zero position once the correction has been effected, said correcting means being connected to energize the resetting bank on completion of the correction.
15. Apparatus as claimed in claim 13, wherein:
- (a) the correcting means comprises a reversible servo-motor coupled to the resetting adjustment on the filling head; and
- (b) a timing circuit connected to respond to the completion of said circuit by the wiper of the analyzing bank and to energize the servo-motor for a predetermined time thereafter, the sense of energizing potential applied to the servo-motor being determined by the sense-determining banks.
16. Apparatus for filling containers as set forth in claim 1, wherein:
- (a) said second spacing is larger than said first spacing;
- (b) said detector means comprising a lamp and photocell circuit providing an output pulse while the light beam from the lamp to the photocell is broken by a container;
- (c) said differentiator means comprising a delay circuit providing an output pulse only if a predetermined delay elapses between the re-making of said light

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beam and the subsequent breaking of said beam, said predetermined delay being arranged to be longer than said first spacing and shorter than said second spacing.

References Cited

UNITED STATES PATENTS

2,628,055 2/1953 Knobel et al. ----- 177—50 XR
 2,688,458 9/1954 Schieser et al. ----- 177—50
 2,688,459 9/1954 Merrill et al. ----- 177—50
 2,697,580 12/1954 Howard ----- 177—50 XR

5

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2,818,888 1/1958 Atwood et al. ----- 177—52 XR
 2,851,063 9/1958 Leinhart ----- 177—52
 2,914,310 11/1959 Bahrs.
 3,073,400 1/1963 Bauder et al. ----- 177—56
 3,094,182 6/1963 Garnett et al. ----- 177—119 XR
 3,119,457 1/1964 Thompson et al. --- 198—39 XR

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U.S. Cl. X.R.

177—52, 120, 164; 198—39

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