

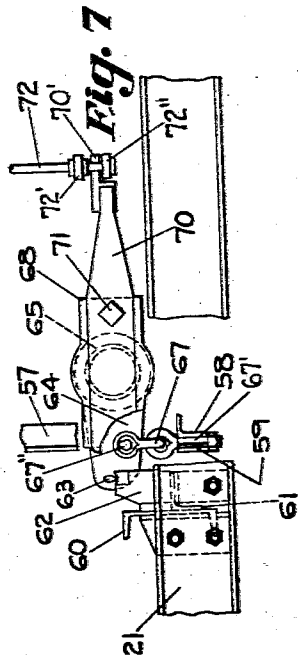
March 17, 1942.

E. V. FRANCIS

2,276,383

CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938 8 Sheets-Sheet 1



March 17, 1942.

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2,276,383

CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

8 Sheets-Sheet 2

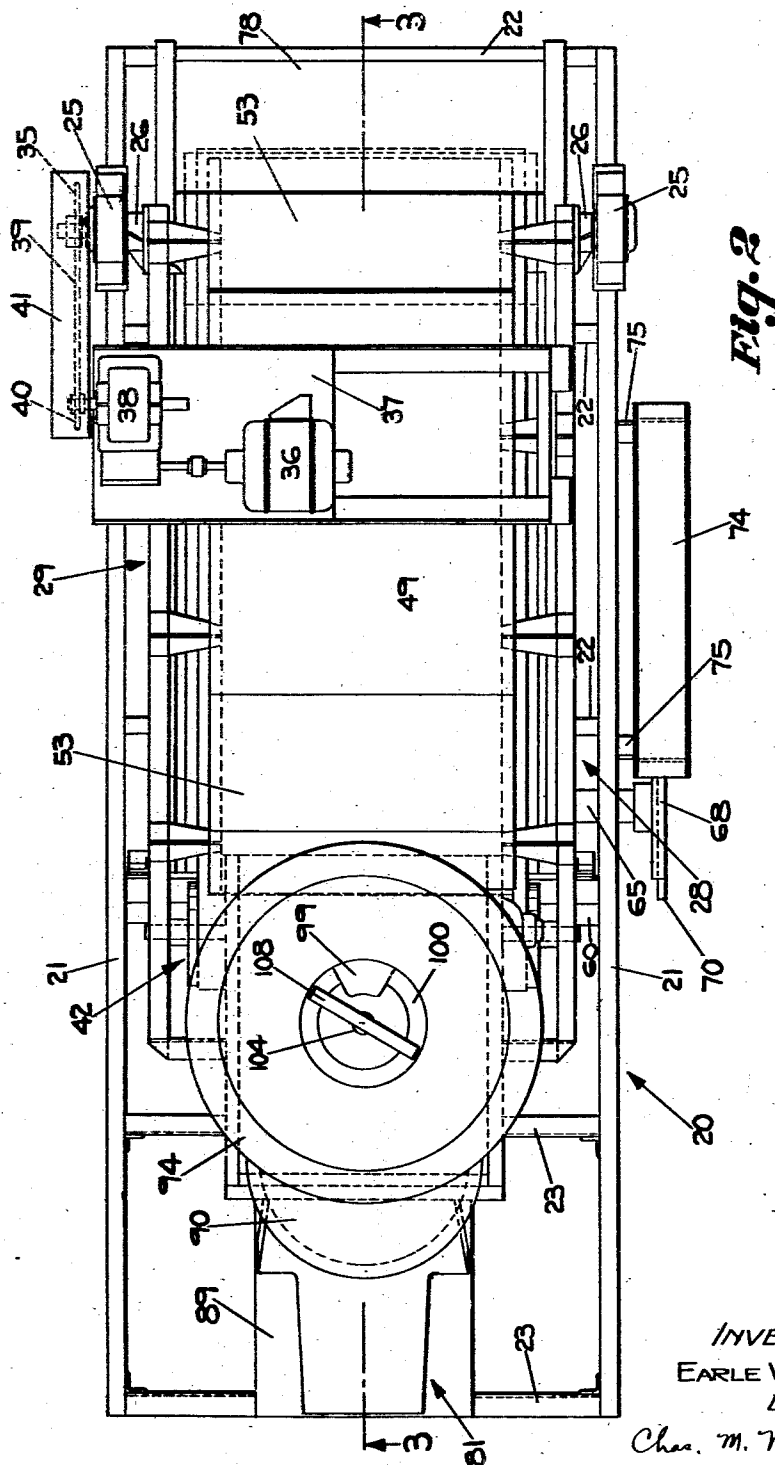


Fig. 2

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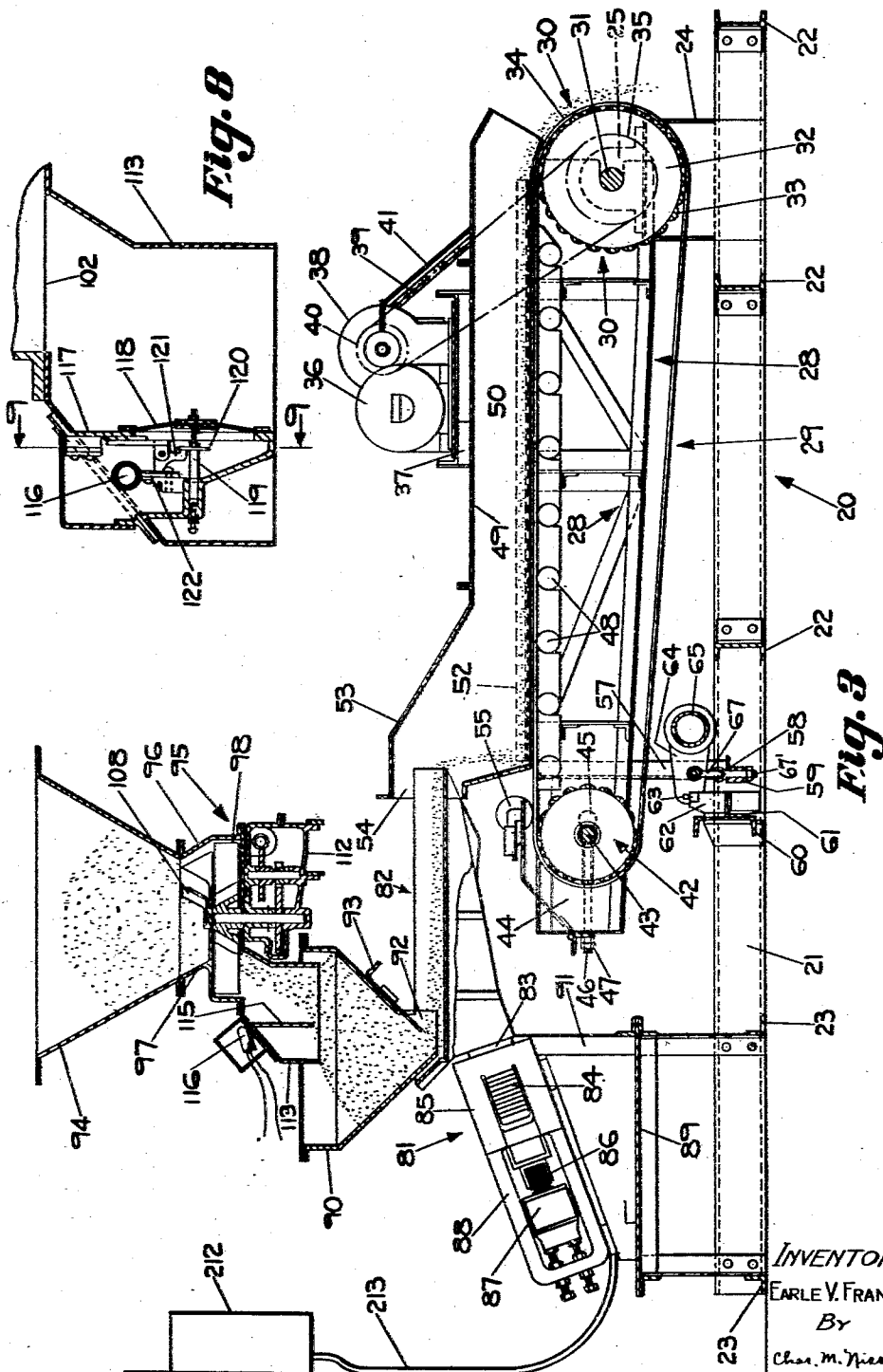
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CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

8 Sheets-Sheet 3



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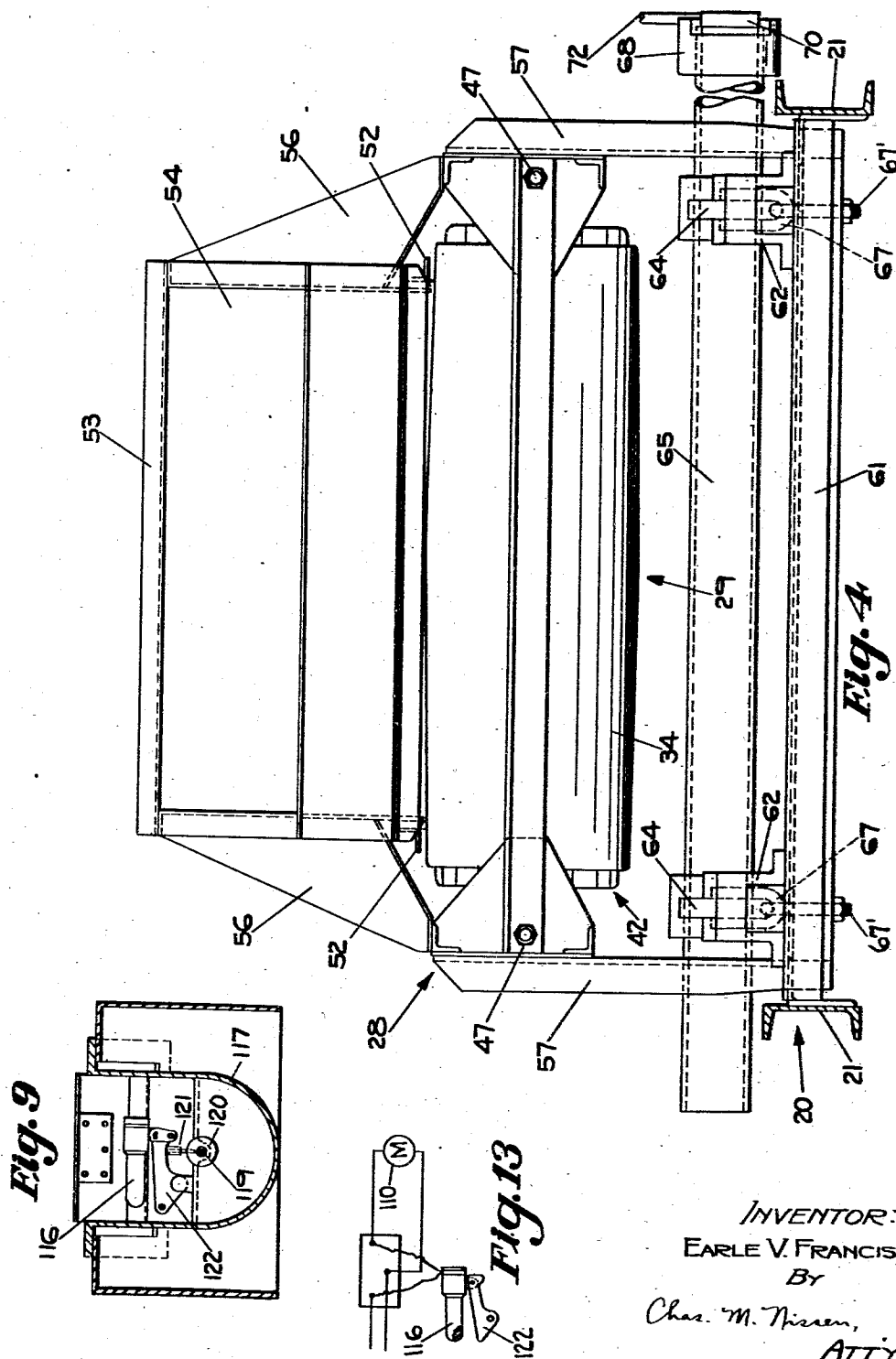
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CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

8 Sheets-Sheet 4



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CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

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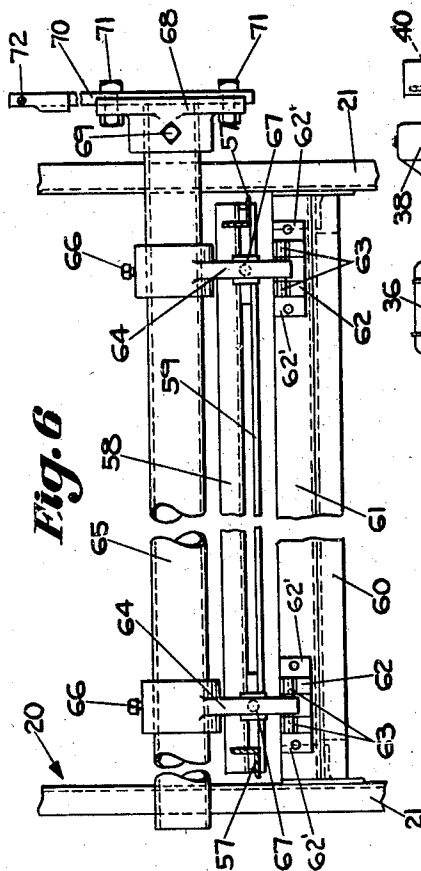


Fig. 6

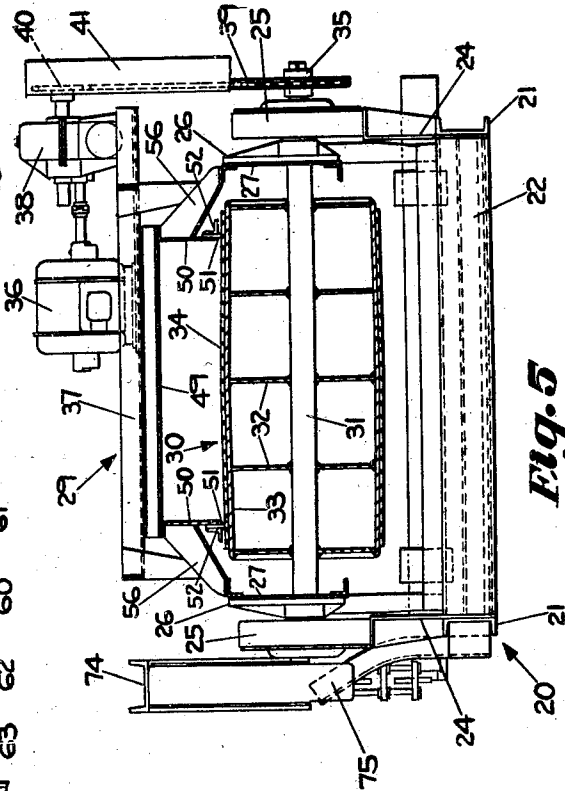


Fig. 5

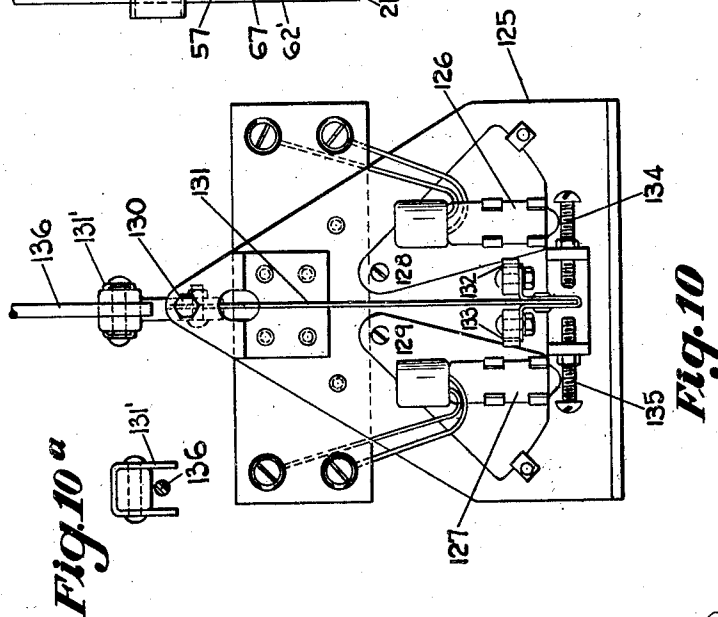


Fig. 10^a

Fig. 10

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CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

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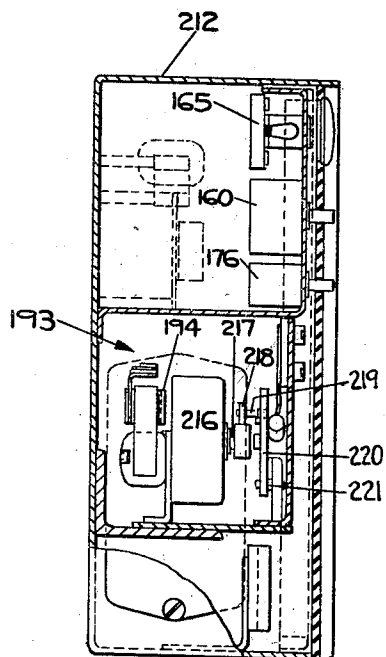
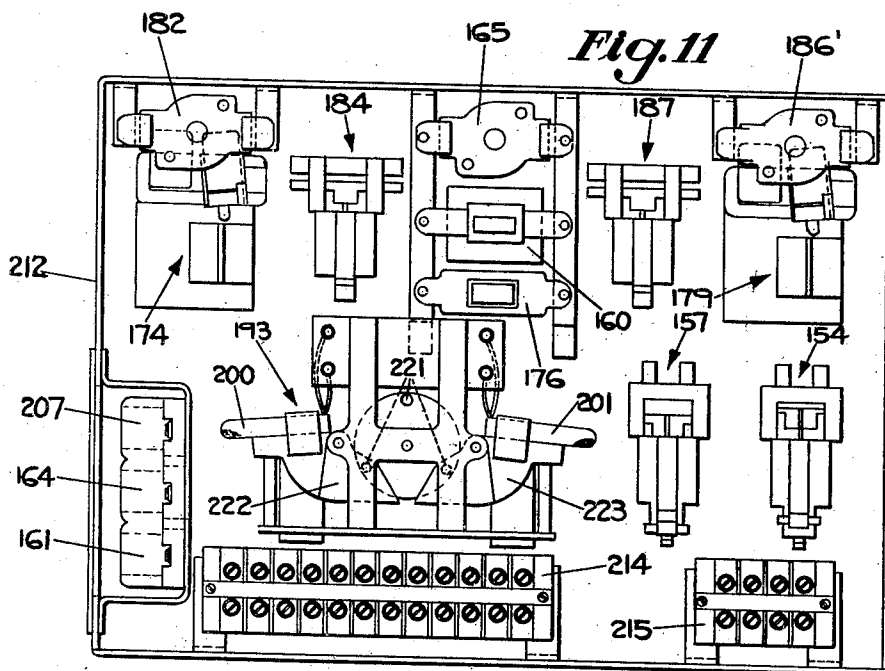


Fig. 12

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CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

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Fig. 14

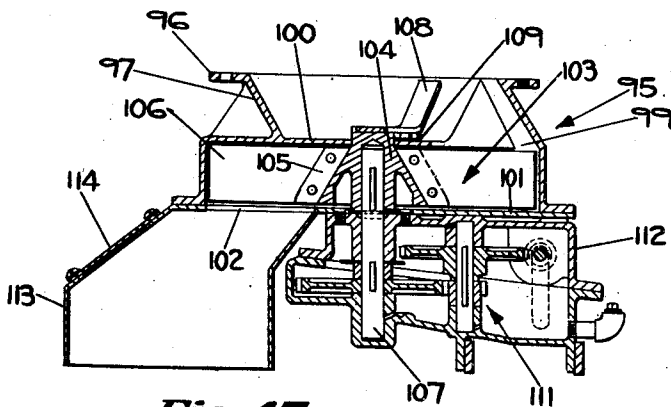
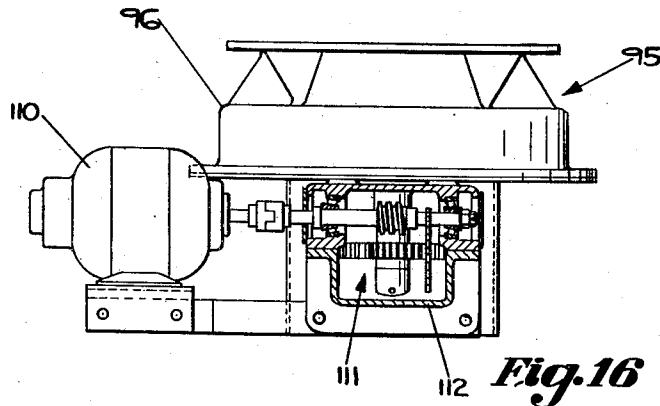
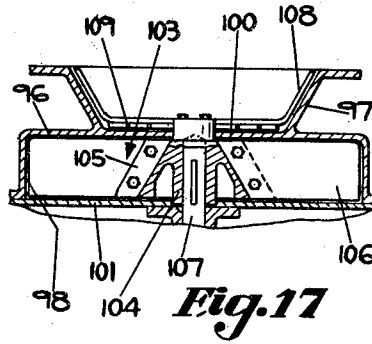
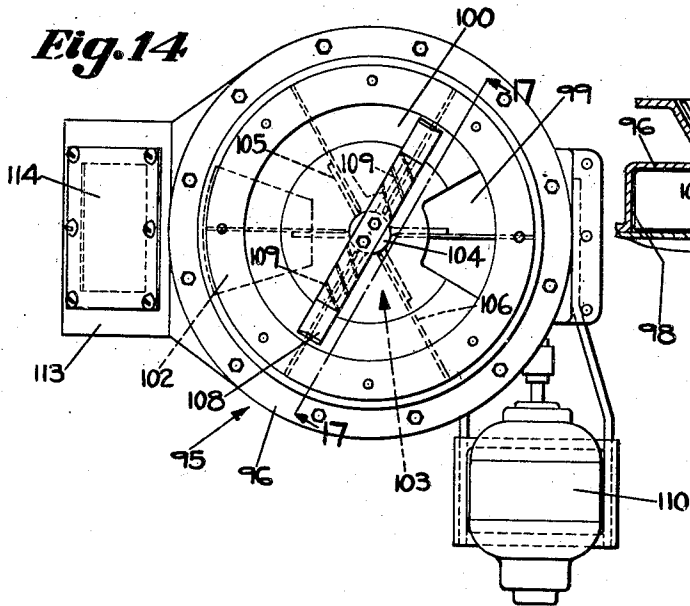


Fig. 15

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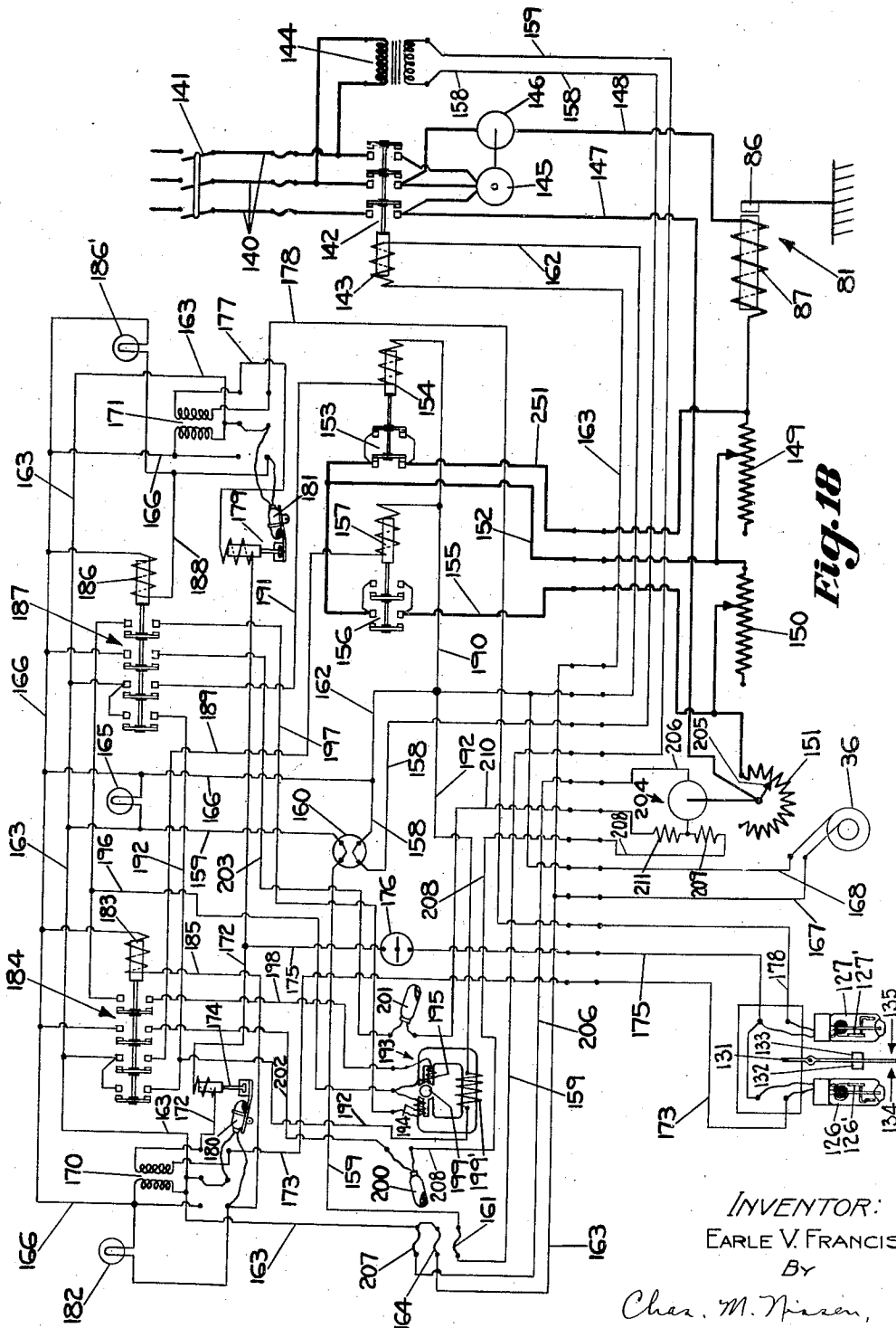
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2,276,383

CONSTANT CAPACITY FEEDER

Original Filed March 10, 1938

8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

2,276,383

CONSTANT CAPACITY FEEDER

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Original application March 10, 1938, Serial No. 195,092. Divided and this application May 26, 1939, Serial No. 275,947

11 Claims. (Cl. 221-118)

This invention relates to apparatus for feeding granular material at a regulated rate, and one of the objects of the invention is the provision of improved and efficient apparatus and controlling means therefor, to effect the feeding of various kinds of granular material continuously at such weight rate as may be predetermined.

Another object of the invention is to provide improved controlling means operated by a belt conveyor pivotally mounted at its discharge end, and operative to regulate a feeder of granular material to such conveyor that disturbances caused by "landslides" from the discharge end of the conveyor shall be reduced to a minimum or eliminated and thereby secure uniformity of delivery of such material from the conveyor by weight per unit of time.

A further object of the invention is the provision of automatic controlling means operated by variations of weight of material being transferred by a continuously operated traveling conveyor to regulate an electric vibratory feeder associated with such conveyor to secure discharge of material from the latter at a regulated rate.

Another object of the invention is to provide automatic control means for a vibratory feeder associated with a belt conveyor, to effect such regulation of the feeder as to secure discharge from the conveyor at a regulated weight rate.

Another object of the invention is the provision of improved means operated by variations of weight of granular material on a traveling belt conveyor to regulate the feeding of the material to the latter to compensate quickly for small amounts of such variations but to retard such compensation when such variations are relatively large and thereby rendering gradual an adjustment of the weight rate discharge from the traveling conveyor.

Still another object of the invention is to provide a constant weight or constant capacity feeder which may be employed with a great many different granular materials and which will insure a substantially constant delivery of materials at any selected rate of delivery regardless of the type of granular material being delivered thereby.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings—

Fig. 1 is a side elevational view of the apparatus comprising my invention;

Fig. 2 is a plan view of the apparatus of Fig. 1;

Fig. 3 is a sectional elevational view of the apparatus of Figs. 1 and 2 taken on the line 3-3 of Fig. 2 of the drawings, except that the vibra-

tory motor structure of the feeder is not shown in section;

Fig. 4 is a transverse sectional and elevational view taken on the line 4-4 of Fig. 1 looking in the direction of the arrows;

Fig. 5 is a transverse sectional and elevational view taken on the line 5-5 of Fig. 1 looking in the direction of the arrows;

Fig. 6 is a plan view of a portion of the apparatus taken on the line 6-6 of Fig. 1 looking in the direction of the arrows;

Fig. 7 is a side elevational view of a detail, parts being broken away in the interest of clearness;

Fig. 8 is a sectional elevational view of a modified form of control switch for the delivery mechanism;

Fig. 9 is a sectional view taken on the line 9-9 of Fig. 8 looking in the direction of the arrows;

Fig. 10 is an enlarged view of the control switch for the vibratory feeder;

Fig. 10^a illustrates a detail;

Fig. 11 shows the interior of the control box for the system with the electrical connections omitted in the interest of clearness;

Fig. 12 is a transverse sectional view through the control box of Fig. 11;

Fig. 13 is a wiring diagram for the motor of the delivery mechanism;

Fig. 14 is a plan view of the delivery mechanism with the storage hopper removed;

Fig. 15 is a sectional elevational view of the delivery mechanism;

Fig. 16 is a side elevational view of the delivery mechanism the reduction gearing thereof shown in section;

Fig. 17 is a sectional elevational view through the upper portion of the delivery mechanism taken on the line 17-17 of Fig. 14; and

Fig. 18 is a wiring diagram for the apparatus.

This application is a division of my application Serial No. 195,092, filed March 10, 1938, entitled Constant capacity feeder.

It has been found in practice that there is a tendency for certain material to "landslide" when discharged from a belt conveyor and therefore in constant capacity or constant weight feeding apparatus if the material is discharged from a constant speed belt conveyor at a point remote from the pivotal axis of said conveyor, the normal equilibrium of the balanced conveyor is disturbed by these landslides which prevents extreme accuracy. In the apparatus comprising my invention the material is fed toward the pivotal axis of the constant speed conveyor and is discharged substantially at this pivotal axis at which position its influence upon the balance of the balanced constant speed conveyor is substan-

tially negligible, on account of the relatively small lever arm.

It has furthermore been found that when certain granular materials were attempted to be fed, such as pulverized limestone and lime, Carlton's earth and activated carbon, or any similar pulverulent material under 200 mesh, said material would tend to flow much after the fashion of a liquid, as a consequence of which even an electro-magnetic vibratory feeder, which is generally susceptible to very accurate control, cannot maintain the material under the desired control at all times.

The apparatus comprising my invention provides for a substantially constant head of material on the vibratory feeder or, in other words, provides for a substantially constant amount of material in the hopper of the vibratory feeder which insures a uniform pressure or head upon the material in the bottom of the feeder hopper regardless of the amount of material in the primary or storage hopper, thus insuring accurate control of the material by the feeder under the influence of the balanced constant speed conveyor. As a consequence, the apparatus comprising my invention can treat a wide range of materials and deliver said materials in a constant amount with extreme accuracy, which amount may be variably adjusted, as hereinafter described in full detail.

Referring particularly to Figs. 1, 2, 3 and 4 of the drawings, the apparatus comprises a main frame 20 formed by a pair of longitudinally extending channel members 21, 21 to which are rigidly attached a plurality of transversely extending channel members 22 and transversely extending angle members 23.

Adjacent the rear end of the main frame 20 and extending upwardly from the channel members 21, 21 is a pair of spaced apart brackets 24, 24 upon which are mounted housings 25, 25 for anti-friction ball bearings which bearings are adapted to support pivotally a pair of spaced castings or brackets 26, 26 (see Fig. 5) which are rigidly attached to plates 27, 27 rigidly attached to and forming a part of the rear end of a frame 28 of a constant speed belt conveyor 29. The constant speed belt conveyor 29 comprises a rear or drive drum or pulley 30 formed by a shaft 31 and a plurality of spaced apart vertical discs 32 which are welded to said shaft 31 and which carry on their peripheries a plurality of transversely extending slats 33 thereby making a corrugated surface for said drum 30 to insure uniform driving of a continuous fabricated rubber belt 34 of said belt conveyor 29. The shaft 31 extends freely through apertures in the above mentioned castings or brackets 26 and is journaled therein.

At one end the shaft 31 extends beyond a housing 25 and receives a drive sprocket 35 which is keyed thereto, which drive sprocket 35 is driven from a constant speed electric motor 36 carried by a stand 37 rigidly attached to the conveyor frame 28, through speed reducing mechanism 38, also carried by said stand 37 which drives a chain 39 through a sprocket 40. It is thus seen that the drum or pulley 30 is driven from the constant speed motor 36 through appropriate speed reduction mechanism and that said motor 36 is supported from the frame 28 of the belt conveyor 29. I also preferably provide a guard 41 for the sprockets 35 and 40 and the chain 39.

Adjacent the opposite or material receiving end the belt conveyor 29 is provided with an adjustable pulley or drum 42 which is generally simi-

lar in construction to the drum 30, but is preferably of smaller diameter. The drum 42 is provided with a supporting shaft bearing 43 the ends of which are slidably supported in end plates 44 rigidly attached to and forming a part of the frame 28, which plates are provided with elongated notches 45 adapted to receive milled ends of the bearing shaft 43 and to hold said shaft against rotation while permitting sliding movement thereof. Belt tensioning rods 46 provided with adjusting nuts 47 cooperate with the shaft 43 to adjust the position thereof in the elongated notches or slots 45 to maintain the belt 34 under proper tension at all times.

In order to support the belt between the drums 30 and 42, I provide a plurality of closely spaced anti-friction mounted idler rollers 48 which are carried by the conveyor frame 28.

Positioned above the belt 34 and carried by the frame 28 by brackets 56 and forming a housing for material carried thereby, is a hood formed by top plate 49 and spaced upright side plates 50, 50 (see Fig. 5), which carry at their bottoms flexible wiping strips 51, 51 preferably made of strips of rubber which are rigidly attached to the plates 50, 50 by riveted angle members 52, 52, the bottoms of the wiping strips 51, 51 having wiping sliding contact with the upper run of the belt 34 and prevent any material being discharged laterally of said belt in its course of travel. At its rear end the above mentioned hood is extended upwardly and rearwardly, as seen at 53, and is provided with an opening 54 for a purpose hereinafter described in complete detail.

Also mounted upon the frame 28 of the conveyor 29 is a counting mechanism 55 adapted to count the units of belt length the belt 34 has moved in any desired time. For example, the counting mechanism 55 will give a direct indication of the number of feet of effective belt travel for any given period of time, which is useful in determining the total weight or amount of material fed over any given length of time, as hereinafter set forth in complete detail.

From the above description it is evident that the entire belt conveyor 29 is pivoted at its rear or discharge end for free pivotal movement about the axis of the shaft 31. It is, of course, evident that the material received by the conveyor 29 will be received adjacent the left-hand end, as viewed in Figs. 1 and 2, and travel toward this pivotal axis, as a consequence of which the effectiveness of any particle of material received by said conveyor 29 is progressively reduced, and that the material on the conveyor 29 directly above the shaft 31 will have substantially no influence whatever in determining the effective weight of said conveyor 29 and the material thereon. It may furthermore be mentioned that the electric motor 36 is a constant speed type of electric motor, preferably a synchronous alternating current motor, and thus it is evident that the conveyor 29 will travel at a constant speed.

To provide for the counterbalancing of the belt conveyor 29 about the pivotal point along the axis of the shaft 31, together with any material carried by said conveyor, and to provide for an adjustment of the amount of material carried by the conveyor necessary to establish a condition of balance, the forward or material receiving end of the conveyor 29 is mounted upon adjustable scale or weighing mechanism now to be described. As best seen by reference to Figs. 3, 4, 6 and 7 of the drawings, the conveyor frame 28 is provided at its front or material receiving

end with a pair of spaced apart downwardly extending angle members 57, 57 formed rigidly therewith.

Adjacent their bottoms the angle members 57 are rigidly attached to a transversely extending angle member 58 and a spaced upstanding bar 59. The angle member 58 and bar 59 form a cross beam which is a rigid unitary part of the frame 28 of the belt conveyor 29. Near to but spaced from said cross beam is a channel member 60 (see Fig. 3) the ends of which are rigidly attached to the channels 21, 21 of the main frame 20, which channel member 60 has rigidly attached thereto an angle member 61. Upon the horizontal flange of the angle member 61 is a pair of spaced apart knife edge bearing blocks 62, 62 each of which is adapted to receive a double knife edge 63, carried by crank arms 64, 64 which are rigidly attached together by a transversely extending pipe 65 to which each of said crank arms 64 is rigidly connected, as by a set screw 66 (Fig. 6).

Intermediate the knife edge bearing 63 and the pipe 65 each of the arms 64 is provided with a flexible connection to the cross beam formed by angle member 58 and bar 59 in the form of a clevis 67, connected to an eye-bolt 67'.

Adjacent one end, the pipe 65 has rigidly attached thereto a casting 68 (see Fig. 6) rigidly attached to the pipe 65 by set screw 69. As best seen by reference to Fig. 6 of the drawings, the casting 68 has a diametrical groove adapted to receive a lever arm 70 which is rigidly and removably attached thereto by a pair of spaced bolts 71, 71. As best seen in Figs. 1 and 7 of the drawings, the lever arm 70 has its rear end supported by a hang rod 72 of a beam scale mechanism 73 which is mounted in a housing 74 supported upon a pair of brackets 75, 75 rigidly attached at their bottoms to the main frame 20. The housing 74 preferably has a front door which is readily opened to afford access to the adjustable weight 76 of the beam scale mechanism 73, to adjust the amount of material necessary to balance the belt conveyor 29.

It should be particularly understood that the tube 65 is free to move up and down bodily to a limited extent. The assembly comprising the tube 65, arms 64 and lever arm 70, is supported solely by the knife edge bearings 63 on the bearing blocks 62, 62 and by the abutment 72' at the lowermost end of the hang rod 72. Movement of the tube 65 longitudinally of itself or transversely of the machine is prevented by the knife edges 63, 63 being confined between the spaced abutments 62', 62', shown in Fig. 6.

As shown in Fig. 7, the clevis 67 is provided with rings at its upper ends on opposite sides of the arm 64, to fit over the knife edges 67'' which project laterally from opposite sides of the arm 64. Extending from the right-hand end of the arm 70, as shown in Fig. 7, is a finger 70' located between the upper and lower abutments 72' and 72'' at the lower end of the hang rod 72.

It will be evident from a consideration of the above described mechanism that the adjustment of the weight 76 along the scale beam will enable regulation to be made of the weight of material delivered from the discharge end of the conveyor 29 in any given time. That is, the setting of the weight 76 on the scale beam predetermines the weight rate discharge per unit of time.

While the conveyor is being driven at a constant predetermined speed, the feed of the material to the receiving end of the conveyor may

be regulated to maintain uniform the weight of material on the conveyor as predetermined by the setting of the weight 76 in the scale beam mechanism 73. The receiving end of the conveyor and the material on the conveyor continue to be balanced by the scale beam mechanism during uniform discharge of material.

When the angle members 57 are depressed the cross-bar 58, 59 acts through the clevis connections to move the tube 65 down on the knife-edge bearings 62 as a fulcrum, and consequently the finger 70' acts on the lowermost abutment 72'' to depress the hang-rod 72. When the angle members 57 rise, the cross-bar 58, 59 frees the clevis connections and permits the scale beam mechanism to act to lift the tube 65 on the knife-edge bearings 62 as a fulcrum.

It may be stated that the beam of the beam scale mechanism 73 is preferably calibrated for various materials in connection with a separate chart showing what amount of any particular material will be discharged per unit of time when the weight is on any particular point on the scale beam. It is also evident that balancing means 77 is provided for said mechanism 73 and that in addition to the weight 76, removable weights may be attached to or removed from the beam thereof in a well-known manner.

The parts of the conveyor 29 and those parts by which it is connected to the beam scale mechanism 73, are preferably so designed that the weight 76 may be placed on the zero position of the beam and said beam scale mechanism 73 adjusted to bring the conveyor 29 into a condition of equilibrium with no material whatever thereon. As a consequence, the weight 76 may be adjusted to determine the amount of material which must be on the pivoted conveyor 29 to establish again this condition of equilibrium.

Adjacent the discharge end of the conveyor 29 I provide a discharge hopper or housing 78 (see Fig. 1) which is rigidly attached to the main frame 20 and this is independent of the conveyor 29 and acts to receive material discharged by the conveyor 29 and direct it into any desired receptacle.

To prevent any clinging of material to the belt 34 I provide a wiper mechanism 79 in the housing 78 which wipes it free of any adhering material, said wiper mechanism 79 comprising a transverse member contacting the entire width of the belt and a pair of pivoted arms at each end thereof, the mechanism being held in wiping position by a spring tension hang rod 80.

In order to provide for the feeding of material, such as granular material, to the balanced constant speed conveyor 29 at a rate which may be controlled in small increments or in a continuously progressive manner, while providing for the feeding of said material in a relatively uniform manner, and over substantially the entire width of the belt 34, I provide an electro-magnetic vibratory feeder or conveyor 81 which may follow substantially the structure of the vibratory feeder disclosed in the application of James A. Flint, Serial No. 73,318 filed April 8, 1936, now Patent No. 2,251,586, dated August 5, 1941, except for the fact that said feeder will not have any grizzly or grid as disclosed in said application, or it may follow the structure disclosed in the patent to James A. Flint, No. 2,094,787 dated October 5, 1937.

Briefly described, said electro-magnetic feeder or conveyor 81 comprises a trough shaped deck 82 which has a width substantially equal to the

distance between the side plates 50, 50 of the conveyor hood but which is slightly less than this distance to provide for its free entry into the opening 54 (Fig. 3) whereby it may vibrate freely without contacting any of the surrounding walls of said opening 54. The deck 82 is rigidly attached to and supported by an armature shaft 83 which is rigidly attached to the centers of a plurality of transversely extending spring bars 84, the ends of which are rigidly clamped in a casting 85 forming the main frame of the feeder 81. The spring bars 84 lie in a plane which forms an acute angle with the plane of the deck 82 so that when the armature shaft 83 and the deck 82 are vibrated a conveying action toward the right as viewed in Fig. 3, will be imparted to any material carried by said deck 82 due to the composite action of the vertical and horizontal components of movement thereof.

Adjacent its rear end the armature shaft 83 carries an armature 86 preferably built up of laminated steel which is acted upon by a field structure 87 including a laminated iron core, which field structure is excited from alternating or "mixed" current to cause vibration of the armature 86. It may be further stated that the field structure 87 is adjustably mounted in a pair of yokes 88 which are rigidly attached to the main frame casting 85. The entire feeder 81 is supported upon a stand 89 attached to the front end of the main frame 20.

The electro-magnetic feeder 81 has the very important characteristics of uniformly distributing over substantially the entire bottom of the deck 82 any granular material received by said deck 82 and discharging it in a relatively uniform stream onto the belt 34 of the constant speed conveyor 29. Furthermore, the rate of feed of this type of feeder may be adjusted between extreme wide limits in relatively small increments so that the material is fed to the balanced constant speed conveyor 29 in a very uniform manner so as not to cause sudden variations in the load on said balanced constant speed conveyor. This is particularly important since it is desirable to feed the material to the constant speed conveyor at its farthest position from the pivotal axis thereof where its effectiveness is a maximum due to the length of the lever arm thereof, which structure is extremely desirable to the end that the material may be fed by the constant speed conveyor toward the pivotal axis thereof to reduce to a minimum the "hunting" time or the time that the mechanism reaches a condition of equilibrium, once it is out of equilibrium which, as hereinafter described, is employed to adjust the rate of feed of the feeder 81.

As was above set forth, there are a number of granular materials, particularly powdered or fine mesh or pulverulent granular materials, which tend to flow like liquid, and it has been found that if a large storage hopper is provided which feeds directly into the deck or pan 82 of the vibratory feeder 81, it is impossible to control satisfactorily the rate of flow of these materials because when the storage hopper or bin is full of material there is a very large head, or high pressure per square inch, on the material which causes it to flow like a liquid even though the feeder 81 is completely shut off. I therefore provide means which is particularly useful with material of this type but which may be omitted where large grained material or material which does not tend to flow, is employed.

To provide a substantially constant head of

material on the deck 82 or, in other words, to segregate the material in the storage hopper from the material which is in direct communication with the deck 82 and to feed from the former to the latter in batches to maintain substantially constant the head or amount of material supported directly from the deck 82, I provide a feeder accumulator in the form of a hopper 90 of relatively low capacity and relatively low height which is supported from the main frame 20 by upstanding angle members 91. The hopper 90 has a bottom opening 92 which opens directly into the trough of the deck 82 and which opening 92 is controlled by an adjustable gate 93. The sidewalls adjacent the bottom of the hopper 90 project into the trough-like deck 82 so that the material in the hopper 90, in effect, rests directly upon the bottom of the deck 82 and due to this overlapping relation there is no spillage of material from the hopper 90 or deck 82.

Positioned above the feeder hopper 90 is a storage hopper 94 which is preferably rigidly bolted or otherwise attached to the bottom of a large storage bin or compartment in which the material to be fed by the constant capacity feeder of my invention is stored.

Interposed between the storage hopper 94 and the feeder hopper 90 is a delivery mechanism 95 which is so constructed as to maintain the segregation of material within the storage hopper 94 and the material within the feeder hopper 90 so that regardless of the amount of material in the feeder hopper 90 or the bin to which it is connected, the pressure exerted by the material in the feeder hopper 90 and any material in direct contact therewith will be definitely limited and will be maintained substantially constant to the end that the feed rate of the feeder 81 will be substantially the same whenever the amplitude of vibration thereof is constant.

The structure of the delivery mechanism 95 is best seen by reference to Figs. 3 and 14 to 17, inclusive, of the drawings, to which attention is now directed. Said delivery mechanism 95 is formed by a casting 96, the top portion of which forms a hopper-like continuation 97 of the storage hopper 94 to which the casting 96 is bolted and by which the delivery mechanism 95 is supported. The bottom portion of the casting 96 forms a material transfer chamber 98, communication to which is provided from the hopper-like continuation 97 by way of a restricted opening 99 (Fig. 14) in the integral web 100 of said casting 96 which forms the bottom of the hopper-like continuation 97 and the top of the material transfer chamber 98. The bottom of the material transfer chamber 98 is formed by a removable disc 101 provided with a restricted opening 102 which is diametrically opposed to the opening 99, as shown in Figs. 14 and 15.

Within the material transfer chamber 98 is a segregator or combined separator and feeder 103 which is adapted to transfer material from the hopper 94 to the hopper 90 when rotated, but to prevent a direct flow of material from said hopper 94. Said segregator 103 is formed by a hub 104 having integral radial wings 105 (there being six in the segregator illustrated) to which are removably attached a plurality of radial blades 106. It will be noted by reference to Fig. 14 of the drawings that the openings 99 and 102 are of such angular relation and radial extension that it is impossible for material to flow from one to the other without being intercepted by one of the blades 106. As a consequence, it is impossible

for material to flow directly from the hopper 94 and out through the opening 102 unless the segregator 103 is caused to rotate.

The segregator 103 is mounted upon an up-standing drive shaft 107 which carries at its top, scraper means 108 adapted to cut or scrape material from the interior walls of the member 97 which carries on its bottom a plurality of angularly disposed blades 109 adapted to force material which may accumulate on the web 100, axially outwardly until it falls through the opening 99.

The drive shaft 107 is driven from an electric motor 110 through reduction gearing mechanism 111 (Figs. 15, 16) contained within a housing 112 all of which is supported by the casting 96. It will thus be evident that whenever the motor 110 is operated the material will be positively transferred from the opening 99 to the opening 102, and unless the segregator 103 is thus rotated material cannot flow from said opening 99 to said opening 102. It will thus be seen that the segregator 103 acts not only as a feeder but also as a multiple radial gate valve between the hopper 94 and the discharge opening 102.

Positioned directly below the opening 102 and forming a tight connection with the disc 101 is a chute 113 the bottom of which extends below the top of the hopper 90, as clearly illustrated in Fig. 3 of the drawings.

Associated with the chute 113 is a removable plate 114 which, in the preferred form of my invention, is removed so that there may be inserted into the chute 113 an electric switch operating mechanism comprising a pivoted plate 115 (see Fig. 3) which carries a tube type mercury switch 116 for opening and closing the circuit of the motor 110, as diametrically illustrated in Fig. 13 of the drawings.

The operation of the delivery mechanism may be briefly described as follows. Since the chute 113 extends into the hopper 90, both said hopper 90 and said chute 113 may be substantially completely filled with material without said material running over from said hopper 90. Whenever the chute 113 is not filled with material the pivoted plate 115 will be in its upright position, as illustrated in Fig. 3, and the switch 116 will be closed to cause operation of the delivery mechanism 95 to deliver material from the hopper 94 to the hopper 90. As material tends to build up in the chute 113 the pivoted plate 115 is swung about its pivot to open the contacts of switch 116 to shut off the motor 110. As a consequence, the hopper 90 will be maintained substantially full of material at all times and when it is full the delivery mechanism 95 will be shut down.

The control mechanism for the motor 110 may be omitted if desired and the motor 110 run continuously, but the inclusion of such control mechanism is preferred for the sake of economy in the consumption of electric current. For example, if the motor 110 runs continuously whenever the constant weight feeder is to be employed, it will deliver material from the hopper 94 to the hopper 90 until said hopper 90 and the chute 113 are completely filled with material. When this condition is realized, the material received between the blades 106 of the segregator 103 will not fall through the opening 102 but will continue to rotate with said blades 106. As a consequence, the segregator 103 will simply be full of material which will continue to rotate with said blades 106. However, since this rotation does no useful work I prefer to control the motor 110

in response to the condition of the material in the hopper 90, as above described. It is to be noted, however, that under either condition of operation the material in the hopper 94 is segregated from the material in the hopper 90 and the head on the deck 82 is maintained substantially constant.

In Figs. 8 and 9 of the drawings, I have illustrated a modified form of control for the mercury switch 116, which may be substituted for that illustrated in Fig. 3 of the drawings. This modified control comprises a frame 117 adapted to replace the cover plate 114 and to extend into the chute 113. Said frame 117 is in the form of an enclosing housing provided with a circular opening closed by a flexible diaphragm 118. To the center of the diaphragm 118 is attached an operating slide rod 119 carrying a disc 120 which bears against a pivoted bell crank lever 121 which is adapted to operate a pivoted lever 122 upon which is supported the mercury switch 116. It will be evident, when this form of operating mechanism is employed, that as the material builds up and fills the chute 113, the diaphragm 118 will yield and move the operating slide rod 119 to the left, as viewed in Fig. 8, thereby to rock the switch 116 through the levers 121 and 122. The weight of the lever 122 and the switch 116 are sufficient to return the diaphragm to the position illustrated in Fig. 8 in the absence of material filling the chute 113.

As has been previously indicated, the balanced or unbalanced condition of the beam scale mechanism 73 is relied upon to control the rate of feed of the vibratory feeder 81, so that said beam scale mechanism 73 is maintained substantially in a balanced condition at all times. In other words, the rate of feed of the feeder 81 is adjusted to a normal condition to correspond with the setting of the weight 76 of beam scale mechanism 73 so that said beam scale mechanism will be in equilibrium and any movement from this condition of equilibrium either on the overload or underload side will be employed to control the feed rate of the feeder 81 to compensate therefor. To effect this control I provide a switch supporting plate 125 (see Figs. 1 and 10) within the housing 74 upon which is mounted a pair of mercury switches 126 and 127 carried by pivotally adjustable plates 128 and 129, respectively. Said switches 126 and 127 are of well known construction and include within them iron attractable armatures 126', 127' (Fig. 18) which will move when a relatively small permanent magnet is placed adjacent the tube of the switch to close the circuit thereof.

Pivotally mounted upon the plate 125 at pivot 130 is a spring lever 131 which carries at its bottom a pair of permanent magnets 132 and 133 associated with switches 126 and 127, respectively. Adjustable stops 134 and 135 are associated with opposite sides of the bottom of said spring lever 131. When the spring lever 131 is swung to the right, as viewed in Fig. 10 the contacts of switch 126 will be closed and when swung to the left the contacts of switch 127 will be closed. When in the neutral position, as illustrated in Fig. 10, the contacts of both of the switches 126 and 127 will be open. The spring lever 131 is operated by flexible operating lever 136 (see Fig. 1) which is secured to and thus controlled by the beam of the beam scale mechanism 73. Whenever the material on the conveyor 29 is sufficient to overbalance the beam the spring lever 131 will be moved to the left to close the contacts of

switch 127 and whenever the material on the conveyor 29 is insufficient to balance said beam the switch 126 will be closed. Whenever the beam is in its normal or balanced condition, spring 131 will be upright, as illustrated in Fig. 10, and both of the switches 126 and 127 will be open.

Attention is now directed particularly to Fig. 18 of the drawings, showing the wiring diagram for the apparatus comprising my invention. Three phase alternating current of any desired voltage, such as 440 volts, is supplied over three phase power mains 140 controlled by switch 141. Also associated with the power mains 140 is a solenoid operated main line switch 142 controlled by a solenoid 143. A step-down transformer 144 is connected between the switches 141 and 142 so that it will always be energized when switch 141 is closed without regard to the condition of switch 142. This step-down transformer is employed to provide 110 volts, or any other desired voltage, on its secondary which is the source of power for the control system.

Leading from the power mains 140 through switch 142 is a three phase alternating current motor 145 which drives a direct current generator 146. One of the power mains 140 leads to main conductor 147 of the motor or power circuit and another of them leads to main conductor 148 of the motor or power circuit in the latter of which the D. C. generator 146 is imposed so that "mixed current," or a combination of alternating and direct currents, will be supplied to the conductors 147 and 148. As was above pointed out, this mixed current is desirable to operate the electro-magnetic feeder 81. In case the feeder 81 is of the type which operates directly from alternating current it is evident that the motor 145 and the generator 146 may be omitted.

The conductor 148 leads directly to the field structure 87 of the feeder 81 and thence successively through hand operated variable rheostats 149 and 150 and motor operated rheostat 151, all in series, the latter of which is connected by a variable tap to the main conductor 147. In other words, the field of the electro-magnetic feeder 81 is connected through three rheostats 149, 150 and 151 in series, the first two of which are variable by a manual operation and the last of which is variable by a motor, as hereinafter described in full detail.

Associated with the rheostat 149 is a shunt circuit provided by a conductor 251 and a conductor 152 under the control of the contacts of an electro-magnetic switch 153. Also associated with the rheostat 150 is a shunt circuit provided by conductor 152 and a conductor 155 under the control of the contacts of an electro-magnetic switch 156.

In the normal condition of the apparatus when the beam scale mechanism 73 is in balance and the switches 126 and 127 are open, the switches 153 and 156 will be in the position illustrated in Fig. 18 with the former closed and the latter opened, under which conditions the rheostat 150 will be effectively in circuit with the field 87 of the feeder 81 in series with the rheostat 151, while the rheostat 149 will be short circuited. It is evident that if both of the switches 153 and 156 are operated to close their contacts respectively, both of the rheostats 149 and 150 will be shunted, while if both of them are operated to open their contacts respectively, both of the rheostats 149 and 150 will be effectively connected in series with the field 87 of

the feeder 81. This circuit may be considered as the power circuit while the other circuits may, in general, be considered as control circuits as they are generally of lower voltage, though this is not necessarily the case, as they may all be of the same voltage, if desired.

As above set forth, the voltage for the control circuit is supplied by the transformer 144 from which the conductors 158 and 159 lead to a master switch 160, the latter through a fuse 161. The closing of the contacts of the master switch 160 produces the following results. It closes the circuit to the solenoid 143 of the switch 142 causing said switch 142 to close its contacts and energize the above-described power circuit, including the feeder 81 and the motor 145. The circuit to this solenoid 143 can be traced through the conductor 158 leading from transformer 144 to and through master switch 160 through continued conductor 153 to branch conductor 152, through solenoid 143, thence by way of conductor 163, fuse 164 in said conductor 163, thence to conductor 159, leading to and through master switch 160 and fuse 161, which leads back to the transformer 144. It also illuminates a signal lamp 165 connected across conductor 159 and branch conductor 166 which, in turn, is connected to conductor 158. In addition, it starts the synchronous motor 36 for driving the constant speed conveyor 29 over branch conductors 167 and 168 which are connected respectively to conductors 163 and 162. It is thus evident that the closing of the master switch 160 will illuminate the light 165 to indicate that the apparatus is in operation, will start the constant speed motor 36 of the conveyor 29 and will start the operation of the electro-magnetic vibratory feeder 81. This, of course, will place the entire apparatus in operation whereupon material will be fed by said vibratory feeder 81 to the constant speed conveyor 29 and by it delivered to any desired receptacle, or the like. As above set forth, this normal operation will take place with the rheostats 150 and 151 connected in series with the field 87 of the electro-magnetic feeder 81 and with the rheostat 149 shunted.

The control system for the feeder 81 is so designed that in response to an underweight of material on the constant speed conveyor 29 the rate of feed of the feeder 81 will be increased to re-establish a condition of equilibrium and a condition of overweight on the conveyor 29 will produce a decrease in the rate of feed of the feeder 81 for the same purpose.

The system is furthermore so designed that in case either an overload or underload condition exists for a prolonged predetermined time interval there is a further adjustment which is more permanent in its nature, the first two mentioned adjustments being substantially instantaneously responsive to a condition of non-equilibrium and the last mentioned adjustment being only responsive to a sustained condition of non-equilibrium. The rheostats 149 and 150 are controlled for the instantaneous adjustment of the rate of feed of the feeder 81 and the rheostat 151 is controlled in response to a sustained condition of non-equilibrium.

To provide for this complete and automatic adjustment of the rate of operation of the feeder 81 to maintain within very small limits the constant rate of feed of the mechanism, I provide the additional controls now to be described. As was previously described, the conductor 163 is connected to the conductor 159 leading to

transformer 144, and the conductor 166 is connected to the conductor 158 also leading to the transformer 144 when the master switch 160 is closed. Connected across conductors 163 and 166 are the primaries of transformers 170 and 171, respectively.

Leading from the secondary of the transformer 170 is a pair of conductors 172 and 173, the former of which includes in circuit therewith the solenoid of electro-magnetically operated mercury switch 174 and leads to a common branch conductor 175 having a control switch 176 therein which conductor 175 is common to a terminal of each of the mercury switches 126 and 127. The conductor 173 leads directly to the other terminal of the mercury switch 126. In a similar manner the secondary of the transformer 171 is connected to conductors 177 and 178 the former of which includes in circuit therewith the solenoid of electro-magnetically operated mercury switch 179 and leads to the aforementioned common conductor 175. Conductor 178 leads directly to the other or non-common terminal of the mercury switch 127.

The closure of the contacts of mercury switch 126 in response to a sub-normal load on the constant speed conveyor 29 energizes the solenoid of electro-magnetic switch 174 which operates to close the contacts of the mercury switch 180 associated therewith, and likewise the closing of the contacts of the mercury switch 127 in response to an overload on the constant speed conveyor results in an energization of the solenoid of electro-magnetic switch 179 and the closing of the contacts of the mercury switch 181 associated therewith. A closure of the contacts of mercury switch 180 is effective to connect the green or underload lamp 182 across the conductors 163 and 166 which are energized, as previously described, and thus illuminate this lamp and at the same time energize the solenoid 183 of a master relay 184 by connecting it across said conductors 163 and 166 by way of conductor 185.

In a similar manner, a closure of the contacts of the mercury switch 181 is effective to connect the red or overload lamp 186 across the conductors 163 and 166 and thus illuminate this lamp and at the same time energize the solenoid 186 of a master relay 187 by connecting it across said conductors 163 and 166 by way of conductor 188.

The operation of the master switch 184 is effective through the third set of contacts, as viewed from the right, to close a circuit from the energized conductor 163 by way of conductor 189 to the solenoid 157 of the control switch 156 controlling the shunt circuit for the rheostat 150 and thereby shunting said rheostat 150, the circuit being completed from said solenoid 157 of switch 156 by way of common conductor 190 which is connected to the other energized conductor 158 over branch conductor 162. It is thus evident that when the load on the constant speed conveyor is light, mercury switch 126 will be closed and this, in turn, will result in the shunting of rheostat 150 thereby increasing the previous rate of feed of the feeder 81.

In a similar manner the operation of the master switch 187 is effective through the third set of contacts, as viewed from the right, to close a circuit from the energized conductor 163 by way of conductor 191 to the solenoid 154 of the control switch 153 controlling the shunt circuit for the rheostat 149 and thereby removing the normal shunt from said rheostat, the circuit being com-

pleted from said solenoid 154 of switch 153 by way of said common conductor 190. It is thus evident that when the load on the constant speed conveyor is heavy, mercury switch 127 will be closed and this, in turn, will result in the removal of the normal shunt around rheostat 149 thereby decreasing the previous rate of feed of the feeder 81.

It is thus evident that any variation which causes a disturbance of the equilibrium of the constant speed conveyor 29 will have as its immediate effect a compensating adjustment of the rate of feed of the electro-magnetic feeder 81.

It is further evident that by adjusting the position of the weight 76 on the beam scale mechanism 73 the capacity of the feeder may be set at any adjustable desired value from substantially zero capacity to the full capacity of the machine.

The above described automatic adjustments of the rate of feed of the feeder 81 by the selective shunting of the rheostats 149 and 150 may be termed instantaneous or immediately responsive adjustments as they are intended primarily to compensate immediately for conditions of unbalance which are of a short time interval and other means are relied upon to compensate for conditions of unbalance of a prolonged period which, for example, might be encountered upon and adjustment of the weight 76 to change the capacity of the feeder from one value to another.

It may further be mentioned that the rheostats 149 and 150 are made independently manually adjustable so that depending upon conditions as encountered in practice the amount of change in the feed rate of the feeder 81 when the relays 153 and 156 are operated may be adjusted so that this change in feed rate may be relatively small or relatively large or any intermediate value.

When either of the master relays 184 or 187 is operated, the left-hand contact of the operated relay is effective to close a circuit by way of conductor 192 to the field coil of a reversible motor forming part of a time delay relay 193 by connecting said coil across the conductors 163 and 158, the latter by way of branch conductor 192, which conductors 163 and 158 are energized as above described.

Associated with and forming a part of the motor of said time delay relay 193 are two shading coils 194 and 195, the former of which is shunted whenever the master relay 187 is energized by the closing of the extreme right hand contacts thereof over common conductor 196 and conductor 197. In a similar manner the extreme right hand contacts of the master relay 184 are effective when operated to provide a shunt for the shading coil 194 by way of common conductor 196 and conductor 198. The shading coils 194 and 195 are operated to determine the direction of rotation of a rotor 199 of said motor of the time delay relay 193 so that when master relay 187 is operated, said rotor 199 will rotate in one direction and when master relay 184 is operated it will rotate in an opposite direction.

Associated with and forming a part of the master or time delay relay 193, the structure which is described in more complete detail hereinafter, are two mercury switches 200 and 201, the former of which is controlled by the second group of contacts of the master switch 184 and the latter of which is controlled by the second group of contacts of master switch 187 over con-

ductors 202 and 203, respectively, and which are operative to control the direction of rotation of a reversible series motor 204 which is operative to adjust the position of a sliding contact 205 to determine the effective portion of the rheostat 151 which is included in circuit with the field 87 of feeder 81. To this end the reversible series motor 204 has a common conductor 206 which is connected to the conductor 163 through fuse 207, which conductor 163 is energized as previously described.

The circuit through the mercury switch 200 leads by way of conductor 208 to one series field 209 of the motor 204 which, when energized, causes said motor to rotate in one direction and in a direction to decrease the effective resistance of said rheostat 151 thereby to increase the rate of feed of the feeder 81.

Likewise, the circuit through the mercury switch 201 leads by way of conductor 210 to another series field 211 of the motor 204 which, when energized, causes said motor to rotate in the opposite direction to increase the effective resistance of said rheostat 151 thereby to decrease the rate of feed of the feeder 81.

As above set forth, the motor 204 is only operated to adjust the rheostat 151 in response to a sustained or prolonged condition of unbalance of the constant speed conveyor 29. It may be pointed out that even though the mercury switches 200 and 201 are closed they will not be effective unless switch 200 is closed at the same time that the contacts of master relay 184 are closed or switch 201 is closed at the same time the contacts of master relay 187 are closed.

In Figs. 11 and 12 of the drawings, to which attention is now directed, there is illustrated a control box 212 which may be mounted on any appropriate control panel, as illustrated in Fig. 3 of the drawings, from which a cable 213 may extend to the feeder mechanism. In said Figs. 11 and 12 of the drawings, substantially all of the electrical conductors have been eliminated in the interest of clearness.

No particular description of the apparatus here disclosed appears necessary as these drawings merely show the relative positions of the various switches, relays and lights which are identified by the reference characters given them. It may be pointed out, however, that within the control box 212 is a terminal block 214 to provide for ready connection and disconnection of all of the control circuits and a terminal block 215 to provide for the connection and disconnection of the power circuits. It may additionally be pointed out that the time delay relay 193 includes a rotary motor having a rotor 199 (see Fig. 18), with which is associated reducing gears 216 which drives a rotating shaft 217 carrying a rotating pin 218.

Positioned in the path of the rotating pin 218 is a contact pin 218 carried by a rotatably mounted disc 220 which, on the opposite side thereof, carries three pins 221. The pins 221 are adapted to contact pivoted cams 222 and 223 (see Fig. 11), which carry the mercury switches 200 and 201, respectively. It is evident that rotation of the disc 220 will cause successive opening and closing of the contacts of each of the switches 200 and 201. Each time the switch 200 has its contacts closed it will operate the motor 204 a relative short distance until said contacts are open again, provided master relay 184 has its contacts closed, as previously described. A similar con-

dition will apply to switch 201 when master switch 187 has its contacts closed.

It is evident that whenever the disc 220 is rotated in one direction by the pin 218 the rotor 199 of the time delay relay 193 must be rotated in the opposite direction through substantially a complete revolution so that the pin 218 will make contact with the opposite side of the pin 219 before said disc 220 can be rotated in the opposite direction. This provides for the time delay feature of the relay 193 and requires that the continuous conveyor 29 be out of balance for a prolonged period of time either as too light or too heavy or that it be out of balance successive short periods of time on one side before adjustment of the rheostat 151 is effected. For example, if the equilibrium of the system is upset so that the master relay 184 is maintained energized for a prolonged period, the time delay relay 193 will operate to send successive impulses which decrease the effective resistance of the rheostat 151 in successive steps until a condition of equilibrium is established. Also, if the master relay 184 is operated successively a number of times without the master relay 187 acting between these successive operations a similar resulting adjustment of rheostat 151 will be effected.

It is, of course, evident that an opposite condition or a sustained unbalancing of the system due to overload will cause a reverse operation of the rheostat 151 under the influence of the master relay 187. This adjustment of the rheostat 151 is such that the system is entirely automatic to adjust the normal feed rate of the feeder 81 to correspond to any desired capacity of the entire feeder which may be widely adjusted, as aforesaid, and the instantaneously responsive adjustments of the rate of feed of the feeder 81 are effected by the rheostats 149 and 150.

In the operation of the apparatus comprising my invention, granular material, which is intended to embrace substantially any material other than a fluid, to be fed at a constant rate will be stored in a large hopper or storage bin with the bottom of which is associated the hopper 94. This granular material is fed from the hopper 94 by the delivery mechanism 95 into the material accumulator or feeder hopper 90 at such a rate as to maintain the material in said feeder hopper 90 substantially constant, or, in other words, to maintain said hopper 90 substantially full of material at all times thereby providing a substantially constant head of granular material on the deck 82 of the electro-magnetic vibratory feeder 81.

It may be stated that, if desired, the hopper 90 may be eliminated entirely and the chute 113 extended downwardly below the top of the deck 82 and provided with a gate 93 or not, as desired.

It may also be pointed out that the control mechanisms for the motor 110 of the delivery mechanism 95, as illustrated in Fig. 3, or as illustrated in Figs. 8 and 9, are preferably employed to prevent operation of said delivery mechanism when the hopper 90 is full of material but said control may be omitted if desired, as above set forth.

It is, of course, evident that this delivery mechanism is effective to isolate the granular material in the hopper 94 and the granular material in the chute 113 and hopper 90 to maintain the aforesaid constant head on the deck 82. This provides for a very accurate control of the rate of feed of the material on the deck 82 as determined substantially entirely by the ampli-

tude of vibration of said electro-magnetic feeder 81.

The granular material is delivered by the feeder 81 to the constant speed conveyor 29 substantially uniformly over the entire width of the belt 34 and at a rate which can be instantaneously controlled and which, during normal operation, is very uniform thus not causing any disturbance of the equilibrium of the balanced constant speed conveyor 29 which would be present if said material were fed in an interrupted or non-continuous or non-uniform manner. This is particularly important in view of the fact that the material is fed to the constant speed conveyor 29 at the position farthest removed from the pivotal point of the frame 28 where it has the maximum disturbing influence due to the fact that the effective lever arm thereof is a maximum. The granular material received by the belt 34 is then conveyed at a constant speed toward the fulcrum point of the pivoted frame 28 of said constant speed conveyor adjacent which it is discharged into the hopper or housing 78 by which it is directed to any desired receptacle. The discharging of this granular material adjacent this pivot point is of importance because some materials tend to form "landslides" which would disturb the equilibrium of the balanced conveyor 29 if removed from the pivotal point thereof. It is, of course, evident that material which is substantially at the pivotal point has little or no balancing influence on the balanced frame 28 as the length of the lever arm thereof is substantially zero.

By virtue of the afore-described automatic mechanism the rate of feed of the feeder 81 will be automatically adjusted as determined by the setting of the adjustable weight 76 of the beam scale mechanism 73 and once a normal condition of feed of the feeder 81 is determined in this automatic manner momentary variations therefrom which will produce a disturbance of the equilibrium of the conveyor frame 28 will immediately produce a compensating feed rate of the vibratory feeder 81. As a consequence, the rate of delivery of the apparatus from the constant speed conveyor 29 will be constant within a very small limitation.

The scale beam may be calibrated in pounds to indicate the weight of material per unit length of conveyor belt. The counter 55 may indicate the number of such unit lengths. For instance, if the weight is at the ten pounds point during equilibrium operation and the counter indicates 100, the indications are that one thousand pounds have been discharged from the conveyor. Such readings are made independently of the speed of the conveyor.

For normal operations for a selected material with the weight 76 set at a predetermined point on the scale beam, the time delay relay does not come into operation. Only when the weight is widely set from a previous point, or when abnormal fluctuations in line voltage occur, does the time delay relay operation take place to automatically adjust the feeding operations to the disturbing or abnormal conditions. Such conditions are usually only temporary and when normal conditions are re-established, the system disclosed in the drawings acts automatically to restore the normal relation between the feeding and delivery; so as to at all times maintain automatically the uniform weight rate discharge from the conveyor.

It may be further pointed out, where extreme

accuracy is not essential, or where there is not a great tendency for the granular material to flow, the delivery mechanism 95 may be omitted and the hopper 94 fed directly into the hopper 90, but in the interest of extreme accuracy, and particularly where the granular material is of the type which tends to flow, as above set forth, it is desirable to employ this mechanism in combination with the other mechanism, as above described.

It is furthermore evident that the delivery mechanism 95 in combination with the hoppers 94 and 90 and the electromagnetic feeder 81 make for an important sub-combination of the entire system which has considerable utility in itself, and may be separately employed where it is desired to feed material from a hopper which material has a tendency to flow under high head and where it is desired to control the rate of feed of said material from substantially zero up to the full capacity of the electro-magnetic feeder 81.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a feeder, the combination with an electric conveyor, of a control circuit for said conveyor comprising two resistors and a variable rheostat, shunt circuits for each of the resistors, a reversible motor for controlling said variable rheostat, a scale, circuit control means responsive to the position of said scale and so constructed and arranged that when the said scale is in a predetermined normal position one of said resistors will be shunted and when in another position both of said resistors will be shunted, and when in a third position none of said resistors will be shunted, whereby the delivery rate of said conveyor will be controlled by said scale, and means operative in response to a sustained positioning of said scale from its normal position to effect operation of said reversible motor in one direction or the other to control said variable rheostat and thereby further control the delivery rate of said conveyor.

2. In feeding apparatus, the combination with an electro-magnetic feeder, of means to control the rate of feed of said feeder in response to a variable condition as normal or abnormal, electrically operable means constructed and arranged to be immediately responsive to an abnormal condition to adjust the feed rate of said feeder, and electrically operable time delay relay means comprising a reversible motor and switches operated thereby constructed and arranged to respond to sustained abnormal condition to adjust the rate of feed of said feeder.

3. In feeding apparatus, the combination with an electro-magnetic feeder, of means to control the rate of feed of said feeder in response to a variable condition as normal or abnormal, electrically operable means constructed and arranged to be immediately responsive to an abnormal condition to adjust the feed rate of said feeder, and electrically operable time delay relay means comprising a rotary electric motor and switches opened and closed thereby constructed and arranged to respond to a sustained abnor-

mal condition to adjust the current flow for said electro-magnetic means.

4. In automatic conveying apparatus, the combination with a conveyor unit, of an electro-magnetically operated feeder associated therewith, two resistors and a variable rheostat connected to the electro-magnet of said feeder, means operative by underloads and overloads of materials on said conveyor unit for cutting in and out of circuit said resistors to speed up the feeder for an underload and slow down the feeder for an overload, and circuits and connections comprising a time delay relay to automatically adjust said variable rheostat to increase the current flow to the electro-magnet of said feeder if an underload persists and to decrease the current flow to said electro-magnet if an overload persists.

5. In a constant capacity feeder, the combination with a main frame, of a conveyor unit pivotally mounted thereon, an electric vibratory feeder for feeding material to said conveyor unit, means comprising a variable rheostat for controlling said electric vibratory feeder to regulate the material fed thereby onto said conveyor, time delay relay mechanism comprising two mercury switches and a reversible electric motor connected thereto to open and close the same, an additional reversible electric motor connected to said variable rheostat, circuits and connections for effecting rotation of said additional electric motor in one direction when one of said mercury switches is closed and in the opposite direction when the other mercury switch is closed, and means controlled by the tilting of said conveyor unit due to the load thereon to effect operation in one direction or the other of said time delay relay mechanism to effect increase or decrease of the feeding of material onto said conveyor unit.

6. In a constant capacity feeder, the combination with a main frame, of a conveyor unit comprising an endless conveyor belt on a conveyor frame pivotally mounted on said main frame, means comprising a driven shaft at the pivot for driving said conveyor belt, an electro-magnetic vibratory feeder for feeding material to said conveyor belt remote from the pivotal axis, means for balancing said frame with a predetermined load on the upper run of the conveyor belt, a rheostat for controlling said electro-magnetic feeder, means acting quickly to control said rheostat when said conveyor unit becomes unbalanced, a variable rheostat, a reversible electric motor connected to said variable rheostat to control the same, and time delay relay mechanism for controlling the direction of rotation of said reversible electric motor when overload or underload of material on said conveyor unit persists, in order to regulate said electro-magnetic feeder to restore the balanced condition of said conveyor unit.

7. In a constant capacity feeder, the combination with a main frame, of a conveyor frame pivotally mounted on said main frame about a pivot at one end thereof, a conveyor belt on said conveyor frame, means for driving said conveyor belt to transfer material toward said pivotal axis and discharge such material adjacent said axis, scale mechanism for supporting the tilting end of said conveyor frame, a vibratory feeder mounted on said frame in position to feed material to said conveyor belt at the tilting end of

said conveyor frame, and automatic means operated by said scale mechanism to control said vibratory feeder to regulate the amount of material fed to said conveyor belt in accordance with the tilting of conveyor frame due to variation of the load of material on the upper run of the conveyor belt.

8. In a constant capacity feeder, the combination with a main frame, of a conveyor frame pivotally mounted on said main frame about a pivot at one end thereof, a belt conveyor on said conveyor frame constructed to deliver material toward said pivotal axis and discharge it adjacent said axis, a scale mechanism supporting the other end of said conveyor frame for pivotal movement, a vibratory feeder mounted on said main frame and positioned to feed the end of said conveyor removed from said pivotal axis, said feeder being under the control of said conveyor frame.

9. In feeding apparatus, the combination with a stationary main frame, of a conveyor frame pivotally connected to said main frame, conveyor mechanism comprising an endless belt carried by a pair of spaced-apart parallel drums one of which is mounted to rotate on the axis of the pivotal connection between said conveyor frame and said main frame, a motor mounted on said main frame, driving mechanism between said motor and the drum rotatable on said pivotal axis to drive the upper run of said endless conveyor belt toward said pivotal axis, and vibratory feeder means for feeding material to said upper run from a position remote from said pivotal axis for transfer of such material toward said pivotal axis and delivery from said belt adjacent to said pivotal axis.

10. In a feeder, the combination with an electric conveyor, of a control circuit for said conveyor comprising two resistors and a variable rheostat, shunt circuits for each of the resistors, a reversible motor for controlling said variable rheostat, a condition indicator, circuit control means responsive to the position of said indicator and so constructed and arranged that when the said indicator is in a predetermined normal position one of said resistors will be shunted and when in another position both of said resistors will be shunted, and when in a third position none of said resistors will be shunted, whereby the delivery rate of said conveyor will be controlled by said indicator, and means operative in response to a sustained positioning of said indicator from its normal position to effect operation of said reversible motor in one direction or the other to control said variable rheostat and thereby further control the delivery rate of said conveyor.

11. In a feeding system, the combination with an electric feeder, of two resistors and a variable rheostat connected to said feeder to control its feed rate, a condition indicator, means operative thereby in response to under and over normal conditions for cutting said resistors in and out of circuit to speed up said feeder for an under normal condition and slow it down for an over normal condition, and circuits and connections comprising a rotary time delay relay to adjust said variable rheostat automatically to increase the current flow to said feeder if the under normal condition persists and to decrease the current flow thereto if the over normal condition persists.

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