Sept. 9, 1969 D. G. NOURSE 3,466,018

MOBILE CEMENT UNIT

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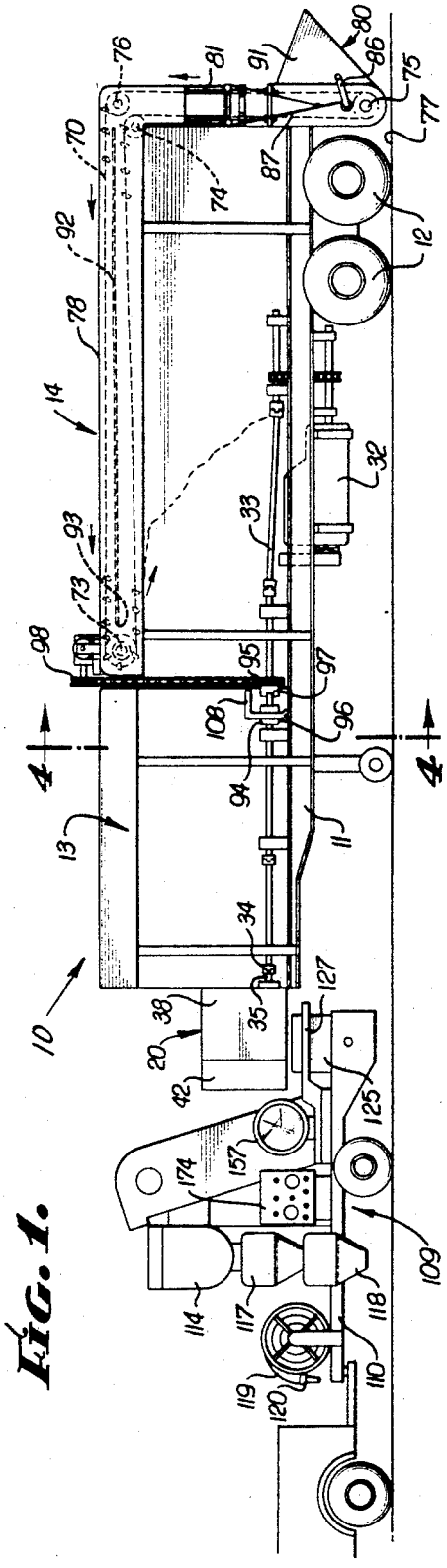


FIG. 1.

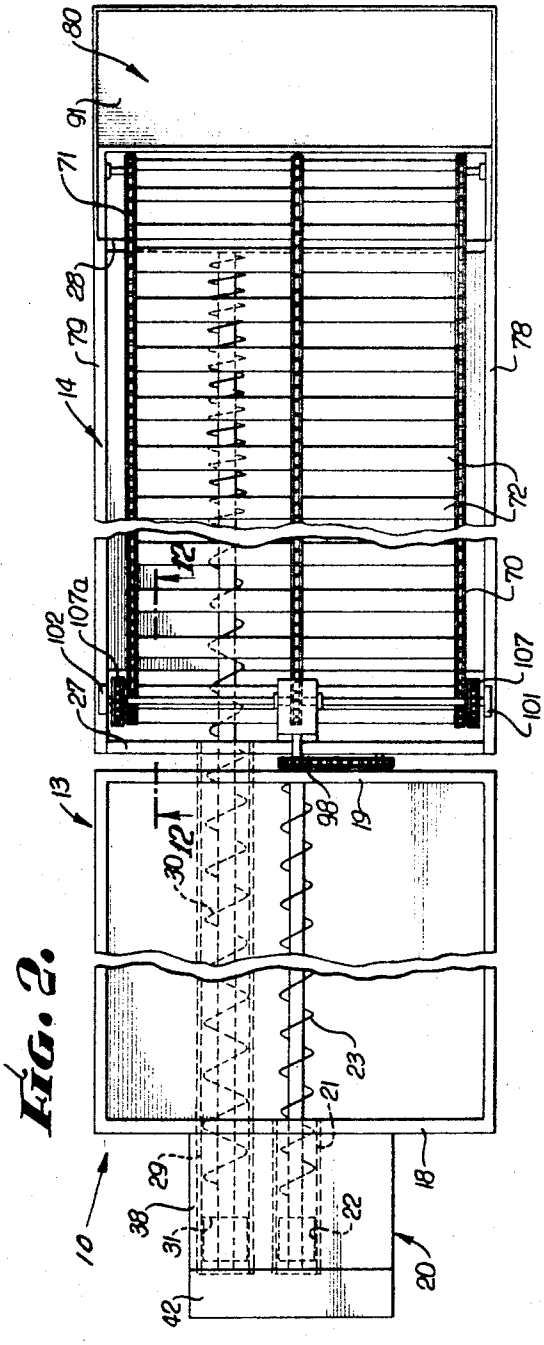


FIG. 2.

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FIG. 3.

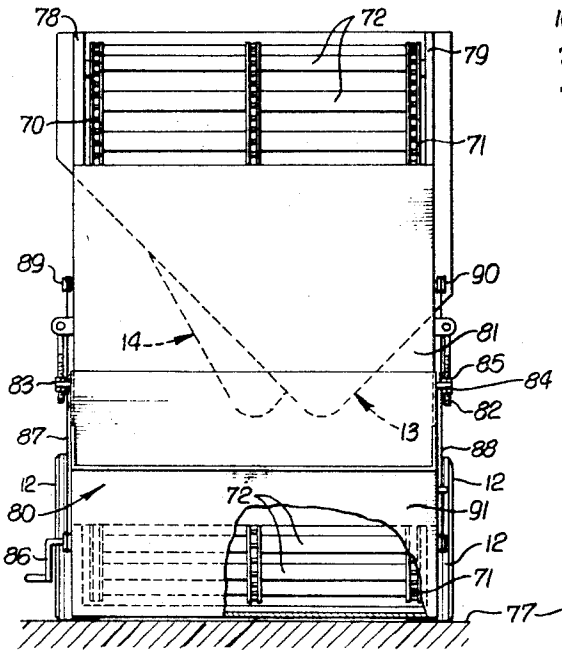



FIG. 4.

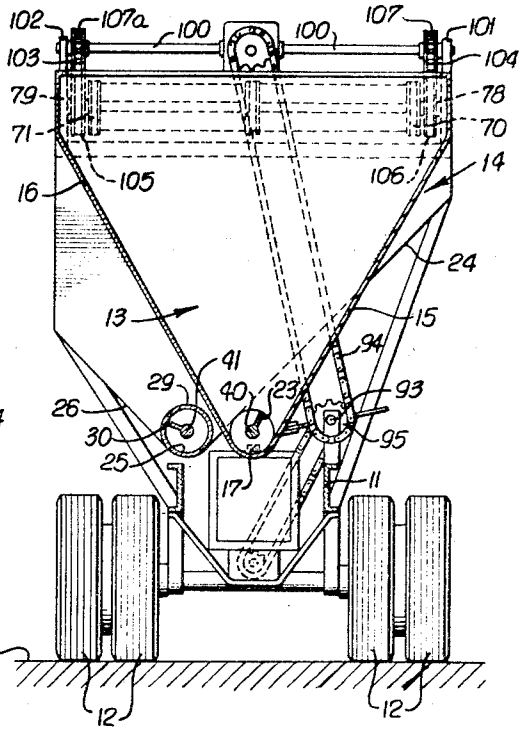



FIG. 10.

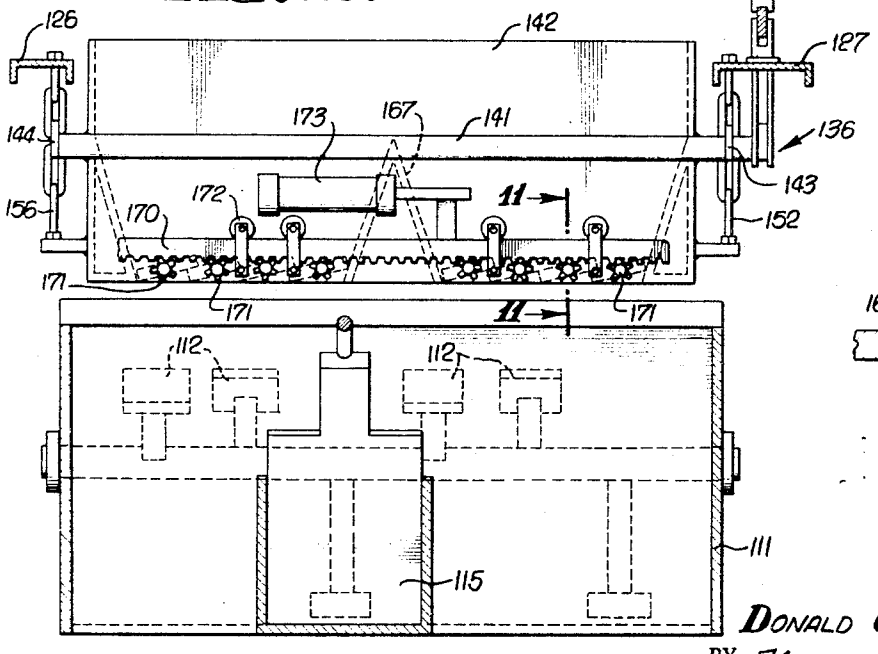
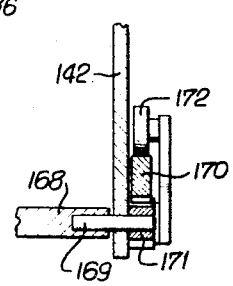



FIG. 11.



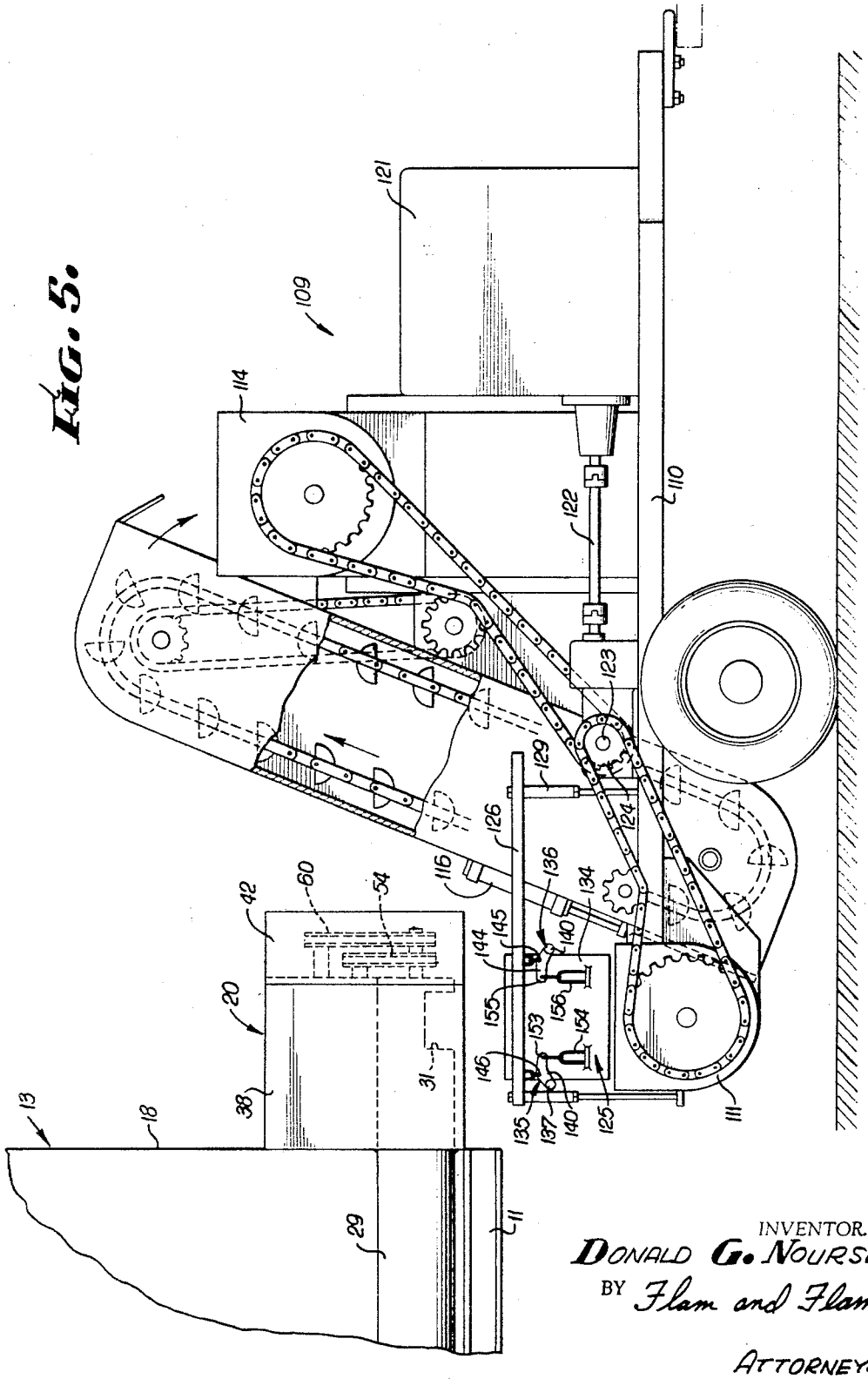

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FIG. 5.




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FIG. 6.

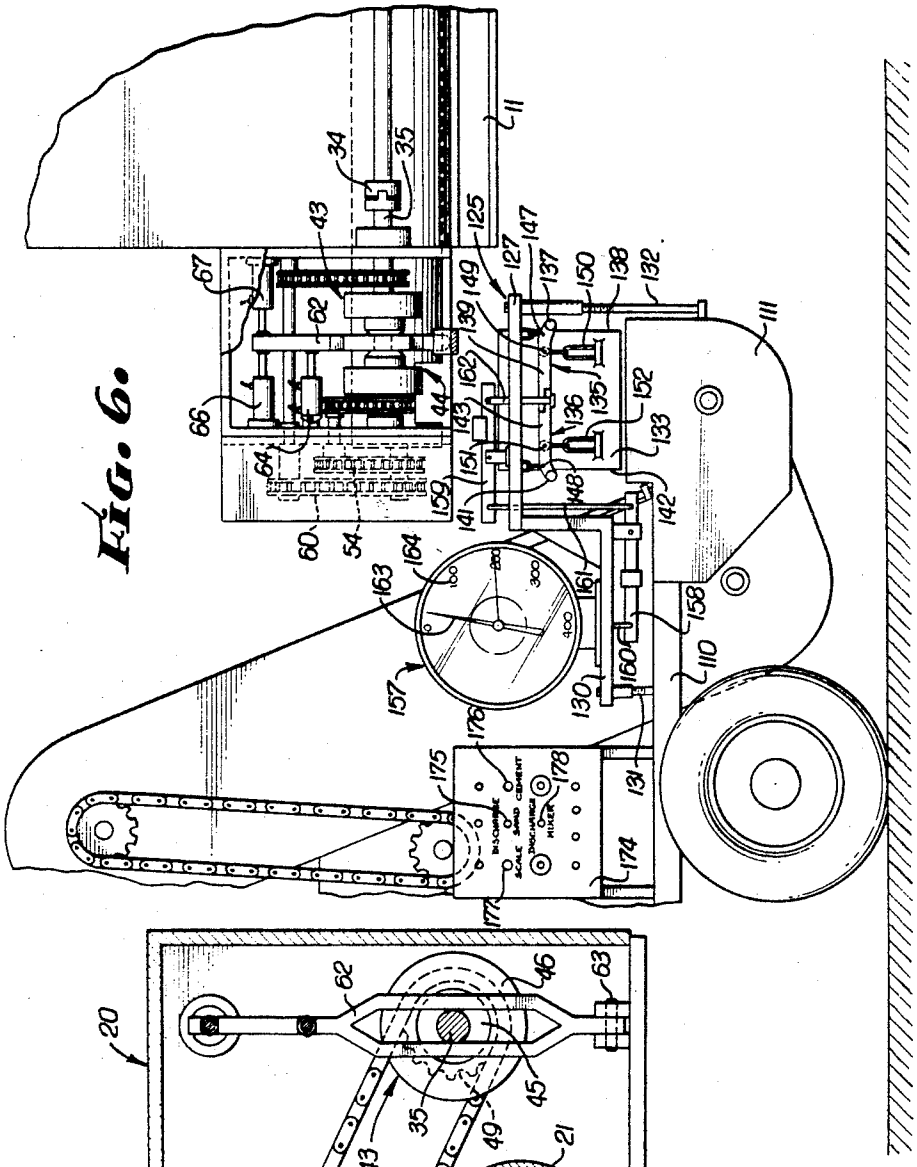
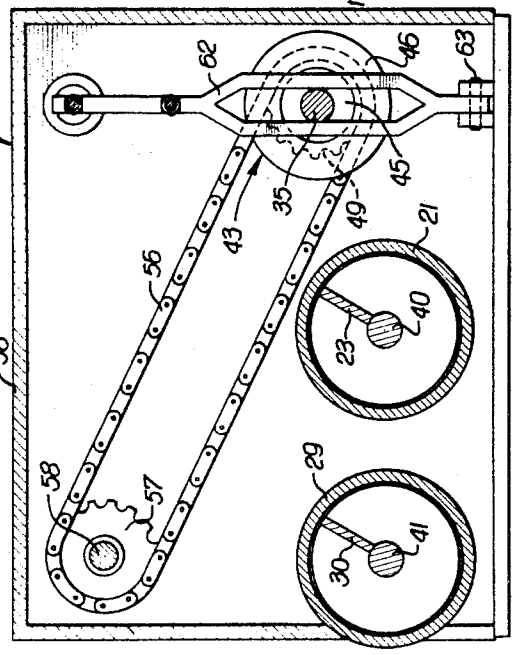


FIG. 8.



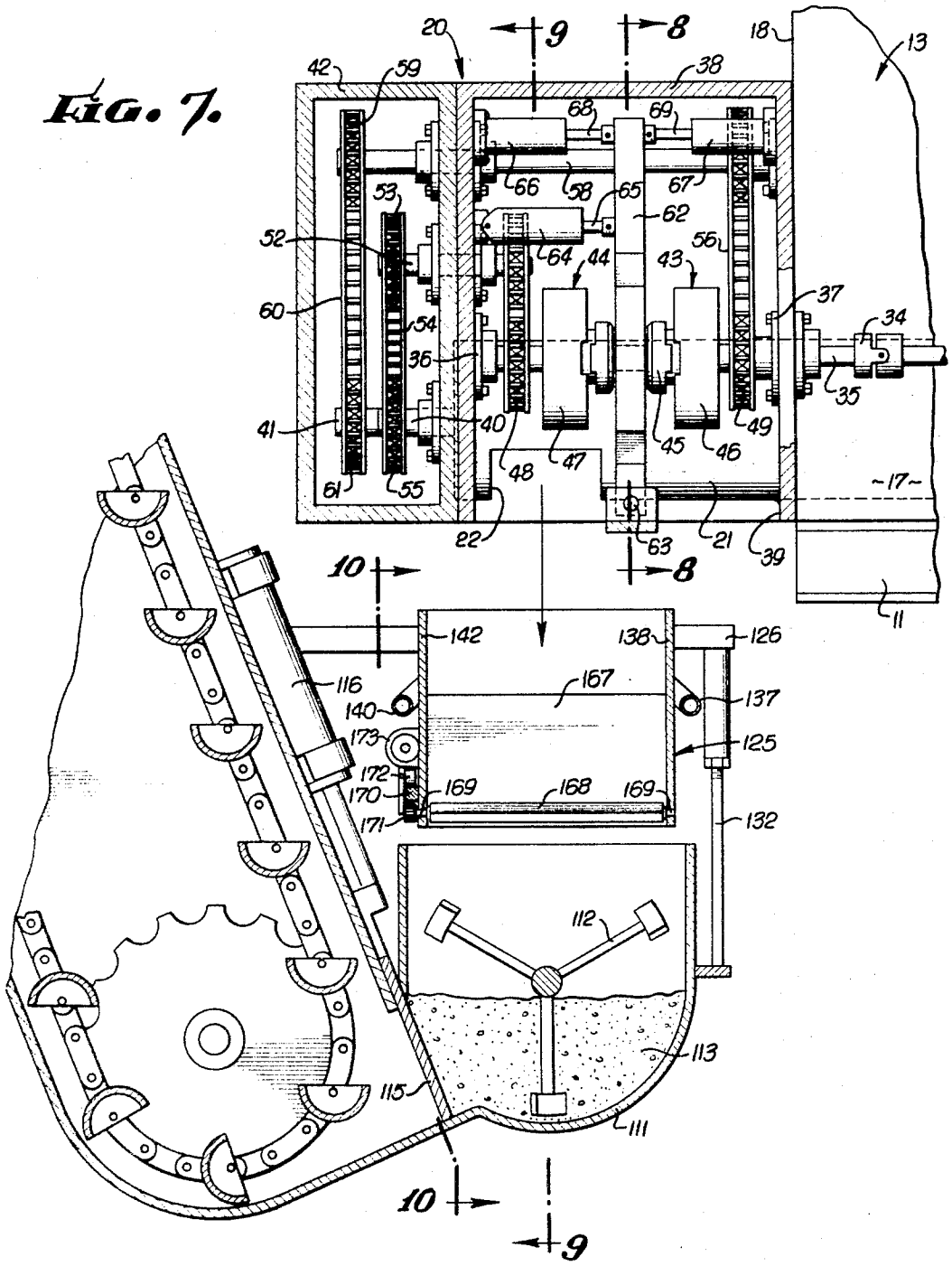
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Fig. 7.




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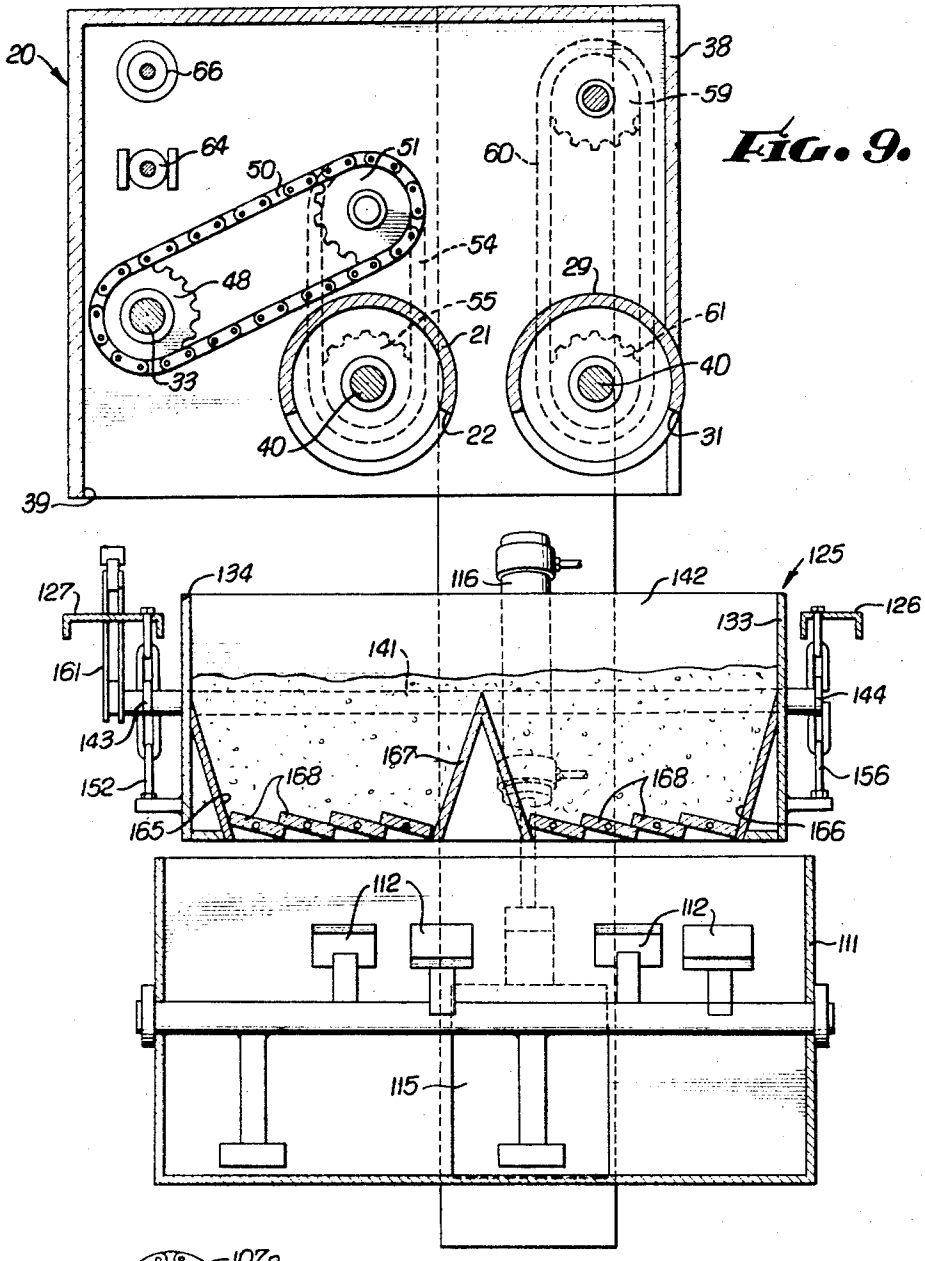



FIG. 9.

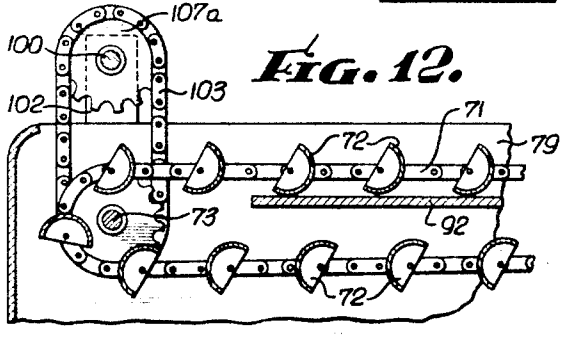



FIG. 12.

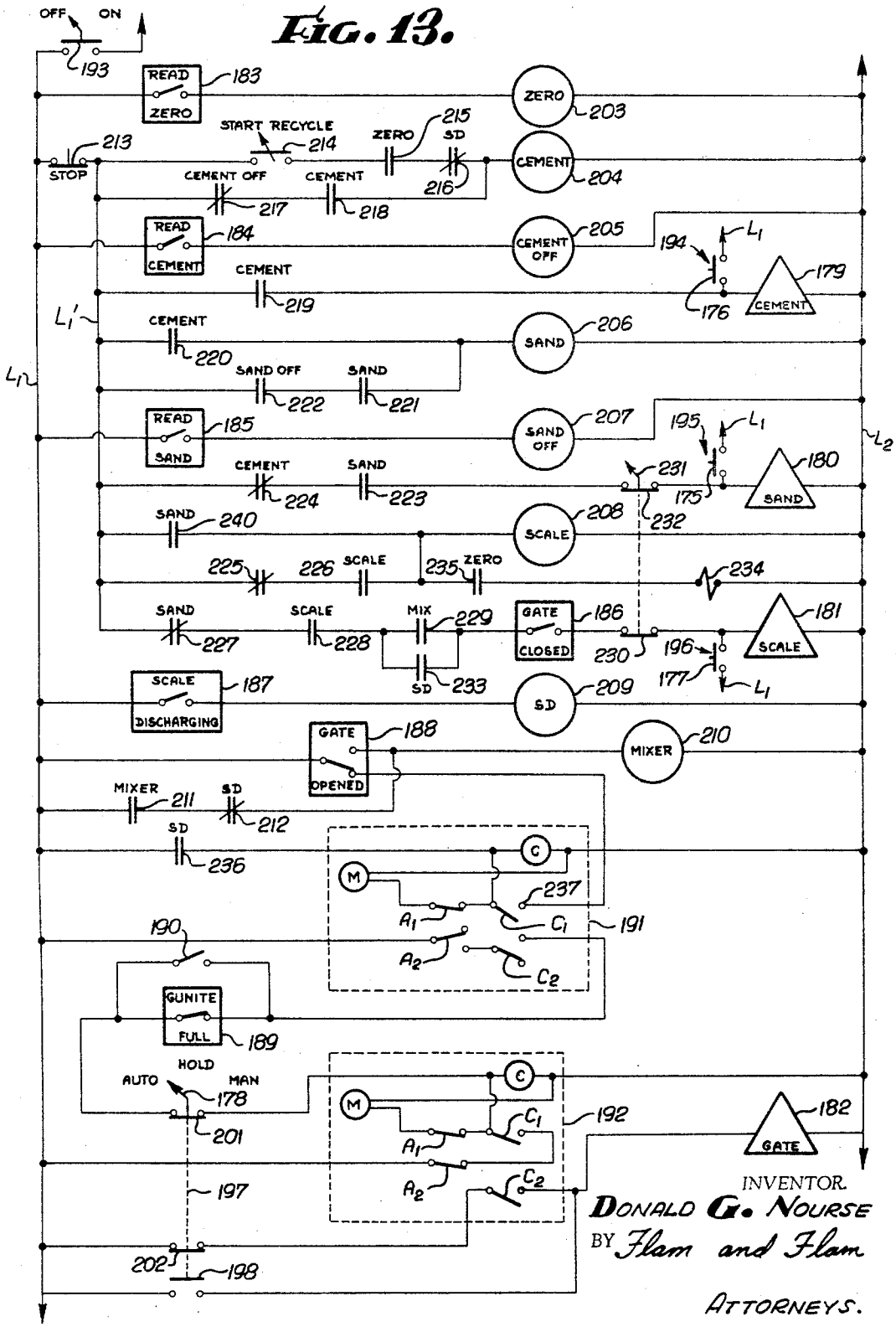
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FIG. 13.




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United States Patent Office 3,466,018 Patented Sept. 9, 1969



3,466,018

# MOBILE CEMENT UNIT

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Int. Cl. B28c 7/00, 7/04; B60p 1/00
U.S. Cl. 259—163 13 Claims

This invention relates to the construction of swimming pools and analogous structures, and particularly to apparatus for automatically loading a Gunite machine.

A Gunite machine, such as shown in U.S. Letters Patent No. 3,072,388 to Ridley, issued Jan. 8, 1963 and entitled "Feeding and Mixing Apparatus for Concrete Guns or the Like," must be loaded with sand and cement. Customarily, sacks of cement are unloaded at the job site and a sand and gravel company dumps a load of sand in the street, on a driveway, or at some other equally undesirable location. The Gunite machine hopper is loaded with sand by a small earth-moving vehicle, and with cement by breaking open a sack of cement and depositing it by hand. This method has several disadvantages. The street, driveway or other place where the sand is dumped is not easily cleaned after the job is finished. Measurements to achieve the proper sand-cement ratio are only very crudely accomplished by the guess of the operator of the earth-moving vehicle, with consequent lack of uniformity.

The primary object of this invention is to provide mobile apparatus that entirely overcomes these disadvantages, and that also reduces the manpower necessary to operate a mobile Gunite apparatus.

A corresponding object of this invention is to provide a vehicle for transporting both sand and cement to a job site that is capable of direct discharge into the receiving hopper of the Gunite machine.

Another object of this invention is to provide a vehicle of this character discharging cement and sand into the receiving hopper of the Gunite machine under the control of automatic weighing apparatus.

Another object of this invention is to provide a system of this character in which the Gunite machine is kept loaded automatically in accordance with the demand for the mixture.

Another object of this invention is to provide a unique weighing mechanism for sand and cement that can be operated by suitable pneumatic motors.

Another object of this invention is to provide a control system for automatically loading a Gunite machine, or the like, having interlocking and interdependent circuitry to ensure safe, proper and efficient handling of materials all within the capabilities of the apparatus.

Still another object of this invention is to provide a vehicle capable of being loaded with sand at the job site directly from a dump truck, or the like, such as for large jobs, without discharging any material on the street or driveway.

Another object of this invention is to provide a vehicle having a number of separate hoppers one behind the other together with discharge screws for delivering the contents of the hoppers substantially at the same location.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming a part of the present specification, and which drawings, unless described as diagrammatic, or unless as otherwise indicated, are true scale. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.



Referring to the drawings:

FIGURE 1 is a side elevational view of a mobile storage unit and Gunite unit incorporating the present invention;

FIG. 2 is an enlarged fragmentary top plan elevational view of the mobile storage unit;

FIG. 3 is an enlarged end elevational view of the mobile storage unit, a portion of the apparatus being broken away and shown in section;

FIG. 4 is an enlarged transverse sectional view taken along the plane indicated by line 4—4 of FIG. 1;

FIG. 5 is a fragmentary side elevational view showing the discharge end of the mobile storage unit and the weighing apparatus forming a part of the Gunite unit, a portion of the apparatus being broken away and shown in section;

FIG. 6 is a side elevational view similar to FIG. 5, but taken from the opposite side of the apparatus;

FIG. 7 is an enlarged fragmentary longitudinal sectional view showing the discharge end of the storage unit, the weighing box and the receiving hopper of the Gunite unit and associated apparatus;

FIG. 8 is a sectional view taken along the plane indicated by line 8—8 of FIG. 7;

FIG. 9 is a sectional view taken along the plane corresponding to line 9—9 of FIG. 7;

FIG. 10 is a transverse sectional view taken along the offset plane indicated by line 10—10 of FIG. 7;

FIG. 11 is an enlarged fragmentary sectional view taken along the plane corresponding to line 11—11 of FIG. 10;

FIG. 12 is a fragmentary sectional view illustrating a portion of the apparatus for loading sand in one of the hoppers of the storage unit; and

FIG. 13 is a diagrammatic view of the control system for operating the weighing unit.

## DISCHARGE OF SAND AND CEMENT

The storage unit **10**, shown in FIGS. 1 and 2, in this instance is built upon a trailer frame **11** provided with rear wheels **12**. Mounted one behind the other upon the frame are two hoppers **13** and **14** for cement and sand respectively. The sand hopper, located behind the cement hopper, has approximately twice the capacity of the cement hopper **13**.

The side walls **15** and **16** (FIG. 4) of the cement hopper slope downwardly to a trough **17** located substantially at the center of the unit **10**. The front and rear walls **18** and **19** (FIG. 2) of the cement hopper **13** extend vertically and are located in spaced parallel transverse planes. In order to load the cement hopper **13**, the entire unit **10** may be moved to a cement factory and the cement hopper **13** positioned beneath the discharge of the mill.

Attached to the front wall **18** of the cement hopper **13** and adjacent the trough area (FIGS. 6 and 7) is a two-part rectangular casing **20**. Lower corners of the casing project laterally beyond the side walls of the cement hopper for access thereto. A discharge conduit **21**, mounted at the lower center of the casing **20**, is aligned with the trough area **17** of the cement hopper **13**. A suitable aperture in the front wall **18** establishes communication between the conduit **21** and the trough **17** of the cement hopper. Cement is discharged to a downwardly opening slot **22** in the conduit **21**. In order to move the cement to the discharge slot **22**, a screw conveyor or pump **23** (FIG. 2) is provided. The screw conveyor **23** is mounted in the conduit **21** (FIG. 8) and extends inwardly of the cement hopper along its trough **17**.

One side wall **24** of the sand hopper **14** angles downwardly to a trough area **25** laterally offset from the trough

area 17 of the cement hopper 13. The other side wall 26 of the sand hopper is angled. The front and rear walls 27 and 28 (FIG. 2) of the sand hopper 14 extend vertically and in spaced parallel transverse planes with the front wall 27 spaced slightly behind the rear wall 19 of the cement hopper.

A discharge conduit 29 projects forwardly of the trough area 25 of the sand hopper and exteriorly along the side wall 16 of the cement hopper. The discharge conduit 29 projects through one lower corner of the casing 20 (see FIGS. 2 and 8). A screw conveyor 30, mounted in the discharge conduit 29 projects rearwardly into the trough of the cement hopper and conveys the sand to a discharge slot 31 (FIGS. 2, 5 and 9).

In order to operate the screw conveyors 23 and 30, an engine 32 is provided that is mounted upon the frame 11 on one side of the sand hopper 14. The engine 32 operates a drive shaft 33. The drive shaft 33 extends forwardly along the side wall 15 of the cement hopper 13 (FIGS. 2 and 4) and is joined by a suitable coupling 34 to the rearwardly projecting end of a power shaft 35 supported at the lower corner of the casing 20 opposite the sand conduit 29.

The power shaft is supported by suitable bearings 36 and 37 (FIG. 7). The bearings 36 and 37 are mounted on the interior surfaces of the front and rear walls of the inner part 38 of the casing 20. The part 38 is substantially rectangular in configuration, with an opening 39 at its lower end for passage of the materials discharged from the conduits 21 and 29.

Shafts 40 and 41, upon which the conveyor screws 23 and 30 are mounted, project forwardly into the companion outer casing part 42 for application of suitable turning torques. The casing part 42 is substantially rectangular and is fastened to the front wall of the rear casing part 38.

The shafts 40 and 41 may be selectively coupled to the power shaft 35. For this purpose, a pair of clutch mechanisms 43 and 44 are provided. The clutch mechanisms 43 and 44 are mounted in axially spaced relationship upon the power shaft 35. The clutch mechanisms include a common clutch shifter or shift collar 45 splined or keyed to the power shaft 35. Driven clutch elements 46 and 47 are mounted upon bearing sleeves journalled upon the power shaft 35 and located on opposite sides of the shift collar 45. Upon movement of the shift collar 45 in one direction, the driven clutch element 36 is engaged while the driven clutch element 47 is disengaged, and vice versa.

Sprocket wheels 48 and 49 are mounted upon the respective bearing sleeves and are respectively connected to the screw shafts 40 and 41. Thus the sprocket wheel 48 (FIG. 9) is engaged by a chain 50 that cooperates with a sprocket wheel 51 mounted at the inner end of a shaft 52 supported by the abutting walls of the casing parts 38 and 42. The other or outer end of the shaft 52 has a sprocket wheel 53 (FIG. 7) located in the casing part 42. A chain 54 engaging the sprocket wheel 53 also engages a sprocket wheel 55 mounted at the end of the screw shaft 40. Accordingly, when the shaft collar 45 is moved to the left as viewed in FIG. 7, the screw 23 is operated and cement is discharged.

The sprocket 49 cooperates with a chain 56 (FIGS. 7 8 and 9) that in turn engages a sprocket wheel 57 mounted on a shaft 58 at an upper corner of the casing part 38. The shaft 58 projects forwardly through the abutting walls of the casing parts 38 and 42 where it mounts a sprocket wheel 59 (FIGS. 7 and 9). The sprocket wheel 59 cooperates with a chain 60 engaging a sprocket wheel 61 carried on the screw shaft 41. Accordingly, when the shift collar 45 is moved to the right as viewed in FIG. 7, sand is delivered.

As shown in FIG. 2, the screws 23 and 30 terminate substantially short of the respective discharge slots 22 and 31. Accordingly, the sand or cement, as the case may be, shears off the inner edge of the discharge slot.

In order to operate the shifter 45, a shifting lever 62 is provided that is mounted upon a pivot arm 63 located below the power shaft (see FIG. 8). The bifurcated intermediate portion of the shifting lever 62 encompasses the power shaft and fits in an annular groove formed centrally of the shifter 45. Accordingly, upon angular movement of the shifting lever 62 in opposite directions about the pivot pin 63, the shift collar 45 is suitably moved. The shift lever 62 is moved by a double-acting pneumatic cylinder 64 having a piston rod 65 joined to an intermediate portion of the shifting lever 62. When air is admitted to one end of the cylinder 64, the shift lever 62 is thrown in one direction; and when air is admitted into the other end of the cylinder 64, the lever 62 is thrown in the opposite direction. Suitable electromagnetically operated control valves (not shown) are mounted in the casing 20.

The shifting lever 62 is capable of being moved to a central neutral position, as indicated in FIG. 7, in which neither driven clutch element 46 or 47 is engaged. The shifting lever 62 may be moved to the central neutral position by the aid of a pair of single-acting pneumatic cylinders 66 and 67. These pneumatic cylinders have rods 68 and 69 which abut opposite sides of the shifting lever 62.

## LOADING

The sand hopper 14 is loaded by a conveyor system shown in FIGS. 1, 2, 3, 4 and 12. The conveyor system includes a pair of endless conveyor chains 70 and 71 between which buckets or scoops 72 are suspended. Preferably the buckets or scoops are confined against angular movement with respect to the chains. The conveyor has a horizontal or discharge run along the entire length of the sand hopper 14 at the top rectangular opening thereof, and the conveyor has a vertical or loading run along the exterior of the rear wall 28 of the hopper.

The conveyor chains 71 are supported by the aid of sprocket structures mounted upon four parallel horizontal shafts 73, 74, 75 and 76. The shaft 73 is located at the top of the hopper 14 just inside the forward hopper wall 28. The shaft 74 is located at the rear upper corner of the hopper 14. The shaft 75 is located substantially at the level of the road or other ground surface 77 and just behind the rear wall 28. The shaft 76 is located upwardly and outwardly of the shaft 74. Three of the shafts 73, 74 and 76 are supported by a pair of parallel angular side plates 78 and 79. The corners of the plates rest upon opposite ends of the end wall 28 of the hopper 14.

From the downwardly projecting ends of the side plates 78 a bin structure 80 is suspended. For this purpose, each side plate has a pair of depending guide rails as at 81 (FIG. 1) in turn supporting threaded suspension rods 82 (see FIGS. 1 and 3). The bin telescopes over the side rails 81. The upper end of the bin has laterally projecting flanges 83 and 84 (FIG. 3) slotted for receiving the suspension rods 82. Nuts 85 mounted upon the rods 82 clamp the flanges 83 and 84 and hold the bin 80 in a desired vertically adjusted position.

When the storage unit 10 is moved, the bin 80 is elevated in order to provide suitable clearance with the ground surface 77. To accomplish such movement, the nuts 85 are loosened and a hand-operated winch 86 (FIGS. 1 and 3) elevates the bin. The winch cooperates with cables 87 and 88 on opposite sides of the unit. The cables extend over idler rollers 89 and 90 mounted upon the side rails 81.

The sprocket shaft 75 is mounted in the bin 80 just below the winch shaft so that the winch shaft extends between the conveyor runs with suitable clearance. When the bin and conveyor system are to be used, the winch is lowered and the nuts 85 are tightened in order suitably to tension the conveyor chains 70 and 71.

The bin 80 has a flexible, rearwardly extending lip 91 into which a dump truck deposits sand. The buckets 72

pick up the sand so deposited and move in the direction indicated by arrows in FIG. 1. As the buckets pass about the sprocket shaft **76** at the outer corner of the unit, the buckets tilt and partially discharge their contents upon a horizontal plate **92** that extends between the upper and lower parts of the horizontal run. The sides of the plate **92** are attached to the side plates **78** and **79**. Accordingly, the sand is carried forwardly to the edge **93** of the plate which is located just short of the sprocket shafts **73** at the forward end of the hopper **14**. The sand is thus deposited in the forward part of the bin. As the sand builds up, the scoops or buckets **72** act to carry the excess sand rearwardly and to level the top of the sand, as indicated by the dotted-line showing. Thus the buckets or scoops **72** not only convey the sand into the hopper **14**, but serve to level it. By virtue of the location of the arrangement illustrated, the hopper **14** can be filled and levelled, ensuring efficient use of the entire space.

The conveyor is adapted to be operated by the engine **32**. For this purpose, a sprocket chain **94** (FIGS. 1 and 4), extending between the slightly separated rear and front walls **19** and **27** of the respective hoppers **13** and **14**, transfers power from the engine shaft **33**. The sprocket chain **94** cooperates with a sprocket wheel **95** journalled upon the engine shaft **33**. A dog clutch element **96**, keyed or splined to the engine shaft, is movable axially to engage a driven clutch part **97** attached to the sprocket wheel **95**.

The other end of the chain **94** engages a sprocket wheel **98** (FIG. 4) projecting laterally from a right-angle drive **99** mounted at the top of the hopper **14** and above the conveyor sprocket shaft **73**. An output shaft **100** extends in opposite directions from the drive **99** in parallel relationship to the conveyor sprocket shaft **73**, and is mounted in suitable bearing structures **101** and **102** affixed to the side plates **78** and **79**. Sprocket chains **103** and **104** at the ends of the drive shaft **100** cooperate with sprockets **105** and **106** located adjacent and outside of the sprockets for the conveyor chains **70** and **71**. The chains **103** and **104** are driven by sprocket wheels **106** and **107** mounted upon the output shaft **100**.

When it is desired to operate the conveyor, the clutch structure shown in FIG. 1 is operated as by the aid of a hand lever **108**.

## GUNITE UNIT

Cooperable with the storage unit **10** is a Gunite unit **109**, in this instance mounted upon a separate vehicle. The Gunite unit **109** has a frame **110** upon which various components are mounted. It incorporates a premixing or receiving hopper **111** (FIGS. 5 and 7) located in the rear end of the frame **110**. Suitable mixing paddles **112** (FIG. 10) are mounted in the receiving hopper **111**. The cementitious material **113** from the receiving hopper **111** is transferred to an elevated secondary mixer **114** (FIGS. 1 and 5) by the aid of a conveyor structure of a type generally shown and described in the Ridley patent above identified. Communication between the conveyor structure and the receiving hopper **111** is provided through a gate **115** that forms a common wall between the lower end of the conveyor and the receiving hopper **111**. When the gate **115** is opened, the paddles or mixing blades **112** urge the cementitious material **113** into the conveyor structure. The gate **115** is operated by a pneumatic cylinder **116** attached to the side of the conveyor.

The secondary mixing chamber **114** deposits material into a transfer chamber **117** having inlet and outlet valve closures respectively cooperable with the mixing chamber **114** and a pressure chamber **118**. In a well understood manner, the chamber **118** is continuously pressurized. Thus the transfer chambler outlet valve is closed while it receives material, and pressurized before the outlet valve is opened. Cooperable with the pressure chamber is a suitable discharge conduit **119** (FIG. 1) at the end of which a manually operated gun or nozzle **120** is attached.

An engine **121** (FIG. 5) operates the mixer of the receiving hopper **111**, the conveyor structure and the secondary mixer structure **114**. The engine has a drive shaft **122** that through a gear reduction box **123** operates a suitable drive sprocket **124** connected appropriately to achieve the desired operation.

## WEIGHING

Sand and cement from the storage unit **10** are weighed by apparatus attached to the frame **110** of the Gunite unit and then released to the receiving hopper **111** thereof. A weighing box **125** (FIGS. 1, 6, 7, 9 and 10) is suspended above the receiving hopper **111** by the aid of a pair of frame members **126** and **127**. The frame member **126** (FIG. 5) is formed as an inverted channel and extends along the right-hand side of the Gunite unit **109**. The frame member **126** is adjustably supported at opposite ends by the aid of threaded posts **128** and **129** in turn attached to the frame **110**. The frame member **127**, as shown in FIG. 6, has an offset configuration providing a table or platform **130** at the left-hand end and forwardly of the weighing box **125**. The frame member **127** is adjustably supported by the aid of levelling screws **131** and **132** respectively mounted upon the frame **110**. The frame members **126** and **127** respectively extend with clearance along opposite side walls **133** and **134** of the weighing box **125**.

The box **125** is suspended upon a pair of companion balancing beams **135** and **136** in turn suspended from the frame members **126** and **127**. The balancing beam **135** is substantially U-shaped. A central connection portion **137** of the balancing beam **135** extends with clearance along the rear wall **138** of the box **125** (see FIGS. 1 and 10), with ends **139** (FIG. 6) and **140** (FIG. 5) projecting forwardly along the side walls **133** and **134**. The companion balancing beam **136** has a connecting portion **141** (FIG. 10) extending along the front wall **142** of the weighing box, with its ends **143** (FIG. 6) and **144** (FIG. 5) projecting rearwardly along the side walls of the weighing box.

From the frame members **126** and **127** four knife edges are chain-suspended. One of the knife edges **145** (FIG. 5) provides a fulcrum for the side arm **144** of the forward balancing beam **136**. The second knife edge **146** provides a fulcrum for the side arm **140** of the rear balancing beam **135**. A third knife edge **147** (FIG. 6) provides a fulcrum for the side arm **139** of the rear balancing beam **135**. And a fourth knife edge **148** provides a fulcrum for the arm **143** of the forward balancing beam **136**. The knife edges **147** and **146** are aligned so as to determine an axis of angular movement of the balancing beam **135**. Similarly, the knife edges **148** and **145** are aligned to determine an axis of movement of the forward balancing beam **136**.

The weighing box **125** is suspended from four knife edges bearing upon the balancing beams **135** and **136**. Thus a knife edge **149**, in turn attached by chain links **150** attached to the side wall **133** of the weighing box **125**, bears upon the balancing beam **135** at a place spaced forwardly of the knife edge fulcrum **147**. A knife edge **151**, in turn attached by chain links **152** attached to the side wall **133** of the weighing box **125**, bears upon the balancing beam **136** at a place spaced rearwardly of the knife edge fulcrum **148**. A knife edge **153**, in turn attached by chain links **154** to the side wall **134** of the weighing box **125**, bears upon the balancing beam **135** at a place aligned with the knife edge **149**. A knife edge **155**, in turn attached by chain links **156** to the side wall **134** of the weighing box **125**, bears upon the balancing beam **136** at a place aligned with the knife edge **151**.

The weight of the box **125** and its contents tends to move the balancing beams angularly about their fulcrums and the adjacent ends of the arms **143** and **139** downwardly. This movement of the beams **135** and **136** is opposed by a scale mechanism **157** mounted on the platform **130**. The scale mechanism connects with the balancing beams

135 and 136 via beams 158 and 159, pivoted on the frame, and links 160, 161 and 162. As the weighing box 125 moves downwardly, the scale pointer 163 moves along scale indications, as at 164, to indicate the net weight of the box 125.

The box 125 is positioned beneath both discharge slots 22 and 31 of the storage unit 10, as shown in FIG. 6, so as to receive the material discharged. The weighing box, as shown in FIG. 9, is open at the top. The lower portion of the box is divided into two discharge hoppers 165 and 166 by the aid of a central dividing wall 167 the top edge of which is recessed substantially beneath the top of the box 125. The lower ends of the discharge hoppers 165 and 166 are each closed by a series of louvers 168. The louvers 168, as shown in FIG. 7, have bearing pins, as at 169, respectively received in bearing apertures of the front and rear walls 142 and 138. The louvers are mounted upon spaced horizontal axes and are capable of movement into overlapping relationship, as illustrated in FIG. 9, for closing the weighing box 125, and are furthermore movable angularly from abutting relationship to parallel vertical relationship so as to open the weighing box 125 and discharge its contents to the receiving hopper 111.

One of the constituent materials from the storage unit 13 is first discharged into the weighing box 125 until the scale indicator 163 moves to a certain position. Thereupon, flow of that one constituent material is interrupted and flow of the other constituent material begins. The flow of the second constituent material is stopped at a time when the scale pointer 163 reaches a second position corresponding to the desired proportion of constituents. The louvers 168 are then moved to open position and the constituents discharged. If desired, a vibrator may be attached to the weighing box 125 so as to ensure rapid and substantially complete discharge of contents. In practice, a certain minimum quantity of the constituent materials adheres to the box. Compensation is readily achieved by suitable zero adjust mechanism incorporated in the weighing apparatus 157.

In order to rotate the louvers 168, a rack 170 (FIG. 10) is provided. The rack 170 engages pinions 171 carried on the projecting ends of the mounting pins, and is horizontally reciprocated along the front wall 142 of the weighing box. Idler rollers 172 attached to the front wall 142 confine the rack against the pinions 170. In order to move the rack, a double-acting pneumatic cylinder 173 is provided that is mounted upon the box wall 142. Mutual abutting relationship of the louvers 168 determines one limit to the movement of the rack 170, and an internal stop of the cylinder 173 determines the open position of the louvers 168.

Operation of the pneumatic cylinders 64, 66 and 67 may be controlled manually by the aid of switches mounted upon a control panel 174 in turn attached to the frame 110. A button 175, for example, operates a switch that moves the pneumatic cylinder 64 to discharge sand. A button 176 may be operated to actuate a switch so as to cause cement to be discharged. A button 177 may operate the pneumatic cylinder 173 to discharge the contents of the weighing box 125. And a switch arm 178 may be operated to cause operation of the cylinder 116 to open the discharge gate 115 of the receiving hopper 111.

## CONTROL SYSTEM

In addition to manual controls, a control system (FIG. 13) is provided for maintaining the Gunite unit filled with suitably mixed sand and cement. Electrically energized actuators 179, 180, 181 and 182 are provided for working the apparatus thus far described. Thus the actuators 179 only when energized causes cement to be discharged from the mobile unit 13. Similarly, the actuator 180 only when energized causes discharge of the sand. The actuator 181 when energized operates the pilot valve of the cylinder 173 to cause the weighing box 125 to be opened. When the actuator 181 is deenergized, the pneumatic cylinder 173 returns the louvers to closed position. Similarly, the actuator 182 when energized causes the discharge gate 115 to be opened, and when the actuator 182 is deenergized, the gate is caused to close.

In order suitably to control the operation of the actuators 179, 180, 181 and 182 for cement, sand, the scale and the mixer gate, a number of sensing switches are provided. Sensing switches are depicted enclosed in rectangles and labelled so as to indicate operation upon the condition named. Until the named condition exists, the sensing switches are in the positions illustrated. Thus a "read zero" switch 183 closes when the scale indicator moves to a zero position. The switch 183 may be of the magnetic reed type cooperable with a magnet carried by the scale indicator. A "read cement" switch 184 closes momentarily when the scale indicator reaches a position corresponding to a desired weight of cement. The position along the scale when the switch 184 is actuated may be adjusted. A "read sand" switch 185 closes when the scale indicator reaches a position corresponding to the desired combined weight of cement and sand. Similarly, this switch may be adjusted along the scale. By adjusting the positions of the switches 184 and 185, the quantity and proportion of sand and cement is controlled in a manner presently to appear.

A "gate closed" switch 186 is a simple limit switch that is associated with the discharge gate 115 and is closed only when the gate is closed. A "scale discharging" switch 187 closes as soon as the louvers of the scale move to open position. Switch 187 may also be suitably positioned to be engaged by the rack 170.

The "gate opened" switch 188 is a double pole switch that moves from the full-line position illustrated to the opposite position when the gate reaches a fully open position. The switch returns to the position illustrated indicated whenever the gate is in other than at a fully open position. A "Gunite full" switch 189 senses the existence of a satisfied condition of the Gunite apparatus and opens upon the existence of such satisfied condition. A bypass switch 190 is providede so as to make the cycle independent of the demands of a Gunite machine.

Also used in the control system are timers 191 and 192. These timers may be of a type commercially available from Automatic Timing & Controls, Inc. of King of Prussia, Pa., and known as an ATC Model 305–B Zero to Two Minute Timer. One of the timers 191 is used to determine the period for pre-mixing of the sand and cement in the receiving hopper 111 of the Gunite machine, and the timer 192 is used to time the period during which the discharge gate 115 is open. Each of the timers includes a motor M and electrically actuated device C for coupling a movable arm to the motor M. When uncoupled, the arm returns to a preset position corresponding to time, as by spring action. The clutch actuator C also moves contacts C1 and C2 to an attracted position from a normal position illustrated. When the arm reaches the zero time position, contacts A1 and A2 are moved away from the position indicated to the opposite position, as by snap action. When the clutch actuator C is deenergized, the arm swings back to the preset time position, and the arms A1, A2, C1 and C2 return to the positions illustrated. The time cycle may then be repeated.

In order to begin operation of the actuators 179, 180, 181 and 182, the engine 121 is started, causing mixer paddles 112 to be continuously operated. Pneumatic and electrical lines are hooked up. A start switch 193 is operated in order to provide power across lines L1 and L2. At this time, the actuators 179, 180, 181 and 182 are deenergized. Manual override switches 194, 195 and 196 are respectively associated with the actuators 179, 180 and 181 and may be operated by the previously identified buttons 176, 175 and 177. Switches 194, 195 and 196 are spring-pressed and normally are open. Thus upon application of digital pressure to any of the but-

tons, the corresponding actuators are energized. The arm **178** operates three switches through a common linkage **197**. When arm **178** is moved clockwise from the position illustrated, a circuit to the actuator **182** is closed through a switch **198**. The arm **178** also causes opening of switches **201** and **202** hereafter to be described. Switch arm **178** may be moved into any one of three stable positions corresponding to "automatic", "hold" and "manual".

In order to achieve automatic operation of the actuators, eight control relays **203**, **204**, **205**, **206**, **207**, **208**, **209** and **210** are provided. These relays are designated the "zero" relay, the "cement" relay, the "C off" (cement off) relay, the "sand" relay, the "S off" (sand off) relay, the "scale" relay, the "SD" (scale discharging) relay and the "mixer" relay. These relays **203–210** are arranged in circuit with the sensing switches **183**, **184**, **185**, **186**, **187**, **188** and **189** and with the timers **191** and **192**, as well as with contacts made and broken by the relays **203–210**.

In order to initiate operation of the automatic cycle, the switch arm **178** is moved to "manual" position and then back to "automatic" position. This cycles the gate actuator **182** and causes opening and closing of the gate **115**. The "gate opened" switch **188** is thus operated and the mixer relay **210** is energized. Energization of the mixer relay **210** is sustained independently of the switch **188** by a holding circuit that is established by virtue of the energization of the mixer relay **210**. Thus the holding circuit from line L1 includes normally open mixer relay contacts **211** and normally closed contacts **212** of the sand discharging relay **209**. Thus the mixer relay **210** is energized and held by momentary operation of the switch **188**. The sand discharging relay **209** being deenergized, the contacts **212** are maintained closed.

A line L1′ is connected to the line L1 through a normally closed stop switch **213**. Some of the relays and actuators are dependent upon the stop switch **213**.

Automatic operation may now commence. The scale is at a zero weight position; accordingly, the zero read switch **183** closes and operates zero relay **203**. Energization of the relay **203** completes an energization circuit for the cement relay **204**. The energization circuit can be traced from line L1, a manually operable selector switch **214** that is moved to the closed "recycle" position, normally open contacts **215** of the zero relay and normally closed contacts **216** of the sand discharging relay, to the cement relay **204** and the line L2. Cement relay **204** is held through a holding circuit including normally closed contacts **217** of the cement off relay (which is as yet deenergized) and normally open contacts **218** of the cement relay **204**.

As the cement relay **204** is energized, a circuit for the cement actuator **179** is established through normally open relay contacts **219**. Accordingly, cement is discharged from the unit **13** to the weighing box **125**. At the same time, an energization circuit for the sand relay **206** is established through normally open contacts **220** of the cement relay **204**. A holding circuit for the sand relay **206** is pulled in through normally open relay contacts **221** of the sand relay **205** and normally closed contacts **222** of the yet unenergized said off relay **207**. Operation of the sand relay **206** causes closure of contacts **223** in an energization circuit for the sand actuator **180**. However, the energization circuit for the sand actuator **180** is also dependent upon normally closed contacts **224** of the cement relay **204**. Hence, the energization circuit for the sand actuator **180** is at this time incomplete.

An energization circuit is also established for the scale relay **208** through normally open contacts **240** of the sand relay **206**. A holding circuit is thereupon effective for the scale relay **208** through normally closed thermal contacts **225** and normally open contacts **226** operated by the scale relay **208**. Operation of the scale relay **208** conditions an energization circuit for the scale actuator **181** through a circuit that includes normally closed contacts **227** of the sand relay **206** (which has been operated and hence is now open), normally open contacts **228** of the scale relay **208** which are now closed, normally open contacts **229** of the mixer relay **210** which has been energized, a sensing switch **186** that is closed because the gate is closed. In the energization circuit for the scale actuator **181** is a normally closed, manually operable switch **230**. The switch **230** is moved to open position by an arm **231** that simultaneously opens a switch **232** in the energization circuit for the sand actuator **180**. The operation of the switches **232** and **230** will be described hereinafter.

Cement continues to flow until the read cement switch **184** closes. This occurs when the box **125** has received the desired quantity of cement. The cement off relay **205** is thereupon energized. This results first of all in the opening of the contacts **217** in the holding circuit for the cement relay **204** which accordingly drops out. Thus discharge of cement ceases due to opening of contacts **219** in the circuit for the cement actuator **179**.

As the cement relay **204** drops out, the relay contacts **224** close and the circuit for the sand actuator **180** is completed. Accordingly, sand begins to discharge into the apparatus. Ultimately, the read sand switch **185** closes and the sand off relay **207** is energized. This results in an interruption of the holding circuit of the sand relay **206** by virtue of the opening of the normally closed contacts **222**. Consequently, the energization circuit of the sand actuator **180** is interrupted through opening of the contacts **223**. Simultaneously, the energization circuit for the scale actuator **181** is energized by virtue of the closing of the contacts **227** of the sand relay **206**.

As a result of the energization of the scale actuator **181**, the scale discharging relay **209** is energized by virtue of the closure of the sensing switch **187** associated with the scale discharge, and contacts **229** are bridged by normally open contacts **233** of the sand discharging relay **209**. This ensures continued operation of the energization circuit for the actuator **181** despite opening of the mixer relay contacts **229**. It fact, the holding circuit for the mixer relay **210** is interrupted by opening of the normally closed contacts **212** operated by the sand discharging relay **209**.

As the contents of the box **125** are discharged, the scale returns toward zero position. The sensing switch **184** is momentarily closed in the process. This results merely in the opening of the previously opened holding circuit for the cement relay **204**.

When the contents of the box are fully discharged, the read zero switch **183** is momentarily closed and the zero relay **203** is energized. This results in interruption of the energization circuit for the scale actuator **181** but only after a short time delay to allow for the scale to reach the equilibrium position. Otherwise, relay **203** would close prematurely, trapping a quantity of sand in the box. In order to provide such time delay circuit, a thermal element **234** is provided that is energized through the holding circuit for the scale relay and normally open contacts **235** of the zero relay **203**. The thermal element or relay **234** heats up (the scale remaining at a zero reading) and thermal contacts **225** open after a second or two. The holding circuit for the scale relay is interrupted, and the thermal relay **234** is also deenergized. Deenergization of the scale relay **208** opens contacts **228** and the circuit for the scale actuator **181** is deenergized. The weighing box **125** closes.

The sand discharging relay is deenergized just as soon as the weighing box **125** is closed by opening of the sensing switch **187**. Accordingly, the contacts **216** in circuit with the cement relay **204** return to closed position and the cycle as thus far described starts again providing the switch **214** is still closed. Thus the switch determines whether or not the cycle is to be repeated. Momentary closure of switch **214** causes one cycle of operation only. Initial operation of the scale actuator **181** is dependent upon the contacts **229** being closed whereas the holding circuit for the mixer relay **210** has

been opened by the scale discharging relay **209**. Hence, even if the box **125** is filled again, its contents cannot be discharged until the mixer relay **210** is re-energized. Continuation of the cycle awaits this event if it has not yet occurred. The mixer relay **210** cannot again be energized until the discharge gate is opened and the sensing switch **188** operated in accordance with the timing circuits presently to be described.

The gate is opened and held open for a time interval adequate to allow discharge of the contents from the hopper **111**. But this timing cycle occurs only after a first timing cycle during which the material is held in the hopper for a predetermined time. When the discharge gate returns to closed position corresponding to emptying of the hopper **111**, the energization circuit for the scale discharged actuator **181** is either conditioned for operation by closure of the sensing switch **186**, or actually operated thereby if the box is full. Thus the mixer relay **210** accomplishes a suitable interlock between the discharge of the hopper **111** and the discharge of the scale box **125**. The control of the opening and closing of the gate **115** will now be described.

The timing cycle for mixing in the hopper **111** is initiated simultaneously with the operation of the sand discharging relay **209**. Thus the clutch C of the mixing timer **191** has an energization circuit dependent only upon normally open contacts **236** of the sand discharging relay **209**. Contacts C1 and C2 are thereupon moved to an attracted position. A holding circuit for the clutch C is effective through a front contact **237** via gate opened switch **188** which is in the full-line position indicated because the gate **115** was not yet opened. The holding circuit also completes an energization circuit for the motor **10** through contact A1 associated with the motor. Thus the motor begins to operate and the switch arm of the timer **191** begins its travel towards the zero position. During this interval of time, the marterial dropped into the pre-mixing hopper is mixed for a time corresponding to the timer setting.

As the arm of the timer **191** reaches the zero time position, the motor contacts A1 and A2 are moved to the opposite position. The energization circuit for the motor M is interrupted and an energization circuit for the second timer **192** is completed. This circuit may be traced from motor contacts A2 of the mixer timer **191**, the contacts C2, level sensing switch **189** and the switch **201** to the clutch C of the timer **192**. As the clutch C of the discharge timer **192** is energized, the contact C2 is established and the gate actuator **182** is energized through a circuit including the switch **202** and the contact C2. The gate accordingly moves to open position.

At the same time, the sensing switch **188** is moved to the position opposite that illustrated in full line. This results in energization of the mixer relay **210**. Operation of the mixer relay closes contacts **229** in the circuit for scale actuator **181**. Furthermore, the holding circuit for the clutch C of the mixer timer **191** is interrupted by opening of the gate open switch **188**. The mixer relay **210** is held energized through its holding circuit and the timer **191** is reset subject to the subsequent command of the sand discharging relay contacts **236**.

The gate actuator **182** is maintained energized for a time interval corresponding to that necessary to achieve discharge of most of the contents of the pre-mixer hopper **111**. The second timer **192** achieves this operation. Thus the clutch C of the timer **192** has a holding circuit through contacts A2 of its motor M and the front contact C1. This holding circuit also provides an energization circuit for the motor M through the contacts A1 independent of the mixer timer **191**.

As the arm of the discharge timer **192** reaches the zero position, it opens the contact A2 and consequently interrupts the holding circuit for the timer **192**. The contact C2 drops out and accordingly energization of the gate actuator **182** is interrupted after the required time interval. As a result of the deenergization of the actuator **182**, the gate **115** closes and the gate closed switch closes to condition or operate the circuit of the scale actuator **181**. Furthermore, closure of the gate **115** conditions for operation the holding circuit for the timer **191** preparatory for the succeeding cycle.

Switch **231** allows the operator to interrupt the cycle during or prior to the discharge of the sand into the weighing box and to prevent energization of the scale actuator or interrupt its energization. The operator can then inspect the scale reading. Immediately upon reclosure of the switches **230** and **232**, the cycle continues in accordance with its previous condition.

The switch arm **178** may be moved to a neutral position to preclude operation of the gate actuator **182** and interrupt the cycle at this point. Operation of the switch **200**, however, does not interrupt the holding circuit for the timer **192**.

The stop switch **213** opens relays **204**, **205**, **206**, **207** and **208**, and also the energization circuits for the cement, sand and scale actuators. If any material is in the weighing box, it will be held there, and more will be added. Whatever material is in the hopper **111** will continue to be processed. Operation may be resumed by manual override switches until the box is discharged, returning control to the read zero switch **183**. The arm **178** is again manipulated to reset the interlock circuits. If it is desired to stop operations after the end of a cycle, the switch **214** may be opened during the cycle.

The inventor claims:

**1.** In a mobile storage unit: a wheel mounted support; a cement hopper and a sand hopper mounted on the support, said sand hopper having a substantially rectangular upper opening; a continuous conveyor structure having a horizontal run along the said sand hopper opening and a vertical run at one end of said sand hopper; a loading hopper located at the lower end of said vertical run; said vertical run having inner and outer parts, and said horizontal run having upper and lower parts; said conveyor structure having buckets extending horizontally and having a width corresponding to said hopper opening; means for moving the conveyor to cause the buckets to run upwardly along the outer part of the vertical run, forwardly along the top part of said horizontal run, rearwardly along the bottom part of said horizontal run and downwardly along the inner part of said horizontal run, and a plate extending between the parts of the horizontal run and having a discharge edge remote from said one end of said sand hopper whereby the sand is initially discharged into the other end of said hopper with the lower part of said run leveling the sand therein.

**2.** In a mobile storage unit: a wheel mounted support; a cement hopper and a sand hopper mounted end to end on the support, said sand hopper having a substantially rectangular upper opening; a continuous conveyor structure having a horizontal run along the said sand hopper opening and a vertical run at one end of said sand hopper; a loading hopper located at the lower end of said vertical run; said vertical run having inner and outer parts, and said horizontal run having upper and lower parts; said conveyor structure having brackets extending horizontally and having a width corresponding to said hopper opening; means for moving the conveyor to cause the buckets to run upwardly along the outer part of the vertical run, forwardly along the top part of said horizontal run, rearwardly along the bottom part of said horizontal run and downwardly along the inner part of said horizontal run, and a plate extending between the parts of the horizontal run and having a discharge edge remote from said one end of said sand hopper whereby the sand is initially discharged into the other end of said hopper with the lower part of said run leveling the sand therein, said means includig a drive chain extending between the adjacent ends of said hoppers.

3. In a mobile storage unit: a wheel mounted support; a storage hopper mounted on the support and having an upper opening; a first conveyor support member mounted transversely at one end of said opening; a second and a third conveyor support member mounted at the other end of said opening; a loading hopper; means mounting the loading hopper for limited vertical movement at the outside of said hopper beneath the said other end of said opening; means adjusting the position of said loading hopper; a fourth conveyor support member mounted in said loading hopper; and an endless bucket conveyor structure carried by said support members to form a vertical run at one end of said storage hopper and a horizontal run along the opening of said hopper.

4. In a mobile storage unit: a wheel mounted support; a storage hopper mounted on the support and having an upper opening; a first conveyor support member mounted transversely at one end of said opening; a second and a third conveyor support member mounted at the other end of said opening; a loading hopper; means mounting the loading hopper for limited vertical movement at the outside of said hopper beneath the said other end of said opening; means adjusting the position of said loading hopper; a fourth conveyor support member mounted in said loading hopper; an endless bucket conveyor structure carried by said support members to form a vertical run at one end of said storage hopper and a horizontal run along the opening of said hopper; and a plate extending between upper and lower parts of the horizontal run, and having a discharge edge adjacent the other end of said storage hopper whereby material is initially discharged into the said other end of said storage hopper and leveled by the lower part of said horizontal run.

5. In a mobile storage unit: a wheel mounted support; a storage hopper mounted on the support and having an upper opening; a first conveyor support member mounted transversely at one end of said opening; a second and a third conveyor support member mounted at the other end of said opening; a loading hopper; means mounting the loading hopper for limited vertical movement at the outside of said hopper beneath the said other end of said opening; means adjusting the position of said loading hopper; a fourth conveyor support member mounted in said loading hopper; an endless bucket conveyor structure carried by said support members to form a vertical run at one end of said storage hopper and a horizontal run along the opening of said hopper; and means for holding the loading hopper in a lowered position for tensioning said conveyor structure.

6. In a batch cement plant: a weighing box; means for conveying cement to said weighing box; means for conveying sand to said weighing box; a mixer; means for discharging the contents of the weighing box to the mixer; means for discharging the contents of the mixer; an actuator for causing operation of the cement conveying means; an actuator for causing operation of the sand conveying means; an actuator for causing operation of the weighing box discharging means; an actuator for causing operation of the mixer discharging means; means sensing the weight of the contents of the box; means for operating the cement actuator and the sand actuator in sequence and under automatic control of said weight sensing means; means responsive to the weight sensing means detecting a zero weight for initiating operation of said sand and cement actuator operating means; means for operating said box actuator after discharge of controlled quantities of sand and cement; means operating said mixer discharge actuator at a predetermined time interval after operation of said box actuator; and means preventing operation of said box actuator during said predetermined time interval.

7. In a batch cement plant: a weighing box; means for conveying cement to said weighing box; means for conveying sand to said weighing box; a mixer; means for discharging the contents of the weighing box to the mixer; means for discharging the contents of the mixer; an actuator for causing operation of the cement conveying means; an actuator for causing operation of the sand conveying means; an actuator for causing operation of the weighing box discharging means; an actuator for causing operation of the mixer discharging means; means sensing the weight of the contents of the box; means for operating the cement actuator and the sand actuator in sequence and under automatic control of said weight sensing means; means responsive to the weight sensing means detecting a zero weight for initiating operation of said sand and cement actuator operating means; means for operating said box actuator after discharge of controlled quantities of sand and cement; means operating said mixer discharge actuator at a predetermined time interval after operation of said box actuator; means for maintaining said mixer discharge actuator operative for a predetermined time interval; and means preventing operation of said box actuator during said time intervals.

8. In a batch cement plant: a weighing box; means for conveying cement to said weighing box; means for conveying sand to said weighing box; a mixer; means for discharging the contents of the weighing box to the mixer; means for discharging the contents of the mixer; an actuator for causing operation of the cement conveying means; an actuator for causing operation of the sand conveying means; an actuator for causing operation of the weighing box discharging means; an actuator for causing operation of the mixer discharging means; means sensing the weight of the contents of the box; means for operating the cement actuator and the sand actuator in sequence and under automatic control of said weight sensing means; means responsive to the weight sensing means detecting a zero weight for initiating operation of said sand and cement actuator operating means; means for operating said box actuator after discharge of controlled quantities of sand and cement; means operating said mixer discharge actuator at a predetermined time interval after operation of said box actuator; means preventing operation of said box actuator during said predetermined time interval; and means sensing a demand for material of said cement plant for preventing operation of said mixer discharge actuator operating means when the demand is satisfied.

9. In a batch cement plant: a weighing box; means for conveying cement to said weighing box; means for conveying sand to said weighing box; a mixer; means for discharging the contents of the weighing box to the mixer; means for discharging the contents of the mixer; an actuator for causing operation of the cement conveying means; an actuator for causing operation of the sand conveying means; an actuator for causing operation of the weighing box discharge means; an actuator for causing operation of the mixer discharging means; means sensing the weight of the contents of the box; means for operating the cement actuator and the sand actuator in sequence and under automatic control of said weight sensing means; means responsive to the weight sensing means detecting a zero weight for initiating operation of said sand and cement actuator operating means; means for operating said box actuator after discharge of controlled quantities of sand and cement; means operating said mixer discharge actuator at a predetermined time interval after operation of said box actuator; means for maintaining said mixer discharge actuator operative for a predetermined time interval; means preventing operation of said box actuator during said time intervals; and means sensing a demand for material of said cement plant for preventing operation of said mixer discharge actuator operating means when the demand is satisfied.

10. In a batch cement plant: a weighing box; means for conveying cement to said weighing box; means for conveying sand to said weighing box; means for discharging the contents of the weighing box; an actuator for causing operation of the cement conveying means; an actuator for causing operation of the sand conveying means; an

actuator for causing operation of the weighing box discharging means; means sensing the weight of the contents of the box; means for operating the cement actuator and the sand actuator in sequence and under automatic control of said weight sensing means; cycle starting means for initiating operation of said sand and cement actuator operating means when the weighing box is empty; and means operating said box actuator after discharge of controlled quantities of sand and cement.

**11.** The combination as set forth in claim **10** together with selectively operable means for causing said cycle starting means to be responsive to the weighing box being empty.

**12.** The combination as set forth in claim **10** together with means continuing the operation of said box actuator until a predetermined time interval after the weight sensing means indicates that the box is empty.



**13.** The combination as set forth in claim **10** together with override means for preventing operation of said box actuator.

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