Dec. 7, 1965 J. H. REIGHART 3,221,380

LADLE ADDITION FEEDING MECHANISM WITH INDEPENDENTLY CONTROLLED FEEDER CONVEYOR

Filed Dec. 21, 1962 3 Sheets-Sheet 1

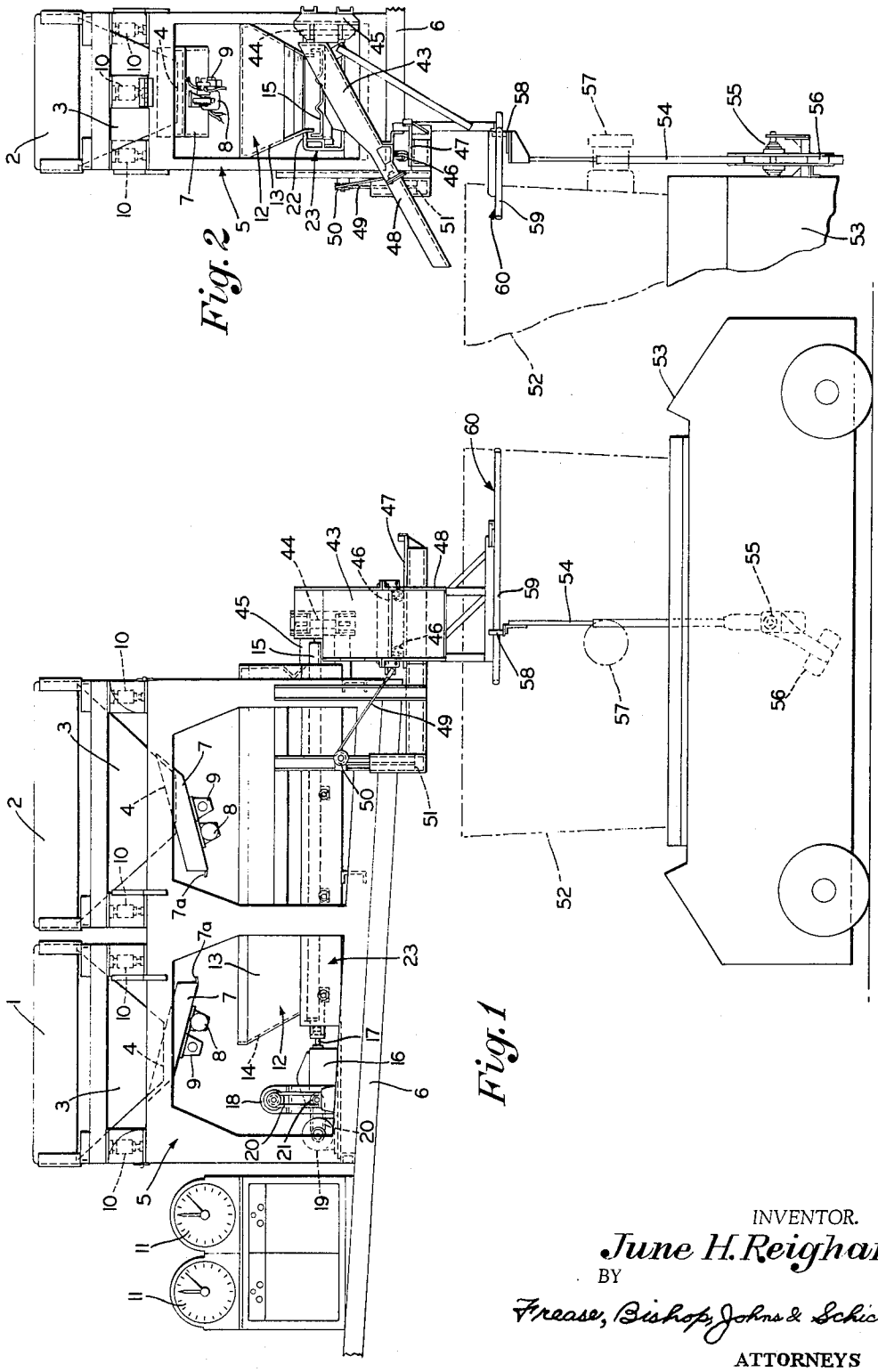


Fig. 2

Fig. 1

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Filed Dec. 21, 1962 3 Sheets-Sheet 2

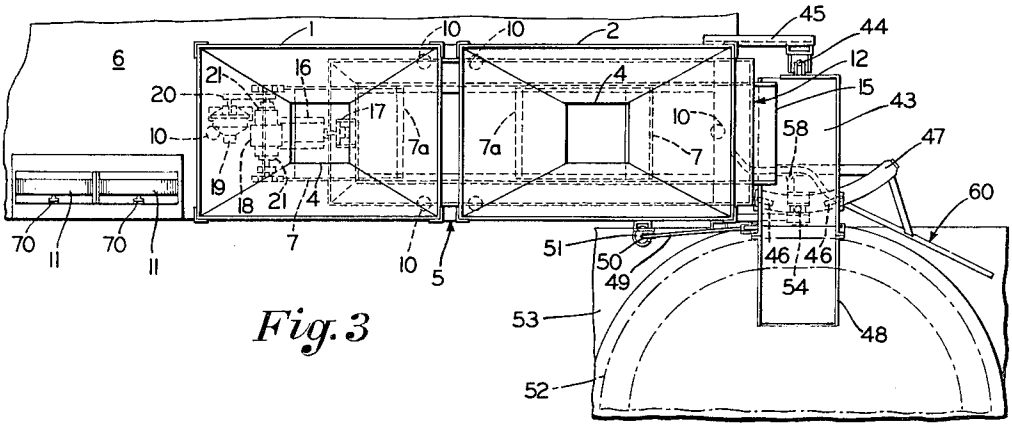


Fig. 3

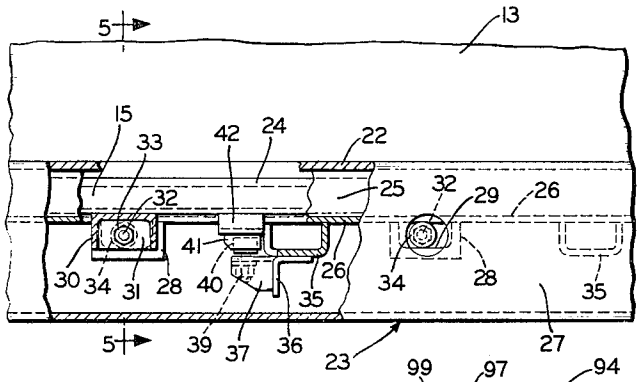


Fig. 4

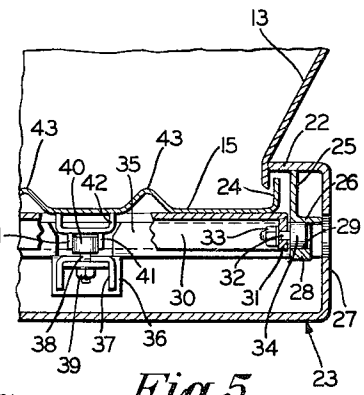


Fig. 5

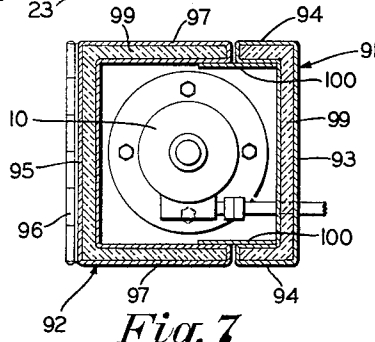


Fig. 7

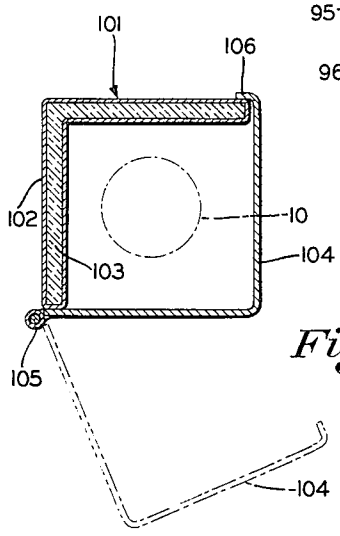


Fig. 8

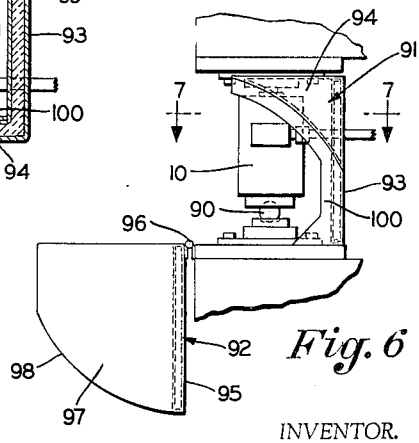


Fig. 6

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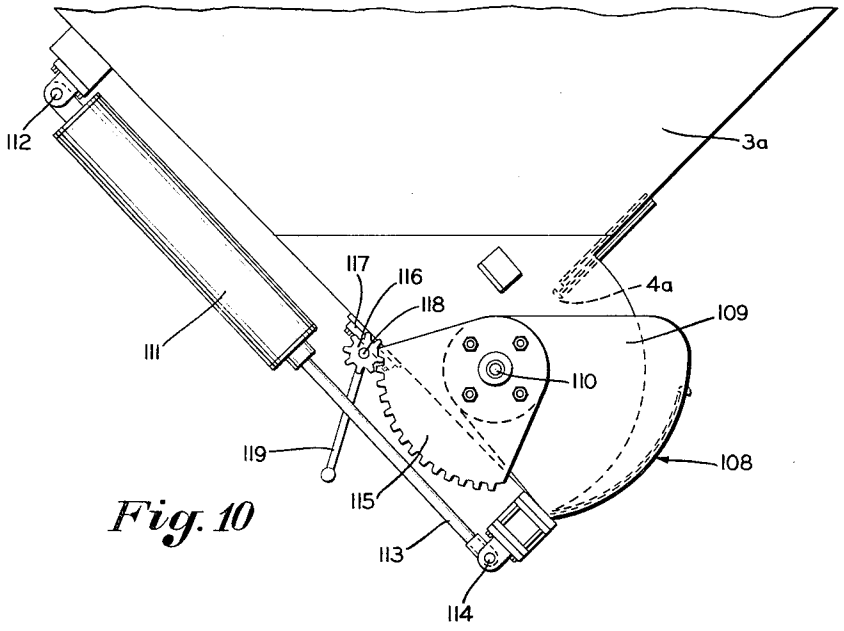


Fig. 10

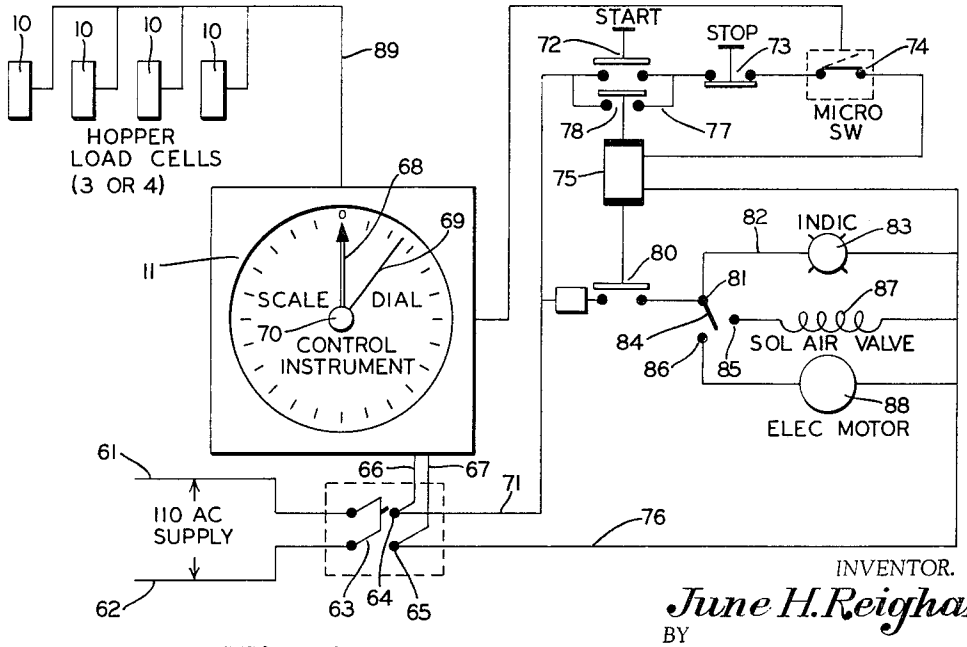


Fig. 9

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United States Patent Office 3,221,380 Patented Dec. 7, 1965

3,221,380

LADLE ADDITION FEEDING MECHANISM WITH INDEPENDENTLY CONTROLLED FEEDER CONVEYOR

June H. Reighart, 1991 Lee Road, Cleveland 18, Ohio

Filed Dec. 21, 1962, Ser. No. 246,498
10 Claims. (Cl. 22—82)

Be it known that, I, June H. Reighart, a citizen of the United States, residing at Cleveland, Cuyahoga County, Ohio, have invented certain improvements in Ladle Addition Feeding Mechanism, of which the following is a specification.

The invention relates to means for feeding additions of alloying materials and the like to the molten metal in a ladle while an open hearth, electric furnace, or other steel making furance is being tapped.

The invention relates more particularly to means for feeding predetermined amounts of different alloying materials to the ladle. It is known that apparatus has been devised including electric load-measuring means supporting a hopper from which a predetermined amount of material may be fed.

Such devices are adapted to feed the material immediately into a ladle, or the like, as it is discharged from the supply hopper. Such devices must be operated immediately up tapping of the furnace. As these devices include load-measuring means, a failure of electric power at the time the furnace is tapped would render the automatic feeding device useless.

It is a principal object of the present invention to provide a ladle addition feeding apparatus including electric load-measuring means for feeding pre-measured amounts of alloying materials upon a normally stationary, substantially horizontal, feeder conveyor which may be in the form of a shaker pan, prior to the tapping of the furnace, or if desired, simultaneously with the tapping of the furnace, with means for reciprocating the shaked pan during the tapping of the furnace for continuously feeding the material from the shaker pan to the ladle.

Another object of the invention is to provide both electric and fluid-operated means for selective operation of the vibrating mechanism for the shaker pan.

A further object of the invention is to provide mechanism of the character referred to in which the gate controlling discharge of material from the hopper may be selectively operated by electric or fluid drive means.

A still further object of the invention is to provide a pivoted chute at the discharge end of the shaker pan with means for automatically swinging the chute upon its pivot to direct the material toward the center of the ladle as the ladle is moved toward the furnace during the tapping operation.

Another object of the invention is to provide mechanism of this character in which the ladle is moved on a car, and a mast upon the ladle car contacts a pivot bar on the pivoted chute to swing the chute upon its pivot as the ladle car is moved.

A further object of the invention is to provide apparatus of the character referred to in which hinged heat shields are provided for the electric load-measuring cells which support the hoppers.

It is also an object of the invention to provide such a heat shield comprising spaced walls of metal with a layer of heat insulation material therebetween.

A still further object of the invention is to provide a device of the character referred to in which the gate for the hopper is in the form of a rotary bucket.

Another object of the invention is to provide a feeding apparatus having a conveyor or shaker pan with side extensions to form a container with capacity for the maximum requirement for ladle additions for one furnace heat.

A further object of the invention is to provide mechanism of the character referred to in which all controls including the scale dials, indicator lights, gate operating controls, selector switch, conveyor operation controls, including rate of feed and alternate drive means, and bypass manual control means for weighing and conveying may be housed in a single cabinet located in a control station.

A still further object of the invention is to provide such a device in which the pivoted chute is provided with mechanical means such as a counter-balance device for retracting the chute when not in use.

Another object of the invention is to provide apparatus of the character referred to in which a lip or ledge is provided at the discharge end of the hopper gate to reduce dribble of material after the operation of the gate has been discontinued.

The above and other objects, apparent from the drawings and following description, may be attained, the above described difficulties overcome and the advantages and results obtained, by the apparatus, construction, arrangements and combinations, sub-combinations and parts which comprise the present invention, a preferred embodiment of which, illustrative of the best mode in which applicant has contemplated applying the principle, being set forth in detail in the following description and illustrated in the accompanying drawings; in which

FIG. 1 is a side elevation of one embodiment of the invention;

FIG. 2 is a front end elevation of the apparatus shown in FIG. 1;

FIG. 3 is a top plan view of the apparatus shown in FIGS. 1 and 2;

FIG. 4 is an enlarged fragmentary side elevation of a portion of the frame and feeder conveyor showing the longitudinal and lateral guide rollers for the reciprocating shaker pan of the conveyor;

FIG. 5 is a fragmentary transverse section taken on the line 5—5, FIG. 4;

FIG. 6 is an enlarged side elevation of one of the load cells with heat shield therefor as used intermediate the corners of a hopper, showing the hinged portion of the heat shield in open position;

FIG. 7 is a further enlarged transverse, horizontal section, taken as on the line 7—7, FIG. 6, with the hinged portion of the heat shield closed;

FIG. 8 is an enlarged transverse horizontal setcion of a heat and impact shield as used for the load cells at corners of a hopper;

FIG. 9 is a schematic wiring diagram for one of the hopper gates as shown in FIGS. 1 to 3; and,

FIG. 10 is an enlarged fragmentary elevation of a rotary bucket-type of gate for the hoppers.

Referring first to the embodiment of the invention shown in FIGS. 1 to 3, a pair of storage hoppers are indicated at 1 and 2 for containing a supply of alloying material. The most commonly used alloys for ladle additions are ferro-manganese and ferro-silicon and each hopper may contain a supply of one of these materials.

Both hoppers are of the same construction, each having the downwardly tapered lower portion 3 with outlet 4 at its lower end. These hoppers are assembled in a frame, indicated generally at 5, which may be mounted upon a lower support 6, as indicated in the drawings, or suspended from suitable hangers or the like attached overhead.

Any suitable gate means may be provided for controlling the outlet for each hopper. For purpose of illustration only, the gate is shown in this embodiment of the in-

vention as a pan 7 located beneath the outlet 4 of each hopper and adapted to be vibrated longitudinally. In order to reduce dribble of material from either hopper after operation of the gates has stopped, a lip or ledge 7*a* is formed at the discharge end of each gate.

For the purpose of illustration, each of these gates is shown as adapted to be selectively vibrated by an electric vibrator indicated at 8 or an air vibrator indicated at 9. These vibrators may be of the type sold by Martin Engineering Company under the trademark "Vibrolator," for which it is understood patents are pending.

Each hopper is supported upon the frame 5 by electric load cells, indicated generally at 10, which are electrically connected to weight indicating and recording scale dials indicated generally at 11 in the manner to be later described. Both the load cells and weight indicating and recording scale dials may be of a type sold by The Atlas Car and Manufacturing Company, which are disclosed in patents owned by said company, and for which it is understood other patents are pending.

Located beneath the hopper, within the frame 5, is a longitudinally disposed feeding conveyor 12 having stationary side walls 13 and rear end wall 14, and its bottom formed by a longitudinally disposed reciprocating shaker pan 15 which is operated independently of the gates 7 for the hoppers 1 and 2.

This feeder conveyor has a capacity for the maximum requirement of materials for additions for one heat of a furnace. Thus, if desired, while the shaker pan 15 remains stationary, the gates of the hoppers 1 and 2 may be operated to discharge the desired amount of alloying materials from these two hoppers to the conveyor 12.

In addition to this, any desired pre-weighed amount of any other alloying material or materials may be placed in the conveyor 12, together with such customary materials as packages of aluminum, bags of carbon and the like.

Means is provided for operating the shaker pan 15 of the conveyor 12 independently of the gates of the hoppers 1 and 2 so that after the complete requirement for one heat's additions have been charged into the feeder conveyor, the shaker pan 15 thereof may be longitudinally reciprocated to discharge the materials therefrom into the ladle.

With such an arrangement, the hopper gates may be operated prior to the tapping of the furnace so that in the event any trouble develops in the mechanism for discharging the pre-measured material from the hoppers, there may be sufficient time to correct the trouble before the furnace is tapped.

Thus, the conveyor 12, positioned beneath the hopper gates, may receive the metered material from the hoppers and hold it until the furnace is tapped, and then feed the additions into the ladle, together with the other "hand" and miscellaneous, pre-weighed additions which may have been also placed on the conveyor.

It should be understood, however, that the shaker pan 15 of the conveyor may, if desired, be operated to feed addition materials into the ladle at the same time that the material is being metered out from the hoppers. Since each hopper and the feeder conveyor may be independently controlled, the timing is at the option of the operator.

The shaker pan 15 of the feeder conveyor is adapted to be reciprocated by a vibratory drive unit indicated at 16 (FIG. 1) connected to the rear end of the shaker pan as indicated at 17. This drive unit 16 is adapted to reciprocate the shaker pan 15 longitudinally, the forward movement being relatively slow, as compared with the rearward movement, so as to continuously discharge material from the forward end of the pan at a controlled rate.

The vibratory drive unit 16 is arranged to be selectively operated by an electric motor 18 or an air motor 19, either of which may be the primary drive means for the unit 16 and the other the auxiliary drive for use in the event of failure of the primary drive.

The conveyor drive unit 16 is connected to the drive motors 18 and 19, as by chain and sprocket gearing 20 with override type clutches, as indicated at 21, so that either drive motor may be used while the other stands still, with no switch-over operation involved.

It will be understood that this conveyor drive means operates entirely independently of the weighing controls for metering predetermined amounts of material from the hoppers 1 and 2.

Conventional electric circuit means is connected to the electric motor 18, with control switch in the circuit at a remote point, such as a control panel. The air motor 19 is in like manner connected to a conventional pneumatic line, with control valve therefor on the control panel.

Referring to FIGS. 4 and 5, the lower edges of the stationary side walls of the conveyor are attached to and supported upon the inturned flanges 22 on the channel-shaped conveyor frame member 23.

Upturned longitudinal flanges 24 are formed at the edges of the shaker pan 15, and extend upwardly, spaced outwardly from the depending edges of the stationary side walls 13 of the feeder conveyor.

For the purpose of mounting the shaker pan 15 for longitudinal movement relative to the stationary side walls 13, an angle member 25 is welded or otherwise attached within each side of the channel-shaped conveyor frame member 23.

As best shown in FIG. 5, the upper edge of the vertical flange of the angle member 25 is attached to the underside of the adjacent inturned flange 22, and the outer edge of the horizontal flange 26 of the angle member is attached to the inner surface of the adjacent vertical side wall 27 of the channel frame member 23.

Spaced blocks 28 with elongated cut-outs 29 in their upper sides are welded or otherwise attached to the under surfaces of the horizontal flanges 26 of the angle members 25 and depend therefrom.

Transversely disposed, inverted channel members 30 are attached at correspondingly spaced points to the lower surface of the shaker pan 15. A plate 31 is welded within each end of each channel member 30, and a spindle 32 is located through a suitable opening in said plate and secured thereto as by a nut 33.

A roller 34 is journalled on the spindle 32 and located within the cut-out 29 of the corresponding block 28. This limits the longitudinal movement of the shaker pan.

For the purpose of preventing lateral play of the shaker pan, a transversely disposed channel member 35 has opposite ends attached to the under surfaces of the horizontal flanges 26 of the angle members 25 at each side of the stationary channel frame member 23 of the feeder conveyor.

An angle bracket 36 is connected to the closed lower surface of the channel member 35, at the center thereof, and an inverted channel portion 37 thereof is disposed beyond one side of the channel member 35.

A vertical spindle 38 is secured to the channel portion 37 of the bracket 36, by the nut 39, and a roller 40 is journalled upon the upper portion of said spindle. The roller 40 is received between the guide flanges 41 of the bracket 42, which is attached to and depends from the underside of the shaker pan 15, at the longitudinal center thereof.

As best shown in FIG. 5, the shaker pan 15 is preferably provided with longitudinal corrugations or ribs 43, which reinforce the pan and assist in keeping the materials distributed transversely thereon.

The pan 15 of the feeder conveyor discharges onto a gravity chute 43 which directs the ladle additions into the ladle at the desired point for maximum alloying results. This chute may be positioned stationary relative to the frame 5, or may be arranged to be rotated during feed-

ing, such as in tapping operations that require movement of the ladle. As shown in FIGS. 1 to 3, the chute may be pivoted at its upper end, as indicated at **44**, to a bracket **45** mounted on the frame **5**.

Midway of its length the chute **43** is provided with wheels **46** which roll upon the arcuate plate **47** supported from the stationary frame **5**. The chute **43** may be constructed with a replaceable section **48** at the discharge end exposed close to the molten metal in the ladle.

Mechanical means may be provided for retracting the chute **43** to initial position when not in operation. Such means is shown as a counter-balance device comprising a cable or equivalent flexible member **49** attached to edge of the chute toward the feeder conveyor, and located over a pulley **50**, with a counter-weight **51** attached to the other end of the cable.

The ladle indicated at **52** is shown mounted upon a car **53** by means of which it may be moved relative to the feeder conveyor during tapping operations that require movement of the ladle.

Means is provided for rotating the chute **43** upon its pivot as the ladle is moved so as to always direct the ladle additions into the ladle at the desired point for maximum alloying results.

This means includes a mast **54**, pivotally mounted as at **55**, upon one side of the ladle car **53**. The counter-weight **56** at the lower end of the mast urges the mast into vertical position resting against the adjacent ladle trunnion **57**, as shown in FIGS. 1 and 2. The offset upper end **58** of the mast **54** is adjusted to contact the horizontal portion **59** of the chute pivot bar **60**.

As the ladle car is moved toward the right, as viewed in FIG. 1, the upper offset end **58** of the mast in contact with the horizontal portion **59** of the chute pivot bar, will rotate the chute **43** upon its pivot so as to continue to direct the chute toward the center of the ladle.

Referring back to the automatic weighing means, each of the hoppers **1** and **2** may be supported by either three or four of the electric load cells **10**. When four load cells are used, one load cell supports each corner of a hopper.

As illustrated in FIGS. 1 to 3 of the drawings, two load cells may support the two corners of one end of a hopper, and a third load cell may be located intermediate the corners at the other end of the hopper.

In FIG. 9 is shown diagrammatically the control circuit for one of the hoppers. Power is supplied on the lines **61** and **62**. A double pole switch **63** is provided for connecting the lines **61** and **62** to the terminals **64** and **65** respectively.

Wires **66** and **67** lead from the terminals **64** and **65** respectively to the electronic scale **11**. The pointer **68** on the scale dial registers the weight of material in the hopper. The adjustable pointer **69** is adjusted relative to the pointer **68** by means of a knob **70** on the outside of the dial.

Conductor **71** leads from switch terminal **64** through normally open push-button type starting switch **72**, normally closed push-button type stop switch **73**, normally closed micro-switch **74** to relay **75**.

Conductor **76** leads from switch terminal **65** to other side of relay **75**. Shunt circuit **77** is located around normally open starting switch **72** and normally open relay switch **78** is located in shunt circuit **77** and operated by relay **75**.

A conductor leads from wire **71** through normally open relay switch **80** to terminal **81**. A wire **82** leads from terminal **81** through indicating light **83** to wire **76**. Selector switch **84** is pivoted on terminal **81** and adapted to selectively contact terminals **85** and **86**.

A solenoid air valve **87** is located between the terminal **85** and the conductor **76** for controlling the air vibrator **9** on the corresponding hopper gate **7**. In like manner an electric motor **88** for operating the electric vibrator **8** is located between the terminal **86** and the conductor **76**.

The electric load cells or transducers **10** supporting the hopper are connected to the electronic instrument scale **11** by conductor **89**, to transmit measurement thereto.

To operate the apparatus, the operator first sets the adjustable pointer **69** on each scale dial for the weight of material required from that hopper. The operator then sets the selector switch **84** for choice of power for gate operation, either the air-powered vibrator **9** through the air solenoid valve **87**, or the electric vibrator **8** through the motor **88**. The two independently-powered vibrators provide for an emergency switch-over in case one or the other fails.

The operator then pushes the starting button **72** to energize the relay **75**, and close the circuit to start the gate vibrator as selected by the selector switch **84**, and discharge material from the storage hopper.

As the material is discharged from the hoppers, the scale dial pointers move back toward "0." The micro-switch **74**, or mercury switch which is attached to the shaft of the scale dial adjustable pointer, opens when this pointer returns to 0.

An adjustable mechanism may be set to trip slightly ahead of 0 to allow for gate cut-off "dribble," the gate control circuit opens and stops the gate vibrator.

In case of electric power failure affecting both gate vibrators (air and electric) the gate may be operated from the control console by air valve to operate air-powered gate vibrator through by-passing air line. If scale dial is still operating manual gate operation guided by watching the weight selection pointer as it returns to 0 will still assure accurate weight withdrawal from the storage hoppers.

The gate operation may be stopped for emergency or other reason by pushing the stop button **73**, de-energizing the relay **75** which opens the circuit.

The required amount of additions from the storage hoppers **1** and **2** may be metered into the feeder conveyor **13** before said feeder conveyor is operated, or, if the automatic weighing mechanism is functioning properly, the feeder conveyor may be operated simultaneously with the operation of the weighing mechanism, or the feeder conveyor may be started at any time during the operation of the weighing mechanism, since the operation of each is independent of the other.

The load cells **10** may have a ball mounting as indicated at **90** in FIG. 6, but it should be understood that this feature is disclosed in a pending application owned by The Atlas Car & Manufacturing Company, and no claim is made to the same by applicant.

In FIGS. 6 to 8 are shown shields for protecting the electric load cells from heat and impact typically found in steel mill operation.

These shields are in the form of a metal box lined with high temperature insulation, hinged for easy access to the cell for servicing. The type of shield shown in FIGS. 6 and 7 is best adapted for protecting load cells located intermediate the corners of a hopper or the like. The shield is formed of a stationary section **91** and a hinged section **92**.

The stationary section comprises a back wall **93** and integral substantially triangular side wall portions **94** extending forwardly from the upper portion of each side edge thereof. The hinged section comprises the front wall **95** hinged at its lower end to the base plate upon which the load cell **10** is supported, as at **96**, and the side walls **97** having the arcuate upper edges **98** shaped to fit the corresponding edges of the stationary side walls **94**.

Each section is formed of a metal shell, which may be a bright-surfaced heat-reflective metal, enclosing a high temperature insulation **99**. A metal flange **100** on the stationary section overlaps the joint between the two sections.

In FIG. 8 is shown a form of shield best adapted for protecting load cells at the corners of a hopper or the like. This shield comprises the stationary section **101** in the form of an upright angle member.

This section may comprise the metal shell **102** with high temperature insulation material **103** therein. The hinged section **104** may be in the form of a heavy steel angle member hinged at one vertical edge to the corresponding vertical edge of the stationary section as shown at **105**, and having a lip **106** at its swinging edge to engage over the corresponding edge of the stationary section.

Although vibratory gates are shown for the hoppers in FIGS. 1 to 3, this is only by way of example and various conventional types of gates such as knife blade, clam shell, rotary bucket and others may be substituted for the vibrating gates illustrated.

By way of example only, a rotary bucket gate is shown in FIG. 10. The lower tapered portion of a hopper is shown at *3a*, with outlet *4a*. The gate indicated generally at **108** has the segmental flanges **109** at its sides, pivoted at **110** to the lower portion of the hopper.

The gate **108** may be opened by the air cylinder **111** pivotally mounted at its upper end to the hopper, as at **112**, the piston rod **113** being pivotally connected at **114** to the gate.

A gear segment **115** on one side of the gate meshes with the pinion **116**, journalled upon a bracket **117** on the hopper. An electric motor of reversing type may be connected to the shaft **118** of the pinion **116**, as an alternate drive means.

In event of failure of both electric and pneumatic power, a hand crank **119** is attached to the shaft **118** for manually operating the gate **108**.

From the above it will be obvious that the ladle additions feeder disclosed is very flexible in operation and use. The shaker pan of the feeder conveyor may be operated throughout the operation of the automatic weighing mechanism, or started at any time during the operation thereof, or may remain stationary until the required amount of additions materials has been placed thereon, at the option of the operator.

All of the controls may be remotely located, housed in a single cabinet or the like, including the scale dials, indicator lights, gate operation controls, selector switch (when alternate gate operation means is incorporated), feeder conveyor controls (including rate of feed and alternate drive means when incorporated) and by-pass manual control means for weighing and conveying.

The electric load cells supporting the hoppers have mounting means providing protection for the load cells from heat and impact, and have hinged parts for easy access to the load cells for servicing.

The pivoted gravity chute onto which the feeder conveyor discharges, directs the ladle additions into the ladle at the desired point for maximum alloying results, and is arranged to be automatically rotated by movement of the ladle, to maintain the desired position during tapping operations that require movement of the ladle.

The feeder may be constructed as a unit with the storage hoppers within the same structural frame as the conveyor, or with the hoppers and conveyor separately supported, either upon the frame base or suspended from hangers attached overhead. The contour of design is fully flexible and adaptable to any platform or furnace arrangement within broad limits.

In the foregoing description certain terms have been used for brevity, clearness and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for descriptive purposes herein and are intended to be broadly construed.

Moreover, the embodiments of the improved construction illustrated and described herein are by way of example, and the scope of the present invention is not limited to the exact details of construction.

Having now described the invention or discovery, the construction, the operation, and use of preferred embodiments thereof, and the advantageous new and useful results obtained thereby; the new and useful construction, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

I claim:

1. Ladle addition feeding mechanism including material hoppers, means for discharging predetermined amounts of materials from said hoppers, a feeder conveyor positioned beneath said hoppers for receiving materials discharged from the hoppers, said feeder conveyor comprising stationary side walls and a horizontal longitudinally reciprocal shaker pan and means for reciprocating said shaker pan independently of the hopper discharge means to discharge material at a controlled rate from the feeder conveyor into a ladle, whereby feeding of the required amount of materials from said hoppers into said feeder may be started at any time prior to topping of a heat of metal into the ladle and reciprocation of said shaker pan may be started at any time during said topping.

2. In ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan and stationary side walls and independent means for reciprocating said shaker pan, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any time during said tapping to feed said material from said conveyor into the ladle.

3. In ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan and downwardly converging stationary side walls and independent means for reciprocating said shaker pan, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any time during said tapping to feed said material from said conveyor into the ladle.

4. In ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan having upturned flanges at its longitudinal edges and stationary side walls of considerably greater height than the upturned flanges of said shaker pan and independent means for reciprocating said shaker pan, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any

time during said tapping to feed said material from said conveyor into the ladle.

5. In ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan having upturned flanges at its longitudinal edges and downwardly converging stationary side walls of considerably greater height than the upturned flanges of said shaker pan and independent means for reciprocating said shaker pan, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any time during said tapping to feed said material from said conveyor into the ladle.

6. In ladle additional feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan and stationary side walls, said conveyor having a capacity for the maximum requirement of addition material for one heat, and independent means for reciprocating said shaker pan, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any time during said tapping to feed said material from said conveyor into the ladle.

7. Ladle addition feeding mechanism including a material hopper, means for discharging a predetermined amount of material from said hopper, a horizontal feeder conveyor positioned beneath said hopper for receiving material discharged therefrom, said feeder conveyor comprising stationary side walls and a horizontal longitudinally reciprocal shaker pan, a vibratory drive unit connected to the shaker pan, electric motor means, fluid motor means, chain and sprocket gearing with over-ride type clutches connecting said motor means to said vibratory drive unit, and valve controlled means for admitting fluid pressure to the fluid motor means to discharge material at a controlled rate from the feeder conveyor into a ladle, whereby in the event of failure of power to either of said motor means the other motor means may operate said vibratory drive unit.

8. Ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric power-operated means connected to said gate means, fluid power-operated means connected to said gate means, valve controlled means for admitting fluid pressure to said fluid power-operated means for operating said gate for discharging a predetermined amount of material through said outlet, a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, and independent means for operating said conveyor for discharging material therefrom whereby feeding of the required amount of material from the hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and operation of said conveyor may be started at any time during said tapping to feed said material from said conveyor into the ladle.

9. In ladle addition feeding mechanism including a material hopper having a discharge outlet, gate means normally closing said outlet, electric load-measuring means, an electric circuit in which said load-measuring means is located, and gate-operating means controlled by said electric circuit whereby a predetermined amount of material may be discharged through said outlet, the improvement characterized by a substantially horizontal conveyor positioned beneath said gate for receiving material discharged from said hopper, said conveyor comprising a longitudinally reciprocal shaker pan and stationary side walls and independent means for reciprocating said shaker pan, for moving the shaker pan forward relatively slowly and backward relatively rapidly, whereby feeding of the required amount of material from the material hopper into said horizontal conveyor may be started at any time prior to tapping of a heat of metal into the ladle, and reciprocation of said shaker pan may be started at any time during said tapping to feed said material from said conveyor into the ladle.

10. In ladle addition feeding mechanism as defined in claim 2, in which the discharge outlet is located at the lower end of a downwardly and inwardly inclined side wall of the hopper, and the gate means for said outlet is a rotary bucket gate comprising segmental flanges pivoted at their inner ends upon the lower portion of the hopper and an outer wall connected to the outer edges of said segments, the lower end of said outer wall of the gate being normally located at the bottom of said discharge outlet and the upper edge thereof being normally located near the discharge outlet, and means for oscillating said rotary bucket gate downwardly to open and upwardly to close the discharge outlet.

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