

Oct. 16, 1962

H. E. STENZEL
LADLE FEEDING MEANS

3,058,621

Filed Sept. 14, 1959

2 Sheets-Sheet 1

Fig. 2.

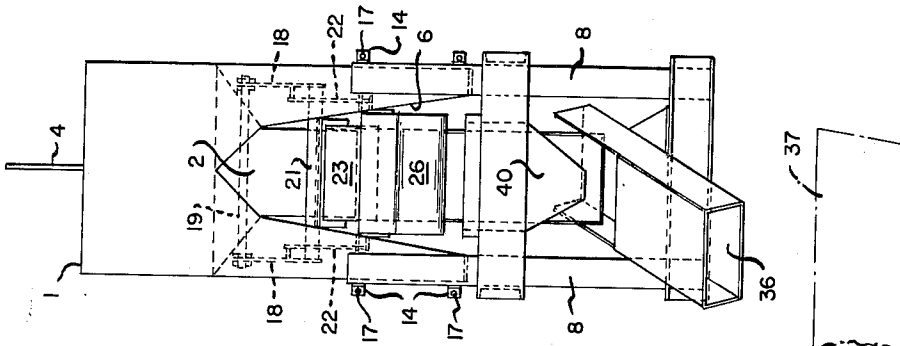
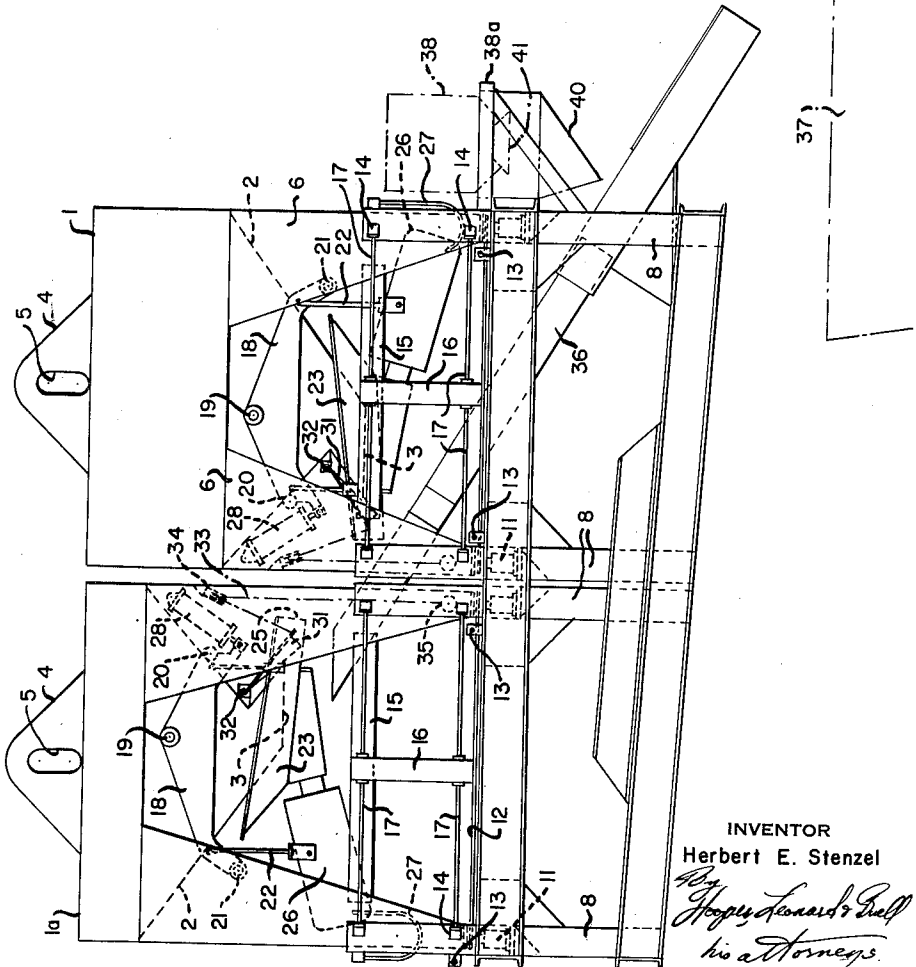


Fig. 1.



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Fig. 3.

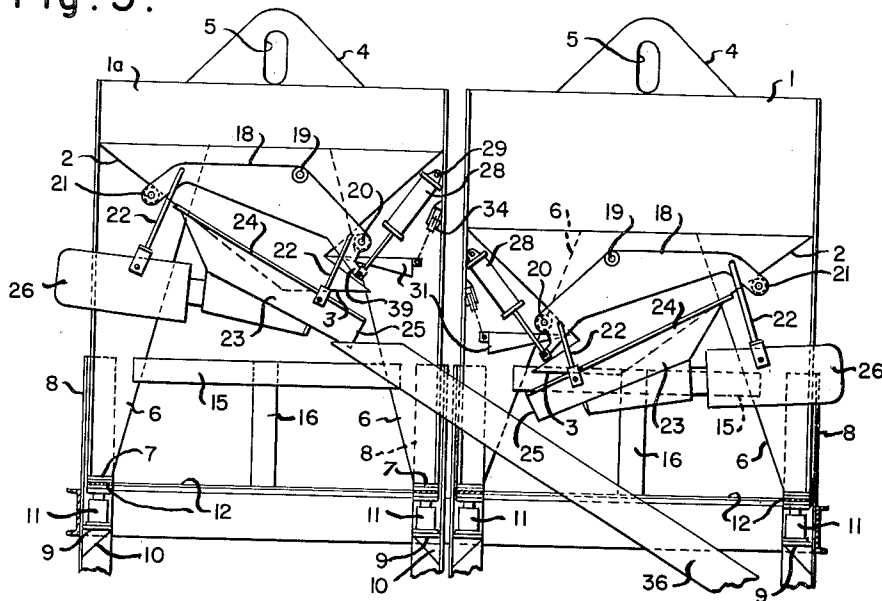
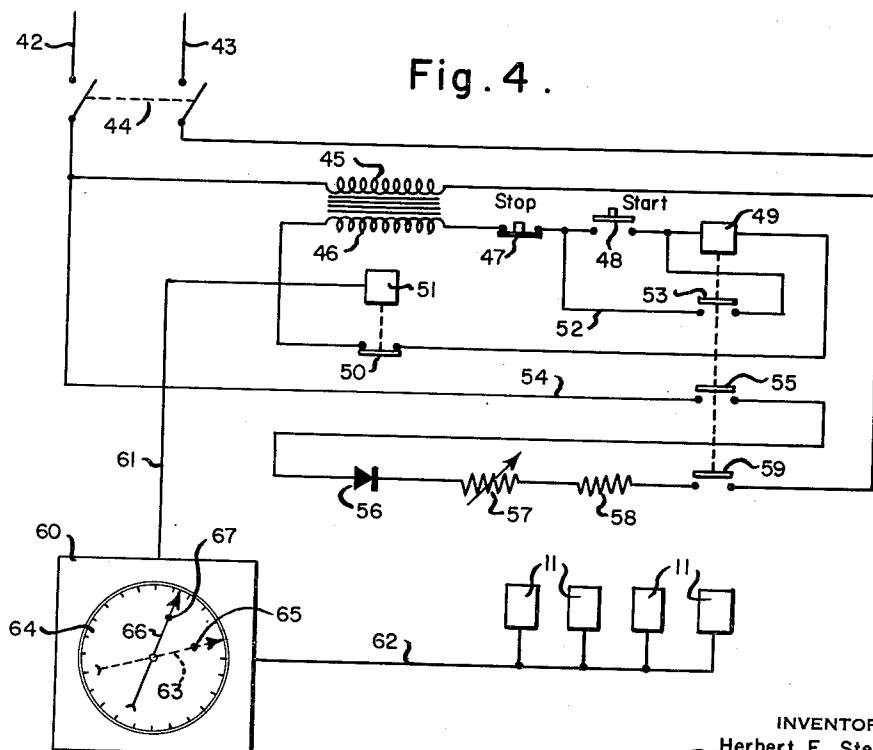


Fig. 4.



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3,058,621

LADLE FEEDING MEANS

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6 Claims. (Cl. 222—58)

This invention relates to the feeding of addition materials to a ladle of molten metal for alloying material into the molten bath and is particularly useful in supplying addition material at a controlled rate during tapping of a furnace.

In the manufacture of metals it is the usual practice to make alloys in which a number of metals are combined. The most notable example is probably in the steel industry. The manufacture of pure iron is extremely rare and commercial practice is directed to the manufacture of various steel alloys. In practice, steel is commonly refined in a furnace, such as an open hearth furnace or an electric furnace, in which impurities are reduced and alloying constituents added. It is customary to make an analysis of the molten steel shortly before tapping the furnace and then to add whatever alloying constituents are necessary. Many such constituents are added to the furnace shortly before tapping. It is, however, common practice to add some alloying materials to the ladle into which the molten metal is tapped while tapping actually takes place. This practice avoids loss of alloying ingredients in the furnace and, if the alloying ingredients are added continuously during tapping, results in their even distribution throughout the ladle.

I provide an addition material supply hopper having an outlet in the lower portion thereof, material receiving means movable between a first position in which material flowing from the outlet accumulates on the material receiving means and a second position in which the material discharges therefrom by gravity for addition into the ladle. I preferably provide trough means placed beneath the addition material outlet and having a first position in which the edges of the trough means extends beyond the confines of the angle of repose of material discharging from said outlet onto the trough means and a second position in which the angle of repose of said material extends beyond at least one edge of said trough means. I preferably provide vibratory means adjacent said trough means and selectively operable to discharge material from said trough means when it is in said first position. I further preferably provide electric load measuring means supporting the supply hopper and combine said means in an electric circuit with preset switch means whereby said vibratory means is selectively operable to cause discharge of addition material from said trough means until the load is reduced to a predetermined level. I further preferably provide means for shifting said trough means between the first position and the second position. I prefer to provide a plurality of hoppers and feeding means discharging into the common chute means for delivery of a plurality of addition materials selectively and simultaneously from a plurality of hoppers into a ladle.

Other details, objects and advantages of my invention will become more apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have illustrated a present preferred embodiment of my invention in which

FIGURE 1 is a side view of an addition material feeding installation embodying my invention;

FIGURE 2 is an end view of the apparatus shown in FIGURE 1;

FIGURE 3 is a view of the apparatus shown in FIGURE 1 with the feeders shown in manual dumping position; and

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FIGURE 4 is a diagrammatic view of the control circuit for one of the vibratory feeders shown in FIGURE 1.

A storage hopper 1 which may contain ferromanganese is provided for use in the manufacture of steel. A similar hopper 1a is provided for storage of ferrosilicon. All of the corresponding members associated with each of the hoppers are substantially alike and they are referred to by like numbers throughout. Each hopper has a lower tapering portion 2 terminating in an outlet 3 at the lower portion thereof. A plate 4 is attached to the upper portion of each hopper 1 and 1a and has an opening 5 formed therein to receive a crane hook. Each hopper is supported by a plurality of generally triangular shaped plate-like members 6 which are welded in right angular relationship to each other beneath the four corners of each hopper. The pair of members 6 at each corner of the hopper narrows toward the lower end and terminates at a pad 7 welded beneath each pair of plate-like members 6 at each hopper corner. The supporting structure formed by members 6 are set within the confines of four vertical angular shaped structural members 8 which are set in the mill floor. A shelf 9 is placed in the inside corner of each structural member 8 and is braced by a member 10. An electric load measuring device 11 such as an "SR-4" load cell, manufactured by Baldwin-Lima-Hamilton Corporation, is placed on each shelf 9. Such load cells comprise a body element supporting the load which is thereby strained in proportion to the applied load and a filamentary member bonded to the body element. The strains in the body element are proportionally transmitted to the filamentary member. The resistance of the filamentary member thus changes in known relationship to the applied load. By making measurements of the resistance of the filamentary member the amount of the applied load and changes therein may be determined. One example form of load cell of these general characteristics is shown in Ruge Patent 2,488,348.

To center the hoppers within the supporting structure to rest on the load cells without vertical restraint, struts 15 are secured across the member 6 on all four sides, and at the center of each strut is secured a vertical member 16 of channel shaped cross section extending downwardly substantially to the level of the pads 7. Flat flexible bars 12 extend between the supporting frame uprights 8 parallel to the struts 15, and are connected at their centers to the vertical member 16. Flexible tie rods 13 and 17 also extend horizontally from the flanges of the channels 16 to brackets 14 on the supporting frame, the tie rods having threaded ends with nuts thereon for adjusting their length and centering the hopper within the frame. It will be seen that the weight of each hopper is carried by load cells 11 and that the hopper is free to move vertically but that horizontal movement is restricted by tie rods 17, and tie rods 13.

A pair of feeder supporting frames 18 are mounted for pivotal movement on a shaft 19 extending through the lower portion of each hopper. A shaft 20 extends between frames 18 at one end and a shaft 21 extends between frames 18 at their opposite ends. A plurality of links 22 are pivotally suspended from each of frames 18 near each end and carry a well-known type of vibratory feeder. A vibratory feeder of the type made by Syntrol Company, may conveniently be used. Each feeder comprises a trough 23 having raised edges 24 which are open at one end to form a discharge at 25. A vibrator 26 is connected to the trough and is supplied from a power cable 27. When vibrator 26 is energized it imparts an uneven vibratory motion to the trough which has the effect of displacing the trough relative to the material in it by rapidly shifting the trough in one direction and then returning it at a more moderate speed. The result is to move the material in the trough in small increments,

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eventually discharging it from the trough at 25. The trough is supported close to the outlet so that the edges of the trough, including the edge at discharge 25 all extend beyond the limits of a pile deposited on the trough from the adjacent hopper when the trough is in the position shown in FIGURE 1. Stated in other terms, the edges of the trough when it is in that position extend beyond and intersect the angle of repose of material flowing from the outlet into the trough.

When frames 18 are in the position shown in FIGURE 1, shaft 20 bears against lower hopper section 2. Rotation of frames 18 to move shaft 20 away from the hopper will bring shaft 21 against the lower hopper portion 2, at which time the trough will be in an inclined position as shown in FIGURE 3. When the trough is inclined as shown in FIGURE 3, the edges of the trough no longer cut off flow of material, and it will slide down the inclined surface of the trough.

A double acting fluid power cylinder 28 is pivotally mounted to the supporting framework on each hopper at 29. The piston rod is connected to bracket 39 on the frame 18. The cylinder is powered in the conventional manner from a compressed air supply which has been omitted from the drawings for the purpose of clarity.

A gate 31 is pivoted from each hopper at 32 and may be lowered into the trough to close discharge 25 while the hopper is being filled. The free end of gate 31 is connected to a cable 33 extending over pulleys 34 and having at its free end a hand ring 35. Gate 31 may be raised or lowered by pulling on the ring 35.

A chute 36 is placed beneath each trough 23 in position to receive material discharged at 25. The chute terminates above a ladle 37 which is shown in tapping position.

An auxiliary addition material hopper 38 is mounted on the framework 38a and discharges through a funnel 40 into chute 36. Hopper 38 is opened and closed by a bell 41 which is movable up and down to close the opening.

FIGURE 4 diagrammatically shows the vibrator control circuit for one of the hoppers. Power is supplied on lines 42 and 43. A line switch 44 is provided for both lines. A primary winding 45 of a stepdown transformer is connected across lines 42 and 43. The secondary winding 46 is connected through a normally closed push button switch 47 and normally open push button switch 48 to a relay 49 and then through a normally closed switch 50 operated by relay 51 from which the circuit is completed to the other side of secondary winding 46. Switch 47 is designated as a "stop" switch and switch 48 is designated as a "start" switch. A circuit 52 bypasses switch 48 through normally open switch 53 which is closed by operation of relay 49.

A circuit 54 extends from power line 42 through normally open switch 55, which is controlled by relay 49, then through rectifier 56 and variable resistor 57 to the coil 58 of the feeder and then through normally open switch 59, which is also controlled by relay 49, to power line 43.

A controller, indicated at 60, is provided for each hopper. It selectively energizes relay 51 through wire 61. The controller receives an electrical signal through wire 62 from load cells 11 which is proportional to the load upon the load cells. The signal is amplified by the controller and produces a corresponding movement of an indicating arm 63 which points to an indicator dial 64 visually showing load carried by the load cells. A correction for tare weight may be included in controller 60 so that the indicated reading will show the amount of material actually in each hopper. An electrical contact point 65 is diagrammatically shown on pointer 63. A second pointer 66 is manually set. It also carries an electrical contact point indicated at 67. When actual measured load, as shown by pointer 63, is reduced to the figure at which pointer 66 is set, contacts 65 and 67 com-

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plete an electrical circuit within the controller which causes the controller to momentarily energize relay 51.

In the use of the invention hoppers 1 and 1a are filled with ferromanganese and ferrosilicon, respectively, at convenient intervals. They may, for example, be filled on a daily schedule at a time which is convenient in the mill. When a heat is about to be tapped into ladle 37 an analysis of the heat is made. The amount of ferrosilicon and ferromanganese which is to be added to the ladle during tapping is then calculated. The reading for each hopper, as shown by the associated pointer 63, is noted and pointer 66 is then set at a smaller figure so that the difference between the two readings is equal to the amount of material to be discharged into the ladle. The associated resistor 57 is adjusted to operate the feeder at a speed which will feed the proper amount of addition material during tapping to the extent desired by the operator. For example, if the amount to be added is small, a reduced rate of feed may be set to add material throughout the time tapping takes place.

When the furnace is initially tapped the operator momentarily pushes the start button closing switch 48 and energizing relay 49. Relay 49 then closes switches 53, 55, and 59, thereby holding itself energized through circuit 52 and connecting the vibratory feeder across the line. The vibrator then produces an uneven vibration of trough 23 causing a rapid movement of the trough in one direction and a relatively slow return movement. This will advance material in the trough over discharge 25 in a well-known fashion. When the load has been reduced to the preset amount contacts 65 and 67 will come together completing a circuit and causing controller 60 to momentarily de-energize relay 51, thereby opening switch 50 and breaking the circuit for relay 49. This in turn will result in opening switches 53, 55, and 59. Operation of the vibrator will then cease and no further discharge will occur.

In the event of malfunctioning of the feeder or an electrical failure, cylinder 28 is energized from a source of compressed air to shift the trough to the position shown in FIGURE 3. The material will then flow from the hopper by gravity across the trough and onto chute 36 from which point it will then flow into the ladle. When the proper amount of material has been provided as indicated by a change in the reading of pointer 63 the operator supplies compressed air to cylinder 28 to return the feeder to horizontal position.

Gates 31 are lowered during filling of the hoppers to prevent accidental discharge due to momentum of material being loaded into the empty hopper.

While I have illustrated and described a present preferred embodiment of my invention it is to be understood that I do not so limit myself and that my invention may be otherwise variously practiced within the scope of the following claims.

I claim:

1. Ladle addition means comprising an addition material supply hopper having an outlet in the lower portion thereof, electric load measuring means supporting said hopper, material receiving means positioned beneath said outlet and extending beyond the limits of a pile formed by discharging material from said outlet onto said material receiving means, said material receiving means having electrically operable means associated therewith to discharge material therefrom, electric circuit means including said load measuring means and preset control means in controlling relationship to said electrically operable means whereby operation of said electrically operable means is stopped when the load measured by said load measuring means is reduced to a preset amount.

2. Ladle addition means comprising an addition material supply hopper having an outlet in its lower portion, electric load measuring means supporting said hopper, material receiving and feeding means mounted beneath

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said hopper and effective in one position to feed material flowing from the outlet, electric circuit means including said load measuring means, and switch means responsive to the load measured by said measuring means and controlling said material receiving means whereby said material receiving means are maintained effective to feed material until the measured load is reduced to a preset value.

3. Ladle addition means comprising an addition material supply hopper having an outlet in its lower portion for gravity discharge of addition material therefrom, a supporting frame for said hopper resting on electric load measuring means, material receiving and feeding means positioned beneath said outlet, drive means for said receiving and feeding means, and electric circuit means controlling said drive means and including said load measuring means and associated switch means adjustably preset to operate when the measured load equals said preset amount whereby said drive means feeds material until the measured load is reduced to said preset value.

4. Ladle addition means comprising an addition material supply hopper having an outlet in its lower portion for gravity discharge of addition material therefrom, a supporting frame for said hopper resting on electric load measuring means, material receiving and feeding means positioned beneath said outlet, drive means for said receiving and feeding means, electric circuit means controlling said drive means and including said load measuring means and associated switch means adjustably preset to operate when the measured load equals said preset amount whereby said drive means operates the receiving and feeding means to feed material until the measured load is reduced to said preset value and then operates the receiving and feeding means to stop feeding material, and selectively operable switch means controlling commencement of operation of said drive means.

5. Ladle addition means comprising an addition material supply hopper having an outlet in its lower portion for gravity discharge of addition material therefrom, a supporting frame for said hopper resting on electric load measuring means, material receiving and feeding means positioned beneath said outlet and movable between a first position in which addition material accumulates on said means and a second position in which addition ma-

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terial discharges from said means by gravity, drive means associated with said means and operable to feed addition material from said means in said first position when said drive means are activated, adjustable switch means in controlling relationship to said drive means, said switch means being in electric circuit with said load measuring means and adjustable to open the drive means circuit when the measured load falls below a predetermined amount whereby the switch means is adjustable to feed a preset weight of addition material.

6. Ladle addition means comprising a plurality of addition material supply hoppers, each hopper having an outlet in its lower portion for gravity discharge of addition material therefrom, a hopper supporting frame supporting each hopper and carried by electric load measuring means, material receiving and feeding means positioned beneath said outlet and movable between a first position in which addition material discharging from said outlet accumulates on said receiving and feeding means and a second position in which said material discharges therefrom by gravity, drive means associated with said receiving and feeding means and operable to discharge material from said receiving and feeding means when in said first position, power means in operative relationship with said receiving and feeding means and operable to shift said means between said first position and said second position, switch means operable to begin operation of said drive means, and preset switch means connected with said load measuring means and operable to open the circuit of said drive means whereby operation of said drive means is stopped when the measured load is reduced to a preset amount.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,058,621

October 16, 1962

Herbert E. Stenzel

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 42, under "References Cited" for
"2,638,244" read -- 2,638,248 --.

Signed and sealed this 5th day of March 1963.

(SEAL)

Attest:

ESTON G. JOHNSON

Attesting Officer

DAVID L. LADD

Commissioner of Patents

Disclaimer

3,058,621.—*Herbert E. Stenzel*, Hampton Township, Allegheny County, Pa.
LADLE FEEDING MEANS. Patent dated Oct. 16, 1962. Disclaimer filed
Jan. 22, 1964, by the assignee, *Blaw-Knox Company*.

Hereby enters this disclaimer to claims 1-6 inclusive of said patent.
[*Official Gazette April 14, 1964.*]