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[54] **PADDLE SWITCH FOR AUTOMATIC GATE CLOSURE ON HOPPERS**

[75] Inventors: **Imre Szendroi**, Allentown; **Jenson E. Ehret**, Bethlehem, both of Pa.

[73] Assignee: **Bethlehem Steel Corporation**, Bethlehem, Pa.

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[52] **U.S. Cl.** ..... **222/66**, 214/17 CA, 214/18.2, 214/35 R

[51] **Int. Cl.** **F27d 3/00**

[58] **Field of Search** ..... 214/18, 17 CA, 35 R, 18.2; 222/59, 52, 64, 65, 66

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Primary Examiner—Robert B. Reeves
Assistant Examiner—Joseph J. Rolla
Attorney, Agent, or Firm—Joseph J. O'Keefe; Michael J. Delaney; John J. Selko

[57] **ABSTRACT**

A hopper has a device for sensing the flow of material through its bottom opening. The sensing device is substantially balanced about a horizontal axis and forms an inverted V with a paddle portion extending into the path of flow of material discharged through the bottom opening of the hopper. Material passing through the bottom opening strikes the paddle portion causing it to pivot about the horizontal axis. When the hopper is empty, the sensing device returns to the balanced position and actuates means to close the bottom opening.

4 Claims, 4 Drawing Figures

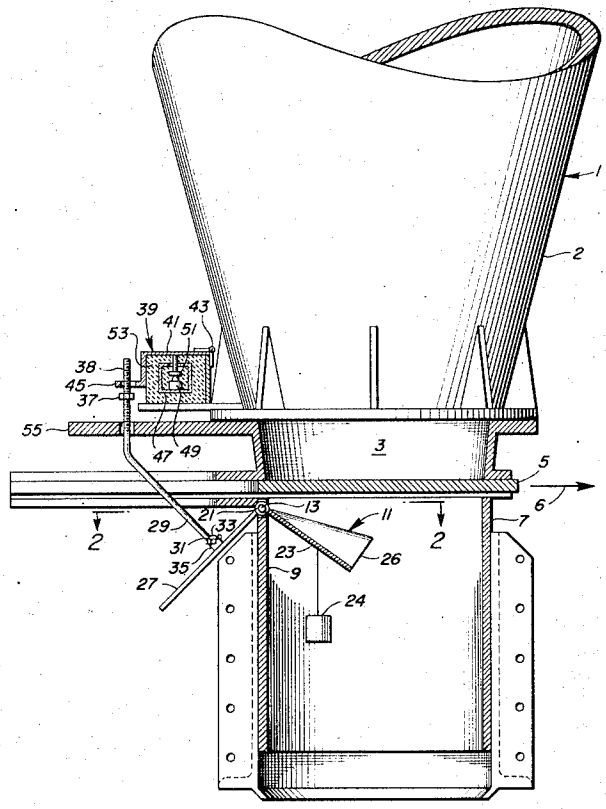


Fig. 3

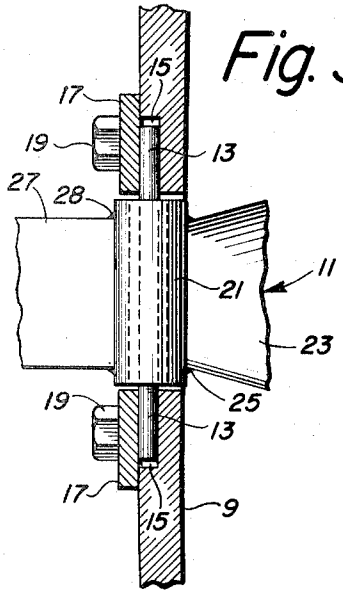


Fig. 1

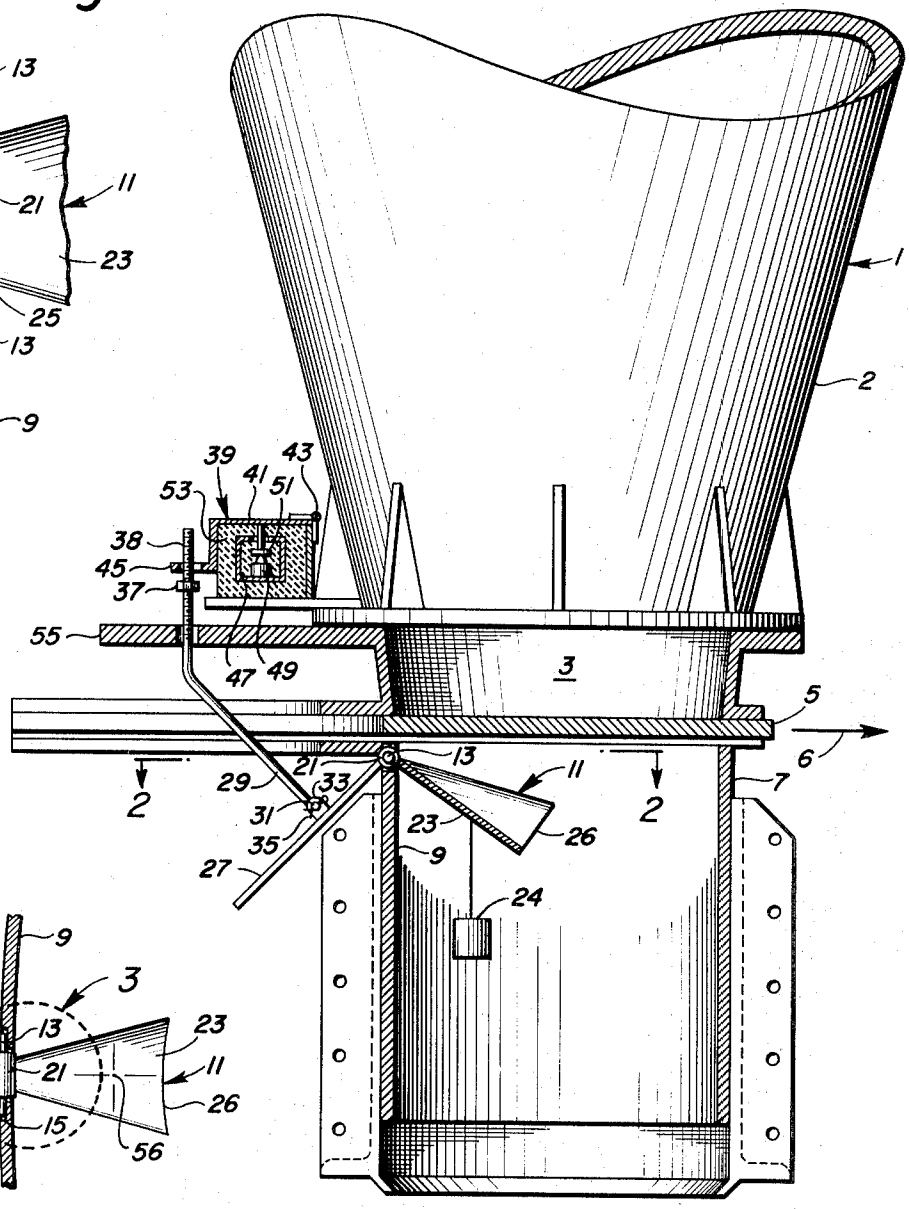
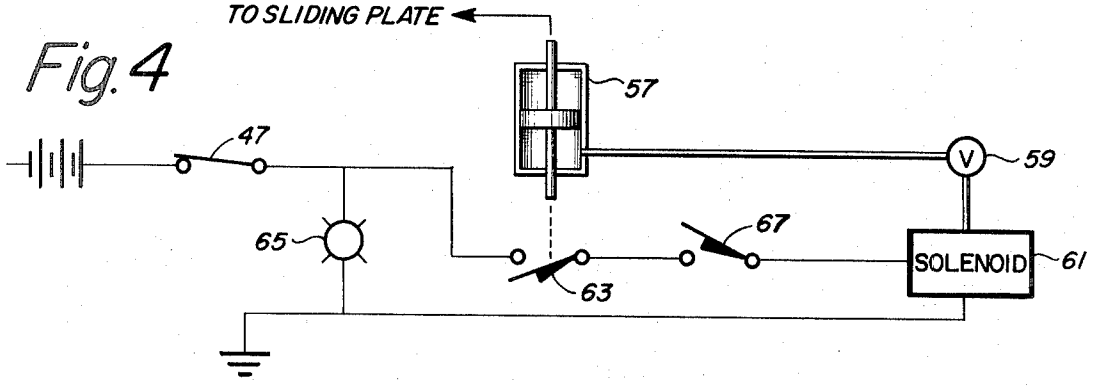


Fig. 2

Fig. 4



PADDLE SWITCH FOR AUTOMATIC GATE CLOSURE ON HOPPERS

BACKGROUND OF THE INVENTION

The invention relates to an apparatus for sensing the flow of coal from a gravity operated hopper on a coke oven larry car, and more particularly to a sensing device which does not materially impede coal flow and which automatically closes the bottom discharge opening as soon as flow ceases.

Coke ovens are charged through a plurality of charging holes, with coal that is transported from a storage bin by a larry car. The larry car moves on rails mounted on the coke oven, and carries a plurality of hoppers which contain the coal to be charged. One type of commonly used hopper is a gravity operated hopper which depends upon gravity to cause coal to flow out a bottom discharge opening in the hopper. After the larry car is positioned so that each hopper is directly above its respective charging hole, a sleeve which is telescoped on a lower extension below the bottom discharge opening, is positioned inside the charging opening, and the hopper is opened. Gravity causes the coal to fall into the coking chamber of the coke oven.

When a hopper is empty, it must be closed quickly in order to prevent gases from the coking chamber from flowing upwardly into the hopper interior. Volatilized materials in such gases can condense on the interior walls of the hopper, and form deposits which can increase the friction between the hopper walls and subsequent coal charges. Because the hoppers do not have mechanical means to assist in their discharge, the friction increasing deposits can slow the discharge of the hopper and in extreme cases can contribute to a condition known as arching, in which no flow takes place. In addition, some of the gases from the coking chamber can pass through the hopper and into the atmosphere, contributing to environmental pollution.

As is well known in the art, the closing of the hopper commonly depends upon the larry car operator who must determine when coal flow ceases and then activate the closing mechanism. The operator may not always close each hopper as soon as coal flow ceases.

There is a need therefore for apparatus to sense when coal flow ceases without materially impeding coal flow and to automatically close the bottom of a gravity operated hopper thereby minimizing escape of gases from the coking chamber into and through the hopper interior.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a gravity operated coal hopper which minimizes escape of coke oven gases into and through the hopper interior.

It is a further object of this invention to provide a gravity operated coal hopper having a sensing device which automatically closes the bottom discharge opening of the hopper when coal flow ceases, without materially impeding flow of coal during discharge of the hopper.

It has been discovered that the above objects can be achieved in a gravity operated coal hopper having a sensing device substantially balanced pivotally around a generally horizontal axis. The sensing device is pivoted by coal discharged through the bottom opening and returns to the substantially balanced position when the hopper is empty, automatically closing the bottom discharge opening.

BRIEF DISCHARGE OF THE DRAWINGS

FIG. 1 is a partial cross sectional elevation of a lower end of a coal hopper with the invention thereon.

FIG. 2 is a view along line 2—2 of FIG. 1.

FIG. 3 is an expanded view of the circled portion of FIG. 2.

FIG. 4 is a diagrammatic control system for closing the coal hopper.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1–3 there is illustrated the lower portion of a gravity operated conical coal hopper 1 with downwardly converging hopper walls 2 which form bottom discharge opening 3. A conventional sliding plate 5 closes bottom discharge opening 3. Plate 5 opens in the direction indicated by arrow 6. The larry car on which hopper 1 is mounted is not shown. Directly below bottom discharge opening 3 is a cylindrical lower extension 7 which forms an opening the same size as bottom discharge opening 3. Mounted below bottom discharge opening 3 on wall 9 of lower extension 7 is a flow sensing device shown generally as 11. The flow sensing device 11 includes a generally horizontal pivot axis 13 mounted in slots 15 of wall 9 out of the flow path of material discharged through bottom opening 3. The axis 13 is held in place by plates 17 which are fastened to lower extension 7 by nuts 19. A bushing 21 is telescoped over axis 13 and is rotatable about axis 13. Paddle 23 is welded at one end 25 to bushing 21. Paddle 23 extends downwardly in the flow path of material discharged through bottom opening 3, and only partially spans the space formed by lower extension 7. Paddle 23 is narrower at bushing end 25 than at outer end 26 but other shapes can be used. Paddle 23 is curved at the same radius as lower extension 7 so that paddle 23 conforms to the inside wall of lower extension 7 when paddle 23 is pivoted by material discharged through bottom opening 3. Arm 27 is welded at end 28 to bushing 21 and extends downwardly outside the flow path of material discharged through bottom opening 3. Between arm 27 and paddle 23 is included an angle of 100°, although other angles can be selected. Upwardly extending push rod 29 is pivotably fastened at end 31 to lug 33 which is welded to arm 27. End 31 forms a right angle which extends through lug 33 and which is fastened by cotter pin 35. Nut 37 is screwed onto upper end 38 of push rod 29 and upper end 38 is slidably fastened to switch means shown generally as 39. Switch means 39 includes switch cover box 41 hinged at 43. Switch cover box 41 has an outwardly extending flange 45 adapted to slidably receive upper end 38 and against which nut 37 occasionally presses to raise switch cover box 41. Inside switch cover box 41 is switch 47 having contact 49. Extending from switch cover box 41 is plunger 51 which depresses contact 49 making switch 47 normally closed so that electrical current can flow through switch 47. Surrounding switch 47 is a suitable insulation material 53 such as asbestos, and below switch assembly 39 is protective plate 55 welded to hopper 1.

The sensing device **11** is substantially balanced pivotally about axis **13** making the device sensitive to small amounts of material flow. The torque about axis **13** exerted by push rod **29** and arm **27** is slightly greater than the torque exerted by paddle **23**, although the sensing device will work if the torque exerted by paddle **23** is exactly equal to the torque exerted by push rod **29** and arm **27**. We prefer to substantially balance sensing device **11** by adjusting the torque exerted by push rod **29** and arm **27** to equal the total torque exerted by paddle **23** plus a small weight preferably 300 grams, shown as **24** temporarily suspended from paddle **23** at a point **56** which is on the centerline midway between end **25** and end **26**. Sensing device **11** becomes substantially balanced when the small weight **24** is removed. Thereafter sensing device **11** is operated without weight **24**. In a plane perpendicular to axis **13**, the sensing device **11** in the substantially balanced position forms an inverted V having the paddle **23** downwardly extending in the flow path of material discharged through bottom opening **3** and the arm **27** downwardly extending outside the flow path of material discharged through bottom opening **3**. Sensing device **11** is therefore arranged to be pivoted by material discharged through bottom opening **3** and to freely and gravitationally return to a substantially balanced position when hopper **1** is empty.

FIG. **4** diagrammatically shows a suitable control system for closing bottom opening **3**. Now shown is a conventional control circuit for opening bottom opening **3**. Plate **5** is moved by conventional closing mechanism (not shown) which mechanism is activated by hydraulic piston **57** which is controlled by hydraulic valve **59**, as is well known in the art. Hydraulic valve **59** is energized by solenoid **61**. Switch **47** is mounted on hopper **1** as previously described. Limit switch **63** is mounted in the larry car cab in a position to be automatically closed by piston **57** when piston **57** moves during the opening of bottom opening **3**. Signal light **65** is mounted in the larry car cab and is lighted when switch **47** is closed, as when sensing device **11** is in the substantially balanced position. Toggle switch **67** is also mounted in the larry car cab and is closed by the operator only after signal light **65** goes out, as when switch **47** is opened by sensing device **11** being pivoted by discharging material. With this system, it can be understood that bottom opening **3** is automatically closed only when switch **47**, limit switch **63**, and toggle switch **67** are all closed.

In operation, loaded hopper **1** is properly positioned. Sensing device **11** is in the substantially balanced position closing switch **47**.

Signal light **65** is on indicating that there is no material flow. Limit switch **63** and toggle switch **67** are both in the open position. Plate **5** is retracted by piston **57** which also closes limit switch **63**. Material flow starts which pivots sensing device **11** and opens switch **47**. Signal light **65** goes off and operator closes toggle switch **67**. When material flow ceases, sensing device **11** freely and gravitationally returns to a substantially balanced position closing switch **47** which automatically causes closure of bottom opening **3**.

In actual practice, we have successfully used a sensing device **11** mounted on hopper **1** having a lower extension **7** with a diameter of 18 inches. Paddle **23** is 8 inches long, 2 inches wide along its chord at bushing end **25** and **8** inches wide along its chord at outer end **26**. An angle of 100° is included between paddle **23** and arm **27**. Sensing device **11** is substantially balanced so that the torque exerted by arm **27** and push rod **29** equals the torque exerted by paddle **23** plus 300 grams temporarily suspended from paddle **23** at point **56**.

We claim:

1. In a gravity operated hopper having downwardly converging walls forming a bottom discharge opening and a lower extension directly below said bottom discharge opening the combination with said gravity operated hopper of:

a. a sensing device extending within said lower extension substantially balanced pivotally about a generally horizontal axis;

b. closure means for said bottom discharge opening above said lower extension;

c. said sensing device arranged to be pivoted by material discharged through said bottom opening and to return to a substantially balanced position when said hopper is empty; and

d. switch means operable by said sensing device for closing said closure means when said sensing device is in the substantially balanced position.

2. The invention of claim **1** in which:

a. the generally horizontal axis of said sensing device is located outside the flow path of material discharged through said bottom opening; and

b. said sensing device in the substantially balanced position forms an inverted V having a paddle portion downwardly extending in the flow path of material discharged through said bottom opening and an arm portion downwardly extending outside the flow path of material discharged through said bottom opening.

3. A gravity operated conical hopper comprising:

a. downwardly converging hopper walls;

b. a bottom discharge opening formed by said hopper walls;

c. a sliding plate closure means for closing said bottom discharge opening;

d. a cylindrical lower extension on said hopper directly below said bottom discharge opening, said lower extension forming an opening the same size as said bottom discharge opening;

e. a sensing device pivotally mounted on a wall of said lower extension, said sensing device including:

i. a horizontal pivot axis;

ii. a rotatable bushing telescoped over said pivot axis;

iii. a paddle portion connected at one end to said bushing, said paddle extending downwardly into the flow path of material discharged through said bottom discharge opening and conforming to the inside wall of said lower extension when said paddle is pivoted;

iv. an arm portion connected on one end to said bushing and extending downwardly outside the flow path of material discharged through said bottom discharge opening;

v. an upwardly extending push rod pivotably fastened at one end to said arm portion; said sensing device substantially balanced about said pivot axis; and

f. switch means on said hopper slidably fastened to said push rod and activated by said sensing device.

4. In a gravity operated hopper having a bottom discharge opening the combination with said gravity operated hopper of:

a. closure means for closing said bottom discharge opening;
b. an extension below said closure means;
c. a sensing device on said extension below said closure means, said sensing device substantially balanced pivotally about a generally horizontal axis and arranged to be pivoted by material discharged through said bottom discharge opening and to return to a substantially balanced position when said hopper is empty; and
d. switch means operable by said sensing device for closing means when said sensing device is in the substantially balanced position.

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