United States Patent [19]

Yoshioka et al.

[11] **3,732,994**

[45] **May 15, 1973**

[54] **APPARATUS FOR CHANGING THE CHARGE DISTRIBUTION IN A VERTICAL FURNACE**

[75] Inventors: **Kengo Yoshioka; Naoto Kishikawa; Hiroyuki Takao,** all of Kitakyushu, Japan

[73] Assignee: **Nippon Steel Corporation,** Tokyo, Japan

[22] Filed: **Apr. 9, 1971**

[21] Appl. No.: **132,737**

[30] **Foreign Application Priority Data**

Apr. 9, 1970 Japan.....45/33654

[52] **U.S. Cl.**.....**214/36,** 266/27

[51] **Int. Cl.**.....**F27b 11/12**

[58] **Field of Search** .....214/18 V, 35 R, 35 A, 214/36, 37; 266/27

[56] **References Cited**

UNITED STATES PATENTS

1,835,225 12/1931 Knoringer et al.....214/36 X

3,009,691 11/1961 Tsujihata et al.....214/36 X

FOREIGN PATENTS OR APPLICATIONS

1,177,333 1/1970 Great Britain.....214/36

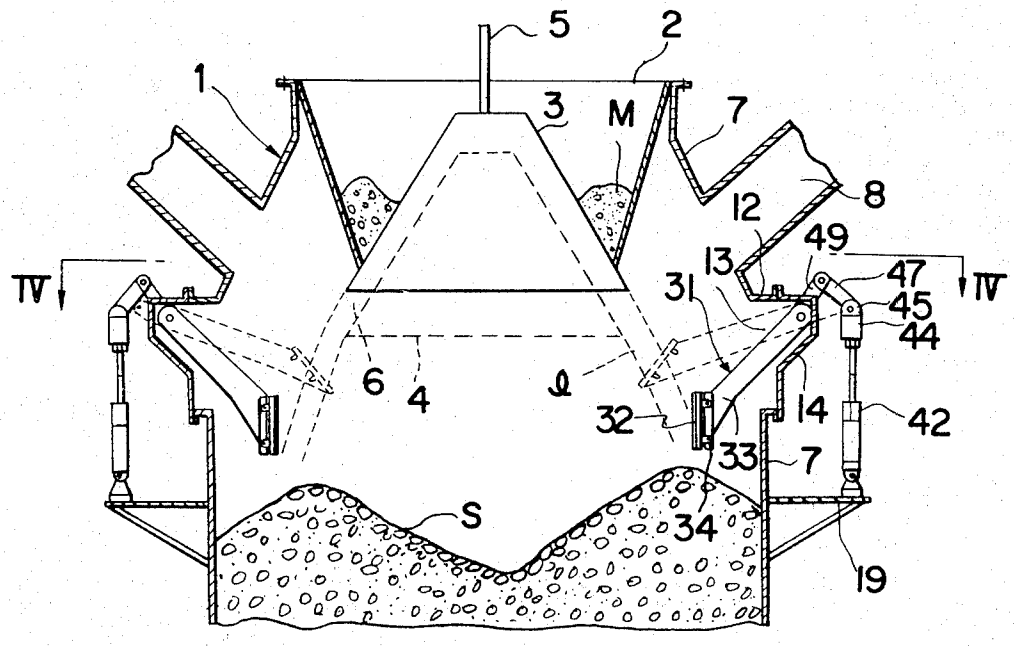
Primary Examiner—Robert G. Sheridan

Attorney—Wenderoth, Lind and Ponack

[57] **ABSTRACT**

An apparatus for changing the distribution of the charge in a vertical furnace which comprises a multiplicity of projections extending outwardly from the shell of the furnace at the top portion thereof, a pivot shaft rotatably extending through each of said projections and equipped with sealing means, with the shaft ends disposed outside the furnace, repellers secured respectively to the pivot shafts inside the furnace, and a pivot shaft driving system engaged with one-side ends of said pivot shafts.

9 Claims, 9 Drawing Figures



PATENTED MAY 1 5 1973

3,732,994

SHEET 1 OF 4

FIG. 1 PRIOR ART

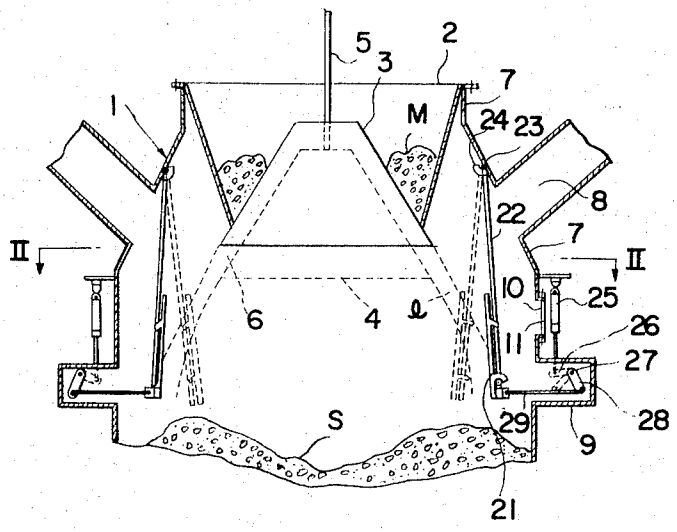
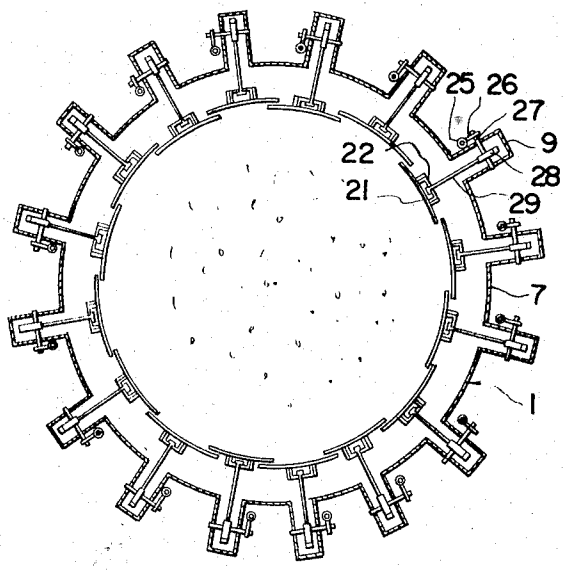


FIG. 2 PRIOR ART



KENGO YOSHIOKA,
NAOTO KISHIKAWA and
HIROYUKI TAKAO,

INVENTORS

BY Wenderoth, Lind & Ponack

ATTORNEYS

FIG. 3

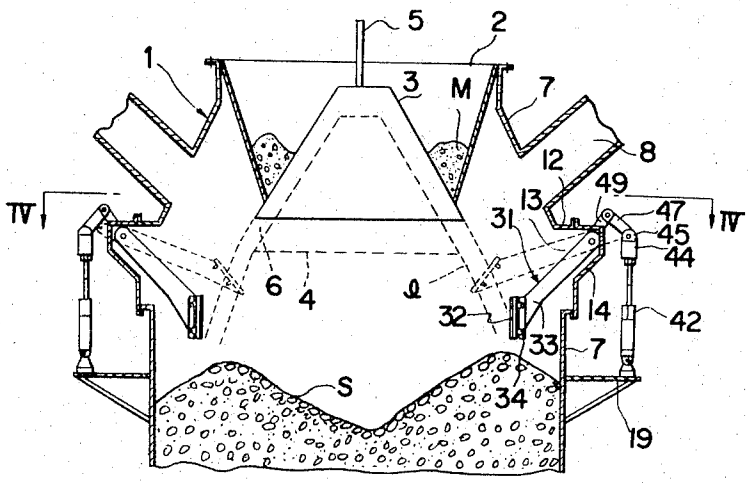
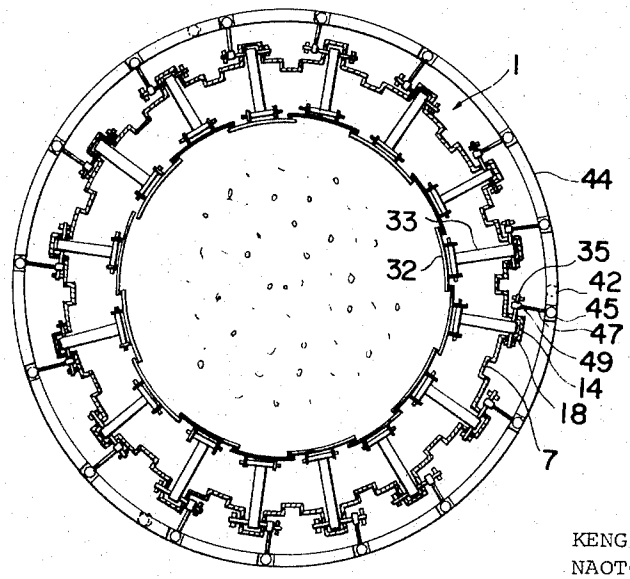


FIG. 4



KENGO YOSHIOKA,
NAOTO KISHIKAWA and
HIROYUKI TAKAO,

INVENTORS

BY Wenderoth, Lind & Ponack

ATTORNEYS

FIG. 5

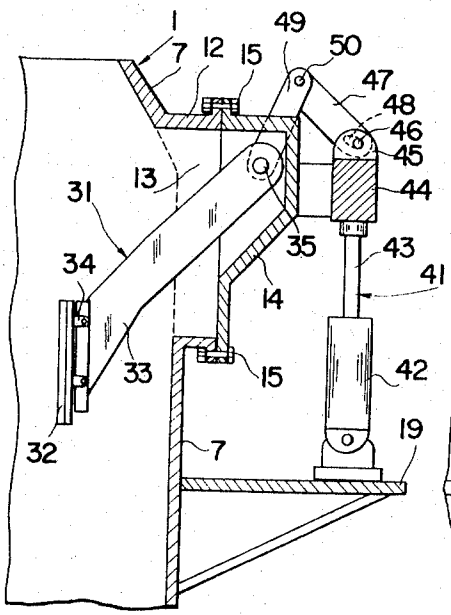


FIG. 6

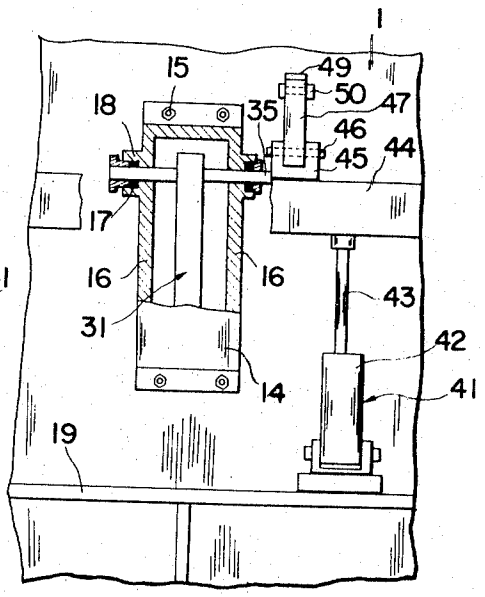
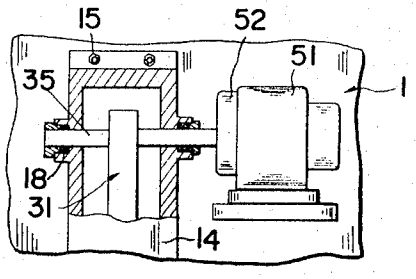


FIG. 7



KENGO YOSHIOKA,
NAOTO KISHIKAWA and
HIROYUKI TAKAO,

INVENTORS

BY Wenderoth, Lind & Ponack

ATTORNEYS

FIG. 8

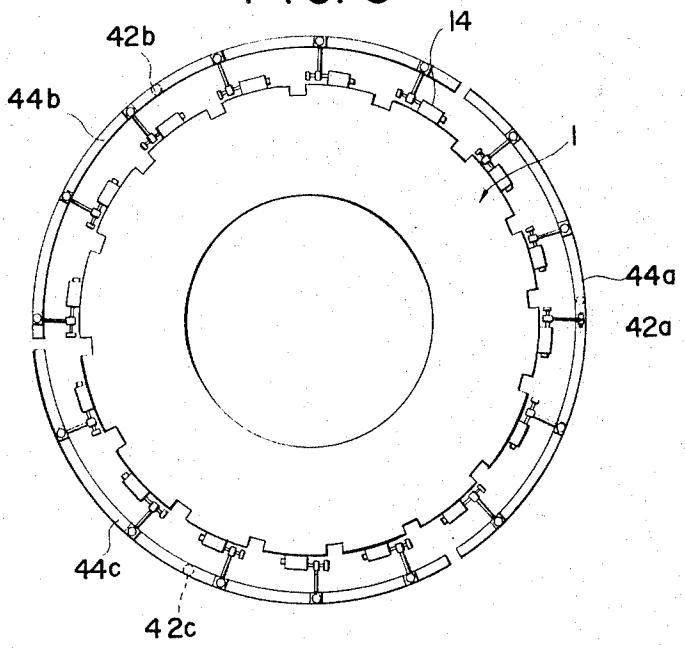
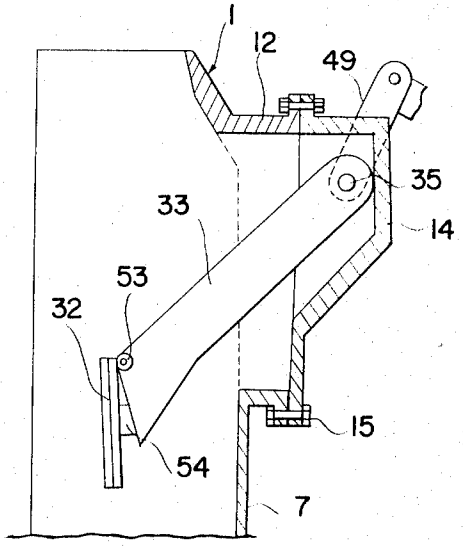


FIG. 9



KENGO YOSHIOKA,
NAOTO KISHIKAWA and
HIROYUKI TAKAO,

INVENTORS

BY Wenderoth, Lind & Ponack

ATTORNEYS

APPARATUS FOR CHANGING THE CHARGE DISTRIBUTION IN A VERTICAL FURNACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to an apparatus for changing the distribution of the charge in a vertical furnace and more particularly to a pivotal inclination type apparatus for adjusting the charge distribution in a vertical furnace, the apparatus including a multiplicity of repelling plates arranged circumferentially inside the top portion of the furnace and variable in the angle of inclination relative to the center line of the furnace to effect said distribution adjustment.

2. Description of the Prior Art

Apparatus which have so far been put to practical use for changing the distribution of charges in vertical furnaces represented by blast furnaces include the so-called horizontal shift type apparatus characterized by radially moving vertical repelling plates and the so-called inclination type apparatus in which repelling plates are inclined by being rotated on pivot shafts. For example, a widely known apparatus of the inclination type is as follows: Repelling plates are carried respectively by hangers which are secured to shafts. The shafts are rotatably fitted to supports fastened to the inside of the upper section of the furnace shell. The repelling plates are each pushed toward the center line of the furnace to a desired inclination by a push rod which extends radially through the furnace shell and is forced from outside the furnace so as to move back and forth radially.

This conventional construction, however, is beset with the following drawbacks:

First, since the pivot shafts are disposed inside the vertical furnace (a blast furnace will be taken hereunder by way of example), the shafts may be deformed as a result of abnormal temperature in the event that channeling phenomenon takes place, or the heat and dust inside the furnace during normal operation may cause the shafts to be bent or seized.

Secondly, when the charge collides with the repelling plates, the impulsive force acts as a great compressive force to the push rods. This, together with the high temperature in the furnace, tends to cause buckling in the push rods.

Thirdly, the character of the prior construction requires the repelling plates and their hangers to be relatively large so that they block the passage of the gas generated in the furnace, to a large extent, thus narrowing the spacing between the large bell and each repelling plate, with the result that the gas flow velocity increases. Thus, the thermal load on the large bell and the cup increases, and the dust contained the collected gas increases in.

Fourthly, the replacement of worn or damaged parts inside the furnace is very difficult because of the required large dimensions and because the repelling plates are not integral with the respective hangers. Furthermore, the worker making the replacement must enter the furnace where there are poisonous gases and dust, as well as very high temperatures. Thus, the replacement is an exceedingly dangerous job.

SUMMARY OF THE INVENTION

The present invention contemplates providing an apparatus for changing the charge distribution in a vertical furnace which does not have these drawbacks. Briefly stated, the novel apparatus comprises a multiplicity of projections extending outwardly from the shell of the furnace at the top portion thereof, a pivot shaft rotatably extending through each of said projections and equipped with sealing means, with the shaft ends disposed outside the furnace, repellers secured respectively to the pivot shafts inside the furnace, and a pivot shaft driving system engaged with side ends of said pivot shafts.

An object of this invention is to provide an apparatus for changing the charge distribution in a vertical furnace which is characterized in that the main members of the apparatus are free from thermal distortion and seizure and have excellent strength.

Another object of the invention is to provide an apparatus for changing the charge distribution which has small repelling plates and gives rise to less blockage to the gas flow in the furnace.

Still another object of the invention is to provide a charge distribution changing apparatus which facilitates the replacement of worn or damaged main members.

Still another object of the invention is to provide an apparatus for variable charge distribution in which the repelling plates are divided into an arbitrary number of groups to be inclined at different angles.

These and other objects of the invention will be apparent from the following description of several embodiments of the invention in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of the top portion of a vertical furnace equipped with a conventional apparatus for changing the charge distribution in the furnace;

FIG. **2** is a section taken along the line II—II in FIG. **1**;

FIG. **3** is a sectional view of the top portion of a vertical furnace provided with a charge distribution changing apparatus embodying the invention;

FIG. **4** is a section taken along the line IV—IV in FIG. **3**;

FIG. **5** is an enlarged section showing the main components of the apparatus shown in FIG. **3**;

FIG. **6** is an enlarged front view of the main components of the apparatus shown in FIG. **3** with the cover partly broken away;

FIG. **7** is a front view showing another exemplary driving system;

FIG. **8** is a schematic plan showing ring segments surrounding the furnace; and

FIG. **9** is a section showing another repeller embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An apparatus of the present invention will be described in more detail in comparison with a conventional apparatus.

Generally, as shown in FIGS. **1** and **2**, a cup shaped hopper **2** is fixed to the top of the furnace body **1**, and the cup **2** has a lower opening which is closed by a large bell **3** suspended from the furnace top by means of a rod **5**. The large bell **3** is moved vertically by a driving means (not shown) provided at the furnace top. The material M to be charged is stored between the cup **2**

and the large bell 3. When the large bell 3 is lowered to the position 4 shown by the dotted line, the material M falls through the clearance 6 between the cup 2 and the large bell 3, drawing a locus as represented by the dotted line *L*. The falling material M collides with the repelling plates 21, thereby changes its falling direction, and accumulates in the furnace. Thus, by changing the angle of each repelling plate 21, the material M can be optionally located in the furnace. In the prior art apparatus, as shown in FIGS. 1 and 2, the repelling plates 21 are each threadably connected or welded to a hanger 22, which in turn is secured to a pivot shaft, for example a supporting shaft 23. The shafts 23 are rotatably and horizontally supported by supports 24 which are fastened to the inside of the shell 7 of the furnace above generated gas collecting ducts 8. The lower portion of each hanger 22 is in sliding contact with a push rod 29 which extends through the shell 7 and can be moved back and forth by an outside driving device 25 such as a hydraulic cylinder through an arm 26 positioned outside the furnace, a shaft 27 extending across a projecting part 9 of the furnace, and an arm 28 placed inside the furnace. A forward or backward movement of each of the push rods 29 causes the corresponding repelling plate 21 to rotate on the supporting shaft 23 until it reaches the desired position. As described already, such construction may give rise to thermal strain or seizure in the supporting shafts 23, that is, the pivot shafts or buckling in the push rods 29. In addition, the repelling plates 21 and the hangers 22 are required to have large dimensions, and therefore block the gas flow passage from the charged material surface S to the generated gas collecting ducts 8. The resulting narrowing of said gas flow passage increases the gas flow velocity and thus increases the thermal influence upon the furnace top charging apparatus. In addition, the collected gas has an increased duct content. Furthermore, as will be easily understood, it is very difficult to replace any of the repelling plates 21, the hangers 22, the push rods 29, and other members by removing the cover 11 fitted to an opening 10 provided in the shell 7 and taking out the members to be replaced, through the opening.

Referring now to FIGS. 3–6 in which an apparatus embodying the present invention is shown, a multiplicity of repelling plates 32 are each fastened to a lever 33 by means of fasteners 34. The repelling plates 32 are slightly concave with respect to the center line of the furnace body 1. The above description of the fastening of the repelling plates 32 to the levers 33 is not limitative. They may be formed integrally by casting or may be welded together and the repelling plates 32 may be each removably attached to the lever 33 to facilitate the replacement of them. The assembly of each repelling plate 32 and the lever 33 will hereinafter be referred to as a repeller 31.

Somewhat below the generated gas collecting ducts 8, the shell 7 of the furnace is formed with outward short projections 12 having openings 13. Box-type covers 14 having a rectangular, triangular or otherwise shaped cross-section are removably attached to the projections 12 by means of bolts 15 so as to close the openings 13. The side walls 16 of the covers 14 are equipped with bearing means 18 having shaft seals 17 including packings of asbestos or the like. A pivot shaft 35 is secured to the lever 33 of each repeller 31 near the other end than that where the repelling plate 32 is attached. The pivot shafts 35 are rotatably supported by the bearing means 18 so as to extend horizontally through the side walls 16. The repellers 31 are so arranged that the repelling plates 32 face toward the center line of the furnace body 1. Instead of the covers 14, the projections 12 may be fitted with the pivot shafts 35 so that the shafts are rotatable. In effect, what is required is to position the pivot shafts 35 deep in the covers 14 or the projections 12. That is, outwardly apart from the inner peiphery of the furnace body 1. The pivot shafts 35 are preferably supported at a level near the level of the bottom end of the large bell 3 when the bell is lowered. In the present invention, the repellers 31 rotate together with the pivot shafts 35 around the shaft axis, so that it is very easy to support the pivot shafts 35 at such a level as described above. This shaft arrangement allows the repelling plates 32 to move substantially along the material falling locus *l* drawn from the large bell 3, and thus increases the function and effect and facilitates making the repelling plates 32 and the levers 33 relatively small and sturdy.

The multiple (16 in this embodiment) repellers 31 attached to the projections 12 or the covers 14, as described above, are angularly spaced around the furnace body 1. The 16 repelling plates 32, which are slightly curved, as described above, define a circle and adjacent repelling plates 32 overlap so that there is no clearance therebetween to allow the falling charge M to leak through.

The following is a description of a driving system 41 for the repellers 31 constructed as described hereinbefore.

An annular deck 19 is provided around the furnace body 1. Three hydraulic cylinders 42 are mounted on the deck 19 at angular intervals of 120°. The hydraulic cylinders 42 may be fastened at their base ends onto the deck 19 or may be pivotally mounted on said deck by means of pin joints. The ends of the piston rods 43 of the hydraulic cylinders 42 are connected to the lower surface of a ring 44 surrounding the furnace body 1, thus supporting the ring 44. Accordingly, when the hydraulic cylinders 42 are operated, the furnace surrounding ring 44 is moved vertically.

Bearing stands 45 are fastened onto the upper surface of the ring 44 corresponding to the positions of the repellers 31. A link 47 is rotatably connected to each of the bearing stands 45 through a shaft 46. The shaft holes 48 of the links 47 are elongated so as not to be gouged by the shafts 46. Meanwhile, an actuating lever 49 is secured to the pivot shaft 35 fastened to each of the repellers 31, at the end of the shaft portion extending through one of the side walls 16. The other end of the actuating lever 49 is connected firmly, not rotatably, to the upper end of the associated link 47 through a pin 50.

The repellers 31 and the driving system 41 thus constructed operate as follows: When the hydraulic cylinders 42 are operated, the ring 44 moves up or down. This vertical movement causes the levers 33 to rotate through the links 47, the actuating levers 49 and the pivot shafts 35, thus changing the positions of the repelling plates 32 and accordingly their inclination angle. By this changing, the charge M falling from the cup 3 can be distributed in the furnace as required.

In the driving system 41, the hydraulic cylinders 42 used as lifting means can be replaced by air cylinders or electric driving devices. In addition, the number of the hydraulic cylinders 42 is not limited to three, which

is the number employed in this embodiment. Furthermore, it is alternatively possible to connect driving devices directly to all actuating levers **49** or to move the actuating levers **49** through gears. Moreover, as shown in FIG. **7**, the pivot shafts **35** can be driven directly by electric motors **51** or through speed reduction gears **52.** In short, it is possible to employ any means that can cause the pivot shafts **35** to rotate. In addition, instead of the above-mentioned single ring **44** surrounding the furnace, an optional number of ring segments can be used to operate the same number of groups of repellers. FIG. **8** shows three furnace-surrounding ring segments **44***a*, **44***b* and **44***c*, which are moved vertically by means of the lifting devices **42***a*, **42***b* and **42***c*, respectively.

Thus, this invention has the advantage that the repellers can be optionally divided into groups and inclined at different angles as well as being inclined at the same angle.

Still further, each of the repelling plates **32** can be attached to the corresponding lever **33** by means of a single connector **53** so as to be rotatable with respect to the lever **33,** and can be kept vertical regardless of the inclination angle of the lever **33.** Besides, the angle of each repelling plate **32** thus attached can be adjusted by fitting a wedge-shaped piece **54** to the lower portion of the repelling plate **32.** It is also possible to interpose an elastic article between repellent plate **32** and lever **33** to weaken the impact by material collision.

As will be apparent from the foregoing description, the apparatus of the invention has the following advantages:

Firstly, the pivot shafts **35** are less subject to damage by gas flow or thermal distortion since they are located in the projections **12** extending outwardly from the shell **7,** thus being far apart from the axis of the furnace and less affected by the charge and gas flow in the furnace.

Secondly, since the apparatus has a very small number of parts to which the impact by the collision of the charge to the repelling plates **32** acts as compressive force, there may occur substantially no damage due to buckling or the like.

Thirdly, because the repelling plates **32** are each moved substantially along the material falling locus *l* from the large bell **2,** the falling material makes positive collision against the repelling plates **32,** even if the material collision area of each said repelling plate **32** is relatively small. Thus, the apparatus can be made smaller in size, and there is less blockage to the gas stream in the furnace.

Fourthly, since a small-sized apparatus can be used as described above, the provision of the shell **7** with removable parts, for example, the covers **14,** greatly facilitates maintenance work such as replacement of worn and damaged members.

Other modifications will be apparent to those skilled in the art. It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty reside in the invention.

What is claimed is:

1. In a vertical furnace having a bell and hopper near the top thereof, and gas collection means adjacent said bell and hopper, an apparatus for changing the distribution of raw materials in a vertical furnace comprising a plurality of repelling devices each having a repelling plate set at one end of a lever, said plurality of repelling devices being arranged to form a circle within said furnace; pivot shafts fixed at the other end of each of said levers and supporting said levers for free rotation at a position below said gas collection means, said position being substantially at the same level as the lower end of said bell when said bell is in its lowered position not communicating with the inner surface of the furnace body; and driving means connected to said pivot shafts to rotate said shafts so as to move said repelling plates substantially along the locus of the path made by the raw materials falling from said bell and hopper, said motion changing the inclination angle of said repelling plates with respect to the axis of the furnace body.

2. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **1** wherein said furnace comprises a plurality of projections extending outwardly from the top portion thereof and wherein said pivot shafts extend through said projections.

3. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **1** wherein said projections are formed with removable box-type covers.

4. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **1** wherein said pivot shaft driving system comprises lifting means, an actuating lever secured to each of said pivot shafts at a portion thereof extending out of the furnace, and links fastened respectively to the actuating levers, whereby the vertical movement of said lifting means causes the pivot shafts to rotate through said actuating levers and said links.

5. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **4** wherein said lifting means comprises cylinder means.

6. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **4** wherein said links are rotatably supported by bearing stands fastened to a ring surrounding the furnace body, said ring being vertically moved by said lifting means.

7. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **6** wherein said plural repellers are divided into a number of groups while said furnace surrounding ring is divided into the identical number of ring segments with the number of the repeller groups, the repellers being operably linked to said ring segments so that the inclination angle of each said group of repellers is adjustable independently of the other repeller groups.

8. An apparatus for changing the charge distribution in a vertical furnace as set forth in claim **1** wherein said pivot shaft driving system comprises electric motors and speed reduction gears in operational connection with the pivot shafts.

9. An apparatus for changing the distribution of the charge in a vertical furnace which comprises a multiplicity of projections extending outwardly from the shell of the furnace at the top portion thereof, a pivot shaft rotatably extending through each of said projections and equipped with sealing means, with the shaft ends disposed outside the furnace, repellers secured respectively to the pivot shafts inside the furnace, and a pivot shaft driving system engaged with one-side ends of said pivot shafts; said pivot shaft driving system comprising lifting means, an actuating lever secured to each of said pivot shafts at a portion thereof extending out of the furnace, and links fastened respectively to the actuating levers; said links being rotatably supported by bearing stands fastened to a ring member surrounding

the furnace body, said ring being vertically moved by said lifting means; said repellers being divided into the identical number of ring segments as the number of repeller groups, the repellers being operably linked to said ring segments so that the inclination angle of each said group of repellers is adjustable independently of the other repeller groups.

* * * * *