

June 9, 1931.

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1,809,324

APPARATUS FOR BLAST FURNACE CONTROL

Original Filed Aug. 30, 1927

4 Sheets-Sheet 1

This technical drawing is a cross-sectional view of a mechanical assembly. At the top, a horizontal section (11) contains a central shaft (40) with a pulley or gear (34) and two side components (8 and 10). Below this, a large, curved, bowl-shaped structure (3) is supported by a central vertical rod (13) that terminates in a foot or valve (26). The bowl is flanked by two vertical, tapered walls (4 and 1). The entire assembly is mounted on a base (5) which has a curved bottom. Two vertical support columns (2) are positioned on either side of the base, each featuring a horizontal adjustment or control lever (7). The drawing includes various hatching patterns to indicate different materials or cross-sections. Numerous numerical labels (1 through 43) identify specific parts and features throughout the diagram.

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4 Sheets-Sheet 2

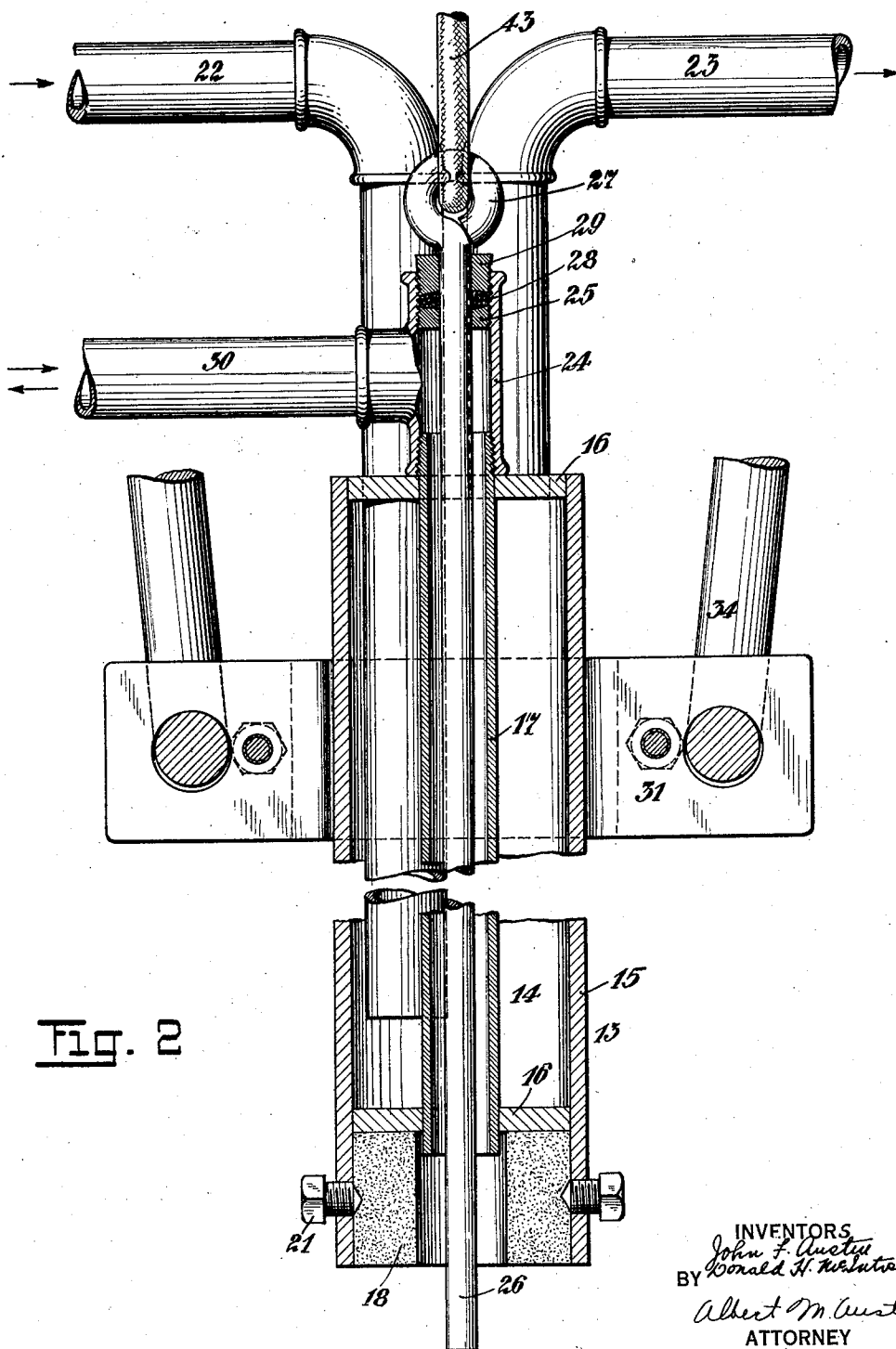


Fig. 2

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4 Sheets-Sheet 3

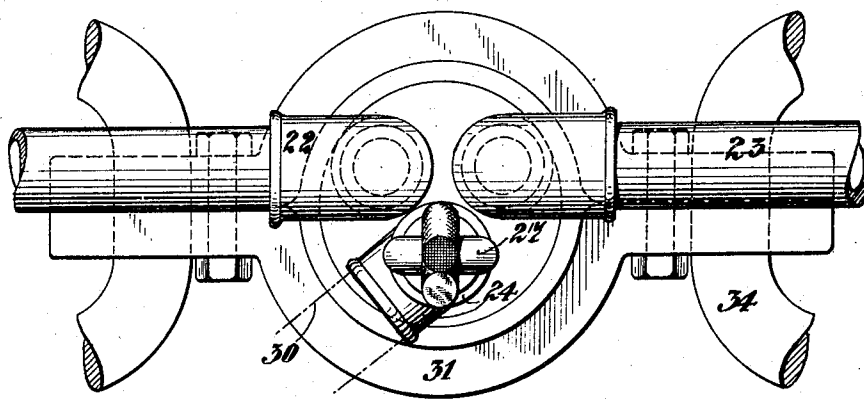


Fig. 3

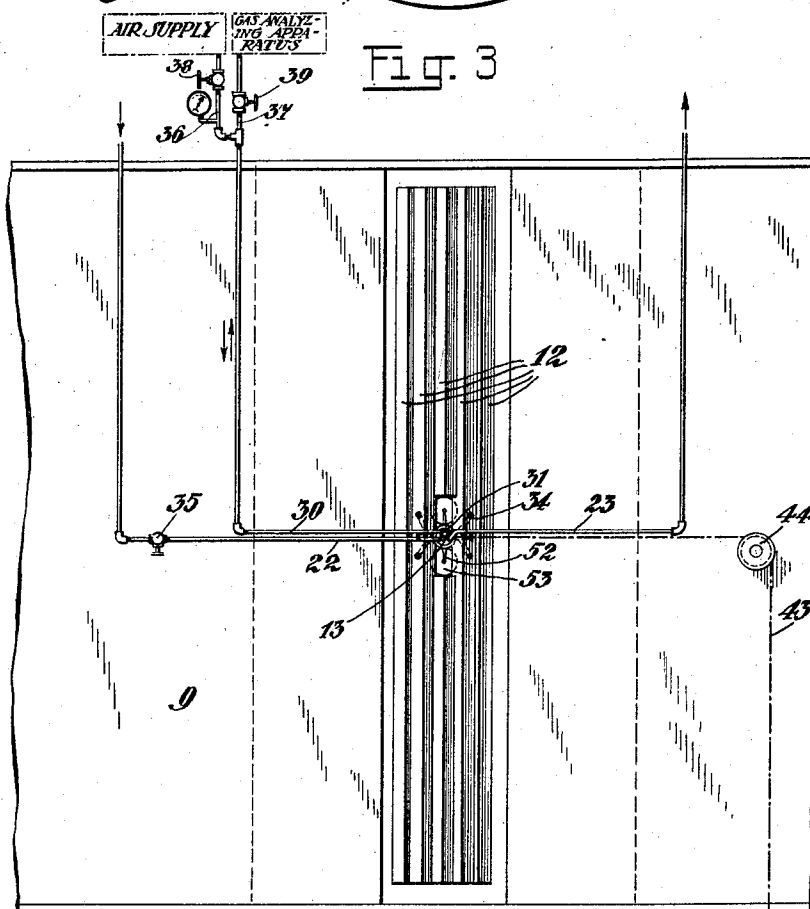


Fig. 4

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4 Sheets-Sheet 4

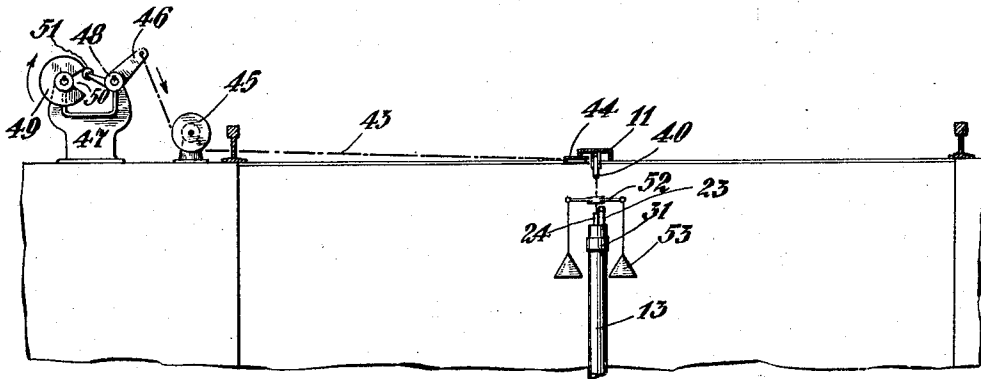


Fig. 5

Fig. 6

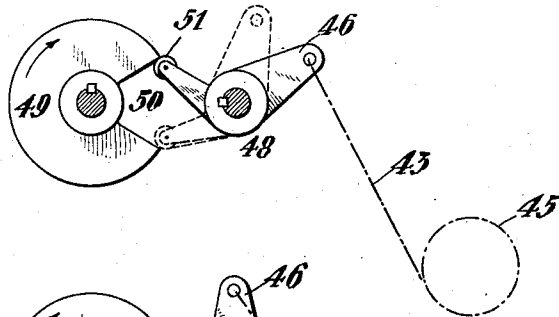


Fig. 7

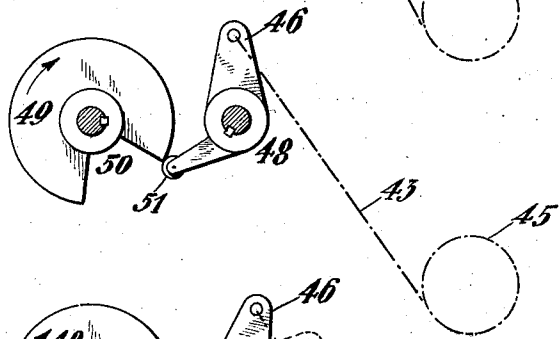
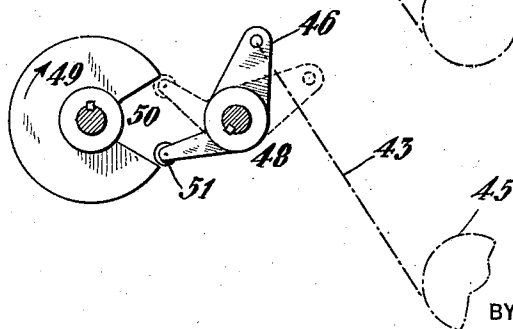


Fig. 8



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UNITED STATES PATENT OFFICE

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APPARATUS FOR BLAST FURNACE CONTROL

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The invention relates in general to the art of metallurgy, and more particularly, to apparatus for controlling the operation of a metallurgical blast furnace.

According to the invention, the operation of a metallurgical blast furnace is controlled in a simple and efficient manner by sampling the gases in the furnace at frequent intervals and then adjusting the fuel feed or blast or both in accordance with the state of the furnace as indicated from the samples. According to the invention the sampling point or zone is that point or zone in the furnace which is most sensitive to changes in the condition of the furnace, and is located in the charge somewhere between the tuyères and the flue.

The apparatus for carrying out the invention may comprise a suitable sampling tube which is inserted preferably through the top of the furnace to communicate with the critical zone. Suitable cooling means may be provided to keep the tube from burning out due to the intense heat of the furnace. The sampling tube may have connected therewith suitable gas analyzing apparatus for analyzing the sample of gas and also a suitable source of compressed air for blowing out the tube at frequent intervals. A suitable plunger passing through the sampling tube may also be provided to prevent the sampling tube from clogging up. The tube may be made to operate as an auxiliary tuyère if desired. Furthermore, suitable apparatus may be connected to the sampling tube so that the porosity of the charge may be measured from time to time.

Various other features and advantages of the invention will be apparent from the following particular description and from an inspection of the accompanying drawings.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection

with the accompanying drawings forming a part thereof, in which

Fig. 1 is a section of a well known type of blast furnace equipped to practice the invention;

Fig. 2 is an elevation partly in section of the sampling tube and associated apparatus;

Fig. 3 is a top plan view of the sampling tube and associated apparatus;

Fig. 4 is a top plan view of the furnace illustrating, more or less diagrammatically, the associated apparatus;

Fig. 5 is a detail showing the mechanism for actuating the plunger; and

Figs. 6, 7 and 8 are diagrammatic views illustrating the operation of the plunger actuating mechanism.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Like reference characters denote like parts in the several figures of the drawings.

Referring now to the drawings, and more particularly to Fig. 1, a conventional type of blast furnace is illustrated with which the invention may be practiced. This furnace, which may be of the type used for smelting lead ores, may comprise the usual shaft 1 supported by a plurality of pillars 2. The shaft may be provided with a flue opening 3 and with a fire brick lining 4. Located between the pillars is the base or crucible 5 of the furnace, and extending between the base and the shaft lining is a water jacket 6, suitable means (not shown) being provided for circulating cooling water. Arranged around the periphery at the lower part of the water jacket 6 is a series of tuyères 7, these tuyères being supplied with an air blast in any desired manner.

Suitable I-beams 8 for supporting the roof 9, are provided at the top of the furnace, the roof having the usual opening 10 through which the charge is fed. Disposed across the opening is an inverted channel iron 11. Disposed within the furnace and below the charge opening is a spreader 12 which is used for

distributing the charge in a manner well known in the art.

The detailed construction of the furnace forms no part of the present invention except in association with the sampling tube 13. The invention may be practiced with any kind of metallurgical furnace and is not limited to the particular furnace shown. The furnace may be charged and operated in any approved manner known in the art.

Referring now more particularly to Figs. 2 and 3, the sampling tube 13 may comprise an outer casing or jacket 14 having a cylindrical side wall 15 and end walls 16 welded therein. Disposed within the outer casing 14 is an inner tube 17 passing through both upper and lower end walls, and secured therein. Located within the outer casing 14 and at the bottom is a ring of fire brick 18 which is suitably held therein by means of set screws 21 until it is fused in position by the heat of the furnace.

Also connected to the outer casing 14 is a pair of water cooling pipes, the intake pipe 22 being extended through the upper end wall 16 to almost the bottom of the casing, and the outlet pipe 23 being extended merely through the upper wall 16.

Connected to the inner tube 17 is a T-fitting 24, the lower end of the fitting being screwed on to the inner tube and the upper end being provided with a disc 25 having an opening through which extends a plunger rod 26 having an eye 27 at its upper end. A packing 28 is arranged in the upper end of the T-fitting, and a gland 29 is threaded into the fitting to compress the packing against the plunger rod to make a tight joint. A connecting pipe 30 is led off from the side of the fitting as shown.

Just below the top of the casing 14 a collar 31 is provided, the collar being made up of two halves suitably clamped together and provided with holes through which links 34 are threaded (see Fig. 1), the links extending up through the spreader 12 and being affixed to the channel iron 11 as shown.

Referring now more particularly to Fig. 4, the inlet pipe 22 for the cooling water is provided with a valve 35 as shown, the outlet pipe 23 being shown as led away from the furnace. The connecting pipe 30 leading away from the furnace is shown as dividing into two branches 36 and 37, each branch being provided with a valve 38 and 39. Branch 36 is connected to a supply of compressed air and has a pressure gage connected thereto on the furnace side of valve 38. Branch 37 is connected to the gas analyzing apparatus which may be of the recording, graphic type or any other well known type.

Mounted within the channel 11 and directly over the plunger rod 26 is a pulley 40 over which passes a cable 43 extending from the plunger rod, the cable extending along the

channel to a pulley 44 by which the direction of the cable is changed at right angles, the cable then extending to a pulley 45, and thence to an operating arm 46.

Mounted at the side of the furnace is a support 47 having a bell crank lever 48 mounted therein and also a cam 49 in the form of a wheel having a notch 50. One end of the lever 48 comprises the operating arm 46, and the other end is provided with a roller 51 which cooperates with the cam. As the cam rotates in the direction of the arrow in Figs. 6, 7 and 8, it will be seen that the operating arm 46 will alternately pull the cable 43 and suddenly release it, the movement of the cable being communicated to the plunger rod to keep the inner tube clear of soot and solid particles. The plunger rod is provided with a cross bar 52 (see Fig. 5) from which suitable weights 53 are suspended to aid the plunger rod in its downward movement.

In order to practice the invention using the apparatus illustrated, the sampling tube 13 is inserted in the furnace in the manner shown in Fig. 1, the lower end being in the charge at the critical or sensitive zone. The cooling water will be circulated and the valve 38 will be closed while the valve 39 will be open. The plunger actuating mechanism will be working and samples of the furnace gases may pass out of the branch 37 into suitable analyzing apparatus indicated diagrammatically for analyzing the various elements present in the gases, such as the carbon dioxide and carbon monoxide. Suitable adjustments may then be made in the supply of fuel and the supply of air, or in both, in accordance with the composition of the furnace gases. These adjustments may be made very frequently since the furnace gases may be analyzed very quickly.

The best and most critical zone is found by placing the sampling tube in the furnace, and purposely changing the proportion of air and fuel and noting its effect on the samples taken from the sampling tube. When the most critical zone has been found, the sampling tube is fixed permanently in position.

The sampling tube is made of rough iron and is so arranged that it will not burn out, will not clog and will not flux with the material of the charge. The sampling tube can be made comparatively inexpensively and can have comparatively long life, always operating satisfactorily.

The method according to the invention gives the accurate condition of the furnace at all times, and since the furnace is adjusted in accordance with each analysis, the efficiency of the furnace is greatly increased. Furthermore, the cooling action of the tube in the furnace holds the reduction zone low, thus decreasing the tendency for blow holes to occur, and thereby making for a more uni-

form furnace operation. Furthermore, the sampling tube may operate as an auxiliary tuyère when the valve 39 is closed, and the valve 38 is opened to blow out the dirt accumulations, this also having a beneficial effect on the running of the furnace. In addition, the sampling tube may be used to measure the porosity of any given charge by noting on the pressure gage the pressure of the blast necessary to blow air through the tube after blowing out the tube.

Thus a method and apparatus has been disclosed by which a blast furnace may be controlled in a simple and efficient manner to give improved results. Samples of gas can be taken as frequently as desired from the selected critical zone and the gas can be analyzed very quickly. The furnace may then be adjusted as indicated by the samples taken. Thus a furnace can be run at all times at a maximum rate of efficiency, resulting not only in a saving of fuel but in an improved smelting action. The use of the sampling tube as an auxiliary tuyère also gives beneficial results and its use to measure porosity of the charge is also of advantage. The apparatus is built ruggedly to withstand the severe operating conditions. The sampling tube will not readily burn out or clog up and will give long and efficient service.

Although certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the form and details of the apparatus illustrated may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. A sampling tube comprising an outer tubular casing having an upper end wall and a lower end wall, said lower wall being spaced from the lower end of the casing, an inner tube passing through said end walls, a T-fitting having one of its aligned branches connected to said inner tube, a plunger rod disposed loosely in said inner tube and said aligned branches, a packing box included in the upper of said aligned branches, water pipes connected to said upper end wall, a lining within said casing below said lower end wall, a connecting pipe secured to the third branch of said T-fitting, and a supporting collar clamped around said casing.

2. A sampling tube comprising a cooling jacket, an inner tube passing through said jacket, a T-fitting having one of its aligned branches connected to said inner tube, a plunger rod disposed loosely in said inner tube and said aligned branches, a packing box included in the upper of said aligned branches, and a connecting pipe secured to the third branch of said T-fitting.

3. A sampling tube comprising an outer cooling jacket, an inner tube passing through

said jacket, and a plunger passing through said inner tube.

4. In combination, a metallurgical blast furnace comprising side walls having a flue near the top thereof and tuyères near the bottom thereof, a roof having a feed opening, a crucible at the bottom of the furnace, a distributor under said feed opening for distributing the charge, and a sampling tube suspended from said roof and passing through said distributor into the furnace.

5. In combination, a metallurgical blast furnace having a flue and a feed opening near the top and air blast tuyères near the bottom, a sampling tube having its inner end within said furnace, a source of compressed air and sampling apparatus for connection to said sampling tube, said tube being permanently in position in said furnace, and means whereby said tube is used for withdrawing samples of furnace gas at intervals between which said compressed air is forced into said furnace through said tube to keep the tube from clogging and to cause said tube to act as an auxiliary tuyère.

6. In combination, a metallurgical blast furnace having a flue and a feed opening near the top and air blast tuyères near the bottom, there being a charge of ore and fuel in said furnace, a sampling tube having its inner end in a zone between said tuyères and flue within the body of said charge, said zone being critical to change of smelting condition within the furnace, a source of compressed air and sampling apparatus for connection to said sampling tube, said tube being permanently in position in said furnace, and means whereby said tube is used for withdrawing samples of furnace gas at intervals between which said compressed air is forced into said furnace through said tube to keep the tube from clogging and to cause said tube to act as an auxiliary tuyère.

In testimony whereof we have hereunto set our hands.

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