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[54] **FEEDING ARRANGEMENT FOR AN ELECTRIC FURNACE HAVING A TUBULAR ELECTRODE**
12 Claims, 1 Drawing Fig.

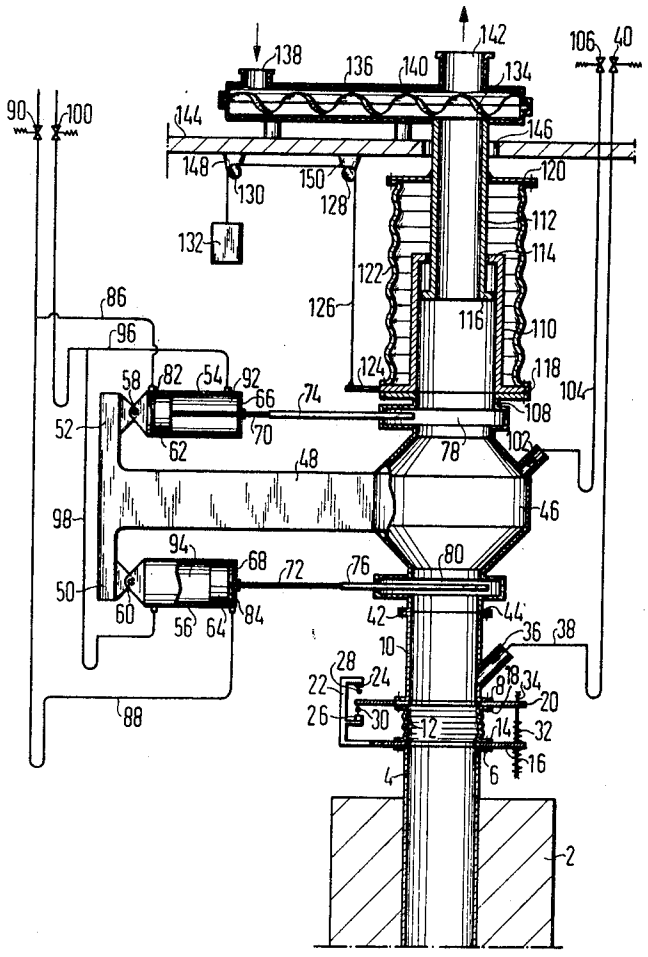
[52] **U.S. Cl.** **13/33,** 214/35
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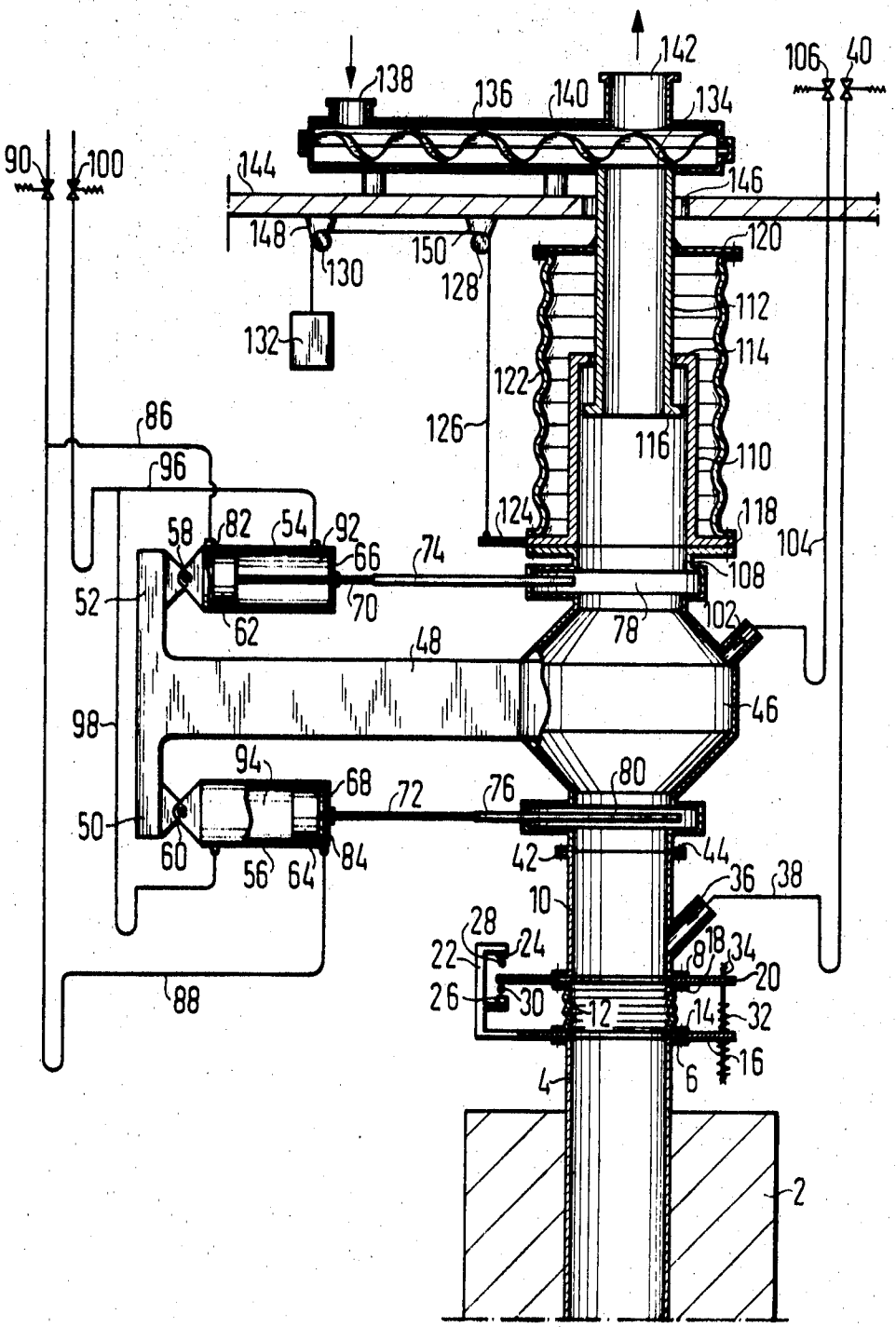
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ABSTRACT: In an electric furnace in which particulate solid material is fed to the furnace hearth from a normally stationary feed pipe through an axially expandable and contractable conduit and through the bore of the electrode, a charging chamber is mounted between the conduit and the electrode and provided with slide valves in its feeding and discharge portions respectively. Suitable operation of the valves permits the material to be introduced into the furnace without release of significant amounts of furnace gases.



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FEEDING ARRANGEMENT FOR AN ELECTRIC FURNACE HAVING A TUBULAR ELECTRODE

This invention relates to electric furnaces, and particularly to improvements in a furnace feeding arrangement in which material is supplied to the furnace hearth from a normally stationary feed pipe having an upright axis through an axially expandable and contractable conduit and through a bore in an electrode mounted for axial movement.

In known feeding arrangements of the aforedescribed type, the fed material falls freely from the feed pipe into the electrode bore. The gas pressure in the bore of the electrode is much higher than ambient atmospheric pressure in such electric furnaces when employed for the manufacture of high-grade calcium carbide or of ferrous alloys, and the hot and usually poisonous furnace gas tends to escape through the feed channel. It has therefore been found necessary in conventional feeding arrangements to connect the stationary feed pipe with a suction line. It was unavoidable heretofore that the hot gases flow through the expandable conduit, and it has been difficult under these conditions to maintain an adequate sealing connection between the bore of the electrode, which must be mounted for axial movement, and the feed pipe.

The primary object of the instant invention is the provision of an improved feeding arrangement in which the expandable and contractable conduit between the electrode bore and the normally stationary feed pipe is protected against contact with significant amounts of the furnace gases.

With this object and others in view, as will hereinafter become apparent, the feeding arrangement of the invention is provided with a charging chamber having a feeding portion and a discharge portion downwardly spaced from the feeding portion. Mounting elements respectively secure the discharge portion to the electrode and secure the feeding portion to the aforementioned axially expandable and contractable conduit. A first valve is movably arranged in the feeding portion and a second valve in the discharge portion. A valve actuating mechanism can move each of the valves between two respective positions in which the valve opens and closes the associated chamber portion to the passage of material from the feed pipe to the bore of the electrode through the charging chamber.

Other features and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing.

The sole FIGURE of the drawing shows a furnace equipped with the feeding arrangement of the invention in fragmentary elevational section, and partly in a diagrammatic manner.

Only as much of the furnace has been illustrated in the drawing as is needed for an understanding of the invention, the furnace chamber proper having been omitted together with the hydraulic hoist mechanism which permits a heavy tubular electrode **2** to be raised and lowered relative to the furnace hearth.

The upright axial bore of the electrode **2** is provided with tubular liner **4** which upwardly projects from the electrode and is equipped with a flange **6** on its projecting top. The flange **6** is vertically connected with a bottom flange **8** on a coaxial connecting pipe **10** by a short section **12** of flanged corrugated tubing. A switch supporting plate **16** is clamped between the lower flange **14** of the tubing section **12** and the flange **6** of the liner **4**. A switch actuating plate **20** is similarly clamped between the upper flange **18** of the corrugated tubing section **12** and the flange **8** of the connecting pipe **10**.

An upright bracket **22** on the plate **16** carries two vertically spaced limit switches **24, 26** whose operating buttons **28, 30** are directed against opposite horizontal faces of the switch actuating plate **20**. A heavy helical wire spring **32** is coiled about a pin **34** which passes through vertically aligned apertures in the plates **16, 20**, the spring **32** being arranged to oppose axial deformation of the tubing section **12** under applied stresses.

A nipple **36** fastened to the outer wall of the connecting pipe **10** and communicating with the interior of the pipe is obliquely downwardly directed. It is connected by flexible tubing **38** and a solenoid-operated valve **40** to a compressor, not shown, whose intake is connected to the furnace chamber. The nipple **36** thus forms a nozzle for injecting compressed furnace gas into the connecting pipe **10** and the liner **4** in the electrode bore.

The upper flange **42** of the connecting pipe **10** is bolted to a flange **44** on the lower, discharge portion of a charging chamber **46**. An approximately T-shaped carrier arm **48** projects from a vertical outer wall of the chamber **46** at right angles to the common axis of the several tubular elements which constitute the vertical main portion of the feed channel in the illustrated apparatus.

The upright branches **50, 52** of the arm **48** are connected to imperforate respective end walls of cylinders **54, 56** by means of pivot pins **58, 60**. The cavities of the cylinders **54, 56** are divided into compartments **82, 92** and **84, 94** by pistons **62, 64** carrying piston rods **70, 72** which project through apertured end walls **66, 68** of the cylinders **54, 56** toward the chamber **46**, and are attached to plate-shaped slide valves **74, 76**.

When the pistons **62, 64** are moved in the cylinders **54, 56**, the slide valves **74, 76** respectively move into and out of the feeding portion **78** and the discharge portion **80** of the chamber **46**, thereby either opening or closing the associated chamber portions to the downward passage of material to the bore of the electrode **2**. The compartments of the two hydraulic motors constituted mainly by the cylinders **54, 56** and the pistons **62, 64** are supplied with pressure fluid or vented through connected flexible conduits **86, 88** and a solenoid valve **90**, and through connected flexible conduits **96, 98** and a solenoid valve **100**. The valve **90** is connected simultaneously with the front compartment **84** of the cylinder **56** and with the rear compartment **82** of the cylinder **54**. The valve **100** is connected with the front compartment **92** of the cylinder **54** and with the rear compartment **94** of the cylinder **56**. Nonillustrated throttling sections in the conduits **88, 96** delay movement of the pistons **62, 64** in a direction away from the chamber **46**.

A nipple **102** leads obliquely downwardly into the chamber **46**. It is connected by flexible tubing **104** with a solenoid valve **106** on a nonillustrated tank containing nitrogen under high pressure.

The rim **108** about the upwardly directed feed opening of the chamber **46** is fixedly fastened to a tube **110** in telescoping engagement with the bottom portion of a normally stationary feeding pipe **112**. The tube **110** is guided on the pipe **112** by an internal flange **114** at the top end of the tube **110** which envelopes the outer wall of the pipe **112**, and by an external flange **116** on the lower end of the pipe **112** which slides on the inner wall of the tube **110**. An outer flange **118** on the lower end of the tube **110** and an annular disc **120** radially projecting from the pipe **112** are sealingly connected by bellows **122** of corrugated metallic tubing.

The weight of the chamber **46** and of the aforedescribed elements extending upwardly from the chamber is balanced by a counterweight **132** suspended from a flexible cable **126** which runs over guide pulleys **130, 128** to a radial bracket **124** on the flange **118**.

A feeder having a horizontal screw **136** in a casing **140** communicates with the feed pipe **112** through a discharge opening **134** in one end of the casing **140**. Particulate solid material is supplied to the feeder through an opening **138** at the other end of the casing **140**. A vent pipe **142** coaxial with the pipe **112**, the tube **110**, the chamber **46**, the connecting pipe **10**, and the liner **4** permanently connects the interior of the casing **140** with the ambient atmosphere.

The feeder is mounted on a stationary platform **144** which is a part of the supporting furnace frame, not otherwise shown, and also carries the mounting brackets **148, 150** for the guide pulleys **128, 130**. The feed pipe **112** passes freely through an aperture **146** in the platform **144**.

The aforedescribed apparatus is operated as follows:

In the illustrated position, the lower slide valve **76** closes the discharge portion **80** of the chamber **46** and the slide valve **74** opens the feeding portion **78**. The valve **100** connects the compartments **92** and **94** to the discharge conduit of a nonillustrated pressure pump while the compartments **82, 84** are vented to a nonillustrated sump by the valve **90**. When the valve **106** is briefly opened, a jet of nitrogen is discharged into the chamber **46** from the nozzle **102**, and the chamber **46**, the tube **110**, and the pipe **112** are purged of residual furnace gases which are diluted and discharged through the vent pipe **142**.

The feeder screw **136** is turned by a nonillustrated motor while a solid furnace charge is supplied through the opening **138**. The screw **136** is operated long enough to transfer a desired batch of material to the chamber **46**. The valve **100** is thereafter switched to the venting position while the valve **90** is moved to connect the nonillustrated pump to the compartments **82, 84**. The pistons **62, 64** move in opposite directions, and the slide valve **74** is almost completely closed before the valve **76** permits furnace gas to enter the chamber **46**. The contents of the chamber are dropped into the connecting pipe **10**.

The valve **40** is simultaneously opened for one or more short periods to discharge blasts of compressed furnace gas into the connecting pipe, and thereby to hasten the downward movement of the charge and to prevent its being welded to the pipe **10**. Ultimately, the solenoid valves **90, 100** are returned to their initial positions, and the slide valves **74, 76** resume the illustrated positions.

If so desired, a narrow bypass may be provided at the valve **40**, or the valve may be prevented from fully closing so that a weak stream of compressed furnace gas is discharged from the nozzle **36** at all times and prevents the nonillustrated molten charge in the furnace from entering the bore in the electrode **2**.

Electrodes of the type for which this invention is most useful may weigh as much as **80** tons and are raised and lowered by hydraulic hoists of corresponding capacity. It would not be practical to make the walls of the chamber **46** of a thickness sufficient to prevent destruction of the chamber if the full force of the hoisting mechanism were applied, as might occur if the pipe **112** jams in the tube **110**. The limit switches **24, 26** are effective in preventing damage to the chamber **46**.

The corrugated tubing section **12** is stiff enough to resist axial deformation under the stresses encountered in normal operation. It expands or contracts axially under stresses higher than normal, but much smaller than those that could cause damage to the chamber **46**, and the resulting relative movement of the plate **16, 20** causes the closing of the limit switch **26** when excessive compressive stress is applied to the tubing section **12**, and causes closing of the switch **22** under excessive tensile stress. The precise stress value at which either switch is operated may be set by suitably selecting the spring **32**. The switches **22, 26** may be arranged in circuit with visible or audible alarms, or they may actuate relays which stop the movement of the electrode **2** by the nonillustrated hydraulic hoist.

The electrode **2** is consumed during operation of the furnace and must be replaced from time to time. For this purpose, the flanges **6, 14** are released from each other. The weight of the chamber **46** and of associated furnace elements is balanced by the counterweight **132**, and the chamber may be raised manually to provide ready access to the partly consumed electrode, and to permit its replacement by a new electrode to which the chamber **46** together with the connecting pipe **10** is lowered. The flange **14** is thereafter fastened to the top flange on the liner of the new electrode.

For the convenience of pictorial representation, the axial lengths of the tube **110** and of the pipe **112** have been greatly reduced in the drawing as compared to other dimensions illustrated, and similar dimensional distortions have been resorted to elsewhere. Neither the electrical power circuit of the electrode **2** nor the automatic controls which normally operate the feed screw **136** and the solenoid valves **90, 100, 108,** and **40** in timed sequence have been shown nor described since they will be obvious to those skilled in the art.

The lower end of the feed pipe **112** and the tube **110** jointly constitute an axially expandable and contractable conduit which is necessary in feeding arrangements of the general type discussed here to permit vertical adjustment of the electrode **2**. The conduit constitutes the portion of the feeding arrangement which is most sensitive to the heat of the furnace gases, particularly when combined with the unavoidable mechanical stresses transmitted by the moving furnace charge. The chamber **46** with its two slide valves **74, 76** reduces the flow of furnace gases into the conduit **110, 112** to a minimum so that the seals between the telescopically engaged conduit portions are capable of extended useful service.

At least some of the advantages of this invention are available even if the two slide valves **74, 76** operate simultaneously. For best results, it is preferred that the opening movement of each valve lag behind the closing movement of the other. The aforementioned throttling elements in the conduits **88, 96** adequately perform this function without requiring moving parts. Other equivalent delay mechanisms will readily suggest themselves to those skilled in the art, and may be resorted to where required.

We claim:

1. In a feeding arrangement for an electric furnace including a normally stationary feed pipe having a vertically extending axis, an electrode formed with a bore axially aligned with said pipe, said electrode being mounted for axial movement, and axially expandable and contractable conduit means interposed between said pipe and said bore and connecting the same for passage of material from said pipe to said bore, the improvement which comprises:

a. a chamber having a feeding portion and a discharge portion, said discharge portion being downwardly spaced from said feeding portion;

b. mounting means respectively securing said discharge portion to said electrode and securing said feeding portion to said conduit means;

c. first valve means movable in said feeding portion;

d. second valve means movable in said discharge portion; and

e. valve actuating means for moving each of said valve means between two respective positions in which the valve means open and close the associated portions of said chamber to the passage of said material from said feed pipe to said bore through said chamber.

2. In an arrangement as set forth in claim **1**, each of said valve means including a slide valve member, and said valve actuating means including means for moving each of said slide valve members transversely of said axis.

3. In an arrangement as set forth in claim **2**, actuating means including two pressure-fluid operated motors respectively associated with said slide valve members each motor including a cylinder member defining a cavity and a piston member slidable in said cavity and dividing the same into two compartments, one member of each motor being mounted on said chamber and the other member being operatively connected to the associated slide valve member, and fluid supply means for supplying fluid under pressure to each of said compartments.

4. In an arrangement as set forth in claim **3**, said fluid supply means including a source of said pressure-fluid, and a conduit simultaneously connecting respective compartments of said motors to said source.

5. In an arrangement as set forth in claim **1**, said expandable and contractable conduit means including two telescoping tubular members secured to said feed pipe and to said chamber respectively for relative axial movement, and sealing means sealing said tubular members to each other during said movement.

6. In an arrangement as set forth in claim **1**, a source of a purging gas under positive pressure, and an injection nozzle mounted on said chamber and communicating with said source for injecting said gas into said chamber.

7. In an arrangement as set forth in claim **6**, a connecting tube axially interposed between said chamber and said elec-

trode and connecting said chamber to said bore, a source of furnace gas under pressure, said furnace gas being different from said purging gas, and another injection nozzle mounted on said connecting tube in a position to inject said furnace gas into said connecting tube in a downward direction.

8. In an arrangement as set forth in claim 1, an axially deformable tubular member interposed between said chamber and said electrode, said tubular member connecting said discharge portion to said bore, limit switch means, and switch operating means for operating said limit switch means in response to a predetermined axial deformation of said tubular member.

9. In an arrangement as set forth in claim 8, said limit switch means including two limit switches, and said switch operating means including means for operating one of said limit switches when the axial dimension of said tubular member reaches a predetermined minimum value, and for operating the other limit switch when said axial dimension reaches a predetermined maximum value.

10. In an arrangement as set forth in claim 8, a spring member operatively interposed between said chamber and said electrode for opposing axial deformation of said tubular member.

11. In an arrangement as set forth in claim 1, venting means permanently venting said feed pipe to the atmosphere.

12. In an arrangement as set forth in claim 1, the mounting means securing said discharge portion to said electrode being releasable, and balancing means upwardly biasing said chamber with a force sufficient to prevent downward movement of said chamber when the same is released from said electrode.