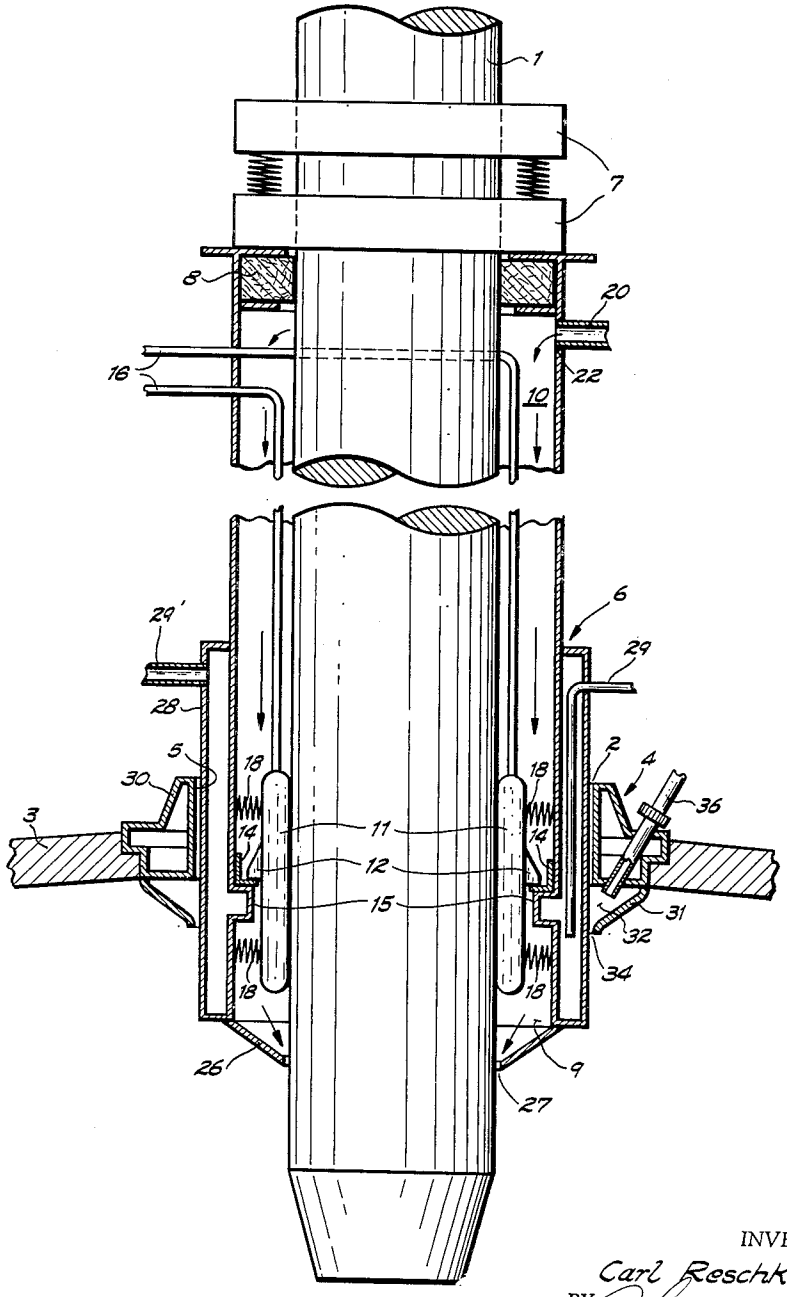
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ELECTRIC ARC FURNACES

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ELECTRIC ARC FURNACES

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This invention relates to electric arc furnaces and more particularly to means for protecting an arc furnace electrode and its associated components from exposure to the interior of the furnace.

Electrical energy is delivered to electric arc furnaces by means of one or more electrodes which extend into the furnace through suitable openings in the furnace cover. These electrodes are energized through the agency of contact jaws tightly pressed against the surface of the electrode and which are connected to an exterior energy source. Electrode clamping and positioning means are generally provided for raising and lowering the electrode as changes in furnace conditions dictate changes in the energy required. In order to insure sufficient effective electrode length when a portion of the electrode is expended in the furnace operation, means are also generally provided for moving the electrode into the furnace relative to the electrode clamping and positioning means and contact jaws.

Electric arc furnace electrodes of the type to which the invention applies are provided with a protective cylinder circumferentially spaced around said electrode and extending from the electrode clamping means through the opening in the furnace cover. The electrode contact jaws along with their associated electrical and cooling fluid connections are generally disposed on the interior of the cylinder. One end of the protective cylinder is generally provided with a bushing or packing which must allow relative movement between the electrode and the cylinder while preventing the escape of furnace gases and heat radiation. It is preferable that this packing be disposed at the outer end of the cylinder so that it will not be exposed to the damaging effects of the furnace heat. However, placing the packing at the exterior of the furnace allows dust and other foreign material from the furnace to enter the open end of the cylinder and adhere to the electrode surface. The abrasive effect of this material causes considerable wear to the contact jaws and electrode surface when the electrode is moved relative to the protective cylinder and contact jaws. For this reason, it was necessary to provide auxiliary means for disengaging the contact jaws from the electrode each time an additional portion of the electrode was fed into the furnace. Such auxiliary means is not only expensive but the separation of the contact jaws from the electrode allows dirt to collect between the contact jaw and the electrode thereby greatly impeding the transfer of current. Also, exposure of the interior of the cylinder to the furnace is undesirable because the heat and waste materials from the furnace have a corrosive effect on the contact jaws themselves as well as the electrical and cooling fluid connections thereto.

Similar packing assemblies are also provided between the exterior of the protective cylinder and the aperture in the furnace cover and they must allow relatively sliding movement between the protective cylinder and the aperture while preventing the escape of furnace gases and heat radiation through the aperture. The abrasive effect of the dust and other waste material from the furnace

which collects on the exterior of the protective cylinder cause an inordinate amount of wear on the bushing surfaces. Also, the intense furnace heat prevents the use of lubricants to enhance the sliding movement between the aperture and the exterior of the protective cylinder.

It is an object of the invention to provide an arc furnace in which the escape of heat, flames and dust from the furnace through the electrode aperture in the furnace cover is prevented.

It is a further object of the invention to provide an arc furnace having a protective electrode cylinder wherein the adherence of furnace waste material on the surface of the electrode and the cylinder is prevented.

It is another object of the invention to provide a protective cylinder for an arc furnace electrode having a packing assembly on its end remote from the interior of the furnace wherein the entrance of heat, flames and dust into the interior of said cylinder is prevented.

It is still another object of the invention to provide an arc furnace electrode having a protective cylinder wherein the escape of heat, flame and dirt around said protective cylinder is prevented.

It is a further object of the invention to provide a protective cylinder for arc furnace electrodes which protects the contact jaws and its associated electrical and cooling fluid connections from the abrasive and corrosive effects of the furnace heat and waste elements. It is a still further object of the invention to provide such arc furnace electrodes with contact jaws which do not require auxiliary means for disengagement from said electrode when an electrode adjustment is made.

It is yet another object of the invention to provide a protective cylinder for an arc furnace electrode which allows the use of lubricants between the outer surface of the cylinder and the aperture in the furnace cover.

It is another object of the invention to provide such protective cylinders with means for preventing the accumulation of furnace dust at the outer periphery thereof.

Other objects and advantages of the invention will become apparent from the following detailed description of the invention taken in view of the single figure of the drawing which schematically illustrates an elevational view partly in section of a protective cylinder embodying the present invention.

Certain of the objects of the invention are accomplished by providing an electric arc furnace having an elongate electrode means which includes an elongate member slidably received in an aperture in said cover with means for directing gas longitudinally along the surface of said elongate member and through the aperture whereby the escape of furnace flames, heat or waste material through the furnace aperture or the accumulation of said waste material on said elongate member is prevented. The elongate member may comprise either the electrode itself or the protective cylinder for said electrode. Where the elongate member comprises the electrode itself the means for directing the flow of gas along the surface of the electrode includes the protective cylinder which forms an open ended chamber around the electrode. Where the elongate member comprises the protective cylinder the gas directing means includes a member surrounding a portion of the protective cylinder and forming therewith a chamber open at its lower end.

Referring now to the drawing in greater detail, an arc furnace electrode **1** is shown extending through an orifice **2** in the cover **3** of an electric arc furnace (not shown). The arc furnace cover **3** is provided with a bushing **4** having a bearing surface **5** for slidably receiving the exterior of an electrode protective cylinder **6**. Electrode **1** is positioned relative to the furnace charge (not shown) by means of electrode clamping rings **7** which secure electrode **1** in any suitable manner well known in the art.

Clamping ring 7 can be raised and lowered in response to changes in furnace conditions by any suitable positioning mechanism (not shown) but which is also well known in the art.

Protective cylinder 6 is secured to the lower of the electrode clamping rings 7 in any suitable manner, so that said protective cylinder will move with electrode 1 during electrode positioning operations. It will be understood that during such positioning operations there will be relative movement between protective cylinder 6 and the bearing surface 5 of bushing 4.

As those skilled in the electric furnace art appreciate, arc furnace electrodes are consumed, worn away, or broken off during normal furnace operation. After a portion of electrode 1 has been expended in this manner, it is necessary to loosen electrode clamping means 7 and slide the electrode 1 toward the furnace charge while clamping means 7 and protective cylinder 6 are held in position, so that the effective electrode length may be readjusted to compensate for that portion consumed. It can be seen that during such readjustments in electrode length there is relative movement between electrode 1 and the protective cylinder 6 with its associated components.

The upper end of protective cylinder 6 is provided with suitable packing assembly 8 which allows relative movement between protective cylinder 6 and electrode 1 while preventing the escape of heat and waste products from the interior of the furnace. This packing can be of any type well known in the art such as packing bricks, asbestos wool or cup packings. The lower end 9 of protective cylinder 6 is open so that cylinder 6 and the surface of electrode 1 define a chamber 10 vented through its lower end 9.

Electrical energy is supplied to electrode 1 through contact jaws 11 supported near the lower end of protective cylinder 6 in any desirable manner such as by means of brackets 12 secured to the exterior side of electrodes 11 and carried by an annular angle member 14 affixed in any well known manner to embossed portions 15 on the interior of protective cylinder 6. Cooling fluid and electrical energy are supplied to contact jaws 11 through connecting members or conduits 16. Contact pressure between contact jaws 11 and electrode 1 is maintained by means of a plurality of contact pressure springs 18 carried on the interior of protective cylinder 6 and bearing against the exterior of each of contact jaws 11.

A conduit 20 is connected to the cylinder 6 and communicates with the chamber 10 through an aperture 22 in the upper end of protective cylinder 6. Conduit 20 is connected to a source of gas under pressure (not shown) for maintaining a continuous flow of gas into the chamber 10 and downwardly along the surface of electrode 1 to the lower end 9 of protective cylinder 6. Thus, if sufficient pressure is maintained in conduit 20, the flow of gas from the lower end 9 of protective cylinder 6 will prevent the entrance of flames and foreign material from the furnace to the interior of chamber 10. The efficiency of this gas flow may be increased by providing an inwardly extending inverted cone-like portion 26 disposed about the electrode and secured to the lower end 9 of protective cylinder 6 and defining an annular restricted opening 27 at the lower end of chamber 10 and about the electrode 1. This restricted opening creates a "Venturi" or nozzle effect at the lower peripheral margin of the protective cylinder 6 so that the velocity of the gas escaping through opening 27 is a great deal larger than the velocity of the gas elsewhere within chamber 10. As a result, the gas pressure that must be maintained in chamber 10 in order to prevent the entrance of foreign material is much less than would be required if opening 27 were unrestricted. It will be appreciated that the innermost diameter of the annular angle member 14 relative to the diameter of the electrode is such as to afford free movement of the gas in the chamber 10 and the horizontal portion of the member 14 may be provided with a plurality of perforations (not shown) to afford further unrestricted flow of gas between the upper and lower ends of chamber 10.

Gas supplied to the chamber 10 may be suitably cooled prior to its entrance into the chamber and thereby augment the cooling effects upon the contact jaws 11 as well as the furnace cover 3.

The lower portion of protective cylinder 6, which is normally exposed to the interior of the furnace during the raising and lowering of electrode 1 in response to changes in furnace conditions, is provided with a jacket portion 28 integral therewith and connected to a source (not shown) of suitable cooling fluid by means of an inlet conduit 29 and outlet conduit 29'. This cools the lower end of protective cylinder 6 and the jacket 28, thereby making it possible to utilize a lubricating fluid between the exterior surface of jacket portion 28 and the bearing surface 5 of bushing 4. This maintains the temperature on the surface of protective cylinder 6 at a sufficiently low value to insure that the lubricating qualities of the lubricant are not destroyed by the furnace heat. In this manner a sliding fit can be maintained between the exterior surface of the protective cylinder 6 and bearing surface 5 of bushing member 4 without requiring the use of expensive heat resistant packing members. Preferably the packing bushing 4 is also provided with a water confining jacket 30 for maintaining the bearing surface 5 at the proper temperature. What jacket 30 is coupled to a source of cooling fluid by any suitable means (not shown) but which is well known in the art.

In order to prevent the accumulation from the furnace of abrasive ash and other foreign material on the exterior surface of the jacket 28 on protective cylinder 6 and on bearing surface 5, means are also provided for directing the flow of gas along the exterior surface of jacket portion 28 of protective cylinder 6. This means includes an annular cup-shaped member 31 secured at its upper end to the underside of cover 3 in spaced apart relation to jacket 28 and providing at its lower end an annular opening 34 disposed about the jacket 28. An annular chamber 32 surrounding the jacket 28 of the protevtive cylinder 6 is thus defined by the member 31, the cover 3, and the jacket portion 28. A fluid delivery connection 36 extends through bushing member 4 to the interior of chamber 32 and is adapted for connection to a source (not shown) of fluid or gas supply maintained under pressure, thereby supplying the chamber 32 with fluid, forcing its egress through opening 34 and preventing the entrance of ashes and other foreign material from the interior of the furnace into said chamber and the accumulation thereof on the surface of the cylinder jacket 28. Opening 34 may be restricted to increase the velocity of the gas as it passes through opening 34 at the lower end of cup-shaped member 31.

By thus cooling bearing surface 5 and preventing the accumulation of waste material on the exterior of protective cylinder jacket 28, it is possible to utilize lubricating fluid or light grease between adjacent surfaces of the jacket 28 and bushing 4. Such lubricant may be applied to bearing surface 5 by injecting vaporized lubricating fluid into the gas stream from conduit 36.

The gas coupled to conduits 20 and 36 may be any neutral gas such as CO_2 which may be obtained by further oxidizing the carbon monoxide given off in the furnace operations.

It is preferable that bushing member 4 be of a nonmagnetic material so that energy losses due to induced currents are avoided.

I claim as my invention:

1. Electrode means for use in an electric arc furnace having a cover provided with an aperture therein for reciprocably receiving the lower end of said electrode means, said electrode means including an electrode and an elongate protective cylinder substantially coaxial with

said electrode and radially spaced therefrom in combination with a bushing in said aperture and slidably engaging said protective cylinder as said electrode means reciprocates, a continuous member disposed within said cover adjacent said bushing and around said cylinder, said member having its upper end secured to said cover in spaced relation to said cylinder, the lower end of said member being in close proximity to said cylinder, so that said member, said cylinder, and said cover define a substantially closed chamber having an annular restricted opening at its lower end, and fluid inlet means communicating with said chamber connected to a source of gas under pressure, whereby the escape of gas through said restricted opening prevents the entrance of waste material from said furnace into said chamber and the accumulation thereof on the exterior surface of said protective cylinder, the portion of said protective cylinder engaged by said bushing being provided with a cooling jacket whereby said portion may be maintained at a sufficiently low temperature to permit the use of lubricant thereon, thereby facilitating the sliding movement between said cylinder and said bushing.

2. Electrode means for use in an electric arc furnace having a cover provided with an aperture therein for reciprocably receiving the lower end of said electrode means, said electrode means including an electrode and an elongate protective cylinder reciprocable therewith, said cylinder being substantially coaxial with said electrode member and radially spaced therefrom, and a bushing in said aperture and slidably engaging said protective cylinder, as said electrode means reciprocates, the portion of said protective cylinder engaged by said bushing being provided with a cooling jacket whereby said portion may be maintained at a sufficiently low temperature to permit the use of lubricant thereon, thereby facilitating the sliding movement between said cylinder and said bushing.

3. Electrode means for use in an electric arc furnace having a cover provided with an aperture therein for reciprocably receiving the lower end of said electrode means, said electrode means including an electrode and a protective cylinder surrounding a portion of said electrode and radially spaced therefrom to define with the exterior surface of said electrode a hollow chamber, the upper end of said protective cylinder being in a sealing relation with said exterior surface, the lower end of said protective cylinder extending generally radially toward the surface of said electrode and terminating at a point in close proximity with said surface to form a continuous restricted opening in said chamber and around said electrode, fluid inlet means communicating with said cylinder connected to a source of gas under pressure, whereby the escape of gas through said restricted opening prevents the entrance of waste material from said furnace into said hollow compartment and the accumulation thereof on said electrode, a plurality of contact jaws disposed interiorly of said cylinder adjacent its lower end, and spring means for applying continuous contact pressure between said contact jaws and said electrode.

4. Electrode means for use in an electric arc furnace having a cover provided with an aperture formed therein for reciprocably receiving the lower end of said electrode means, said electrode means comprising an electrode and an elongate protective cylinder concentric with said electrode and including a cooling jacket on the lower end thereof, a bushing in said aperture slidably engaging said cooling jacket, said bushing also being provided with a cooling jacket, a member surrounding a portion of said protective cylinder and radially spaced therefrom to define with the exterior surface of said cylinder a substantially closed chamber, the upper end of said member being in a sealing relation with said exterior surface and the lower end thereof terminating at a point in close proximity with said exterior surface to form a restricted opening in said chamber and about said elongate cylinder, and fluid inlet means in said member connected to a source of gas under pressure, whereby the escape of gas through said restricted opening prevents the entrance of waste material from said furnace into said chamber and the accumulation thereof on the exterior surface of said protective cylinder.

5. Electrode means for use in an electric arc furnace having a cover provided with an aperture therein for reciprocably receiving the lower end of said electrode means, said electrode means including an electrode and an elongate protective cylinder coaxial with said electrode and radially spaced therefrom, the upper end of said cylinder being in sealing engagement with said electrode and the lower end thereof being spaced therefrom so that said cylinder and said electrode define a chamber open at its lower end, a bushing in said aperture slidably engaging said protective cylinder, an annular member disposed within said cover adjacent said bushing and around said cylinder, said member having its upper end secured to said cover in spaced relation to said cylinder, the lower end of said member being in close proximity to said cylinder, so that said member, said cylinder, and said cover define a substantially closed chamber having an annular restricted opening at its lower end and, first and second pressure inlet means to said cylinder and to said member respectively, each of said pressure inlet means being connected to a source of gas under pressure, whereby the escape of gas through the openings in said cylinder and said member prevents the entrance of waste material from said furnace into either of said chambers and the accumulation of said waste material on the exterior surface of said electrode and said protective cylinder.

6. Electrode means for use in an electric arc furnace having a cover provided with an aperture therein for reciprocally receiving the lower end of said electrode means, said electrode including an electrode protective cylinder surrounding an arc furnace electrode, a member surrounding a portion of said protective cylinder and spaced radially therefrom, the end of said member disposed toward the upper end of said cylinder being in a sealing relation therewith, the other end of said member being radially spaced from the surface of said cylinder so that said surface and said member define a hollow chamber open at its lower end, and fluid inlet means communicating with said cylinder and connected to a source of gas under pressure, whereby the escape of gas through the lower end of said chamber prevents the entrance of waste material from said furnace into said chamber and the accumulation thereof on the surface of said cylinder.

7. An electric arc furnace having a body and an electrode whose lower end extends into said body, a cover for said furnace body having an aperture formed therein for receiving the lower end of said electrode, a protective cylinder surrounding a substantial portion of said electrode and being radially spaced therefrom, the upper end of said protective cylinder being in a sealing relation with the exterior surface of said electrode, the other end of said cylinder extending into said aperture to surround a substantial portion of the lower end of said electrode within said furnace body and being radially spaced therefrom, said cylinder and the surface of said electrode thereby defining a hollow chamber having an opening in its lower end, fluid inlet means communicating with said cylinder and connected to a source of gas under pressure, the radial spacing between said cylinder and said electrode being sufficiently great to permit unrestricted gas flow between said inlet means and said opening, whereby the escape of gas through said opening prevents the entrance of waste material from said furnace into said chamber and the accumulation thereof on said electrode, the portion of said cylinder extending into said aperture being provided with a cooling jacket whereby said portion may be maintained at a sufficiently low temperature to permit the use of lubricant thereon, thereby facilitating the sliding movement between said cylinder and said aperture.

8. An electric arc furnace having an electrode, a cover for said furnace having an aperture formed therein for receiving the lower end of said electrode, a protective

cylinder surrounding a substantial portion of said electrode and being radially spaced therefrom, the upper end of said protective cylinder being in a sealing relation with said exterior surface, the other end of said cylinder being radially spaced from the surface of said electrode, said cylinder and the surface of said electrode thereby defining a hollow chamber having an opening at its lower end, fluid inlet means communicating with said cylinder and connected to a source of gas under pressure, the radial spacing between said cylinder and said electrode being sufficiently great to permit unrestricted gas flow between said inlet means and said opening, whereby the escape of gas through said opening prevents the entrance of waste material from said furnace into said chamber and the accumulation thereof on said electrode, a plurality of contact jaws disposed interiorly of said cylinder and adjacent its lower end, and means for applying contact pressure between said contact jaws and said electrode.

9. An electric arc furnace having an electrode, a cover for said furnace having an aperture formed therein for receiving the lower end of said electrode, a protective cylinder surrounding a substantial portion of said electrode and having a central portion radially spaced from the surface thereof, the upper end of said protective cylinder being in a sealing relation with the exterior surface of

said electrode, said cylinder and the surface of said electrode thereby defining a hollow chamber, the lower end of said cylinder being in substantially closer proximity to the surface of said electrode than said central portion to define a restricted opening for said chamber, fluid inlet means communicating with said cylinder and connected to a source of gas under pressure, the radial spacing between said cylinder and said electrode being sufficiently great to permit unrestricted gas flow between said inlet means and the lower end of said chamber, whereby the gas exhausting through the restricted opening in the lower end of said chamber travels at an appreciably higher velocity than the gas flowing between said inlet means and the lower end of said chamber, contact jaw means disposed interiorly of said cylinder and adjacent its lower end, means for applying contact pressure between said contact jaw means and said electrode.

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