APPLICATION FOR A STANDARD PATENT

T/We

ELKEM a/s,

a company incorporated under the laws of Norway,
of Middelthunsgate 27, Oslo 3, NORWAY

hereby apply for the grant of a Standard Patent for an invention entitled

"SUSPENSION ARRANGEMENTS FOR BAKING FURNACES"

which is described in the accompanying provisional specification.

For a Convention application — details of basic application(s) —

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>COUNTRY</th>
<th>DATE OF APPLICATION</th>
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<tr>
<td>853219</td>
<td>NORWAY</td>
<td>22nd August, 1985</td>
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My address for service is COLLISON & CO., Patent Attorneys, 117 King William Street, Adelaide, South Australia, 5000:

Dated this 13th day of August 1986.

ELKEM a/s,

By their Patent Attorneys,

COLLISON & CO.

PATENT OFFICE

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100 DOLLARS

90 DOLLARS

50 DOLLARS

The Commissioner of Patents

13 August 1986

Adelaide

(THE COMMISSIONER OF PATENTS)

(FEE STAMP TO VALUE OF

$1250 ATTACHED)

This form must be accompanied by either a provisional specification (Form B and true copy) or by a complete specification (Form 10 and true copy).
DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention application made for a patent for an invention entitled:

"ARRANGEMENT FOR SUSPENSION OF A BAKING FURNACE FOR ELECTRODES"

WE, JAN P. ROMSAAS AND LEIF KOPPERSTAD

of Middelthuns gate 27, Oslo 3, Norway

do solemnly and sincerely declare as follows:

1. I am the applicant for the patent.

   (for, in the case of an application by a body corporate)

   1. I am authorized by Elkem a/s, the applicant

      for the patent to make this declaration on its behalf.

   2. The basic application as defined by section 141 of the Act was made in Norway on the

      22nd day of August 1985 by Elkem a/s.

   3. I am the actual inventor of the invention referred to in the basic application.

      (for, where a person other than the inventor is the applicant)

   4. HENRIK M. KVIVIK, a Norwegian subject, of Vardåsveien 14A, 4600 Kristiansand, Norway.

   I, the actual inventor of the invention and the facts upon which I am entitled to make the application are as follows:

   Assignment from Henrik M. Kvivik to Elkem a/s dated September 5th, 1985

   4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a

      Convention country in respect of the invention the subject of the application.

      (for where a request is made under section 142AA of the Patents Act 1952, for

      an earlier application made in a Convention country to be disregarded)

   5. (1.) The basic application referred to in paragraph 2 of this Declaration was not the first application made in

      a Convention country in respect of the invention the subject of the application.

      (2.) An earlier application in respect of the invention the subject of the application was made in

      — on

      (3.) A request has been made to you under section 142AA of the Patents Act 1952 to disregard that earlier

      application.

      (where or, for an succeeding subparagraph, the facts that show why section 142AA is applicable)

      — on

      (4.) On the basis of the facts stated in this paragraph, the basic application referred to in paragraph 2 of this Declaration was the first

      application made in a Convention country in respect of the invention the subject of the application.

   Declared at Oslo this 10th day of July 1986

   pr.pr. Elkem a/s

   TO:

   THE COMMISSIONER OF PATENTS

   Jan P. Romsaas Signature of Declarant
   Vice president
   Vice president.

   [Signature of Declarant]

   [Vice president]

   [Vice president]

   [Date: 10/07/1986]
Suspension arrangements for baking furnaces

Claim

1. Suspension arrangement for suspending a baking furnace about an elongate carbonaceous workpiece comprising: a generally tubular baking furnace; guide means for guiding said workpiece through said furnace along a guidance axis; and suspension means for suspending said furnace in such manner that it is pivotable about axes transverse of said guidance axis.

21. Arrangement for suspending a baking furnace for continuous production of carbon electrodes in direct connection with a smelting furnace wherein the electrodes are consumed, wherein the baking furnace is suspended from a baking furnace frame by means of at least three support members connected to the baking furnace frame at their upper ends by means of first universal joints and wherein the baking furnace is connected to the support members by means of second universal joints; the baking furnace having means at its upper end for guiding the electrode.
The following statement is a full description of this invention, including the best method of performing it known to me.
SUSPENSION ARRANGEMENTS FOR BAKING FURNACES

The present invention relates to suspension arrangements for baking furnaces, to smelting furnaces having such an arrangement, to methods of baking workpieces and to methods of operating smelting furnaces.

It is known to produce continuous carbon electrodes in direct connection with a furnace in which they are consumed. The electrodes are produced by supplying heat energy to a workpiece consisting of unbaked electrode paste comprising a particulate carbon material and a carbonaceous binder.

The baking furnace is arranged above the level where electric operating current is supplied to the electrode. Green electrode paste is charged into a steel casing which is removed when the electrode has passed through the baking furnace before it enters the smelting zone. In this way the product which is produced in the smelting furnace is not contaminated by the iron of the steel casing. As the electrode is consumed, new sections of steel casing are put on the top of the electrode and additional green electrode paste is charged into the casing, before being passed through the baking furnace.

In order to produce a homogeneous electrode it is important that the baking furnace moves continuously or substantially continuously relative to the workpiece with a velocity which corresponds to a preset baking speed for the workpiece.

During the baking, the electrode paste becomes more or less liquid, whereafter it is burned to a solid carbon electrode. As the baking temperature is between
700 and 1300°C, the steel casing will become very soft in the baking zone inside the baking furnace. The workpiece and its casing therefore have an extremely low strength when inside the baking furnace. In order to produce a continuous workpiece, the electrode therefore has to be guided through the baking furnace.

Because the electrode has to pass through another two fixed points, namely current clamps for conducting electric operating current to the electrode and electrode holding and slipping equipment, any deviation from a straight line will result in binding or sticking of the workpiece or electrode. Thus either the electrode will break at a point between the three fixed points through which it passes or it will be impossible to slip the electrode through the electrode holder.

It is further important that the workpiece during the baking process is guided centrally in the baking furnace in order to obtain equal heating conditions about the periphery of the workpiece.

It is therefore an object of the present invention to provide a suspension arrangement for the baking furnace which can avoid guiding the electrode through three fixed points, but which can guide the workpiece correctly in the baking furnace.

According to one aspect of the invention there is provided a suspension arrangement for suspending a baking furnace about an elongate carbonaceous workpiece, comprising: a generally tubular baking furnace; guide means for guiding said workpiece through said furnace along a guidance axis; and suspension means for suspending said furnace in such manner that it is pivotable about axes transverse of said guidance axis.
By allowing the baking furnace to pivot about said transverse axes, the furnace may move to accommodate irregularities in the workpiece to avoid binding.

The suspension arrangement will function even more effectively if said suspension means is further arranged to permit displacement of said furnace transversely of said guidance axis.

In one embodiment, the suspension means comprises at least three elongate support members extending generally parallel to said guidance axis.

One way of achieving pivoting of the furnace or transverse displacement is to provide a universal coupling on at least one end of each support member.

Expediently, each support member has universal coupling at each end thereof. This provides the maximum degree of freedom of movement of the baking furnace.

It will be appreciated that each support member may be coupled to the furnace by a respective universal coupling. Similarly, each support member may be coupled to a suspension device by a respective universal coupling.

A suitable form of universal coupling is a Cardan joint. Another form of universal coupling which may be employed is a spherical bearing.

In one embodiment of the invention, each support member is a threaded spindle.

The furnace may carry a plurality of nut members for engaging with respective ones of said spindles.

Each nut member may be coupled to the furnace via respective spherical bearing.

In order to permit movement of the furnace longitudinally of the workpiece, the spindles may be
coupled to a common drive means for rotation thereof.

In another embodiment of the invention, each support member is a respective hydraulic cylinder.

One preferred form of guide means for guiding the workpiece through the furnace comprises a guide ring for peripheral engagement with the workpiece. Said guide ring may consist of iron rod.

Where the guide ring is provided at one end of the furnace, the guide means may further comprise a guide device at the other end of the furnace. This guide device may comprise at least three wheels for engagement with the workpiece.

Another aspect of the invention provides an arrangement for suspending a baking furnace for continuous production of carbon electrodes in direct connection with a smelting furnace in which the electrodes are consumed, wherein the baking furnace is suspended from a frame by means of at least three support members connected to the frame at their upper end by means of first universal joints and wherein the baking furnace is connected to the support members by means of second universal joints, the baking furnace having means at its upper end for guiding the electrode.

According to a further aspect of the invention, there is provided a smelting furnace comprising means for advancing an elongate carbon electrode into a working zone; means for supplying current to the electrode; and a baking furnace for baking carbonaceous material to form said electrode, said furnace being suspended above said advancing means by a suspension arrangement according to the above described aspects of the invention.
According to another aspect of the invention, there is provided a method of baking a carbonaceous workpiece in which said workpiece is passed through a generally tubular baking furnace while being guided along a guidance axis thereof and the furnace is permitted to pivot about axes transverse of said guidance axis.

Preferably, the furnace is permitted to displace transversely of said axis.

Another aspect of the invention provides a method of operating a smelting furnace in which a carbonaceous electrode is baked according to the above-defined method of baking a carbonaceous workpiece, to form a carbon electrode, the electrode being advanced into a smelting zone and electrically current being supplied to the electrode.

Where the support members are threaded spindles or hydraulic cylinders, the baking furnace can be moved continuously or substantially continuously relative to the electrode at a speed equal to the preferred baking speed of the electrode.

When spindles are used as support members, the spindles are preferably connected to the baking furnace by means of nuts which are fixed by spherical bearings to the baking furnace. In order to move the baking furnace up or down the spindles are interconnected by axes to a common drive unit, so that the three spindles are rotated at the same time and at the same speed.

When hydraulic cylinders are used as support members the movements of pistons of the cylinders are interconnected in order to move the three pistons at the same time and at the same speed.

Arrangements according to preferred embodiments of
the present invention will now be described by way of example in connection with the drawings in which:

FIGURE 1 is a schematic side view of an electrode in an electric furnace showing an arrangement for suspension of a baking furnace according to one embodiment of the present invention;

FIGURE 2 is an enlarged view of the upper part of Figure 1, showing the baking furnace and the arrangement for suspension of the baking furnace;

FIGURE 3 is vertical sectional view taken along line I - I in Figure 2; and

FIGURE 4 is a schematic view similar to Figure 2 showing another embodiment of the present invention.

Figure 1 shows an electrode 1 in a working zone 2 of an electric smelting furnace. The smelting furnace has a smoke hood or roof 3 and the level of charge in the furnace is indicated by reference numeral 4.

Current clamps for conduction of electric operating current to the furnace are schematically shown by reference numeral 5. The current clamps 5 are pressed against the surface of the electrode by means of a pressure ring 6. The current clamps 5 and the pressure ring 6 have internal channels for circulation of a cooling fluid (not shown). The current clamps 5 are suspended from an electrode frame 8 via rods 7.

On the electrode frame 8, there are arranged two conventional holding and slipping rings 9 and 10 for the electrode 1. The lower holding and slipping ring 9 can be moved vertically by means of hydraulic or pneumatic cylinders 11 and 12.

The electrode frame 8 is suspended in the furnace building by means of hydraulic electrode regulating
cylinders 13 and 14. On the electrode frame 8, there is arranged a baking furnace frame 15. From the top of the baking furnace frame 15 three supports 16 are suspended. The supports 16 are suspended from the frame 15 by means of universal joints such as ball connections or cardan joints 17.

In the embodiment shown in Figure 2, the supports 16 are in the form of spindles with threads 18. A baking furnace 19 for baking of the electrode is connected to the spindles 16 by means of nuts 20, best shown in Figure 3.

As shown in Figure 3, the nuts 20 are connected to the baking furnace by spherical bearings 25. In order to move the baking furnace 19 up or down relative to the electrode, the spindles 16 are interconnected by axles 26 to a common drive unit 27 whereby the spindles 16 can be rotated together at the same speed.

The baking furnace 19 is equipped at its upper end with a guide ring 21 made from iron rod or the like. The inner diameter of the ring 21 is equal to or somewhat larger than the diameter of the electrode casing 22. The guide ring 21 is intended to guide the electrode through the baking furnace 19.

Below the baking furnace 19 guide wheels 23 are preferably arranged and via brackets 24 are affixed to the baking furnace 19. The guide wheels 23 are intended to guide the baked electrode.

In Figure 4 there is shown another embodiment of the present invention where the supports 16 are in the form of hydraulic cylinders 16. The lower end of the cylinders 16 are connected to the baking furnace by means of universal joints such as ball connection or cardan joints. In order to obtain a continuous or
substantially continuous movement of the baking furnace, the supplies of hydraulic fluid to the cylinders 16 are interconnected.

The baking furnace 19 is equipped with means for supply of heat energy, such as oil or gas burners or electric heating elements (not shown). As the electrode is consumed in the smelting furnace, it moves down through the current clamps by operation of the holding and slipping rings 9, 10.

The movement of the baking furnace 19 is preferably interconnected with the electrode slipping equipment in such a way that when the electrode is slipped a certain increment through the holding and slipping rings 9, 10 the baking furnace 19 will automatically be moved an equal distance downwards. In this way the position of the baking furnace is kept in the same position relative to the baking zone in the electrode.

It will be apparent that the important characteristics of the suspension arrangement are that it can pivot about horizontal axes whilst still correctly guiding the workpiece centrally, and preferably that it can also displace transversely. These characteristics can conveniently be achieved by using universal joints as illustrated.

When the baking furnace is suspended on supports which are connected to the baking furnace frame and to the baking furnace by universal joints and the electrode is guided at least in the upper part of the baking furnace, a deviation from a straight-lined electrode will imply that the baking furnace is automatically moved radially outwards from the center line of the electrode while the electrode still will be
centrally situated in the baking furnace. It is thereby avoided that deviations from a straight-lined electrode will clamp the electrode. It has further surprisingly been found that if a deviation from a straight electrode occurs, and the baking furnace thereby moves out from the center line for a straight electrode, the electrode will soon move back to the center line for a straight electrode. This means that the described arrangements for suspending the baking furnace are self-centering.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Suspension arrangement for suspending a baking furnace about an elongate carbonaceous workpiece comprising: a generally tubular baking furnace; guide means for guiding said workpiece through said furnace along a guidance axis; and suspension means for suspending said furnace in such manner that it is pivotable about axes transverse of said guidance axis.

2. An arrangement according to claim 1 wherein said suspension means is further arranged to permit displacement of said furnace transversely of said guidance axis.

3. An arrangement according to claim 2 wherein said suspension means comprises at least three elongate support members extending generally parallel to said guidance axis.

4. An arrangement according to claim 3 wherein each support member is provided with a universal coupling on at least one end thereof.

5. An arrangement according to claim 4 wherein each support member has a universal coupling at each end thereof.

6. An arrangement according to claim 4 or 5 wherein each support member is coupled to said furnace by a respective universal coupling.

7. An arrangement according to claim 4, 5 or 6 wherein each support member is coupled to a suspension
device by a respective universal coupling.

8. An arrangement according to any one of claims 4 to 7 wherein a Cardan joint is provided on at least one end of each support member.

9. An arrangement according to any one of claims 4 to 8 wherein a spherical bearing is provided on at least one end of each support member.

10. An arrangement according to any one of the preceding claims wherein each support member is a threaded spindle.

11. An arrangement according to claim 10 wherein said furnace carries a plurality of nut members engaging with respective ones of said spindles.

12. An arrangement according to claim 11 when dependent on claim 9 wherein each nut member is coupled to said furnace via a respective spherical bearing.

13. An arrangement according to any one of claims 10 to 12 wherein said spindles are coupled to a common drive means for rotation thereof.

14. An arrangement according to any one of claims 1 to 9 wherein each support member is a respective hydraulic cylinder.

15. An arrangement according to any one of the preceding claims wherein said guide means comprises a guide ring for peripheral engagement with said workpiece.
16. An arrangement according to claim 15 wherein said guide ring consists of iron rod.

17. An arrangement according to claim 15 or 16 wherein said guide ring is at one end of said furnace.

18. An arrangement according to claim 17 wherein said guide means further comprises a guide device at the other end of said furnace.

19. An arrangement according to claim 18 wherein said guide device comprises at least three wheels for engagement with said workpiece.

20. A suspension arrangement substantially as hereinbefore described with reference to Figures 1 to 3 or to Figure 4 of the accompanying drawings.

21. Arrangement for suspending a baking furnace for continuous production of carbon electrodes in direct connection with a smelting furnace wherein the electrodes are consumed, wherein the baking furnace is suspended from a baking furnace frame by means of at least three support members connected to the baking furnace frame at their upper ends by means of first universal joints and wherein the baking furnace is connected to the support members by means of second universal joints, the baking furnace having means at its upper end for guiding the electrode.

22. A smelting furnace comprising: means for advancing
an elongate carbon electrode into a working zone; means
for supplying current to the electrode; and a baking
furnace for baking carbonaceous material to form said
electrode, said furnace being suspended above said
advancing means by a suspension arrangement according
to any one of the preceding claims.

23. A smelting furnace substantially as hereinbefore
described with reference to the accompanying drawings.

24. A method of baking a carbonaceous workpiece in
which said workpiece is passed through a generally-
tubular baking furnace whilst being guided along a
guidance axis thereof, and the furnace is permitted to
pivot about axes transverse of said guidance axis.

25. A method according to claim 24 wherein said
furnace is permitted to displace transversely of said
axis.

26. A method of baking a carbonaceous workpiece
according to claim 24 and substantially as hereinbefore
described.

27. A method of operating a smelting furnace in which
a carbonaceous electrode is baked according to claim
24 or 25 to form a carbon electrode, the electrode is
advanced into a smelting zone, and electrical current
is supplied to the electrode.

28. A method of operating a smelting furnace according
to claim 27 and substantially as hereinbefore
described.

Dated this 13th day of August, 1986.

ELKEM a/s,
By their Patent Attorneys,
COLLISON & CO.

G.E. HAGEL