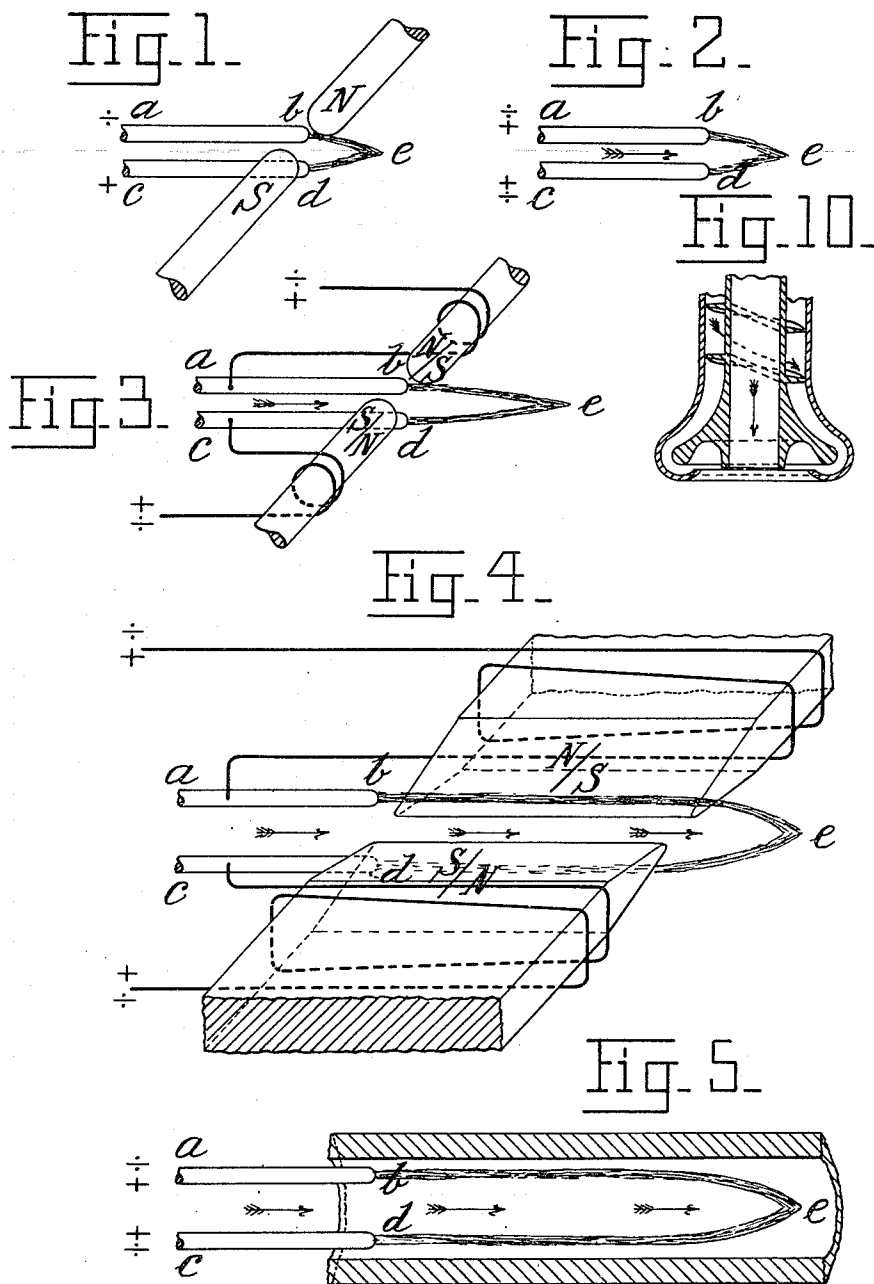


F. H. A. WIELGOŁASKI.
METHOD AND APPARATUS FOR PRODUCING LONG ELECTRICAL ARCS.
APPLICATION FILED MAY 16, 1912

1,054,886.

Patented Mar. 4, 1913.

4 SHEETS-SHEET 1.



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4 SHEETS—SHEET 2.

Fig. 6.

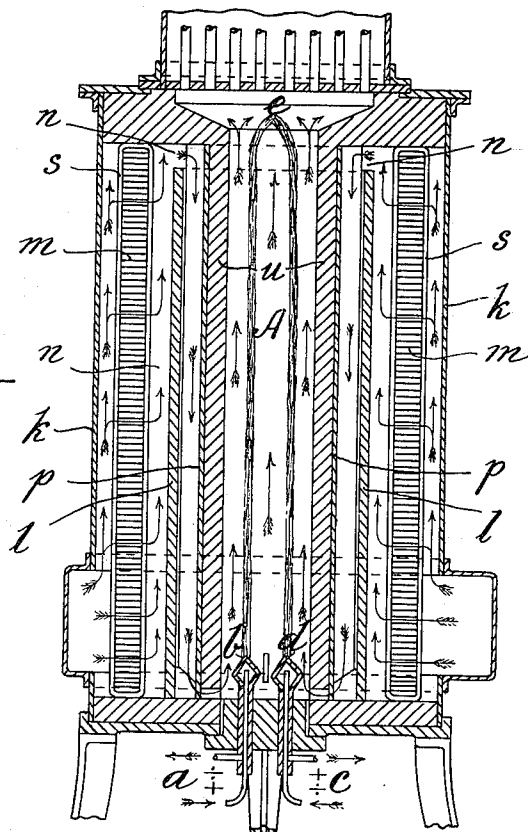
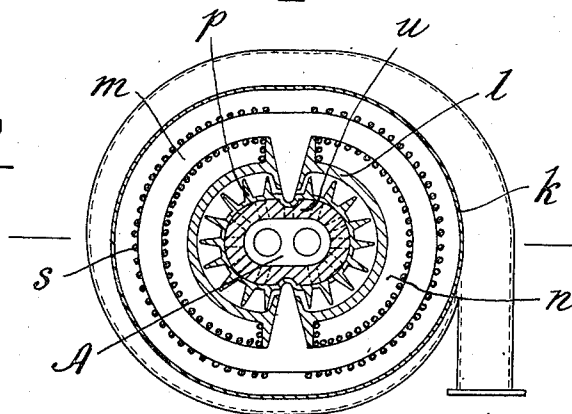


Fig. 7.



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4 SHEETS-SHEET 3.

Fig. 8.

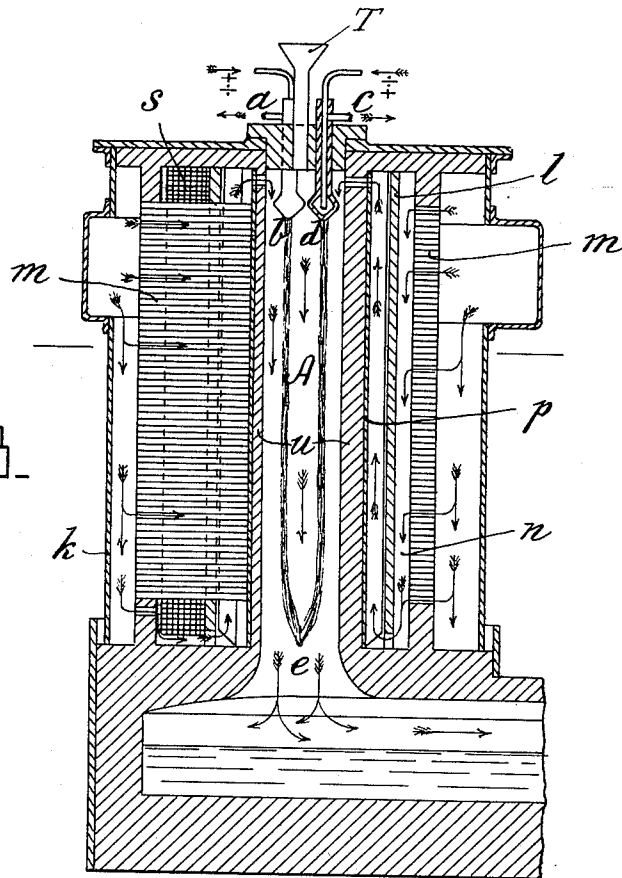
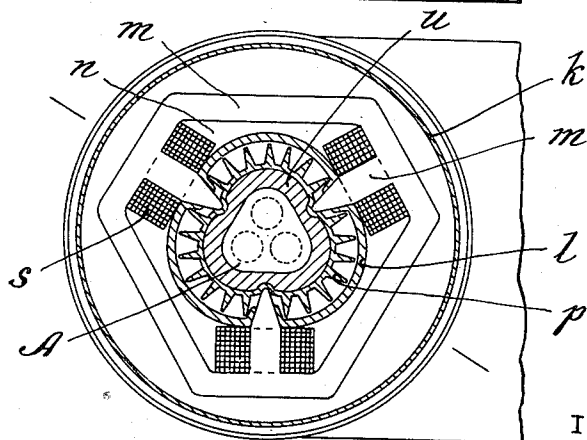


Fig. 9.



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4 SHEETS—SHEET 4.

Fig. 11.

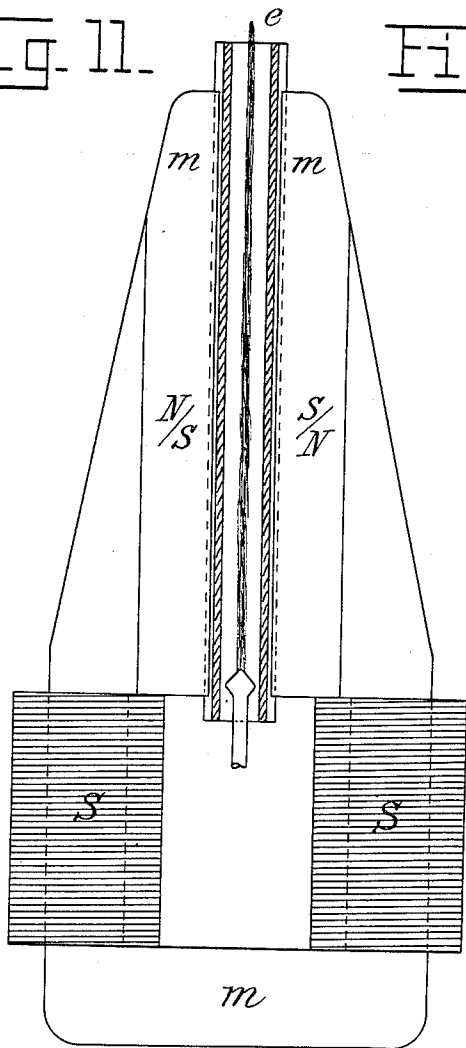


Fig. 12.

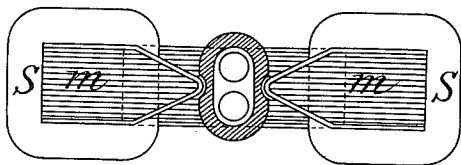
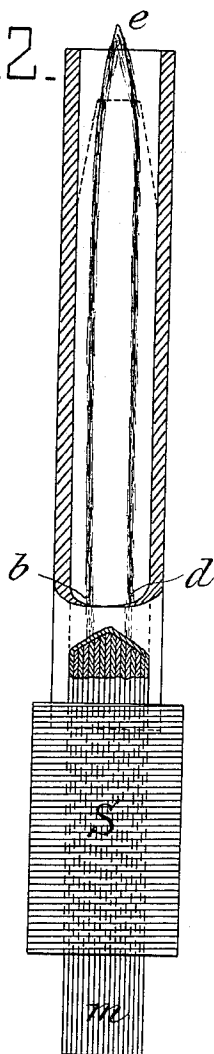


Fig. 13.

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR PRODUCING LONG ELECTRICAL ARCS.

1,054,886.

Specification of Letters Patent.

Patented Mar. 4, 1913.

Application filed May 16, 1912. Serial No. 697,778.

To all whom it may concern:

Be it known that I, FRANS HENRIK AUBERT WIELGOLASKI, citizen of Norway, and resident of Odinsgate 1, Christiania, Norway, have invented certain new and useful Improvements in Methods and Apparatus for Producing Long Electrical Arcs, of which the following is a specification.

This invention relates to the treatment of various materials at very high temperature and has for its object to provide a process and apparatus for the production of a long elastic arc and for the passage thereto of the material to be treated.

In the accompanying drawings Figure 1 is a diagrammatic perspective view illustrating the effect of a magnetic field upon an electric arc; Fig. 2 is a similar view illustrating the effect of a current of gas on the arc; Fig. 3 is a similar view showing the combined effects of the magnetic field and the current of gas, the arc and magnet being adapted to alternating current; Fig. 4 is a similar view to Fig. 3 but showing also the magnet poles adapted for a wide thin magnetic field; Fig. 5 is a longitudinal sectional view showing the channel shaped furnace in which the arc is formed. Figs. 6 and 7 show vertical and horizontal sections respectively of one form of practical embodiment of the apparatus with two magnet poles. Figs. 8 and 9 show similar views of another form having more than two magnet poles. Fig. 10 is a vertical sectional view of a hollow electrode adapted to be easily cooled and to produce an arc with rotating ends. Figs. 11, 12 and 13, show front, side and plan views respectively of a horseshoe magnet adapted for the apparatus and process.

It is a well-known fact that an electric arc is affected in such a manner by a magnetic field, that the arc—in case the same passes through the magnetic field across the direction of the lines of forces—is forced out to one or the other side perpendicular to the magnetic lines of force according as the electric current flows in one or the other direction in relation to the direction of the magnetic lines of force. If the electrodes should be in alinement with each other, so that the ends of the arc have an opportunity of moving along the electrodes, the so-called "Birkeland"—arcs are formed on account of the physical law above referred to. But if the ends of the arc are prevented in some manner from moving along the electrodes,

which in such case should be arranged more or less parallel to each other as indicated in Fig. 1 of the annexed drawings, the arc is forced out so as to obtain the shape of a long bight, which is more or less pointed. Such an arc is that marked $b-e-d$ in Fig. 1, in which $a-b$ and $c-d$ are the electrodes, and N, S designate the magnets forming the magnetic field. In Fig. 1 I have presumed the use of direct current and a constant direction of the magnetic lines of force. Alternating current may have the same result, if the main or working current or a shunt current of the same is utilized for the production of the magnetic field, for in such case the direction of the magnetic flux alters simultaneously with the flowing direction of the current, see Figs. 3 and 4. If the magnetic field is caused to take the shape of a disk located in direction of the lines of force, by means of more or less knife-shaped magnet poles, the electric double-arc may even be stretched out to a considerable length.

Fig. 2 illustrates the same electrodes after the removal of the magnetic field but in which a cold gas current is blown along the electrodes as indicated by the arrow. Also in such case the arc is forced out in a manner similar to that indicated in the figure at $b-e-d$. Here it is indifferent, if direct or alternating current is used, because in both cases the arc is forced out in the same direction and caused to form a pointed double-arc. However in this manner one does not advantageously succeed in stretching out the arc to a considerable degree, because the gases soon become hot and electrically conductive, so that short-circuits take place between the two branches of the arc.

If now both these methods are combined as shown diagrammatically in Fig. 3, the arc is acted upon in the same direction by two different forces, viz: by the magnetic flux and by the gas flow, whereby it is possible to stretch out the arc considerably easier and longer, especially if the magnets are given the elongated knife-shape with their pole edges directed toward each other and located each at one side and along the long double-arc.

In order to have the gases and the arc confined the same are inclosed in a tube (not shown in Fig. 4) of a refractory and electrically non-conducting material which thus forms a channel-shaped furnace space in

which the double arc is caused to take the shape shown in Figs. 4, 5, 6 and 8 of the drawing.

The shape of the arc is clearly shown in Fig. 5, in which the magnets are removed and only their influence upon the arc illustrated. It is seen that the electrical current in the arc from the middle of the same is forced to flow back parallel to itself, whereby a double-arc is formed, which for the same total length requires a furnace of half the length compared with the furnaces utilizing the single arcs. Thus the furnace will have less cooling surface. Moreover, there are electrodes only in the coldest end of the furnace space. Thus two important advantages are obtained. In the same manner arcs with more branches may be produced by means of polyphase currents.

According to the above, the present method consists in stretching out long electrical arcs (which according to the circumstances are constantly, stably or pulsatively or intermittently burning) into a double shape in channel-shaped furnace spaces by means of wide, thin and, in the direction of the lines of force, disk-shaped magnet fields, the magnetic flux direction of which is perpendicular to the longitudinal direction of the said arcs and the highest width of which extends along the arcs. And in obtaining this result, I may also make use of a gas current passing in the longitudinal direction of the arcs.

Figs. 6 and 7 are respectively longitudinal and vertical sectional views of a construction of apparatus suitable for practically carrying out the present method by means of direct current or single-phase alternating current. Figs. 8 and 9 are similar sections of an apparatus, in which all the three phases of a three-phase alternating current system are utilized in the same furnace space for producing a triple arc. In similar manner furnaces utilizing four-phase alternating current, etc., may be constructed.

As shown in Figs. 6, 7 and 8, 9 the furnace comprises a channel-shaped space —A— of refractory bricks —u— and a non-magnetic metal cover —p— which at its outer side should preferably be provided with longitudinal ribs for cooling purposes. Outside these ribs a cover —l— is arranged, which should preferably be non-conducting and heat-insulating. Between the said ribs the gases pass partly in order to be pre-heated themselves and partly in order to prevent over heating the brick-work —u—. Outside the cover —l— the electromagnet —m— is arranged, which in case of alternating current is built up of laminæ, as usual. Between the electro-magnet and the cover —l— the space also forms channels —n— for conducting the gases, and outside

the electromagnets is finally arranged a gas distributing cover —k— which is preferably non-magnetizable and is of importance especially for cooling the magnet laminæ when alternating current is used. —S— are magnet windings, which according to the circumstances may be traversed by the whole main current or by a shunt current. The latter arrangement is advantageous especially in polyphase systems as for instance that shown in Figs. 8 and 9. The arrows in Figs. 6 and 8 indicate the paths of the gases. If in case of alternating current the electro-magnets consist of laminæ, the cold gases should pass from the outer distributing cover —k— (see Figs. 6 and 8) between the said laminæ in order to maintain the cooling of the same during their flow into the channel —n—. In case of direct current and singlephase alternating current the number of electrodes is —two—, and if polyphase current is used, more electrodes will be necessary. All electrodes are arranged side by side in the coldest end of the furnace and are surrounded only by the relatively cold gases, which is advantageous in several respects as shown for three-phase-current in Figs. 8 and 9. The electrodes are preferably made with their operative surface annular, and the gases are under rotation blown into the furnace at the electrodes, whereby the arc ends may rotate on the same, so that the electrodes are less heated. Such an electrode is shown in Fig. 10, in which gases are passed through a screwed space between the outer casing and the inner core or tube. From the other end of the channel —A— in Fig. 6 the hot gases exhaust and here they may be quickly cooled, if desired, for instance by introducing them into the tube system of a steam boiler, as shown in Fig. 6.

In case of direct current and singlephase alternating current the furnace space is preferably oval in cross section, see Fig. 7, and in case of threephase current I prefer a rounded triangular cross section as shown in Fig. 9, and so on.

The apparatus of course need not be mounted in vertical position as in Figs. 6 and 8, but it may be arranged horizontally or in any other suitable position.

The electro-magnet need not surround all the length of the furnace as a single magnet ring or tubular magnet, but it may also be divided into more rings or into shorter tubes each having its coil, which coils are interconnected so as to coact with each other. It then may easily be so arranged that the magnetic field is stronger at one end of the furnace space than at the other, for instance strongest where the arc is to be formed, because here the electromotoric force and the current intensity of the arc are highest on account of the small resistance in the short

(new-formed) arc. Therefore also a large force is required to stretch out the arc at the commencement of such stretching.

The above mentioned variation of the strength of the magnet field along the arcs and the furnace may also be obtained by constructing the electro-magnets fork-shaped and arranging the fork branches along the furnace sides and consequently along the arcs as shown in Figs. 11, 12 and 13 for a two-branched arc; and a similar poly-forked magnet may be used in case of polyphase alternating current.

In Figs. 8 and 9 is illustrated in what manner double-arcs produced according to the present method may be utilized in the well-known treatment of powdrous solid substances, etc., singly or in combination with gases or vapors. In the case illustrated it is assumed that the products are partly liquid and in case partly gaseous or vaporous, and on account hereof I have arranged a collecting chamber at the lower part of the furnace for collecting the liquid products. In such an apparatus I may for instance carry out a reducing or oxidizing melting of ore-mud without preparatory briqueting. In case of reducing processes, for instance melting of iron-ore or reduction of roasted zinc-ore-mud, one should add such a quantity of carbon powder, that the gases during the whole process are constantly sufficiently reduced. In such a furnace I also may produce carbids by treating a mixture of subdivided lime or the like and carbon in carbon-monoxid-gas, and cyanids by treating the said mixture or carbid-powder in nitrogen-gas.

By treating powdrous oxids or the like with nitrogen or hydrogen or with water gas I may produce nitrids or hydrogenous compounds directly. In similar manner I may produce carborundum and many other compounds. By treating carbon powder in carbon monoxid in such a furnace graphite powder is produced. I may also treat nebular liquids and solutions with vapors and gases and in such manner produce for instance light hydrocarbons from heavy ones, and so on.

In case the solid or liquid compound produced is inclined to disassociate, if it is not cooled quickly, or if the said compound is not quickly withdrawn from the influence of the gaseous products produced, I may counteract or prevent such disassociation by arranging gas outlet openings at other places of the furnace channel (furnace space) and thereby causing the falling powdrous raw materials (and especially the final product) to meet with unaffected hot or cooled gases of the correct chemical nature.

By means of the last-mentioned arrangement the double-arcs produced according to

the present method may be even more extensively utilized.

The powdrous material may be introduced into the furnace space in different ways, and as the manner, in which this takes place, has nothing to do with the present invention, I for this purpose have only indicated diagrammatically in Fig. 8 a funnel-pipe —T— at the top of the furnace, although it might be more preferable to introduce the powdrous material through the electrodes which for that purpose are made hollow. Such hollow electrodes may be constructed in several ways, and they are very suitable for the simultaneous production of arcs with rotating ends. They may be built with gas cooling as indicated in Fig. 10, which is easily understood without further explanation. But they may also be built with a more intense cooling of the annular surface, on which the arc shall rotate.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of creating a long electric arc, consisting in subjecting an arc to a wide thin magnetic field to stretch the arc.
2. A method of treating material, consisting in subjecting an arc to a magnetic field to stretch the arc longitudinally into a long U-shaped arc, and passing gas into said field in a direction away from the electrodes of the arc.
3. A method of treating materials, consisting in subjecting an arc to a wide thin magnetic field to stretch the arc longitudinally into a long U-shaped arc, and passing material to be treated into said arc.
4. A method for the production of a long electric arc, consisting in providing an arc between electrodes, and passing a wide thin magnetic field substantially between said electrodes to stretch the arc into a long U-shape, the flux lines passing between legs of said arc, the field being extended in the direction of the length of the arc.
5. A method for the production of a long electric arc, consisting in providing an arc between the electrodes at one end of a furnace space; and passing a wide thin magnetic field substantially between said electrodes whereby said arc is stretched into a long U-shape longitudinally in said space; the flux lines passing between the legs of the arc substantially perpendicular to the plane of the arc, said field being extended in width in the direction of the length of said space and arc.
6. A method for the treatment of material with a long electric arc, consisting in providing an arc between the electrodes at one end of a furnace space, passing a wide thin magnetic field substantially between said electrodes whereby said arc is stretched into a long U-shape longitudinally in said

space; the flux lines passing between the legs of the arc substantially perpendicular to the plane of the arc, said field being extended in width in the direction of the length of said space and arc and passing a current of gas into the said space between the legs of the arc.

7. A method for the treatment of material with a long electric arc, consisting in providing an arc between the electrodes at one end of a furnace space, passing a wide thin magnetic field substantially between said electrodes whereby said arc is stretched into a long U-shape longitudinally in said space; the flux lines passing between the legs of the arc substantially perpendicular to the plane of the arc, said field being extended in width in the direction of the length of said space and arc; and passing a current of gas into the said space between the legs of the arc in the direction of the arc.

8. A method for the treatment of material with a long electric arc, consisting in providing an arc between the electrodes at the sides of a furnace space; passing a wide thin magnetic field substantially between said electrodes whereby said arc is stretched into a long U shape longitudinally in said space, the flux lines passing between the legs of the arc substantially perpendicular to the plane of the arc, said field being extended in width in the direction of the length of said space and arc; passing material to be treated through the heated space of the furnace and arc.

9. A method for the treatment of material with a long electric arc, consisting in providing an arc between the electrodes at the sides of a furnace space; passing a wide thin magnetic field substantially between said electrodes whereby said arc is stretched into a long U shape longitudinally in said space, the flux lines passing between the legs of the arc substantially perpendicular to the plane of the arc, said field being extended in width in the direction of the length of said space and arc; and passing gas and material to be treated through the heated space of the furnace and arc.

10. In a furnace system, the combination of a means for producing a wide thin magnetic field, and a means for producing an electric arc passing parallel to the plane of the lines of the flux of the field.

11. In a furnace system, the combination of electrodes for producing an electric arc, and means for producing a wide thin magnetic field substantially between said electrodes on a plane perpendicular to the line of the electrodes and extending a distance from said line greater than the distance between the electrodes.

12. In a furnace system, the combination of a furnace provided with a long-channel

shaped furnace space; electrodes at one end of said space; and means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof.

13. In a furnace system, the combination of a furnace provided with a long channel-shaped furnace space; electrodes at one end of said space; means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof and means for directing gas into said furnace space.

14. In a furnace system, the combination of a furnace provided with a long channel-shaped furnace space; electrodes at one end of said space; means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof and means for directing gas into said furnace space in the direction of the arc.

15. In a furnace system, the combination of a furnace provided with a long channel-shaped furnace space; electrodes at one end of said space; means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof and means for directing material to be treated into said furnace space.

16. In a furnace system, the combination of a furnace provided with a long channel shaped furnace space, electrodes at one end of said space; means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof; means for directing material to be treated into the furnace space and means for directing gas into the furnace space.

17. In a furnace system, the combination of a furnace provided with a long channel shaped furnace space, electrodes at one end of said space; and means for producing a thin magnetic field across said space and

substantially between said electrodes, said field being extended in width and away from said electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof; the flux producing means being adapted to concentrate lines of force near the electrodes.

18. In a furnace system, the combination of a furnace provided with a long channel shaped furnace space, electrodes at one end of said space; means for producing a thin magnetic field across said space and substantially between said electrodes, said field being extended in width and away from said

electrodes, whereby the arc is stretched into a U-shape, the flux lines extending between the legs of the arc perpendicular to the plane thereof; the flux producing means being adapted to concentrate lines of force near the electrodes; and means for cooling the flux producing means with gas and directing the gas into the furnace space.

Signed at Christiania Norway this 29th day of April A. D. 1912.

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