

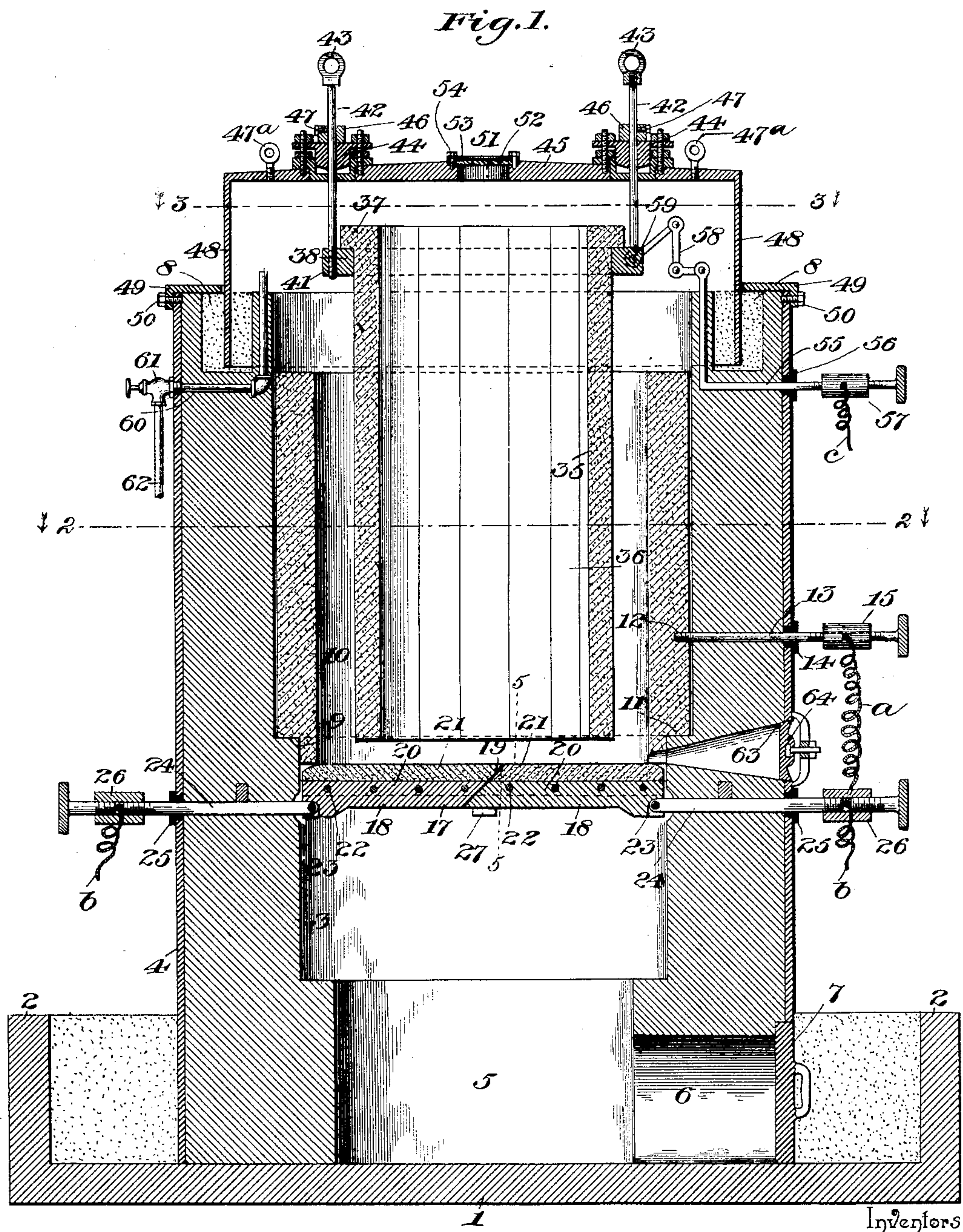
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3 Sheets—Sheet 1.

H. ELDRIDGE, G. H. WRIGHT & D. J. CLARK.  
VACUUM ELECTRIC ARC FURNACE.

No. 583,618.

Patented June 1, 1897.



Witnesses  
*C. W. Smith*  
*D. J. Clark*

By their Attorneys,

Hilliary Eldridge  
George H. Wright  
and Daniel J. Clark

*C. A. Snow & Co.*



(No Model.)

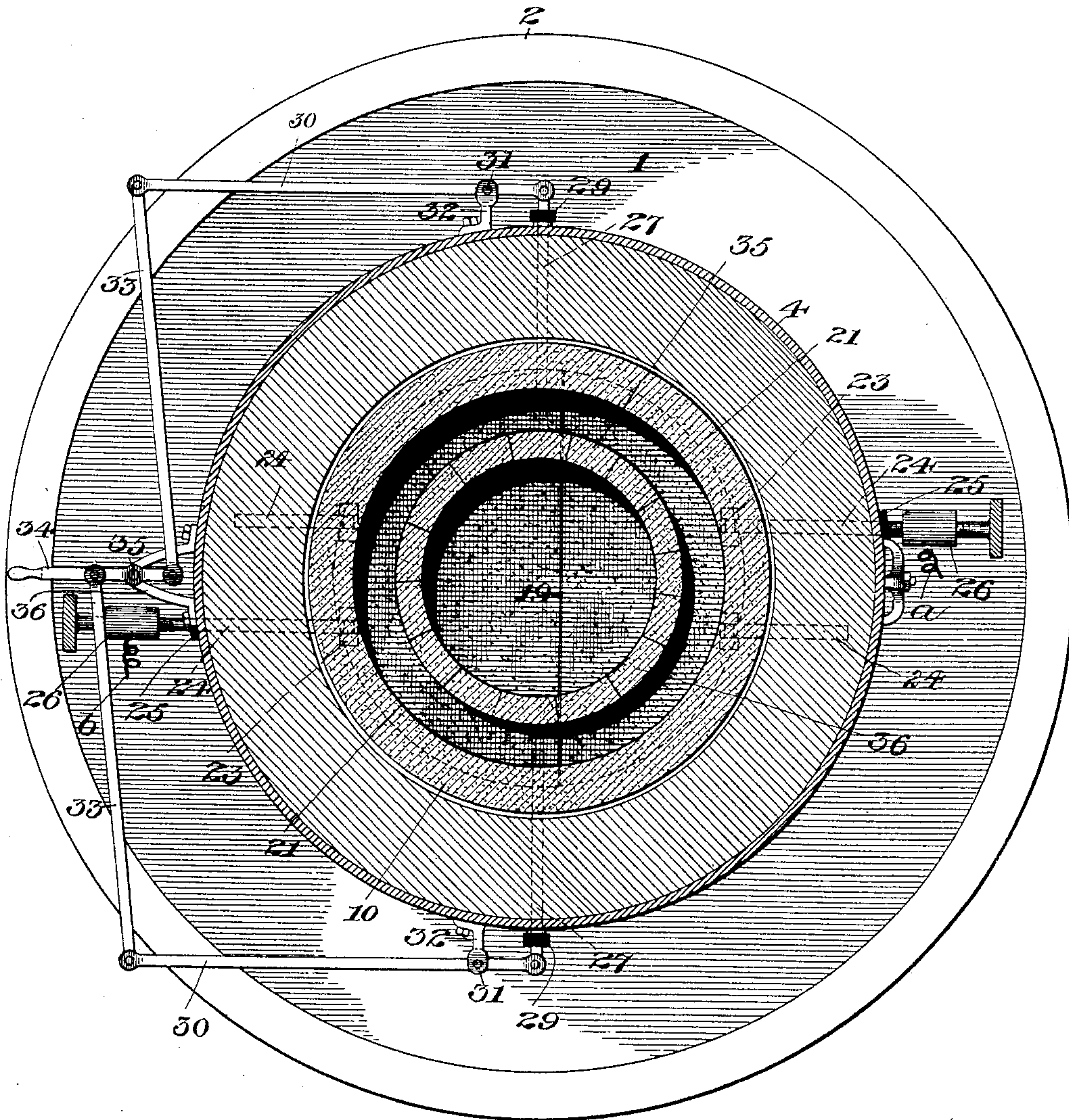
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Fig. 2.



Witnesses  
*A. W. Smith*  
*D. P. Hollander*

By their Attorneys,

Inventors  
*Hilliary Eldridge*  
*George H. Wright*  
and  
*Daniel J. Clark*

*C. A. Snow & Co.*



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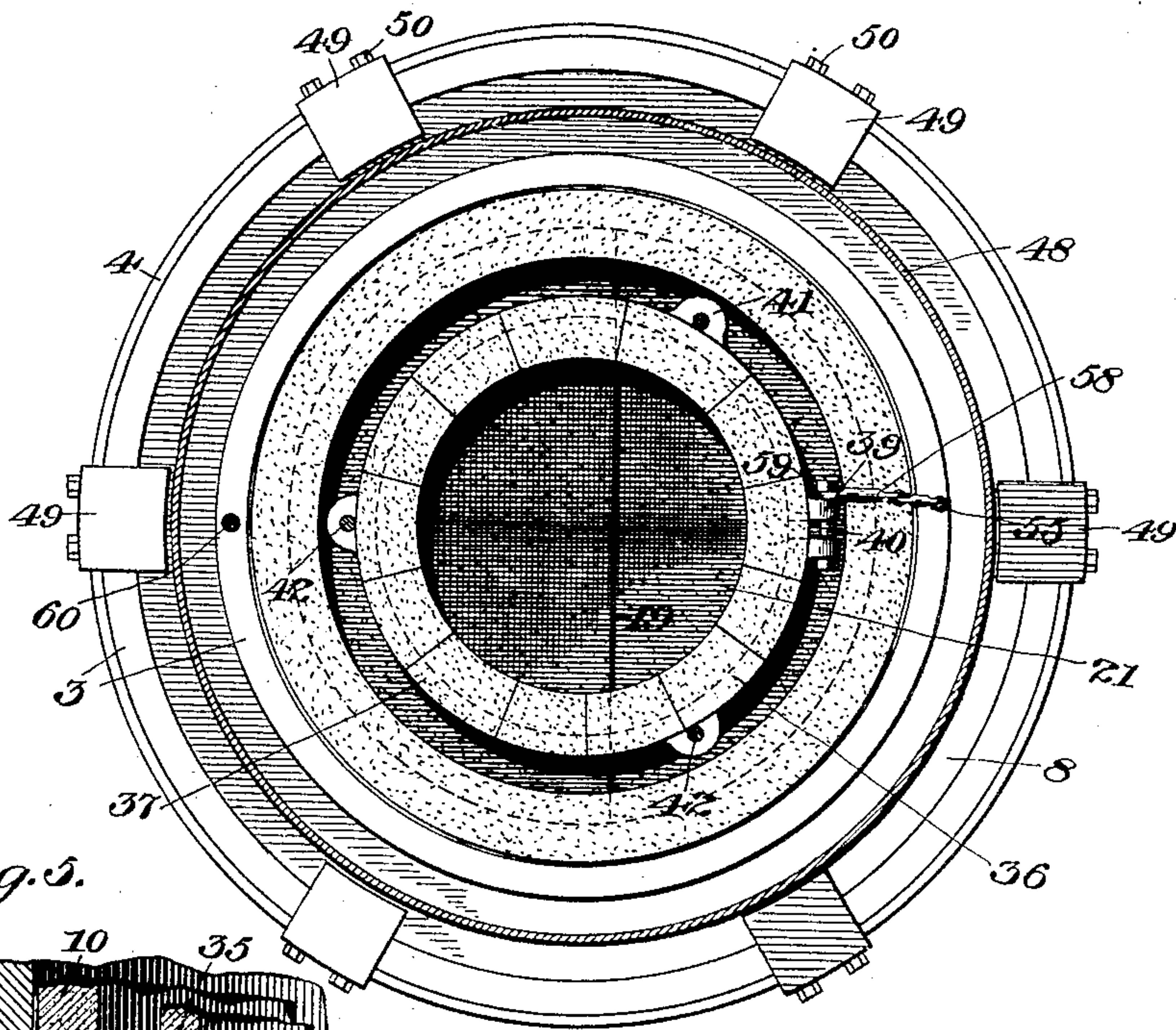
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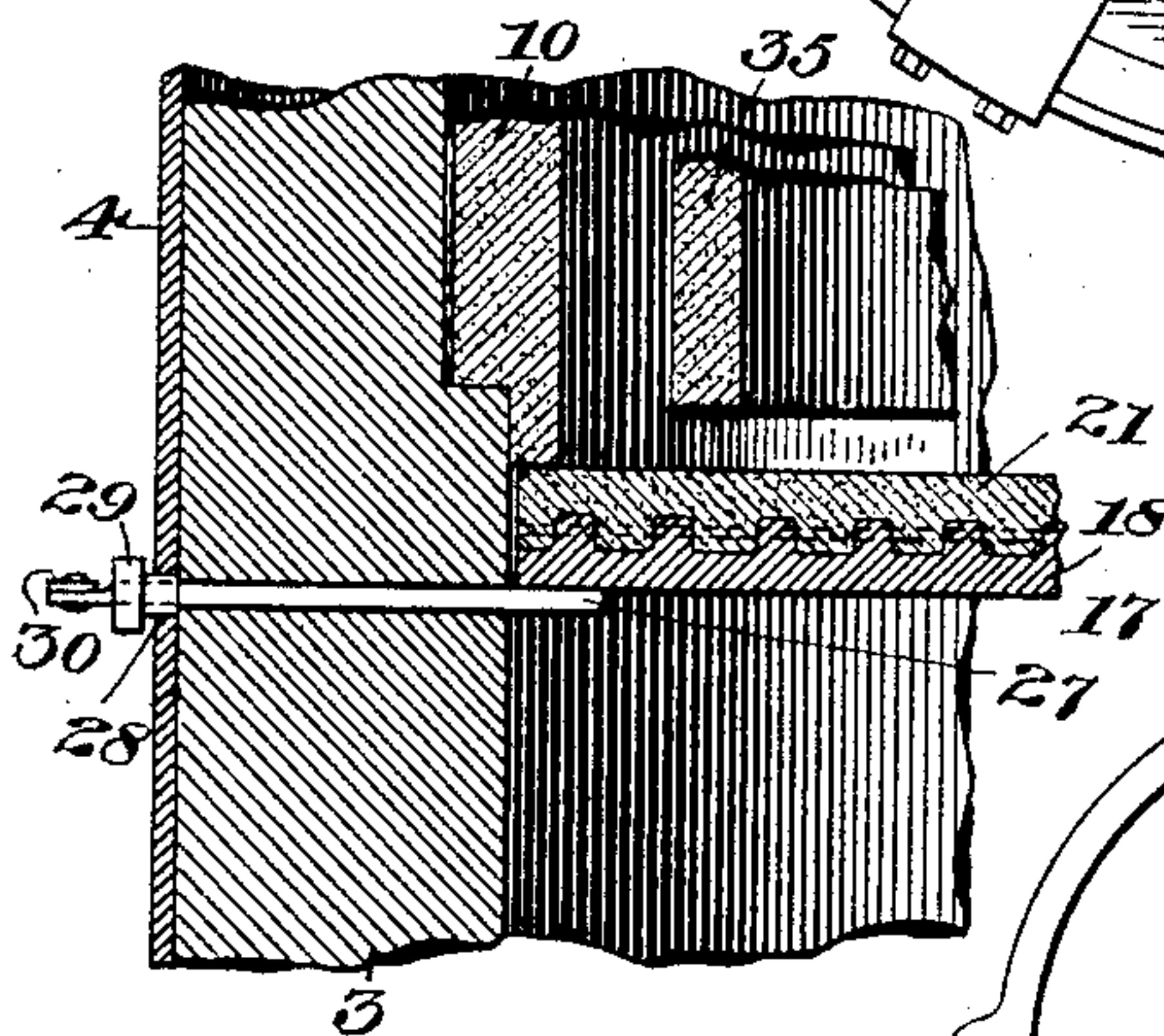
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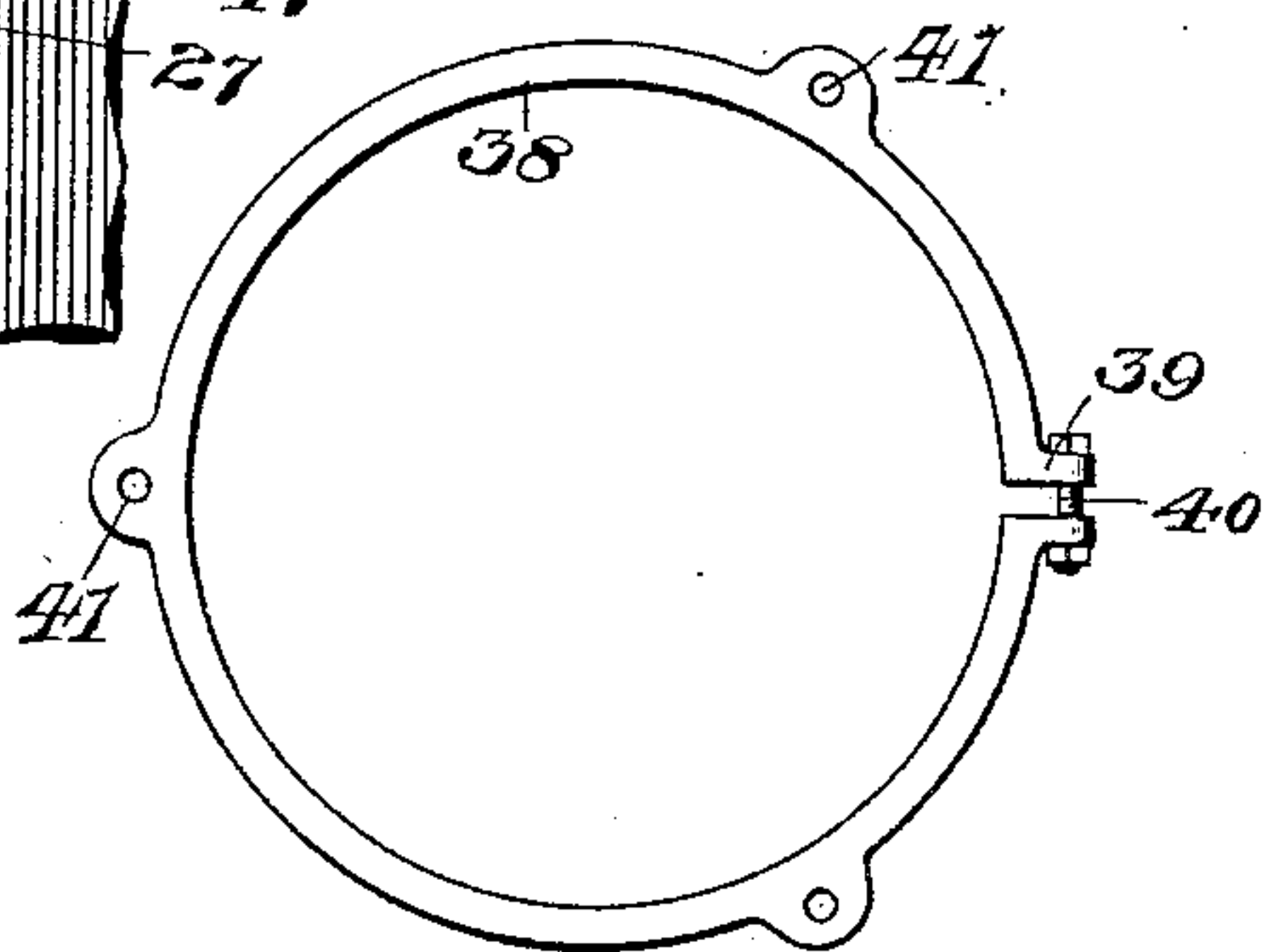
*Fig. 3.*



*Fig. 5.*



*Fig. 4*



Witnesses

*C. W. Smith*  
*D. J. Clark*

By their Attorneys,

Inventors  
*Hilliary Eldridge*  
*George H. Wright*  
and  
*Daniel J. Clark*

*C. A. Snow & Co.*



# UNITED STATES PATENT OFFICE.

HILLIARY ELDRIDGE, GEORGE HUDSON WRIGHT, AND DANIEL J. CLARK,  
OF GALVESTON, TEXAS.

## VACUUM ELECTRIC-ARC FURNACE.

SPECIFICATION forming part of Letters Patent No. 583,618, dated June 1, 1897.

Application filed February 24, 1896. Serial No. 580,439. (No model.)

*To all whom it may concern:*

Be it known that we, HILLIARY ELDRIDGE, GEORGE HUDSON WRIGHT, and DANIEL J. CLARK, citizens of the United States, residing at Galveston, in the county of Galveston and State of Texas, have invented a new and useful Vacuum Electric-Arc Furnace, of which the following is a specification.

This invention relates to a new and useful vacuum electric-arc furnace; and it has for its object to effect certain improvements in furnaces of this character that are designed for the fusion of metals, the reduction of ores and the metallic oxids, and the manufacture of various alloys, &c.

To this end the main and primary object of the present invention is to provide an improved electric furnace having means to positively insure the thorough fusion or reduction of the substances placed therein without loss due to combustion or the oxidation of such substances, while at the same time providing an effective distribution of the heat and the prevention of the loss of carbon by combustion.

With these and many other objects in view, which will readily appear as the nature of the invention is better understood, the same consists in the novel construction, combination, and arrangement of parts hereinafter more fully described, illustrated, and claimed.

In the drawings, Figure 1 is a vertical sectional view of an electrical furnace constructed in accordance with this invention. Fig. 2 is a cross-sectional view on the line 2 2 of Fig. 1. Fig. 3 is a similar view on the line 3 3 of Fig. 1. Fig. 4 is a plan view of the clamp-ring for supporting the cylindrical hollow anode. Fig. 5 is a detail sectional view on the line 5 5 of Fig. 1.

Referring to the accompanying drawings, 1 designates a supporting-base made of fire-brick or other suitable material and provided with a peripheral upwardly-disposed circular wall 2, which incloses a space within which rests the lower open end of the cylindrical furnace-casing 3. The cylindrical furnace-casing 3 is made of fire-brick or other refractory material and rests at its lower end directly on the upper side of the base 1 within the wall 2 thereof, and the said casing 3 is exteriorly encircled by a metallic or other

suitable exterior jacket or shell 4, which serves as a protective covering for the furnace.

The space between the lower end of the casing 3 and the wall 2 of the base 1 is designed to be filled with sand or other suitable filling to provide a seal for the lower end of the furnace-casing in order to make such casing perfectly air-tight at that point, as will be readily understood, and the lower open end of the said furnace-casing forms a receiving-pit 5 for the fused substances, and with which pit communicates a door-opening 6, formed in one side of the furnace-casing at the extreme lower end thereof and adapted to be covered and uncovered at the outer side of the furnace-casing by a suitable door 7, which, when removed from the casing, allows access through the door-opening 6 to the receiving-pit 5, so that the substances which may have been dumped in such pit can be readily removed.

The cylindrical furnace-casing 3 is disposed in an upright position and is provided in its top edge with an annular recess or pocket 8 and at a point intermediate of its upper and lower ends with an interior supporting-shoulder 9, which forms a rigid support for the inner cylindrical cathode 10. The inner cylindrical cathode 10 snugly registers within the interior of the cylindrical casing 3 and is preferably made of carbon; but said cathode may be made of any other suitable conducting material that is refractory to heat in a vacuum. The cylindrical cathode 10 practically forms the fusing-pot of the furnace and is provided near its lower edge with an exteriorly-formed rest-shoulder 11, resting directly on the interior shoulder 9 of the furnace-casing, whereby the said cathode is firmly and removably supported in place, and the said cathode has detachably connected to one side thereof the inner threaded end 12 of the conducting-rod 13, extended through the wall of the furnace-casing 3 and through an insulator-bushing 14, fitted in the metallic jacket or shell 4 of the casing. The said conducting-rod 13, which has a detachable connection at its inner end with the cathode, is provided at its outer end, outside of the furnace-casing, with a binding-post 15, in which is secured one terminal of the branch conductor  $\alpha$ , and it will of course be understood



that, if desired, more than one of said conductor-rods may be employed in connection with the cathode to insure the proper distribution of the electrical current throughout the same.

Arranged within the furnace-casing at the lower open end of the cylindrical carbon cathode 10 is a circular drop-bottom 17, which practically forms the bottom of the cathode, to complete the fusing-pot of the furnace. The cathode drop-bottom 17 essentially consists of duplicate semicircular sections 18, provided with chamfered overlapping meeting edges 19, and each of said bottom-sections 18 comprises a metallic body portion 20 and a carbon lining-plate 21, preferably secured on said body portion 20 by means of suitable fastening-screws 22, and when the said bottom-sections 18 are in horizontal alinement to form the complete circular bottom for the cathode the said carbon plates 21 contact with the lower edge of the cylindrical body 10 of the cathode, so that there will be a proper distribution of the electric current throughout the entire cathode of the furnace.

Each semicircular section 18 of the drop-bottom 17 has a hinge connection 23 with the inner ends of a pair of hinge-rods 24, fitted in the walls of the furnace-casing 3, and certain of said hinge-rods 24 at diametrically opposite sides of the furnace-casing extend through and are insulated from the jacket 4 at the point 25 and are provided at their outer ends with the binding-posts 26, in which are secured the wire terminals *b*, which are preferably designed to lead to a common point on a suitably-arranged switchboard and form one terminal of the main circuit, and at this point it is to be observed that the branch conductor *a* for the cylindrical cathode 10 is connected with one of said binding-posts 26 in order to complete the proper electrical circuit. The separate sections of the drop-bottom are sustained in horizontal alinement in a normally-elevated position by means of the diametrically opposite supporting slide-bars 27. The oppositely-arranged slide-bars 27 are mounted to freely slide in slide-openings 28, formed in the walls of the casing, and the inner ends of said slide-bars 27 are designed to be projected sufficiently within the furnace-casing, so as to be disposed under diametrically opposite edges of the drop-bottom 17, and also under the chamfered overlapping meeting edges of the sections of said bottom, whereby the bottom will be firmly supported in a horizontal position to form the bottom of the cathode fusing-pot of the furnace. The supporting slide-bars 27 work through insulated stuffing-boxes 29 at the outer sides of the furnace-casing and are pivotally connected at their outer ends to one end of the oscillating adjusting-bars 30, pivotally supported intermediate of their ends, as at 31, by the supporting-brackets 32, secured to the outer sides of the furnace-casing, and at their ends opposite the connection

with the slide-bars 27 the adjusting-bars 30 are pivotally connected to one end of the connecting-bars 33, the other ends of which bars are pivotally connected to an adjusting-lever 34, respectively, at opposite sides of the pivot of said lever. The adjusting-lever 34 is pivotally mounted at a point intermediate of its ends, as at 35, on a lever-bracket 36, suitably fastened to the outside of the furnace-casing between its upper and lower ends. The connections described provide means for a simultaneous movement of both slide-bars 27 when the lever 34 is manipulated, as will be readily understood.

Arranged to work within the cylindrical cathode 10 of the furnace is a hollow cylindrical carbon anode 35, which is of a smaller diameter and a greater height than the cylindrical cathode 10. The anode 35 preferably comprises a circularly-grouped series of carbon staves or bars 36, and at its upper end the said anode is provided with an exterior annular flange 37, beneath which is arranged a split clamp-ring 38. The clamp-ring 38 embraces the hollow cylindrical anode 35, below the flange 37, and is provided at its adjacent extremities with the bolt-lugs 39, engaged by the clamp-bolt 40, which provides for tightly clamping the ring 38 onto the anode, and said ring 38 is further provided with a series of threaded ears 41, which detachably receive the lower threaded extremities of the lifting-rods 42, to the upper extremities of which lifting-rods are detachably secured the eyepieces 43, which are designed to be engaged by suitable lifting-tackle. The lifting-rods 42 for the cylindrical hollow anode 35 are designed to work through the insulated stuffing-boxes 44, fitted to the top of the flanged furnace-cover 45, and directly above the stuffing-boxes 44 the said lifting-rods 42 are designed to have fitted thereon the adjustable collars 46, held fast on the rods 42 by means of the set-screws 47, so that the cover and the cylindrical anode 35 may be raised and lowered together, as will be readily understood. The flanged furnace-cover 45 has fitted to the top thereof the lifting-eyes 47<sup>a</sup>, designed to be engaged by suitable lifting-tackle, and the peripheral depending flange 48 of the cover is designed to work into the annular recess or pocket 8 in the top edge of the furnace-casing 3, and said recess or pocket 8 is designed to be filled with sand or its equivalent to provide a seal connection between the flanged cover and the furnace-casing to totally exclude air at the top of the furnace for the same purpose that air is excluded at the bottom of the furnace. The flange 48 of the furnace-cover is properly guided in and out of the said recess or pocket 8 by means of a series of short-flanged guide-plates 49, fastened to the outer top edge of the jacket 4, as at 50, and projecting at their inner ends slightly over the outer wall of the said recess or pocket 8.

The furnace-cover 45 is provided centrally



in its top with an observation-opening 51, over which opening is arranged a mica or other suitable transparent plate 52, the edges of which plate are engaged by a clamp-ring 53 and a gasket surrounding the top edge of the opening 51 and secured to the top of the cover by the clamp-screws 54, as illustrated in the drawings. At this point it will be observed that the covered observation-opening 51 not only provides for an easy inspection of the interior of the furnace, but also affords means, by the removal of the mica plate, for refilling the furnace without disturbing any of the parts or various attachments thereof.

In connection with the vertically-adjustable cylindrical hollow anode 35 is employed an angled conductor-rod 55, extended through and insulated from the jacket of the casing at 56 and provided at its outer end with a binding-post 57, in which is secured one end of a conductor *c*, included in a suitable circuit with the conductors *b* at a switchboard in order to provide for completing an electrical circuit within the furnace between the anode and cathode. The inner end of the conducting-rod 55 extends above the top edge of the furnace-casing and has connected thereto a series of toggle-links 58, which links are also suitably connected at 59 to the clamp-ring 38 for supporting the anode, said toggle-links providing an adjustable connection between the anode and its wire connection whereby said anode may be freely adjusted up and down without disturbing the electrical circuit.

A gas-escape pipe 60 is fitted in the wall of the furnace-casing near the top edge thereof, and the inner end of said pipe projects above the top edge of the furnace-casing into the space inclosed by the flanged furnace-cover 45 and provides means for carrying off the gases which accumulate within the top part of the furnace, and at its outer end the said pipe 60 is provided with a regulating-cock 61, which controls the escape of gas from the furnace into the outer air. At its outer end the pipe 60 has connected therewith a pipe extension 62, which is designed to lead to a tank of water or other suitable fluid, so that the escaping gas will pass through such fluid and escape into the outer air without allowing the return of air into the furnace, and it will also be obvious that if necessary to produce the required vacuum within the furnace a suitable air-pump connection may be made with the gas-escape pipe 60 to draw out the air from within the furnace, it being understood that the object of the invention is to have a substantial vacuum within the furnace during the operation thereof, so that there will be no loss of carbon nor of the substances being fused.

The metal which is fused in the furnace may be drawn off therefrom through the draw-off opening 63, piercing one side of the furnace-casing and communicating with the interior thereof directly above the drop-bottom

17, and the outer end of said opening is closed in an air-tight joint by means of a suitable manhole-cover 64, fastened in place in the usual manner. The draw-off opening 63 is also filled with loose material refractory to heat.

In the operation of the furnace all of the different parts are adjusted and combined together in the manner described before the cylindrical anode 35 or the cover of the furnace are placed in position. The said anode is then lowered by means of suitable tackle engaging with the eyepieces 43 until the lower end of said anode rests directly on top of the drop-bottom 17 of the cathode. The hollow cylindrical anode 35 is then filled with the substance or substances to be fused, after which the eyepieces 43 are removed from the rods 42 and the adjustable link connection 58 made with the clamp-ring 38 of the said anode. The cover 45 can then be readily lowered in place, so that the lower edge of the flange thereof will sink into the sand in the recess or pocket 8, while the lifting-rods 42 for the anode freely pass through the stuffing-boxes 44 as the said cover is lowered by means of a crane or other suitable lifting-tackle having a connection with the lifting-eyes 47<sup>a</sup> of said cover. After this adjustment of course the eyepieces 43 and the collars 46 are attached to the lifting-rods 42, so that the cover and the anode may be lifted together and also so that the anode 35 may be adjusted vertically independently of the cover by engaging lifting-tackle with the said eyepieces 43, as will be readily understood. The current is now turned on through the wire connections and at the same time the anode 35 is raised sufficiently above the drop-bottom 17 to form an electric arc between the lower extremity of the anode and the carbon-plates of said drop-bottom. After the arc is established at the lower end of the anode the said cylindrical anode is raised slowly until the arc jumps across the space between the adjacent sides of the anode and the cathode 10. At this point the cylindrical anode 35 is allowed to remain in a stationary position, and in this position with an arc established between the adjacent sides of the anode and the cathode the said arc will travel up and down between the sides of the anode and cathode and practically form a "traveling arc," which travels from the top to the bottom of the fusing-pot of the furnace and creates such an intense heat as to fuse the substance or substances within the furnace in a very short time. After the fusion has been completed the fused substance or substances can be drawn off through the draw-off opening 63 or dumped into the receiving-pit 5 of the furnace-casing by manipulating the lever 34 so as to withdraw the bars 27 from under the edges of the drop-bottom 17, thereby allowing the bottom sections 18 to freely swing downward and dump the fusing-pot of the furnace of its contents. After the dumping of the drop-bot-



tom the slag and other substances can be readily removed from the pit 5 by opening the door 7, and the sections of the drop-bottom are then readjusted and secured in place  
5 by the bars 27, ready for another operation. The cylindrical anode 35 is again lowered onto the drop-bottom and is refilled by either removing or replacing the cover 45 in the manner described or through the observation-  
10 opening 51, hereinbefore referred to.

From the foregoing it is thought that the construction, operation, and many advantages of the herein-described electrical furnace will be readily apparent to those skilled  
15 in the art without further description, and it will be understood that changes in the form, proportion, and the minor details of construction may be resorted to without departing from the principle or sacrificing any of the  
20 advantages of this invention.

Having thus described the invention, what is claimed, and desired to be secured by Letters Patent, is—

1. In an electric furnace, a cylindrical pot-  
25 cathode, and a hollow cylindrical anode supported for vertical adjustment within the cathode, and of a diameter nearly equaling that of the cathode to form a receptacle for holding the substance to be fused, and so as  
30 to lie in sufficiently close proximity to the sides of the cathode whereby an arc will be maintained between the adjacent sides of the anode and cathode, substantially as set forth.

2. In an electric furnace, an upright furnace-casing, means for temporarily sealing the casing hermetically at the top and bottom, a pot-cathode supported within the casing and having a carbon lining included in the electric circuit, and a vertically-adjust-  
40 able hollow cylindrical anode supported within the cathode and forming the receptacle for holding the substance to be fused, substantially as set forth.

3. In an electric furnace, a base having a  
45 peripheral upwardly-extending circular wall, an upright jacketed furnace-casing of a smaller diameter than the base and resting at its lower end within said base and provided at such end within one side with a door-  
50 opening, the space between the base-wall and the casing being adapted to contain a sand or similar filling, a cover having a hermetically-sealed connection at its edge with the upper end of the casing, a cylindrical pot-  
55 cathode fitted within the casing and having a drop-bottom, and a hollow cylindrical anode supported for vertical adjustment and arranged entirely below the cover and within said cathode, substantially as set forth.

4. In an electric furnace, the casing, a cy-  
60 lindrical cathode fitted within the casing, a circular drop-bottom arranged immediately below the lower end of the cathode and comprising duplicate semicircular sections hav-  
65 ing a hinged support at one edge and each consisting of a metallic body portion, means

for securing the carbon plates on the body portions of the bottom sections, and a separate carbon plate on top of such body portion, means for sustaining the sections of said  
70 drop-bottom in horizontal alinement, and a hollow cylindrical anode supported for vertical adjustment within said cathode, substantially as set forth.

5. In an electric furnace, the casing, a cy-  
75 lindrical carbon cathode fitted within the casing, a circular drop-bottom arranged immediately below the lower end of the cathode and comprising duplicate semicircular sections having carbon plates and provided with  
80 chamfered overlapping meeting edges, opposite pairs of hinge-rods fitted within the casing and having hinge connections at their inner ends respectively with the separate sections of said drop-bottom, one of the hinge-  
85 rods for each section of the bottom being extended beyond the furnace-casing and carrying at its outer end a binding-post for wire connections, a suitable wire connection be-  
90 tween one of said binding-posts and said cylindrical cathode, oppositely-arranged slide-bars mounted to slide in opposite sides of the casing and having their inner ends working under diametrically opposite edges of the  
95 drop-bottom to sustain the same in a horizontal position, a system of levers connected with the outer ends of said slide-bars to provide for the simultaneous adjustment thereof, and a hollow cylindrical anode supported for ver-  
100 tical adjustment within the cathode, substantially as set forth.

6. In an electric furnace, the casing provided in its top edge with an annular recess or pocket, a cylindrical pot-cathode supported within the casing, a hollow cylindrical anode  
105 arranged within the cathode, a clamp-ring fitted exteriorly on the anode at its upper end, a series of lifting-rods connected at their lower ends to said clamp-ring and provided at their upper ends with removable eyepieces,  
110 a flanged furnace-cover provided with a series of insulated stuffing-boxes receiving said lifting-rods, and having its depending flange working into the annular recess or pocket at the top edge of the casing, guide-plates at-  
115 tached to the top edge of the casing and overhanging said recess or pocket to guide the flange or cover therein, lifting-eyes fitted to the top of the cover, adjustable collars fitted on said lifting-rods above said stuffing-boxes,  
120 and suitable electrical connections for the anode and cathode, substantially as set forth.

In testimony that we claim the foregoing as our own we have hereto affixed our signatures in the presence of two witnesses.

HILLIARY ELDRIDGE.  
GEORGE HUDSON WRIGHT.  
DANIEL J. CLARK.

Witnesses:  
WM. H. SINCLAIR,  
R. P. ARNOLD.