No. 775,282. PATENTED NOV. 15, 1904.

R. RADDATZ.

ELECTRIC FURNACE.

APPLICATION FILED JUNE 23, 1899.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

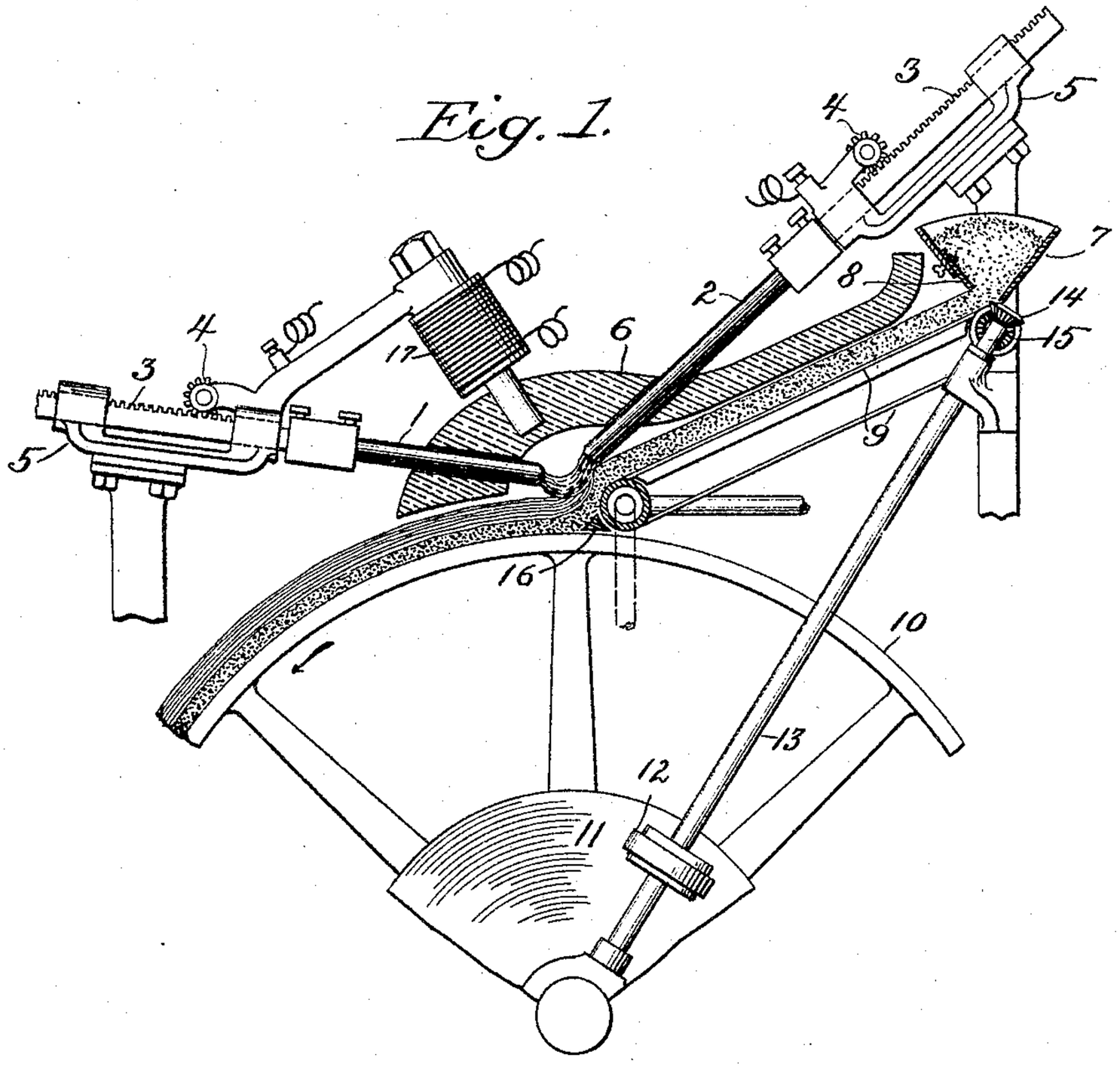
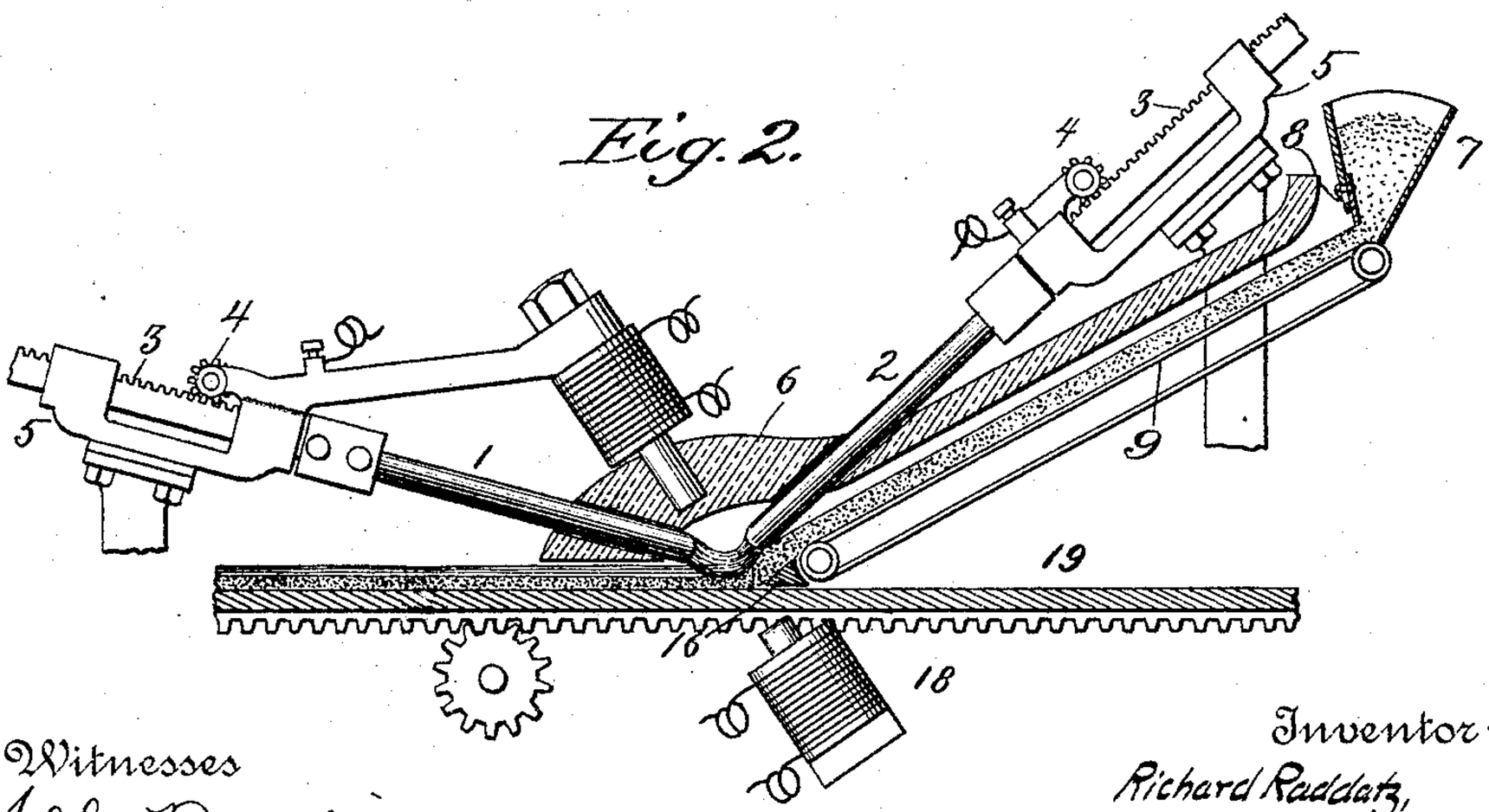


Fig. 2.



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ELECTRIC FURNACE.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

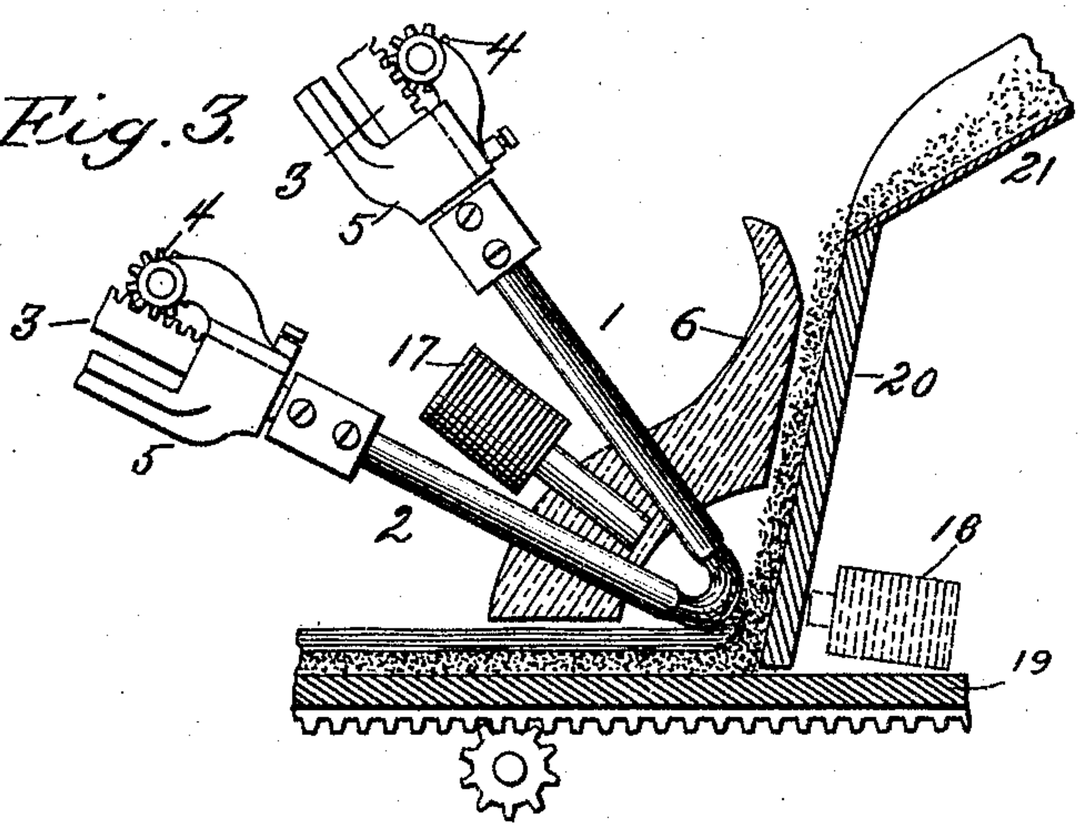


Fig. 4.

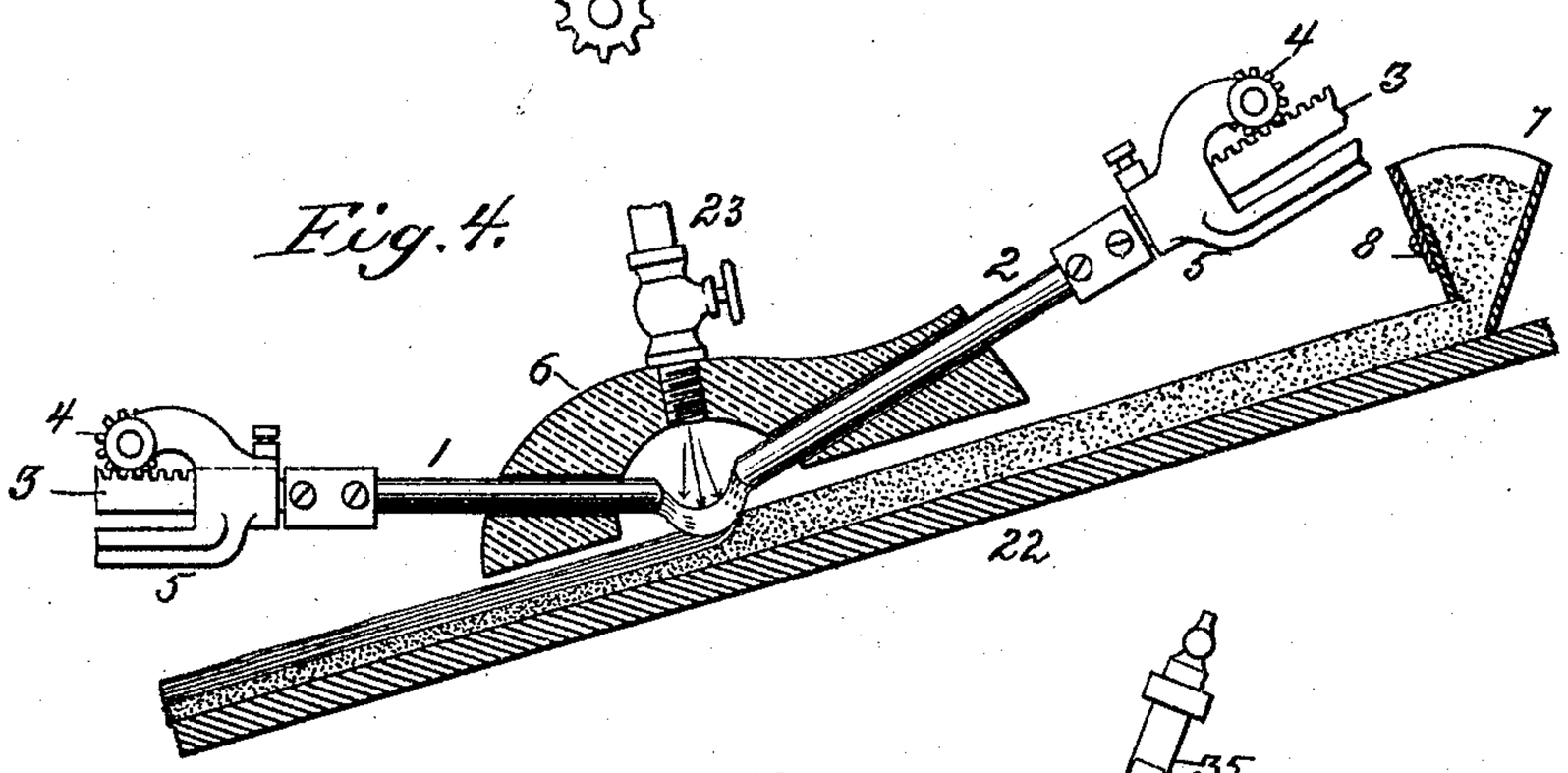
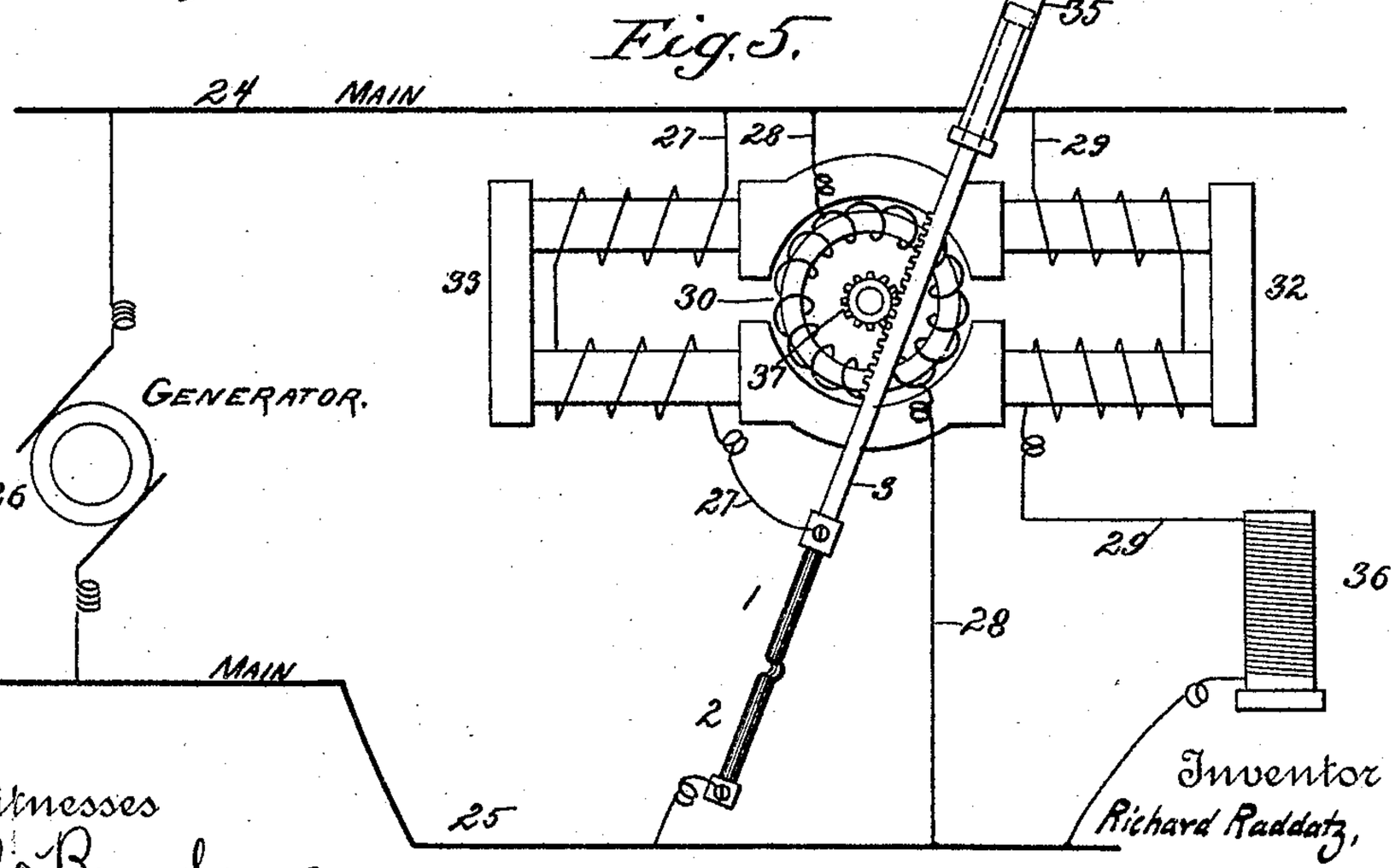


Fig. 5.



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No. 775,282. Patented November 15, 1904.

UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 775,282, dated November 15, 1904.

Application filed June 23, 1899. Serial No. 721,598. (No model.)

To all whom it may concern:

Be it known that I, RICHARD RADDATZ, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

My invention relates to electric furnaces; and it consists in a variety of novel features, details, and combinations hereinafter explained, and set forth in the claims.

In the drawings accompanying this description, Figure 1 is a sectional elevation of the operative parts of my furnace constructed with a rotatable supporting and carrying bed; Fig. 2, a similar view showing a horizontal traveling bed or support and two arc-deflecting magnets instead of a single one, as in Fig. 1; Figs. 3 and 4, views illustrating variations or modifications of the invention, and Fig. 5 a diagrammatic view illustrating a mode of regulating the distance between electrodes.

Electric furnaces have during the past few years come into prominence and met with a high measure of success as a means of reducing the more refractory substances which had theretofore proven incapable of reduction or which had been reduced only with exceeding difficulty. Owing to various causes such furnaces have hitherto had a comparatively narrow field of application, and it is the purpose of the present invention to remove these causes and extend the range of usefulness of such furnaces.

Prominent among the objects sought are the following: first, to render the action of the furnace continuous, which is done by providing an automatic feed and an automatic delivery; second, to provide a differential feed and take-off or delivery, whereby compensation shall be automatically made for shrinkage or expansion in volume occasioned by the fusing or other action of the electric current; third, to bring the arc into contact with or to direct it against the material to be acted upon without necessarily carrying the electrodes into contact with or into the path of said material, so that the electrodes may be freely adjusted and neither clogged nor short-circuited by the material under treatment should this otherwise be found to occur; fourth, to utilize a portion of the heat hitherto lost through radiation and conduction and to apply the same to a preliminary heating of the material under treatment; fifth, so to construct the furnace as to permit the incoming material to be fed in whole or in part into the pool of fused or liquid material beneath or before the arc where such feeding is desirable; sixth, to provide means for maintaining a proper working relation between the feed of material, the delivery or take-off of the product, and the action of the arc; seventh, to provide means for automatically adjusting the electrodes to maintain a proper length of arc and to make the same proportionate to the work to be performed by it.

These objects I attain by the construction shown in the accompanying drawings, which contemplates placing the regulating-electrode, and, if found desirable, both electrodes, out of contact with and out of the path of travel of the material under treatment when found that same would otherwise clog, short-circuit, or interfere with the action of the electrodes and by the deflection of the arc so that it shall impinge upon the material or substance to be treated.

Referring first to Fig. 1, the electrodes 1 and 2 are represented as standing at an obtuse angle one to the other, each being carried by a rack-bar 3, moved by a pinion 4, which may be rotated in any convenient manner. The rack-bars 3 move through suitable supporting-guides 5, which will be connected with the framework of the furnace or with the floor or other suitable fixture. 6 indicates a hood, top, or cover formed of highly-refractory material and designed to cover the proximate ends of the electrodes, the arc between them, the substance immediately under treatment, and the incoming supply of material. The hood 6 may for ordinary purposes be

made of fire-brick or fire-clay; but where the substance or substances under treatment liberate or give off fumes or gases which would injuriously affect such fire-clay other material suited to the substance under treatment will be substituted. I do not mean to restrict myself to any particular material for the hood, but propose to vary the same according to actual working conditions, employing in each instance such material as is well known to those familiar with the art as suitable to the particular metal or substance under treatment. In Fig. 1 said material is represented as supplied to a hopper 7, from which it escapes in quantity regulated by a gate 8 to an endless belt or apron 9. From the apron the material falls upon the periphery of a cylinder, drum, or wheel 10, to which rotary motion will be imparted from any convenient prime mover. Concentric with the wheel or drum 10 is a disk 11, against which bears the periphery of a friction-wheel 12, slidably secured upon a shaft 13, which shaft carries a pinion 14 to mesh with and give motion to a second pinion 15, carried by the shaft of one of the cylinders or pulleys about which the feeding belt or band 9 passes. By moving the friction-wheel 12 toward and from the center or axis of the disk 11 the rate of feed may be lessened or increased to any desired extent, as will be understood from the drawings without further explanation. To prevent material from falling backward or passing beneath the delivery-point of the belt or apron 9, a fixed bar 16 is provided, as shown in Figs. 1 and 2, which bar may be of refractory material, if necessary.

In Fig. 1 I have shown an electromagnet 17 carried by a suitable support and having its core extended down toward the proximate ends of the electrodes 1 and 2, said magnet being so wound that its pole shall cause a deflection of the arc between said electrodes, as indicated in Fig. 1. In Fig. 2 a similar arrangement is shown, supplemented, however, by a magnet 18, so wound as to attract the arc or to cause it to be deflected toward the magnet, thus better insuring the impingement of the arc upon the material under treatment than where the single magnet is used. Instead of the rotating cylinder 10 of Fig. 1 a horizontal traveling bed 19 is shown in Fig. 2. This may be a bed of such length as that it may travel continuously in one direction a length of time sufficient for the particular operation intended to be performed, or it may represent merely a section of an endless bed the planes or sections of which reach consecutively the point or position indicated in Fig. 2. It is obviously immaterial how the bed or plate is moved and whether it be given a right-line movement or travel about a fixed center, in which case it will be of circular form. In Figs. 2 and 3 the bed is shown with a toothed rack with which meshes a driving-pinion for imparting motion to the bed, whether said bed be arranged to move in a right line or in a circular path.

It will be seen that owing to the upward inclination of the hood 6 and to the natural tendency of heated gases to rise there will be a movement of heated air upward between the incoming material and the under surface of the hood 6 under the constructions shown in Figs. 1 and 2. This heat, hitherto wasted in greater or less degree, serves to preliminarily heat the incoming material, and thus to prepare it for the action of the arc. In this way the time required to fuse or otherwise reduce the substances is appreciably lessened and the expenditure of current is proportionately decreased.

Referring now to Fig. 3, it will be seen that the electrodes 1 and 2 are arranged at an acute angle one to the other, the magnet 17 being placed between them, as before; but the magnet may used or omitted, as desired, since by reason of the current traveling in one direction in one electrode and in the opposite direction in the other electrode the arc is deflected outward, as indicated, even in the absence of the magnet. It is, however, preferred to employ means to effect a more certain and marked deflection of the arc. It will further be observed that under the construction shown in Fig. 3 the hood 6 is made shorter and is carried upward in a more nearly vertical direction. Facing but slightly removed from the upright face of the hood 6 is a stationary wall 20, above which is a feed hopper or chute 21, which delivers the material for treatment into the space between the hood and the wall 20 and to the bed 19, which, as before, travels constantly in one direction.

Fig. 4 shows another modification or variation of the embodiment of the invention. In this the electrodes are arranged in substantially the same relation as in Figs. 1 and 2, and the bed 22 in this case is placed at such an angle as shall cause the material under treatment to flow or travel over its surface by gravity, the bed being meanwhile rapped or jarred, if found desirable. The angle of inclination may of course be varied at will to meet the requirements of the material under treatment. 23 indicates a pipe or nozzle arranged directly above the arc or the proximate ends of the electrodes and designed for the introduction of a stream of air, gas, oil, or vapor for the purpose of deflecting the arc and causing it to act more directly and effectively upon the material passing beneath it. Said stream of air, gas, &c., may to advantage carry solid particles with it, either of the same material as that under treatment or other. The purpose of introducing solid particles with the current of air or gas is prima-

rily to insure the perfect formation and the persistence of the arc and to permit a greater separation of the electrodes than would otherwise be feasible. The delivery of minute particles of matter to the arc or to the space between electrodes is common and well understood, and hence is not broadly claimed by me.

It is desirable to regulate automatically the position or adjustment of the electrodes to compensate for their burning away in use, so that the action of the furnace may be constant and uniform, or practically so. Various of the devices employed for feeding and regulating the electrodes of electric-arc lamps may be used for this purpose. I prefer, however, the construction or arrangement illustrated in Fig. 5, in which 24 and 25 indicate the two lines or conductors of a main supplied from a generator 26 and connected by three conductors or multiple-arc connections 27, 28, and 29. Circuit 28 includes and supplies the armature 30 of a motor having field-magnets 32 and 33. Circuit or branch 27 includes the field-magnets 33 of the motor and the electrodes 1 and 2. Circuit or conductor 29 includes the field-magnets 32 and a resistance device 36, by which the resistance may be increased or diminished, if desired, though obviously the resistance of this circuit may be determined in the first instance and thereafter remain unchanged. The electrode 1 is represented as attached to a bar or holder 3, made in the form of a toothed rack, the teeth of which mesh with a pinion 37, secured to the shaft of the armature or otherwise caused to rotate therewith. The winding of the field-magnets 32 and 33 is such that the poles produced neutralize each other when the current passes equally through the circuits 27 and 29; but if at any time, owing to the wasting away of the electrodes 1 and 2 or to other cause, the resistance in circuit 27 becomes greater than that in circuit 29 the higher magnetization of the poles of field-magnets 32 and 33 will cause a rotation of the armature 30 in a given direction, dependent upon the winding of the field-magnets and armature, or in the direction of the hands of a clock when wound, as indicated in the drawings. As the electrodes are thus brought nearer together, the resistance in circuit 27 proportionately decreases until an adjustment is reached where the resistance of one circuit equals that of the other and the field-magnets exactly neutralize each other. In this manner and by this means the length of arc is maintained constant and compensation is made for the wasting away of the electrodes. A slight variation in the relative resistance of the two circuits will cause a slight gradual movement of the electrodes; but should there be a sudden variation in the resistance, as through the breaking off of one of the electrodes or from like cause, the movement would be more sudden and pronounced. To guard against too sudden movement, a dash-pot 35 or equivalent retarding device may be applied to the bar 3 or to some connected member.

Referring again to Figs. 1, 2, 3, and 4, it will be seen that a considerable depth or thickness of material is represented upon the bed and that fusion is indicated to only a part of the depth thereof. It is intended in practice thus to feed the material in a comparatively thick or heavy layer, so that the unfused portion lying beneath that which is fused shall protect the bed and apron from excessive heat and consequent injury. This, however, is not essential, as the bed may be made of refractory material and the layer or stratum of substance under treatment may be made of such depth as to permit complete fusion of all its contents.

It is often desirable that the incoming stock or material be delivered directly into a pool or puddle of the fused material, as the fusion is in this way greatly facilitated with certain substances. For this mode of treatment the arrangement shown in Fig. 3 will be found well suited, and this form is also adapted to the preliminary heating of the incoming material, which falls in a loose or separated condition through the ascending stream or current of heated air necessarily arising from the arc and the fused material beneath it.

The rate of feed of the material, whether effected by gravity and controlled by a gate or regulated opening or produced by a traveling bed with or without regulated supply, will be proportioned to the character of the material and the capacity or rate of action of the arc, this being a matter of adjustment or regulation falling within the province of the user or attendant and variable as circumstances require.

A feature of importance is that the regulating-electrode should be free when such material is being acted on as would clog the electrodes. In a roasting process one or both electrodes could be buried, and in many operations one of the electrodes (not the main regulating-electrode) could be in contact with or buried in the material under treatment. The bar 16 by causing the under layer of material to bank up at the end of the apron or delivery-incline produces a sort of dam and causes the fused material to form a pool or puddle at that point into which the incoming material may be in whole or in part delivered.

It is obvious that the details of the apparatus may be varied considerably without departing from the spirit of my invention.

If deemed necessary, any parts subject to injury by excessive heat may be artificially cooled—as, for instance, by making them hollow and passing water or other cooling agent through them. This is indicated in connection with the belt-roll in Fig. 1.

The apparatus may be used with either straight or alternating current. When the straight or continuous current is used, the positive electrode wastes away more rapidly than the negative. It is therefore advantageous to feed the material through or under the arc from the negative toward the positive electrode, since the positive being the hotter the greatest heat will under this arrangement be applied in the finishing-work or complete fusing of the material under treatment. This arrangement is further advantageous in that it leaves the more rapidly wasted electrode in better position for adjustment without liability of clogging in the event of too rapid supply of material to the arc, which material may entirely and completely bury the other electrode without necessarily clogging the apparatus or interfering with its operation. When an alternating current is employed, it is of course immaterial which electrode is placed nearest the incoming material, as each is positive and negative by turns and their rate of waste is equal.

Having thus described my invention, what I claim is—

1. In combination with a bed or support; a feeding device for delivering material thereto; driving mechanism for imparting motion to the bed and the feeding devices; means for varying the relative movements of the bed and the feeding devices; and electrodes having their ends brought within "arcing" distance of each other in proximity to the point at which the feeding devices deliver material upon the bed.

2. In an electric furnace, the combination of a bed or support for the material to be treated; electrodes having their ends within "arcing" distance of each other in proximity to said bed; an incline over which material is fed to said bed or support; and a hood extending from the bed over the proximate ends of the electrodes and upward over the inclined feed-surfaces, substantially as shown and described, whereby the waste heat from the arc and from the fused material is caused to act upon the incoming material and to impart heat thereto.

3. In an electric furnace, the combination of a traveling supporting bed or surface adapted to support and to carry forward the substance to be treated; electrodes arranged in proximity to said bed; a source of electric energy in circuit with the electrodes; feeding devices for delivering to the supporting bed or surface the substance to be treated; and driving mechanism for the bed and the feeding devices adapted to drive the same at varying relative speeds, whereby the feed and delivery may be accurately proportioned to the rate at which the material is reduced by the furnace.

4. In an electric furnace, the combination of a bed or support for the material to be treated; a feeding-inlet for said material; means for moving said bed past said inlet; and two electrodes arranged at proper arcing distance from each other, the negative electrode being relatively nearer to and the positive electrode farther from the feeding-inlet, substantially as and for the purpose set forth.

5. In an electric furnace, the combination of a movable supporting-bed; feeding mechanism for supplying material to said bed; electrodes arranged in proximity to the bed, and in circuit with a source of electric energy; and driving-gear connecting the bed and the feeding mechanism and adjustable, substantially as described, to vary the relative rates of movement of the bed and the feeding mechanism to correspond with the rate of reduction of the substance treated.

In witness whereof I hereunto set my hand in the presence of two witnesses.

RICHARD RADDATZ.

Witnesses:
B. A. BRENNAN,
R. M. STONE.