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G. JAEGER

2,294,034

ANNEALING FURNACE

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Fig. 1.

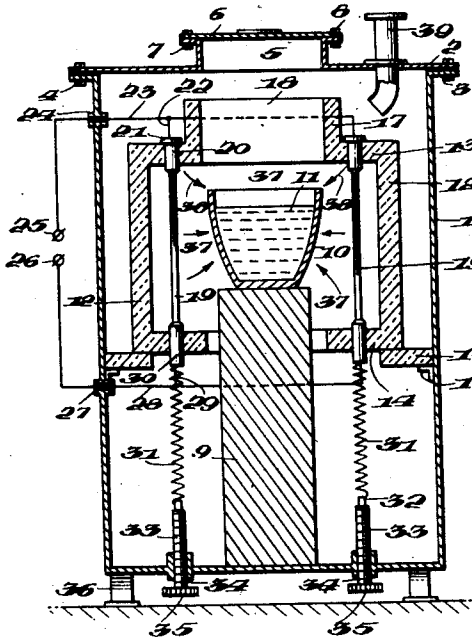


Fig. 2.

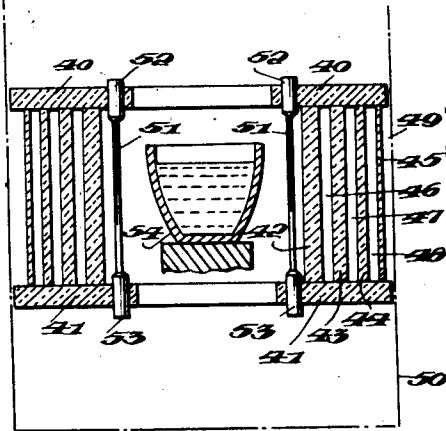


Fig. 5.

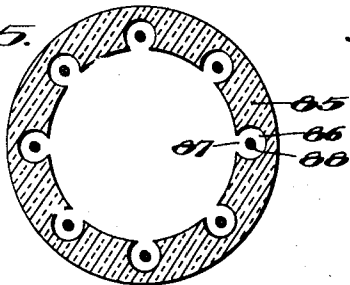


Fig. 3.

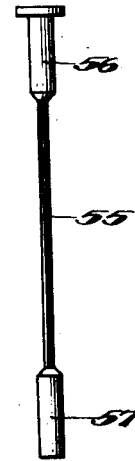
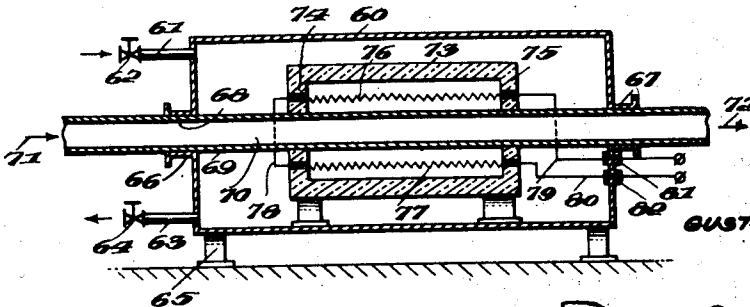


Fig. 4.



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UNITED STATES PATENT OFFICE

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ANNEALING FURNACE

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1 Claim. (Cl. 13—20)

The invention relates to an annealing furnace, especially a crucible annealing furnace with electrical resistance heating for maximum temperatures.

Hitherto annealing furnaces have been known to have containers made from carbon, serving as heating elements and also as receptacles for the annealing charge. The walls of this container were connected with the heating current circuit and could be heated by the heating current.

These annealing furnaces have, however, certain disadvantages, especially with respect to the carbon crucibles, as, for instance, the danger of contamination of the melting charge, the danger of fracture of the crucible and, especially, the danger of reactions of the crucible, for instance, with the hydrogen often present in the crucible space.

Now it was found that annealing furnaces may be constructed in a very simple manner without the above mentioned disadvantages if inside of a furnace made from or lined with refractory oxides such as beryllium oxide, magnesium oxide, thorium oxide, zirconium oxide or aluminium oxide of high purity heat conductors made from molybdenum and/or tungsten are arranged entirely free, i. e., in such manner that their radiant parts do not touch the walls so that they may freely radiate in the direction of the crucible or the passage tube containing the heating charge. The grade of purity of the refractory masses like alumina is preferably over 98%, preferably between 99% and 100%. Of the refractory oxides mentioned above, I prefer to use magnesium oxide and especially aluminium oxide.

These furnaces according to my invention show a plurality of advantages. Owing to the electrical indifference of the type of insulation used to high temperatures and long stress, the heat conductors may be arranged in a particularly simple manner. A further advantage is to be seen in the fact that undesired heat transfer through the walls of the annealing chamber does not occur and that the walls will be shielded from heat. Local overheatings were never observed. Moreover, the walls may be very thin and, if desired, made out of several layers.

The heat conductors will undergo a very uniform stress, especially with respect to thermal charges. They do not react with the material of the walls, are easily attachable and replaceable and may readily be watched.

The furnaces according to my invention have the special advantage that they may be controlled in the most precise manner and be

regulated to a constant temperature as the heat conductors possess only a relatively small capacity for heat.

All parts of the furnace may easily be arranged in such manner that a compact unit will result.

If the walls surrounding the heat conductors are made of several layers it is advisable to fill out the interspaces with granulated insulating material.

It has proved expedient to arrange the heat conductors in such manner that they form a cage, encompassing a crucible or, for instance, a passage tube for the annealing charge.

Furthermore, considerable benefits may be gained from the fact that the heat conductors, especially if they are arranged parallel to the longitudinal axis of the heating chamber, may be kept in longitudinal tension, for instance, by means of springs adjustable in their tension, preferably arranged outside the annealing zones. The same may be effected by forming the heat conductors as helical springs which are elastic in longitudinal direction. The longitudinal deflection property has the special advantage that the heat conductors may be completely re-straightened if they are subjected to distortions, for instance, on account of the heat inside the annealing chamber. In consequence thereof, the uniformity of the radiation is always perfectly maintained.

If necessary, the heat conductors, preferably made from molybdenum and/or tungsten, are arranged in a known way in slots, expediently in longitudinal slots inside of the encasing walls of the heat chamber. The slots are formed in such manner that the heat conductors are only encased to a minor degree so that they are able to radiate as strongly as possible.

In furnaces with elliptical walls it has proved advantageous to arrange the heat conductors so that a local effect of the radiations will be created. This is performed by grouping the heat conductors, for instance, at the focus of parabolic, ellipsoidal walls or the like.

It was further observed that furnaces of special suitability and high efficiency may be obtained if a protecting gas (for instance hydrogen), inert gas or a mixture of nitrogen and hydrogen) are passed into the annealing area and again drawn off therefrom. Instead of a protecting gas vacuum may also be used. When employing a protecting gas, the gas flow is preferably conducted in such manner that the gas will flow completely around the heat conductors.

The furnace according to my invention is preferably suitable for the heat treatment of all sorts of substances, especially metals. With this furnace it was for the first time possible to fuse perfectly slow melting metals such as beryllium, titanium, zirconium and the like, as well as metals which may be recovered only in a pulverulent state and which can not be subjected to a high frequency heating. An addition of fluxes is thereby not necessary.

If desired, it is possible to equip the inner space of the furnace, for instance, between the crucible and the encasing heat conductors, with bus bars made from an refractory mass which direct the crucible centrally into the annealing zone and keep it there. The bars are expediently made from the same refractory oxides which are used for the furnace walls.

The furnace may be completed without difficulty in such manner that it may be utilized in a known way, not only for the heating of an annealing charge but also for the casting of a fused charge. This may be effected by superimposing a special container on the top side of the furnace into which the crucible with the molten charge is passed whereafter the crucible is discharged by tilting into a mould or the like.

My invention may be illustrated by the affixed drawing.

Fig. 1 shows a longitudinal section of an annealing furnace with crucible.

Fig. 2 shows another type of the refractory walls surrounding the crucible.

Fig. 3 is a type of a heat conductor.

Fig. 4 shows another annealing furnace with a passage tube for passing the annealing charge; and

Fig. 5 shows a section of a special form of a wall made from a refractory mass and a special grouping of the heat conductors in the walls.

The protective metal casing 1 is closed with the cover 2, supported and sealed by the flanges of the casing 1 and tightly connected with it by means of bolts 3, 4 or the like. In the center of cover 2 is an aperture 5, preferably closed with a lid 6 which is tightly connected with flanges projecting from a collar of cover 2 by means of bolts 7, 8. The cover 6 is preferably equipped with sight-holes made of a transparent refractory substance in order to watch the inner part of the protective casing 1 and the annealing chamber.

On the bottom of casing 1 there is a base 9 on which the crucible 10 containing the annealing charge 11 rests freely. The crucible is surrounded by walls 12 made from highly refractory oxides, for instance, sintered aluminium oxide with a degree of purity of more than 99, 5%. The walls 12 are, for instance, cylindrically constructed and on the front surface turned towards cover 2 of casing 1, equipped with an inwardly protruding circular flange 13. In accordance therewith the end of the wall 12, turned aside from the cover 2 and turned towards the bottom of the casing, is furnished with an inwardly protruding circular flange 14. The flanges form passages in to the annealing chamber. To support the cylinder made from a refractory mass, supporting bodies, as for instance, a ring 15, made from the same material, are provided. This ring is supported on angle irons 16 or the like which are fixed in the inner walls of the casing 1.

On the side turned towards cover 2 the refractory cylinder body has a collar like projection 17 fixed on the inner wall of flange 13. The inner

space or passage opening of collar 17 is indicated at 18.

Opposite the wall 12 and between it and crucible 10 the electrical heat conductors 19 are freely arranged. Where they pass through flange 13, the heat conductors have bulged out parts 20 which are axially shiftable in the flange. By means of a flange 21 outside the flange 13 and supported against it the possibility of axial displacement is restricted.

A wire 22 runs from heat conductor 19 to a circular shaped collecting bar 23, conducted through a sealed passage 24 from inside the container to a connector block 25 outside of it. The other terminal 26 is connected with a conductor 28, guided through the sealed passage 27 into the inner space of container 1. The connection of collecting bar conductor 28 to one of the heating conductors is indicated at 29.

At the end towards the conductor 29 the heat conductor 19 is preferably bulged out. The bulged out part passes through flange 14 of the insulating body 12 and is axially shiftable in it. To this shiftable bulge 30 a helical spring or the like 31 is attached which tends to draw heat conductor 19 axially downwards. The spring 31 is fixed on an adjusting rod, axially shiftable in bearing body 33 and equipped with, for instance, a female thread or the like which works together with a set screw 34 with operating head 35. This regulating screw is located below and outside of the container 1, in order to be adjusted manually.

The casing 1 is supported on feet 36 which may be so high that an easy manual operation of the set screws 34, 35 is possible.

The annealing space is indicated at 37. Arrows 38 show the direction of the heat radiation, especially to the crucible. In cover 2 also a pipe socket 39 is provided through which a protecting gas, for instance, an inert gas such as argon, may be conducted into the casing area and the annealing chamber.

In the modified type according to Fig. 2, 40 and 41 are two rings of highly refractory oxides between which concentric cylinders 42, 43, 44 and 45, made also from highly refractory oxides, are arranged. Between the cylinders there are annular spaces filled with air (46, 47, 48 and 49) whereby the space 49 lies between the outermost cylinder of insulating material 45 and the casing wall 50, turned towards the cylinder.

Turned towards the annealing chamber opposite the innermost refractory cylinder 42 there are, for instance, heat conductors forming a cage 51 with bulging out parts 52 and 53 at the refractory rings. The crucible, encased within the heat conductors and cylinders made from insulating materials, bears the number 54.

Fig. 3 shows a heat conductor 55 with bulged out ends 56 and 57 in an enlarged scale.

According to the form of Fig. 4, 60 is a protective casing with connection socket 61 and shut off valve 62, and a further connection socket 63 with shut off valve 64. The casing 60 is supported by feet 65 and bears at its ends socket-like projections 66 and 67, lying diametrically opposite each other. Socket 66 is equipped inside with a seal, expediently with a stuffing box 68. Stuffing box 68 seals the line pipe 69, passing through casing 60 and the annealing zone, at the passage point in the casing. The arrows 71 and 72 show the direction of the inlet and outlet flow.

Inside of casing 60 is, for instance, a cylindrical body 73 made from highly refractory oxide

surrounding tube 69 in the annealing zone. Cylinder 73 is equipped at its ends with inwardly projecting flanges 74, 75 which form a passage opening to the passage of tube 69.

Between wall 73 and passage tube 69, the heat conductors 76 and 77 are arranged parallel to the longitudinal axis of tube 69. An electric connecting guide between the heat conductors is indicated at 78. Further connecting rods for supply and discharge of the electric current are shown at 79 and 80, passing at 81 and 82 under seal through the wall of casing 60.

The above mentioned pipe sockets 61 and 63 serve for supply and discharge of the protective gas, the arrows indicating the direction of the flow.

In the type according to Fig. 5, 35 is, for instance, a cylindrical insulating body made from highly refractory oxide. This body is equipped with a longitudinal slot in the wall turned towards the inner hollow interspace, which slot has a passage cleft 87 on the wall turned towards the interspace. The rodlike heat conductor 88 which is fixed in the slot 86 may radiate through the

passage cleft into the inner space of the insulating body 85.

My invention is not restricted to the particular arrangement of apparatus shown in the drawing and described above since that is given here merely by way of illustration of my invention.

What I claim is:

Annealing furnace for high temperatures comprising walls forming a heating chamber, the inner surfaces of the walls of said chamber being composed of material containing at least 98% of at least one oxide of a substance selected from the group consisting of beryllium, magnesium, zirconium and aluminum, heating conductors comprising elongated bars extending parallel to the furnace walls and spaced therefrom to heat the charge by radiation, said heating conductors being formed of a material selected from the group consisting of molybdenum and tungsten, and springs arranged outside said chamber and connected to said heating conductors to maintain a tension thereon.

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