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PROCESS AND APPARATUS FOR CARRYING OUT
TECHNICAL PROCESSES BY GLOW DISCHARGES
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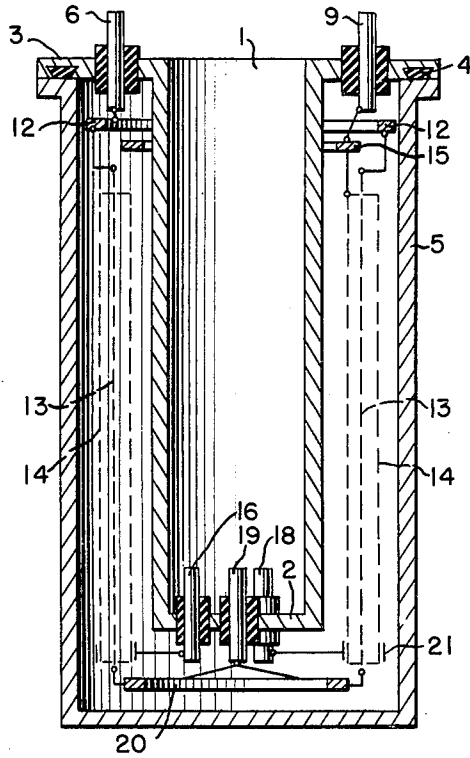


FIG. 1

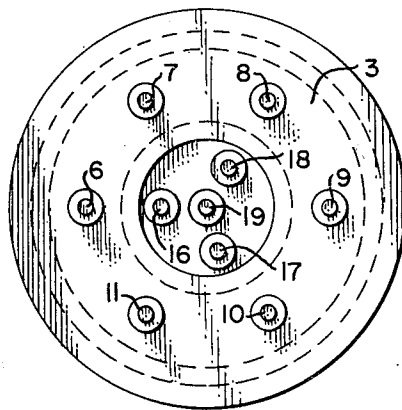


FIG. 2

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PROCESS AND APPARATUS FOR CARRYING OUT TECHNICAL PROCESSES BY GLOW DISCHARGES

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It is already known to carry out technical processes, more particularly metallurgical processes, by a glow discharge. Great difficulties and disadvantages however, have arisen in practical operation when charging a metallic discharge vessel with a plurality of work-pieces to be treated, owing to the peculiarity of this process. During the treatment the work-pieces had assumed very different temperatures which resulted in large precipitation variations in the treated articles.

The invention, which avoids these difficulties and disadvantages, consists in a process and apparatus for the treatment of a plurality of metal work-pieces in a glow discharge vessel which is characterized by the feature that the individual work-pieces or parts thereof have approximately the same angular parts of heat radiating, heat absorbing and heat reflecting surfaces. Preferably, the work-pieces to be treated are arranged in a formation in which all the work-pieces behave approximately identically both electrically and thermally relatively to each other and to the wall of the vessel on all sides. It is especially advantageous to dispose the work-pieces at the same distances from each other and from the boundary on the periphery of a circle which is concentric with the axis of the glow discharge vessel. The work-pieces are preferably so arranged that their distances from one another are greater than double the thickness of the precipitation on the cathode during the glow discharge.

The invention also relates to an apparatus for carrying out the process hereinbefore referred to, which apparatus is characterized by the fact that the glow discharge metal vessel is provided with leading-in insulators and holders for the work-pieces and/or auxiliary electrodes arranged symmetrically about the central axis, these parts being constructionally connected together so that they can be inserted together into an outer container. Further, at least two separate groups of such insulators are preferably provided on a common constructional part. The apparatus is also characterized by the fact that the work-pieces to be treated are secured to leading-in insulators which are arranged circularly in a plane and that the work-pieces or auxiliary electrodes are supported on a group of leading-in insulators arranged in a second plane at a distance from the first group determined by the dimensions and number of work-pieces. The current carrying holding and supporting constructional parts are preferably so arranged as to behave in the same manner electrically and thermally relatively to the work-pieces, or parts thereof, the said constructional parts being preferably arranged symmetrically with respect to the central axis of the receptacle.

According to the invention, for the required uniform heat treatment of a work-piece, identical with that of the other pieces, no work-piece or part thereof must present, compared with another work-piece within the discharge chamber, a different angular part of surfaces to be heated or cooled. It is required that the arrangement of the work-pieces shall be the same on all sides, relatively to one another and to the wall of the discharge vessel (receptacle wall), the radiation metal sheets etc. Between work-pieces which have the same or opposite polarity and

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also auxiliary electrodes, it is necessary to provide arrangements which are of the same kind or which behave at least electrically identically, and it is also required that the distances of the work-pieces and of the auxiliary electrodes with respect to the receptacle wall shall be the same or electrically identical. As already pointed out above, the apparatus according to the invention is characterized by two separate groups of leading-in insulators provided on a common constructional part. A number of these may also serve solely as mechanical supports, without being connected to the electric circuit from the outside. Since insulators cannot be freely mounted in gas discharges and have to be screened by protective gaps against the destructive influence of the discharge, cooling is preferably provided in order to avoid the disintegration of the insulating materials. Such insulating supports serving only for purely mechanical purposes are constructively almost identical with a leading-in insulator, and in this sense this designation will hereinafter be used also for such supporting insulators which, constructively, fulfill only a purely mechanical function. In certain favourable working conditions, it is possible to use insulators provided with protective screens, also without any special cooling measures being taken for this purpose. The apparatus according to the invention may also be provided with heat-insulating as well as with water-cooled walls or also include inside a reflecting radiation surface. The measures provided by the present invention are especially important when the gas discharge is fed by a supply of multiphase currents, preferably those used in industry, wherein more particularly the uniform distribution of the work-pieces, with respect to the individual phases for the purpose of equal load-distribution, is of special importance. In order to be able to carry out readily and safely all the measures, such as adjustment etc., when auxiliary electrodes and controls are provided, as well as mount the individual work-pieces, more particularly in the case of a large number in one charge, it is necessary that there shall be an easy access from all sides to the individual work-pieces etc., as is described hereinbelow, by way of example, in connection with one form of construction.

The apparatus according to the invention should be sufficiently secured against outer pressure without any complicated reinforcing devices being used and it should be possible to provide all the packings in a simple manner, use being accordingly made of preferably circular packings; the apparatus should also have but a small unused or dead space within the receptacle, in order to avoid using pump installations of large dimensions, which is uneconomical.

The accompanying drawing illustrates, by way of example, an apparatus according to the invention suitable for the treatment of tubular work-pieces in which, owing to a very large ratio of length to diameter, an auxiliary electrode consisting of a wire passes axially through the tubular articles, a supply of three-phase current being used for the electric discharge. By means of such an apparatus, the hardening of tubes by nitridation can for instance be carried out. The individual work-pieces are suspended and they are guided at the lower end, thereby allowing for expansion of the work-pieces during the heat treatment, but preventing any oscillation thereof. The same applies to the auxiliary electrodes which may be arranged in a similar way by being tensioned by the pull of a weight.

In the attached drawing, Fig. 1 is a central vertical section through an apparatus constructed in accordance with the invention; while Fig. 2 is a top plan view thereof.

Referring to Figure 1 of the accompanying drawings, 1 is the central inner part of the gas discharge vessel provided with a lower closing part 2 and an upper general closing flange 3. The inner part 1 is constructed as

a unit and is placed with a packing 4 on the outer wall 5. The double wall of the parts 1, 2, 3 and 5, which is always required for the purpose of water cooling, is not shown in this diagrammatic illustration. Likewise, all the water cooling connections for the leading-in insulators are not shown, as they form no part of the invention. A group of leading-in insulators 6, 7, 8, 9, 10 and 11 is provided in the flange 3. The leading-in insulators 6, 8 and 10 are provided with an annular support 12 serving for the suspension and centering of the auxiliary electrodes 13 which are drawn through the axis of the tubes 14. The tubular work-pieces 14 to be treated are suspended from the leading-in insulators 7, 9 and 11, either individually or in groups; in the latter case there is further provided, for instance, annular supporting connecting elements 15. The lower end of the central inner part 1 carries at its lower closing part 2 a second group of leading-in insulators 16, 17, 18 and 19. To the leading-in insulator 19 there is secured a ring 20, which supports the lower centering devices for the auxiliary electrodes 13. The lower ends of the work-pieces 14 are supported on the leading-in insulators 16, 17, and 18 and guided in rings 21. Each of the work-pieces is connected for instance to one phase, but the auxiliary electrodes are connected together to the star point of the electric installation. According to the invention, the supply of three-phase current effects the treatment of at least three work-pieces or a multiple thereof. In the case of more than one work-piece per phase, the individual work-pieces are alternately cyclically connected to the succession of the phases.

Referring to Fig. 2, the leading-in insulators 6, 7, 8, 9, 10 and 11 are arranged in the closing flange 3 and the leading-in insulators 16, 17, 18 and 19, in the closing wall 2 at the lower end of the central inner part 1.

The apparatus according to the invention may be modified in various respects; for instance, constructions have been developed in which the metal part serving for the provision of a second group of leading-in insulators was not constructed as a rigidly built tube, as in the example hereinbefore described, but, by using tubes of comparatively small diameter as a supporting element, the lower constructional unit was secured to the upper closing cover of the receptacle. This also enables a displacement in the direction of height of the lower group of leading-in insulators to take place so that it is possible to adapt the work-pieces to different lengths. The apparatus according to the invention may otherwise be modified without departing from the scope of the invention as claimed in the appended claims.

I claim:

1. Apparatus for the simultaneous treatment of a plurality of metallic articles with an electric glow discharge, comprising a chamber including an outer wall and means providing an inner wall spaced from the outer wall to form an intervening space for receiving said articles, and a plurality of means secured in one of the walls and arranged symmetrically about the central axis of such wall for supporting said articles, whereby the articles to be treated may be mounted on said wall prior to assembly of the latter with the other wall to form the sealed glow discharge chamber.

2. Apparatus according to claim 1, wherein the wall provided with said supporting means constitutes the inner wall of said chamber.

3. Apparatus according to claim 2, wherein the supporting means comprise leading-in insulators containing electrical conductors for connection with the metallic articles.

4. Apparatus for the simultaneous treatment of a plurality of metallic articles with an electric glow discharge, comprising a chamber including a cylindrical metallic outer wall and a cylindrical metallic inner wall having at the top thereof an annular flange for sealing against the top of the outer wall, the walls forming an annular space therebetween, uniformly spaced insulators passing

through said flange, electrical conductors passing through at least certain of said insulators for carrying current to said articles, and insulators arranged adjacent to the bottom of said inner wall and provided with means for supporting the lower ends of said articles.

5. Apparatus for the simultaneous treatment of a plurality of metallic articles with an electric glow discharge, comprising a chamber including a cylindrical metallic outer wall and a cylindrical metallic inner wall, each having a bottom wall, the inner wall having an annular flange at the top thereof, adapted to coact with the upper edge of the outer wall for sealing the chamber, the inner wall being of less height than the outer wall, whereby a U-shaped space is formed between the walls, a plurality of insulators passing through the flange and uniformly spaced about the central axis of the chamber, a plurality of insulators passing through the bottom of the inner wall and symmetrically arranged with respect to said central axis, means connected to said second group of insulators for supporting a plurality of articles within the chamber, and conductors passing through at least certain of the first group of insulators for supplying current for the glow discharge.

6. Apparatus according to claim 5, including wire electrodes adapted to pass through the axis of tubular articles and connected to the aforementioned conductors.

7. Apparatus according to claim 6, including means attached to the inner wall for centering the articles to be treated.

8. Apparatus according to claim 5, wherein the conductors are connected together in alternation, the so-formed groups being connected to a multi-phase supply circuit.

9. Apparatus according to claim 1, wherein the supporting means include insulators disposed at an upper plane on the wall structure and additional insulators arranged in a lower plane on said wall structure.

10. Apparatus according to claim 9, including an annular support connected to alternate insulators disposed in the upper plane, auxiliary electrodes connected to such support, and a ring suspended from one of the insulators disposed in the lower plane, said auxiliary electrodes being connected to said ring.

11. Apparatus according to claim 1, wherein the supporting means include insulators disposed at an upper plane on the wall structure and additional insulators arranged in a lower plane on said wall structure, an annular support suspended from certain of the electrodes disposed in the upper plane, and a second support for said articles carried by certain of the insulators disposed in the lower plane.

12. Process for the treatment of a plurality of metallic articles in an electric glow discharge under the same thermal conditions, comprising generating heat by electrical glow discharge at the articles being treated, and maintaining for each of the articles and the corresponding parts thereof the heat balance between the heat supply consisting of the heating of the surfaces of the articles by the glow discharge and the heat radiated to it by all surfaces in the environment, on the one hand, and the heat lost by radiation from the surfaces of the articles, on the other hand, at the same value, and arranging the individual articles so that the corresponding parts thereof exposed to heat-radiating and heat reflecting surrounding surfaces subtend the same solid angle.

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