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METHOD OF ELIMINATING IMPURITIES CONTAINED IN IRON AND STEEL, AND VACUUM OVEN HEATED BY GLOW DISCHARGE, MORE PARTICULARLY ANNEALING AND MELTING OVEN ADAPTED TO CARRY INTO EFFECT SAID METHOD

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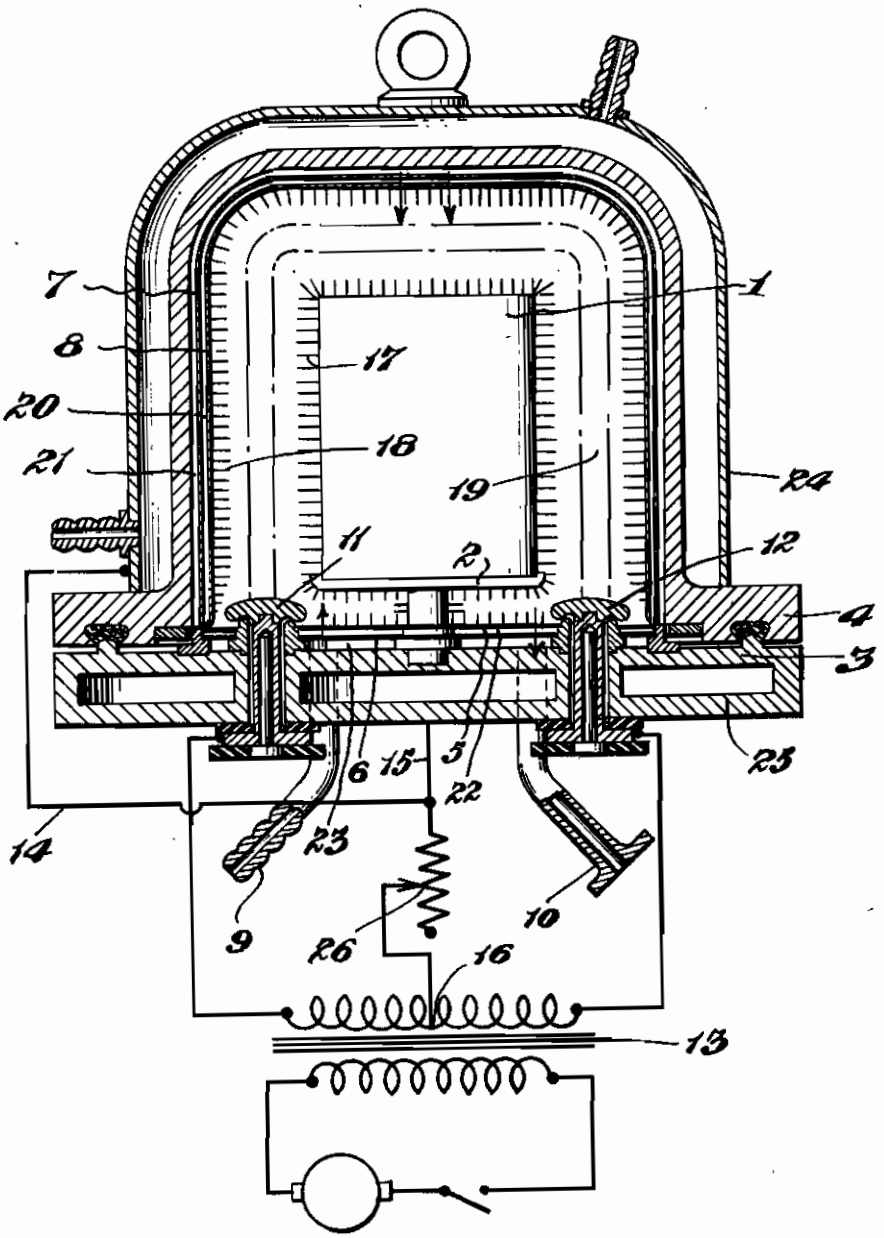

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METHOD OF ELIMINATING IMPURITIES CONTAINED IN IRON AND STEEL, AND VACUUM OVEN HEATED BY GLOW DISCHARGE, MORE PARTICULARLY ANNEALING AND MELTING OVEN ADAPTED TO CARRY INTO EFFECT SAID METHOD

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It is common knowledge that the impurities contained in iron and steel have an adverse effect on the properties of the material. Impurities, such as sulfur, phosphorus, arsenic, silicon, oxygen, or oxygen compounds, such as oxydes, are difficult to eliminate. They are found in every industrial iron or steel in small percentages. It is the object of the present invention to eliminate such impurities from the solid article to a considerable extent and to improve the mechanical properties of the treated material.

The invention relates to a method of eliminating impurities contained in iron and steel articles and is distingulshed by the fact that the articles to be treated are kept in a gas discharge at a temperature of 500° C for a long duration, i. e. longer than it would be necessary for the elimination of gases. Advantageously, the article hereby is heated to a temperature in excess of 600° C, for instance to 1000 or 1100° C, at the highest limit up to the solidus point (fusibility point). As filling gas it can be used an inert gas, for instance a noble gas, or particularly a reducing gas, for instance hydrogen or hydrogen compounds. The subatmospheric pressure is between 5 to 0.001 mm Hg. The article can then be separated from the cathode or be connected as cathode. The method of the invention may be used for half-finished products or finished products.

If the article is connected as cathode and hydrogen is used as filling gas, the article when connected up as cathode is intensely loaded with the ionized hydrogen. This ionized atomic hydrogen entering the article is, at the prevailing temperature, easily capable of reducing oxydes and forming volatile hydrogen compounds with other impurities, such as sulfur, phosphorus, arsenic, etc. which volatilize at the prevailing subatmospheric pressure. In order to be able to keep the percentage of hydrogen small and yet to obtain an economical gas discharge heating under favorable current-voltage conditions, another gas, for instance, a noble gas, is admixed to the hydrogen. The liberated hydrogen compounds and sulfur and phosphorus vapors respectively are flushed out of the oven by the continuous supply of filling gas and current maintenance of vacuum.

For instance, it has been treated an article consisting of chrome-nickel steel and having the following dimensions: length 177 mm, outside diameter 145 mm and 22.5 mm thickness at a temperature of 1000° C in the presence of hydrogen gas at a pressure of 4 mm Hg, for 40 hours, after the elimination of gases had been stopped since 4 hours. By this treatment the tensile strength of the material of 100 kg/mm² was increased up to 145 kg/mm² at the same conditions.

This method has rendered it possible, at annealing times of up to 20 hours, to reduce by more than 50 per cent. the phosphorus and sulfur contents and also the oxygen content of the annealed material at a temperature of 900° C. At higher temperatures and by a longer annealing operation respectively it will be possible to reduce the impurities to a still higher degree. Purified alloy steels showed after the treatment an increase in strength of up to 40 per cent. at an almost constant elongation and in the case of ordinary carbon steel an increase in strength of up to 15 per cent. could be obtained, no account having been taken of the reduction in strength due to decarburization.

The invention further relates to a vacuum oven heated by glow discharge, more particularly annealing and melting oven, adapted to carry into effect the method referred to and which is distinguished by the fact that the wall thereof and the material to be annealed are connected up as electrodes of same sign, e. g., cathodes, and that one, two, or more insulated and screened, opposite electrodes, e. g., anodes, are lead in through the wall. Due to this mode of action and the interaction between the space charge fields, the advantage will be obtained that the oven may be operated on a lower voltage and higher current.

When operated by alternating current, the center tap or neutral point of the transformer is applied to the material to be annealed and the wall of the oven and free ends of the transformer are connected by a protective or stabilizing resistance to the electrodes led in through the wall the number of which electrodes corresponds to the number of phases. The stabilizing resistance however is suitably connected to the neutral wire leading to the transformer.

The device is diagrammatically and by way of example illustrated in the accompanying drawing which shows a section through a vacuum annealing and melting oven heated by gas discharge and operated by either direct current or two-phase alternating current.

The material 1 to be annealed rests on a metallic support 2 conductively connected to the wall of the oven. The oven is provided with a metallic lower part 3 and a detachable, vacuum-tight, set up, metallic upper part 4. The lower part is equipped with two jackets 5 and 6 and the upper part with two jackets 7 and 8. The gaps 22, 23 connected to the space of the oven and the gaps

20 and 21 situated between the wall of the oven and jackets and between the jackets respectively are chosen so narrow that no glow discharge in the gap is possible. The parts 24 and 25 are cooling jackets. Through the pipe socket 9 a filling gas may be supplied in regulated quantity for the maintenance of the desired subatmospheric pressure approximating 5 to 0.001 mm. mercury in the oven. The pipe socket 10 is connected to a vacuum pump. The parts 11 and 12 are two opposite electrodes, e. g., anodes, introduced into the chamber of the oven in an insulated and screened manner. The wires 14 and 15 lead to the cathode of a source of direct current or to the star-point 16 of a transformer 13 over a rheostat 26. The opposite electrodes 11 and 12 are connected to the positive pole of a source of direct current or to the free ends of a transformer. When operated by direct current, the glow fringe 17 forms around the article and the glow fringe 18 around the wall of the oven, whilst the positive column 19 is situated between both of them.

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