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METALLIC APPARATUS FOR CARRYING OUT CHEMICAL AND OTHER PROCESSES

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When carrying out chemical and other processes with gases, vapors, liquids and the like, which contain hydrogen, oxygen or sulfur, or several of these elements (for the purpose of the present invention these elements may be referred to as destroying elements) in a free or combined state, in metallic apparatus, as for example such as are made of steel or copper, and especially when pressures or high temperatures are employed, a loosening of the structure of the metal, tending to porosity and fracture of the material, occurs after a short period of exposure to such high temperatures or pressures. Consequently the affected parts of the apparatus very soon become unfit for use.

We have now found that these drawbacks may be overcome by constructing the apparatus of metals or alloys which are particularly free from impurities, such as oxygen, sulfur, carbon and the like. Such materials may be prepared either by direct metallurgical working, or by treating metals of an ordinary type at high temperatures with gases which react with the impurities in the metals or alloys to form volatile compounds, so that the said impurities are eliminated. Hydrogen, or mixtures of reducing and oxidizing gases such as gas mixtures containing hydrogen, water vapor, carbon monoxid or carbon dioxid, with or without an admixture of inert gases may be mentioned as examples of gases suitable for this purpose. When mixed gases are used, the relative proportions of the oxidizing and reducing gases should be adjusted so that no oxidation of the metal will result.

For example, iron prepared with the aid of manganese by the Martin smelting process, and which is freed from oxid as completely as possible, forms a very suitable material for the apparatus; or a tube or other article made of ordinary mild steel (ingot steel) may be practically freed from carbon and oxygen by prolonged treatment with hydrogen at a temperature exceeding 900° C.; by the said treatment it acquires the requisite purity for the purpose required and simultaneously undergoes an advantageous change in its structure.

Metals and alloys so prepared have not the drawbacks above referred to and the apparatus or parts of apparatus constructed of them have an exceedingly long working life.

For example, when aqueous solutions, such as those of sodium hydroxid, sodium nitrate, ammonium nitrate and the like are concentrated in vessels made of wrought iron or the like, extensive destruction of the vessels occurs after a comparatively short time, whereas when vessels constructed of iron which has to a large extent been freed from impurities, as for example in the manner described, are used, the apparatus may be kept in use for a long time without revealing any substantial corrosion of the material. Again, when working with nitrous gases (i. e. gases containing nitrogen oxides), for example in cast iron or wrought iron apparatus there is soon noticeable an extensive destruction in the shape of cracking or peeling of the material which, however, does not occur when the iron used for making the apparatus has been to a considerable extent freed from impurities. Still further in the heat treatment of coal, tars, mineral oils and other materials contaminated with impurities containing sulfur, and especially when such treatment is carried out with hydrogen under pressure, the metallic apparatus quickly suffers extensive injury, which does not occur when the apparatus is constructed of metals or alloys treated in the manner herein described.

We have also found that there is not always a need to treat the metal for such a length of time that all the impurities are eliminated. In many cases the treatment may be interrupted at an earlier stage, since it frequently happens that the impurities become harmless after a less protracted treatment.

In order to determine whether the metals or alloys are suitable for the particular purpose required, a sample of the material to be used may be treated at high temperatures, and under pressure if necessary, with gases, vapors or liquids which contain free or combined oxygen or sulfur and which are hereinafter referred to as corroding agents and preferably in the presence of hydrogen. The microscopic examination of the treated sample will reveal whether the material is

suitable, because if it is not, the sample will exhibit the effects of corrosion in the boundaries of the grains. It is often advisable, prior to making such microscopic examination, to subject the treated sample to a superficial oxidation, such as is usual in the case of iron by annealing till blue, since under these conditions the interstitial substance between the grains is more clearly visible. The temperatures to be employed for this purpose will depend on the nature of the metals or alloys under examination. When ascertaining the suitability of iron, steel and the like, higher temperatures will naturally be used than when examining such metals as aluminium or magnesium. The temperatures to be employed in these tests are substantially higher generally speaking than the working temperatures of the apparatus made of the metals or alloys under examination. When the working is to be carried out under pressure in the apparatus, it is also advisable to carry out the tests under pressure. Commercial iron, construction steel for example, becomes corroded by the formation of inclusions at the boundaries of the grains when the working operations are carried on with gases containing hydrogen, in the presence of oxygen or sulfur, free or combined, at raised temperature and under pressure, the iron thereby losing its mechanical strength, which result will in practice become apparent only after it has been in use for some months. If, however, a sample of such iron be treated with a weakly oxidizing mixture of hydrogen and water vapor for 144 hours under a pressure of about 150 atmospheres and at a temperature of 550° to 600° C., the microscopic examination will disclose corrosion round the grains of the metal, thereby quickly shewing that the iron under examination is unsuitable for the purpose required. When a sample of commercial iron is treated with a gas at a high temperature, for example in the manner above described, the microscopic examination will not reveal any such corrosion, and the metal will prove very suitable for the required purpose.

It may also be advantageous not only to construct the apparatus of the said metals or alloys which have been largely freed from impurities or in which the impurities have been rendered innocuous, but to apply to it further a coating of resistant material, this coating being applied at least to the parts which are most exposed to attack. Chromium, tungsten, uranium, manganese, aluminium, silver, copper, enamel, and the like may be mentioned as highly resistant materials suitable for such coating. Apparatus of this kind display unusually high resistance and may be kept in use for a long time without shewing any corrosion.

What we claim is:

1. Metallic apparatus for carrying out processes in the presence of destroying elements which comprise iron which has been treated at high temperatures and under conditions precluding oxidation, with a gas capable of forming gaseous compounds with the impurities originally contained in the said metal, the said iron on being treated with corroding agents and then subjected to microscopic examination no longer showing the effects of corrosion in the boundaries of the microscopic grains.

2. Metallic apparatus for carrying out processes in the presence of destroying elements which comprise iron which has been treated at high temperatures and under conditions precluding oxidation, with a gas capable of forming gaseous compounds with the impurities originally contained in the said metal, in such a manner that the impurities are present after the treatment in an innocuous form, the said iron on being treated with corroding agents and then subjected to microscopic examination no longer showing the effects of corrosion in the boundaries of the microscopic grains.

3. Metallic apparatus for carrying out processes in the presence of destroying elements which comprise iron which has been treated at high temperatures with hydrogen, the said iron on being treated with corroding agents and then subjected to microscopic examination no longer showing the effects of corrosion in the boundaries of the microscopic grains.

In testimony whereof we have hereunto set our hands.

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