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METHOD OF FLAW DETECTION

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1

This invention relates to a method for detecting flaws in metallic bodies, more particularly to a method for detecting and determining the location of fissures or defects in metallic bodies and to a method of processing metallic bodies in preparation for such detection.

An object of this invention is to devise a rapid method for the detection of defects in metallic objects.

A further object is to provide a method which is capable of distinguishing between surface defects or scratches and deeper defects or fissures.

A still further object of the invention is to devise a method of flaw detection by means of which standardized or consistent results may be obtained.

Another object is to provide a method of flaw detection which is relatively simple and inexpensive.

Another object is to provide a novel method of processing metallic bodies for flaw detection.

The foregoing and other objects of the invention will be best understood from the following description of an exemplification thereof.

In the production of high-vacuum thermionic tubes, particularly tubes of large power, lead-in wires, usually of tungsten and of relatively large diameter, are sealed through the wall of the glass envelope into the interior thereof. Small but deep fissures existing in these wires are not ordinarily sealed off from the atmosphere by the glass-to-metal seal, and leakage occurs through these fissures into the interior of the tube envelope, thus destroying the vacuum therein. It is therefore important to be able to detect the presence and location of these deeper fissures or cracks in wire to be used for lead-ins.

In order to utilize the process or method of this invention, the metallic objects must be clean, that is, free from grease, oil, and dirt. The objects should be degreased and subsequently cleaned by some chemical method, for example by dipping in a bath of molten sodium nitrite.

The first step in processing the bodies for flaw detection is the preparation of a mixture of a finely divided silica powder and fluorescein, in the proportions of approximately one ounce of fluorescein to one pound of silica powder. The silica powder consists mainly of silicon dioxide (SiO_2) and has a particle size within the colloidal range. It is a product which is commercially available, and is a relatively inert finely divided or colloidal powder, being insoluble in water or oil and non-corrosive to metals but capable of being wetted by oil. The fluorescein is a technical grade water and oil-soluble fluorescent powder, which has very strong fluorescent properties. The silica powder and the fluorescein are mixed thoroughly to provide a fine powdery mixture.

2

The clean objects to be inspected or examined for flaws are first placed in the container of mixture, where they are shaken and rolled in the mixture for approximately two minutes. This causes the powder to deposit in or sift into the superficial cracks of the bodies, without adhering to the smooth surfaces thereof to any appreciable extent. Next, the objects are placed in a wire mesh cylinder which is transferred to the container containing the mixture. The cylinder containing the objects or bodies is rotated in the powdery mixture for a few minutes, during which time the mixture deposits in or sifts into any deep fissures present in the objects. During these first two steps, therefore, the mixture is worked into the cracks or fissures in the bodies.

The objects are then removed from the mixture and are immersed in an oil bath for approximately ten seconds. This oil bath may consist of kerosene, corn oil, or light mineral oil, although the latter is preferred. The silica powder present in the fissures of the bodies acts like a blotter for the oil, since it is capable of being wetted by oil but is not soluble in oil. It therefore acts to effectively hold or retain the oil in the fissures. The fluorescent powder, being partially soluble in oil, dissolves therein and is retained in the fissures also. About three minutes is allowed for the excess oil to drain off the objects.

The next step is to wash the excess oil and powder off the bodies. The bodies are washed with a stream of warm water, after which a minimum amount of soap (enough to clean the surfaces of the bodies) is added, and the bodies are shaken back and forth a few times in the suds, following which the bodies are rinsed thoroughly with a stream of clean water and are placed on absorbent paper to dry. The length of time of this washing and the amount of agitation therewith are sufficient to remove the powder (and oil) from the smooth surfaces and superficial cracks of the bodies, but are not sufficient to remove the powder (and oil) from the deep fissures because the silica "blotter" is insoluble in water and there is insufficient scouring or agitation to remove it mechanically.

Following this, the articles are placed in an oven at a temperature of approximately 200° F. and left there until they are dry, which will require from 15 to 20 minutes.

The foregoing steps constitute what may be termed the processing for flaw detection, while the next and final step is the flaw detection (or fluorescent inspection) itself. It will be remembered that the articles being inspected are free of oil and fluorescent powder (and also, of course, silica powder) everywhere except in deep fissures or cracks. Since the oil has been "blotted" by the silica powder, capillary action tends to cause

seepage slowly out of the deep fissures where it is present toward the top surface of the silica powder near the top outlets of such deep fissures. Since the fluorescent powder has been dissolved in the oil, it will be carried thereby toward the surface, also. The fluorescent examination of the articles or bodies is carried out under radiations in the near ultra-violet range, which may be termed fluorescigenous radiations, the wave length of the radiations used being approximately 3600 Angstrom units. Under these fluorescigenous radiations, the fluorescent powder appears a bright yellow-green, against the purple background of the metal. Since the oil tends to seep out toward the surface outlets of the deep fissures, carrying with it the fluorescent material, the presence, location, and relative size of such fissures, or at least of the surface outlets thereof, are made apparent, and the bodies may be either rejected or accepted according to the standards set up. It will be appreciated that, because the silica powder (and therefore, also, the oil and fluorescent powder) has been washed out of the superficial or surface scratches or defects, no indications will be given, under the fluorescigenous radiations, of these defects, so that only the deeper fissures will be indicated. Therefore, the deep fissures will be distinguished from superficial cracks, and standardized or consistent results may be obtained. The steps of the above process require a total time of 40 to 45 minutes, so it will be seen that the inspection method of this invention is relatively rapid.

The method of this invention may be used to check the porosity of sintered parts produced by powder metallurgy, to check the vacuum-tight seals in metal tubes, to check glass-to-metal seals, to inspect the continuity of welds, and for many other purposes.

Of course, it is to be understood that this invention is not limited to the particular details as described above, as many equivalents will suggest themselves to those skilled in the art. For example, other oils than those mentioned might be used for the oil bath, and other washing procedures could be used. Other fluorescent dyes such as eosin can be used in place of the fluorescein in compounding the powder mixture. Various other variations will suggest themselves. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of this invention within the art.

What is claimed is:

1. A method of processing a metallic body for the detection of flaws therein, comprising working a mixture of finely-divided powder of a material insoluble in a liquid and a powder of a fluorescent material soluble in said liquid into the flaws of said body, immersing the body in said liquid, and removing the excess liquid and powder from the surface of the body.
2. A method of processing a metallic body for the detection of flaws therein, comprising working a mixture of a finely-divided silica powder soluble in a liquid and a fluorescent powder into the flaws of said body, immersing the body in said liquid, and removing the excess liquid and powder from the surface of the body.
3. A method of processing a metallic body for the detection of deep fissures therein, comprising working a mixture of a finely-divided powder of a

material insoluble in a liquid and a powder of a fluorescent material soluble in said liquid into both the surface and the deep fissures of said body, immersing the body in said liquid, and removing the excess liquid and powder from the surface of the body and from the surface fissures while leaving said liquid and powder in the deep fissures.

4. A method of processing a metallic body for the detection of deep fissures therein, comprising working a mixture of a finely-divided silica powder and fluorescein powder into both the surface and the deep fissures of said body, immersing the body in a liquid, and washing the excess liquid and powder from the surface of the body and from the surface fissures while leaving said liquid and powder in the deep fissures.

5. A method of detecting flaws in a metallic body, comprising working a mixture of a finely-divided powder of a material insoluble in a liquid and a powder of a fluorescent material soluble in said liquid into the flaws of said body, immersing the body in said liquid, washing the excess liquid and powder from the surface of the body, drying the body, and subsequently examining the body under fluorescigenous radiations.

6. A method of detecting flaws in a metallic body, comprising working a mixture of a finely-divided silica powder and a fluorescent powder soluble in an oil into the flaws of said body, immersing the body in said oil, washing the excess oil and powder from the surface of the body, drying the body, and subsequently subjecting the body to fluorescigenous radiations.

7. A method of detecting deep fissures in a metallic body, comprising working a mixture of a finely-divided powder of a material insoluble in a liquid and a powder of a fluorescent material soluble in said liquid into both the surface and the deep fissures of said body, immersing the body in said liquid, washing the excess liquid and powder from the surface of the body and from the surface fissures while leaving said liquid and powder in the deep fissures, drying the body, and subsequently examining the body under fluorescigenous radiations.

8. A method of detecting deep fissures in a metallic body, comprising working a mixture of a finely-divided silica powder and a fluorescent powder soluble in an oil into both the surface and the deep fissures of said body, immersing the body in said oil, washing the excess oil and powder from the surface of the body and from the surface fissures while leaving said oil and powder in the deep fissures, drying the body, and subsequently examining the body under fluorescigenous radiations.

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