

United States Patent

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3,386,920 6/1968 Alburger 250/71X

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[54] **REVERSE PENETRANT METHOD AND MEANS**
4 Claims, No Drawings

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[56] **References Cited**
UNITED STATES PATENTS

2,340,940 2/1944 De Forest 250/71UX

ABSTRACT: In a liquid dye penetrant system, conventional daylight visible bleeding dye penetrant is initially applied to a test surface, and cleaned therefrom leaving residual dye penetrant within cracks and defects. A fluorescing developer coating is applied to the test surface and viewed under ultraviolet light, the solid fluorescing background revealing a nonfluorescing pattern of defects which appears as a black trace wherever residual dye penetrant contacts the developer coating.

REVERSE PENETRANT METHOD AND MEANS

BACKGROUND OF THE INVENTION

The invention is in the field of liquid dye penetrant non-destructive testing, particularly for the purpose of locating or identifying minute surface discontinuities from various causes such as stress cracks, quenching cracks, porosity, scratches, tool marks, submicroscopic fissures, and the like.

It is well known in the prior art that daylight visible dye, when added to a solvent and applied to a test surface, can be cleaned therefrom leaving residual dye or dye penetrant in the minute cracks or voids thereof. Such residual dye is made more clearly visible by applying a white developer coating to the same test surface, either in powdered or liquid form, providing background contrast with the dye.

One general type of developer used in the foregoing process is disclosed in Example I of U.S. Pat. No. 3,279,243 issued Oct. 18, 1966 to this same patentee, comprising a vinyl chloride-vinyl acetate copolymer resin in combination with suitable solvents and a plasticizer. The penetrant and developer material taught by the mentioned U.S. Pat. No. 3,279,243 may be adapted by certain modifications discussed herein to perform the inventive process in this case, although such process may also be practiced with other types of developers in addition to those used illustratively to explain the process.

In addition to the foregoing, it is also well known in the prior art to use fluorescent material in a liquid dye penetrant and to follow essentially the same steps described above whereby surface defects are discovered by fluorescing of residual dye penetrant under ultraviolet or so-called black light, either with or without a developer coating. Fluorescent dye penetrants are most frequently used when the test surface defects are extremely small and close together, such as embrittlement cracks, quenching cracks, etc., requiring extremely high sensitivity and definition of the penetrant. However, the daylight visible dye penetrants are typically much less expensive than fluorescent penetrants although considerably less sensitive and therefore poorly suited in applications requiring extremely high definition or resolution.

SUMMARY OF THE INVENTION

This invention comprises a method and means for enabling a relatively inexpensive daylight visible nonfluorescent dye penetrant to achieve defect revealing capabilities equal or superior to those formerly achieved only be costly fluorescent penetrants. The novel method is practiced by application of dye penetrant to the test surface in a conventional manner, followed by superficial cleaning of such surface to leave residual dye in the surface defects. Thereafter, a premixed developer coating including fluorescent material is lightly applied to the test surface to render the same fluorescent under ultraviolet illumination. The resulting test pattern comprises dark dye traces wherever residual dye penetrant is entrapped in surface defects which stand out in sharp contrast with the brilliance of the fluorescing background coating. The clarity and definition of such trace is equal to that of the most sensitive fluorescent dye penetrants known to the prior art, but is achieved at considerably lower cost.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The inventive concept disclosed herein is based upon the fact that certain daylight visible color values identified with the chromatic spectrum, particularly but not exclusively in a range from about 300 to about 500 millimicrons wave length, and from about 600 to 700 millimicrons wave length, absorb ultraviolet light radiation and do not emit any visible light or color when exposed thereto in otherwise complete darkness. In contrast, fluorescent materials such as used in commercially available liquid fluorescent dye penetrants, emit light in a wave length which is brilliantly visible under ultraviolet illumination when properly activated. The foregoing two

phenomena result in a third fact, the significance of which has not been heretofore recognized or availed of in the use of dye penetrants for nondestructive testing; namely, that a trace of daylight visible dye, when mixed into a quantity of fluorescing dye penetrant, can destroy the ability of such penetrant to fluoresce under ultraviolet light. This killing effect is particularly great in the red and orange color range, but is found also in black, violet and blue range wave lengths. It has been found by actual test that as little as five parts of red dye penetrant, including various commercially available types widely used in industry, when added to 95 parts of fluorescent dye penetrant by volume, renders the latter useless as a means for detecting cracks of any size in test specimens using methods known to the prior art.

The inventive process disclosed herein begins with application of liquid dye penetrant containing nonfluorescing daylight visible dye to the surface of the specimen. The novel process does not depend upon the selection of any particular dye or solvent, but may be practiced with any oily or nonoily organic solvents known to the prior art, including oil soluble and spirit soluble solvents, whether fast or slow drying. Suitable dyes would include Oil Red "O" and Sudan Red, also Oil Black and Blue dyes, all of which are sold by the General Aniline and Film Corporation, as well as Mefford No. 322 dye and many others. Orange dye such as Oil Scarlet 6G sold by Allied Chemical Corporation has been used with consummate success.

Following the foregoing step, excess penetrant is removed from the test surface by any suitable means, either with or without an emulsifier or solvent for the dye, and even water in the case of water-washable penetrants. Preferably, the test surface is not cleaned so completely as to remove residual dye penetrant or dye entrapped within surface cracks or defects. Although not essential, the test surface after the mentioned cleaning step should preferably be dried, either using heat or air blasting where convenient to accelerate the same.

After the foregoing steps, the test surface is coated with a developer containing fluorescing material. The developer may take a variety of different forms insofar as type and basic composition, including those taught or discussed in mentioned U.S. Pat. No. 3,279,243, and many other developers known to the prior art if adapted for the purpose as described more fully below. Thus, regardless of basic differences in the composition of the developer coating, it is essential to the concept disclosed herein that the developer contain a quantity of fluorescing material such as Fluoral 7GA sold by General Aniline and Film Corporation, or the like, with or without a brightening agent included therein. The inventive method has been practiced with particular success using a developer corresponding with that disclosed in Example I of mentioned U.S. Pat. No. 3,279,243 and broadly characterized as a vinyl base paint. The mentioned paint may illustratively comprise 15 parts by volume of the developer, to which is added one-half part by volume of a commercial brightening agent sold under the name Calcofluor White RW, sold by Switzer Brothers, Inc., one-fourth part by volume of Fluoral 7GA dye, and sufficient trichloroethane thinner to reduce the paint to spraying consistency. The resulting developer material is preferably applied to the test surface by lightly spraying the same with an airbrush. Inspection is accomplished under ultraviolet light wherein migration of residual dye or dye penetrant through the vinyl fluorescent coating kills the fluorescence thereof wherever cracks or surface defects are located. The indications of such cracks will appear as completely black, even when orange or red dye is used in the penetrant, since the dye will not emit visible light traces under black light. The degree of resolution and definition using the foregoing materials is of excellent quality, equal or surpassing that normally associated with exotic and costly fluorescent dye penetrants.

In addition to the mentioned vinyl paint-type developer, the inventive process may be practiced using slurry-type developers having a powder in suspension, provided that a small quantity of fluorescent material is combined therewith

before application of the developer to the test surface. Thus, the daylightvisible red and blue dye penetrants and penetrant materials taught in U.S. Pat. No. 2,806,959 as well as the developers taught therein, are amendable for use in the novel process disclosed herein, provided the developer includes a small quantity of Fluoral 7GA or other fluorescent agent sufficient to render a fluorescent background to the test surface when the coated surface is viewed under black light. Also, commercial fluorescing paints such as Hi-Viz or Day-Glo paint sold by Switzer Brothers, Inc. of Cleveland, Ohio, are amenable for use as developers in practicing the concept disclosed herein.

I claim:

1. A method of inspection for surface discontinuities, in a specimen, consisting of the steps of:

applying to said specimen surface a liquid dye penetrant containing a daylight visible dye having substantially no light emission under ultraviolet illumination;

cleaning said surface to remove excess penetrant therefrom while some of said dye remains in said surface discontinuities, and thereafter;

applying to said surface a developer coating containing a fluorescent material in sufficient amount for said coating to fluoresce uniformly over said surface in contrast with said residual dye in said flow area.

2. The method set forth in claim 1 above wherein said dye has a hue within the chromatic spectrum on the low wave length range from about 400 to about 500 millimicrons, or on the high wave length range from about 600 to 695 millimicrons.

3. The method set forth in claim 1 above, wherein said liquid dye penetrant further comprises an exuding solvent.

4. The method set forth in claim 1 above, wherein said developer further comprises a resin base paint containing a copolymer of vinyl.

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