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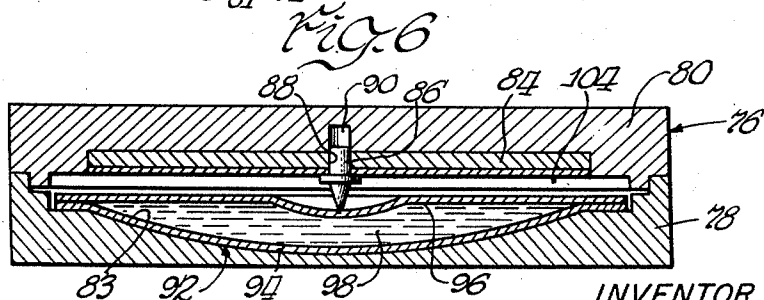
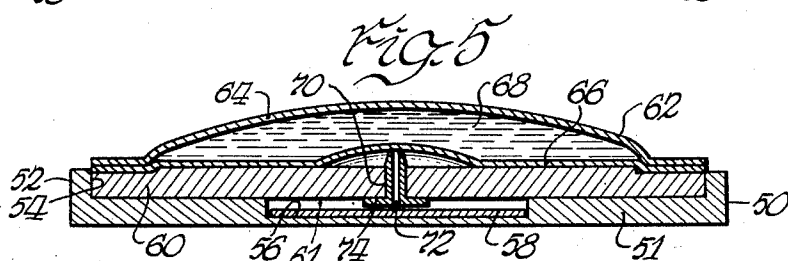
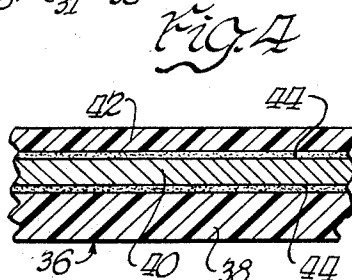
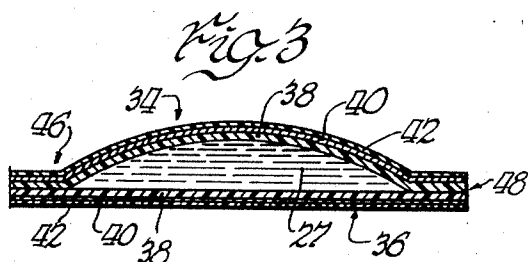
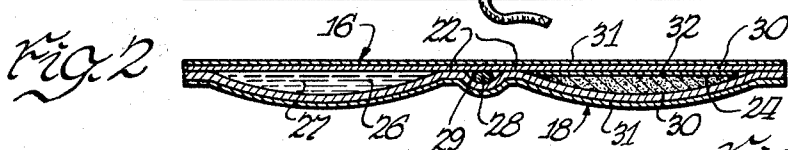
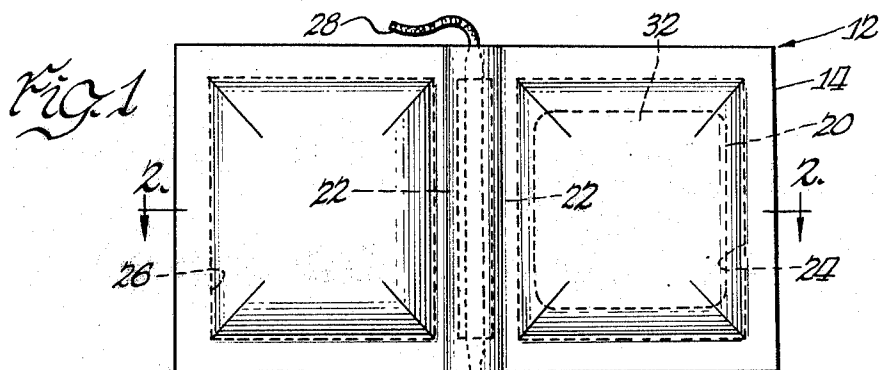
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RADIOACTIVITY INDICATING DEVICE AND METHOD

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2 Sheets-Sheet 1



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2,917,631

RADIOACTIVITY INDICATING DEVICE AND METHOD

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This invention relates to radioactivity dosimeters. It also has to do with a one-step photographic developing process and to a photometric calibrating scale and visual safety indicator for film, all of which are usable with the dosimeter.

An object of the invention is to provide a radioactivity dosimeter of novel construction adapted for use in measuring the extent of exposure to radioactivity.

Another object is to provide a self-contained radioactivity dosimeter including an envelope containing a photographic film and a developing medium, and constructed for convenient carrying, as in a pocket or attached to the clothes as a badge, and in the use of which development of the film may be accomplished without the use of any agencies external to the dosimeter.

Another object is to provide a radioactivity dosimeter including an envelope having a plurality of compartments with a photosensitive film in one compartment and a developing material in another compartment, in which the envelope is provided with novel means for normally separating the compartments and sealing them from each other, which is rupturable or otherwise conditionable by manual manipulation for providing communication between the compartments for enabling application of the developing material to the film.

Still another object is to provide a radioactivity dosimeter of the foregoing character in which, in the respective embodiments of the invention, the separating means is conditionable for providing communication between the compartments by rupture or fracture, removal, or movement in the envelope and consequent relative movement of the film and developing material into interengagement.

A further object is to provide a novel one-step photographic developing process.

Another object is to provide a one-step photographic developing process which includes applying a portion of a developing medium to the film to be developed prior to exposure, and the remainder, which constitutes an essential portion, at such time that a completed photograph is desired or that it is desired to test for the presence of radiation capable of affecting the film.

A further object is to provide a photographic developing process in which the developing phase and fixing phase are performed simultaneously and in which the developing phase is completed rapidly and before completion of the fixing phase so that the image will not be deleteriously affected in the fixing phase.

A still further object is to provide a one-step photographic developing process in which a first portion of a developing medium, constituting a developing agent, is included in the image-forming emulsion on the film to be treated, and which is normally inert to chemical reaction with the image-forming emulsion, and a second and essential portion including a reactor and fixing agent is applied to the film only after exposure of the film, wherein a reserve of the developing agent is diffused in the emulsion and the entire fixing agent is contained in the sec-

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ond portion of the developing medium, whereby the necessity for diffusion of the developing agent into the emulsion during developing is eliminated and the developing phase therefore is completed more rapidly than the fixing phase.

Still another object is to provide a radioactivity dosimeter of novel construction especially adapted for utilizing the one-step developing process of the present invention.

A still further object is to provide a radioactivity dosimeter having an envelope, a film and a developing medium in the envelope, in which a portion of the developing medium is contained in the image-forming emulsion applied to the film and is normally inert to chemical reaction with the image-forming emulsion, and another and essential portion of the developing medium is normally separated from the film and effective for producing development and fixation of the film when applied thereto.

A further object is to provide a dosimeter including an envelope having a compartment containing a developing material in fluid form, and novel means including a substance chemically reactable with said developing material for visually indicating leakage of the latter from the envelope.

Another object is to provide a radioactivity dosimeter containing a photosensitive film, and means for detecting and indicating pseudo-exposure, or false exposure, of the film.

Still another object is to provide a photographic film having visual safety indicating means for use in a device such as a radioactivity dosimeter including an envelope impervious to light rays but pervious to so-called nuclear radiation, wherein the film includes a portion sensitive to light and nuclear radiation and a second portion insensitive to normal doses of nuclear radiation but sensitive to normal light exposures, where the second portion serves as an indicator of unintentional or accidental spoiling of the film as by light, heat or chemicals.

A still further object is to provide a novel photometric calibrating scale.

Another object is to provide a photometric calibrating scale on a photosensitive film adapted for use in a device such as a radioactivity dosimeter, in which the film has a detecting area sensitive to nuclear radiation, and a grey scale insensitive to light and nuclear radiation provided with a plurality of areas of various optical densities serving as calibrating means for comparing the detecting area for determining the quantity of nuclear radiation to which the film has been subjected.

Other objects and advantages of the invention will be apparent upon reference to the following detail description taken in conjunction with the accompanying drawings in which:

Figure 1 illustrates one form of radioactivity dosimeter constructed in accordance with the principles of the present invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view of a dosimeter wall construction including a leakage indicator suitable for use in the dosimeter of Fig. 1;

Fig. 4 is a greatly enlarged cross-sectional view of a portion of a wall element shown in Fig. 2;

Fig. 5 is a cross-sectional view of a modified form of dosimeter construction;

Fig. 6 is a cross-sectional view of a further modified form of dosimeter construction;

Fig. 7 shows the dosimeter of Fig. 6 with sponge means in the capsule containing the liquid developing material;

Fig. 8 is a cross-sectional view of a still further modified form of dosimeter construction;

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Fig. 9 is a cross-sectional view of another modified form of dosimeter construction;

Fig. 10 shows a photosensitive film including a calibrating scale and safety indicator made according to the principles of the invention, showing the film before exposure;

Fig. 11 illustrates the film of Fig. 10 but after exposure in a regular manner for the purpose intended; and

Fig. 12 illustrates the film of Figs. 10 and 11 but after having been rendered defective, as by improper exposure, or from other causes.

The dosimeter of the present invention is adapted for use in detecting exposure to radioactivity, or so-called nuclear radiation, and for measuring and indicating the cumulative extent of such exposure. The dosimeter is especially useful indicating the dosage to which an individual has been exposed, therefore, it is so constructed that it is adapted for convenient carrying on the person as in the pocket or as a badge attached to the clothes. In order that the dosimeter may be utilized to best advantage, it is made in the form of a relatively small package that can be easily carried and manipulated with facility in developing the photosensitive film contained in it for registering the effects of the radiation tested for. The package includes an envelope or enclosing wall member through which nuclear radiation is capable of penetrating but which seals the interior against light.

The dosimeter includes a photographic film which, of course, is sensitive to both nuclear radiation and light. The dosimeter includes a package and contains a developing medium normally, at least partially, separated from the film but which package is constructed for enabling application of the developing medium to the film by manually manipulating the package whereby the user can make a test on the scene and rapidly determine whether or not nuclear radiation does exist.

A dosimeter made in accordance with the principles of the present invention preferably takes the form of that shown in Figs. 1 and 2. The dosimeter 12 includes an envelope or enclosing wall member 14 made of a pair of superposed and registered, flexible wall members 16 and 18 preferably in the form of sheets, and of any suitable outline shape, sealed together around their marginal edge portions as at 20. The wall members are also sealed at central portions 22 forming interior compartments 24 and 26, which are sealed from each other as well as to the exterior, against the entrance of light and all foreign materials. The compartment 26 contains a quantity of liquid 27 forming at least a portion of a developing medium. As will be brought out more fully hereinafter, the dosimeter is adapted for utilizing the one-step development process of the present invention. In that process, a portion of the developing medium is incorporated in the emulsion on the film, and another portion constituting a reactor is applied to the film when it is desired to develop the film. The liquid 27 may be such a reactor, and hence is referred to as a developing material. It is pointed out, however, that insofar as the construction of the dosimeter is concerned, it can be utilized with conventional developers, and in that event the liquid 27 would constitute the complete developing medium. In any event, the dosimeter is so constructed and utilized that when the liquid developing material 27 is applied to the film, development (and fixation) of the film is effected.

In the space 29 between the central sealed portions 22 is a thread or wick 28 interposed between the wall members and extending transversely of the dosimeter with its end portions projecting laterally from the side edges of the dosimeter for forming pull tabs for separating or ripping the wall members apart, as will be explained more fully hereinafter. The marginal edge portions 20 of the wall members are sealed over the thread 28, but the thread, which is preferably of an absorbent character, interrupts the marginal seal of the edge portions enabling any liquid 27 or vapors of said liquid 27 that, by reason

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of accidental impairment of the seal provided by the envelope, may find its way into the space 29, to pass out through the interstices of the thread and not into the compartment 24 by reason of an accidental impairment of the seal provided by the envelope. However, the sealed portions 22 are continuous between the opposite side portions of the sealed perimeter 20 so that the compartments 24 and 26 are normally sealed from each other and are sealed from the exterior, normally preventing escape of the liquid from the compartment 26 until the dosimeter is manipulated to force the liquid into the compartment 24, or until the dosimeter is opened. In the use of the dosimeter the central sealed portions 22 are adapted to be ruptured, as by the pressure applied by the hand to the dosimeter at the compartment 26, for establishing communication between the compartments for enabling passage of the liquid from the compartment 26 to the compartment 24.

The wall members 16 and 18, as hereinabove mentioned, are impervious to light but are pervious to nuclear radiation. The wall members 16 and 18, in accordance with their above stated characteristics in admitting nuclear radiation without admitting light, may be of any of a number of different materials. One suitable construction includes wall members having at least one layer of a suitable and known type of plastic material, which may be impervious to light but is pervious to nuclear radiation and at the same time is adapted to sealing of the layers together by the application of heat and pressure. The plastic is also impervious to the liquid 27. The plastic is furthermore flexible for enabling rupture of the central sealed portions 22 upon the application of force to the dosimeter in the area of the compartment 26 for forcing the liquid from compartment 26 into the compartment 24. A number of plastics suitable for the purpose are known.

The wall members 16 and 18 contain such layers of plastic 30, each provided with an outer coating of metal foil 31 which may be aluminum foil secured to the plastic layers by any suitable adhesive means or thermal process. The wall members 16 and 18 are placed together with the layers of plastic 30 disposed toward each other and sealed in the areas mentioned, the film 32 being placed in position and the liquid injected at suitable times in the assembling operation. The sealing operation is such as to enable manual separation of the wall members.

The metal foil layers 31 serve as effective shielding means to prevent the entrance of light to the interior of the dosimeter in its unopened condition, whereby, when the dosimeter is utilized for detecting the presence of nuclear radiation, assurance is afforded that light will not enter the interior of the dosimeter, and any image that may be present on the film after development is caused by nuclear radiation of such character capable of penetrating through the walls of the dosimeter.

Mounted in the compartment 24 is a photosensitive film 32 which, insofar as the construction of the dosimeter is concerned, may be a conventional photographic film. However, I prefer to utilize a film made according to the one-step developing process of the invention, to be described hereinafter. It is also within the teachings of the present invention that the portion of the layer 30 in the compartment 24 itself constitutes the film, as by having an image-forming emulsion deposited directly thereon, thereby eliminating the necessity of a separate film such as the film 32. The term "film" as used herein designates a layer of supporting material having a layer of image-forming emulsion deposited thereon. The supporting layer is sometimes known technically as the "film support" while the layer of emulsion is sometimes known as the "film." The film, when formed as a separate film 32, is supported on one of the wall members 16, 18 within the compartment 24, and as herein shown is supported on the wall member 16, by a suitable adhesive means such as will enable the film to be easily removed

from the wall member when the dosimeter is opened and it is desired to remove the film from the dosimeter for storing purposes. The film 32 may assume any desired outline shape, whether polygonal in conformity with the outline shape of the compartment 24, or circular as is the film shown in Figs. 10 to 12, the latter being adapted for use in the dosimeter as will be explained hereinafter.

The film 32 includes an emulsion which includes a rigid gelatin containing a silver halide sensitive to light and to nuclear radiation. After exposure, or after having made a test to determine the presence of radiation of the type to which the film is intended to indicate, a developing medium is applied to the film for developing the film. As mentioned above, development is effected by forcing the developing material 27 into the compartment 24 which is thereby applied to the film.

When it is desired to test for the presence of radiation of the character for which the dosimeter is intended to indicate, as when the user carries it in an area where it is feared that nuclear radiation exists, the user applies pressure as by the hand to the dosimeter in the area of the compartment 26, which contains a substantial quantity of the liquid developing material. The pressure causes the central sealed areas 22 to be ruptured and the wall members to be spread apart, whereby the liquid developing means 27 flows from the compartment 26 to the compartment 24 and thus is applied to the film 32. After an appropriate period of time, the user rips the wall members apart, which operation may be facilitated by means of the thread 28 the end of which the user may grasp, and by holding one of the wall members, pulling the string in the appropriate direction will rip the other wall member therefrom. The film, after opening the dosimeter, is of course exposed to view and the user can detect whether the film has been exposed to nuclear radiation by observing whether an image is formed on the film. Such image may of course be without outline configuration, but its color density may be compared with the calibrating scale of the character illustrated in Figs. 10 and 12 and described hereinafter, and hence the quantity of radiation to which the film is subjected may be determined. The film may be removed from the wall member 16 and stored after application thereto of appropriate inscriptions, or otherwise identified or classified as to the circumstances surrounding the test.

The provision of a pair of spaced central sealed areas 22 assures against accidental passage of the liquid developing means from the compartment 26 into the compartment 24, as by an unintentional fracture or rupture of the central sealed areas. If, for example, the area 22, defining one edge of the compartment 26 should become accidentally ruptured or fractured, the liquid 27 would pass into the space 29 and not pass into the compartment 24 as long as the opposite area 22 remains in full sealing effect. The thread 28, which is of absorbent character, acts as a vent to the exterior of the dosimeter and prevents moisture from passing into the compartment 24. Such moisture in the space 29 may occur because of either rupture of the area 22 or slow seepage there-through.

The thread 28 may also serve as a visual leak indicator when the liquid developing means 27 is an alkali or an acid. The thread may be saturated with a suitable and well known pH indicator, and its change in color will indicate whether any of the liquid has leaked from the compartment 26, the liquid passing through the interstices of the thread to the external pull tab portions thereof by capillary action.

The term "nuclear radiation" as used herein includes all radiation in the "short wave length" end of the electro-magnetic spectrum beyond the ultraviolet band and including high energy particles ejected from the nucleus

of the atom of which alpha rays and beta rays are examples.

The term "radiation" as used herein includes visible light, and nuclear radiation as defined above.

The principles of the present invention may be incorporated in a photographic device, similar in construction to the dosimeter described above, for use in connection with dental X-ray work. Such device may be provided with wall members of appropriate imperviousness to radiation of the wave lengths utilized.

The construction of the dosimeter illustrated in Figures 1 and 2 may contain, in addition to its structural features hereinabove described, the leakage indicating means of Figs. 3 and 4. The dosimeter wall members 34 and 36 of Figs. 3 and 4 are each made up of an inner layer 38 of plastic, and a layer 40 of metal foil on the outer surface of the layer of plastic. An outer coating or film of material 42, such as a suitable and known plastic of transparent character, is secured to the outer surface of the foil layer 40. The dimensions in thickness of the wall elements of Figs. 3 and 4 are exaggerated for the purpose of more clearly illustrating the construction of the wall members. The various layers are bonded together by means of suitable adhesive material shown in layers 44 in the form of films. Such adhesive material may be of a number of available and known types. The wall members 34 and 36 are secured together by heat sealing the plastic layers 38 where they abut around the marginal portions and otherwise as described in connection with Fig. 1.

It may occur that leaks develop in portions of the dosimeter and particularly at such points as 46 where the wall member changes in direction rather abruptly, and at 48 in the sealed portion between the wall members. The leaks usually are of pinhole size and therefore difficult to detect. In addition, they often do not develop until an appreciable time after the dosimeter is fabricated and are not detected in the usual tests made for that purpose immediately after manufacture. However, even though these leaks may be of minute size, depletion of the contents does occur, although slowly.

An effective means for readily detecting the presence of such a leak and the location thereof consists of a pH indicator applied as a coating to the exterior surface of the dosimeter at potential leak areas, when the liquid utilized as a developing material is an alkali or an acid. A suitable pH indicator of known type may be used and preferably is applied by dissolving it in the adhesive material 44 used to bond the transparent acetate layer 42 to the outer surface of the foil layer 40. Thus if a leak should occur, as at a point 46 for example, the liquid developing material would change the color of the pH indicator according to whether it is alkali or acid. The layer of adhesive 44 under the outer coating 42, if it should change color, would accordingly be visible through the transparent film or layer 42. It will be understood of course that the leak indicator material may be applied throughout the area of the surface of the dosimeter, or only in selected areas where it is more likely that leaks will occur, as desired.

An alternative method of applying a leak indicator to the dosimeter is to dissolve it in a lacquer and apply the solution to the potential leak areas such as points 46 or 48, or other areas.

The dosimeter hereinabove described may include the leak indicating means of Figs. 1 and 2, or that of Figs. 3 and 4, or both.

A dosimeter made in accordance with principles of the present invention may assume other forms of construction, such as illustrated in Figs. 5 to 9. Preferably the dosimeter, in its several forms of construction of Figs. 5 to 9, includes a film and developing medium made and utilized in accordance with the one-step developing process of the invention, as mentioned in connection with Fig. 1. However, the dosimeter may also be used in

connection with films and developing media heretofore known.

The construction illustrated in Fig. 5 includes a bottom member or base 50 including a wall member 51 having a surrounding upwardly extending flange 52 defining a recess 54. The outline shape of the base may be as desired, as for example, circular. The wall member 51 preferably is provided with a counter-sunk portion or recess 56 in its upper surface in which is disposed a photosensitive film 58 of the character mentioned above, sensitive to nuclear radiation and to light. Disposed in the recess 54 is a second member 60 of generally plate-like form, which may be referred to also as a separating member. The members 50 and 60 are preferably made of a suitable plastic and are sealed together at their marginal edge portions as by heat sealing or by means of a suitable adhesive material, forming a compartment 61 in which the film is contained, and are manually separable for exposing the film to view after development thereof. The members 50 and 60 are impervious to light but pervious to nuclear radiation.

A capsule 62, forming a second compartment, is superimposed over the separating member 60 and includes a pair of wall elements 64 and 66 in the form of membranes, preferably made of plastic, and of flexible nature enabling compression of the capsule and forcing the liquid developing material 68 therefrom upon puncturing of the capsule. The wall elements 64 and 66 are sealed together around their marginal edge portions as by a suitable heat sealing operation and are together sealed to the marginal edge portion of the separating member 60. The various elements of the dosimeter thus are all secured together and normally maintained in an effectively unitary structure.

The separating member 60 is provided with an aperture 70 through which extends a tubular piercing pin 72 having a base member 74 of suitable construction engageable with the under surface of the member 60 and disposed adjacent to the film 58. The piercing pin and base have a passage therethrough for enabling flow or passage of the liquid developing material 68 from the capsule therethrough onto the film 58 upon puncturing the wall element 66. The upper end of the piercing pin 72 is pointed at 73 for forming a piercing element for puncturing the wall element 66. Upon application of sufficient downward pressure to the upper wall element 64 as by the hand, and suitable reaction pressure on the wall member 51, the lower wall element 66 is forced against the piercing pin which punctures the wall element and projects into the interior of the capsule enabling the liquid developing material to flow or pass through the tubular piercing pin and onto the film to effect development of the latter.

When it is desired to develop the film, as after the dosimeter has been carried in an area where it is desired to test for the presence of nuclear radiation, the user applies pressure to the upper wall element or membrane 64 as described, and after holding the wall element depressed for the prescribed period, opens the dosimeter by removing the separating member 60 from the base 50 which exposes the film to view. It will be understood that either one or both of the wall elements or membranes 64 may be impervious to light so as to shield the film against light through the aperture in the piercing pin 72. However, the various elements making up the dosimeter are pervious to nuclear radiation, at least in those portions where necessary for enabling the radiation to penetrate to the film.

A dosimeter constructed in accordance with the principles of the present invention may take the form shown in Fig. 6 where the envelope or housing 76 is made up of a base or lower portion 78 and a top portion or cover 80 arranged for fitting on the base. The housing members 78 and 80, as in the case of the previous constructions

referred to, may be of suitable material and are preferably of plastic of such type as to enable thermo-sealing of the interengaging surfaces. The dosimeter of Fig. 6 is also constructed for applying the developing material to the film by means of pressure applied to the housing and accordingly a portion of at least one of the housing members is flexible, and is also resilient so as to resume its original shape upon release of the pressure. One convenient location for the desired flexibility and resilience is in the central portion 82 of the base 78 which is relatively thin, so shaped by the dished upper surface 83, and can be flexed inwardly in response to pressure applied to that portion and the opposite portion on the cover 80, as by the hand.

The dosimeter includes a photosensitive film 84 which may be of the general character referred to in connection with Figs. 1 and 5. A piercing pin 86 is mounted in a convenient manner such as by positioning its shank portion in an aperture 88 in the film, the upper housing member 80 having a recess 90 arranged to receive a portion of the shank of the piercing pin in the operation of applying pressure and puncturing the capsule to be described presently. The capsule 92 may be generally similar to the capsule 62, having a pair of flexible and resilient wall elements 94 and 96 preferably in the form of membranes secured together around their marginal edge portions and containing a liquid developing material 98 therein. The capsule may have one rounded portion suitably received in the dished portion 83 of the base member 78. The space in the interior of the envelope or housing, but exteriorly of the capsule, may be considered as a compartment, while the interior of the capsule is a second compartment. Upon applying sufficient inward pressure to the opposite side walls, one of which includes the thin portion 82, the latter is flexed inwardly forcing the wall element or membrane 96 against the piercing pin 86 and puncturing it, enabling the liquid 98 to flow or pass out of the hole thus formed and on to the film 84. Upon release of the pressure on the envelope or housing, the housing resumes its original normal shape, and the capsule likewise resumes its original shape, creating a partial vacuum therein which draws excess liquid thereinto from the surface of the film. The housing members 78 and 80 are manually separable, for exposing the film to view after development thereof.

The dosimeter of Fig. 7 is similar to that of Fig. 6 with the addition of sponge means 102 in the capsule 92. The sponge means 102 may be of any well known form and in the dosimeter, is saturated with the liquid developing material. The sponge means 102 is of suitable elastic character such that it tends to resume its original volume after having been compressed and the compression force removed. The film of the dosimeter of Fig. 7 is developed in the manner described in connection with Fig. 6, that is, the wall element of the capsule is punctured and the liquid applied to the film. Upon release of the pressure causing puncturing of the capsule, the capsule assumes its original volume, creating a partial vacuum therein, and draws the excess liquid from the space 104 between the wall element 96 and the film, and the sponge functions to absorb the liquid so drawn in.

It will be understood that the wall elements 94 and 96 are normally impervious to the liquid developing material so that in their unpunctured form they retain the liquid developer in the capsule.

Another form the dosimeter of the present invention may assume is illustrated in Fig. 8, which embodies a construction wherein a divider element is interposed between the film and developing material and forms compartments in which they are respectively disposed. When it is desired to develop the film to test for the presence of radiation, the divider means is removed from its normal position in the dosimeter to the exterior, enabling the developing material to engage the film. For con-

venience, a portion of the divider normally extends to the exterior and forms a convenient tab for grasping and removing the divider. The dosimeter 106 of Fig. 8 includes an envelope or housing 107 having base 108 and a top member or cover 110 of suitable and complementary outline form. The housing members 108 and 110, as in the previous forms of dosimeter, are preferably of a suitable plastic impervious to light but pervious to nuclear radiation and are sealed around their periphery by suitable means such as by an adhesive material or by thermo-sealing. The base 108 is preferably formed with a recess 112 in its upper surface in which is disposed a developing material 114 in the form of a rigid gel. Similarly the top member or cover 110 is provided with a recess 116 in which is disposed a photosensitive film 118. Interposed between the film 118 and developing means 114 is a divider or sheet 120 preferably of a suitable plastic at least as great, and preferably greater, in outline dimensions, as the film and developing gel. One or the other housing members 108, 110 may have a suitable recess or depression 122 for receiving the divider means. The thickness of the divider and depth of the depression 122 are of course greatly exaggerated in the drawings, for the sake of clarity. The end of the divider means is extended through an aperture 124 in one of the housing members, such as the top member 110 to the exterior, where it forms a tab 126 for removal of the divider from the interior of the dosimeter. The divider is normally gripped between the housing parts and thus seals the interior of the housing from the aperture 124. When it is desired to develop the film to determine the presence of radiation tested for, the divider 120 is withdrawn, which enables the film and developing gel to be brought into mutual contact. The divider is of very minor thickness, being in the nature of a foil, whereby the film and developing gel will be substantially in mutual contact upon removal of the divider.

A still further form of dosimeter construction made according to the principles of the present invention is illustrated in Fig. 9, in which the film and developing material are both relatively solid and rigid. The film and developing material are initially in relatively offset positions and effectively separated by a divider, and arranged for relative movement into superposed position upon movement of the divider which also serves as a pull member having a portion extending to the exterior and forming a tab for grasping it. In the dosimeter 128 of Fig. 9 the envelope or housing 129 includes a bottom or base 130 and a top or cover portion 132, both of which, as in the previous forms, may be of any suitable material, but preferably plastic, and are impervious to light but pervious to nuclear radiation. The housing portions are secured together in the assembled dosimeter by suitable means such as by an adhesive material or by thermo-sealing them around their marginal edges, sealing the interior of the housing at their sealed portions against the entrance of light and foreign materials. The lower portion or base 130 includes a recess 134 extending throughout the greater portion of the area of the base surrounded by an upturned flange 136 engaged by the top or cover. Toward one side of the base and defining one side of the recess is an upraised or thickened bottom wall portion 138 in which is formed an aperture 140 leading to the exterior. Disposed in the recess 134 is a stiffening element 142 preferably congruent with the recess, which may be formed of suitable material such as cardboard. The stiffener 142 is provided with an aperture 144 in which is fitted a cup 146 preferably of metal foil which contains a developing material 148 preferably in the form of a rigid gel. The upper surface of the developing means 148 is substantially flush with the upper surface of the thickened wall portion 138.

A photosensitive film 150 is positioned normally in offset relation or spatially separated from the developing material, the interior of the housing and the developing

material and film being of such relative dimensions as to enable such arrangement. The film 150 is disposed generally in the recess 152 formed in the top or cover means 132 and mounted in or connected to a pull member 154 which is preferably made of an upper element or layer 156 of black paper and a second layer 158 of metal foil. The film is secured to the black paper element 156 as by adhesive material, the paper being illustrated as having a downwardly opening cup 160 receiving the film while the foil member 158 is provided with an opening or aperture through which the film projects. The two layers 156 and 158 are secured together by suitable means such as adhesive material, and the pull member 154 formed of the two layers extends out through the aperture 140 where its extended end forms a pull tab 162. When it is desired to develop the film 150, the user grasps the tab 162 and draws downwardly or outwardly thereon until the film 150 is moved into position (to the right, Fig. 9) wherein it overlies the developing material 148 in contact engagement therewith. The pull member 154, as the elements are arranged, preferably engages the developing material and effectively forms compartments in which the developing material and film are respectively contained. The lower surface of the film is substantially flush with the lower surface of the pull member, whereby when the film is moved to developing position it is positioned in contact with the developing material. The dimensions of the cavity in the dosimeter housing in vertical direction, and the elements therein, are so interrelated that engagement by the black paper layer 156 with the upper wall of the recess 152 assures contact engagement between the film and developing material when the former is brought into position superposed over the latter. After the film is thus positioned for developing it for the prescribed period of time the housing is opened by separating its portions and the film is then exposed to view. The dimensions of the elements illustrated in Fig. 9 are exaggerated for the purpose of more clearly showing the construction of the dosimeter. The pull member 154 is normally gripped between the housing portions so as to seal the interior from the aperture 140 against the entrance of light and foreign material, the black paper aiding in this respect, and sealing it against moisture.

A dosimeter may, according to any of the illustrations shown and hereinabove described, be utilized for development on the scene of the test. There is no necessity for external agencies or devices for developing the film. When it is determined to test an area for the presence of nuclear radiation, the user merely manipulates the dosimeter according to the character of its construction as described above for applying the developing material to the film. In certain cases pressure is applied, as by the hand; in another instance a divider means is removed from the dosimeter, and in still another instance, the film is moved relatively to the developing material by means of the divider and pull member; and after the prescribed lapse of time the dosimeter is opened and the film is exposed to view. An indication as to the presence of nuclear radiation is thereby given and any desired steps may be taken in accordance with whether nuclear radiation is present, and the film may be filed or stored away for future reference.

The present invention also encompasses a one-step developing process, and such process may be utilized in a dosimeter of the character above disclosed, in keeping with the desirability of developing the film on the scene of the test and with rapidity, and eliminating the necessity for external agencies for aiding in developing the film. The film and developing means are contained in the dosimeter so that the dosimeter is a completely self-contained article. Broadly, the term "developing" include a developing phase and a fixing phase. After a photosensitive film is exposed to radiation and it is desired to "develop" it, it is both developed and fixed, that is, the portions of the silver halide emulsion exposed to radiation are developed,

in which step or phase the silver halide is reduced to metallic silver and the unexposed portions are fixed to a light stable complex. The developing medium accordingly contains not only a means or material for developing the film but a means or agent for fixing the film. Since the film used in the dosimeter is sensitive to nuclear radiation as well as light, the fixing phase utilized renders the unexposed portions of the film stable not only with respect to light but with respect to all radiation and it is with such understanding that the term "light stable complex" is used herein.

A one-step developing process is highly advantageous in that it is time-saving and possesses a second advantage of extreme simplicity. However, disadvantages have been noted in the use of one-step developing processes heretofore known. A one-step developing process must include both a developing phase and a fixing phase, and these phases must be carried out simultaneously if the process is to be a one-step developing process. The developing phase must reach completion rapidly or the fixing phase will remove exposed silver halide at the expense of image quality. The development rate may be increased by means of two chemical expedients (1) proper choice of a reducing agent with a high reduction potential and (2) increasing the alkalinity of the developer solution, but there is a practical limit to developer activity. Disadvantages of an over-active developer are chemical fogging in the unexposed regions and poor keeping qualities of the developer. It is the purpose of the one-step developing process of the present invention to greatly minimize, and to substantially eliminate, the disadvantages mentioned.

The one-step developing process of the present invention is adapted for utilization in the dosimeter of the invention and to other photographic applications. The process involves applying a first portion of a developing medium to the photosensitive film prior to exposure and the remainder of the medium at the time a finished photograph or image is desired, or at the time it is desired to test for the presence of radiation. The portion of the developing medium that is applied to or incorporated in the film prior to exposure is normally inert with respect to development processes, i.e., inert to chemical reaction with the image-forming emulsion on the film, so that no effect is produced by it on the film as the result of exposure to radiation or otherwise except when the developing medium is again combined when the second portion is applied to the film. The second portion of the developing medium contains a reactor which reacts with the first portion and produces development, and a fixing agent.

The portion of the developing medium which is applied to or incorporated in the film before exposure, and for purposes of convenience herein, will be referred to as a developing agent. Hydroquinone (para-dihydroxybenzene), pyrocatechin (ortho-dihydroxybenzene), elon (methyl-p-aminophenol), metol and amidol have been found suitable for use as such developing agents in the practice of the present invention. The film utilized in carrying out the present one-step developing process includes a conventional emulsion containing a gelatin and silver halide suspended therein, and a developing agent in the form of a reducing agent consisting of any of the above mentioned materials or mixtures thereof, diffused in the emulsion. The photosensitive emulsion so prepared is stable to ordinary atmospheric influences prior to and after exposure to radiation as in the case of conventional silver halide photosensitive emulsion. There is no noticeable effect of such developing agent or reducing agent on the photosensitive properties of the emulsion, in the absence of a medium containing hydroxyl ions.

Following exposure, the specially prepared photosensitive emulsion referred to above, which includes the developing or reducing agent, becomes developable in

a medium containing hydroxyl ions which, for convenience, will be referred to herein as the "reactor." Each of the following alkali materials in solution has been found effective as a liquid reactor: sodium hydroxide, potassium hydroxide, and trisodium phosphate; and ammonia has been found effective as a gaseous reactor. Such reactor mediums are stable under ordinary conditions of storage.

The fixing agent, or means for fixing the unexposed portions of the silver halide and rendering it light stable, is preferably contained in the reactor and is therefore applied to the film with the reactor when development is desired. Sodium thiosulphate and potassium cyanide each has been found satisfactory as a fixing agent.

The reactor, when applied to the film having the developing agent diffused in the emulsion, itself diffuses into the emulsion, and the theretofore inert developing agent is ionized and made reactible with the exposed silver halide particles. The developing agent includes a large reserve beyond that necessary for development purposes and it is unnecessary to depend upon the diffusion rate of the developing agent into the emulsion to replenish the portions of the developing agent previously exhausted in reducing the silver halide. There is a reserve of developing agent molecules adjacent the silver halide grains which instantaneously replace the oxidized developing agent molecules. The developing action thus proceeds to completion rapidly. Fixation speed, however, depends upon the rate of diffusion of the fixing agent molecules or ions from the reactor solution into the emulsion, since the fixing agent is contained in the reactor solution and diffuses into the emulsion only after the reactor solution is applied to the film, and the rate of replenishment of the fixing agent is limited by its diffusion rate into the emulsion. The fixing action therefore proceeds slower than the developing action. Accordingly, the latent image is developed before the fixing agent has had an opportunity to affect the latent image. The present process, while being a one-step development process, takes on certain characteristics of a two-step process in the sense that development occurs more rapidly than fixation. It will be understood though that the process is a one-step process in the sense that only a single manipulation is required by the user, and the developing process and fixing process begin simultaneously.

The preferred materials, and the proportions thereof, utilized in carrying out the invention are shown in the following tables ("Solution A" and "Solution B"). However, the other materials mentioned have been found satisfactory. The portion of the developing medium applied to or incorporated in the emulsion on the film, i.e. the developing agent, is shown in the table, Solution A. The photosensitive material is bathed in such Solution A and then dried:

Solution A

Pyrocatechin	gms.	5
Water, to make	cc.	100

A film including the above developing agent may be exposed to radiation, whether in a dosimeter made according to the present invention or other forms of photographic device, and after exposure to radiation the second portion of the developing medium, i.e. the reactor solution, including the reactor and fixing agent, is applied to the film as by bathing the film therein. Such second portion of the developing medium includes the materials indicated in the table, Solution B:

Solution B

Potassium hydroxide	gms.	14
Sodium sulphite	do.	50
Formalin (37%)	cc.	6
Sodium thiosulphate	gms.	30
Water, to make	cc.	600

Development is completed in 15 to 180 seconds, depending upon the photosensitive material used. Sodium

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sulphite in the reactor solution (Solution B) functions as a preservative and minimizes staining of the photosensitive emulsion layer and emulsion support layer, sometimes known as "film support." Other materials found satisfactory as preservatives are potassium bisulfite and sodium metabisulfite. Formalin hardens the gelatin emulsion and prevents scratching thereof.

The one-step developer process may be utilized in a dosimeter of any of the forms described above but is not limited thereto and may be utilized in connection with other forms of device. Such a one-step development process is particularly advantageous in connection with a dosimeter or similar device where development is desired rapidly, as on the scene of a test and where other photographic paraphernalia is relatively inaccessible. When so utilized, the film, e.g. film 32 of Fig. 1, is made according to the one-step developing process and has a developing agent (Solution A) diffused in the emulsion thereon; the liquid developing means 27 is constituted by the reactor solution including the reactor and fixing agent (Solution B).

The invention furthermore encompasses a calibrating scale for a photographic photometer and a safety means for indicating pseudo-exposure or false exposure of the film. The calibrating scale is made according to a novel process, and is adapted to use in a dosimeter made according to the present invention, as well as in other devices. The safety indicating means is similarly adapted to use in a dosimeter made according to the present invention, as well as other devices. The calibrating scale and safety indicating means may be suitably provided in a film as illustrated in Figs. 10 to 12. For convenience, the film of Figs. 10 to 12 is shown as circular in outline although the outline shape may be as desired as, for example, when it is embodied in a dosimeter as in Fig. 1 it may be of polygonal shape. The same film is shown in each of Figs. 10, 11 and 12 but in different conditions of exposure.

The film 164 is a photosensitive film processed according to the principles of the present invention to provide a central detecting area 166, a plurality of grey scale areas 168, as well as a safety indicating area 170. The film may be provided with a hole 172 for convenience in handling the film. The area 170 includes a spot or area 174, both of which are insensitive to normal doses of nuclear radiation but sensitive to normal light exposures, and form a safety indicating means to indicate when the film has been accidentally exposed to light, or otherwise rendered defective as by heat or chemical action and thus indicate whether the detecting area 166 accurately indicates the condition tested for. Such accidental or pseudo-exposure may be encountered, for example, as when the film is used in a dosimeter of the character above described and utilized for detecting the presence of nuclear radiation. The film is sensitive not only to nuclear radiation, but to light as well, and if the dosimeter should be accidentally ruptured or torn, so as to admit light, the safety indicating means will so indicate, and then the detecting area 166 will be known to be not accurate in indicating the condition tested for.

The grey scale areas 168 are represented in the drawings as shaded according to the conventional shading utilizing for indicating black, but with the lines of respectively different thicknesses to indicate various intensities of grey, and hence various optical densities. Progressing clockwise from the area 168 immediately to the right of the hole 172, the areas 168 are of decreasing, known optical densities ranging from a dark grey approaching black to a very light grey. After exposure and development of the film, comparison may be made between the optical densities of the area 166 and the areas 168, to determine the quantity of radiation to which the film has been subjected. The area 166 and the areas 168 may be alternatively sensitive and insensitive, re-

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spectively, to nuclear radiation, according to the two forms of the invention.

In one form of the invention, the grey scale areas 168, when the film is processed and in condition for use, are insensitive to radiation, while the area 166 is sensitive thereto. Any radiation to which the detecting area 166 may be subjected has no effect on the grey scale areas, and since the areas 168 are of known optical densities, the area 166 can be compared with the grey scale areas 168 to determine the quantity of radiation to which the film has been subjected. In thus forming the calibrating scale on the photosensitive film 164, the grey scale areas 168 are exposed to light in graded quantities while the area 166 is shielded and protected from exposure. After thus exposing the grey scale areas the film is developed, but not fixed, in which process the area 166 may be subjected to the developing process, as a matter of convenience, since the developing process does not affect the unexposed area 166. Thereafter the metallic silver image is bleached away by a suitable bleaching process which does not affect the silver halide. A bleach including potassium bichromate has been found suitable for this purpose.

The next step is to expose the grey scale areas to saturation radiation, for example light, while still protecting or shielding the detecting area 166 from such radiation. The silver halide remaining after the first exposure and development forms latent images which, when later developed, form the graded grey scale areas 168. The film as thus prepared, and without further development, is conditioned for use, as in a dosimeter.

It will be understood that the detecting area may be provided on a separate member (not shown) from the calibration scale. After treatment these two members (not shown) are superposed and then inserted in the plastic package. In another form of the invention the detecting area may be formed on a disc (not shown) contained in the pouch and the calibration scale on a loose sheet (not shown) which is attached to the outside of the pocket.

When the film as thus processed is subjected to nuclear radiation, the radiation affects the detecting area 166 but not the grey scale areas since the latter have been exposed to saturation radiation. Upon subsequent development and fixation, as in the dosimeter, the detecting area 166 assumes an optical density according to the quantity of radiation to which exposed, and this density may be compared with the grey scale for determining the quantity of radiation. Fig. 10 shows the film processed for use but before exposure as in normal use, and Fig. 11 shows the film after such exposure, the detecting area 166 being of an optical density according to the quantity of radiation to which exposed.

The calibrating scale compensates for any changes in activity in the developing medium, since it is finally developed and fixed simultaneously with the detecting area, as it is in a dosimeter as above described. Any changes that may affect the area 166 will affect the areas 168 respectively proportional amounts, and the relative densities of the area 168 will remain constant.

It will be understood that the film 164 containing the grey scale, may be constructed and utilized in accordance with the principles of the novel one-step developing process hereinbefore described; the normally inert developing agent may be incorporated in the emulsion on the film, before exposure, and the second portion of the developing medium including the reactor and fixing agent applied after exposure, or when it is desired to test for the presence of radiation.

Another form of film having a grey scale made according to the principles of the invention involves a detecting area 166 of known optical density and insensitive to radiation, and a grey scale sensitive to radiation and capable of registering radiation while the relative densities of the areas 168 remain constant. In carrying

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out the present form of the invention the film 164 is subjected to the first exposure and development of the film as above described, namely, graded exposure of the areas 168 with controlled exposure to area 166, and subsequent development (without fixation). The film is then bleached to remove the metallic silver image from the areas 168 and 166. The next step, differing from that of the first embodiment of the invention, includes exposing the detecting area 166 to a known, preferably saturation, exposure while shielding and protecting the grey scale areas, and subsequently developing and fixing the area 166. The film thus processed is in condition for use as in a dosimeter, and upon further exposure, as by nuclear radiation, and development, the grey scale will have changed in density, while the relative densities between the areas 168 remain constant, and the area 166 of known density will have been unaffected. Comparison between the grey scale and area 166 will indicate the quantity of radiation tested for.

When the film of Figs. 10 to 12 is used in a dosimeter for example, it is desirable that an indication be given as to whether the dosimeter has been rendered defective, as by accidentally exposing the film to light or to other agencies that may deleteriously affect the film, such as heat or chemicals. For instance, when the film is used in a dosimeter for detecting nuclear radiation and if the dosimeter should become accidentally defective so as to expose the film to light, the detecting area which is sensitive to light will be affected thereby and will not accurately indicate the presence of nuclear radiation tested for. The safety indicator in the area 170 will so indicate such accidental exposure.

In the present description of the safety indicating means, the grey scale is not described, but it will be understood that when both are incorporated in a single film they may be formed in a combined series of operating steps, while each is formed according to the individual series of steps relating thereto.

In processing the film for use in detecting radiation, the safety spot 174 and the area 170 around it are exposed to respectively different quantities of light, the spot 174 preferably having less exposure than the area surrounding it. For example, the area surrounding the spot may be subjected to twice the exposure that the spot is subjected to. During this exposure the detecting area 166 is protected or shielded from exposure. The film is then developed (but not fixed); the detecting area may also be subjected to the development process, for convenience, but it is not affected thereby. Thereafter the film is subjected to a bleaching process of the nature referred to above in connection with the grey scale in which the metallic silver forming the respective images is bleached away. In this bleaching process the silver halide is not affected. The areas 174 and 170 thus treated are insensitive to normal dosages of nuclear radiation. The film may then be used to full advantage in a dosimeter for detecting nuclear radiation. In normal use of the dosimeter and in which the dosimeter does not become defective, the nuclear radiation that affects the detecting area 166 does not affect either of the areas 174 or 170. In such normal use of the film the areas 174 and 170, when subjected to nuclear radiation and developed in normal use of the dosimeter, remain light colored or substantially white as shown in Figs. 10 and 11 and the user, when he opens the dosimeter, will thereby be notified that the dosimeter was not defective and the optical density of the detecting area 166 will accurately indicate the condition as to nuclear radiation.

The areas 174 and 170 are, however, sensitive to light as well as heat and chemicals, and if the dosimeter in which the film is used should become defective, the areas 174 and 170 will indicate the fact. For example, if light should enter the dosimeter it will affect the areas 174 and 170 (as well as the detecting area 166) and upon development of the film the areas 174 and 170

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will be darkened, and while the detecting area 166 will also be darkened, the detecting area will not indicate whether the dosimeter is defective. A film thus rendered defective is shown in Fig. 12 where the area 170 and spot 174 are relatively darkened.

Due to the fact that the areas 174 and 170 were given different quantities of exposure in the preparatory processing steps they will assume different densities of grey when exposed and developed. Since the area 170 around the spot 174 was given greater exposure than the spot in pre-processing the film, and more of the silver halide was reduced, and removed in the bleach, it shows up as a lighter grey than the spot. The relative densities of the areas 174 and 170 serve as a more convenient means for indicating pseudo-exposure than if only a single area were provided in that a contrast between areas of different optical densities will more readily provide an indication than would a discoloration of film without such contrast.

I claim:

1. A radioactivity dosimeter comprising an envelope including portions normally secured together but manually separable, said envelope being impervious to light but pervious to nuclear radiation, and forming an effectively unitary structure and having a plurality of compartments distributed therein, separating means between and normally sealing the compartments from each other, a photosensitive film in a first of said compartments and having an image-forming emulsion thereon sensitive to nuclear radiation, said emulsion containing diffused therein a developing agent normally inert to chemical reaction with said emulsion, a reactor medium in a second of said compartments and containing a developing reactor and a fixing agent, said separating means having at least a portion capable of being removed from sealing condition for thereby providing communication between the compartments and enabling relative movement of said reactor medium and film for application of said reactor medium to the film, said developing reactor when applied to said film being effective with said developing agent for causing development of the exposed portions of the film, said developing agent being present in quantity greater than that required for utilization in developing the film, and said fixing agent when applied to said film being effective for fixing the unexposed portions of the film.

2. A radioactivity dosimeter comprising an envelope impervious to light but pervious to nuclear radiation, said envelope being formed of a pair of flexible elements fitted together and sealed around their edges and sealed at an intermediate portion to form a pair of compartments sealed from each other, a photosensitive film in one of said compartments, a developing medium in said envelope, at least an essential fluid component of said developing medium being contained in the second of said compartments, said central sealed portion being rupturable by pressure produced in said second compartment in response to external force applied thereto, and a thread embedded in said envelope between said compartments and between the elements of the envelope and having at least a portion exposed to the exterior for forming a tab for separating the elements of the envelope and presenting said film to the exterior.

3. A radioactivity dosimeter comprising an envelope impervious to light but pervious to nuclear radiation and made of a pair of flexible wall members sealed together around their marginal edges defining an interior space, said envelope having central, spaced sealed portions separating the interior space into a pair of compartments sealed from each other, said central sealed portions defining a central space therebetween, an absorbent wick in said central space with portions embedded in the sealed marginal edge portions of the envelope and extending to the exterior, said wick being impregnated

with a visual pH indicator, a photosensitive film in one of said compartments, and a developing medium in said envelope, at least one essential and fluid component of said developing medium being contained in the second of said compartments and being chemically reactible with said pH indicator, said central sealed portion being rupturable in response to external pressure applied to the dosimeter at the position of said second compartment for providing communication between the compartments.

4. A radioactivity dosimeter comprising a flexible envelope impervious to light but pervious to nuclear radiation, and having a pair of opposed side wall members and a central sealed portion dividing the interior of the envelope into a pair of compartments, said compartments being sealed from each other and from the exterior, a photosensitive film in one of said compartments, and a developing medium in said envelope, at least one essential and fluid component of said developing medium being contained in the second of said compartments, said central sealed portion being rupturable in response to external pressure applied to the dosimeter at the position of said second compartment for providing communication between the compartments.

5. A dosimeter as recited in claim 1 and comprising an envelope normally sealed but adapted to be opened and containing a photosensitive film therein, and including a flexible capsule containing a fluid developing means, said capsule having a wall element positioned for application of pressure thereto from the exterior of the envelope, and a piercing pin in said envelope positioned for engagement by an inner wall element of said capsule in response to pressure applied to said exterior wall element of the capsule and consequent piercing of the inner wall element, said piercing pin being positioned for piercing said inner wall element at a location enabling said developing means to pass into contact with said film.

6. A radioactivity dosimeter as recited in claim 1 and comprising a base, a photosensitive film on said base, a separating member secured to said base in overlying relation to said film, a flexible capsule secured to said separating member in overlying relation thereto, said base, separating member, and capsule forming an enclosing housing, a developing medium in said housing, said capsule containing at least one essential component of said developing medium in liquid form, and a piercing pin carried by said separating member in position to puncture said capsule in response to flexing the outer portion of the capsule toward the separating member, said separating member having an aperture therethrough for passage of the liquid into engagement with said film, said base, separating member and capsule sealing said film from light but having at least a portion pervious to nuclear radiation.

7. A dosimeter as recited in claim 1 and comprising a relative flat base member having an upper surface and a surrounding upturned flange, said upper surface having a recess, a photosensitive film in said recess, a relatively flat separating member removably secured to said upper surface and having an aperture therein, a tubular piercing pin disposed in said aperture and having a piercing element projecting beyond the upper surface of the member and defining a passage through the member to said film, a capsule superimposed on said separating member and secured thereto and having an inner puncturable wall element adjacent said piercing pin and an outer opposite flexible wall element, and a developing medium in said dosimeter, at least one essential component of said developing medium being contained in said capsule, said base member, separating member and capsule sealing said film from light but having at least a portion pervious to nuclear radiation.

8. A radioactivity dosimeter as recited in claim 1 and comprising a housing impervious to light but pervious to nuclear radiation, at least one of opposite walls of

the housing having a yieldable portion for enabling relative movement of portions of the respective walls toward each other, a photosensitive film in said housing, a developing medium in said housing, a sealed capsule in said housing and containing at least one essential component of said developing medium in fluid form, said capsule having a puncturable wall adjacent said film, and a piercing pin in said housing normally positioned for relative movement toward said puncturable wall of the capsule for puncturing the same by one of said housing wall portions in response to movement of said housing wall portions relatively toward each other.

9. A radioactivity dosimeter as recited in claim 1 and comprising a housing made up of parts normally sealed together but separable and being impervious to light but pervious to nuclear radiation, at least one of opposite walls of the housing having a yieldable and resilient portion for enabling relative movement of portions of the respective walls toward each other, a photosensitive film in said housing and having an aperture therein, a piercing pin in said aperture and having a piercing element projecting from the surface of said film, a developing medium in said housing, a sealed capsule in said housing and containing at least one essential component of said developing medium in fluid form, said capsule being yieldable and resilient and having a puncturable wall adjacent said film and positioned for engagement with said piercing pin in response to relative movement of said housing wall portions relatively toward each other.

10. A radioactivity dosimeter as recited in claim 1 and comprising a housing impervious to light but pervious to nuclear radiation, at least one of opposite walls of the housing having a portion yieldable and resilient for enabling relative movement of portions of the respective walls toward and from each other, a photosensitive film in said housing, a developing medium in said housing, a sealed, flexible and resilient capsule in said housing and containing sponge-like material and at least one essential component of said developing medium in fluid form, said capsule having a puncturable wall adjacent said film, and a piercing pin in said housing normally positioned for relative movement toward said puncturable wall of the capsule for puncturing the same by one of said housing wall portions in response to movement of said housing wall portions relatively toward each other.

11. The method of developing a photosensitive film having image-forming material thereon by the use of a developing medium which includes a first portion consisting of a normally chemically inert developing agent and a second portion including a developing reactor and a fixing agent, said method comprising the steps of applying said first portion of said developing medium to said film, exposing the film to radiation, and thereafter applying said second portion of the developing medium to the film.

12. The method of developing a photosensitive film having an image-forming emulsion thereon by the use of a developing medium which includes a first portion consisting of a normally chemically inert developing agent and a second portion including a developing reactor and a fixing agent, said method comprising the steps of diffusing said first portion of said developing medium throughout said emulsion in quantities greater than that required for utilization in developing the film, exposing the film to radiation, and thereafter applying said second portion of the developing medium to the film.

13. A photosensitive film having an emulsion including a gel with silver halide diffused therein, and a developing agent diffused in said emulsion, said developing agent being normally inert to chemical reaction with the silver halide but capable of reducing the silver halide in response to diffusion into the emulsion of a fluid containing hydroxyl ions, said developing agent being present in quantities greater than that required for complete re-

duction of the silver halide, and the emulsion being free of any fixing agent.

14. A dosimeter as recited in claim 1 and comprising an envelope containing a photosensitive film and a fluid developing means sealed therein, and said envelope being normally impervious to said developing means and having a coating on at least a portion of its outer surface including a material capable of reacting chemically with said developing means and to form a visual leakage indicator.

15. A dosimeter as recited in claim 1 and comprising a flexible envelope including complementary parts normally sealed around their marginal portions but manually separable, a photosensitive film in said envelope, a fluid developing means sealed therein, and said envelope being normally impervious to said developing means and having a coating on at least a portion of its outer surface including a material capable of reacting chemically with said developing means and forming a visual leakage indicator.

16. A dosimeter as recited in claim 1 and comprising an envelope having a pair of compartments, said compartments being sealed to the exterior and the envelope having separating means normally sealing the compartments from each other, a developing medium in said envelope, a photosensitive film in one of said compartments, said film having an image-forming emulsion thereon including a portion of said developing medium therein and a second portion of said developing medium in the second of said compartments, said second portion of the developing medium being in fluid form and constituting a developing reactor capable with said first portion of causing development of said film, said separating means being frangible for providing communication between said compartments for enabling application of said reactor to said

film, said reactor having an alkaline component, and said envelope having a coating on at least a portion of its outer surface including a pH indicator capable of reacting chemically with said reactor for forming a visual leakage indicator.

17. An article of manufacture comprising envelope means, a photosensitive film in the envelope means having an emulsion including a gel with silver halide diffused therein, and a developing agent diffused in said emulsion, said developing agent being normally inert to chemical reaction with the silver halide but capable of reducing the silver halide in response to diffusion into the emulsion of a fluid containing hydroxyl ions, said developing agent being present in quantities greater than that required for complete reduction of the silver halide, and the emulsion being free of any fixing agent, and envelope means containing developing reactor and fixing agent capable of diffusing into the emulsion, which together with the developing agent form a medium capable of developing a latent image in the film and fixing the unexposed portions thereof to a light stable complex.

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