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J. S. SMITH

2,648,013

FLUORESCENT SCREEN

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Fig. 1.

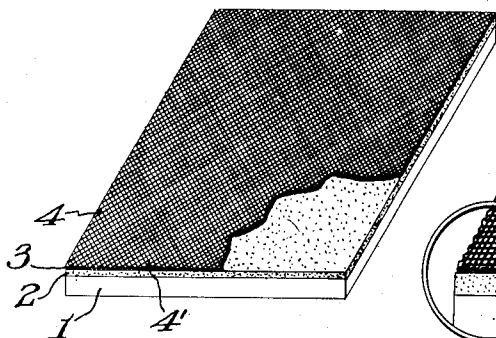


Fig. 2.

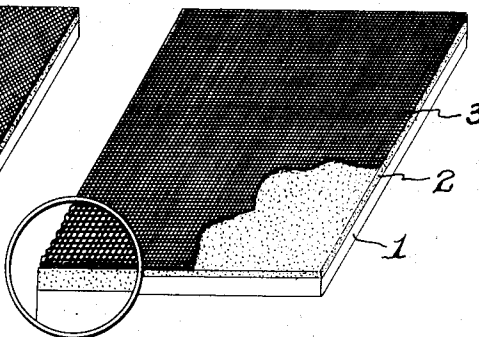


Fig. 3.

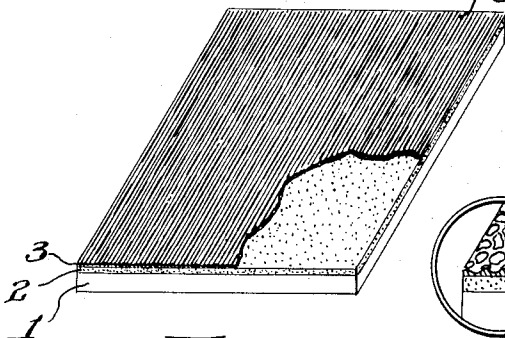


Fig. 5.

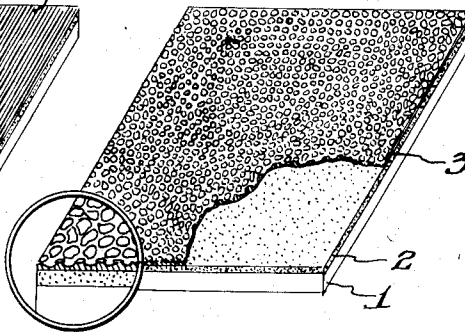


Fig. 6.



Fig. 7.



Fig. 8.



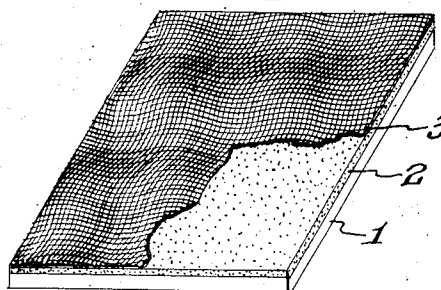
Fig. 9.



Fig. 10.



Fig. 4.



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FLUORESCENT SCREEN

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9 Claims. (Cl. 250—80)

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This invention relates to fluorescent screens. More particularly it relates to X-ray intensifying screens which have increased resistance to scratching and abrasion. Still more particularly it relates to X-ray intensifying screens which have indented groove patterns in their outer surfaces.

X-ray intensifying screens usually consist of a stiff cardboard or film support that carries a layer of discrete particles of an X-ray fluorescent material which are uniformly distributed throughout a hard-film-forming binding agent, e. g., a cellulose derivative, synthetic resin, superpolymer, etc. The surface of the fluorescent layer is protected by means of a thin layer of a hydrophobic film-forming material. The latter layer is necessary because the layer containing fluorescent particles is generally somewhat porous and abrasive and sometimes is deleteriously affected by cleaning fluids.

The protective surface layers of X-ray intensifying screens become dented, abraded and scratched in normal use by dirt and dust, etc. Denting is caused by forcing a particle into the surface of the screen. Abrasion is usually the result of long use. Repeated insertion and withdrawal of X-ray film sheets from cassettes provided with X-ray intensifying screens and the shearing action which obtain during the closing of cassettes are the principal factors which cause abrasion of the screen surface. Scratching is caused by particles moving over the screen surface, e. g., by inserting and withdrawing X-ray film sheets and by cleaning the screen surface.

The useful life of an X-ray intensifying screen, as is apparent from the above, is determined by its resistance to scratching, denting and abrasion. Various proposals have been made to improve such resistance, e. g., the incorporation of wax particles in the outer layer, but they are not entirely satisfactory. While the lubricating action is helpful, denting, scratching and abrasion are not eliminated.

An object of this invention is to provide X-ray fluorescent intensifying screens which have improved surface characteristics and are more resistant to denting, scratching and abrasion. Another object is to provide such screens which can be cleaned readily. A further object is to provide such screens in a simple and economical manner. Still further objects will be apparent from the following description of the invention.

The above objects are attained in accordance with this invention by providing the outer surface of an X-ray fluorescent intensifying screen

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with indented shallow groove patterns which grooves preferably extend to edges of the screens. The grooves may be straight, striated, curved or sinuous or irregular or somewhat discontinuous, viz., having spaces between small areas such as dots, squares, diamonds, etc., and free from sharp corners or angles. The grooves or striations ordinarily should not be of such width or depth that they would leave a significant pattern in the resulting exposed and developed radiograph. A width of 0.1 to 0.25 mm. and a depth of 0.02 to 0.035 millimeters are, in general, satisfactory. The average distance between the centers of the grooves preferably is from 0.10 to 2.5 mm. The cross-section of the groove may vary also and be curvilinear, U-shaped, V-shaped, etc. The grooves preferably extend across the entire surface of the screen forming gratings, grids or crisscross patterns.

The novel groove-patterned screen surfaces can be prepared in various ways. A practical manner consists in coating a solution of the film-forming polymer used as the protective surface of the fluorescent screen onto a casting surface which has a ridged pattern to form a thin layer. A suspension of fluorescent particles in a solution of a suitable film-forming binding agent is coated onto the thin layer of the protective material. A backing sheet of paper, cardboard, cellulose derivative, synthetic resin or superpolymer is applied to the freshly cast surface of the fluorescent layer and the entire assembly stripped from the casting surface. The outer protective layer contains a groove pattern which corresponds to the ridged pattern on the casting surface. The casting surface for the method just described may be patterned glass, smoothly ruled metal, etc.

Another practical method consists in providing a gelatin sheet with a ridged or grid pattern, e. g., a rectangular grid or diagonal crisscross grid pattern on which a solution of a hard-film-forming polymer in a solvent which is a non-solvent for the gelatin is coated. A dispersion of fluorescent particles in a suitable film-forming polymeric binding agent is cast onto the polymer protective layer. A sheet support is then applied to the freshly cast fluorescent layer. The sheet support is applied to give the fluorescent screen more strength and rigidity. The screens preferably have such a backing but it is not a necessity. After drying, the assembly is stripped from the patterned gelatin sheet. Any particles of gelatin which are left in the grooved pattern of the outside surface of the resulting X-ray

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screen can be removed by washing or brushing, e. g., means of warm water or a damp rag.

The invention will be further illustrated with reference to the accompanying drawing wherein similar reference numerals refer to the same parts throughout the several views; and

Fig. 1 is an enlarged perspective view, with parts broken away, of a unit area of fluorescent screen having a diagonal crisscross grooved surface,

Fig. 2 is an enlarged perspective view with parts broken away of a unit area of a fluorescent screen having a horizontal-vertical grid-grooved surface,

Fig. 3 is an enlarged perspective view with parts broken away of a unit area of a fluorescent screen having a striated grooved surface,

Fig. 4 is an enlarged perspective view with parts broken away of a unit area of a fluorescent screen having a crossed sinuous grooved surface.

Fig. 5 is an enlarged perspective view with parts broken away of a unit area of a fluorescent screen having a rounded dot surface,

Fig. 6 is an elevation of the surface of a suitable sine-groove,

Fig. 7 is an elevation of the surface of a modified sinuous groove wherein the peaks are flattened and wider than the grooves,

Fig. 8 is an elevation of the surface of a modified sinuous groove wherein the grooves are flattened and wider than the peaks,

Fig. 9 is an elevation of the surface of a modified sinuous groove wherein the broad and narrow peaks alternate with broad and narrow grooves, and

Fig. 10 is an elevation of the surface of a modified sinuous groove wherein pairs of shallow and deep grooves recur.

It is to be understood that the groove shapes of Figs. 6 and 7 apply to crisscross types as well as parallel types of surfaces.

Referring now to the drawings, a cardboard support 1 carries on one surface thereof a layer 2 of X-ray fluorescent particles which are embedded in a film-forming binding agent, e. g., cellulose acetate. A thin outer protective layer 3 which is composed of a hard or non-tacky film-forming polymer, e. g., cellulose acetate, cellulose nitrate, polymethyl methacrylate or mixtures of the latter with cellulose nitrate is carried by the fluorescent layer. The outer layer is provided with diagonally crossed rows of U-shaped grooves 4 and 4' and the surfaces between the grooves are rounded off so that a section taken along the diagonal has an elevation similar to that shown in Fig. 6. The diagonal grooves may be at any angle but angles from 45° to 60° from the vertical are preferred.

The screen of Fig. 2 is similar to that of Fig. 1 except that the U-shaped grooves are horizontally and vertically disposed and the surfaces between the grooves are rounded off. A horizontal section of this surface also has an elevation like that shown in Fig. 6.

The screen of Fig. 3 is like that of Figs. 1 and 2 except in place of the crossed rows of grooves the surface contains a series of essentially parallel or striated grooves 5. The ridges between the grooves are rounded off.

In Fig. 4 the screen is similar to that of Figs. 1 and 2 except that the grooves are curved or sinuous lengthwise.

The screen of Fig. 5 has a pebble-grain finish so that the surface has raised and depressed por-

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tions more irregularly disposed. Each pebble has a rounded-off outer surface.

Dust, etc., particles settle in all of the above grooves or depressed areas and thus are removed from significant abrasive contact with the outermost surface of the screen. The particles which settle in the grooves can be removed readily by cleaning with a damp cloth.

The screens of Figs. 1 and 2 constitute the preferred aspect of this invention. Since the grooves are regular and continuous and extended to the edges of the screen the dust particles can be readily removed by cleaning.

The invention is, of course, not limited to the particular groove patterns shown in Figs. 1 to 5 inclusive. Various other designs obviously can be used. Circular grooves extending in a radial manner from centers on a straight line can be resorted to if desired. Other curved grooves can be used so that the particles can be removed more readily in cleaning by curved sweeping motions.

The invention will be further illustrated but is not intended to be limited by the following examples.

Example I

A sheet of gelatin which has disposed on its surface a series of vertical and horizontal rounded ridges in which the heights of the ridges are from 0.02 to 0.035 mm. and the distance between the centers is approximately 0.17 mm. is placed on a table. A 5% solution of cellulose acetate in dioxan is cast onto the gelatin sheet so that the ridges and surface are completely covered to form a layer approximately 0.4 mm. thick. Fluorescent mixed crystals of lead and barium sulfate are milled into a cellulose nitrate solution in N-butylacetate which contains dibutylphthalate as a plasticizer and cast onto the dry cellulose acetate layer. After the fluorescent layer has set up but is still somewhat tacky a piece of cardboard is pressed into contact with the layer and the entire assembly is allowed to dry for a period of about 16 hours. The fluorescent screen assembly is then stripped from the gelatin sheet and the resulting outer protective surface has a grooved pattern the reverse of that on the gelatin sheet. A pair of such screens when inserted in a cassette and used in the normal manner shows a superior resistance to abrasion, denting and scratching as compared to a similar screen prepared on a smooth, polished surface.

Example II

A glass plate provided with a pattern which is the reverse or impression of that illustrated in Fig. 1 is coated with a solution of cellulose nitrate in amylacetate to form a layer having a thickness of 0.5 mm. A dispersion of calcium wolframate in an ethyl cellulose solution in propanol-2 and toluene is cast onto the dry layer of cellulose nitrate and, after it is set up to a tacky condition, a layer of cardboard is applied to the outer surface and the entire assembly allowed to dry for a period of 8 to 20 hours. The fluorescent screen assembly is then stripped from the glass plate and its front surface has the pattern shown in Fig. 1. A pair of such screens when used in normal manner in a cassette has superior resistance to abrasion, scratching and denting when compared with a similar one having no grooved pattern surface.

In place of the particular fluorescent materials described in the foregoing examples there may be substituted equivalent amounts of other fluorescent compounds or mixtures of compounds which

are suitable for fluorescent screens. Additional suitable materials include zinc sulfide, zinc silicate, mixed crystals of zinc sulfide and cadmium sulfide, zinc oxide and calcium silicate.

In place of the particular film-forming materials given in the foregoing example there may be substituted various other hard-film-forming polymers which produce smooth, non-tacky, water-resistant films. Suitable additional polymeric materials include cellulose acetate propionate, cellulose acetate butyrate, polymethyl methacrylate, polystyrene, polyvinyl chloride, nylon, superpolyesters of terephthalic acid and ethylene glycol and/or ethylene polyglycols, polyethyl methacrylate, polyvinyl acetate and polyvinyl acetate chloride.

In place of the cardboard supports described in the foregoing examples there may be substituted various other flexible or relatively stiff supports including sheets of various plastic materials, e. g., cellulose derivatives, superpolymers and synthetic resins. Suitable materials of this type include cellulose nitrate, cellulose acetate, cellulose acetate propionate, cellulose acetate butyrate, polyvinyl chloride, polystyrene, polyethylene terephthalate, etc., mixtures of polyvinyl acetate and cellulose nitrate, polymethyl methacrylate and polyethyl methacrylate. The polymeric materials for the supports may contain various light occluding materials, e. g., dyes and pigments in order to make the base more opaque to the light. Suitable materials include magnesium oxide, Luxol Fast Yellow T, aluminum powder and titania.

The screens may also be provided with a light-reflecting layer between the support and the fluorescent layer. This layer may be composed of a cellulose derivative, resin or superpolymer which has a pigment or dye dispersed throughout to reduce or increase reflection of the fluorescent light. Magnesium oxide-pigmented-cellulose nitrate or -ethyl cellulose or -polyvinyl acetate form useful pigmented layers.

In place of a particular solvent given in the examples there may be substituted other high boiling solvents which have a solvent action on the polymeric material used for the outer protective layer or for the binding agent for the fluorescent particles. Suitable additional solvents include methyl lactate, ethyl lactate, diacetone alcohol, and mixtures of two or more of such solvents. In addition, various low boiling solvents, e. g., acetone, butanone, pentanone, ethyl acetate, propyl acetate, amyl acetate, dioxalane, methyl dioxalane, and the propanols and butanols can be mixed with the higher boiling solvents and used in the coating compositions for the protective layer and the fluorescent layer.

An advantage of this invention resides in the fact that the fluorescent screens which have a groove-patterned protective surface are more resistant to marring such as denting, scratching and abrasion. These screens, if the patterns are sufficiently fine, do not interfere in any way with their utility in radiographic exposures. The depth and shape of the indentations in the patterns should be just small enough so that no objectionable patterns are evident in the fluorescent image. This can be readily determined by a simple test. The patterned screens have, in a sense, a dotted outer surface because of the rounded peaks, etc., which means that only a portion of the total area of a screen contacts with a flat surface. This reduces scratching and abrasion.

A further advantage of the screens resides in

the fact that dust particles fall into the grooves or depressions so that scratching and denting is eliminated during normal use of the screens because the particles are removed from the outermost surfaces.

A further advantage of the invention and particularly that of the long interconnected indentations or grooves is that passages are provided for the escape of air trapped between the screen and light-sensitive film element upon closing the cassette. The feature enables one to obtain a more rapid contact between the light-sensitive surface of the film element and the surface of the appertaining screen.

A still further advantage of the invention resides in the fact that the patterns destroy the continuity of any long scratches or dents, thus improving the appearance of the screens. Still another advantage resides in the fact the screens may be readily cleaned.

As many widely different embodiments of this invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not to be limited except as defined by the claims.

What is claimed is:

1. A fluorescent screen comprising a support, a layer of fluorescent particles on said support and an outer protective layer composed of a hydrophobic, hard-film-forming polymer, the outer surface of which has a shallow grooved pattern surface, said grooves being regularly spaced, continuous and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2.5 mm.

2. A fluorescent screen comprising a sheet support, a layer of fluorescent particles on said support and an outer protective layer composed of a hydrophobic, hard-film-forming polymer, the outer surface of which has a shallow grooved pattern surface, said grooves being regularly spaced, straight and continuous and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2.5 mm.

3. A fluorescent screen comprising a support, a layer of fluorescent particles and an outer protective layer composed of a hydrophobic hard-film-forming polymer the outer surface of which has a regularly spaced crisscross, ridged and grooved pattern surface, said grooves being continuous and extending to the respective edges of the screen and having cross-sections of such dimensions that they produce no significant visual image pattern upon excitation of the fluorescent particles.

4. A fluorescent screen comprising a support, a layer of fluorescent particles and an outer protective layer composed of a hydrophobic hard-film-forming polymer the outer surface of which has a regularly spaced, crisscross, ridged and grooved pattern surface, said grooves being continuous and extending to the respective edges of the screen and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2 mm.

5. A fluorescent screen comprising a support, a layer of fluorescent particles and an outer protective layer composed of a hydrophobic hard-film-forming polymer the outer surface of which has a regularly spaced, diagonally crisscross, ridged and grooved pattern surface, said grooves being continuous and extending to the respective edges of the screen and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2 mm.

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6. A screen as set forth in claim 5 wherein said support is cardboard said polymer is a cellulose derivative and said fluorescent material is mixed crystals of lead and barium sulfate.

7. A screen as set forth in claim 6 wherein said derivative is cellulose nitrate.

8. A fluorescent screen comprising a support, a light-reflecting layer, a layer of fluorescent particles and an outer protective layer composed of a hydrophobic hard-film-forming polymer the outer surface of which has a regularly spaced, crisscross, ridged and grooved pattern surface, said grooves being continuous and extending to the respective edges of the screen and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2 mm.

9. A fluorescent screen comprising a support, a layer of fluorescent particles and an outer pro-

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protective layer composed of a hydrophobic hard-film-forming polymer the outer surface of which has a regularly spaced, crisscross, ridged and grooved pattern surface, said grooves being straight, continuous and extending to the respective edges of the screen and being from 0.02 to 0.035 mm. in depth and 0.1 to 0.25 mm. in width and the centers being spaced from 0.1 to 2 mm.

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