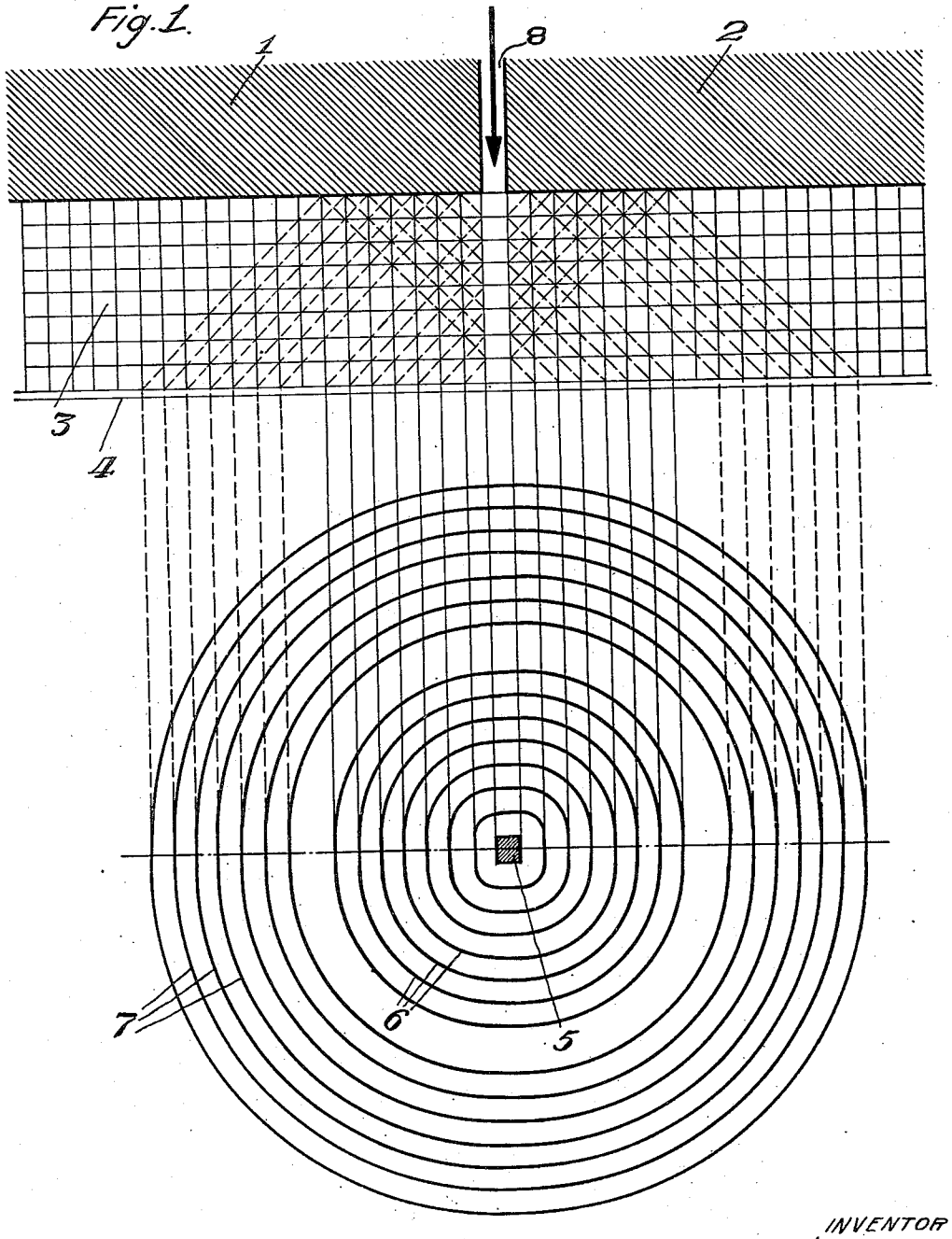
Aug. 3, 1937. J. HARTMANN 2,088,595

FLUORESCENT SCREEN

Filed May 12, 1931 2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

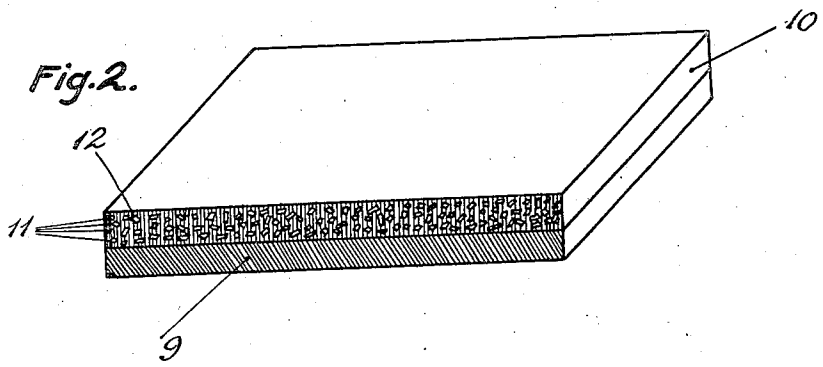


Fig. 3.

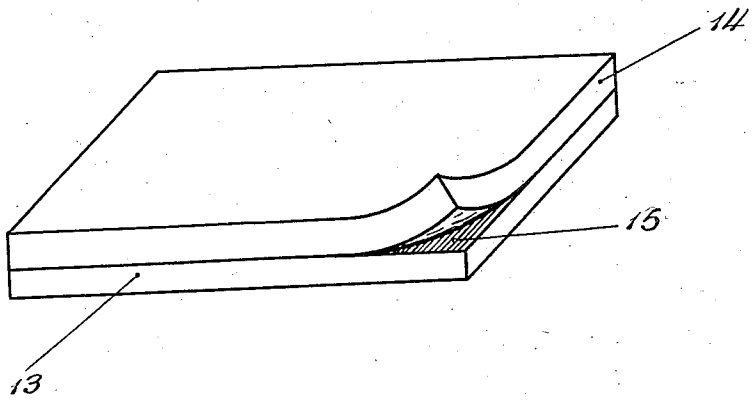
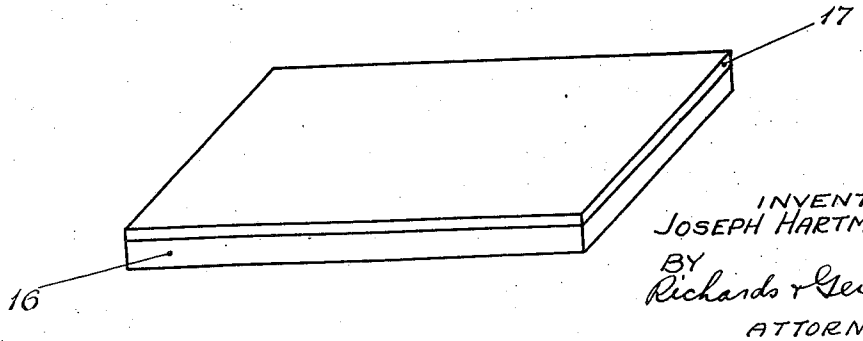


Fig. 4.



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FLUORESCENT SCREEN

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Application May 12, 1931, Serial No. 536,954
In Germany May 24, 1930

4 Claims. (Cl. 250—34)

This invention refers to improvements in X-ray photography and relates more particularly to fluorescent screens and the method of producing the same.

In the art of producing X-ray images fluorescent screens are used for the purpose of diminishing the time of exposure during photography. Such screens are constructed with a view to obtaining the best possible efficiency of light and consequently the most favorable coefficient of strengthening. It has been found, however, that such fluorescent screens, when used, considerably diminish the fineness of outlines, as compared with devices wherein no strengthening is employed during photography. No means have been found heretofore to obviate this drawback of an insufficient fineness of outlines due primarily to the fact, verified by experiments, that a part of the light projected to all sides from the individual crystals, i. e., the fluorescent material of the fluorescent layer reaches the sensitized layer of a photographic film or plate only after it had been reflected either once or many times by the adjacent crystals or by the base of the screen.

The main object of this invention is to obviate the above-mentioned drawback by eliminating the causes to which it is due.

This invention consists in the provision of a method of making fluorescent screens in such a way that such screens either annihilate as much as possible the diffused light which blurs the picture or prevent this light from spreading. This is achieved according to this invention, for instance, by coloring the fixing means in which the crystals are embedded and which together with the crystals constitutes the fluorescent layer, or by making the base non-reflective. A considerable improvement may also be obtained by substantially diminishing the thickness of the fluorescent layer as compared with layers used heretofore.

In prior art the thickness of the fluorescent layer had been chosen from the point of view of the best strengthening only. It has been found thereby that the best results are obtained when using double films which are common nowadays, if two fluorescent screens are employed having fluorescent layers of an equal thickness of about .15 millimeter to .20 millimeter each. A somewhat thinner fluorescent layer of about .12 millimeter thickness has also been used for the fluorescent screen lying between the focus and the sensitized layer of a photographic film or plate owing to the fact that the fluorescent screen lying close to the focus absorbs the X-rays to an undesirable extent when thicker fluorescent layers are used. A fluorescent layer which is .20 millimeter thicker than the above-mentioned one was usually chosen for the fluorescent screen lying furthest from the focus, because the strengthening action of the last-mentioned screen increases with an increase in the thickness of the layer, respectively the amount of luminous substance and also because the last-mentioned screen does not noticeably absorb the X-rays.

Owing to the fact that the fineness of outlines of two different fluorescent screens is determined by the fineness of outlines of the worst screen, the better fineness of outlines of the screen lying close to the focus which is possible to obtain by making the fluorescent layer of this screen thinner could not have any effect on the general results. As already explained, the effect of one screen was destroyed by the effect of the other screen. This combination of screens having fluorescent layers of different thicknesses, known in prior art, has consequently been used not to improve the fineness of the outlines produced by the fluorescent screens, but to increase the strengthening effect to an amount higher than that obtained by screens having equal thicknesses. The fact that the fineness of outlines produced by the screens can be varied by using fine-crystallic luminous substances has not been exploited because crystals of a smaller size resulting in a better fineness of outlines produce on the other hand a smaller luminous power and a weaker strengthening effect.

I have found that when very thin fluorescent layers of about .04 to .08 millimeter thickness are used, the above-mentioned drawback is obviated and such fine outlines are produced by the fluorescent screens that it is hardly possible to ascertain the difference in the fineness of outlines between two photographic films equally blackened, one of which is provided with screens during exposure whereas the other has no screens. The strengthening effect of the fluorescent screen is somewhat diminished but it retains its capacity of considerably shortening the time of exposure. In using such screens, by means of which an optimum of the strengthening effect cannot be produced, it is possible to obtain photographic negatives having considerably finer outlines, if the time of exposure is somewhat lengthened. Whenever using fluorescent screens for double films, obviously two fluorescent screens must be employed, which should not be thicker than the above-mentioned ones.

In prior art a white, powerfully reflecting base

was always used with fluorescent screens and I have found that such a base also diminishes the fineness of outlines. According to this invention, this drawback is obviated by preventing the light emerging from the fluorescent layer from being reflected by the base of the fluorescent screen. For this purpose I provide a black base or a base having an approximately complementary color to the light emerging from the fluorescent layer to be used as the base of this fluorescent layer. For instance, a black cardboard with a colorless glue may be used or the back surface of the fluorescent layer may be correspondingly colored.

I have also found that it is also particularly advantageous to color the fluorescent layer itself, either totally or partly, for instance in a stratified way, In this case also the strengthening effect is somewhat diminished but on the other hand the fineness of outlines is considerably improved. For coloring purposes I prefer to use either black substances or substances of another color which sufficiently absorb the light of the screen, and I prefer to add said substances, either in a solid or in a dissolved state, to the glue of the fluorescent layer before the working up takes place. With such fluorescent screens negatives having very fine and well outlined contours may be obtained even if these screens are made thicker and it is hardly possible to distinguish these negatives from negatives which have been obtained without the use of screens. A colored fluorescent layer improves the fineness of outlines due to the fact that it absorbs luminescent rays which do not fall directly upon the film surface but travel a longer way in the layer than the directly falling rays. These luminescent rays are the ones which spoil most of all the fineness of outlines and they are readily absorbed by a colored fluorescent layer.

The fineness of outlines of luminous screens, as well as that of fluorescent screens, may be improved in a similar way by diminishing the thickness of the fluorescent layer or by obviating the reflection of light at the base of the screen or at the layer itself.

The invention will appear more clearly from the following description when taken in connection with the accompanying drawings showing preferred embodiments of the inventive idea.

In the drawings:

Figure 1 shows diagrammatically the diffusion of light caused by a thick fluorescent screen.

Figure 2 shows a fluorescent screen provided with a colored fluorescent layer.

Figure 3 shows a fluorescent screen provided with a non-reflectant base.

Figure 4 shows a fluorescent screen having a very thin fluorescent layer.

The diagram illustrated in Figure 1 shows sheets 1 and 2 made of lead, a fluorescent layer 3 and a photographic film 4. For simplicity's sake the crystals of the fluorescent layer have been represented as being cubes although actually they have the shape of a more complicated geometrical figure. Roentgen rays pass through the slot 8 and produce a dark spot 5 on the film. Some of these rays are caught, however, by the edges of the crystals and are compelled to traverse a longer path within the fluorescent layer 3 until they reach the film 4. These rays produce circles 6 on the film 4, and, obviously, diminish the fineness of outlines. Other rays are reflected by the crystals onto the lead plates 1 and 2, and travel through the fluorescent layer 3 in two directions until they finally reach the film 4. These rays produce circles 7 on the film and diminish still further the fineness of outlines.

The diagram shows that in order to increase the fineness of outlines, the fluorescent layer should be made as thin as possible, so as to decrease the number of superposed crystals. The same object can be realized by intercepting reflected light rays traveling through the layer, which is accomplished by adding a coloring substance to said layer; in the example illustrated this would eliminate circles 6 and 7 from the film. It is also possible to make the base of the fluorescent screen non-reflectant, which would eliminate the circles 7.

The fluorescent screen shown in Figure 2 comprises a base 9 made of cardboard or other suitable material and carrying a fluorescent layer 10. The layer 10 consists of fluorescent crystals 11 embedded in a binding substance 12 which is mixed with a pigment and is colored through the presence of said pigment.

The fluorescent screen shown in Figure 3 comprises a base 13 carrying a fluorescent layer 14. One corner of the layer 14 is bent upwards and away from the base 13 to show that the surface 15 of the base 13, which is nearest to the layer 14, is made non-reflectant, for instance, black.

Figure 4 shows a fluorescent screen comprising a base 16 and a very thin fluorescent layer 17, which may have the thickness of less than one tenth of a millimeter.

I claim:—

1. In a fluorescent screen, in combination, a fluorescent material adapted to emit a fluorescent light, some of said light being diffused and reflected, and means diminishing the amount of substantially all wave lengths of the fluorescent light which affects the light-sensitive layer, said means absorbing at least part of said diffused and reflected fluorescent light, whereby the fineness of outlines of a photograph, produced by the effect of the emitted fluorescent light upon the light-sensitive layer, is increased.

2. In a fluorescent screen, a fluorescent material adapted to emit a fluorescent light, some of said light being diffused and reflected, and a colored substance diminishing the amount of substantially all wave lengths of the fluorescent light which affects the light-sensitive layer, said colored substance absorbing a part of said diffused and reflected fluorescent light, whereby the fineness of outlines of a photograph, produced by the effect of the emitted fluorescent light upon the light-sensitive layer, is increased, said colored substance being admixed with at least a part of said fluorescent material.

3. In a fluorescent screen, a fluorescent material adapted to emit a fluorescent light, fixing means in which said fluorescent material is imbedded, some of said fluorescent light being diffused and reflected, and a coloring substance diminishing the amount of substantially all wave lengths of the fluorescent light which affects the light-sensitive layer, said coloring substance absorbing at least a part of said diffused and reflected fluorescent light, whereby the fineness of outlines of a photograph, produced by the effect of the emitted fluorescent light upon the light-sensitive layer, is increased, said fixing means being admixed with said coloring substance.

4. In a fluorescent screen, a fluorescent material adapted to emit a fluorescent light, fixing means in which said fluorescent material is im-

bedded, some of said fluorescent light being diffused and reflected, and a coloring substance diminishing the amount of substantially all wave lengths of the fluorescent light which affects the light-sensitive layer, said coloring substance absorbing at least a part of said diffused and reflected fluorescent light, whereby the fineness of outlines of a photograph produced by the effect of the emitted fluorescent light upon the light-sensitive layer, is increased, said coloring substance being admixed with a part of said fixing means.

JOSEPH HARTMANN.