April 7, 1942. 2,279,023

HARTMUT ISRAEL KALLMANN, FORMERLY KNOWN AS HARTMUT KALLMANN ET AL

METHOD AND DEVICE FOR DEPICTING OBJECTS

Filed Oct. 19, 1939

Fig. 1.

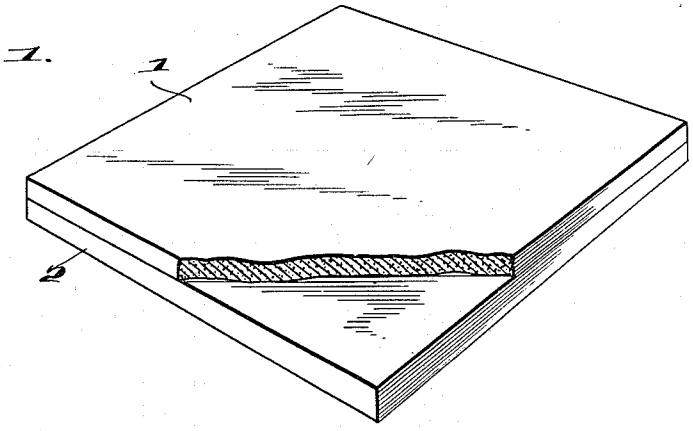



Fig. 2.

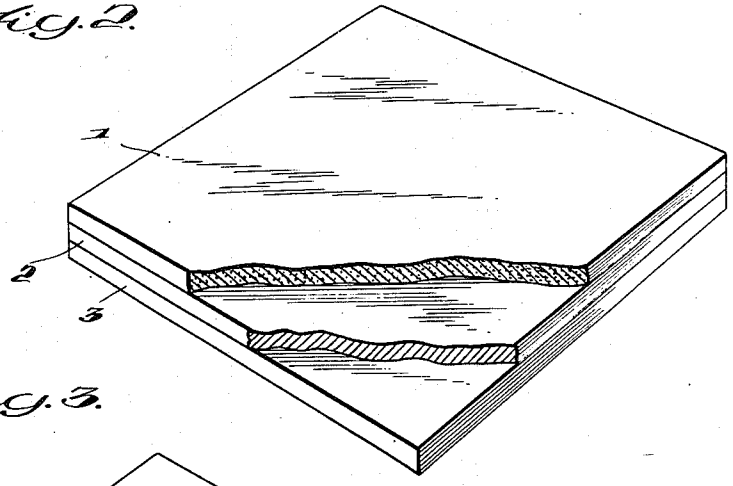
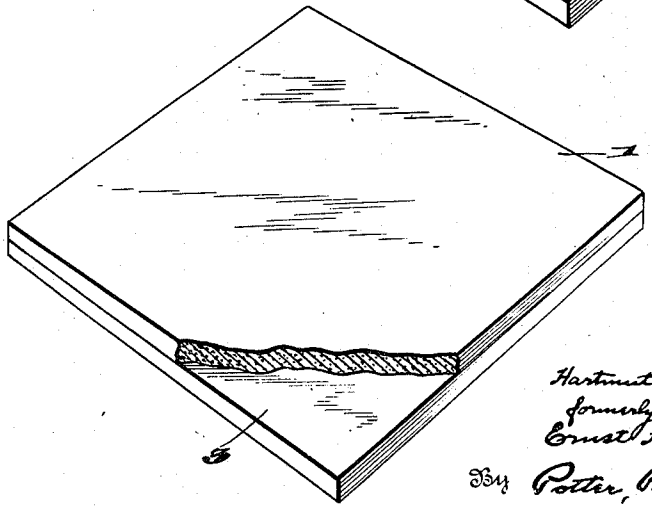



Fig. 3.




Inventors:
Hartmut Israel Kallmann,
formerly known as Hartmut Kallmann,
Ernst Kuhn,
By Potter, Pierce & Scheffler,
Attorneys.

Patented Apr. 7, 1942

2,279,023

# UNITED STATES PATENT OFFICE

2,279,023

## METHOD AND DEVICE FOR DEPICTING OBJECTS

Hartmut Israel Kallmann, formerly known as Hartmut Kallmann, Berlin-Charlottenburg, and Ernst Kuhn, Berlin, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany

Application October 19, 1939, Serial No. 300,276
In Germany October 19, 1938

15 Claims. (Cl. 250—83)

This invention relates to a method for the investigation of substances with the aid of quick neutrons and is particularly concerned with the provision of means for showing the distribution of the intensity in a beam of quick neutrons.

It has already been suggested to show the distribution of the intensity in a beam of slow neutrons by first causing the slow neutrons to produce heavy particles, electrons or gamma rays in an intermediate layer and then causing said heavy particles etc. to act upon a fluorescent material or/and a photographic layer adjacent to the first layer. Showing the distribution of the intensity in a beam of slow neutrons is important especially when the neutrons are directed through objects, for instance, living bodies, in order to depict these objects with the aid of slow neutrons.

Under certain circumstances the transillumination and depicting of objects by means of slow neutrons is however rather difficult to be carried out especially if the objects investigated absorb slow neutrons particularly strongly.

It is an object of the present invention to obviate these difficulties. Another object of the invention is the provision of means for showing a representation of the distribution of the intensity in a beam of quick neutrons. These inventive objects are attained by directing a beam of quick neutrons through a body or substance and by causing the quick neutrons emerging from the body or substance to encounter an intermediate layer in which heavy particles, positively or negatively charged electrons, or gamma radiation are produced under the action of the quick neutrons. These heavy particles etc. are in turn caused to act upon fluorescent material and/or a photosensitive plate or film adjacent to the intermediate reaction layer in the usual way. They thus produce a representation of the distribution of the intensity of the beam of quick neutrons on the fluorescent material and/or the photosensitive plate or film.

Showing a representation of the distribution of the intensity of a beam of quick neutrons is in general more complicated than showing a representation of a beam of slow neutrons due to the small power of absorption of the intermediate reaction layers against quick neutrons and due to their being necessarily rather thin in order to obtain sharpness of the images. The following layers are, however, well adapted to the purpose in view. For instance a thin layer of paraffin can be most adavntageously used in the following manner. The quick neutrons are caused to liberate hydrogen nuclei from the layer of paraffin by collisions, said nuclei emerging from the paraffin with high velocity are in turn caused to energize an adjacent fluorescent substance the radiation proceeding from which can be used for blackening a photosensitive layer or for visual observation. Under certain circumstances it is more favourable to cause the hydrogen nuclei emerging from the paraffin to act directly upon a photosensitive layer. Instead of the paraffin also other hydrogenous compounds can be employed; finally also other atomic nuclei can be caused to be liberated by the quick neutrons, but owing to their larger mass the transmission of energy to these nuclei is much slighter than with hydrogen nuclei and in consequence thereof the output is very small.

The intermediate reaction layer may, furthermore, advantageously consist of a substance in which the quick neutrons produce nuclei disintegration processes being accompanied by the emission of heavy charged particles these particles being caused to excite a fluorescent substance or/and to act directly or indirectly upon a photosensitive layer. Such reactions take place for instance in magnesium or in layers containing this metal.

As intermediate reactions furthermore such nuclear reactions may be employed in the course of which radioactive nuclei are generated under the influence of the quick neutrons. These radioactive nuclei emit electrons which can be in turn caused to energize fluorescent material or/and to act directly or indirectly upon a photosensitive layer.

As intermediate reaction finally all processes can be employed in the course of which excited nuclei are anyhow generated under the action of the quick neutrons. These excited nuclei give off their energy of excitation, for instance in form of gamma radiation which can act directly or indirectly upon fluorescent material or/and a photosensitive layer. As an example for such reaction we mention the excitation of the cadmium and copper nucleus by collision with quick neutrons. This process is distinguished by its comparatively large output.

Embodiments of the invention are illustrated in the accompanying drawing, in which

Fig. 1 is a perspective view, with parts broken away, of a device incorporating principles of the present invention, and

Figs. 2 and 3 are perspective views of modified forms of the device illustrated in Fig. 1.

In Figs. 1 and 2, 1 is a layer of paraffin or

equivalent intermediate substance, and 2 is a layer of fluorescent substance adjacent layer 1. In Fig. 2, 3 is a photosensitive layer adjacent layer 2 and on the side of the latter remote from layer 1. In Fig. 3, the layer of fluorescent substance shown at 2 in Fig. 2 is omitted, and the photosensitive layer is brought adjacent layer 1.

We claim:

1. A method of obtaining an image of an object by means of quick neutrons, which comprises directing a beam of quick neutrons upon the object, causing the emergent beam of quick neutrons to impinge upon a layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, and causing the radiation to impinge upon an adjacent layer of material which is sensitive to said radiation.

2. A method of obtaining an image of an object by means of quick neutrons, which comprises directing a beam of quick neutrons upon the object, causing the emergent beam of quick neutrons to impinge upon a layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, and causing the radiation to impinge upon an adjacent layer of fluorescent material.

3. A method of obtaining an image of an object by means of quick neutrons, which comprises directing a beam of quick neutrons upon the object, causing the emergent beam of quick neutrons to impinge upon a layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, and causing the radiation to impinge upon an adjacent layer of photo-sensitive material.

4. A method of obtaining an image of an object by means of quick neutrons, which comprises directing a beam of quick neutrons upon the object, causing the emergent beam of quick neutrons to impinge upon a layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, causing the radiation to impinge upon an adjacent layer of fluorescent material, and causing the resulting visible radiation to impinge upon a photo-sensitive layer.

5. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, said front layer being immediately adjacent to a layer of material which is sensitive to radiation emitted under the influence of quick neutrons.

6. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, said front layer being immediately adjacent to a layer of fluorescent material.

7. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, said front layer being immediately adjacent to a layer of photo-sensitive material.

8. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit radiation of the group consisting of charged particles and gamma radiation, said front layer being immediately adjacent to a layer of fluorescent material, and a back layer of photo-sensitive material adjacent said fluorescent material layer.

9. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit gamma radiation, said front layer being immediately adjacent to a layer of material which is sensitive to gamma radiation.

10. The device defined in claim 9, in which the gamma radiation-emitting substance of the front layer is a metal of the group consisting of cadmium and copper.

11. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a hydrocarbonaceous substance which reacts with quick neutrons to emit high velocity hydrogen nuclei, said front layer being immediately adjacent to a layer of material which is sensitive to high velocity hydrogen nuclei.

12. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing paraffin which reacts with quick neutrons to emit high velocity hydrogen nuclei, said front layer being immediately adjacent to a material which is sensitive to high velocity hydrogen nuclei.

13. A device for forming an image of the distribution of the intensity of a beam of quick neutrons, which comprises a front layer containing a substance which reacts with quick neutrons to emit charged particles, said front layer being immediately adjacent to a layer of material which is sensitive to charged particles.

14. The device defined in claim 13, in which the charged-particle-emitting substance is magnesium.

15. A method of obtaining an image of an object by means of quick neutrons, which comprises directing a beam of quick neutrons upon the object, causing the emergent beam of quick neutrons to impinge upon a layer containing paraffin which reacts with quick neutrons to emit high velocity hydrogen nuclei, and causing such emitted nuclei to impinge upon an adjacent layer of material which is sensitive to high velocity hydrogen nuclei.

HARTMUT ISRAEL KALLMANN,
*Formerly known as Hartmut Kallmann.*
ERNST KUHN.