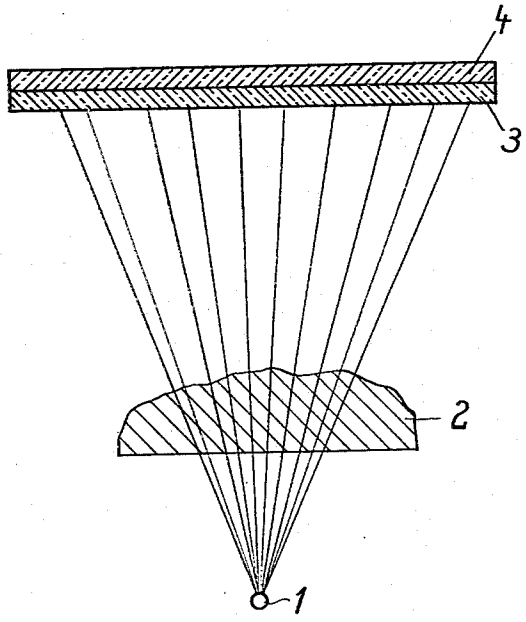
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METHOD OF INVESTIGATING SUBSTANCES

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METHOD OF INVESTIGATING SUBSTANCES

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19 Claims. (Cl. 250—83)

This invention relates to a method for the investigation of substances with the aid of slowly moving neutrons and is particularly concerned with the provision of a device for showing the distribution of the intensity in a neutron beam directed through the body or substance being investigated. It has already been suggested to investigate substances, including for instance living tissue, with the aid of slowly moving neutrons, as many substances considerably absorb or disperse slow neutrons, i. e., those of which the de Broglie wave length is approximately equal to, or is greater than the nuclear diameter of the body or substance. This investigation may be carried out by directing a beam of neutrons through the body or substance and causing the neutrons that emerge from it to encounter a layer in which heavy charged particles or radioactive nuclei emitting positively or negatively charged particles are produced under the action of the impinging neutrons. These particles are in turn caused to act upon a layer of fluorescent material or an adjacent photographic layer thus producing there an image of the investigated body or substance (as disclosed and claimed in our copending application Serial No. 270,354 filed April 27, 1939). Which special intermediate reaction has to be used depends on the specific investigation desired to be carried out.

It has been found that not all slow neutrons have the same velocity; on the contrary their velocities are distributed over a large velocity spectrum extending from thermal energy ($^1/_{40}$ volt, at room temperature) up to several volts. The different intermediate reactions differently strongly respond to neutrons of different velocity range. If therefore a definite reaction is chosen, the investigated body is preferably depicted by neutrons of a certain definite velocity range.

But there exist still other reactions, which are more or less sensitive to neutrons of other velocity ranges. Such reactions are those in which gamma radiation emitting nuclei are formed under the action of the impinging neutrons. It is an object of the present invention to utilize this gamma radiation reaction for showing the distribution of the intensity in a neutron beam for the investigation of substances.

According to the present invention the neutrons after having traversed the substance to be investigated are caused to act upon an intermediate layer containing atomic nuclei, such as cadmium adapted to be transformed into gamma radiation emitting nuclei by the action of the impinging neutrons. The gamma radiation, thus generated in the intermediate layer by the neutrons, is in turn caused to act upon a layer of fluorescent material and/or a photographic plate or film adjacent to the reaction layer and produces an image of the distribution of the intensity in the neutron beam in this second layer either by energizing the fluorescent material or by directly blackening the photosensitive layer. The radiation proceeding from the fluorescent material can be either directly observed or caused to blocken an adjacent photographic plate or film. The fluorescent material and the gamma radiation emitting material may be mixed together or one or more layers of fluorescent material or photosensitive material may be arranged between two or more layers of the gamma radiation emitting material so that a layer of the former lies between each two adjacent layers of the latter.

Processes in which gamma radiation emitting nuclei are formed, take place for instance, if neutrons are captured by any atomic nuclei. In such a case new non-radioactive atomic nuclei are formed which contain one neutron more than the original nuclei. These new atomic nuclei give off the energy liberated at said capture in the form of gamma radiation.

The simplest form of carrying out the invention is now more specially described with reference to the accompanying drawing in which the single figure schematically illustrates a mode of using the invention. In the figure a source of neutrons is conventionally indicated at 1. 2 is the body being investigated. The neutrons emerging from this body encounter the layer 3 which contains atomic nuclei which can be transformed into gamma radiation emitting nuclei by the action of the neutrons.

The radiation thus proceeding from the layer 3 produces then an image of the distribution of the intensity over the impinging neutron beam in the adjacent layer 4, which may be a fluorescent screen or a photographic-sensitive layer. The energizing of the fluorescent screen or the blackening of the photographic layer respectively takes place owing to the secondary electrons liberated by the gamma radiation.

We claim:

1. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of fluorescent

material and exposing the associated layers to the action of a beam of slow neutrons.

2. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing cadmium atoms adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of fluorescent material and exposing the associated layers to the action of a beam of the slow neutrons.

3. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of fluorescent material adjacent to a photosensitive layer and exposing the associated layers to the action of a beam of slow neutrons.

4. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing cadmium atoms nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of fluorescent material adjacent to a photosensitive layer and exposing the associated layers to the action of a beam of slow neutrons.

5. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of photosensitive material and exposing the associated layers to the action of a beam of slow neutrons.

6. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing cadmium atoms nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of photosensitive material and exposing the associated layers to the action of a beam of slow neutrons.

7. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises mixing a substance containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons with a substance of fluorescent material and exposing the mixture of said substances to the action of a beam of slow neutrons.

8. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons, said layer being arranged adjacent to a layer of fluorescent material so that rays emitted by said first named layer act upon the fluorescent material.

9. The device defined in claim 8 in which the gamma radiation emitting layer contains cadmium atoms.

10. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons, said layer being arranged adjacent to a layer of fluorescent material which in turn is arranged adjacent to a photosensitive layer so that rays emitted by said first named layer act upon the fluorescent material which in turn acts on the photosensitive layer.

11. A device defined in claim 10 in which the gamma radiation emitting layer contains cadmium atoms.

12. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons, said layer being arranged adjacent to a layer of photosensitive material so that rays emitted by said first named layer act upon the photosensitive material.

13. A device defined in claim 12 in which the gamma radiation emitting layer contains cadmium atoms.

14. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing a fluorescent material mixed with a material containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons.

15. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing a photosensitive material mixed with a material containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons.

16. A device for showing the distribution of the intensity in a neutron beam which comprises a plurality of layers containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons and a layer comprising a fluorescent material and a photosensitive material positioned between an adjacent pair of said first named layers.

17. A device for showing the distribution of the intensity in a neutron beam which comprises a plurality of layers containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons, and a layer of photosensitive material between each adjacent pair of layers.

18. A method for showing a representation of the distribution of the intensity in a neutron beam, which comprises applying a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons to a layer of a material of the group consisting of fluorescent and photosensitive materials and exposing the associated layers to the action of a beam of slow neutrons.

19. A device for showing a representation of the distribution of the intensity in a neutron beam which comprises a layer containing atomic nuclei adapted to be transformed into gamma radiation emitting nuclei by the action of impinging neutrons, said layer being arranged adjacent to a layer of a material of the group consisting of fluorescent and photosensitive materials so that rays emitted by said first named layer act upon the material.

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