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METHOD AND DEVICE FOR DEPICTING OBJECTS
BY MEANS OF NEUTRONS OR X-RAYS
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Fig. 1

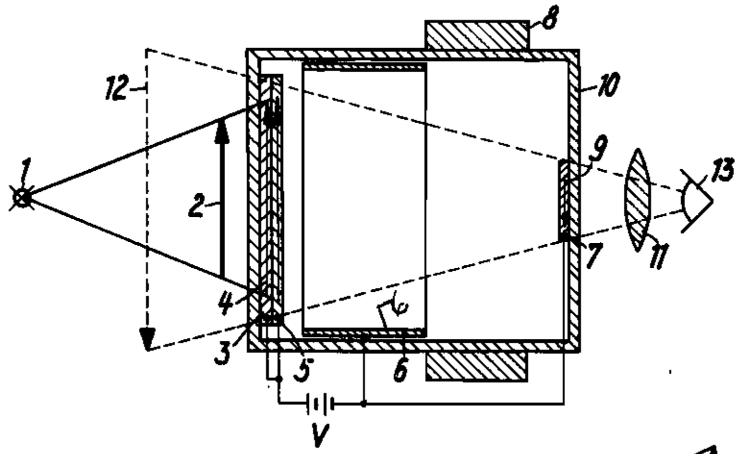

Fig. 2

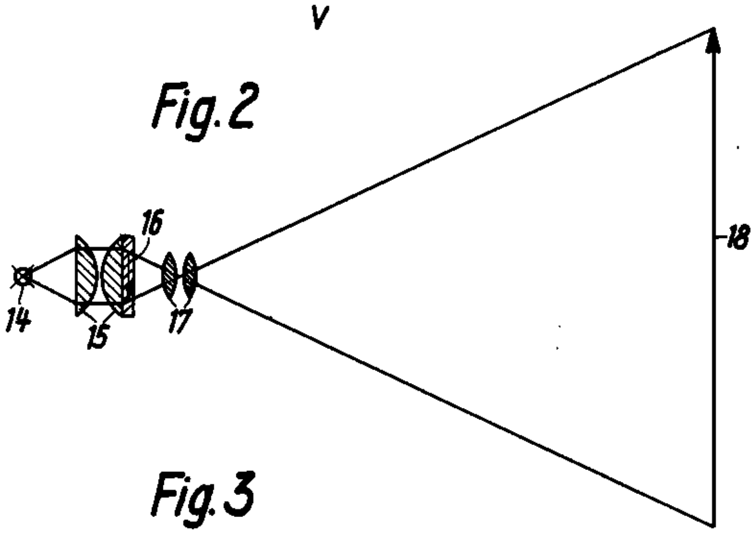

Fig. 3

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METHOD AND DEVICE FOR DEPICTING OBJECTS BY MEANS OF NEUTRONS OR X-RAYS

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It has been proposed to depict objects by means of neutrons in a similar manner as it is known from X-rays. The difficulty consists, however, that the sources of neutrons which are at disposal possess only a slight intensity in proportion to the possibility to blacken a photographic layer by means of neutrons, so that even with the best neutron-photographing systems known at the time, it is necessary to expose for a comparatively long time. Increasing of the intensity of the source of neutrons, which would be possible in principle, is connected with a very considerable technical expense and requires besides very much space. It has further been proposed, to use for the production of photographic pictures of objects by means of neutrons a neutron-image-converter, in which in a neutron-reactive layer by the neutrons depicting the objects charged particles or gamma rays are released, which produce secondary electrons directly or indirectly through the intermediary of a luminescent mass, said secondary electrons being accelerated and collected with the aid of suitable electron-optical means upon a photographic layer where they produce an image of the depicted object. It has also been proposed, to collect, for increasing the sensitiveness of this image-converter, these electrons not directly upon a photographic layer but upon a luminescent screen, the radiation of said screen emitted under the influence of the impinging electrons acting upon the photographic layer. However, even if these special auxiliary means are employed, a comparatively intensive source of neutrons is still required if the picture has to be produced within a few minutes with sufficient sharpness.

It is an object of the present invention to overcome this drawback. This and other inventive purposes are attained thereby that in the neutron-image-converter the released secondary electrons, preferably after their acceleration, are collected by electron-optical means to form an image of the object to be depicted reduced in size on an luminescent screen and/or on a photographic layer and that this image reduced in size is enlarged to a real or virtual image under circumstances after the latent photographic image has been developed. It is then advisable to adjust the image-converter, so that the originally slow secondary electrons are preferably employed for the copying. At the electron-optical reducing neither a loss in intensity nor a loss in sharpness of the picture occurs. At this reducing practically all secondary electrons are employed which are emitted to one side. In opposition here to at a light-optical reduction only that portion of the light radiation is utilized, which enters into the lens aperture. At the electron-optical reduction the brightness per unit area is therefore practically inversely proportional to the size of the image. The strongly reduced image produced in this manner is preferably light-optically enlarged. If a latent photographic image reduced in size has been produced with the image-converter, the enlargement will be carried out after the development of the latent photographic image, for instance to the size of the latent image originally produced by the neutrons. The enlarged image possesses the same sharpness as the image which has been produced on an luminescent screen and/or on a photographic layer according to the methods formerly proposed. The exposing time necessary in the method according to the invention for the production of a photographic image is, however, for instance with a linear reduction in the proportion 1:10, hundred times shorter than in the formerly proposed methods. When retaining the time of exposing, it is therefore possible to use in the application of the method according to the invention a source of neutrons the intensity of which amounts to only 1/100 of the intensity of the source of neutrons necessary in the former methods.

This advantage of the method according to the invention is due amongst other reasons to that the reduced photographic image is subsequently enlarged by an additional source of energy, such as for instance the source of the light-optical enlarging arrangement which is absolutely independent on the source of neutrons. If the sharpness of the original image produced by the neutrons has to be preserved, the measure of the reduction and therewith the gain in intensity is practically limited by the dissolving power and the structure of the photographic system.

This method may also be employed for improving the visual observation of a luminescent screen image produced by means of the neutron-image-converter. The latent image primarily produced by the neutrons on the neutron-reactive layer is reduced and copied in the neutron-image-converter on a luminescent screen, and this reduced luminescent screen image is viewed through a magnifying glass. By viewing the luminescent screen image through a magnifying glass much more light will get into the eye from the locked on portion of the luminescent screen image than without magnifying glass, owing to the enlargement of the opening angle. For the reason that by the image converter the whole image can be reduced to the size of the field of vision of the magnifying glass, a larger portion of the light emitted by the luminescent screen gets into the eye, without decrease of the sharpness of the virtual picture.

Owing to the above mentioned reasons, the method described is very important for the depicting of objects by means of neutrons. Under certain circumstances it may, however, be employed also with advantage at the depicting of objects with the aid of X-rays can be produced nowadays up to very great efficiencies, but on the other hand the requirements as regards thickness of the objects to be depicted are also increased more and more, so that the exposing times are undesirably long even when the strongest transportable plants are used which are at disposal. In such conditions an X-ray-image-converter is used in which secondary electrons are released by the X-rays themselves, said secondary electrons being collected to form a luminescent screen- or latent photographic-image of the object to be depicted reduced in size, which reduced image is enlarged just as described in the case of the depicting by means of neutrons.

Two embodiments of the invention are diagrammatically shown by way of example in the accompanying drawing.

As shown in Fig. 1, the object 2 diagrammatically represented by an arrow is latently depicted on the neutron-reactive layer 3 by a source 1 of neutrons. The latent image 4 is, as regards size, as a rule not considerably different from the object 2. It is, however, also possible, with the arrangement shown, to produce on the reaction layer enlarged images of the object 2 when the distances between the source of radiation the object and the reaction layer are correspondingly selected. Charged particles or gamma rays are produced by the depicting radiation in the reaction layer 3, said particles or gamma rays releasing directly or indirectly secondary electrons in this reaction layer 3 or in an adjacent layer 5. These secondary electrons released from this layer 5 or from the layer 3 are accelerated by the electric field between the layer and the electrode 6 and electron-optically collected in known manner on the electronsensitive screen 7 to produce an image of the object 2. This screen 7 may consist of a luminescent screen on which the impinging electrons produce a luminous image of the object. By corresponding selection of the electron optical system, for instance of the magnetic lens 8, care is taken according to the invention that the image 9 of the object produced on the screen sensitive against electrons is much smaller than the latent image 4, which is produced in the reaction layer and as regards size corresponds substantially to the object to be depicted.

Through the wall 10 of the tube transparent at least behind the screen 7 and consisting for instance, of glass, a strongly enlarged virtual image 12 is produced with the aid of the magnifying lens 11, this image being viewed by means of the eye 13 which is diagrammatically shown.

Instead of the screen 7 just described and sensitive against electrons, which consisted of a luminescent screen, a photographic system may also be employed, on which in a similar manner a reduced latent photographic image 9 of the object 2 is produced. This image can be looked at only after the developing. With this object in view either a magnifying lens may be employed with the aid of which, as shown in Fig. 1, a virtual image is produced, or an enlarging arrangement may be used, which is diagrammatically illustrated in Fig. 2. By a source of energy 14, preferably independent on the source for the production of the depicting radiation, the developed reduced image 16 is exposed, if desired by interposition of a lens 15, and from this reduced image an enlarged real or virtual photograph 18 is produced by means of the enlarging light-optical system 17.

The production of the latent photographic image 9 by the secondary electrons released from the layers 3 or 5 may also be obtained by the circuitous way of a luminescent screen adjacent to a photographic layer. In this instance the electron-sensitive screen 7 is composed, as shown in Fig. 3, of two layers, i. e. a luminescent screen 19 on which the electrons act and a photographic layer 20.

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