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[54] **TELEVISION DISPLAY SYSTEM FOR ELECTROMAGNETIC BEAM APPARATUS**

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[51] **Int. Cl.** **H01j 37/26,** H04n 7/18

[58] **Field of Search** 178/6.8, 7.2; 250/311

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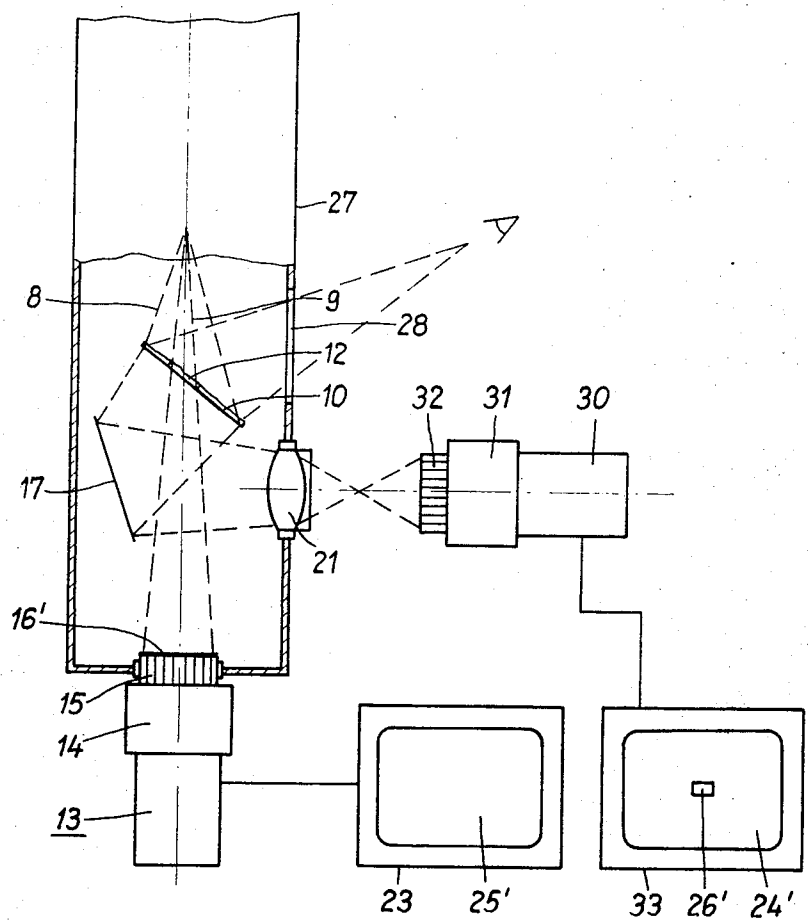
[57] **ABSTRACT**

An electromagnetic particle beam device, such as an electron microscope, includes a fluorescent screen mounted in the focal plane of the beam for providing a direct image a television camera arranged behind a window in the flourescent screen separately picks up and enlarges the part of the image which falls in the area of the window to permit simultaneous viewing of an overall picture and an electronically enlarged section of the picture.

4 Claims, 4 Drawing Figures



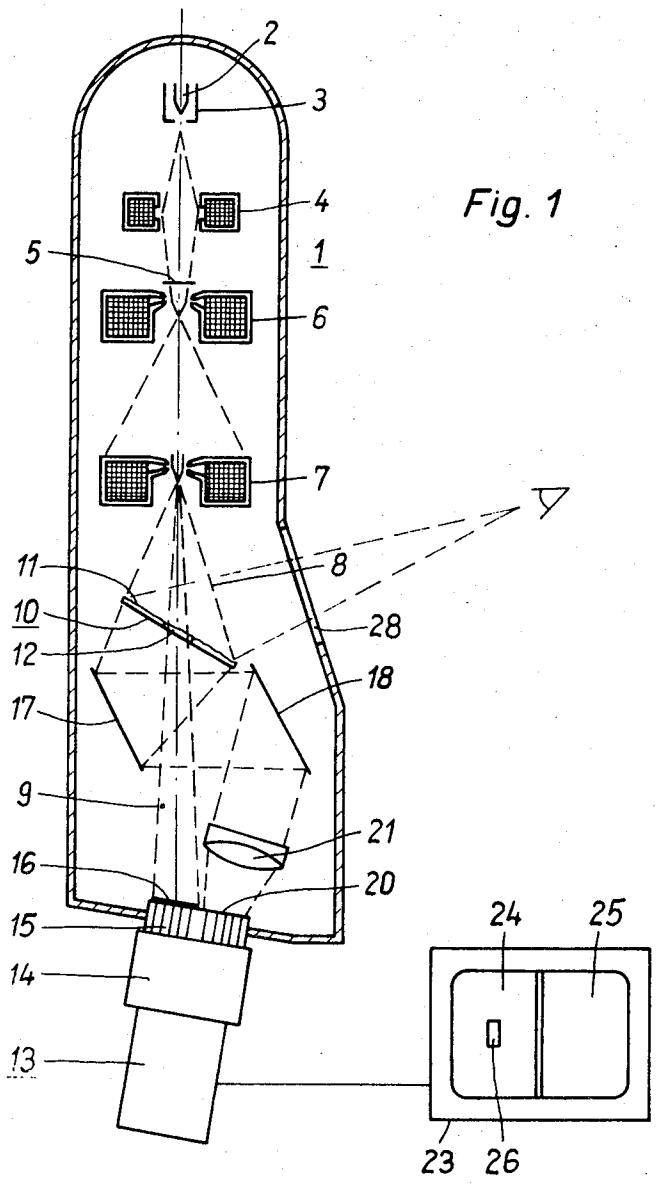


Fig. 1

Fig. 2

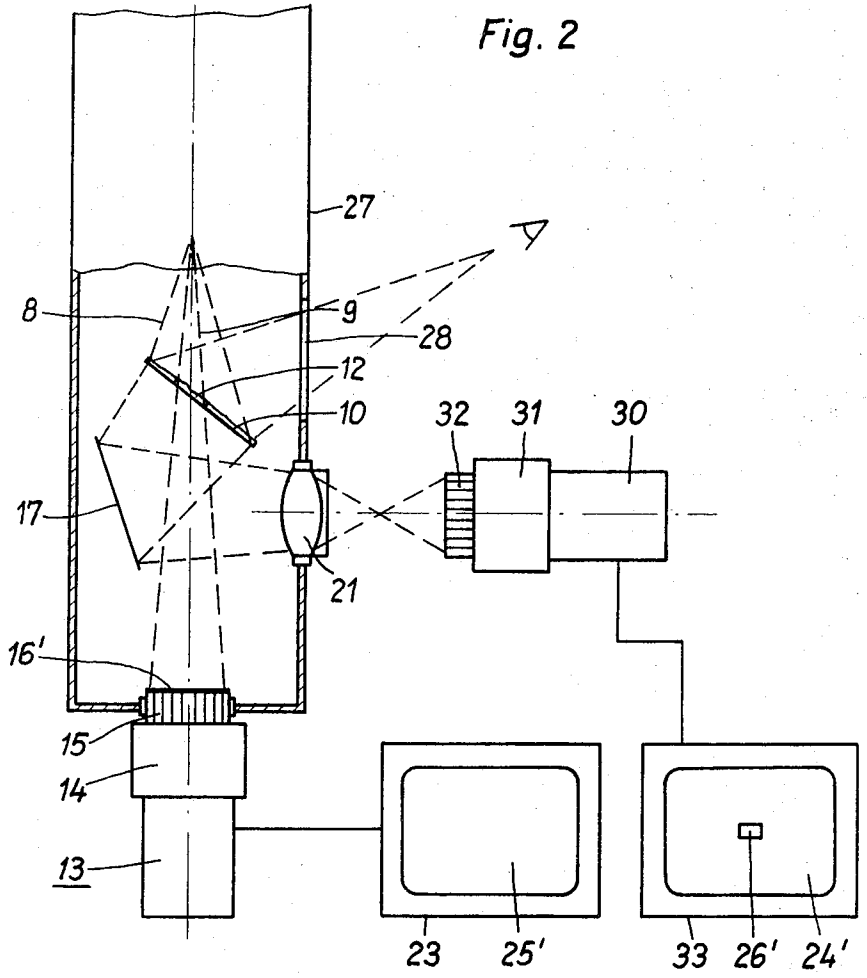


Fig. 3

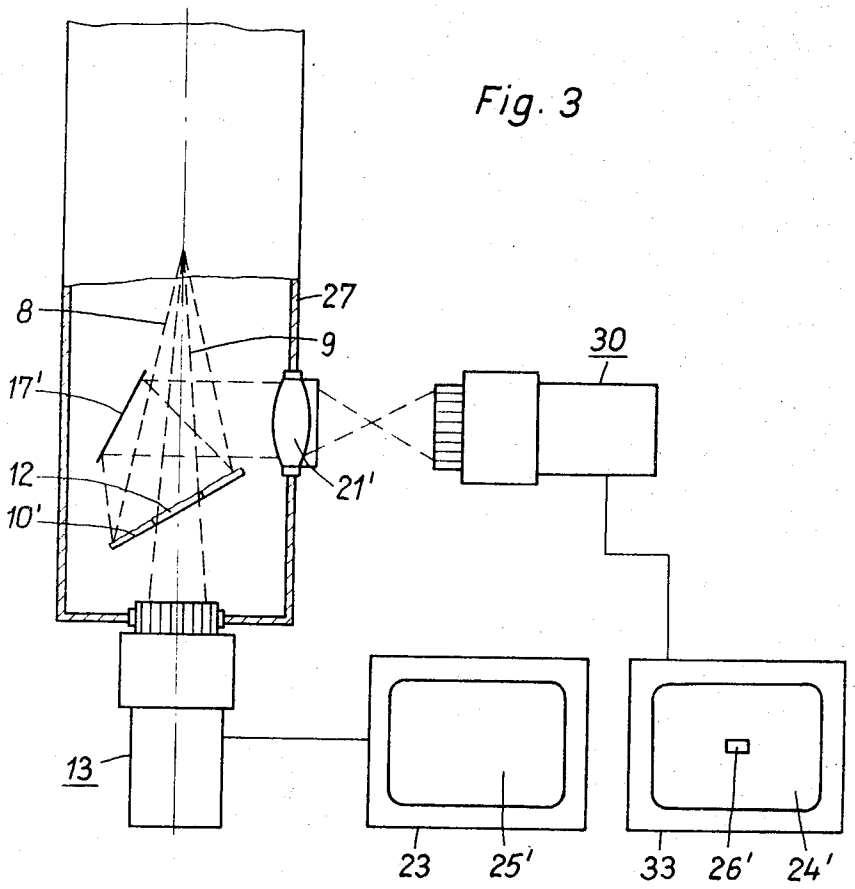
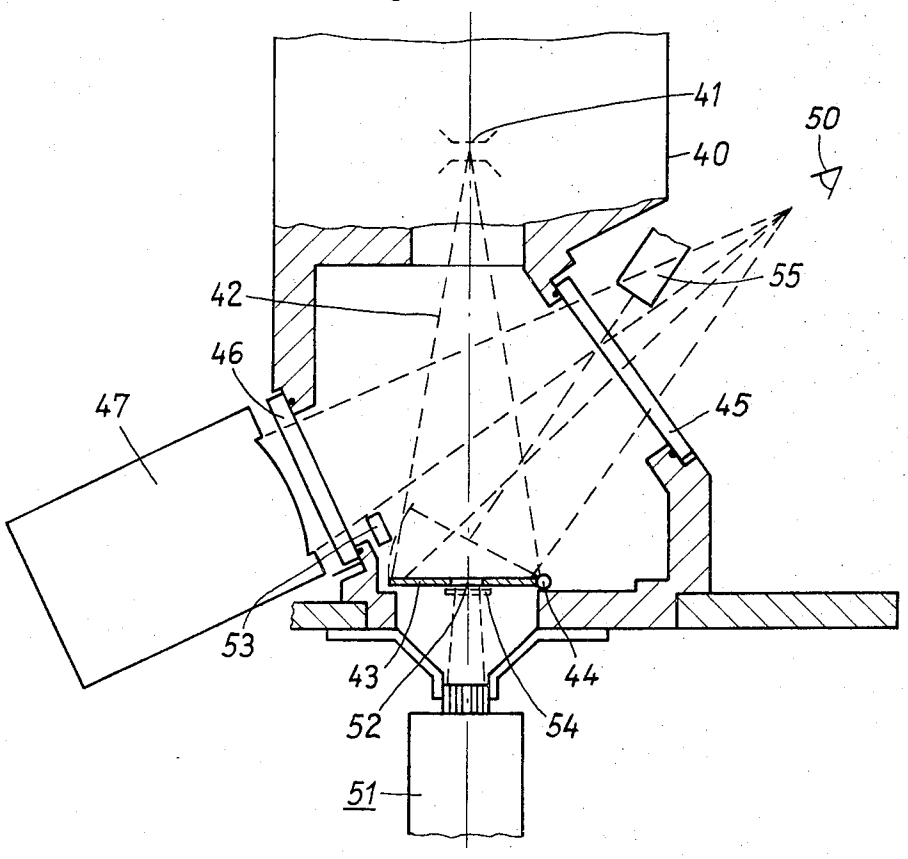


Fig. 4



TELEVISION DISPLAY SYSTEM FOR ELECTROMAGNETIC BEAM APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to display systems for electromagnetic beam apparatus such as electron microscopes.

When investigating objects by means of electromagnetic particle beam apparatus, for instance, an electron microscope, one is interested on the one hand, in studying the object to the most detailed extent possible, but with increasing magnification, the total area of the object that can be observed becomes smaller. If one wishes to observe both the details and the area surrounding them, it is necessary to use changing magnification. One way to do this is to make and evaluate photographic pictures, which entails a relatively large expenditure of labor and time.

SUMMARY OF THE INVENTION

The present invention facilitates the investigation of objects at different magnifications using electromagnetic particle ray apparatus, particularly an electron microscope, which has a fluorescent screen for making the picture projected by the particle ray visible, as well as an arrangement for viewing the picture by means of a television camera and a television monitor. According to the invention, the fluorescent screen has a window, and the television camera is arranged in the beam path behind the window for picking up the part of the picture that passes through the window. This permits simultaneous viewing of an overall picture and an electronically enlarged section of the picture.

In specific embodiments of the invention, the overall picture and the enlarged section of the picture both can be presented to the use on television monitors arranged for convenient viewing by providing a separate television camera to pick up the picture projected on the fluorescent screen. In addition, an observation window can be provided in the wall of the vacuum chamber of the apparatus to allow viewing the fluorescent screen directly, thus avoiding any image degradation by the television transmission.

The picture projected on the fluorescent screen can be imaged by means of a light-optical lens system on the entrance plane of a television camera. In one embodiment, the television camera for transmitting the enlarged section of the picture can be used by arranging the ray paths of the overall picture and the picture section so that the overall picture and the enlarged section each occupy one-half of the entrance area of the camera. The advantages of this arrangement are that only one transmission channel is required and that the overall and the section picture appear on a monitor side by side. Of course, the overall picture can also be fed to the previously mentioned separate television camera, so that the overall picture and the enlarged sectional picture appear on separate monitors. In either case, the area corresponding to the enlarged section (i.e., the window of the fluorescent screen) appears dark in the overall picture.

At least one mirror may be arranged between the fluorescent screen and the light-optical lens system for directing the overall picture either out of the vacuum chamber into a television camera or within the vacuum chamber toward the television camera which is common for the overall picture and the enlarged sectional picture. It may be advantageous for the arrangement of the light-optical lens system and the mirrors to use a fluorescent screen which is light-transparent (transmission-type fluorescent screen), but the mirror and lens system can also be used to pick up and pass on the picture projected on a reflection-type fluorescent screen. In the latter case, the fluorescent screen is preferably arranged at an angle to the axis of the corpuscular beam to obtain a more favorable ray path.

Although the television monitor for reproducing the enlarged sectional picture may be situated either directly next to the corpuscular-ray apparatus or at any remote location, in one embodiment of the invention the picture screen of the monitor is located behind a second observation window in the direction of view through the first observation window described above for viewing the fluorescent screen. The overall picture and the enlarged sectional picture are thereby presented in close physical relationship for convenient viewing by looking directly at or into the vacuum chamber of the apparatus. For this embodiment of the invention the fluorescent screen is preferably hinged for rotation in the direction of the first observation window to provide a more favorable viewing angle or to pass the particle beam to a photographic recording device mounted behind the fluorescent screen.

In any of the above embodiments of the invention an additional small fluorescent screen can be provided for closing the window of the fluorescent screen on which the overall picture is produced so that the entire picture can be viewed without the darkened section caused by the window.

Particularly in conjunction with the embodiment of the invention having two observation windows, it is desirable to provide a device for indicating the scale of magnification arranged between the second observation window and the fluorescent screen in such a manner that it is always in the observer's field of view.

The invention will be explained more fully below with reference to the following figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an embodiment of an electron microscope with two mirrors and one television camera.

FIG. **2** shows another embodiment having one mirror and two television cameras.

FIG. **3** shows an embodiment similar to FIG. **2**, in which the mirror is located in front of the fluorescent screen.

FIG. **4** shows a further embodiment with two observation windows and one television camera.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a schematic drawing of an electron microscope **1** in cross section. An electron beam **8** is generated by means of a cathode **2** and an anode cylinder **3** powered by a high-voltage source, not shown. A magnetic condenser lens **4** focuses the beam on an object **5** which is then magnified by a magnetic objective lens **6** and imaged by a projection lens **7** on a fluorescent screen **10.** In the following discussion, this image will be called the overall picture.

The fluorescent screen **10** has a window **12** through which can pass a portion **9** of the electron beam representing a section of the overall picture. The sectional

beam 9 is directed toward a television camera 13, which is equipped with an image intensifier 14 and fiber optics 15 having about half of its entrance area provided with a fluorescent layer 16. This half of the entrance area corresponds to the projection area of beam 9. The remaining area 22 of the entrance end of fiber optics 15 is available for the overall picture, which is transmitted to the television camera 13 in the following manner.

Fluorescent screen 10 is arranged at an angle to the axis of beam 8 and is a transmission-type fluorescent screen (i.e., light-transparent). A first mirror 17 located behind screen 10 reflects the image which is visible on the lower side of the fluorescent screen approximately perpendicularly to the axis of the electron beam. A second mirror 18 picks up the picture and deflects it again approximately parallel to the direction of beam 9. The overall picture is then imaged on the area 20 of the fiber optics 15 by a light-optical lens system 21.

Picture signals are therefore available at television camera 13 for the overall picture as well as for the sectional picture. The picture signals are fed to a television monitor 23 via suitable amplifiers, not shown; the monitor shows the overall picture 24 and the sectional picture 25, which appears as a dark area 26 in the overall picture 24.

In the embodiment of FIG. 2 the parts arranged above the projection lens are omitted, and parts which correspond to those of FIG. 1 are labelled with the same reference symbols.

As in FIG. 1, a beam 8 produces an overall picture on fluorescent screen 10, while a portion 9 passes through window 12 and furnishes a sectional picture. However, in this embodiment the entire entrance area of television camera 13 is available for this sectional picture. Accordingly, fiber optics 15 is fully covered with a fluorescent layer 16', and monitor 23 shows a sectional picture 25' on the entire area of the picture screen.

In contrast to the embodiment of FIG. 1, a light-optical lens system 21' is arranged in a wall 27 of the vacuum chamber of the electron microscope. The overall picture reflected by mirror 17 is therefore transmitted out of the vacuum chamber to a second television camera 30 with an image intensifier 31 and fiber optics 32. The picture signals are amplified and fed to a second monitor 33, which shows the overall picture 24' on the entire picture screen, the sectional picture again appearing as a dark area 26'.

An observation window 28 is arranged in wall 27 for direct viewing of fluorescent screen 10. This same arrangement can be provided also in the other illustrated embodiments if desired.

The embodiments of FIGS. 1 and 2 have transmission-type fluorescent screens, the mirrors being arranged behind the screen, as seen in the direction of the beam. Referring to FIG. 3, a reflection-type fluorescent screen 16' can also be used in conjunction with a mirror 17' arranged in front of the screen, as seen in the direction of the beam. The arrangement of television cameras 13 and 30 and monitors 23 and 33 essentially corresponds with that in FIG. 2.

In FIG. 4 shows still another embodiment of the invention in an electron microscope having a vacuum chamber housing 40, shown partially in cross section, with a projection lens 41. The electron beam 42 is directed toward a fluorescent screen 43 which is hinged for rotation about an axis 44. The fluorescent screen 43 can be observed directly through a first observation window 45 in one side of housing 40. A second observation window 46 is set in the opposite side of housing 40 with a television monitor 47 mounted behind the second window. The observation windows 45 and 46 are arranged so that an observer, whose eye is indicated at 50, can view the fluorescent screen 43 as well as the picture screen of the monitor 47.

The enlarged sectional picture which appears on the picture screen of the monitor 47 is obtained by a television camera 51 located in the path of electron beam 42 behind a window 52 in fluorescent screen 43. An observer can therefore perceive simultaneously the overall picture on fluorescent screen 43 and an enlarged section on the picture screen of monitor 47.

If desired, a photographic recording device consisting of supply and storage magazines for photographic plates with a transport device for selectively placing the plates into the beam path can be mounted behind the fluorescent screen in a known manner to permit photographic records to be made by swinging the hinged screen out of the way.

As an additional feature, window 52 of fluorescent screen 43 can be closed by a second fluorescent screen 54 to permit viewing the entire picture directly without the cutout section caused by the window. In FIG. 4, fluorescent screen 54 is arranged behind fluorescent screen 43, but the same effect can be obtained if the additional fluorescent screen 54 is arranged in front of or is inserted directly into the window. For any of these arrangements, conventional mechanical devices, not shown, can be provided for removably placing fluorescent screen 54 in the area of window 52. As mentioned previously, the additional fluorescent screen can also be used in the previously described embodiments.

A further feature of the embodiment of FIG. 4 is a device 53, for indicating the scale of magnification of either or both pictures, arranged between the second observation window 46 and fluorescent screen 43 to be in the field of view defined by the first observation window 45. The indicating device can have luminous dials which give the scale of magnification as a numerical value. Alternatively, the indicating device can be mounted outside the vacuum chamber, for instance, in such a manner that it can be read through the observation window 46.

For magnified viewing of fluorescent screen 43, a magnifying glass 55 is further indicated in FIG. 4. This magnifying glass may be mounted in a fixed position or removably or in such a manner that it can be directed onto any point of the fluorescent screen as required. The screen can be swung up partially, as shown by the dashed lines, so that it is perpendicular to the line of sight from the magnifying glass to provide sharp focus for the overall picture.

We claim:

1. In apparatus of the type having a vacuum chamber and means for generating a beam of electromagnetic particles, for directing the beam at a specimen in the chamber, and for projecting the beam from the specimen, an improved image display system comprising:

a first screen located within the chamber in the path of the projected beam, the screen including material responsive to the beam particles for producing an optical image of the specimen, the material

being distributed throughout the area of the screen except for a window section which passes a portion of the projected beam through the screen;

a television camera positioned behind the screen in the path of the passed portion of the projected beam for picking up the portion of the projected image that falls within the area of the window; and

a television monitor connected to the television camera for displaying the image portion picked up by the camera.

2. The apparatus of claim **1** further comprising:

a first window located in one wall of the vacuum chamber to permit direct viewing of the first screen and

a second window located in a wall of the vacuum chamber within the field of view through the first window, the television monitor being positioned outside the chamber with its viewing screen adjacent to the second window to permit simultaneous viewing of the overall picture on the first screen and the portion of the picture delineated by the window on the television monitor.

3. The apparatus of claim **1** wherein the first television camera includes an entrance aperture having a layer of material responsive to the beam particles for producing an optical image of the portion of the projected image that falls within the area of the window.

4. The apparatus of claim **3** wherein the area of the entrance aperture of the first television camera is larger than the area of the layer of material responsive to the beam particles for producing an optical image, and the display system further comprises a mirror positioned to reflect the overall image produced on the first screen toward the area of the entrance area that is not covered by the layer of material.

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