Feb. 28, 1950 E. G. DORNFELD 2,499,019

ADJUSTABLE SPECIMEN SUPPORT FOR ELECTRON-OPTICAL INSTRUMENTS

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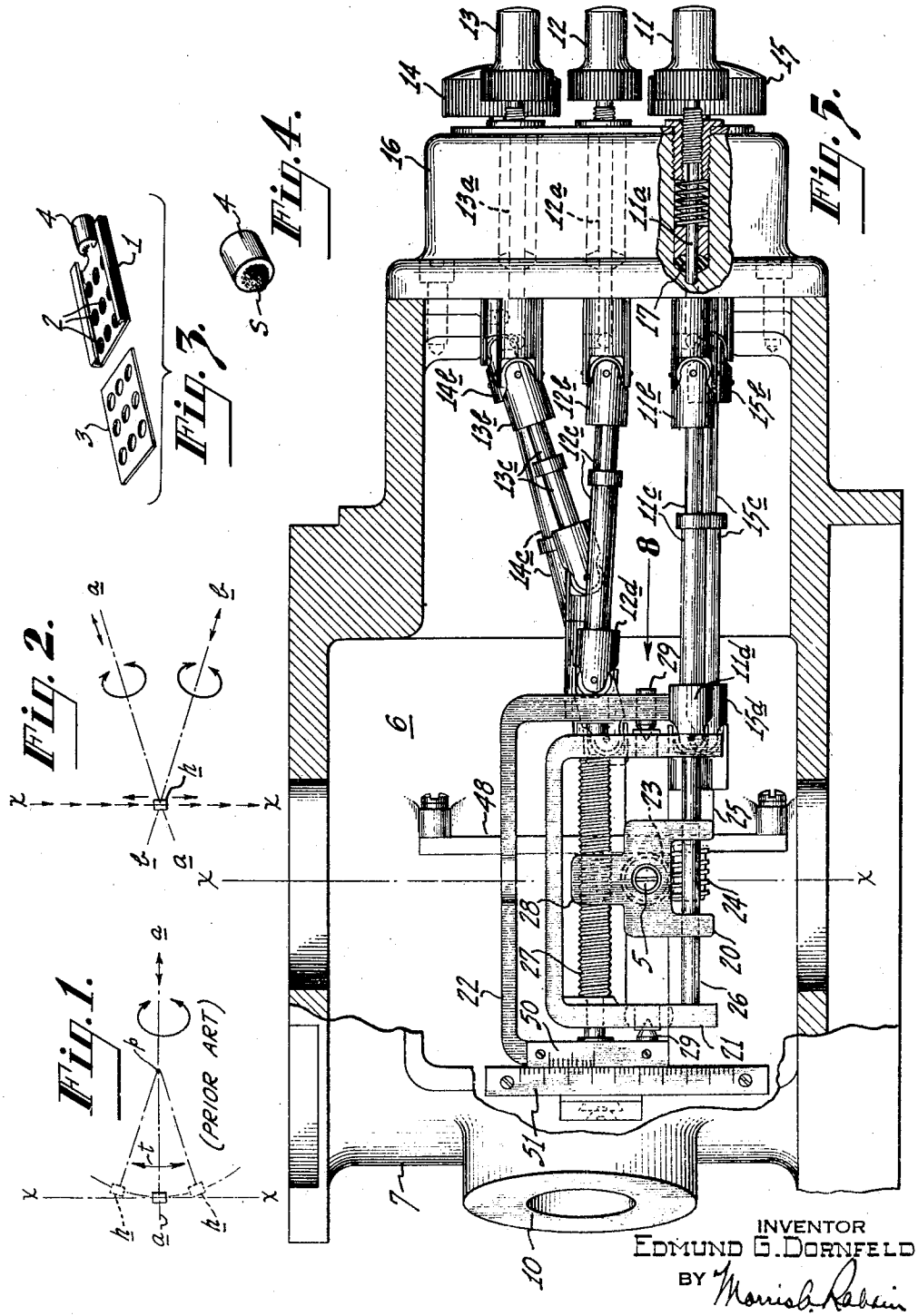

Fig. 1. (PRIOR ART)

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

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Fig. 6.

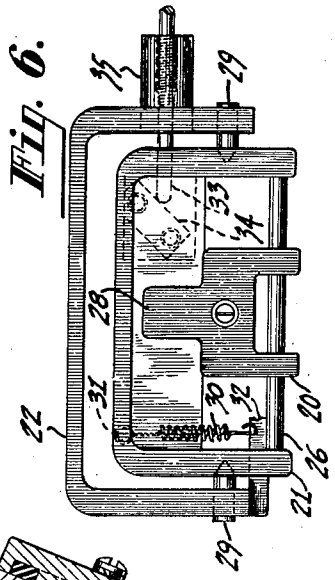

Fig. 7.

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Fig. 8.

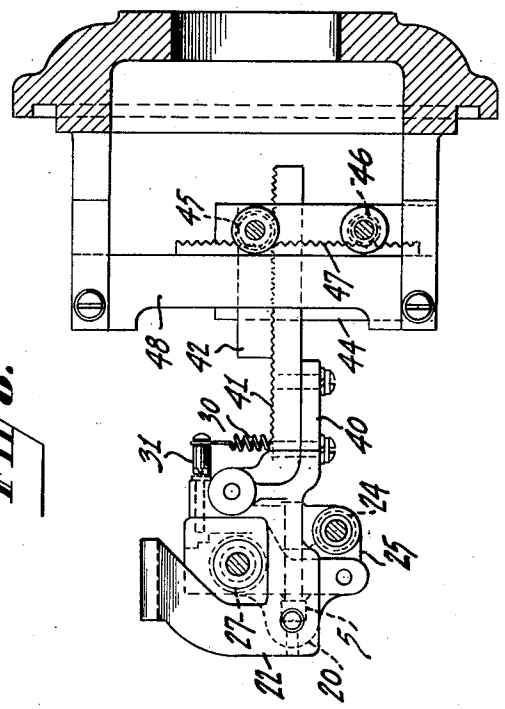
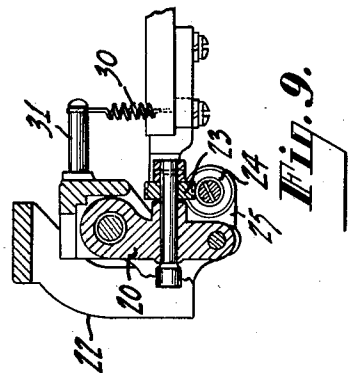


Fig. 9.



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ADJUSTABLE SPECIMEN SUPPORT FOR ELECTRON-OPTICAL INSTRUMENTS

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Application January 29, 1949, Serial No. 73,536

7 Claims. (Cl. 250—49.5)

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This invention relates to electron-optical instruments and particularly to improvements in adjustable specimen-holders for such instruments.

The invention and the problems and objects with which the invention is concerned are described in connection with the accompanying drawings, wherein:

Fig. 1 is a diagrammatic representation of a specimen-holder of the prior art, the axes of the drawing being marked with arrows to indicate the several ways in which the holder may be manipulated to achieve a desired orientation with respect to the electron beam of the instrument,

Fig. 2 is a view similar to Fig. 1 but showing, diagrammatically, the axes and directions of movement of the specimen-holder of the present invention,

Fig. 3 is an exploded view of a detachable holder for a plurality of transparent microscope-specimens,

Fig. 4 is a view in perspective of a detachable holder for an opaque diffraction-specimen,

Fig. 5 is a front elevational view, partly in section, showing the interior of an electron-optical instrument containing a specimen-holder and adjusting mechanism constructed in accordance with the principle of the present invention,

Fig. 6 is a fragmentary front elevational view with certain of the parts of Fig. 5 removed to reveal the tiltable parts of the adjusting mechanism of Fig. 5,

Fig. 7 is a partly broken-away plan view, partly in section, of the device of Figs. 4, 5 and 6,

Fig. 8 is a side elevational view, partly in section, looking in the direction of the arrow 8 in Fig. 5 and showing the mechanism for imparting a vertical movement and one (of the two) horizontal movements of the tri-part yoke of Figs. 5, 6 and 7.

Fig. 9 is a fragmentary view partly in section of the yoke end of the mechanism of Fig. 8.

Runge U. S. Patent No. 2,418,903, issued April 15, 1947, discloses a specimen-holder capable of being oriented in virtually all directions with respect to the electron-optical axis of a microscope, diffraction camera, or the like, without breaking the vacuum in the instrument. As shown diagrammatically in Fig. 1, Runge's specimen holder h is mounted to permit both direct axial and direct rotational movement about an axis a—a normal to the electron-optical axis x—x. The third or vertical movement (i. e., parallel to the axis x—x) in Runge's device cannot be achieved directly but only indirectly by means of a bowed

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support capable of tilting the mount (as indicated by arrow t) about a virtual pivot p on the axis a—a, and then moving the pivot point axially, and if necessary, rotationally. The complicated nature of this latter adjustment limits the extent of all of the said movements to such a degree that, as a practical matter, the specimen-holder can not ordinarily be made large enough to accommodate more than one or two specimens at a time.

Accordingly, the principal object of the present invention is to provide an improved specimen-holder for use in electron-optical instruments and one which shall be free from the above described limitations to present-day adjustable specimen holders.

Another and specific object of the present invention is to provide a specimen-holder, and an adjusting mechanism therefor, having various discrete freedoms of movement and hence capable of moving the holder to a desired position without affecting any previously achieved setting or orientation of the holder.

As shown diagrammatically in Fig. 2, the specimen holder h is mounted in accordance with the present invention to permit it to be moved parallel to the electron-optical axis x—x (as indicated by the vertical arrows) as well as along and about separate axes a—a, b—b, at right angles to each other in a (vertically movable) plane normal to the optical axis. The manner in which these several movements are accomplished will be described in connection with the apparatus shown in Figs. 5 to 9 inclusive. However, before proceeding to the description of the adjusting mechanism per se, attention is called to the different specimen-type holders shown in Figs. 3 and 4.

The specimen holder shown in Fig. 3 is designed to carry a number (in this case, nine) of transparent microscope specimens and, to this end, comprises a small tray 1 having a corresponding number of apertures therein within which the specimens are discretely supported, each on a collodion film deposited in the usual way upon one of the spaced-apart removable fine-mesh screens 2 in the said holes. A removable apertured cover 3 is provided for holding the screens in their seats upon the tray. Tray 1 terminates at its inner end in a centrally disposed collar 4 which fits on the free end of a rotatable stub shaft 5 (Figs. 5 to 9) within the specimen chamber 6 of the instrument. As will hereinafter more fully appear, the adjusting mechanism is capable of presenting each one of the nine specimens, selectively, to the beam at any angle re-

quired to produce an electron micrograph of that specimen.

Referring to Fig. 4, in the event that the electron-optical instrument is to be used as a diffraction camera, the tray 1 of the holder shown in Fig. 3 may be omitted and a crystalline or other (usually opaque) specimen S may be cemented or otherwise affixed to the free end of a detachable collar 4', similar to the one shown at 4 in Fig. 3. As in Fig. 3, this collar is adapted to be pressed onto the free end of the supporting button or shaft 5 in the specimen chamber 6 (Figs. 5 and 7).

As shown in Figs. 5 and 7, the specimen chamber 6 comprises simply the interior of a hollow metal casting or other casing 7 which will be understood to form a part of an evacuable column surrounding the electron-optical axis x—x along which electrons travel, in the form of a beam, from an "upper" source (not shown) to the specimen and thence to a "lower" fluorescent screen, photographic plate or other target, (not shown).

The front of the casing 7 is provided with a tight door 8 (Fig. 7) through which access may be had to the interior of the chamber 6 for the purpose of mounting an appropriate specimen holder 4 or 4' (Figs. 3 and 4) on its support 5. The door 8 contains a window 9 through which the orientation of the specimen holder may be observed when the door is closed. In the instant case the casing 7 is also provided with a port 10 within which an auxiliary source of electrons (not shown, but which may be similar to the one described in copending application Serial No. 10,084, filed February 21, 1948, now Patent No. 2,467,224, of Picard) may be mounted so that the low velocity electrons from the said source impinge upon the specimen to prevent it from "going positive" when subject to bombardment by the high velocity electrons of which the main beam is comprised.

As shown more clearly in Fig. 5 there is a bank of five control knobs, 11 to 15 inclusive, mounted on the exterior of the casing 6 as on a block 16, convenient to the right hand of an operator looking through the window 9 in the door 8. The control shafts 11*a*—15*a* to which these knobs are affixed extend through vacuum-tight bushings 17 (which may be of the type shown in Runge 2,418,903, supra) into the chamber 6 where they terminate each in a universal joint 11*b*—15*b*, respectively, from which telescopic shafts 11*c*—15*c* extend in the direction of the "cradle" upon which the specimen-holder support 5 is mounted. These telescopic shafts 11*c*—15*c* are in turn connected to the various movable parts of the cradle through universal joints 11*d*—15*d* respectively.

The cradle upon which the specimen-holder support 5 is mounted comprises a nest of three U-shape yokes 21, 22, and 23, which, in the instant case, are mounted upside-down at the "rear" of the electron-optical axis x—x of the instrument.

As previously indicated, the specimen-holder support 5 comprises the free end of a rotatable shaft. This shaft 5 is journaled for rotation in the base of the innermost yoke 20 and terminates, adjacent to its rear end, in a driven gear 23. The driving gear for this driven gear 23 comprises a worm gear 24 which is conveniently supported for rotation on a small bracket 25 (Figs. 7 and 8) on the rear of the yoke 20. The worm 24 and hence the driven gear 23 and shaft 5 are connected in torque-transfer relation with the knob 11, on shaft 11*a*, through the universal joints 11*b* and 11*d* at opposite ends of the telescopic shaft 11*c*. Thus, upon turning the knob 11 clockwise or counterclockwise the support 5, and hence the specimen-holder thereon, will be rotated in the corresponding direction as viewed by an observer at the front of the instrument looking through the window 9.

The smallest or innermost yoke 20 is supported on a rod 26 for lateral movement in the space between the downwardly extending arms of the second or intermediate yoke 21. The force required to move the innermost yoke 20 (and hence the specimen-holder support 5, thereon) to the left or to the right (as viewed in Figs. 5 and 7) is applied to it through a lead screw 27 which extends through a nut 28 fixed on the inverted base of said yoke. The lead screw, in turn, is driven by torque applied to the knob 12 and transmitted to said screw through the straight shaft 12*a*, the telescopic shaft 12*c* and the universal joints 12*b* and 12*d*.

The second or intermediate yoke 21 is supported intermediate its ends on pivots 29 mounted between the parallel arms of the outermost yoke 22. As shown more clearly in Fig. 6, the intermediate yoke 21 is biased to its upright position by means of a coil spring 30 which is connected at one end to an arm 31 on the base of the yoke 21 and, at its other end, to an arm 32 on the outermost yoke 22. The yoke 21 (and hence the yoke 20 and the specimen-holder support 5 thereon) may be tilted against the biasing force of the spring 30 by means of a threaded plunger 33 which bears against an inclined surface 34 (Fig. 6) on said yoke and extends through a complementarily threaded bushing 35 secured to the right arm of the outermost yoke 22. The rotary force required to move the plunger 33 in-and-out is applied through the knob 13, which is connected to the said plunger through the straight shaft 13*a*, the telescopic shaft 13*c* and the universal joints 13*b* and 13*d* at the opposite ends of the shaft 13*c*.

The largest or outermost yoke 22 is not subject to the tilting force applied to the intermediate yoke 21 nor to the left-and-right movement applied to the innermost yoke 20, but is mounted to permit of forward and rearward movements (with respect to the observer) and vertical (up-and-down) movement (i. e., parallel to the electron-optical axis x—x of the instrument). The mechanisms through which these latter movements are effected are shown more clearly in Figs. 7 and 8.

It will be observed upon inspection of Figs. 7 and 8 that the outermost yoke 22 is provided on its rear surface with a rearwardly extending arm 40 which carries a horizontally disposed rack 41 on its upper surface and a mounting block 42 adjacent to one side of the free end of the rack. The mounting block is splined, as indicated at 43 (Fig. 7) for vertical movement in a bracket 44 which extends inwardly from the rear wall of the chamber 6 a distance sufficient to provide a clearance space for the rearward movement of the horizontal rack 41. The block 42 has two pinions 45 and 46 journaled for rotation thereon and subject to the vertical movements of the block. The pinion 45 when rotated under the control of the large knob 14 serves to impart forward and rearward movement to the yoke 22 (and hence to the other yokes 20 and 21, and the specimen-holder support 5) through the rack 41.

The other pinion 46 meshes with the teeth on a second rack 47 (Fig. 8) which is rigidly supported in an upright position upon a stationary

arm 48 of the bracket 44. When the second pinion 46 turns in its bearing on the vertically movable block 42, it carries the said block (and hence the horizontal rack 41 and the parts which are supported thereon) upwardly or downwardly as determined by its direction of rotation. The force required to actuate this pinion 46 is applied through the other large knob, 15 (Fig. 5).

As shown in Fig. 5, the vertical position of the specimen with respect to a fixed point on the electron-optical axis x—x may be ascertained by reference to a cursor or scale 50, fixed on the left leg of the yoke 22 and arranged to be read in conjunction with a stationary scale 51 supported on a bracket 52 (Fig. 7) within the specimen chamber 6. This indicator 50—51 is of especial utility when the instrument is used as an electron-diffraction camera, since the setting required to achieve a particular size or spacing of the diffraction rings can easily be duplicated by reference to the indicator-reading.

From the foregoing detailed description of a preferred embodiment it will be apparent that the present invention provides, in combination: an electron-optical device having an axis (x—x) along which electrons travel, a shaft (5) having an axis of rotation and comprising a support for a specimen-holder (4, 4', Figs. 3, 4) mounted (on the "cradle" 20, 21, 22) for movement within said device adjacent to said electron-axis, means (rack 47) for moving said shaft in a first direction parallel to said electron axis (i. e. "up-or-down"), means (rack 41) for moving said shaft in a second direction (e. g., "forward or backward") normal to said first-mentioned direction, means (lead screw 27 and nut 28) for moving said shaft in a third direction (e. g., "left-or-right") normal to said first and second directions irrespective of the position to which it has been moved in said first and second directions, means (the inclined surface 34 and plunger 33) for tilting said shaft in a fourth direction irrespective of the position to which it has been moved in said first, second and third directions, and means (gear 23 and worm 24) for rotating said shaft irrespective of the position to which it has been moved in said first, second, third and fourth directions.

In carrying the invention into effect it has been found that the adjusting mechanism can handle any type of specimen or conventional group of specimens when the straight-line movements of the mechanism are about one-inch in extent. Similarly, it has been found that the degree of tilt imparted to the holder seldom need exceed 5°, nor is it ordinarily necessary to make its angle of rotation exceed 180°.

It will be understood that the foregoing description of a preferred practical embodiment of the invention should be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an electron-optical device having an axis along which electrons travel, a shaft having an axis of rotation and comprising a support for a specimen-holder mounted for movement within said device adjacent to said electron axis, means for moving said shaft in a direction parallel to said electron axis, and means for rotating said shaft irrespective of the position to which it has been moved parallel to said axis.

2. The invention as set forth in claim 1 wherein said specimen-holder shaft is mounted within an evacuable specimen chamber and said shaft-moving and shaft-rotating means are provided with separate actuating mechanisms which extend to the exterior of said evacuable chamber.

3. The invention as set forth in claim 2 and wherein at least one of said actuating mechanisms comprises a control shaft mounted for rotation in a wall of said chamber and provided with a universal joint on its inner end, a telescopic shaft connected to said rotatable shaft through said universal joint, and a second universal joint connected at one end to the inner end of said telescopic shaft and at the other end to the means for moving said specimen-holder shaft.

4. In an electron-optical device having an axis along which electrons travel, a shaft having an axis of rotation and comprising a support for a specimen-holder mounted for movement within said device adjacent to said electron-axis, means for moving said shaft in a first direction parallel to said electron-axis, means for moving said shaft in a second direction substantially normal to said first mentioned direction, and means for rotating said shaft irrespective of the position to which it has been moved in said first and second directions.

5. In an electron-optical device having an axis along which electrons travel, a shaft having an axis of rotation and comprising a support for a specimen-holder mounted for movement within said device adjacent to said electron-axis, means for moving said shaft in a first direction parallel to said electron-axis, means for moving said shaft in a second direction substantially normal to said first-mentioned direction, means for moving said shaft in a third direction normal to said first and second directions irrespective of the position to which it has been moved in said first and second directions, and means for rotating said shaft irrespective of the position to which it has been moved in said first, second and third directions.

6. In an electron-optical device having an axis along which electrons travel, a shaft having an axis of rotation and comprising a support for a specimen-holder mounted for movement within said device adjacent to said electron-axis, means for moving said shaft in a first direction parallel to said electron-axis, means for moving said shaft in a second direction substantially normal to said first-mentioned direction, means for moving said shaft in a third direction normal to said first and second directions irrespective of the position to which it has been moved in said first and second directions, means for tilting said shaft in a fourth direction irrespective of the position to which it has been moved in said first, second and third directions, and means for rotating said shaft irrespective of the position to which it has been moved in said first, second, third and fourth directions.

7. The invention as set forth in claim 6 wherein said shaft is contained in an evacuable specimen-chamber and wherein each of said means for moving said shaft is provided with a separate actuating mechanism which extends to the exterior of said evacuable chamber.

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No references cited.