

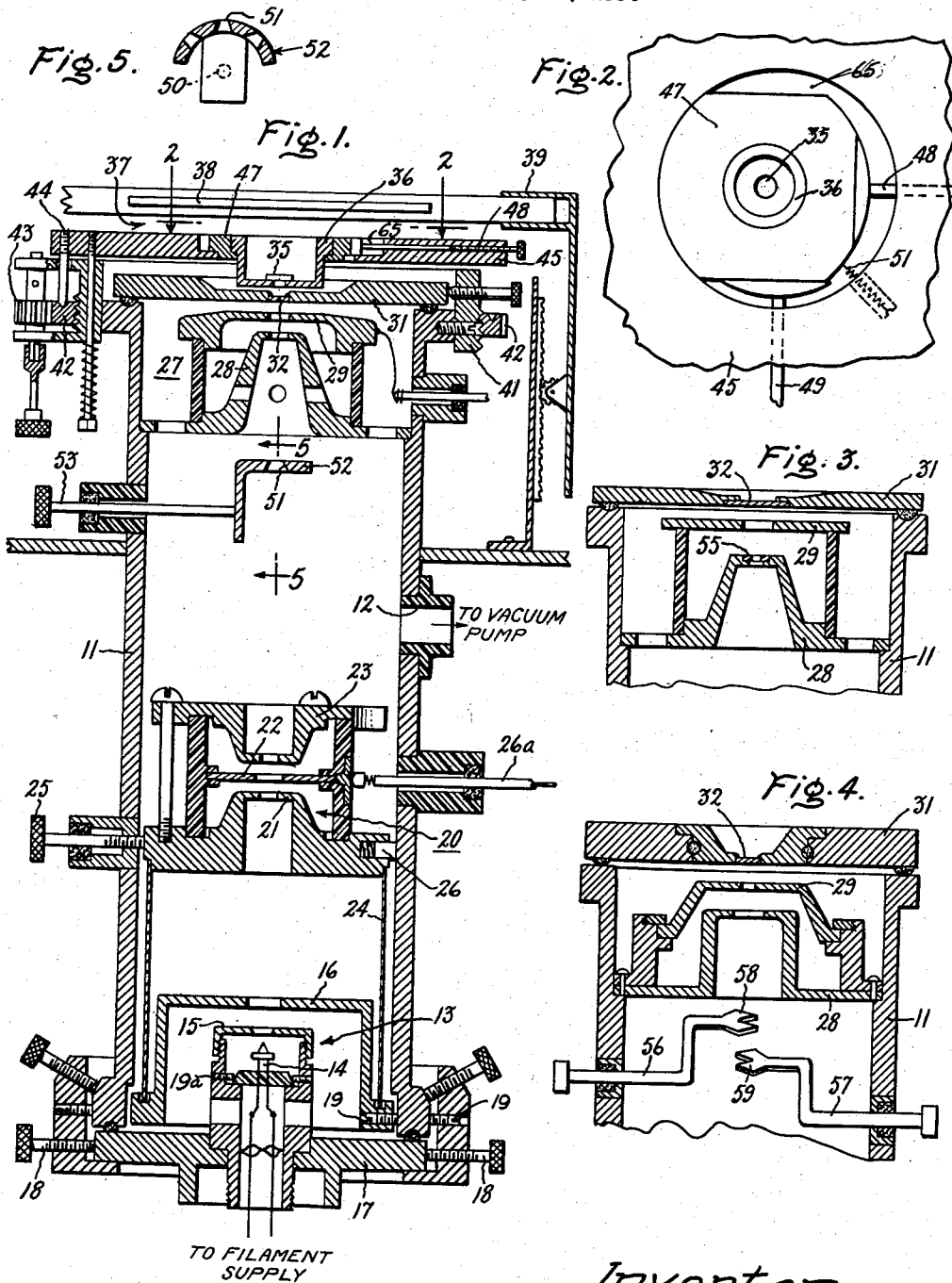
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X-RAY MICROSCOPE

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X-RAY MICROSCOPE

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The present invention relates to an X-ray microscope. More particularly, the invention relates to X-ray microscopes of the shadow-graph type wherein the object to be examined is disposed in the path of a beam of X-rays, and the shadow cast thereby is directed onto a photographic plate.

X-ray shadow microscopes are relatively well-known in the art and have been described in an article by Von Ardemne appearing in vol. 27 (1939) issue of the German publication "Naturwissenschaften" on page 485, and in an article by Cosslett and Nixon appearing in the May (1953) issue of the "Journal of Applied Physics." While the instruments described in the above-identified articles, and others heretofore known in the art, have been suitable for some purposes, they have not been entirely satisfactory due to the fact that the X-rays developed thereby have not had sufficient intensity to produce sharp distinct images of the objects being examined. Additionally, these instruments cannot be readily adapted for use with different specimens requiring widely varying resolving powers, and X-ray voltages, and, hence, their operation is somewhat complicated and requires a considerable amount of skill. Further, these instruments are relatively complex in construction, and expensive to manufacture.

It is, therefore, one object of the present invention to provide a new and improved X-ray shadow microscope capable of developing relatively high intensity X-rays for use in producing sharply defined shadow graphs of objects to be examined.

Another object of the invention is to provide X-ray shadow microscopes which can readily be adapted for use with problems requiring widely different resolving powers, and X-ray voltages, and which is easy to operate.

Still another object of the invention is to provide a new and improved X-ray shadow microscope which is relatively simple in construction and inexpensive to manufacture.

In practicing the invention an X-ray shadow microscope is provided which includes an electron beam source and at least one set of electrostatic field producing plates which are disposed along the electron beam path and form an electron beam objective lens assembly. An X-ray producing target-window structure is positioned to intercept the electron beam after the same passes through the objective lens assembly, and an electron beam defining aperture is positioned along the electron beam path on the side of the electrostatic field producing plates closest to the electron beam source. In a preferred embodiment of the invention, the electron beam defining aperture is formed in a movable member having a plurality of different size apertures therein for selective movement into beam forming relationship with respect to the electron beam path.

Other objects, features, and many of the attendant advantages of this invention will be appreciated more readily as the same becomes better understood by reference to the following detailed description, when considered in connection with the accompanying drawings, wherein like

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parts are identified by the same reference character, and wherein:

Fig. 1 is a cross-sectional view of a new and improved X-ray shadow microscope constructed in accordance with the invention;

Fig. 2 is an enlarged fragmentary plan view of a manipulator comprising a part of the X-ray shadow microscope illustrated in Fig. 1, which plan view is taken on a line corresponding with 2—2 in Fig. 1 looking in the direction of the arrows;

Fig. 3 is a cross-sectional view of an alternative objective lens and target window structure suitable for use in an X-ray shadow microscope of the type shown in Fig. 1; and

Fig. 4 is still another alternative form of objective lens and target window construction, and comprises a part of the invention.

Fig. 5 is a sectional view taken on a line corresponding with 5—5 in Fig. 1 looking in the direction of the arrows.

A new and improved X-ray shadow microscope shown in Fig. 1 includes a suitable housing 11 which is preferably cylindrically shaped, and has a connection 12 to a suitable vacuum-pumping system for maintaining the interior of the housing under vacuum. Mounted in the lower end of the housing 11 is an electron beam source 13 consisting of an electron filament 14, a focusing electrode 15, and an accelerating electrode 16 all aligned over the filament 14 in a manner so as to form the electrons emitted therefrom into a beam of electron rays and accelerate the rays out through the opening in the accelerating electrode. The focusing electrode 15 is secured to a bottom plate 17 that closes one end of the cylindrical housing 11, and is held in place by means of set screws 18. The set screws can be used to adjust the position of the opening in the focusing electrode 15 with respect to the accelerating electrode 16 so as to properly position the electron beam emitting therefrom relative to the remainder of the elements in the housing. The accelerating electrode 16 is insulatingly supported separately from the focusing electrode 15 by means of adjustable set screws 19 which provide a means for adjusting the horizontal position of the aperture in the accelerating electrode relative to the electron filament 14 and the remainder of the elements in housing 11. The electron filament itself may be adjusted relative to the optic axis of the housing by means of individual set screws 19a disposed on opposite sides of the base thereof.

Positioned immediately above the electron beam source 13 is a first set of electrostatic field producing plates 21, 22 and 23 which form condenser lens 20. Each of these plates has a central aperture formed therein aligned along the electron beam path so as to form an electron beam condenser lens structure. This structure is supported in place by means of a sleeve 24 that forms a magnetic shield. The sleeve is based on a lip portion of the accelerating electrode 16 in the electron gun, and may be adjusted relative to the electron beam path by means of a screw rod 25 having a knurled knob on the free end thereof and the inner end engaging electrode plate. Screw rod 25 acts against a spring loaded pusher element 26 which serves to provide a return adjusting motion to the structure and thereby assists in aligning the same. Each of the plates 23 and 21 are secured together by bolts so that movement of one by adjustment of knob 25 results in the movement of the other, and the middle plate 22 is supported between each of the plates 21 and 23 so that it follows adjustment of the assembly. Hence, all three electrostatic field producing plates can be moved relative to the electron beam path for purposes of alignment. Operating potential is supplied to the central plate 22 through a high voltage connection 26a having a resilient contact

that allows the connection to follow the movement of the assembly.

For a more complete description of the manner in which the electrostatic field producing plates 21, 22 and 23 operate as a condenser lens assembly to properly shape the electron beam into essentially parallel rays of electrons, reference is made to the book entitled, "The Electron Microscope" by D. Gabor published by the Chemical Publishing, Inc., 1948, Brooklyn, N. Y., and in particular to chapters 2 and 3 thereof. For further information concerning the principle of operation of the condenser lens assembly, reference is made to the book entitled, "Electron Microscopy" by V. E. Cosslett, Academic Press, Inc. publishers, London and N. Y. (1951). Chapter 2 of the Cosslett book has an excellent discussion of the electrostatic lens theory. Briefly, however, it can be stated that the condenser lens assembly serves to bend the electron rays into curved paths during transit therethrough, and through this bending action, serves to bring the group of divergent electron rays emitted from the filament 14 into a beam of substantially parallel or slightly convergent rays. Because of this characteristic, the structure is termed a condenser lens assembly.

Disposed in the housing 11 opposite electron beam source 13 and aligned along the electron beam path is a second set of electrostatic field producing plates 28, 29 and 31 which form objective lens 27. These field producing plates form an objective lens assembly, and for this reason are disposed on the side of the condenser lens assembly 20 opposite from the electron beam source 13. This objective lens assembly is supported on a lip formed on the interior surface of housing 11 in a straight forward fashion, and serves to bend the parallel electron rays transmitted thereto from the condenser lens assembly 27 in such a manner so as to bring all of the rays together at a particular focal point determined by the design of the electrostatic plates. For a more detailed description of the action of the objective lens assembly, reference is again made to the two above-identified texts by Cosslett and Gabor.

Located at the focal point of the objective lens assembly is a target-window structure 32. This target window preferably comprises a flat plate, and, in the instances of heavy metal structures which are necessarily in the order of .001 millimeter, and hence quite thin, a sandwich structure of a .025 millimeter of beryllium coated with the heavy metal can be used. This target-window structure is joined to the end of the housing 11 by a suitable bonding agent. The target-window structure is preferably secured to the inner surface of the last electrostatic plate element 31 in the objective lens assembly at a point furthest from the electron beam source 13 so that electron rays hit the target window after passing through the condenser lens assembly and the object lens assembly. Because the target-window 32 is a flat plate, and is substantially flush with the surfaces of the electrostatic plate element 31, the target window does not adversely affect the electrostatic field so as to produce defocusing of the objective lens assembly.

In operation, the condenser lens assembly 20 serves to bend the divergent rays of electrons produced by the electron source 13 into a beam of substantially parallel rays of electrons, and the beam thus formed is directed to the objective lens assembly 27 comprised by plates 28, 29, and 31. The objective lens assembly thereafter bends the rays again to focus most of them on the focal point of the objective lens where the target-window structure 32 is located. Impingement of the focused electron rays on a point on the surface of the target-window produces X-rays which pass out through the opposite side of the target-window structure from that on which the electron beam impinges. The intensity of these X-rays is inversely proportional to the square of the focal length of the objective lens assembly 27.

The X-rays produced at the target-window structure 32

pass from the structure through and marginally of an object being examined 35 which is supported in a small cup-shaped specimen holder 36 seated in a manipulator shown generally at 37. After passing through or marginally of object 35 being examined, the X-rays then impinge on an X-ray sensitive photographic plate, indicated at 38, which is supported in a suitable holder 39, and if desired, may comprise an X-ray sensitive film that may be developed by conventional wet processing or by so called dry processing while still associated with the microscope. Because the X-rays will tend to diverge outwardly from the point source on the target-window structure 32, corresponding to the spot on which the electron beam impinges, the X-rays passing marginally of or through the object 35 will cast an enlarged image of the object, thereby serving to magnify its proportions.

In order to assure that the specimen is properly centered with respect to the point source of X-rays on target-window structure 32, the manipulator device 37 is provided. The manipulator includes a base member 41 having a threaded exterior, and is secured to the housing 11 by set screws. Coacting with the threaded exterior surface of base member 41, is a rotatable adjusting ring 42 that can be rotated circumferentially by a ratchet 43 driven through a suitable adjusting knob arrangement. The rotatable adjusting ring 42 has a grooved upper surface which seats a plurality of pins 44 on which a base plate 45 is supported. The base plate 45 has a counterbored central opening 65 therein in which a specimen holder disk 47, best seen in Fig. 2 of the drawing, is positioned. The opening 65 in plate 45 which accommodates the disk 47 is sufficiently long to allow the disk to be moved in either one of two directions by a pair of adjusting pins shown at 48 and 49 acting against a tension spring 51 secured to one corner of the disk. By this construction, it is possible to raise or lower the specimen holder cup 36, which is carried in disk 47, and hence the specimen 35 with respect to the target-window structure 32, and to move the specimen holder in any desired direction in the horizontal plane relative to the target-window structure. Consequently, by proper operation of the manipulating device 37, it is possible to position the specimen holder at the exact point to provide optimum magnification of the specimen.

Because of the well-known inability of the electron lens assemblies such as shown at 27 to focus marginal rays of electrons, as well as paraxial rays, it is necessary that some means be provided in the microscope for effectively limiting the angular spread of the marginal rays of electrons emitting from the lens assemblies, and thereby preventing them from impinging on the target-window structure 32. In previously known instruments of this type, it has been necessary that a beam forming or limiting aperture be provided between the objective lens assembly 27 and the target-window structure 32 to the X-ray microscope. For example, in the Von Ardenne structure described in "Elektronen Uber Mikroskopie" page 72, Julius Springer 1940, the aperture is located on the last electrostatic plate element in the objective lens assembly and the target-window structure of the microscope. Because of the necessity to locate such an aperture in that position, the focal length of the objective lens assembly necessarily had to be lengthened to exclude large angle electrons. As previously stated, the intensity of X-rays produced by an X-ray shadow microscope is inversely proportional to the square of the focal length of the objective lens assembly. Hence, by lengthening the focal length of the objective lens, the intensity of the X-rays produced by the microscope was necessarily lessened. To circumvent this difficulty, Cosslett and Nixon developed an X-ray shadow microscope using electromagnetic lens assemblies wherein it was possible to locate beam defining apertures right within the objective lens assembly itself, since the aperture would have no effect on the electromagnetic focusing field. By this means, it was possible to

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increase the intensity of the X-rays produced by the X-ray microscope by a factor of 6 or more. There are certain disadvantages in the use of electromagnetic focusing principle, however. In particular, these disadvantages are that the electromagnetic instrument is susceptible to disturbances from specimens having ferromagnetic properties which include among other things most of the steel alloys. Another disadvantage is that an electromagnetic lens assembly requires a separate, highly stabilized power supply, and imposes more stringent requirements on the high voltage supplied to the assembly. Further, in order to obtain short focal length, the bore of the magnetic lens must be very small whereby the room for sealing the window and mounting the specimen is seriously limited. Additionally, it is difficult to alter the accelerating voltage of an electromagnetic microscope because with the electromagnetic lens, the instrument has to be refocused at each new accelerating voltage level. Because of these difficulties, a microscope using electrostatic condenser and objective lens assemblies is most desirable, providing the intensity of the X-rays produced by such an instrument are sufficiently increased.

In order to overcome the above-listed difficulties, applicant has provided an electron beam defining aperture 51 located in a movable member 52 that is semi-circularly shaped and secured to the end of a rotatable control rod journaled in housing 11. The plate 52 illustrated fragmentarily, may be of semi-cylindrical or other arcuate configuration and provided with a plurality of different size apertures, such as 51, formed therein, so that by merely rotating the control rod 53, an aperture of any desired diameter, see Fig. 5, can be brought into alignment with the electron beam path. As can be noted, the aperture 51 is located along the electron beam path adjacent the second set of electrostatic field producing plates 27 that form the objective lens assembly on the side thereof closest to the electron beam source 13 so that, in effect, divergent electrons are eliminated prior to passage through the objective lens assembly. In this manner, applicant is able to limit the marginal rays of electrons not brought into parallel relationship by the condenser lens assembly, thereby doing away with any adverse effect they might have should they impinge upon the target-window structure 32. Applicant has been able to accomplish this result without in any way requiring an extension or elongation of the focal length of the objective lens assembly with its consequent decrease in X-ray intensity. By this construction, the target-window structure 32 may be mounted on the inner surface of the last electrostatic field producing plate element of the objective lens assembly, thereby reducing the focal length of the objective lens assembly to an absolute minimum, and assuring that maximum intensity X-rays can be produced with the instrument. Consequently, extremely sharp shadow graphs can be produced by applicant's novel microscope construction. Also, because of the simple manner in which the size of the beam forming or limiting apertures 51 can be changed, the resolving power of the instrument can be quickly adjusted without requiring complete or partial disassembly of the instrument. Additionally, the simplified construction, facilitates manufacture of the instrument as well as decreases its cost.

A second form of the invention is shown in Fig. 3 of the drawings wherein elements similar to those described with relation to the instrument shown in Fig. 1 of the drawing, are given the same reference numeral. The structure shown in Fig. 3 constitutes the objective lens assembly, the beam forming aperture construction, and the target-window structure of an X-ray shadow microscope which is, in all other respects, identical to that shown in Fig. 1. For this reason, only that portion of the instrument that does differ in construction from the Fig. 1 arrangement has been illustrated. The structure shown in Fig. 3 comprises a second set of electrostatic field producing plates 28, 29 and 31 mounted on one end

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of the housing 11, and forming an objective lens assembly. The manner in which the electrostatic field produced by the plates coacts to focus some of the electron rays on the target-window structure 32, can be obtained more fully by reference to the above-identified Cosslett, and Gabor texts. It is believed sufficient to point out that the lens assembly does serve to bend sufficient electron rays to cause the same to come together at the focal point where they impinge upon the target-window structure resulting in the production of X-rays that emanate from the opposite side of the structure. In this construction, the beam-defining aperture 55 is secured to that electrostatic plate of the second set forming the objective lens assembly which is closest to the electron beam source. The beam defining aperture, as previously described, serves to limit marginal rays of electrons which were not focused into paraxial positions by the preceding condenser lens assembly, thereby preventing such marginal rays from reaching the target-window structure with its consequent blurring of the shadow graph. By constructing the beam defining aperture 55 in this manner, it is still possible to have the focal point of the objective lens assembly located to fall right at a point co-linear with the last plate element in the lens assembly, thereby allowing the target-window structure to be mounted in a manner so as to reduce the focal length of the objective lens assembly to an absolute minimum. Consequently, it can be appreciated that the structure shown in Fig. 3, incorporates all the operating advantages as shown in Fig. 1 of the drawings; however, the structure shown in Fig. 3 has a further advantage of being much more simple in construction, and not requiring a separate structure for the beam defining aperture. Otherwise, the operation and advantages of the two constructions are entirely similar.

Still a different form of the invention is shown in Fig. 4 of the drawings wherein the structure disclosed differs from the instrument shown in Fig. 1 only in the portion illustrated. The embodiment of the invention shown in Fig. 4 comprises a second set of electrostatic field producing plates 28, 29 and 31 which form an objective lens assembly. An X-ray target-window structure 32 is secured to the inner surface of the plate 31 so as to intercept the electron beam passing through the objective lens assembly thereto. In the arrangement shown in Fig. 4, a beam forming aperture structure is provided and positioned immediately preceding the objective lens assembly formed by plates 28, 29 and 31. This structure includes a pair of arms 56 and 57 supported in the housing 11 in a manner such that the arms may be translated in or out, or may be rotated. Secured to the inner ends of each of the arms 56 and 57 are bifurcated end pieces 58 and 59 which coact to form a beam defining aperture. The size of this aperture may be readily controlled by adjustment of the relative distances that each of the arms 56 and 57 protrude inward, or by rotation of one of the bifurcated end pieces 58, 59 with respect to the other. In this manner the size of the beam forming aperture provided by the structure can be adjusted to a very fine degree thereby providing an excellent means for controlling the resolving power of the instrument. In addition to this very desirable feature, the structure incorporates all of the advantages of the arrangements described in relation to Figs. 1 and 3 in that the target-window structure 32 may be located at a point where the focal length of the objective lens is reduced to an absolute minimum, and hence, maximum intensity X-rays can be obtained from the instrument. While the electrostatic field producing plate structures 28, 29 and 31 have not been described in detail, it can be appreciated from a consideration of each of Fig. 1, Fig. 3 and Fig. 4, that the desirable results that can be obtained by reason of applicant's invention are not limited to a particular electrostatic lens assembly, but can

be obtained generally with any type of electron beam lens construction.

From the foregoing description, it can be appreciated that the invention provides a new and improved shadow X-ray microscope construction as capable of developing high intensity X-rays thereby making it possible to produce sharply defined shadow graphs of objects being examined. Additionally, the improved microscope is designed so that the resolving power can readily be adjusted for use with problems requiring different degrees of resolving power, and hence, easy to operate and requires no special skill. In addition to these above advantages, the construction of the structure of the microscope is relatively simple, and can be manufactured at low cost.

Obviously, other modifications and variations of the invention are possible and will be suggested to those skilled in the art in the light of the above teachings. It is, therefore, to be understood that changes may be made herein which are within the full intended scope of the invention as defined by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An X-ray shadow microscope including in combination an electron beam source, at least one set of electrostatic field producing plates disposed along the electron beam path for forming an electron beam objective lens assembly, an X-ray producing target-window structure positioned to intercept the electron beam, and an element provided with an electron beam defining aperture positioned along the electron beam path on the side of said set of electrostatic field producing plates nearest the electron beam source.

2. An X-ray shadow microscope including in combination an electron beam source, a first set of electrostatic field producing plates disposed along the electron beam path and forming an electron beam condenser lens assembly, a second set of electrostatic field producing plates disposed along the electron beam path on the side of said first set of plates opposite from the electron beam source for forming an electron beam objective lens assembly, an X-ray producing target-window structure positioned to intercept the electron beam, and an element provided with an electron beam defining aperture positioned along the electron beam path on the side of said second set of plates closest to the electron beam source.

3. An X-ray shadow microscope including in combination an electron beam source, a first set of electrostatic field producing plates disposed along the electron beam path and forming an electron beam condenser lens assembly, a second set of electrostatic field producing plates disposed along the electron beam path on the side of said first set of plates opposite from the electron beam source for forming an electron beam objective lens assembly, an X-ray producing target-window structure positioned to intercept the electron beam, and an element provided with an electron beam defining aperture secured to the plate of the second set of electrostatic plates which is closest the electron beam source.

4. An X-ray shadow microscope including in combination an electron beam source, a first set of electrostatic field producing plates disposed along the electron beam path and forming an electron beam condenser lens assembly, a second set of electrostatic field producing plates disposed along the electron beam path on the side of said first set of plates opposite from the electron beam source for forming an electron beam objective lens assembly, an X-ray producing target-window structure positioned to intercept the electron beam, an element provided with an electron beam defining aperture positioned along the electron beam path on the side of said second set of plates closest to the electron beam source, and a housing having said electron beam source supported at one end thereof and enclosing said field producing plates with the remain-

ing end thereof being closed by said target-window structure, said electron beam source and said target-window structure being translatable with respect to said housing and with respect to each other.

5. An X-ray shadow microscope including in combination an electron beam source, at least one set of spaced-apart electrostatic field producing plates aligned along the electron beam path for forming an electron beam objective lens assembly, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, said X-ray producing target window structure being substantially flush with the innermost surface of said flat plate so as not to adversely affect the electrostatic field produced thereby, and an element provided with an electron beam defining aperture positioned along the electron beam path for shaping and defining the electron beam, said aperture being positioned on the side of said set of electrostatic plates nearest the electron beam source.

6. An X-ray shadow microscope including in combination an electron beam source, a first set of spaced-apart electrostatic field producing plates aligned along the electron beam path and forming an electron beam condenser lens assembly, a second set of spaced-apart electrostatic field producing plates aligned along the electron beam path on the side of said first set of plates opposite from said electron beam source, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, and an element provided with an electron beam defining aperture positioned along the electron beam path for shaping and defining the electron beam, said aperture being located on the side of said second set of electrostatic plates closest to the electron beam source.

7. An X-ray shadow microscope including in combination an electron beam source, a first set of spaced-apart electrostatic field producing plates aligned along the electron beam path and forming an electron beam condenser lens assembly, a second set of spaced-apart electrostatic field producing plates aligned along the electron beam path on the side of said first set of plates opposite from said electron beam source, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, and an element provided with an electron beam defining aperture secured to the plate of the second set of electrostatic plates which is closest the electron beam source for shaping and defining the electron beam.

8. An X-ray shadow microscope including in combination an electron beam source, a first set of spaced-apart electrostatic field producing plates aligned along the electron beam path and forming an electron beam condenser lens assembly, a second set of spaced-apart electrostatic field producing plates aligned along the electron beam path on the side of said first set of plates opposite from said electron beam source, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, said X-ray producing target-window structure being substantially flush with the innermost surface of the flat plate so as not to adversely affect the electrostatic field produced thereby, an element provided with an electron beam defining aperture positioned along the electron beam path for shaping and defining the electron beam, said aperture being located on the side of said second set of electrostatic plates closest to the electron beam source, and a housing having said electron beam source supported at one end thereof and enclosing said field producing plates with the remaining end thereof being closed by said target-window structure, said electron beam source and said target-window structure being translatable

with respect to said housing and with respect to each other.

9. An X-ray shadow microscope including in combination an electron beam source, at least one set of spaced-apart electrostatic field producing plates aligned along the electron beam path for forming an electron beam objective lens assembly, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, said X-ray producing target-window structure being substantially flush with the innermost surface of said flat plate so as to not adversely affect the electrostatic field produced thereby, and an arcuate element provided with a plurality of electron beam defining apertures of varying sizes positioned along the electron beam path for shaping and defining the electron beam, said aperture being located on the side of said set of electrostatic plates closest to the electron beam source.

10. An X-ray shadow microscope including in combination an electron beam source, at least one set of spaced-apart electrostatic field producing plates aligned along the electron beam path for forming an electron beam objective lens assembly, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, and a movable member having a plurality of electron beam defining apertures formed therein positioned along the electron beam path on the side of said second set of electrostatic plates closest to the electron beam source, said movable member being adjustable to locate an aperture of any desired dimension in beam defining relationship with respect to said electron beam path.

11. An X-ray shadow microscope including in combination an electron beam source, a first set of spaced-apart electrostatic field producing plates aligned along the electron beam path and forming an electron beam condenser lens assembly, a second set of spaced-apart electrostatic field producing plates aligned along the electron beam path on the side of said first set of plates opposite from said electron beam source, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, said X-ray producing target-window structure being substantially flush with the innermost surface of said flat plate so as to not adversely affect the electrostatic field produced thereby, and a movable member having a plurality of electron beam defining apertures

formed therein positioned along the electron beam path on the side of said second set of electrostatic plates closest to the electron beam source, said movable member being adjustable to locate an aperture of any desired dimension in beam defining relationship with respect to said electron beam path.

12. An X-ray shadow microscope including in combination an electron beam source, a first set of spaced-apart electrostatic field producing plates aligned along the electron beam path and forming an electron beam condenser lens assembly, a second set of spaced-apart electrostatic field producing plates aligned along the electron beam path on the side of said first set of plates opposite from said electron beam source, a flat plate comprising an X-ray producing target-window structure positioned to intercept the electron beam and secured to the electrostatic field producing plate furthest from said electron beam source, and a pair of opposed translatable and rotatable members having bifurcated end pieces positioned along the electron beam path for forming an electron beam shaping and defining aperture, said members being located on the side of said second set of electrostatic plates closest to the electron beam source.

13. An X-ray shadow microscope including in combination an electron beam source, at least one set of electrostatic field producing plates disposed along the electron beam path and forming an electron beam objective lens assembly, an X-ray producing target-window structure positioned to intercept the electron beam, and a movable member having a plurality of electron beam defining apertures formed thereon positioned along the electron beam path on the side of said sets of electrostatic field producing plates nearest the electron beam source, said movable member being adjustable to locate an aperture of any desired dimension in beam defining relationship with respect to said electron beam path.

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