

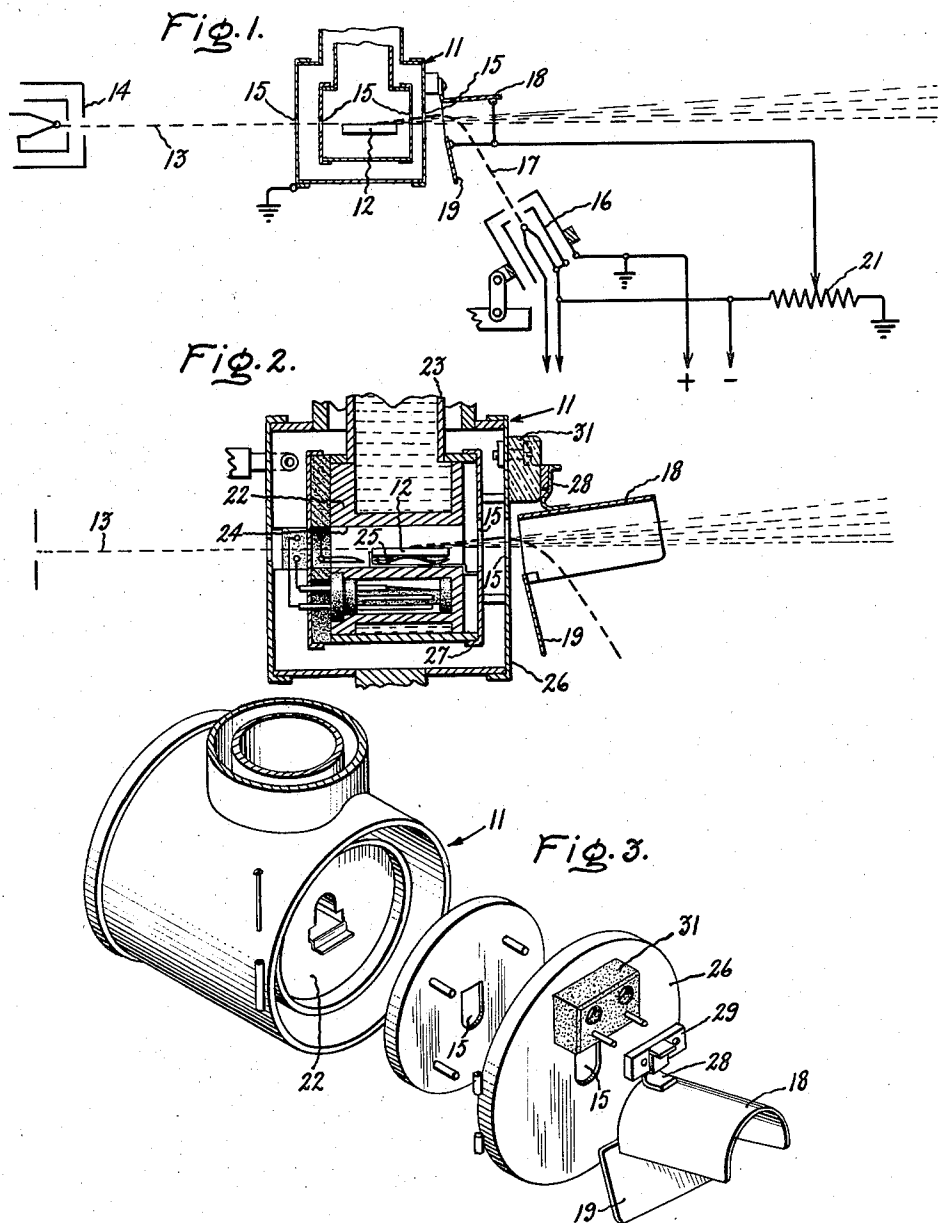
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SYSTEM FOR CHARGE NEUTRALIZATION

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SYSTEM FOR CHARGE NEUTRALIZATION

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The present invention relates to a charge neutralization system for instruments of the type using charged particles to effect examinations of target specimens.

More particularly, the invention relates to a charged neutralization system for the target sample of an electron-optics instrument, such as an electron diffraction instrument or an electron microscope for preventing the accumulation of an electric charge by the target sample which would adversely affect the operation of the instrument.

In electron-optics instruments, such as the electron diffraction instrument, a target sample of material to be analyzed is bombarded with a beam of high energy electrons. In the case of the electron diffraction instrument, the high energy electron beam is diffracted off in characteristic diffraction patterns whose configurations provide information about the lattice spacing of the atoms of the crystals comprising the specimen material. In this process, however, free electrons in the surface of the sample are drawn off with the diffracted electron beam, and the release of these free electrons results in the building-up of a positive charge on the target sample which adversely affects the operation of the instrument. In order to overcome this effect the present invention was developed.

It is, therefore, one object of the invention to provide a charge neutralization system for instruments of the type using charged particles to analyze a target specimen which is effective to discharge the target specimen, and yet, which does not adversely affect or interfere with the high energy beam of charged particles used for analysis.

Another object of the invention is to provide a charge neutralization system having the above characteristics which is simple in construction and requires the addition of relatively few additional parts to existing instruments requiring such neutralization systems.

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

Fig. 1 is a schematic illustration of an electron-optics instrument incorporating the present invention as a part thereof;

Fig. 2 is a cross-sectional view of the target specimen holder of an electron-optics instrument such as that shown in Fig. 1, and illustrates the physical construction of a portion of the invention, and how that portion is incorporated into an existing electron-optics instrument structure; and

Fig. 3 is an exploded perspective view of the sample holder and the portion of the charge neutralization system illustrated in cross section in Fig. 2.

Fig. 1 of the drawing discloses schematically the basic working elements of an electron-optics instrument of the

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type that uses charged particles to effect examination of target specimens, and which comprises a housing 11 for supporting a target specimen 12 in the path of a beam of high energy charged particles comprising a high voltage electron beam 13 produced by an electron gun 14. The housing 11 has a series of apertures 15 therein which define an unobstructed passageway that passes entirely through the housing 11 from one side to the other, and accommodates the electron beam 13 allowing the same to impinge upon the target specimen 12 to be analyzed, and be diffracted therefrom out through the exit apertures 15. The diffracted electron beam is then directed against a suitable recording medium such as a photographic plate, not shown.

For a more detailed description of the construction and operation of an electron-optics instrument of the type shown in Fig. 1, reference is made to U.S. Patent No. 2,606,292, Maynard J. Columbe, issued August 5, 1952, and assigned to the same assignee as the present invention, which discloses an electron diffraction instrument similar to that illustrated in Fig. 1. Briefly, however, the instrument operates in the following manner: the high voltage electrons contained in the high voltage electron beam 13 pass through the entrance opening in the sample housing 11, and in approaching the surface of the target specimen 12, are reflected from the surface of the target sample in what are referred to as characteristic diffraction pattern rings. The spacing of these diffraction rings provides considerable information about the lattice spacing of the atoms of the crystals comprising the specimen material. By correlation of the diffraction pattern with the diffraction patterns of known materials, the chemical composition of the target specimen can be obtained. In approaching the target specimen 12 and in being diffracted therefrom, it quite frequently happens that the high voltage electrons draw off free electrons in the surface of the target specimen. Because of this tendency, the target specimen 12 tends to acquire a positive charge with respect to the electron beam, and the building up of this positive charge on the target specimen adversely affects the characteristic diffraction patterns being produced by the high voltage electron beam. A similar phenomenon also occurs in electron microscopes, and other instruments of this type wherein a target specimen is bombarded with high energy charged particles.

My invention operates to overcome the objectionable tendency of an electric charge building up on the target specimen 12 in the manner described above. In accord with the invention an auxiliary source of low voltage electrons 16 is positioned to one side of the high voltage electron beam path so that it directs a beam of low voltage electrons 17 toward the housing 11. Positioned intermediate the source of low voltage electrons 16 and the housing 11 is a low voltage electron beam deflection means. This last-mentioned means comprises a deflecting plate 18 positioned over the exit end of the passageway in the housing 11 formed by the series of apertures 15, and an electrically conductive shield 19 is secured to the deflecting plate 18. A low value negative potential is supplied to the deflecting plate 18 and to the conductive plate 19 from a potentiometer formed by a resistor 21 connected across a source of negative potential.

The exact details of construction of a particular embodiment of the invention are best shown in Figs. 2 and 3 of the drawings, wherein it can be seen that the housing 11 comprises a sample chamber 22 that is supported at the end of a supporting post 23, and that has a central passageway 24 formed therein for accommodating the high voltage electron beam 13 produced by the high voltage electron source 14. For further details of the construction of sample chamber 22 and the housing 11, refer-

ence is made to applicant's copending application Serial Number 453,540, filed September 1, 1954, now Patent No. 2,826,701, entitled "Low Temperature Chamber for Electron-Optics Instruments," and assigned to the same assignee as the present application. For purposes of the present disclosure, however, it is sufficient to point out that the central passageway 24 in the sample chamber 22 is adapted to contain a sample holder 25 on which the target specimen 12 is disposed. The specimen 12 is inserted within the central passageway 24 through a double door arrangement formed by a pair of metallic end members 26 and 27 in which the aligned apertures 15 are formed to provide an exit opening for the diffracted electron beam. The low voltage electron beam deflecting means comprises the deflection plates 18 and 19 which are elongated in the direction of the high voltage electron beam, and has one end thereof secured to the housing 11 over the exit end of the passageway formed by the apertures 15 in the housing. The free end of the elongated deflecting plate 18 is bent away from the axis of the high voltage electron beam so that it does not interfere with the diffracted electrons emitted from the exit end of the passageway of the housing 11, and the sides of the plate are bent along its entire length in the shape of a semi-circle about the axis of the diffracted electron beam in the manner best seen in Fig. 3 of the drawings. The deflecting plate 18 is secured to the housing 11 by means of an L-shaped clamp 28 having one of the legs thereof soldered or welded or otherwise secured to the deflecting plate 18, and having the remaining leg thereof secured to a crosshead bar 29. The crosshead bar 29 is then attached to an insulating block 31 which is permanently bolted to the outer door 26 of the housing 11 in the manner shown, in Fig. 2 of the drawings. Shield 19 is attached in an apron-like fashion to the downwardly protruding edges or sides of the semi-circular deflecting plate 18 on the end of the deflecting plate closest to the housing 11.

In operation, the high voltage electrons in the diffracted electron beam 13 on the specimen 12 tend to produce positive charges on the specimen by pulling off free electrons from the surface of the target specimen. To overcome this positive charge low voltage electrons are sprayed thereon from the low voltage electron source 16. As a matter of comparison, the low voltage electrons from the source 16 are at a potential of a few hundred volts in contrast to the 50,000 volt energy of the electrons from the high voltage electron source 14. The deflecting plate 18 and shield 19 are likewise at a low value negative potential in the neighborhood of a few hundred volts so that the deflecting plates 18 and 19 and the low voltage electrons from the source 16 are at substantially the same energy level. Consequently, the electrons in the low voltage electron beam 17 will be deflected by the deflecting plate 18 and shield 19, and bent inwardly through the apertures 15 forming the exit passageway in the housing 11 and onto the target specimen 12. Because of the low potential value of deflecting plate 18 and the low voltage electrons, they have substantially little or no effect on the high voltage electrons in the diffracted electron beam, and consequently, do not adversely affect the operation of the instrument. Hence by spraying the target specimen 12 with low voltage electrons, the target specimen is prevented from acquiring a positive charge due to the loss of surface electrons to the high voltage electron beam, and the undesirable effects of such a tendency are overcome. To assure that the electrons in the low voltage beam 17 are not absorbed by housing 11, but come within the influence of the deflecting plate 18, the shield 19 is disposed in the manner of an apron as shown. By this construction, shield 19 prevents the low voltage electrons from being attracted to the housing 11 which is at a positive potential with respect to the low voltage electrons, and would tend to attract such electrons if the

shield 19 were not provided. Consequently, the shield 19 and the plate 18 coact to assure that the low voltage electrons will be bent or deflected into the exit end of the passageway provided by the apertures 15 in the housing 11, and impinge upon the target specimen 12.

From the foregoing description, it can be appreciated that the invention provides a charge neutralization system for instruments of the type using charge particles to effect examination of target specimens which is effective to discharge the target specimen. Because of the manner in which the components of the system are positioned with relation to the main beam of charge particles used for examination purposes, it does not obstruct or interfere with such beam of charge particles. Additionally, the neutralization system is very simple in construction, and requires relatively few parts in addition to those already present in instruments requiring such systems.

Obviously, other modifications and variations in the present invention are possible in the light of the above teachings. It is, therefore, 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. A system for neutralizing the charge of a target subjected to an impinging electron beam comprising, a target support means, an auxiliary source of charged particles supplying particles of opposite polarity to that assumed by a target, said auxiliary source being positioned out of the path of the electron beam, charged particle deflection means fixedly positioned intermediate the target support means and said auxiliary source of charged particles for permanently deflecting the beam from said auxiliary source onto the target, and additional charged particle shield means positioned adjacent said target support means for preventing the auxiliary beam of charged particles from impinging thereon.

2. A system for neutralizing the charge of a target subjected to a charged particle beam comprising, a housing having an unobstructed passageway extending therethrough for supporting the target and passing the charged particle beam, an auxiliary source of electrons positioned out of the path of the charged particle beam, said auxiliary source of electrons supplying particles of a polarity opposite to that assumed by the target and positioned toward the exit end of the passageway in said housing, and a deflection plate positioned intermediate said auxiliary source of electrons and the exit end of said housing for permanently deflecting the auxiliary beam of electrons along a fixed path into the exit end of the passageway and onto the target.

3. A system for neutralizing the charge of a target in an electron diffraction instrument comprising, a housing for supporting a target having an unobstructed passageway extending entirely therethrough, a main electron source for supplying a beam of high energy charged particles and directing said particles through said housing, an auxiliary source of low energy charged particles of opposite polarity to that assumed by the target, said auxiliary source being positioned toward the exit end of the passageway in said housing to direct an auxiliary beam of low energy charged particles toward the exit end of said passageway, a deflection plate at the exit end of said passageway for deflecting the auxiliary beam of low energy charged particles along a fixed path into the passageway and onto said target, and means for applying an electric potential to said deflection plate for causing the same to influence the course of the charged particles in transit from the auxiliary source toward said housing.

4. An electron diffraction device for neutralizing a target comprising, a housing having an unobstructed passageway extending therethrough, a main charged particle source for supplying a high voltage electron beam and directing it through said housing, an auxiliary source

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of low voltage electrons positioned to direct an auxiliary low voltage electron beam toward the exit end of the passageway in said housing, and a deflection plate having one end secured to said housing over the exit end of said passageway with the free end thereof bent away from the exit of said main electron beam for deflecting the auxiliary beam of low voltage electrons into the passageway and onto said target.

5. A system for neutralizing the charge of a target in an electron diffraction device comprising, a housing having an unobstructed passageway extending therethrough for supporting a target, a main source of charged particles for directing a high voltage electron beam through said passageway in said housing, an auxiliary source of low voltage electrons positioned to direct an auxiliary low voltage electron beam toward the exit end of the passageway in said housing, a deflection plate having one end secured to said housing over the exit end of said passageway with the free end thereof bent away from the exit of said main electron beam, said deflecting plate being curved in the shape of a semicircle about the axis of the high voltage electron beam, an additional conductive shield secured to the downwardly protruding edges of said deflecting plate for preventing the auxiliary low voltage electron beam from impinging on said housing, and means for applying a low voltage negative potential to said deflecting plate and conduc-

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tive shield for causing the same to deflect the auxiliary beam of low voltage electrons into the passageway and onto said target.

6. A system for neutralizing the charge of a target subjected to an electron beam comprising, a housing having an unobstructed passageway extending entirely therethrough for supporting a target therein, electron gun means for directing electrons at high energies through said housing to bombard the target and continue through said passageway, an auxiliary source of electrons, deflection means positioned to direct said auxiliary electrons in the form of a low energy beam toward the exit end of the passageway in said housing, said deflection means including a plate positioned intermediate said auxiliary electron source in the exit end of said housing for deflecting the auxiliary beam of electrons along a fixed path into the exit end of the passageway and onto said target, and means for applying a negative potential on said deflection means for causing the same to influence the course of the electrons in transit from the auxiliary source toward said housing.

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