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[54] **ELECTRON BEAM SCANNING APPARATUS**
4 Claims, 2 Drawing Figs.

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[56] **References Cited**
UNITED STATES PATENTS

2,213,176	8/1940	Rose	313/79
2,959,705	11/1960	Downing et al.	313/313
2,237,065	4/1941	Van Den Bosch	220/2.1 A

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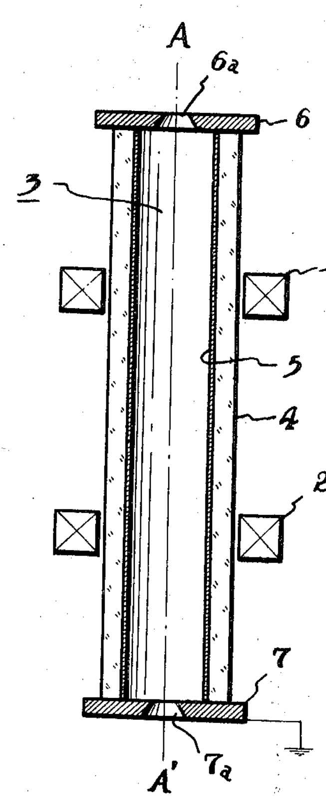
ABSTRACT: An electron beam scanning apparatus comprising a chamber defined, for example, by a cylindrical glass structure spaced about a mean electron beam path. Deflection coils are positioned outside the chamber. An electroconductive coating, for example, a layer of gold vapor deposited on the inside surface of the structure is grounded. The electron beam is deflected by magnetic fluxes at right angles to the path produced by deflection coils. Stray electrons are collected by the electroconductive coating.



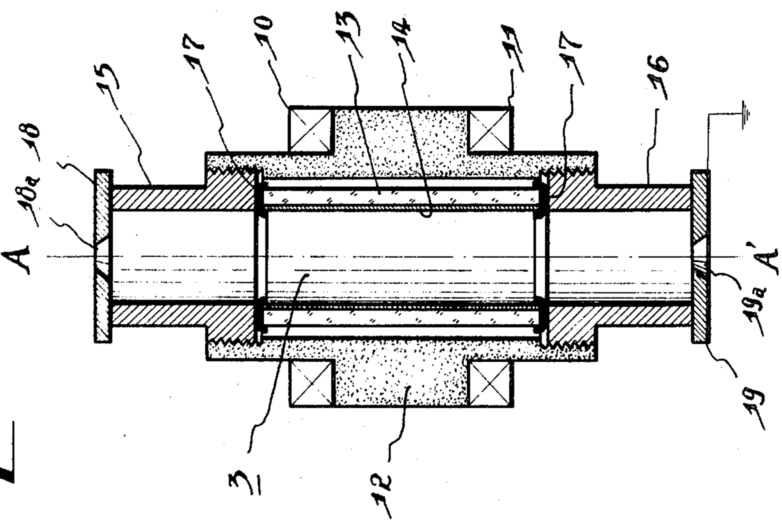


Fig. 2

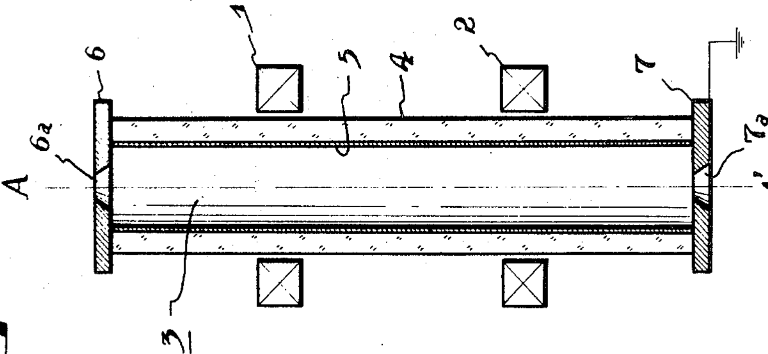


Fig. 1

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ELECTRON BEAM SCANNING APPARATUS

This invention relates to an electron beam scanning apparatus. More particularly, it relates to an electron beam scanning apparatus with little or no high-frequency loss.

In a scanning electron microscope or the like, a deflection coil is provided for causing the electron beam to scan. A magnetic flux is produced by the coil at right angles to the mean path of the electron beam causing the deflection. If a varying current is applied to the coil, the electron beam will be deflected corresponding to the intensity of the current.

A shield is positioned between the coil and the electron beam path to prevent the coil from being impinged by stray electrons. In the past, shields have been made from an insulating or conducting material. If an insulating material is employed, the impingement of stray electrons on the shield caused it to become electrically charged. This condition resulted in the beam being undesirably deflected.

On the other hand, if a conducting material was employed and the shield was grounded, the electric charge effect was eliminated. However, when a high-frequency current (e.g., 15.75 kHz.) was applied to the deflection coil to cause the electron beam to scan at high speeds, for example, in the case of television, a high-frequency magnetic flux was produced. As a result, an eddy current was induced in the shield reducing the high-frequency magnetic flux being applied at right angles to the electron beam path.

According to this invention, an electron beam scanning apparatus is provided with a shield between the deflection coil or coils and the beam path comprising an insulating (nonconducting) material upon which grounded electroconducting coating is applied facing the beam path.

It is an advantage of electron beam scanning apparatus according to the present invention that little or no high-frequency loss is experienced. Furthermore, the electron beam scanning apparatus is unaffected by electrical charges.

Other objects and advantages will become apparent to those skilled in the art from the following detailed descriptions made with reference to the drawings in which:

FIG. 1 is a sectional view of a portion of an apparatus according to this invention.

FIG. 2 shows a sectional view of another embodiment of the present invention.

Referring to FIG. 1, external deflection coils 1 and 2 are arranged to produce magnetic fluxes at right angles to the mean electron beam path A–A'. A cylindrical shield 4 is positioned between the coils and the electron beam path 3 to prevent the coils from being impinged by stray electrons. The shield 4 is made from an insulating material. Suitable insulating materials comprise ceramics including porcelain-type materials; glass, for example, quartz glass and semidevitrified materials and the like. Further suitable insulating materials comprise plastics or rubber materials which are any of a group of synthetic or natural materials that may be shaped or hardened including resins, resinoids, polymers, cellulose derivatives, casein material, proteins and the like. An electroconductive coating or membrane 5 on the inner surface of the shield is connected electrically with electroconductive end plates 6 and 7 fitted to the upper and lower ends of the cylindrical member 4 respectively. The plate 7 is grounded.

Suitable electroconductive coatings comprise, for example, vapor-deposited metals, very thin metal foils, and metal, carbon or other conductor carrying paints or the like. The thickness of the coating is preferably less than about 1,000 Angstroms.

In the above arrangement, the electron beam, created by well-known means, enters the cylindrical shield 4 by an opening *6a* in the end plate 6 and exits by an opening *7a* in the end plate 7. During its passage through the shield 4, the beam is deflected by the magnetic fluxes produced by the deflection coils 1 and 2. Preferably, the respective currents applied to the said coils are synchronized and the electron beam is deflected by the first and second deflection coils respectively. Electron beam scanning is carried out by applying varying currents to the said coils. According to this embodiment, the charge attributable to the stray electrons impinging on the membrane or coating 5 is discharged through the said membrane or coating and the plate 7. Further, when a high-frequency current is applied to the said coils, no eddy currents appear in the shield and little or no eddy currents appear in the electroconductive membrane 5. As a result, high-frequency loss is virtually eliminated.

FIG. 2 shows a modification of the embodiment shown in FIG. 1. Two deflection coils 10 and 11 are provided for causing an electron beam to scan in perpendicular directions. The coils are fitted with a cylindrical coil supporter 12 made of an insulating material such as plastic. A quartz glass cylindrical protecting shield 13, to the inner surface of which 1,000-Angstrom thick vapor-deposited layer of gold 14 is secured, is arranged inside the coil supporter 12. The shield 13 is supported by brass (or some other suitable nonmagnetic material) cylindrical members 15 and 16 provided at the upper and lower ends of the said shield 13 respectively. Layers of silver foil 17 are placed between the protecting shield 13 and the cylindrical members 15 and 16, in order to contact the gold layer 14 and the cylindrical members 15 and 16 electrically. Electroconductive plates 18 and 19 are fitted to the upper and lower ends of the cylindrical members 15 and 16 respectively. Electroconductive plate 19 is grounded.

The upper and lower inner surfaces of the coil supporter 12, the lower outer surface of the cylindrical member 15 and the upper outer surface of the cylindrical member 16 are threaded so that by screwing the cylindrical members 15 and 16 to the coil supporter 12, the shield 13 is secured tightly. Moreover, this arrangement makes assembly and disassembly of the apparatus very easy.

In this embodiment, the electron beam enters the protecting member 13 by opening *18a* in the plate 18 and exists by opening *19a* and in the plate 19. During its passage through the shield 13, the electron beam traverses the magnetic fluxes produced by the deflection coils 10 and 11 and, as a result, is caused to scan in proportion to the intensity of the currents applied to the said coils. Stray electrons impinging on the gold layer 14 are discharged through the cylindrical members 16 and the plate 19, thereby preventing any buildup of charges on the coil supporter 12 and protecting member 13. Further, even if high-frequency magnetic fluxes are produced by applying high-frequency currents to the deflection coils, eddy currents do not occur in the coil supporter and protecting shield, and there is little or no eddy current effect in the thin gold layer. As a consequence, the high-frequency magnetic fluxes are directed to the electron beam path with little or no high-frequency loss.

It should be understood, that the shield may take numerous forms so long as it separates the coils from the stray electrons. There is no need that it be cylindrical or any other particular shape.

Having thus described the invention with detail and particularly as required by the patent laws what is desired protected by Letters Patent is set forth in the following claims.

1. In an electron beam scanning apparatus of a scanning electron microscope, in which an electron beam is deflected about a mean path, at least one deflection coil is provided, to which a high-frequency current is applied, for producing a magnetic field at right angles to the mean path, the improvement comprising an electrical insulating shield positioned between said coil and said mean path having a grounded electroconductive coating facing said beam path, the coating being so thin that little or no eddy currents appear in said coating.

2. An electron beam scanning apparatus according to claim 1 wherein the said electroconductive coating is a vapor-deposited gold layer.

3. An electron beam scanning apparatus according to claim 1 wherein the said shield is quartz glass.

4. An electron beam scanning apparatus according to claim 1 wherein the said shield is of plastic.