The dimensions of tube **640** and hole **740** are typically the same as those of tube **630** and hole **720**. Alignment is necessary to eliminate collection of light scattered from mesh **610** into tube **640**. Such scattered light can affect the measurement's accuracy of the optical autofocusing. When the sample is located at an optimal working distance, light at the focus of lens **750** enters tube **640** through hole **740** and propagates along the axis of tube **640**.

For optimal focusing of beam **690** by lens **700** and high collection efficiency of beam **730** by lens **750**, both lenses must have a relatively large numerical aperture. A relatively large numerical aperture can be achieved by mounting the lenses close to opening **720** and **740** while keeping their size small. Typical numerical aperture and focal length are 0.1 and 20 mm, respectively. Lenses **700** and **750** are located in close proximity, approximately 20 mm from the sample where emitted electrons are present.

Optical lenses are typically made of insulating materials which may be charged by electrons emitted from sample **620**. Charging of lenses **700** and **750** can produce electrical fields which disturb the electron beam propagation, causing improper SEM operation. Lenses **700** and **750** must therefore be coated with a thin conductive layer, which still allows light to pass but prevents them from being charged. This conductive layer is in contact with the tube housing the lens. Thus it is at the same potential as the tube. In spite of their small size (especially at their conical-shaped ends), tubes **630** and **640** may still break the symmetry of the leakage fields, the field produced by the ETD's, and the rotational symmetry of the detectors. This absence of symmetry introduces astigmatic distortion and thus inaccuracy to the system measurement. This disturbance must be corrected in order to maintain rotational symmetry.

FIG. 4—SEM SYSTEMS WITH RADIAL TOP VIEW SYMMETRY—SECOND PREFERRED EMBODIMENT

FIG. **4** is a top cross-sectional view of a SEM system with a structure similar to that of FIG. **3**. This configuration maintains rotational symmetry and avoids creating astigmatism of the electron beam. The cross-sectional plane is parallel to the surface of the measured sample, and is located beneath the polepiece (**600** of FIG. **3**).

FIG. **4** shows tubes **800**, **810**, **820**, and **830** which have a similar construction as tubes **630** and **640** of FIG. **3**. Tubes **800**, **810**, **820**, and **830** are joined to the polepiece of the SEM (not shown) by bars **840**, **850**, **860**, and **870**. Screening mesh **880** is placed above measured sample **890** and is attached to tubes **800–830** (not shown). The holes (not shown) in the conelike shape at the edge of the tubes are aligned with the space between the wires of mesh **880**, as described supra.

Mesh **880** has an exit **900** at the center, typically 100 microns in diameter, where the electron beam passes through toward sample **890**. Emitted electrons from sample **890** travel toward ETDs **910–940**. By proper alignment and spacing of the detectors, emitted electrons can be forced to travel through spaces between the wires of mesh **880**, along the space between tubes **800–830**. These electrons suffer only a very small disturbance, such as scattering and absorption caused by mesh **880** and tubes **800–830**.

The system of FIG. **4** contains four tubes arranged in two pairs that are disposed symmetrically about hole **900** in mesh **880**. This structure has the advantage of being closer to rotational symmetry than the system of FIG. **3**, which has only one pair of tubes. This symmetry with its four tubes causes less astigmatism than the system of FIG. **3**. Only two tubes (one opposing pair) out of the four tubes are used as a part of the autofocus system, e.g., tubes **810** and **830**. The other pair, such as tubes **800** and **820**, may have no optical use and are placed only for improving the system radial symmetry and for improving the stability of the mounting of mesh **880**.

Tubes **800–830** can be electrically biased by insulating them from the polepiece and applying a certain voltage on them at electrodes **950–980**, which are connected to tubes **800–830** respectively. Voltage applied to the electrodes causes an increase of the efficiency of detectors **910–940** in collecting emitted electrons from sample **890**. The value and polarity of those voltages are selected to increase the detectors' efficiency and do not significantly influence the high-energy electrons in the SEM's beam.

Summary, Ramifications, and Scope

We have described a method and apparatus which provide shielding of the sample region in a SEM. An optimal WD is maintained, independent of the measured sample composition or configuration. The optimal WD is precisely determined through the use of an optical autofocus system. The combination of these advantages makes it possible to examine objects quickly and with high resolution.

The above-described implementations of the present system are not the only ones possible. Magnetic fields can be employed instead of or in addition to electric fields, for example. Adjustable electric and magnetic field gradients can be incorporated in conjunction with the mesh to maximize collection efficiency of the microscope's detectors, while minimizing distortion of the scanned image. The dimensions, materials, and shapes of the components can be varied in various manners well known to those skilled in the art. Although the description of the method and apparatus relates to the field of electron microscopy, the same method and apparatus can be used in other technologies where shielding a measured sample from a stray field is required for improvement of measurement accuracy.

Therefore, the scope of this invention should be determined not by the examples given, but by the appended claims and their equivalents.

We claim:

1. A scanning system comprising:

(a) means for producing a scanning electron beam and scanning a measured sample of a substance with said beam along a scanning range,

(b) focusing means having a depth of focus and a focal plane remote from said focusing means at a focal length distant from said focusing means,

(c) said focusing means being arranged to produce a focused electron beam and focus said electron beam onto a focusing spot on said focal plane such that said focal plane coincides with a surface of said sample within an accuracy range equal to said depth of focus throughout said scanning range of said scanning electron beam,

(d) sensor means for detecting an emission selected from the group consisting of X-rays emitted from said sample, electrons emitted from said sample, and electrons reflected from said sample,

(e) said sensor means being arranged to provide a sensor output in response to said detecting,