ment of the optical properties of a specimen. The spectro-reflectometer provides a light beam of controllable wavelength and includes reflection measurement instrumentation. As used herein it is employed principally as a light source. In the spectro-reflectometer an oscillating mirror **99** alternately reflects a light beam along paths **101***a* and **101***b* . In each of these paths the respective light beam **101***a* or **101***b* is reflected from a mirror **102** and directed through an optical integrating sphere **103.** The integrating sphere **103** of the conventional spectro-reflectometer is not used directly in operation of the simulation and measurement apparatus herein described but is retained in position in the light paths so that specimens may be provided in the windows thereof for calibration purposes.

The typical light beam **101***a* after passing through the optical integrating sphere **103** is converged by a concave mirror **104***a* and directed to a flat mirror **106***a* which in turn reflects the light beam through a window **96***a* in the optical integrating sphere **29.** The light beam **101***a* is directed to the measuring aperture **28** so as to fall upon a specimen mounted therein.

The light beam **101***b* follows a similar path to the light beam **101***a* except that it is directed onto a standard surface **107** having known optical properties. In practice the oscillating mirror **99** of the spectro-reflectometer causes this instrument to alternately illuminate a specimen in the measuring aperture **28** and the standard surface **107** by way of the optical paths **101***a* and **101***b*, respectively so that the optical properties of the specimen at each wavelength are continually compared with the standard surface. A conventional photomultiplier tube or lead sulfide photodetector (not shown) is mounted in a housing **108** (FIGS. **1** and **2**) so that the measuring aperture of the photodetector is substantially flush with the inner surface of the optical integrating sphere **29.**

In order to obtain measurements of the optical properties of a specimen in the measuring aperture **28** the specimen and the standard surface **107** are alternately illuminated by the spectro-reflectometer **98** with light of a selected wavelength. Light scattered from the specimen or standard surface, respectively, is sensed by the photomultiplier and the measured light intensity is determined by the reflectance of the respective surfaces. The photomultiplier views substantially the entire inner surface of the optical integrating sphere **29** and in order to obtain maximum response from the instrument the interior of the optical integrating sphere is coated with a layer of magnesium oxide smoked on in a conventional manner; that is, by burning magnesium ribbon in the sphere to deposit finely divided magnesium oxide on all exposed surfaces. Magnesium oxide forms a high reflectivity diffuse coating on the interior of the optical integrating sphere and this material is preferred since its reflectance is substantially insensitive to wave-length over a relatively broad range of wavelengths. Any light reflected from the specimen or standard surfaces, respectively, is also reflected by the magnesium oxide coated interior of the optical integrating sphere and measured by the photomultiplier so that the angular position of the photomultiplier relative to the surfaces is immaterial. This type of spectral reflectance measurement employing an optical integrating sphere and obtaining comparative values between an unknown specimen and a known surface is a conventional technique.

It has also been found in practice of this invention that absolute measurements of spectral reflectance can be made with an improved optical integrating sphere used in place of the conventional integrating sphere **29.** Such an improved sphere **109** is illustrated in FIGS. **10** and **11** which show a pair of cross-sections of the improved optical integrating sphere in orthogonal directions. As in the previously described embodiment of an optical integrating sphere **29,** the improved sphere **109** is formed in two hemispherical halves **111** and **112,** respectively. A measuring aperture **113** is provided in a side of the hemisphere **111** so that a specimen **114** can be positioned in the aperture for reflectivity measurements. A light source **116** such as the above described spectro-reflectometer for providing monochromatic illumination of the specimen **114** is provided outside a window **117** in the hemisphere **112.** The light source **116** is directed so as to illuminate only the specimen **114** or alternately a selected portion of the interior wall of the hemisphere **111.**

A photomultiplier **118** mounted in a housing **119** so that the measuring aperture of the photomultiplier is substantially flush with the inside surface of the sphere is also located in the hemisphere **112.** An opaque shield **120** is mounted on a wire frame **121** clamped between the two hemispheres **111** and **112.** The concave surfaces of the opaque shield **120** are coated with a layer of highly reflective magnesium oxide as is the interior of the integrating sphere **109** and the wire frame **121.** The opaque shield **120** is arranged exactly between the photomultiplier **118** and the specimen **114** so that no direct reflection from the specimen falls on the photomultiplier. The shield **120** also obscures that portion of the wall of the hemisphere **111** illuminated by the light source **116** in its alternate mode, so that the light reflected from that region of the wall does not fall directly on the multiplier **118.**

In operation the spectro-reflectometer **116** is employed as hereinabove described and a light beam of known wavelength is alternately directed on the specimen **114** and on the wall of the hemisphere **111** in the region obscured from the photomultiplier **118** by the opaque shield **120.** The photomultiplier measures the intensity of light reflected from the specimen **114** and illuminated portion of the hemisphere **111,** respectively.

By arranging the photomultiplier flush with the wall of the hemisphere **112** and providing an opaque shield **120** between the photomultiplier and the directly illuminated portion of the sphere, the photomultiplier receives light reflected from substantially all interior surfaces of the integrating sphere **109** except that region directly illuminated by the light source **116.** That is, all light falling on the photomultiplier **118** has been reflected by the interior surface of the optical integrating sphere. Thus, for example, when the specimen is illuminated, light reflected therefrom cannot travel directly to the photomultiplier because of the shield but can reach that instrument only after reflecting off the highly reflective magnesium oxide coating within the optical integrating sphere. Since all light, in any case, reaching the photomultiplier is reflected at least once off of the magnesium oxide surfaces and the comparison standard is, in effect, the magnesium oxide surface of the hemisphere **111** directly illuminated by the light source **116,** the effect of the standard or reference sur-