exit slit of the monochromator from the reference beam cable **43**, the value σ can be written as follows:

$$\sigma = \frac{N_S - N_D}{N_W - N_D} \quad (6)$$

Accordingly, from equations (4) and (5):

$$\sigma = \frac{y_s(g_1 r + g_2 \rho)}{y_w g_3 \rho} \quad (7)$$

When a black cavity is placed over the sample port of the integrating sphere, the reflectivity of the black cavity sample will be zero. The value of the ratio σ_B for the black cavity will accordingly be represented as follows:

$$\sigma_B = \frac{y_s g_2}{y_w g_3} \quad (8)$$

When a white standard having a known reflectance R is placed over the sample port and the value of the ratio σ_w for the white standard will be represented by the following equation:

$$\sigma_w = \frac{y_s(g_1 R + g_2 \rho)}{y_4 g_3 \rho} \quad (9)$$

The value of the ratio σ for the unknown sample of which the reflectance is being measured, defined as σ_x, and having a reflectance r_x can be represented by the following equation:

$$\sigma_x = \frac{y_s(g_1 r_x + g_2 \rho)}{y_w g_3 \rho} \quad (10)$$

The value of the reflectance r_x can then be written in terms of the σ values as follows:

$$r_x = \frac{\sigma_x - \sigma_B}{\sigma_w - \sigma_B} \times R \quad (11)$$

Thus, the unknown reflectance of any sample can be determined by knowing the reflectance of a given standard by means of the equation 11 and this can be computed at all wavelengths by taking the ratio of the dark corrected analog-to-digital converter output from the sample to the dark corrected output of the analog-to-digital converter for the wall of the sphere as represented by equation 6. The monochromator efficiency, the k factor of the analog-to-digital converter and, most important, the I term of equation (1), which includes the wall discoloration and diminution factor, all factor out of the determination.

To use the instrument, a black cavity is placed over the entrance port and σ_B ratios for each 5 nanometer bandwidth increment is measured and stored. Then a white standard is placed over the sample port of the integrating sphere and σ_x ratios are determined for each wavelength and stored. The instrument is then ready to measure the reflectivity of a sample. The sample is placed over the entrance port and the values of σ_x are determined for each 5 nanometer bandwidth increment and stored in the memory of the computer. The computer then determines the reflectivity of the sample r_x for each 5 nanometer bandwidth increment in accordance with the equation 11. The measurement of σ_B for the black cavity and σ_w for the white standard need not be made prior to each measurement of an unknown sample, but only need to be made periodically, for example, once a day, to account for drift in the values of the factors which determine σ_B and σ_w. The computer will determine the reflectivity values from the last values of σ_B and σ_w measured and stored, together with the known spectral value of R.

The above described instrument provides a highly accurate and efficient measurement of the reflectivity of the sample at each different wavelength spread over the spectrum from 380 nanometers to 720 nanometers with the measurements being made at five nanometer intervals and each measurement being made integrated over a 5 nanometer bandwidth. As a result, a highly quantitative analysis of the reflectivity of the sample is obtained. The use of the reference beam measurements made on the light transmitted through the fiber optic cable **41** effectively eliminates any errors due to diminution or variation in the intensity of illumination provided within the sphere **21**. This cancellation is very efficiently and conveniently provided by the optical beam switching mechanism comprising the fiber optic cables **31** and **41**, which also provide a convenient means of averaging variations in the reflectivity over the sample surface and eliminating any effect of polarization of the reflected light by the sample.

The above description is of a preferred embodiment of the invention and many modifications may be made thereto without departing from the spirit and scope of the invention which is defined in the appended claims.

What is claimed is:

1. A reflectance measurement instrument comprising an integrating sphere having means to introduce light into said sphere and defining a sample port to receive a sample, a sample beam exit port to receive light reflected from a sample positioned at said sample port, and a reference beam exit port positioned to receive light reflected from the interior wall of said sphere, measuring means to make quantitative measurements on received light intensity, a first fiber optic cable arranged to receive light transmitted through said sample beam exit port, a second fiber optic cable arranged to receive light transmitted through said reference beam exit port, and beam switching means operable to selectively position said first fiber optic cable or said second fiber optic cable to transmit the light received thereby to said measuring means.

2. A reflectance measurement instrument as recited in claim **1**, wherein said measuring means includes a monochromator to isolate narrow portions of the spectrum of the light received by said measuring means and means to make quantitative measurements on the intensity of said isolated portions.

3. A reflectance measurment instrument as recited in claim **2**, wherein said monochromator includes an optical grating and defines an entrance slit for illuminating said optical grating, said beam switching means positioning the transmitting ends of said first and second fiber optic cables in alignment with said entrance slit, the transmitting ends of said fiber optic cables having the fibers thereof arranged in a rectangular shape to correspond with the shape of the entrance slit of said monochromator.

4. A reflectance measurement instrument as recited in claim **3**, wherein the rectangular shapes of the transmitting ends of said fiber optic cables are slightly larger