Optical schemes for nondestructive optical testing of cylindrical surfaces by spatially matched conical light beams are presented. A theoretical model is elaborated which describes profilometers with conical beams. The operation regime of the profilometers is characterized by a nonzero spatial frequency of output signal. It allow us to apply a new algorithm for the interpretation of the output signal the calculation of the azimuth spectrum which characterizes the deviation of tested profiles from the circular ones. Cylindrically symmetric solutions of the free-space wave equation for conical waves which used in optical profilometry of cylindrical surfaces are found. These solutions correspond to the ТЕ- and ТН- polarized waves which are of interest for profilometry. Using the radially and azimuthally polarized waves in profilometry allows one to avoid the cross-polarization effects, which are not associated with the presence of the defects. A novel analytical formulation of diffraction properties of the conical field reflected from the cylindrical surface is derived. This formulation is based on introducing some effective entrance transparency. The transparency is characterized by a flat profile and by a transmission function modeling the two-dimensional amplitude-phase profile of the field reflected from the cylindrical surface. A modified 2D-diffraction integral allows to calculate the reflected beams in the near-field, Fresnel, and far-field regions.

We describe such profilometer schemes as a) Profilometers based on the Mach-Zehnder interferometer and profilometers based on the Michelson interferometer (The output signal of these schemes is an interference pattern produced by the object and reference waves); b) Far-field profilometer (In this profilometer output signal is the two-dimensional Fourier-spectrum. The radial structure of the Fourier-spectrum accumulates the distortions of the surface integrated over its length. This profilometer does not require of a reference wave and, therefore, has a high stability against vibrations.); c) Profilometers with focusing of conical beam (During the measurements the object must move along the optical axis. The reflected field can be analyzed both directly, i.e. without using the reference wave, and as an interferogram. The longitudinal resolution of the profilometer is high and is limited to the available focusing sharpness of the conic beam.)