This experimental study addresses the re-initiation mechanism of detonation waves following the Mach reflection of a shock-flame complex. The detonation diffraction around a cylinder is used to reproducibly generate the shock-flame complex of interest. The experiments are performed in methane-oxygen. We use a novel experimental technique of coupling a two-in-line-spark flash system with a double-frame camera in order to obtain microsecond time resolution permitting accurate schlieren velocimetry. The first series of experiments compares the non-reactive sequence of shock reflections with the reflection over a rough wall under identical conditions. It was found that the hot reaction products generated along the rough wall are entrained by the wall jet into a large vortex structure behind the Mach stem. The second series of experiments performed in more sensitive mixtures addressed the sequence of events leading to the detonation establishment along the Mach and transverse waves. Following ignition and jet entrainment, a detonation first appears along the Mach stem while the transverse wave remains non-reactive. The structure of the unburned tongue however indicates local instabilities and hot spot formation, leading to the rapid reaction of this gas. Numerical simulations are also reported, confirming the sequence of ignition events obtained experimentally.