CHAPTER 4

HOLOGRAPHY FOR DEFECT DETECTION ON ARTILLERY PROJECTILES

Paul J. Kisatsky

US Army Armament Research and Development Command

Dover, New Jersey

INTRODUCTION

A matter of grave concern in the production of artillery projectiles is the presence of cracks in the steel projectile body. During rough handling and active usage by the troops, small sub-critical cracks can grow to critical dimensions. Ultimately, the high stresses induced in the shell by the set back forces of gun launch can cause the cracks to completely fracture the shell while still in-bore. An in-bore premature is extremely serious, resulting in destruction of the weapon and possible loss of life.

Inspecting for cracked projectiles is now accomplished by two conventional methods; magnetic particle penetrant or ultrasonic pulse echo testing. The first of these has the advantage of visual defect observation but it does not distinguish between critical cracks and cosmetic blemishes. Further, being visually inspected, the process is subject to operator fatigue and error resulting in critically defective shells often being accepted. In comparison, ultrasonic echo testing lends itself to automation but is highly dependent on proper use of "standards" to adjust the accept-reject pulse threshold margins. It requires water immersion of the part, is fallible to false echos, and is intrinsically a nonimaging method requiring elaborate scanning and multiple channel transducer configurations.

As part of the R & D effort in holographic nondestructive inspection (NDI) in our laboratory, we initiated a series of experiments to ascertain the feasibility of employing holographic interferometry for cracks in projectiles. When feasible and practical, holographic NDI offers certain intrinsic advantages while doing

J. J. Burke et al. (eds.), *Risk and Failure Analysis for Improved Performance and Reliability*

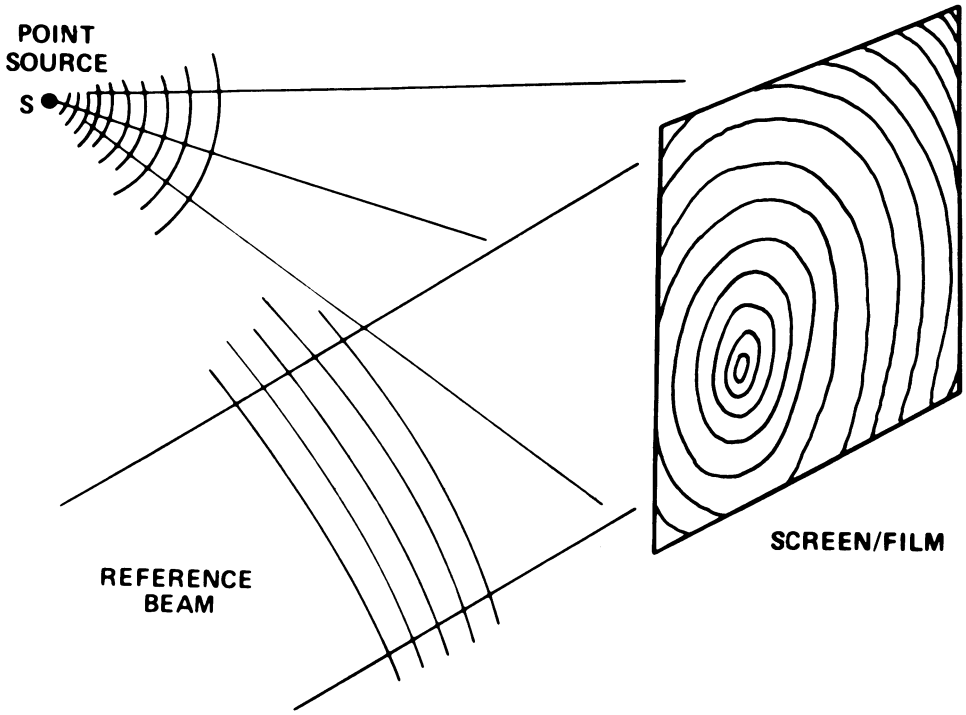

Figure 1. Constructing an elementary hologram.

away with some of the main disadvantages of magnetic particle or ultrasonic NDI. The artillery shells worked with and currently under investigation are the 105mm HEP M393, the 155MM RAP, M549 and the 155MM, GPC, M483.

PRINCIPLES OF HOLOGRAPHIC INTERFEROMETRY

To better understand the experiments described in this chapter, the basic principles of nondestructive inspection by holographic interferometry are reviewed here. The construction of an elementary hologram is shown in Figure 1. If we simultaneously illuminate a screen with coherent radiation from a point source and that from a columated beam, later known as the reference wave, it will be noticed that a series of fringes will form on the screen due to the interference of the two waves. These fringe patterns are shown in a highly exaggerated form in Figure 1. If the screen is replaced with photographic film which is exposed and developed into a transparency, the fringe pattern formed by the source and the reference beam will be recorded. If the developed film is then placed back into its original position and illuminated with the same reference beam in the absence of the original point source, upon looking through the