Study of Chemical Reactions in Gases Emerging From the Muzzle of a Gun, by Means of High-Speed Photography

PAPER I—5

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The intensity of reactions of approximately 100 msec duration at various points in a jet stream depends upon the temperature and concentration of oxygen prevailing in these regions. High-speed photography is a powerful tool for studying these chemical reactions. The present note describes investigations on flash from W and NH propellants at camera speeds of 1500 and 3000 frames/sec.

Two COMBUSTIBLE constituents of gases coming out from the muzzle of a gun are carbon monoxide and hydrogen. On emergence at the muzzle, these gases react with atmospheric oxygen and undergo oxidation. This results in a large flash. The intensity of reactions at various places in the jet stream depends upon the temperature and concentration of oxygen prevailing in these regions. The duration of these reactions is very small — say, 100 msec or so. High-speed photography is a powerful tool for studying these chemical reactions. The present note describes investigations on flash from W and NH propellants.

Experimental

A 3.7-in. antiaircraft gun was selected for studying the flash. Rounds containing NH and W propellants were fired from this gun. Such a combination of a high-pressure gun and a fully flashing propellant results in a flame at the muzzle which exhibits, with sufficient intensity, most of the structural features of the general phenomenon of flash. A Fastax camera loaded with super XX films was used for this study. The firings were done at dusk. Figures 1–4 are photographs of the flash from NH and W propellants at camera speeds of 3000 and 1500 frames/sec.

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Discussion

The photographs show that the flash from these propellants is of two types.

(*1*) *Primary flash:* This is localized at the muzzle. It arises from the high temperature and pressure behind the normal shock wave.

(*2*) *Secondary flash:* This appears a few milliseconds after the shot escapes from the muzzle. The secondary flash starts in a small region and gradually builds in size. Certain regions in the photographs are exceptionally bright. It is reasonable to infer that in these regions oxygen is available in sufficiently large concentrations. Oxygen reaches these regions as a result of turbulent flow and also as a result of the presence of a comparatively low pressure in the central positions of the jet stream.

The present study provides some very interesting and useful information regarding the distribution of temperature and pressure in the stream of gases from the muzzle.

(*See the following page for Figs. 1–4.*)

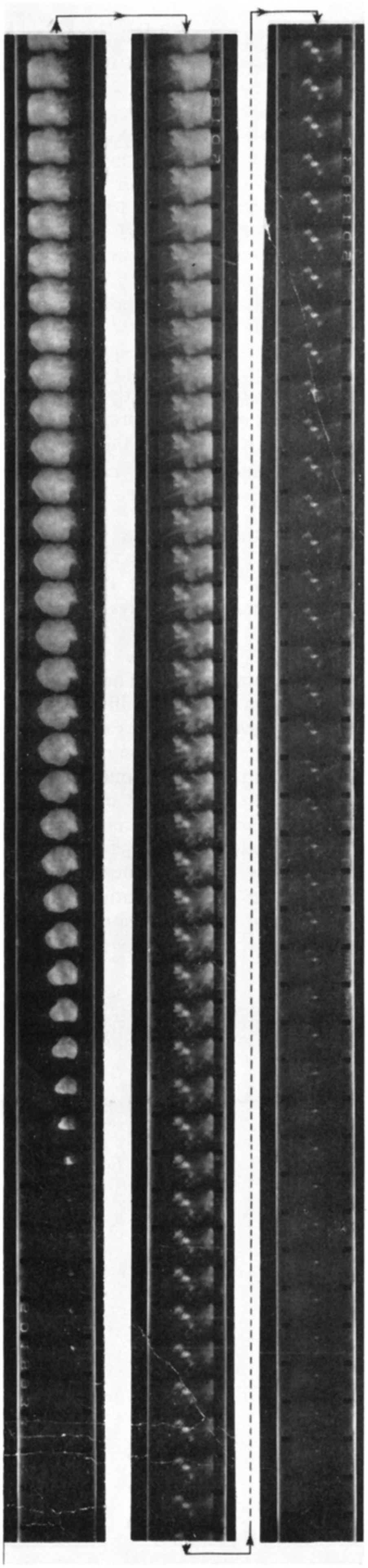

Fig. 1. Flash from NH propellant (3000 frames/sec).

Fig. 2. Flash from NH propellant (1500 frames/sec).

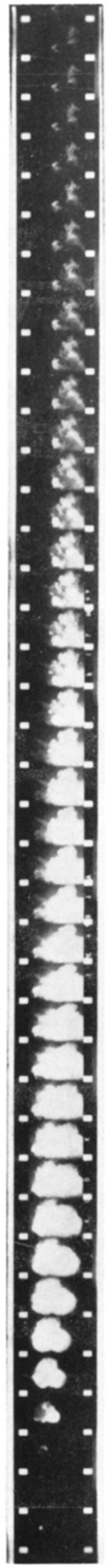

Fig. 3. Flash from W cordite (3000 frames/sec).

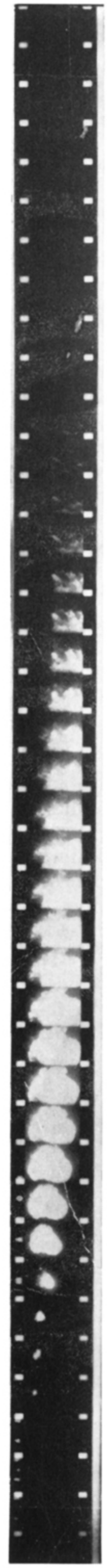

Fig. 4. Flash from W cordite (1500 frames/sec).