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A NOTE ON THE TRAVEL OF ' MUNROE ' JETS IN AIR

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ABSTRACT

Following Kolsky et al., the travel of the ' Munroe ' jets in air from shaped charges having conical liners of different metals and of different calibres have been studied by photographic methods, and notable differences for different metals have been observed.

Introduction

Kolsky, Snow and Shearman[1] took photographs of the travel of the ' Munroe ' jets in air by opening the shutter of the camera in complete darkness before firing the charges. They fired 6 mm. and 1 cm. copper and steel liners and the beams were photographed from a distance of about one metre. In this note, the photographic study of the jet is extended to shaped charges of bigger calibres ($1\frac{1}{2}$ in. to $2\frac{1}{2}$ in.) having copper, steel, aluminium, zinc and tin conical liners.

Experimental Work

Conical liners of different metals and of different base diameters (referred to as calibre and denoted as D) were machined from rods of different metals and soldered to suitable lengths of gas pipes at one end. The angles and thicknesses of the liners were 45° and 0·032 D respectively. High explosive, which was a mixture of T.N.T. and tetryl in the ratio of 70 : 30, was cast. A guncotton primer was used as a booster and was primed by an electric detonator. The equipment was fired vertically upwards in the air. Photographs of the jets were taken from a distance of 200 feet from the place of firing. The shutter of the camera was opened in complete darkness before firing the charge.

Discussion

Figures 1 and 2 show the photographs of the ' Munroe ' jets from charges of different calibres and having liners of copper and steel respectively. The luminescent beam, beyond its first 20 feet of travel, breaks up into a number of beams having straight tracks confined to a very narrow cone which is observed better on the original negatives. As the beams travel forward, these lose intensity rapidly. The luminescence of the beam (or beams) may be due to the hot incandescent metal of the liner and/or to the adiabatic compression of the air in front of the fast moving jet. In case of copper jets, the mean over all heights to which the luminescent tracks travel by firing equipments of $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ in. calibres are 55, 75, and 110 feet respectively and the tracks end abruptly. In case of steel jets, the straight tracks which might possibly

be due to several small incandescent fragments do not end abruptly, but these incandescent fragments seem to fall downwards giving a bushy appearances to the top ends of the jets.

Fig. 3 shows the photographs of the zinc and tin jets. These jets do not have straight tracks but appear like pulsating cylindrical columns. The first half of the aluminium jet has a close resemblance to the zinc and tin jets, while the second half looks similar to the copper jet.

The differences in the structural appearances of the various jets, as seen from the photographs, may be explained on the basis of the physical condition (fragmentary or gaseous) of the metals in the jets. The splitting of the luminescent beams, in case of copper and steel jets, beyond their first 20 feet of travel, into several straight tracks indicate that the metals in the jets are discrete incandescent particles or fragments. It appears also that the metals in the jets during their first 20 feet of travel may be both fragmentary and gaseous (dense vapours). With linings of zinc and tin, the jets may be composed of streams of dense vapours. In case of aluminium lining, the first half of the jet appears to be composed of fine fragments and dense vapours, and the second half of a stream of fine fragments.

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REFERENCE

[1] Kolsky, H., Snow, C. I. and Shearman, A.C., Research, 2, 92, 1949

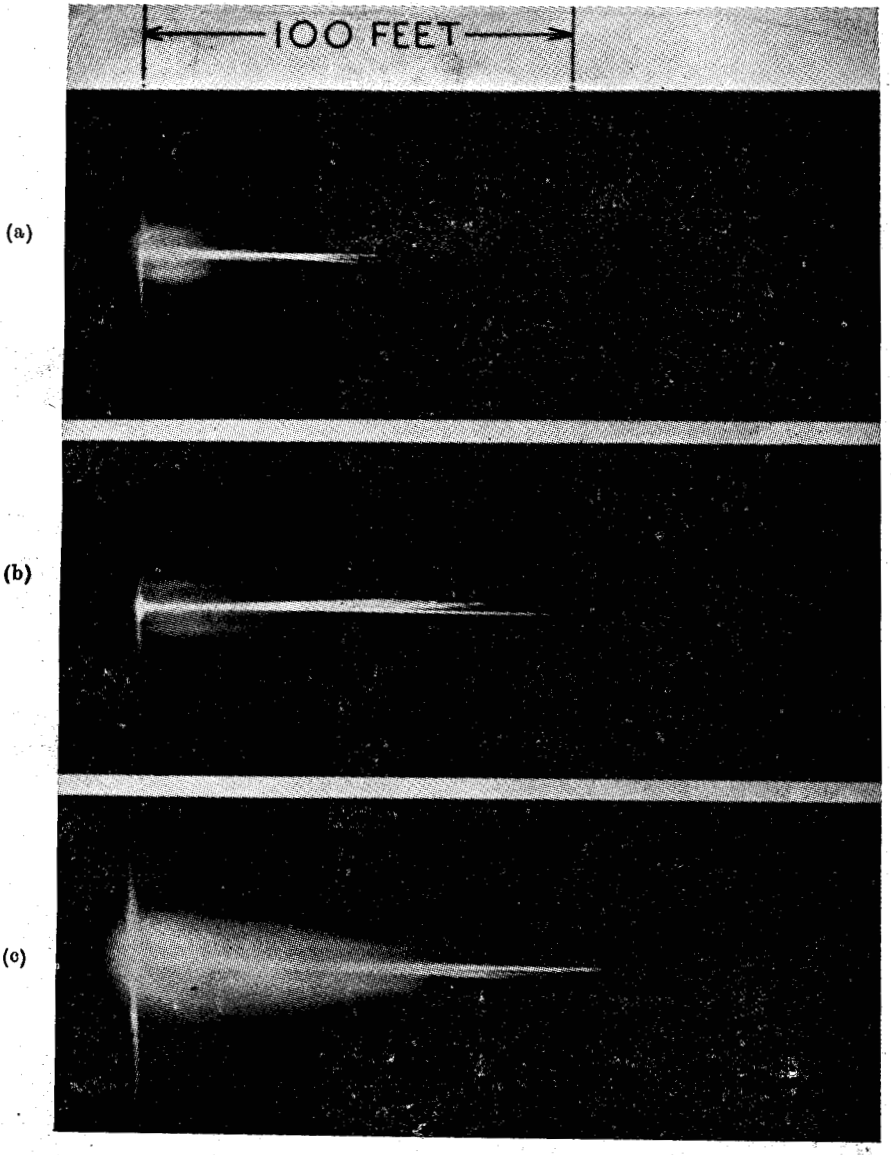

FIG. 1. 'MUNROE' JETS IN AIR FROM SHAPED CHARGES HAVING 45° COPPER CONICAL LINERS OF (a) 1½ IN. CALIBRE, (b) 2 IN. CALIBRE AND (c) 2½ IN. CALIBRE.

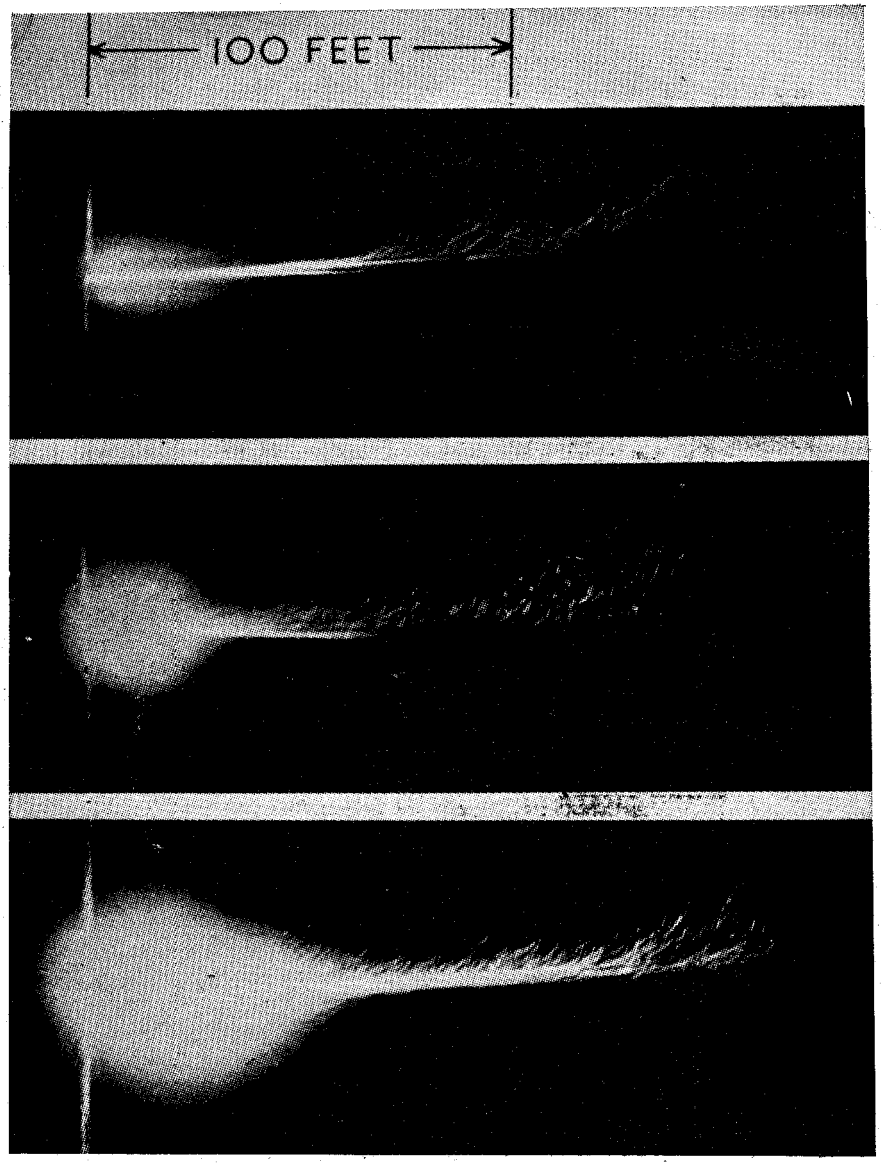

FIG. 2. 'MUNROE' JETS IN AIR FROM SHAPED CHARGES HAVING 45° STEEL CONICAL LINERS OF (a) 1½ IN. CALIBRE, (b) 2 IN. CALIBRE AND (c) 2½ IN. CALIBRE.

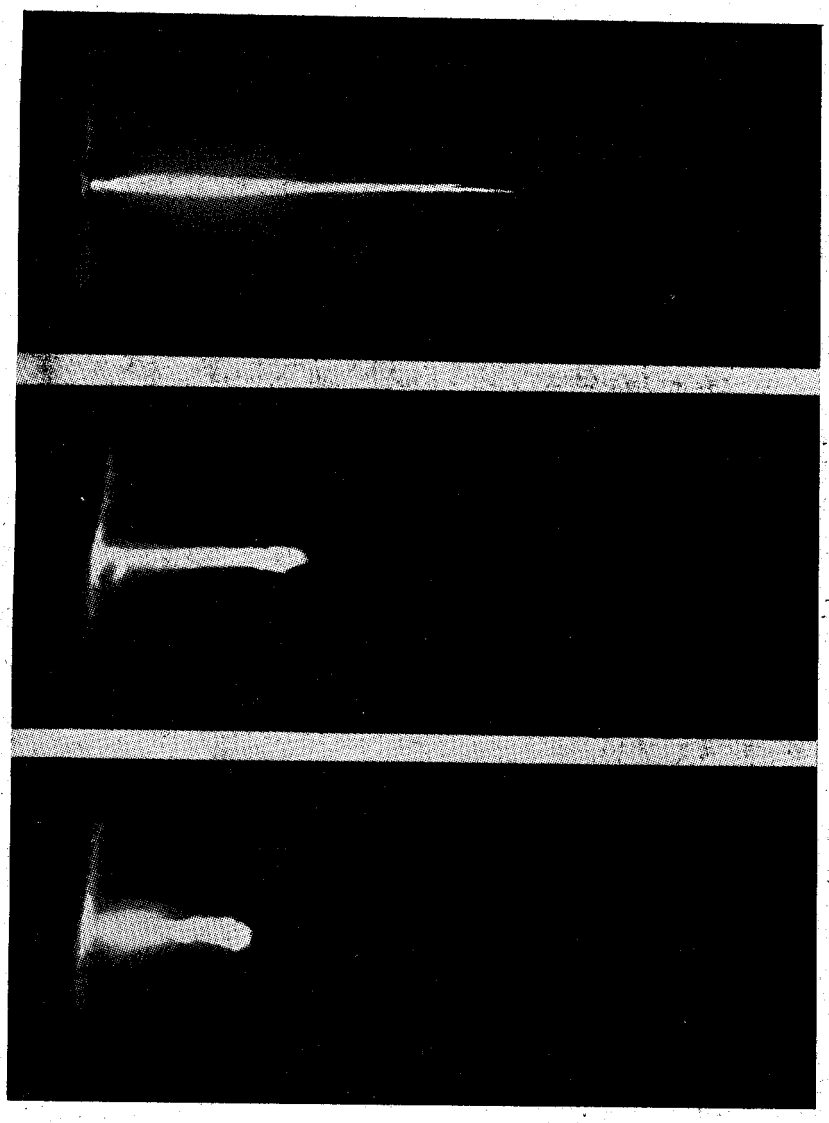

FIG. 3. 'MUNROE' JETS IN AIR FROM SHAPED CHARGES OF 2½ IN. CALIBRE AND HAVING 45° CONICAL LINERS OF (a) ALUMINIUM, (b) ZINC AND (c) TIN