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LOS ALAMOS • NEW MEXICO

Broach for Shearing Rotating Bands
From Rifle-Bore-Fired Projectiles

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Broach for Shearing Rotating Bands
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BROACH FOR SHEARING ROTATING BANDS
FROM RIFLE-BORE-FIRED PROJECTILES

by

Paul E. Barbo and Ben J. Gillespie

ABSTRACT

A broach for cutting off the protruding portion of the rotating band on an artillery shell as the shell leaves the gun muzzle is being developed by Group W-3 at Los Alamos Scientific Laboratory. The purpose of the band broach is to decrease the frontal area of the shell and, thereby, decrease the drag during flight. The percentage of increase in maximum range equals about seven-tenths of the percentage of decrease in frontal area.

INTRODUCTION

The information contained in this report should be considered to be preliminary. Component configurations are in a developmental stage and are subject to change as additional work is done on the project.

DISCUSSION

Work on the band broach was started at LASL in mid 1967 after a "technical" journal¹ reported that Russian researchers were making gears by shooting metal blanks through a broach with a gun. The Russians had reported small cutting resistance and "no measurable tool wear" when cutting ordinary steels.

The work at LASL has thus far utilized a 105-mm howitzer and a band broach consisting of a holding fixture filled with a broaching tool, as illustrated in Fig. 1.

Fig. 1. Band broach.

Figure 2 shows the band broach mounted on the muzzle of the 105-mm howitzer. Standard military rounds having rotating band material of gilding metal were fired through the broach. The protruding portions of the rotating bands were cleanly sheared off, as shown in Fig. 3; preliminary results from velocity measurements indicate that little work was required. The present 105-mm-howitzer band broach leaves a band that protrudes approximately 0.007 in. beyond the shell circumference.

In recent experiments with fluid dynamic drag,² drag coefficients have been measured for a variety of imperfections on an otherwise streamlined projectile. Although the results vary somewhat with Reynolds number, Mach number, and shape and size of the projection, a value of $C_d = .8$ approximates the data from subsonic velocities through Mach 2; this coefficient is based on the frontal area

Fig. 2. Band broach mounted on 105-mm howitzer.

Fig. 3. 105-mm military shell with band broached off.

of the projection. "Good" aerodynamic shapes have transonic drag coefficients of the order of .25, based on total frontal area. Therefore, the percentage increase in drag due to a thin ring projecting above the smooth surface is:

$$\% \frac{\Delta C_d}{C_{do}} = 100\% \times \frac{.8(\pi Dh)}{.25(\pi D^2/4)} = 1280 \frac{h}{D} \%$$

Thus, a 0.045-in. band on a 105-mm shell increases the drag about 14%; a 0.007-in. band, about 2%. Based on results from computations by Group W-3 personnel for projectile trajectories which show an increase in range equals seven-tenths of the percentage of decrease in drag, the net increase in range is about 8%.

Present plans for additional development work on the band broach include more firings from the 105 mm howitzer and firings from a 155-mm gun. A holding fixture and broaching tool have been designed and built for the 155-mm gun. The purpose of the additional shots is to determine the optimum shape and material of the broaching tool for long tool life and low cutting force.

Projectile broaches are readily adaptable to all existing military guns, with no required modifications to the projectiles or guns. A broach can be easily

removed, if desired, so that existing range tables can be correct.

REFERENCES

1. W. S. Bacon, Popular Science, 191, 3, Sept. 1967, p.26.
2. S. F. Hoerner, Fluid-Dynamic Drag, 2nd Ed., published by author, Midland Park, New Jersey, 1965, p.20-13.