U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

ROTATING BAND SEATING MEASUREMENTS

1. OBJECTIVE

The objective of this test procedure is to instruct personnel in the methods and techniques for measuring rotating band seating of artillery projectiles.

2. BACKGROUND

Rotating band seating measurements are valuable when used in conjunction with proving ground tests in which low velocity or poor velocity uniformity is found and is suspected of having resulted from poor rotating band seating. (See Appendix A for effects of rotating band seating.)

3. REQUIRED EQUIPMENT

a. For Nondestructive Tests:

1) Hydraulic Press DTM Model RB-20 (for 20-mm projectiles)
2) Hydraulic Press DTM Model RB-1 (for 75-mm through 120-mm projectiles)
3) Hydraulic Press DTM Model RB-2 (for 155-mm through 8-inch projectiles)

b. For Destructive Tests:

1) Hacksaw
2) Micrometer calipers

4. REFERENCES

A. Purchase Description, Shell, Steel, Manufactured from Forgings, PA-PD-348, 11 April 1953

B. Purchase Description, Projectile, HE, 175-mm, M437, Metal Parts Assembly, FA-PD-MI-2445, Rev. 3, 24 August 1962, with Amendment 1, 14 August 1963

C. Gibson, Capt H. B., Jr., The Effect of Decreasing Exterior Rotating Band Dimensions on Velocity of a 90-mm Shell, HE, M71, Aberdeen Proving Ground Firing Record P-42324, 14-17 July 1947

D. Noble, E. A., Shell, HE, M71, 90-mm, Rotating Band Clearance Measurements, Aberdeen Proving Ground, BRL Memo Report 465, 1 August 1947

E. Rosenfeld, A., Effect of Rotating Band Clearance on the Muzzle Velocity of Several Type Artillery Shell, Aberdeen Proving Ground, BRL Memo Report 777, April 1954

* Supersedes Interim Pamphlet 80-46

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F. To Determine the Correlation Between the Velocity of the 90-mm, HE, M71 Shell and D. T. M. Measurements of Rotating Band Clearance, Aberdeen Proving Ground Firing Record P-41922, 6 June 1947
G. FA Drawing 8593429, Band Seating Testing Machine Indentor and Test Data (DTM Model RB-1)
H. FA Drawing 8596059, Band Seating Testing Machine Indentor and Test Data (DTM Model RB-2)
I. Lake City Army Ammunition Plant Drawing 7259306, Indentor, Band Tightness Tester (DTM Model RB-20)

5. SCOPE

5.1 SUMMARY

This test procedure relates the nondestructive and destructive methods of measuring rotating band seating.

5.2 LIMITATIONS

Measurements of band seating are customarily made on projectiles of caliber 75-mm and over; they may be made on smaller projectiles if necessary. Nondestructive measurements may be made on HE-loaded as well as inert-loaded projectiles; destructive measurements are normally restricted to inert-loaded or empty projectiles but may be made on HE-loaded projectiles through the use of remote-controlled machining processes.

6. PROCEDURES

6.1 PREPARATION FOR TEST

Determine the proper machine indentures and pressures to be applied using the criteria given in Appendix B.

6.2 TEST CONDUCT

6.2.1 Nondestructive Tests

a. Place the projectile to be tested in the proper machine (see Appendix B) so that the indentors, placed in the rams, contact diametrically opposite and equal areas on the rotating band.

b. Apply a load to the hydraulic press rams and record the travel of the ram while in contact with the rotating band, as indicated on the hydraulic press indicator dial. Remove the load.

NOTE: The indicated travel is a combination of an elastic deformation of the projectile and a permanent deformation of the rotating band caused by seating the rotating band securely on the band seat.

c. Reapply the load to the projectile and record the indication on the hydraulic press indicator panel.

NOTE: The indicated travel is a measurement of the elastic deformation of the projectile only.

6.2.2 Destructive Tests

NOTE: Destructive tests are used only in the absence of suitable nondestructive equipment or for the measurement of sintered iron rotating bands.

a. Measure and record the outer diameter of the rotating band, using micrometer calipers, at three equally spaced positions.

b. Mark the measured positions on the projectile.

c. Carefully remove the rotating band.

NOTE: If this operation is required on HE-loaded projectiles, the removal of the rotating band shall be accomplished by remote control with the operator suitably protected.

d. Measure and record the thickness of the rotating band at the positions used to measure the band's outer diameter.

e. Measure and record the diameter of the rotating band seat at the positions indicated on the projectile.

f. Visually inspect the inner surface of the rotating band and record evidence of proper/improper band seating and variations in degree of seating. (Figures 1 and 2 show evidence of differences in band seating.)

NOTE: 1. A band that has been properly seated will show impressions of the tooling marks from the band seat on the inner surface of the rotating band.

2. Variations in degree of seating from one radial position to another and from the front to the rear of the rotating band can be detected by visual examination.

6.3 TEST DATA

6.3.1 Nondestructive Tests

Record the following:

a. Load applied in pounds
b. First deflection to nearest thousandths of an inch
c. Second deflection to nearest thousandths of an inch

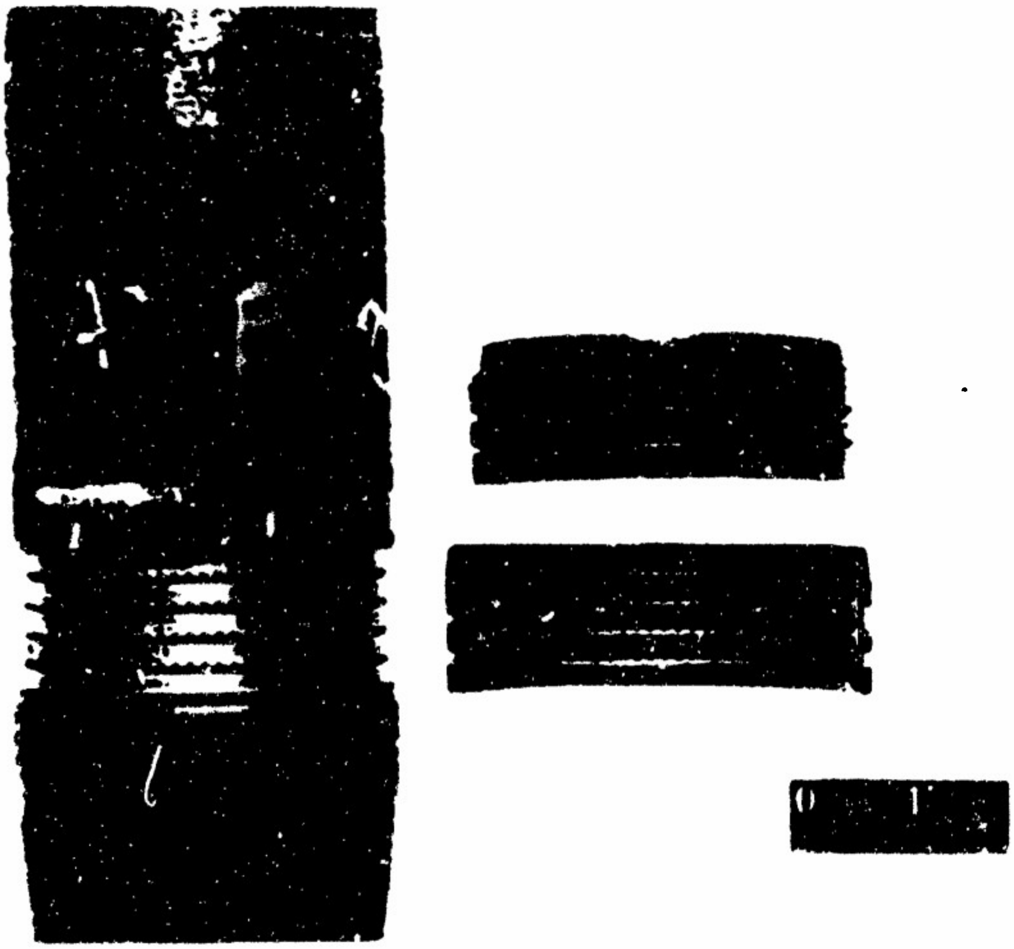

Figure 1. Properly Seated Band. Note Uniformly Deep Knurling and Regularity of Machining Marks Made by Impression of Band Seat

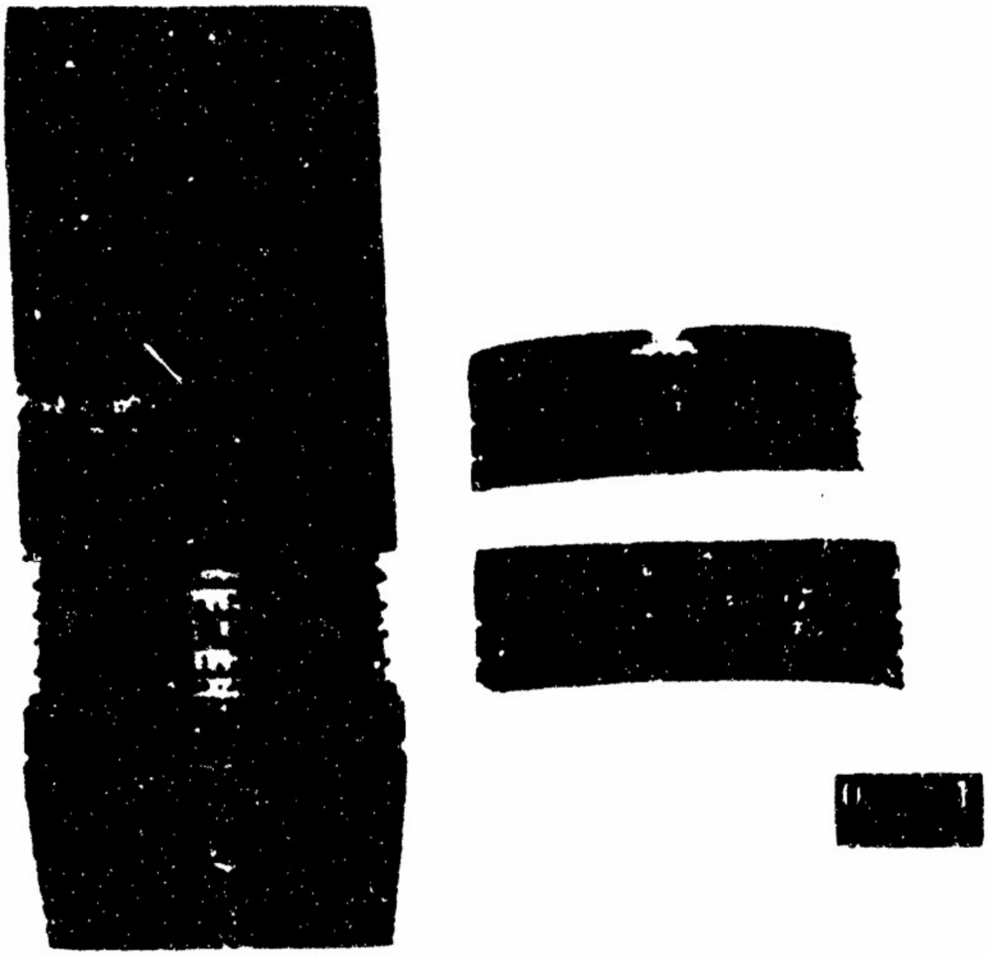

Figure 2. Poorly Seated Band. Note Shallow Indentations and Irregularity of Machining Marks Impressed by Band Seat

6.3.2 Destructive Tests

Record the following:

a. For each position pair location:

1) Rotating band outer diameter in thousandths of an inch
2) Band seat diameter in thousandths of an inch
3) Rotating band thickness(at 6 places) in thousandths of an inch

b. Indication of band seating is determined by visual examination.

6.4 DATA REDUCTION AND PRESENTATION

Determine and present the "indicated diametric clearance" as follows:

6.4.1 Nondestructive Tests

Subtract the second deflection reading [projectile elastic deformation] from the first deflection reading [projectile elastic deformation plus the rotating band permanent deformation (clearance between the rotating band inner diameter and the projectile band seat)]

6.4.2 Destructive Tests

a. Average the following:

1) Six values obtained for the rotating band thickness
2) Three values obtained for the rotating band outer diameter
3) Three values obtained for the projectile band seat diameter

b. Determine the rotating band inner diameter by subtracting twice the average band thickness from the average outer diameter.

c. Subtract the average projectile band seat diameter from the rotating band inner diameter, obtained in b, and divide the result in half.

APPENDIX A

EFFECTS OF ROTATING BAND SEATING

Rotating band seating measurements are customarily used in conjunction with acceptance tests of metal parts of projectiles, as well as other proving ground tests.

If a projectile has a tightly seated rotating band, the resistance to movement as the band is engraved by the rifling of the tube is high. The motion of the projectile is retarded by this resistance. The propellant pressure consequently rises and the burning rate is increased. More rapid combustion of the propellant produces even higher pressures and increases muzzle velocity over that which would have existed if the engraving forces had been lower.

A projectile having a loosely seated rotating band will encounter lower engraving forces because the rotating band metal will be squeezed into the clearance between the band and its seat, thereby reducing the amount of metal that normally flows into the rifling grooves. Thus, poor rotating band seating reduces pressure and velocity. Reduction in velocity from this type of seating has been observed to be as great as 40 to 50 feet per second in 90- and 105-mm projectiles (Ref. 4D).

In weapons which have not eroded at the origin of rifling, engraving of the rotating band occurs while the propellant is beginning to burn and produces relatively large increases in the rate of combustion. If the projectile is free to travel a short distance before engraving, however, as in an eroded weapon, combustion is not affected to so large a degree; consequently, neither is velocity. This difference is pronounced for fixed ammunition because the projectile is prevented from moving into contact with the lands during loading by the action of the cartridge case crimp. For separate loading ammunition, the difference between new and worn or eroded weapons is not so distinct because the projectile is rammed into contact with the lands.

In 75- to 155-mm weapons that are new or have very little erosion at the origin of rifling, the effect of clearance under the rotating band is to decrease the velocity from 0.5 to 2 feet per second per 0.001 inch diametric clearance (Refs. 4D and E). If a weapon is appreciably eroded, with resultant considerable loss in muzzle velocity, the added small loss of velocity caused by rotating band clearance is of secondary importance.

The velocity effect of rotating band clearance is great in weapons having relatively slow propellant combustion and small in those having rapid propellant combustion. For example, in the case of high velocity (slow propellant) guns, the muzzle velocity will diminish about 1.5 to 2.0 feet per second for every 0.001 inch of clearance. In addition, the velocity effect tends to increase with decreasing caliber.

APPENDIX B

SELECTION OF NONDESTRUCTIVE MACHINES, INDENTURES, SETTINGS, PRESSURES AND ACCURACY

1. Machine Selection - Nondestructive measurements of rotating band seating are made with hydraulic presses having movable rams capable of exerting forces of 12,000 pounds or more. Three machines are currently in use and are designated as DTM Model RB-20 for 20-mm projectiles, DTM Model RB-1 for projectiles 75- through 120-mm, and DTM Model RB-2 for projectiles 155-mm through 8-inch. Hydraulic Press DTM Model RB-1 is illustrated in Figure B-1.

2. Machine Settings - The indentors are selected to match the curvature and the size of a cylindrical surface of the rotating band. Pressures applied to the ram are selected to be great enough to insure seating of the portion of the rotating band under the ram, but not so large as to permit excessive peening or thinning of the band. The correct indentors, ram pressures, and band clearances limits for the various size and model projectiles are contained in references 4G, 4H, and 4I. These references are constantly being updated to include projectiles that are currently being manufactured and for which nondestructive band clearance parameters have not been previously obtained.

3. Positioning of Indentor - The indentor should be applied to the most forward position of the rotating band. Clearance in this region is known to have a greater effect on velocity than clearance toward the rear of the band (Ref. 3). Measurements should be made at two or three equally spaced radial positions on each projectile. (Measurements at three positions generally are necessary, but are not required if the measurements at two positions are sufficiently uniform.)

The projectile must be carefully aligned to insure that the indentor face contacts the rotating band uniformly. The alignment is controlled by placing the projectile in a V-block rest on the machine. If the marks that the indentors leave on the rotating band are deeper on one edge than on the other, improper alignment is indicated.

4. Precision of Measurement - Comparison of measurements made as outlined above with those made by destructive tests (6.2.2) have shown that the measurements do not have any appreciable bias; that is, the average nondestructive measurement is very nearly equal to that obtained by the more direct measurement of the destructive test method. For projectiles with copper or gliding metal bands other than those shown in the table, an indentor size and load should be selected that will provide a pressure of about 80,000 pounds per square inch on the indentor face during measurement.

The precision of individual measurement made by the nondestructive method has been estimated to be within 0.001 inch. This is probably more accurate than can be obtained by the destructive method because of the several micrometer measurements and the band removal required by the destructive test (reference 4D).

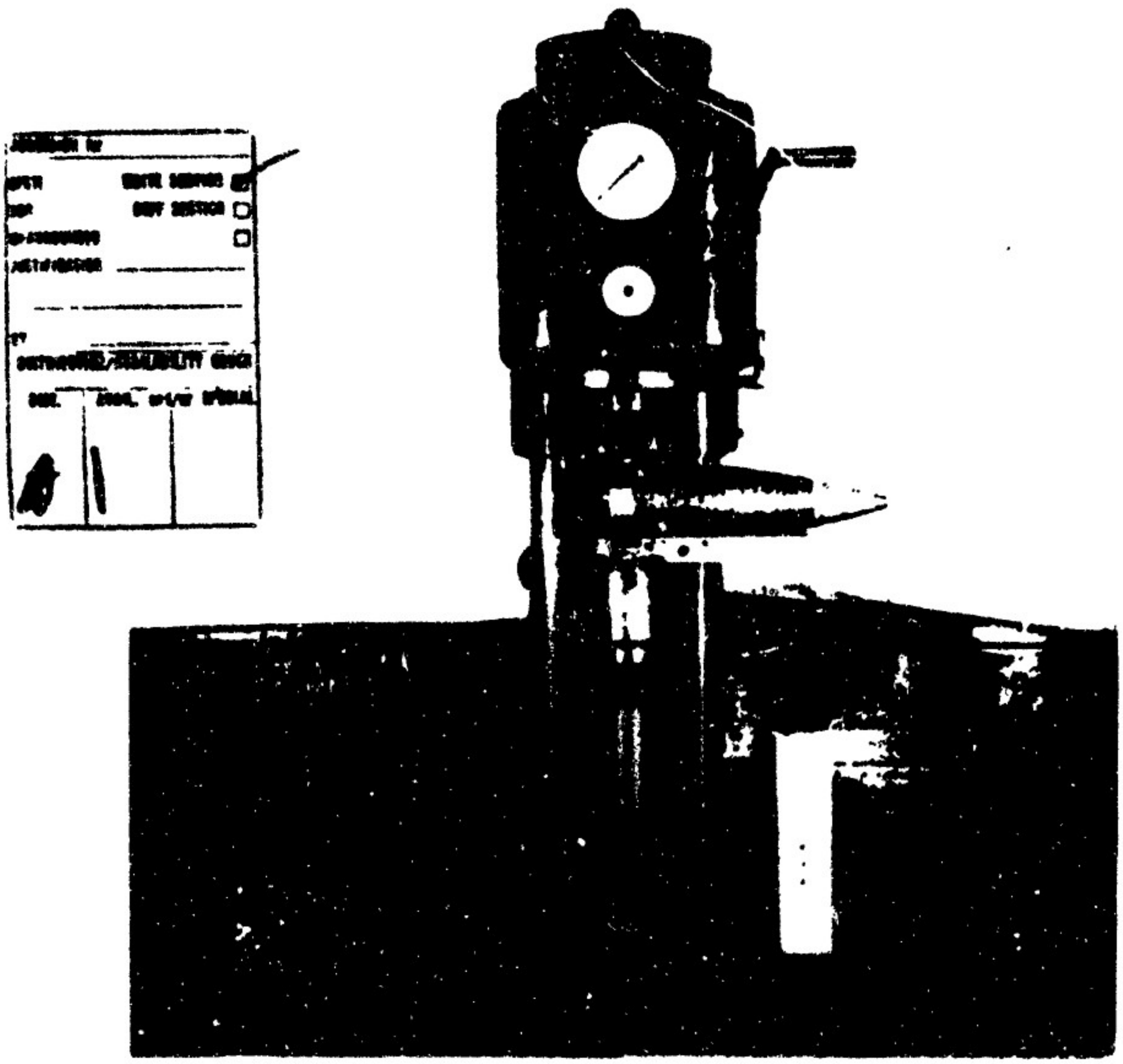

Figure B-1. DTM Model RB-1 Testing Machine for Band Seating Inspection

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