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SIFIED LABORA... INDEX

710/18

REPORT NO. 710/18

LIGHT ARMOR PLATE

ABSTRACT OF PAPER

"BULLET RESISTING ALLOYS"
BY
KOTARA HONDA
JAPAN NICKEL REVIEW
VOL. 1, NO. 1, APRIL 1933

D. J. MARTIN
1ST. LT., ORD. DEPT.

1934

WATERTOWN ARSENAL
WATERTOWN, MASS.

Frankford Arsenal—4-18-34—200

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Report No. 710/18 June 1, 1934
Watertown Arsenal

Light Armor Plate

Tests of efficiency of various metals and alloys in resisting penetration were made, using standard Japanese ammunition and the Japanese service rifle.

Distance from muzzle to armor plate was about 2 metres (6 ft. 7¼ in.). The bullet used was 33 mm. (1.29 in. long), 6.5 mm. (.25 in.) dia. and weighed 9 grams.

A ballistic pendulum, with suitable magnifying apparatus for recording, was used to measure the residual velocity of bullets after their penetration of the plate samples. The pendulum was a large box of sand that weighed 193.5 kg. and the plate specimen was 15 x 15 cm. (5.9 in. x 5.9 in.) x the thickness of the individual specimen. Service velocity ammunition was used in most of the tests. This velocity (initial) was 790 m/sec (2595 ft/sec.).

The shielding efficiency of a plate was calculated from the following deductions:

$$E = \frac{\frac{1}{2} MVo^2 - \frac{1}{2}MV^2}{\frac{1}{2} MV_o^2} = \frac{Vo^2 - V^2}{V_o^2}$$

where:

E = efficiency

M = mass of the bullet

Vo = initial velocity of the bullet

V = residual velocity of bullet (pendulum measurement)

By using specimens of a single material of varying thickness, a "Characteristic Curve " was obtained for that material, of the form shown in Figure 1.

Velocities of 790, 760 and 500 m/sec. (2595, 2496 and 1644 ft/sec.) were used to show the effect of muzzle velocity on one plate material. This effect is shown in Figure 2.

A number of plates of one material, each 1 mm. thick, were tested to compare laminated plates with the same thickness in a single plate. Results indicated that the single plate was more efficient.

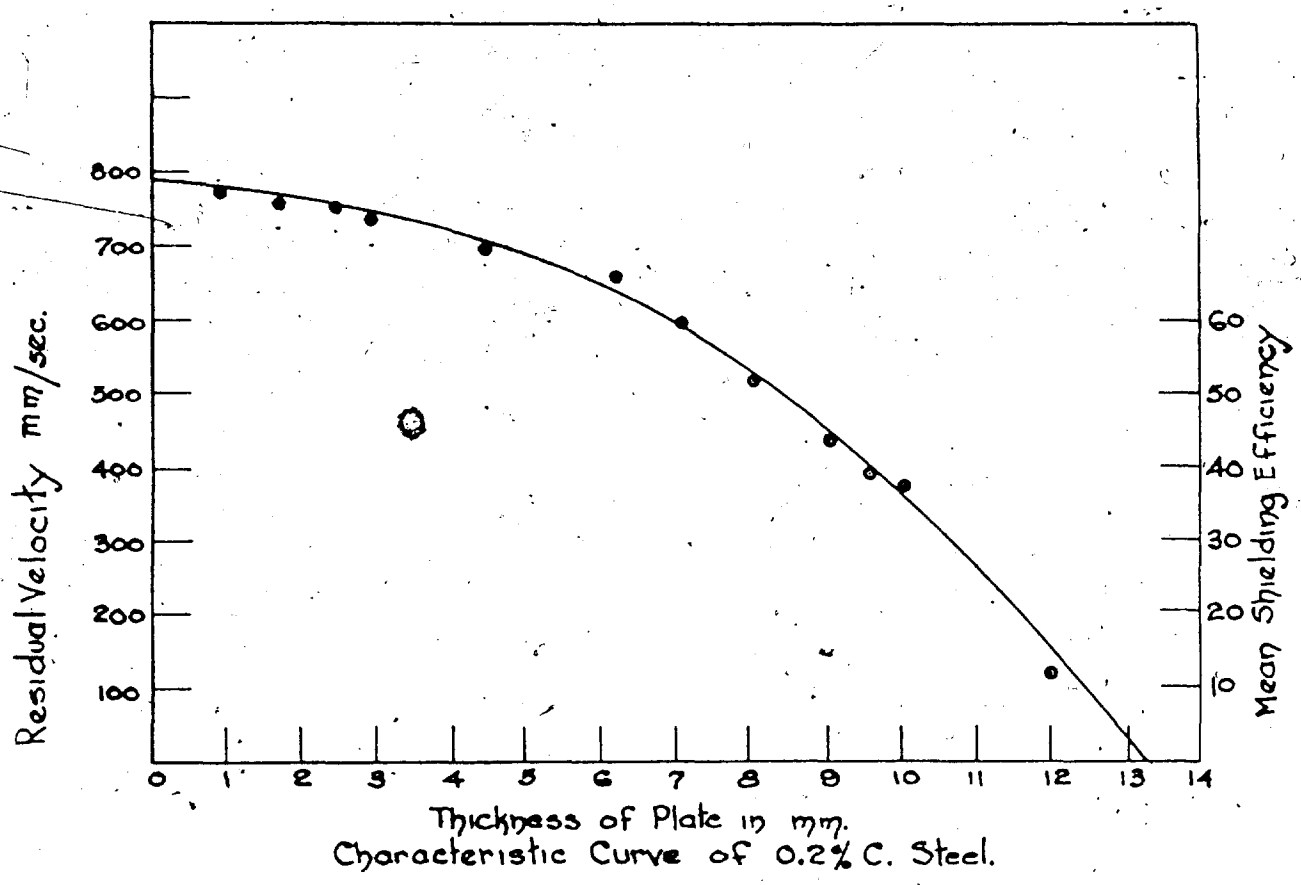
Characteristic curves for a number of materials are shown in Figure 3.

The results shown in Figure 3, altered to correct all the materials to the density of steel, are shown in Figure 4.

The author recommended a 3% Ni. 1% Cr. steel as the best alloy for bullet resistance. He showed characteristics curves for this alloy - annealed and quenched with various subsequent draw temperatures. These give a penetration distance of 4.5 mm. (.17 in.) for this steel, quenched and drawn to about 450 Brinell. Further hardening by the Cloudburst method reduced this distance to 3.8 mm. Results are shown in Figure 5.

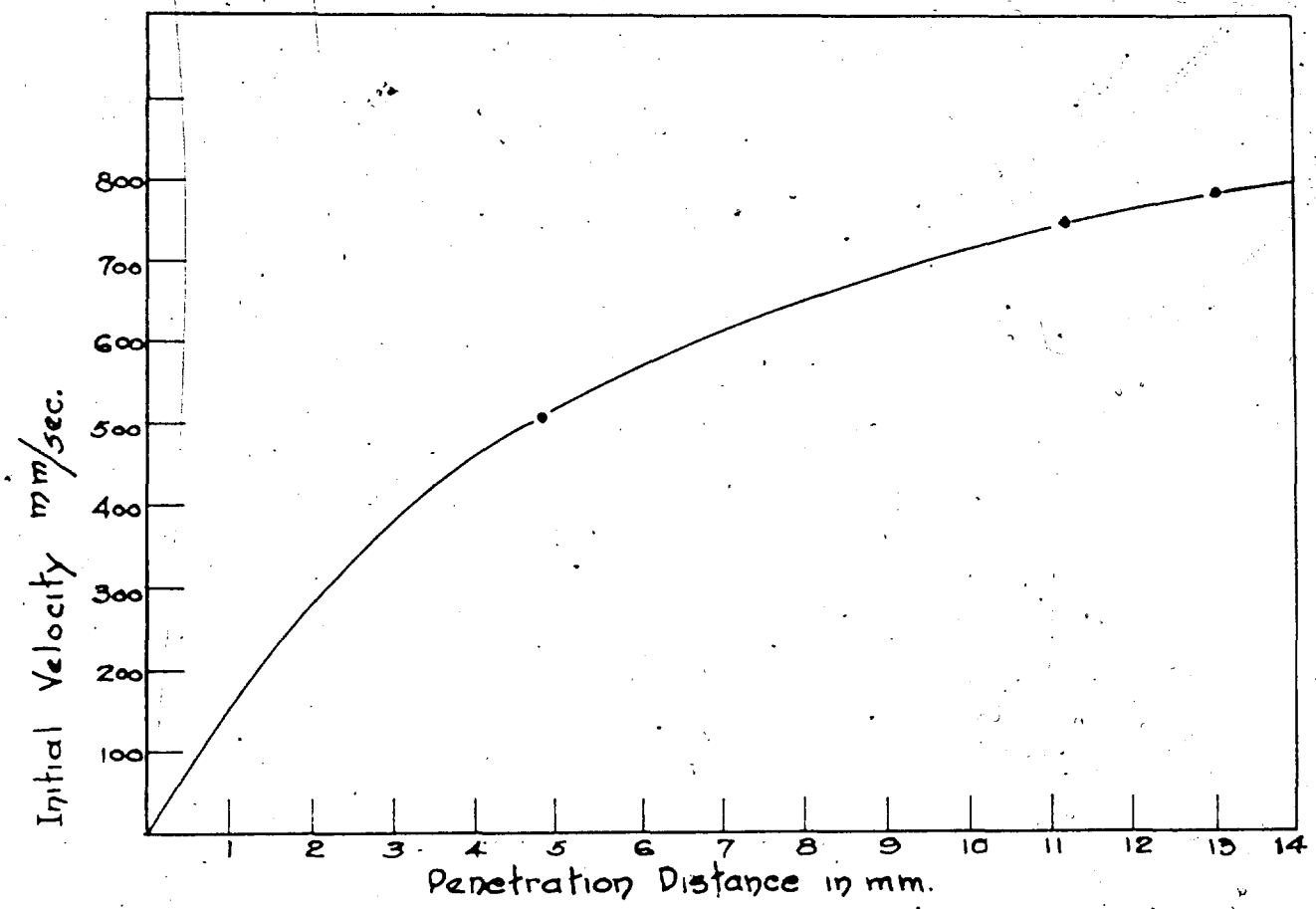
Respectfully submitted,

D. J. Martin,
1st Lt., Ord. Dept.



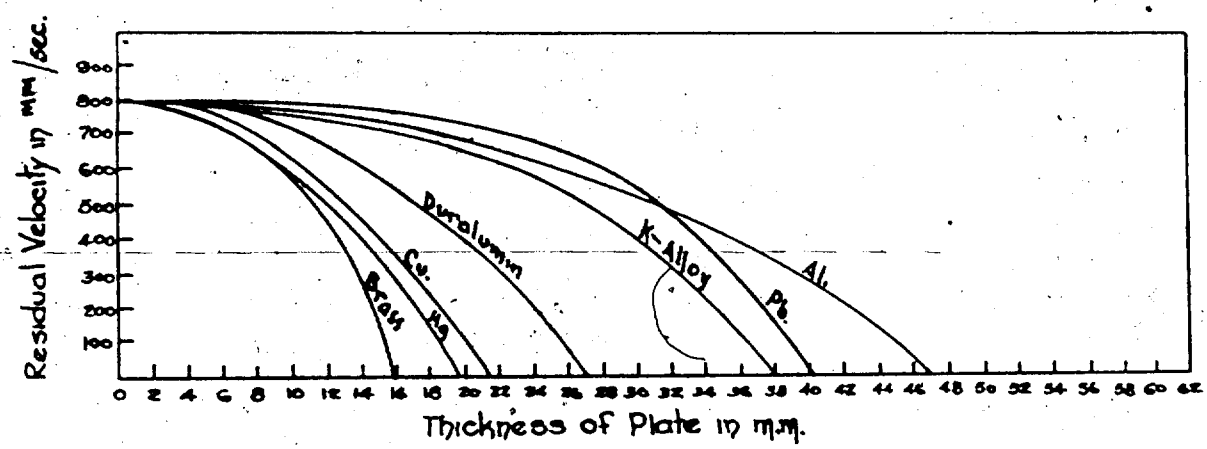
Characteristic Curve of 0.2% C. Steel.

FIG. 1.



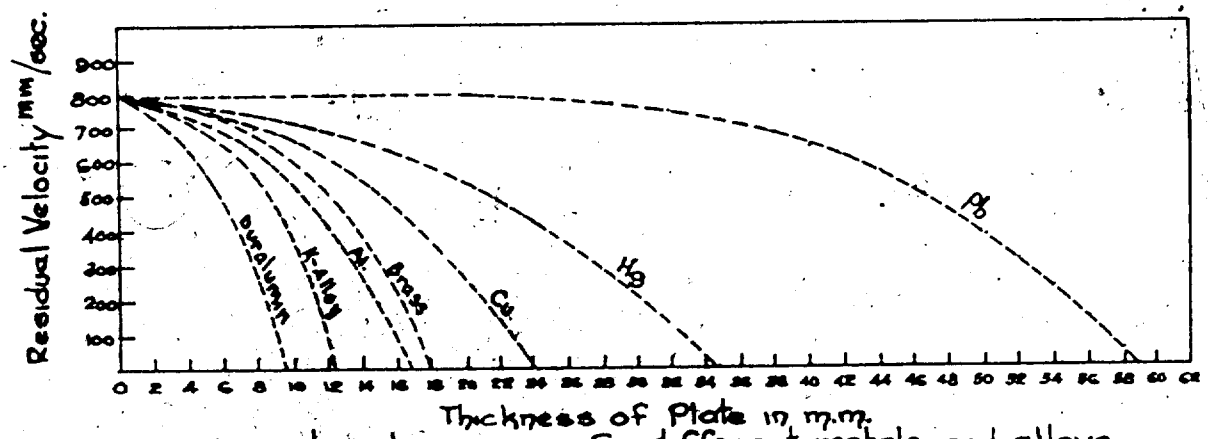
The Relation Between Initial Velocity and Penetration Distance

FIG. 2.



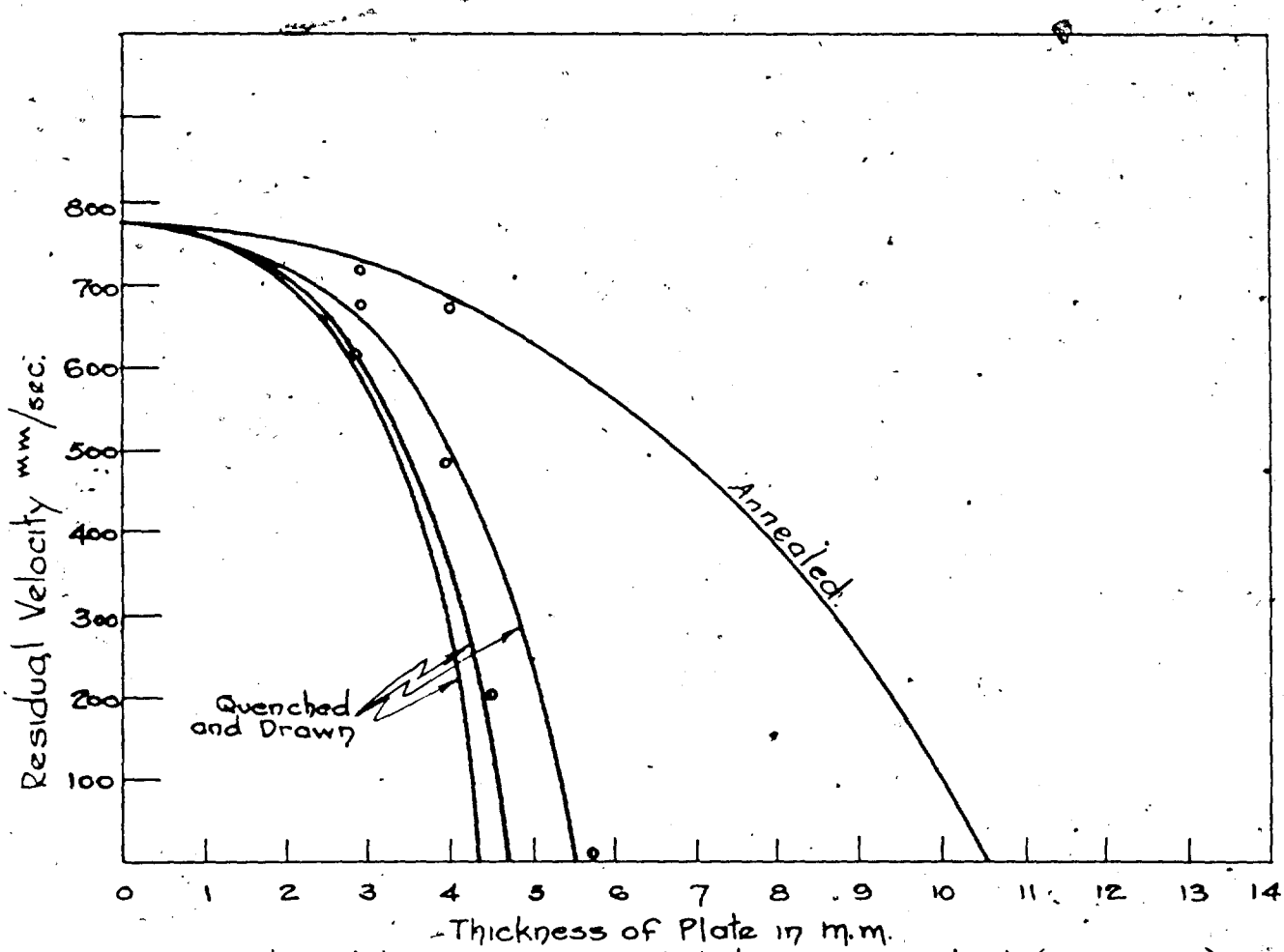
Characteristic curves for different metals and alloys.

FIG. 3



Characteristic curves for different metals and alloys

FIG. 4.



Characteristic Curves for Nickel-chromium Steel. (3% Ni. 1% Cr.)

FIG. 5.