WATERTOWN ARSENAL
WATERTOWN, MASS.

WATERTOWN ARSENAL LABORATORY

MEMORANDUM REPORT

NO. WAL 710/615

Ballistic Characteristics of Four Types of Light Gauge (.044" to .051") Steels Submitted by Republic Steel Corporation

BY
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DATE 21 April 1944

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Second Partial Report on Problem B-8.2

21 April 1944

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1. In accordance with a request from the Office, Chief of Ordnance,[1] a program is being conducted at this arsenal to develop improved components of body armor assemblies. In conjunction with this program tests have recently been conducted on four types of steels submitted by Republic Steel Corporation.

2. Stainless steel in the "1/4 hard" (27 Rockwell "C") condition exhibited much better overall resistance characteristics than stainless steel in the "1/2 hard" (33 Rockwell "C") or "full hard" (45 Rockwell "C") condition, but was slightly inferior to Hadfield manganese steel of equivalent weight. SAE 4330 steel, heat treated to a hardness of 34 to 36 Rockwell "C" exhibited inadequate resistance characteristics as compared with other heat-treatable steels previously tested here.

3. Samples of these four types were rigidly clamped to a wooden ballistic frame which allowed an area 8"x8" to be unsupported from the back. Impacts with the cal. .22 fragment-simulating projectile G-2 (17 grains)[2] and with standard cal. .45 ball ammunition were then spaced fairly over this area and ballistic limits determined. The results appear in Table I.

4. Because of the thickness variation resultant from the various degrees of cold reduction necessary to develop hardness differences in stainless steel analysis of the results of these tests is somewhat more difficult than would have been the case had the thicknesses been identical. However, under impact of the cal. .22 fragment-simulating projectile G-2 and the steel-jacketed cal. .45 ball, the "1/4 hard" material shows greater superiority over the

1. O.O. 422.3/71(c) - Wtn. 470.5/7443(c) dated 28 September 1943.

2. WAL Memorandum Rpt. No. 762/253(c).

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other two samples than can be attributed to the mere difference in thickness. The ballistic limits of even this type under impact of standard cal. .45 ammunition (912 feet-per-second) and projectile G-2 (1675 feet-per-second) are somewhat less than those of Hadfield manganese steel which currently is used as a critical component of body armor assemblies. The ballistic limits of an equivalent weight of average Hadfield steel are 1000 feet-per-second and 1750 feet-per-second respectively.

5. Although heat-treatable steels in gauges identical with those of the SAE 4330 samples have not yet been tested in sufficient number to allow a proper evaluation of their ballistic characteristics to be made, it is felt that the performance of these samples will not compare favorably with that of other heat-treated steels. Their ballistic limits with cal. .45 ball ammunition (698 feet-per-second and 665 feet-per-second) are substantially lower than that of the "1/4 hard" stainless sample (912 feet-per-second) and their limits with projectile G-2 (1553 feet-per-second and 1545 feet-per-second) are appreciably lower than that of the softer stainless (1675 feet-per-second).

6. Thus, of the four types tested, the "1/2 hard" and "full hard" varieties of stainless steel apparently have been deleteriously affected by the cold reduction process of hardening and do not seem to offer promise as good body armor components. The "1/4 hard" variety has apparently not reached that critical degree of cold reduction which produces poor properties of ballistic resistance, and exhibits encouraging characteristics. While the exact status of SAE 4330 steel relative to other heat-treatable steels is not yet determinable it may reasonably be estimated that it will not compare favorably with the best of such steels. Further consideration, therefore, of material of this composition as prospective body armor component material seems unwarranted.

7. It appears, however, that further development of stainless steel in the softer conditions is indicated by the results of these tests.

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TABLE I

Summary of Ballistic Tests Conducted at Watertown Arsenal

on Four Types of Steels Submitted by Republic Steel Corporation

Sample	Gauge	Ballistic Limit	
		G-2 (Cal. .22, 17 Grains)	Standard Cal. .45 Ball*
1/4 Hard Stainless (Rockwell C - 27)	.051"	1675	912
1/2 Hard Stainless (Rockwell C - 33)	.048"	1173	646
Full Hard Stainless (Rockwell C - 45)	.044"	1118	658
SAE 4330 (Rockwell C - 36)	.048"	1553	698
SAE 4330 (Rockwell C - 38)	.050"	1545	665
Hadfield Manganese (Average)	.050"	1750	1000

*Steel-jacketed

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ABSTRACT:

The ballistic characteristics of four types of light gauge (0.044 in. to 0.051 in.) steels were determined to develop improved components of body armor. Impacts with the cal. .22 fragment-simulating projectile G-2 and with standard cal. .45 ball ammunition were spaced fairly over an 8 in. x 8 in. sample area and the ballistic limits determined. Stainless steel in the "1/4 hard" (27 Rockwell "C") condition exhibited much better over-all resistance characteristics than stainless steel in the "1/2 hard" (33 Rockwell "C") or "full hard" (45 Rockwell "C") condition, but was slightly inferior to Hadfield manganese steel of equivalent weight. SAE 4330 stainless steel, heat treated to a hardness of from 34 to 36 Rockwell "C" exhibited inadequate resistance characteristics as compared with other heat-treatable steels. It appears that further development of stainless steel in the softer condition is indicated.

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