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REPORT NO. 315.1/11

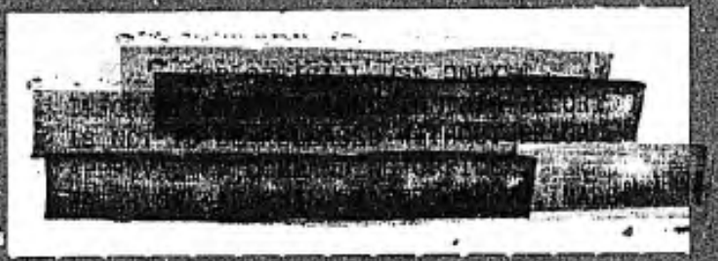
SHOP NOTES

DRILLING ARMOR PLATE

By

C. K. ALLEN

1st Lieutenant, Ordnance Department



JUNE 23, 1938

WATERTOWN ARSENAL
WATERTOWN, MASS.

W. A. Form No. 158

Frankford Arsenal—11-23-38—3,000

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Report No. 315.1/1
Watertown Arsenal

June 23, 1938

SHOP NOTES

DRILLING ARMOR PLATE

Object

To secure a proper form of tool and composition for drilling of armor plate.

Conclusions

The flat type of drill has been able to drill through hardened steel plate satisfactorily where the usual twist drills failed. The rigidity of the former type is believed to be the principal cause of its effectiveness. A large cross-section of metal gives stiffness to the shank, and a less acute point angle gives extra strength to the point of the drill.

Insufficiently few number of competitive tests have been performed with various tool steels to make any definite assertions regarding the effectiveness of any particular steel. However, the satisfactory results obtained with the molybdenum steel amply support the findings of Watertown Arsenal Experimental Report #359 that this steel is practically as efficient as the standard tungsten steel.

Discussion

In the erecting of Gun Directors, MK XXXVI, it became necessary to perform drilling on hardened steel armor plate due to the fact that some plate as received from the manufacturer was not drilled as required.

High speed twist drills were unable to do the work and the use of flat drills was resorted to. The following observations were made in the course of determining the most suitable type of tool to perform the necessary drilling.

In the tests described in the tabulation below, flat drills of a design as shown in the accompanying drawing were used. Except as otherwise noted, the tests were made on a radial drill and the feed was by hand; lubricant was not used.

Material	Drill		Speed	Results	Date
	Diameter	Steel			
Armor plate, homogeneous, 1/2" thick.	17/32"	Mo	90 RPM	24 holes drilled without resharpening; air motor.	12/5/36
As above.	5/8"	Mo	90 RPM	6 holes drilled without resharpening; air motor.	12/5/36
As above.	5/8"	Rex,AAA	80 RPM	Failure.	12/5/36
As above	5/8"	Va	80 RPM	Failure.	15/5/36
Armor casting, 1-1/8", Brinell 415-420	1/2"	Mo	80-90 RPM	4 holes drilled. When tried with lubricant, drill rotated over surface without cutting.	29/5/36
As above.	Var. Sizes 5/32" to 3/4"	Mo	-	Holes drilled successfully.	29/5/36
Armor plate,#625-9 1/2", Brinell 510	1/2"	Mo	80 RPM	1 hole drilled.	29/5/36
Armor plate, #1-444, 1/2", Brinell 510-535 in front; 340-365 in back.	1/2"	Mo	80 RPM	1 hole drilled.	29/5/36
Armor plate, 13/32", Brinell 1000 in front; 400-450 in back.	1/2"	Mo	80 RPM	1 hole drilled.	29/5/36
Hadfield manganese plate, 1/2", Brinell 240.	15/32"	Mo	80 RPM	1 hole drilled.	2/6/36

Material	Drill		Speed	Results	Date
	Diameter	Steel			
Hadfield manganese plate, 1/2", Brinell 240.	3/4"	Mo	24 RPM	1 hole drilled.	2/6/36
Armor plate, 1/2", Brinell 555.	15/32"	Mo	80 RPM	1 hole drilled.	2/6/36
As above.	3/4"	Mo	24 RPM	1 hole drilled.	2/6/36
Armor plate, 1/2", face-hardened to 1000 Brinell.	15/32"	Mo	30 RPM	1 hole drilled.	6/2/36
As above.	1/2"	"Hercules Major" Twist drill.	60 RPM	Failure; drill flattened at end without cutting. Drill ground as prescribed by maker. Short body to give extra rigidity.	6/3/36

The applicability of the flat type of drill having been demonstrated, a few additional tests were conducted with flat drills of several tool steels available in the Machine Shop. The results are summarized as follows:

Drills of "Nova-Superior" and "Rex AAA" tested on plate face-hardened to 1,000 Brinell failed to cut surface.

A Ludlum "LMW" drill shattered when tried on 601 Brinell homogeneous plate.

Drills of molybdenum steel and molybdenum-vanadium ("MV") steel went through 1/2" plate, 340-364 Brinell. Drills read 62 Rockwell "C".

On 1/2" homogeneous plate of 555 Brinell, the "MV" drill cut the surface but made little more progress after one re-grinding, while on the same plate, the molybdenum steel finished a hole with one re-grinding.

The molybdenum tool went through 627 Brinell homogeneous plate with one re-grinding.

The molybdenum steel referred to has recently been developed as a substitute for the 18-4-1 type whose chief component is strategic tungsten. It is the subject of Watertown Arsenal Experimental Report #359, which states it to be "90% as efficient as the

standard tungsten steel.....for small and medium lathe and planer tools". Its composition is:

C	.75%
W	Nil
Mo	9.30%
Cr	3.78%
V	1.20%

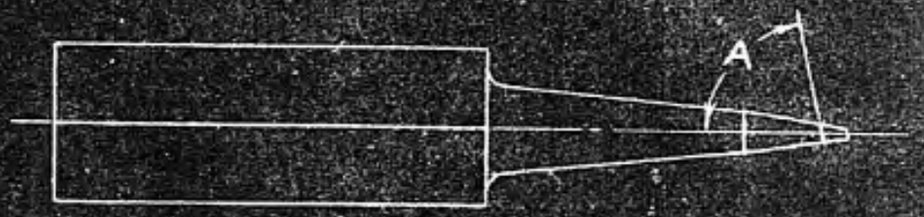
The "MV" steel was developed by the Crucible Steel Company and is still in its experimental stage. It should be of interest to this Arsenal because of its low tungsten content.

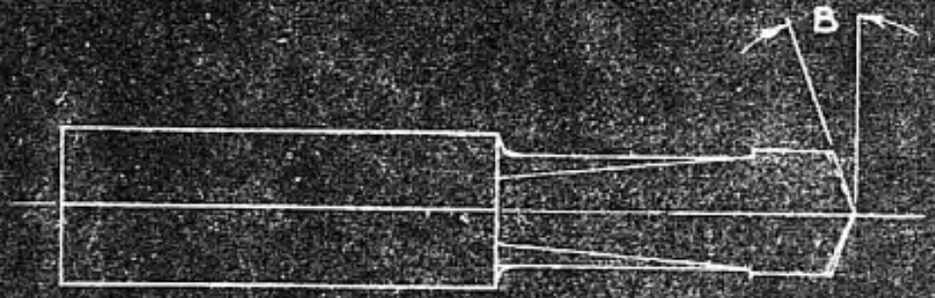
It was observed that the greatest difficulty encountered in these drilling tests was in the first penetration of the material, and in breaking through the lower surface. Giving rigidity to the drill by means of a short and thick shank and the use of the tool without lubricant was found to be an aid to initial penetration. Frequently in approaching the lower surface of the material being drilled, vibration and consequently poor cutting was noticed, especially when the drilling was being done over a slot or hole in the platen. In several cases the drill pushed out a button of metal. A remedy for this is to re-grind the drill and to reinforce the stock beneath the drill with a plate of softer steel.

Respectfully submitted,

C. K. Allen

C. K. Allen,
1st Lieutenant,
Ordnance Department.





FLAT DRILL

	A	B	
	80°	16°	

WATERTOWN ARSENAL	
DRAWN BY T. HUGHES	APPROVED BY
JULY-6-1936	C. K. Wells, Lieut

September 4, 1940

Subject: Armour Plate Drill

Attention: Capt. Skinner

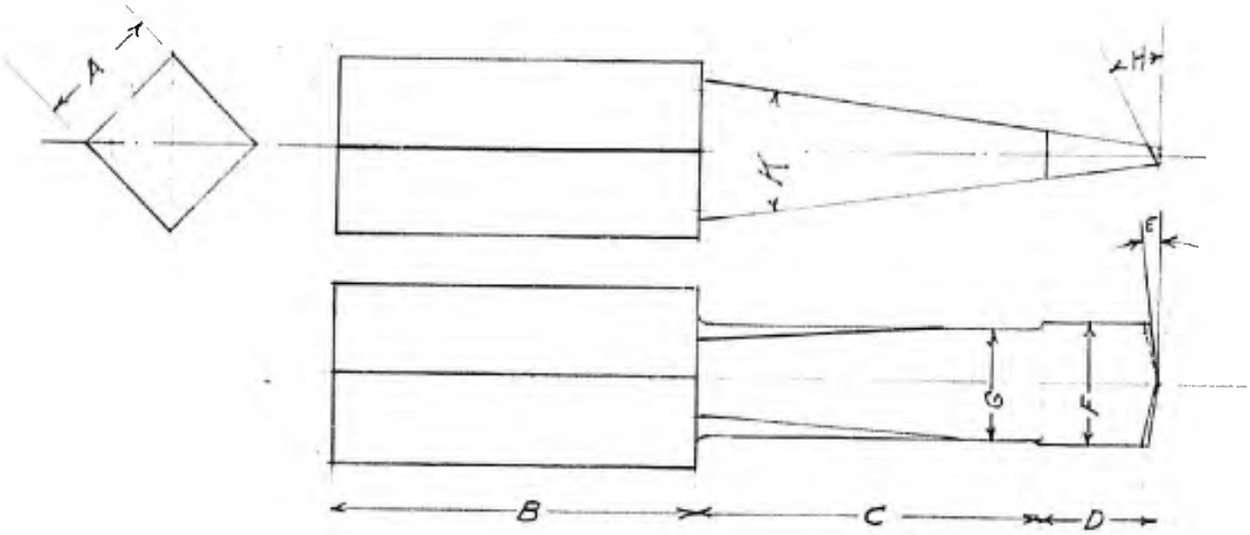
Speed. 90 R. P. M.

Feed. 1/16" Per. Minute

NOTE: USE NO LUBRICANT

Plate that has been drilled

				# of Holes	Size of drill
Thickness	5/8"	Brinell	420	22	5/8
"	5/8"	"	580	22	5/8
"	5/8"	"	555	10	5/8
"	5/8"	"	640		
"	1 1/4"	"	580	1	5/8
"	5/8"	Nitrated one side	1,000	1	5/8 & 5/8
"	1 1/8"	Tank Castings		2	5/8 & 5/8
Hatfield Manganese Steel 5/8 Thick			} SAMPLE	5	3/4"
"	"	" 1"	"	10	3/4"



ARMOR PLATE DRILL

A	B	C	D	E	F	G	H
3/8"	1"	1"	3/8"	7 1/2 Deg	1/4"	G = F − .030"	25 Deg
3/8"	1"	1"	3/8"	7 1/2 "	5/16"		25 Deg
7/16"	1 1/4"	1 1/4"	7/16"	7 1/2 "	3/8"		25 Deg
1/2"	1 3/8"	1 3/8"	1/2"	7 1/2 "	7/16"		25 Deg
1/2"	1 1/2"	1 1/2"	1/2"	7 1/2 "	1/2"		25 Deg
5/8"	1 1/2"	1 1/2"	5/8"	7 1/2 "	9/16"		15 Deg
5/8"	1 3/4"	1 3/4"	5/8"	7 1/2 "	5/8"		15 Deg
3/4"	1 3/4"	1 3/4"	3/4"	7 1/2 "	11/16"		15 Deg
3/4"	2"	2	3/4"	7 1/2 "	3/4"		15 Deg
1"	2"	2	1"	7 1/2 "	13/16"		15 Deg
1"	2"	2	1"	7 1/2 "	7/8"		15 Deg
1"	2"	2	1"	7 1/2 "	15/16"		15 Deg
1"	2"	2	1"	7 1/2 "	1"		15 Deg.

K	= 15 Degree's on All size Dr. II's.

J.T.P.