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FINAL REPORT OF GRIT BLASTING AND METAL SPRAYING TRIALS CARRIED OUT AT H.M. DOCKYARD, DEVONPORT

- by -

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Introduction

Mild steel surfaces that are to be protected by aluminium or zinc spray coatings are generally prepared by blasting with chilled iron angular grit. Previous work[1] had shown that a relationship exists between the grit blasting conditions (at least in terms of blasting angle and grit condition), the reflectivity of the blasted surface and the bond strength of a spray coating of aluminium on the blasted surface. An instrument has been developed that assesses the suitability of a blasted surface for subsequent spraying by measuring the reflectivity and has proved reasonably successful under laboratory conditions. The present need is to ascertain the performance of this reflectivity meter under shop and site conditions. The opportunity to carry out such tests at H.M. Dockyard, Devonport, was offered by the Ministry of Defence and a series of tests was made on 16th June, 1965.

Programme of tests

It was arranged that grit blasting should be examined at three locations i.e. two workshops (the M.G. House and Plumbers Shop) and on a ship that was under construction. In the two workshops samples were to be grit blasted, the surface reflectivity measured and the surfaces metal sprayed in order to relate blasting angle, reflectivity and bond strength. On the ship it was only possible to examine, by reflectivity tests, an area of the hull that had been grit blasted, but the examination gave an indication of working conditions.

Materials and Equipment

The test pieces consisted of 3 inch diameter by $^3/_4$ inch discs cut from mild steel bar. New G 24 and G 39 chilled iron angular grit was used for blasting and aluminium or zinc wire for the spray coatings.

Blasting and spraying was carried out using conventional commercial equipment.

Bond testing was carried out on a 6.7 ton Denison tensile testing machine using the jig shown in Fig. 1.

Procedure

All grit blasting and spraying was carried out by dockyard personnel, and reflectivity readings by the writer and his assistant.

In the M.G. House a total of 19 test plates (Specimen Nos. 1 - 19)

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[1]Apps, R.L. 'Assessment of Blasted Surfaces: Progress Report No. 3', CoA Memo. Mat. No. 52, September, 1964.

were blasted at a pressure of 65 p.s.g. Of these 10 were blasted at a nominal angle of 90° i.e. normal to the surface, and 9 at a nominal angle of 30°. Conditions did not allow the blasting operation to be observed. After the reflectivity had been measured the test plates were transferred to the Plumbers Shop and sprayed with aluminium or zinc (as shown in Table 1). All spraying was carried out within 100 minutes of grit blasting.

A further 3 test plates (Nos. 33 - 35) were left at the M.G. House to be blasted and aluminium sprayed after 2, 4 and 6 days respectively in order to indicate the effects of blunting or breakdown of the grit.

In the Plumbers Shop, 13 test plates (Nos. 20 - 32) were blasted at nominal angles of 90° and 30°; again it was not possible to observe the blasting operation. Reflectivity measurements were taken on the test surfaces which were then sprayed as indicated in Table 1. These test plates were sprayed within 60 minutes of blasting.

Two visits were paid to a ship under construction and some grit blasting of a hull section was observed and reflectivity measurements taken.

New G24 grit was used for blasting in the M.G. House and Plumbers Shop, and new G39 on the ship's hull. Samples of grit were taken at various stages of the tests.

Results

The results of measurements of reflectivity, coating thickness and bond strength are given in Table 1.

In the M.G. House no difference in reflectivity was observed between plates blasted at nominal angles of 90° and 30°, and blasting was rated acceptable in all cases. Bond strengths supported this rating, falling within 765 - 1065 p.s.i. The plates (Nos. 33 - 35) blasted after 2, 4 and 6 days, gave slightly lower bond strengths of 566 - 727 p.s.i.

In the Plumbers shop the plates blasted at a nominal angle of 90° had a much lower reflectivity and higher bond strength (813 - 1175 p.s.i.) than the plates blasted at a nominal angle of 30° (52 - 505 p.s.i.).

Reflectivity measurements made on the ship's hull were satisfactory, although the section examined was readily accessible whereas other parts of the hull presented problems of accessibility. It was noted that in some areas all the rust was not completely removed and this might have a detrimental affect on bond strength. The weather was wet during the first visit to the ship and the presence of water was noted on some blasted surfaces. In some cases spraying preceded welding which effectively destroyed patches of the coating.

Grit quality is shown in Figs. 2 - 8. Comparison of new G 24 grit with a sample taken after preparing 19 test plates indicate that the grit quality was unaffected. The grit condition after 2, 4 and 6 days is shown in Figs. 4 - 6. Unfortunately the extent to which the grit was used over this period was not recorded; some blunting of the grit is evident but, on the whole, the condition has remained good. The new G 39 grit used on the ships hull is shown in Fig. 7 and may be compared with used G 39 grit taken from the same location.

Discussion

This series of tests showed the same relation between reflectivity and bond strength that had been found in previous tests. Low reflectivities (up to 1.2 on the arbitrary scale) gave bond strengths in excess of 765 p.s.i. whereas high reflectivities (between 6.1 and 8.4) gave low bond strengths (52 - 505 p.s.i.). These results indicate that the operator in the M.G. House did not carry out his instructions with regard to blasting angle whereas the operator in the Plumbers Shop used blasting angles of approximately 90° and 30° as instructed. This reluctance to produce poor quality surfaces has been found with other operators.

The levels of bond strength obtained with aluminium coatings agree with those obtained in previous work despite a considerable variation in coating thickness. The effect of coating thickness has not been investigated in work at Cranfield but thicker coatings are generally agreed to have lower bond strengths. In the present tests, coating thickness varied between 0.005 inch and 0.019 inch, and no relation between strength and coating thickness could be observed. The grit used for blasting was adequate (Fig. 1) and showed no signs of breakdown (Fig. 2).

The three test plates made after 2, 4 and 6 days had a lower bond strength than the plates prepared in the M.G. House on June 16th. The reason for this lower bond strength is not obvious although the grit showed some signs of blunting (compare Fig. 1 with Fig. 6). The problem of grit blunting and breakdown has not so far been examined and some information is obviously necessary.

Fewer results are available for zinc sprayed test plates. Bond strengths are low for four out of five tests and no correlation was found between reflectivity and bond strength.

The work on the ship's hull indicated that the blasting operators were capable of working to satisfactory standards. The use of G 39 grit is fairly widespread in the industry, on the grounds that the grit soon breaks down to a smaller size. This breakdown is shown by comparing Figs. 7 and 8; the used G 39 grit contains a quantity of sharp angular particles but rounded and blunted particles are also evident.

Accessibility is a problem with blasting and spraying on ships' hulls and it is difficult to see how it can be avoided. The presence of moisture is more serious and could be detrimental to coating quality. The practical difficulties are recognised but it is strongly recommended that surfaces should be kept dry before spraying and also that blasting and spraying operations should be carried out after the completion of welding.

Conclusions

1) The reflectivity meter can be used under shop and site conditions to indicate the quality of blasted surfaces.

2) The Dockyard operators are capable of producing blasted surfaces of the required quality.

TABLE 1

Specimen No.	Location	Grit Blasting Angle	Reflectivity Meter Readings				Spray Coating	Coating Thickness ins.	Coating Diameter ins.	Pull-off Strength p.s.i.
			Top		Bottom					
			Max.	Min.	Max.	Min.				
1	MG House	90°	0.0	0.0	0.0	0.0	Al.	.006-.008		
2			0.0	0.0	1.4	0.8		.010-.012	.992	765
3			0.0	0.0	0.1	0.0		.010-.012		
4			0.0	0.0	1.7	0.4		.005		
5			0.0	0.0	0.2	0.0		.009-.010	.997	1065
6			0.0	0.0	0.0	0.0		.012-.013	.978	1060
7			0.0	0.0	0.0	0.0		.009-.012		
8			0.0	0.0	0.0	0.0		.015-.017		
9			0.0	0.0	0.8	0.1	Zn.	.011	.992	928
10			0.0	0.0	1.0	0.7		.011	.985	440
11		30°	0.0	0.0	0.8	0.4	Al.	.009-.011		
12			0.0	0.0	0.8	0.4		.011-.013		
13			0.0	0.0	0.0	0.0		.014-.019		
14			0.1	0.0	0.0	0.0		.014-.016	.994	840
15			0.1	0.0	0.0	0.0		.015-.019	.995	834
16			0.0	0.0	0.0	0.0		.005-.006	.989	844
17			0.1	0.0	0.0	0.0		.011-.014		
18			0.1	0.0	0.0	0.0		.011-.014	.993	802
19			0.0	0.0	1.3	0.7	Zn.	.011		
20	Plumbers	90°	0.4	0.0	0.4	0.1	Al.	.015		
21	Shop		0.0	0.0	0.0	0.0		.008-.010	.986	1175
22			1.2	0.2	0.0	0.0		.008-.009	.991	1015
23			0.0	0.0	0.0	0.0		.007-.013	.985	813
24			0.2	0.0	0.2	0.0		.016-.017	.995	1160
25			0.0	0.0	0.4	0.1	Zn.	.014-.015	.988	298
26			0.1	0.0	0.0	0.0		.012-.014	.990	540
27		30°	8.4	3.4	6.2	4.4	Al.	.009-.011	.995	158
28			8.0	2.7	6.4	3.3		.009-.010	.995	52
29			7.0	4.6	7.2	3.4		.010-.012	.990	
30			7.2	4.0	7.0	4.2		.015-.018	.991	282
31			6.1	4.4	6.3	3.0		.015-.017	.990	505
32			5.8	4.6	5.2	3.5	Zn.	.012-.014	.981	455
33	MG House	90°					Al.		.985	640
34									.990	727
35									.990	566

Note: All specimens blasted with G24 chilled iron angular grit at 65 p.s.i.

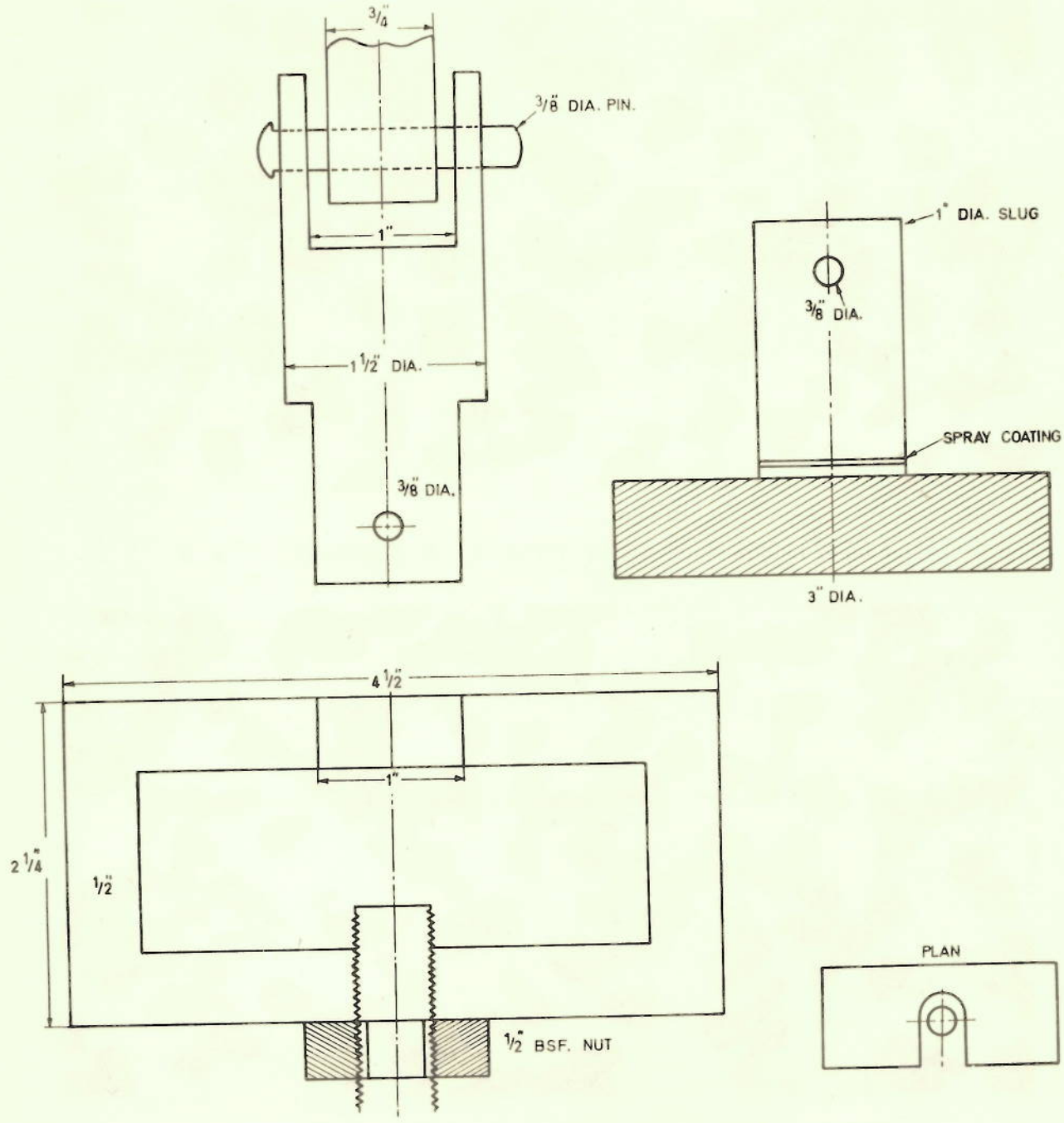

FIG. 1. JIG USED FOR TESTING BOND STRENGTH

FIG.2. NEW G24 GRIT USED IN M.G.HOUSE x 5

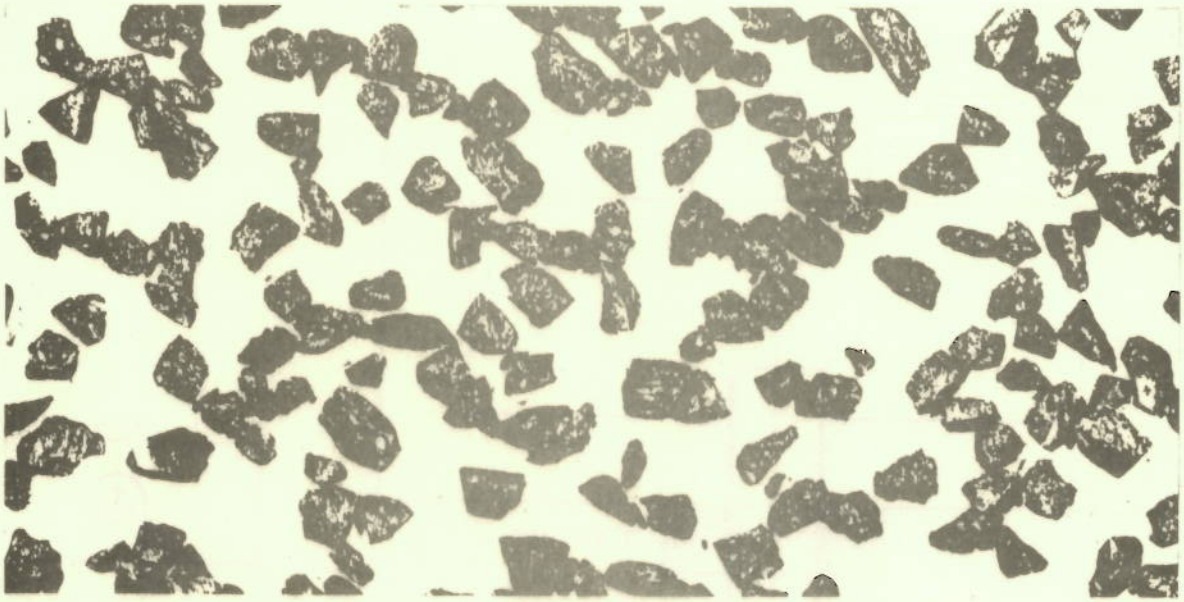

FIG.3. G24 GRIT FROM M.G.HOUSE AFTER COMPLETION OF SPECIMEN NO.19. x 5

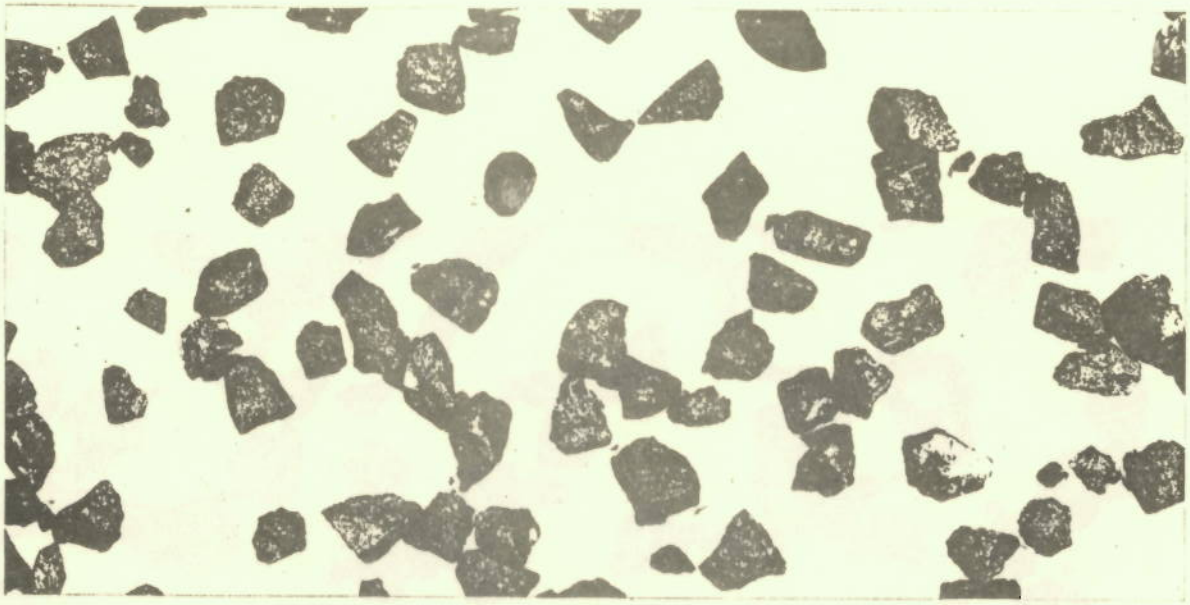

FIG.4. G24 GRIT FROM M.G.HOUSE AFTER TWO DAYS AND COMPLETION OF SPECIMEN NO.33. x 5

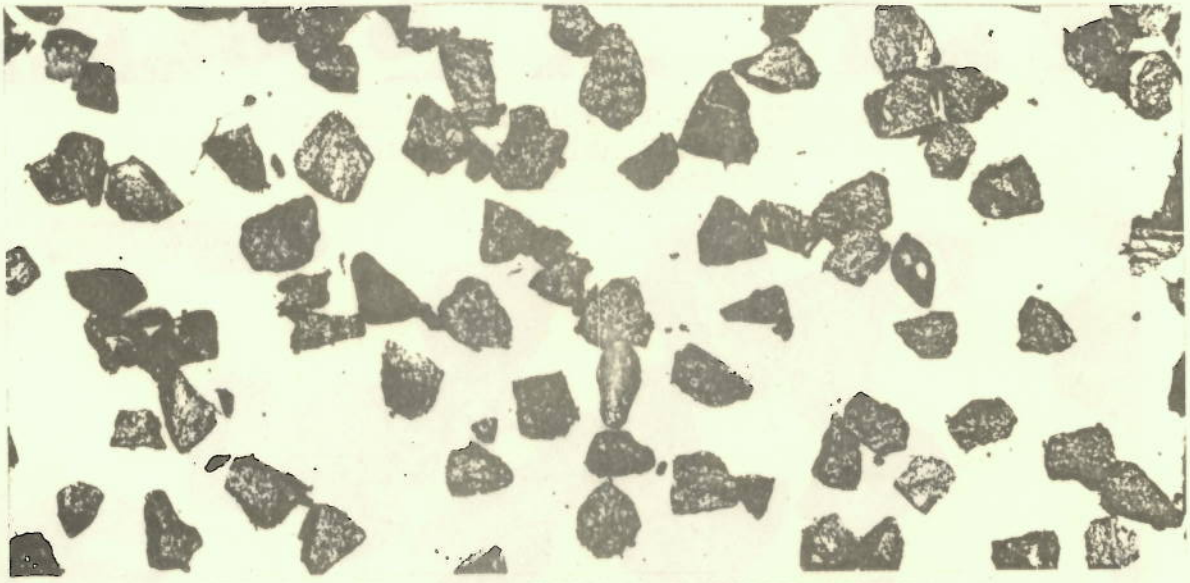

FIG.5. G24 GRIT FROM M.G.HOUSE AFTER FOUR DAYS AND COMPLETION OF SPECIMEN NO.34. x 5

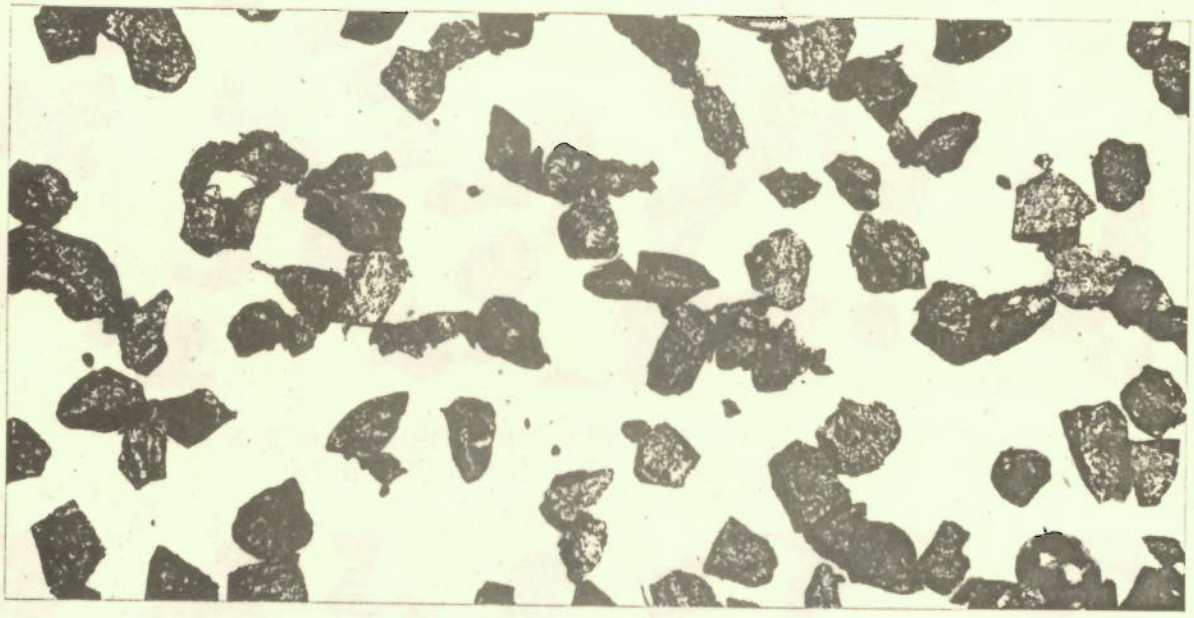

FIG.6. G24 GRIT FROM M.G.HOUSE AFTER SIX DAYS AND COMPLETION OF SPECIMEN NO.39. x 5

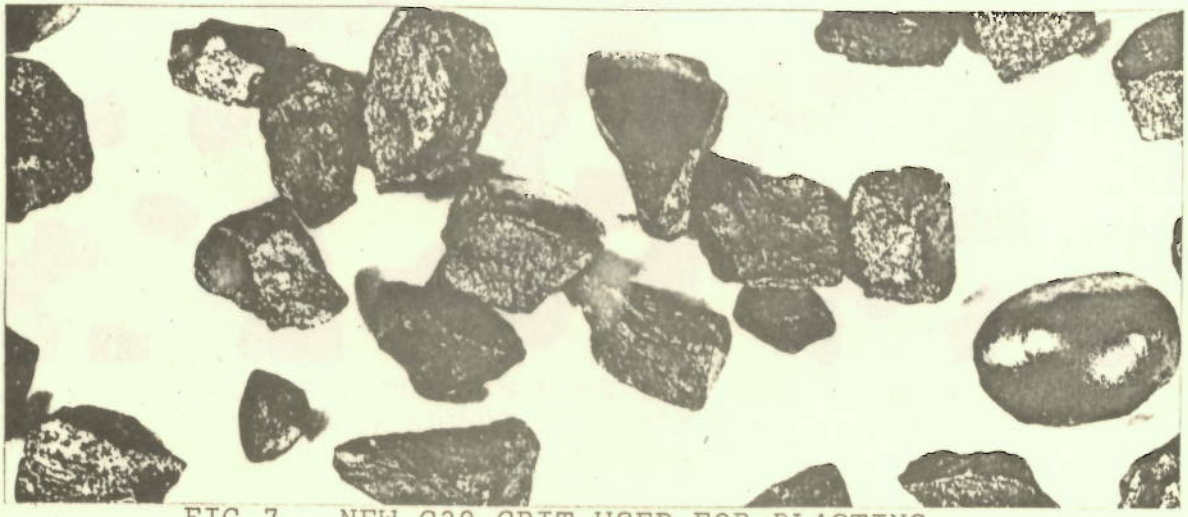

FIG.7. NEW G39 GRIT USED FOR BLASTING OF SHIP'S HULL x 5

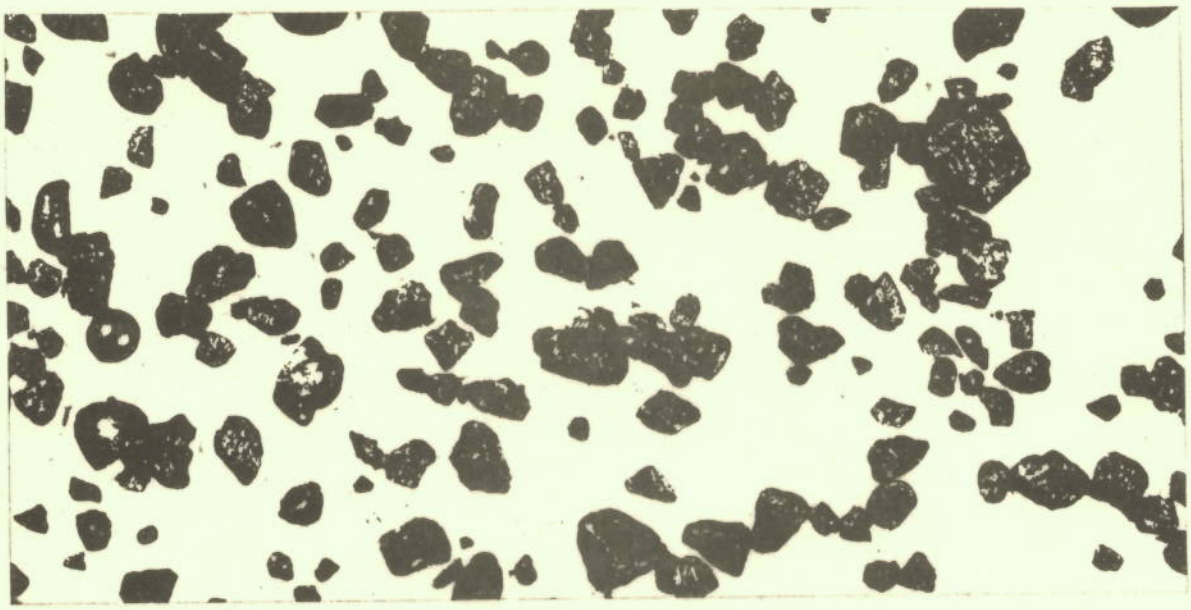

FIG.8. G39 GRIT USED FOR BLASTING OF SHIP'S HULL, AFTER USE x 5