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Watertown Report No. TD-107

INDEXED

Progress Report on
Cold Heading Versus Hot Heading
and Rivet Design

H. A. Matthews
Asst. Dir., Ord. Dept.

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July 8, 1941
WATERTOWN ARSENAL
WATERTOWN, MASS.

Test. Lab.

Memorandum
Report No. 710/373
Watertown Arsenal

July 8, 1941

Progress Report on
Cold Heading versus Hot Heading
and Rivet Design

1. As an extension of the program on the cold heading versus hot heading of rivets and rivet design reported in Memorandum Report #710/371 dated May 5, 1941, two additional riveted sections have recently been tested at this arsenal. A complete report of the rivet investigations incorporating metallurgical studies of sectioned rivets will be forwarded in the near future.

2. The results of this investigation indicate:

a. That the original heads should be filleted on all rivets used in the fabrication of armored structures subject to ballistic impact.

b. SAE 2315 appears much more satisfactory than Cromansil, SAE 4615, or N-A-X High Tensile in the heat treated and non-filleted condition in which they were used. Although no failures occurred in the SAE 2315 rivets, some cracks were discovered upon sectioning.

c. The manganese steel in the normalized condition appears very satisfactory if provided with at least a $3/32$ " (preferably $1/8$ ") fillet at the original head.

d. Machining of a $1/8$ " radius on the faces of the drilled

holes should be provided on both the rear and front of the section to take full advantage of the filleted head and provide a fillet on the hot or cold formed head.

e. Cold heading appears satisfactory if used in conjunction with a filleted rivet and properly radiused holes. But from the results on section 15, it should be noted that cold heading is dangerous unless proper fillets and radiused holes are provided.

3. Section No. 14, see Figures #1 and #2 attached, was made up of a 1/2" face hardened plate on the face riveted to a 1/4" structural steel backing plate with the rivets spaced on 3" centers. All rivets were normalized from 1550°F.

The following rivets composed the section:

Row 1	Rivets 1-3	Manganese high tensile steel (.20 C - 1.25 Mn) hot headed from the rear.
Row 2	Rivets 1-3	Manganese high tensile steel, hot headed from the front.
Row 3	Rivets 1-3	Manganese high tensile steel, cold headed from the rear.

The manganese steel rivets, obtained from the Navy, were filleted with a 3/32" radius fillet under the original head. The drilled holes on both faces of the section were machined to form a 1/8" radius fillet to accommodate the filleted rivets and produce a fillet on the formed head. Rows 1 and 2, Rivets 4 and 5, SAE 2315, cold headed from the front.

Row 3 Rivets 4 and 5, SAE 2315, cold headed from the rear.

The rivet holes for the SAE 2315 rivets were countersunk with

a 60° included angle tool to a depth of 1/16" on both the front and rear of the section.

4. Section No. 15, see Figures #3 and #4 attached, was made up of a 1/2" face hardened plate and a 1/4" structural steel backing plate. All rivet holes on this section were countersunk on the front and rear of the section with a 60° included angle tool to a depth of 1/16". All the rivets used in this section were also normalized from 1550°F.

Row 1	Rivets 1-4	Cromasil steel (manganese, silicon, chrome, vanadium) cold headed from the front.
Row 2	Rivets 1-4	SAE 4615, cold headed from the front.
Row 3	Rivets 1-4	N-A-X High Tensile steel, cold headed from the front.

5. Figures #5 and #6 attached show the front and rear of section No. 15 after ballistic testing. All shots fired were .50 caliber A.P. at a striking velocity of 2400 f/s. It will be noted that although many of the rivet heads were severely distorted by the impacts of projectiles, no heads were fractured from the section. In the case of the SAE 2315 rivets although no heads were fractured off, sectioning of several of these rivets revealed cracks propagating at the non-filleted original rivet heads. This condition resulted irregardless of whether the non-filleted head was on the front or the rear of the section. No cracks were found at the original filleted heads of the manganese steel rivets.

6. Figures #7 and #8 attached show the front and rear of section No. 15 after similar ballistic tests. Although a greatly less number of shots were fired at this section, the original unfilleted heads

fractured off in the great majority of cases although in many cases impacts were up to two inches removed from the rivets.

Respectfully submitted,

N. A. Matthews,
1st Lt., Ord. Dept.

APPROVED:

S. B. Ritchie,
Lt. Col., Ord. Dept.,
Director of Laboratory.

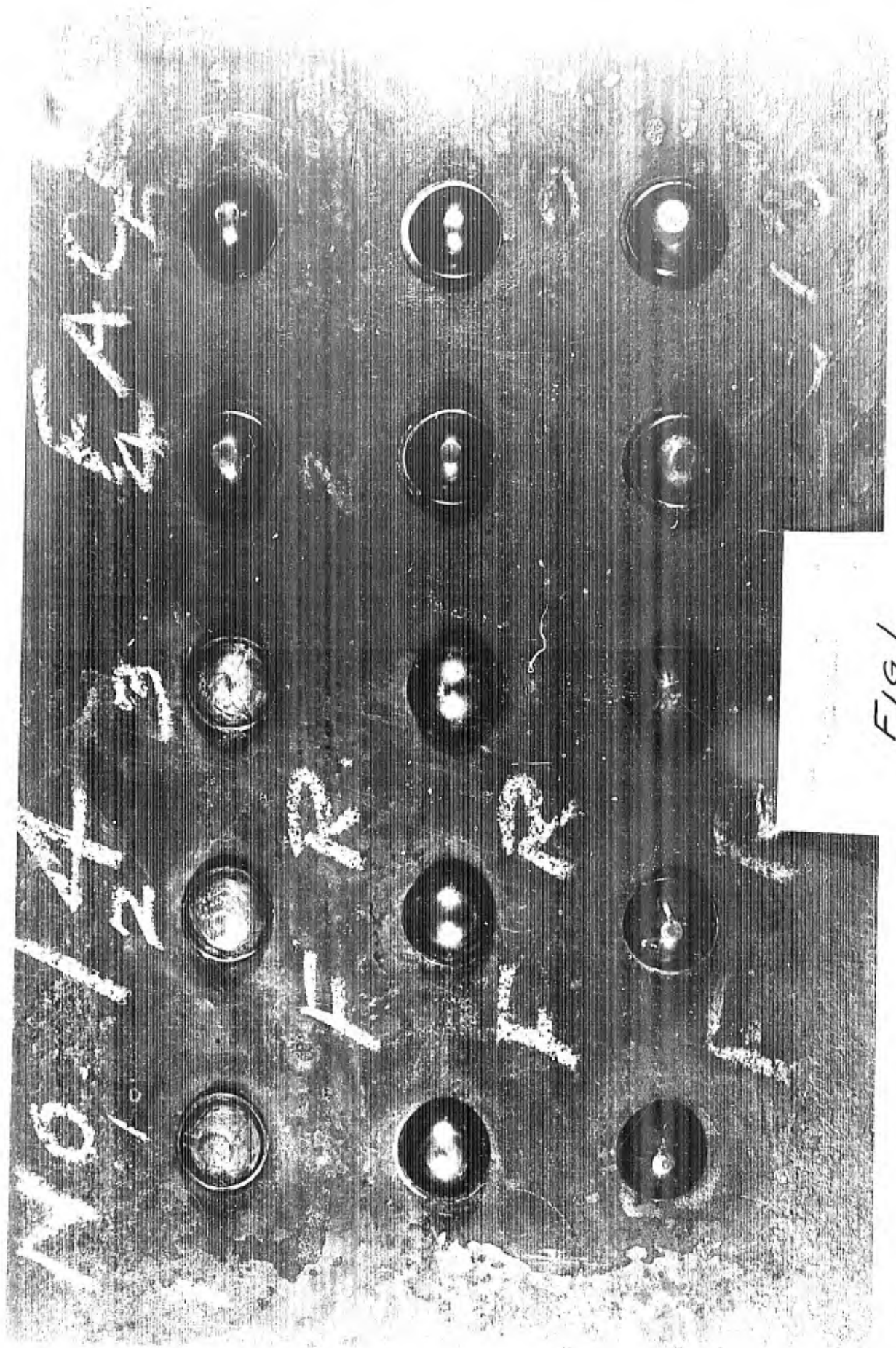
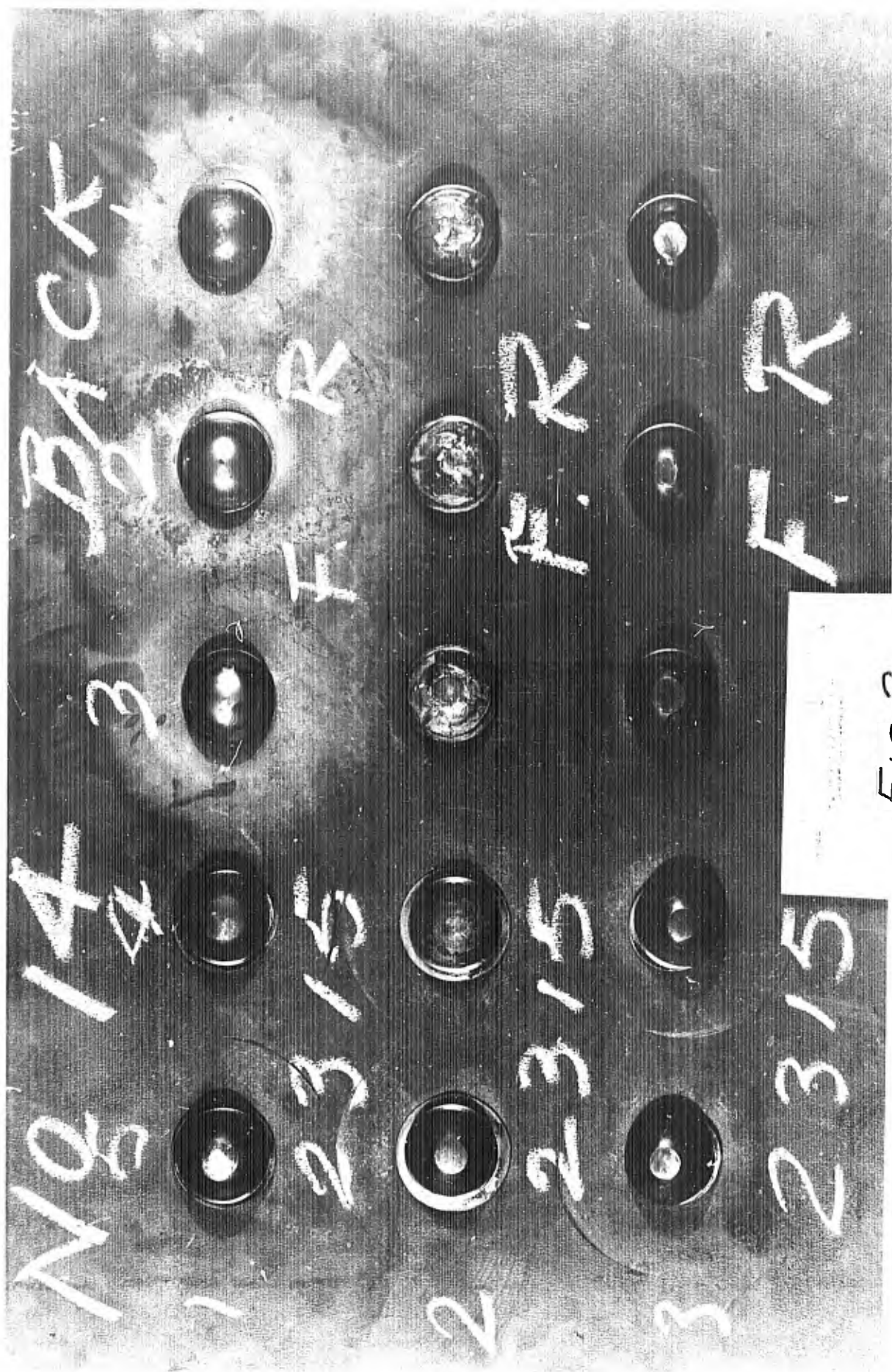


Fig. 1



BACK



14



15

16



17

2

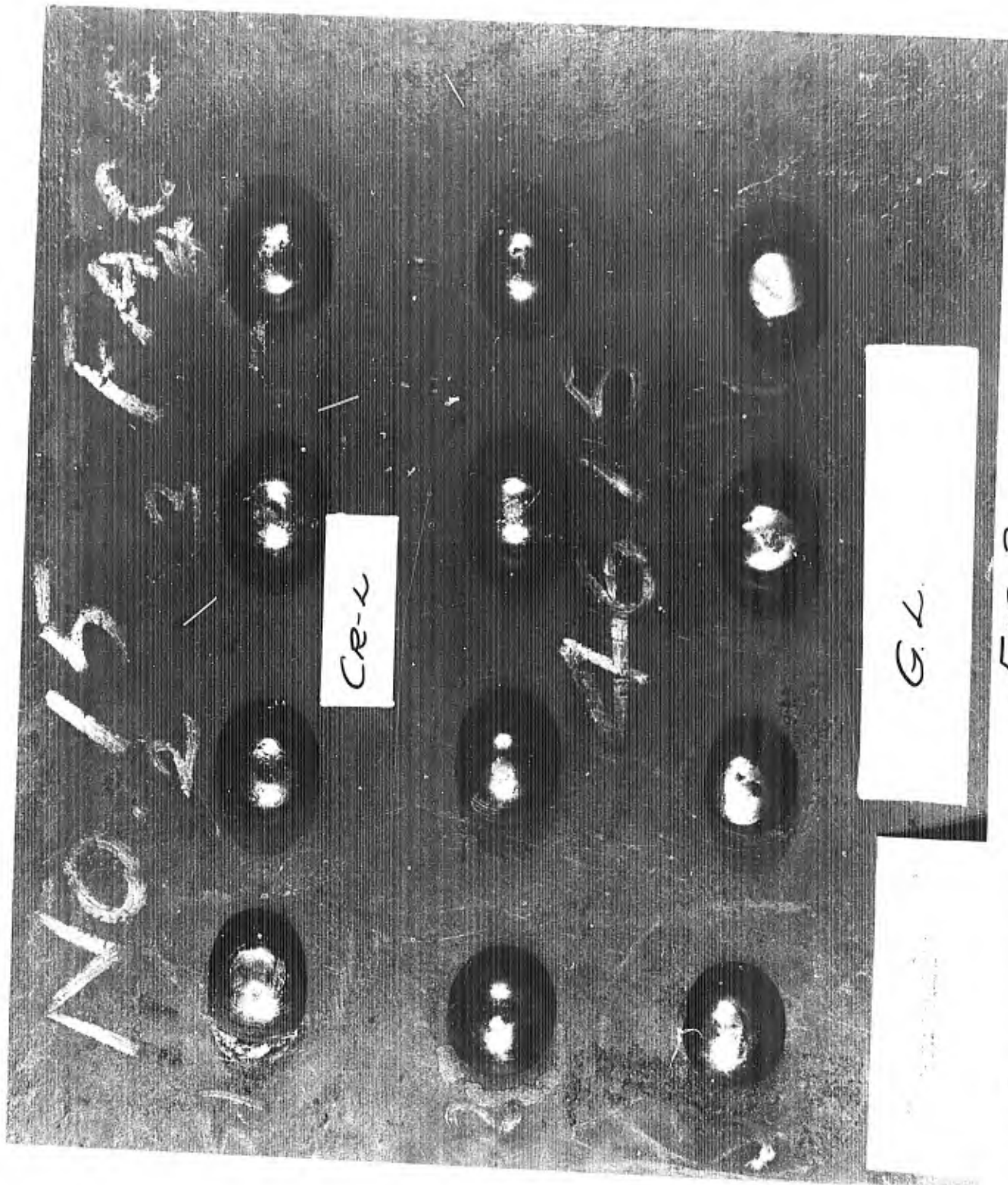
2315

3

2315

F.R.

FIG. 2



CR-2

G.L.

FIG. 3

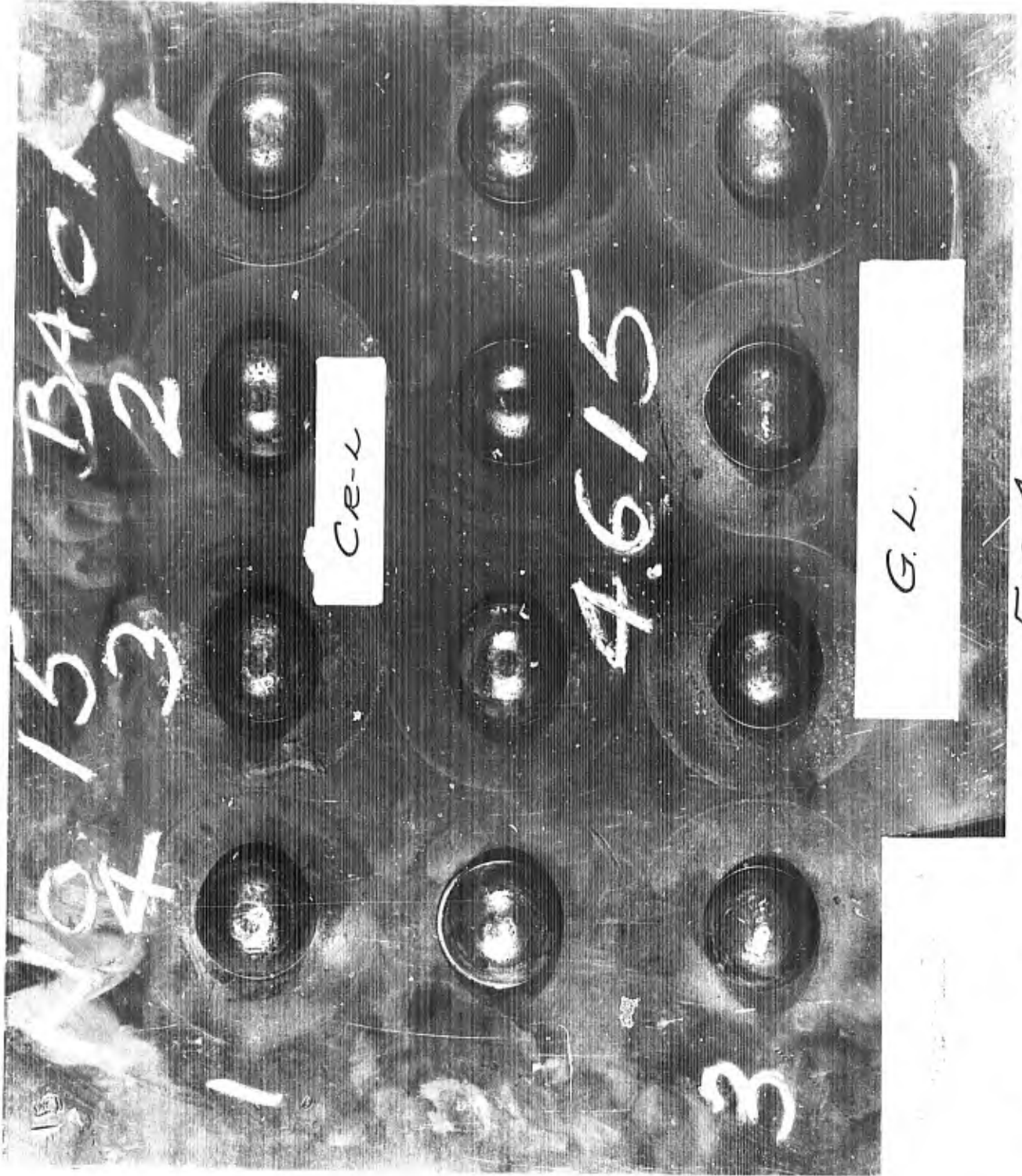


FIG 4

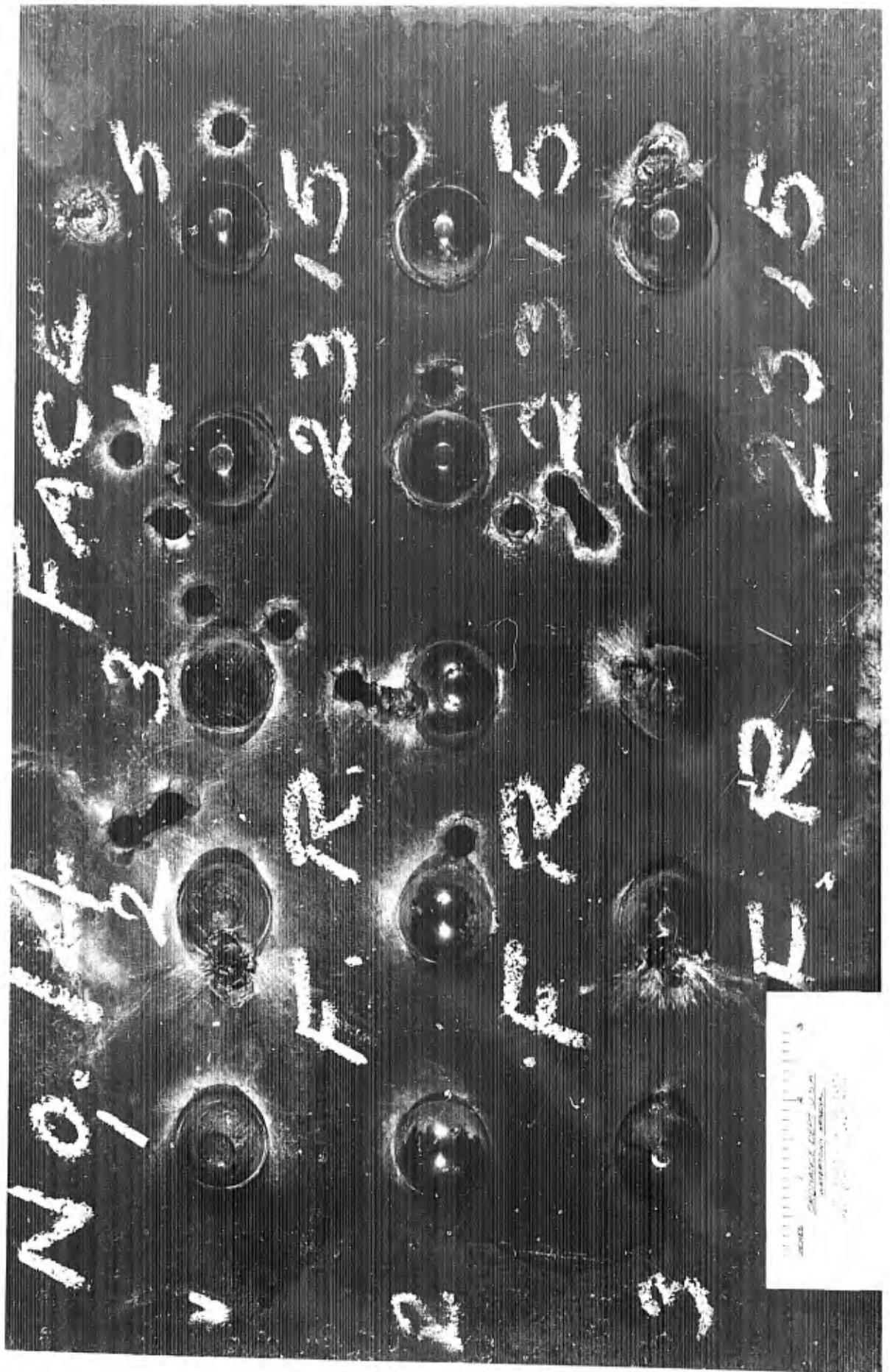


FIG. 5

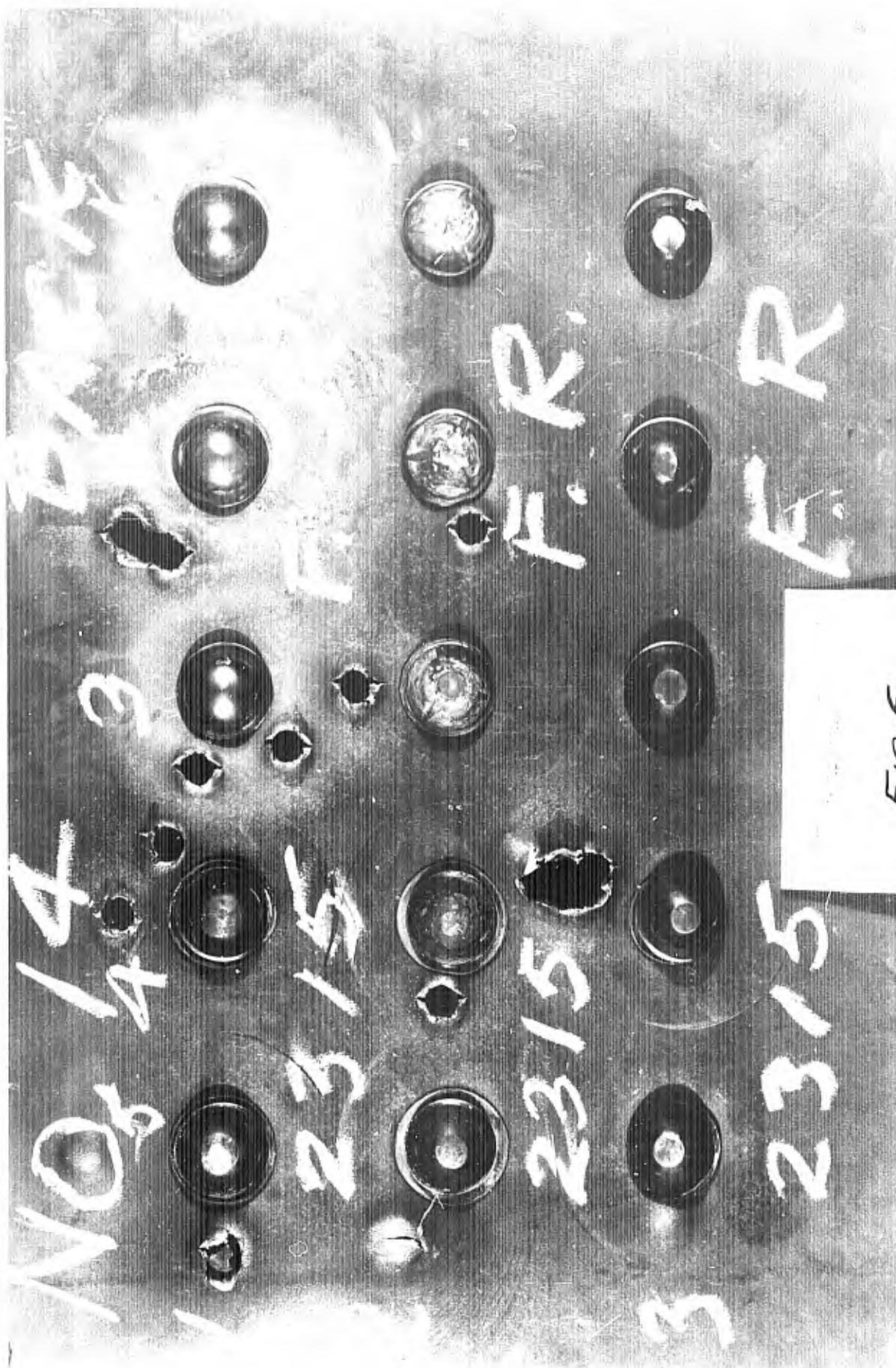


FIG. 6

NO. 14

2315

2315

2315

3

F.R.

F.R.

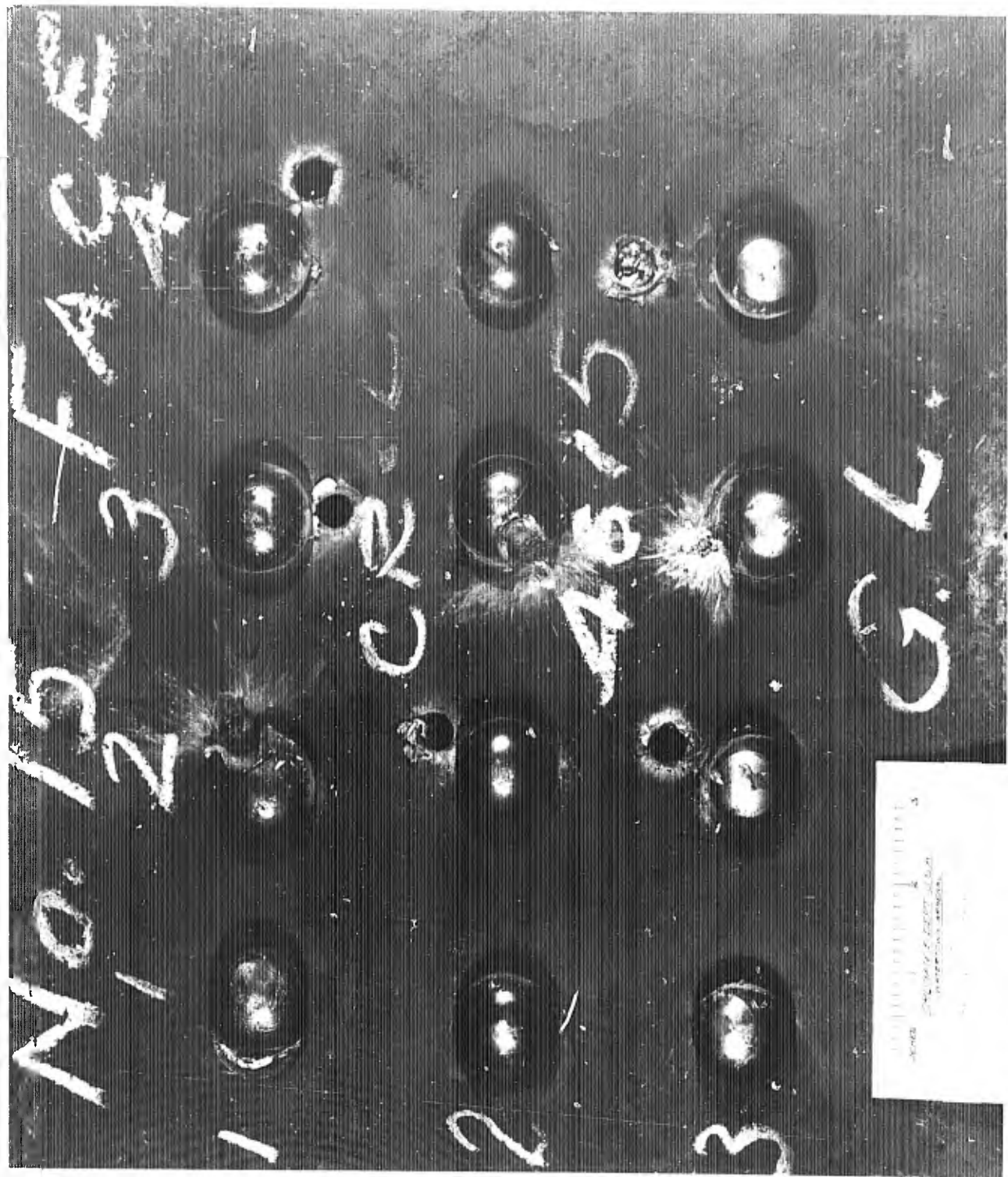


FIG. 7

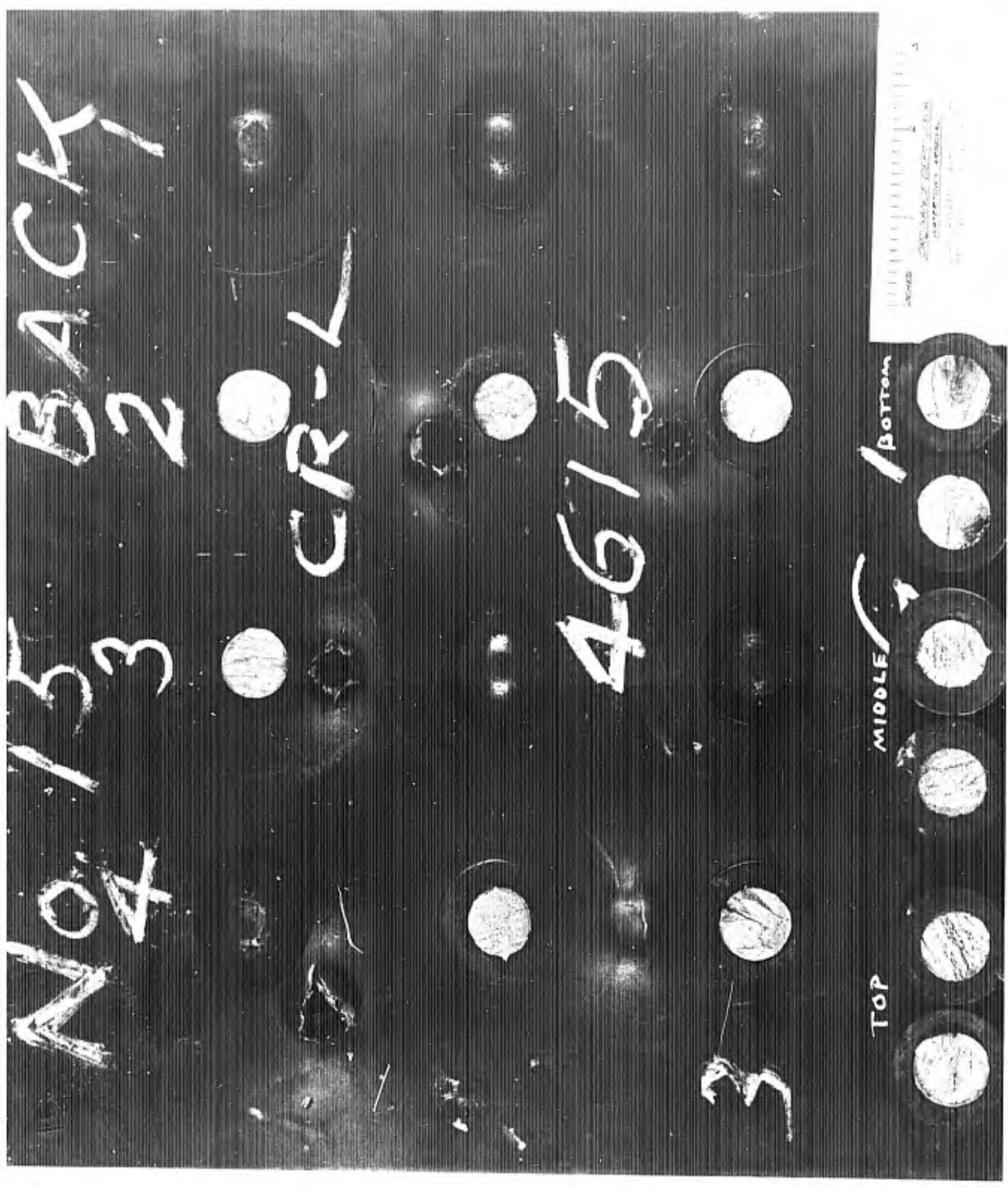


FIG 8