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REPORT NO. 710/33

ARMOR PIERCING BULLET CORE STOCK

BY

H. G. CARTER

1934
WATERTOWN ARSENAL
WATERTOWN, MASS.

W. A. Form No. 2.

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Report No. 710/33
Watertown Arsenal

October 22, 1934

ARMOR PIERCING BULLET CORE STOCK.

References.

O.O. 471.84/759
W.A. 471.84/4
F.A. 461/1357-1

Material

Six specimens of A. P. Bullet Core Stock were received from Frankford Arsenal for metallurgical study. Their description was given in F. A. 461/1357-1 1st Ind.

Conclusions

1. Specimens 1, 2, 3 were fairly clean.
   " 4 and 6 were dirty.
   " 5 was rather dirty, contained many fine inclusions in bands.

2. No appreciable surface decarburization was found.

3. All specimens had a banded high carbon center suggestive of the segregation of piped stock.

4. The metal near the surfaces of all specimens showed only slight banding.

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1. Specimens 1, 2, 3 were fairly clean.
   " 4 and 6 were dirty.
   " 5 was rather dirty, contained many fine inclusions in bands.

2. No appreciable surface decarburization was found.

3. All specimens had a banded high carbon center suggestive of the segregation of piped stock.

4. The metal near the surfaces of all specimens showed only slight banding.

5. The structure of cores

1 and 4 were sorbitic and slightly spheroidized.

2, 3, 6 were completely spheroidized.

5 was sorbitic and partially spheroidized.

Specimens

According to Frankford Arsenal letter 461/1357-1 1st Ind., the specimens were selected as follows:-

1. Carpenter Steel Co. Cal. .30 old stock ground to size.

2. Universal Steel Co. Cal. .30 new stock ground to size Heat C 11281.

3. Universal Steel Co. Cal. .30 new stock ground to size Heat C 11282.

4. Carpenter Steel Co. Cal. .50 old stock carburized cold drawn.

5. Carpenter Steel Co. Cal. .50 old stock carburized cold drawn normalized.

6. Crucible Steel Co. Cal. .50 new stock carburized Heat 39417 ground to size.

Chemical Analysis

Core	C	Mn	Si	S	P	Cr	W
1	1.06	.24	.29	.015	.014	.64	4.13
2	1.025	.28	.305	.016	.008	.62	4.08
3	1.055	.29	.28	.014	.010	.60	4.11
4 outside	1.005	.37	.315	.014	.016	.70	4.34
4A center	1.13	.37	.31	.014	.014	.69	4.32
5 outside	.82	.25	.28	.015	.009	.45	4.38
5A center	.985	.25	.275	.016	.015	.47	4.23
6 outside	1.075	.29	.25	.016	.017	.58	3.76
6A center	1.075	.30	.23	.015	.019	.59	3.88

Discussion

Specimens 1, 2, 3 were fairly clean and 4, 5, 6 were rather dirty, however, the amount of dirt was well within the usual commercial limits. No decarburization was found in 1, 2, 3 and 6 but inasmuch as these had been ground to size, decarburization would not be expected unless severe decarburization had taken place in processing. Cores 4 and 5 had a shallow skin of about .80C.

The microstructure of all specimens had a banded higher carbon center suggestive of the segregation of piped stock. The metal near the surfaces showed only slight banding. The banding consisted primarily of long chains of carbides which were larger than the carbides between the chains. The structure of the cores, aside from carbide chains, varies as follows:-

Cores 1 and 4 sorbite with a slight tendency to spheroidize.

Core 5 sorbite partially spheroidized.

Cores 2, 3 and 6 completely spheroidized.

According to Frankford Arsenal letter 461/1357-1 - 3rd Ind. lots 4 and 5 are exhausted, therefore, will not be considered further in this report.

To remove the chainlike carbide segregation in the centers of the cores it will probably require a somewhat

higher temperature than is at present used, namely, Cal. .30 1480-1500°F, Cal. .50 1500-1520°F. Probably a double heat treatment may be required, such as

Stock Normalized
1700°F - 1 hr. - air
Machined and Hardened from
1500°F - 1/4 hr. - oil
400°F - 1/2 hr. - air

It is noted in the heat treatment as given by Frankford Arsenal that the cores are quenched in water at 70°F. This seems rather drastic. This type of steel is often referred to as oil hardening steel.

It is believed that the completely spheroidized cores 2, 3 and 6 will respond to heat treatments much more readily than core #1 which is eorbitic with little spheroidization of the carbides.

Respectfully submitted,

H. G. Carter.

Fig. 1

X100	Unetched	A.P. Core #1	Fairly clean

MA 6

Fig. 2

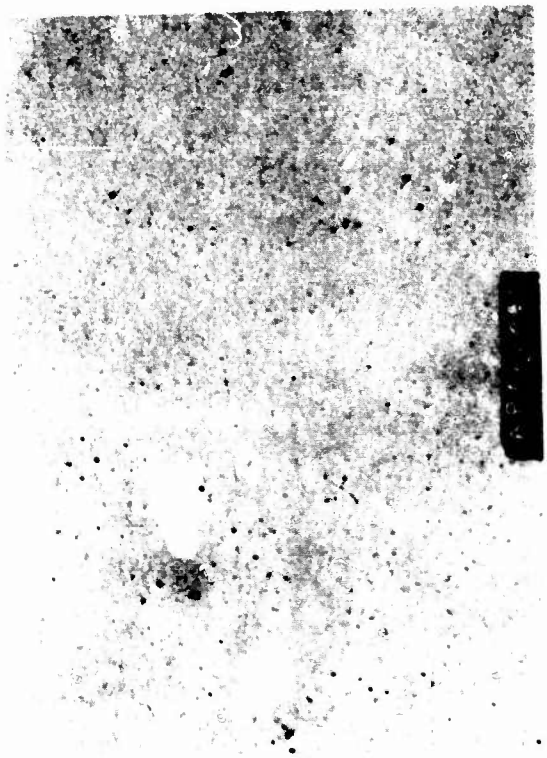
X100	1% Nital etched	A.P. Core #1	Outside. Fine, uniform, very slightly banded sorbite. No decarburization.

MA 14

Fig. 3.

X100	1% Nital etched	A.P. Core #1	Center. Fine banded sorbite. Slightly segregated carbides as chains. See Fig. 13.

MA 15



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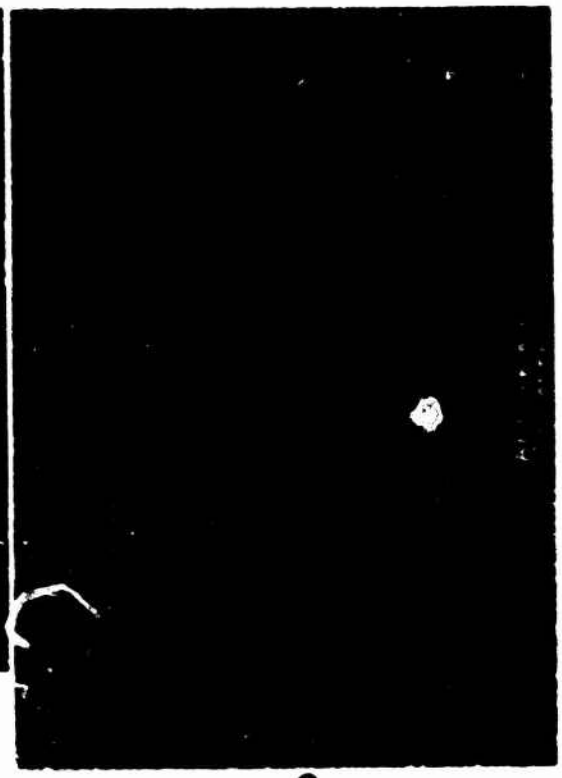

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Fig. 4

X100	Unetched	A.P. Core #2	Fairly clean.

MA 7

Fig. 5

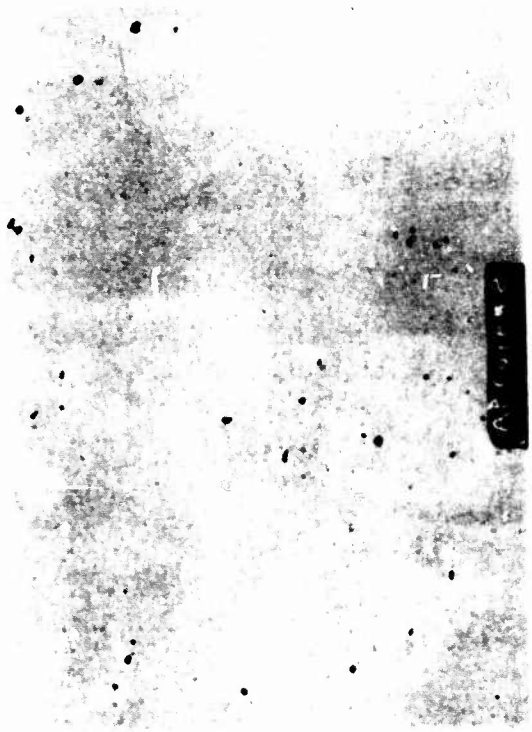
X100	1% Nital etched	A.P. Core #2	Outside. Fine uniform. Very slightly banded, completely spheroidized sorbite. No decarburization.

MA 16

Fig. 6

X100	1% Nital etched	A.P. Core #2	Center. Fine, banded, slightly segregated carbide chains, completely spheroidized sorbite. See Fig. 21.

MA 17



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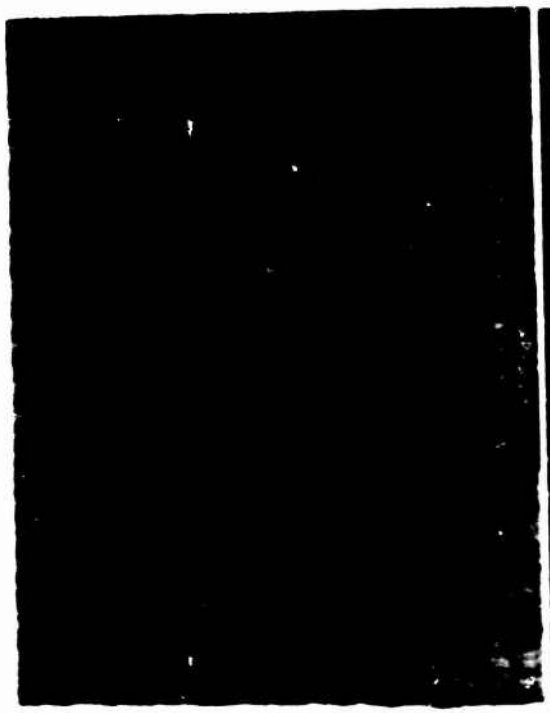

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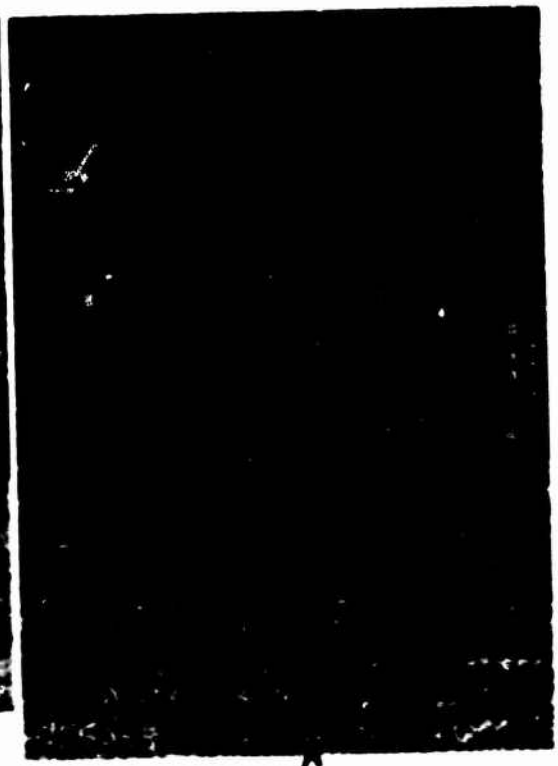

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Fig. 7

X100	Unetched	A.P. Core #3	Fairly clean.

MA 8

Fig. 8

X100	1% Nital	A.P. Core #3	Outside. Fine, uniform, very slightly banded, completely spheroidized sorbite. No decarburization.

MA 18

Fig. 9

X100	1% Nital	A.P. Core #3	Center. Fine, banded, slightly segregated carbide chains, completely spheroidized sorbite. See Fig. 21.

MA 19

7

8

9

Fig. 10

X100	Unetched	A.P. Core #4	Dirty.

MA 9

Fig. 11

X100	1% Nital etched	A.P. Core #4	Outside. Fine, uniform, very slightly banded sorbite. Decarburized .005" to .80 C.

MA 20

Fig. 12

X100	1% Nital etched	A.P. Core #4	Center. Fine banded sorbite considerably segregated carbide chains.

MA 21

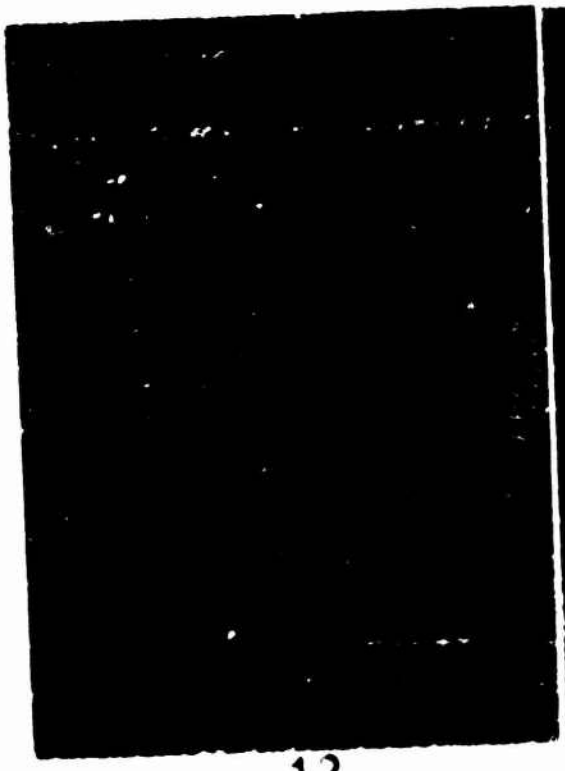
Fig. 13

X1000	1% Nital etched	A.P. Core #4	1/2 O.C. Slightly spheroidized sorbite. Numerous carbide segregates.

MA 26

10

11



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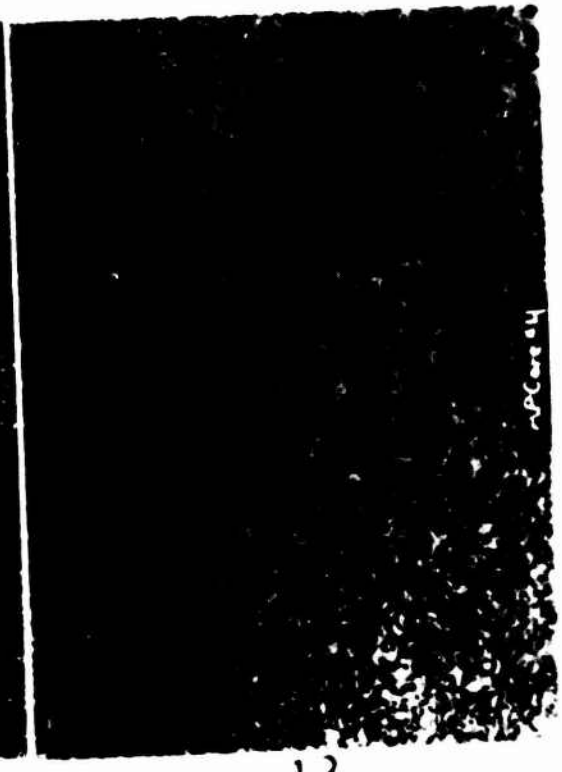

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Fig. 14

X100	Unetched	A.P. Core #5	Fairly dirty. Many fine banded inclusions.

MA 10

Fig. 15

X100	1% Nital	A.P. Core #5	Outside. Fine, uniform, very slightly banded sorbite. Decarburized .007" to .80 C.

MA 22

Fig. 16

X100	1% Nital	A.P. Core #5	Center. Fine banded sorbite considerably segregated carbide chains.

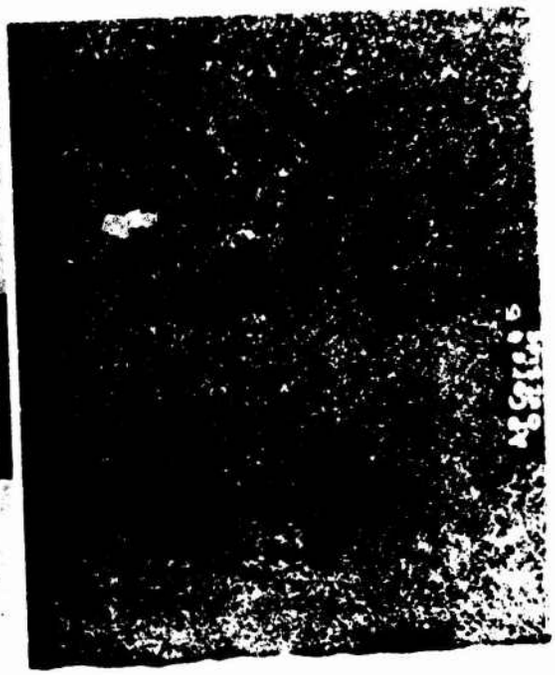
MA 23

Fig. 17

X1000	1% Nital	A.P. Core #5	1/2 O-C. Partially spheroidized sorbite. Numerous carbide segregates.

MA 27

14



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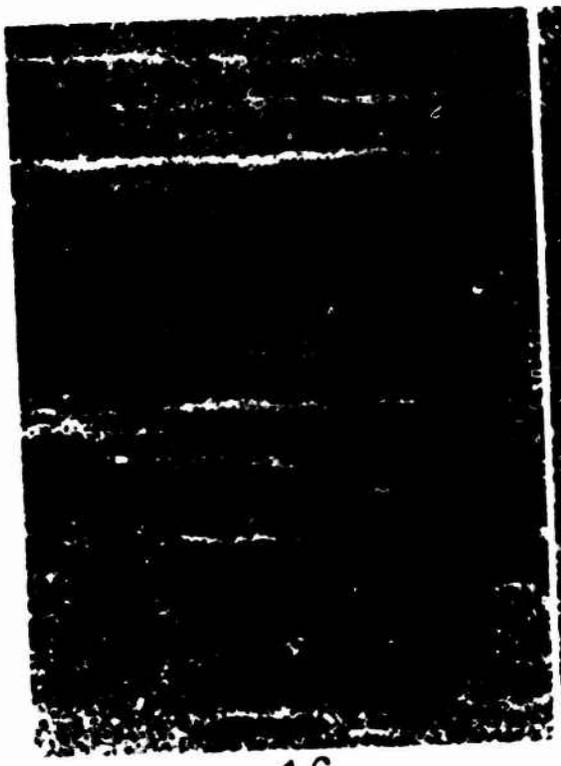

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Fig. 18

X100	Unetched	A.P. Core #6	Dirty.

MA 11

Fig. 19

X100	1% Nital etched	A.P. Core #6	Outside. Fine, uniform, very slightly banded sorbite. No decarburization.

MA 24

Fig. 20

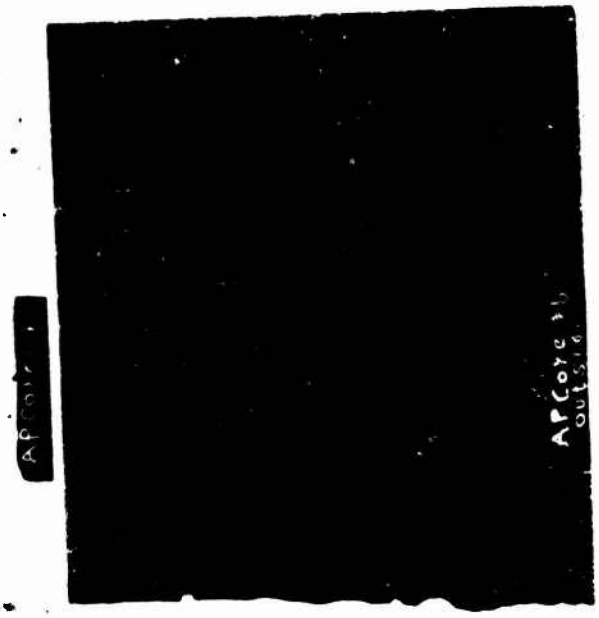
X100	1% Nital etched	A.P. Core #6	Center. Fine, banded, sorbite. Slightly segregated carbide chains.

MA 25

Fig. 21

X1000	1% Nital etched	A.P. Core #6	1/2 O-C. Completely spheroidized sorbite.

MA 28



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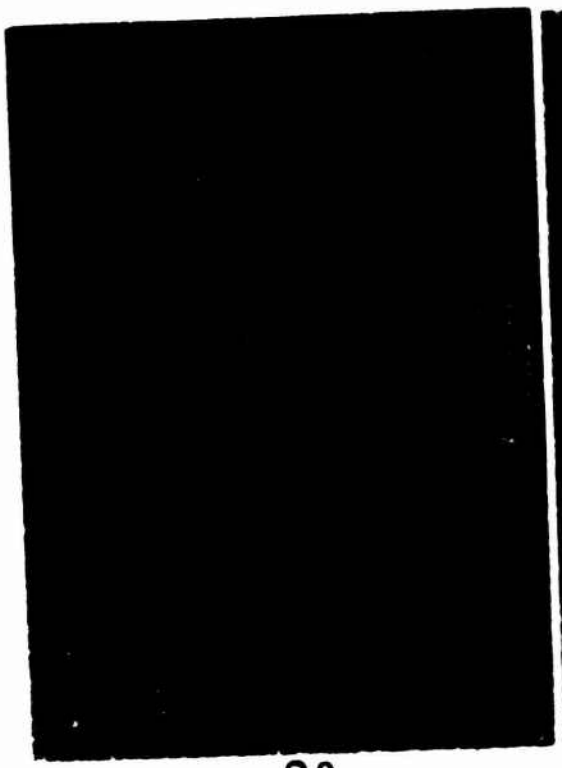

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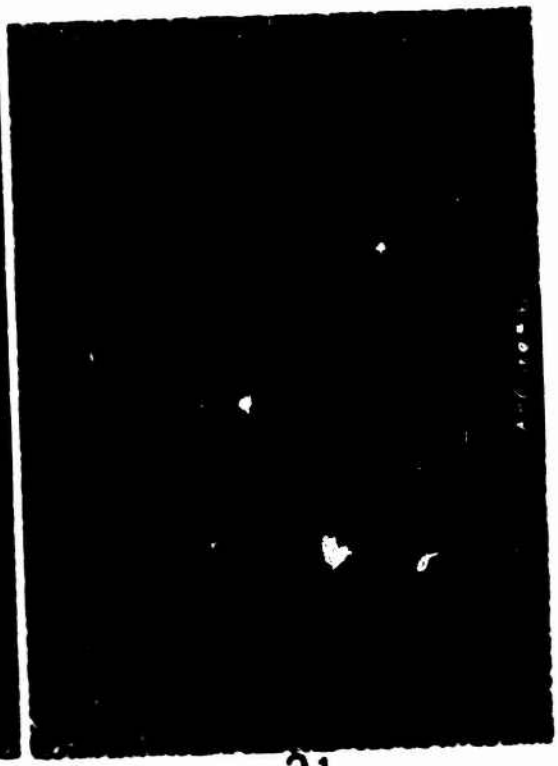

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