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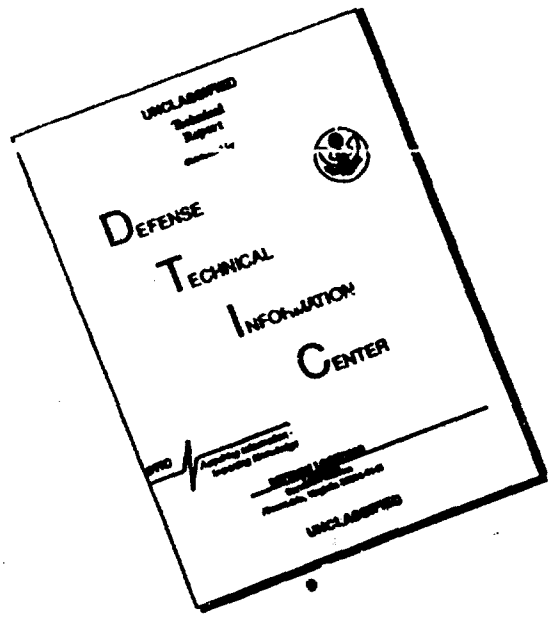

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GENERAL DYNAMICS | CONVAIR

Report No. 8926-094

Material - Finishes and Coatings - Wear Resistant

Abrasion Resistance

L. A. Mappus, J. C. George, E. E. Keller

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Abstract

Twenty materials consisting of various fabrics and tapes (polyester, teflon, nylon, dacron), fiberglass laminate (epoxy, polyester, phenolic), epoxy enamel hard anodized coatings (Anachrome Corp., Southgate, California), lubricant films, and Type 301 Half Hard stainless steel were applied to 2024-T3 and 7075-T6 aluminum alloy materials and wear tested in various combinations in a sliding abrasion test machine. Dacron tape (Connecticut Hard Rubber Co., New Haven, Connecticut, Temp - R- Tape) sandwiched between sliding 2024-T3 aluminum alloy surfaces displayed the best wear preventative characteristics of all the materials tested at 14 cycles of oscillation* under 2.5 psi pressure.

Reference: Mappus, L. A., George, J. C., Keller, E. E., "Abrasion Wear Preventive Devices In Vibrating Faying Surfaces, Evaluation of," General Dynamics/ Convair Report MP 58-470, San Diego, California, 21 July 1959. (Reference attached.)

*Per Second

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO

STRUCTURES & MATERIALS LABORATORY

REPORT NP 58-470
DATE 21 July 1958
MODEL 30

TITLE

REPORT NO. NP 58-470

ABRASION WEAR PREVENTIVE DEVICES IN VIBRATING FAYING SURFACES - EVALUATION OF

MODEL: 30

PREPARED BY L. A. Mappus
L. A. Mappus

GROUP Materials & Processes Lab.

CHECKED BY: J. C. George
J. C. George

REFERENCE

CHECKED BY E. E. Keller
E. E. Keller

APPROVED BY E. F. Strong
E. F. Strong, Chief Of Structures & Materials Lab.

NO. OF PAGES 16

NO. OF DIAGRAMS 14

J. W. Sutherland
J. W. Sutherland, Grp. Engr.

REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED

FORM 1012A-6

INTRODUCTION:

In order to prevent the abrasive wear in faying surfaces of primary structures or parts whose replacement would be costly, the design groups intend to install wear preventive devices between the primary structure and bolted on doors, panels, fairings, etc. This test request was originated to evaluate various wear preventive devices installed in clad aluminum alloy metallic joints and subjected to vibration.

OBJECT:

To evaluate, under simulated vibration conditions, various wear preventive devices installed in clad aluminum alloy faying surface joints.

CONCLUSIONS:

Of the 20 different wear preventive devices tested, Dacron Temp-R-Tape, manufactured by the Connecticut Hard Rubber Company, New Haven, Conn., was the best material tested for use in faying surface joints from the standpoint of wear prevention and ease of installation.

TEST SPECIMENS:

Twenty (20) different faying surface combinations were evaluated. In each combination, one surface was attached to, or a part of, an .040 inch thick sheet of 2024-T3 clad aluminum alloy. The other surface was attached to a 1.5 x 2 x 3 inch 2024-T3 aluminum alloy block. The faying surfaces are listed in Table I.

TEST PROCEDURE:

A photograph of the test jig is shown in Figure 1. The design of this machine made it possible to test sixteen (16) faying surface combinations simultaneously. A motor whose speed was controlled by a Variac, turned two cam wheels. Each cam actuated two rods, each rod moving 4 specimens. The rods were spring loaded to hold them against the cams. Loads were applied to each specimen by means of calibrated springs. Conditions set for this test were as follows: The motor speed was set at 850 RPM which was approximately fourteen (14) cycles per second; the cams were made to give an amplitude of vibration of .0625 inches; the springs were adjusted to give a pressure of 2.5 PSI on the faying surface joint.

Specimens without their own adhesive, were attached to the blocks and sheets by means of double faced Permacel No. 94 polyester tape. This method of attachment facilitated the removal and replacement of faying surfaces. When it was desired to eliminate a faying surface from test completely a metal sleeve was substituted for the block.

Report No. 8926-094

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Abrasion Resistance

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DATE 21 July 1958

MODEL 30

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REPORT NO. MP 58-470

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MODEL: 30

PREPARED BY L. A. Mappus
L. A. Mappus

GROUP Materials & Processes Lab.

CHECKED BY: J. C. George
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REFERENCE

CHECKED BY E. E. Keller
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E. F. Strong, Chief Of Structures & Materials Lab.

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J. W. Sutherland
J. W. Sutherland, Grp. Engr.

REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED

FORM 1812A-4

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Specimens without their own adhesive, were attached to the blocks and sheets by means of double faced Permacel No. 94 polyester tape. This method of attachment facilitated the removal and replacement of faying surfaces. When it was desired to eliminate a faying surface from test completely a metal sleeve was substituted for the block.

TEST PROCEDURE: (Cont'd)

The faying surface joints were dis-assembled periodically for inspection. Photographs of the faying surfaces were taken after 20, 100, 200, and 300 hours of testing. These photographs are shown in Figures 2 thru 9. Each hour of testing represents 51,000 cycles. Tests were stopped after 300 hours (15,300,000 cycles).

RESULTS & DISCUSSION:

Results are listed in Table II. Conditions of the faying surfaces are shown in Figures 2. through 9. The Figure numbers and positions shown in Table II refer to the location of the most severe condition of wear for each faying surface combination in the Figures. Positions in the Figures are numbered from top to bottom and left to right as follows:

1	5
2	6
3	7
4	8

Faying surfaces 1, 4, 5, 6, 10, 11, 19, and 20 were all eliminated because of galling. Faying surfaces 8 and 9 were not considered because it is not practical to keep the joints lubricated. Faying surfaces 2, 3, 7, 12, 14, 15, 16, 17, and 18 did not offer as much protection as 13 and, in addition, would be more difficult to install in the production shop.

ACKNOWLEDGEMENT:

The test jig was designed by Mr. Gerard DeVries of the Convair, San Diego, Engineering Department.

NOTE: Test data from which this report was prepared may be found in Engineering Test Laboratories Data Book No. 3004.

Table I
Faying Surfaces Tested

Faying Surface No.	Block Surface	Sheet Surface
1	.040 inch 2024-T3 Clad al.alloy	.040 inch 2024-T3 Clad al.alloy
2	.015 inch Nylatron GS (Molybdenum disulphide impregnated nylon) Mfg. by Polymer Corp; Reading Pa.	.015 inch Nylatron GS
3	.002 inch Polyester tape 3M Co. Tape # 853	.002 inch Polyester tape 3M Co. Tape # 853
4	.040 inch 2024-T3 Clad al.alloy Lubricated with ELF Lube Stick Mfg. by Aviation Lubricants Co; San Diego, Calif.	.040 inch 2024-T3 Clad al.alloy
5	.040 inch 2024-T3 al.alloy with .002 inch hard anodized surface Mfg. by Anachrome Corp; Southgate, Calif.	.040 inch 2024-T3 al.alloy
6	.040 inch 7075 al.alloy with .002 inch hard anodized surface Mfg.by Anachrome Corp; Southgate, Calif.	.040 inch 2024-T3 Clad al.alloy
7	.040 inch 2024-T3 al.alloy with .002 inch hard anodized surface Mfg. by Anachrome Corp; Southgate, Calif.	.002 inch Polyester tape(Mylar) 3M Co. Tape # 853

Table I(Cont'd)

Faying Surface No.	Block Surface	Sheet Surface
8	Convair Spec. 0-03021, Type II White epoxy enamel, Mfg.by Andrew Brown Co. Lubricated with ELF Lubestick	.040 inch 2024-T3 Clad al.alloy
9	Convair Spec. 0-03021,Type II White epoxy enamel, Mfg.by Andrew Brown Co. Lubricated with ELF Lubestick	Convair Spec.0-03021, Type II White epoxy enamel Mfg.by Andrew Brown Co.
10	.040 inch 2024-T3 al.alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate, Calif.	.040 inch 2024-T3 al.alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate, Calif
11	.018 inch 301 1/2 hard stainless steel	.040 inch 2024-T3 al. alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate,Calif.
12	.015 inch Nylatron film Mfg. by Polymer Corp; Reading Pa.	.040 inch 2024-T3 Clad al.alloy
13	Dacron tape, Temp.-R-Tape DV (CVAC No.310282) Mfg. by Connecticut Hard Rubber Co; New Haven,Conn.	.040 inch 2024-T3 Clad al.alloy

Table I(Cont'd)

Faying Surface No.	Block Surface	Sheet Surface
14	.0065 inch Teflon Tape 3M Co. No.549	.040 inch 2024-T3 Clad al.alloy
15	.002 inch Polyester Tape 3M Co. No.853	.040 inch 2024-T3 Clad al.alloy
16	.031 inch Epoxy Laminate Mil-P-18177A,Type GEE	.040 inch 2024-T3 Clad al.alloy
17	.031 inch Polyester Laminate Mil-P-8013, Type I	.040 inch 2024-T3 Clad al.alloy
18	.031 inch Phenolic Laminate Mil-P-15035B, FBM	.040 inch 2024-T3 Clad al.alloy
19	.012 inch Type 301,1/2 hard stainless steel,Mil-S-5059A	.040 inch 2024-T3 Clad al.alloy
20	Convair Spec.0-03021,Type II White epoxy enamel,mfg. by Andrew Brown Co.	Convair Spec. 0-03021,Type II epoxy enamel (White) mfg. by Andrew Brown Co.

Table II
Results of Tests

Faying Surface No.	Hours Tested	Comments	Ref. Fig. No.& Position	Relative Rating
1	210	Control-discontinued after 210 hours because of severe galling	Fig.8 Pos.1	Poor
2	300	Good abrasion resistance but not as easily installed as faying surface No.13	Fig.8 Pos.2	Good
3	300	Same as above	Fig.8 Pos.3	Good
4	100	Galling occured even with lubrication	Fig.4 Pos.4	Poor
5	10	Discontinued because of galling,substituted faying surface No.10	Not shown	Poor
6	20	Discontinued because of galling	Fig.2 Pos.6	Poor
7	300	No advantage over faying surface No.15	Fig.8 Pos.7	Good
8	300	Protected aluminum but may not be practical to keep surface lubricated	Fig.8 Pos.8	Good
9	200	Same as above	Fig.8 Pos.4	Good
10	1	Discontinued because of galling	Not shown	Poor

Table II(Cont'd)

Faying Surface No.	Hours Tested	Comments	Ref.Fig. No.& Position	Relative Reading
11	30	Discontinued because of galling & fretting corrosion	Fig.4 Pos.5	Poor
12	300	Clad aluminum scratched by Nylatron	Fig.9 Pos.1	Godd
13	300	Clad aluminum in excellent condition; Dacron fabric is only slighty worn.	Fig.9 Pos.2	Excellent
14	300	Clad aluminum slighty scratched	Fig.9 Pos.3	Good
15	300	Clad aluminum slighty scratched	Fig.9 Pos.4	Good
16	300	In all three of these cases, the wear occured on the fiberglass laminate . Clad aluminum not worn.	Fig.9 Pos.5	Good
17	300		Fig.9 Pos.6	Good
18	300		Fig.9 Pos.7	Good
19	100	Discontinued after 100 hours because of wear and galling	Fig.5 Pos.8	Poor
20	200	Galling	Fig.9 Pos.8	Poor

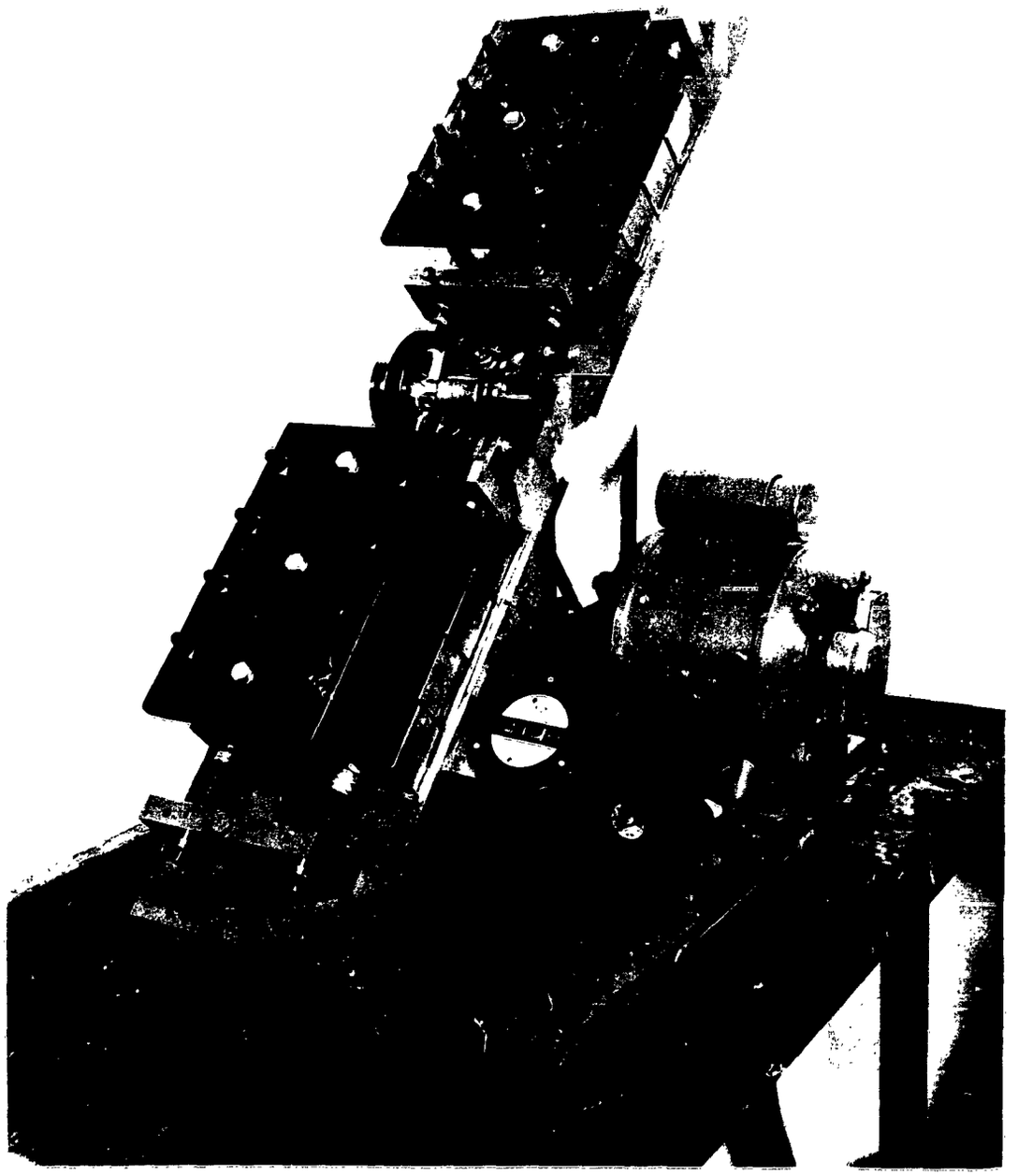

FIGURE 1

FAYING SURFACE ABRASION TEST JIG

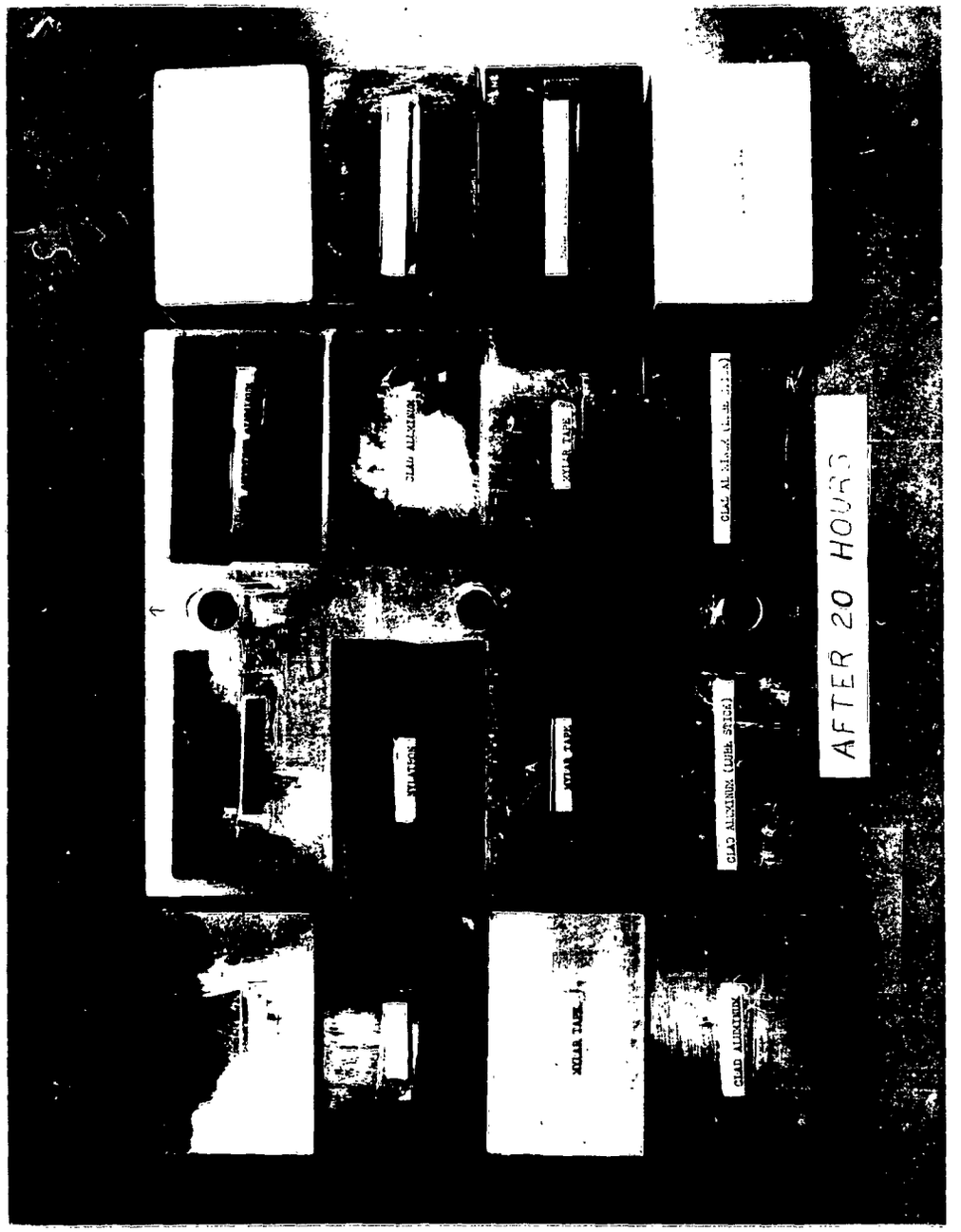

FIGURE 2
CONDITION AFTER 20 HOURS

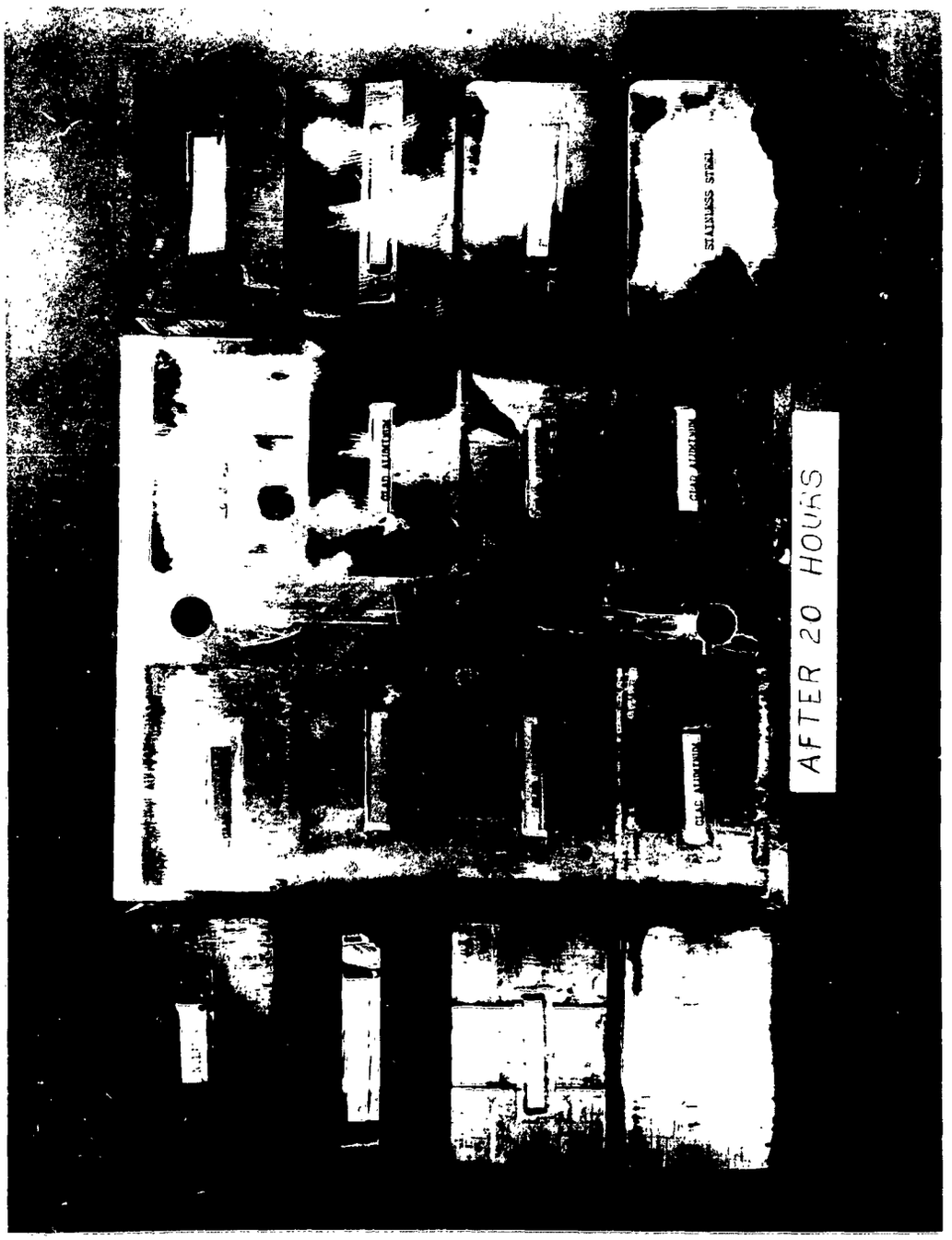

FIGURE 3
CONDITION AFTER 20 HOURS

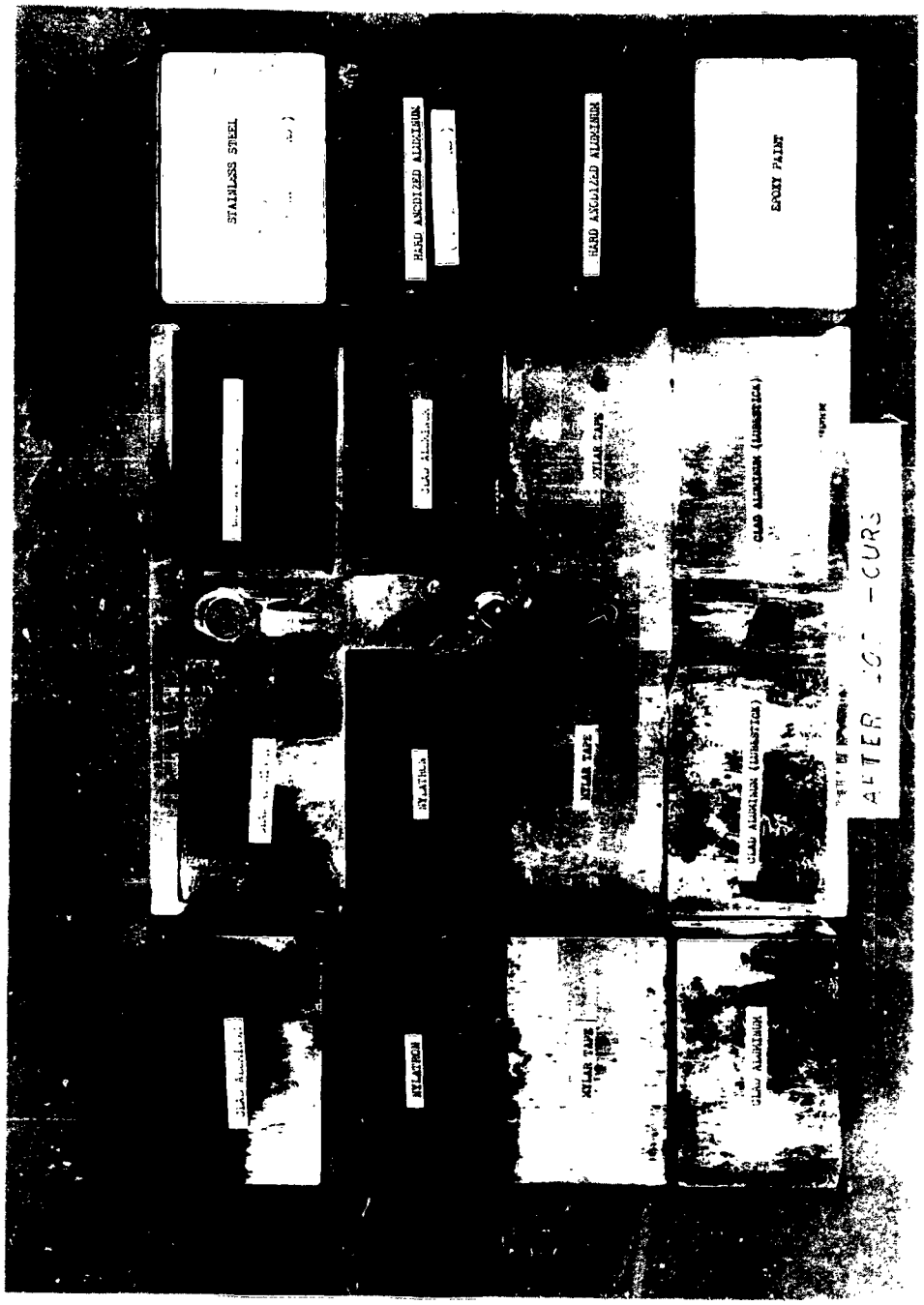

FIGURE 4
CONDITION AFTER 100 HOURS

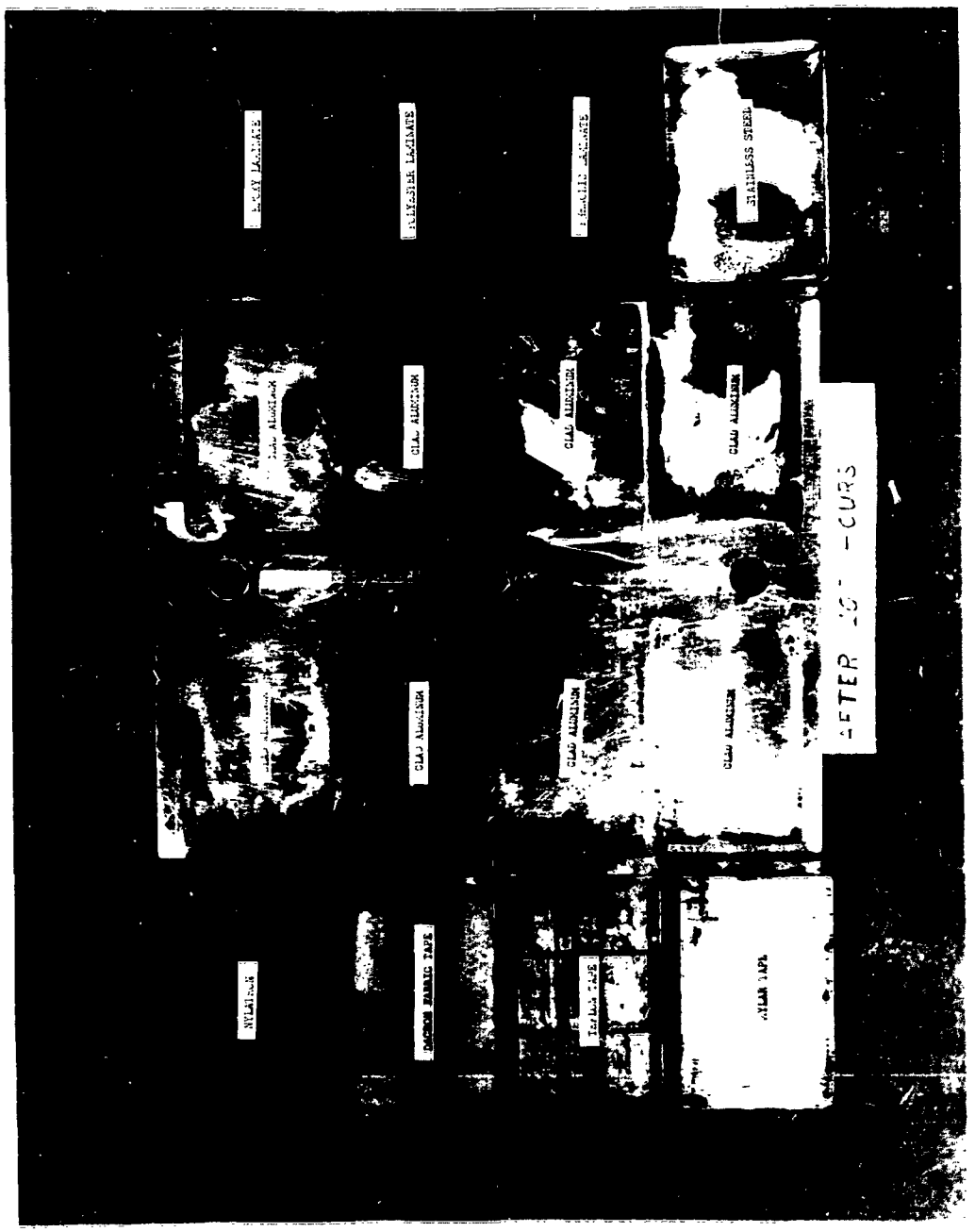

FIGURE 5
CONDITIONS AFTER 100 HOURS

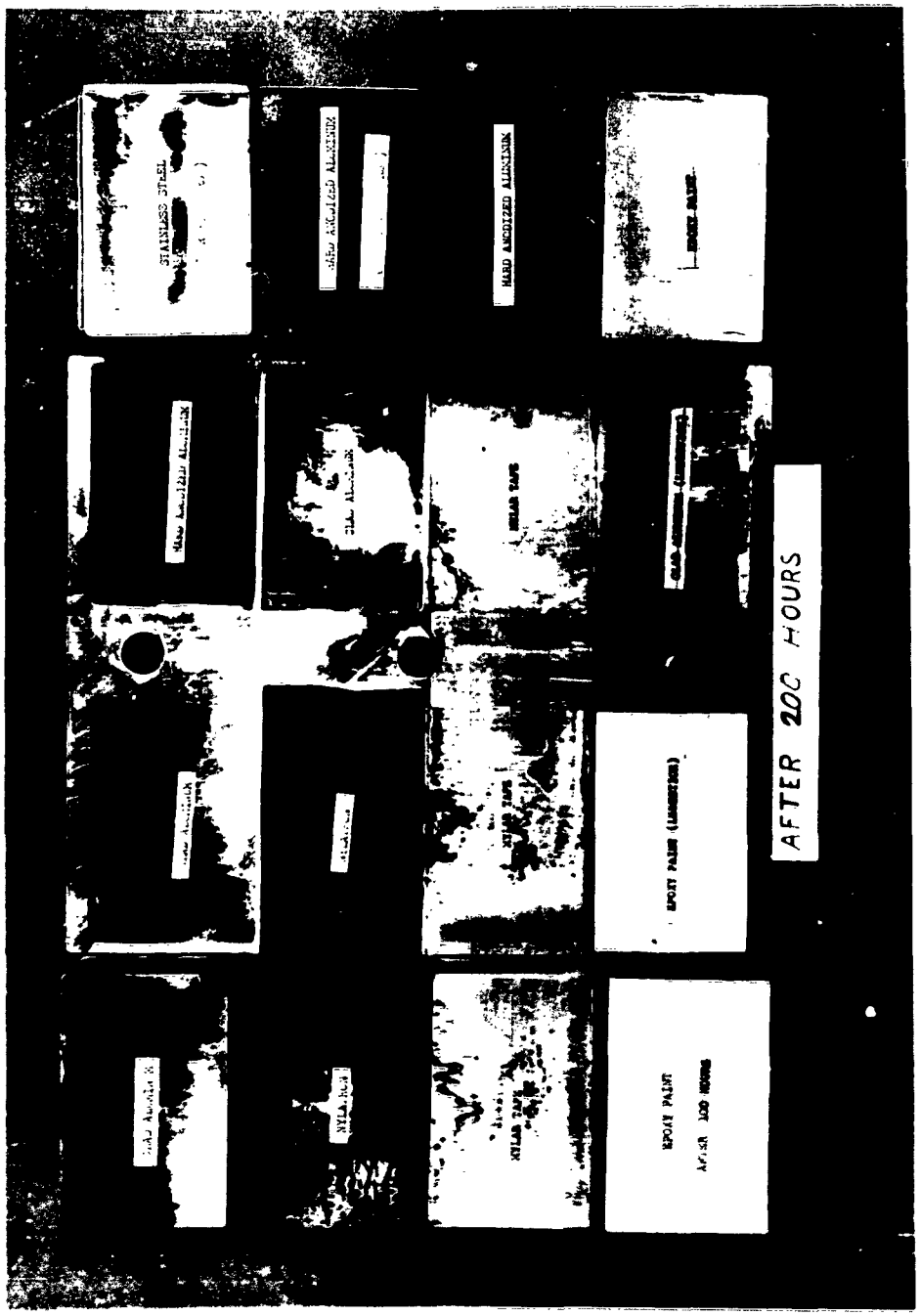

FIGURE 6
CONDITION AFTER 200 HOURS

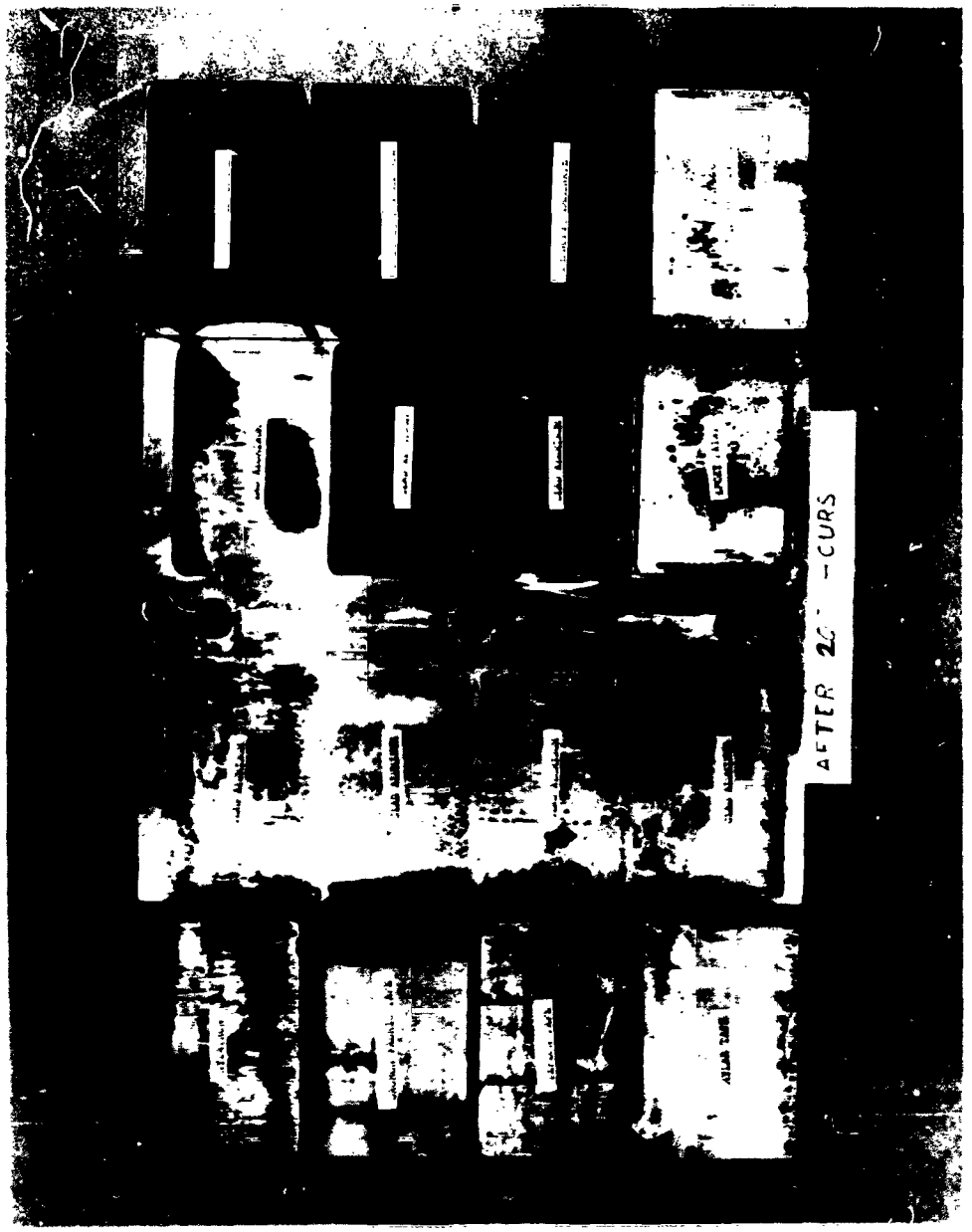

FIGURE 7

CONDITION AFTER 200 HOURS

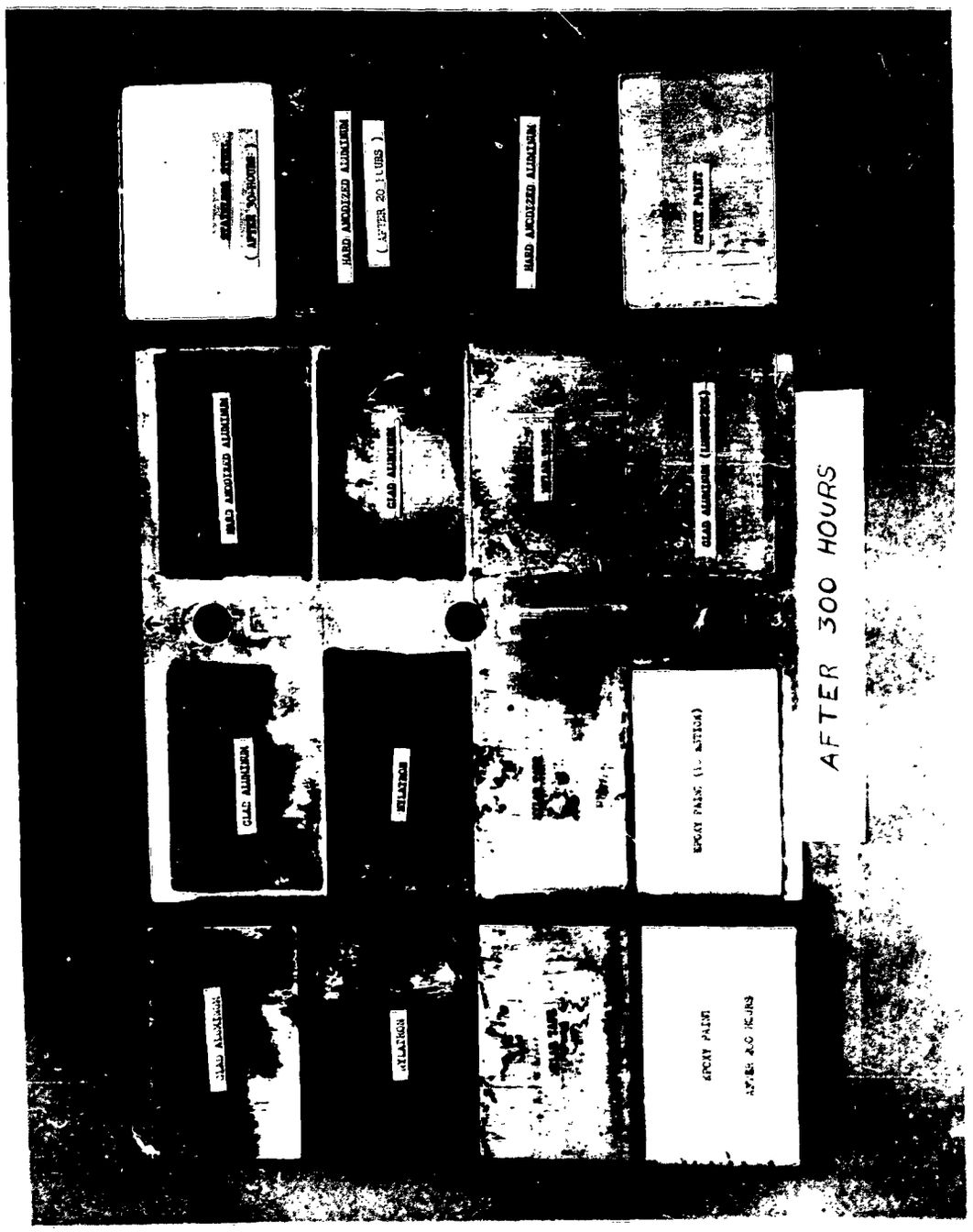

FIGURE 8
CONDITION AFTER 300 HOURS

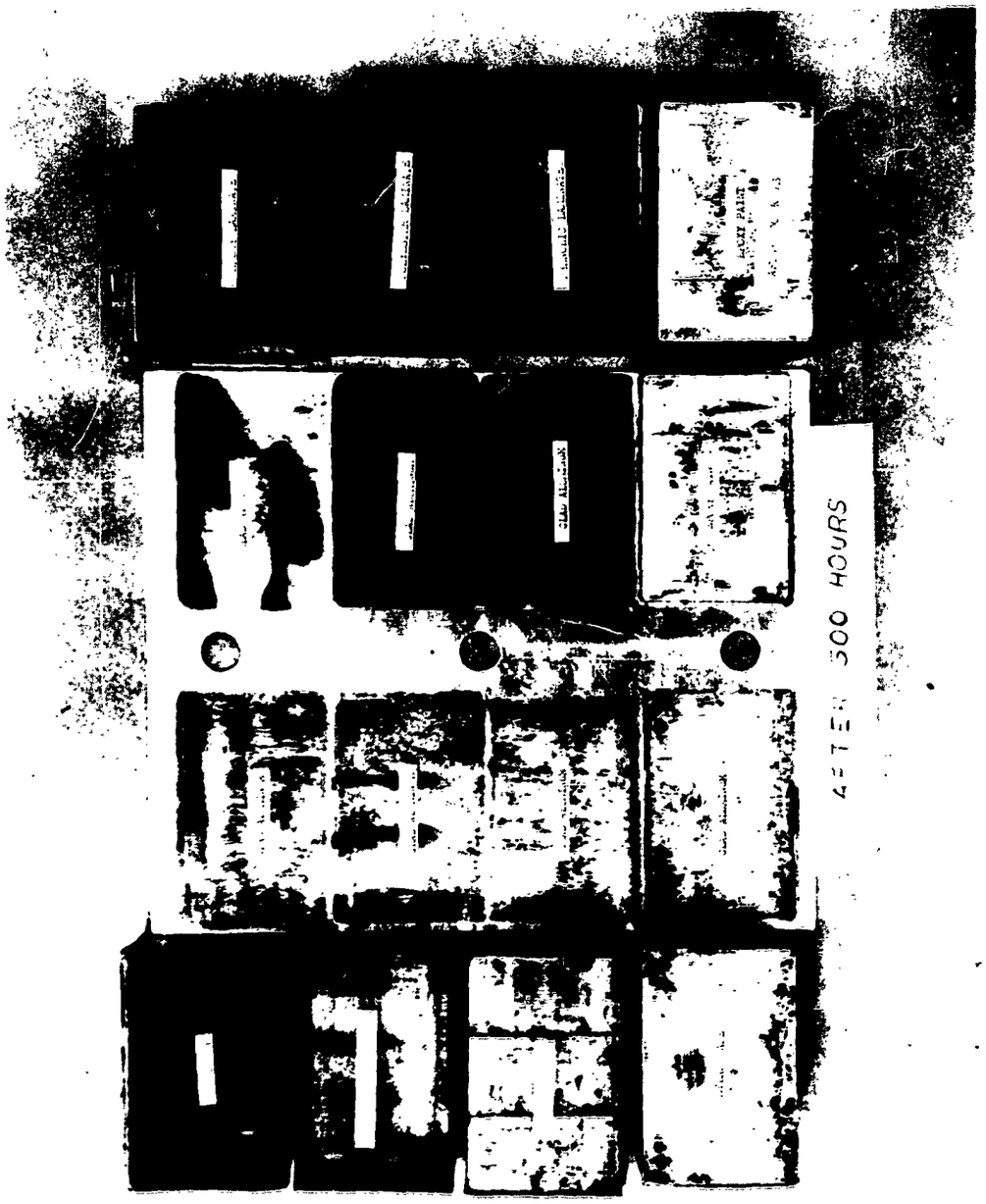

FIGURE 9
CONDITION AFTER 300 HOURS