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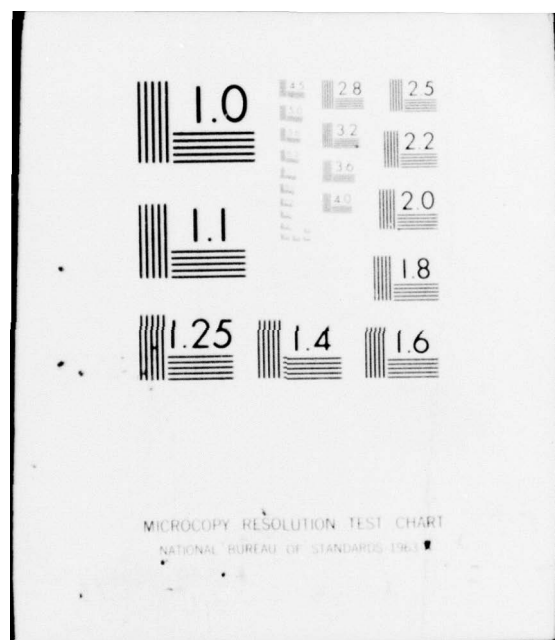
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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36362

STEBG-TD

SUBJECT: Letter Report of Product Improvement Test of Mast,
P/N 204-040-366-7, in the UH-1D Helicopter, USATECOM
Project No. 4-5-0151-04

TO: Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-BG
Aberdeen Proving Ground, Maryland 21005

1. References.

- a. Message, STEBG-ENTP 1-13, President, US Army Aviation Test Board, 10 January 1963, subject: "YUH-1D Mast Bearings."
- b. Message, AMCPM-IRFO-T-03-13121, Commanding General, US Army Materiel Command, 17 March 1964, subject: "Permission to Operate Mast Assembly on YUH-1D S/N 60-6034 to 1140 Hours."
- c. Message, AMCPM-IRFO-T(A)-11-13123, Commanding General, US Army Materiel Command, 24 November 1964, subject: "Request for Test of Product Improvement Items."
- d. Message, APG 20383, Commanding General, US Army Test and Evaluation Command, 10 December 1964, subject: "Additional Test Items for Installation and Test Under USATECOM Project Number 4-3-0150-16." (Reference Message, AMCPM-IRFO-T(A)-11-13123, Commanding General, US Army Materiel Command, 24 November 1964.)
- e. Plan of Test, "Plan of Test for Product Improvement Test of Mast P/N 204-040-366-7 in the UH-1D Helicopter, USATECOM Project Number 4-5-0151-04," US Army Aviation Test Board, undated.

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Project No. 4-5-0151-04

f. TM 55-1520-211-20, "Organizational Maintenance Manual,
UH-1A/B Helicopter," April 1965.

g. Interim Report, "Continuation of the Logistical Evaluation
of the YUH-1D Helicopter, DA Project Number, None; USATECOM
Project Number 4-3-0150-06," US Army Aviation Test Board, 10 March
1965.

2. Authority.

a. Directive.

(1) Letter, AMSTE-BG, Headquarters, US Army Test and
Evaluation Command, 27 January 1965, subject: "Test Directive,
USATECOM Project Number 4-4-0151-(), Product Improvement Test,
UH-1D."

(2) USATECOM Project Transcript, AMSTE-BG, USATECOM
Project Number 4-5-0151-04, "Mast P/N 204-040-366-7, S/N C9-77,"
4 February 1965.

b. Purpose.

The purpose of this report is

To develop for and provide to the Iroquois Project Manager
the results of operational experience on modified mast assembly, P/N
204-040-366-7, S/N C9-77, relative to its suitability.

3. Background.

a. The established time between overhaul (TBO) of the standard
mast assembly, P/N 204-040-366, was 300 hours due to a history of
excessive wear of the main mast bearing. Action was taken to modify
main mast bearings to reduce bearing wear and increase the TBO of the
mast assembly. The manufacturer modified the mast assembly by
incorporating hardened steel (M-50) ball bearings in the main mast
bearing. The modified mast assembly (P/N 204-040-366-7) is the test
item for this report. This test item was operated for a total of 1239
flight hours during the conduct of the YUH-1D logistical evaluation test.

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The test item was removed at the completion of 1239 hours and the mast bearing was analytically inspected during November and December of 1964. Several discrepancies were found during this inspection; however, the mast bearing was serviceable.

b. For the purpose of continuity, the following are the results of the November/December 1964 inspection of the mast bearing (flight time 1239 hours):

(1) The first ball to the right of the "S/N 10" etched on the cage had a roughness when the ball was pressed away from the center of the cage and rotated. The same condition existed in the ball 180 degrees opposite.

(2) The first, seventh, eighth, and ninth balls to the left of the "S/N 10" etched on the cage had one-to-several discoloration marks. These marks represented minor corrosion; however, no pitting or roughness in the area could be determined. The largest of the marks measured 1/16-inch in diameter.

c. A decision was made to reinstall the test item for further testing with a scheduled inspection 50 hours after installation. The reinstallation of the test item was accomplished on 13 February 1965.

4. Findings.

a. After 54 hours and 40 minutes of additional testing, the test item was removed for the scheduled inspection (total test time 1293.67 hours). During this inspection at the US Army Aviation Test Board, the following were noted with respect to the bearing:

(1) The first ball to the right of the "S/N 10" mark had a line running the entire circumference of the ball. A definite roughness existed at this line. Further visual inspection revealed that most of the balls had this line visible and detectable by touch to varying degrees (photograph 1, inclosure 1). The circumferential line of the balls appears to be a parting line formed during the impression-die-forging.

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(2) The second ball to the left of the "S/N 10" mark had a 3/16-inch long groove or scratch on it (photograph 2, inclosure 1). The groove or scratch could be seen and felt. In addition, grooves or scratches could be seen and felt on several of the other balls (photograph 3, inclosure 1). The grooves or scratches varied in length up to 3/16 inch. They appear to have been caused by metal particles or other foreign materials.

(3) All of these balls had some corrosion marks present. The number of these marks appeared to have increased since the last inspection but not the size. The largest appeared about 1/16-inch in diameter.

(4) The outer race of the bearing had the following marks present (photograph 4, inclosure 1).

(a) A mark perpendicular to the circumference of the race and located 3/4-inch to the left of the "F" in the manufacturer's trademark. This mark was approximately 3/32-inch in length and was located in the center of the outer race.

(b) A mark perpendicular to the circumference of the race and directly under the "a" in the manufacturer's trademark. The mark was 1/32-inch long and was located in the center of the outer race.

(c) A mark perpendicular to the circumference of the race and 5/16-inch to the left of the "U" in "USA." The mark was 1/16-inch long and was located in the center of the outer race.

(5) Spectrographic oil analysis revealed no abnormal metal content.

(6) None of the balls exhibited any roughness in rotation when pressed away from the center of the cage.

b. The bearing was then returned to the manufacturer for inspection and analytical report. The manufacturer forwarded the bearing to the subcontractor for analysis. Following is a list of findings

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and comments provided by the subcontractor and concurred in by the manufacturer:

(1) The corrosion-etched spot of the first ball to the right of the "S/N 10" mark on the cage was unchanged in depth and width since the 1239.0-hour inspection.

(2) The color of the balls had darkened slightly since the 1239.0-hour inspection.

(3) Magnetic-particle inspection revealed the races to be acceptable.

(4) Radial play was 0.0105 inch at the 1239.0-hour inspection. It had progressed to 0.0108 inch at the 1293.67-hour inspection. The maximum allowable radial play is 0.0120 inch.

(5) The end play at the 1239.0-hour inspection was 0.0340 inch. It had progressed to 0.0344 inch at the 1293.67-hour inspection. The maximum allowable end play is 0.040 inch.

(6) The bores of the inner rings showed some fretting wear. The inner bores showed over-maximum blueprint dimension of +0.000050 to +0.00025 inch. The blueprint dimensions are $4.3302^{+0.0005}_{-0.0000}$.

(7) The matter of the worn bore should be considered before using the bearing other than in a test rig.

c. Reference the discrepancy reported in paragraph 4a(1) above. The manufacturer stated that they were unable to determine whether the balls were formed by impression-die-forging or skew rolling since the subcontractor considered this proprietary information. The detection of this line by feel was an abnormality which was not mentioned in the manufacturer's report.

d. The discrepancies reported in paragraphs 4a(2) and 4a(4) above were not mentioned in the manufacturer's report.

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e. As a result of the above findings, the mast bearing (S/N 10) is considered unserviceable for further testing in an aircraft.

5. Conclusions.

It is concluded that: (1)

a. The mast assembly incorporating the M-50 mast bearing is suitable for use on the UH-1 helicopter; (2)

b. The test mast bearing (S/N 10) is unserviceable for further flight testing; (3)

c. Further test data are required before an operating period beyond 1100 hours can be established. and (4)

d. The TBO of the mast assembly (1100 hours) currently authorized by TM 55-1520-211-20, dated April 1965, is valid. ✓

6. Recommendations. It is recommended that:

a. The retirement of the bearing assembly remain at 1100 hours.

b. The helicopter manufacturer be requested to perform a further study of the test bearing assembly, S/N 10, to determine whether the discrepancies not noted by the manufacturer's report (such as the feel-detectable circumferential lines and scratches or grooves on the balls) are characteristic of a design deficiency and that the cause of the discrepancies be determined.

c. Additional samples be flight tested beyond 1100 hours prior to extending the present TBO.

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RAYMOND E. JOHNSON
Colonel, Artillery
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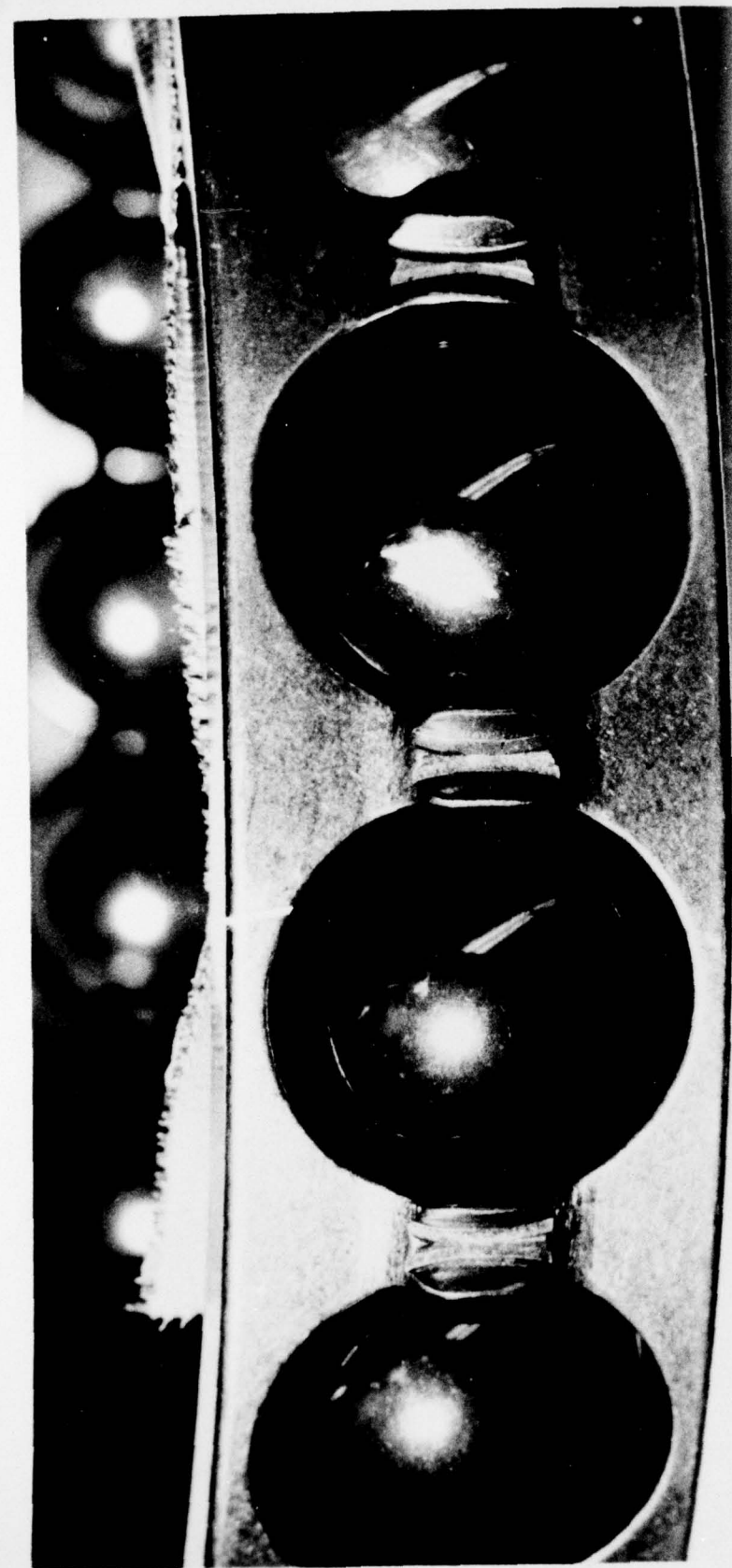
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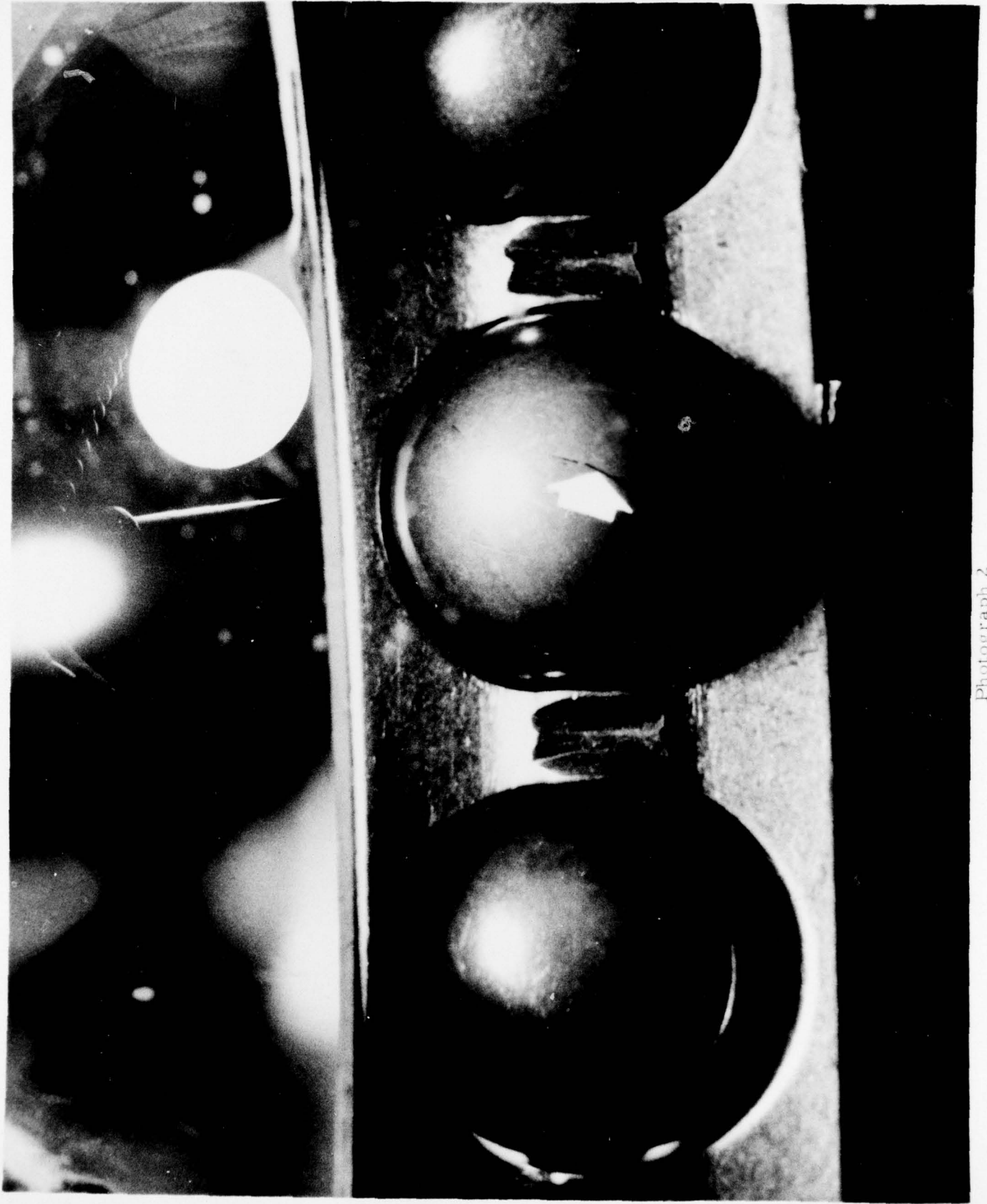
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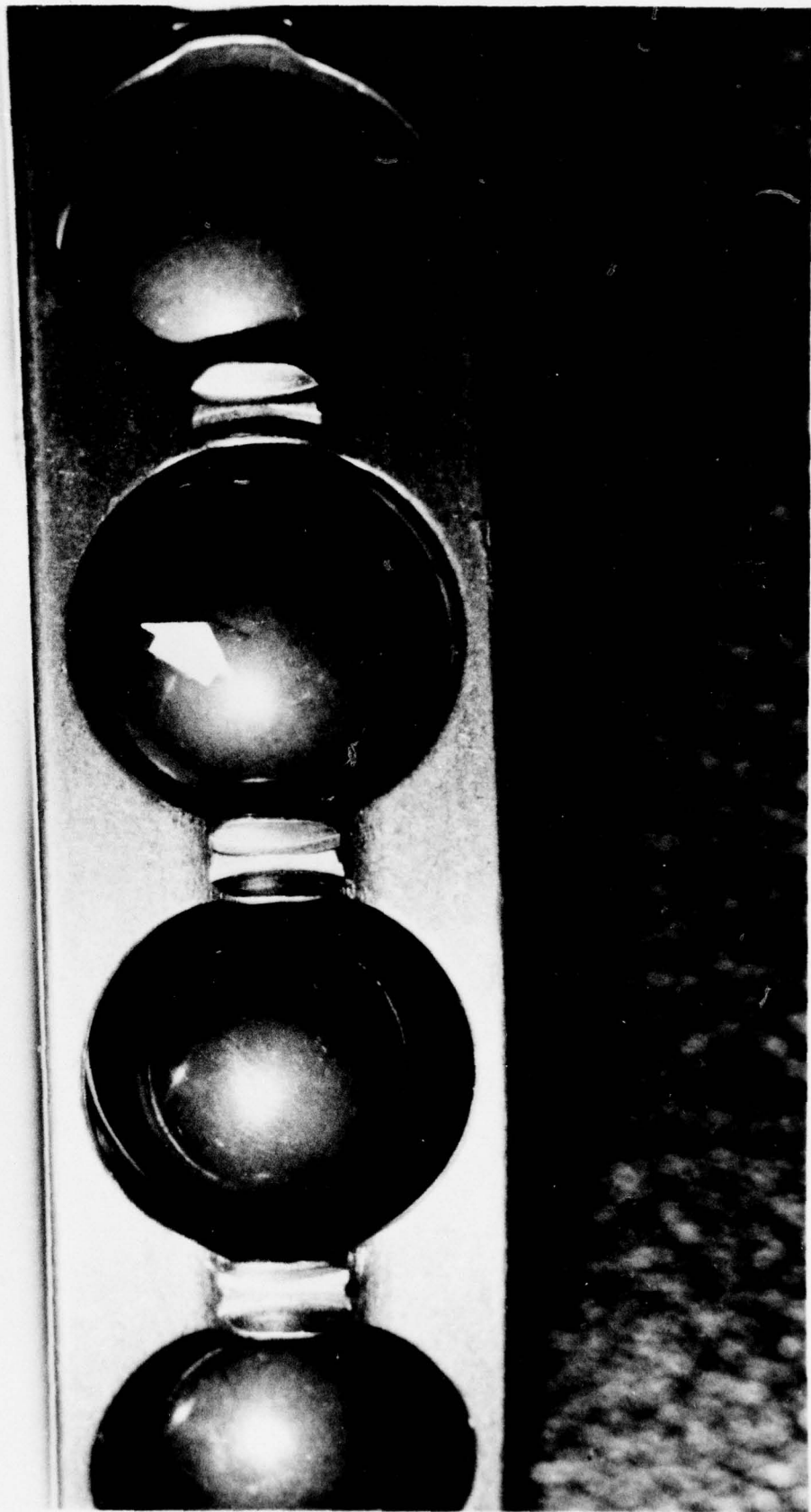
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Photograph 1



Photograph 2



Photograph 3



Photograph 4

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