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Flowserve Corporation
Anchor/Darling Valves
Edward Valves

November 10, 2022

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: 10 CFR Part 21 Report – 38878-8 Solenoid Valve at Duke, Catawba
Flowserve Evaluation #105

Flowserve Corporation hereby submits the enclosed written notification of the identification of a defect, in accordance with the requirements of 10 CFR 21.21(d)(3)(ii). This notification pertains to the failure of the solenoid valve (model 38878-8) at Duke, Catawba.

Sincerely,

DocuSigned by:
Thomas "Kayn" Dills
Thomas "Kayn" Dills
Quality Manager
Flowserve Corp, Flow Control Division
1900 S. Saunders St.
Raleigh, NC 27603

Enclosures:
1. Plants / customers potentially impacted
2. Reportable condition per 21.21(d)
3. Description of Evaluation

cc:

Hylton Kipe – Director, Flowserve Plant Manager
Matt Hobbs – Flowserve Engineering Manager
Chuck Dowd – Director, Global Sales

✓	RC	Reportable Condition
	NC	Not Capable (§21.21(b))

Enclosure 1:
List of Plants / Customers potentially Impacted:

- Duke – Catawba
- Luminant – Comanche Peak
- Exelon – Byron
- Exelon – Braidwood
- NextEra Energy - Seabrook

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Enclosure 2: Reportable Condition per 21.21(d)

10 CFR 21 REPORT

38878-8 Solenoid Valve at Duke, Catawba

1. **Name and address of the Individual or individuals informing the Commission**

   Kayn Dills
   Quality Manager
   Flowserve Corp, Flow Control Division
   1900 S. Saunders St.
   Raleigh, NC 27603

2. **Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which contains a defect or noncompliance.**

   Duke Energy Carolinas, LLC (Duke Engergy)
   Catawba Nuclear Station

3. **Identification of the firm construction the facility or supplying the basic component which fails to comply or contains a defect**

   Flowserve Corp, Flow Control Division
   1900 S. Saunders St.
   Raleigh, NC 27603

4. **Nature of the defect or failure to comply and the safety hazard to which Is created or could be created by such defect or failure to comply.**

   The solenoid valve received by Duke Energy failed to shuttle position when the coil was initially energized. This solenoid valve is part of the feedwater isolation valve assembly and failure to shuttle will prevent the feedwater isolation valve from closing on demand.

5. **The date on which the information of such defect or failure to comply was obtained.**

   Flowserve was initially notified on September 11, 2022. Flowserve provided response to Duke (see Enclosure 4 of this report) on September 15, 2022 to confirm that Flowserve would perform the evaluation within 45 days upon receipt of the solenoid valve. Flowserve received the solenoid valve for evaluation on October 5, 2022.

6. **In the case of a basic component which contains a defect or failure to comply, the number and location of these components in use at, supplied for, being supplied for, or may be supplied for, manufactured, or being manufactured for one or more facilities or activities subject to the regulations in this part.**

   The solenoid valves have been provided to various domestic nuclear plants with a known list contained within Enclosure 1 of this report.

7. **The corrective action, which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and length of time that has been or will be taken to complete the action.**

   See Enclosure 3 of this report. Flowserve will (1) revise the assembly and test procedure for the Model 38878 solenoid valve to add a final test after the thread lock component has been applied and been allowed to cure to verify the solenoid valve shifts when energized, and (2) provide training to assembly and test personnel on the importance of ensuring that excess thread lock compound has not been applied.

   These actions will be completed by December 15, 2022.

8. **Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.**

   See Enclosure 3 of this report. Nuclear power plants with model 38878 solenoid valves that have not undergone acceptance testing should verify that these suspect solenoid valves will shift on demand when energized.

9. **In the case of an early site permit, the entities to whom an early site permit was transferred.**

   Not applicable.

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Valtek Control Products
Worcester Valves

Enclosure 3: Description of Evaluation

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Failure Analysis of 38878-8 Solenoid Valve
Duke – Catawba
Serial Number BT443

Complaint:
During pre-outage checks of a replacement solenoid for our feedwater isolation valve (Model 38878-8), technicians identified that a solenoid (S/N# BT 443) failed to shuttle when initially energized. While investigating the issue the solenoid was electrically cycled multiple times without shuttling of the spool piece. It was left continuously powered for approximately 10 minutes when it did finally shuttle. After this initial shuttle the SOV was shuttling when demanded but due to the suspect operation, the customer considered it unusable. Serial number BT443 solenoid valve was assembled and tested on June 6, 2016, as part of SO 115795, line item 001, Duke Purchase Order 03014228-REV.001.
This solenoid valve is part of the actuator for the Feedwater Isolation Valve. Failure of this solenoid valve to shift when energized could result in the actuator not being able to close the Feedwater Isolation Valve.

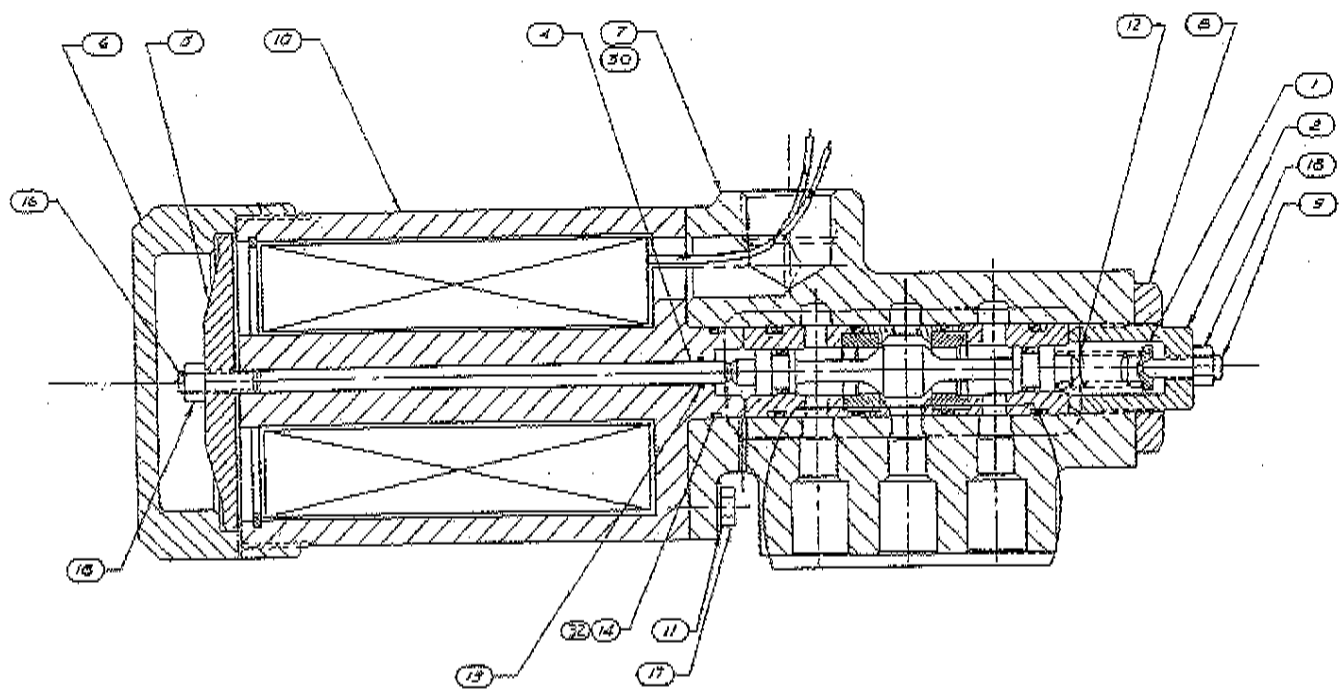

Figure 1: Solenoid Cross-Section View

As Received Condition:
10/27/2022:
Serial Number: BT443
Coil Resistance: 293.6 ohms
Initial Visual Inspection: Verified solenoid valve serial number. The solenoid appears to have not been installed and was in like new condition. Tamper evident paint on fasteners was intact.

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Test per MS-9792, Functional Test Procedures for 38878 Solenoid Valves:

Para.	Description	U/M	Min	Max	Recorded Value
6.3.2.5	Seat Leakage Test, De-energized	Drop/10 Minutes	0	1	0
6.3.2.6	Seat Leakage Test, Energized	Drop/10 Minutes	0	1	0
	Solenoid valve shifted on demand with no delay.				
6.3.2.8	Steady State Current, Energized @125 +/- 5 VDC	Amps	0.37	0.45	0.38
6.4	External Leakage Test			ZERO	0
Removed End Cap (6) from Coil Assembly (10). Evidence of excess thread lock compound observed on threads of End Cap (6) and the Coil Assembly (10). Evidence of excess thread lock compound observed on the Coil Cap (5).					
6.2.4.3	Gap between Coil Cap (5) and Coil Assembly (10) Measurement	Inches	0.0025	0.0035	Not Measurable
	Excess thread lock compound on bottom of Coil Cap (5) and top of Coil Assembly (10) probably caused this discrepancy.				

Removed Coil Assembly (10) from solenoid valve for inspection. Since the solenoid valve passed acceptance testing, further disassembly of the solenoid valve was considered unnecessary.

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End Cap (6): Visual inspection showed no signs of damage. Excess thread lock compound observed on threads and internal surfaces.

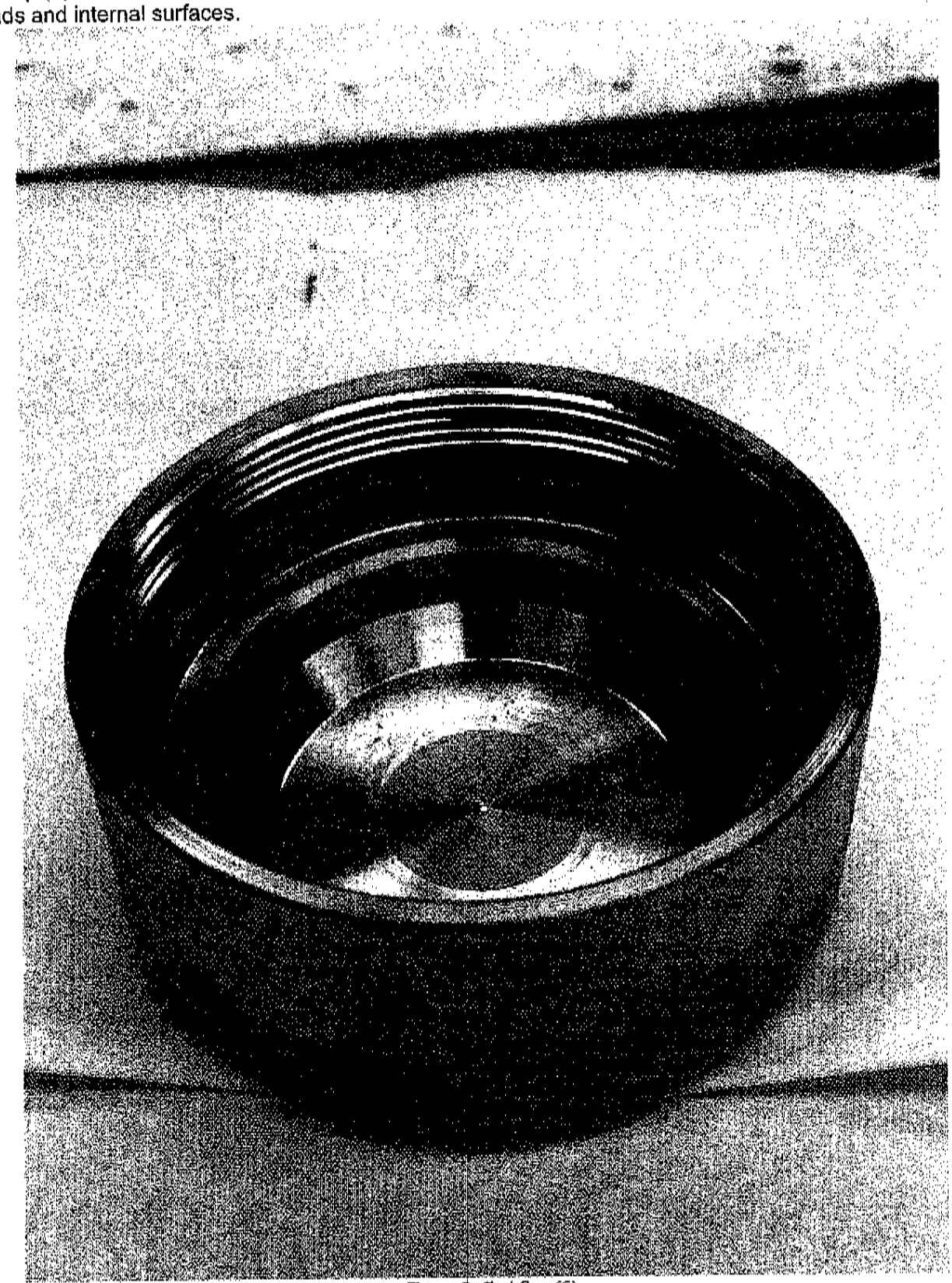

Figure 2: End Cap (6)

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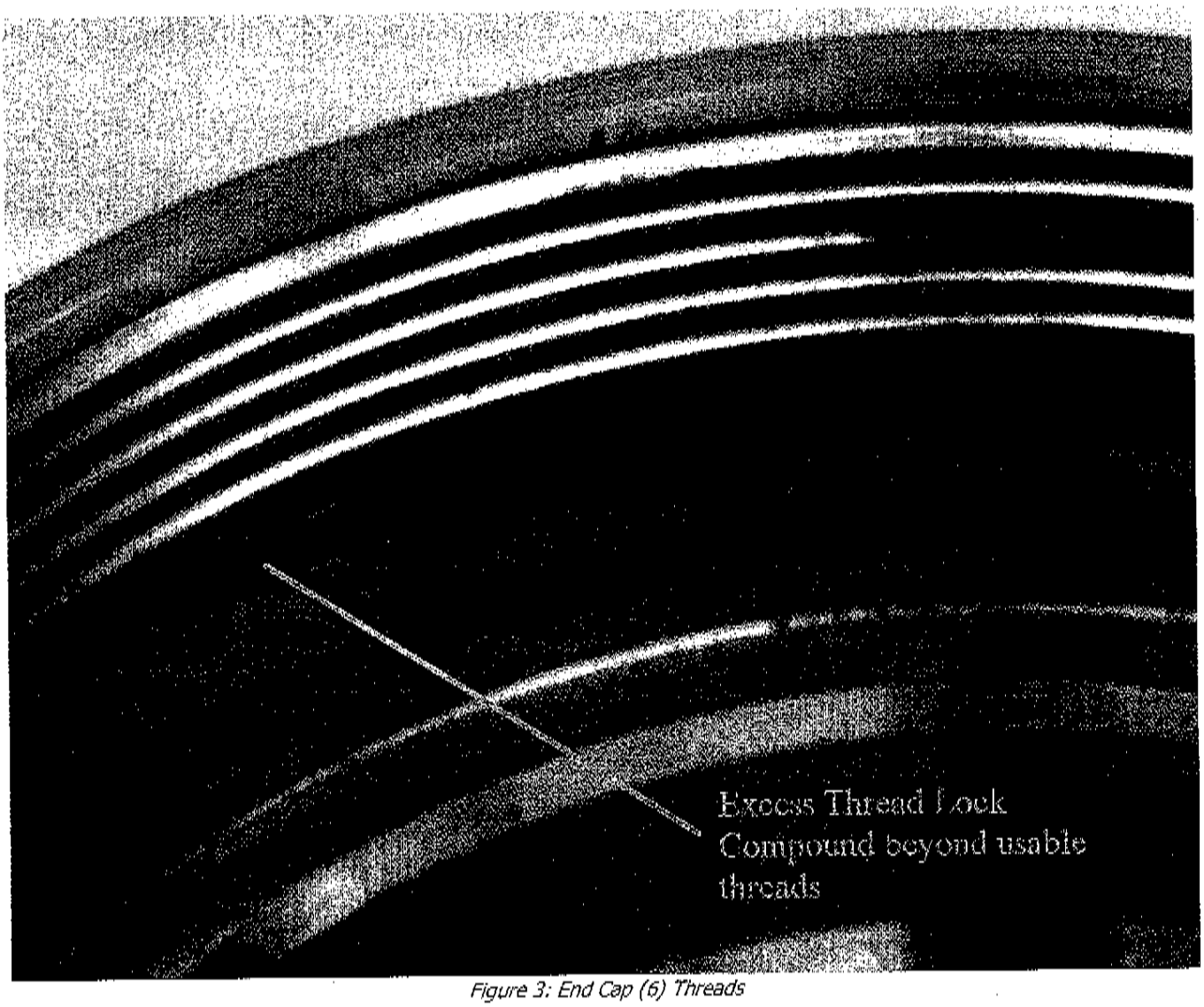

Figure 3: End Cap (6) Threads

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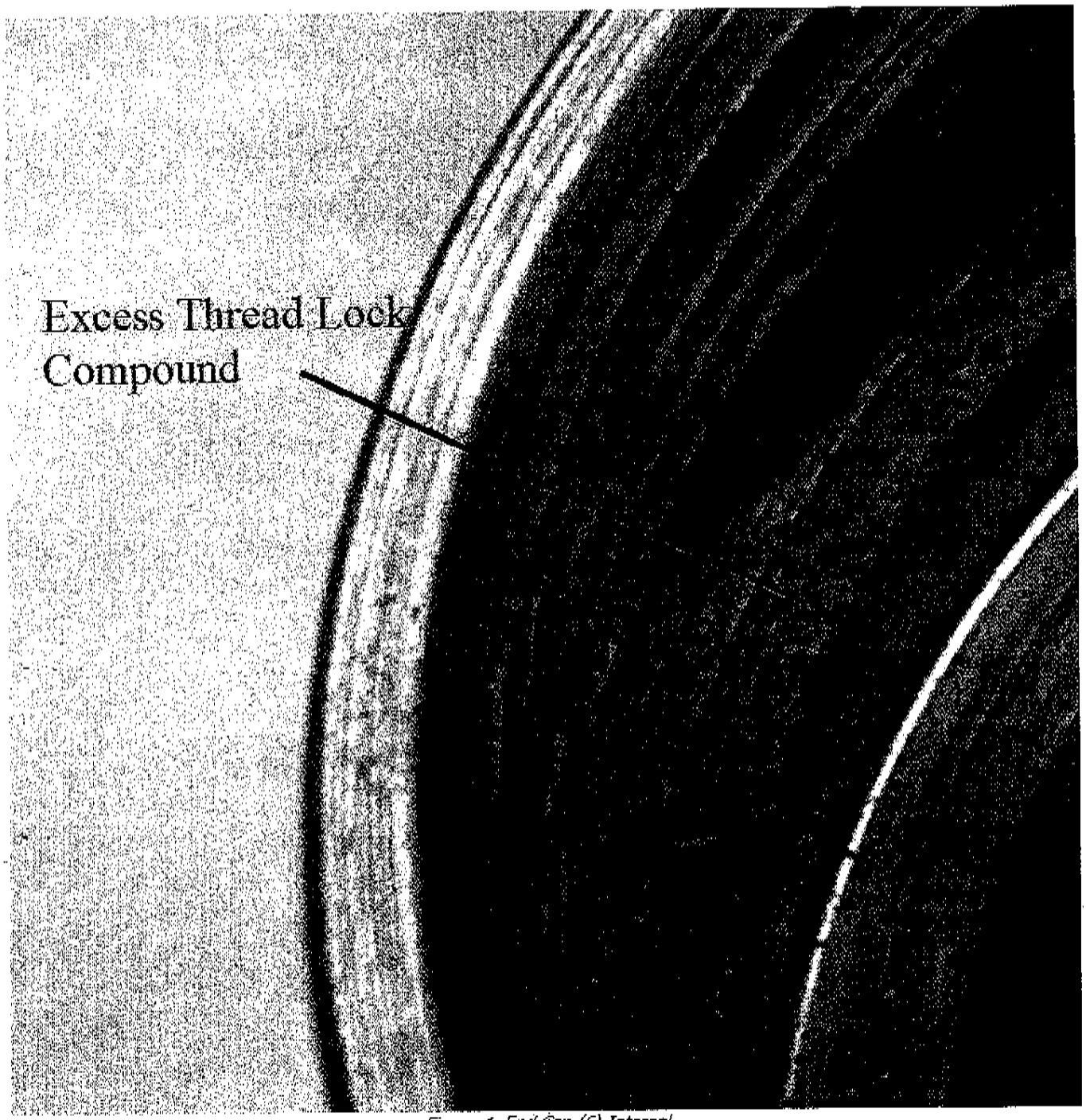

Figure 4: End Cap (6) Internal

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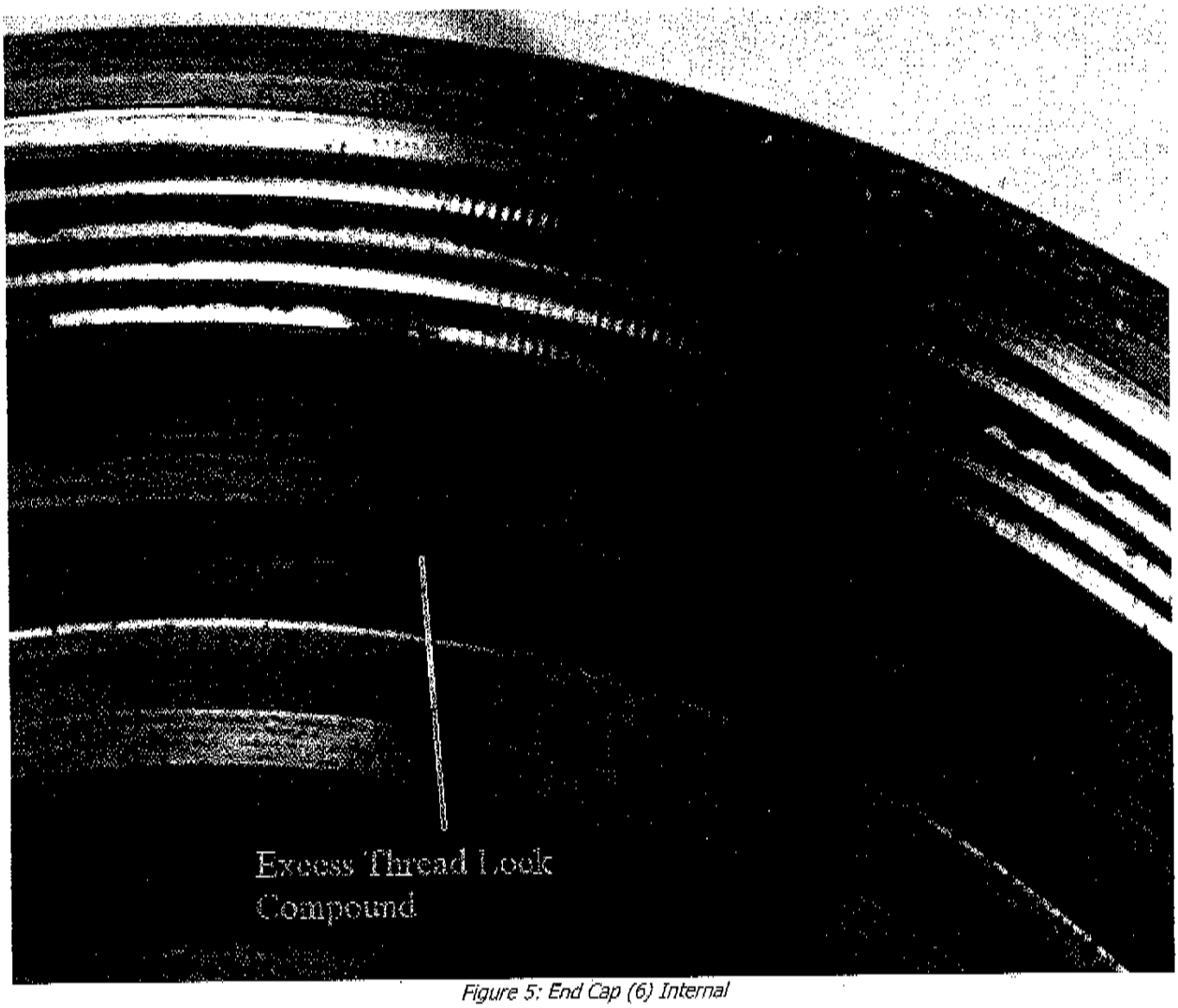

Figure 5: End Cap (6) Internal

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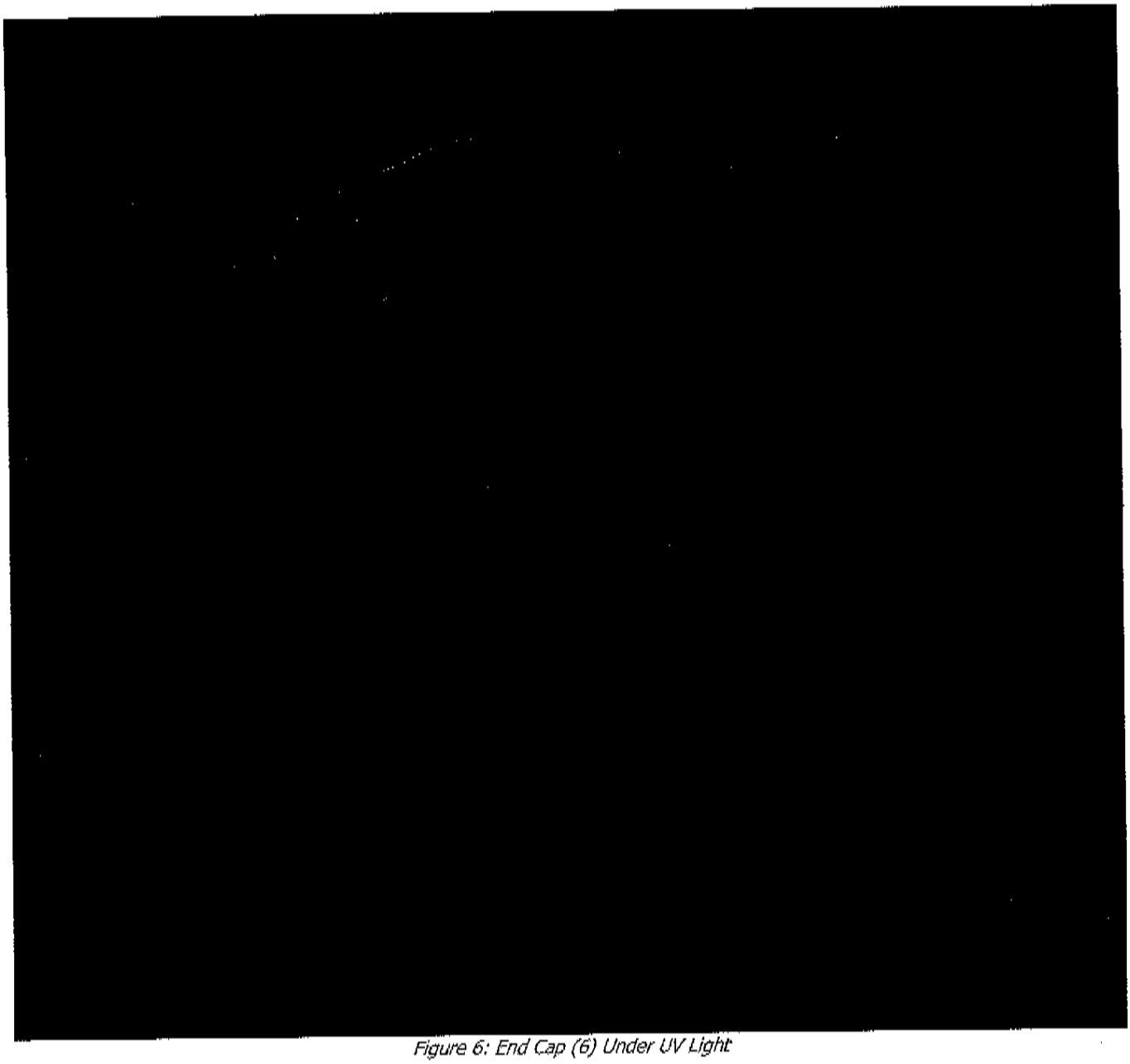

Figure 6: End Cap (6) Under UV Light

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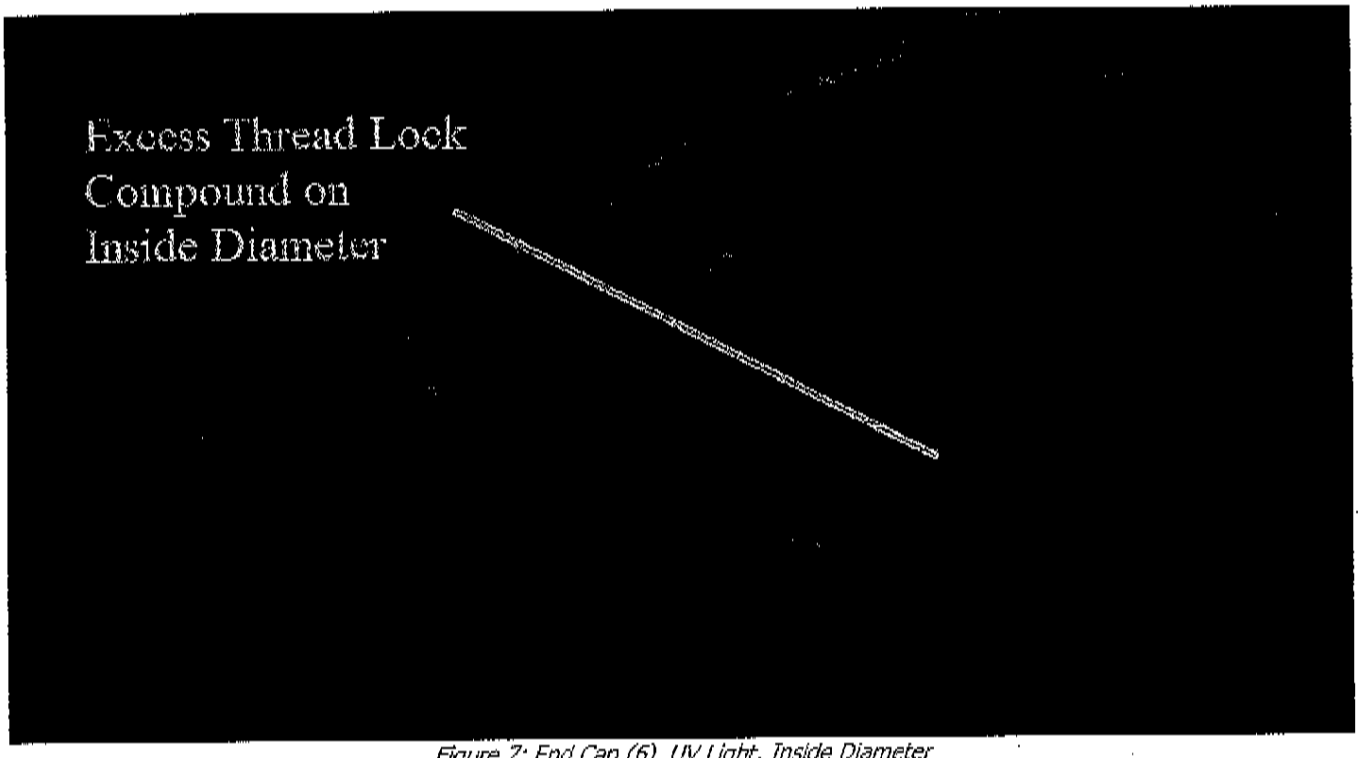

Figure 7: End Cap (6), UV Light, Inside Diameter

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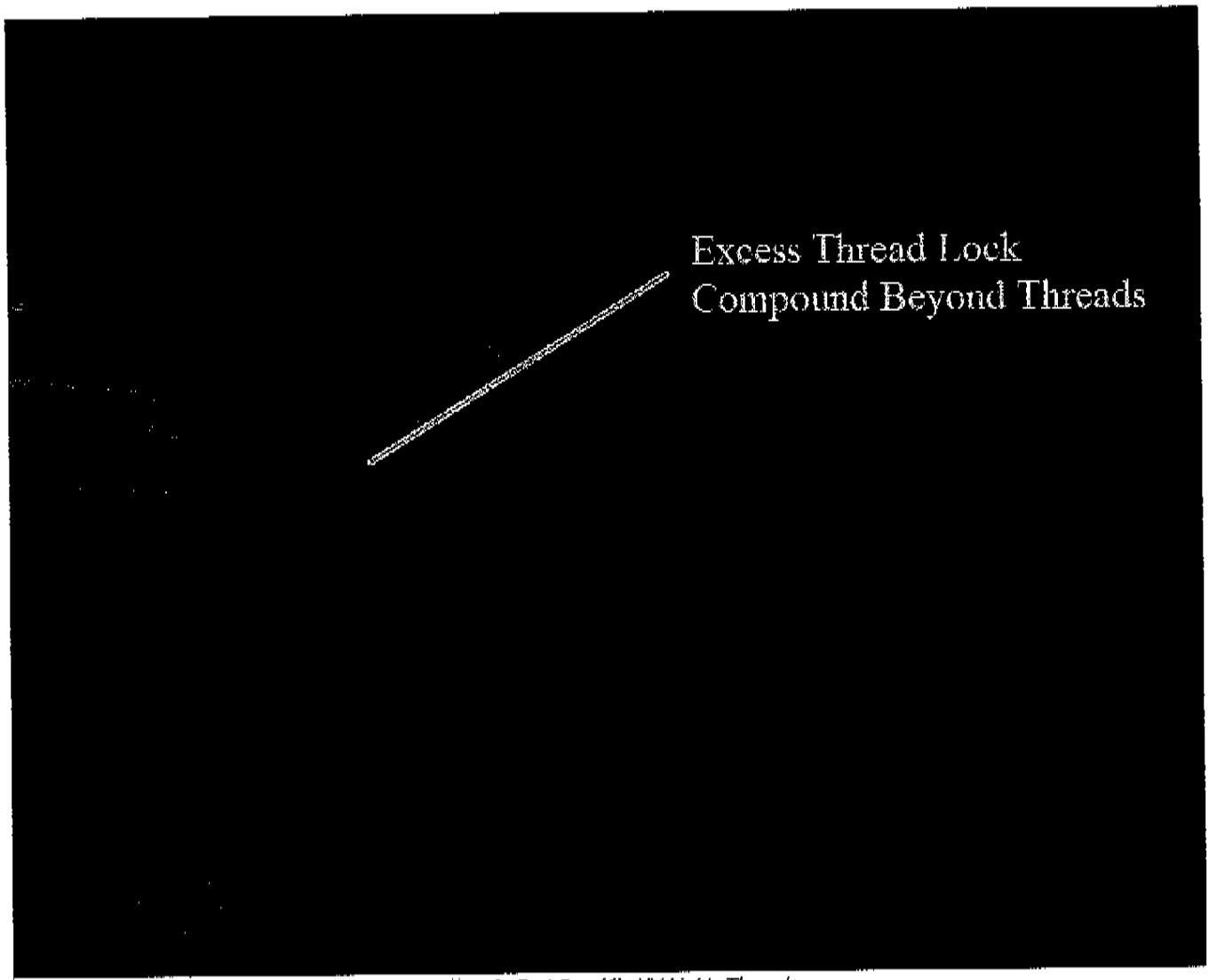

Figure 8: End Cap (6), UV Light, Threads

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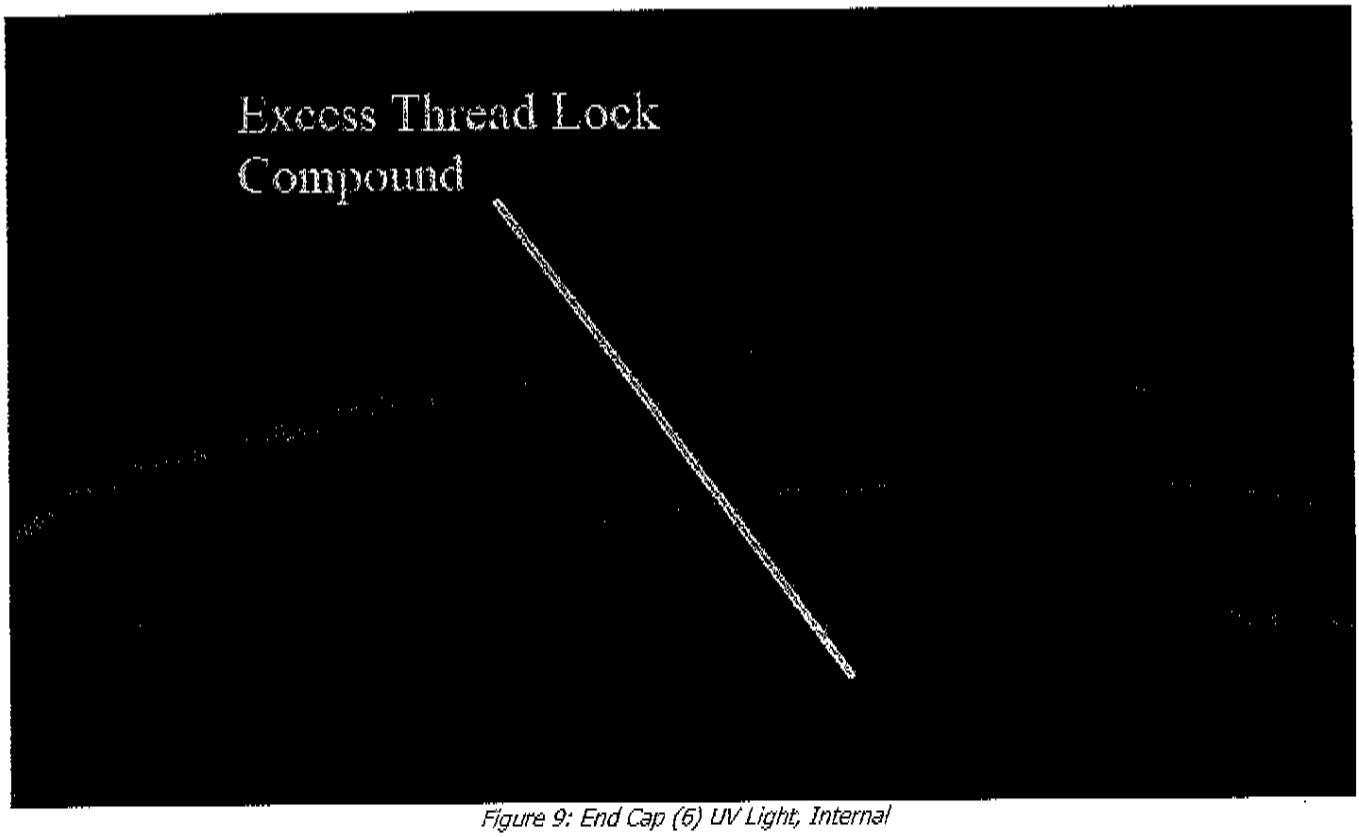

Figure 9: End Cap (6) UV Light, Internal

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Coil Cap (5): Visual inspection showed no signs of damage. Excess thread lock compound observed on top, bottom near the outside diameter and side.

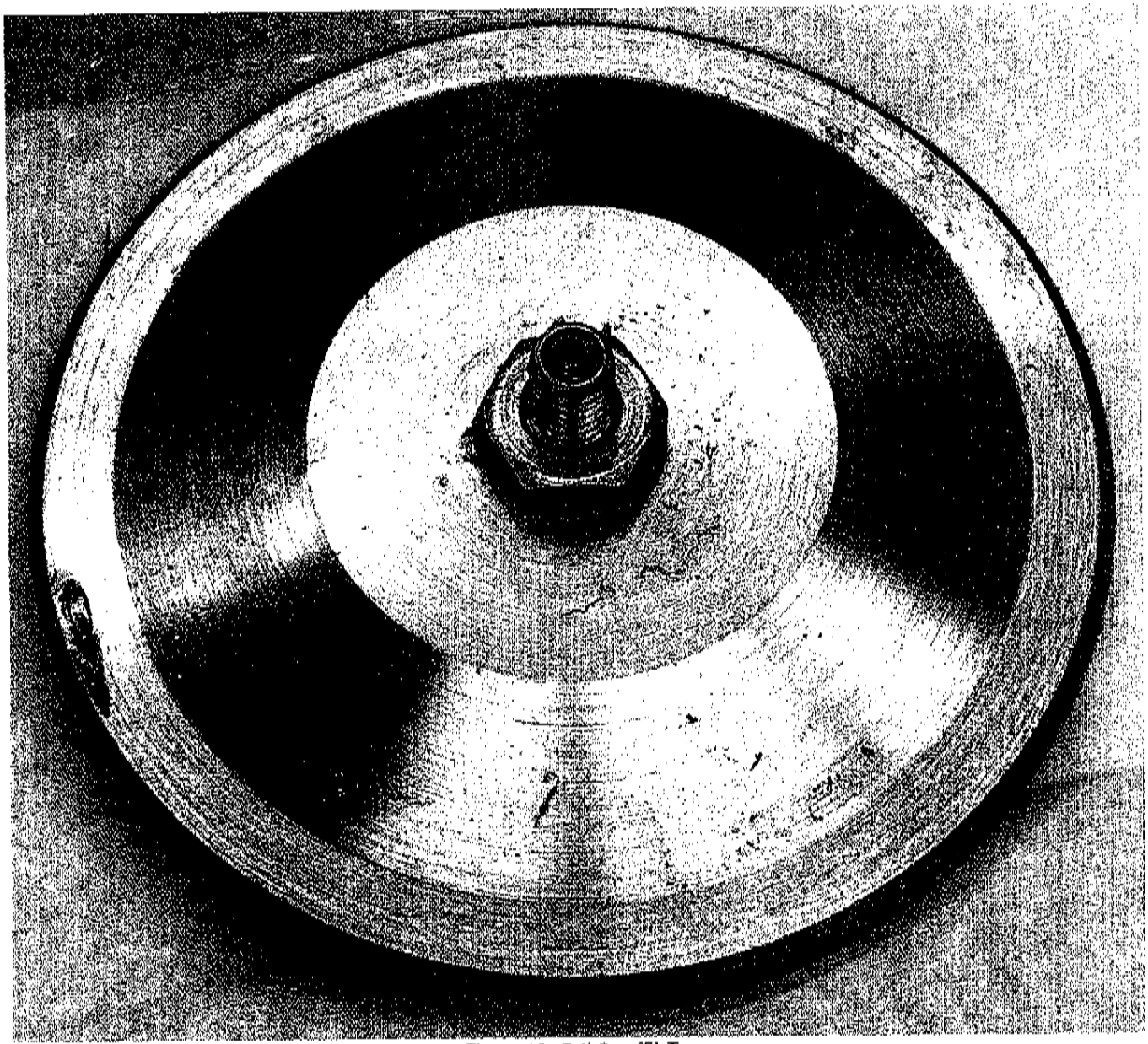

Figure 10: Coil Cap (5) Top

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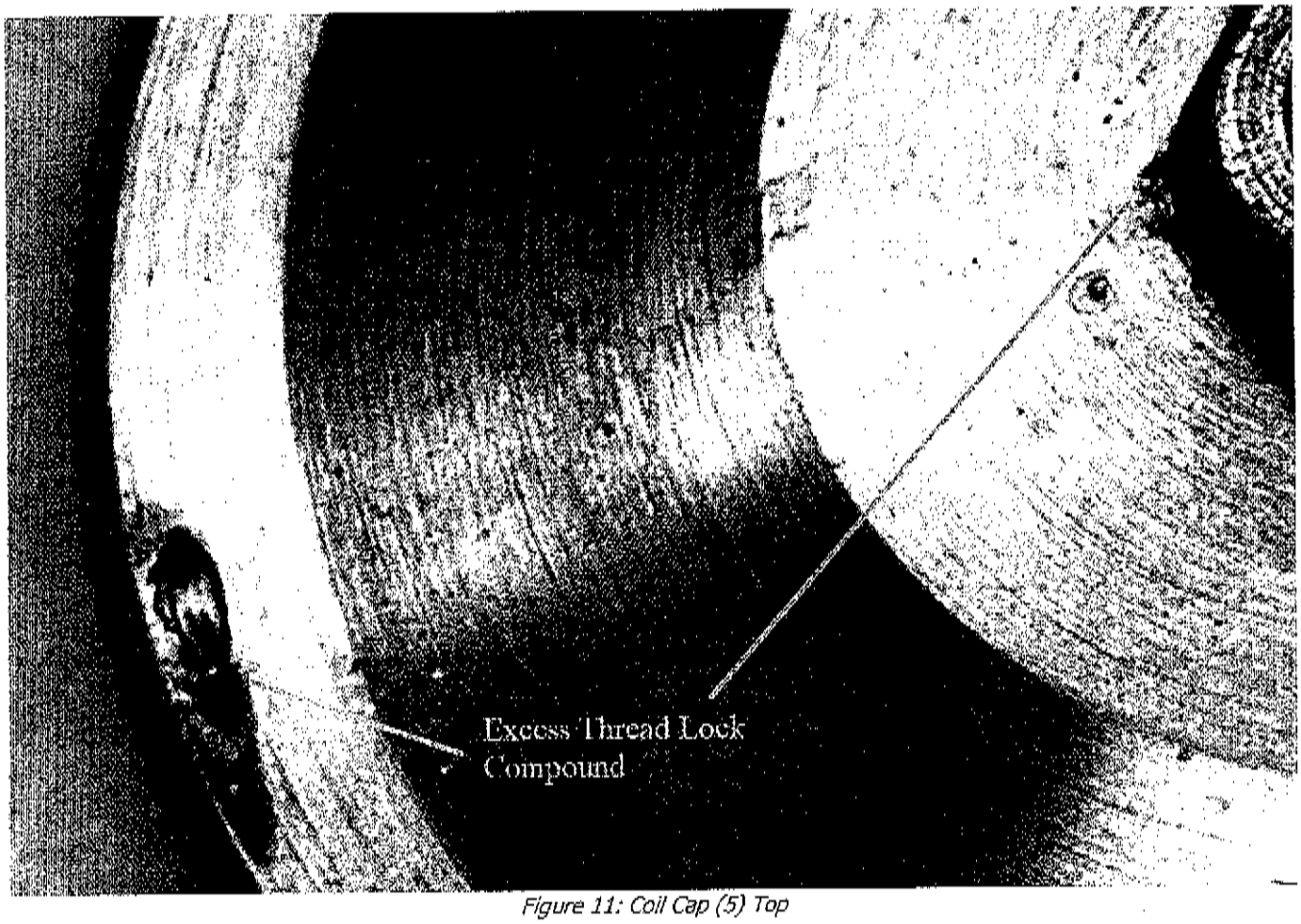

Figure 11: Coil Cap (5) Top

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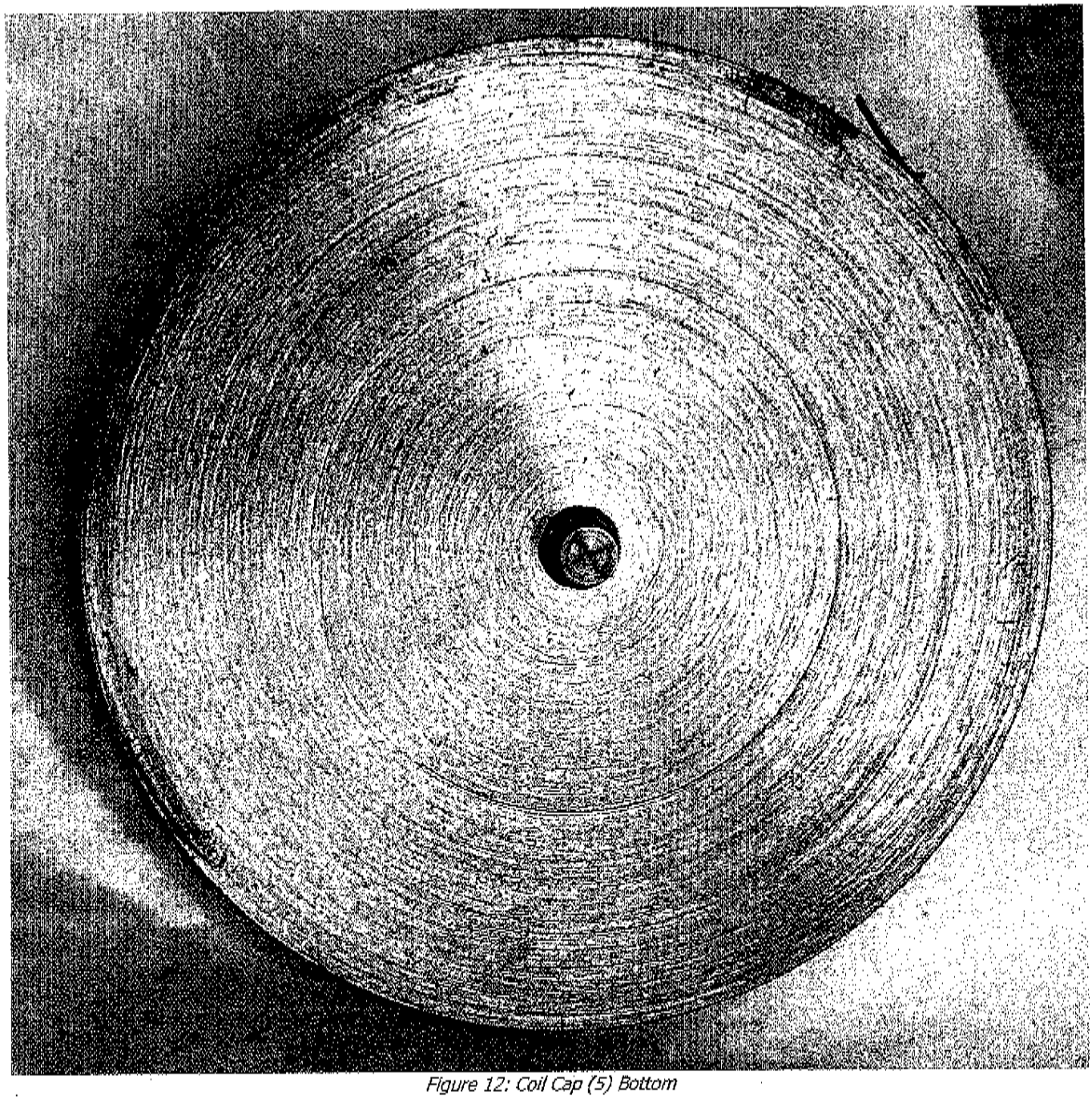

Figure 12: Coil Cap (5) Bottom

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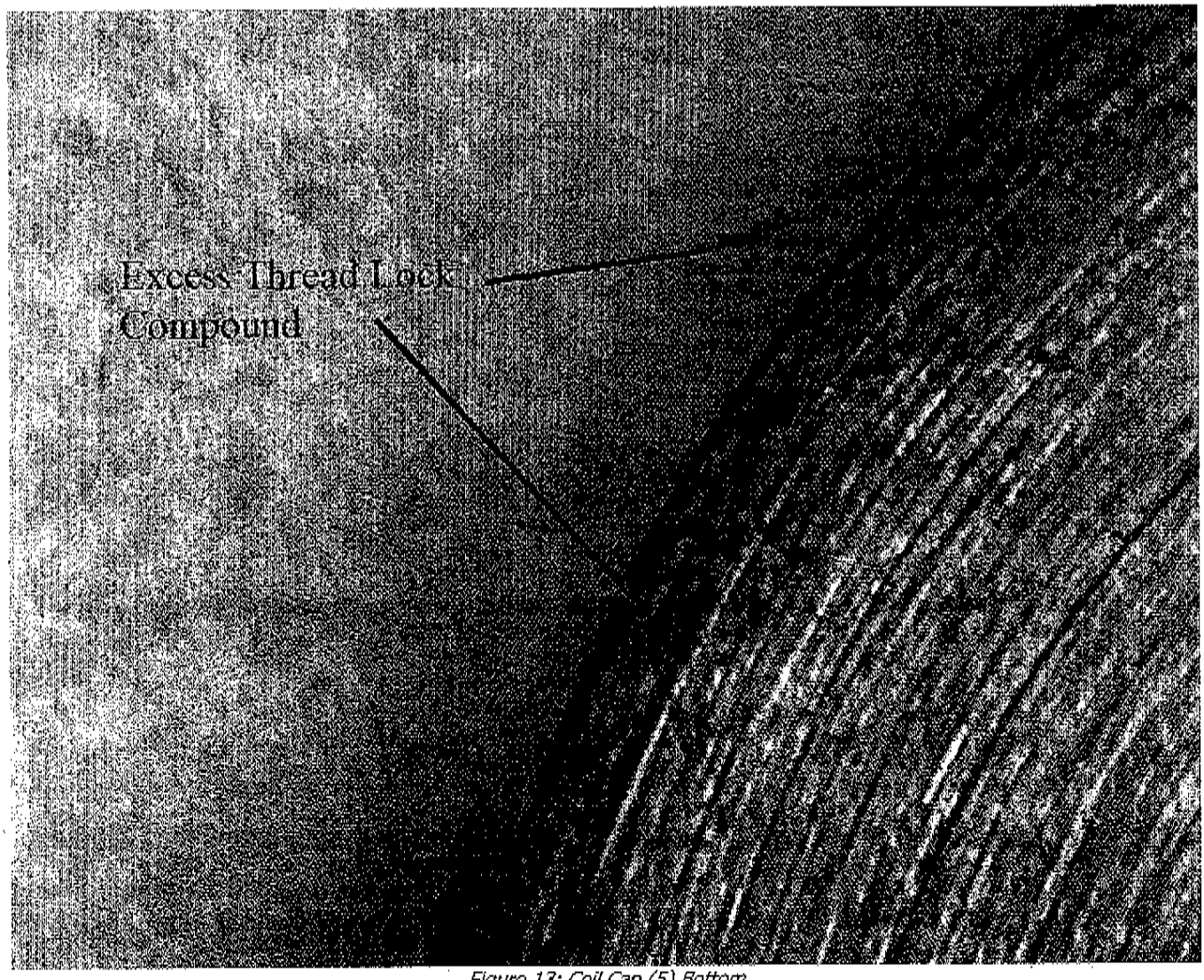

Figure 13: Coil Cap (5) Bottom

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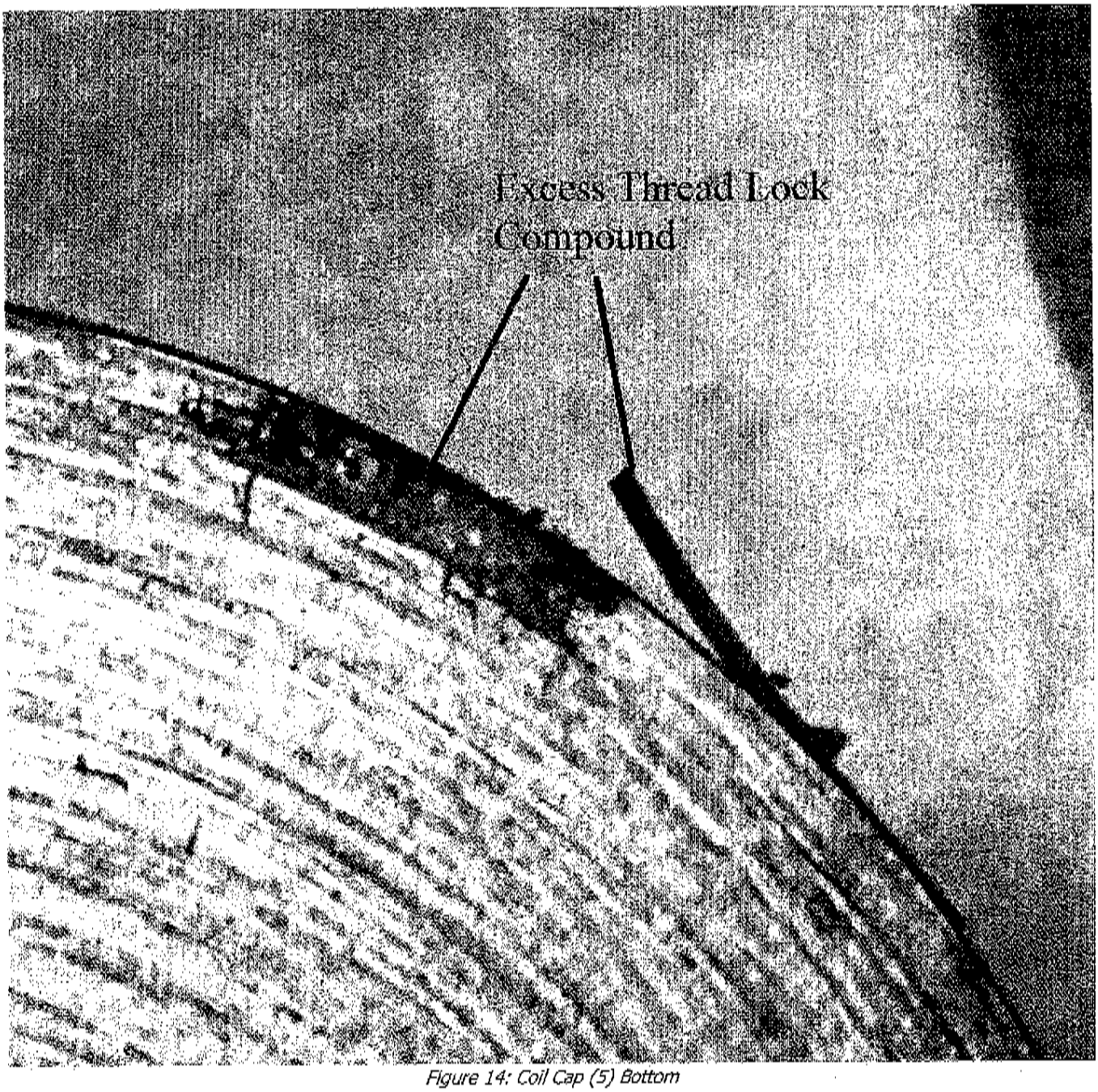

Figure 14: Coil Cap (5) Bottom

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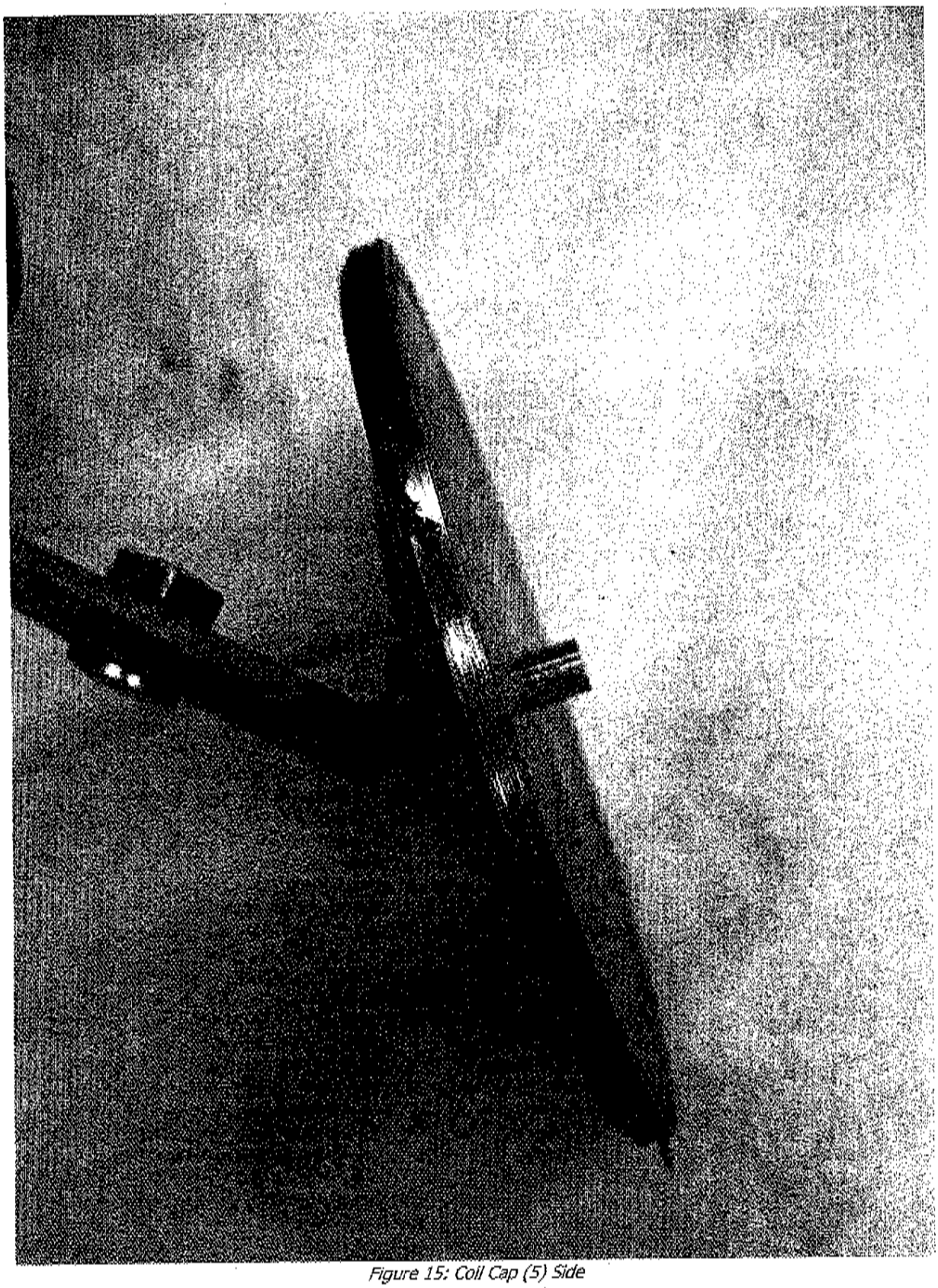

Figure 15: Coil Cap (5) Side

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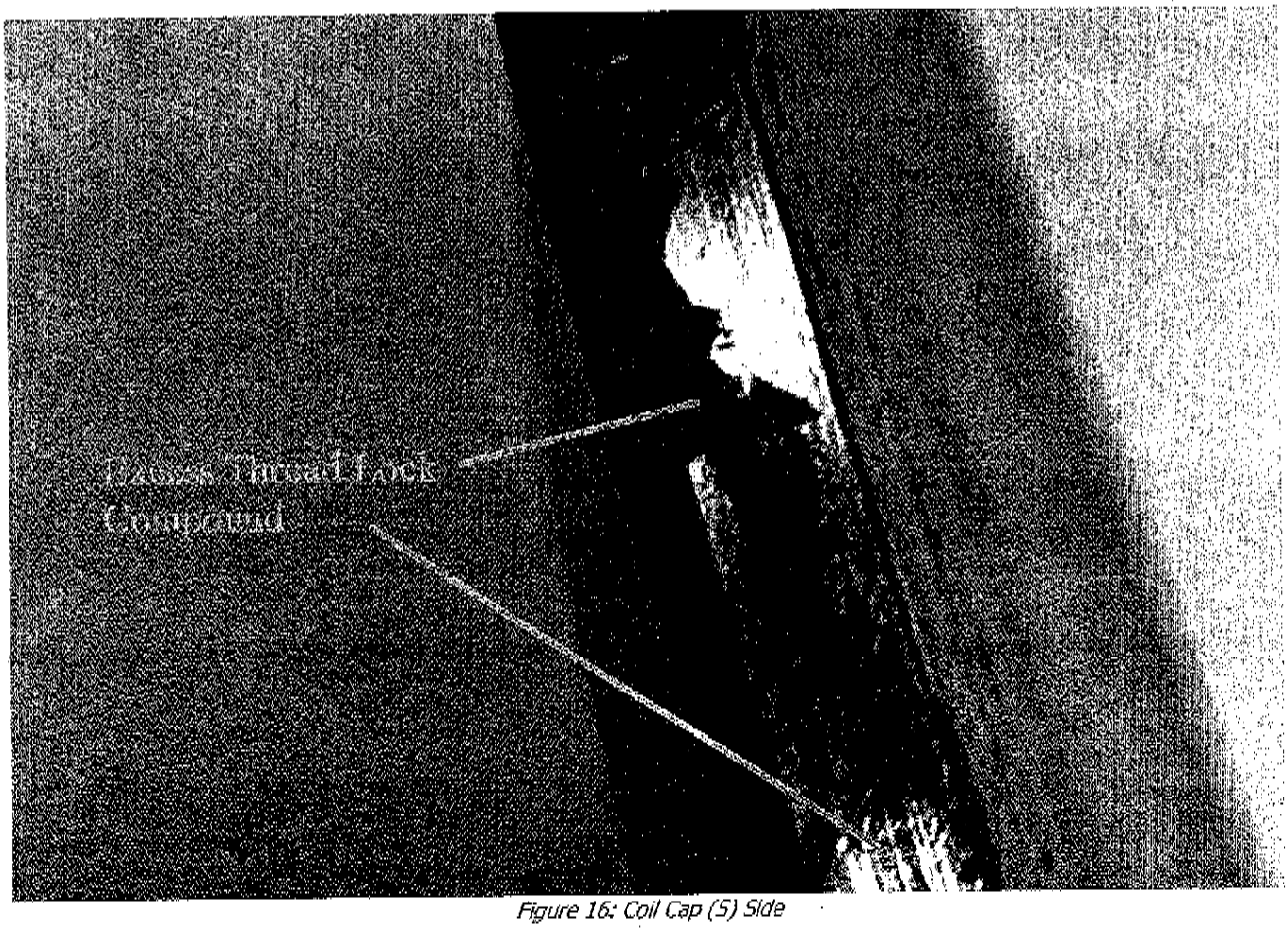

Figure 16: Coil Cap (5) Side

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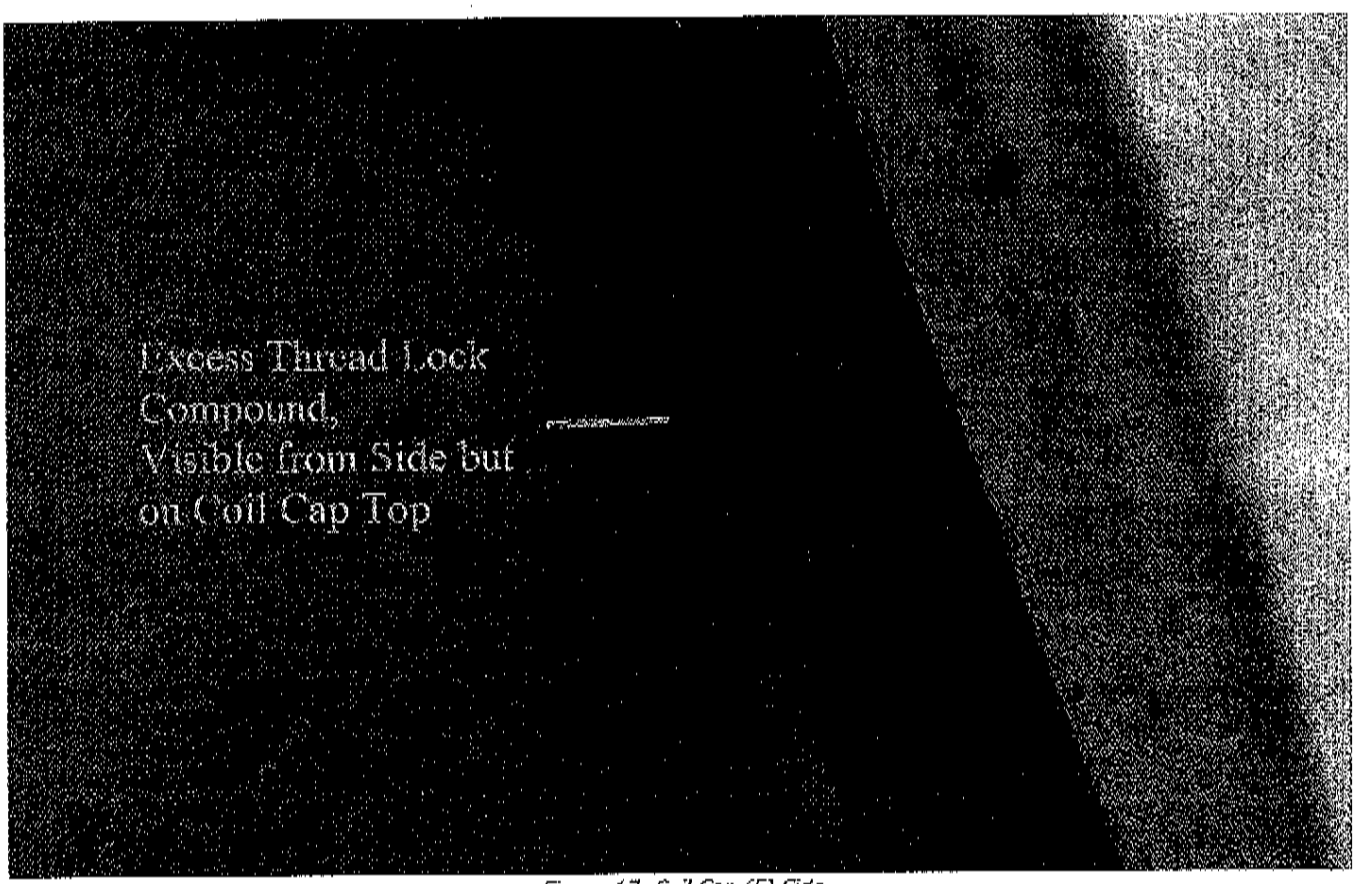

Figure 17: Coil Cap (5) Side

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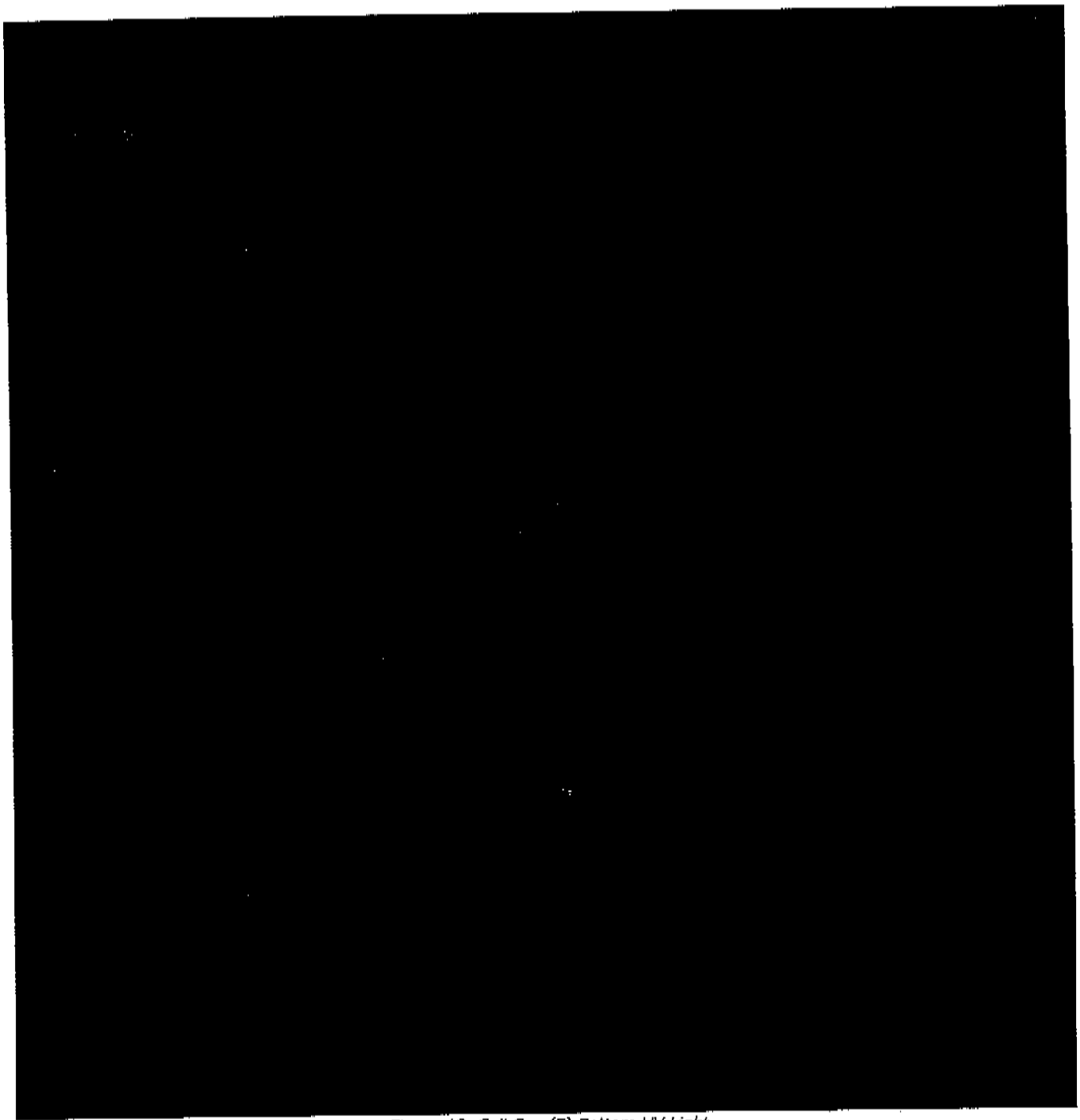

Figure 18: Coil Cap (5) Bottom UV Light

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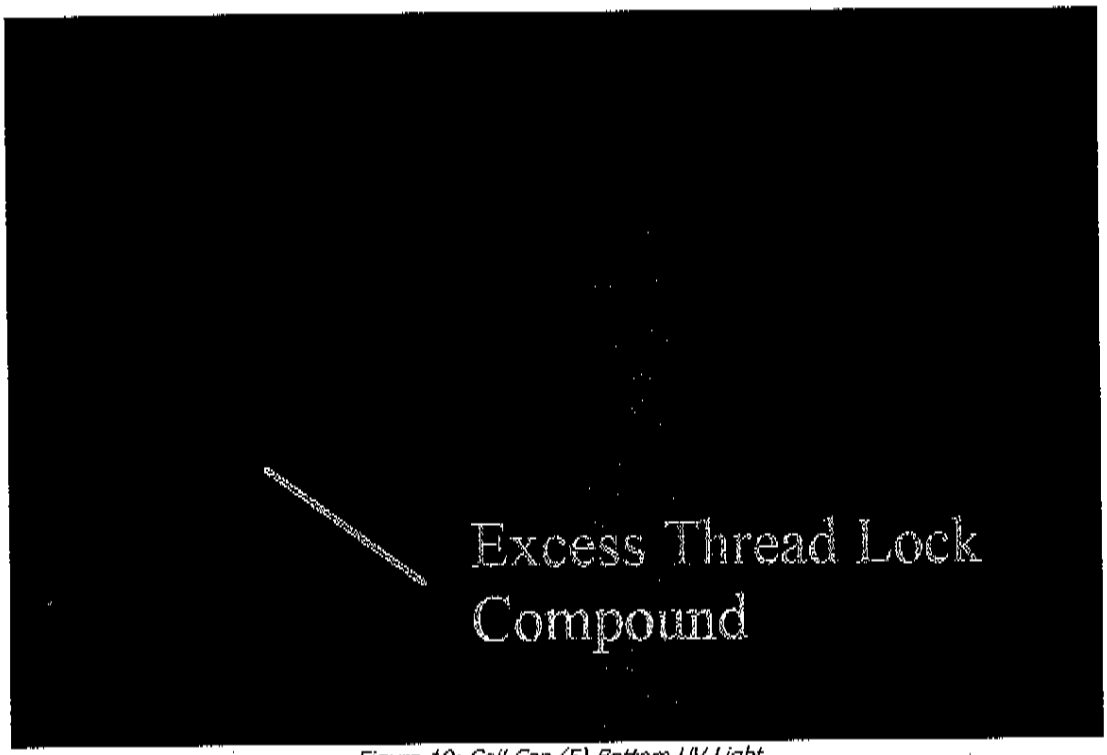

Figure 19: Coil Cap (5) Bottom UV Light

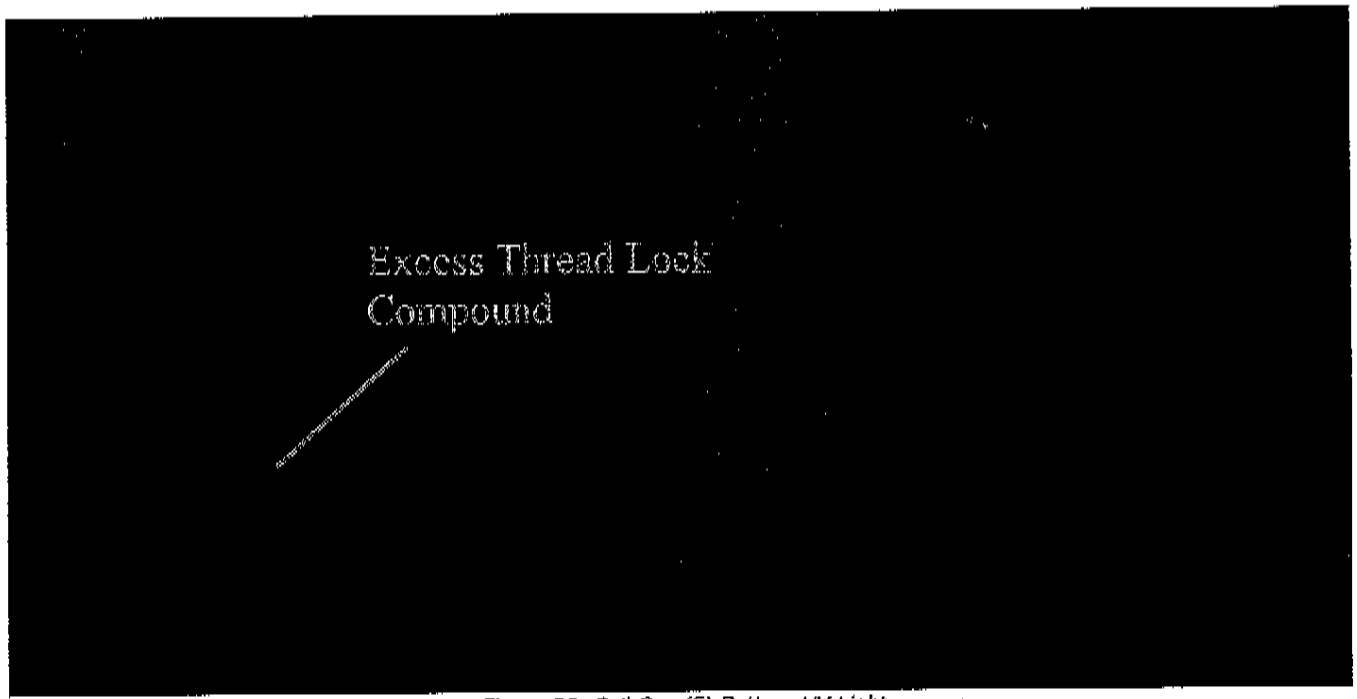

Figure 20: Coil Cap (5) Bottom UV Light

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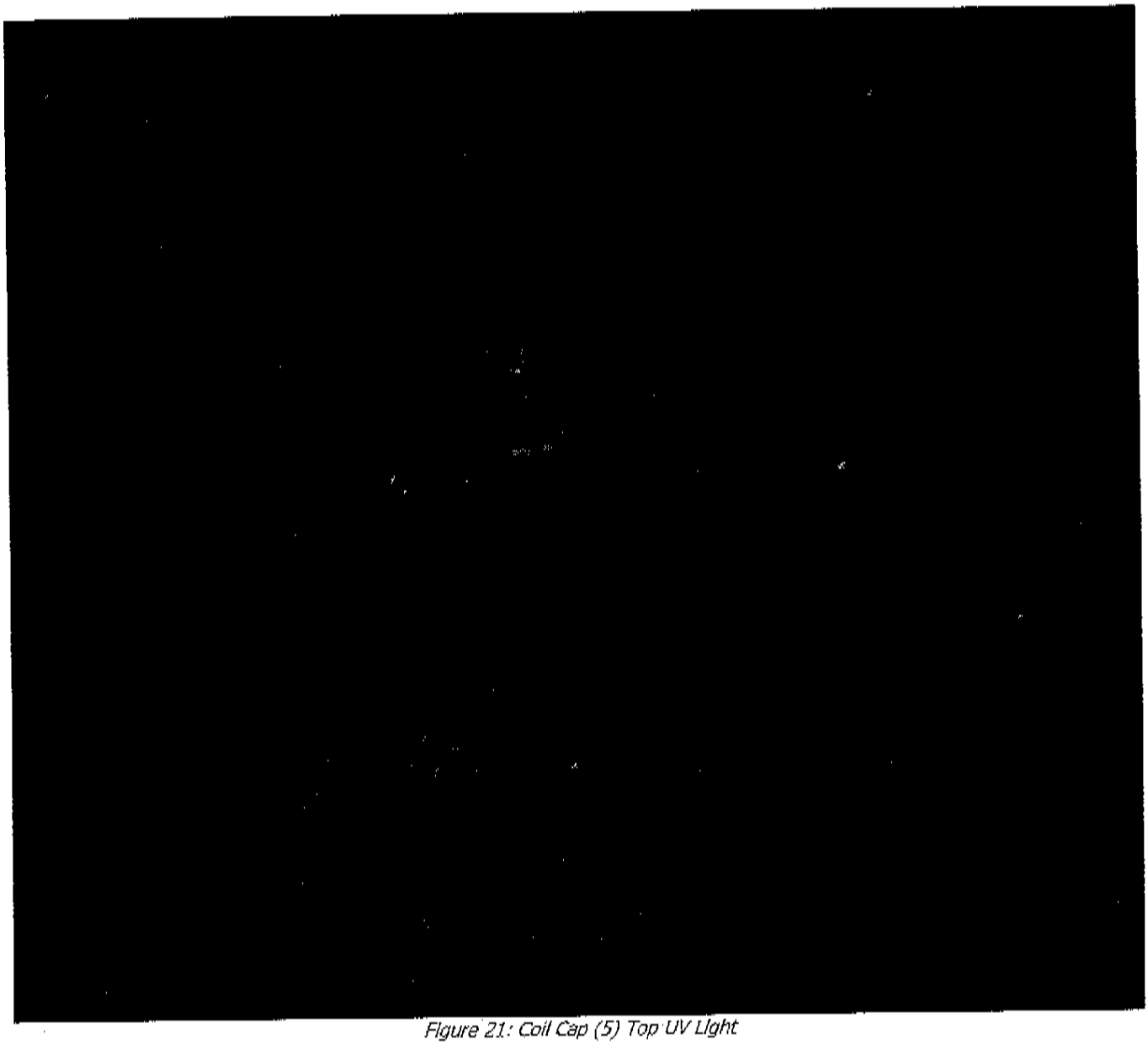

Figure 21: Coil Cap (5) Top UV Light

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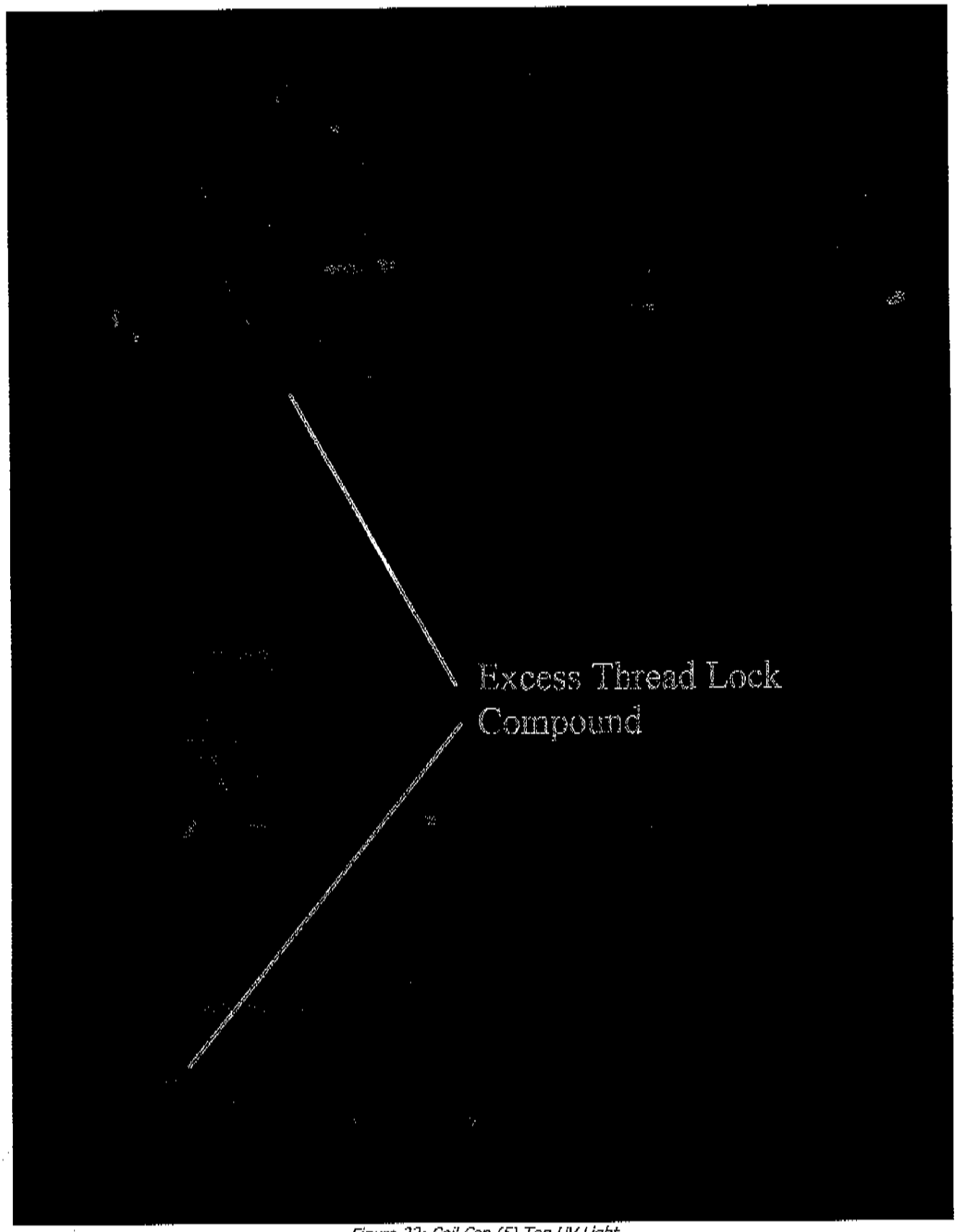

Figure 22: Coil Cap (5) Top UV Light

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Rod, Spool Adjustment: Visual examination showed no signs of damage.

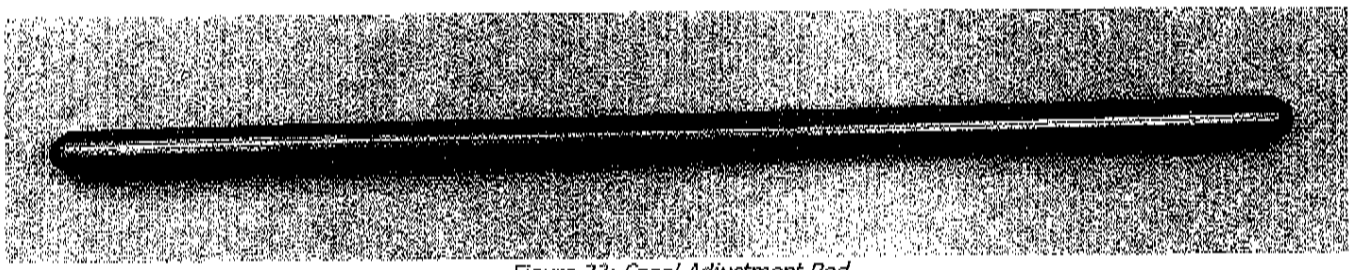

Figure 23: Spool Adjustment Rod

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Coil Assembly (10): Visual examination showed no signs of damage. Excess thread lock compound observed on top surface in the area of the gap between the Coil Assembly (10) and the Coil Cap (5).

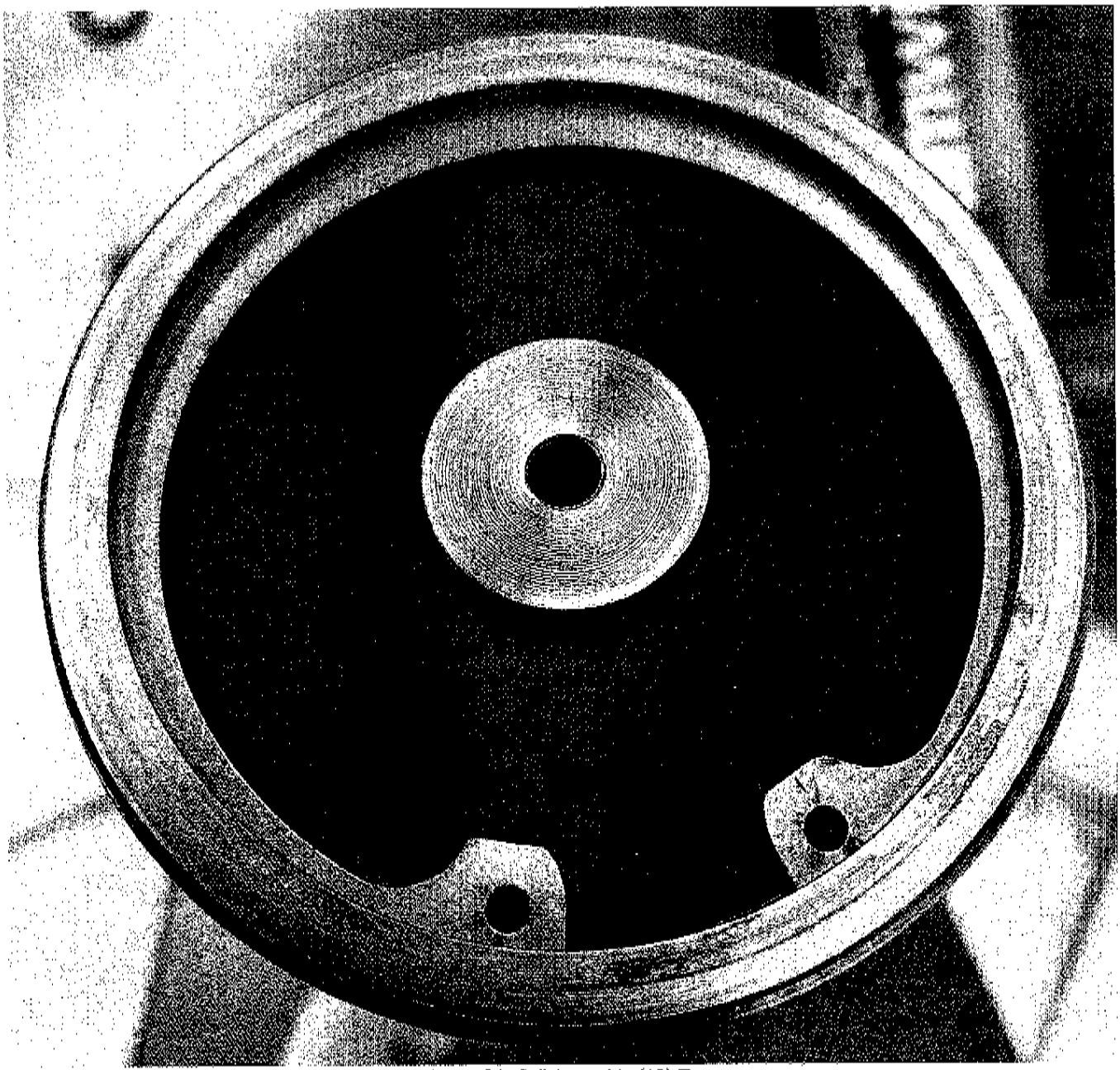

Figure 24: Coil Assembly (10) Top

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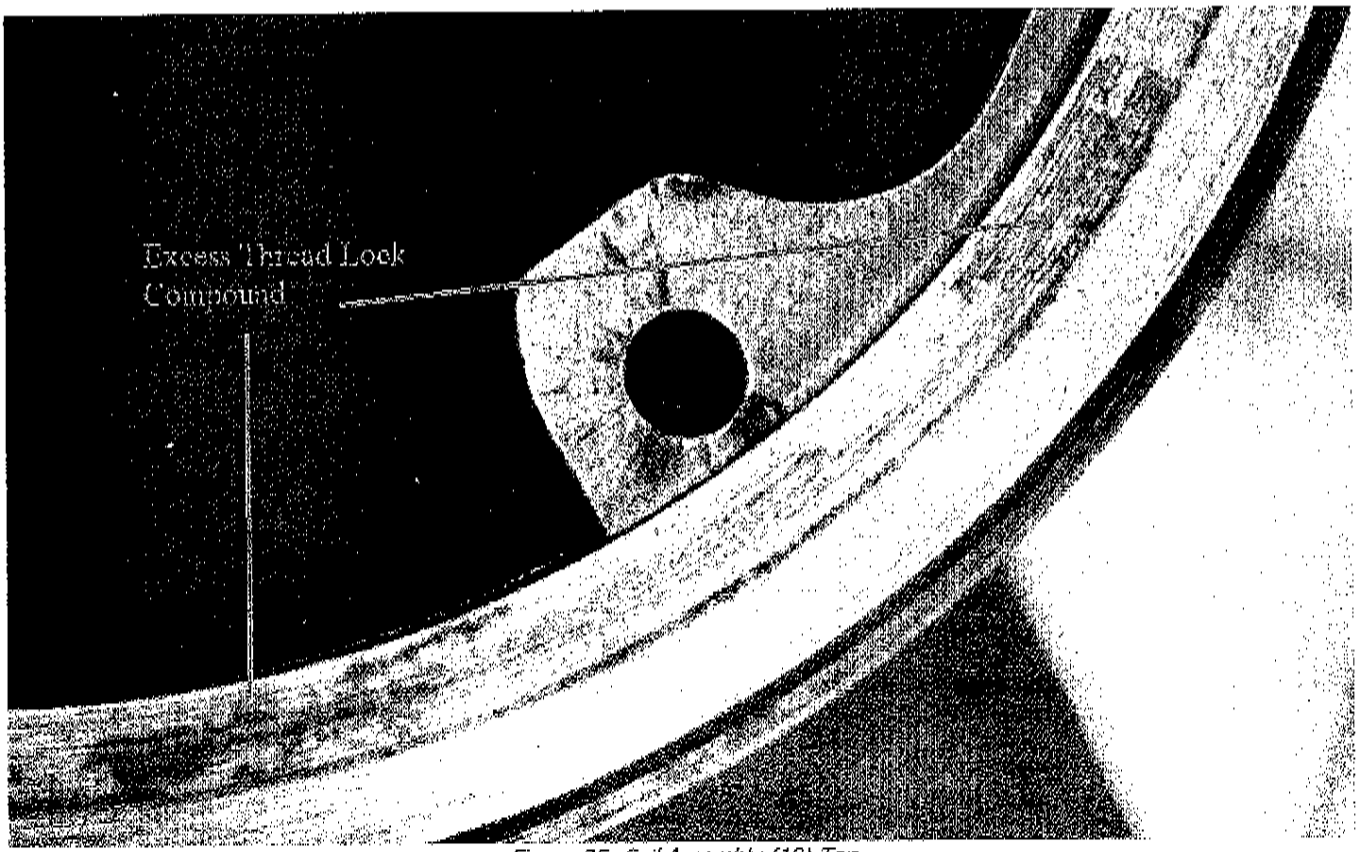

Figure 25: Coil Assembly (10) Top

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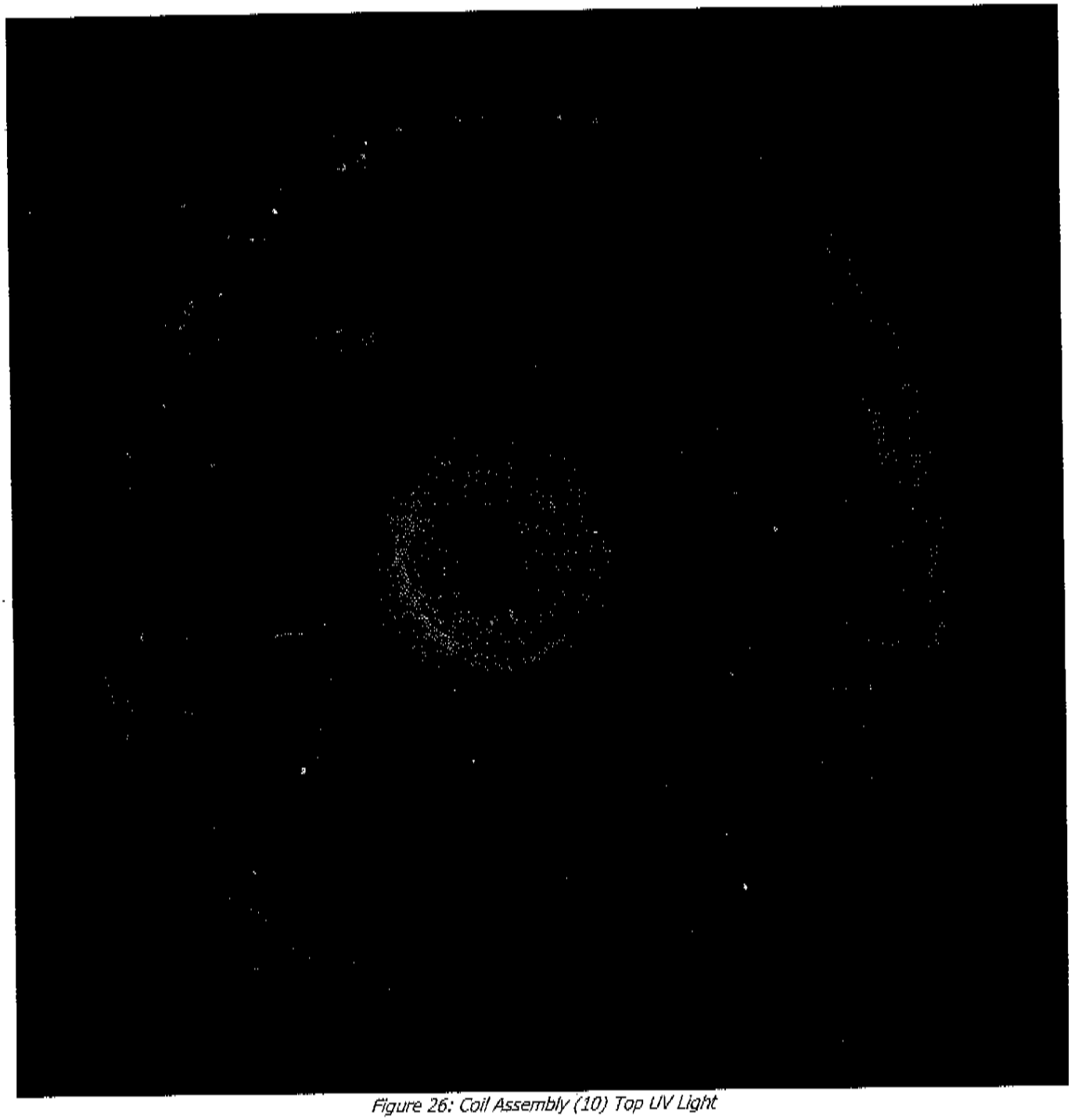

Figure 26: Coil Assembly (10) Top UV Light

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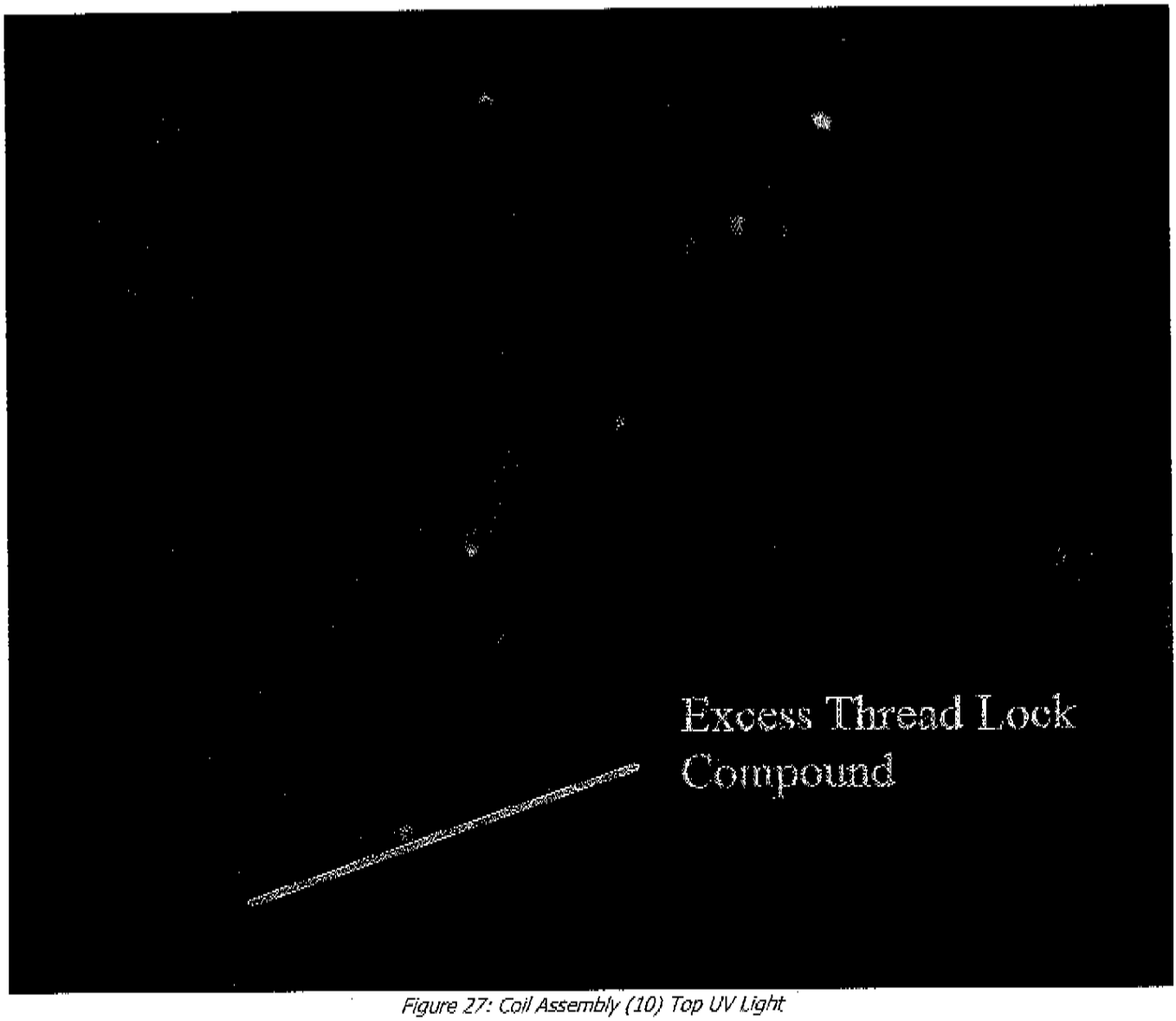

Figure 27: Coil Assembly (10) Top UV Light

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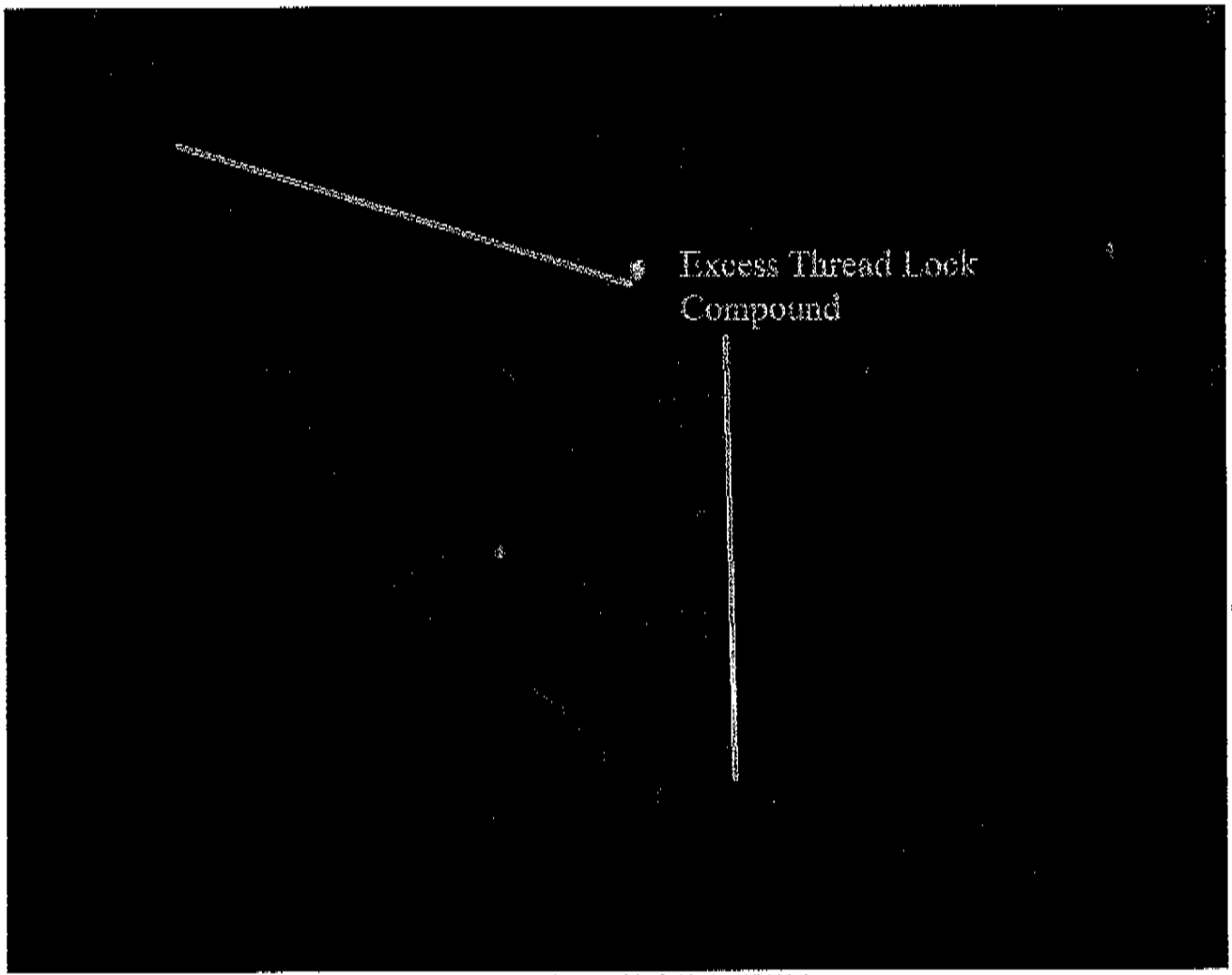

Figure 28: Coil Assembly (10) Top UV Light

Root Cause of Failure:
During Flowserve's investigation into the root cause of the solenoid valve failure, Flowserve was unable to replicate this failure. Based on examination of the solenoid valve components, excess thread lock compound had been applied to the Set Screw (16) and Nut (18) on the Coil Cap (5). The excess thread lock compound then ran down the Coil Cap (5) and wicked between the Coil Cap (5) outside diameter and the End Cap (6) inside diameter. Once this excess thread lock compound cured, the Coil Cap (5) was locked in the de-energized position, preventing the Coil Cap (5) from shifting. After the customer left the solenoid valve energized for 10 minutes, the Coil Cap (5) broke free from de-energized position and was able to shift freely. In the procedure for assembly and testing of this solenoid valve, the solenoid valve is not energized after application of the thread lock compound.

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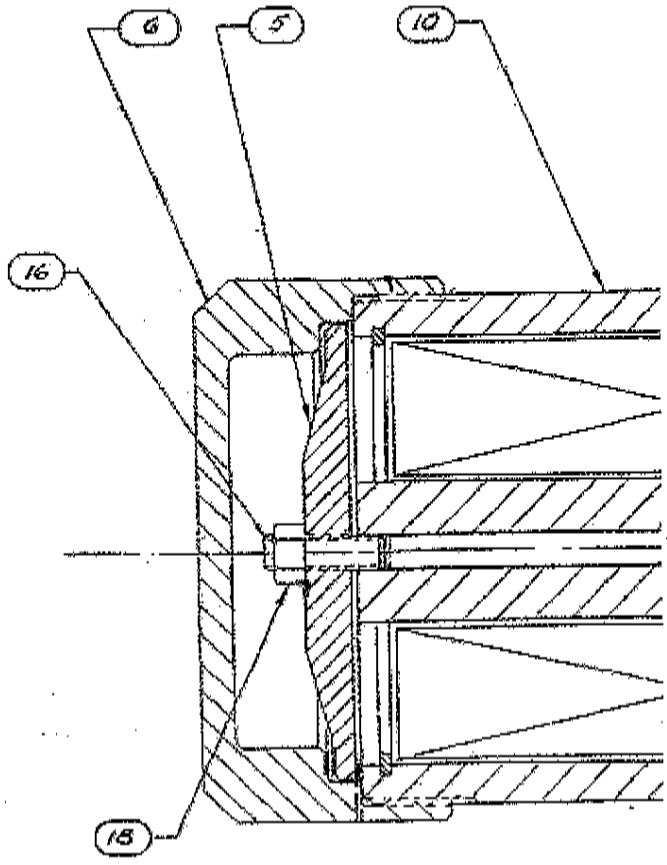

Figure 29: Areas Where Excess Thread Lock Compound was Observed

Extent of Condition:
All model 38878 solenoid valves that have not undergone testing after receipt by nuclear power plant customers.

Proposed Corrective Actions (Short Term):
Nuclear Power Plant Customers with model 38878 solenoid valves that have not undergone acceptance testing should verify that these suspect solenoid valves will shift on demand when energized.

Proposed Corrective Actions (Long Term):
Provide training to assembly and test personnel on the importance of ensuring that excess thread lock compound has not been applied. The assembly and test procedure for the Model 38878 solenoid valves will be revised to add a final test after the thread lock compound has been applied and been allowed to cure to verify the solenoid valve shifts when energized.

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Evaluated By:

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11/7/2022

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