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AFIRS2 TEST EVALUATION

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13. ABSTRACT (Maximum 200 words)

The test results of the automatic fuze inspection by radiography system (AFIRS) were reviewed. The M549 fuze data analyzed was in the form of the digital radiographic and printed test results. The data showed the system to be making good analysis decisions, but some errors in the archiving system were found.

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INTRODUCTION

The purpose of this work was to review the test results and archived radiographic images from the automatic fuze inspection by radiography system (AFIRS2) at Milan Army Ammunition Plant. The data was delivered in the form of a test run printout and six 8-mm exabyte tapes. A report from Science Applications International Corporation (SAIC) on the test run was also provided.

BACKGROUND

The test consisted of 5000 M549 fuzes run through the AFIRS. The system acquires an x-ray radiograph of the fuze and performs analysis on it looking for defects, misassemblies, and tolerances. The system's accept or reject decision of all fuzes are printed out by index number. Just the number means an accept. A reject is printed with the date and time and the defect found. A typical printout page from the AFIRS2 is shown in figure 1.

The radiographic fuze images are also archived on 8-mm exabyte tape. Each fuze is archived as an axial view radiograph and a transverse view radiograph. The horizontal resolution is 512 pixels. The vertical resolution is 1024 pixels with 32 pixels unused underneath each view. Each pixel is one byte for 256 levels of gray. An archived fuze image with the 32 unused lines under the axial view is shown in figure 2.

The format of these archived tapes is simply raw data. There is a text file first on each tape, which describes certain system algorithms. Then there is a second file on the tape which is the fuzes, each 524288 bytes long, one after the other, until the tape ends or some error occurs. The fuzes are not identified on the archive tape, which makes for some interesting problems to be explained in this report.

PROCEDURE/METHODOLOGY

The equipment used to read the tapes was a UNIX workstation with imaging software designed and developed in-house specifically for reading these archived tapes. Problems were encountered reading three out of six tapes delivered. In reading these tapes, a tape error was encountered that caused the computer to abandon reading. This error occurred on two separate exabyte drives. To get the fuze data off the tape it was required to skip to a point past the error. The errors skipped over did not correspond to any event on the printout such as system failure or shutdown. All tapes except the last, however, ended with an error rather than an end of file mark. These were events of system error, reset, or shutdown.

The data obtained off the archived tapes are shown in table 1. Tapes 1, 4, and 5 are split (bytes on tape column) since there was a tape error encountered. The third column shows the number of fuzes on the tape based on the number of bytes. The fourth column shows the actual fuzes found on the tape that are on the AFIRS test printout. The fifth column shows the difference between columns three and four, or the number of extra fuze images on the archive tape. These fuzes were not on the printout.

The procedure to find a particular fuze radiographic image on the archive tape and its corresponding test results on the printout was time consuming. Starting at the beginning of a fuzes archive one could count to where a defect was detected by the AFIRS system as specified in the printout. If the defective fuze image was not there, additional searching of the archive set was required.

The procedure to check the test results of the AFIRS2 required checking the archived fuze radiographs against the printout of AFIRS decisions. This task was done while searching for the rejected fuzes. Mechanical drawings were used to help identify all parts of the fuze. A simplified drawing of the fuze with major components labeled is shown in figure 3.

CONCLUSIONS/RESULTS

In column five of table 1, one can see that there were more fuzes on the archive tapes than the automatic fuze inspection by radiography system (AFIRS) said it analyzed. Through observation of the images, it was determined that some of them are duplicates. While this does not effect the decision making of the AFIRS, it creates confusion when attempting to locate fuze images within the archive tape. For example, figure 4 shows fuze number 4798 and according to the AFIRS analysis the "actuator was not fully seated or adequately crimped." This is correct although it is difficult to see against the others (fig. 2 or any of the other fuze pictures, see how the actuator is more curved and centered in them). Fuze 4800 also has the same defect with the actuator. If one advances two fuzes in the archive from 4798 to 4800 and does not see this defect, then some extra fuze images were introduced into the archive and one can then, upon finding the duplicates, find archived fuze 4800.

Some duplicate fuze images occurred around a table malfunction, but this did not account for all of them.

The need for clearly identified archived fuze images is apparent. Some solutions include printing the AFIRS index in each fuze image, printing a bar code number in each fuze image, or having a lead index number x-rayed with each fuze. Some method is needed to clearly distinguish one fuze image from surrounding archived fuze images.

All rejected fuzes were found in the archived tape set. Ones that were marked as false rejects were verified as such. No accepted fuzes were found that looked rejectable. The test run report from SAIC was verified. There were 108 rejects from a total of 5024; eight due to indexing table malfunctions, etc.

Fuze number 1532, which has a short firing pin is shown in figure 2. This was missed by the x-ray film inspectors. This is an example of the AFIRS detecting defects that are extremely hard to see.

Fuze number 635 is shown in figure 5. This was rejected by AFIRS for the setback spring not being level. Looking at the image, one can see the spring is level, but it is touching the rotor gear assembly. This is a false reject. Fuzes such as this accounted for a majority of false rejects in this test run. An analysis of the setback spring area algorithms may be necessary.

Table 1. Archived tape summary

Tape No.	Bytes on Tape	Bytes = Fuzes	Fuzes Found	Duplicate Fuzes
1	391 MB then Error	745	1 ⇒ 720 + 15 stds. and 20 fuzes	0
	128.5 MB	245	721 ⇒ 960	6
2	70.2 MB	134	961 ⇒ 1071 + 15 stds. and 5 fuzes	4
3	77.6 MB	148	1165 ⇒ 1298 * 1072 ⇒ 1164 not archived	15
4	292.3 MB then Error	557	1335 ⇒ 1892 *1299 ⇒ 1334 not archived	0
	125.8 MB	240	1893 ⇒ 2131	2
5	211 MB than Errror	402	2131 ⇒ 2534	1
	858.6 MB	1637	2535 ⇒ 4160	12
6	453 MB	864	4161 ⇒ 5024	1

```
**********     51 **********
**********     52 **********
**********     53 **********
**********     54 **********
**********     55 **********
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**********     61 **********
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**********     78 **********
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**********     83 **********
**********     84 **********
**********     85 **********
**********     86 **********
**********     87 **********
**********     88 **********
**********     89 **********
**********     90 **********
**********     91 **********
**********     92 **********
**********     93 **********
**********     94 **********
**********     95 **********
28 Apr 1993 14:35:49
SETBACK SPRING DAMAGED "AREA 7B"
SETBACK SPRING NO"  EVEL F/B OR DAMAGED


**********     96 **********
**********     97 **********
**********     98 **********
**********     99 **********
**********    100 **********
**********    101 **********
**********    102 **********
**********    103 **********
**********    104 **********
**********    105 **********
**********    106 **********
**********    107 **********
**********    108 **********
**********    109 **********
**********    110 **********
```

Figure 1. Printout page

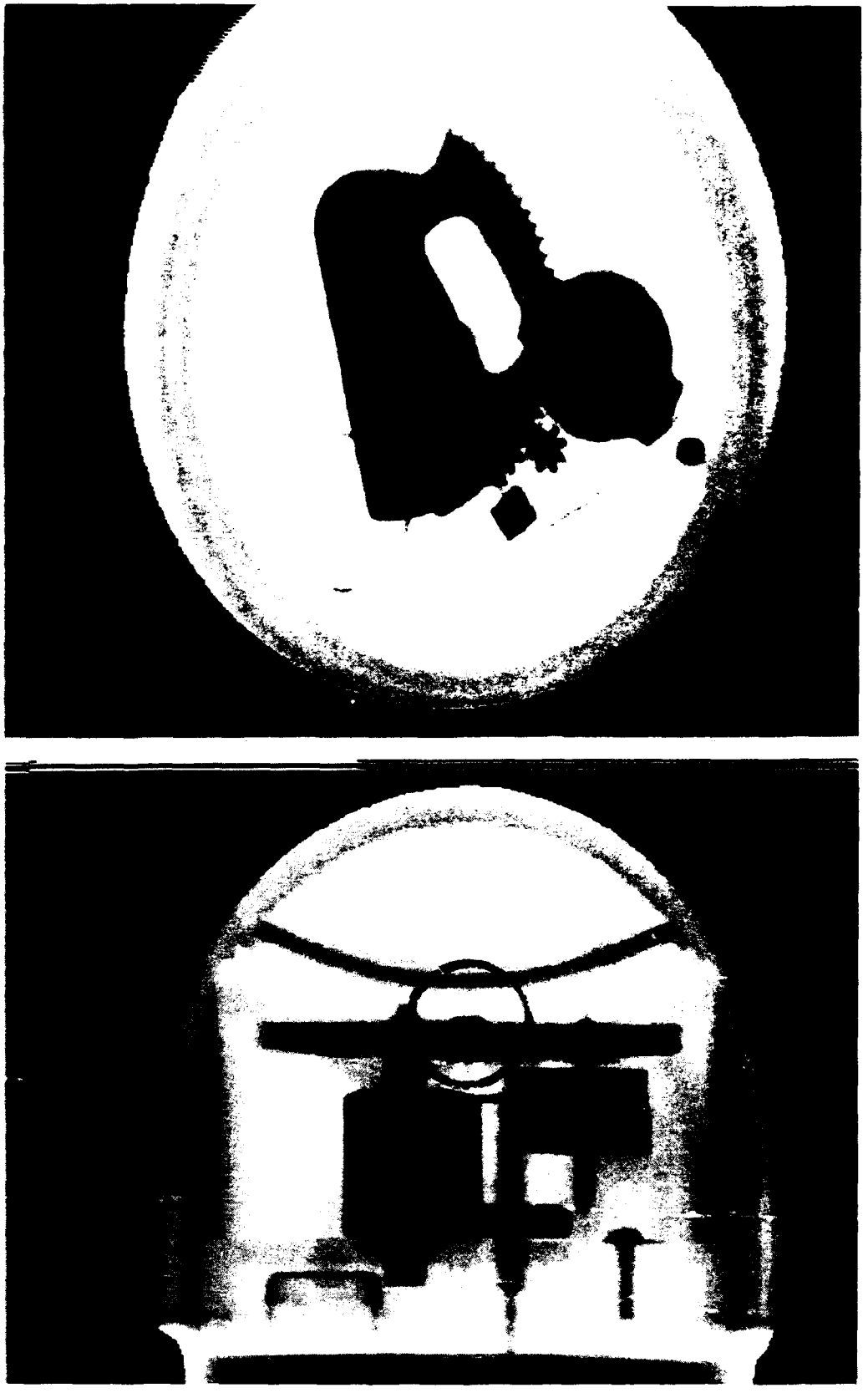

Figure 2. Fuze number 1532

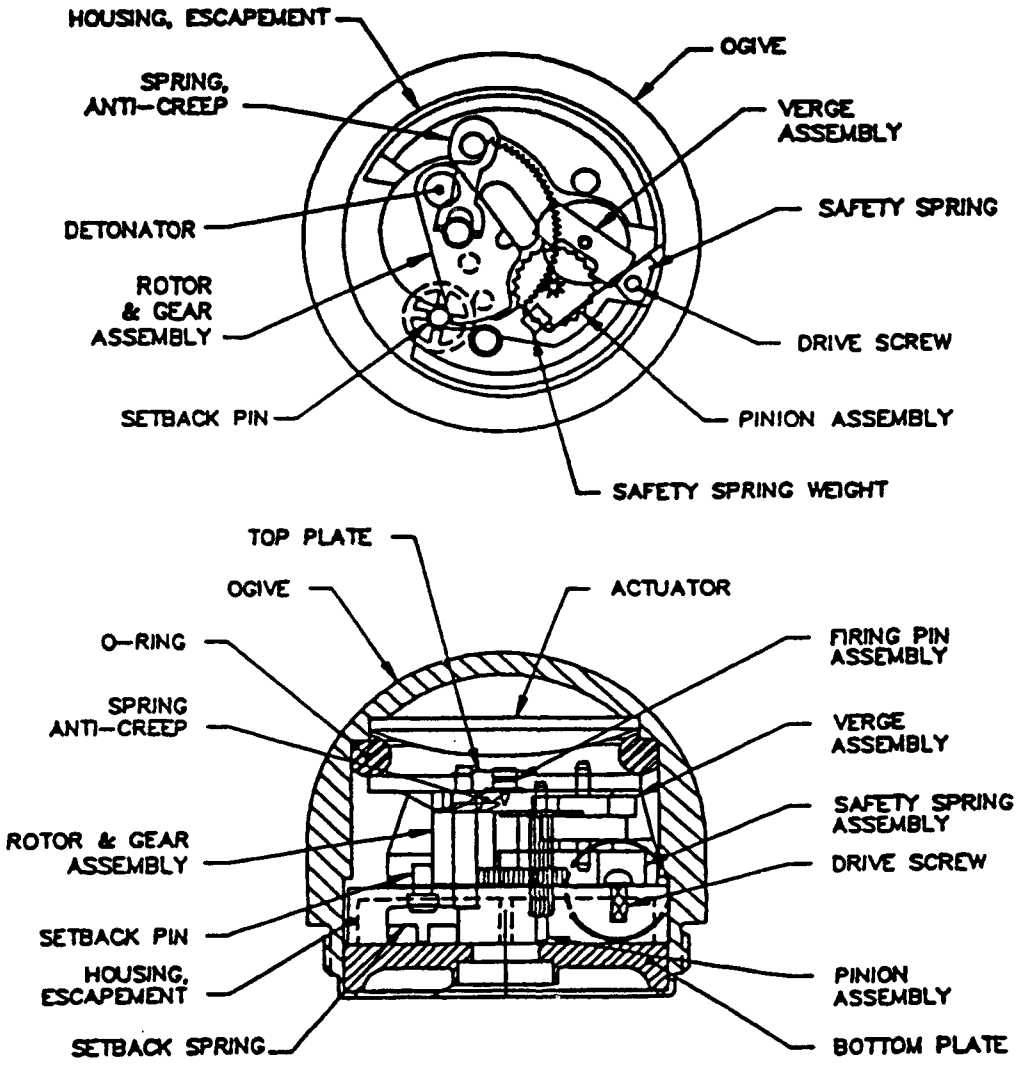

Figure 3. Fuze components

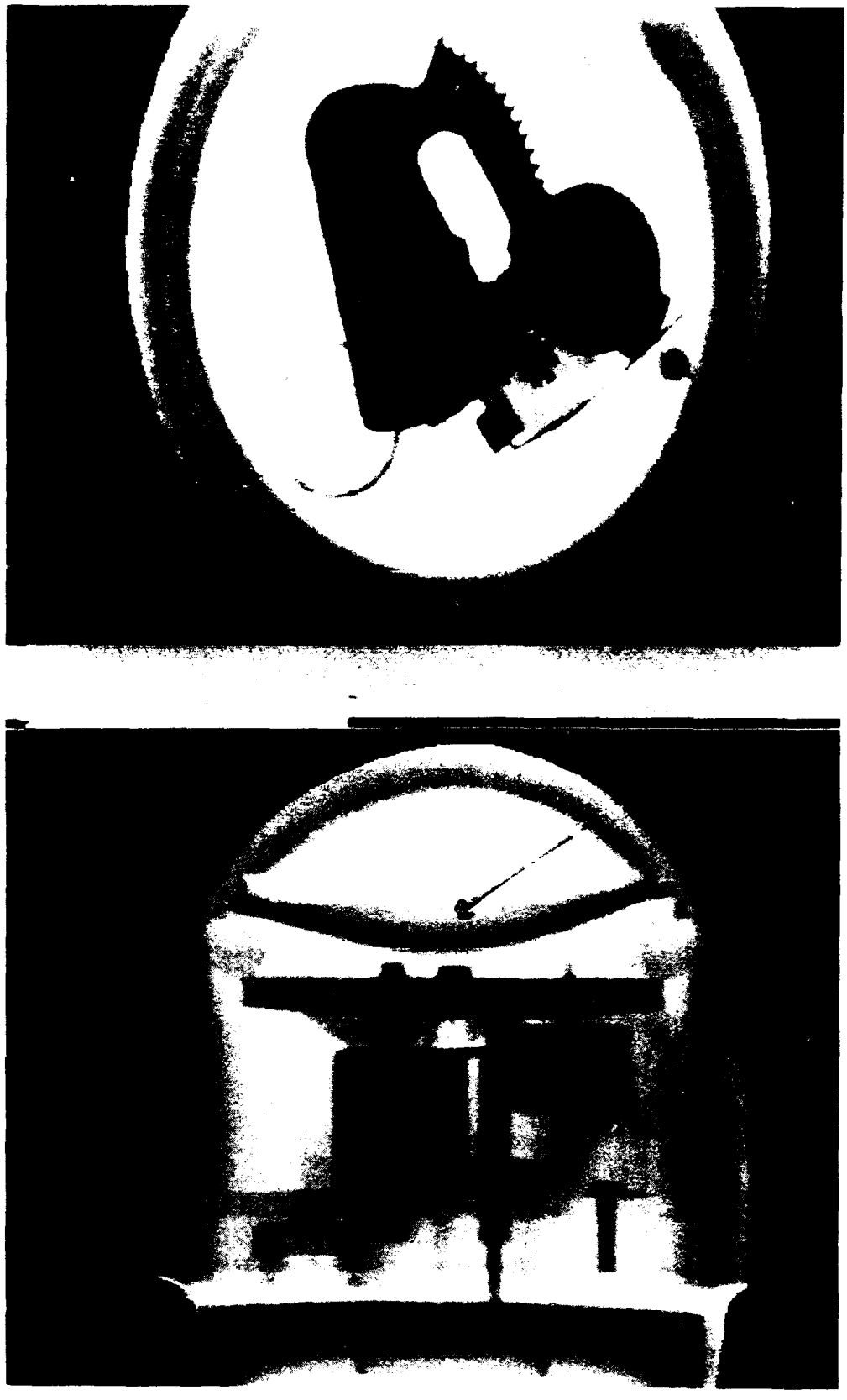

Figure 4. Fuze number 4798

ERROR: ur
OFFENDINC

STACK:

proc
90
60

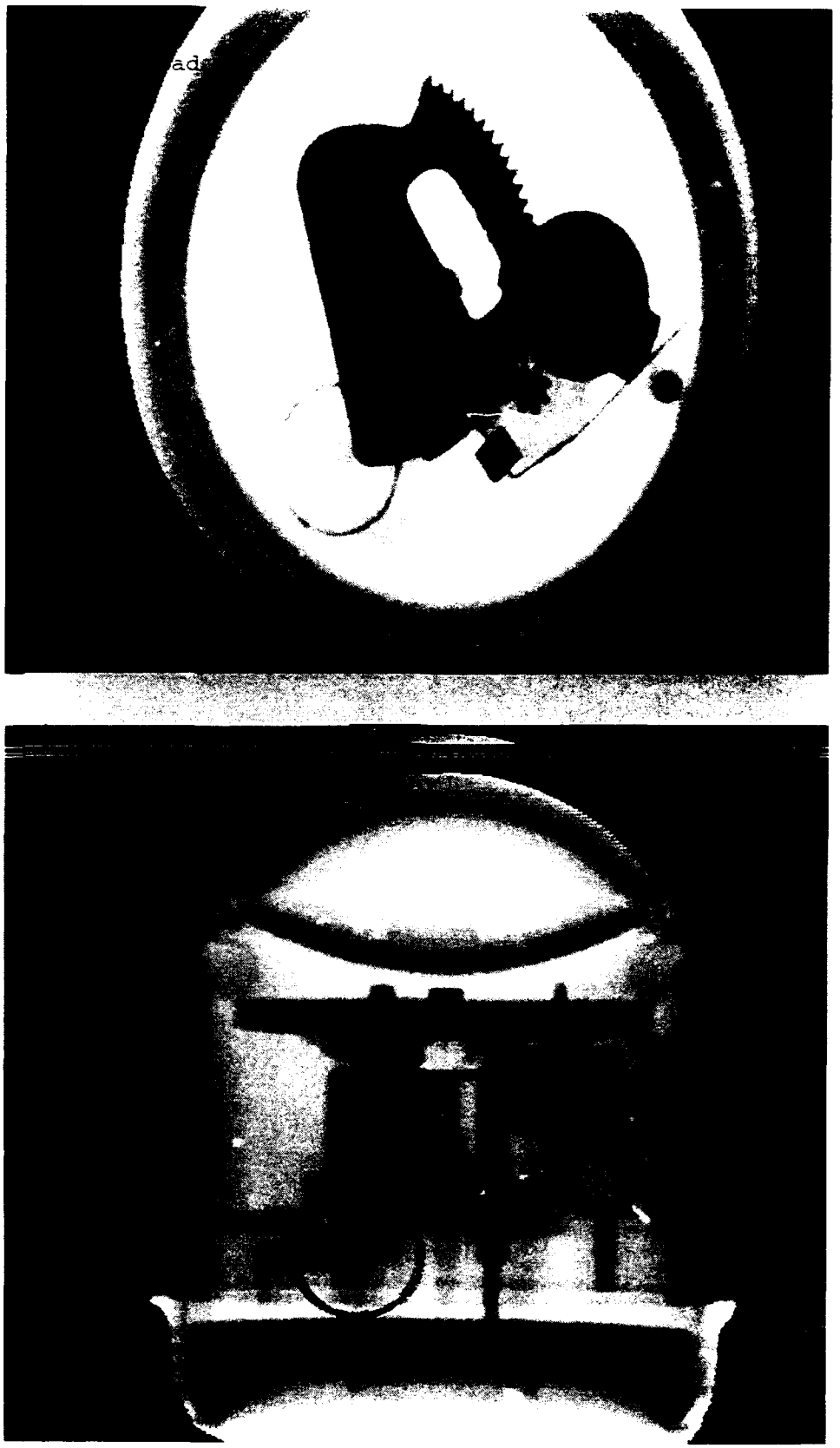

Figure 5. Fuze number 635

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