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SANDIA SYSTEMATIC DECLASSIFICATION REVIEW

1st Review Date: 5-05-97
Authority: ☐ ADC ☒ ADD
Name: W Layne
2nd Review Date: 5/5/97
Authority: ADD
Name: RB Crane

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1 Classification Retained
(2) Classification Changed to: U
Contains No DOE Classified Information
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5 Contains UCNI
(6) Comments:
OK for Open Lit

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COMPONENT EVALUATION REPORT FOR THE MC-337A

R. L. Maxwell - 1471-1

SANDIA SYSTEMATIC DECLASSIFICATION REVIEW
DOWNGRADING OR DECLASSIFICATION STAMP

CLASSIFICATION CHANGED TO: U
Estella Segos 5/7/97
PERSON CHANGING MARKING & DATE
Rosemarie Galligan
PERSON VERIFYING MARKING & DATE 5/30/97

AUTHORITY: R. B. Crane
RECORD ID: 97SW1723
DATED: 5/5/97

ABSTRACT

This report covers the changes required to convert the MC-337 timer to the MC-337A. It also covers the development history and an evaluation test summary of the MC-337A.

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Case No. 439.03 [redacted] March 13, 1957

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COMPONENT EVALUATION REPORT FOR THE MC-337A

FOREWARD

Since the MC-337A is very similar to the MC-337 and, in fact, can be produced by a simple rework of the MC-337, this report is being published as an addendum to the original MC-337 Evaluation Report published October 7, 1954.

The MC-337A is a fixed interval timer having a 2-minute and a 6-minute time delay interval in each of the two independent timing elements. The design and development of this timer was requested for use in the radar- and baro-fused W-5/Regulus I adaption kits in a letter from the Chief of the Bureau of Aeronautics, Department of the Navy, to the Manager of the Santa Fe Operations Office, dated December 19, 1955. The MC-337A is a replacement for the MC-337 on the Regulus I missile as the safe-separation timer for the Mk 5 warhead, and its function and operation are identical to the MC-337 except for the length of time intervals. The designing of the MC-337A, which was really a redesign of the MC-337, was done entirely within Sandia Corporation and it was design-released by PCO MC-337-27D1, dated September 24, 1956. The top assembly drawing number for the MC-337A is 310420. The present plan is that all MC-337's are to be reworked into MC-337A's by an AEC agency at a rate prescribed by the U. S. Navy agency.

EVALUATION SUMMARY AND CONCLUSION

Since the MC-337A is almost identical to the MC-337 and differs significantly only in the design of the timing arm (see Figs. 1 and 2) and, of course, the nameplate, it was considered reasonable to assume that the MC-337A would meet all the environmental requirements of the MC-337 (see TM 026-54-93, "MC-337 Evaluation Report," p. 3). The environmental requirements for the two timers are identical. However,

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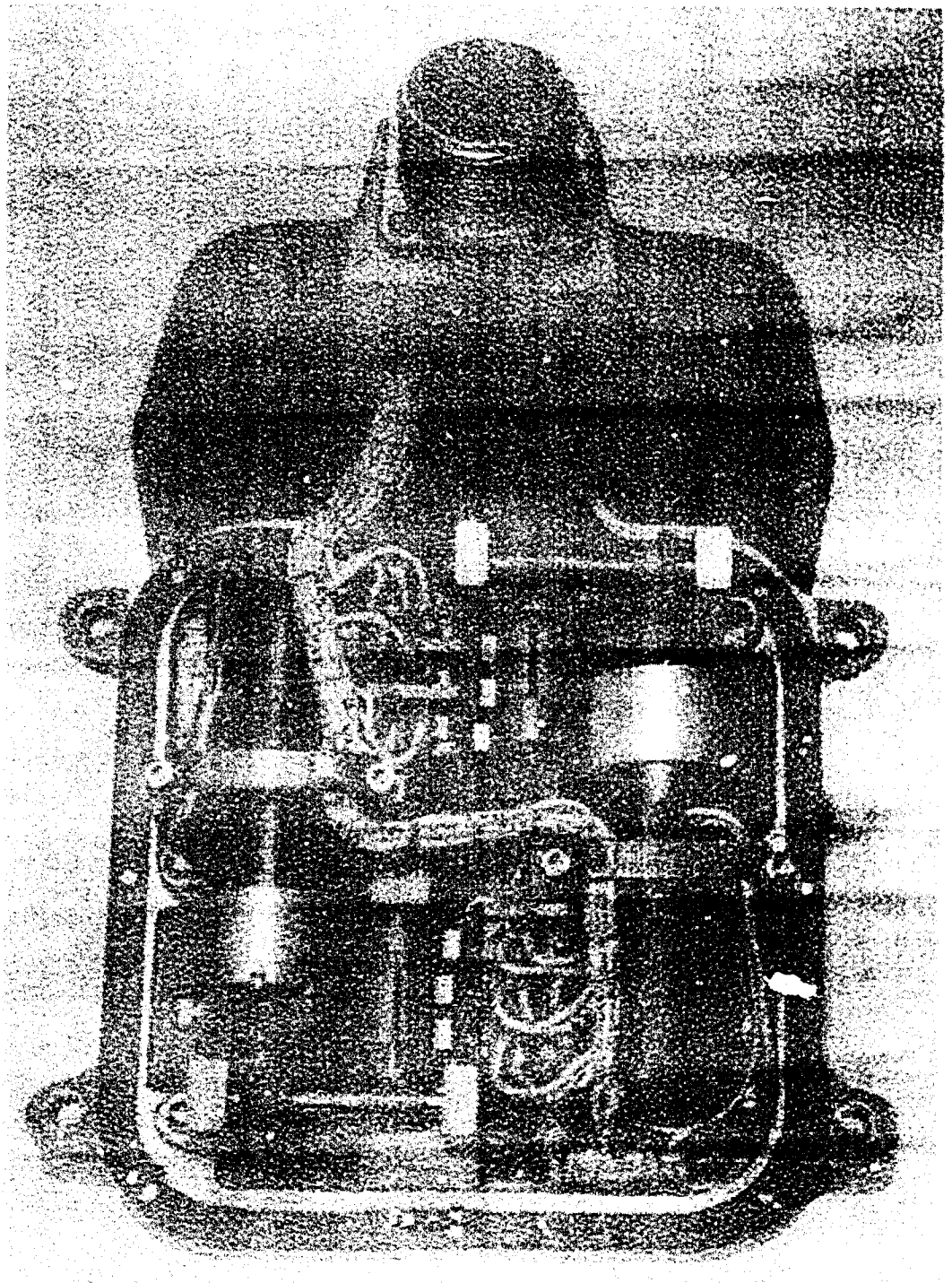

Figure 1
M-577 Tiger

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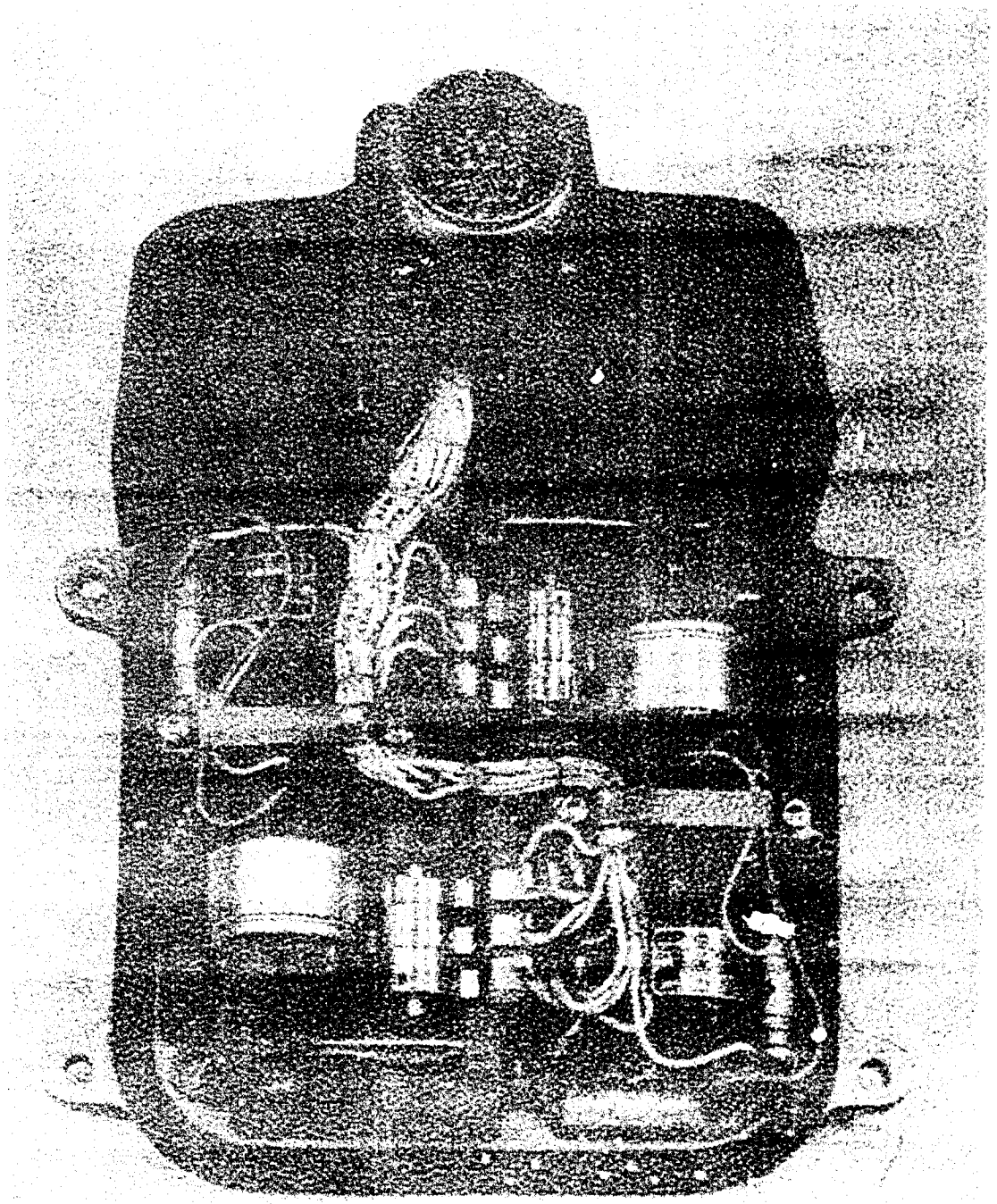

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a limited amount of testing to some of the environmental requirements such as vibration, high and low temperature, mechanical shock, and operating life was performed on a total quantity of six units reworked from the MC-337's in the 1471 laboratory. Based on the results of these evaluation tests performed at Sandia Corporation, the MC-337A meets the required field tolerance of ±1 minute on the 6-minute interval and ±1/2 minute on the 2-minute interval with ease under all environmental conditions prescribed for the Regulus I weapon system. In fact, the limits of all readings, including those at environmental extremes, from properly assembled timers were within approximately ±7 seconds of the nominal time delay. The manufacturing tolerance as prescribed in the MC-337A product drawings is ±15 seconds for each interval at normal room conditions and ±18 seconds on each interval at the environmental extremes.

DESCRIPTION OF THE CHANGE

As mentioned above, the only design change that distinguishes the MC-337A from the MC-337 is in the timing cam itself (see Figs. 3 and 4). The MC-337A cam assembly has two separate end-time lobes, one located at 90 degrees (2 minutes of time) from the reset lobe, and the other 288 degrees (6 minutes of time) from the reset lobe. The cam assembly rotates at the rate of .8 degree per second. The three cams (reset, 2-minute, and 6-minute, see Fig. 4) are all anchored to a common spool and, if desired, can be located at any relative position to each other to provide any time setting from approximately 1/2 minute to 7 minutes on either of the two end-time switches per element. This is a factory-type adjustment, however, and cannot be made without partially disassembling the timer. Of course, anything other than the 2-minute and 6-minute setting does not constitute an MC-337A. The 3-cam assembly was not a requirement for the MC-337A, but was utilized primarily for ease of fabrication. No electrofilm or other lubrication is necessary on this replacement cam.

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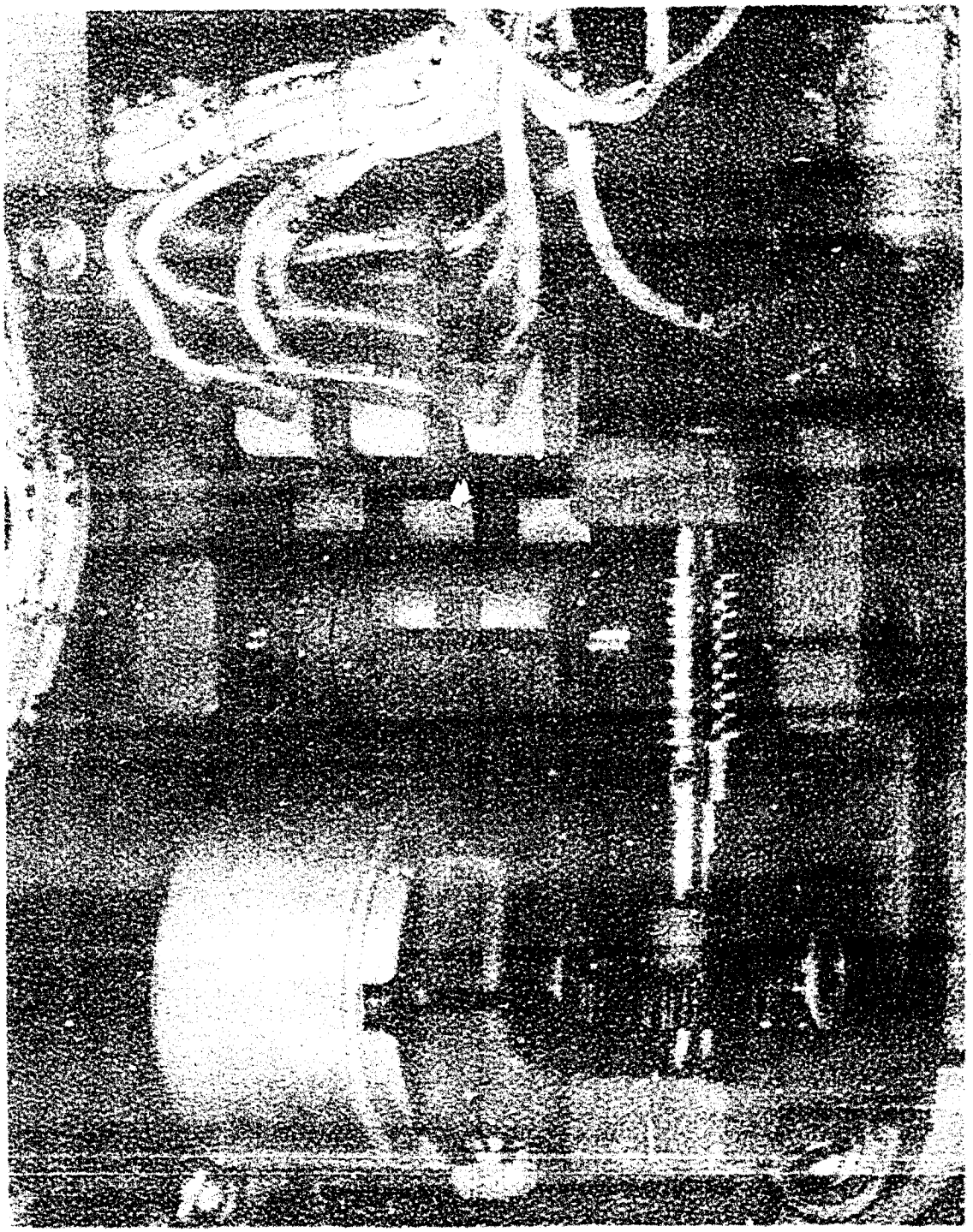

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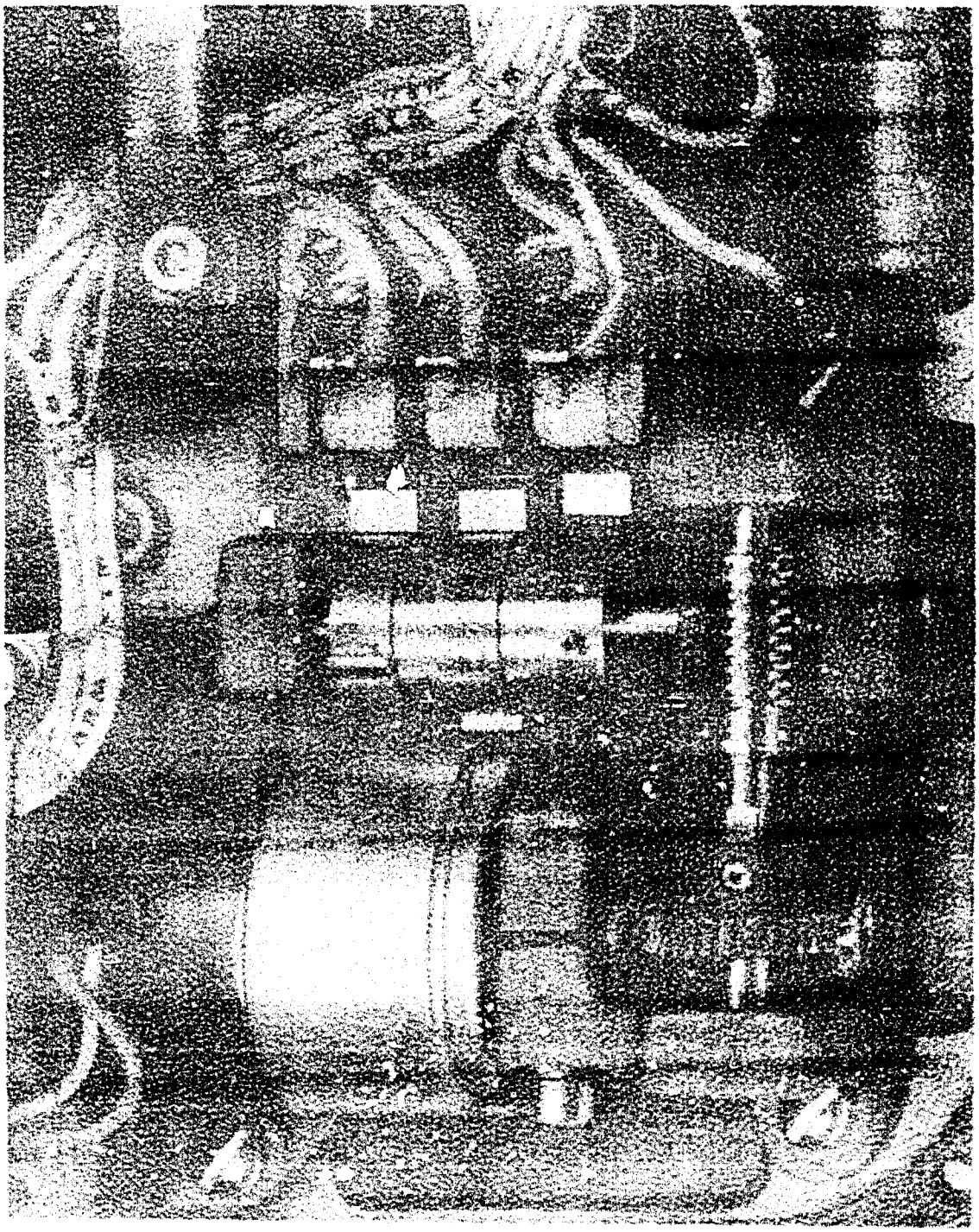

Figure 4
KH-9 Flating Gas

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To install the new cam assembly in the timer and thus make the conversion from the MC-337 to the MC-337A, the following general procedure will be followed:

1. The cover will be loosened and tipped back or completely removed at the discretion of the person doing the rework.
2. The cam shaft on each element will next be removed after first loosening the set screws in the old cam and the cam-shaft worm wheel, and removing a bearing retaining ring. The old cam is then removed.
3. If the switches in the particular unit being reworked are black in color, which also contain a doubtful contact material, they will be removed by clipping the terminal leads and removing the four mounting screws. New white switches with a more suitable gold-silver alloy contact will then be installed and, provided the leads on the wiring harness are still long enough, they will be restripped and resoldered to the respective switch terminal. If the unit being reworked was originally equipped with white switches, step No. 3 will not be necessary.
4. A new cam assembly, previously adjusted per the assembly drawing, will be placed in the timing element, the camshaft reinstalled, and the switch actuators readjusted.
5. The cover will then be reinstalled and the testing per TB-310320 will be performed.

The reset signal in the MC-337A stays on only approximately 18±3 seconds from the reset position after power is applied to the timing motor. Likewise, if the motor is not stopped at the end-time position, either the 2-minute or the 6-minute, the end-time signal, which is a switch closure, will be maintained for only approximately 18±3 seconds.

Since the BA-33 was recently superseded by the BA-33A, all new production of the MC-337A will contain BA-33A motors. The BA-33A is being

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incorporated into the MC-337A drawings by a C class ECO, since the 2781 ECO would have made the change retroactive. A unit rework cost of approximately $95 each for units requiring only the cam change, and approximately $135 each for units requiring the new cam and new switches was unofficially estimated jointly by Divisions 1471 and 2541. This estimate included spare parts, assembly time, testing, etc., and was based on a total quantity of 300 units and a rework rate of 30 per month.

The change of one circuit in each timing element to a 2-minute interval necessitated a change in the field test equipment, also. The T-113 used for testing the MC-337 was converted to a T-113A for testing the MC-337A. This conversion consisted basically of certain internal changes to the T-113, plus the addition of an adapter, the T-2029, which enabled the test operator to select either the 2-minute interval or the 6-minute interval for testing.

A contact resistance in excess of the 0.12-ohm maximum allowed per the MC-337 drawings was discovered while testing a limited number of MC-337's which contained a palladium-copper alloy switch contact material. Specifically, the results showed that approximately 20 per cent of the closed contacts exceeded the specified 0.12-ohm maximum contact resistance. Some were as high as 9.5 ohms when checked by the fall of potential method using 100-milliampere current from a 6-v DC source. The maximum resistance under more typical use conditions of 300 milliamperes from a 28-v DC source was approximately 3.5 ohms. Although it was concluded that 3.5 ohms would probably not cause a weapon failure, it may be approaching the danger point and, furthermore, there is no assurance that the contact resistance would not continue to increase. It was therefore decided to replace all switches containing the palladium-copper alloy contacts in the MC-337 with SA-37's containing a more suitable gold-silver alloy contact when the rework to the new timer is accomplished. This switch change involves only approximately

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the first 125 MT-337's produced. The change in switch case material and contact material was incorporated in the switch at the same time, and the switches can be identified in that manner. All black switches contain the palladium-copper alloy contacts, while all white switches contain the more suitable gold-silver alloy contacts.

APPLICATION

The intended application for this timer is the same as for the MT-337 (see p. 15 of TM 226-34-73). Its purpose is to electrically and nuclearly safe the Regulus missile at the launching site and in flight after launch until a safe distance has elapsed. The added 2-minute interval is intended primarily for missiles aimed at targets less than 5 minutes away, for instance, those missiles launched from submarines. Prior to launch, the selection of the desired interval is made in the weapon, but external to the timer by the selection of the proper position of the switch in the weapon junction box.

TEST RESULTS

A summary of the tests performed on the six test models of the MT-337A are summarized in the attached chart. The original data from these tests may be found in Engineering T Book No. 71 on the pages as indicated on the chart.

T. L. MARSHALL - [illegible]

[illegible] Apr. 63
March 11, 1963

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SUMMARY OF ENVIRONMENTAL TESTING OF MC-337A TIMER

Test (See Note 1)	Test Conditions	Specification Spec. No.	Para.	No. of Units Tested	Unit Ser. No.	Remarks	Eng. T-Book No. 71-2222
Operation	Room conditions	TS-310420	2.1	6	1-2-3-4 5-6	See Note 2	5-7-25
Low Temperature	-65°F	TS-310420	3.1	2	4-5	See Note 3	7
High Temperature	+165°F	TS-310420	3.1	2	1-2	See Note 4	7
Vibration	10 g's to 500 cps	TS-310420	3.2	3	2-3-4	See Note 5	9-13-21
Mechanical Shock	100 g's for .011-sec	135222	2.5.4	2	2-4	See Note 6	11
Operating Life	600 cycles	135222	2.4	4	3-4-5-6	See Note 7	13-15-17-23 25-27

Note 1: Since the cam assembly is the only part changed from the previous proven MC-337 design, the tests listed on the chart were the only ones considered necessary to prove the MC-337A.

Note 2: The tests at room conditions were run at 24 v DC and 30 v DC. All readings were satisfactory.

Note 3: The test runs at -65°F were made at 24 v DC. All readings were satisfactory.

Note 4: The test runs at +165°F were made at 30 v DC. All readings were satisfactory.

Note 5: During the first vibration test on Unit No. 3, the flat-pointed unstaked set-screws loosened. These setscrews were replaced with cup-pointed setscrews and were glyptol-staked and the test rerun. All other test readings were satisfactory. The cup-point setscrews and the glyptol staking are specified on the MC-337A drawings. The slight contact chatter on the SA-87 switch discovered in the MC-337 was still evident in the MC-337A.

Note 6: The shock test time readings were taken after the shock in each direction at 24 v DC. All readings were satisfactory.

Note 7: Since the normal operating life as described in the Design Information Drawing 135222, Paragraph 2.4, is limited by the operating life of the motor which had already been proven, an accelerated life test was used to prove the cam. In this test the cam was rotated in the timer by an auxiliary motor at a rate of approximately 15 revolutions per minute. This accelerated test was performed on units No. 3, 4, and 5. At the end of 600 revolutions of the cam, corresponding to the maximum normal operating life of the timer, an insignificant amount of wear was noted regardless of cam material (brass or phosphor bronze). At the end of 3000, 5000, and 8000 revolutions of the cam on various elements, the cam and actuators did show appreciable wear. Brass with no lubricant, however, was considered satisfactory as a cam material. Unit No. 5 was operated in the normal life test manner, that is, at the rate of one revolution in 7-1/2 minutes with satisfactory results.

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1 GENERAL

The conditions stated herein establish the criteria that governed the design of the MC-337A.

Conformance to the conditions stated herein is a Sandia Corporation responsibility and shall not be construed as a requirement upon the manufacturer unless otherwise stated in a contract or purchase order.

2 CONDITIONS

2.1 Housing. -- The housing of the MC-337A was designed to have two aluminum castings of gasket sealed construction with an AN type, size 28, 24 pin, non-pressure tight, electrical connector. The housing is rigidly mounted with 4 lugs on 4 1/2 x 7 1/16 inch centers and the overall size is approximately 7 3/4 x 2 3/4 x 8 1/2 inches, including the mounting lugs and electrical connector.

2.2 Function. -- The MC-337A was designed to provide time delay intervals, starting with the initial application of 24 to 30-v DC to the motor leads and ending with the closure of a normally open circuit.

2.3 Circuit Design. -- The MC-337A contains two individual timing elements, each having two separate timing circuits.

2.3.1 Time Delay Intervals. -- Each of the two timing elements provides a fixed two-minute time delay interval and a fixed six-minute time delay interval which start together and run concurrently. At the end of each time delay interval, an electrical circuit is opened and another closed by the action of a SPDT snap-action switch. The time delay intervals are internally factory-adjustable over a range of approximately 0.5 to 7 minutes.

2.3.2 Reset Position. -- The MC-337A was designed so that the reset position of each of its two timing elements is indicated by the actuation of another SPDT snap-action switch.

2.3.3 Circuit Resistance. -- The MC-337A was designed so that each circuit, except the motor circuits, should have a resistance of not more than 0.12 ohms when used in a 28-v DC, 0.30 ampere application.

2.3.4 High Potential. -- The MC-337A was designed so that with 500 ± 25-v DC applied between its circuits and between its circuits and the timer housing, the insulation resistance in ohms should not be less than that indicated below.

APPLIED BETWEEN	MINIMUM MEGOHMS
Circuits and timer housing, except motor circuits	5.0
Motor circuits and other circuits	5.0
Motor circuits and timer housing	0.5

REV	AUTHORIZATION	CHG IND	DATE
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ACTION	ORG	NAME	DATE
TYPE	1633	[illegible]	3/22
APPD	1633	[illegible]	[illegible]
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DWG CLASSIFICATION

UNCLASSIFIED

TITLE

DESIGN INFORMATION FOR MC-337A

SW

DWG SIZE A

DWG NO 135212

SHEET 1 OF 1

2.4 Current Rating. — The MC-337A was designed for that application, except the motor armature, to operate and controlling up to 3 amperes at 28-V DC.

2.5 Life. — The MC-337A was designed to operate as indicated in 2.2 without failure a minimum of 600 consecutive times.

2.5 Operating Environment. — The MC-337A was designed to function as indicated in 2.2 without subjection to any of the following conditions.

2.5.1 Temperature and Humidity. — Temperatures ranging from -65° to 85°F with a relative humidity of 30 to 100 per cent (including condensation and frost conditions) and to any temperature between 85° and 160°F with the relative humidity decreasing linearly from 30 per cent at 85°F to 5 per cent at 160°F. Also, thermal shock caused by sudden variation between the temperature extremes of -65° and 160°F.

2.5.2 Pressure. — A pressure reduced (concurrently with timing) from 30 to 2 inches of mercury at a rate of approximately 5 inches of mercury per minute.

2.5.3 Vibration. — Vibrations along each of the three mutually perpendicular axes of the MC-337A at any temperature between -65° and 160°F with vibrational frequencies from 3 to 500 cps and vibrational accelerations to 10 g.

2.5.4 Mechanical Shock. — Loads of 50 g in both directions along each of three mutually perpendicular axes of the MC-337A. Each shock should reach its maximum in 5.5 milliseconds and should have a duration of 11 ± .. milliseconds.

2.5.5 Linear Acceleration. — Accelerations up to 50 g in both directions along each of the three mutually perpendicular axes of the MC-337A.

2.5.6 Explosive Atmosphere. — In an explosive atmosphere at any of the temperatures specified in paragraph 2.5.1. While operating as indicated in 2.2 in the explosive atmosphere (gasoline or some other explosive vapor), the MC-337A should not cause ignition or explosion of the vapors.

2.6 Nonoperating Environment. — The MC-337A was designed to be operative as indicated in 2.2 after being subjected to any of the following conditions.

2.6.1 Storage

2.6.1.1 Temperature and Humidity.

a. Storage for five years at temperatures varying from 20° to 90°F and at a relative humidity of less than 40 per cent.
b. Storage for six months at temperatures of -80° to 160°F and at relative humidities from 30 to 100 per cent with condensation or frost occurring between -80° and 85°F.

The relative humidity may decrease linearly from 30 per cent at 85°F to 5 per cent at 160°F.

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DWG CLASSIFICATION

TITLE
DESIGN INFORMATION FOR MC-337A

SY

DWG SIZE A

DWG NO 1[illegible]

SHEET 2 OF 3

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2.6.1.2 Marine Atmosphere. — Storage and exposure conditions encountered near a large body of salt water for a period of six months.

2.6.2 Sand and Dust. — Blowing and settling sand and dust conditions that exist in desert atmospheres.

2.6.3 Fungus. — Six months to the fungus spore conditions which normally exist in a tropical atmosphere.

2.6.4 Rain. — Short periods to the direct rainfall of any locality.

2.6.5 Sunshine. — Radiant energy equivalent to 30 days of natural exposure to direct sunlight.

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ORG CLASSIFICATION

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TITLE

DESIGN INFORMATION FOR KS-3376

SHT 5 OF 5

SIZE A

DWG NO

SHEET 5 OF 5

2 GENERAL

1.1 Test Facilities at the Place of Manufacture. -- The manufacturer shall arrange for test facilities and equipment of sufficient accuracy and quality to make the required tests. The facilities shall be of sufficient capacity for inspection to be current with production.

1.2 Test Records. -- The attachment of the timer nameplate shall indicate that all tests have been satisfactorily passed.

1.3 Accuracy of Test Equipment. -- Test equipment used for the measurements provided herein shall have an accuracy as follows:

1.3.1 Time Measuring Devices. -- The timing test equipment shall be accurate to ± 0.5 seconds.

1.3.2 Temperature Measuring Devices. -- The temperature test equipment shall conform to good practice and be accurate to ± 1°F.

1.3.3 Electrical Measuring Devices. -- Measurements of electrical potential, current, and resistance shall be made in a manner conforming with good practice and with equipment accurate to ± 3 per cent of its reading, except where greater accuracy is required per a specific test tolerance.

1.4 Definitions

1.4.1 Timer. -- This term denotes the complete [illegible]-337A assembly, as provided by the manufacturer to the procuring agency.

1.4.2 Timer Element. -- This term denotes one of the two similar circuit closing mechanisms which make up the timer.

1.4.3 Reset Position. -- This term denotes the starting position for any timing cycle. Indication of reset position shall be initial circuit closure between pins P and T and pins G and J.

1.4.4 Time Delay Interval. -- This term denotes the elapsed time between application of voltage across pins Q and R and pins W and Z and completion of circuits between pins Y and F, pins A and V, pins N and B, and pins B and V. The term is significant only when the timer is in the reset position upon application of voltage between pins Q and R and pins W and Z.

1.4.5 End Point. -- This term denotes the completion point for any time delay interval. Indication of end point position shall be initial circuit closure between pins Y and F, pins A and V, pins N and B, and pins B and V.

1.4.6 Timing Motor. -- This term denotes the electrically powered series timing motor [illegible] as the time standard in the timer element.

1.4.7 Loop Resistance. -- This term denotes the electrical resistance of any circuit within the timer, measured at the AN connector terminals.

REV	AUTHORIZATION	DATE	NOTES	DWG CLASSIFICATION
A	[illegible]	[illegible]	[illegible]	UNCLASSIFIED

TITLE	SY	DWG NO
TEST REQUIREMENTS FOR ML-337A FIXED INTERVAL TIMER	DWG SIZE A	TR-[illegible]
	SHEET 1 OF 4	

1.4 Equipment Conditions and Tolerances. -- Test equipment and tolerances shall be of at least equal to that of the timer being tested thereon. Tests shall be performed at ambient laboratory atmospheric conditions.

Unless otherwise specified, maximum allowable tolerances on test condition measurements shall be as follows:

Temperature: ± 5°F

Vibration Tolerance:

Amplitude: ± 5 per cent
Frequency: ± 2 per cent

2 PRODUCTION TESTS

Each timer shall be subjected to and meet the requirements of all the following tests at an ambient temperature of 80 ± 20°F and atmospheric pressure of 760 ± 150 millimeters of mercury. Actual measurements shall be made of temperatures, resistances, currents, voltages and time intervals, which are stated as requirements or as test conditions when determining whether each timer has qualified under each test.

2.1 Operational Test. -- Obtain three measurements of the time delay intervals for each potential of 24 ± 1-volts DC and 30 ± 1 volts DC. The time delay interval for circuit closure between pins F and Y and pins B and V shall be two minutes ± 11 seconds. The time delay interval for circuit closure between pins A and U and pins E and N shall be 6 minutes ± 11 seconds.

2.2 Resistance Tests. -- The loop resistance between the following points on the electrical connector shall be measured while applying 6 ± 1 volts DC to the loop through a series resistor which limits the loop current to 200 ± 20 milliamperes. No loop resistance shall exceed 0.12 ohms.

2.2.1 Timer at Reset Position:

From pin	To pin
C	V
D	N
G	J
H	C
P	Y
X	Y

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TITLE: TEST REQUIREMENTS FOR MC-3178 FIRED INTERVAL TIMER

SIZE: 5Y

DWG NO: A

SHEET 7 OF 8

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2.3.2 Timer at End Point Position:

From (Pin)	To (Pin)	
A	U	[illegible]
B	T	[illegible]
E	N	[illegible]
F	L	[illegible]
J	K	[illegible]
M	P	[illegible]

2.3 Dielectric Strength. -- The insulation shall withstand 500 ± 25 volts DC when applied between the following pins of the connector and the case for at least 5 seconds, but not more than 60 seconds. The resistance shall not be less than 5 megohms.

2.3.1 Timer at Reset Position:

Pin
V
N
J
U
P
R
M
Y

2.3.2 Timer at End Point Positions:

Pin	
V	at 7 minute end point
N	at 6 minute end point
J	at either end point
U	at 6 minute end point
P	at either end point
Y	at 7 minute end point

3 PRODUCTION SAMPLING TESTS

The product shall be capable of meeting the following test requirements which may be applied on a sampling basis. The sampling method employed should be appropriate and in conformance with recognized practice. Written approval shall be obtained from the Sandia Corporation on the sampling plan used by any vendor undertaking manufacture of the product under this specification.

Disposition of all items subjected to these tests will be conducted in accordance with the approved sampling plan.

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DWG CLASSIFICATION

UNCLASSIFIED

TITLE: TEST REQUIREMENTS FOR MC-337A FIXED INTERVAL TIMER

SIZE: SY

DWG SIZE: A

DWG NO: TS-316120

SHEET 3 OF 4

3.1 Operation Test - Temperature. -- The timer shall be placed in a test chamber maintained at each of the temperatures as indicated below for a period of 2 hours for each temperature. While at these temperatures, the timer shall be operated three times at each potential of 24 ± 1 volts DC and 30 ± 1 volts DC. At the -65°F temperature, a period of 30 minutes shall elapse between each operation test to enable the timer to stabilize at -65°F. The time delay intervals for each element shall be measured by a suitable means. The time delay intervals shall be 2 minutes and 6 minutes in accordance with the tolerances listed below. A sampling plan shall be used for timer elements which will assure an AOQL of 5 per cent.

Temperature (°F)	Timing Tolerances (sec)
+ 165	± 18
- 65	± 18

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3.2 Operating Test - Vibration. -- The timer shall be secured to a vibration table by its four mounting lugs, and shall be vibrated in each of three mutually perpendicular planes under the following test conditions:

Condition	Frequency range (cps)	Constant acceleration or double amplitude (g or inches)	Duration of cycle (minutes)	Duration of test (minutes)
1	10-30-10	0.109	6	12
2	30-60-30	0.054	6	12
3	60-500-60	10 g	6	12

During each cycle of vibration under each condition in each of the three planes, the timer shall be operated with a potential of 24 ± 1 volts DC. The time delay intervals for each element shall be measured by a suitable means. The time delay intervals shall be 2 minutes and 6 minutes ± 18 seconds. This test shall be applied on a spot check basis, one MC-337A shall be tested from each 50. Since this test is considered destructive, all units thus tested shall be disposed of at the discretion of the procuring agency.

SYM	AUTHORIZATION	DATE	ACTION	ORG	DATE
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DWG CLASSIFICATION

UNCLASSIFIED

TITLE: TEST REQUIREMENTS FOR MC-337A FIXED INTERVAL TIMER

5Y

DWG SIZE: A

DWG NO: [illegible]

SHEET 1 OF 1