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STRUCTURAL AND ENVIRONMENTAL TESTING OF AERO X61 BOMB RACKS

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Executive Order 10501 issued 5 November 1953
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1 Nov. 1954

PAUL B. WINTERHALTER
ARMAMENT LABORATORY

APRIL 1952

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STRUCTURAL AND ENVIRONMENTAL TESTING OF AERO X61 BOMB RACKS

Paul B. Winterbalter
Armament Laboratory

April 1952

RDO No. 552-659

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

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FOREWORD

This report was prepared by the Armament Laboratory of Wright Air Development Center. Work was initiated and completed under Research and Development Order No. 552-659, Bomb Suspension and Related Special Weapons Equipment.

Project engineer on this work was Mr. Paul B. Winterhalter.

ABSTRACT

A program of static and environmental testing was conducted on the Aero X61A and Aero X61B bomb racks in the Armament Laboratory of Wright Air Development Center between August 1951 and February 1952.

The purpose of the tests was to determine the suitability of the bomb racks to function under adverse climatic conditions and, in addition, to determine the capability of the racks to release loads approximating 10,000 lbs.

No data on flight tests of a complete bomb suspension and release system incorporating the Aero X61 series of bomb racks has been included in this report because of security requirements.

The bomb racks are designed for the release of 2000 lb. stores. Mechanical revisions in the racks were necessitated by the need for a release mechanism capable of releasing the 10,000 lb. load.

Redesign recommendations were forwarded to the Douglas Aircraft Company as operational failures in the bomb racks were encountered and analyzed. These failures usually resulted as attempts were made to operate the racks under the higher load condition.

It is concluded that the Aero X61B bomb rack, incorporating the design revisions as recommended, is acceptable for Air Force use.

The security classification of the title of this report is [redacted] UNCLASSIFIED

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDING GENERAL:

for GORDON A. BLAKE
Brigadier General, USAF
Chief, Weapons Components Division

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INTRODUCTION

The Aero X61A bomb rack, commonly referred to as the "Three-Hook Bomb Rack", is an external store carrying unit with built-in sway braces, hoist attaching fitting, and electrical release mechanism. Essentially, the rack consists of a housing containing two carrying hooks (with three point suspension, one forward and two aft); spring loaded cocking levers; and a solenoid for electrical actuation of the release mechanism. Weight of the external store rack is 22.3 lbs.

The salient feature of the Aero X61B bomb rack is the incorporation of a dual solenoid in the electrical release mechanism. By contrast, the Aero X61A bomb rack utilizes a single solenoid.

The bomb racks were manufactured by the Douglas Aircraft Company, El Segundo, California. Two racks of the B type and one of the A type were delivered to the Air Force for test and evaluation. Douglas part number of the A rack was 5258077-500; serial number 2H. Corresponding numbers of the B racks were 5432515-501, serial number X3; and 5432515-501, serial number X4. For the purpose of brevity, The Aero X61A bomb rack is referred to throughout the body of the report as the 2H rack. By the same token, the Aero X61B bomb racks are referred to as the X3 and X4 racks, respectively.

The sole test to which the Aero X61A bomb rack was subjected was the static load test. All other tests including time of release, cold, heat, frost, humidity, sand and dust, salt spray, natural vibration frequency survey, high voltage, minimum voltage, minimum impulse, and the life test were performed on the Aero X61B bomb racks.

I Static Load Tests:

The 2H bomb rack was subjected to structural tests in accordance with the load factor requirements outlined below.

The rack satisfactorily supported 100 per cent ultimate load for all required loading conditions. The rack was tested to destruction for the down load condition. As 215 per cent ultimate load was being applied, (59,100lbs.), the rack release mechanism failed.

The load factor requirements under which the rack was tested are as follows:

Condition A - Straight pull-out

11 G down

Condition B - Rolling pull-out

B1 -7.938 G down and 0.939 G outboard combined with

(1) left yaw 1557 lbs. at bomb station 92.78 outboard and 333 lbs. at bomb station 176.00 up.

or (2) right yaw 3199 lbs. at bomb station 75.39 inboard and 333 lbs. at bomb station 176.00 up.

B2 3.831 G down and 1.665 G outboard combined with

(1) left yaw 1769 lbs. at bomb station 81.50 outboard and 303 lbs. at bomb station 182.60 up.

or (2) right yaw 1769 lbs. at bomb station 78.10 inboard and 303 lbs. at bomb station 182.60 up.

Condition C - Straight yaw

1.0 G down combined with

(1) left yaw 3156 lbs. at bomb station 98.8 outboard and 383 lbs. at bomb station -285.5 up.

or (2) right yaw 5160 lbs. at bomb station 77.7 inboard and 383 lbs. at bomb station -285.5 up.

Condition D - Ejector Loads

10,000 lbs. at bomb station 61.0 down and 1000 lbs. at bomb station 101.0 down.

Note: These ejector loads are to be combined with loads for conditions A, B and C, above.

These loading conditions were based upon external carriage of a 1700 lb. store on a F-84G airplane on a pylon equipped with bomb ejectors which apply preload to the store until the store is released.

The results of all structural tests are contained in Tables I through IV. A sketch showing the arrangement of structural members during the tests is shown following Table IV.

Illustrations 1 through 4 indicate the condition of the 2H rack subsequent to the destruction test. As is visibly evident, breakage occured in the channel, Douglas part number 2267266.

II Time of Release Tests:

In order to determine the time of release characteristics of the bomb rack under various loading conditions, a series of loads was applied to the X3 rack, and each load in turn was released by the application of 28 volts to the

TABLE I

Equipment Tested: Aero X61A Bomb Rack   Type of Test: Ultimate Load Test   Test Data: Load Schedule in Lbs

% Ultimate Load	Test No. 1			Test No. 2						Test No. 3						Test No. 4		
	Sta. 63	Sta. 60	Sta. 100	Sta. 63	Sta. 63	Sta. 60	Sta. 100	Sta. 92.78	Sta. 176	Sta. 63	Sta. 63	Sta. 60	Sta. 100	Sta. 75.39	Sta. 176	Sta. 63	Sta. 63	Sta. 60
20	4400	2120	240	3175	374	2120	240	312	67	3175	374	2120	240	640	67	1532	666	2120
40	8800	4240	480	6350	748	4240	480	624	133	6350	748	4240	480	1280	133	3064	1332	4240
60	13200	6360	720	9525	1122	6260	720	936	200	9525	1122	6360	720	1920	200	4596	2000	6360
80	17600	8480	960	12700	1496	8480	960	1248	266	12700	1496	8480	960	2560	266	6128	2664	8480
100	22000	10600	1200	15875	1870	10600	1200	1560	333	15876	1870	10600	1200	3200	333	7660	3330	10600
	Down	Down	Down	Down	Side	Down	Down	Side	Up	Down	Side	Down	Down	Side	Up	Down	Side	Down

TABLE II

Equipment Tested: Aero X61A Bomb Rack   Type of Test: Ultimate Load Test   Test Data: Load Schedule in Lbs

% Ultimate Load	Test No. 4			Test No. 5						Test No. 6					Test No. 7				
	Sta. 100	Sta. 81.5	Sta. 182.6	Sta. 63	Sta. 63	Sta. 60	Sta. 100	Sta. 78.1	Sta. 182.6	Sta. 63	Sta. 60	Sta. 100	Sta. 98.8	Sta. -285.5	Sta. 63	Sta. 60	Sta. 100	Sta. 77.7	Sta. -285.5
20	240	200	60	1532	666	2120	240	354	60	400	2120	240	631	77	400	2120	240	1032	77
40	480	400	120	3064	1332	4240	480	708	120	800	4240	480	1262	153	800	4240	480	2064	153
60	720	600	180	4596	1998	6360	720	1062	180	1200	6360	720	1894	230	1200	6360	720	3096	230
80	960	800	240	6128	2664	8480	960	1416	240	1600	8480	960	2525	306	1600	8480	960	4128	306
100	1200	1000	300	7660	3330	10600	1200	1770	300	2000	10600	1200	3156	383	2000	10600	1200	5160	383
	Down	Side	Up	Down	Side	Down	Down	Side	Up	Down	Down	Down	Side	Up	Down	Down	Down	Side	Up

TABLE III

Equipment Tested:
Aero X61A Bomb Rack

Type of Test:
Ultimate Load Tests

Test Data:
Deflection Data in Inches

% Ultimate Load	Test No. 1				Test No. 2				Test No. 3				No. 4	
	1L	2L	1R	2R	1L	2L	1R	2R	1L	2L	1R	2R	1L	2L
0	.4320	.3905	.4825	.5150	.4130	.3885	.4635	.5025	.4175	.4000	.4520	.4930	.4170	.4000
20	.4160	.3865	.4565	.4965	.4210	.4115	.4140	.4645	.4230	.4230	.3910	.4470	.4310	.4235
40	.3910	.3745	.4325	.4815	.4100	.4200	.3710	.4380	.4240	.4360	.3495	.4160	.4375	.4400
60	.3680	.3620	.4090	.4690	.4100	.4280	.3425	.4180	.4280	.4500	.3040	.3869	.4355	.4510
80	.3430	.3510	.3840	.4565	.4040	.4320	.3015	.3975	.4240	.4580	.2495	.3530	.4355	.4635
100	.3210	.3400	.3600	.4440	.3970	.4345	.2590	.3770	.4185	.4655	.1540	.3135	.4320	.4690
0	.4115	.3870	.4595	.4996	.4190	.4025	.4500	.4900	.4200	.4060	....	.4865	.4220	.4080

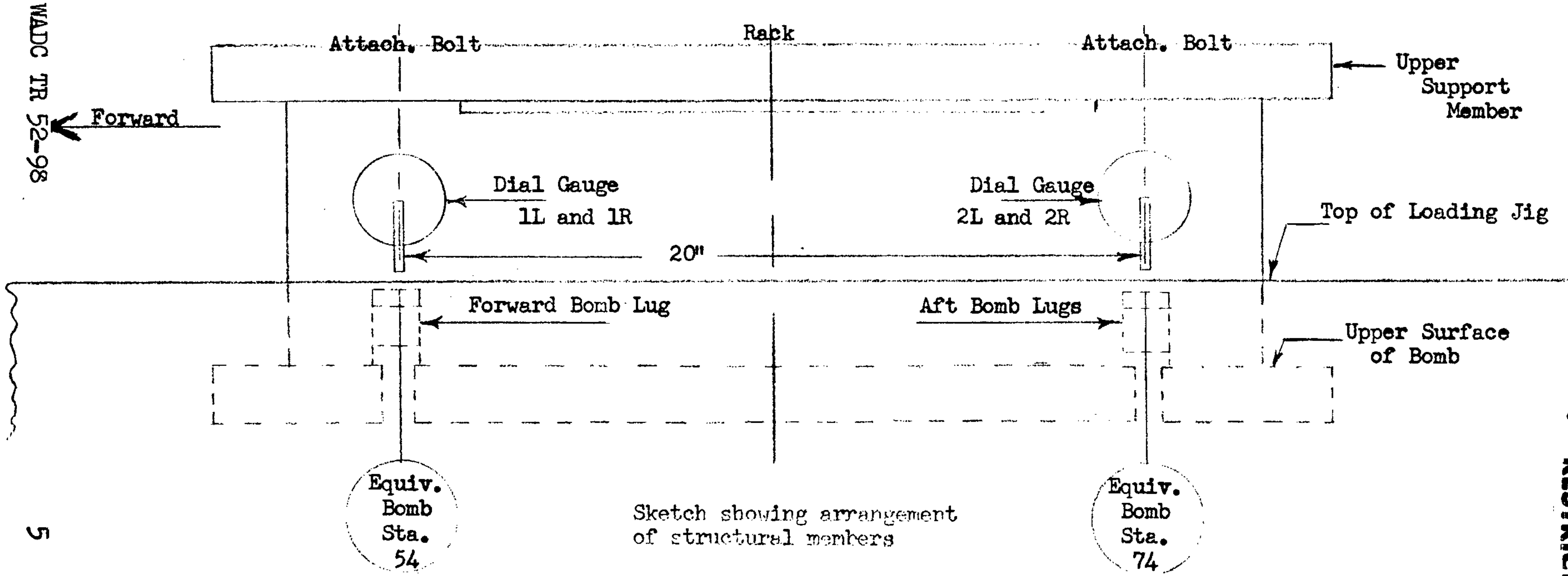
TABLE IV

Equipment Tested:
Aero X61A Bomb Rack

Type of Test:
Ultimate Load Tests

Test Data:
Deflection Data in Inches

% Ultimate Load	No. 4		Test No. 5				Test No. 6				Test No. 7			
	1R	2R	1L	2L	1R	2R	1L	2L	1R	2R	1L	2L	1R	2R
0	.4510	.4910	.4210	.4070	.4465	.4880	.4215	.4070	.4445	.4885	.4190	.3930	.4500	.4880
20	.4080	.4510	.4345	.4280	.4045	.4470	.4490	.4200	.4230	.4500	.4630	.4265	.4075	.4280
40	.3720	.4170	.4415	.4460	.3680	.4115	.4745	.4365	.3870	.4025	.4830	.4385	.3850	.3930
60	.3445	.3925	.4430	.4600	.3330	.3740	.4910	.4460	.3655	.3690	.4980	.4500	.3630	.3560
80	.3120	.3560	.4440	.4715	.3020	.3365	.5040	.4510	.3480	.3385	.5135	.4580	.3425	.3140
100	.2915	.3250	.4435	.4815	.2760	.2950	.5140	.4560	.3255	.3020	.5270	.4670	.3205	.....
0	.4450	.4850	.4230	.4115	.4425	.4845	.4285	.4050	.4415	.4775	.4315	.4020	.4435	.4775



Sketch showing arrangement of structural members

Dial gauges 1L and 2L are on the left side of the rack. 1R and 2R are on the right side. Distance between 1L and 1R or 2L and 2R is 5 inches. Dial gauges are mounted between the top of the loading jig and the upper support member. All side loads were applied to the jig from right to left.

For the destruction test the down loads at stations 60 and 100 were maintained at 100% ultimate load and the down load at station 63 was increased until the rack failed. The rack supported 210 % ultimate load at station 63, but as 215 % ultimate load was being applied the rack release mechanism failed. 210 % ultimate load was determined to be 46,200 lbs. 215 % ultimate load was determined to be 47,300 lbs.

Loads at failure:

Station 60	10,600 lbs.	
Station 63	47,300 lbs.	
Station 100	1,200 lbs	
	59,100 lbs	- Total

release solenoid. The time of release was defined to be the elapsed time from the beginning of the electrical impulse through the release circuit to the moment when the carrying hooks begin to open.

Summarized results for selected loads are as follows:

Load Lbs.	Time of Release Milliseconds
0	17
1000	17
2500	25
5000	17
7500	21
10000	17
12500	15
15000	16

Additional tests of a similar nature were conducted on the X3 rack in order to investigate the effect of a variable voltage upon the time of release of the rack under various high load conditions.

Summarized results:

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	7500	25
20	7500	17
20	7500	20
20	10000	36
20	10000	27
20	10000	25
20	10000	32
20	12500	No Release
20	12500	No Release
22	12500	No Release
24	12500	No Release
26	12500	No Release
26	10000	250
20	12500	62
20	12500	49
26	12500	Released
26	12500	Released
26	12500	Released

On the final release, above, the AN 392-25 pin was sheared. This 1/8 inch diameter pin is a part of the toggle shaft assembly, which in turn is a part of the release mechanism. The AN 392-25 pin was replaced by a pin having the same physical characteristics as to its diameter and tensile strength.

Elongation of the spacer hole through which the above-mentioned pin is positioned was also noticed. Modification of the spacer was effected to the extent that the outer diameter of the spacer was increased from its original dimension of 5/8 inch to 11/16 inch, thus enlarging the wall thickness of the spacer by 1/32 inch. Douglas part number of the spacer is 2267547.

The X3 rack was again subjected to time of release tests under various loads and voltages.

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	0	24
20	2000	24
20	2000	22
20	5000	41
27.5	2000	16
27.5	2000	18
27.5	5000	17
20	5000	No Release
20	5000	No Release
27.5	5000	14
20	5000	33

On the final release, above, the AN 392-25 pin once again sheared. The pin was replaced by a pin having the same dimensions but heat treated to a tensile strength of approximately 130,000 p.s.i.

The X3 rack was again subjected to time of release tests under various loads and voltages in order to determine the suitability of the revised pin to withstand the high loads.

Voltage Volts	Load Lbs.	Time of Release Milliseconds
27.5	5000	17
20	5000	26
27.5	7500	18

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	7500	37
27.5	10000	26
20	10000	No Release
20	10000	33
27.5	12500	18
20	12500	No Release
20	12500	No Release
22	12500	No Release
24	12500	36
27.5	15000	16
20	15000	33

The revised AN 392-25 pin did not shear throughout the series of releases outlined above.

It is not readily apparent from the data accumulated throughout the timing tests just what combination of load and voltage rating could be considered critical as to whether or not the rack would consistently release. Subsequent inspection of the rack interior, however, revealed a brinelling of the K6AR48 bearing surface. It was theorized that failure to release would be encountered should the sear assembly, Douglas part number 2386807, which is linked to the release solenoid, engage the K6AR48 bearing at a point where indentation of the bearing surface has occured.

III Cold Tests:

The X3 rack was placed in a chamber whose ambient temperature was maintained at -65 degrees Fahrenheit. After a period of twenty-four hours had elapsed at this temperature, various loads and release voltages were applied to the rack in order to investigate the release characteristics.

Summary of Results:

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	7000	34
20	10000	47
20	10000	127

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	10000	No Release
20	10000	No Release
27.5	10000	19

The AN 392-25 pin (130,000 p.s.i. tensile strength) again sheared on the final release, above. The pin was replaced by a pin of chrome-molybdenum alloy steel, which was heat treated to approximately 160,000 p.s.i. tensile strength.

IV Frost Test:

The X4 rack, not previously tested, replaced the X3 rack in the cold chamber. The X4 rack was modified to the extent that the AN 392-25 pin was replaced by a pin of chrome-molybdenum alloy steel having a tensile strength of 160,000 p.s.i. Twenty-four hours in an ambient temperature of - 65 degrees Fahrenheit preceded the withdrawal of the X4 rack from the chamber and its placement in a chamber whose interior was maintained at a temperature of ≁ 76 degrees Fahrenheit and a relative humidity of 98 per cent. The X4 rack remained in this environment until all the accumulated frost had disappeared and moisture had collected over the entire rack. The rack was then returned to the cold chamber and a temperature of - 65 degrees Fahrenheit. The temperature was then raised to zero degrees Fahrenheit after eight hours at the lower temperature and the rack subjected to time of release investigation under various loads and voltages. The results are as follows:

Voltage Volts	Load Lbs.	Time of Release Milliseconds
20	2000	25
20	10000	530
27.5	10000	29
20	10000	44
20	15000	No Release
22	15000	No Release
24	15000	No Release
26	15000	No Release
27.5	15000	307

The X4 rack was then subjected to a relative humidity condition of 98 per cent at ≠ 50 degrees Fahrenheit while still in the cold chamber. The temperature was subsequently lowered to - 40 degrees Fahrenheit and kept in that state for seventeen hours. A load of 2000 lbs. was then applied to the rack. Upon the application of 28 volts to the release solenoid the rack released in twenty milliseconds.

The above cycle was then repeated to the extent that the ambient temperature and relative humidity were raised to ≠ 50 degrees Fahrenheit and 98 per cent, respectively. The release portion of the test, however, was more demanding of the rack from a performance standpoint. Instead of maintaining a temperature of - 40 degrees Fahrenheit for a period of seventeen hours and then applying a 2000 lb. load, a temperature of - 65 degrees Fahrenheit was maintained for a similar period and a 10,000 lb. load applied. Two consecutive releases of the heavier load with a voltage of twenty volts resulted in releases of 53 and 65 milliseconds respectively.

V Life Test:

The X4 rack was subjected to a life test, the object of which was to determine the capability of the rack to release high loads consistently and to cycle the bomb rack until mechanical failure occured within the rack. Each cycle consisted of loading the rack to 10,000 lbs. and then releasing the rack electrically with a rated voltage of 28 volts.

During the first 120 cycles of the life test 14 failures to release were encountered before the AN 392-25 pin again sheared.

In order to alleviate the intermittent failure condition, three changes were made in the release mechanism of the rack. These changes were:

(1) A Nice bearing, AN 201-KP8A, with a higher radial load characteristic was substituted for the Fafnir bearing, part number K6AR48. The Fafnir bearing maximum radial load was 600 lbs., while the Nice bearing would support 1950 lbs. It was hoped that this change would eliminate the brinelling situation which the higher loads were imposing on the K6AR48 bearing.

(2) The substitute AN 392-25 pin was replaced by a pin having a diameter enlarged by 1/32 inch. The physical characteristics of this pin were a material of chrome-molybdenum alloy steel heat treated to 160,000 p.s.i. and having a diameter of 5/32 inch.

(3) Douglas spacer number 2267547 was replaced by a spacer of steel material. The Douglas spacer, being made of aluminum, was exhibiting elongation of the hole through which the AN 392-25 pin was positioned. The new steel spacer was also machined to accommodate the larger diameter pin mentioned above.

Following the above changes, the X4 rack, under a 10,000 lb. load condition released 2523 consecutive times before rack failure was noted. Disassembly of the X4 rack revealed the following conditions:

(1) Breakage of spring number 2267936

(2) Severe deformation of stop number 2254177

(3) Excessive wear on the housing assembly caused by the lateral movement of link number 2267255 against housing bosses.

(4) Rough movement of the dual solenoid as evidenced by manual operation.

(5) Indentation of channel number 2267266 at a point where it contacts clip number 2432871.

Illustrations 5 through 7 indicate the condition of the bomb rack and stop after the life test had been completed.

This rack failure must not be construed as a failure to release. The presence of the load in this case would be sufficient to cause the carrying hooks to open when the solenoid was electrically activated.

It was thought advisable to ascertain certain physical aspects to which the bomb rack was being subjected under a high load as applied by the test jig. To attain this information, high speed motion pictures were made of the X4 rack in operation. Attention was focused on the displacements, velocities and accelerations imparted to the carrying hooks, and the cocking handle as it revolved, upon release.

Illustrations 8 through 10 indicate a comparison between the physical aspects imparted to the rack while releasing loads of 2000 and 15,000 lbs. The weight referred to in illustration number 10 is a 65 lb. metal slab of dimensions 30 inches by 5 inches by 1½ inches. The loads referred to were hydraulically applied through this item which incorporated three carrying lugs. Essentially, this article simulated an actual bomb of three point suspension.

VI Minimum Voltage Test:

A minimum voltage test was conducted on both the X3 and the X4 racks simultaneously. It was established that the lowest no load release voltage at this time necessary to trip the rack was 13.8 volts on each rack.

VII X3 Rack Rework:

At the suggestion of the Douglas Aircraft Company, the X3 rack was returned to the Douglas organization in order to introduce an anti-icing feature into the bomb rack. This additional feature was the outgrowth of tests conducted by Douglas Aircraft on the use of Dow Corning DC4a water repellent compound at critical points throughout the rack. Satisfactory performance under cold conditions without the use of internal heaters was the objective of the use of Dow Corning water repellent compound.

When the X3 rack was returned by Douglas Aircraft it embodied seven fittings through which the DC4a compound was to be inserted into the rack. These fittings were positioned at the following places:

(1) At both ends of the aft pin around which the aft hooks pivot.

(2) At both ends of the cocking shaft.

(3) At both ends of the manual release shaft.

(4) On the left hand side, looking aft, of the front pin, around which the forward hook pivots.

In addition, at the request of the Air Force, the rack hoist bracket was discarded and replaced by a simple cover assembly consisting of two discs 3-15/32 inches in diameter connected by a NAS 42DD-106 spacer. The cocking handle was also changed to the extent that it no longer rotated when the rack was released.

VIII Comparison Cold and Frost Tests:

Upon receipt of the modified X3 rack, it was impregnated with the DC4a compound as specified. A series of comparison frost and cold tests between the X3 rack (with the water repellent compound) and the X4 rack was begun. A chronological sequence of events is outlined below.

(1) The X3 rack was subjected to a - 65 degree Fahrenheit temperature for seven hours; withdrawn from the chamber and placed in an ambient temperature of ≠ 76 degrees Fahrenheit until the accumulated frost had melted.

(2) A weight of sixty-five lbs. was loaded to the X3 rack; the rack was reinserted into the cold chamber at - 65 degrees Fahrenheit and successfully electrically operated after twenty hours at this temperature.

(3) The X4 rack was subjected to the same conditions outlined in 1 and 2, above, terminating in successful electrical operation.

(4) The X4 rack was again defrosted and reinserted into the cold chamber with the accompanying temperature of - 65 degrees Fahrenheit.

(5) Seven hours after being returned to the cold chamber the X4 rack would not release, either electrically or manually.

(6) The X3 rack, loaded to sixty-five lbs., was again subjected to a - 65 degree temperature for a period of sixteen hours; withdrawn for frosting and defrosting; reinserted into the cold chamber at - 65 degrees Fahrenheit; and successfully operated by electrical actuation after seven hours at the low temperature.

(7) The X3 rack was again subjected to the above procedure with the above exception that a period of sixteen hours after reinsertion elapsed before a successful electrical operation was attempted.

(8) Two additional successful electrical releases were made on the X3 rack after being frost cycled; i.e., removal from the cold chamber

after twenty-four hours at - 65 degrees Fahrenheit; placement in a chamber maintained at ≁ 76 degrees Fahrenheit and 98 per cent relative humidity until moisture covers the rack; re-insertion into the cold chamber at - 65 degrees Fahrenheit for a period of eighteen hours.

(9) When the X4 rack (without water repellent compound) underwent the procedure outlined in 6, above, failure to release the rack either electrically or manually was encountered.

The evidence indicates that the presence of the DC4a compound was advantageous to the successful operation of the rack under frost and cold conditions while carrying a small load.

IX High Voltage Tests:

The dual solenoid of the X3 rack underwent a test to determine whether the electromagnetic unit would withstand a voltage of 30 volts d.c. for a period of thirty seconds without incurring damage. Although no temperature or insulation readings were made, current variations through the solenoid are indicated. Several test runs were made at selected intervals.

Summary of Results:

	Time in Seconds	Current in Amperes
(1)	0	13.3
	10	12.3
	20	11.6
	30	10.9
One minute interval		
(2)	0	12.0
	10	11.4
	20	10.8
	30	10.4
Three minute interval		
(3)	0	11.8
	10	11.2
	20	10.7
	30	10.3

X Natural Vibration Frequency Survey:

A natural frequency survey was conducted on the X3 rack throughout the frequency range of zero to 300 cycles per second on the three major axes of the rack assembly.

A natural frequency of a component part within the rack was noted at a frequency of 103 cycles per second while the rack was being vibrated in a vertical plane. Evidence to support the claim that a component was being vibrated at its natural frequency was present in the form of noise emanating from the rack interior and the sudden increase in vibratory acceleration indicated through instrumentation.

A fatigue test was performed on the X3 rack at a frequency of 103 cycles per second. The rack was vibrated at an acceleration of 4 G's along the vertical axis.

In order to facilitate stroboscopic investigation of the rack interior under a vibrating condition, one half of the X3 housing was removed and replaced by a remachined housing of the 2H rack which was previously rendered inoperative as a result of structural testing.

The X3 rack was vibrated continously at a frequency of 103 cycles per second for a period of time necessary to accomplish 10 million cycles. Throughout the fatigue test the rack was cocked with no applied load.

With the aid of a stroboscope it was apparent that considerable lateral movement, both in a fore and aft and sideways direction was occuring in link number 2267255 which connects the fore and aft carrying hooks. The extent of the damage which this lateral movement was causing was not perceptible until the fatigue test was completed and the housing was removed. Inspection of the interior then revealed the presence of minute metal filings in areas immediately around the points where the aforementioned link is joined to the fore and aft hooks. It was concluded that the lateral movement and resulting wear was not sufficient to impair the operational qualities of the bomb rack.

XI Minimum Impulse Test:

The X3 rack was subjected to a release impulse test to insure that the release mechanism would operate on an electrical impulse of duration not exceeding 20 milliseconds. As is evident from the following data, the rack operates well within the impulse limit of 20 milliseconds, with an impulse of 8 milliseconds appearing to be the critical length of impulse.

Minimum Impulse Results:

Seconds	
.006	No Release
.006	No Release
.008	No Release
.008	No Release
,008	No Release
.008	Release
.010	Release
.010	Release
.012	Release
.012	Release
.012	Release
.014	Release
.014	Release

XII Sand and Dust Test:

The X3 bomb rack, thoroughly impregnated with the DC4a compound, underwent a sand and dust test in accordance with the following procedure.

The equipment was placed in a test chamber where the sand and dust density was maintained at 0.1 to 0.5 grams per cubic foot within the test space. The relative humidity did not exceed 30 per cent at any time during the test. The internal temperature of the test chamber was maintained at +77 degrees Fahrenheit for a period of twelve hours with air velocity through the test area of approximately 800 feet per minute; then raised to a temperature of +160 degrees Fahrenheit for an additional period of twelve hours with the same air velocity. At the expiration of this twenty-four hour period the bomb rack was permitted to cool. The X3 rack was then subjected to time of release investigation. Under a no-load condition, the bomb rack mean release time of six releases was found to be seventeen milliseconds. Condition of the bomb rack interior after test may be seen in illustrations 11 and 12.

XIII Heat Test:

The X3 bomb rack, incorporating the DC4a compound, was placed in a heat chamber and subjected to a temperature of + 165 degrees Fahrenheit for a period of four hours. The time of release characteristics of the bomb rack were investigated at the end of this period. The bomb rack mean time of three releases was found to approximate eighteen milliseconds.

XIV Salt Spray Test:

The X3 bomb rack was then placed in a salt fog chamber whose temperature was maintained at + 95 degrees Fahrenheit. Atomizing equipment, designed to produce a finely divided, wet, dense salt fog was present inside the chamber. At the end of the salt spray test which lasted fifty-two hours, the bomb rack was examined and satisfactorily operated. Visual inspection revealed very little corrosion, either on the bomb rack interior or exterior.

XV Humidity Tests:

The X4 bomb rack was subjected to a humidity test in accordance with the following procedure.

The rack was placed in a test chamber capable of being sealed and maintained at a temperature of + 160 degrees Fahrenheit and a relative humidity of 95 per cent for a period of 6 hours. At the conclusion of the 6-hour period the heat was turned off. During the following 18-hour period the temperature was permitted to drop at a uniform rate. The cycle was then repeated a sufficient number of times to extend the total time of the test to 360 hours or 15 cycles. Two hours after the 15 cycles were completed and the bomb rack had been removed from the test chamber, two consecutive electrically activated releases were effected. Four days later, however, neither electrical or manual releases on the X4 rack could be made. Subsequent inspection of the rack interior revealed a considerable amount of rust on spring number 2267936, bearing number AN 201-KP8A, and on areas adjacent to and linkages coupled to the double solenoid.

It was thought that at least two factors contributed to the rusting of the aforementioned parts:

(1) The X4 rack had previously been subjected to a life test and the relatively great number of high load releases could have possibly removed some of the protective plating.

(2) The humidity condition inside the test chamber was maintained through the use of ordinary tap water rather than distilled water as specified. This tap water contained a certain amount of mineral matter which was probably a factor in the producing of the rust.

In order to remedy the previous invalid humidity test the X3 bomb rack, which had been subjected to a relatively small number of releases, was placed in a test chamber whose humidity condition was obtained from the use of distilled water.

In addition, a bomb rack of the A type, Douglas part number 5258077 ; serial number 127 F, was obtained from the Special Weapons Command, Kirtland Air Force Base, on a loan basis. This rack had never been subjected to test or frequent releases. The A rack was also placed in the test chamber along with the X3 rack in order to serve as a basis of comparison.

The previously mentioned humidity cycling procedure was repeated until fifteen cycles had been completed on both racks.

Two days after the racks had been removed from the test chamber and the humidity test, electrical release of each rack was accomplished. Inspection of the rack interiors, however, revealed a pronounced contrast. While the A type of rack interior remained free of a rusting condition, the X3 rack interior was heavily corroded much in the same manner that the X4 rack interior was corroded after a humidity test.

CONCLUSIONS

Structurally and operationally, the Aero X61 series of bomb racks are acceptable mechanisms for the carriage and release of 2000 lb. external stores in the subsonic speed range.

No data on flight tests of a complete bomb suspension and release system incorporating the Aero X61 series of bomb racks has been included in this report because of security requirements.

Redesign emphasis was placed upon modification of the B type of rack. The type of rack found acceptable for Air Force use evolved, through engineering changes, into a rack defined by Douglas part number 5432515-509.

A recapitulation of changes made on the original type of rack presented for test and evaluation follows.

(1) Elimination of the internal heaters and controlling thermostat.

(2) Placement of NAS 497 fittings on both ends of the aft hook pin assembly in order to accommodate Dow Corning water repellent compound.

(3) Placement of the same type fitting on both ends of the cocking toggle shaft assembly, on both ends of the manual release shaft, and on one end of the forward hook pin assembly; all fittings to accommodate the water repellent compound. In addition, access holes to enable the compound to spread freely over the outer portion of the shafts and pins were positioned at selected intervals on the shafts and pins.

(4) The hoisting bracket was discarded and replaced by a simple cover assembly consisting of two discs connected by a spacer.

(5) The AN 392-25 1/8 inch diameter stop pin was replaced by a pin of 5/32 inch diameter and heat treated to a tensile strength of 160,000 - 180,000 p.s.i.

(6) The preceding change thereby necessitated corresponding diameter changes in the spacer and channel through which the stop pin is positioned.

(7) The Fafnir bearing, number K6AR48, was replaced by bearing AN 201KP-8A.

A bomb rack of the B type which encompassed all of the above changes successfully underwent the testing noted in this report.

Although no dielectric breakdown tests were conducted, no apparent damage to the electromechanical unit was noticed and the dual solenoid operated satisfactorily many times after the high voltage test was performed.

The humidity test disclosed that a substantial amount of internal corrosion may be expected after several releases should the bomb rack remain in a humid environment.

RECOMMENDATIONS

Occasions may arise where a type of release mechanism of three point suspension capable of the carriage and release of external stores not exceeding 10,000 lbs. in weight is desired for use.

When this situation exists, and the lateral distance between the fore and aft suspension points is of the order of twenty inches, then the Aero X61B external stores rack defined by Douglas part number 5432515-509 is recommended for use.

Maintenance operations on the Aero X61B external stores rack should include provisions for periodic inspection of the rack interior to investigate for the possible presence of corrosion.

Where corrosion exists, disassembly of the rack and replacement of affected parts should be accomplished.

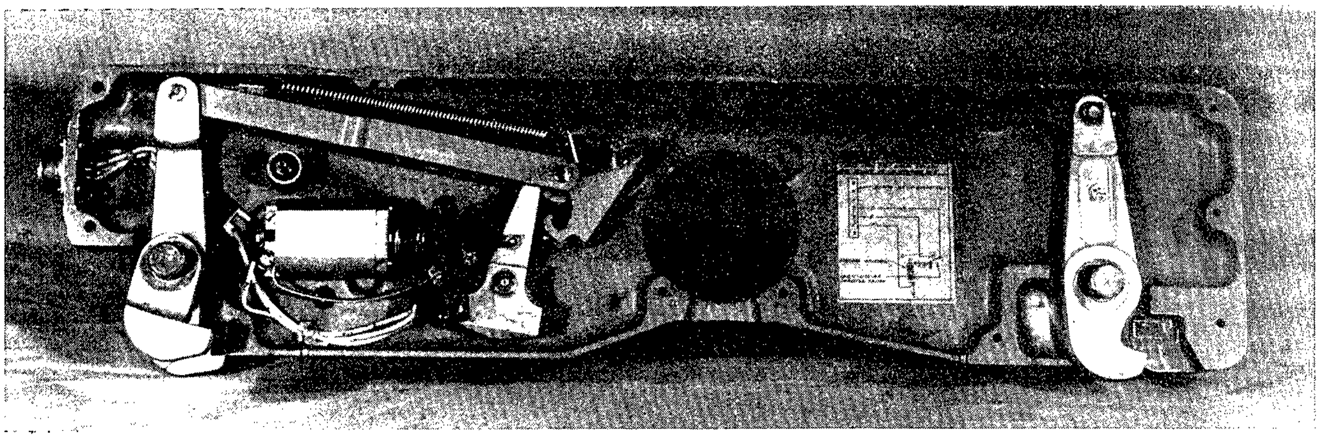


Figure 1. Aero X61A Bomb Rack After Structural Testing

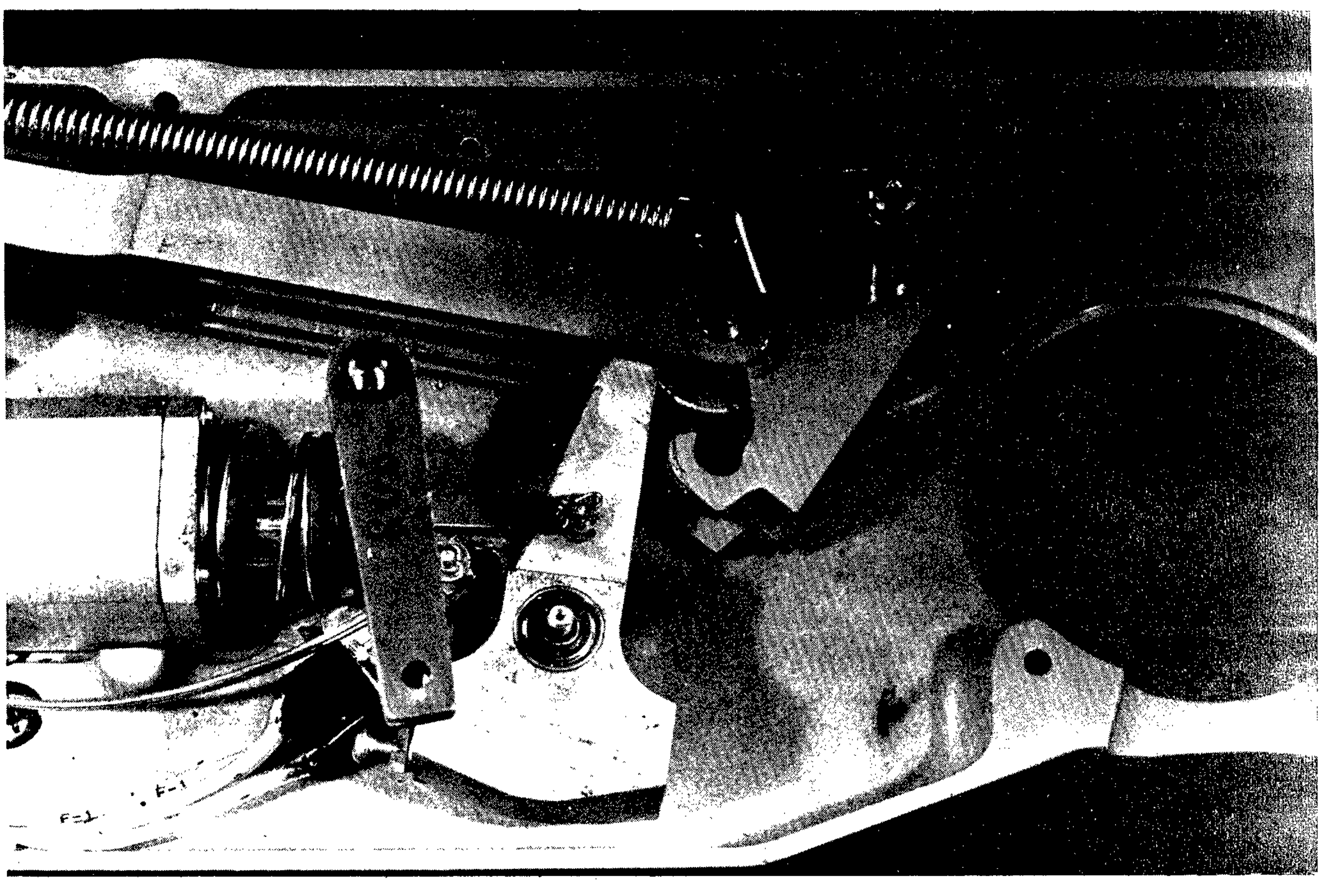
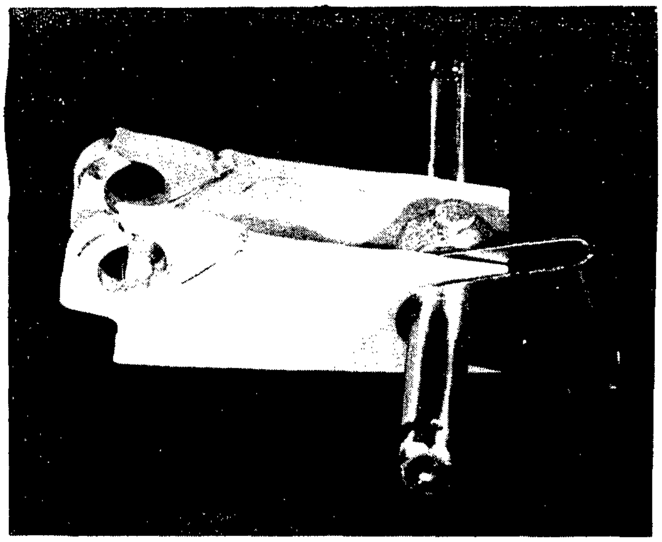


Figure 2. Close-Up of Aero X61A Bomb Rack After Structural Testing



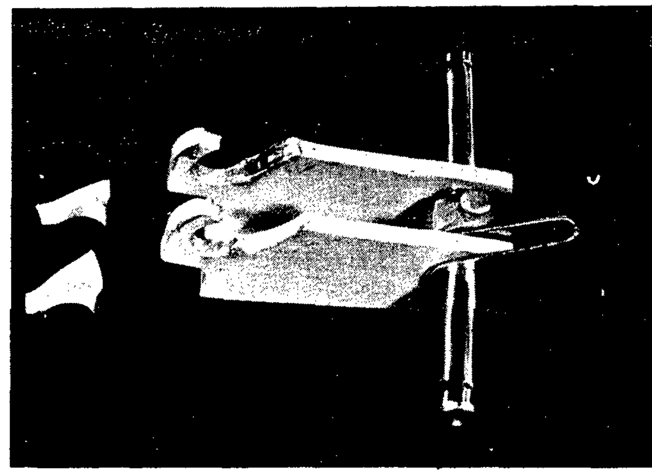


Figure 4. Channel No. 2267266 After Structural Testing

Figure 3. Channel No. 2267266 After Structural Testing

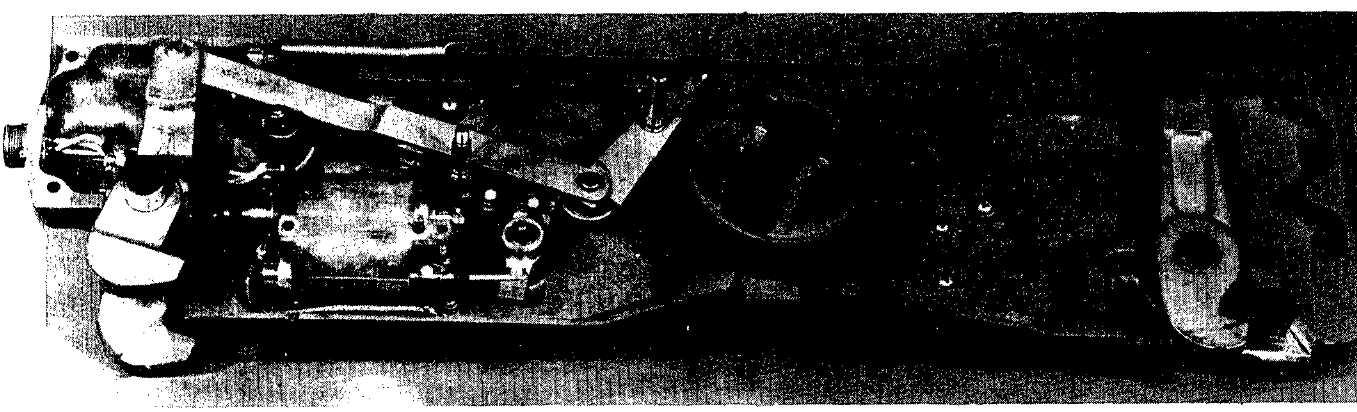


Figure 5. Aero X61B Bomb Rack After Life Test

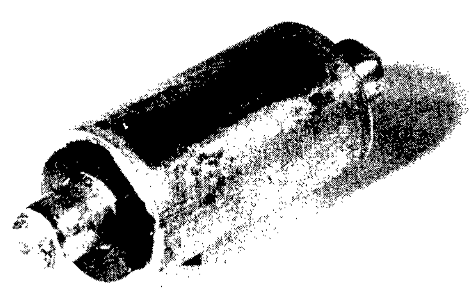


Figure 6. Aero X61B Bomb Rack Stop No. 2254177 After Life Test

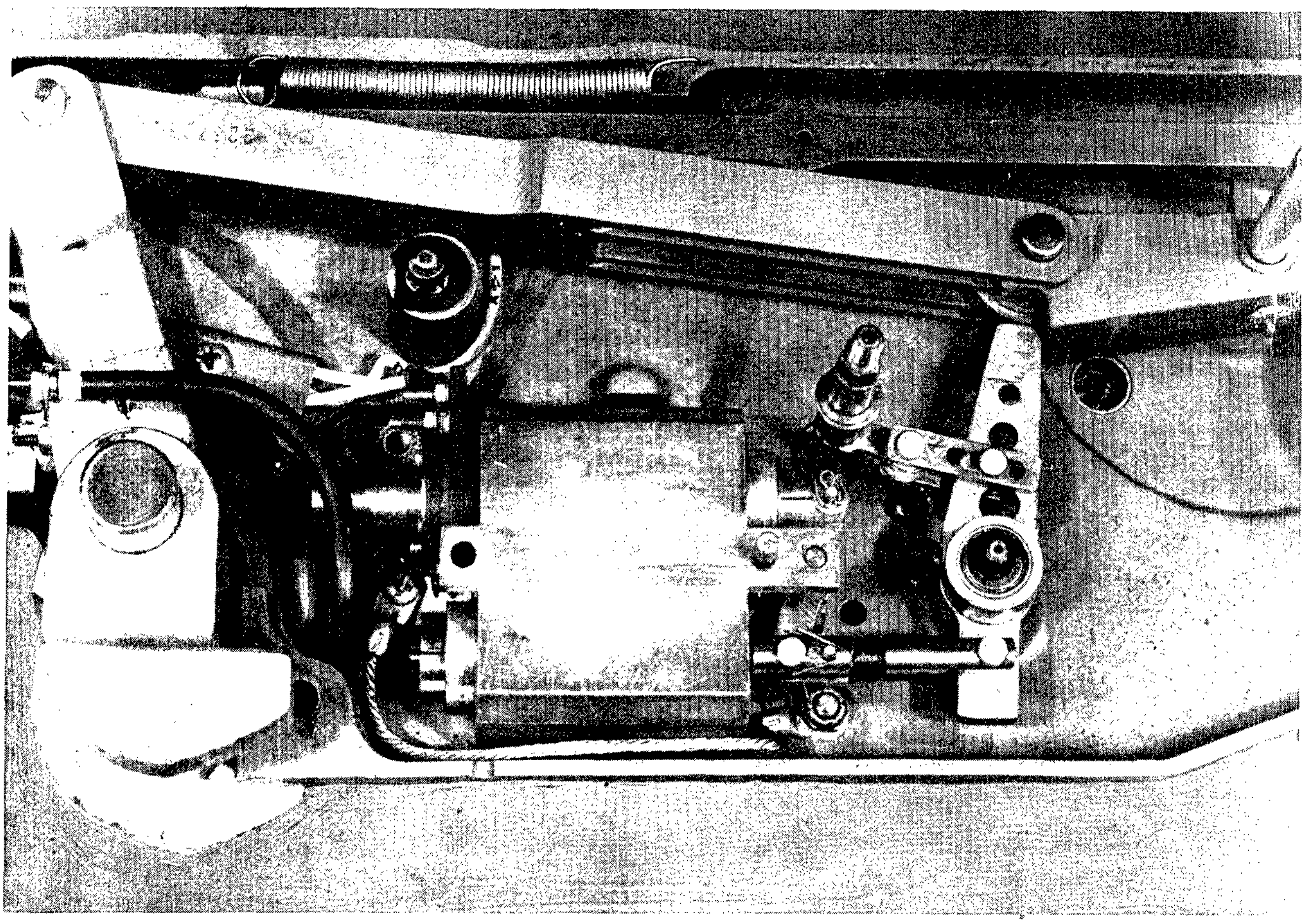


Figure 7. Close-Up of Aero X61B Bomb Rack After Life Test

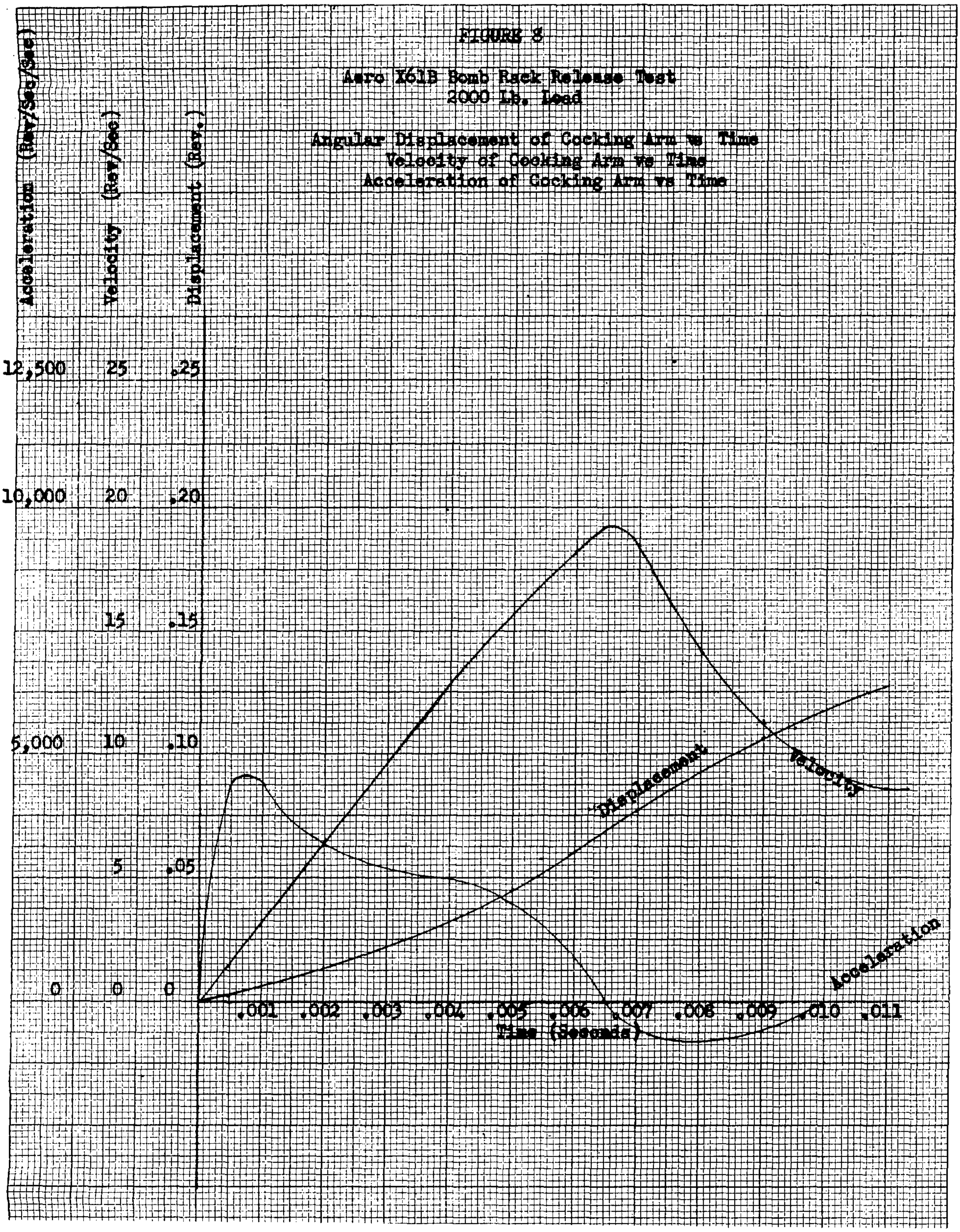


FIGURE 8
Aero X61B Bomb Rack Release Test
2000 Lb. Load
Angular Displacement of Cocking Arm vs Time
Velocity of Cocking Arm vs Time
Acceleration of Cocking Arm vs Time
Acceleration (Rev/Sec/Sec)
Velocity (Rev/Sec)
Displacement (Rev.)
12,500 25 .25
10,000 20 .20
15 .15
5,000 10 .10
5 .05
0 0 0
.001 .002 .003 .004 .005 .006 .007 .008 .009 .010 .011
Time (Seconds)
Displacement
Velocity
Acceleration

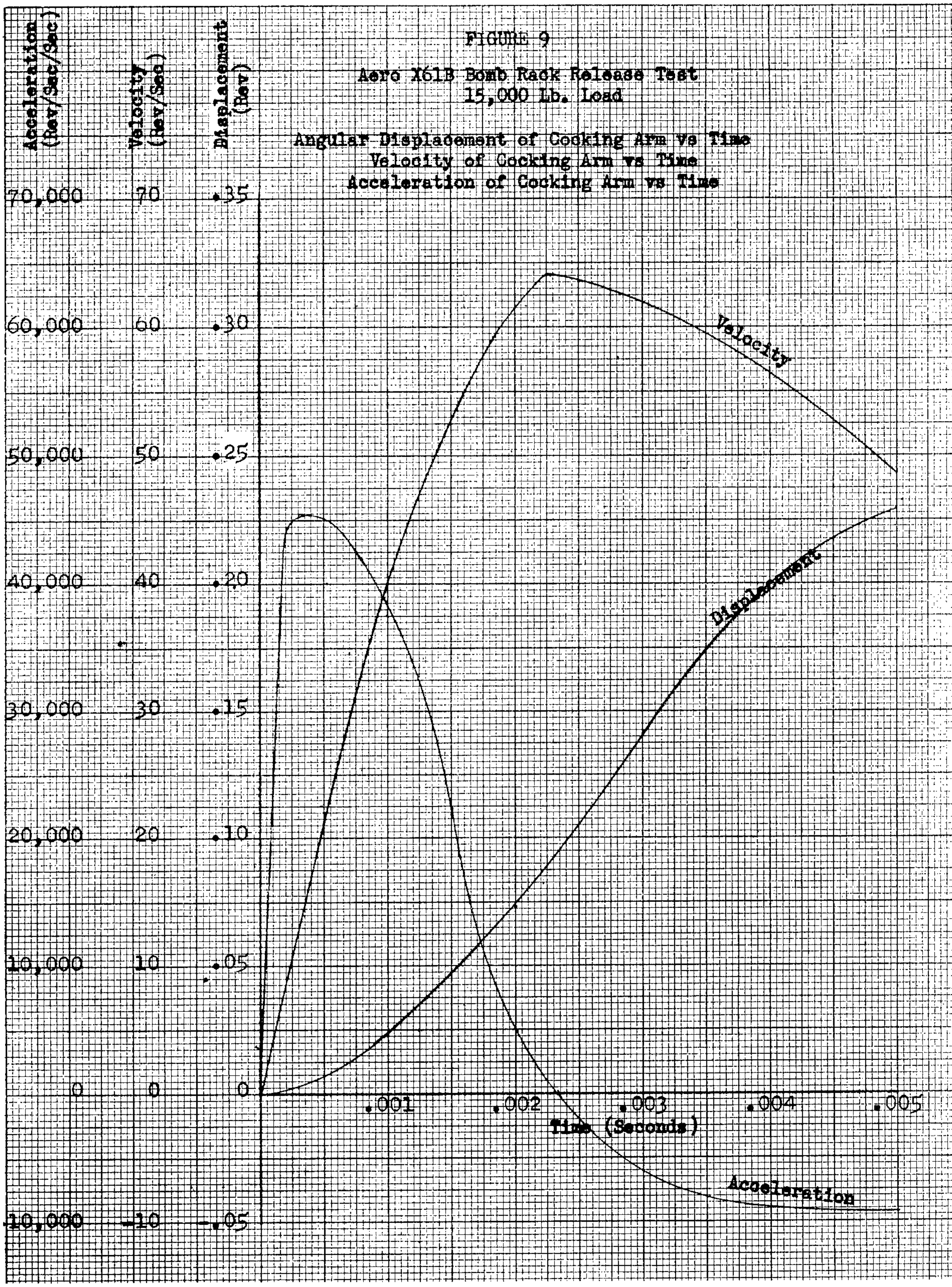


FIGURE 9
Aero X61B Bomb Rack Release Test
15,000 Lb. Load
Angular Displacement of Cocking Arm vs Time
Velocity of Cocking Arm vs Time
Acceleration of Cocking Arm vs Time
Acceleration (Rev/Sec/Sec)
Velocity (Rev/Sec)
Displacement (Rev)
70,000
70
.35
60,000
60
.30
50,000
50
.25
40,000
40
.20
30,000
30
.15
20,000
20
.10
10,000
10
.05
0
0
0
-10,000
-10
-.05
.001
.002
.003
.004
.005
Time (Seconds)
Velocity
Displacement
Acceleration

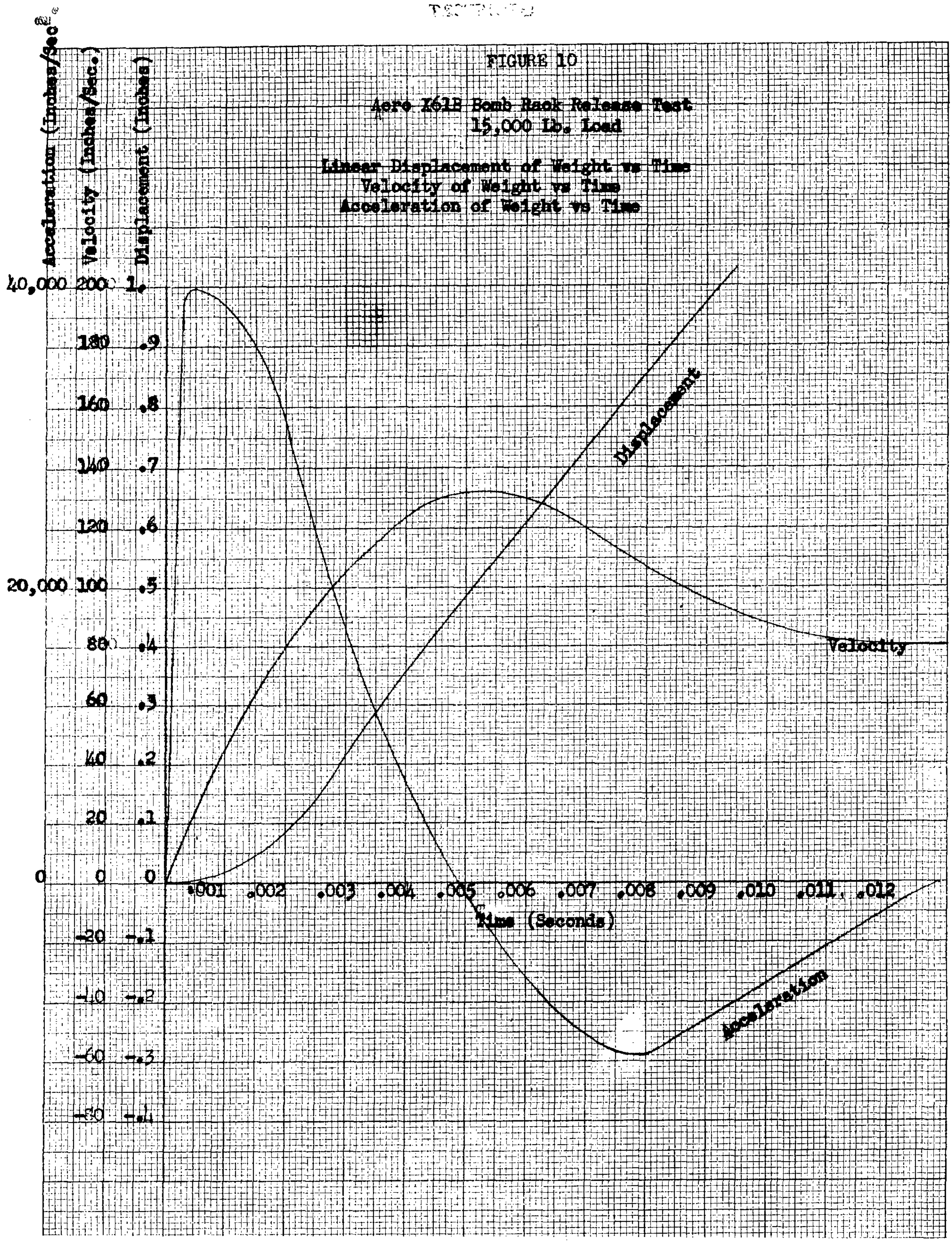


FIGURE 10
Aero X61B Bomb Rack Release Test
15,000 Lb. Load
Linear Displacement of Weight vs Time
Velocity of Weight vs Time
Acceleration of Weight vs Time
Acceleration (Inches/Sec²)
Velocity (Inches/Sec.)
Displacement (Inches)
40,000
20,000
0
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
-.1
-.2
-.3
-.4
.001
.002
.003
.004
.005
.006
.007
.008
.009
.010
.011
.012
Time (Seconds)
Displacement
Velocity
Acceleration

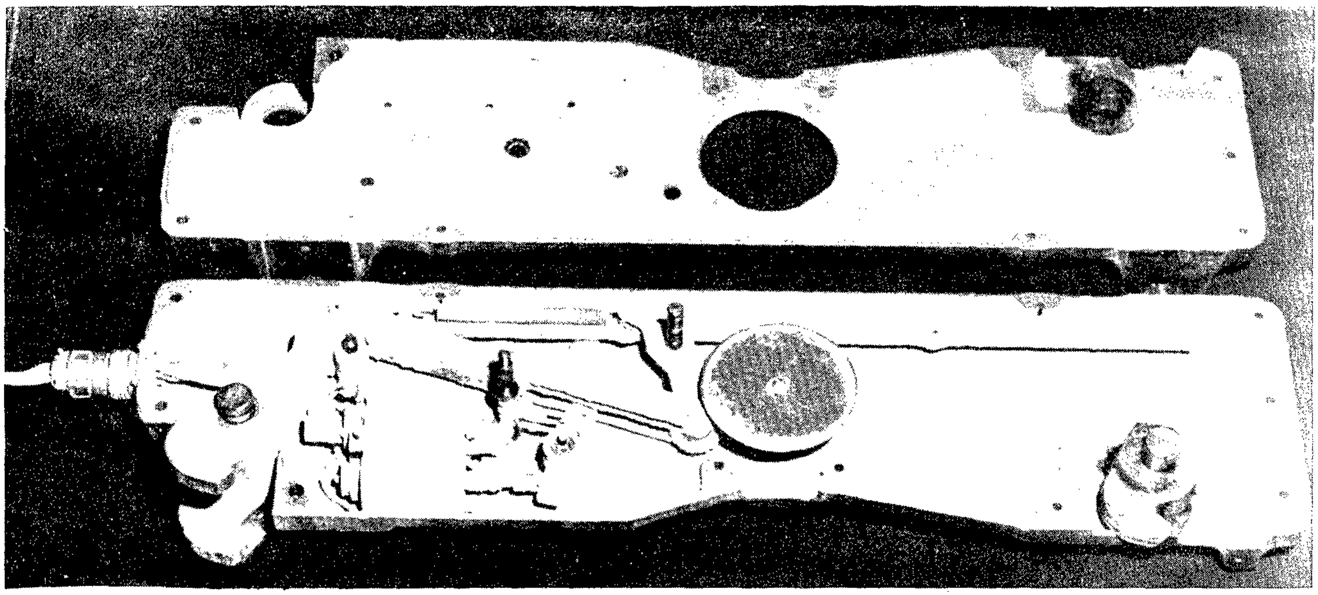


Figure 11. Aero X61B Bomb Rack After Sand and Dust Test

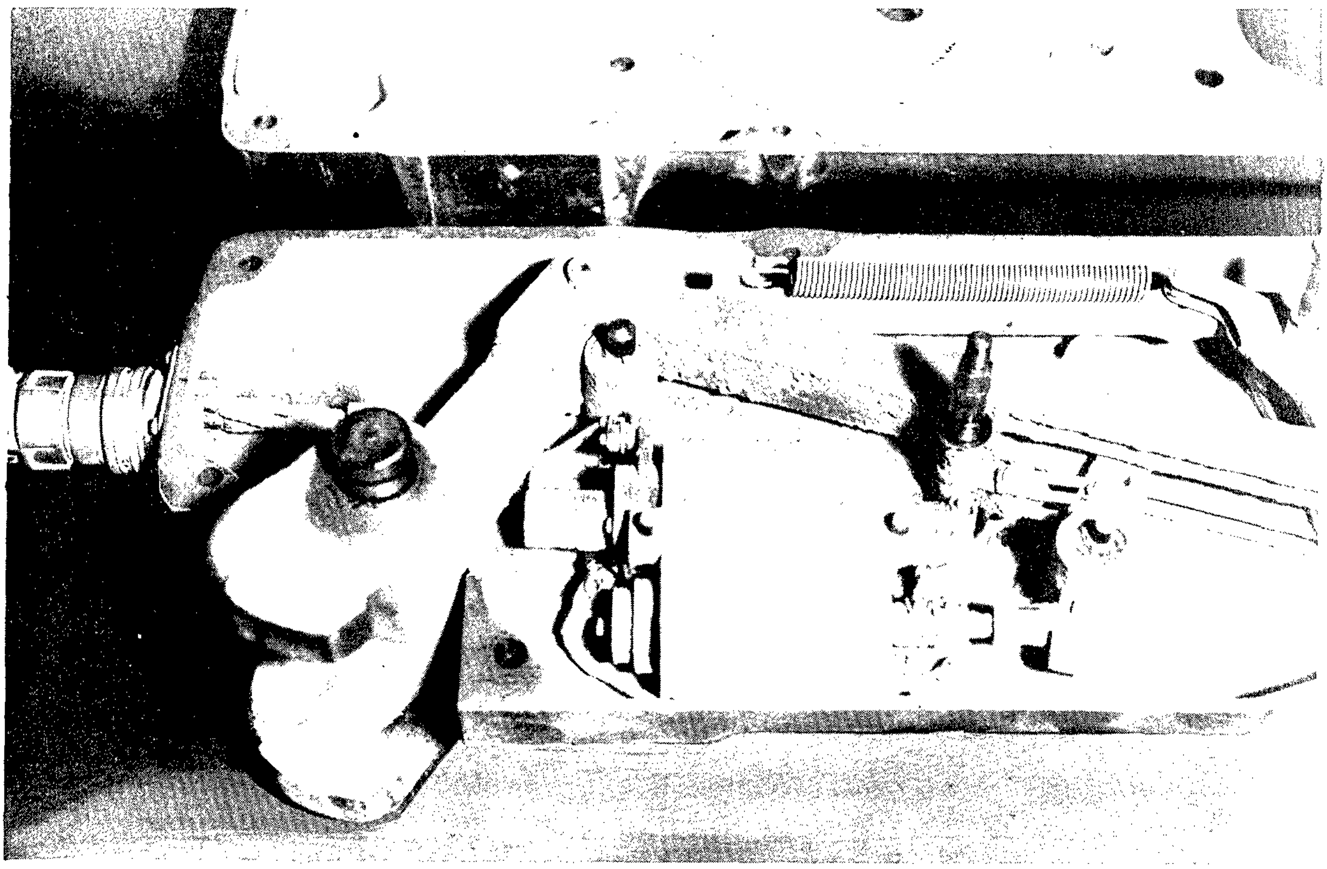


Figure 12. Close-Up of Aero X61B Bomb Rack After Sand and Dust Test

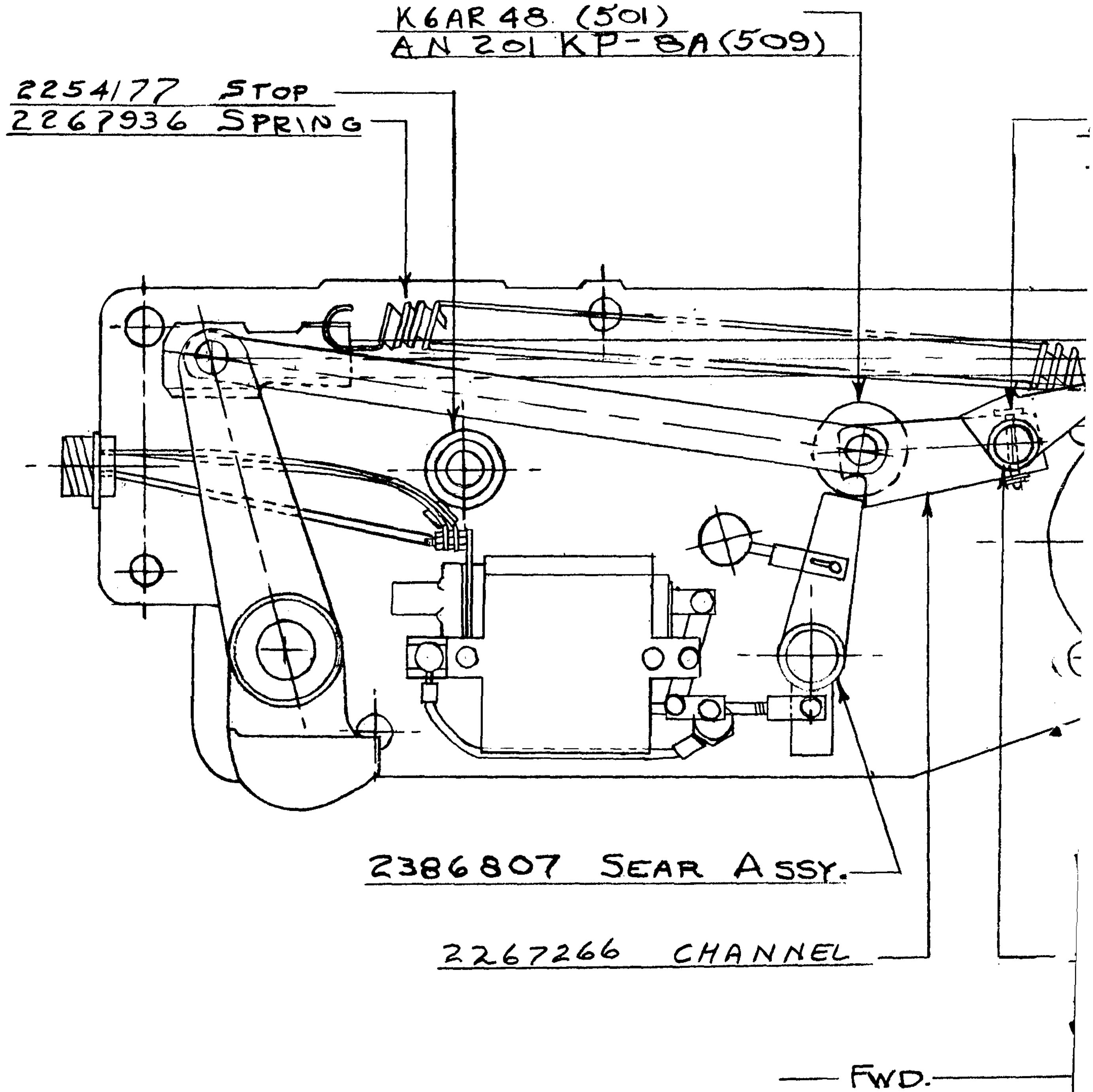
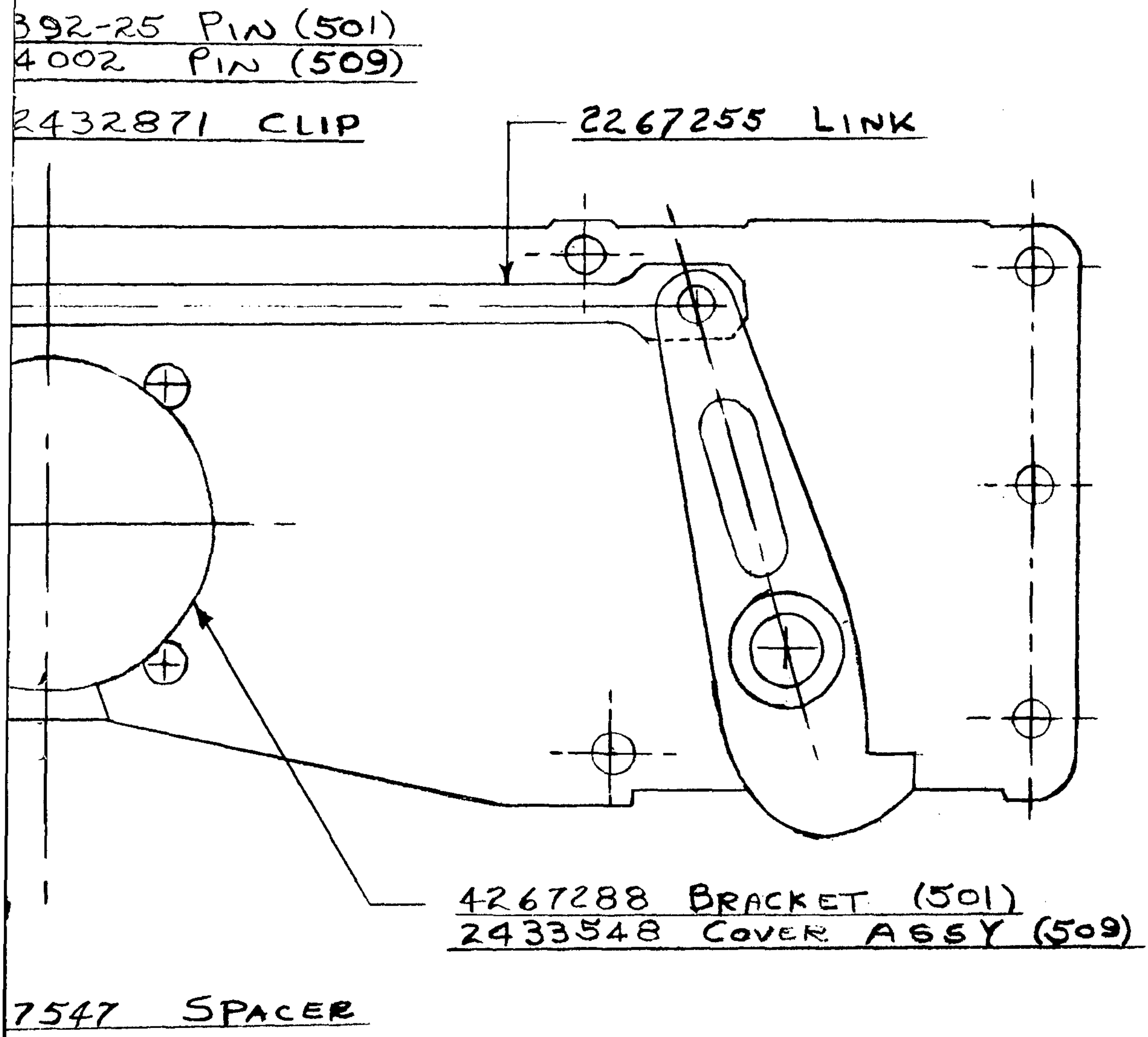


Figure 13. Drawing of Aero X61B Bomb Rack Outlining Parts Referred to in Report



BOMB RACK ~ DUAL
SOLENOID, THREE HOOK

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1	WCNSO
2	WCEGH
1	WCSWB
1	WCSS
1	WCSWF
1	MCPPAA
1	MCPPAE
1	MCMMTF-41
4	BAGR-CD, Mrs. D. Martin
2	DSC-SA

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1	Commanding G eneral Air Research and Development Command ATTN: RDON P.O. Box 1395 Baltimore 3, Maryland
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1	Commanding General Special Weapons Center ATTN: ARDC Representative Kirtland AF Base, New Mexico
1	Commanding General Air Proving Ground Command ATTN: Class. Data Br., D/OI Eglin Air Force Base, Florida
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