ATM-835

ALSEP CASK ASSEMBLY GEARBOX

THERMAL VACUUM TEST

1 July 1969

Prepared by: L. P. Wagman

Approved by: L. R. Lewis

1.0 Introduction

As a result of Chit #S-3 which was generated at the ALSEP Cask Assembly CARR of 24 and 25 June 1969 the following summary of test results is submitted. This summary deals with the results of a thermal vacuum test on the ACA gearbox assembly which was conducted during the ACA prototype test series. The purpose of the test was to verify the operation of the ACA Gearbox Assembly when subjected to a high vacuum and a higher than predicted thermal environment. The subject test was run in a manner such that a comparison between gearbox operation at ambient temperature and pressure and high vacuum and elevated temperatures could be made.

A copy of the "as-run" procedure and preliminary test report including raw data is included in the addendum. Also included in this addendum are engineering drawings of the test setup.

2.0 Test Setup

The Gearbox Assembly, 2335015, was mounted on a test fixture in the Bendix Aerospace 2' x 5' thermal vacuum chamber as shown in Figure 1 of the addendum. The setup was such that incremental loads simulating the tilting of the Cask Assembly could be applied to the test article by means of a magnetic feedthrough penetration. An identical magnetic feedthrough was used to apply the input force to the gearbox assembly by means of the gearbox ball chain. This chain was placed over a sprocket which was of the same diameter of the gearbox sprocket wheel and was coupled to the magnetic feedthrough by means of a rigid shaft. It should be noted that the sprocket housing was removed prior to test initiation. This change was caused by interference problems between the ball chain and the sprocket housing. The problem was rectified on Qualification and Flight Hardware by changing the design of the sprocket housing. These changes can be noted in the hardware drawings included in the addendum. It should be noted that the sprocket housing changes are the only differences between the test article and present Qualification and Flight hardware.

3.0 Test Method

Tilting load was applied to the output shaft of the gearbox by wrapping a cord around the circumference of the magnetic feedthrough and applying six weights incremental until a maximum force of 20.4 lbs was attained. Load to the ball-chain was applied by again wrapping a cord around the corresponding feedthrough and attaching a bucket on each end of the cord. In this way by adding sand to each bucket the weight of the strain gage load cell could be nulled out. Sand was then added to only one bucket for each output load increment until static friction was overcome and the drive shaft moved uniformly for at least 45 degrees.

For the following conditions the above procedure was followed for each 3.4 lb load increment and at each of four positions of the sprocket wheel until a maximum load of 20.4 lbs was reached.

1. Ambient temperature and pressure
2. Elevated temperature and ambient pressure
3. Elevated temperature and reduced pressure
4. Endurance test by rotating chain drive feedthru 30 times under full load at ambient temperature and pressure.

4.0 Test Data

The following table represents a compilation of the data obtained during the subject test. The following information was used to reduce the raw data:

1. Magnetic feedthrough - 5-7/8 in. O.D., Varian Associates Model Number 954-5039, 3 inch moment arm.

2. Distance from gearbox shaft to C.G. of GLFC = 7.5 in.

3. Sprocket wheel O.D. = 1.5 in. 0.75 in. moment arm.

4. Raw data to true force conversion = 3/.75 = 4

5. Wt of ACA Band Assembly, GLFC and FCA = 46 lbs at 1 g = 7.67 lbs at 1/6 g.

Table 1. Test Data Compilation

Position of Chain, degrees	Pressure, Torr	Temperature, °F	Uncorrected Gearbox Force, lb	Correlated Gearbox Force lb.
0	Ambient	Ambient	3.25	13.0
0 repeat	Ambient	Ambient	2.50	10.0
90	Ambient	Ambient	3.00	12.0
180	Ambient	Ambient	2.25	9.0
270	Ambient	Ambient	3.25	13.0
270 repeat	Ambient	Ambient	2.00	8.0
Ambient Average				10.8
0	Ambient	710	2.00	8.0
90	Ambient	730	2.80	11.2
180	Ambient	710	3.25	13.0
270	Ambient	685	3.25	13.0
Ambient Pressure/Elevated Temperature Average				11.3
0	8.6×10^{-8}	717	2.25	9.0
90	9.2×10^{-8}	717	2.60	10.4
180	9.0×10^{-8}	717	2.75	11.0
270	9.0×10^{-8}	717	3.50	14.0
Reduced Pressure/Elevated Temperature Average				11.1
Endurance, 10th Cycle	Ambient	Ambient	3.75	15.0
Endurance, 20th Cycle	Ambient	Ambient	5.25	21.0
Endurance, 30th Cycle	Ambient	Ambient	5.50	22.0

6. Torque on gearbox shaft = 7.67 lb 1/6 g x 7.5 in.
= 57.5 in.-lbs
= 19.2 lbs load on 3 in. moment arm
(6 in. O.D. magnetic feedthrough)

7. Overtest load = 20.4 lbs = 6.3% overload.

5.0 Conclusions

It may be concluded from the results of the subject test that the effects of temperature and reduced pressure on the ACA Gearbox Assembly are negligible. With the exception of the endurance test all forces were well below the 20 lbs maximum sustained pull force that the astronauts can apply while on the lunar surface. In the case of the endurance test the number of cycles the test article was subjected to was far in excess of the one cycle the astronaut will apply and the three cycles applied prior to flight.

The bakeout and flaking of the Molykote lubricant noted in the "as-run" procedure is not considered to be of significance in that acceptable forces were measured with the absence of the lubricant and the test temperature environment was 150 to 200°F above the expected operational environment.

Bendix Aerospace Systems Division
SYSTEMS TEST DEPARTMENT

TR 3092
DATE 11 Apr 68

TEST REPORT

Item: ALSEP Cask Mount Gear Box
Test: Thermal-Vacuum DVT
Requested by: J. E. Whiteford
Work Order No.: 97421-97-03-18-318 Authorisation: PWO LR 3276
Completion Date: 4 Mar 68 Disposition of Item: Returned to D/974
Performed by: R. Lannin, Test Engineer (Acting)
Approved by: J. E. Whiteford, Project Engineer
Test Witness: R. C. De Voll, D 280: R. Foster, D980; R. J. Hostettler, D974
Distribution: J. Whiteford, L. Wagman - 1 Reproducible; All Witnesses

REFERENCE

Procedure No. ATP-D-96
Procedure Title: ALSEP Fuel Cask Mount Gearbox Thermal Test Procedure.

TEST RESULTS

At the end of the test the gear box was removed from the T-V chamber and opened. It was determined that the Micro-lube had hardened and flaked off. On removal of the chain drive extension it was determined that the extension was 2 1/2 turns off of being seated. Figures 3-20 and Table 1 of the Procedure show the test data recorded.

METHODS AND DATA

The method for applying load to the chain drive drum was altered to nullify the weight of the load cell (approximately 1.5 pounds). A counterweight was added and balanced out with the chain off (unloaded). See Photos 4, 5 and 8.

With the chain drive drum balanced, the chain was replaced and the run made for the series of weights added as specified in the procedure. Sand was added to the empty bucket until the drum rotated through at least 45 degrees. The load cell then measured the amount of force required to drive the gearbox. A weight was then added to the output of the gearbox and the process was repeated until the six 3.14 pound weights were all added. Each weight represented the application of approximately 10 inch-pounds of force at the output of the gearbox.

This method of applying a force was devised to provide a means for controlling the force and for determining how much force was applied.

This method zeroed out the bias, and provided a means for applying the force smoothly.

A funnel was used to control the flow rate of the sand into the empty can.

DEVIATION FROM PROCEDURE

Prior to the test the wire pulley of the gear box was changed to a chain sprocket (Photographs 9 and 10). A new pulley shroud and cover were made, but were not used in the test.

Photograph 11 shows the drive chain support (wrench) used in the pre-test runs.

Photograph 12 shows the drive chain support (steel tube) used in the test.

RELIABILITY		REVISIONS			CONFIG MGT.
APPD	PREDICTION	LTR	DESCRIPTION	DATE	APPV'D
					TR3092

LR 3276

ALSEP FUEL CASK MOUNT GEARBOX

THERMAL TEST PROCEDURE

23 January 1968

DRAWING AND PART APPLICATION	PART NO.	NEXT ASSY	END ITEM NO.	SERIAL NO.

This document contains the environmental test procedure to perform the Fuel Cask Mount Gearbox Thermal Tests.

CONTR NO.		
DRAWN		
CHECKED		
TEST		
QUAL CONT		
ENGR		1-31-68

Bendix **Aerospace Systems Division**

TITLE
ALSEP FUEL CASK MOUNT GEARBOX
THERMAL TEST PROCEDURE

SIZE	CODE IDENT NO.	DRAWING NUMBER
A	07038	ATP-D-96

SCALE	WEIGHT	SHEET 1 of 18

RELIABILITY		REVISIONS			CONFIG MGT
APPD	PREDICTION	LTR	DESCRIPTION	DATE	APPV'D
					TR2092

TABLE OF CONTENTS

DRAWING AND PART APPLICATION			
PART NO.	NEXT ASSY	END ITEM NO.	SERIAL NO.

CONTR NO.		
DRAWN		
CHECKED		
TEST		
QUAL CONT		
ENGR		

Bendix Aerospace Systems Division

TITLE ALSEP FUEL CASK MOUNT GEARBOX THERMAL TEST PROCEDURE

SIZE	CODE IDENT NO.	DRAWING NUMBER
A	07038	ATP-D-96

SCALE	WEIGHT	SHEET
		2 of 18

1.0 PURPOSE

The purpose of the test is to verify that the Gearbox Assembly will withstand and operate satisfactorily under conditions of maximum torque while subjected to lunar environments.

2.0 SCOPE

The Gearbox Assembly will be mounted on a test fixture in such a way that it can be subjected to the maximum design torque loads while being subjected to ambient and lunar environments. The test will evaluate any changes which may occur in the efficiency of the test item.

3.0 APPLICABLE DOCUMENTS

Drawing No.	Title
2334850	Fuel Cask Support Assembly
2335000	Structure Assembly, Fuel Cask
2335013	Band Assembly, Cask
2335015	Assembly, Gearbox, Tilt
2335041	Band Assembly, Bottom Radial
2335043	Block, Trunnion Lower LH
[illegible]	Thermal/Vacuum Test - ALSEP Full Cask Gearbox

TR3092

4.0 PARTICIPANTS REQUIRED

ALSEP Test Conductor

Bendix Test Operations Engineer

Bendix Quality Assurance Representative

ALSEP Engineering Representative

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5.0 EQUIPMENT REQUIRED

Item	Manufacturer	*Model	*SN	*Calibration Expiration Date
Oven	Bendix			NA
Potentiometer	Leeds & Northrup	8640	1602018	2 APRIL 68
Gearbox Mounting Fixture	Bendix			NA
Shaft Extension		BSX-7290-10		NA
POWER-STAT (GAUGE)	GENERAL RADIO	W10MT3	BSD 10295	NA
Power-Stat (OVEN)	GENERAL RADIO	W10MT3	BSD 7669	NA
Calibrated Weights, As Required	Bendix	~~3345-500~~	109	
Load Cell	LEBOW	3345-500	109	17 OCT 68
Strain Gage Equipment	Minn. Honeywell	BSD 08883A		6 JUNE 68
X-Y Plotter	Moseley	BSD 14287		3 JULY 68
Mechanical Feedthru	Varian		BSD 10960	NA
Mechanical Feedthru	Varian			NA
T-V 2 x 5 ft Chamber and Instrumentation	VARIAN	964-0006	317-564	
STRAIN GAGE AMP	MINN. HONEYWELL	BSD 11992		5 JUNE 68
REID HEAD GAUGE	N.R.C	754	H004	1 JULY 68
VACUUM THERMOCOUPLE GAUGE	HASTING	VT 6E DV-6	5973	8 AUG 68

*To be completed prior to testing

6.0 PROCEDURE

6.1 Test Setup

6.1.1 Mount test fixture with gearbox Part No. _____ in oven, as shown in Figures 1 and 2.

6.1.2 Place oven in the chamber and secure so that the Cask drive shaft is aligned with mechanical passthru.

6.1.3 Connect Cask drive shaft to magnetic drive mechanical pass-thru with flexible drive.

6.1.4 Cut four chromel constantan no. 30 gage thermocouple wires ten ft in length. 2-6-68

6.1.5 Strip insulation from TC wire three ft from one end. 2-6-68

6.1.6 Tin TC wire 1/4 to 1/2 inch from insulation with silver braze.

6.1.7 Insert TC wires from the outside of a Varian 8-tube pass-thru until the tinned area can be seen.

6.1.8 Silver braze wires at inner end of tubes only and clean excess flux from wires.

6.1.9 Install TC passthru on the 2 x 5 ft vacuum chamber.

6.1.10 Slip small-diameter glass tubing over TC wire for insulation.

6.1.11 Weld two thermocouples to the inner surface of the oven.

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No. ATP-D-96
Page 6A

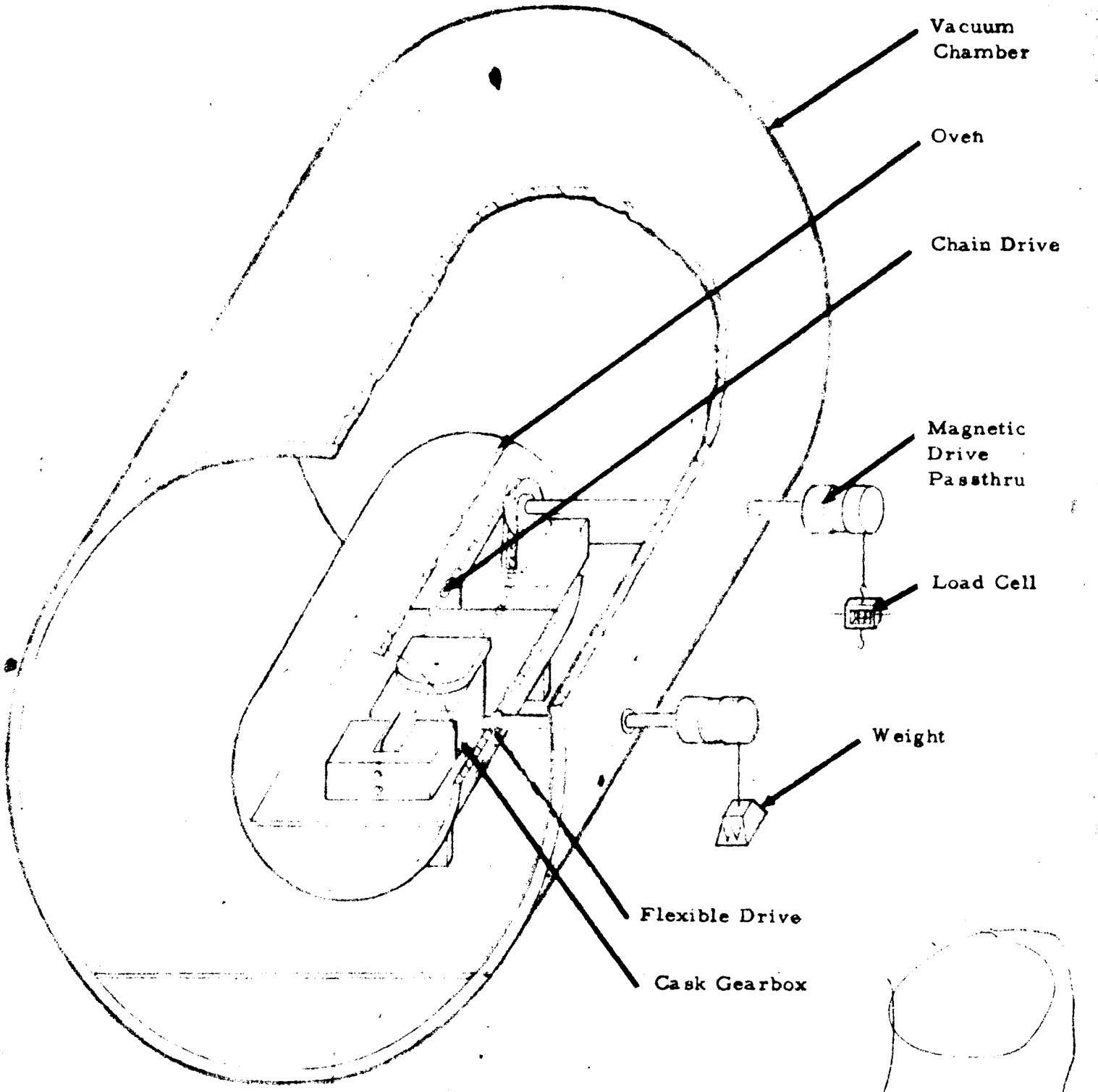

Figure 1

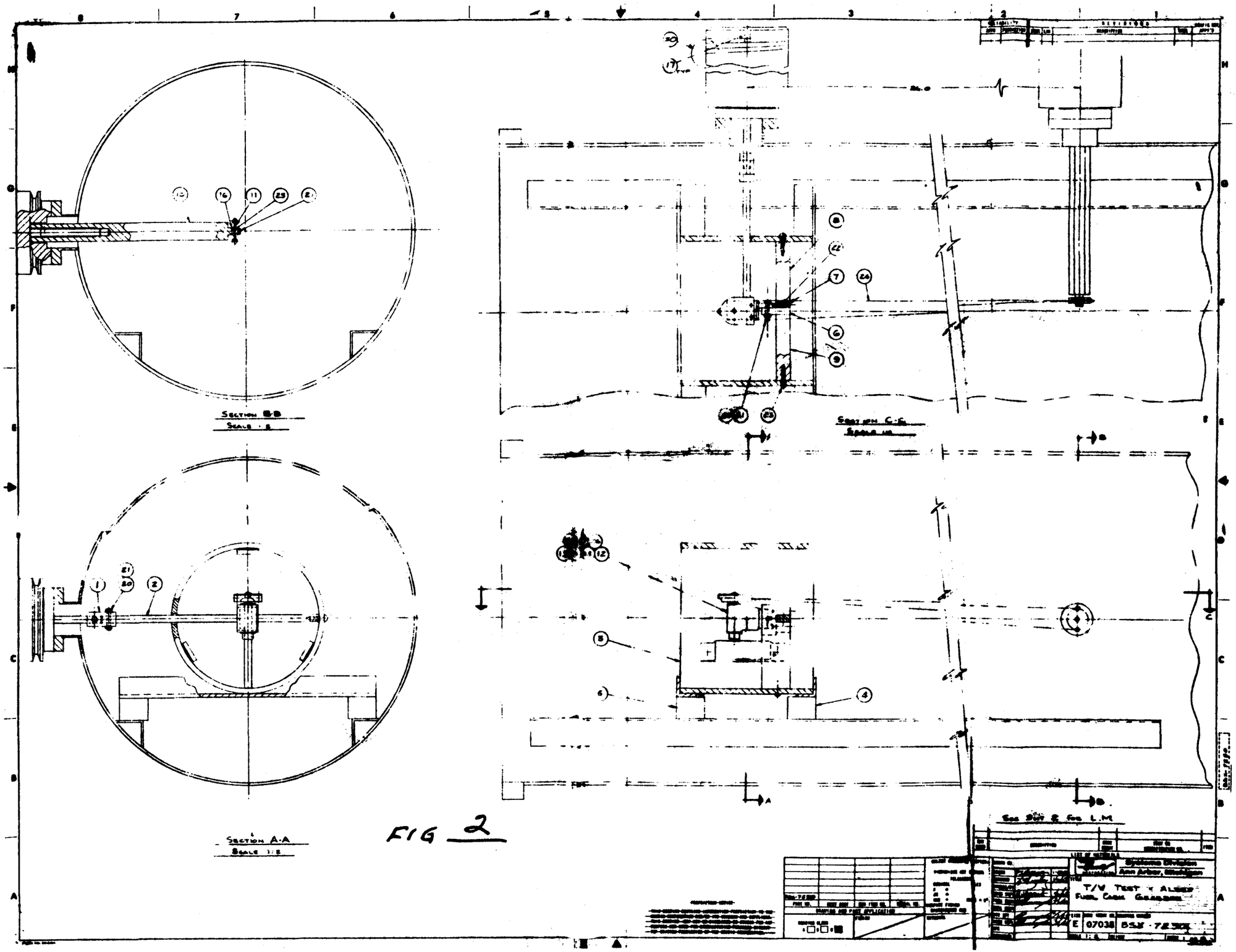
SECTION B-B
SCALE 1:8
SECTION A-A
SCALE 1:8
Systems Division
Ann Arbor, Michigan
T/V TEST ASSY
FUEL CASK GARAGE
E 07038 BSM-72305

FIG 2

TR3092

6.1.12 Weld two thermocouples to the gearbox.

6.1.13 Couple gearbox drive chain to sprocket on second magnetic drive mechanical passthru.

6.1.14 Attach one end of a 6-ft section of nylon cord to each of the mechanical passthrus.

6.1.15 Wrap the cord around the cask drive shaft feedthru drum in a clockwise direction.

6.1.16 Wrap the cord around the chain-drive feedthru drum in a counter clockwise direction.

6.1.17 Connect oven heater wires thru an electrical passthru using bare wire with glass tube to insulate as required.

6.1.18 Photograph test setup in the chamber and insert in photo data section 7.2.

6.1.19 Wrap oven in aluminum foil that has been cleaned.

6.1.20 Connect load cell output to X-Y plotter using the Minneapolis-Honeywell strain gage signal conditioner and exciter.

6.1.21 Adjust the X-Y plotter to produce ~~one~~ TWO centimeter deflection for each lb of force ON THE LOAD CELL. (in the gearbox chain.)

6.1.22 Attach load cell to nylon cord on the chain-drive passthru.

6.1.23 Connect thermocouples to a thermocouple switch box.

6.1.24 Connect thermocouple switch box to Leeds & Northrup potentiometer and melting ice reference junction.

6.1.25 Photograph the external chamber test setup and insert photos in section 7.2 of this procedure.

6.1.26 Turn X-Y plotter on a 20 second/inch (2 SEC/CM) sweep.

6.1.27 Apply load thru the load cell to obtain a baseline gearbox drag.

6.2 Ambient Test

6.2.1 Hang a 3.4 lb weight on the Cask drive nylon cord so that the weight clears the floor. (28 FEB 68)

6.2.2 Record input force applied to the load cell on the X-Y plotter and turn on the plotter time sweep.

6.2.3 Continue to record on X-Y plotter while the force on the load cell is smoothly increased until static friction is overcome and Cask drive shaft moves uniformly.

6.2.4 Return Cask drive shaft to the position at start.

6.2.5 Add 3.4 lb more to cord and repeat paragraph 6.2.1 thru 6.2.4 until 20.4 lb are hanging from the cord.

6.2.6 Remove weights from cord.

6.2.7 Disconnect ~~scale~~ Load Cell from chain.

* Change starting point by 90° on the chain drive. IR 3092

28 Feb 68

6.2.8 * Pull chain until chaindrive shaft has rotated 90 degrees counterclockwise.

6.2.9 Repeat paragraph 6.2.1 thru 6.2.8 until data has been obtained at the 0°, 90°, 180° and 270° position of the ~~output~~ INPUT shaft.

6.2.10 Insert X-Y plots in paragraph 7.1 as data.

6.3 High Temperature Test (700° F)

6.3.1 Wrap oven in 1-in. Fiberfax blanket so only the chain and output shaft protrude beyond insulation. 29 Feb 68

6.3.2 Raise and maintain the temperature of the oven to 725° F by adjusting the Power Stat. 1900 29 Feb 68

6.3.3 Hang a 3.4 lb-weight on the Cask drive nylon cord so that the weight clears the floor.

6.3.4 Record input force applied to the load cell on the X-Y plotter and turn on the plotter time sweep.

6.3.5 Continue to record on X-Y plotter while the force on the load cell is smoothly increased until static friction is overcome and Cask drive shaft moves uniformly.

6.3.6 Return Cask drive shaft to the position at start.

6.3.7 Add 3.4 lb more to cord and repeat paragraph 6.3.3 thru 6.3.6 until 20.4 lb are hanging from the cord.

6.3.8 Remove weights from cord.

6.3.9 Disconnect scale from chain.

6.3.10 Pull chain until chain drive shaft has rotated 90 degrees counterclockwise.

6.3.11 Repeat paragraph 6.3.3 thru 6.3.10 until data has been obtained at the 0°, 90°, 180°, and 270 position of the output shaft.

6.3.12 Insert X-Y plots in paragraph 7.1 as data.

6.4 Temperature and Vacuum Test

6.4.1 Remove Fiberfax insulation from around oven.

6.4.2 Close chamber door.

6.4.3 Rough-pump the 2 x 5 ft chamber.

6.4.4 Bake chamber, Vac-ion pump and Redhead vacuum gage to 500° F. 506°F MAX T. ALLOWED 600°F

6.4.5 Increase oven and gearbox temperature to 700 ±25 F. 690°F

6.4.6 Start chamber Vac-ion and titanium sublimation pumps after four hours of bakeout.

NOTE: Bakeout may be discontinued if necessary to get Vac-ion pump started. After pump starts, continue bakeout for four more hours.

6.4.7 Maintain temperature of gearbox at 700 ±25 F.

6.4.8 Continue pumping until the chamber pressure is less than 1×10^{-7} torr.

NOTE: Chamber pressure must be as low as practical in a reasonable period of time to be determined at the discretion of the Test Operations Engineer.

6.4.9 Hang a 3.4 lb weight on the Cask drive nylon cord so that the weight clears the floor.

6.4.10 Record input force applied to the load cell on the X-Y plotter and turn on the plotter time sweep.

6.4.11 Continue to record on X-Y plotter while the force on the load cell is smoothly increased until static friction is overcome and Cask drive shaft moves uniformly.

6.4.12 Return Cask drive shaft to the position at start.

6.4.13 Add 3.4 lb more to cord and repeat paragraph 6.4.9 thru 6.4.12 until 20.4 lb are hanging from the cord.

6.4.14 Remove weights from cord.

6.4.15 Disconnect scale from chain.

6.4.16 Pull chain until chain drive shaft has rotated 90 degrees counterclockwise.

6.4.17 Repeat paragraph 6.4.9 thru 6.4.16 until data has been obtained at the 0°, 90°, 180°, and 270° position of the output shaft.

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6.4.18 Insert X-Y plots in paragraph 7.1 as data.

6.5 Teardown of Test

4 MAR 68

6.5.1 Remove power from oven.

6.5.2 Open 2 x 5 ft chamber.

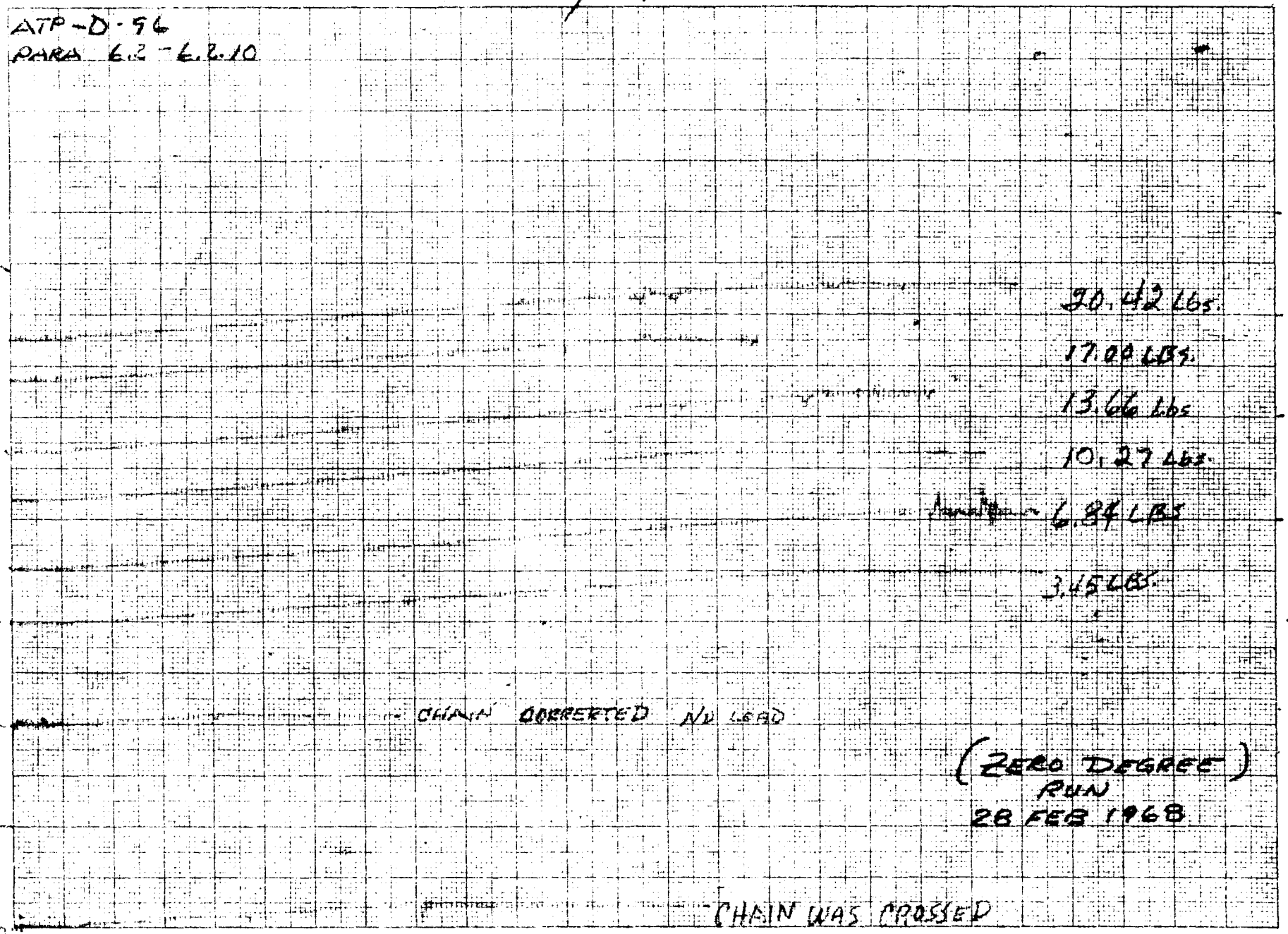
6.5.3 Remove shaft extension.

6.5.4 Remove gearbox and inspect for deterioration.

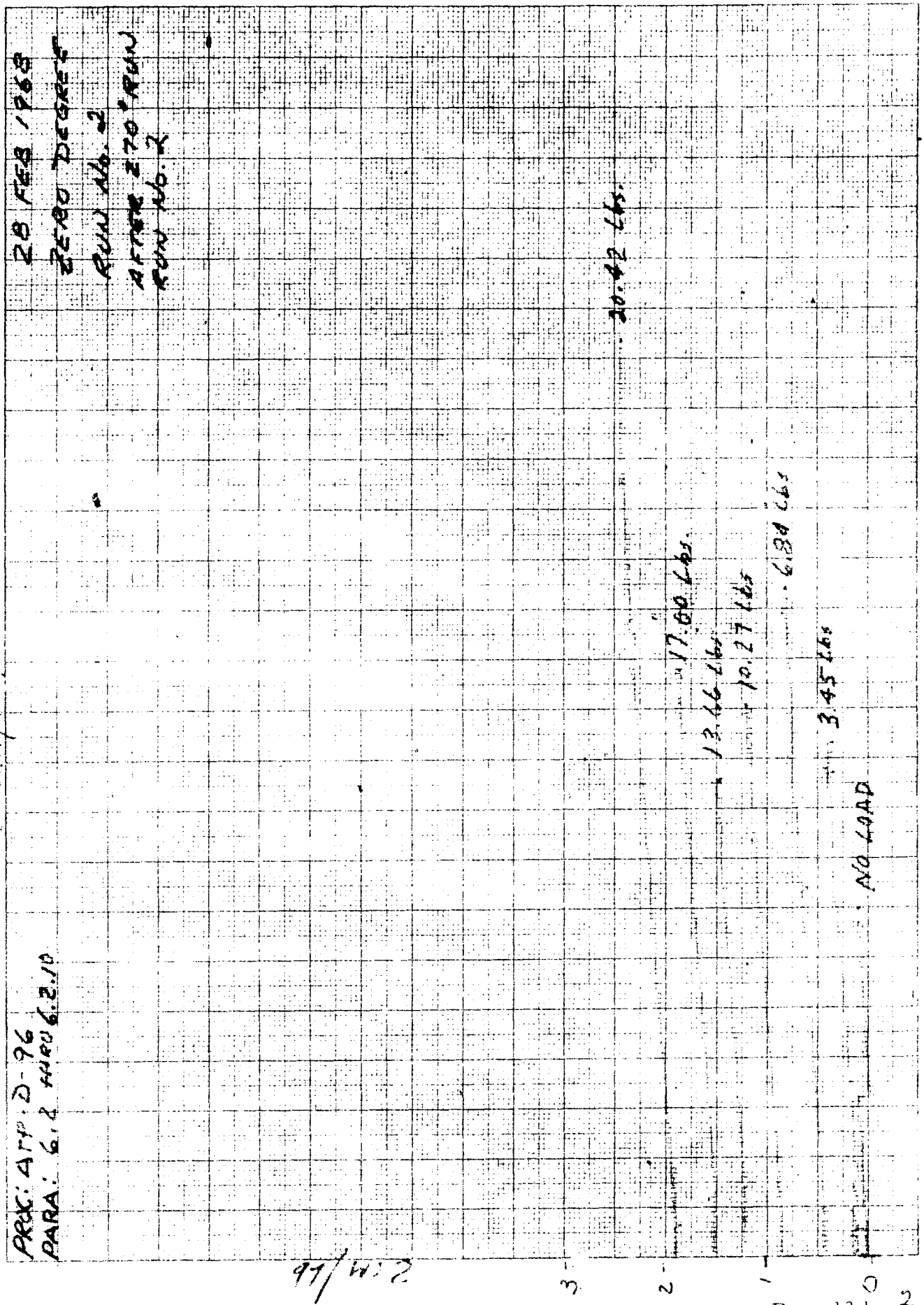
6.5.5 Photograph gearbox with the Polaroid camera and attach to test photo page.

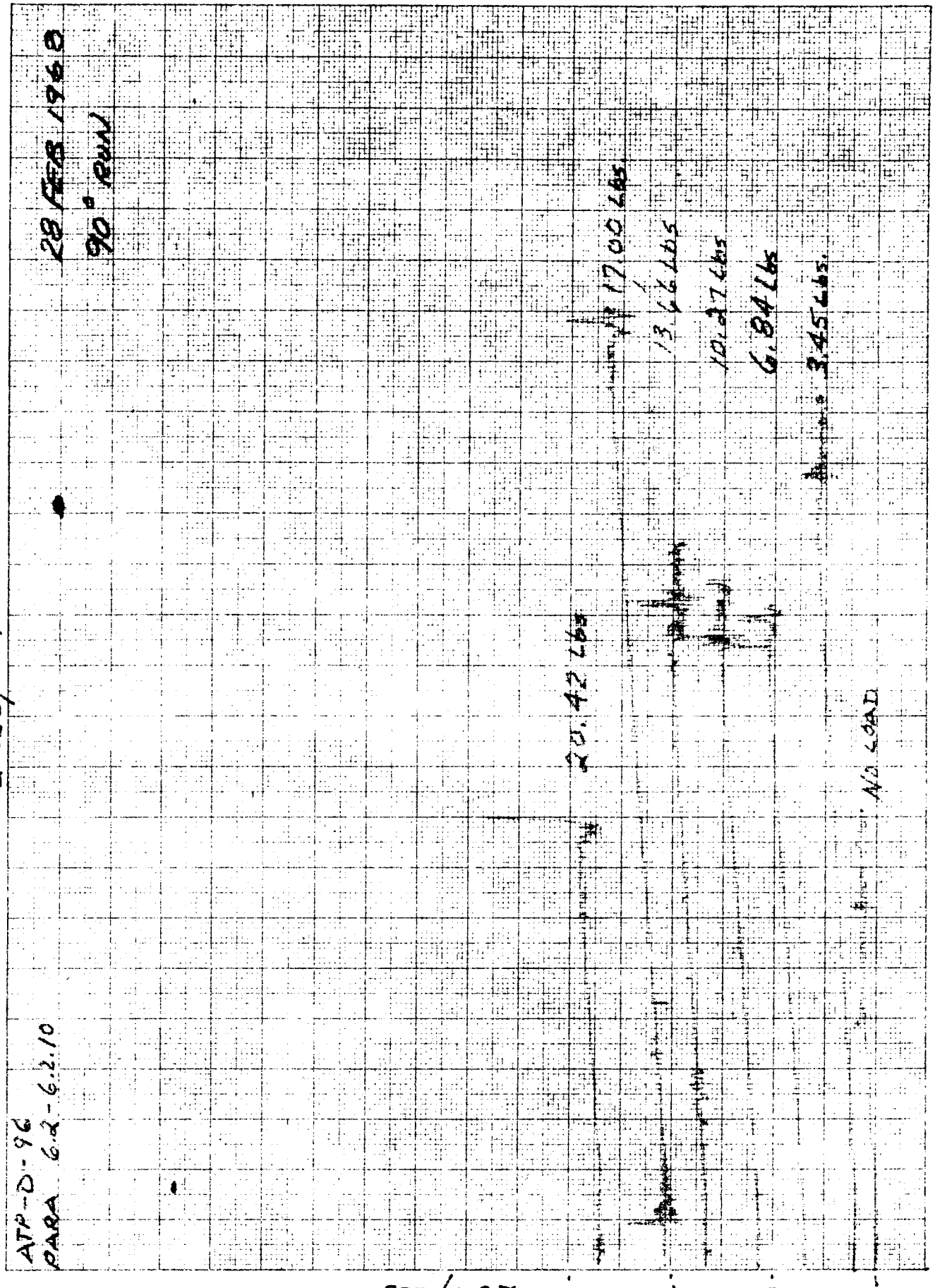
6.5.6 Disassemble test setup and return equipment to normal storage locations.

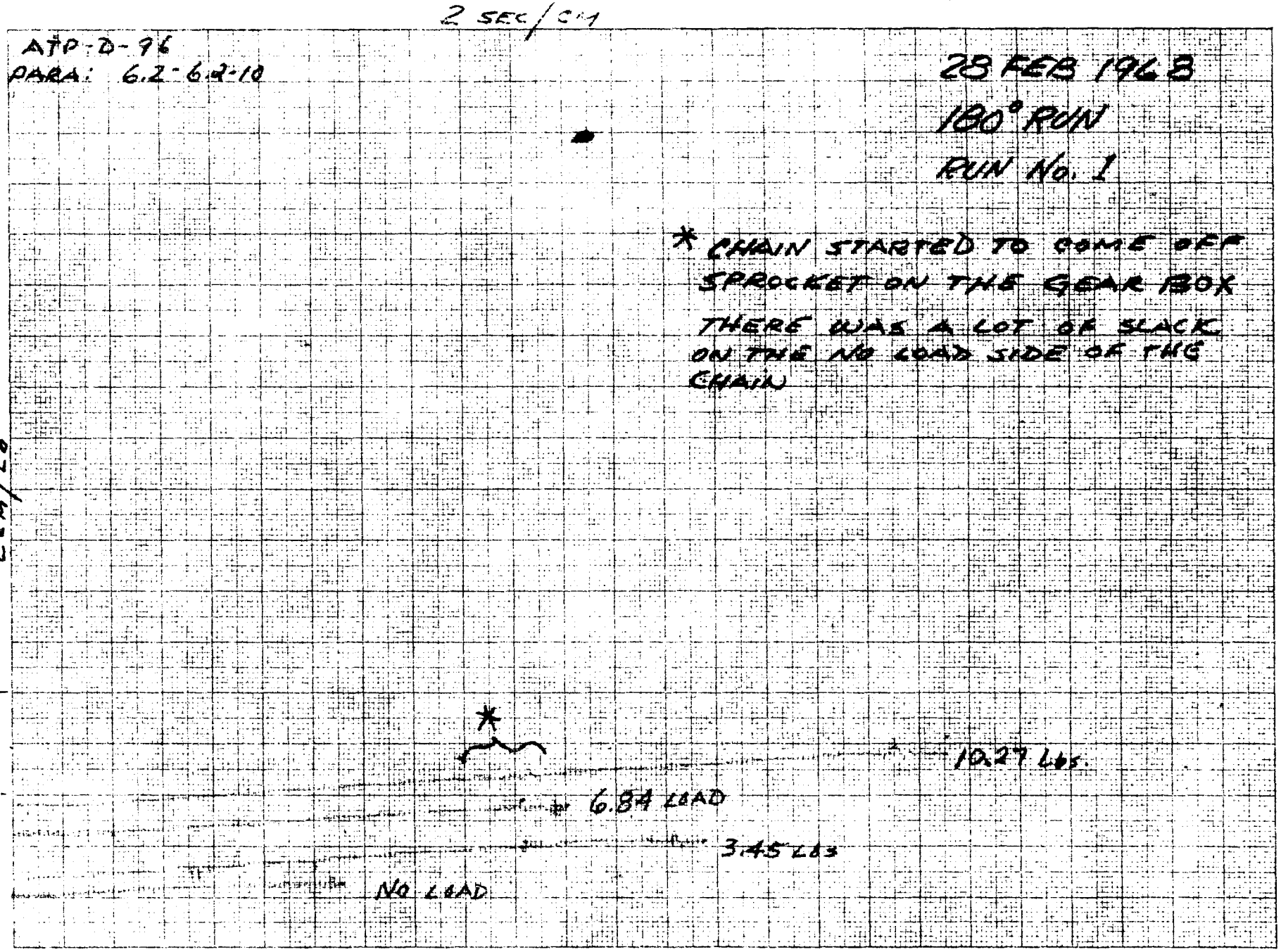
7.0 DATA PAGE



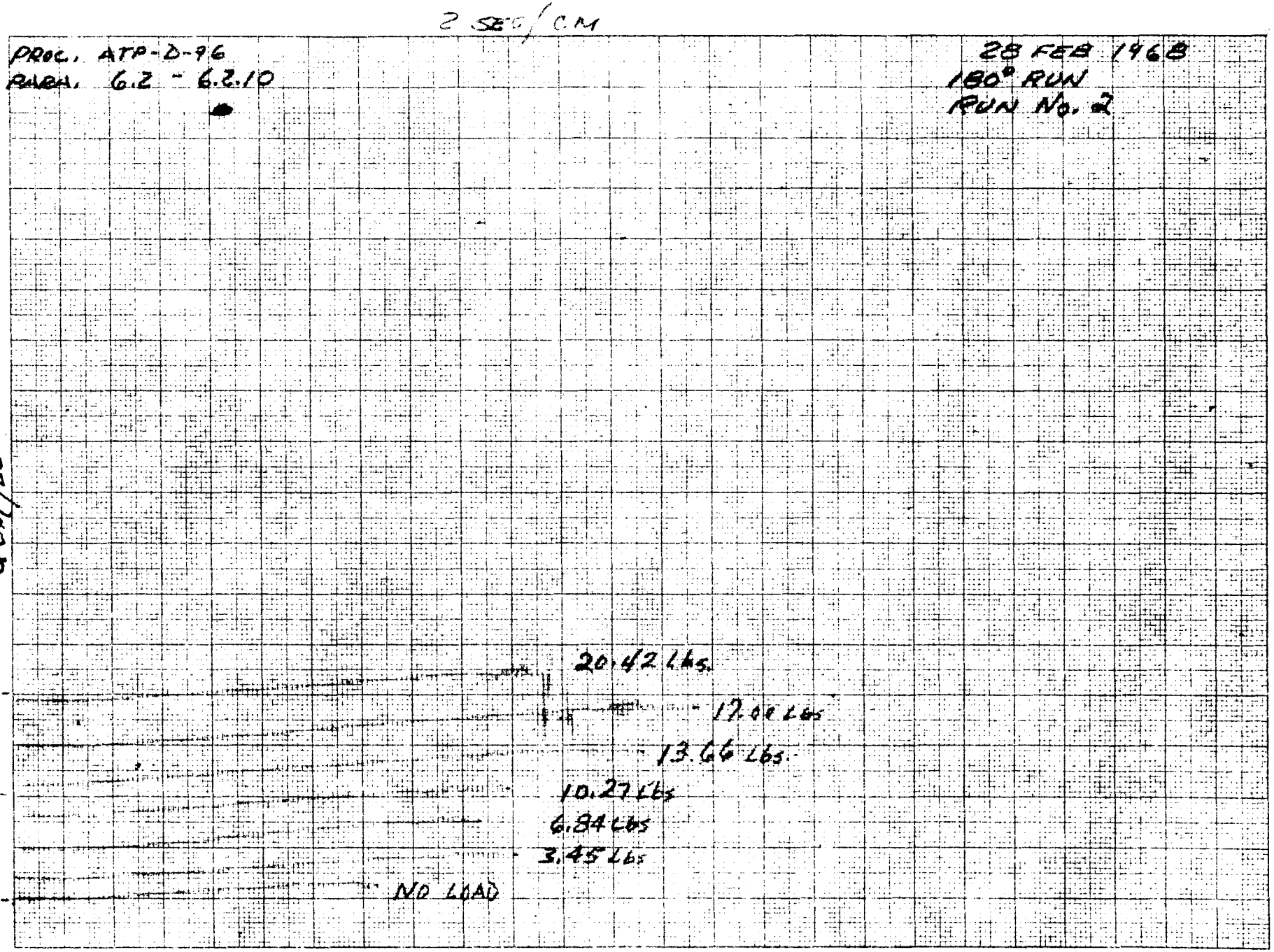
TR 3092
Figure 3


28 FEB 1968
ZERO DEGREE
RUN No. 2
AFTER 270° RUN
RUN No. 2
PROC: APP: D-96
PARA: 6.2 thru 6.2.10
20,42 Lbs.
17.00 Lbs.
13,46 Lbs.
10,27 Lbs.
6,84 Lbs.
3.45 Lbs.
NO LOAD
3
2
1
0


ATP-D-96
PARA 6.2-6.2.10
2 SEC / cm
29 FEB 1968
90° RWJ
20,42 LBS
17,00 LBS
13,66 LBS
10,47 LBS
6,84 LBS
3,45 LBS
NO LOAD
2cm/LBS
3.
2.
1.
0.



TR 3092
Figure 6



TR 3062
Figure 7

2 sec/cm.

PROC. ATP-D-96
AREA: 6.2 - 6.2.10

28 FEB 1968
270° RUN
RUN No. 1

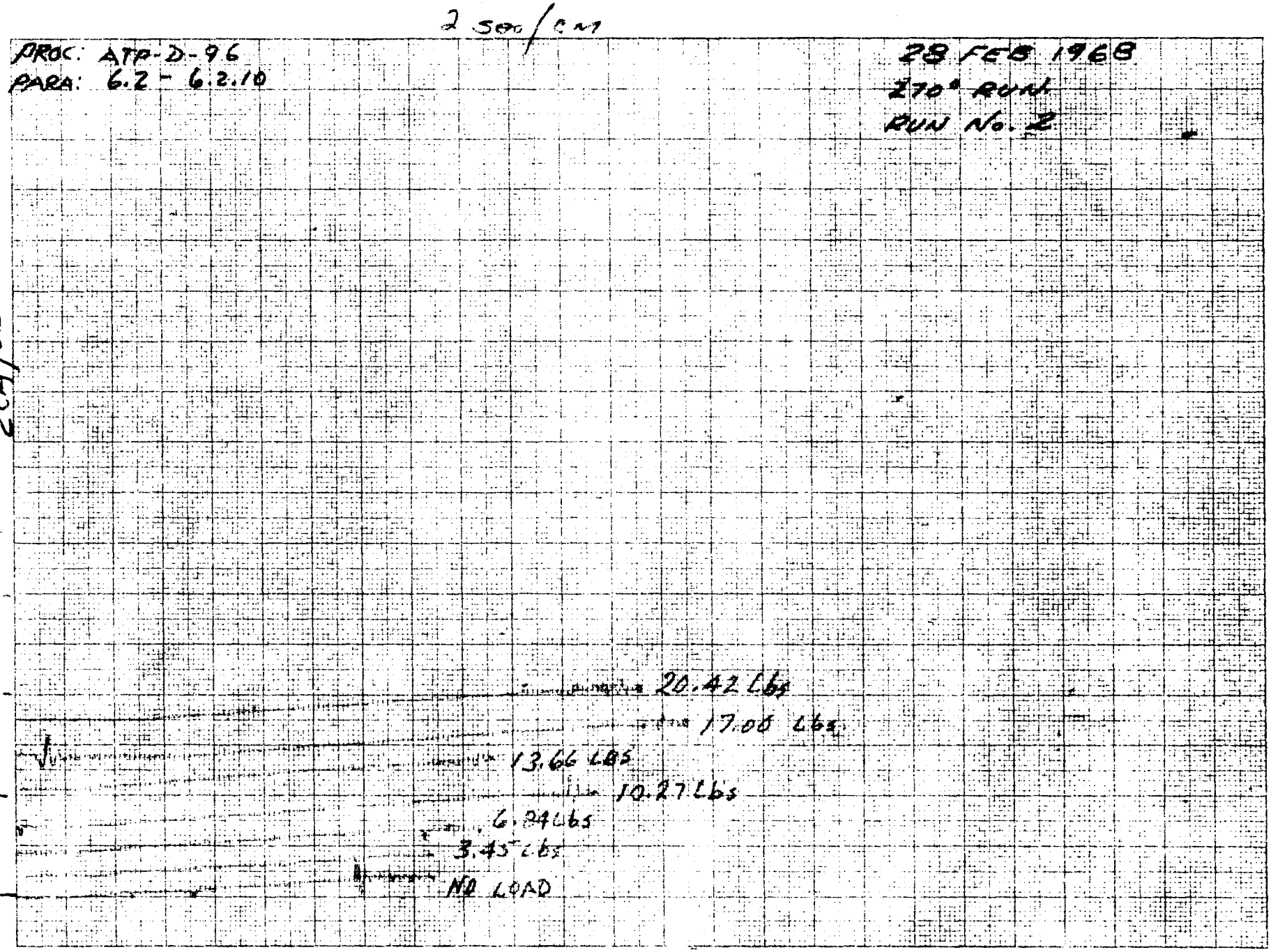
* LOAD CELL & LOAD WTS DROPPED
POSSIBLEY MAGNETIC COUPLING SLIPPED ON GEAR BOX DRIVE SHAFT
GEAR BOX SHAFT WENT OUT OF PHASE 90°

2 CM/LB

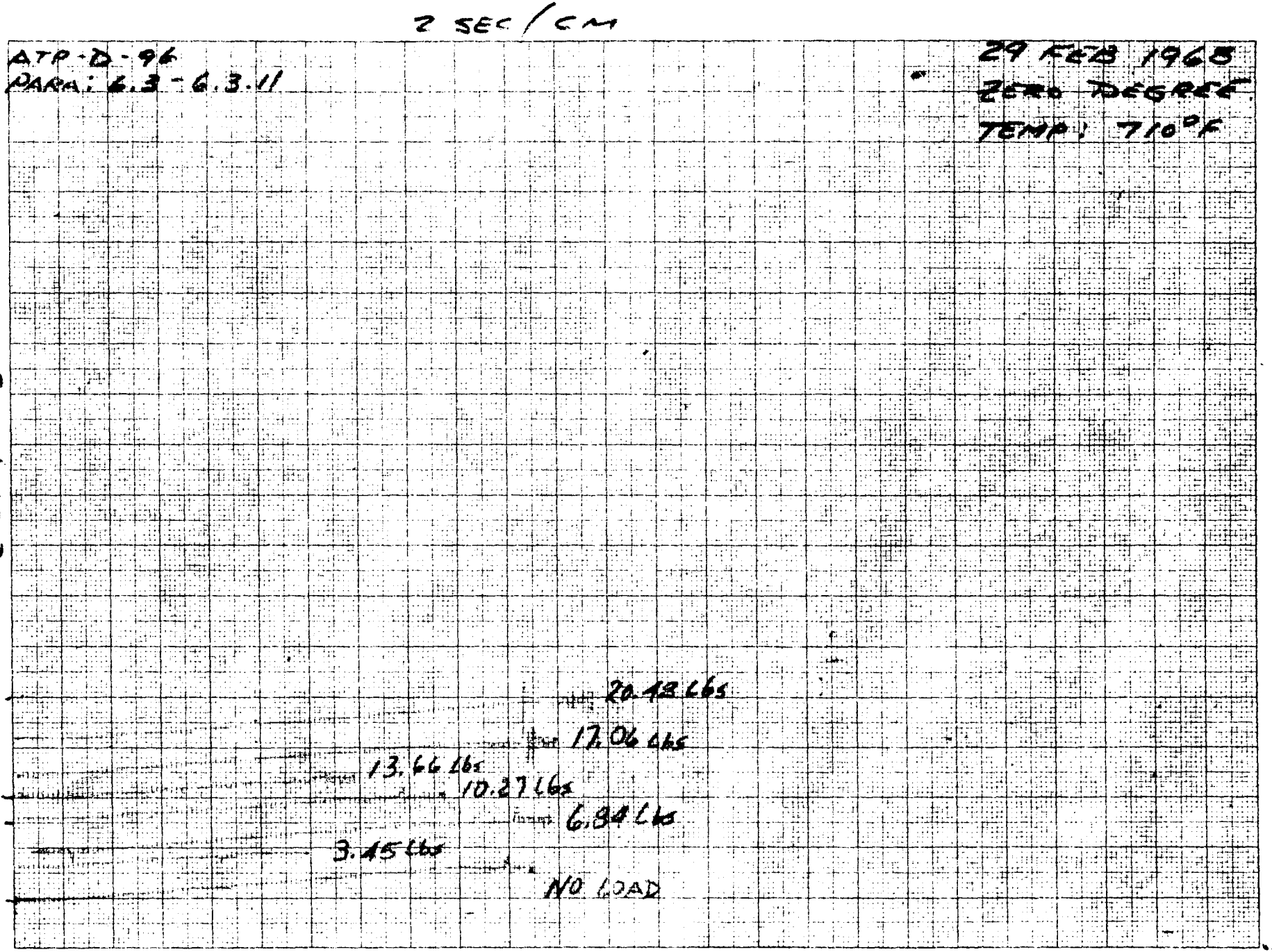
20.92 LBS
17.00 LBS
13.66 LBS
10.27 LBS
6.84
3.45 LBS
NO LOAD

3
2
1
0

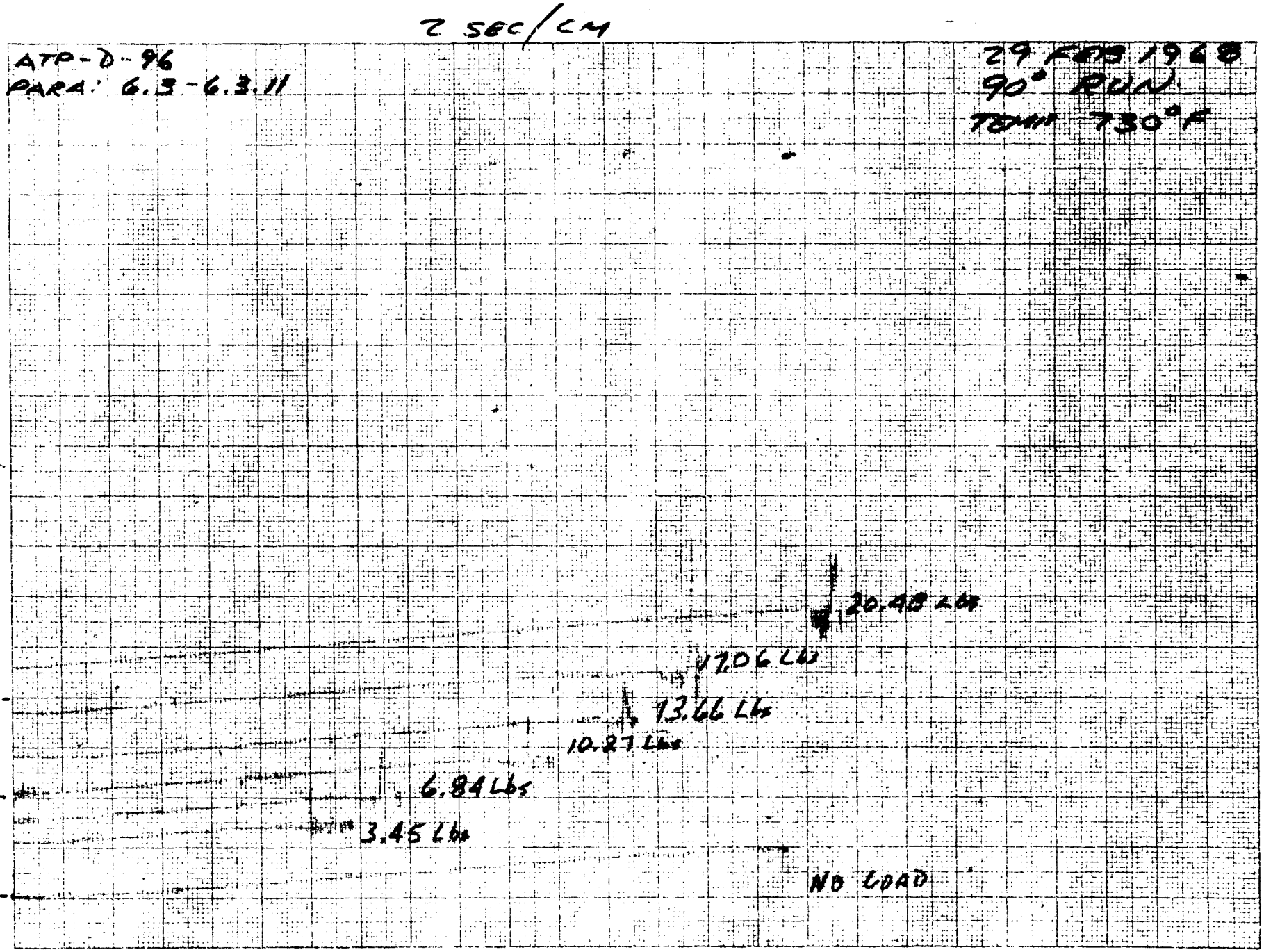
TR 3092
Figure 8



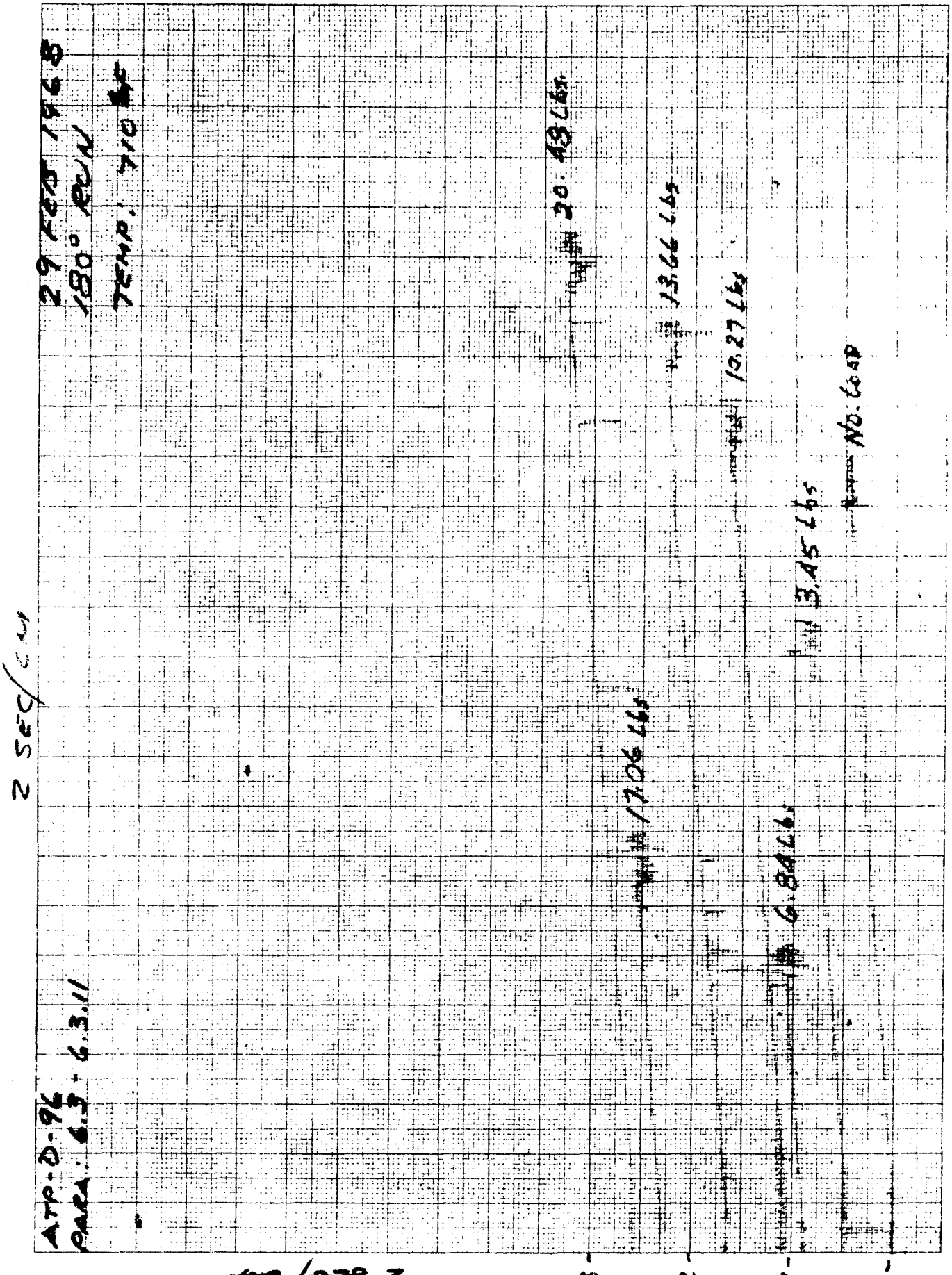
TR 3092
Figure 9

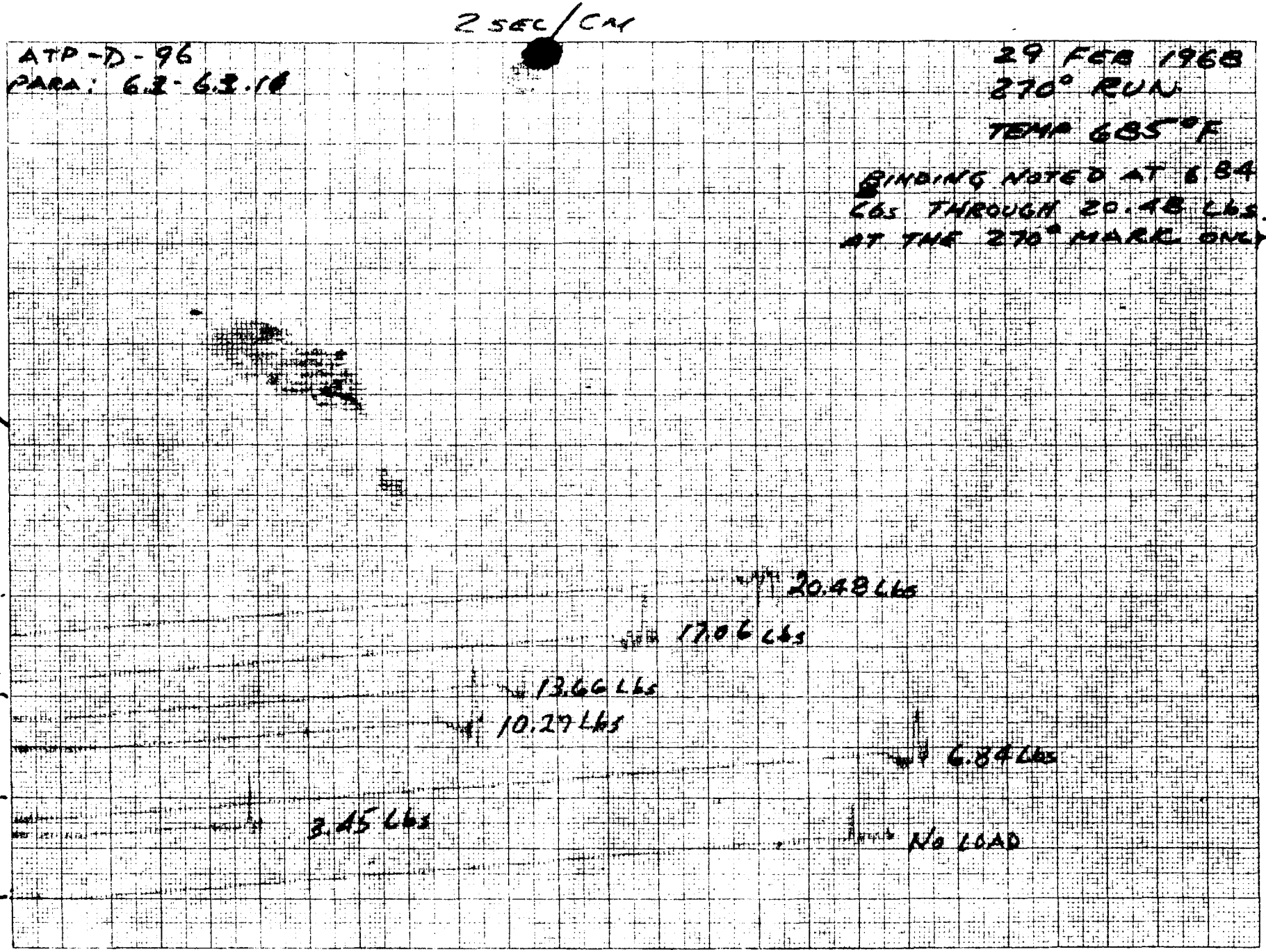


TR 3092
Figure 10

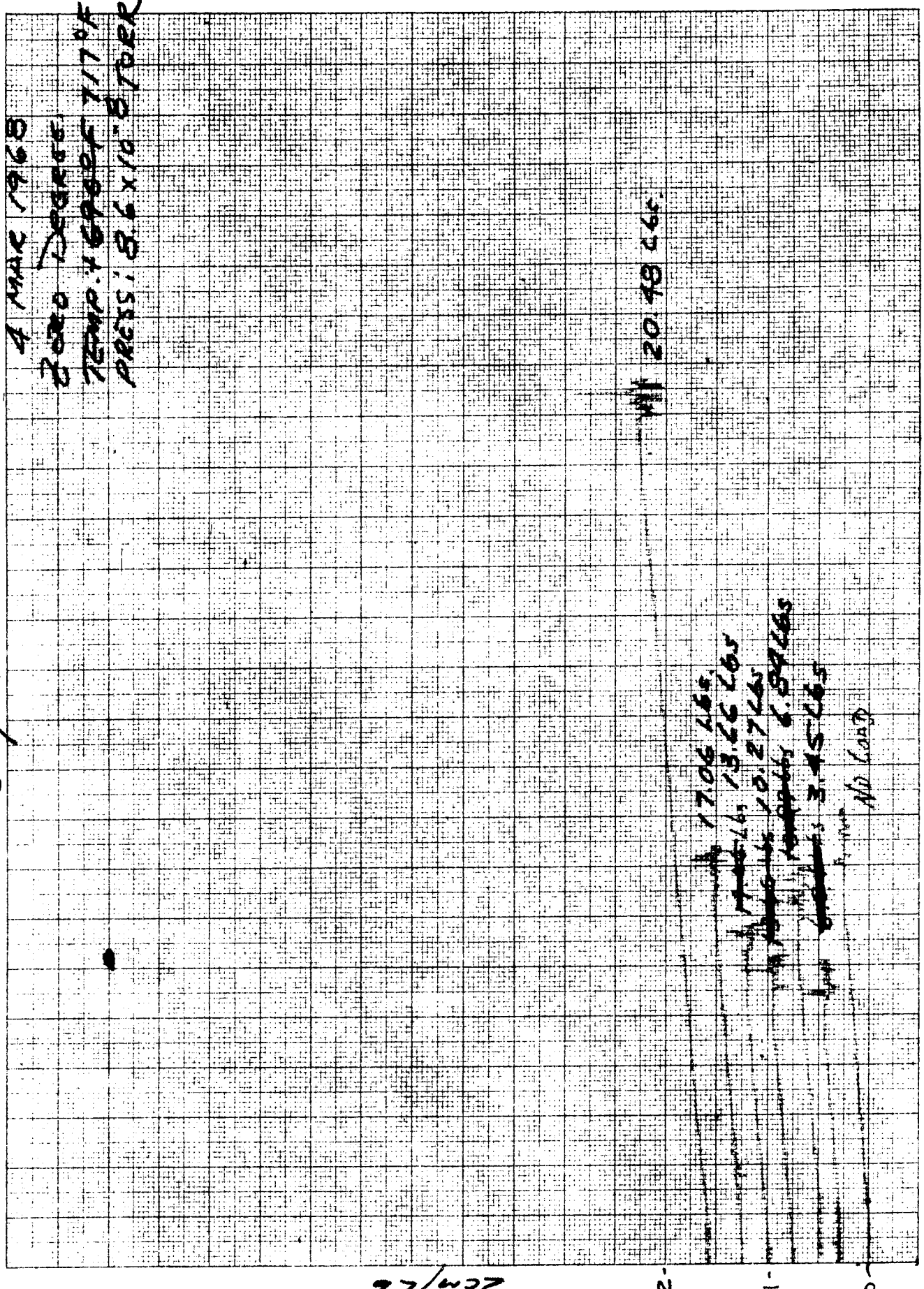


TR 3092
Figure 11

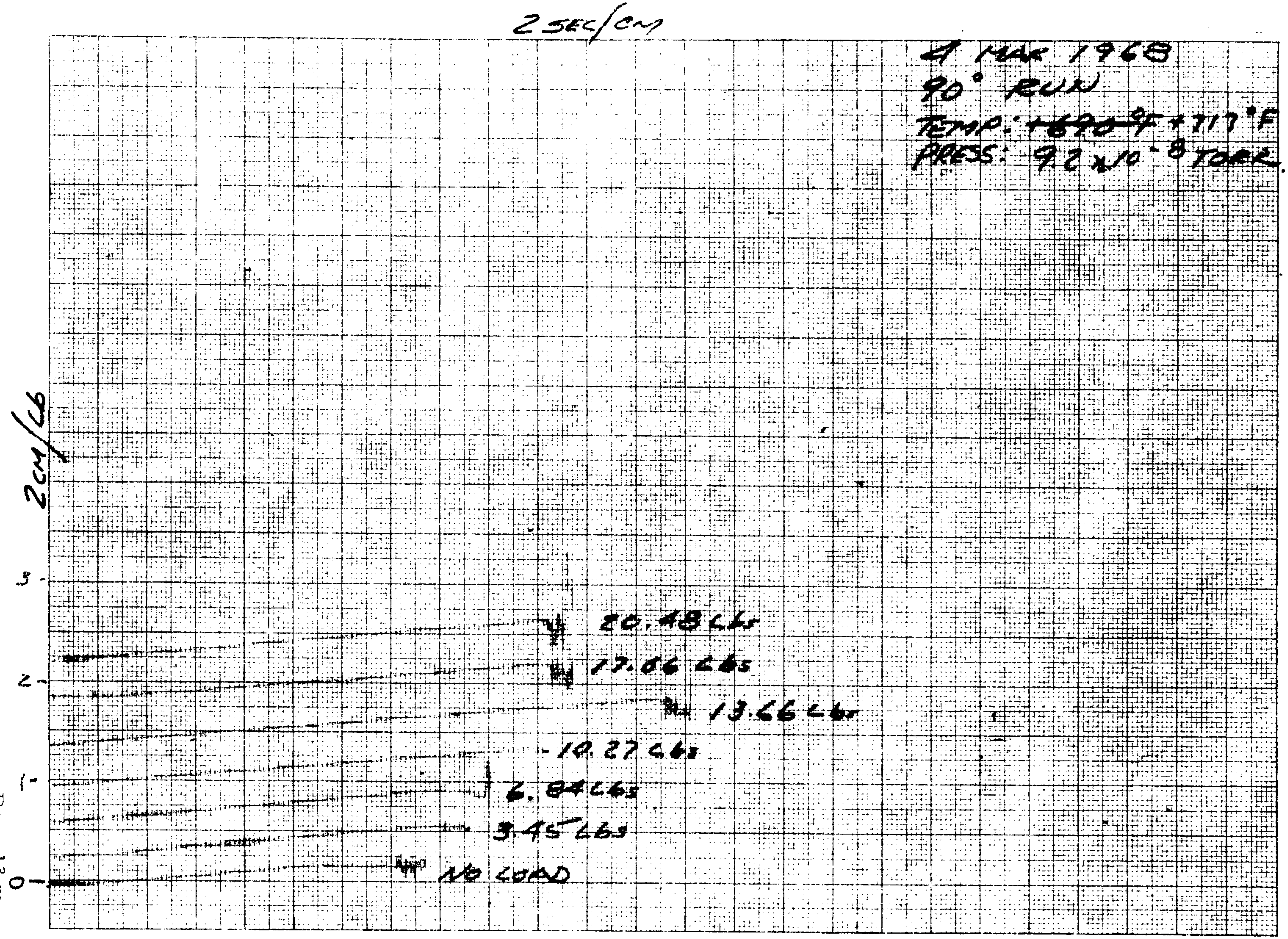

ATP-D-96
PARA: 6.3 - 6.3.11
2 SEC/CM
29 FEB 1968
180° REV
TEMP. 710 °F
20.49 Lbs.
13.66 Lbs
10.27 Lbs
12.06 Lbs
6.84 Lbs
3.45 Lbs
NO. LOAD
CM
2 SEC/DIV
3
2
1
0



TR 3092
Figure 13


4 MAR 1968
ZERO DEGREE, 717°F
TEMP. 1600°F
PRESS. 8.6 x 10⁻⁶ TORR
2 SET/CM.
WT 20.49 GMS.
17.06 LBS.
13.66 LBS.
10.27 LBS.
6.89 LBS.
3.45 LBS.
NO LOAD
2 CM/CM
2
1
0

TR 3092
Figure 15



Take photographs of test setup.

Photograph failures when possible.

PHOTO No. 1

Para. 6.1.18

1-Gear Box

2-Oven

3-Thermocouples

4-Heaters

5-Cask Drive Shaft

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO No. 2

Para. 6.1.25

1-Cask Drive Feed-Through

2-Chain Drive Feed-Through

3-Oven

4-Vacuum Chamber

5-Thermal Blanket

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

PHOTO No. 3

Para. 6.1.25

1-Strain Gage Amplifier and Power Supply

2-Strain Gage X-Y Recorder

3-Vacuum-Thermocouple Gage

4-Vacuum Gage

5-Thermocouple Recorder

6-Power Controllers

7-Calibrated Weights

440-75

TEST LOAD SETUP

Take photographs of test setup.

Photograph failures when possible.

PHOTO No. 4

1-Chain Drive Feed-Through

2-Cask Drive Feed-Through

3-Load Cell

4-Calibrated Load

5-Variable Loads

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO No. 5

1-Chain Drive

2-Load Cell

3-Variable Loads (Containing Sand)

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

440-75

Take photographs of test setup

Photograph failures when possible.

PHOTO No. 6

1-Gear Box

2-Chain

3-Feed-Through Shaft

PHOTO No. 7

1-Chain Drive Shaft

2-Cask Drive Feed-Through Shaft

3-Titanium Simulator Baffle

4-Over Power Leads

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO No. 8

Calibrated Loads

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

Bendix

Aerospace Systems Division

ALSEP FUEL CASK MOUNT GEARBOX
THERMAL TEST PROCEDURE

NO.	REV. NO.
ATP-D-96	

PAGE 15d OF 18

DATE 23 Jan 68

PROCEDURE VARIATION

Take photographs of test setup

Photograph failures when possible.

PHOTO No. 9

1-Old Pulley Shroud and Cover

2-Old Sprocket

3-New Pulley Shroud and Cover (not used in test)

4-New Sprocket

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO 10

New Sprocket (mounted)

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

440-75

Take photographs of test setup

Photograph failures when possible.

PHOTO No. 11

Wrench used to Support Chain during 700° ±25° F at 1 Atm Pre-Test Run

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO No. 12

Steel Tube used to support chain during 700° ±25° F at 1 Atm Test

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

440-75

Take photographs of test setup

Photograph failures when possible.

PHOTO No. 13

Thermal Blanket Covering Oven in 700° ±25° F at 1 Atm Test

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

PHOTO No. 14

Thermal Blanket Covering Oven 700° ±25° F at 1 Atm Test

Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

PHOTO No. 15

Para 6.5.5

Gear Box after Test

Take photographs of test setup.

Photograph failures when possible.

PHOTO No. 16

1-Inside of Gear Box

2-Chain Drive Sprocket

3-Lubricant Residue

Identify photos on reverse, and identify the top edge.

Attach photo to this sheet by stapling thru tab on end of photo.

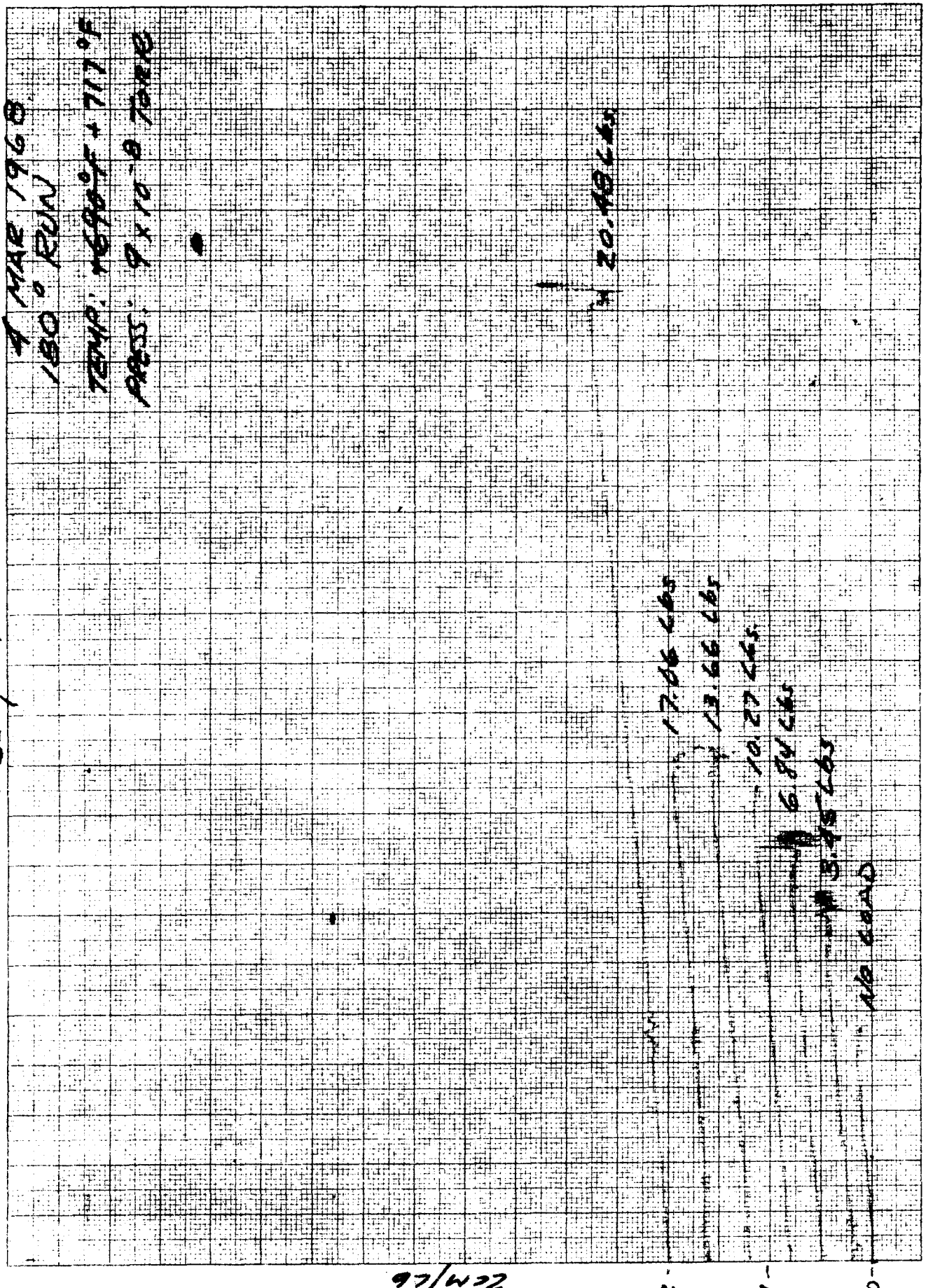
PHOTO No. 17

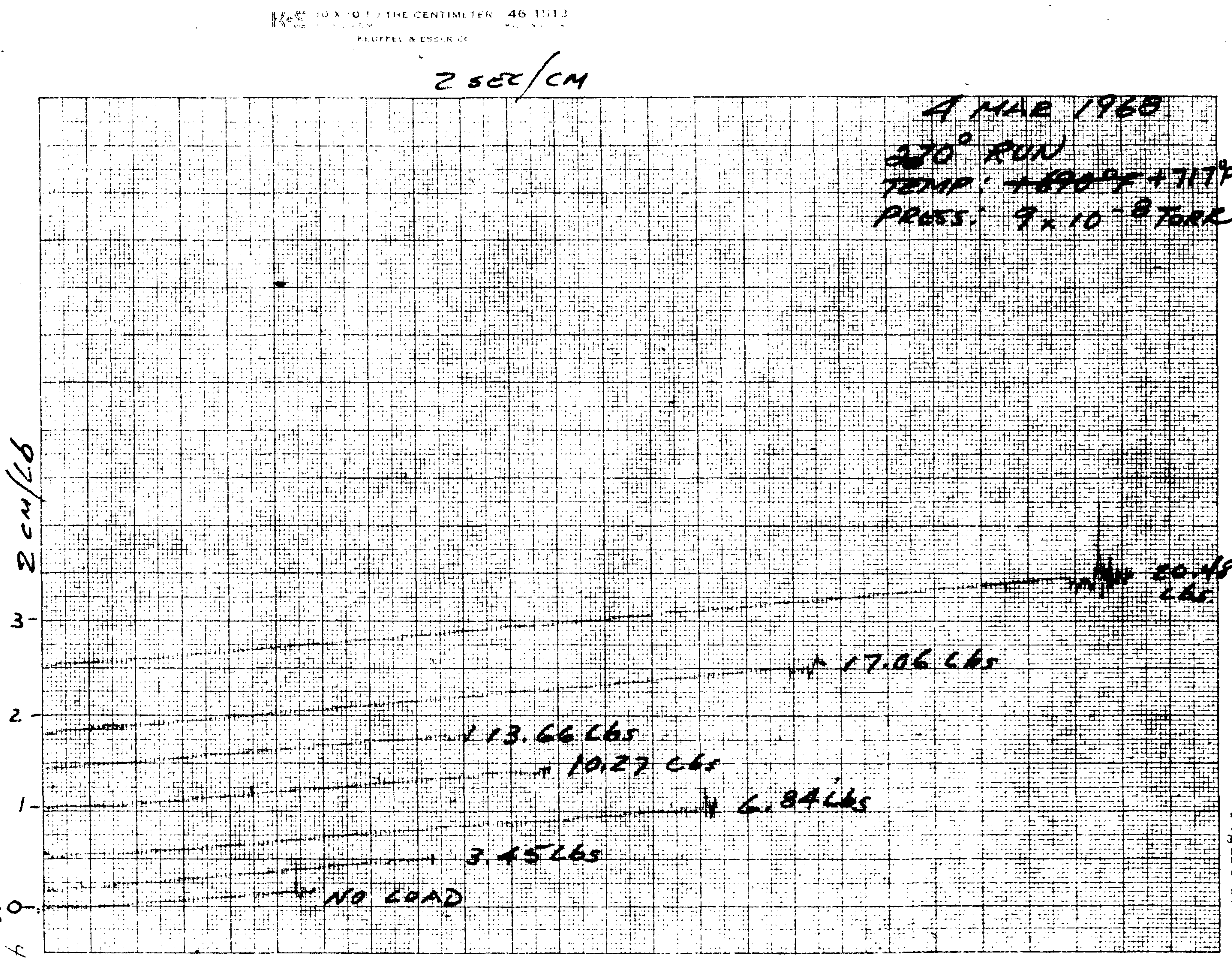
1-Moly-Kote Residue (Dark Substance)-Typical

2-Micro-Lube Residue (White Specks)-Typical

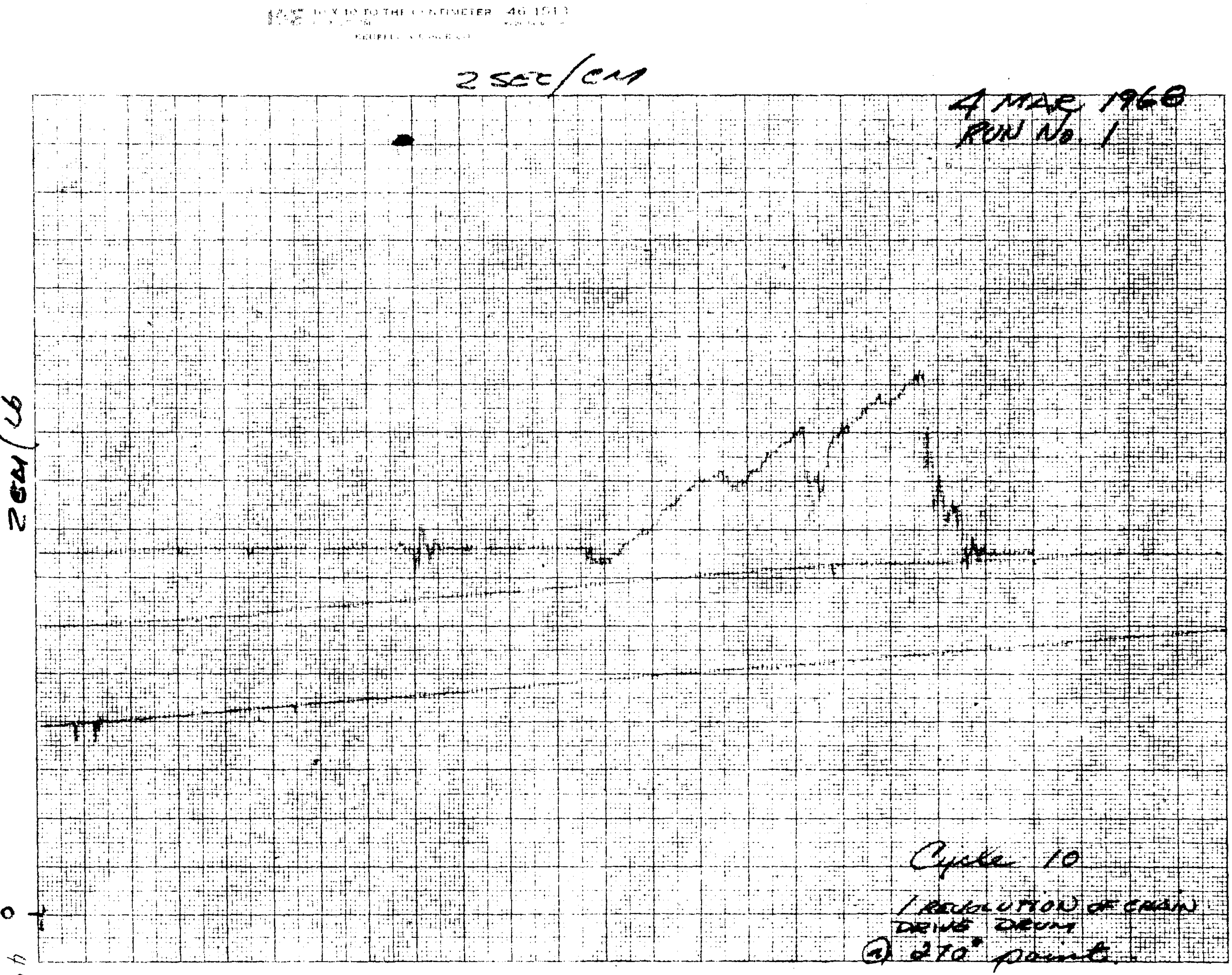
Write caption at right of each photo.

Identify test item, test equipment, failure, axis, etc.

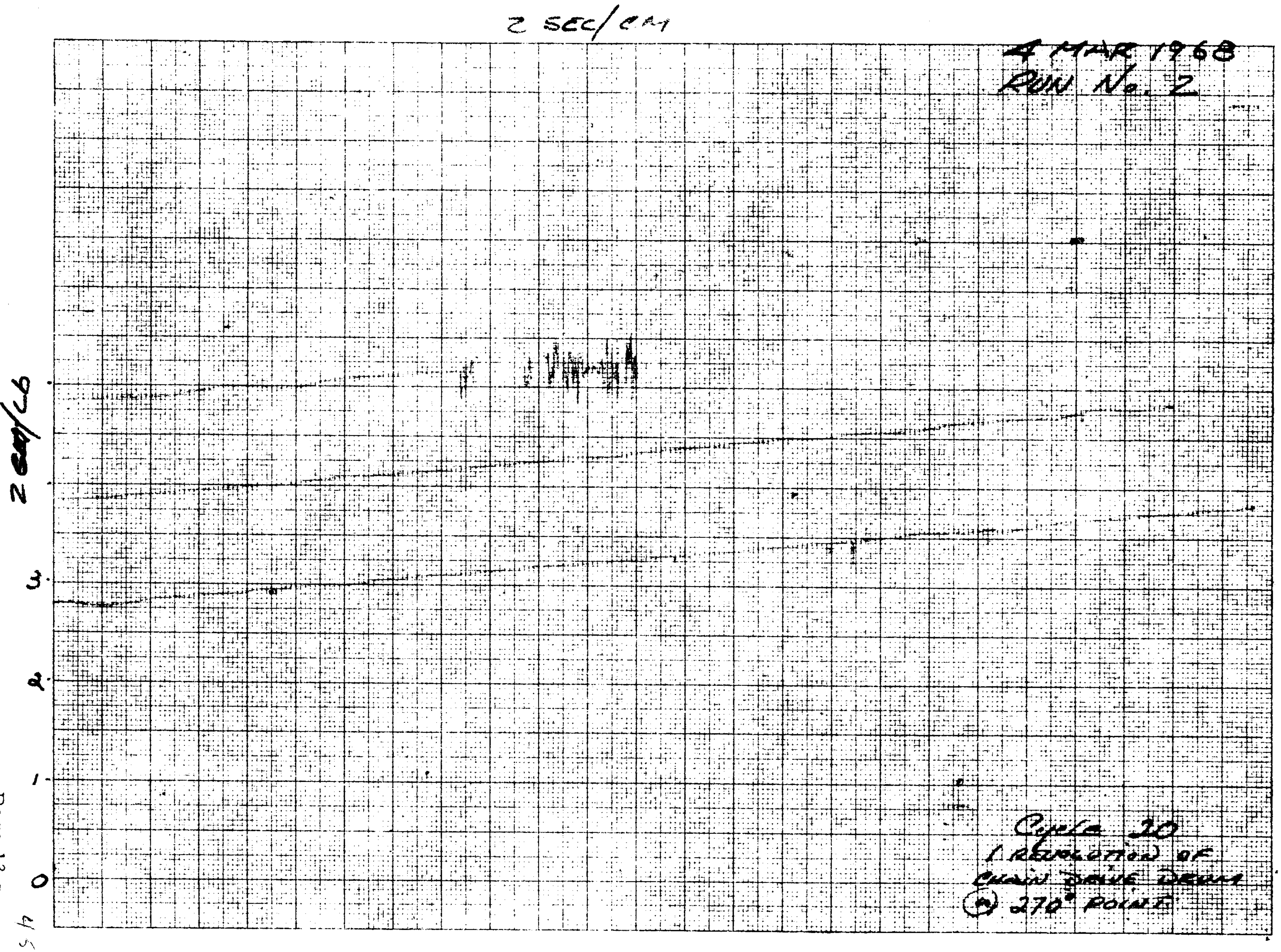

1 MAR 1968
180° RUN
TEMP: -69.8°F + 717°F
PRESS: 0 x 10⁻⁹ TORR
+ 20,000 LBS
17,000 LBS
13,000 LBS
10,000 LBS
6,000 LBS
3,000 LBS
N/O LOAD
2 SEC/IN
22MM/SEC
N
1
0



TR 3092
Figure 17

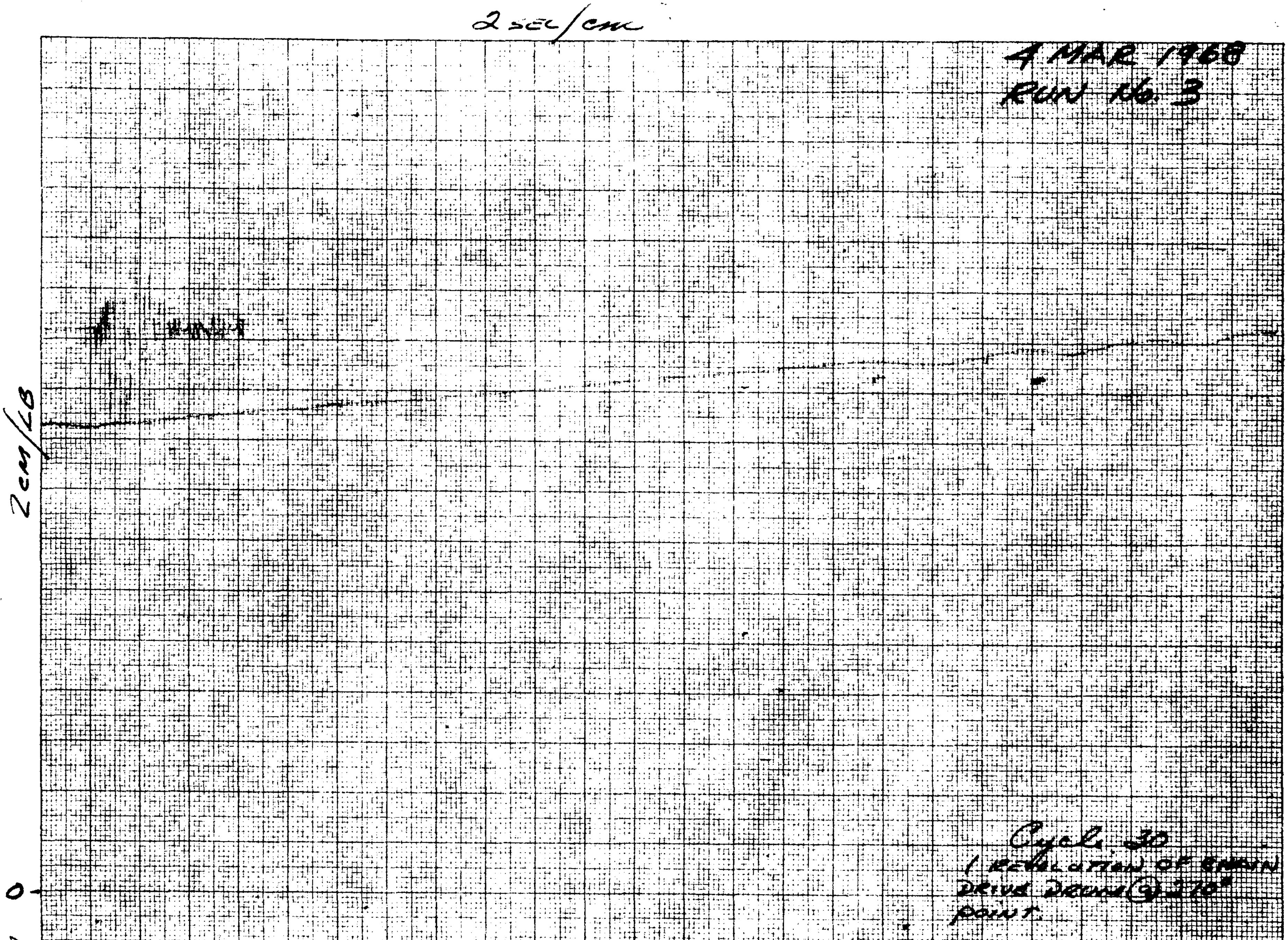


TR 3092
Figure 18



TR 3092
Figure 19

K+E 10 X 10 TO THE CENTIMETER 46 1513
KEUFFEL & ESSER CO.



TR 3092
Figure 20

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THE [illegible] CORPORATION

SPACE SYSTEMS DIVISION · ANN ARBOR, MICHIGAN

Systems Test Department

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Page 14a

Table I
THERMOCOUPLE TEMPERATURES - °F

Test Item CASK GEAR BOX Test THERMAL - VACUUM. Date 1 MAR 60

TC No.	1500 MV	1500 °F	1515 MV	1515 °F	1600 Day MV	1600 Day °F	1700		1800		1900	
1	14.02	410	16.9	475	26.6	700	27.75	725	25.72	680	24.9	660
2	13.6	400	16.7	475	25.4	670	26.80	705	26.14	690	25.30	670
3	14.3	420	16.8	475	24.0	640	25.56	675	25.42	672	24.9	655
4	15.3	440	17.2	480	24.5	650	25.80	675	24.56	653	23.50	630
5	20.3	550	18.8	500	20.0	550	14.81	425	9.06	280	7.08	230
6	15.2	430	13.25	390	16.4	465	11.4	345	7.82	230	5.55	190
7	20.6	560	18.2	510	23.5	630	15.48	440	9.62	300	7.5	245
8	18.7	520	19.2	530	23.6	630	24.18	645	23.83	640	25.58	675
9												
10												
11												

TC No.	2000 MV	2000 °F	2100 MV	2100 °F	2300 MV	2300 °F	2300 MV	2300 °F	2400 MV	2400 °F		
1	24.98	640	25.75	670	25.30	670	25.30	670	25.40	673		
2	25.13	665	26.13	665	26.41	700	26.43	700	26.60	702		
3	24.55	650	24.61	660	24.70	660	24.68	660	24.82	660		
4	23.26	625	23.60	630	24.50	650	24.60	655	24.71	660		
5	5.06	180	5.55	190	5.67	192	5.75	194	5.81	195		
6	4.15	150	5.21	183	5.43	176	5.53	180	5.62	195		
7	5.25	183	5.35	175	5.47	126	5.57	181	5.72	192		
8	25.47	673	25.68	677	26.12	690	26.27	690	26.41	695		
22												
23												
24												
Avg												
Obs by												

Note: Record time of day from midnight to midnight (0 to 2400 hours).

THE Bendix CORPORATION

GUIDANCE SYSTEMS DIVISION · ANN ARBOR, MICHIGAN

Systems Test Department

LR 3276
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Table I (Continued)
THERMOCOUPLE TEMPERATURES - °F

Test Item TASK Gear Box Test Thermal Vacuum Date 2 Mar 68

TC No.	0430 MV	0430 °F	1000 MV	1000 °F	Time of Day 1100 MV	1100 °F	1300 MV	1300 °F	1330 MV	1330 °F	1445 MV	1445 °F
							VARIAC: 75		VARIAC: 70		VARIAC: 65	
1	12.06	360	15.7	450	23.6	655	30.0	780	30.0	780	30.0	780
2	12.4	370	15.8	450	23.8	635	30.3	780	30.2	780	30.2	780
3	10.8	330	15.1	430	22.9	615	29.4	760	29.4	760	29.4	760
4	10.03	310	13.9	405	21.8	590	28.0	750	28.1	730	28.2	730
5											3.6	140
6											3.4	135
7											3.2	125
8					28.2	735	25.3	670	25.3	670	25.2	670
9	1530		0800		0800		0925		1000		1245	
10	MV	°F	0	①	21.8	590	25.0	660	25.8	680	27.3	715
11	27.8	730	1	②	21.9	590	25.1	660	25.9	685	27.5	720
12	28.6	745	2	③	21.0	570	23.9	640	24.7	660	26.2	690
13	27.3	715	3	④	20.4	560	23.2	620	23.9	640	25.3	670
14	26.7	700	4									
15	12.4	370	5									
16	10.4	330										
17	16.5	465										
18	24.2	645										
19			PRESSURE		2.5_{10}^{-7}		$2(10^{-7})$		$1.4(10^{-6})$		$2(10^{-6})$	
20	MV 0830 °F		MV 0930 °F									
21	27.4	120	27.3	715								
22	27.4	720	27.4	720								
23	26.2	690	26.1	690								
24	25.3	670	25.2	670								
5			$9(10^{-8})$ TORR									
6			END OF									
Avg			TEST									
Disp												

Note: Record time of day from midnight to midnight (0 to 2400 hours).

PRESSURE $1.8(10^{-7})$

8.0 DISCREPANCY AND PROCEDURE VARIATION SHEET

8.1 *Discrepancy and/or Variation

Reference Paragraph	Instruction
1.	PREVENT CHAIN SPROCKET HOUSING FROM ROTATION BY FIXING TWO ANCHOR PLATES TO GEAR BOX BODY TO HOLD HOUSING 2/8/68.
2.	APPLY DRY LUBRICANT (MOLY. DISULPHIDE) TO BEAD CHAIN. 2/8/68
3.	Endurance Test - Cycle by rotating chain drive drum through 360°, ten times under full load (24.4 pounds) and measure input load required to move drum. Repeat three times. 3-4-68

4 Mar 68
Test Conductor Date

3-4-68
ALSEP Test Conductor Date

*By definition:

Discrepancy - unintentional operation of equipment
Variation - intentional variation in test not requiring procedure change

9.0 SIGN-OFF SHEET

9.1 The Thermal Test on Fuel Cask Mount Gearbox has been performed in accordance with the foregoing procedure.

R. T. DeVall — 3-4-68
ALSEP Test Conductor — Date

R. Lannum — 4 Mar 68
ALSEP Test Director — Date

Robert A. Foster — 3/4/68
ALSEP Engineering Representative — Date

10.0 PROCEDURE REVISION SHEET

Procedure No ATP-D-96, Revision —, Date _____

The below procedure changes will be incorporated in .

Revision —, per ECN —

Paragraph	Instructions

SEE PAGE 16 FOR DETAILS.

R. Lannin — 4 MAR 68
Test Conductor — Date

Robert B. Fitts — 3/4/68
ALSEP Project Engineer — Date

R. L. DeVall — 3-4-68
ALSEP Test Conductor — Date

Bendix Aerospace Systems Division
SYSTEMS TEST DEPARTMENT

TR 3093
DATE 30 April 1968

TEST REPORT

Item: ALSEP Kurz and Root 25 KW A.C. Motor Generator
Test: Functional Load Test (Engineering)
Requested by: R. Shay, Department 974
Work Order No.: 97431-970-321-000 **Authorisation:** P.W.O. **LR** 3309
Completion Date: 8 Mar 1968 **Disposition of Item:** Returned to Department 974
Performed by: G. Pietrzyba — G. Pietrzyba, Test Engineer
Approved by: J. Whiteford — J. Whiteford, Project Engineer
Test Witness: None
Distribution: R. Shay, Dept. 974; P. Sprouse, Dept. 440, C. Garbe, Dept. 974 Rep.

REFERENCE:

(A) Interdepartmental Letter No. 68-440-1293

TEST RESULTS:

The ALSEP Kurz and Root Motor Generator was tested as requested in Reference (a). The test item failed under half-load and under full-load conditions.

TEST METHOD AND DATA:

The motor-generator was wired for single phase operation with terminal T-1 grounded as shown in Figure 1. A one ohm resistor was used for full-load operation and a 1.8 ohm resistor was used for half-load operation.

At first it was found that the motor generator would blow 60A fuses. Fuses were increased to 100A rated and a clamp-on current meter was connected to one phase of the supply line.

When switching the motor generator the initial surge current would exceed 300 amps and would stabilize at 40 amps. After about 15 seconds a time delay relay would activate the field current in the motor. At that time the supply current would either go up to 90 amps or down to 9 amps in each phase.

The 90 amps operation was obviously faulty and the unit was immediately switched off. After several attempts the unit could be brought to operate at low current (9 amps no load).

In the course of determining what was wrong the following was tried:

(a) The phase wires at the input were exchanged. Effect: No change in operation.

(b) The direction was reversed. Effect: No change.

(c) The field current was decreased by changing transformer taps of the field supply transformer. Effect: No change.

The manufacturer was informed about the malfunction of the motor generator and it was decided to return the unit for repair.

Before return of the unit to the manufacturer attempts were made to get the motor generator in the proper mode of operation and perform some functional test.

The following findings were made:

1. The unit was started operating properly (9 amperes primary) for no-load condition) the output voltage was adjusted for 118 VAC.

2. Half load (50 amps) operation.

   (a) Primary current increased to 14 amps.

   (b) Instantaneous drop in output voltage was about one volt during switching. Restored to 118 VAC immediately.

3. Full load (100 amps) operation.

   (a) Primary current increased to 19 amps.

   (b) Instantaneous drop in output voltage by about one volt during switching. Stabilized at less than 1/2 Volt below nominal (118 VAC).

4. Transient monitoring.

   The load was adjusted to 50 amps and the output closely watched for transients as read on a VTVM (HP-Model 400 H). Several instantaneous changes of the output voltage were observed. The amplitude change did not exceed 1.5 Volts. The output voltage would always return to nominal 118 VAC.

A certain amount of vibration was noticed during the operation of the motor generator. The vibrations were more pronounced at the motor end.

After one hour of operation the load was increased to 100 amps.

Loss of power/output voltage decay. The supply to the motor-generator was switched off in order to find out how long it would take before the output voltage on full load will drop below 105 VAC. It took approximately 4 seconds.

The output voltage waveform was observed on an oscilloscope Tektronix 545 for all load conditions. The waveform was a reasonably clean sine wave.

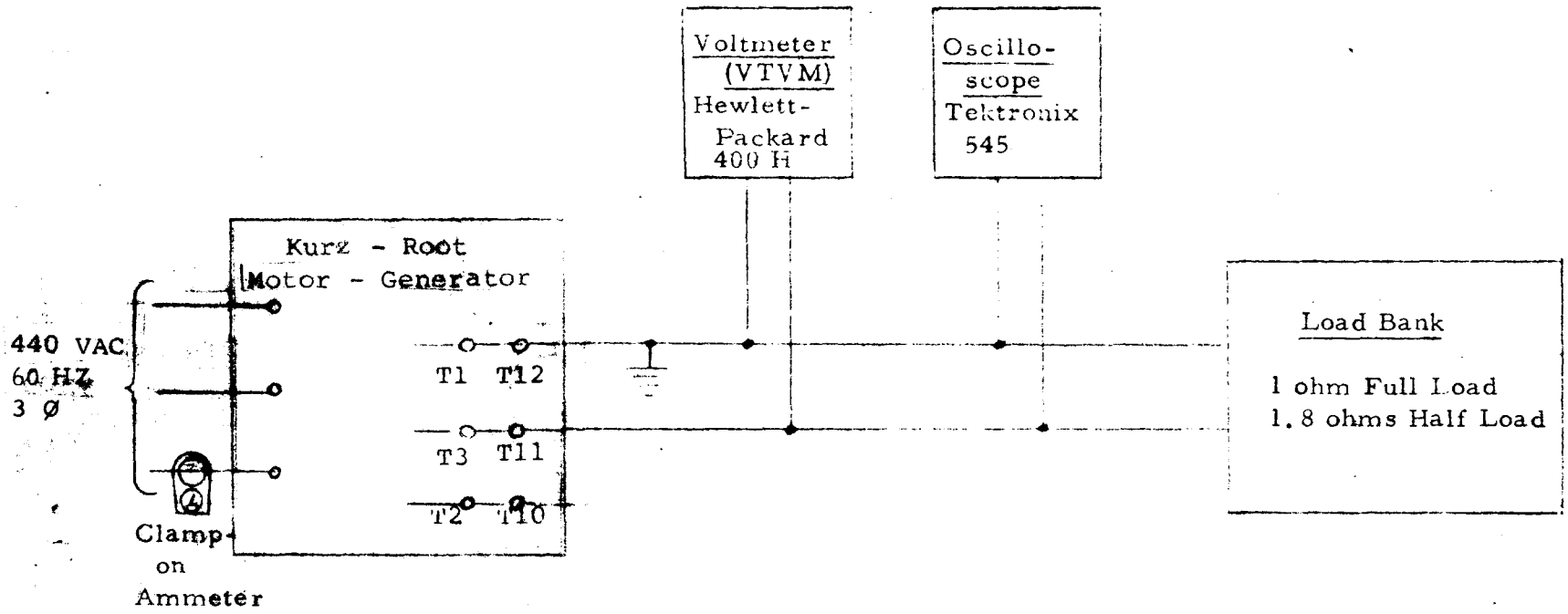

Figure 1 - Motor Generator Load Test Setup

TR 3093