

UNCLASSIFIED

AD 401 157

*Reproduced
by the*

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

6.3-3-2

ASTIA
CATALOGED
AS AD No. 401157

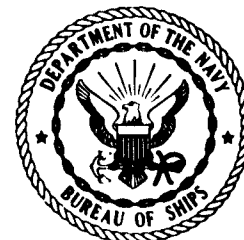
401 157

**DIAMOND POWER SPECIALTY CORPORATION
DIAMOND MODEL DP-3000 DURA-PORT GAGE**

Evaluation Report
NBTL Project No. B-518
Subtask 4181
SF013-06-16
12 March 1963
by
J. ISINGER

**NAVAL BOILER AND TURBINE LABORATORY
PHILADELPHIA NAVAL SHIPYARD
PHILADELPHIA 12, PENNA.**

ASTIA
RECEIVED
APR 12 1963

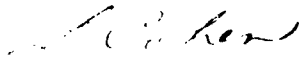


DIAMOND POWER SPECIALTY CORPORATION
DIAMOND MODEL DP-3000 DURA-PORT GAGE

Evaluation Report
NBTL Project No. B-518
Subtask 4181
SF013-06-16
12 March 1963
by
J. ISINGER

APPROVAL INFORMATION

Submitted by:


I. COHEN
Head
Heat Exchanger Branch


P. E. JORGENSEN
Head
Heat Power Division

Approved by:


W. W. BRALEY
Captain, USN
Director

TABLE OF CONTENTS

	<u>Page No.</u>
ABSTRACT	i
SUMMARY PAGE	ii
ADMINISTRATIVE INFORMATION	iii
REPORT OF INVESTIGATION	1
Description of Material	1
Procedure and Results	1
Introduction	1
Shock and Vibration Evaluation	2
Installation on Operating Boiler	3
Installation on Water Gage Evaluation Facility	3
Conclusions	6
Appendix I	NRL Shock and Vibration Report

LIST OF ILLUSTRATIONS

(Dura-Port) BI-Color Navy Type Water Gage Assembly Dwg. No. 103656-1056	1
Illuminator and Wide Angle Hood Assembly Dwg. No. 103657-1154	2
Photograph-Main Body of Gage	3
Photograph-Gage with Viewing Hood and Illuminator Attached	4

Tests were conducted on a pressure gauge

NBTL PROJECT B-518

ABSTRACT

A Diamond Power Specialty Corporation "Dura-Port" Gauge, designed to operate at pressures up to 3000 psig, ~~was~~ *was* evaluated to determine its suitability for shipboard service.

The gage was first shock and vibration tested at the Naval Research Laboratory. The gage insert withstood shock and vibration tests without leakage or glass failure; the illuminator and hood assembly required modification to provide adequate shock and vibration resistance.

The gage was installed on the Laboratory's DDG-15 boiler for determination of clarity and angle of visibility. Readability of the gage, requiring reliance on the color-refraction principle, was considered satisfactory while incorporating a better than 100° viewing angle. Optimum discernment of water level was obtained at distances ten to fifteen feet from the gage.

A 256-hour full pressure test, with blowdown every forty-eight hours and a rapid pressure drop and rise every twenty-four hours, was conducted ~~on the laboratory's water-gage test facility~~ without steam leakage or mica or glass failure of the main insert. The shut-off valves showed no leakage at hand tightness during and after cooling. The leakage through the closed ball check was excessive with an average of approximately 1000 cc every 3 minutes and 10 seconds.

NBTL PROJECT B-518

SUMMARY PAGE

The Problem

Evaluate a Diamond Model DP-3000, Dura-Port Water Gauge for naval service on 1200 psi boilers. Agenda for testing was to be in accordance with revised specifications MIL-G16356B of 25 September 1961, paragraphs 4.2 through 4.2.7. and 4.5 through 4.5.6, shock and vibration tests were to be in accordance with MIL-S-901 of 19 December 1955, and MIL-S-167 of 20 December 1954, respectively.

Findings

After modifications to the gage, illuminator, and hood the entire assembly successfully withstood shock and vibration tests with the exception of light bulbs which failed during shock tests.

Evaluation of the gage on both an operating boiler and the water gage evaluation facility indicated discernment of water level was good. The gage was reliable and required little or no maintenance during several hundred hours of operation. Performance of water gage assembly valves was satisfactory with the exception that excessive leakage occurred through the closed ball check.

NBTL PROJECT B-518

ADMINISTRATIVE INFORMATION

This project was authorized by BUSHIPS ltr 9510/1-3
Ser 651D-1450 of 18 October 1961. Costs were chargeable to
Allotment 290/RDT & EN 62.2421, Budget Project 50. This is
a final report of an RDT & E project.

REPORT OF INVESTIGATION

DESCRIPTION OF MATERIALS

The ported boiler water gage submitted for evaluation was manufactured by Diamond-Power Specialty Corporation. This gage, designated as a Diamond Model DP-3000 Dura-Port Gauge, included an illuminator and wide angle hood, and was designed and built to operate at pressures up to 3000 psig. This gage was to be an improved design over the Diamond Multi-Port Gauge previously evaluated at the Laboratory under NBTL Project B-379 and found to be unsatisfactory because of glass and mica failures.

Previous dual color gages operating on the refraction principle required direct "head-on" viewing to ascertain correct water level. This was a distinct disadvantage. The subject gage was designed to provide a viewing angle of approximately 100° . Details and description of the Dura-Port gage can be obtained by referring to the drawings and photographs included as Plates 1 to 4 of this report. Information as to maintenance and operation of the gage can be obtained from the Diamond Instruction Manual, Bulletin No. 2572, of November 1961.

PROCEDURE AND RESULTS

Introduction

The Bureau of Ships authorized the Laboratory to evaluate the manufacturer's latest design Dura-Port gage according to requirements of the

NBTL PROJECT B-518

revised specifications MIL-G-16356B. Specified tests included operation on both the high pressure water gage test facility and a Laboratory 1200 psi boiler, and a complete shock and vibration evaluation.

Shock and Vibration Evaluation

Because the weight of the water gage plus its mounting exceeded the limit for the Laboratory's vibration testing machine, the Naval Research Laboratory was authorized by the Laboratory to perform both the vibration and shock tests.

While there was no leakage or glass failure during vibration tests, modifications were required to enable the complete gage assembly to meet requirements. The single expansion loop at the top of the gage was replaced with a double, symmetrical loop arrangement, shortening the radius of the loop, producing a more vibration resistant construction in this area; the sides of the wide angle viewing hood were strengthened; other modifications were made to the gage, illuminator and hood. After incorporation of all modifications, the complete assembly successfully passed the vibration requirements of MIL-STD-167 (Ships) for all frequencies between 0 and 33 cps and in each of the three principal directions of vibration.

The gage proper and the wide angle viewing hood and its lens successfully withstood the shock tests, but the function of

NBTL PROJECT B-518

the illuminator was impaired because its light bulbs failed and the glass lenses cracked and/or broke.

A complete description of the procedure and results of the shock and vibration tests are presented in Appendix I, the Naval Research Laboratory's report on the tests.

Installation on Operating Boiler

After shock and vibration tests, the gage was installed on the Laboratory's DDG-15 boiler for determination of clarity and angle of visibility and simplicity of installation.

Although the sharpest designation of water level was had at distances between ten and fifteen feet of the gage, readability, dependent upon the two-color or light refraction principle, was satisfactory with close ups from four to six feet. Difficulty was experienced while mounting the insert to the already assembled bottom valve; the small metal sealing gasket was dislodged from its position on the surface of the raised face of the valve flange. The result of this was considerable steam leakage and a damaged raised face.

Installation on Water Gage Evaluation Facility

The gage was installed on the Laboratory's high pressure water gage testing facility and subjected to a series of rapid

NBTL PROJECT B-518

pressure drops and rises, blowdowns, and pressures and temperatures and water conditions representative of those encountered in current naval power plants. Operation was conducted for 256 hours at full pressure of 1250 psig with blowdown every 48 hours and a rapid pressure drop and rise every 24 hours. A 1000 hour evaluation of the gage was not completed because of reports of successful operation aboard USS SARATOGA (CVA 60).

The gage illuminator assembly functioned satisfactorily throughout the total operating time. No leaks occurred at the port assemblies, no mica or glass failures occurred, and no maintenance was required. Three light bulb failures occurred. Visibility or discernment of water level was good, with a better than 100° viewing angle on the DDG-15 boiler; the distant views were the best. Some difficulty was encountered in replacing burned out light bulbs due to heat from the main insert and the bulb assembly. Gage valve operation was satisfactory, with no leakage through either the steam, water or drain valves during and after cooling and throughout the securing tests. The ball check rose readily, requiring approximately 58.6 lbs. per hour of escaping saturated steam. The seating ability of the ball check, however, was not satisfactory,

NBTL PROJECT B-518

allowing an average leakage of approximately 1000 cc every three minutes and ten seconds, well above the allowable leakage stated in specification MIL-G-16356B, paragraph 3.12.7.2.

During the initial steam and water shut-off valve hot cycling operation, the handwheel torques required for tight valve closure averaged 20 lb. ft. Further valve cycling produced slight packing leaks that were stopped by tightening the gland follower just enough to prevent leakage. Following the gland tightening, valve cycling operation was resumed and it was disclosed that increased handwheel torques were now required for tight valve closure. Torques up to 40 lb. ft. and 35 lb. ft. were necessary for tight closure and subsequent re-opening, respectively. These torques are above the 15 lb. ft. allowable stated in specification MIL-G-16356B, paragraphs 3.10.2 and 3.10.3.

CONCLUSIONS

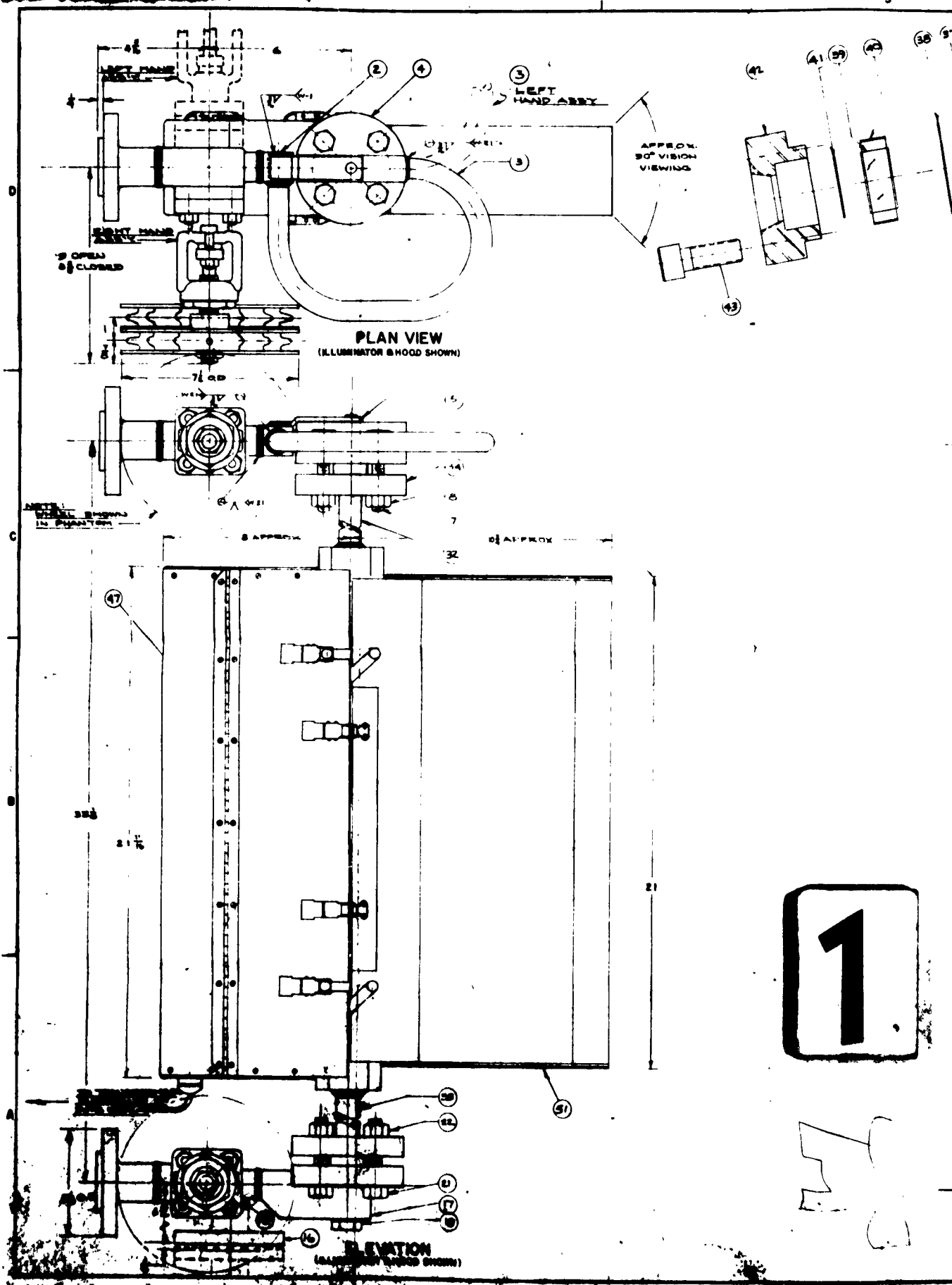
Performance of the gage proper and illuminator during observation and operating test indicated adequate reliability for service use.

The illuminator, required for proper water level indication, is adequate from a shock and vibration standpoint; determination of clarity and angle of visibility was satisfactory although there is still room for improvement for close up views of four to five feet from the gage.

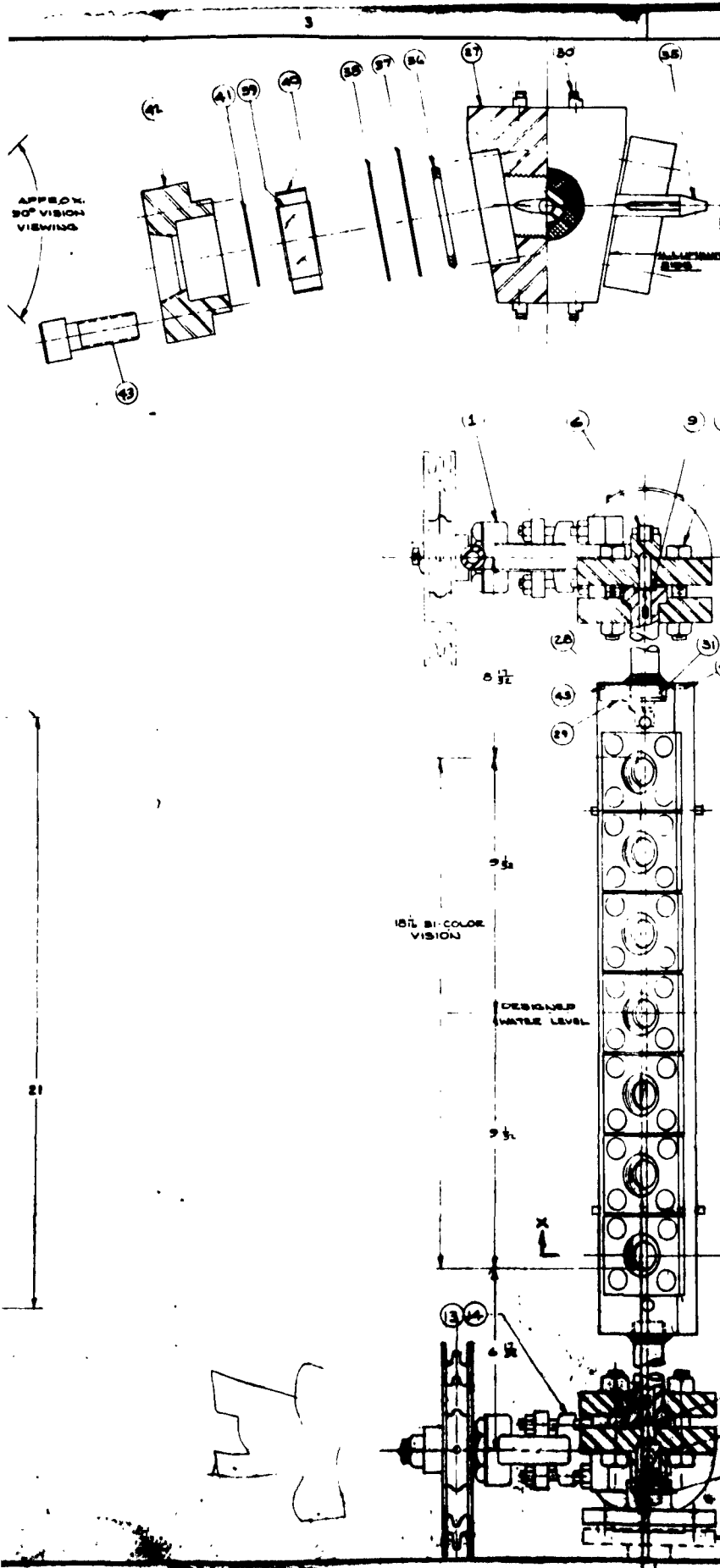
The main gage insert possessed advantages, namely in its light weight and ease in changing parts; however, care must be used in the assembly of the main insert to the bottom water valve, to avoid dislodging the small sealing gasket.

The ball check valve was closed by 58.6 lbs per hour of escaping saturated steam, which is below the required flow rate. The seating ability of the ball check was unsatisfactory, allowing an average leakage of approximately 1000 cc every three minutes and ten seconds.

Although the shut-off valve operation was satisfactory with no leakage throughout the securing tests, as stated on page 4, it was determined that the handwheel torques required for tight closure and re-opening ranged between 20 and 40 lb. ft.



1



LIST OF MATERIAL - QUANTITIES FOR ONE RM. ASSY. & ONE									
PC. NO.	NAME	QTY.	MATERIAL	MAT'L SPEC.	MANUFACTURER'S NAME	DWG. NO.	BUSHIPS DWG. NO.	UNIT	STD. SYD.
UPPER VALVE ASSEMBLIES									
1	UPPER VALVE ASSY	1	SEE ASSY. DETAIL	BRFC	102416-4037				
2	CONNECTOR BODY	1	CARBON STL.	DPSC	102419-0114				
3	LOOP-EXPANSION	1	CARBON STL.	DPSC	102597-0112				
4	FLANGE-LOOP	1	CARBON STL.	DPSC	102674-0112				
5	SEMI-GLIDE	1	CARBON STL.	DPSC	102688-0112				
6	GUIDE-EXPANSION	1	CARBON STL.	DPSC	102617-0114				
7	1/16 HEX. HD BOLT 3/16	4	STAINLESS	DPSC	102628-1112				
8	1/16 HEX. NUT	4	CARBON STL.	DPSC	102729-0110				
9	GASKET 1/2" ID. 1/4" TH	1	ASBESTOS	COML	904560-0001				
10									
11									
12									
LOWER VALVE ASSEMBLIES									
13	LOWER VALVE ASSY (SEE DETAIL)	1	SEE ASSY. DETAIL	DPSC	102626-4037				
14	LOWER VALVE ASSY (SEE DETAIL)	1	SEE ASSY. DETAIL	DPSC	102626-4037				
15	1/4" FL. SLEEVE	1	CARBON STL.	DPSC	102593-0114				
16	FLANGE-SPRAIN	1	CARBON STL.	DPSC	102593-0117				
17	CONNECTOR BODY	1	CARBON STL.	DPSC	102576-1112				
18	EXTENSIBLE-BALL	1	STAINLESS	DPSC	102579-1112				
19	GASKET 1/2" ID. 1/4" TH	1	ASBESTOS	COML	904560-0001				
20	DIA. BALL CHECK	1	STAINLESS	DPSC	102745-0111				
21	1/16 HEX. HD BOLT 3/16	4	STAINLESS	DPSC	102715-1110				
22	1/16 HEX. NUT	4	CARBON STL.	DPSC	102729-0110				
23	GASKET 1/2" ID. 1/4" TH	1	ASBESTOS	COML	904560-0001				
24									
25									
26									
GAUGE ASSEMBLIES									
27	CENTER PLATE	1	BRASS	DPSC	102479-1112				
28	TUBE-SPRAIN	1	CARBON STL.	DPSC	102480-1114				
29	INSTRUCTION PLATE	1	BRASS	DPSC	100081-0110				
30	PIN LATCH	2	STAINLESS	DPSC	102408-0117				
31	SHIM-SPRAIN	2	BRASS	DPSC	102477-1111				
32	END STEM UPPER	1	STAINLESS	DPSC	102476-1112				
33	END STEM LOWER	1	STAINLESS	DPSC	102476-1110				
34	FLANGE GAUGE	2	CARBON STL.	DPSC	102575-0117				
35	PIN-SCREEN GAUGE	2	CARBON STL.	DPSC	102449-1116				
36	GASKET SEALING	14	BRASS	DPSC	102447-1112				
37	GASKET PROTECTIVE	14	BRASS	DPSC	102447-1119				
38	GASKET PICA	14	PICA	DPSC	102448-1110				
39	GLASS GAUGE	14	GLASS	COML	102444-1111				
40	PACKING STRIP	14	ASBESTOS	COML	102448-1112				
41	GASKET-CLIMON	14	ASBESTOS	COML	102448-1112				
42	COVER PLATE GAUGE	14	CARBON STL.	DPSC	102449-1115				
43	CAP GROUND-SPRAIN	24	CARBON STL.	DPSC	102439-1110				
44	FLUG-SEAL	4	CARBON STL.	DPSC	100151-0112				
45	FLUG-SEAL	4	CARBON STL.	DPSC	100151-0112				
46									
ILLUMINATOR ASSEMBLIES									
47	ILLUMINATOR ASSY	1	SEE ASSY. DETAIL	DPSC	102626-1028				
48									
49									
50									
WIDE ANGLE DIRECT READING HOOD ASSEMBLIES									
51	HOOD ASSY	1	SEE ASSY. DETAIL	DPSC	102426-1027				
52									
53									
54									
DRAIN VALVE ASSEMBLY (THE FOLLOWING DETAILS ARE									
55	DRAIN VALVE PLATE	1	CARBON STL.	DPSC	102281-0112				
56	1/2" DRAIN VALVE	2	BRASS	COML	3022-U				
57	1/2" NIPPLE SCHEDULE 40	1	CARBON STL.	DPSC	102281-0112				
58	1/2" HANGER STD. RES.	2	CARBON STL.	DPSC	102281-0112				
59	STUD	4	CARBON STL.	DPSC	102281-0112				
60	GASKET 1/2" ID. 1/4" TH	1	ASBESTOS	COML	904560-0001				

2

LIST OF MATERIAL - QUANTITIES FOR ONE RH ASSY & ONE LH ASSY

PC NO	NAME	NO REQ OR 1 OR 2	MATERIAL	MATL SPEC	MANUFACTURERS NAME DWG NO	BUSHIPS DWG NO	UNIT WT/LB	STD NAVY STOCK NO	REMARKS
UPPER VALVE ASSEMBLIES									
1	UPPER VALVE ASSY	1	1	SEE ASSY DWG 102355-0007	DRSC	102355-0007			
2	CONNECTOR BODY	1	1	CARBON STL MIL-S-5545	DRSC	102355-0116			
3	LOOP EXPANSION	1	1	CARBON STL MIL-S-5545	DRSC	102355-0112			
4	FLANGE LOOP	1	1	CARBON STL MIL-S-5545	DRSC	102355-0112			
5	ARM-GUIDE	1	1	CARBON STL MIL-S-5545	DRSC	102355-0112			
6	GUIDE EXPANSION	1	1	CARBON STL MIL-S-5545	DRSC	102355-0116			
7	1/16 HEX HD BOLT 3/4	4	4	CARBON STL MIL-S-5545	DRSC	102355-0110			
8	1/16 HEX NUT	4	4	CARBON STL MIL-S-5545	DRSC	102355-0110			
9	GASKET BODY (LH)	1	1	PRINCE METAL ALUMINUM	COML	90456-0002			OTHER 901
10									
11									
12									
LOWER VALVE ASSEMBLIES									
13	LOWER VALVE ASSY (LEFT DETAIL)	1	1	SEE ASSY DWG 102355-0007	DRSC	102355-0007			RIGHT HAND
14	LOWER VALVE ASSY (LEFT DETAIL)	1	1	SEE ASSY DWG 102355-0007	DRSC	102355-0007			LEFT HAND
15	NIPPLE - DRAIN	1	1	CARBON STL MIL-S-5545	DRSC	102355-0116			
16	FLANGE - DRAIN	1	1	CARBON STL MIL-S-5545	DRSC	102355-0117			
17	CONNECTOR BODY	1	1	CARBON STL MIL-S-5545	DRSC	102355-0112			
18	RETAINER BALL	1	1	STAINLESS STEEL	DRSC	102355-0112			
19	GASKET (LH)	1	1	PRINCE METAL ALUMINUM	COML	90456-0001			FILE 901
20	2 DIA BALL CHECK	1	1	STAINLESS STEEL	DRSC	102355-0111			
21	1/16 HEX HD BOLT 3/4	4	4	CARBON STL MIL-S-5545	DRSC	102355-0110			
22	1/16 HEX HD NUT	4	4	CARBON STL MIL-S-5545	DRSC	102355-0110			
23	GASKET BODY (LH)	1	1	PRINCE METAL ALUMINUM	COML	90456-0002			OTHER 901
24									
25									
26									
GAUGE ASSEMBLIES									
27	CENTERPLATE	1	1	STAINLESS STEEL	DRSC	102355-0111			PC 27 SHOWN IN FIG 102355-0111
28	TUBE - BYPASS	1	1	STAINLESS STEEL	DRSC	102355-0111			
29	INSTRUCTION PLATE	1	1	BRASS	COML	102355-0111			
30	PIN - LATCH	8	8	STAINLESS STEEL	DRSC	102355-0111			
31	SHIM END STEM	4	4	STAINLESS STEEL	DRSC	102355-0111			
32	END STEM UPPER	1	1	STAINLESS STEEL	DRSC	102355-0111			
33	END STEM LOWER	1	1	STAINLESS STEEL	DRSC	102355-0111			
34	FLANGE - GAUGE	2	2	CARBON STL MIL-S-5545	DRSC	102355-0117			
35	PIN SCREEN GUIDE	2	2	STAINLESS STEEL	DRSC	102355-0111			
36	GASKET SEALING	14	14	STAINLESS STEEL	DRSC	102355-0111			
37	GASKET PROTECTIVE	14	14	STAINLESS STEEL	DRSC	102355-0111			
38	GASKET MICA	14	14	MICA	INEMA MICA	102355-0111			FORMULA 100-22
39	GLASS GAUGE	14	14	GLASS	COML	102355-0111			STYLE A 3L
40	PACKING JUMP	14	14	ASBESTOS	COML	102355-0111			STYLE 600
41	GASKET CUSHION	14	14	ASBESTOS	COML	102355-0111			
42	COVER PLATE GAUGE	4	4	ALUMINUM	AS R	102355-0111			
43	CAP SCREEN SOCKET NO	80	80	CARBON STL MIL-S-5545	DRSC	102355-0111			
44	FLUG - SEAL	4	4	STAINLESS STEEL	DRSC	102355-0111			
45	FLUG - SEAL	2	2	CARBON STL MIL-S-5545	DRSC	102355-0111			
46									
ILLUMINATOR ASSEMBLIES									
47	ILLUMINATOR ASSY	1	1	SEE ASSY DWG 102355-0111	DRSC	102355-0111			PC 47 SHOWN IN FIG 102355-0111
48									
49									
50									
WIDE ANGLE DIRECT READING HOOD ASSEMBLIES									
51	HOOD ASSY	1	1	SEE ASSY DWG 102355-0111	DRSC	102355-0111			PC 51 SHOWN IN FIG 102355-0111
52									
53									
54									
DRAIN VALVE ASSEMBLY (THE FOLLOWING DETAILS ARE SHIPPED LOOSE)									
55	DRAIN VALVE FLANGE	1	1	CARBON STL MIL-S-5545	DRSC	102355-0116			
56	1500 DRAIN VALVE	2	2	CARBON STL MIL-S-5545	DRSC	3652-U			SEE FIG 102355-0116
57	NIPPLE - SCHEDULE 80	1	1	CARBON STL MIL-S-5545	DRSC	102355-0116			
58	10-10 CAMER STD. FEE	8	8	CARBON STL MIL-S-5545	DRSC	102355-0116			
59	STUD	4	4	ALLOY STL MIL-S-5545	DRSC	102355-0116			
60	GASKET (HOOD ASSY)	1	1	PRINCE METAL ALUMINUM	COML	90456-0002			FILE 901

NO	DESCRIPTION	REV	DATE
A	CERTIFIED MICA - CHANGE - DETAIL 2 THREE 4-1/2 IN. DIA. HOLES WERE INCORRECTLY SHOWN WITH FLANGES. DWG NO. 102355-0111	4/2/54	4/2/54
B	CERTIFIED MICA - CHANGE - DETAIL 2 THREE 4-1/2 IN. DIA. HOLES WERE INCORRECTLY SHOWN WITH FLANGES. DWG NO. 102355-0111	4/2/54	4/2/54

NOTE A
THIS GAUGE IS USED FOR DIRECT VISION. THE RED
ILLUMINATOR (WATER TIGHT) IS OBTAINED BY THE
USE OF THE ILLUMINATOR PC 47 SHOWN IN FIG 102355-0111.

NOTE B
TO REMOVE GAUGE FROM VALVE WHILE THE
SYSTEM IS UNDER PRESSURE, CLOSE VALVE, ALIGHT
LOCK Y ARROWS ON GAUGE STEM. PC 38115
AND REMOVE GAUGE TOWARD OPERATOR.

NOTE C
PC 38115 WILL FURNISH MATERIAL OF COMMERICAL
SPECIFICATIONS IN LIEU OF MILITARY SPECIFICATIONS
FOR FILES LISTED IN TABLE BELOW.

PC NO	MILITARY SPECIFICATION	COMMERICAL SPECIFICATION
34	MIL-S-5545 CLB	ASTM-A181B C.P. 342, 300GA
39	AS-1000	ASTM-A181B C.P. 342, 300GA
40	AS-1000	ASTM-A181B C.P. 342, 300GA
41	AS-1000	ASTM-A181B C.P. 342, 300GA
42	AS-1000	ASTM-A181B C.P. 342, 300GA
43	AS-1000	ASTM-A181B C.P. 342, 300GA
44	AS-1000	ASTM-A181B C.P. 342, 300GA
45	AS-1000	ASTM-A181B C.P. 342, 300GA

NO	DESCRIPTION	REV	DATE
1	CENTERPLATE (CENTER PLATE)	102355-0111	102355-0111
2	ILLUMINATOR (HOOD ASSY)	102355-0111	102355-0111

NOT FURNISHED
BY LHM-10001

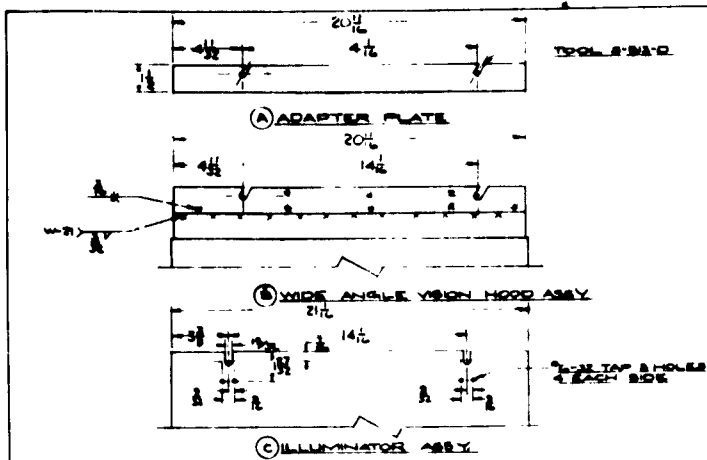
3

ELEVATION
(SHOWN WITHOUT ILLUMINATOR &
HOOD ASSEMBLY)

PI ATT-1

LIST OF MATERIAL QUANTITIES FOR

PC NO	NAME	NO REQD	MATERIAL	MAT'L SPEC	MANUFACTURER NAME	QUANTITY
(5) HOOD ASSY #103486						
50	PLATE SIDE R.H.	1	4010	DPSC M9	DPSC	103490-1130
51	PLATE SIDE L.H.	1	4010	DPSC M9	DPSC	03491-1139
52	PLATE END	2	4010	DPSC M9	DPSC	10348-1114
53	STRIP-SPACER	2	4010	DPSC M9	DPSC	10371-1114
54	MARK	1	4010	DPSC M9	DPSC	10377-1110
55	SCREW	8	STEEL	COM'L	ETHLENA	06581-0604
56	LENS	1	NYLONITE	COM'L	NYLONITE	10372-1113
57	8-32 X 1/2 SCREW	6	STEEL	COM'L	ETHLENA	06560-0810
58	8-32 X 1/2 NUT	6	STEEL	COM'L	ETHLENA	06560-0800
59	8-32 X 1/2 WASHER	6	STEEL	COM'L	ETHLENA	069010-0800
60	LAMP STEP	2	4010	DPSC M9	DPSC	10377-1111
61	PLATE ADAPTOR	2	4010	DPSC M9	DPSC	103670-1108
62						
63						
64						
65						
66						
67						
68						
69						



ENCLOSED (A) ADAPTER PLATE ASSY. WAS ATTACHED TO (B) HOOD ASSY. AS SHOWN.

ENCLOSED (C) ILLUMINATOR ASSY. WAS TAPPED AND SHOTTER AS SHOWN.

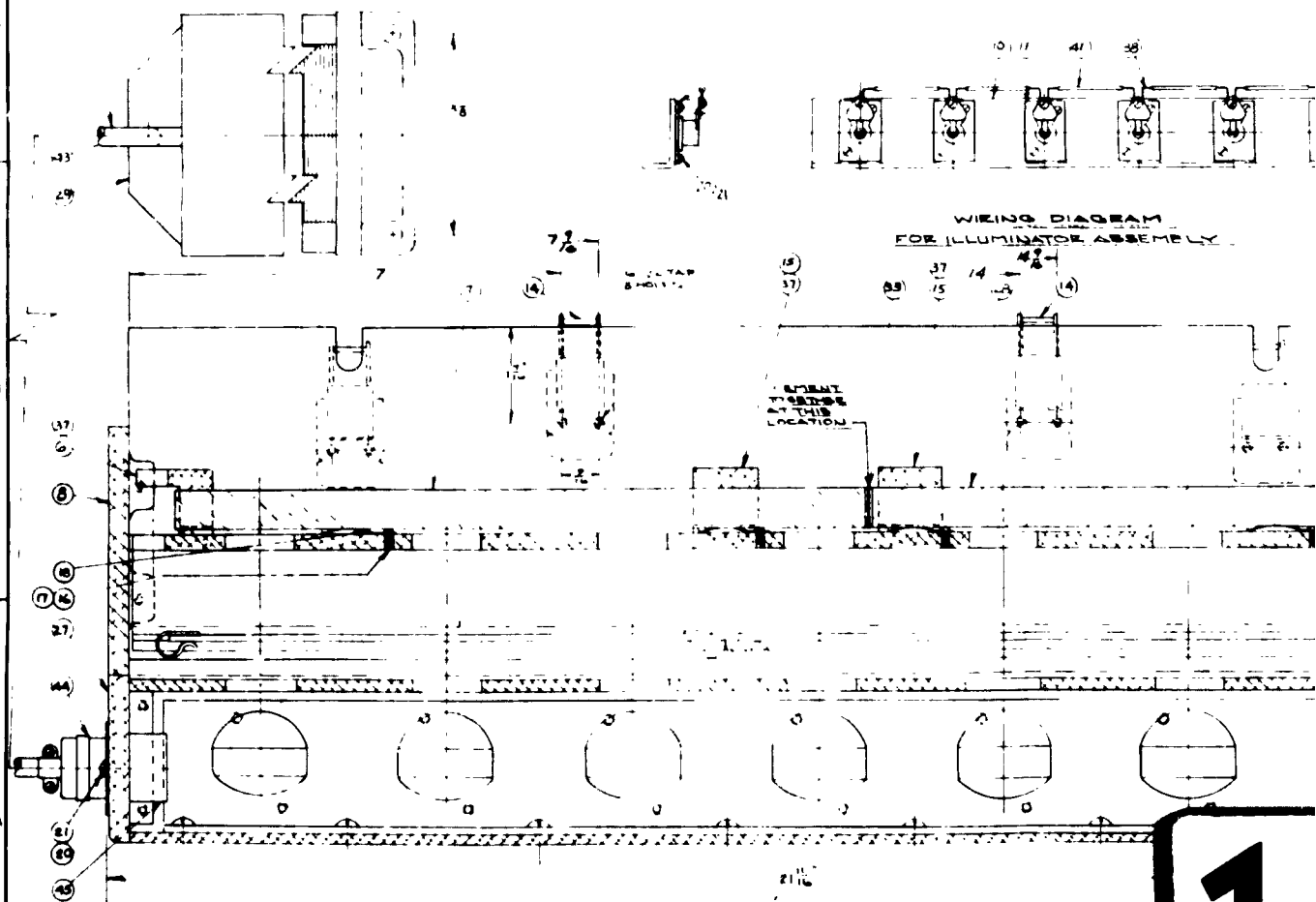
THE ABOVE ASSYS. WERE FURNISHED ON ORDER LW-12001 TEST GAUGES.

10 FT. OF CORD

NOTE:
LOCATE DET. 10 AWAY
FROM ILLUMINATOR ASSY.

4-32 TAP
4 HOLES

(4) ADAPTER PLATE 103670

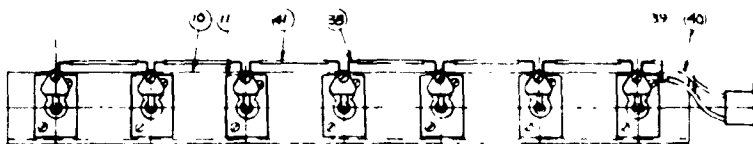
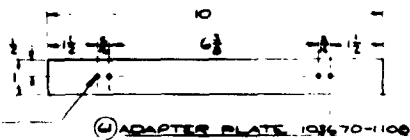


(1) ILLUMINATOR ASSY #103285-1048

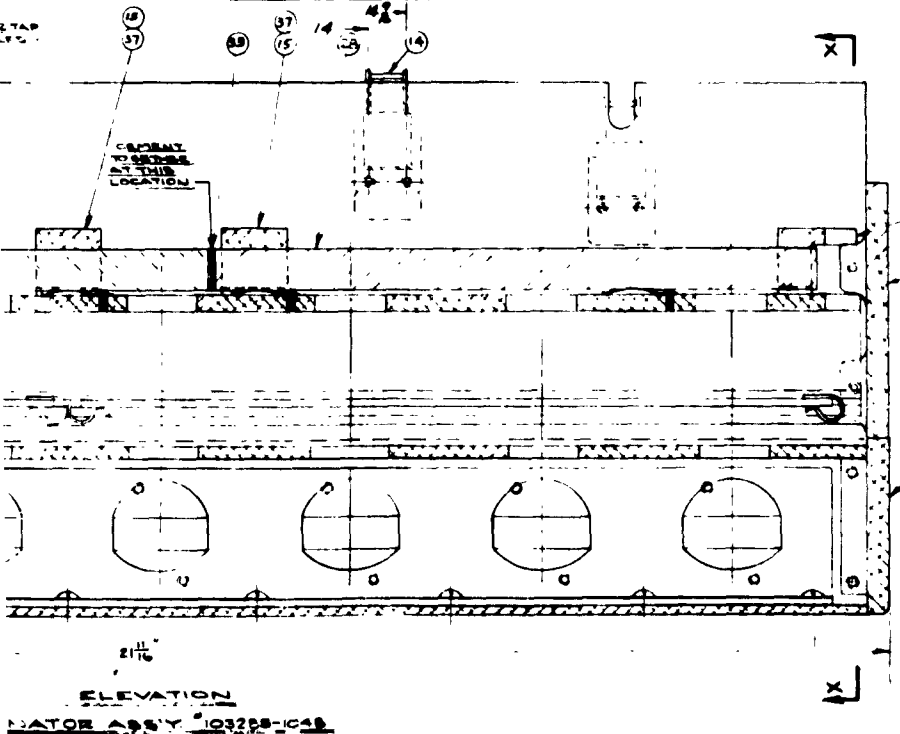
1

LIST OF MATERIAL QUANTITIES FOR ONE

PC NO	NAME	NO REQD	MATERIAL	MAT'L SPEC	MANUFACTURER	SHIP'S OWN NO	STD NAVY STOCK NO	REMARKS
(5) HOOD ASSEMBLY 103486-1037 (SEE NOTE 4)								
50	PLATE - SIDE - R.H.D.	1	ALUMINUM	DPSC HR	BRSC	103490-1120		
51	PLATE - SIDE - L.H.D.	1	ALUMINUM	DPSC HR	BRSC	103491-1120		
52	PLATE - END	2	ALUMINUM	DPSC HR	BRSC	103492-1114		
53	STEP - SPACER	5	ALUMINUM	DPSC HR	BRSC	103771-1114		
54	MARK	1	ALUMINUM	DPSC HR	BRSC	103772-1110		
55	COVER - BOTTOM	1	ALUMINUM	DPSC HR	BRSC	103773-1110		
56	LENS	1	ALUMINUM	DPSC HR	BRSC	103774-1110		CAB PLATED
57	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103775-1110		
58	COVER - TOP	1	ALUMINUM	DPSC HR	BRSC	103776-1110		CAB PLATED
59	COVER - BOTTOM	1	ALUMINUM	DPSC HR	BRSC	103777-1110		CAB PLATED
60	CLAMP STRIP	2	ALUMINUM	DPSC HR	BRSC	103778-1110		
61	PLATE - ADAPTOR	2	ALUMINUM	DPSC HR	BRSC	103779-1110		
62								
63								
64								
65								
66								
67								
68								
69								

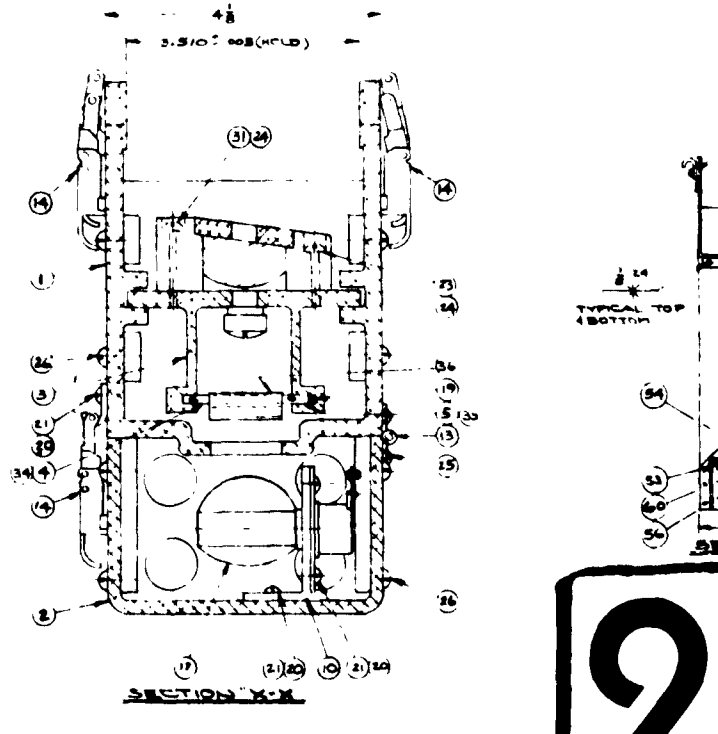


WIRING DIAGRAM FOR ILLUMINATOR ASSEMBLY



LIST OF MATERIAL QUANTITIES FOR ONE

PC NO	NAME	NO REQD	MATERIAL	MAT'L SPEC	MANUFACTURER	SHIP'S OWN NO	STD NAVY STOCK NO	REMARKS
(7) ILLUMINATOR ASSEMBLY								
1	BODY - ILLUMINATOR	1	ALUMINUM	DPSC HR	BRSC	103493-1120		
2	LAMP HOUSING	1	ALUMINUM	DPSC HR	BRSC	103494-1120		
3	RETAINER - COARSE SCREEN	1	ALUMINUM	DPSC HR	BRSC	103495-1120		
4	SCREEN - COARSE	1	ALUMINUM	DPSC HR	BRSC	103496-1120		
5	SCREEN - FINE	1	ALUMINUM	DPSC HR	BRSC	103497-1120		
6	RETAINER - LENS - BOTTOM	1	ALUMINUM	DPSC HR	BRSC	103498-1120		
7	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103499-1120		
8	COVER - ILLUMINATOR	2	ALUMINUM	DPSC HR	BRSC	103500-1120		
9	COVER - TOP	1	ALUMINUM	DPSC HR	BRSC	103501-1120		
10	BRACKET - SOCKET MOUNT	1	ALUMINUM	DPSC HR	BRSC	103502-1120		
11	HOLDER - LAMP	1	ALUMINUM	DPSC HR	BRSC	103503-1120		
12	LAMP - 25 WATT	1	ALUMINUM	DPSC HR	BRSC	103504-1120		
13	WIND	1	ALUMINUM	DPSC HR	BRSC	103505-1120		
14	COARSE CATCH (STEEL)	10	ALUMINUM	DPSC HR	BRSC	103506-1120		
15	RETAINER - LENS	2	ALUMINUM	DPSC HR	BRSC	103507-1120		
16	COVER - BOTTOM	4	ALUMINUM	DPSC HR	BRSC	103508-1120		
17	LOCKWASHER - INTERNAL	4	ALUMINUM	DPSC HR	BRSC	103509-1120		
18	SPRING - STRIP LENS	4	ALUMINUM	DPSC HR	BRSC	103510-1120		
19	SPRING - STRIP	1	ALUMINUM	DPSC HR	BRSC	103511-1120		
20	SEAL - COARSE SCREEN	40	ALUMINUM	DPSC HR	BRSC	103512-1120		
21	WASHER - STRIP	40	ALUMINUM	DPSC HR	BRSC	103513-1120		
22								
23	LENS - STEP	4	ALUMINUM	DPSC HR	BRSC	103514-1120		
24	LENS - STEP	8	ALUMINUM	DPSC HR	BRSC	103515-1120		
25	LENS - STEP	16	ALUMINUM	DPSC HR	BRSC	103516-1120		
26	LENS - STEP	16	ALUMINUM	DPSC HR	BRSC	103517-1120		
27	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103518-1120		
28	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103519-1120		
29	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103520-1120		
30	LENS - STEP	1	ALUMINUM	DPSC HR	BRSC	103521-1120		
31	LENS - STEP	4	ALUMINUM	DPSC HR	BRSC	103522-1120		
32								
33	BRACKET	1	ALUMINUM	DPSC HR	BRSC	103523-1120		
34	BRACKET - COARSE SCREEN	1	ALUMINUM	DPSC HR	BRSC	103524-1120		
35	BRACKET - FINE SCREEN	1	ALUMINUM	DPSC HR	BRSC	103525-1120		
36	CLIP - COARSE SCREEN	4	ALUMINUM	DPSC HR	BRSC	103526-1120		
37	CLIP - FINE SCREEN	4	ALUMINUM	DPSC HR	BRSC	103527-1120		
38	COFFER WIRE 1/4 IN. DIA.	1	ALUMINUM	DPSC HR	BRSC	103528-1120		
39	COFFER WIRE 1/4 IN. DIA.	1	ALUMINUM	DPSC HR	BRSC	103529-1120		
40	TUBING 1/2 IN. DIA.	2	ALUMINUM	DPSC HR	BRSC	103530-1120		
41	TUBING 1/2 IN. DIA.	2	ALUMINUM	DPSC HR	BRSC	103531-1120		
42								
43	WIRE - LAMP	1	ALUMINUM	DPSC HR	BRSC	103532-1120		
44	CONNECTOR PLUG	1	ALUMINUM	DPSC HR	BRSC	103533-1120		
45	CONNECTOR - RECEPT	1	ALUMINUM	DPSC HR	BRSC	103534-1120		
46								
47								
48								
49								

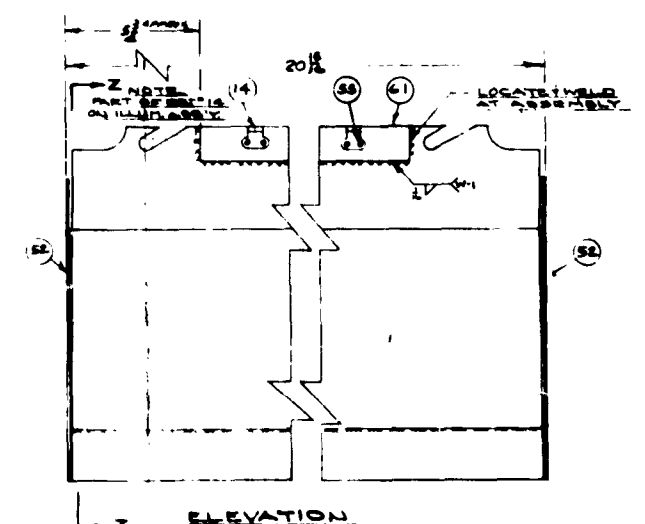
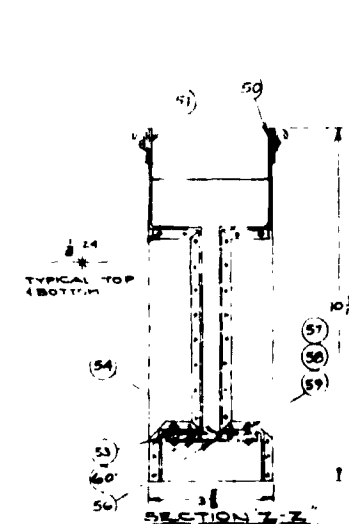
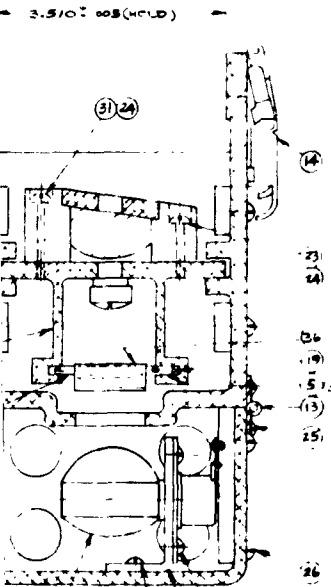


LIST OF MATERIAL QUANTITIES FOR ONE

PC NO	NAME	NO REQD	MATERIAL	MATL SPEC	MANUFACTURER	SHIPSWG NO	STD NAVY STOCK NO	REMARKS
(1) ILLUMINATOR ASSY. 103185-1048 (SEE NOTE 1)								
1	BODY - ILLUMINATOR	1	ALUMINUM	6061-T6	DRSC	103483-039		CLAMP
2	LAMP HOUSING	1	ALUMINUM	6061-T6	DRSC	103487-019		CLAMP
3	RETAINER - COARSE SCREEN	1	ALUMINUM	6061-T6	DRSC	103488-018		CLAMP
4	SCREEN - COARSE	1	ALUMINUM	6061-T6	DRSC	103489-017		FORMULA 2400
5	SCREEN - COARSE	1	ALUMINUM	6061-T6	DRSC	103490-016		FORMULA 2400
6	RETAINER - LENS - BOTTOM	1	ALUMINUM	6061-T6	DRSC	103491-015		CLAMP
7	LENS - STRIP	1	GLASS	COM'L	DRSC	103492-014		FORMULA 2720
8	COVER ILLUMINATOR	2	ALUMINUM	6061-T6	DRSC	103493-013		CLAMP
9	COVER - TOP	1	ALUMINUM	6061-T6	DRSC	103494-012		CLAMP
10	BRACKET - SOCKET MOUNT	1	ALUMINUM	6061-T6	DRSC	103495-011		CLAMP
11	HOLDER - LAMP	7	BRASS	COM'L	DRSC	103496-010		CLAMP
12	LAMP - 18 VOLT/40 WATT	7	GLASS	COM'L	DRSC	103497-009		CLAMP
13	WINGS	1	STEEL	COM'L	DRSC	103498-008		CLAMP
14	COBIN CATCH - STRIKE	10	STEEL	COM'L	DRSC	103499-007		CLAMP
15	RETAINER - LENS	2	ALUMINUM	6061-T6	DRSC	103500-006		CLAMP
16	4x4 COARSE SCREEN TYPE	4	STEEL	COM'L	DRSC	103501-005		CLAMP
17	4x4 LOCKWASHER	4	STEEL	COM'L	DRSC	103502-004		CLAMP
18	SPRING - STRIP LENS	4	STEEL	COM'L	DRSC	103503-003		CLAMP
19	SPRING - STRIP	1	STEEL	COM'L	DRSC	103504-002		CLAMP
20	3x3x1/8 HD. FLAT SCREW	40	STEEL	COM'L	DRSC	103505-001		CLAMP
21	1/8x1/8x1/8 FLAT SCREW	40	STEEL	COM'L	DRSC	103506-000		CLAMP
22	1/8x1/8x1/8 FLAT SCREW	4	STEEL	COM'L	DRSC	103507-000		CLAMP
23	1/8x1/8x1/8 FLAT SCREW	8	STEEL	COM'L	DRSC	103508-000		CLAMP
24	1/8x1/8x1/8 FLAT SCREW	16	STEEL	COM'L	DRSC	103509-000		CLAMP
25	1/8x1/8x1/8 FLAT SCREW	16	STEEL	COM'L	DRSC	103510-000		CLAMP
26	1/8x1/8x1/8 FLAT SCREW	1	STEEL	COM'L	DRSC	103511-000		CLAMP
27	COVER - BOTTOM (Housing)	1	ALUMINUM	6061-T6	DRSC	103512-000		CLAMP
28	LENS - STRIP	1	GLASS	COM'L	DRSC	103513-000		CLAMP
29	TRANSFORMER - 150 WATT	1	ALUMINUM	6061-T6	DRSC	103514-000		CLAMP
30	RETAINER - LENS - TOP	1	ALUMINUM	6061-T6	DRSC	103515-000		CLAMP
31	STRIP - 1/8x1/8x1/8	4	STEEL	COM'L	DRSC	103516-000		CLAMP
32	GASKET	1	ALUMINUM	6061-T6	DRSC	103517-000		CLAMP
33	SCREEN - COARSE 1/8x1/8	1	ALUMINUM	6061-T6	DRSC	103518-000		CLAMP
34	SCREEN - COARSE 1/8x1/8	1	ALUMINUM	6061-T6	DRSC	103519-000		CLAMP
35	SCREEN - COARSE 1/8x1/8	1	ALUMINUM	6061-T6	DRSC	103520-000		CLAMP
36	CLIP - COARSE SCREEN	4	STEEL	COM'L	DRSC	103521-000		CLAMP
37	1/8x1/8x1/8 FLAT SCREW	4	STEEL	COM'L	DRSC	103522-000		CLAMP
38	COFFER WIRE 1/4 DIA	1	STEEL	COM'L	DRSC	103523-000		CLAMP
39	COFFER WIRE 1/4 DIA	1	STEEL	COM'L	DRSC	103524-000		CLAMP
40	TUBING 1/2x1/2x1/8	2	STEEL	COM'L	DRSC	103525-000		CLAMP
41	TUBING 1/2x1/2x1/8	2	STEEL	COM'L	DRSC	103526-000		CLAMP
42	WIRE - LAMP	10	STEEL	COM'L	DRSC	103527-000		CLAMP
43	CONNECTOR - PLUG	1	STEEL	COM'L	DRSC	103528-000		CLAMP
44	CONNECTOR - RECEPT	1	STEEL	COM'L	DRSC	103529-000		CLAMP

REV	DESCRIPTION	REV	DESCRIPTION
A	CERTIFIED WIRE CHANGES: ADDED WIDE ANGLE VISION HOOD ASSEMBLY ILLUMINATOR ASSEMBLY WAS SHOWN WITH SLOTTED HOLES AS SHOWN IN THE CHANGED WIRE OF THE (2) TEST CHANGES REVISED ASSETS TO CALL FOR STANDARD PARTS		

NOTE 1: HOOD ASSEMBLY IS PL. 51 ON 103485-1028
NOTE 2: ILLUMINATOR ASSEMBLY IS PL. 57 ON 103486-1028



(5) HOOD ASSY. 103486-1027

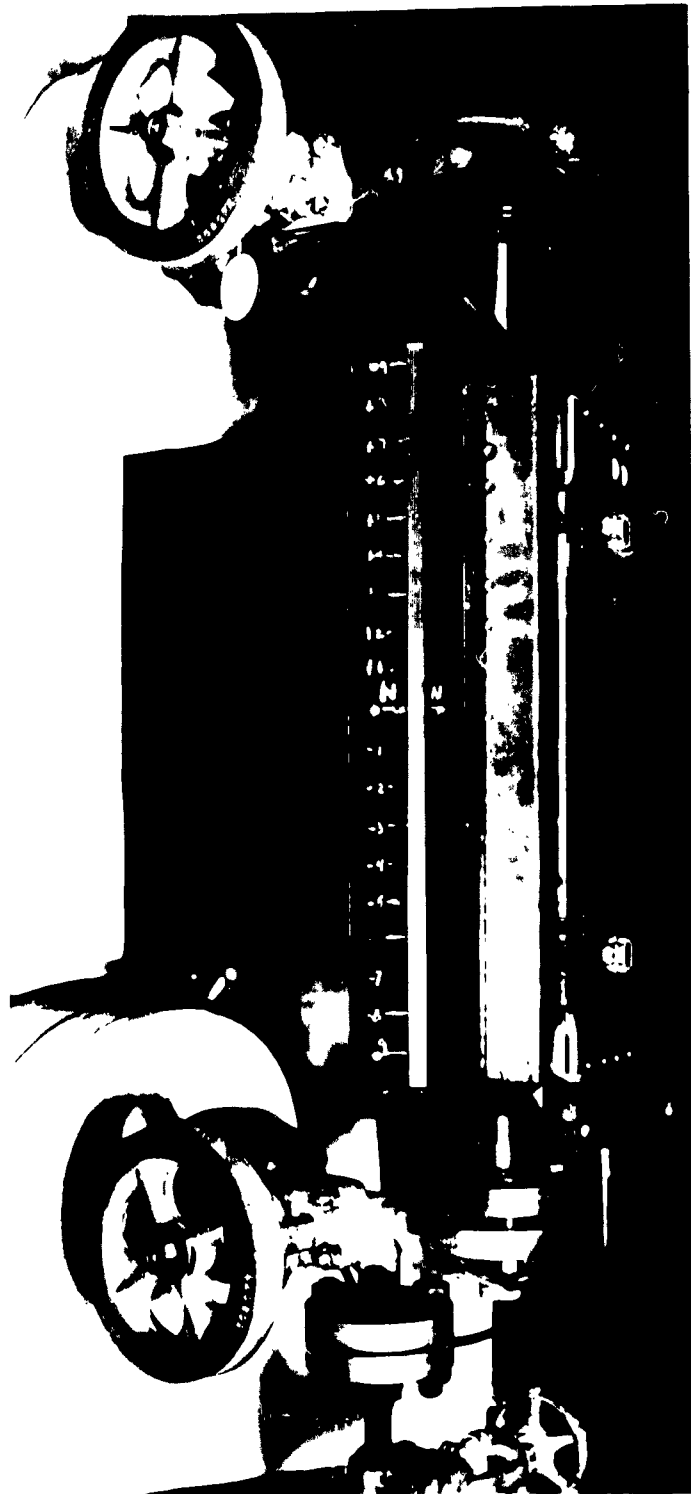
PAINT SPEC. PAINT INSIDE HOODS -
WITH F. 24 DULL BLACK

DRAWN BY CHECKED BY DATE 6-5-61	MASTER DRAWING ILLUMINATOR WIDE ANGLE HOOD ASSY. FOR DP-5000 (BURA-PORT) SC. NAVY TYPE GAUGE.	DWS. NO. 103486-1027 NAVY DEPT. BUREAU OF NAVAL PLATE 2
---------------------------------------	---	---

3



DIAMOND DURA-PORT WATER GAGE
MAIN BODY



DIAMOND DURA-PORT WATER GAGE WITH VIEWING
HOOD AND ILLUMINATOR ATTACHED

COPY

U. S. NAVAL RESEARCH LABORATORY
WASHINGTON 25, D. C.

In Reply Refer To.
6253-49A:RCN:dd
NRL Prob F03-15
12 September 1962

Shock and Vibration Folder No. 920

Subj: Dura-Port Boiler Water-Level Gage, vibration and shock testing of; NRL Problem F03-15; report on

Ref: (a) NBTL ltr Code 2722-9510(B-490) (B-518) (B-526) of 2 Feb 1962
(b) Mil Spec MIL-STD-167 of 20 Dec 1954 for vibration
(c) Mil Spec MIL-S-901B(Navy) of 9 Apr 1954 for shock

Fig: (1) Gage assembly, prior to modifications, mounted on the table of a reaction type vibration machine. (The boiler drum nozzles are shown in an intermediate stage of development.)
(2) Gage assembly on vibration machine following modifications and development of boiler drum nozzles.
(3) Sketch of suitable boiler drum nozzles to which gage assembly was secured.
(4) Close-up showing modified upper suspension system for gage.
(5) Gage assembly mounted on vibration machine table for testing in horizontal direction perpendicular to the front.
(6) Gage assembly secured to a 30-degree inclined bulkhead fixture and mounted on the table of a medium-weight high-impact shock machine.

Introduction

1. As requested in reference (a) vibration and shock tests in accordance with references (b) and (c) respectively were conducted on a DP-3000 Dura-Port Boiler Water Level Gauge manufactured by Diamond Power Specialty Corporation of Lancaster, Ohio. This report concludes the vibration and shock work on this phase of the problem.

Encl (1) to NRL ltr
6253-49:RCN:dd
SER: 9818

APPENDIX I

2. The tests were conducted at the U. S. Naval Research Laboratory Washington 25, D. C. during the period 26 February through 16 April 1962 and were witnessed by representatives of the manufacturer, Naval Boiler and Turbine Laboratory, and BUSHIPS.

Description of Unit

3. The gage assembly without the illuminator and wide-angle viewer weighed 175 lb. Its maximum dimensions were: Height 50-1/2 in.; Width 29 in.; Depth 12 in. The aluminum illuminator and steel wide-angle viewer totaled 33 lb. The illuminator was equipped with seven (7) 28-volt, 40 watt reflector type lamps manufactured by Grimes Mfg. Co. of Urbana, Ohio (Grimes part No. 19022). The gage was hydrostatically pressurized to 1500 psig during the variable frequency, and 2-hr endurance vibration tests, and the shock tests.

Vibration Testing Procedure

4. The unit was tested on a reaction-type vibration machine and was subjected to the outlined test procedure separately in each of the 3 mutually perpendicular directions. The test procedure in accordance with reference (b) was as follows:

a. Exploratory Vibration Test. With a table excursion of 0.020 in., an exploratory vibration check was conducted between 5 and 33 cps in discrete frequency intervals of 1 cps at 15 sec per interval.

b. Variable Frequency Test. Vibration was conducted between 5 and 33 cps in discrete frequency intervals of 1 cps at 5 min per interval. The frequency and corresponding table vibratory excursions were as follows: 5-15 cps, 0.060 in.; 16-25 cps, 0.040 in.; and 26-33 cps, 0.020 in.

c. Endurance Test. A 2-hr test in each direction was required at 33 cps or at any resonant frequency below 33 cps, at the appropriate table vibratory excursion outlined in paragraph 4b.

Exploratory Vibration - Horizontal Direction Parallel with the
Front Boiler-Drum Nozzle Development

5. The gage assembly was secured at its mounting flanges to the flanges of a pair of boiler drum nozzles supplied by NBTL. The 1-5/8-in OD x 13/16-in ID steel nozzles were welded to a steel plate which simulated a boiler drum and was secured to a mounting bulkhead on the table of a reaction type vibration machine (Figure 1). With no reinforcing gussets welded to the nozzles the mounted assembly resonated at 14 cps with a TR of 33.5:1 (Transmissibility Ratio is the ratio of the unit's excursion to the vibration table excursion) measured at the gage body. In several stages of development maximum rigidity and the best vibration characteristics of the nozzles were achieved with 4 gussets welded to the nozzles and flanges and steel mounting plate as shown in Figure 2 and delineated in Figure 3. With this arrangement resonance of the gage assembly was observed at 27 cps with a TR of approximately 10:1 measured on the gage.

Development of Gage-Assembly Suspension

6. During the exploratory vibration test the following developmental corrections and modifications were incorporated in the gage assembly to improve its structural and vibration characteristics:

a) Relative motion between the gage upper and lower valve mounting flanges and the nozzle mounting flanges was eliminated by inserting a ring-type steel spacer between the 2 flanges (Figure 4).

b) The single-pipe expansion-loop suspension at the upper end of the gage was replaced with a more rigid double-pipe expansion, loop suspension (Figure 4).

c) Side-to-side relative motion between the upper valve assembly and the upper end of the gage assembly was reduced by a key and keyway block assembly (Figure 4). Clearance between mating parts must be provided at the upper suspension area to allow for thermal expansion.

d) The suitcase-type latches did not adequately secure the illuminator and wide-angle viewer which were suspended each on four 1/4-in diam. steel pins projecting from the gage. The latches

were removed. The 1/4-in diam. steel pins were each replaced with a 5/16-18NC hex-socket-head cap screw which secured the illuminator and viewer to the gage (Compare Figures 1 and 2).

e) Cracks developed in the viewer around its suspension slots and at the sharp 90-degree bend where it fitted around the gage. The portion of the viewer which was fitted and secured to the gage was reinforced by tack and spot welding a 7/64-in thick formed steel plate to the full length of each side (Figures 4 and 5).

The foregoing corrections and modifications raised resonance above 33 cps and lowered the TR to approximately 6:1 measured at the upper end of the gage body when vibrated in the horizontal direction parallel with the front.

Variable Frequency and Two-Hr Endurance Tests - Horizontal Direction Parallel with the Front

8. The variable frequency test from 5 through 33 cps, and the 2-hr endurance test at 33 cps in accordance with paragraphs 4b and 4c respectively were completed satisfactorily.

Vibration Testing - Vertical Direction

9. No resonances were observed below 33 cps in this direction and the maximum TR of 4.3:1 was measured at the upper end of the gage body at this frequency.

10. The variable frequency test from 5 through 33 cps, and the 2-hr endurance test at 33 cps were conducted without damage or hydraulic leaks.

Vibration Testing - Horizontal Direction Perpendicular to the Front

11. The gage assembly was mounted on the vibration machine table as shown in Figure 5 for testing in this direction. No resonances were observed below 33 cps and the maximum TR of approximately 2:1 was measured at the upper end of the gage.

12. The variable frequency test, 5-33 cps, and the 2-hr endurance test at 33 cps were conducted satisfactorily.

Shock Testing Procedure

13. The gage and nozzle assembly mounting plate was secured to a 30-degree inclined-bulkhead fixture which was mounted on the table of a mediumweight high-impact shock machine (Figure 6). The gage was pressurized to 1500 psig. during the shock testing procedure.

14. With a total of 2925 lb. on the shock machine table the assembly was subjected to a total of 6 Class A shock blows in accordance with reference (c). The shock blows consisted of 2 hammer drops from a height of 1.25 ft with a 3-in table travel, 2 drops from a height of 2.25-ft with a 3-in table travel, and 2 drops from a height of 2.25 ft with a 1-1/2-in table travel. The lamp positions in the illuminator were designated numerically with No. 1 at the top.

15. The results of the shock blows were:

a. Blow 1. 1.25 ft hammer drop, 3-in table travel.

1. The filaments of bulbs Nos. 1, 3, 6, and 7 fractured. New bulbs were inserted. No other damage resulted.

b. Blow 2. 1.25-ft hammer drop, 3-in table travel.

1. The filaments of bulbs Nos. 2, 6, and 7 fractured. The bulbs were replaced.

c. Blow 3. 2.25 ft hammer drop, 3-in table travel.

1. The filaments of bulbs Nos. 1, 3, and 6 fractured. No replacements were made.

2. A 0.070 in. vertical clearance was measured between the keyblock and keyway block.

d. Blow 4. 2.25-ft hammer drop, 3-in table travel.

1. The filaments of bulbs Nos. 4 and 7 failed. The bulbs were not replaced.

2. A clearance of 0.115 in. was measured between the keyblock and the keywayblock.

e. Blow 5. 2.25 ft hammer drop, 1-1/2-in table travel.

1. The filament of bulb No. 5 failed. The bulb was not replaced.

2. A 7/32-in clearance was measured between the keyblock and keywayblock.

f. Blow 6. 2.25-ft hammer drop, 1-1/2-in table travel.

1. No additional obvious damages resulted from this blow.

16. Following completion of shock testing examination of the interior of the viewer showed the lower strip lens to be fractured at the retaining spring, and the upper strip lens was chipped at its lower support bracket. The progressive increase of clearance between the keyblock and keywayblock resulted from slight deformation of the double-pipe expansion assembly. The use of a dovetail-shaped key and keyway would prevent separation of mating parts. No hydrostatic pressure drop resulted in the gage from the 6 shock blows. Following shock testing the gage was pressurized hydrostatically to 2250 psig for 30 min and no leaks were observed.

Conclusions

17. On the basis of the tests conducted the subject gage is considered satisfactory for vibration and shock conditions as defined by references (b) and (c) respectively subject to compliance with the following recommendations.

Recommendations

18. It is recommended that:

a. The gage assembly shall be secured to boiler drum nozzles which are at least as rigid as the modified nozzles developed at NRL and shown in Figures 2 and 3.

6253-49A:RCN:dd
NRL Prob F03-15

b. The modifications and corrections noted in paragraphs 6a through 6e or their equivalent be incorporated in the production model gage assembly.

c. If available, the use of Navy "rough-service" type lamps in the illuminator should be considered.

Report prepared by

Report approved by

/s/ Richard C. Nowak
Richard C. Nowak
Mechanical Engineer

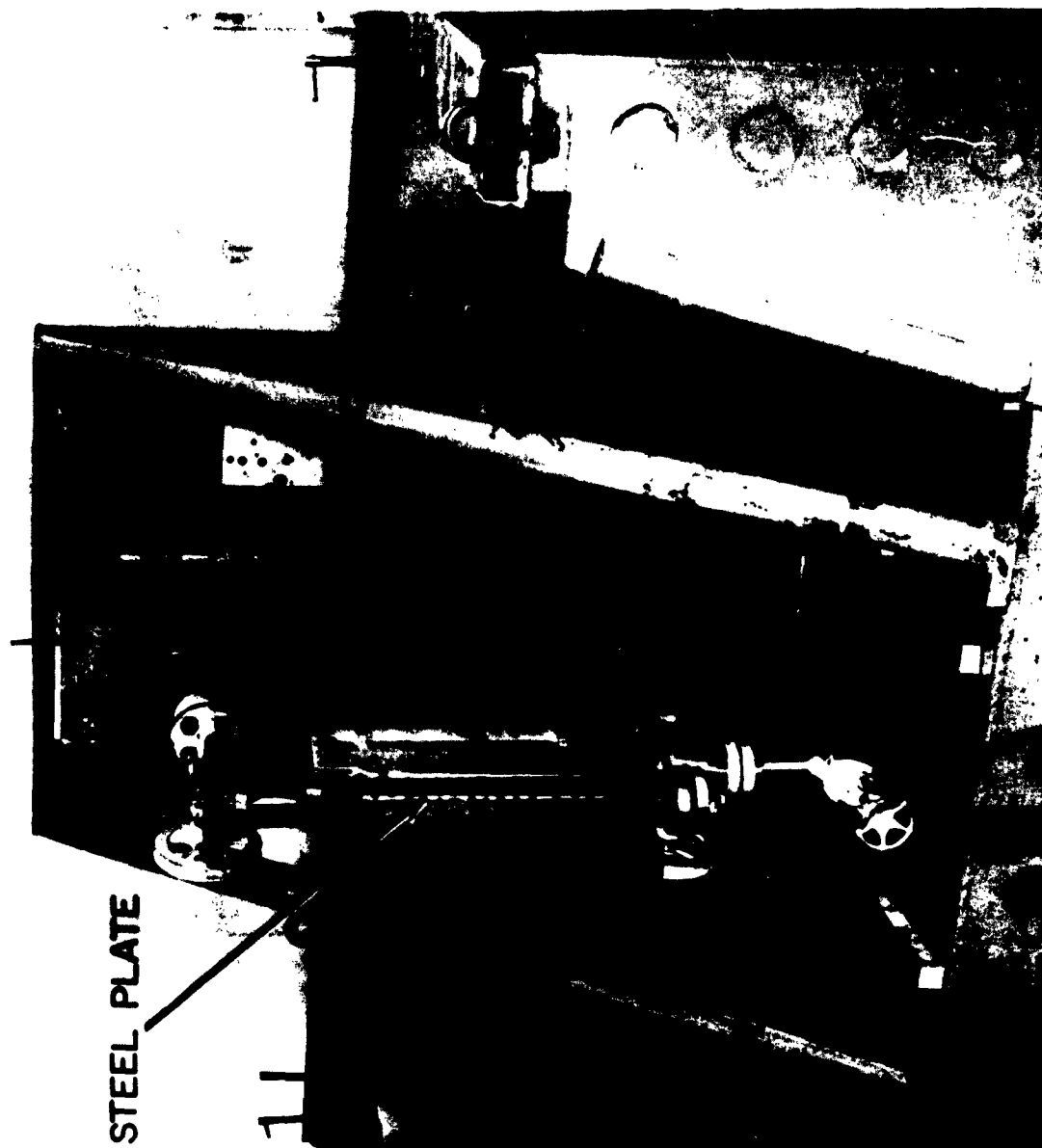
/s/ Harold M. Forkois
Harold M. Forkois
Mechanical Engineer



6253-49A

1246-12-02(1)

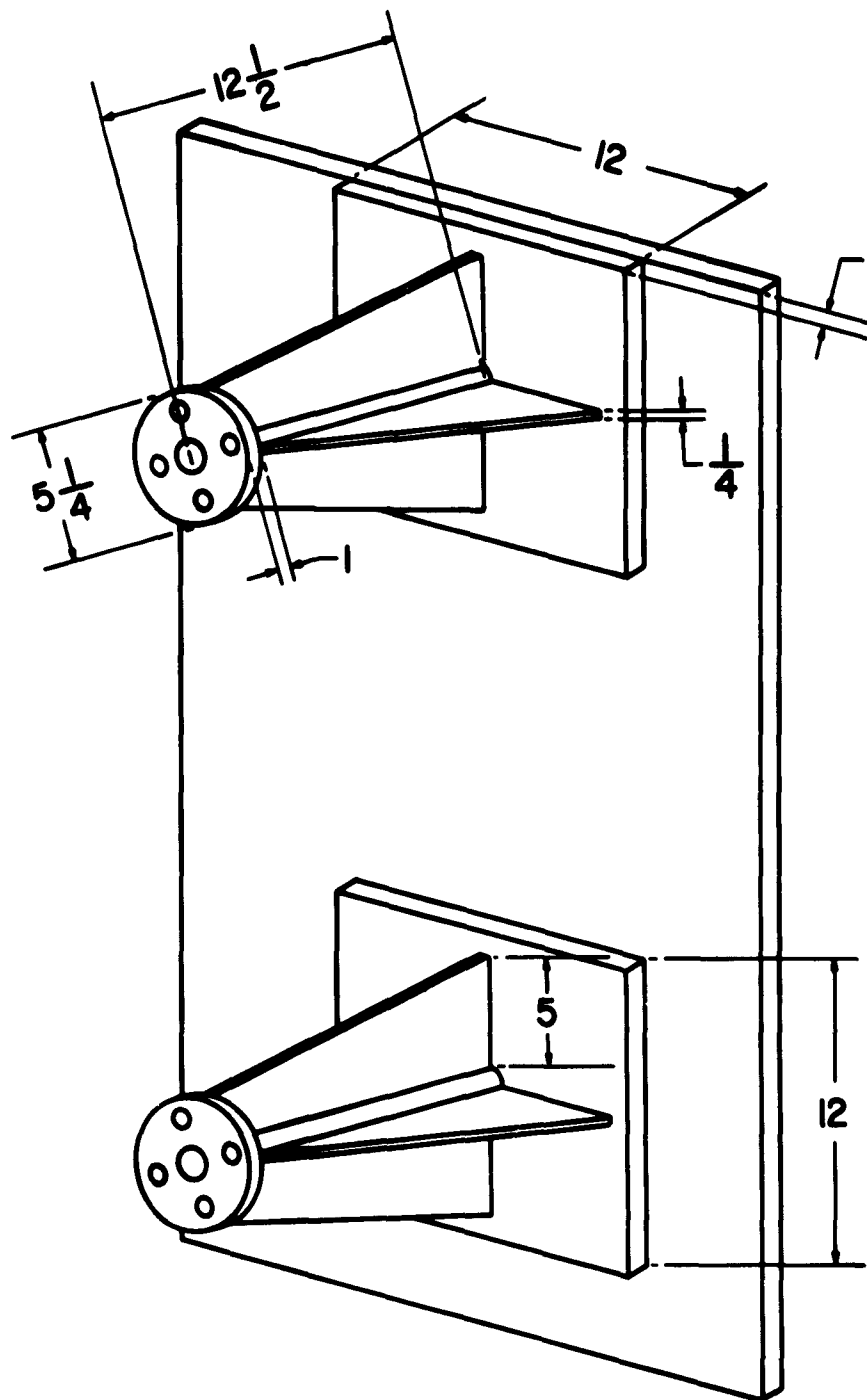
Figure 1



6253-49A

1000-100-1 (1)

Figure 2

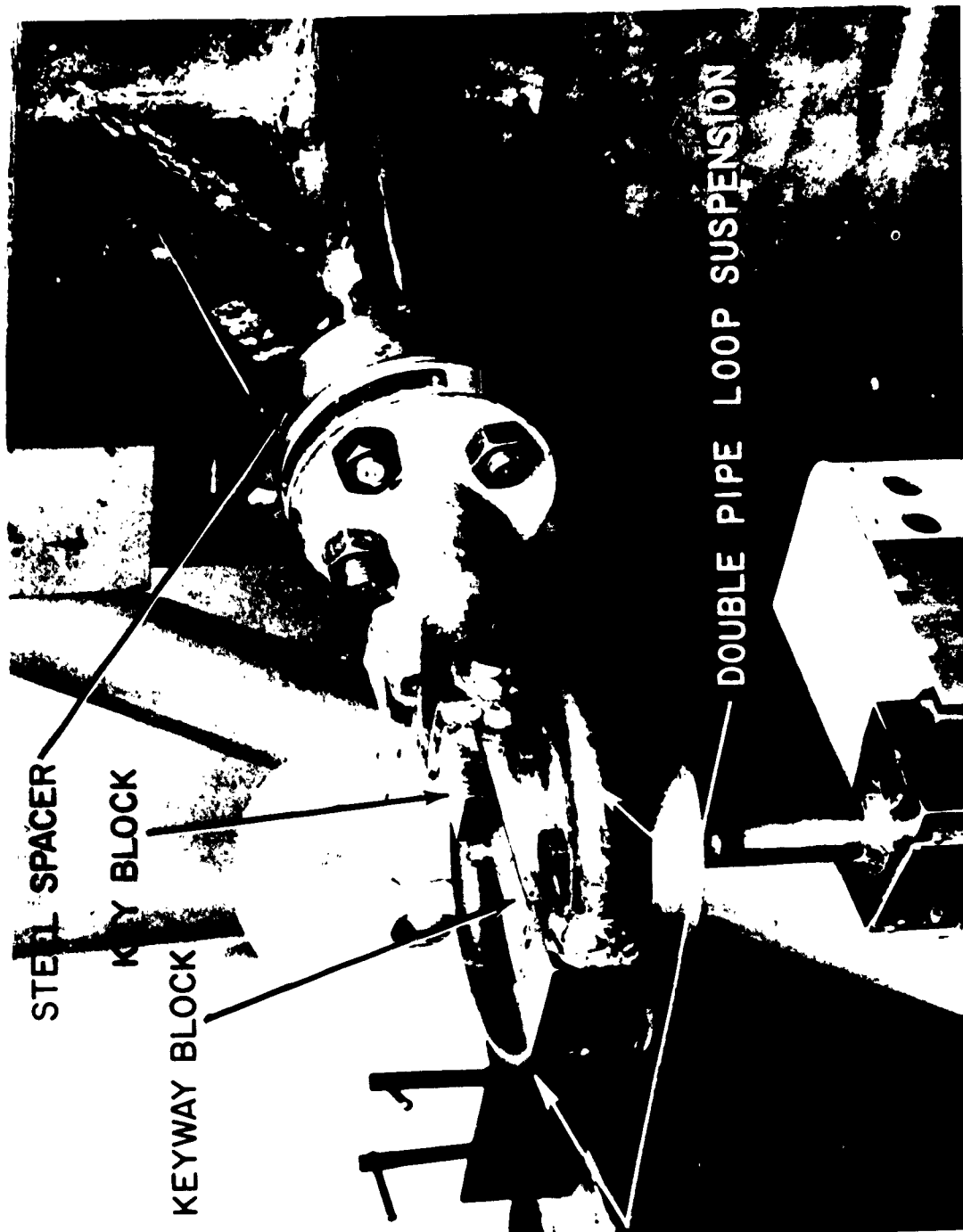


BOILER GAUGE NOZZLE REINFORCEMENT

6253-49A

60-1-63

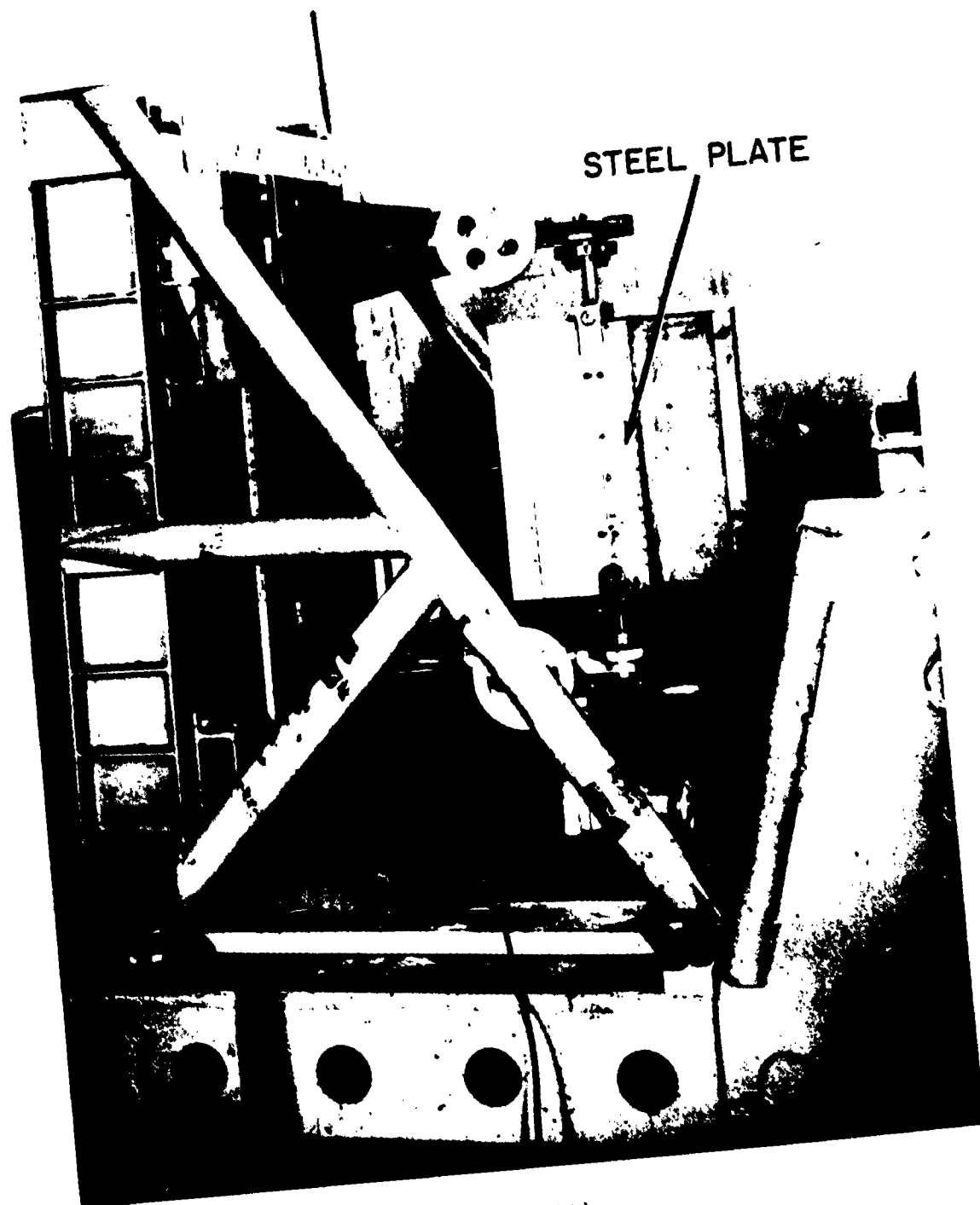
Figure 3



6253-19A

100-1-10 ()

Figure 4



6253-19A

Figure 5

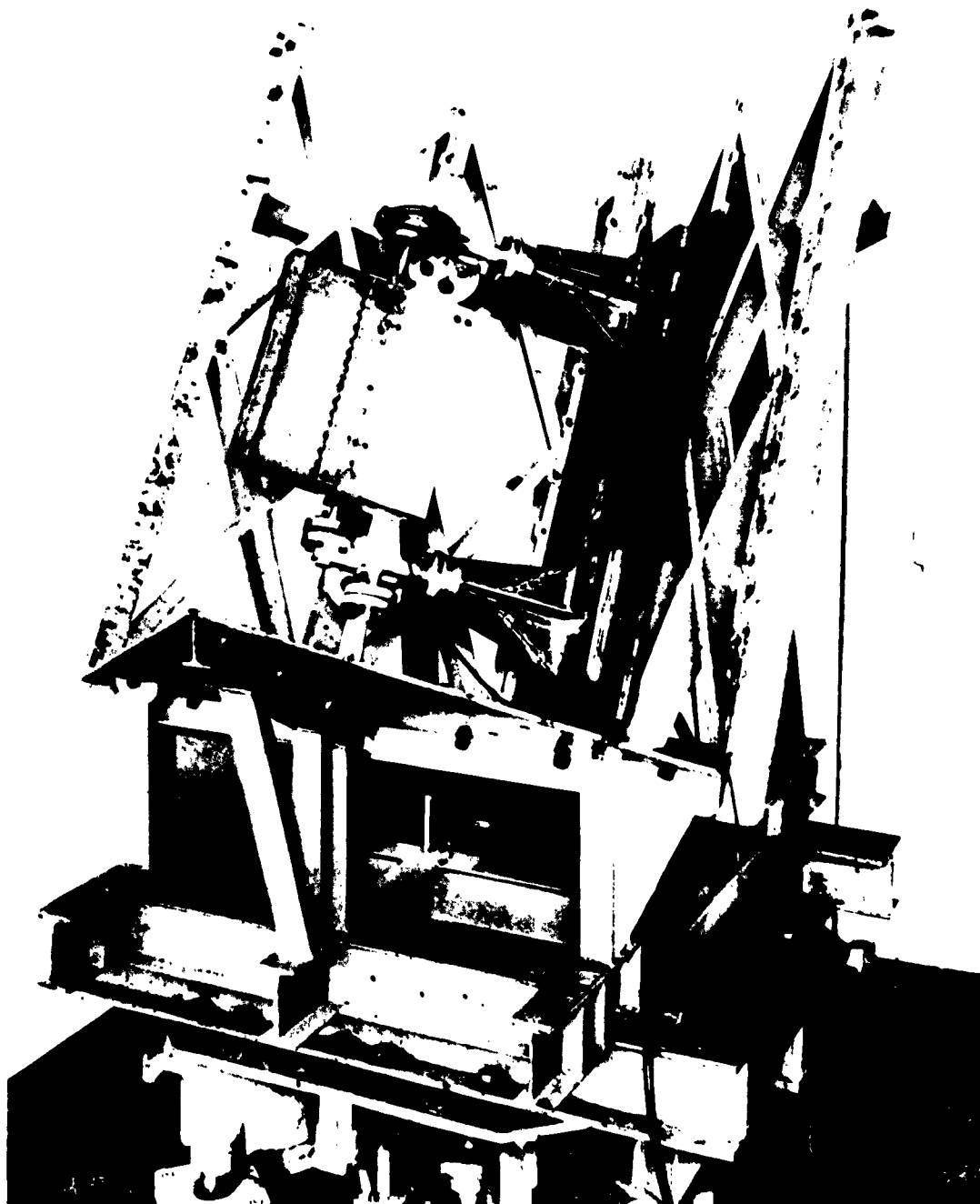


Figure 6

Figure 6

The gage was shock and vibration tested at NRL. The gage insert withstood shock and vibration tests without leakage or glass failure; the illuminator and hood assembly required modification to provide adequate shock and vibration resistance. Readability of the gage, requiring reliance on the color-refraction principle, was considered satisfactory while incorporating a better than 100° viewing angle. Optimum discernment of water level was obtained at (See other card)	The gage was shock and vibration tested at NRL. The gage insert withstood shock and vibration tests without leakage or glass failure; the illuminator and hood assembly required modification to provide adequate shock and vibration resistance. Readability of the gage, requiring reliance on the color-refraction principle, was considered satisfactory while incorporating a better than 100° viewing angle. Optimum discernment of water level was obtained at (See other card)
The gage was shock and vibration tested at NRL. The gage insert withstood shock and vibration tests without leakage or glass failure; the illuminator and hood assembly required modification to provide adequate shock and vibration resistance. Readability of the gage, requiring reliance on the color-refraction principle, was considered satisfactory while incorporating a better than 100° viewing angle. Optimum discernment of water level was obtained at (see other card)	The gage was shock and vibration tested at NRL. The gage insert withstood shock and vibration tests without leakage or glass failure; the illuminator and hood assembly required modification to provide adequate shock and vibration resistance. Readability of the gage, requiring reliance on the color-refraction principle, was considered satisfactory while incorporating a better than 100° viewing angle. Optimum discernment of water level was obtained at (See other card)