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MC DONNELL AIRCRAFT CORP., ST. LOUIS, MO. (REPORT 2343)

RAM JET HELICOPTER DEVELOPMENT - PROGRESS REPORT 61 - MONTH OF SEPT 1951 - MODEL XH-20

WOOD, C.R., JR. 15 OCT'51 26PP PHOTOS, GRAPHS, DRWGS

USAF CONTR. NO. AF-33(038)-9845

HELICOPTER ROTORS, JET
ENGINES, RAM JET
HELICOPTERS, JET
H-20

ROTATING WING AIRCRAFT (34)
ROTOR DESIGN (4)

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REPORT NO. 2343 15 OCTOBER 1951

PROGRESS REPORT NO. 61

RAM JET HELICOPTER DEVELOPMENT

CONTRACT AF 33(038)-9845

SERIAL 3

Enclosure (1)
Ref: 2143-301-2130

MAC 273 (REV. 2-24-50)

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PROPELLER LABORATORY

REPORT 2343
DATE 15 October 1951
REVISED

McDONNELL Aircraft Corporation
ST. LOUIS 3, MISSOURI

PROGRESS REPORT 61

MONTH OF SEPTEMBER 1951

RAM JET HELICOPTER DEVELOPMENT

SUBMITTED UNDER Contract AF 33(038)-9845

PREPARED BY C. R. Wood, Jr.
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APPROVED BY C. H. Burkamp

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1. SUMMARY

No. 1, 27-foot diameter rotor blades are being repaired in the small areas where the bonding of the metal cover had not been properly applied. MAC ram jet development under subject contract has approximately tripled blower ram jet thrust as in the table on Page 5. Improvement of MAC's ram jet test facilities now under construction will expedite development.

2. ROTOR DEVELOPMENT

2.1 No. 1, 27-Foot Diameter Rotor Blade

2.1.1 The small cracks in the metalbond adjesive of the No. 1, 27-foot diameter rotor blade are under repair. A study indicated that the small areas where the bonding of the metal cover had not been properly applied could most easily be repaired by removal of No. 4 and No. 5 panels of the trailing edge assembly from the outboard tip of Blade No. 1; and panels No.s 3 and 4, from the outboard tip of Blade No. 2. In disassembly of blade for repair, the adhesive bond was strong and difficult to remove. Replacement panels have been manufactured, a portion of the channel located aft of the main spar cut out; the parts are to be reassembled with Epon VI. Figure (2) shows one new panel being tested for fit prior to installation. Figures (3) and (4) show one blade under repair and one blade completed. The enclosed blade assembly drawing J1-2162; deviation nos. 46237 and 44509; drawings J1-0156 and J1-2162DD-2 specify details of the blade repair.

2.1.2 While the blade is disassembled for repair, the ram jet connection to the fuel line at the blade tip is being modified to expedite installation and removal of the ram jets.

2.1.3 The rotor calibration tests results reported in Progress Reports Nos. 59 and 60, for July and August, have been further modified to include a small change in the value of the density ratio. The use of this revised density ratio in the reduction of test data to standard atmospheric conditions resulted in only a small change in test results; see Figures (1) and (5) of this report.

2.2 No. 2, 27-Foot Diameter Rotor

The No. 2, 27-foot diameter rotor will be of modified design; the design is now in preparation. It is proposed that the blades have CCA filler aft of the main spar; a one piece trailing edge; and continuous upper and lower surfaces, if possible. Tests for the accumulation of the data necessary to substantiate the design are next on the flight schedule.

3. RAM JETS

3.1 MAC Ram Jet Development

The following summary of development of ram jets for the 27-foot diameter rotor under subject contract is submitted to supplement the ram jet development data submitted with Progress Report for July 1951, No. 59.

MAC NO.	LENGTH (IN)	MAX. DIA. (IN)	EXIT DIA. (IN)	WEIGHT (LBS.)	TEST SPEED (FPS)	THRUST BLOWER (LBS.)	THRUST WHIRL TESTS (LBS.)	COMMENTS
26	18	7.25	4.5	9.5	600	24	-	Originally tested on 27-foot rotor max tip speeds 800 fps
27	18	7.25	4.5	9.5	600	24	-	
28	18	7.25	5.0	9.5	600	32	-	Ram jets had improved fuel spray characteristics tested on 20-foot and 27-foot rotors, tip speeds to 800 fps - destroyed by accident
29	18	7.25	5.0	9.5	600	32	-	
30	18	7.25	4.5	12.6	800	50	-	Very high noise level and resonance frequencies caused early structural failures
31	18	7.25	4.5	12.6	800	50	-	
32	21.5	7.25	5.4	15	800	50	38(approx)	Developed frequent cracks with no appreciably improved performance on 20-foot and 27-foot rotor to 800 fps
33	21.5	7.25	5.4	15	800	50	38(approx)	
34	22.0	8.71	5.8	12.2	800	80	62(est)	Scaled-up version of Nos.28 and 29 now under test showing higher thrust
35	22.0	8.71	5.8	12.2	800	80	62(est)	

3.4 Modified Whirl Stand

Figure (10) shows the P & W R-985 engine being prepared for the MAC sponsored installation on the whirl test stand. This assembly is replacing government furnished test equipment. Figure (11) shows a 27-foot diameter rotor assembly on the present whirl test stand. The new test stand will be more fully instrumented and will have 52 slip rings for measurement of temperatures, stresses, etc. Figure (12) shows the blower air supply which currently consists of Type "B" turbo superchargers driven by electric motors. Means of improving this air supply have been studied and a MAC sponsored installation is planned.

4. XH-20, USAF 46-689 and 46-690

4.1 XH-20, No. 1, USAF 46-689

The XH-20, No. 1 was loaded into a WADC aircraft at MAC on 21 September for ferrying to WADC. It is to be displayed at the Ordnance Demonstration on 5 and 6 October.

4.2 Modified XH-20, No. 2, USAF 46-690

The helicopter was out of commission in September for repair of the No. 1, 27-foot diameter rotor blade. It is standing by for further evaluation tests of the rotor and of the rotor assembly changes, so that the design of the No. 2, 27-foot diameter rotor can be completed and submitted to WADC for approval. Figure (13) shows the helicopter with the rotor removed.

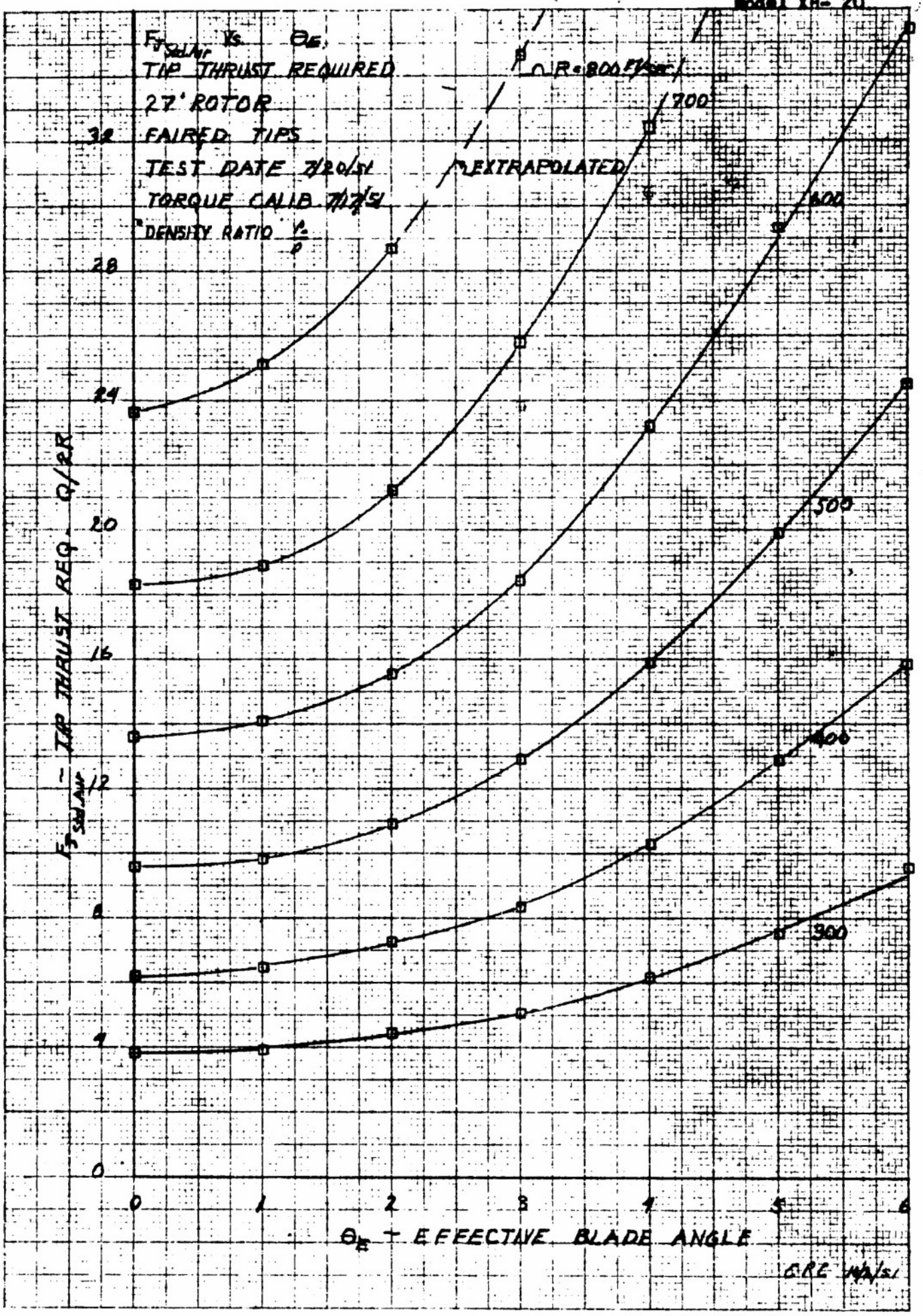
5. DAILY FLIGHT SHEETS, - XH-20 Helicopter Test Data

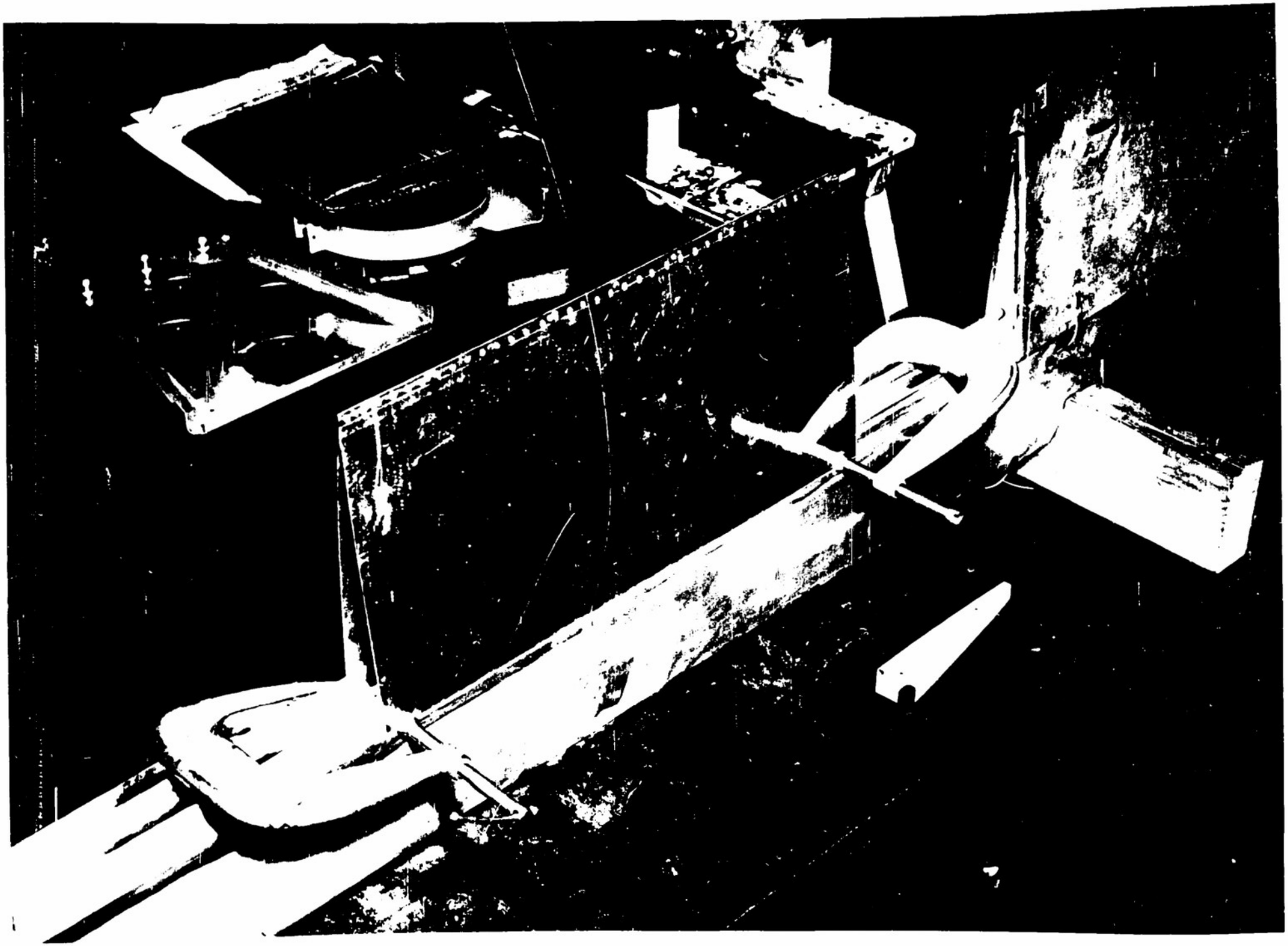
There were no operations scheduled for the XH-20 during September.

6. WORK PLANNED FOR MONTH OF OCTOBER

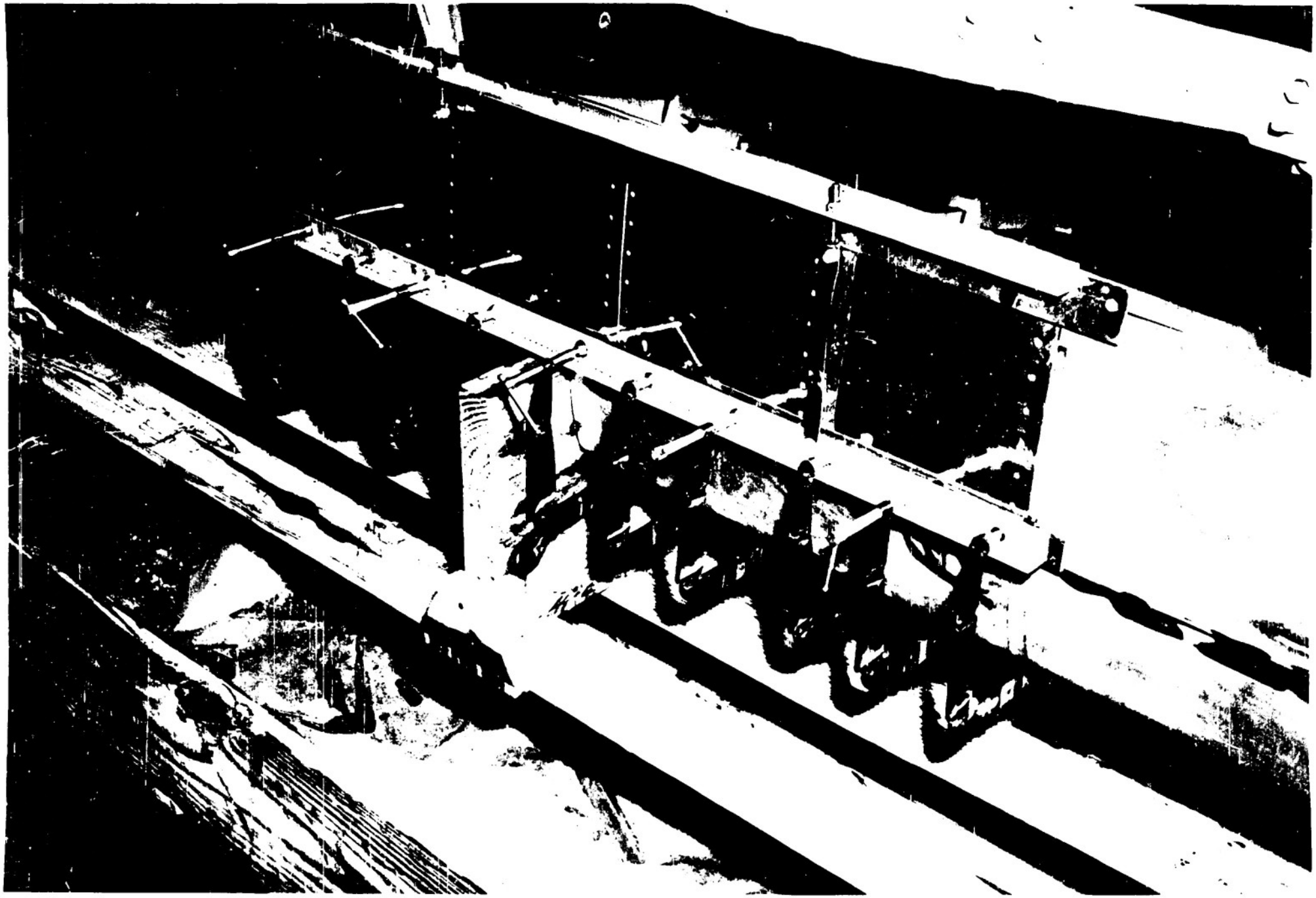
Further evaluation of the rotor and rotor assembly changes are scheduled upon completion of repair to the rotor blade and assembly of suitable ram jets.

FIGURE 1


$F_{T_{Std\,Air}}$ Vs. θ_E
TIP THRUST REQUIRED
27' ROTOR
FAIRED TIPS
TEST DATE 7/20/51
TORQUE CALIB 7/17/51
*DENSITY RATIO $\frac{\rho_0}{\rho}$
∩ R = 800 FT/SEC
700
600
500
400
300
EXTRAPOLATED
$F_{T_{Std\,Air}}$ - TIP THRUST REQ. Q/2R
0
4
8
12
16
20
24
28
32
0
1
2
3
4
5
6
θ_E - EFFECTIVE BLADE ANGLE
CRC 10/2/51



FITTING REPLACEMENT PANEL TO NO. 1, 27-FOOT DIAMETER ROTOR
10/2/51



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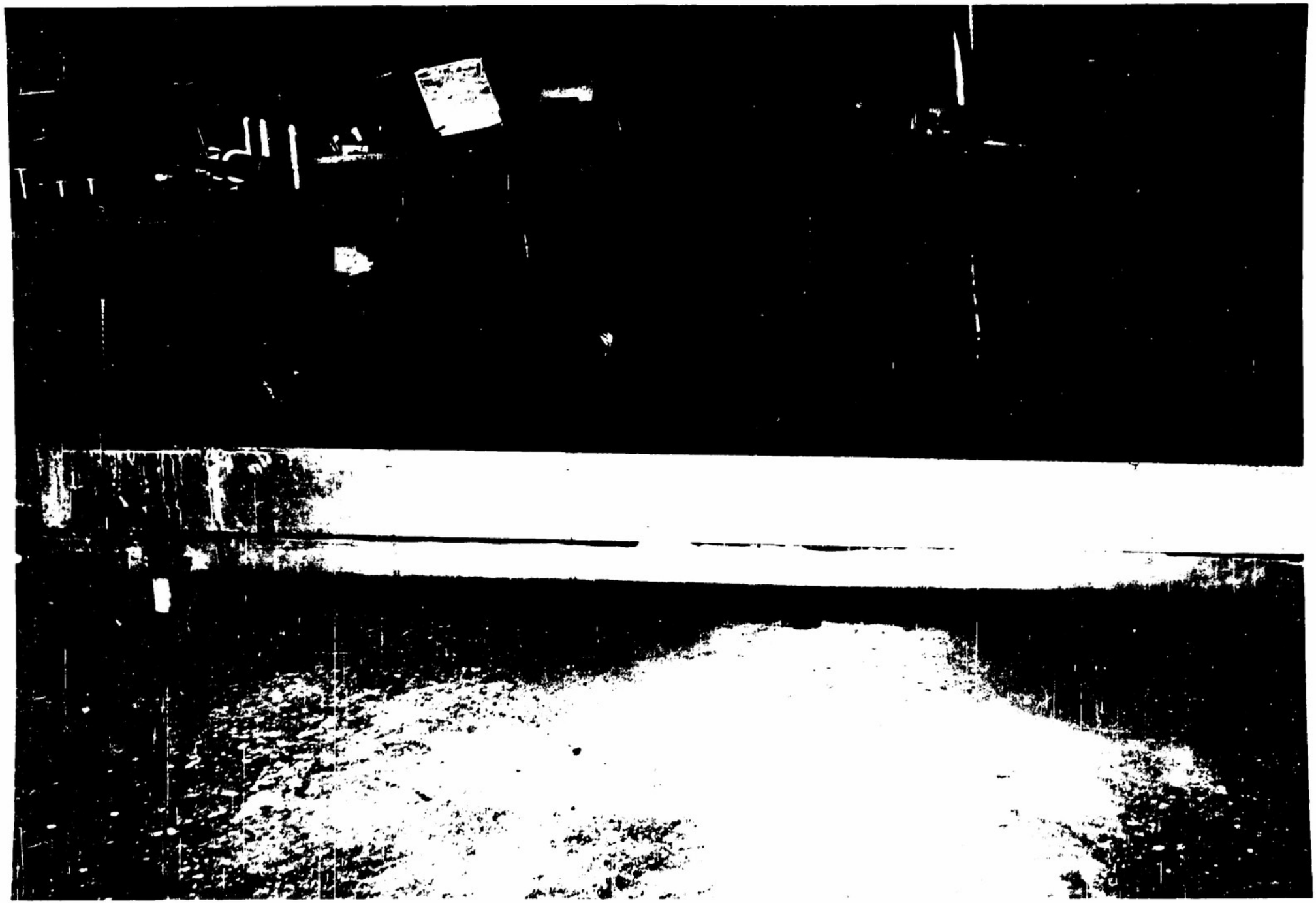
D4E 25784

CEMENTING REPLACEMENT PANELS ON NO. 1, 27-FOOT ROTOR 10/11/51

FIGURE (3)



359-14 KEUFFEL & ESSER CO.
Millimeters, 5 mm. lines accented, cm. lines heavy.
MADE IN U.S.A.

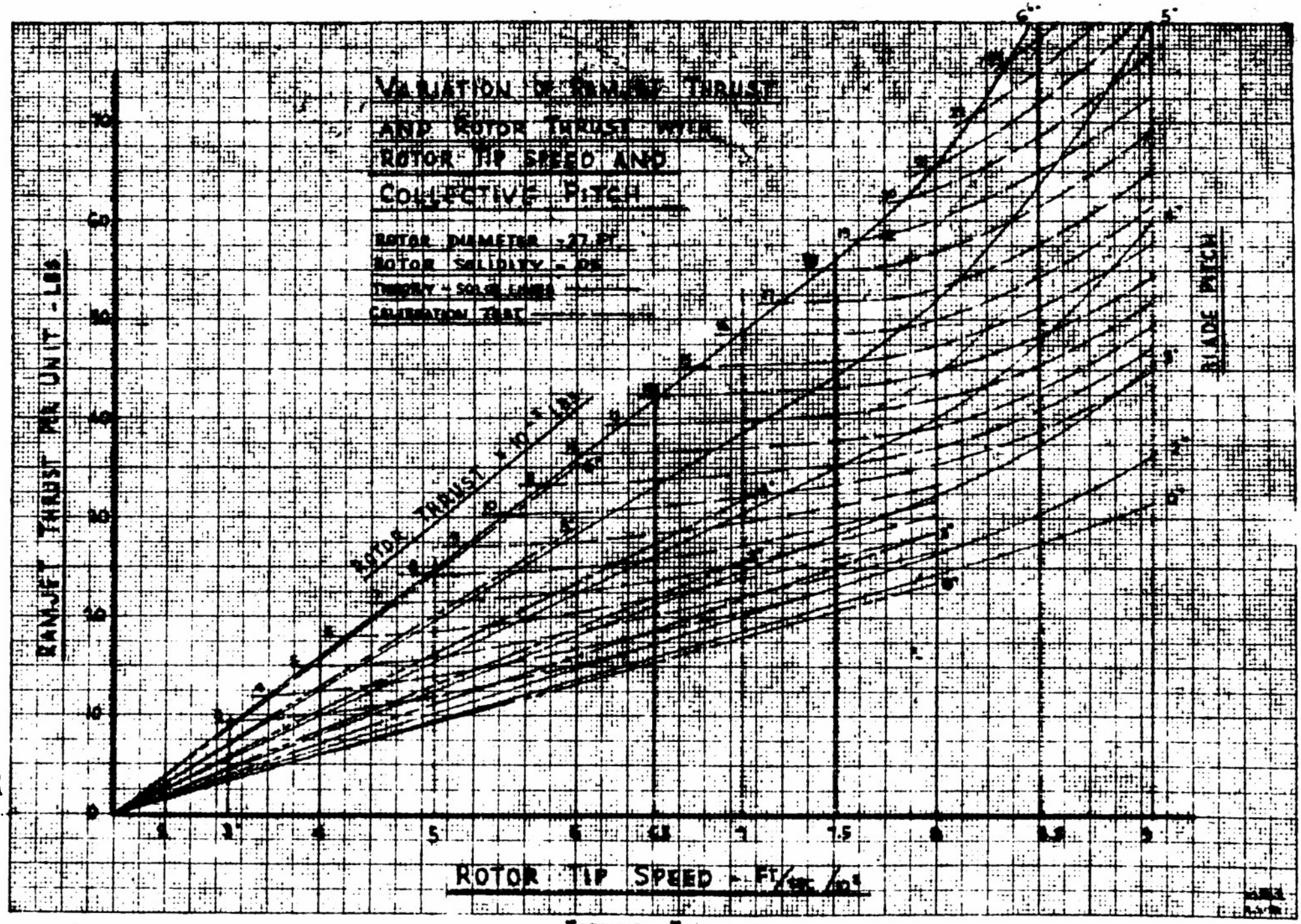
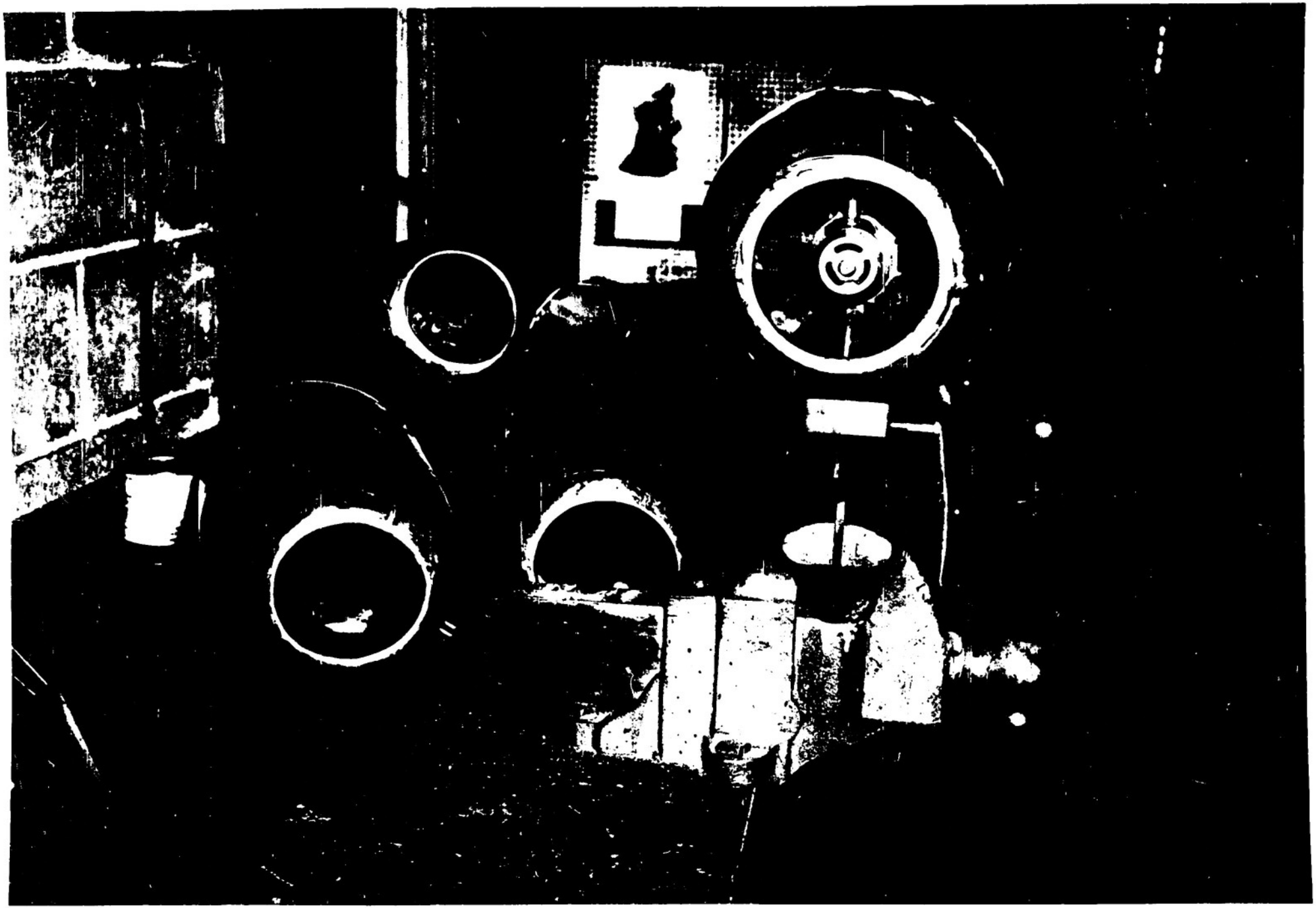


FIGURE 5



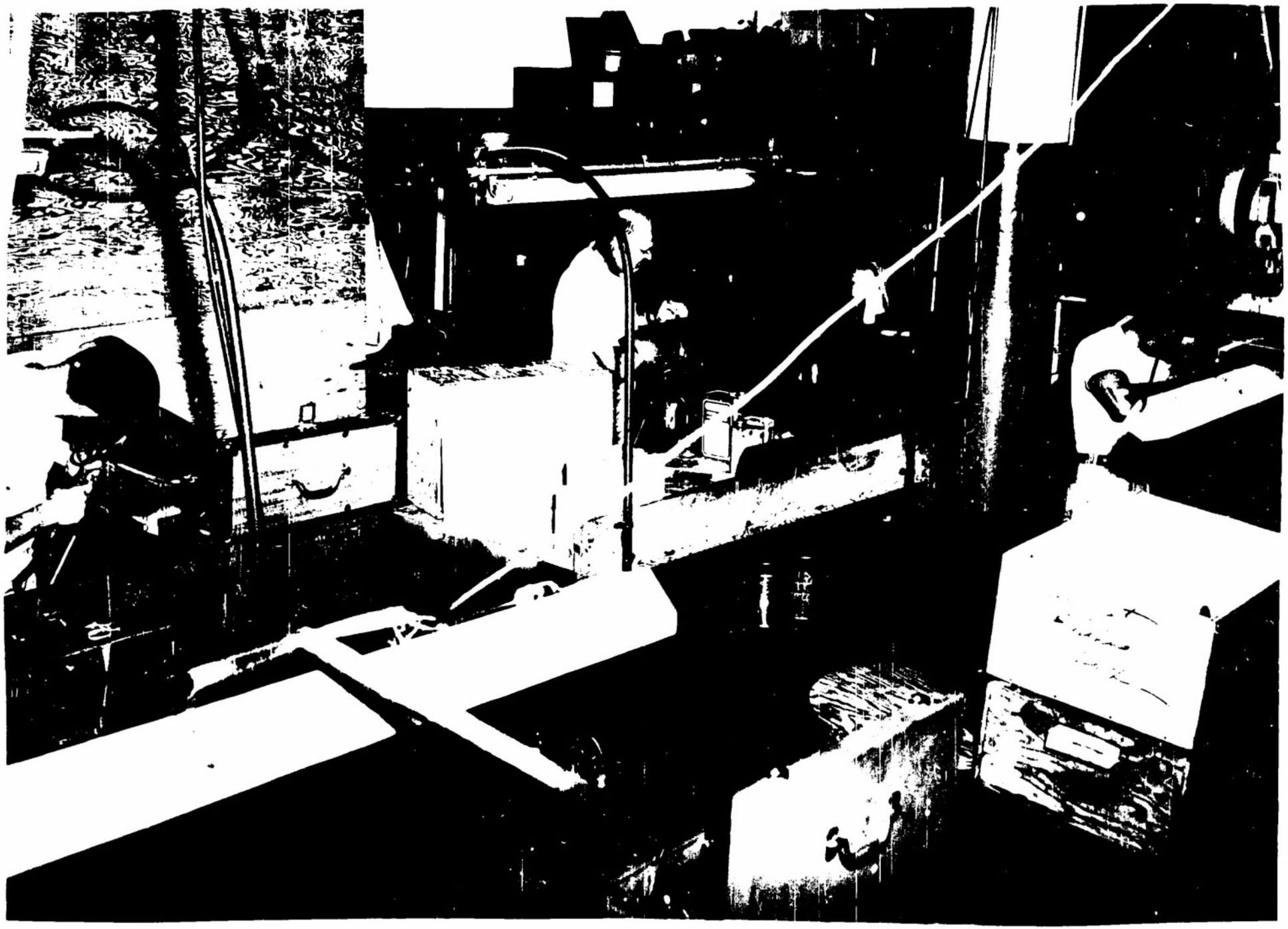
REPORT 2343 8.71-IN DIAMETER TEST RAM JETS AT PROPULSION LAB 10/2/51 FIGURE (6) PAGE 16
D4E 25730

REPORT 2343 8.71-IN DIAMETER RAM JETS IN PRODUCTION IN MAIN MANUFACTURING AREA 10/2/51 FIGURE (7) PAGE 17
D4E 25729

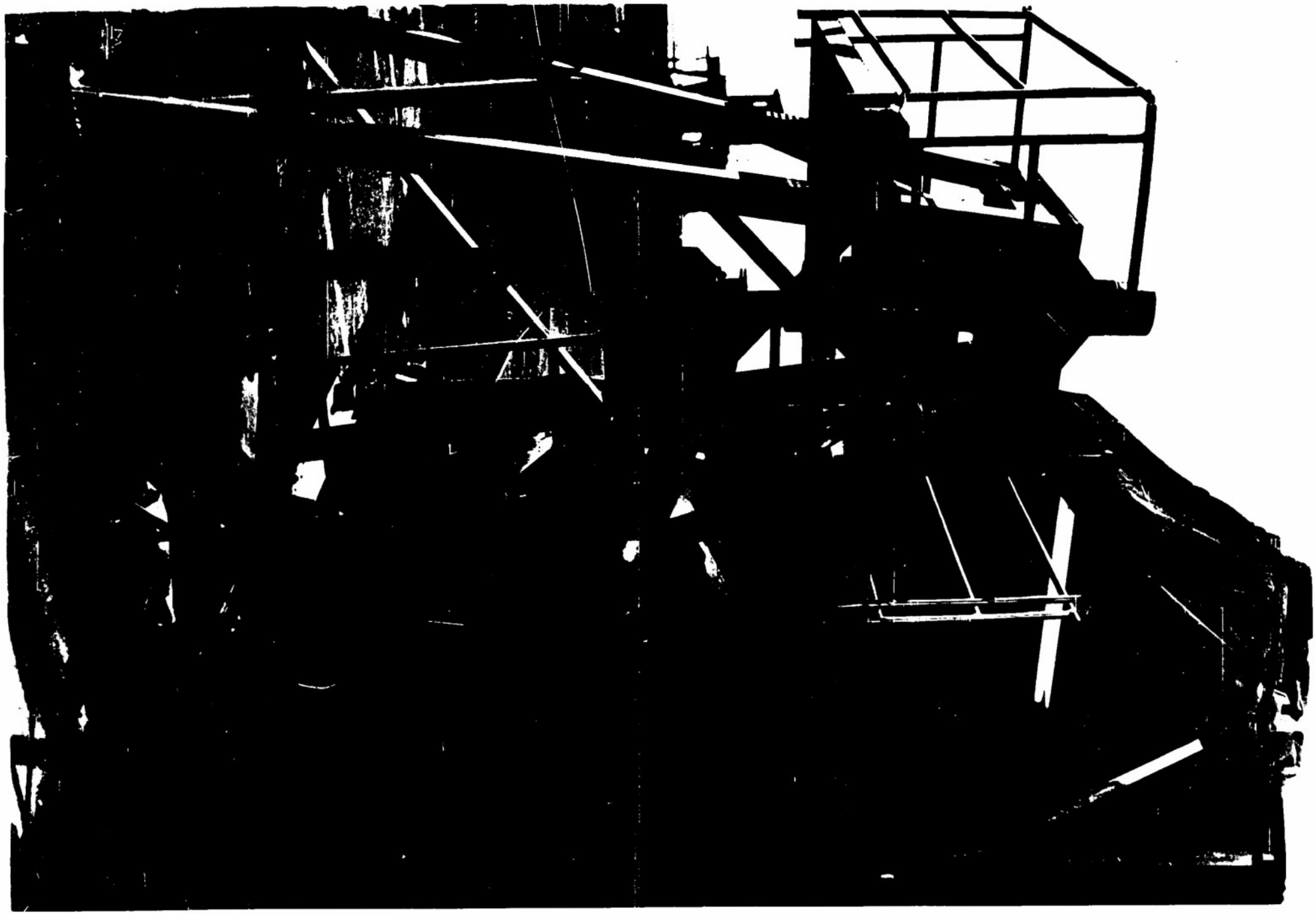
REPORT 2343
D4E 25722

7.25-IN DIAMETER RAM JET BEING REPAIRED - CRACKED SECTION REMOVED AND REPLACED 10/2/51

FIGURE (8)



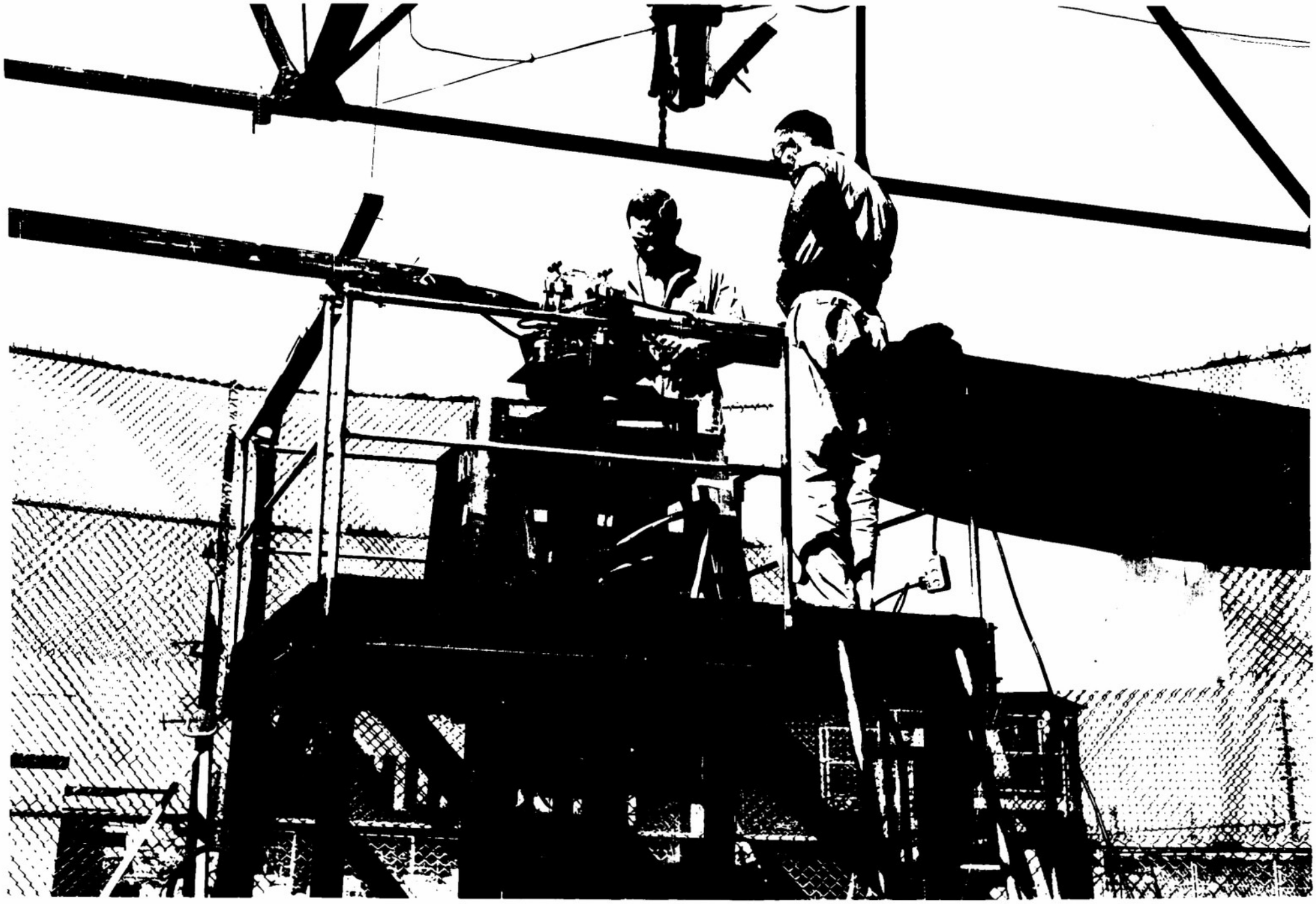
REPORT 2343 MAC EXPERIMENTAL RAM JET SHOP 10/7/51 FIGURE (9) PAGE 19
D4E 25723



REPORT 2343
D4E 25731

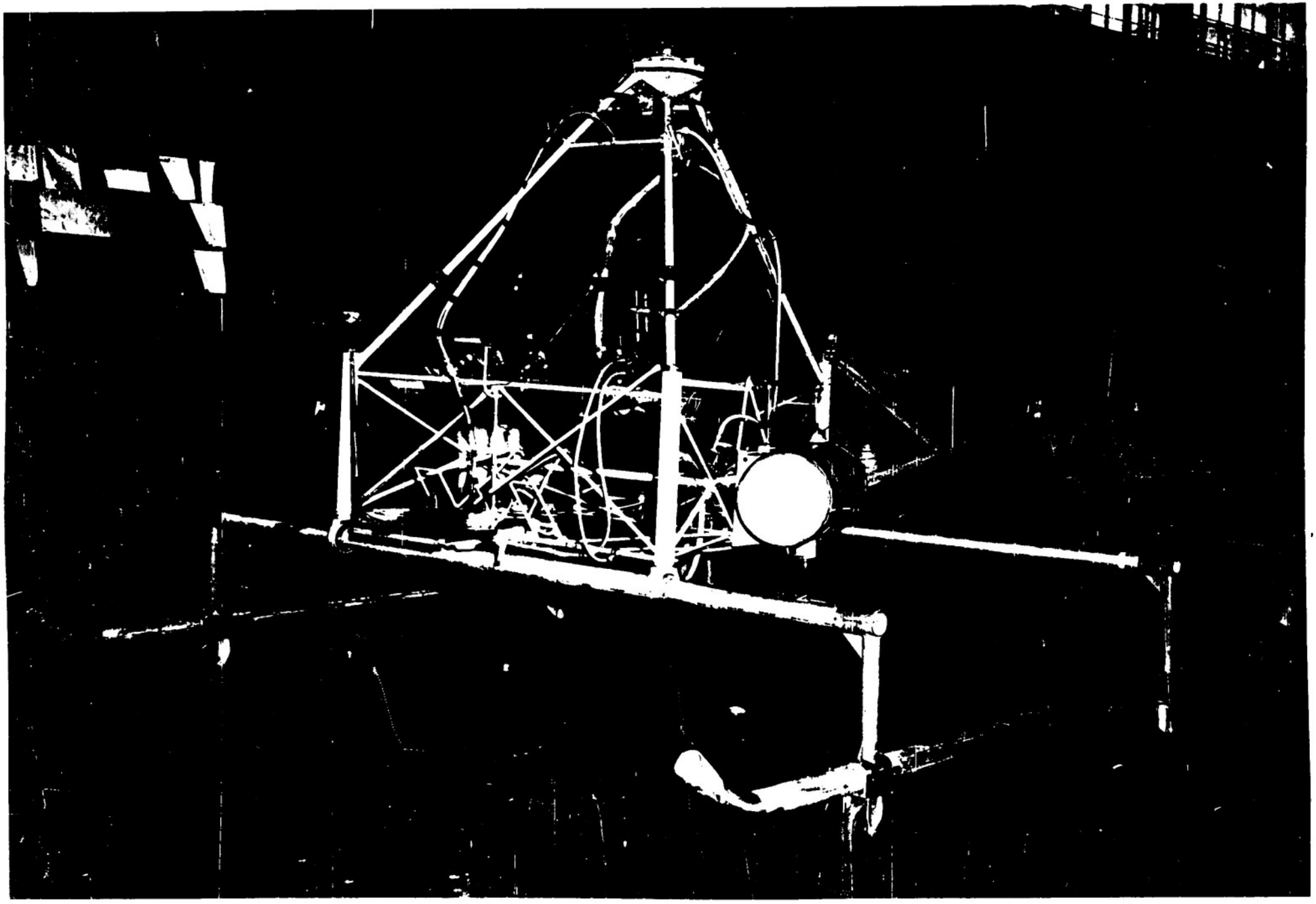
450 HP ENGINE INSTALLATION FOR IMPROVED WHIRL TEST STAND 10/2/51

FIGURE (10)

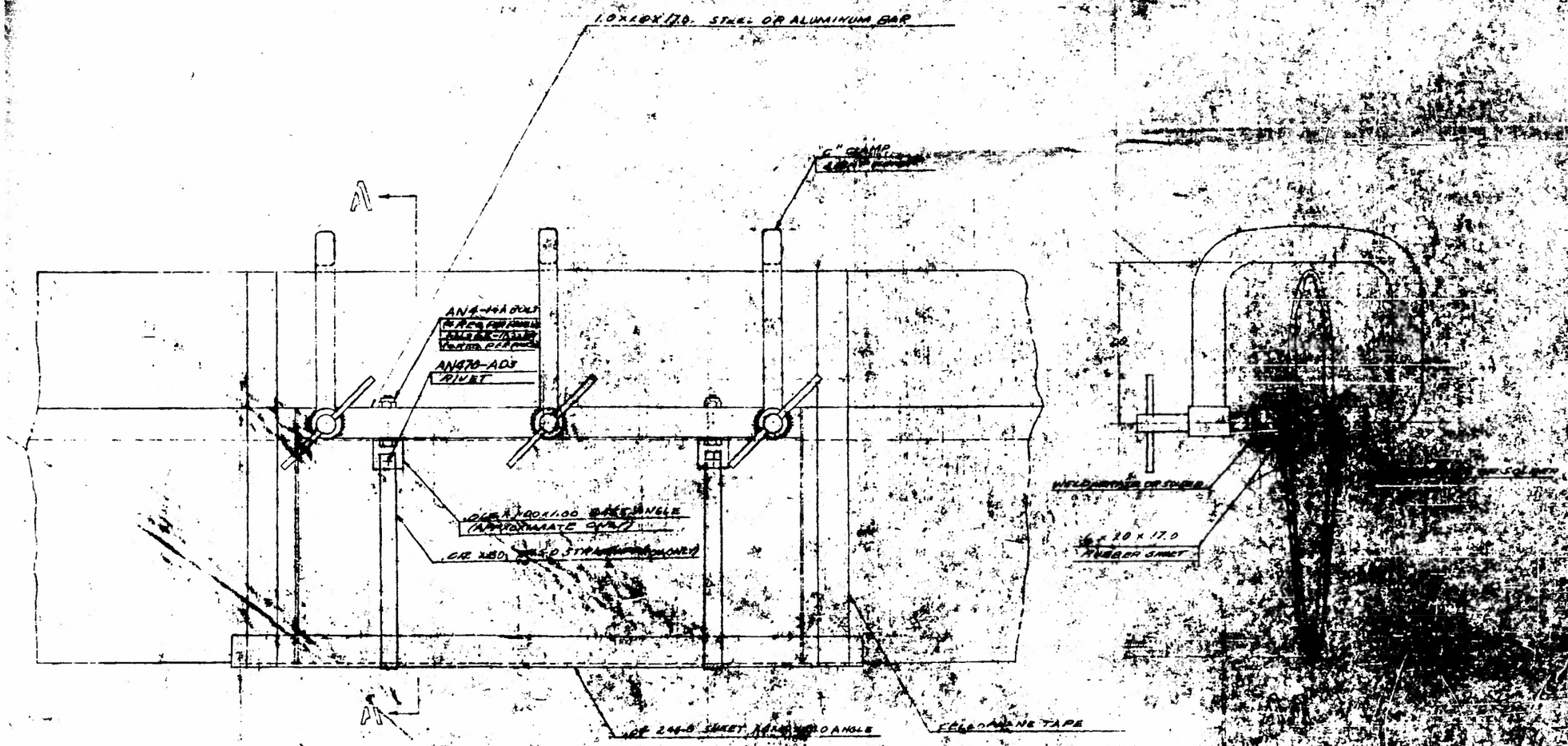


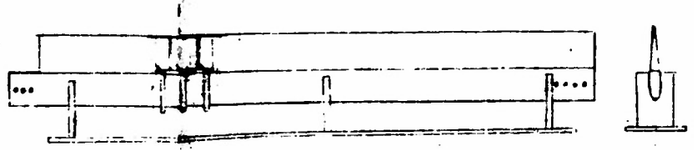
REPORT 2343 27-FOOT DIAMETER ROTOR ON PRESENT MAC WHIRL TEST STAND 10/2/51 FIGURE (11) PAGE 21
D4E 25733

REPORT 2343 MAC BLOWER AIR SUPPLY POWER PLANT 10/2/51 FIGURE (12) PAGE 22
D4E 25732



REPORT 2343 XH-20 NO. 2, STANDING BY FOR 27-FOOT DIAMETER ROTOR 10/2/51 FIGURE (13) PAGE 23
DLE 25726



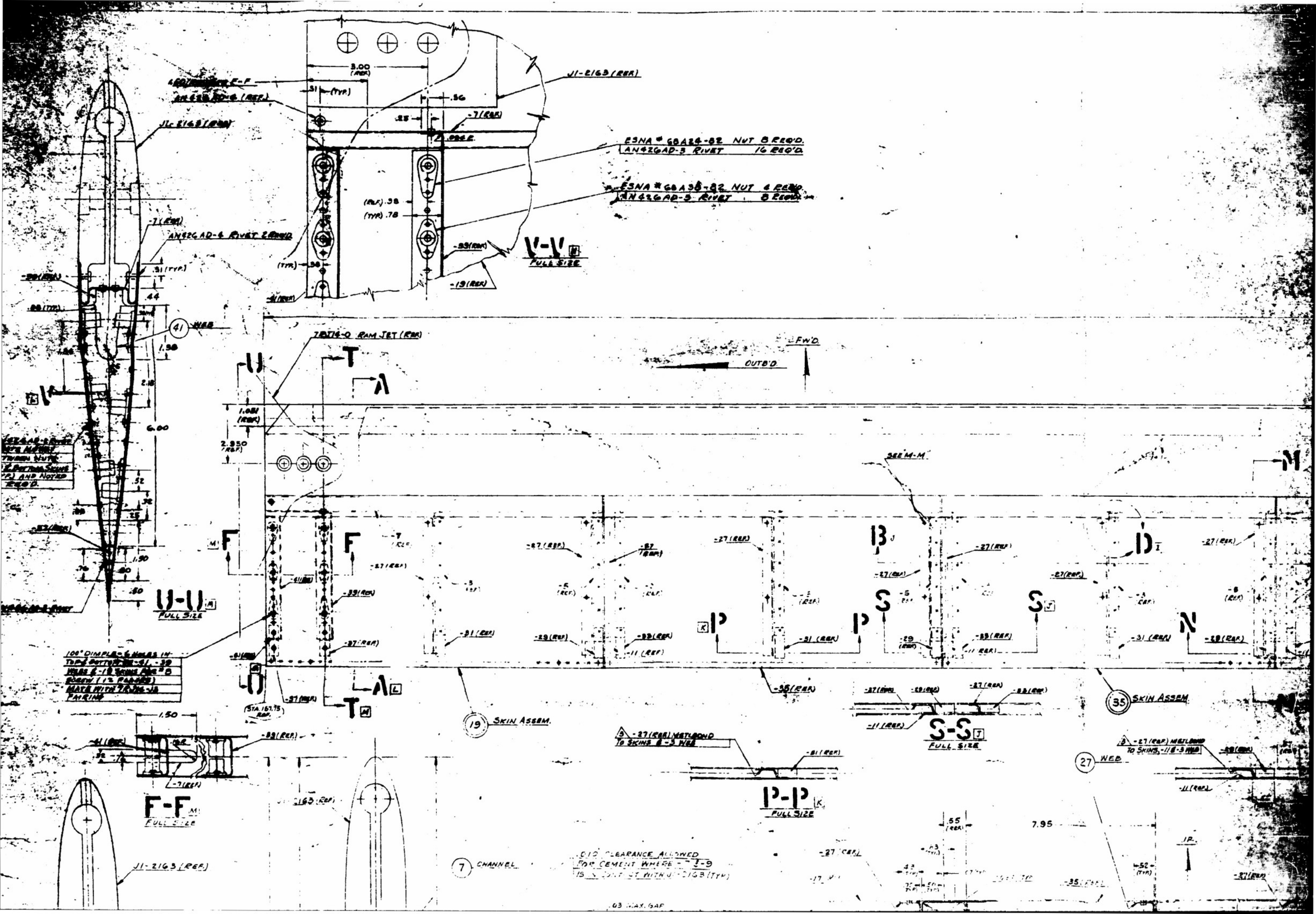


SKETCH SHOWING OVERALL SET-UP
NO SCALE

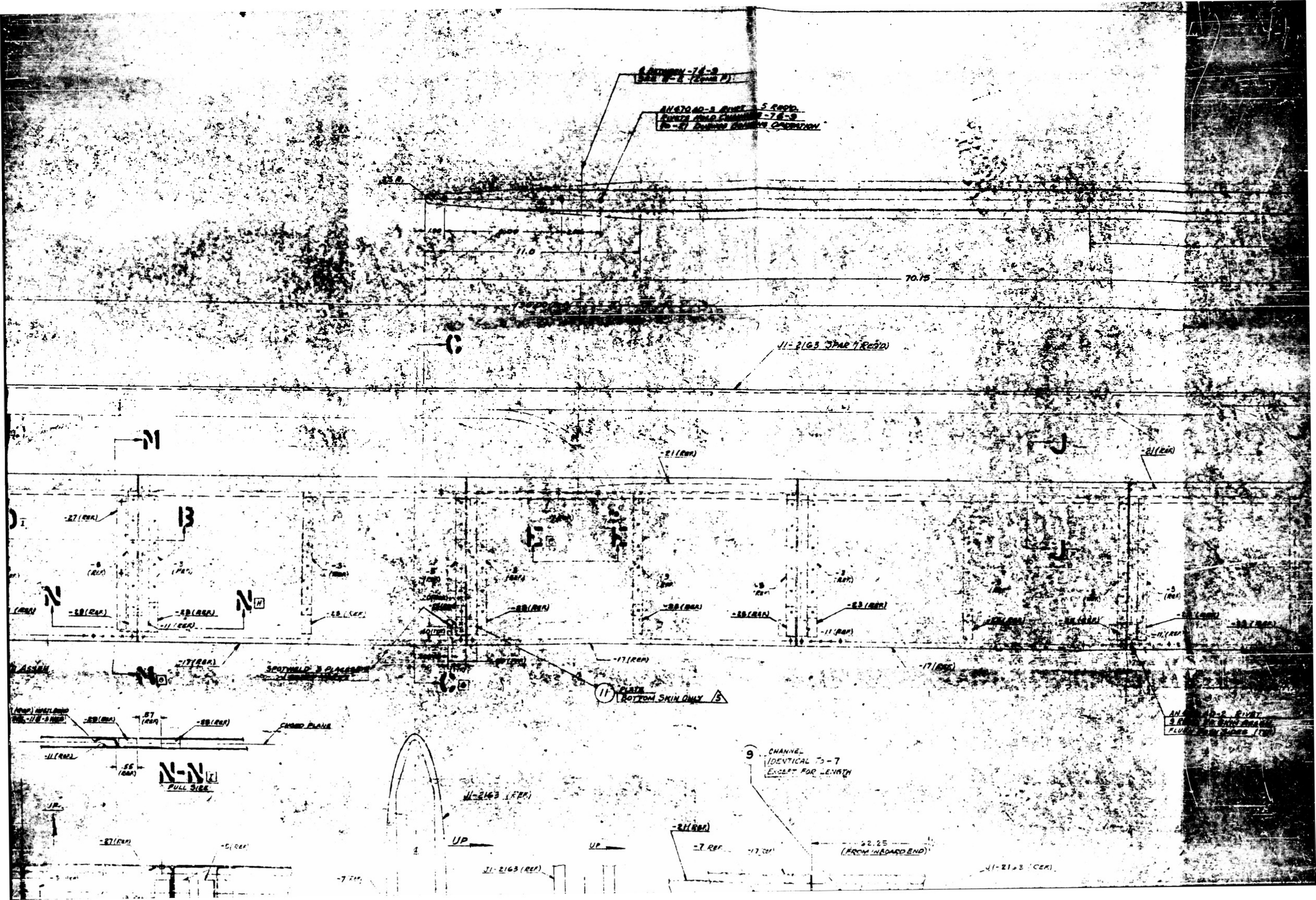
5. SET-UP MAY BE MODIFIED AS NECESSARY FOR REPLACEMENT OF TWO OR MORE ADJOINING SECTIONS.
4. CLEAN NEW PANEL SECTIONS [illegible] SULFURIC ACID, [illegible] OF SODIUM DICHROMATE AND 30 PARTS WATER AT [illegible] IN WARM WATER.
3. [illegible]
2. USE [illegible]
1. APPLY [illegible] CLAMPS TO HOLD THEM IN POSITION.

NOTES:

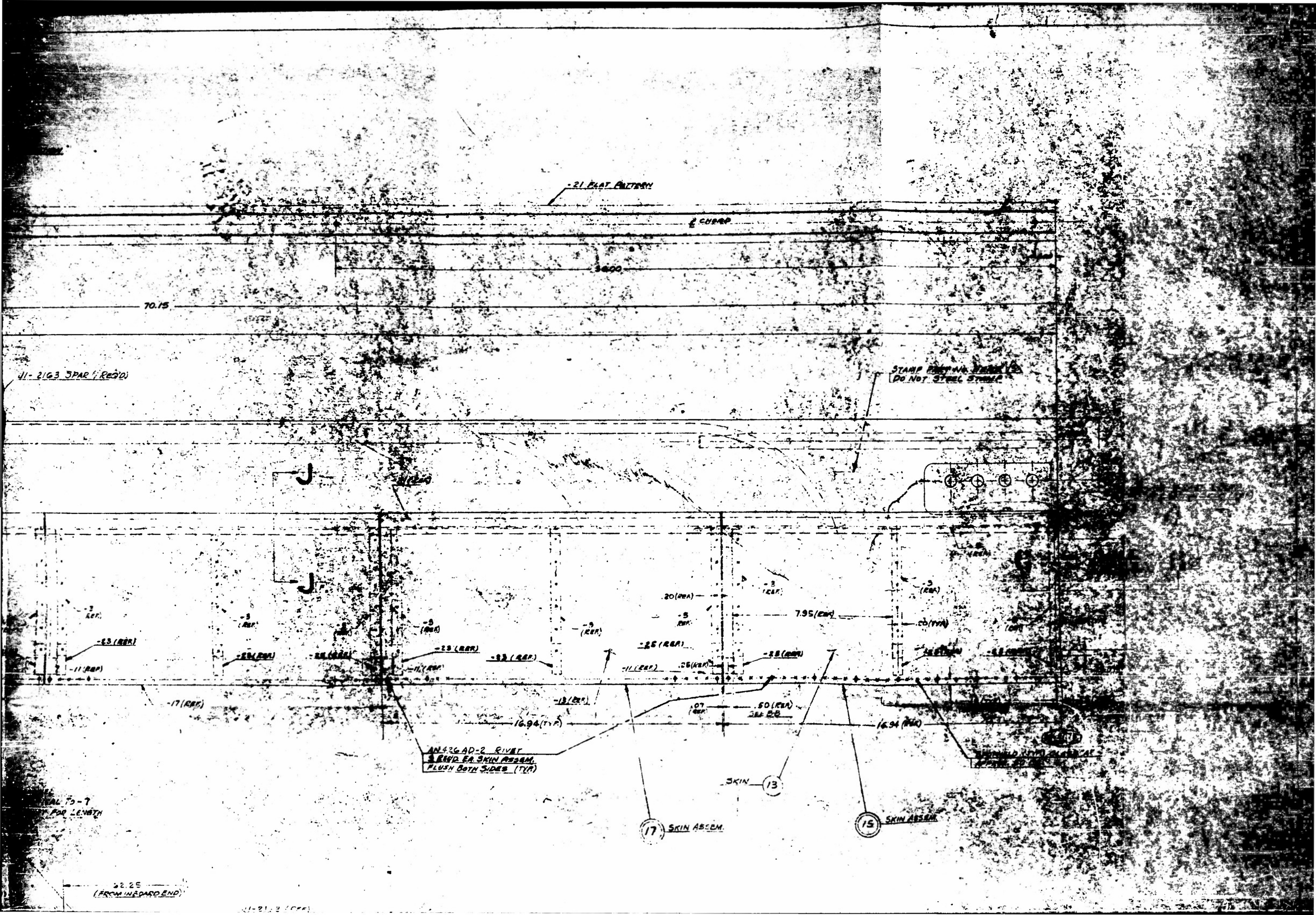
E D C B



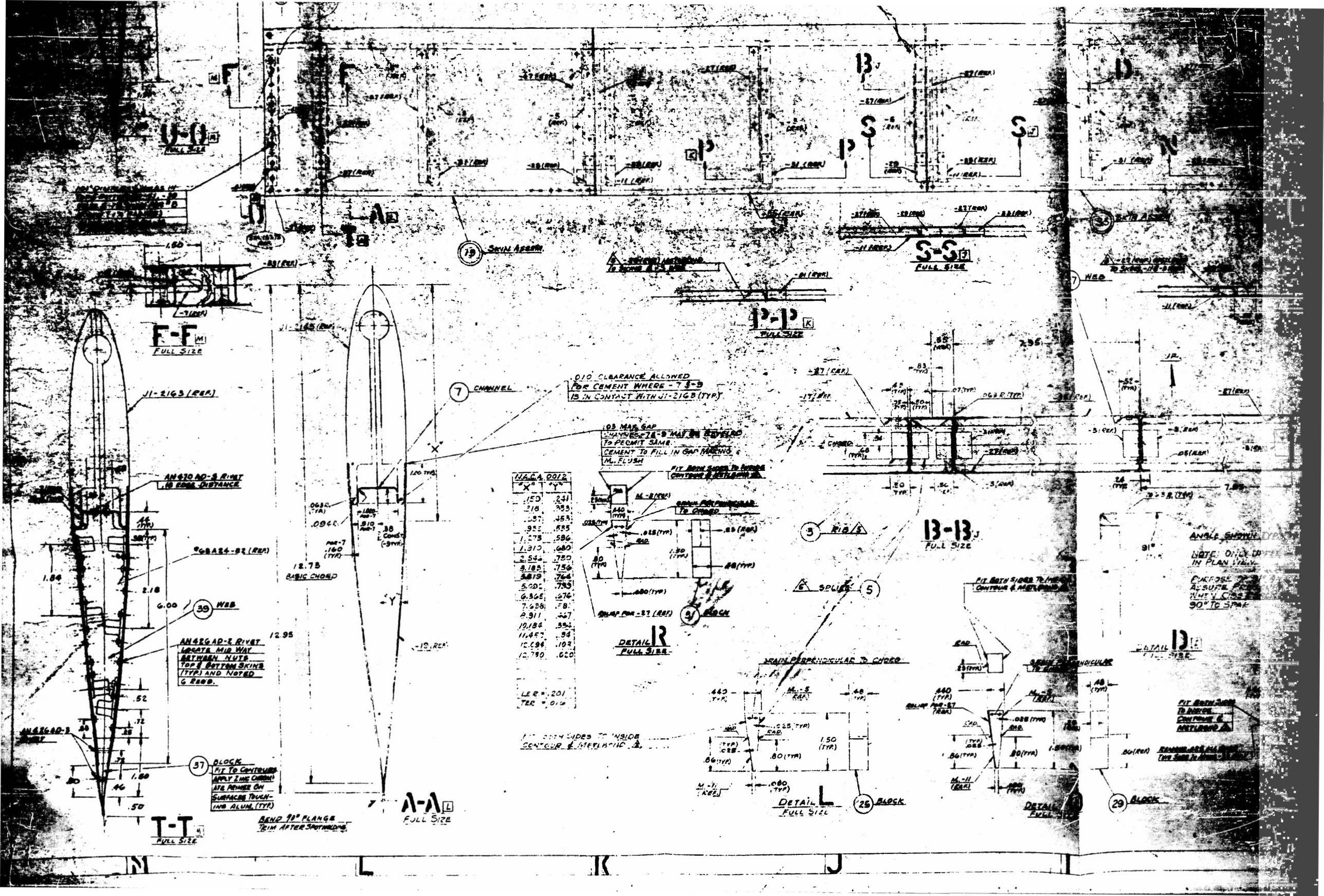
J1-2163 (REF)
ESNA # 68A24-82 NUT 8 REQ'D.
AN426AD-3 RIVET 16 REQ'D.
ESNA # 68A38-82 NUT 4 REQ'D.
AN426AD-3 RIVET 8 REQ'D.
V-V
FULL SIZE
AN426AD-4 RIVET 2 REQ'D.
41 WEB
7BJ14-0 RAM JET (REF)
FW'D.
OUTB'D.
SEE M-M
U-U
FULL SIZE
100° DIMPLE - 6 HOLES IN TOP & BOTTOM SKINS FOR #8 SCREW (12 PLACES) MATE WITH 7BJ16-13 FAIRING
19 SKIN ASSEM.
35 SKIN ASSEM.
S-S
FULL SIZE
27 WEB
P-P
FULL SIZE
F-F
FULL SIZE
7 CHANNEL
.010 CLEARANCE ALLOWED FOR CEMENT WHERE -7 & -9 IS IN CONTACT WITH J1-2163 (TYP)
.03 MAX. GAP



AN470AD-3 RIVET 5 REQ'D.
11.0
70.15
J1-2163 SPAR 7 REQ'D
-21 (REF)
-27 (REF)
-23 (REF)
-11 (REF)
-17 (REF)
SPOTWELD 3 PLACES
PLATE
BOTTOM SKIN ONLY
CHORD PLANE
N-N
FULL SIZE
J1-2163 (REF)
UP
CHANNEL
IDENTICAL TO -7
EXCEPT FOR LENGTH
62.25
(FROM INBOARD END)

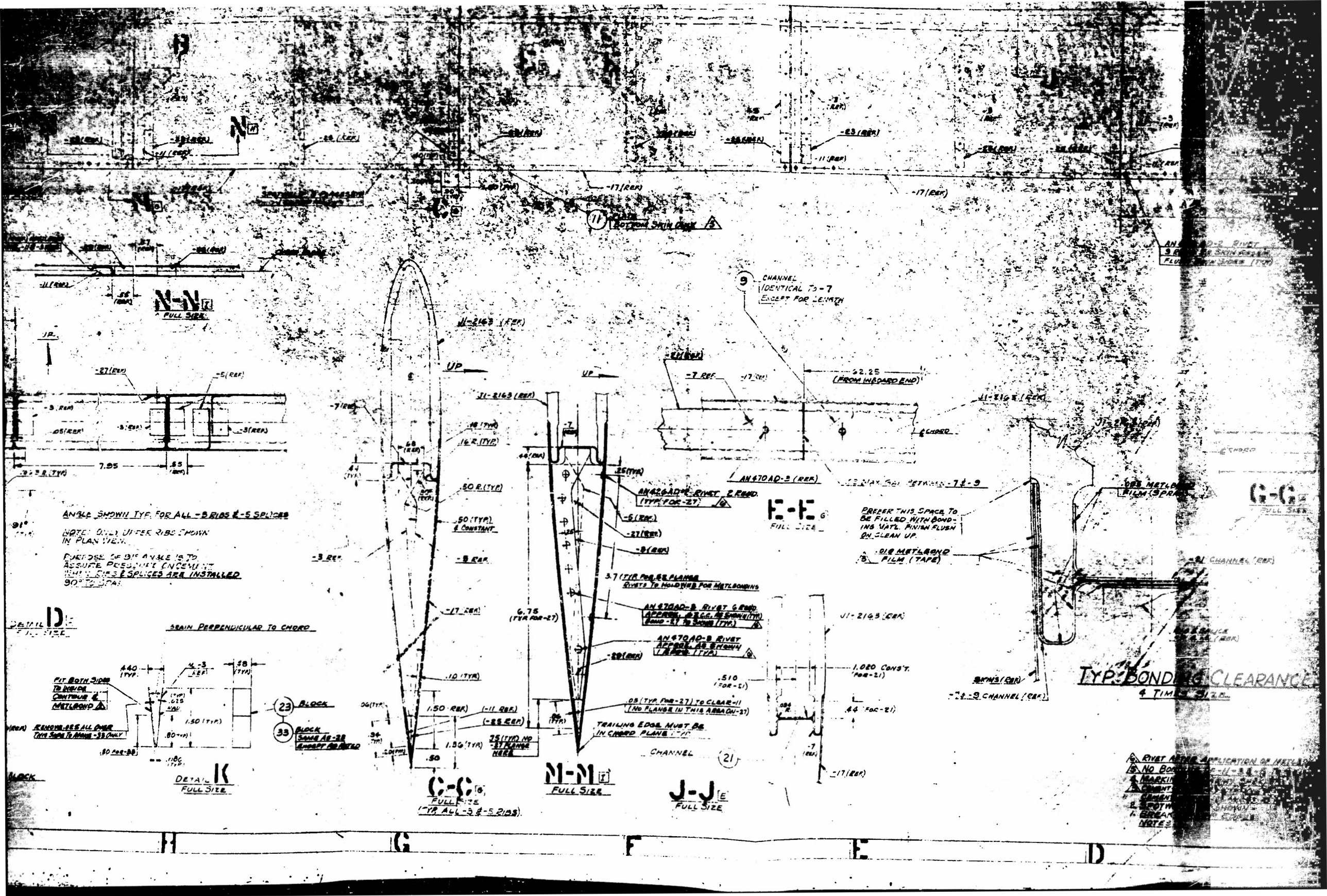


-21 FLAT PATTERN
℄ CHORD
36.00
70.15
J1-2163 SPAR (REQ'D)
STAMP PART NO. HERE
DO NOT STEEL STAMP
J
J
-23 (REF)
-11 (REF)
-17 (REF)
-13 (REF)
-25 (REF)
.20 (REF)
7.95 (REF)
.50 (REF)
SEE B-B
16.94 (TYP)
16.94 (REF)
AN426AD-2 RIVET
3 REQ'D EA. SKIN ASSEM.
FLUSH BOTH SIDES (TYP)
SKIN
13
17
SKIN ASSEM.
15
SKIN ASSEM.
FOR LENGTH
62.25
(FROM INBOARD END)

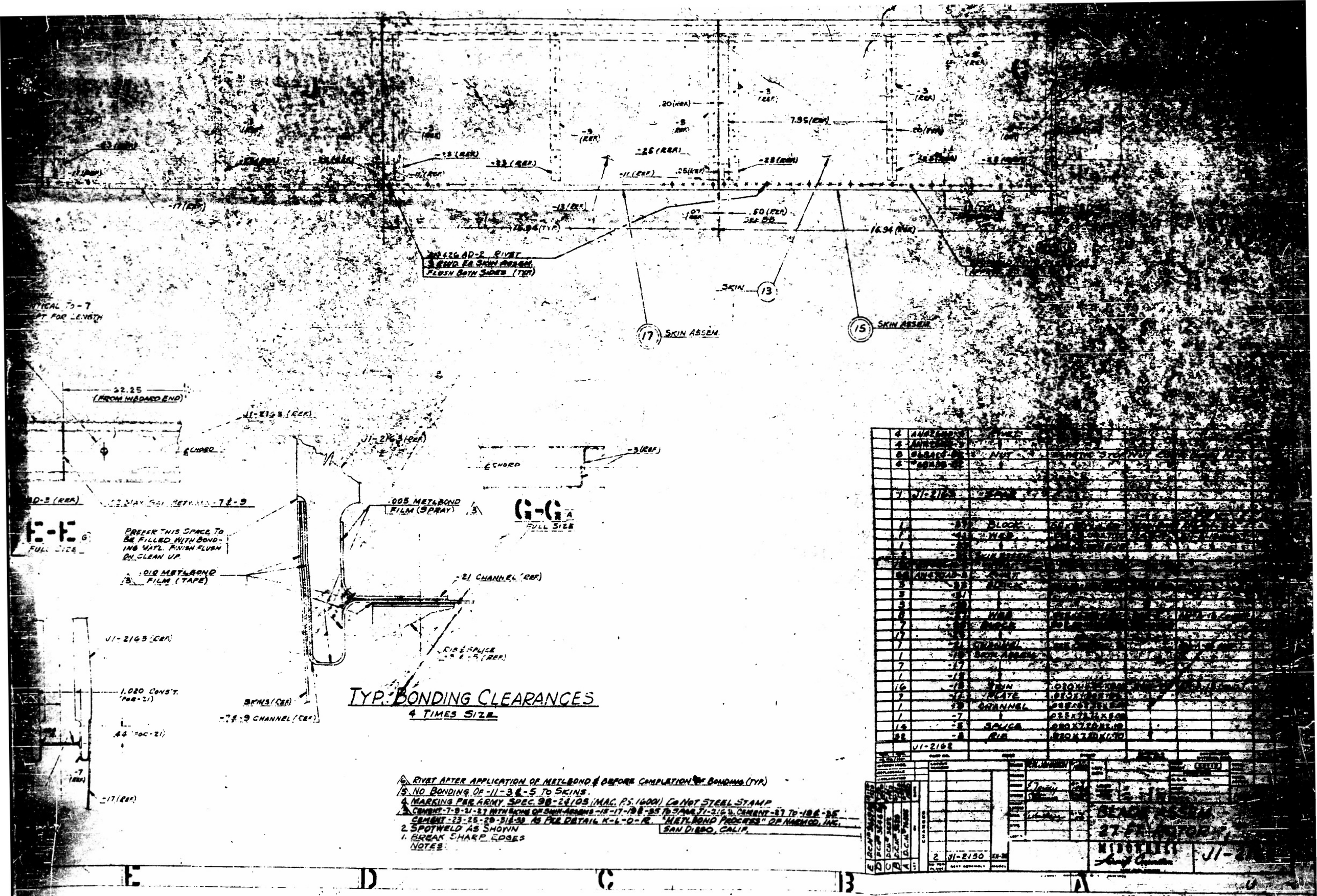


N.A.C.A. 0012	
"X"	"Y"
.150	.241
.218	.333
.337	.453
.955	.535
1.273	.596
1.910	.680
2.546	.730
3.183	.756
3.819	.764
5.092	.733
6.365	.676
7.638	.581
8.911	.467
10.184	.334
11.457	.94
12.094	.103
12.730	.020

LER = .201
TER = .016



N-N
FULL SIZE
ANGLE SHOWN TYP. FOR ALL -3 RIBS & -5 SPLICES
NOTE: ONLY UPPER RIBS SHOWN IN PLAN VIEW.
PURPOSE OF 91° ANGLE IS TO ASSURE PRESSURE ON CEMENT WHEN RIBS & SPLICES ARE INSTALLED 90° TO SPAR.
DETAIL D
GRAIN PERPENDICULAR TO CHORD
DETAIL K
FULL SIZE
C-C
FULL SIZE
(TYP. ALL -3 & -5 RIBS)
M-M
FULL SIZE
J-J
FULL SIZE
E-E
FULL SIZE
G-G
FULL SIZE
CHANNEL IDENTICAL TO -7 EXCEPT FOR LENGTH
62.25 (FROM INBOARD END)
PREFER THIS SPACE TO BE FILLED WITH BONDING MAT'L. FINISH FLUSH ON CLEAN UP.
.010 METLBOND FILM (TAPE)
TYP. BONDING CLEARANCE
4 TIMES SIZE
BOTTOM SKIN DUCK
J1-2163 (REF)
UP
CHANNEL

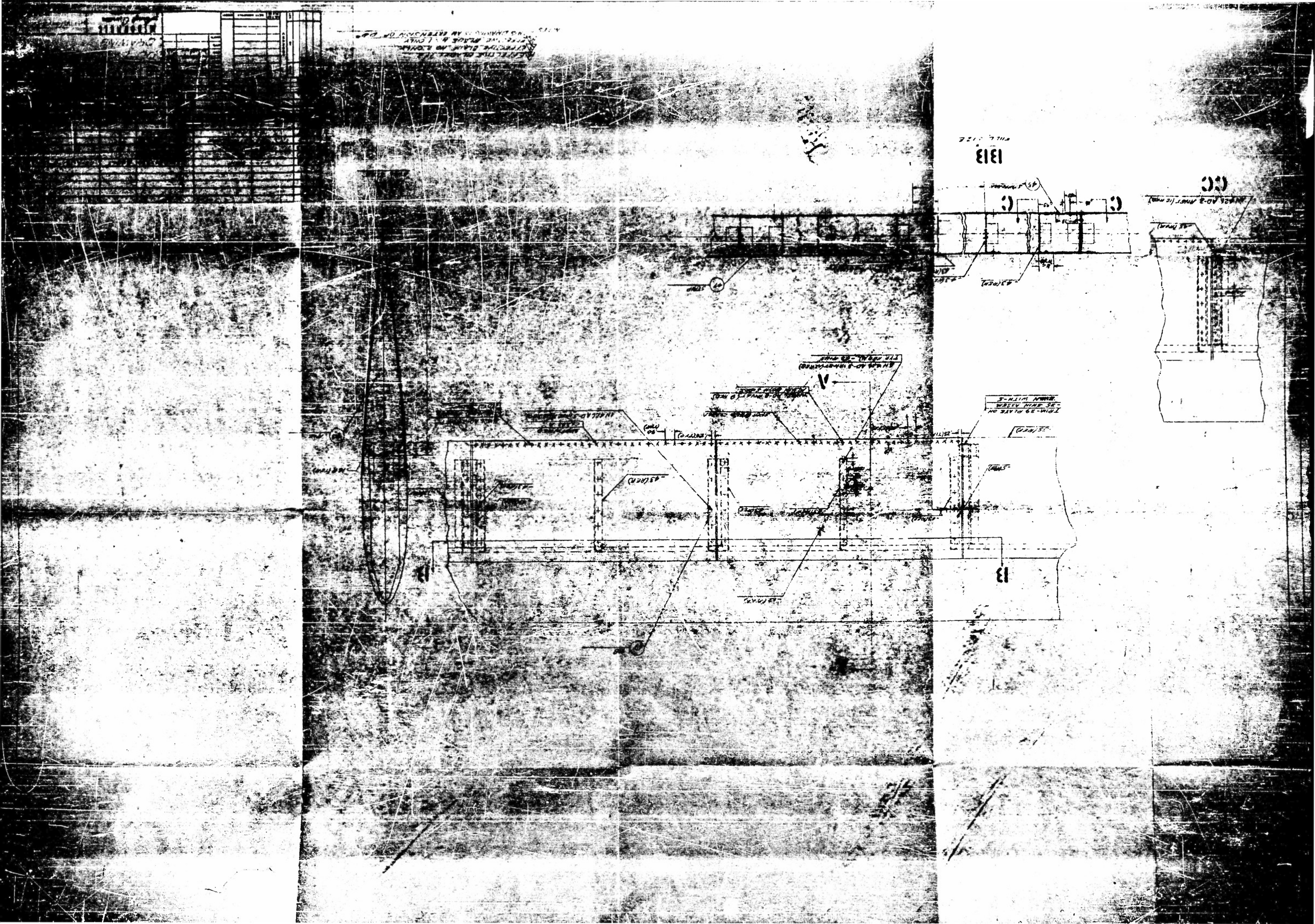


TYP. BONDING CLEARANCES
4 TIMES SIZE

6. RIVET AFTER APPLICATION OF METLBOND & BEFORE COMPLETION OF BONDING (TYP.)
5. NO BONDING OF -11-3 & -5 TO SKINS.
4. MARKING PER ARMY SPEC. 98-2 & 105 (MAC. P.S. 16001) DO NOT STEEL STAMP
3. CEMENT -7-9-21-27 WITH SKINS OF SKIN ASSEMS -15-17-19 & -35 TO SPAR J1-2163. CEMENT -27 TO -19 & -35 CEMENT -23-25-29-31 & -33 AS PER DETAIL K-6-0-R. "METLBOND PROCESS" OF NARMCO, INC. SAN DIEGO, CALIF.
2. SPOTWELD AS SHOWN
1. BREAK SHARP EDGES
NOTES:

4	AN426AD-2	RIVET			
4	AN426AD-3				
8	[illegible]	NUT	[illegible]		
4	[illegible]				
7	J1-2163	SPAR			
1	-39	BLOCK	[illegible]		
1	-41	WEB	[illegible]		
1	[illegible]				
2	[illegible]				
[illegible]	[illegible]				
3	-33	BLOCK			
3	-31				
3	[illegible]				
8	[illegible]	WEB	[illegible]		
7	[illegible]	BLOCK	[illegible]		
17	[illegible]				
1	-21	CHANNEL	[illegible]		
1	-15	SKIN ASSEM.			
7	-17				
1	-13				
16	-13	SKIN	.020 X [illegible]		
7	-11	PLATE	.020 X [illegible]		
1	-9	CHANNEL	[illegible]		
1	-7		.025 X [illegible]		
14	-5	SPLICE	.020 X 7.20 X 2.10		
32	-3	RIB	.020 X 7.20 X 1.70		
	J1-2162				

E	D.C.M. [illegible]		
D	D.C.M. [illegible]		
C	D.C.M. [illegible]		
B	D.C.M. [illegible]		
A	D.C.M. [illegible]		
		CHANGED	
	2	J1-2150	[illegible]

BLADE ASSEM.
27 FT. ROTOR
MINOWHEEL
J1-2

2163-104