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AUTHORITY

ONR ltr, 4 May 1977

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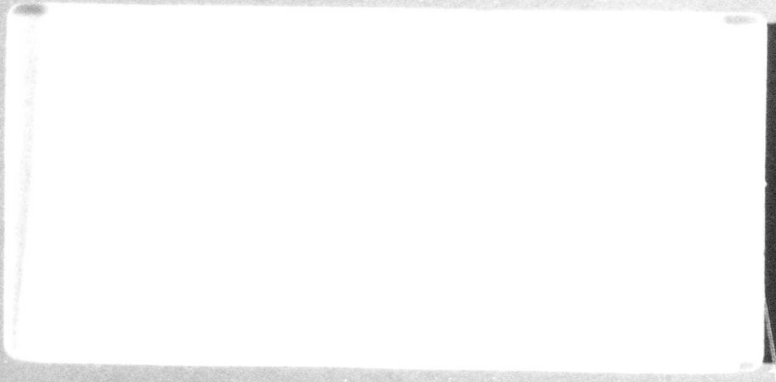

HUGHES TOOL COMPANY · AIRCRAFT DIVISION
Culver City, California

HTC-AD 65-15

Volume III

APPENDIXES G AND H

SUMMARY TECHNICAL REPORT ROTOR/WING CONCEPT STUDY

September 1965

Prepared by Robert E. Head

Contract Number: Nonr-4588(00)
Authority: NR 212-162/12-8-64

An Experimental Research Program sponsored by Air Programs, Office of Naval Research, and Airframe Design Division, Bureau of Naval Weapons, U. S. Navy

HUGHES TOOL COMPANY -- AIRCRAFT DIVISION
Culver City, California

FOREWORD

This report presents the results of whirlstand and wind tunnel tests of a one-sixth scale model of the Rotor/Wing high-speed VTOL aircraft. The main body of the report presented as Volume I, discusses highlights of the test results, includes a discussion of the application of the test results to full-scale, and describes the characteristics of such an aircraft. Volume II, which includes Appendixes A through F, contains detailed analyses and test data from the model research program. Volume III, which includes Appendixes G and H, contains a collection of the detailed drawings of the model and the stress analysis used in the design.

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APPENDIX H - STRUCTURAL ANALYSIS	III-26

APPENDIX G

ROTOR/WING MODEL DRAWINGS

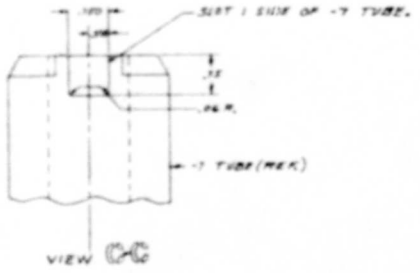
APPENDIX G

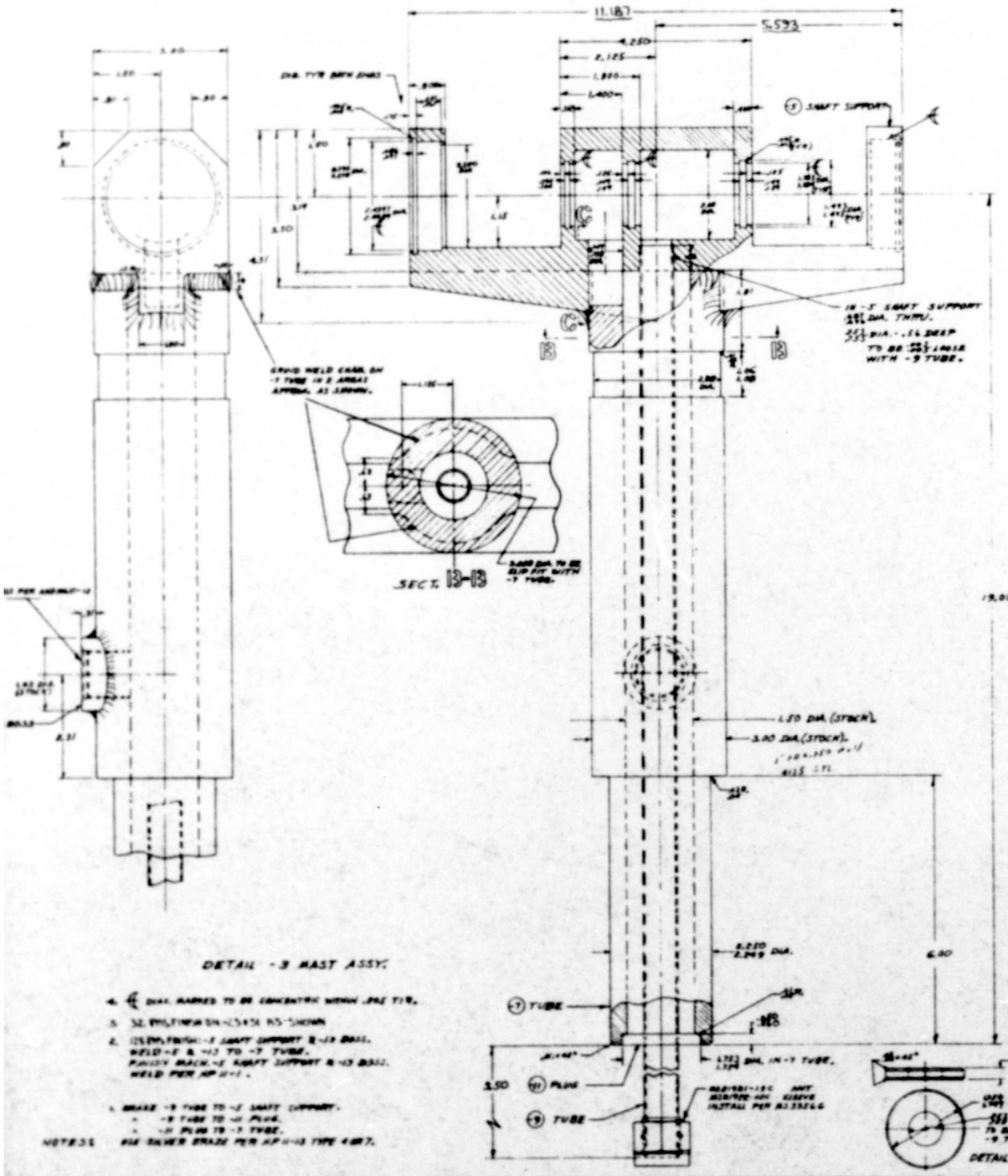
ROTOR/WING MODEL DRAWINGS

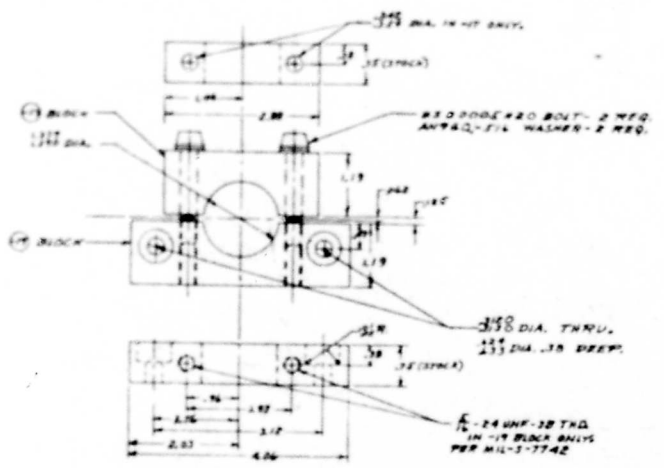
This Appendix includes the layout drawings for the major components of the model, and the detail drawings for the actual components. The basic layout drawings for the model may be seen in Volume I as Figures 9, 10, and 11. Drawings included herein are:

Drawing Number	Sheet	Title
356-0602	1	Mast Assembly
356-0603	1	Image Strut Assembly
356-0700	1, 2	Fuselage
356-0800	1, 2	Empennage*
356-0801	1, 2	Empennage
356-0900	1, 2	Rotor
356-0902	1	Spoiler
356-0903	1	Empennage
356-1000	1, 2, 3	Controls
356-1001	1	Swashplate
356-1002	1	Swashplate
356-1003	1	Swashplate
356-1005	1	Swashplate
356-1006	1	Swashplate
356-1100	1, 2	Propulsion System
356-1501	1	Tachometer

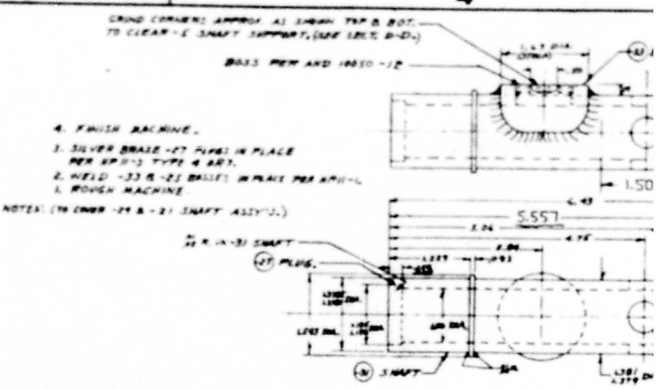
*An engine nacelle was included in the drawing, but it was not constructed.


SLOT 1 SIDE OF -7 TUBE.
-7 TUBE (REF.)
VIEW C-C

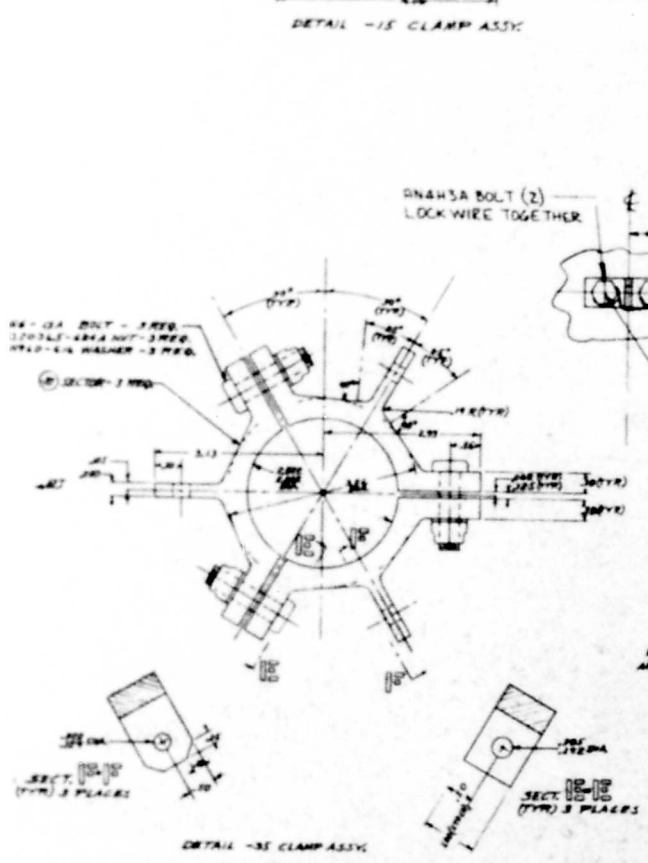

11.187
5.593
SHAFT SUPPORT
SECT. B-B
DETAIL -3 MAST ASSY.
-7 TUBE
PLUG
-9 TUBE
DETAIL -11 PLUG.



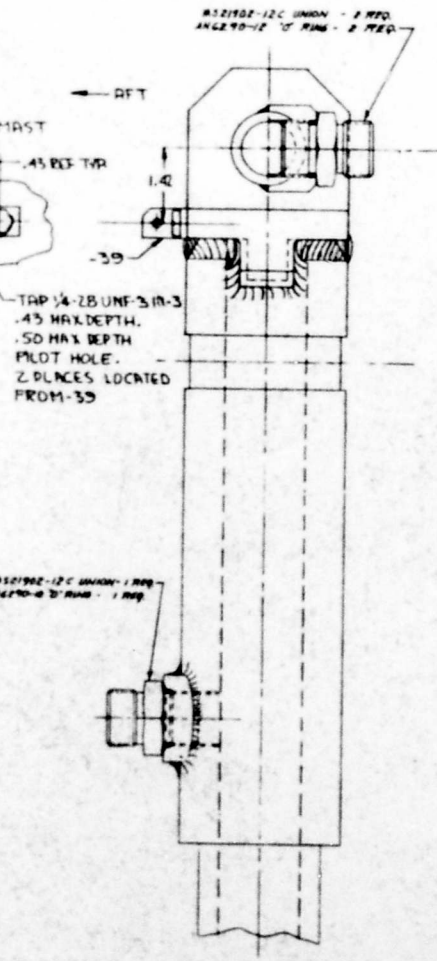
DETAIL -15 CLAMP ASSY.



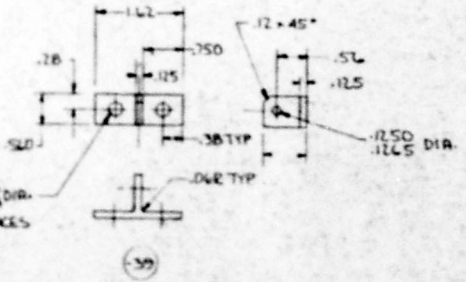
DETAIL -29 SHAFT ASSY.



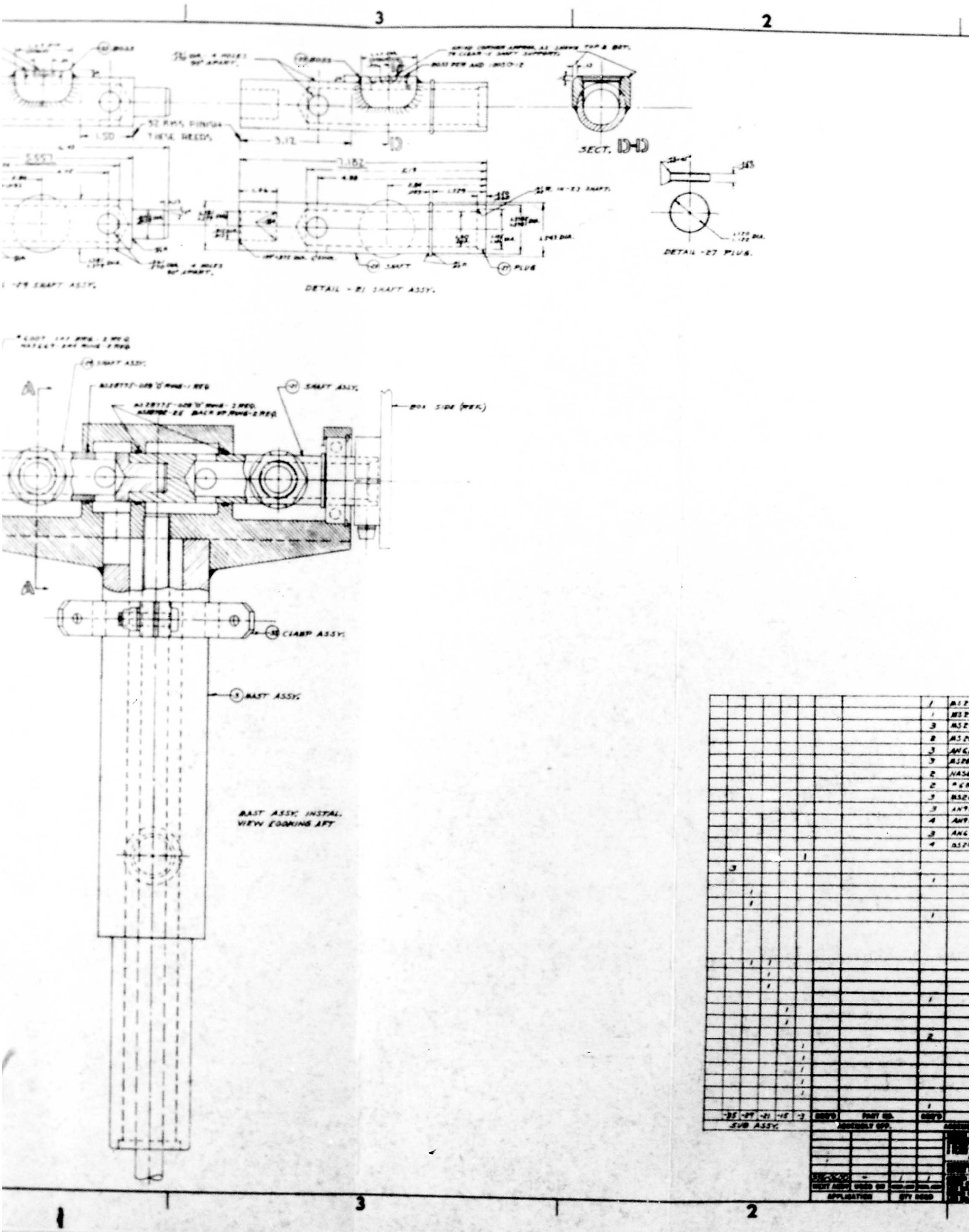
DETAIL -35 CLAMP ASSY.



SECT. AA

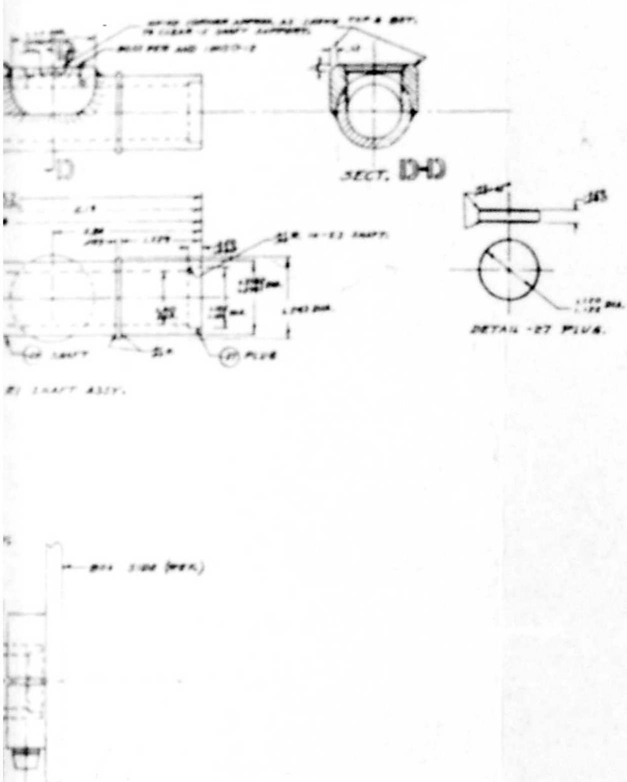


-39


3
2
32 RMS FINISH
THESE REEDS
1.50
3.12
SECT. D-D
DETAIL -27 PLUG.
DETAIL -21 SHAFT ASSY.
-29 SHAFT ASSY.
SHAFT
PLUG
SHAFT ASSY.
BOX SIDE (REF.)
CLAMP ASSY.
MAST ASSY.
MAST ASSY. INSTAL.
VIEW LOOKING AFT
SUB ASSY.
PART NO.
APPLICATION
3
2

3	2	1

REVISIONS						



	-35	-29	-21	-15	-3	CODE	PART NO.	CODE	PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION
								1	MS21922-12C	SLEEVE			
								1	MS21921-12C	NUT			
								3	MS21902-12C	UNION			
								2	MS28782-25	BACK UP RING			
								3	AN6290-12	"O" RING			
								3	MS28775-028	"O" RING			
								2	NAS669-244	SNAP RING			
								2	*6807	SKF BRG.			
								3	MS20365-624A	NUT			
								3	AN960-616	WASHER			
								4	AN960-516	WASHER			
								3	AN6-13A	BOLT			
								4	MS20005H20	BOLT			
					1				-39	BRKT	[illegible]	2024-T4	
	3								-37	SECTOR	[illegible]	4130 STL. PLATE	MIL-S-18729 COND. A
								1	-35	CLAMP ASSY.			
		1							-33	BOSS	[illegible]	4130 STL. TUBE	[illegible]
		1							-31	SHAFT	[illegible]	4130 ROUND BAR	[illegible]
								1	-29	SHAFT ASSY.			
													356-0602
		1	1						-27	PLUG	[illegible]	4130 ROUND BAR	[illegible]
			1						-25	BOSS	[illegible]	4130 STL. TUBE	[illegible]
			1						-23	SHAFT	[illegible]	4130 ROUND BAR	[illegible]
								1	-21	SHAFT ASSY			
				1					-19	BLOCK	[illegible]	4130 STL. BAR	[illegible]
				1					-17	BLOCK	[illegible]	4130 STL. BAR	[illegible]
								2	-15	CLAMP ASSY.			
					1				-13	BOSS	[illegible]	4130 STL. TUBE	[illegible]
					1				-11	PLUG	[illegible]	4130 ROUND BAR	[illegible]
					1				-9	TUBE	[illegible]	4130 ROUND TUBE	[illegible]
					1				-7	TUBE	[illegible]	[illegible] ROUND TUBE	AMS 6372
					1				-5	SHAFT SUPPORT	[illegible]	4130 STL. BAR	[illegible]
								1	-3	MAST ASSY.			

SUB ASSY. — ASSEMBLY UPP. — ASSEMBLY CONSIST — LIST OF MATERIAL

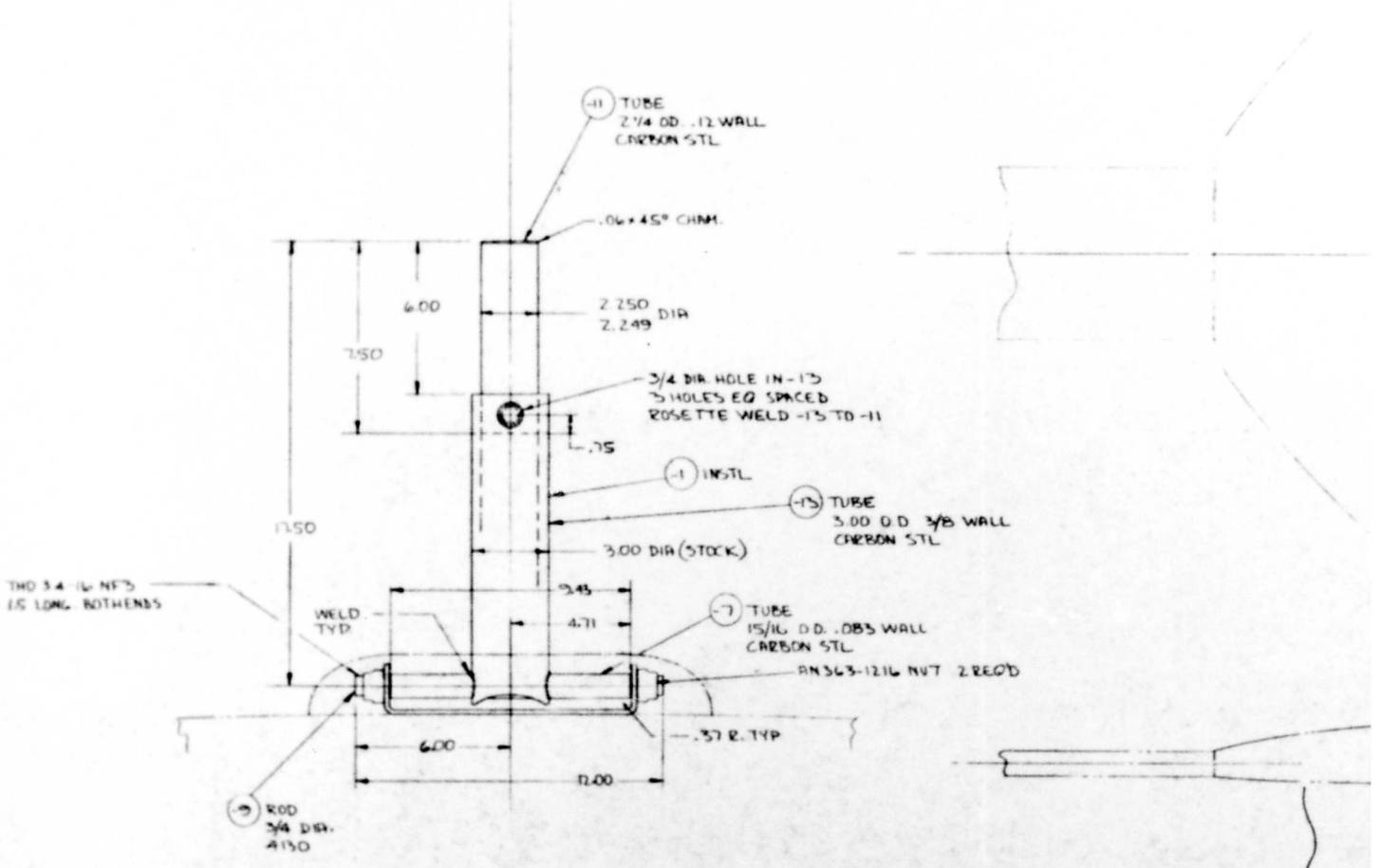
MAST ASSY-
ONR ROTOR-WING
WIND TUNNEL MODEL

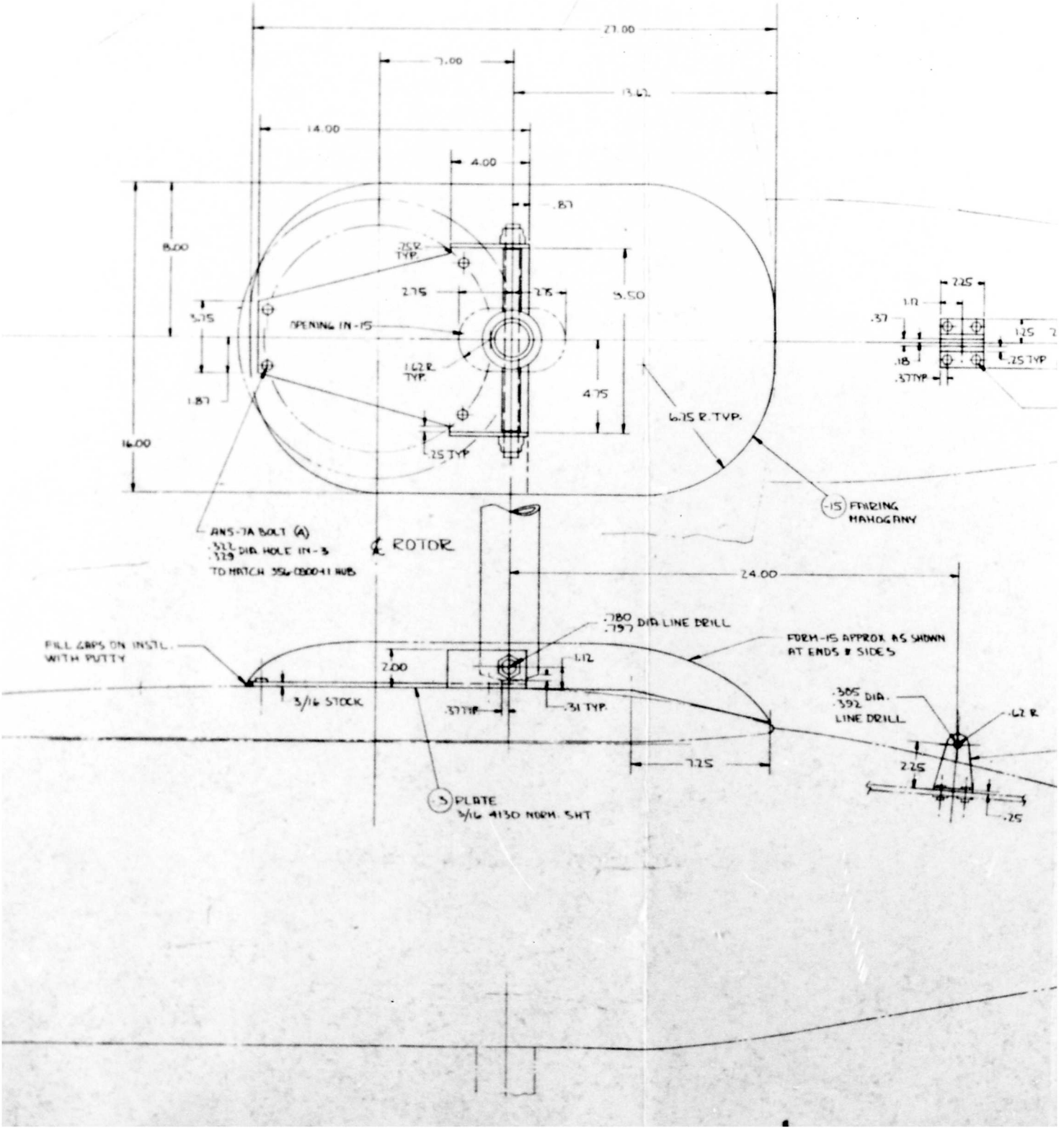
SCALE FULL

02731

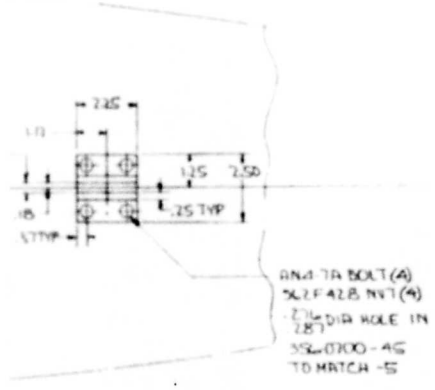
356-0602

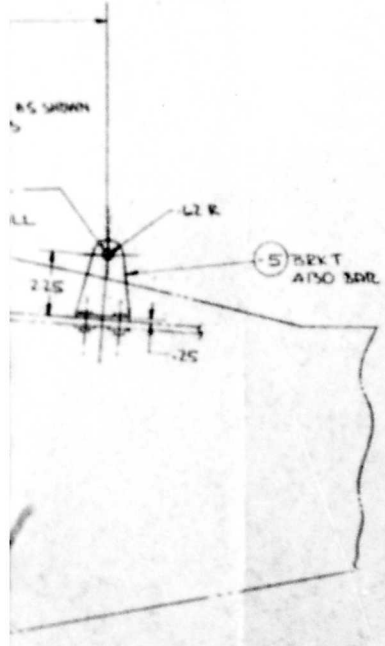
3	2	1


-11 TUBE
2 1/4 OD .12 WALL
CARBON STL
.06 x 45° CHM.
6.00
2.250
2.249 DIA
7.50
3/4 DIA HOLE IN -13
3 HOLES EQ SPACED
ROSETTE WELD -13 TO -11
.75
-1 INSTL
-13 TUBE
3.00 O.D 3/8 WALL
CARBON STL
11.50
3.00 DIA (STOCK)
THD 3/4-16 NF3
1.5 LONG BOTHENDS
WELD
TYP
9.45
4.71
-7 TUBE
15/16 O.D. .083 WALL
CARBON STL
AN363-1216 NUT 2 REQ'D
.37 R. TYP
6.00
12.00
-9 ROD
3/4 DIA.
4130


27.00
7.00
13.62
14.00
4.00
.87
8.00
.25R TYP.
2.75
2.75
5.50
3.75
OPENING IN -15
1.62R TYP.
1.87
4.75
16.00
.25 TYP
6.75 R TYP.
2.25
1.12
.37
1.25
.18
.25 TYP
.37 TYP
-15 FAIRING MAHOGANY
ANS-3A BOLT (4)
.322 .329 DIA HOLE IN -3
TO MATCH 356 C80041 HUB
℄ ROTOR
24.00
.780 .797 DIA LINE DRILL
FORM -15 APPROX AS SHOWN AT ENDS & SIDES
FILL GAPS ON INSTL. WITH PUTTY
2.00
1.12
3/16 STOCK
.37 TYP
.31 TYP
.305 .392 DIA. LINE DRILL
.62 R
7.25
2.25
.25
-3 PLATE 3/16 4130 NORM. SHT

REVISIONS					
SYM	E.O.S.	DESCRIPTION	DRWN	APP'D	DATE

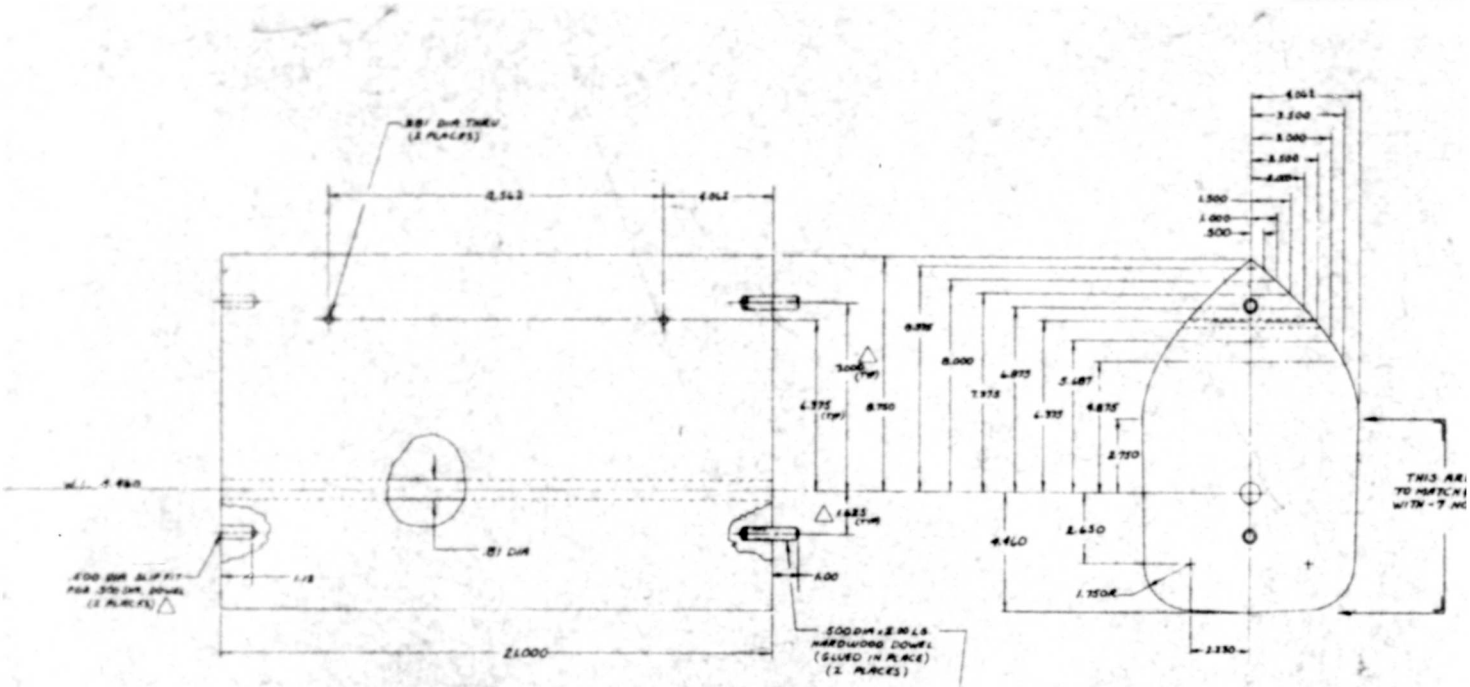




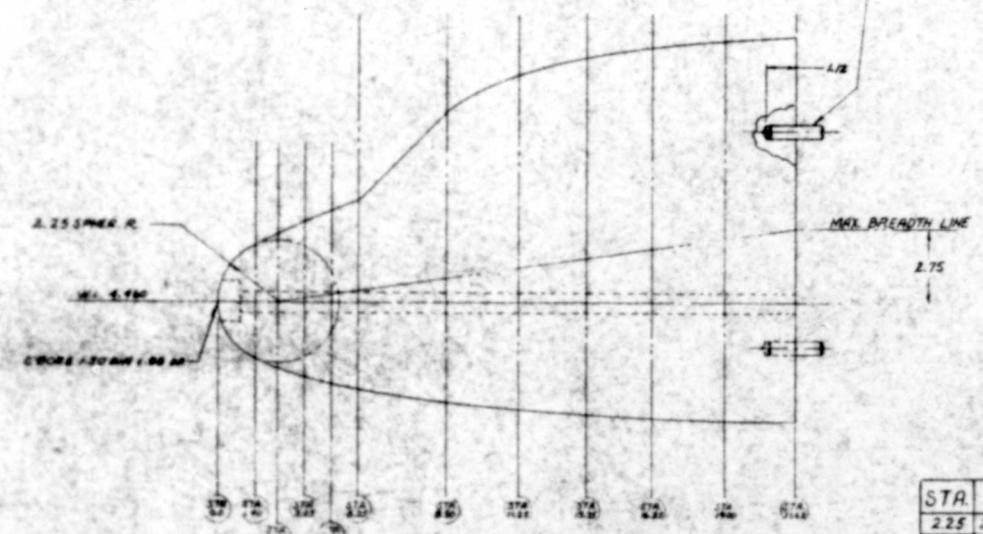
356-0603

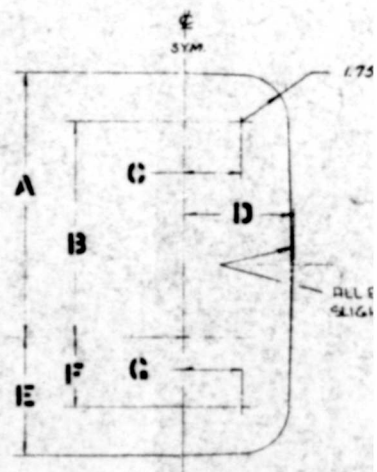
IMAGE MAST PASSIVE
ONR ROTOR-WING
WIND TUNNEL MODEL

356-0603

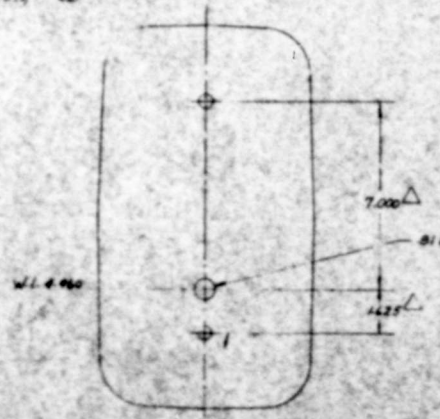


-9 EXTENSION
MAHOGANY

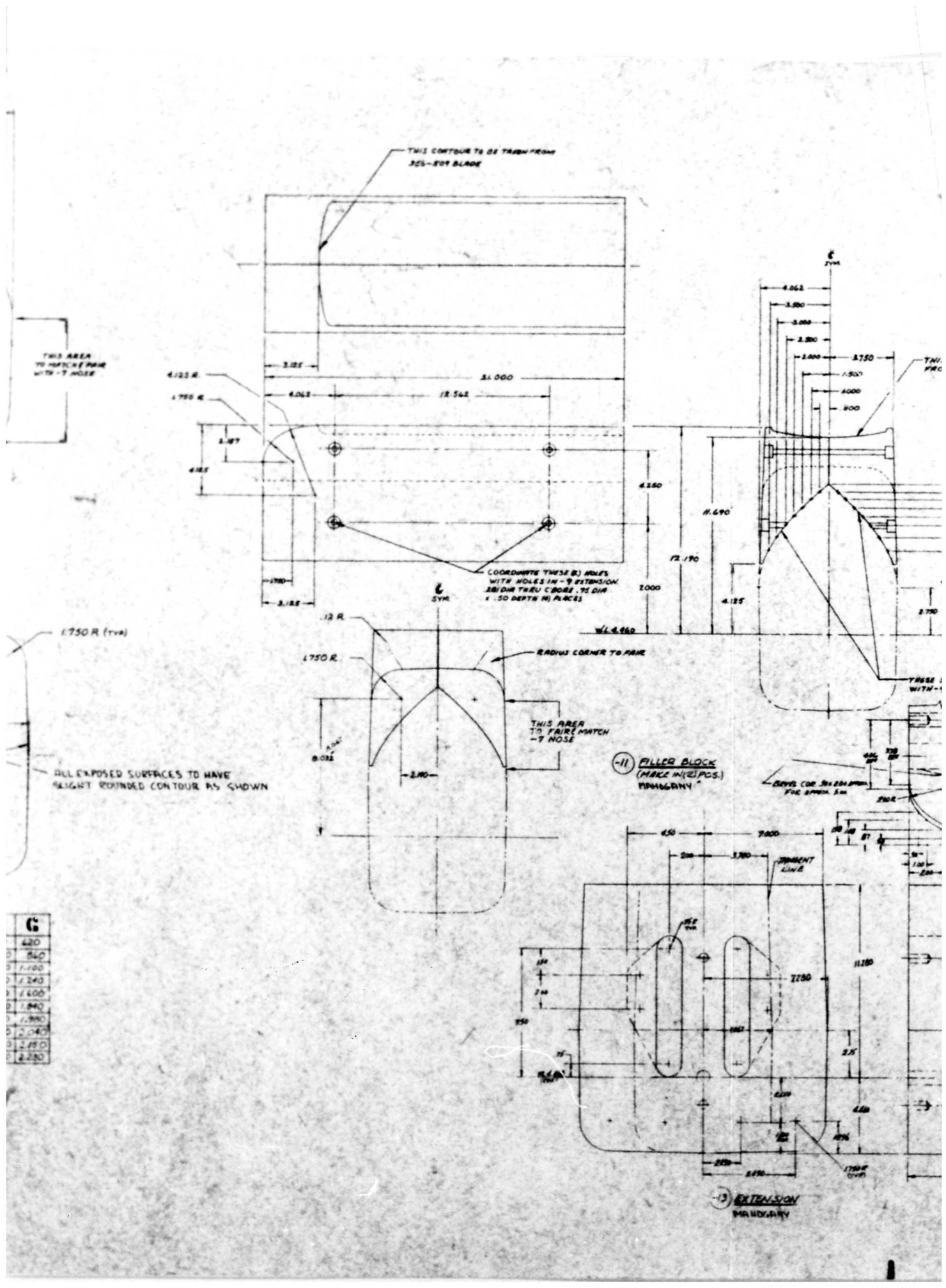




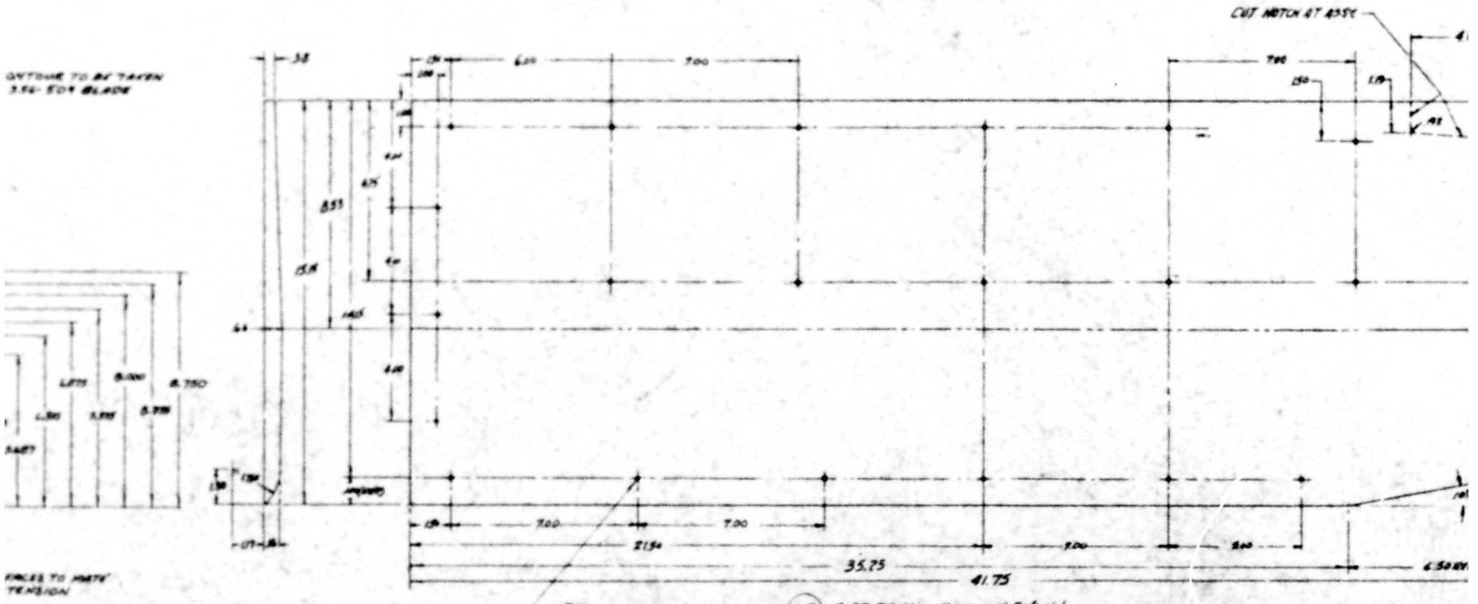
STA.	A	B	C	D	E	F	G
2.25	2.840	.800	.400	2.340	[illegible]	.470	.620
3.25	3.000	1.230	.840	2.820	2.780	1.000	.860
4.25	3.420	1.640	1.040	2.860	3.060	1.220	1.100
5.25	3.800	2.000	1.200	3.020	3.220	1.440	1.240
8.50	7.125	5.340	1.500	3.400	3.820	2.010	1.600
11.25	8.500	6.720	1.720	3.640	4.000	2.300	1.840
13.75	9.125	7.340	1.860	3.800	4.160	2.380	1.990
16.25	9.500	7.680	1.940	3.880	4.300	2.480	2.040
19.00	9.750	7.960	2.060	3.980	4.400	2.540	2.150
21.62	9.875	8.062	2.140	4.062	4.460	2.630	2.230



-7 NOSE
MAHOGANY

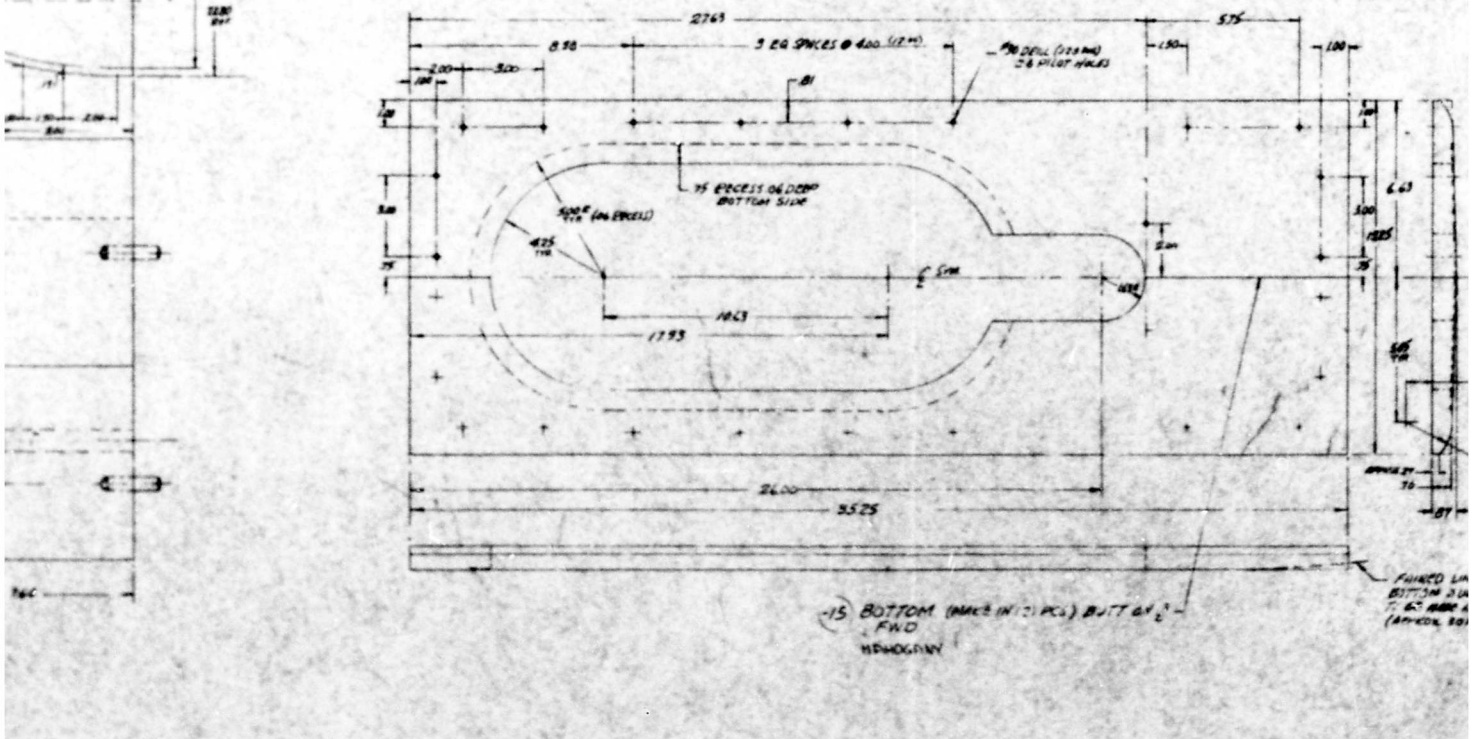


G
420
540
1.100
1.240
1.400
1.840
1.980
2.040
2.180
2.280

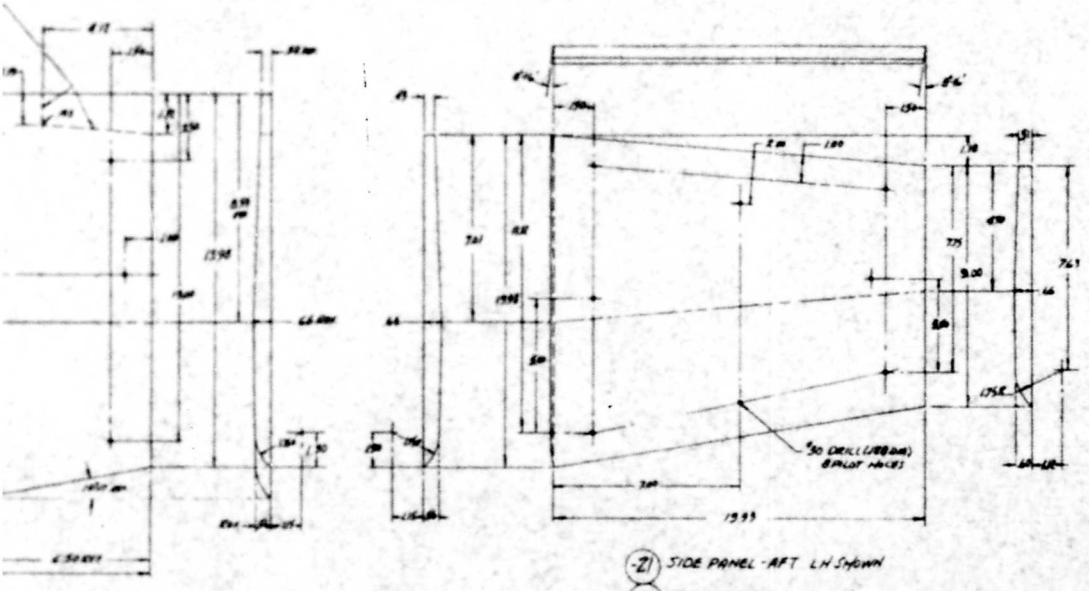


(-17) SIDE PANEL - FWD. LH SHOWN

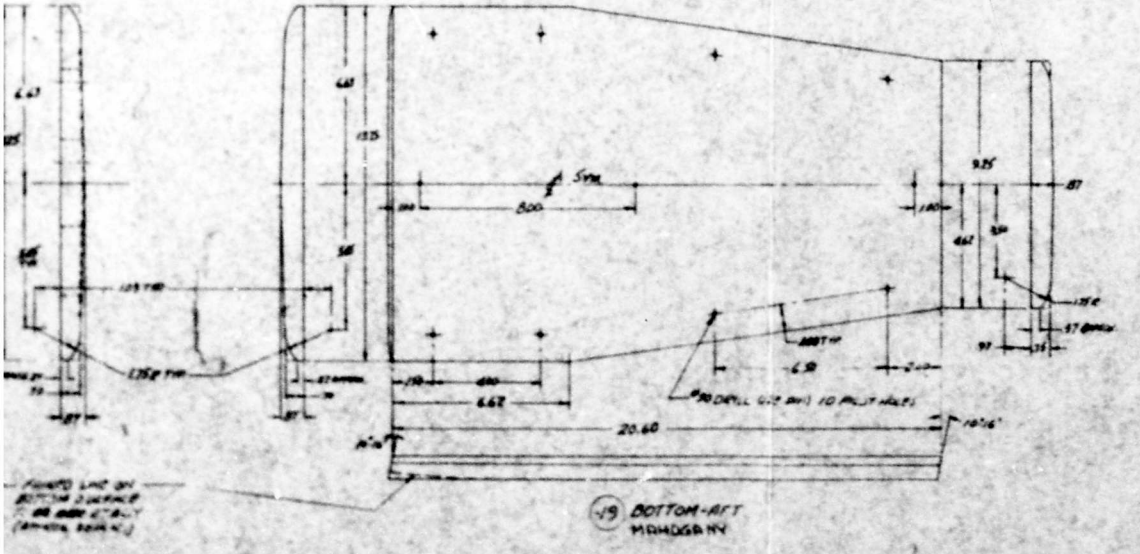
(-18) RH OPPOSITE
MAHOGANY



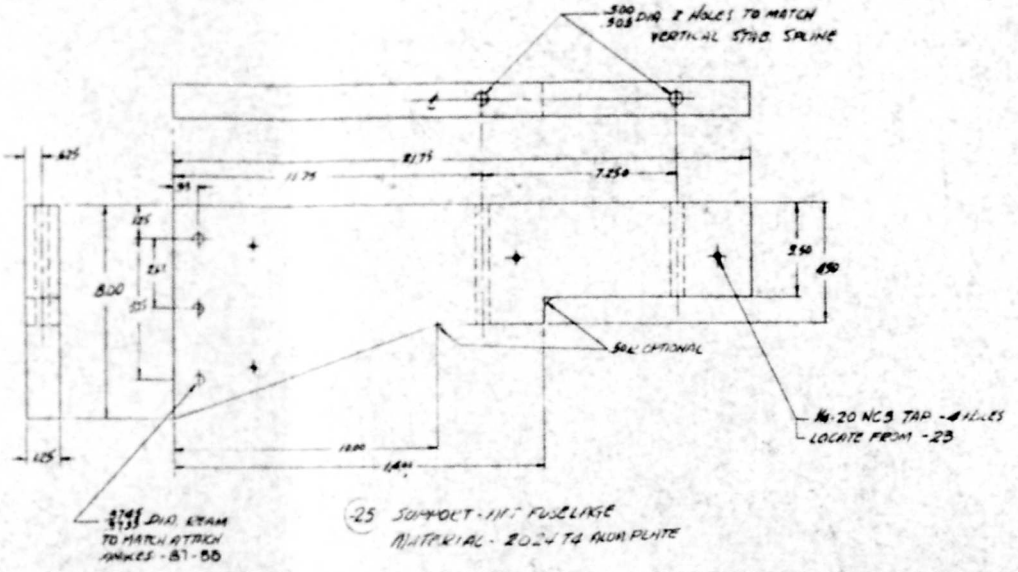
(-15) BOTTOM (MADE IN 2 PCS.) BUTT GLUED FWD
MAHOGANY



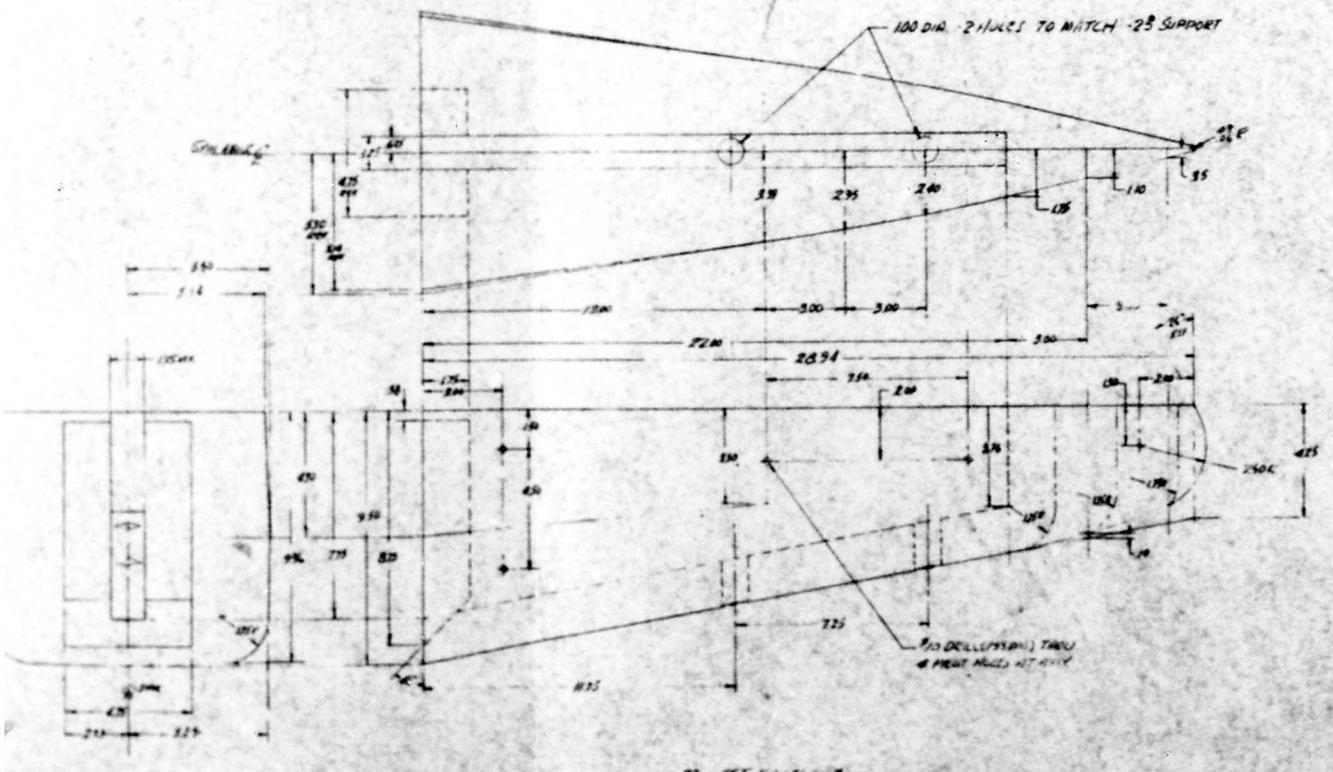
-21 SIDE PANEL - AFT LH SHOWN
-22 RH OPPOSITE
MAHOGANY



-19 BOTTOM - AFT
MAHOGANY



-25 SUPPORT - INT. FUSELAGE
MATERIAL - 2024 T4 ALUM. PLATE



-23 INT. FUSELAGE
MAHOGANY

REVISIONS					
ZONE	E.C.N.	DESCRIPTION	DRWN	APP'D	DATE

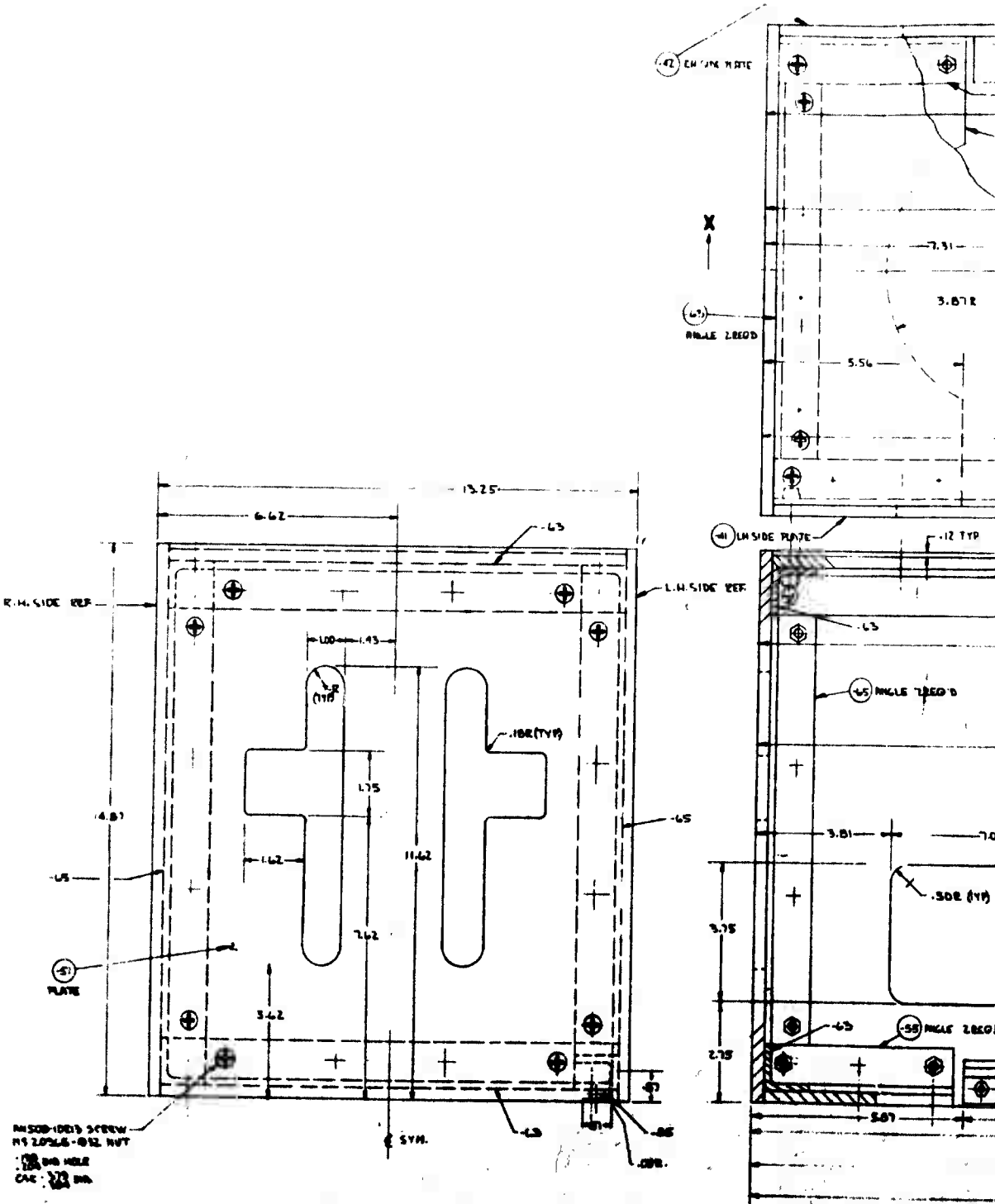
TRIP ANGLES
11 - 23

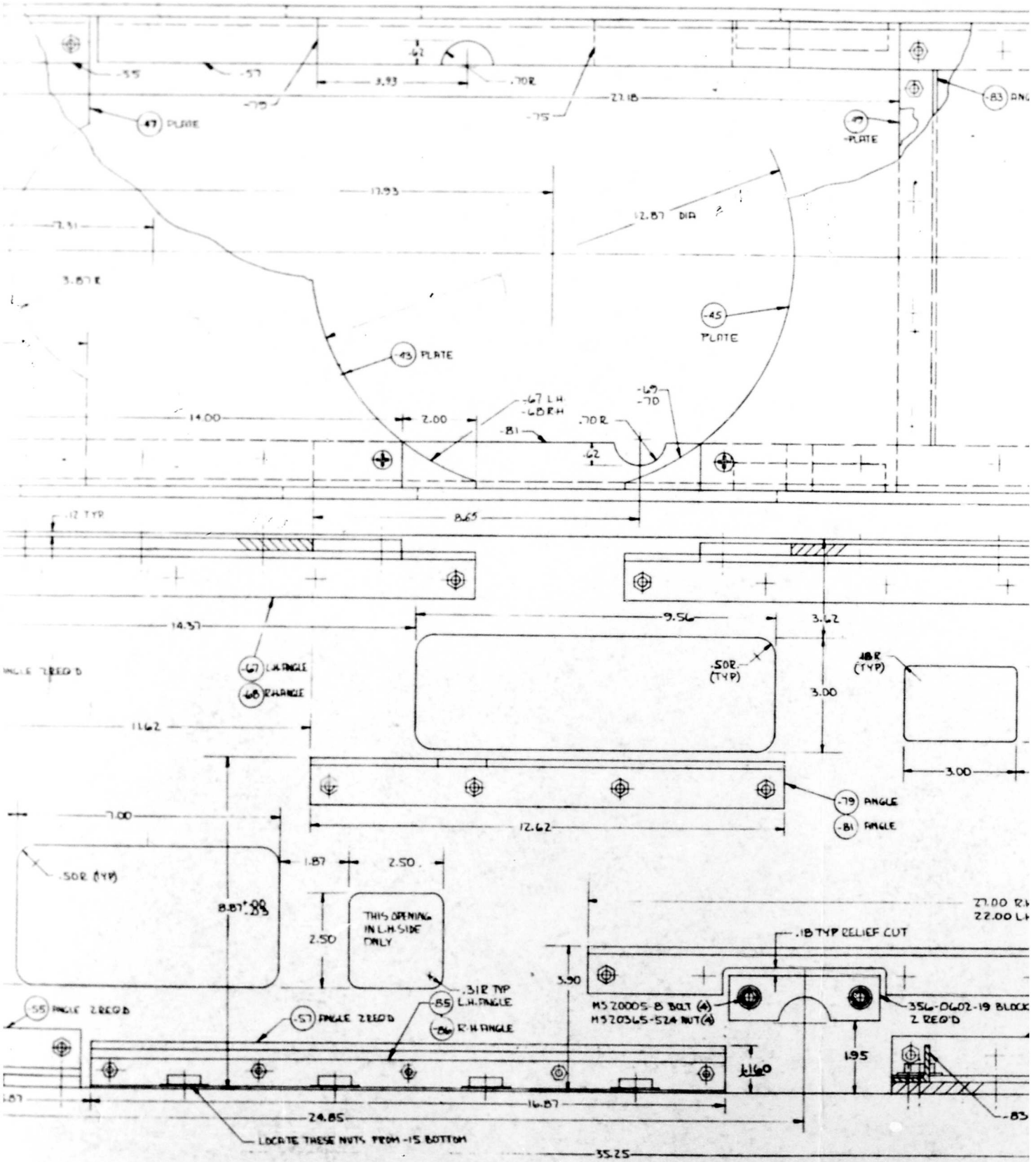
T SUPPORT

354-0700

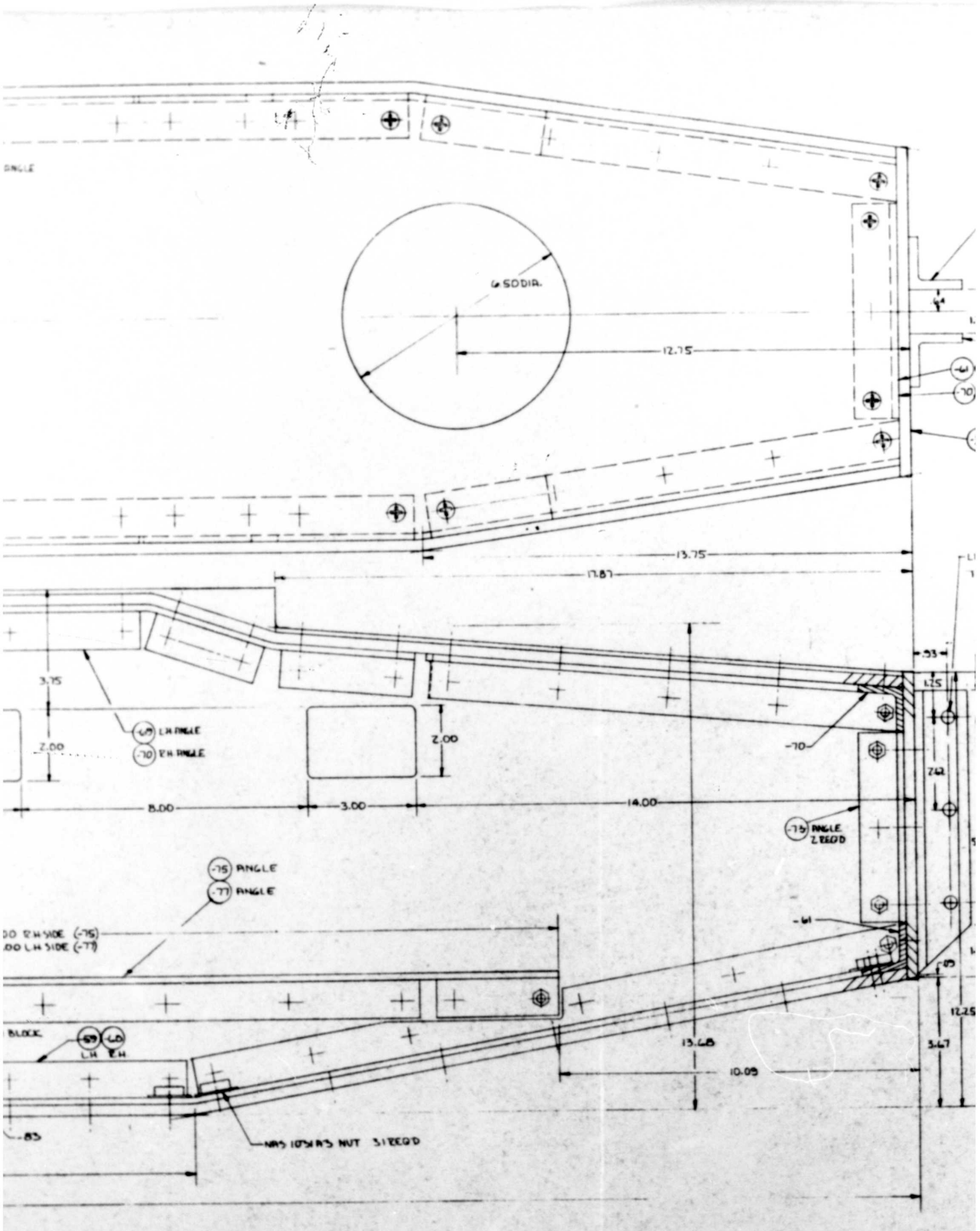
								FUSELAGE -	
								VARIATIONS WING	
								WIND TUNNEL MODEL	
NEXT ASSY	USED ON							SCALE	
APPLICATION		QTY REQD							

RSG-07000


13.25
6.62
.63
R.H. SIDE REF
L.H. SIDE REF
1.00
1.43
.18Ø (TYP)
1.75
11.62
7.62
1.62
3.62
4.81
.65
.45
PLATE
SYM.
.12 TYP
LH SIDE PLATE
ANGLE 2 REQ'D
7.31
3.87 R
5.56
3.81
.50Ø (TYP)
3.75
2.75
5.87


-55
-57
-75
.62
3.93
.70R
27.18
-83 ANG
-47 PLATE
-47 PLATE
13.93
12.87 DIA
7.31
3.87 R
-45 PLATE
-43 PLATE
-67 L.H.
-68 R.H.
-69
-70
14.00
2.00
-81
.70R
.62
.12 TYP
8.65
14.37
9.56
3.62
-67 L.H. ANGLE
-68 R.H. ANGLE
.50R (TYP)
.188 (TYP)
3.00
11.62
3.00
-79 ANGLE
-81 ANGLE
12.62
7.00
.50R (TYP)
1.87
2.50
8.87 +.00 -.05
2.50
THIS OPENING IN L.H. SIDE ONLY
27.00 R.H.
22.00 L.H.
.18 TYP RELIEF CUT
3.90
.312 TYP
-85 L.H. ANGLE
-86 R.H. ANGLE
MS20005-8 BOLT (4)
MS20365-524 NUT(4)
356-0602-19 BLOCK
2 REQ'D
-55 ANGLE 2 REQ'D
-57 ANGLE 2 REQ'D
1.160
1.95
1.87
16.87
24.85
LOCATE THESE NUTS FROM -15 BOTTOM
-83
35.25
55.50

SECTION X-X


6.500 DIA.
12.75
13.75
17.87
3.75
2.00
2.00
-69 LH ANGLE
-70 RH ANGLE
8.00
3.00
14.00
-70
-75 ANGLE
-75 ANGLE
-77 ANGLE
-61
.93
1.25
7.62
12.25
3.67
13.68
10.09
-69
-70
LH
RH
NAS 1054A3 NUT 31 REQD

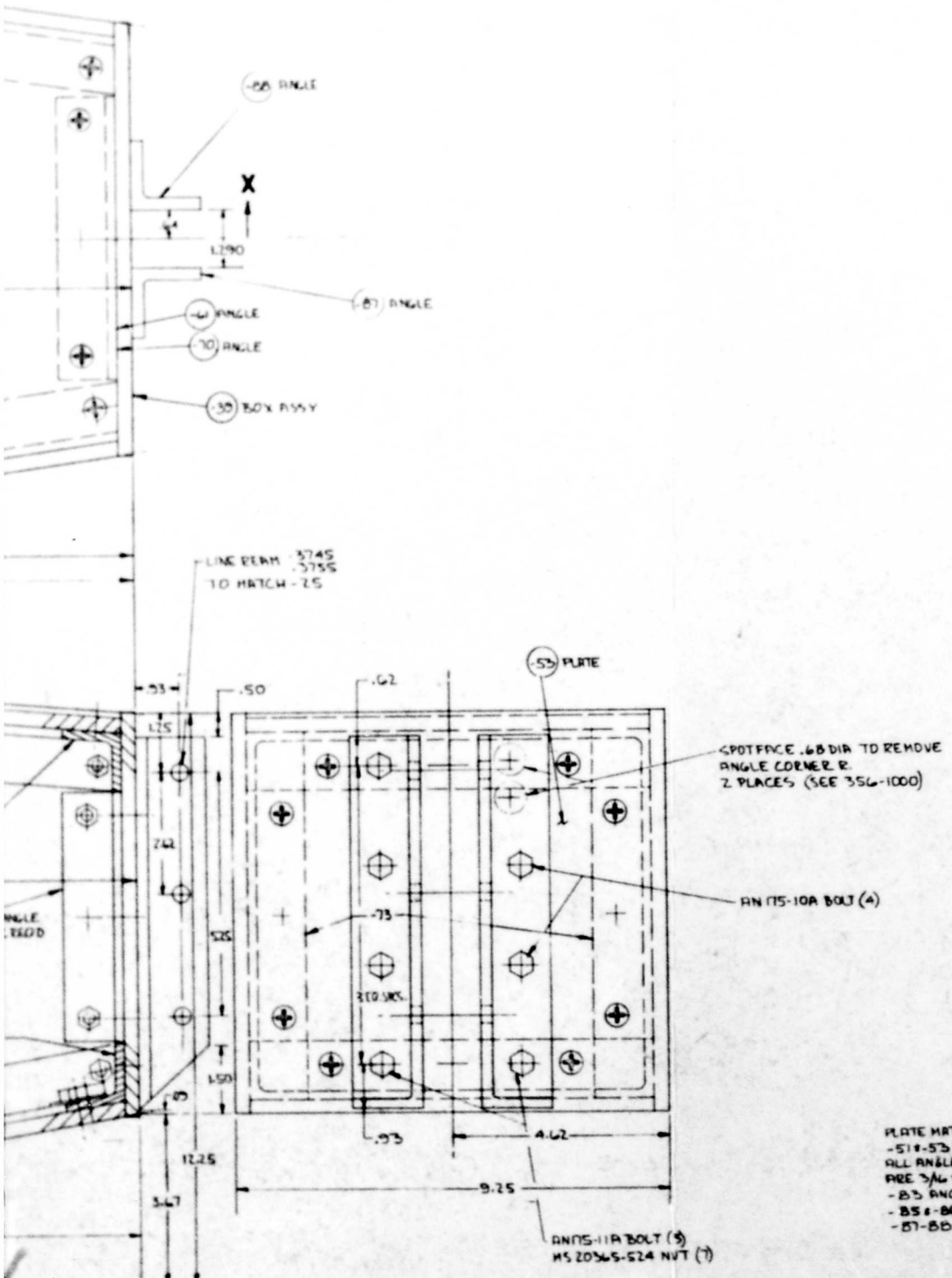


PLATE MAT (EXCEPT -51-53) 5/16 2024-T4.
-51-53 PLATE 5/16 2024-T4.
ALL ANGLES (EXCEPT -83-85-86-87-88)
ARE 3/16 x 1 1/4 x 1 1/4 2024-T4.
-83 ANGLE IS 1/8 x 1 x 1 2024-T4.
-85-86 ANGLE MADE OF .06 2024-0. HT TO T4.
-87-88 ANGLE: 1/4 x 1 1/2 x 1 1/2. 2024-T4

REVISIONS						
SYM	E.O.'S	DESCRIPTION	DRWN	APP'D	DATE	ZONE

-87 ANGLE

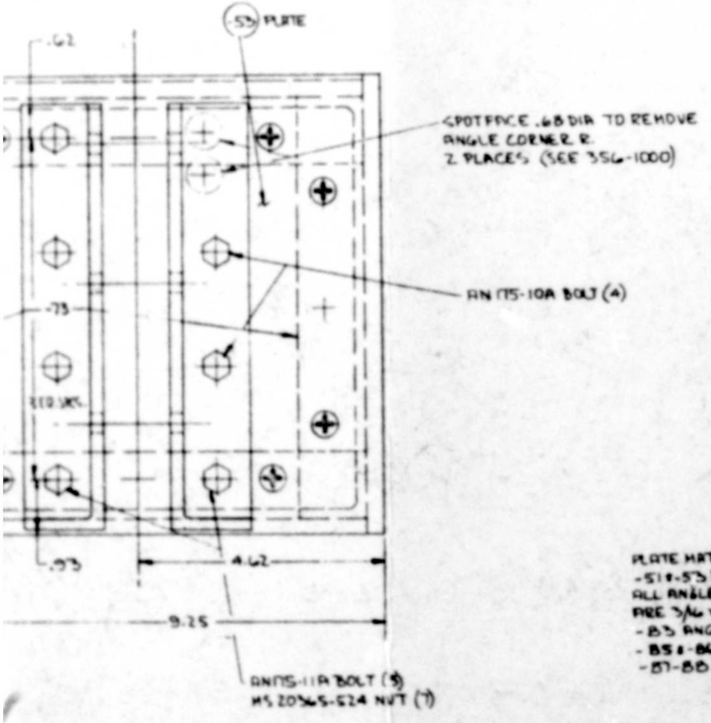


PLATE MAT (EXCEPT -51-53) 3/16 2024-T4.
-51 & -53 PLATE 5/16 2024-T4.
ALL ANGLES (EXCEPT -83-85-86-87-88)
ARE 3/16 x 1 1/4 x 1 1/4 2024-T4.
-83 ANGLE IS 1/8 x 1 x 1 2024-T4.
-85 & -86 ANGLE MADE OF .06 2024-0. HT TO T4.
-87-88 ANGLE: 1/4 x 1 1/2 x 1 1/2 . 2024-T4

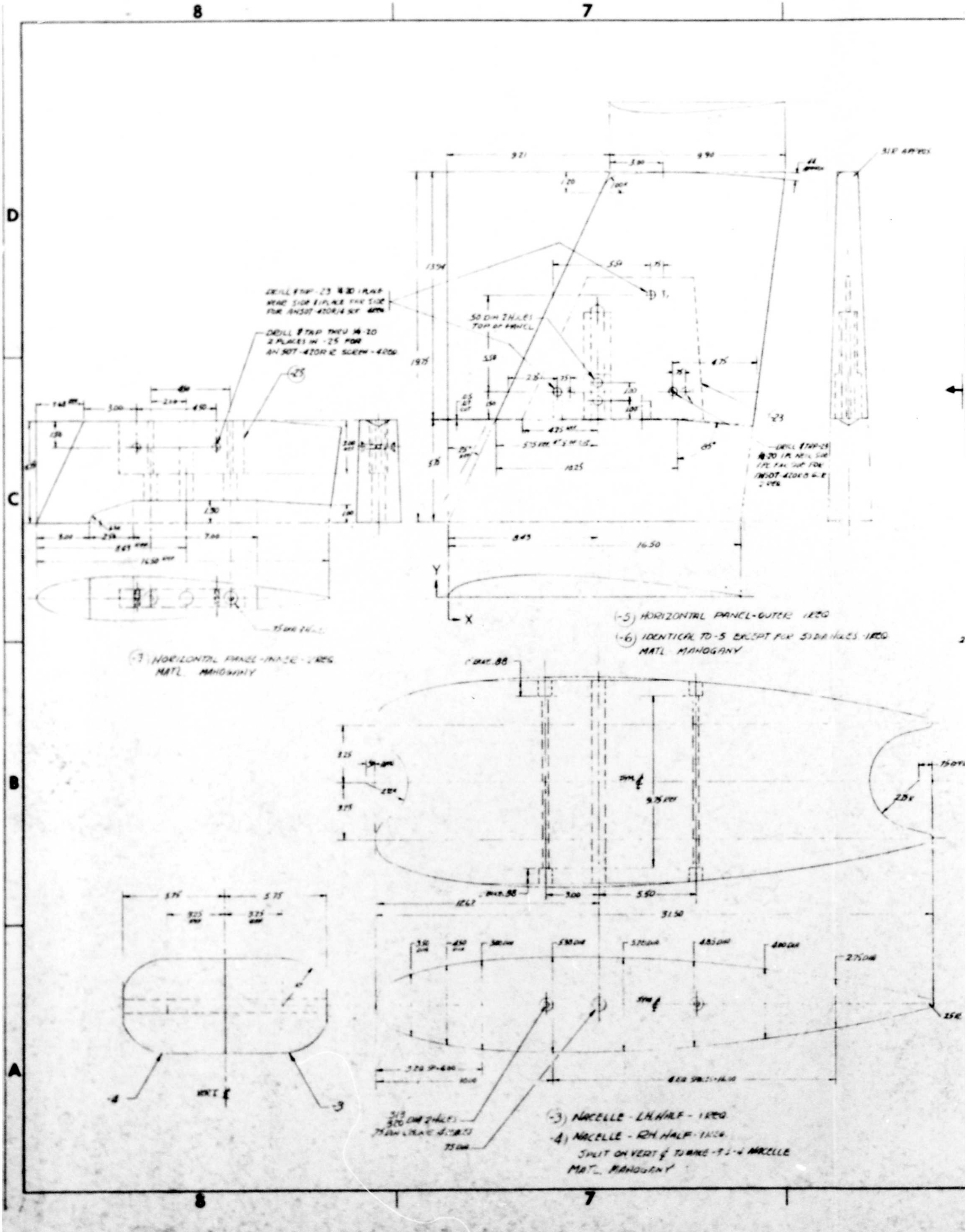
356-0700

FUSELAGE -
ONR ROTOR-WING
WIND TUNNEL MODEL

356-0700

APPLICATION

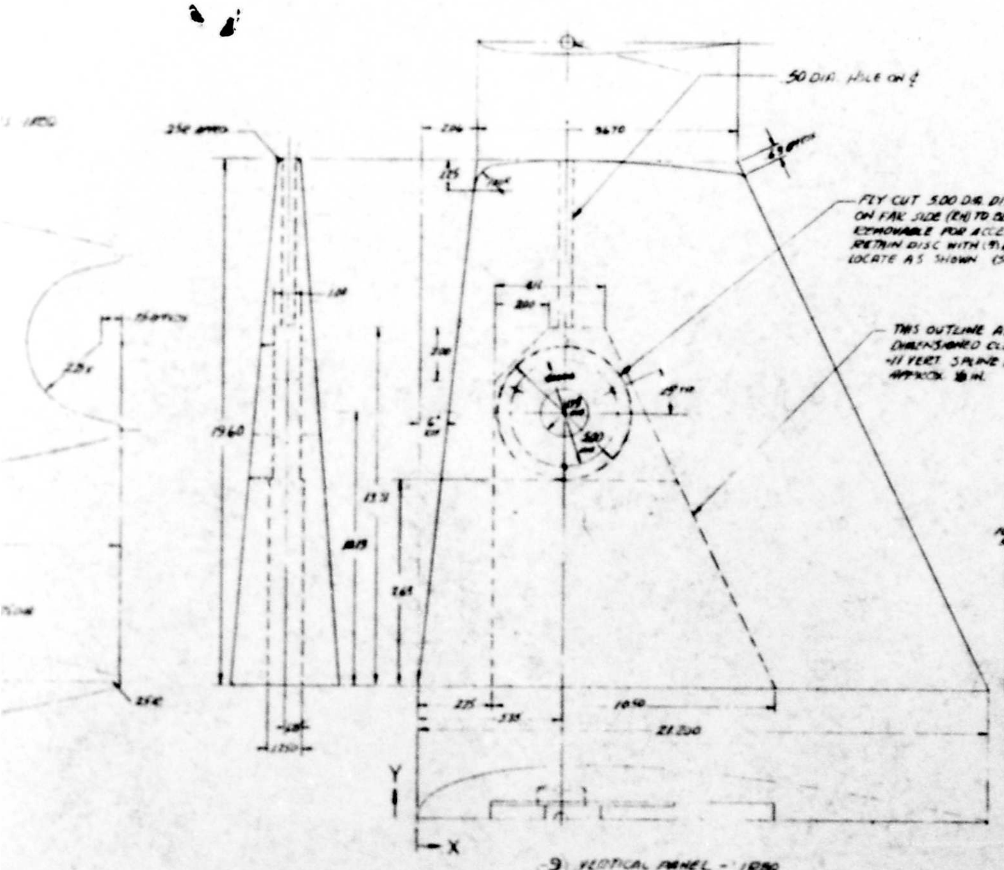
SCALE 1/1


(-3) HORIZONTAL PANEL-INBOARD-1REQ
MATL MAHOGANY
(-5) HORIZONTAL PANEL-OUTER 1REQ
(-6) IDENTICAL TO -5 EXCEPT FOR .50 DIA HOLES 1REQ
MATL MAHOGANY
DRILL & TAP THRU ¼-20
2 PLACES IN -25 FOR
AN 507-420R12 SCREW-4REQ
.50 DIA 2 HOLES
TOP OF PANEL
(-3) NACELLE - LH HALF - 1REQ
(-4) NACELLE - RH HALF - 1REQ
SPLIT ON VERT ℄ TO MAKE -3 & -4 NACELLE
MAT'L MAHOGANY
VERT ℄
.75 DIA

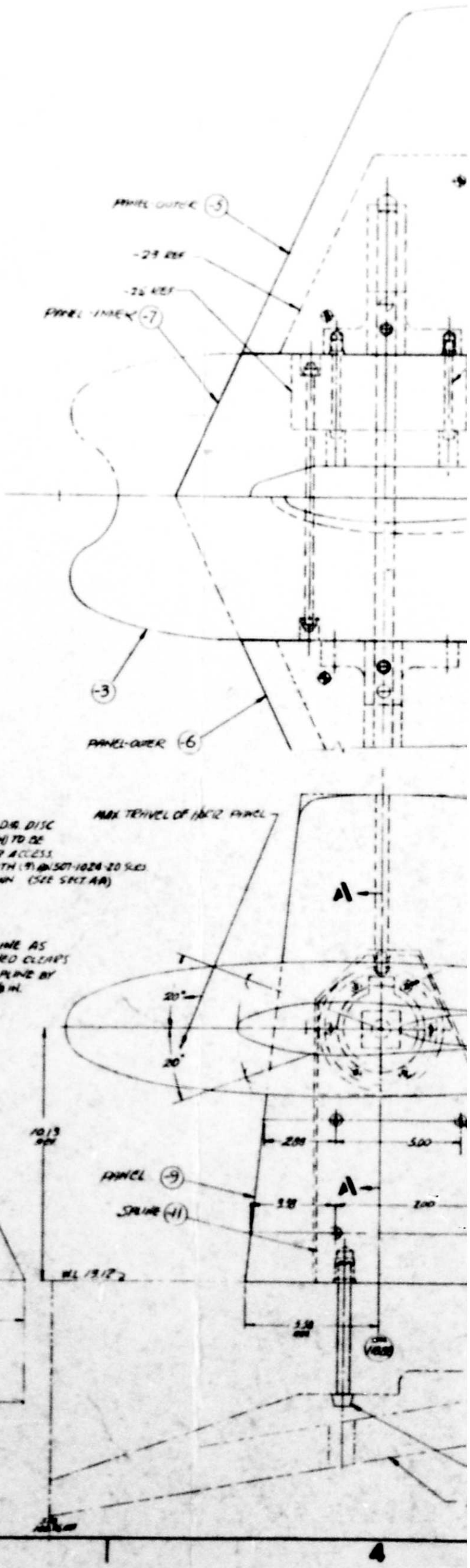
ORDINANCES

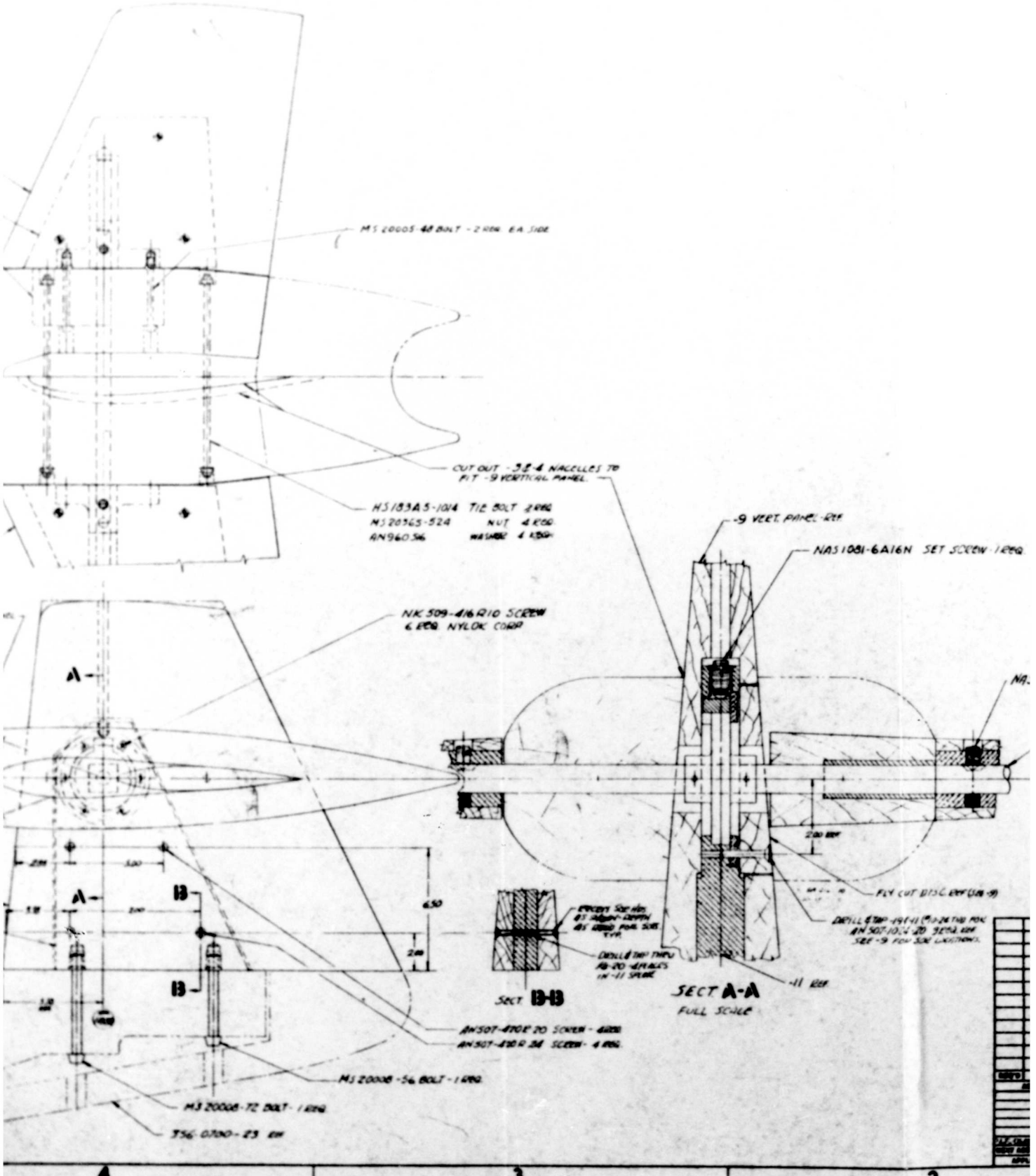
% chord	HORIZONTAL SURFACE ROOT C-16.50 NACA 0015 X	Y	TIP C-9.90 NACA 0012 X	Y
0	0	0	0	0
1.25	.206	[illegible]	.124	.197
2.5	.412	.539	.247	.268
5	.825	.734	.495	.351
7.5	1.238	.868	.742	.414
10	1.650	.962	.990	.463
15	2.475	1.109	1.485	.529
20	3.300	1.183	1.980	.565
25	4.125	1.227	2.475	.599
30	4.950	1.238	2.970	.594
40	6.600	1.196	3.960	.576
50	8.250	1.097	4.950	.524
60	9.900	.941	5.940	.451
70	11.550	.752	6.930	.365
80	13.200	.542	7.920	.262
90	14.850	.298	8.910	.144
95	15.675	.165	9.405	.079
100	16.500	.025	9.900	.013
	L.E.R.	.245	L.E.R.	.117

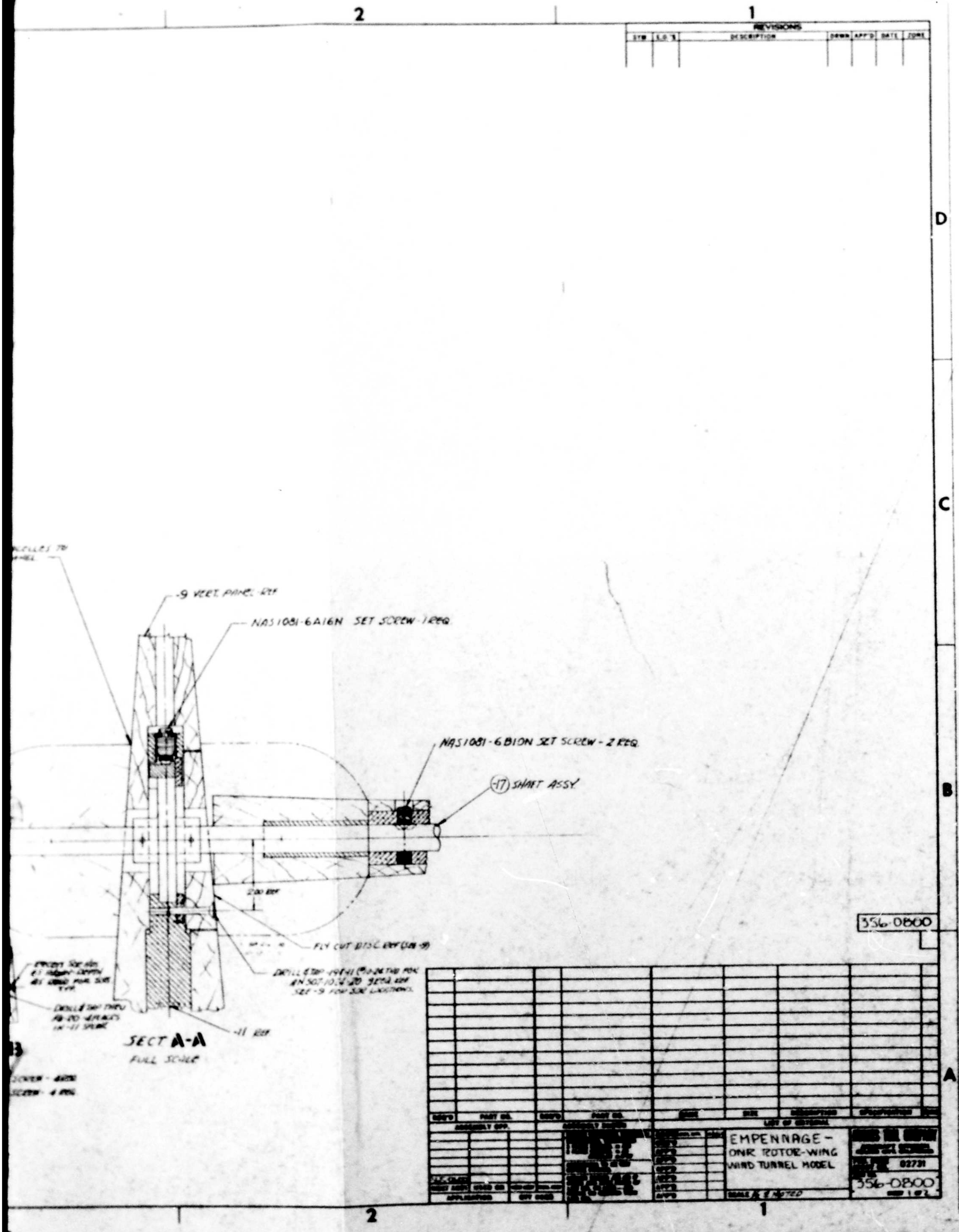
% chord	VERTICAL SURFACE ROOT C-21.20 NACA 0019 X	Y	TIP C-9.670 NACA 0009 X	Y
0	0	0	0	0
1.25	.265	.656	.121	.137
2.50	.530	.877	.242	.190
5	1.060	1.195	.484	.258
7.5	1.590	1.410	.725	.305
10	2.120	1.571	.967	.339
15	3.180	1.785	1.451	.388
20	4.240	1.924	1.934	.416
25	5.300	1.996	2.418	.431
30	6.360	2.016	2.901	.435
40	8.480	1.947	3.868	.421
50	10.600	1.777	4.835	.384
60	12.720	1.541	5.802	.331
70	14.840	1.251	6.769	.266
80	16.960	.882	7.736	.190
90	19.080	.498	8.703	.105
95	20.140	.269	9.187	.058
100	21.200	.045	9.670	.010
	L.E.R.	.598	L.E.R.	.086

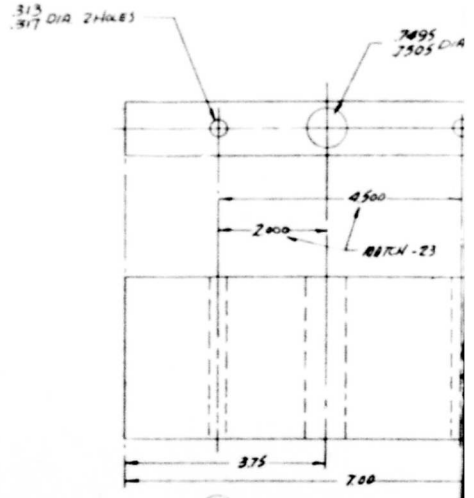


-9 VERTICAL PANEL - 1 REQ
MATL - MAHOGANY

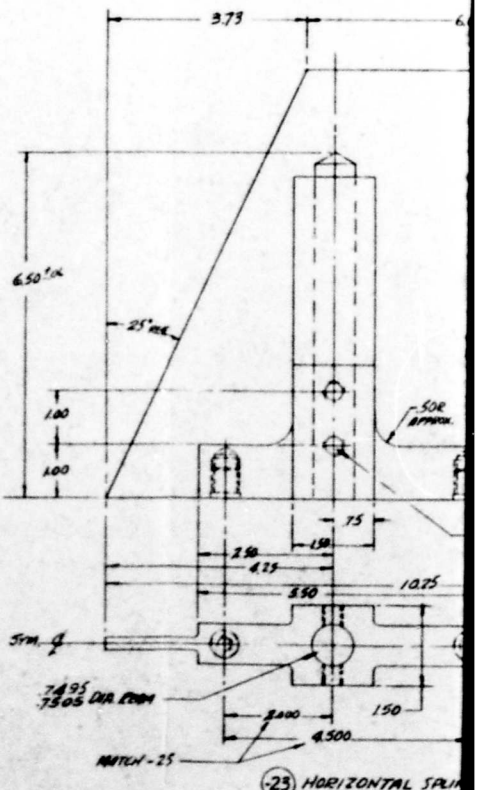



MS 20005-48 BOLT - 2 REQ. EA SIDE
CUT OUT - 3E-4 NACELLES TO FIT -9 VERTICAL PANEL
MS 183A5-1014 TIE BOLT 2 REQ
MS 20365-524 NUT 4 REQ
AN 960-516 WASHER 4 REQ
-9 VERT. PANEL REF
NAS 1081-6A16N SET SCREW - 1 REQ
NK 509-416 R10 SCREW 6 REQ NYLOC COMP
A
B
B
SECT B-B
SECT A-A
FULL SCALE
AN 507-410 R 20 SCREW - 4 REQ
AN 507-410 R 36 SCREW - 4 REQ
MS 20006-56 BOLT - 1 REQ
MS 20006-72 BOLT - 1 REQ
356-0700-23 EA

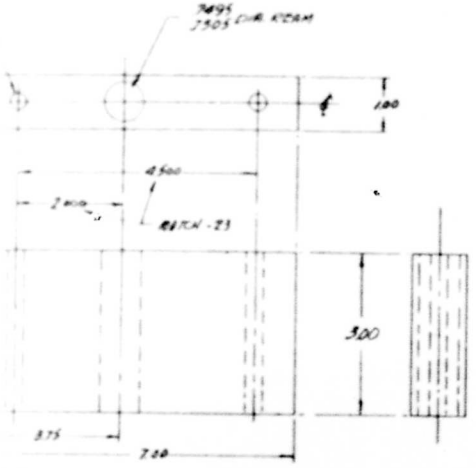

REVISIONS
-9 VERT. PANEL-REF
NAS1081-6A16N SET SCREW-1 REQ
NAS1081-6B10N SET SCREW-2 REQ.
(-17) SHAFT ASSY.
FLY CUT DISC REF
-11 REF
SECT A-A
FULL SCALE
356-0800
EMPENNAGE-
ONR ROTOR-WING
WIND TUNNEL MODEL
02731
356-0800



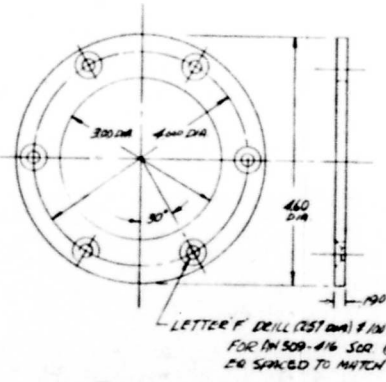
-25 HORIZ. SPLINE-INNER
MATL. 2024 T4 ALUM PLATE



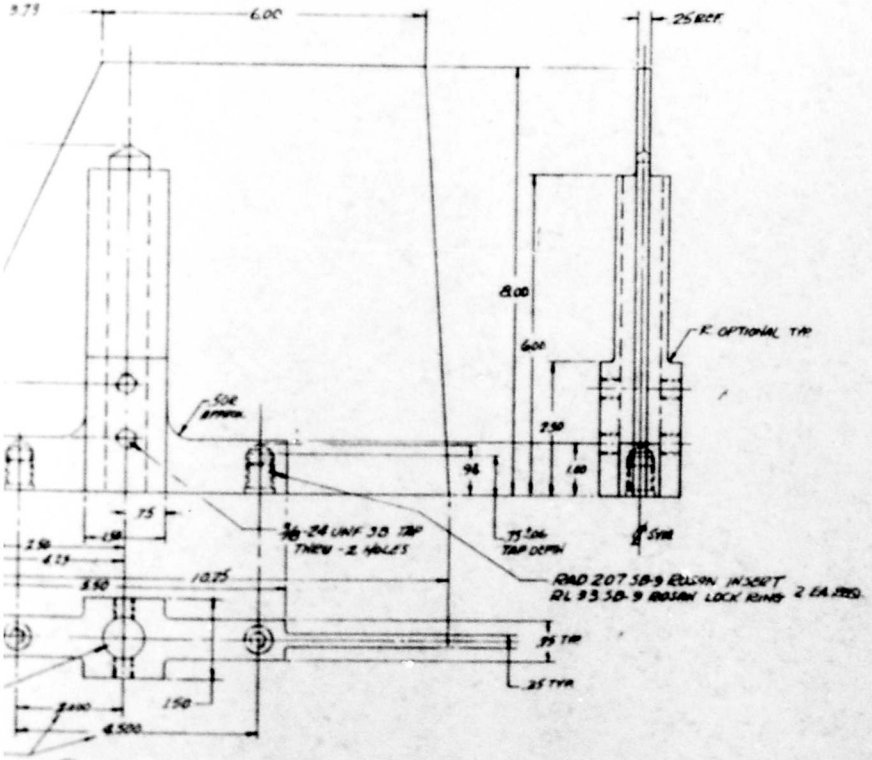
-23 HORIZONTAL SPLI
MATL - 2024 T4 AL



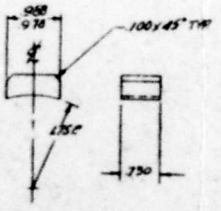
(25) HORIZ SPLINE-INNER 2 REQ.
MAT'L 2024 T4 ALUM PLATE



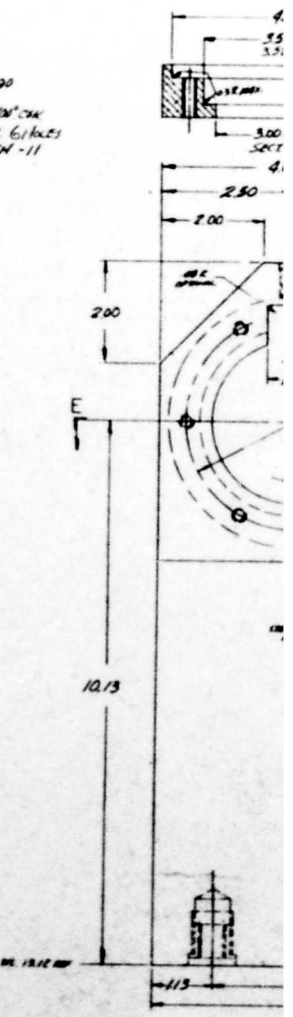
(-19) RETAINER 1 REQ.
MAT'L - 190 TH. 2024-T3 ALUM. SHT

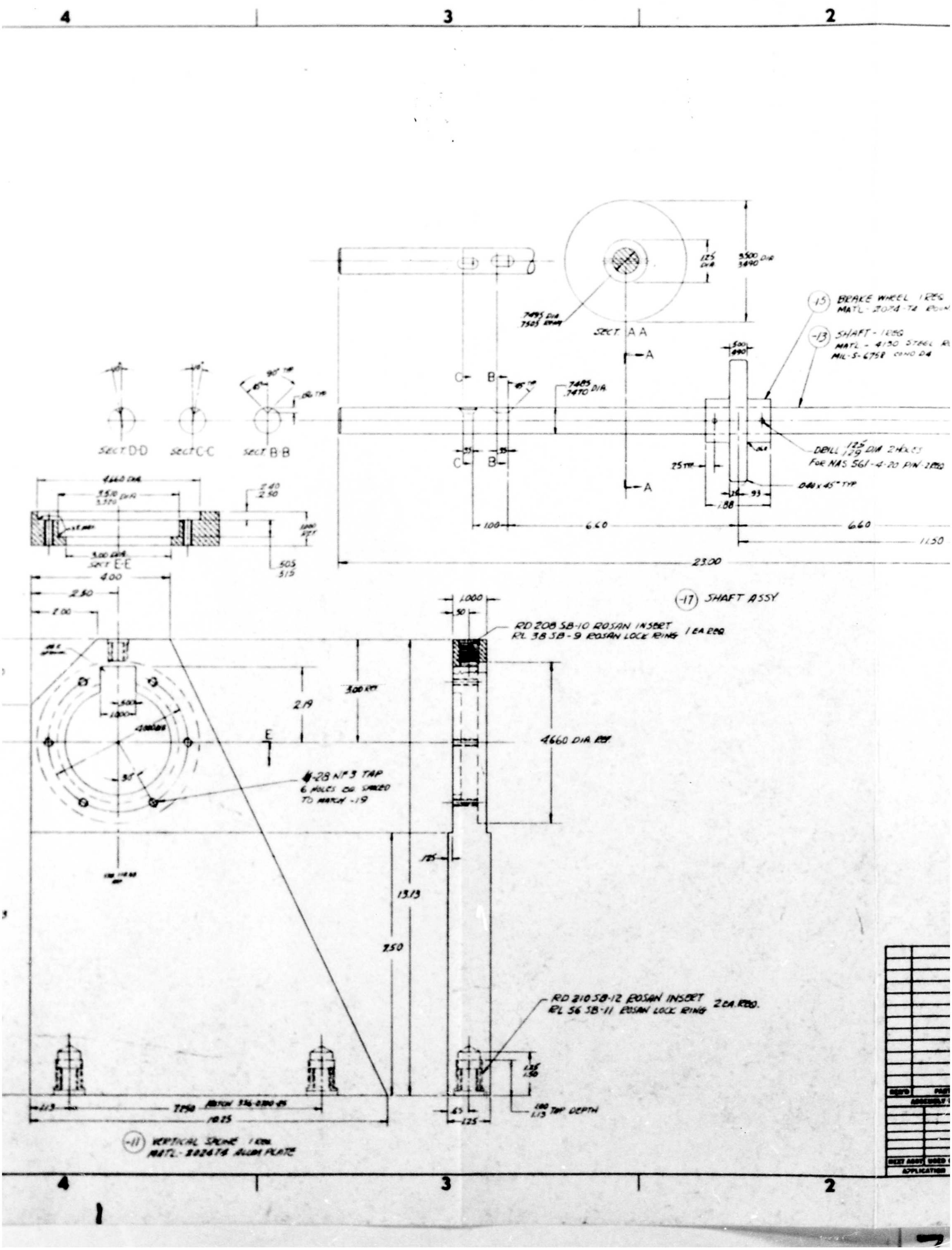


(-23) HORIZONTAL SPLINE 2 REQ.
MAT'L - 2024 T4 ALUM PLATE

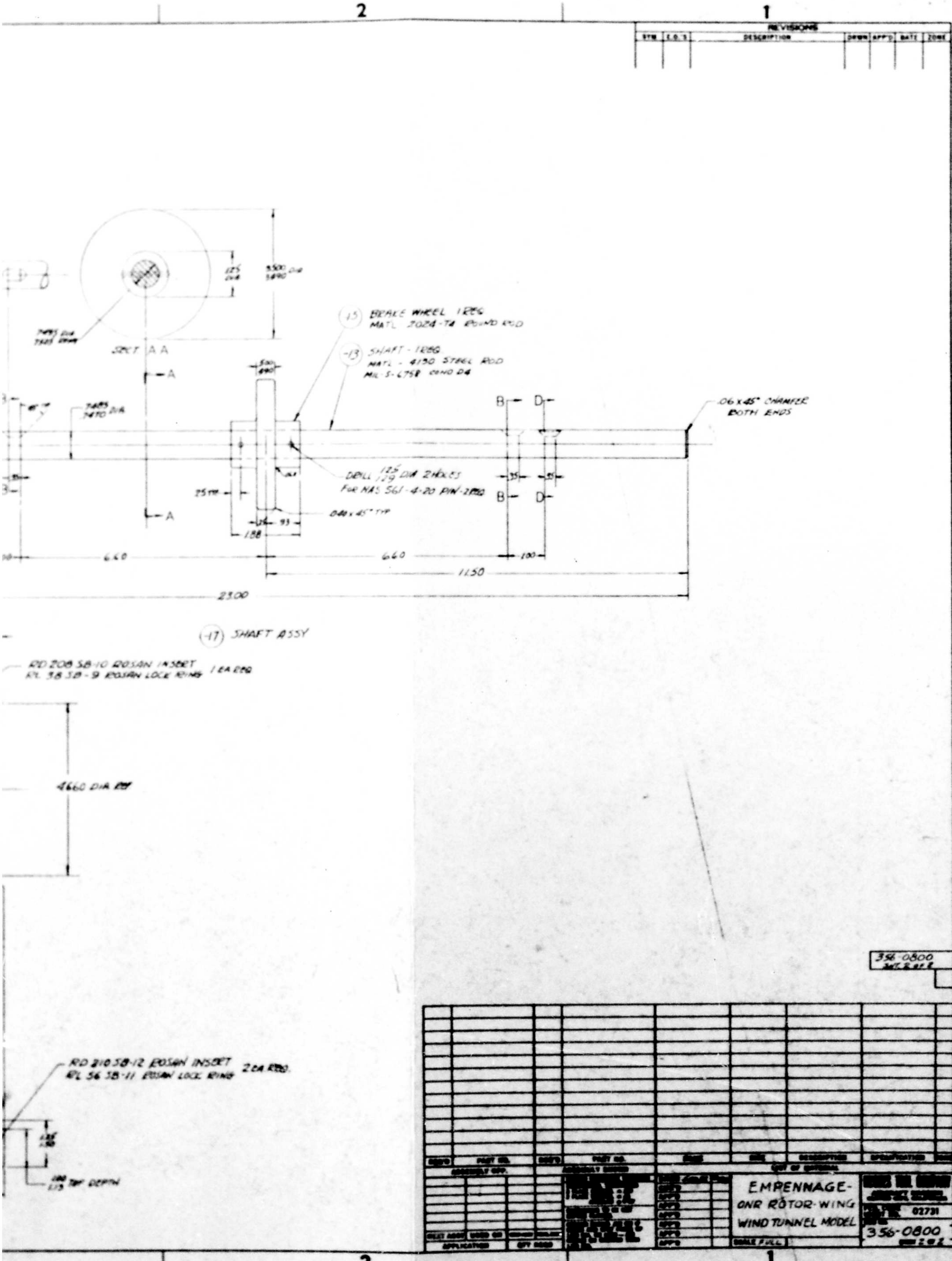


(-21) DEPTH BLOCK 1 REQ.
MAT'L - 4130 OR 1025 STEEL BAR

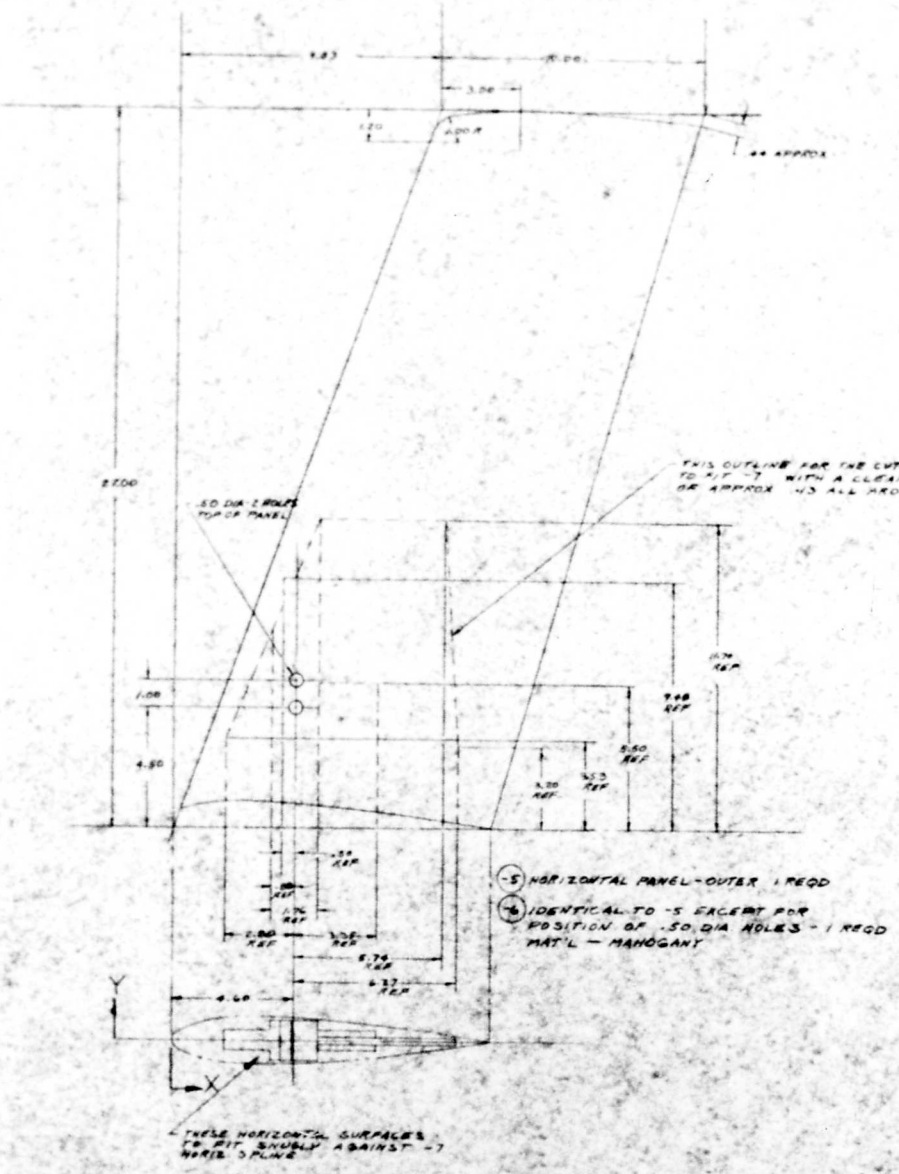




SECT. A A
(-15) BRAKE WHEEL 1 REQ
MATL - 2024-T4
(-13) SHAFT - 1 REQ
MATL - 4130 STEEL
MIL-S-6758 COND D4
DRILL .125/.129 DIA 2 HOLES
FOR NAS 561-4-20 PIN
.040 x 45° TYP
SECT. D-D
SECT. C-C
SECT. B-B
SECT. E-E
4.660 DIA
3.510 DIA
3.00 DIA
(-17) SHAFT ASSY
23.00
6.60
11.50
RD 208 SB-10 ROSAN INSERT
RL 38 SB-9 ROSAN LOCK RING 1 EA REQ
4660 DIA REF
#-28 NF 3 TAP
6 HOLES EQ SPACED
TO MATCH -19
RD 210 SB-12 ROSAN INSERT
RL 56 SB-11 ROSAN LOCK RING 2 EA REQ.
TAP DEPTH
10.25
(-11) VERTICAL SPINE 1 REQ
MATL - 2024T4 ALUM PLATE



2
1
REVISIONS
SYM
DESCRIPTION
DRWN
APP'D
DATE
ZONE
D
C
B
A
SECT A A
(15) BRAKE WHEEL 1 REQ
MATL 2024-T4 ROUND ROD
(13) SHAFT - 1 REQ
MATL - 4130 STEEL ROD
MIL-S-6758 COND D4
.06 x 45° CHAMFER
BOTH ENDS
DRILL .125/.129 DIA 2 HOLES
FOR NAS 561-4-20 PIN - 2 REQ
.040 x 45° TYP
.188
6.60
6.60
11.50
23.00
(17) SHAFT ASSY
RD 208 SB-10 ROSAN INSERT
RL 38 SB-9 ROSAN LOCK RING 1 EA REQ
4.660 DIA REF
RD 210 SB-12 ROSAN INSERT
RL 56 SB-11 ROSAN LOCK RING 2 EA REQ
356-0800
EMPENNAGE-
ONR ROTOR-WING
WIND TUNNEL MODEL
02731
SCALE FULL


.50 DIA 2 HOLES TOP OF PANEL
THIS OUTLINE FOR THE CUT OUT TO FIT -7 WITH A CLEARANCE OF APPROX .43 ALL AROUND
-5 HORIZONTAL PANEL - OUTER 1 REQD
-6 IDENTICAL TO -5 EXCEPT FOR POSITION OF .50 DIA HOLES - 1 REQD
MAT'L - MAHOGANY
THESE HORIZONTAL SURFACES TO FIT SNUGLY AGAINST -7 HORIZ SPLINE
.50 DIA HOLE
-13 DISC
25.00
-3 VERTICAL

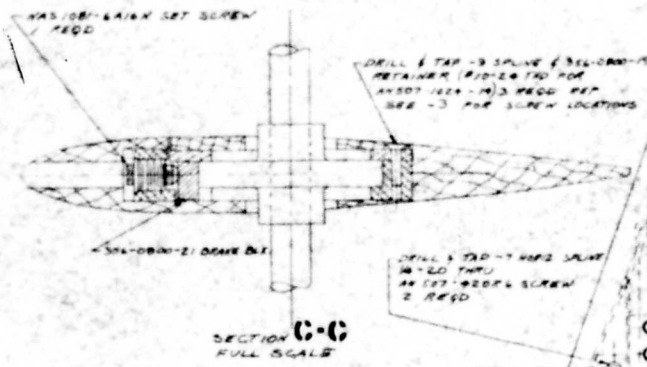
ORDINATES

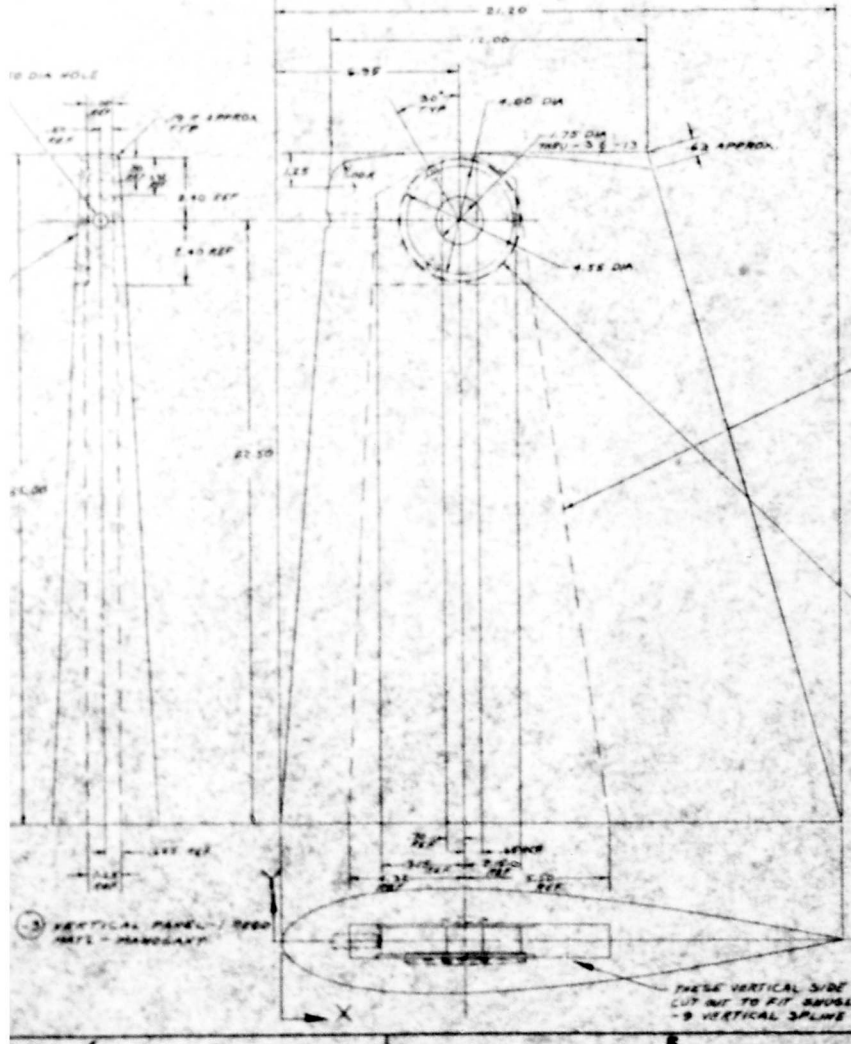
HORIZONTAL SURFACE

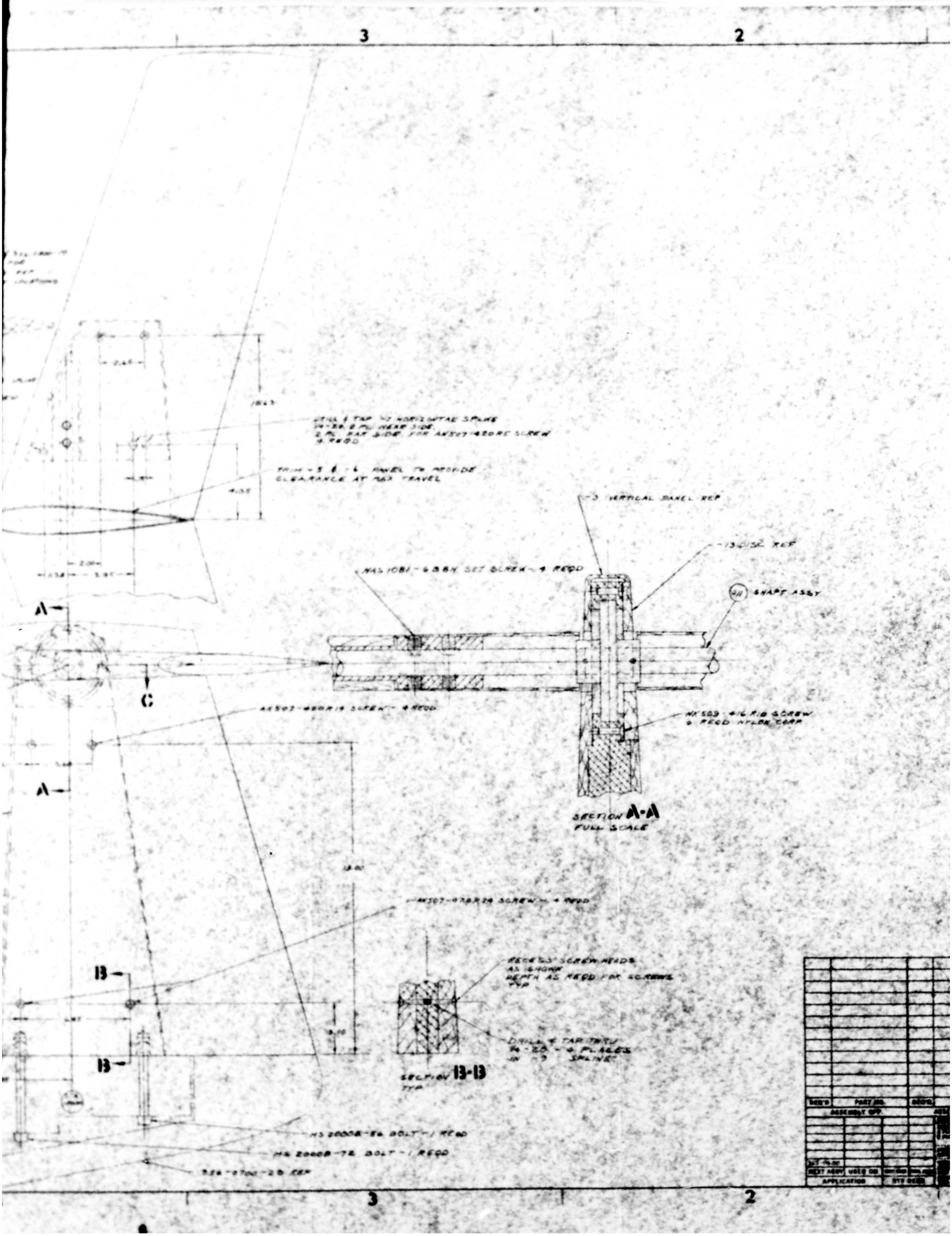
	X	Y	X	Y

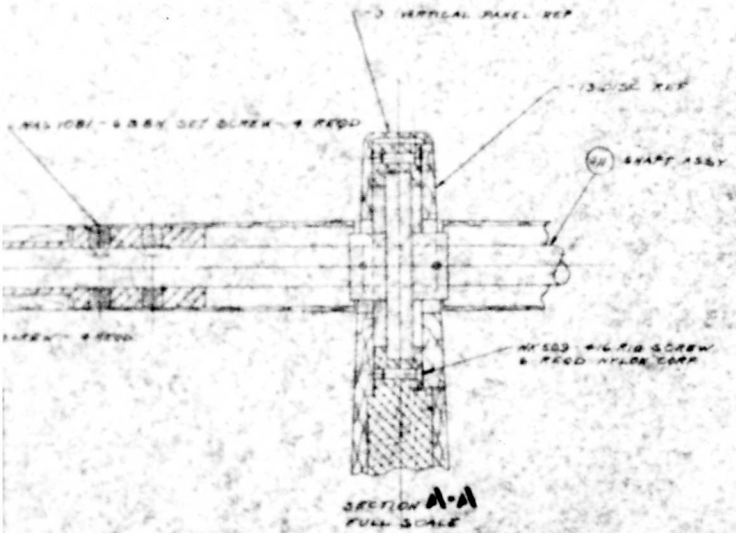
VERTICAL SURFACE

	X	Y	X	Y






3
2
TRIM -5 & -6 PANEL TO PROVIDE CLEARANCE AT MAX TRAVEL
-3 VERTICAL PANEL REF
-13 DISC REF
NAS 1081-6 SET SCREW - 4 REQD
SHAFT ASSY
AN507-420R14 SCREW - 4 REQD
SECTION A-A
FULL SCALE
RECESS SCREW HEADS AS SHOWN
DEPTH AS REQD FOR SCREWS
TYP
SECTION B-B
TYP
MS 20008-56 BOLT - 1 REQD
MS 20008-72 BOLT - 1 REQD
A
C
B
ASSEMBLY OPP
APPLICATION
3
2

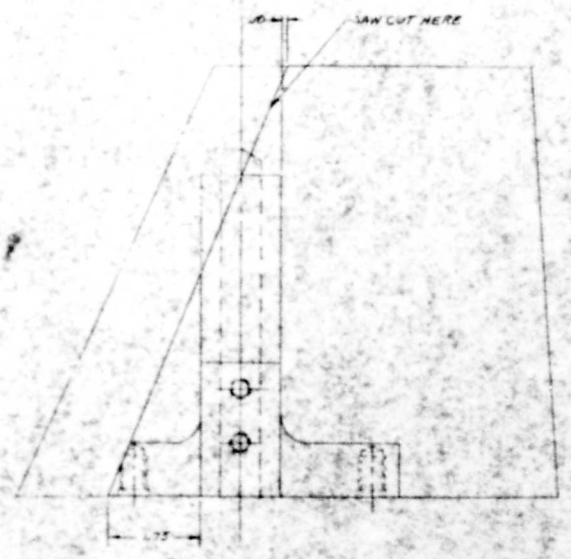


SECTION A-A
FULL SCALE

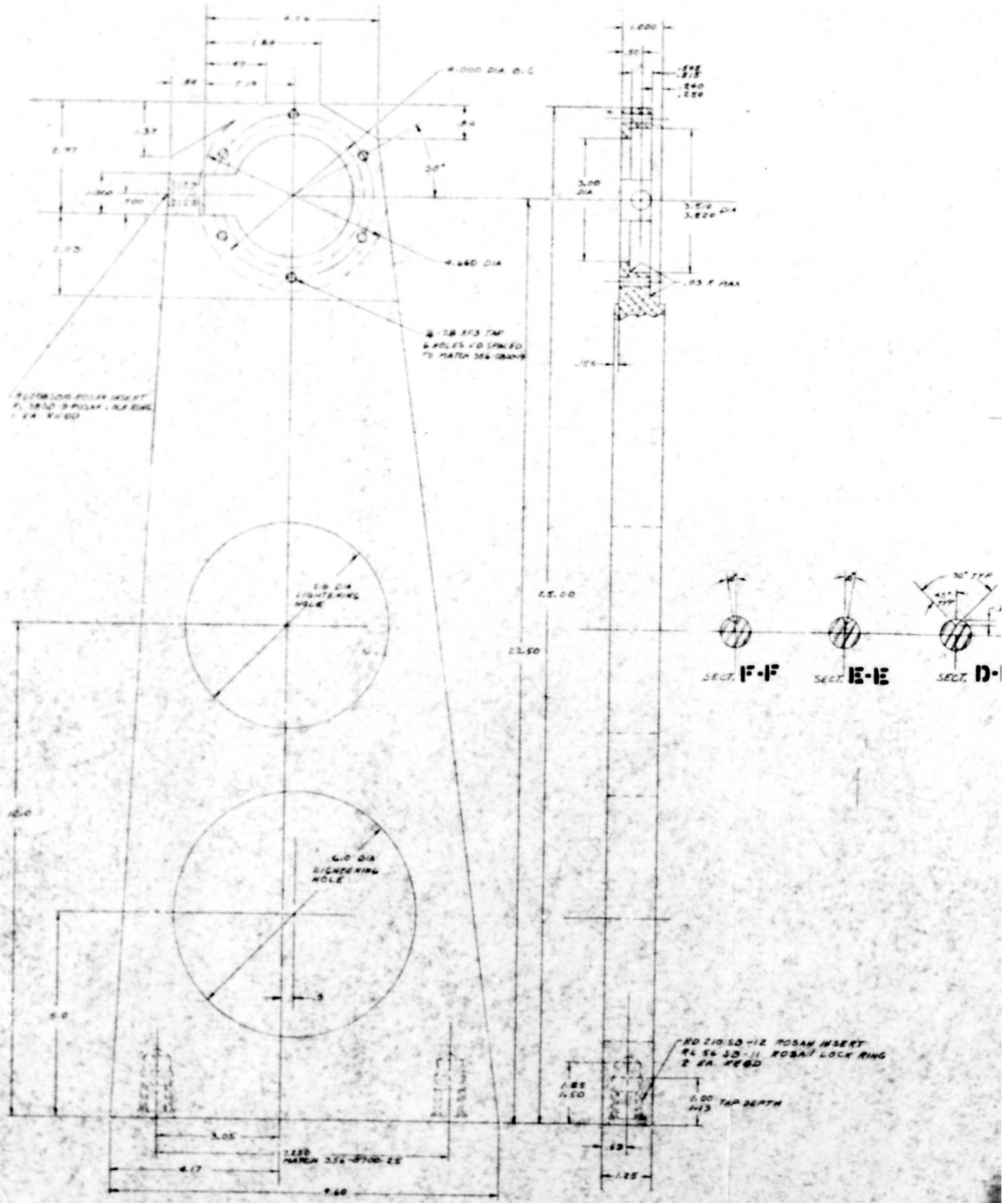
SECTION B-B

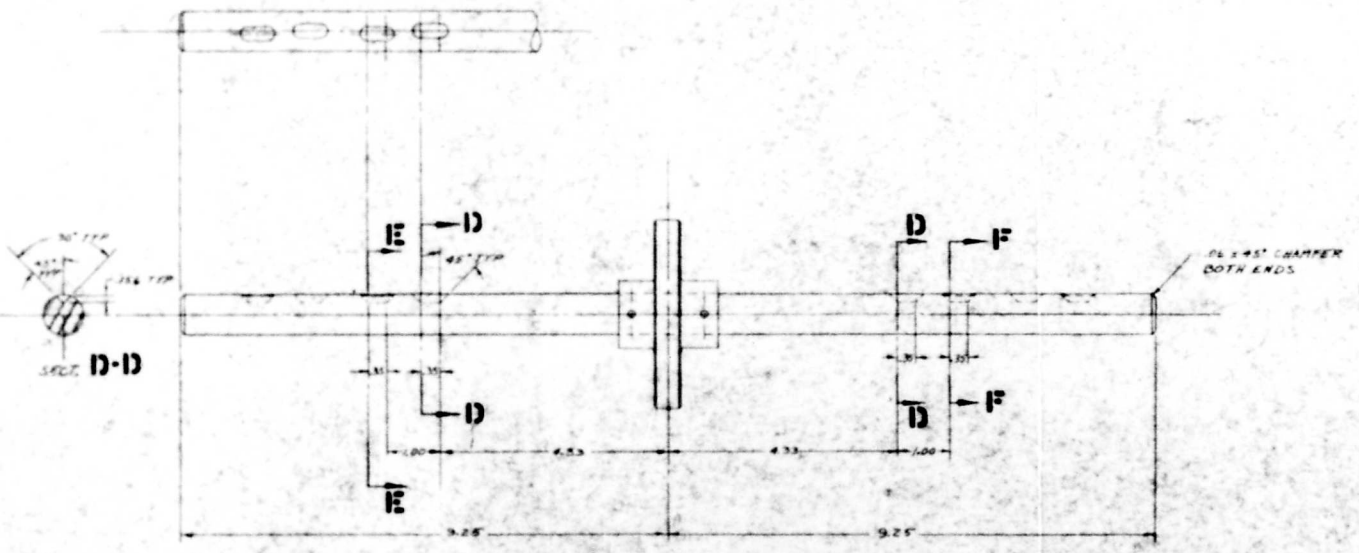
EMPENNAGE -
ONE ROTOR WING
WIND TUNNEL MODEL

356-0801

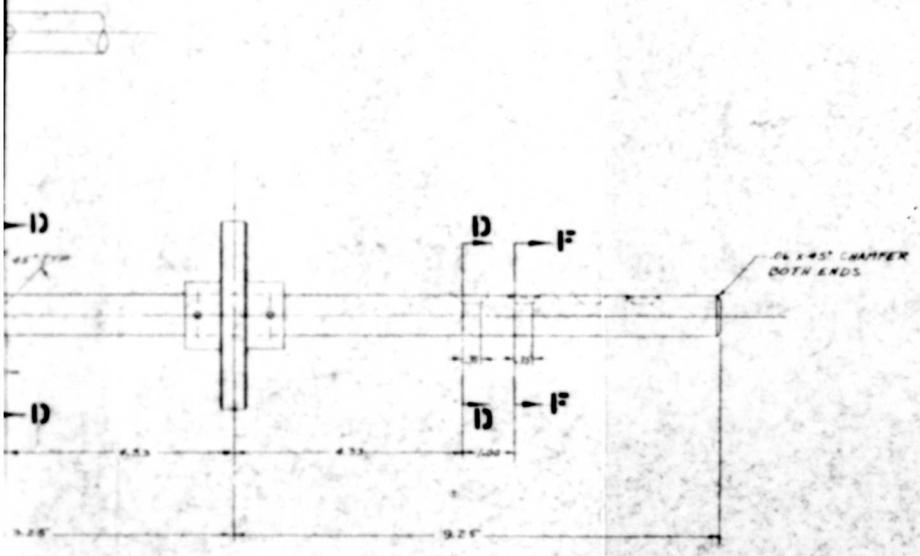


(-1) HORIZONTAL SPLINE & REDD
MAKE FROM 356-0800-23 HORIZ. SPLINE


4.000 DIA B.C
4.660 DIA
3.00 DIA
3.510
3.820 DIA
.03 R MAX
30°
5.0 DIA LIGHTENING HOLE
6.0 DIA LIGHTENING HOLE
65.00
22.50
SECT F-F
SECT E-E
SECT D-D
30° TYP
RD 210 SD-12 ROSAN INSERT
RL 56 SD-11 ROSAN LOCK RING
2 EA REQD
1.00 TAP DEPTH
5.05
4.17
9.60
.53
1.25
VERTICAL SPLINE 1 REQD
MATL - 2024 T4 ALUM PLATE



(-11) SHAFT ASSY
MAKE FROM 356-0800-17 SHAFT ASSY



(-8) SHAFT ASSY
MAKE FROM 356-0800-17 SHAFT ASSY

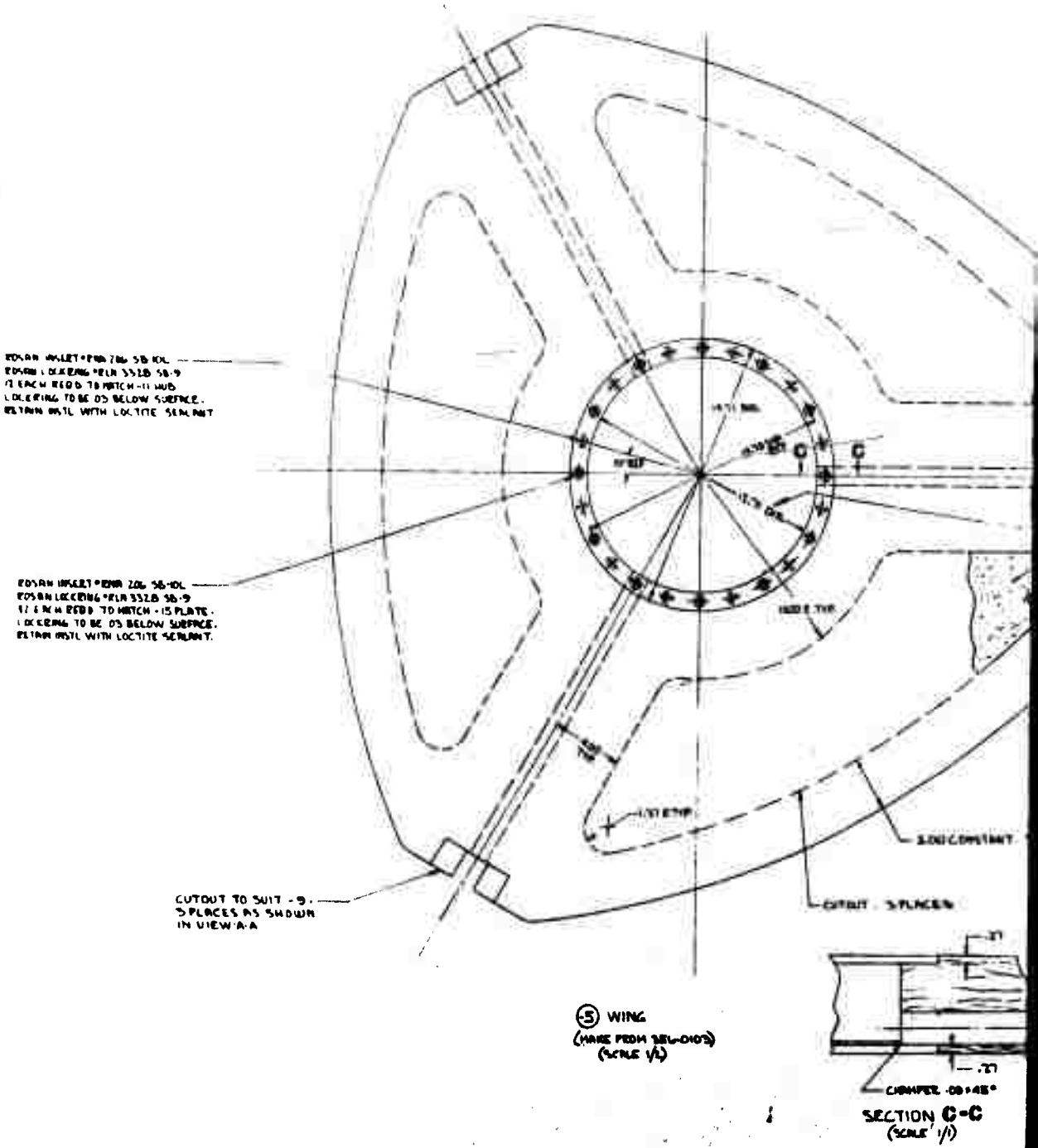
PART NO.	NOMEN	MAT'L	DESCRIPTION	SPECIFICATION	QUAN

LIST OF MATERIAL

Hughes Tool Company Aircraft Division
CULVER CITY, CALIFORNIA

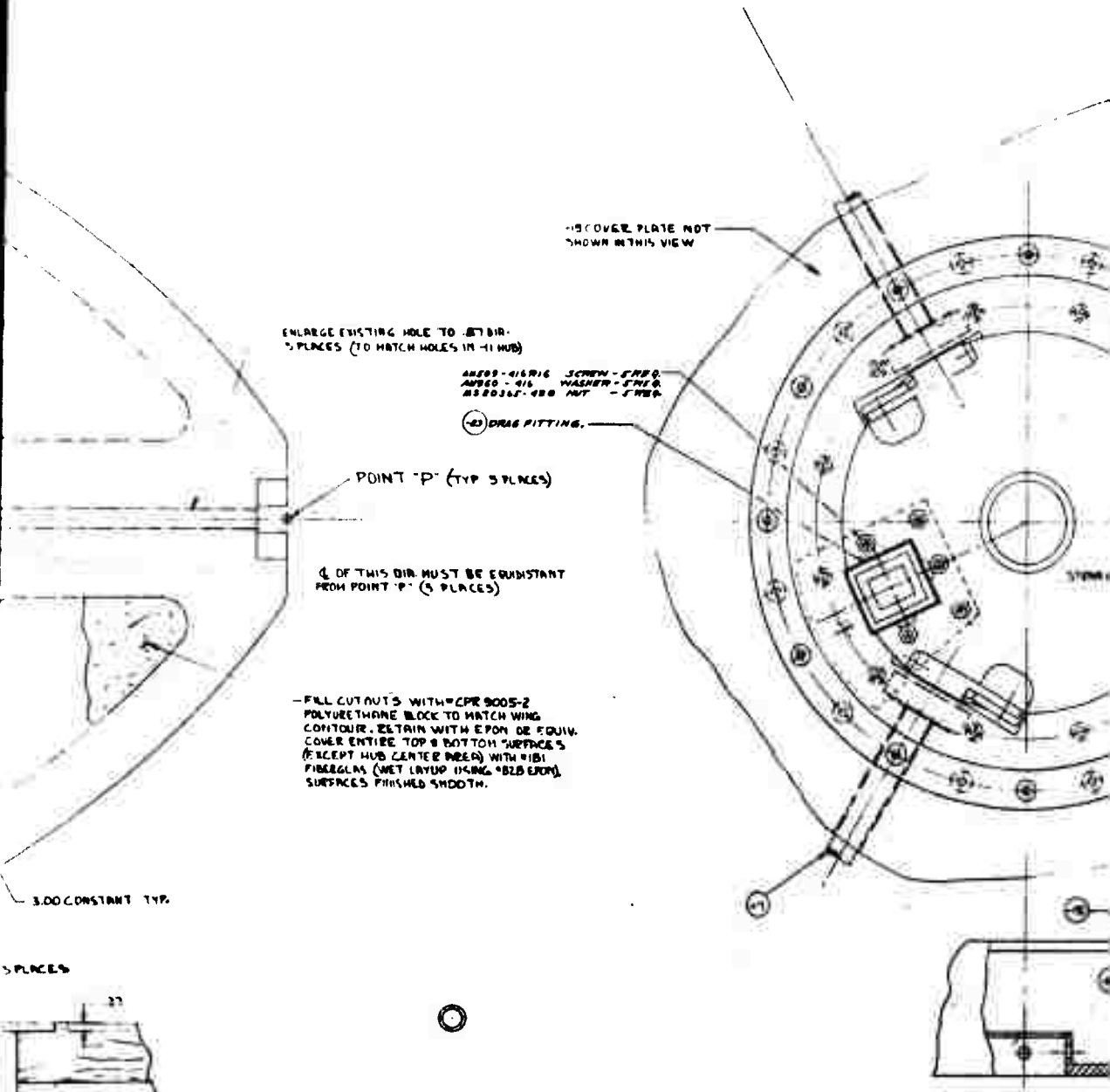
EMPENNAGE
ONR ROTOR-WING
WIND TUNNEL MODEL

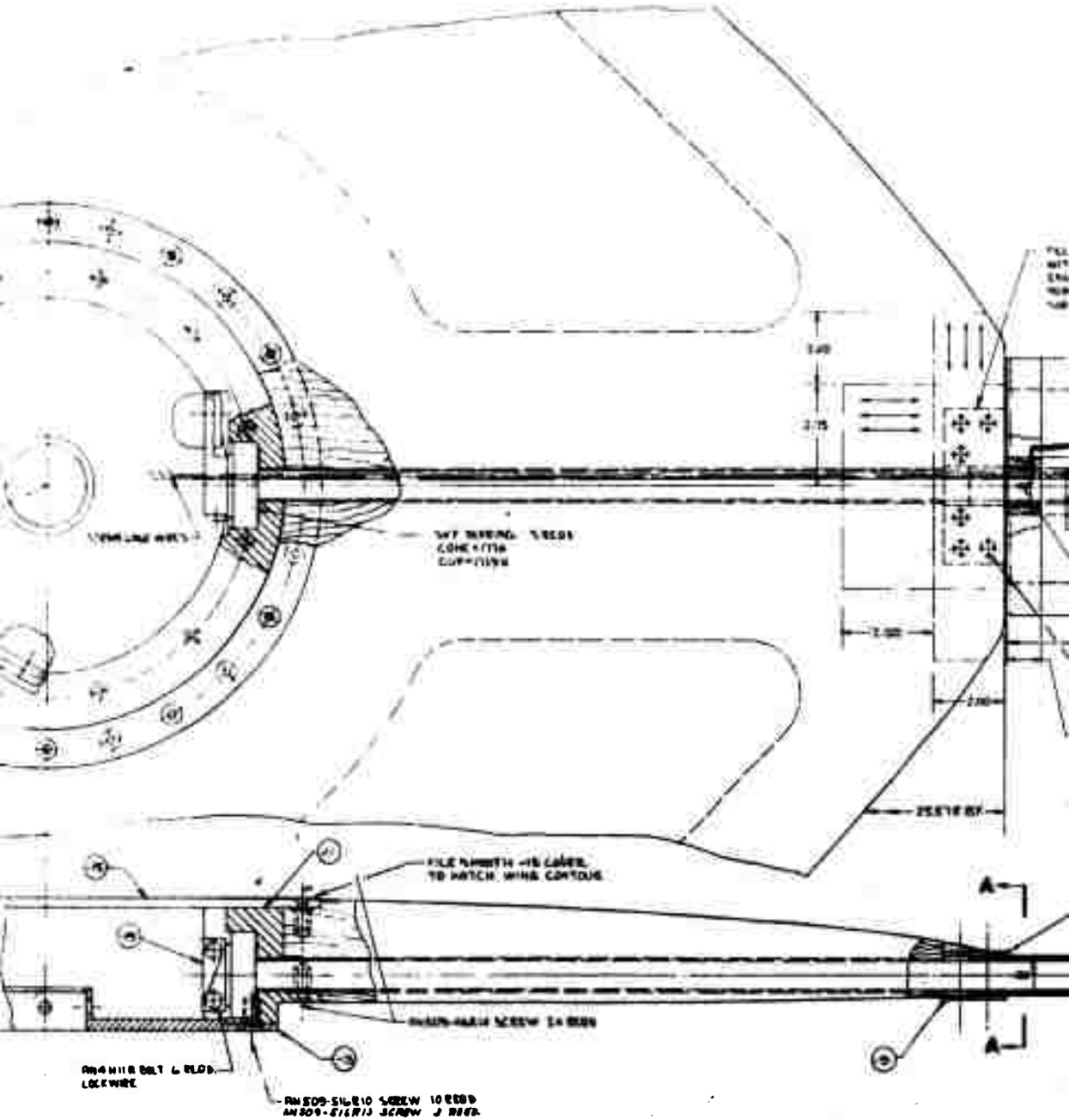
J 02731 356-0801



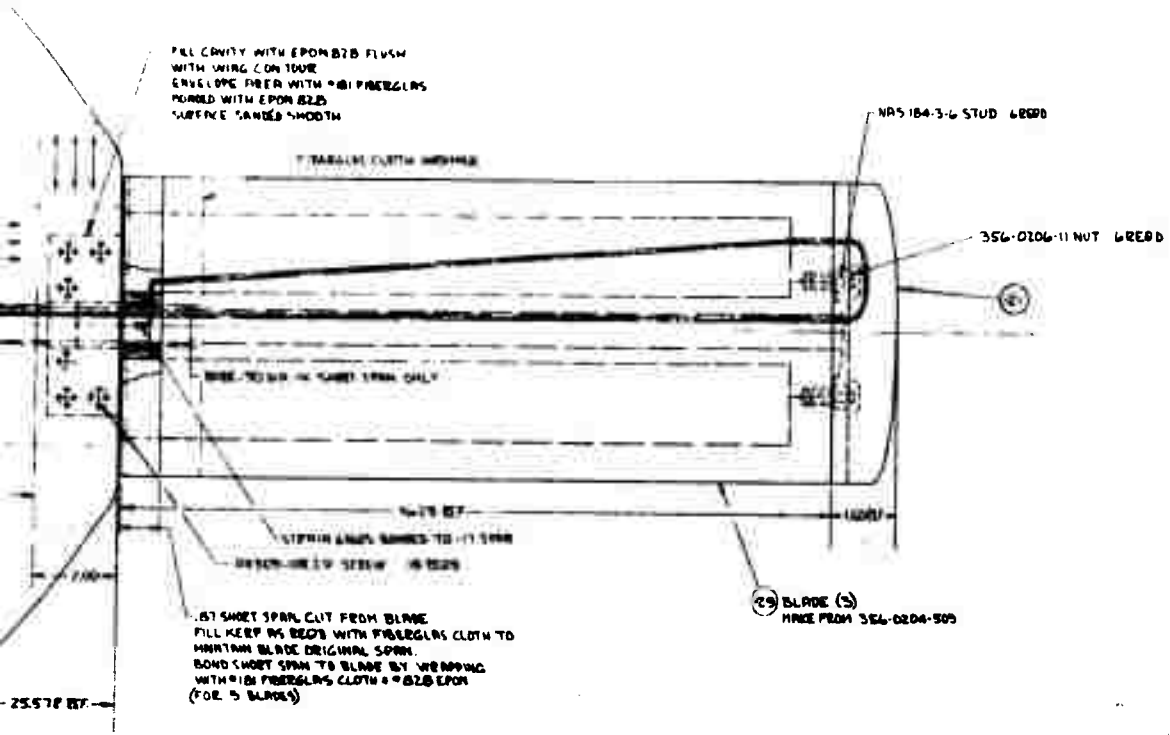
(-5) WING
(MADE FROM 3EG-0103)
(SCALE 1/4)

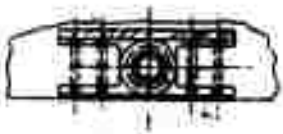
SECTION C-C
(SCALE 1/1)


-19 COVER PLATE NOT SHOWN IN THIS VIEW
ENLARGE EXISTING HOLE TO .87 DIA. 5 PLACES (TO MATCH HOLES IN -41 HUB)
AN509-416R16 SCREW - 5 REQ.
AN960 - 416 WASHER - 5 REQ.
MS20365-416 NUT - 5 REQ.
-83 DRAG FITTING.
POINT "P" (TYP 5 PLACES)
℄ OF THIS DIA. MUST BE EQUIDISTANT FROM POINT "P" (5 PLACES)
- FILL CUTOUTS WITH CPR 9005-2 POLYURETHANE BLOCK TO MATCH WING CONTOUR. RETAIN WITH EPON OR EQUIV. COVER ENTIRE TOP & BOTTOM SURFACES (EXCEPT HUB CENTER AREA) WITH 4 181 FIBERGLAS (WET LAYUP USING "BZB EPON). SURFACES FINISHED SMOOTH.
3.00 CONSTANT TYP.
5 PLACES
.27
.37
CTION C-C



-3 ASSY

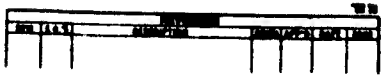




VIEW A-A

1. DIAMETERS MARKED (TO BE CO
WITHIN .002 T.I.E.

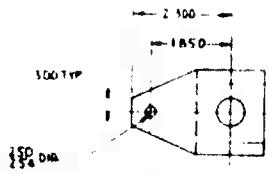
NOTES:



(21)

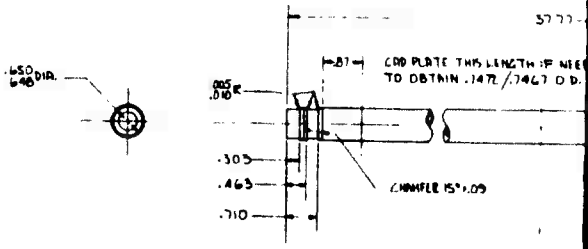
356-0900

NOTES

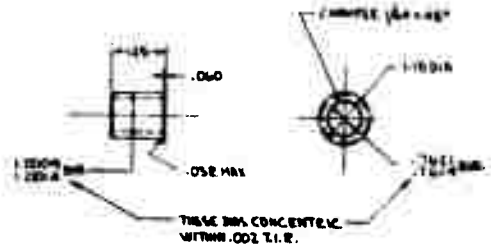


REWORK 356-0205 PITCH ARM AS SHOWN

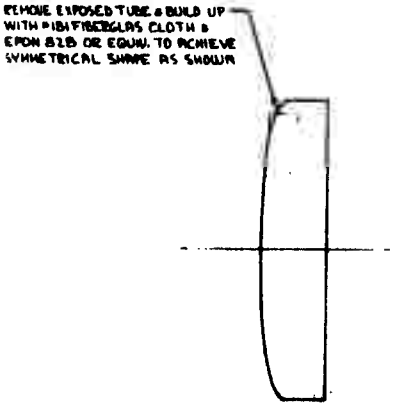
(19) PITCH ARM
3 REQD



REWORK



(-1) BUSHING
3 REQ'D
MADE OF OILITE BRONZE



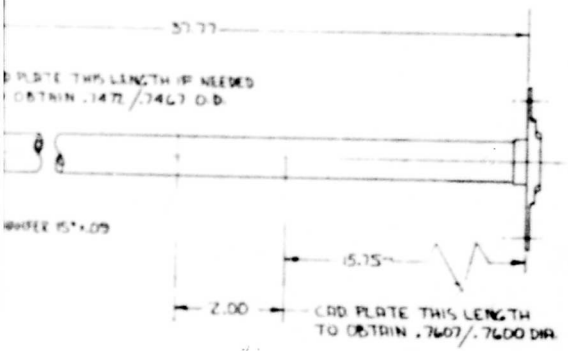
356-0206-505 TIP
REWORK AS INDICATED

(21) BLADE TIP
3 REQ'D

DRILL .190 DIA.
.194
CSK 100° .370
.364
6 PLACES

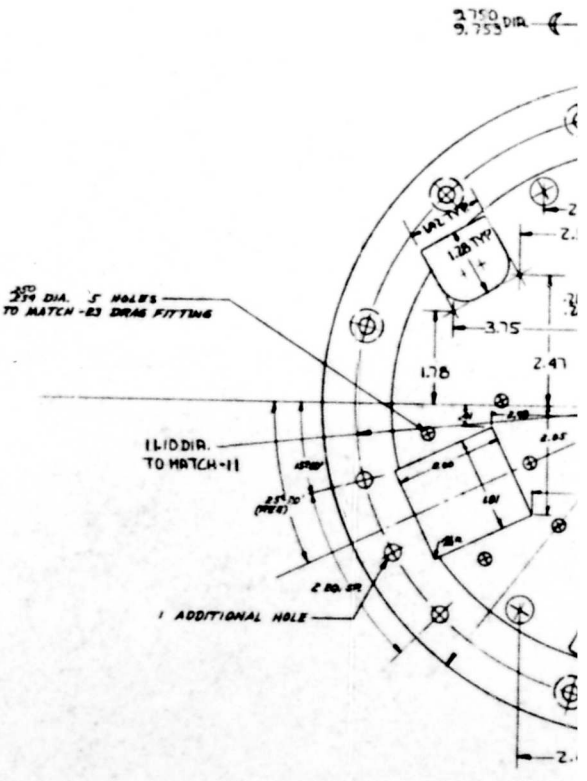
.06 R TYP.

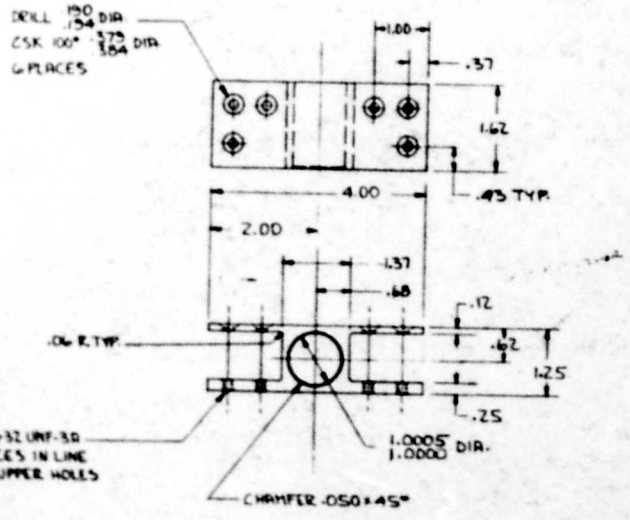
TAP 10-32 UNF-3B
6 PLACES IN LINE
WITH UPPER HOLES



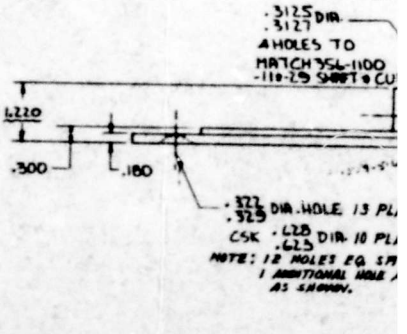
REWORK 356D211 RETAINER TUBE

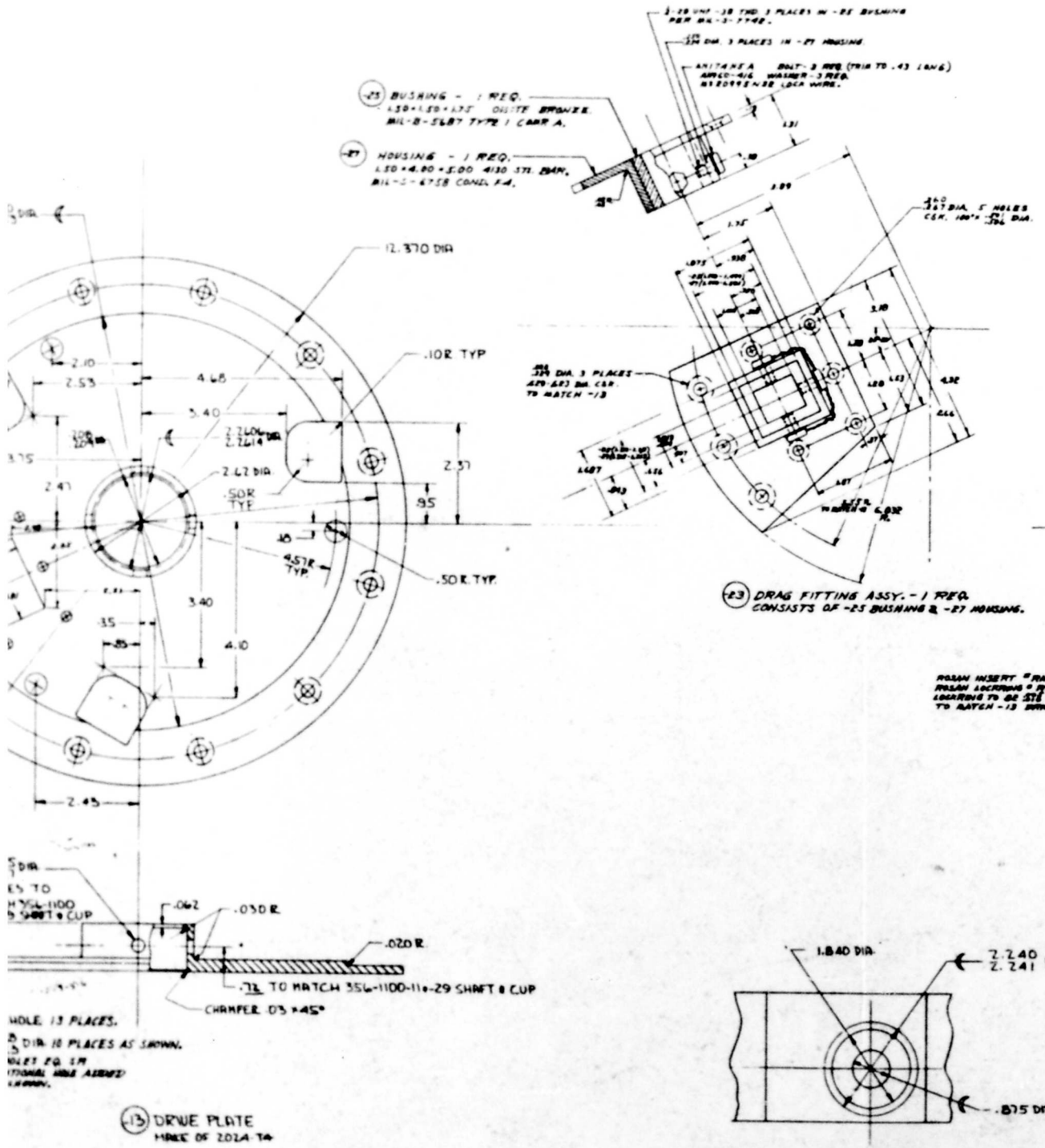
(47) SPAR
3 REQ'D

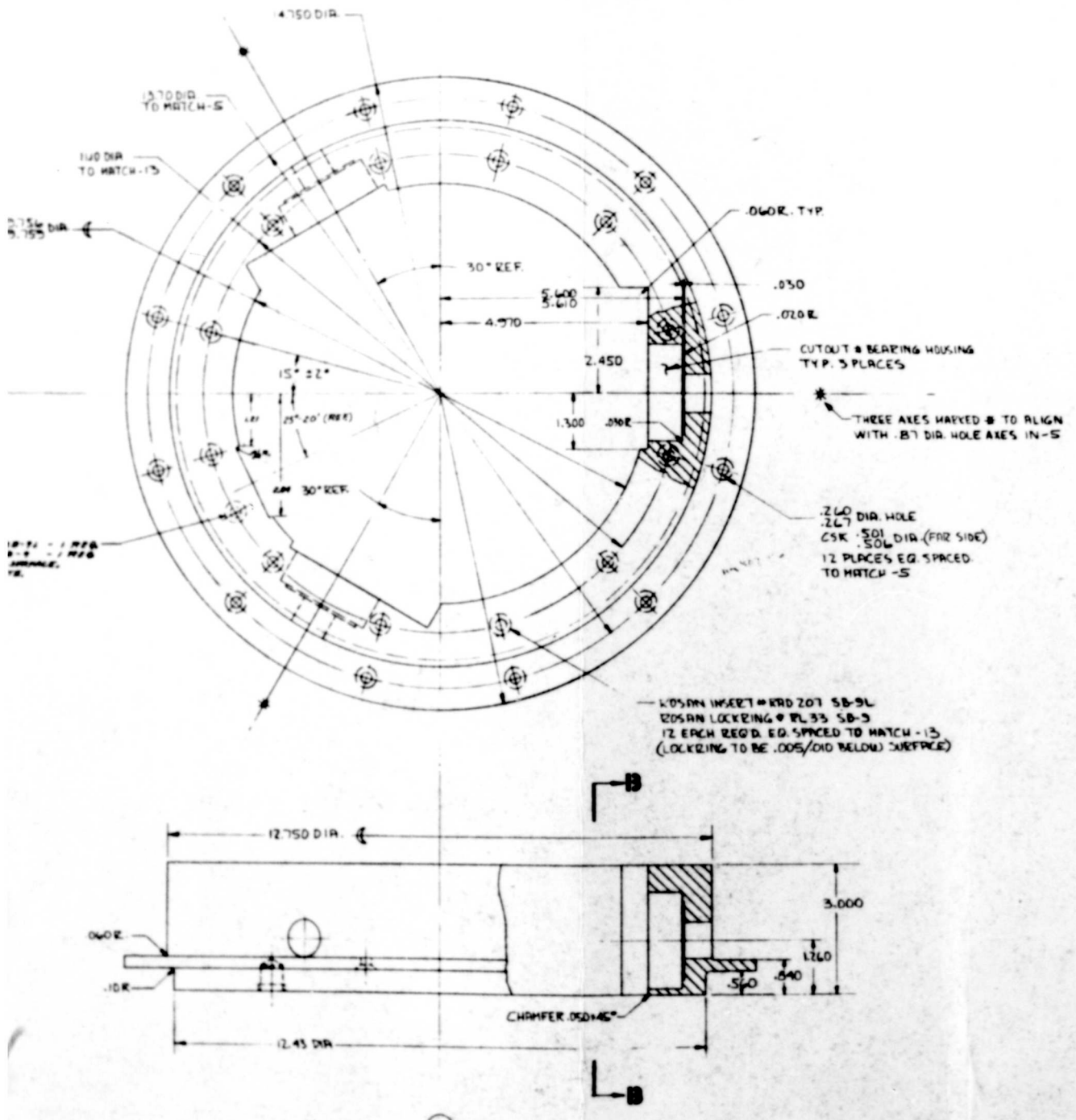




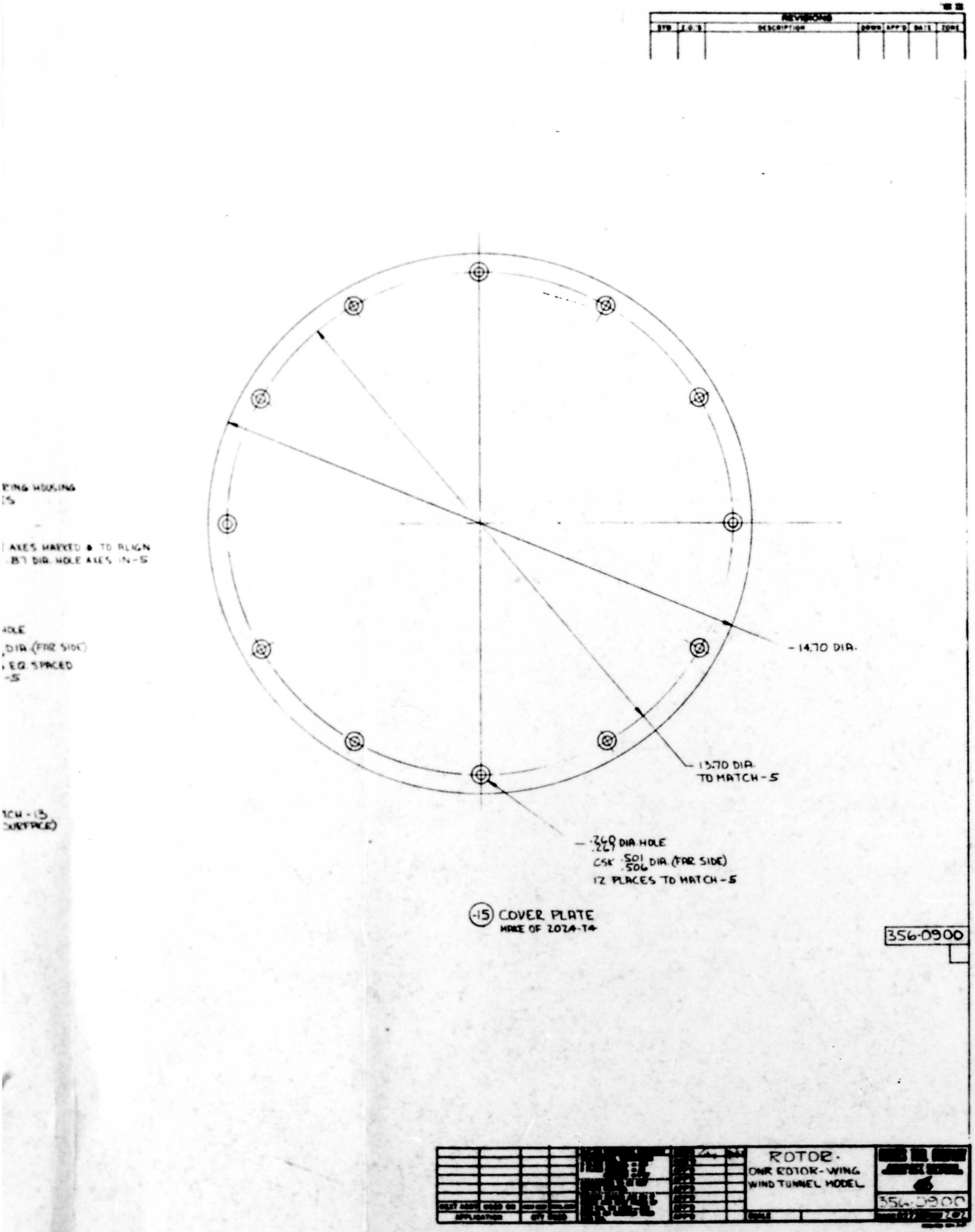
(-9) HOUSING
MADE OF 2024-T4
3 REQ'D

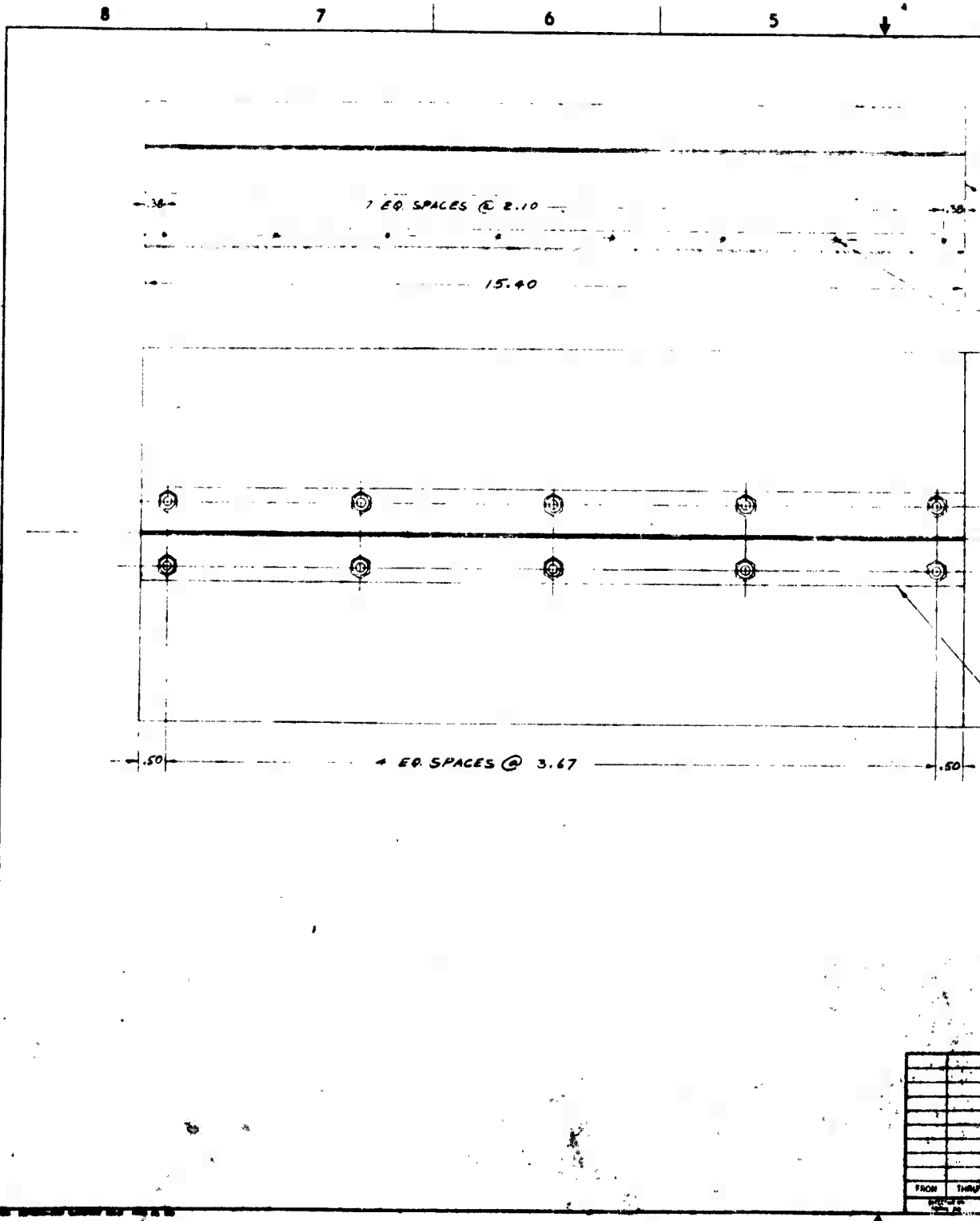



-25 BUSHING - 1 REQ.
-27 HOUSING - 1 REQ.
12.370 DIA
.10R TYP
.50R TYP
2.67 DIA
2.37
.95
3.40
4.10
2.45
.062
.030 R
.020 R
.71 TO MATCH 356-1100-110-29 SHAFT & CUP
CHAMFER .03 x 45°
-13 DRIVE PLATE
MADE OF 2024-T4
-23 DRAG FITTING ASSY. - 1 REQ.
CONSISTS OF -25 BUSHING & -27 HOUSING.
1.840 DIA
2.240
2.241 DIA
.875 DIA
VIEW B-B



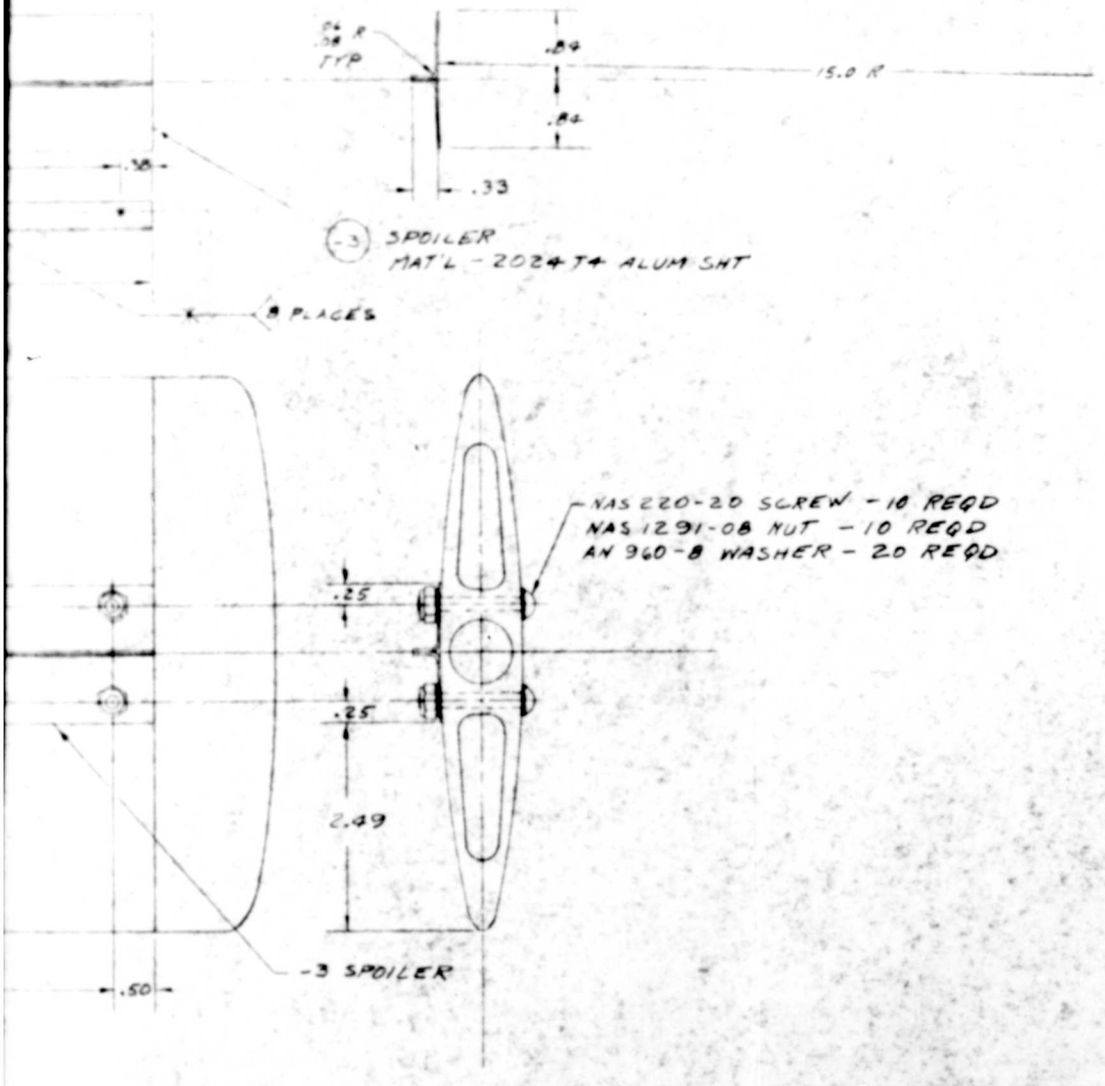
(-11) HUB
MADE OF 2024-T4


REVISIONS
SYM
E.O.
DESCRIPTION
DRWN
APP'D
DATE
ZONE
RING HOUSING
S
AXES MARKED TO ALIGN
.B7 DIA. HOLE AXES IN -5
HOLE
DIA. (FAR SIDE)
EQ. SPACED
-5
TCH -13
SURFACE)
14.70 DIA.
13.70 DIA.
TO MATCH -5
.260 .267 DIA. HOLE
CSK .501 .506 DIA. (FAR SIDE)
12 PLACES TO MATCH -5
(-15) COVER PLATE
MAKE OF 2024-T4
356-0900
ROTOR -
ONR ROTOR-WING
WIND TUNNEL MODEL
356-0900
APPLICATION
SCALE
5


8
7
6
5
D
C
B
A
.38
7 EQ. SPACES @ 2.10
.38
15.40
.50
4 EQ. SPACES @ 3.67
.50

4 3 2 1

EFFECTIVE ON	REVISIONS DWR	LTR	DESCRIPTION	DATE	APPROVED DATE



356-0902

PART NO	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE

LIST OF MATERIAL

FROM	THRU	NEXT ASSY	USED ON	QTY REQD

APPLICATION

UNLESS OTHERWISE SPECIFIED
3 PLACE DECIMAL ± .010
2 PLACE DECIMAL ± .03
ANGULAR ± 1°

MATERIAL AND PROCESS

CONTRACT NO.

DRWN	R.D.
CHK'D	
APP'D	
APP'D	
APP'D	
APP'D	
APP'D	

HTCAD APPROVAL

APPROVAL

HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

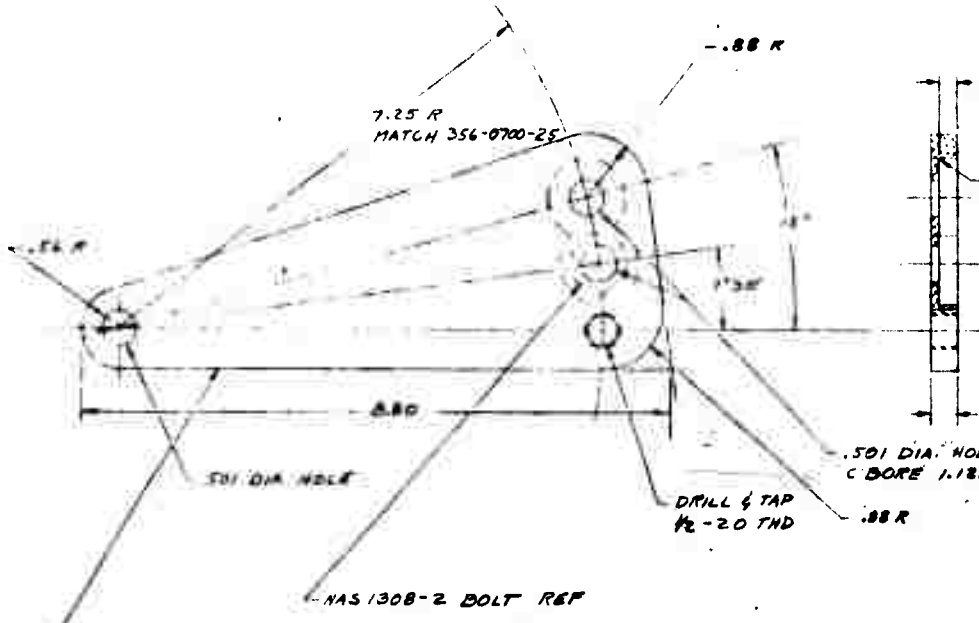
DWG TITLE
SPOILER
ONR ROTOR-WING
WIND TUNNEL MODEL

SIZE	CODE IDENT NO	DWG NO
D	02731	356-0902

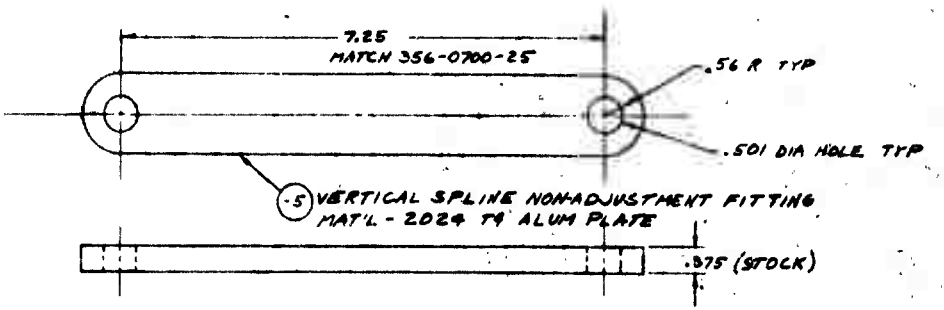
SCALE FULL SHEET 1 OF 1

D C B A

2



(-3) VERTICAL SPLINE ADJUSTMENT FITTING
MAT'L - 2024 T4 ALUM PLATE



(-5) VERTICAL SPLINE NONADJUSTMENT FITTING
MAT'L - 2024 T4 ALUM PLATE

4 3 2 1

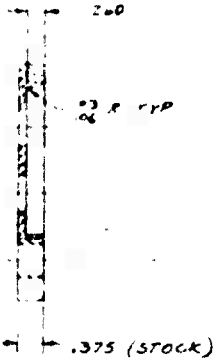
REVISIONS					
LTR	ZONE	ECN	DESCRIPTION	DATE	APPR'D DATE

D

C

B

A



.01 DIA HOLE
BORE 1.185 DIA

.08 R

TYP

PART NO	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE

LIST OF MATERIAL

NEXT ASSY	USED ON

APPLICATION

QTY REQD

UNLESS OTHERWISE SPECIFIED
GENERAL TOLERANCES
3 PLACE DECIMAL ± .010
2 PLACE DECIMAL ± .03
ANGULAR ± 1°

MATERIAL AND PROCESS

CONTRACT NO.

ORIG	
REV A	
REV B	
REV C	
REV D	

HTC AD APPROVAL

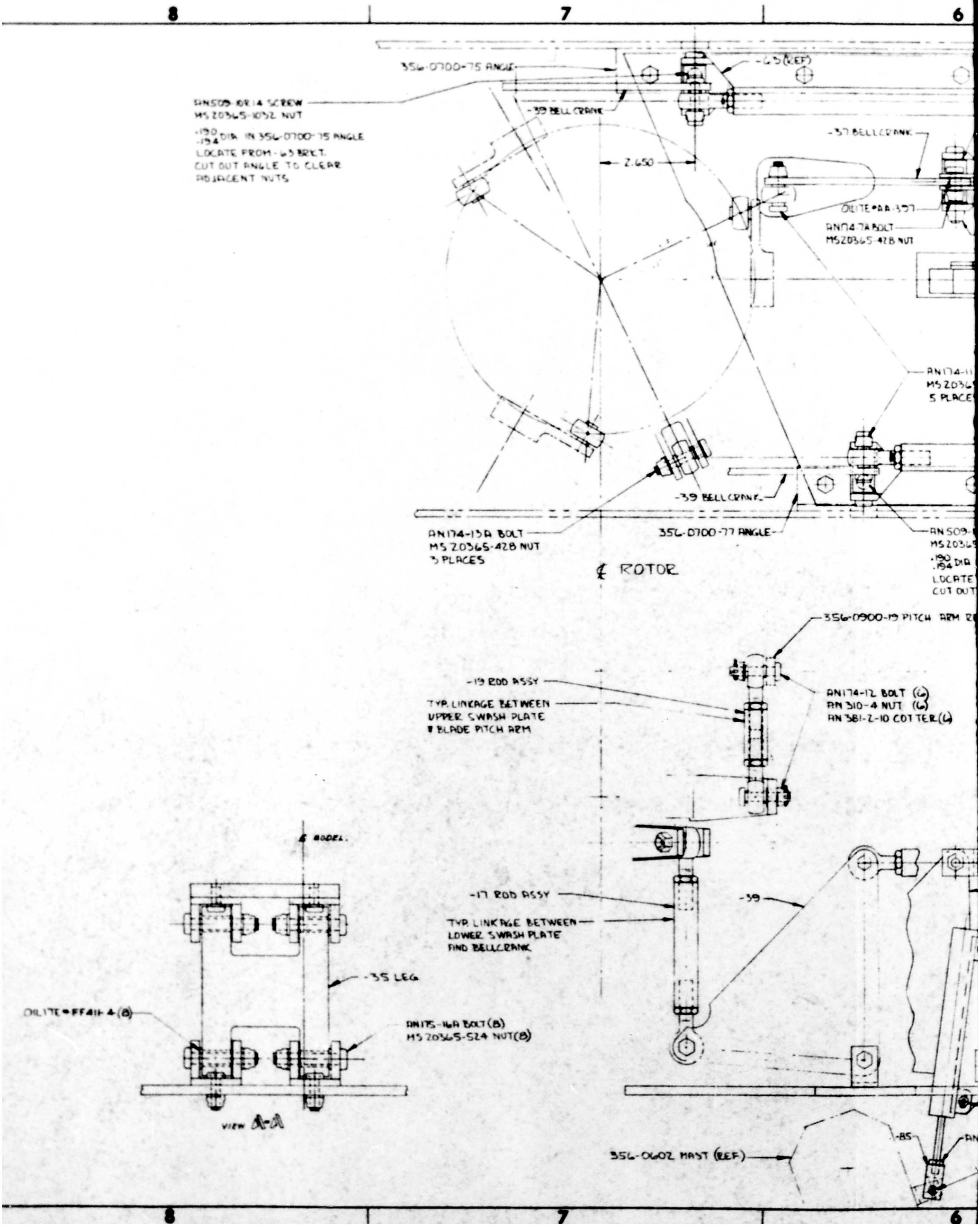
APPROVAL

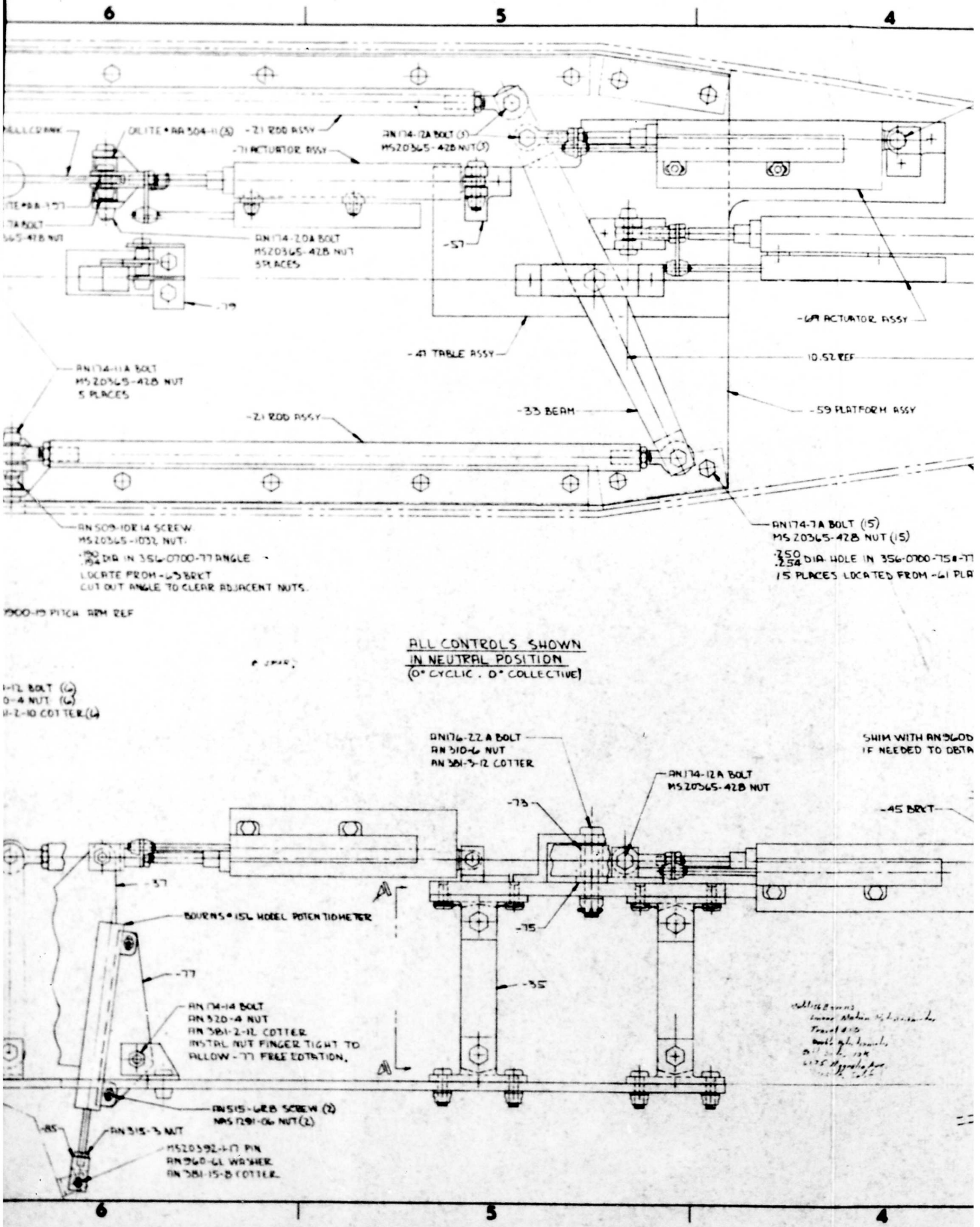
HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

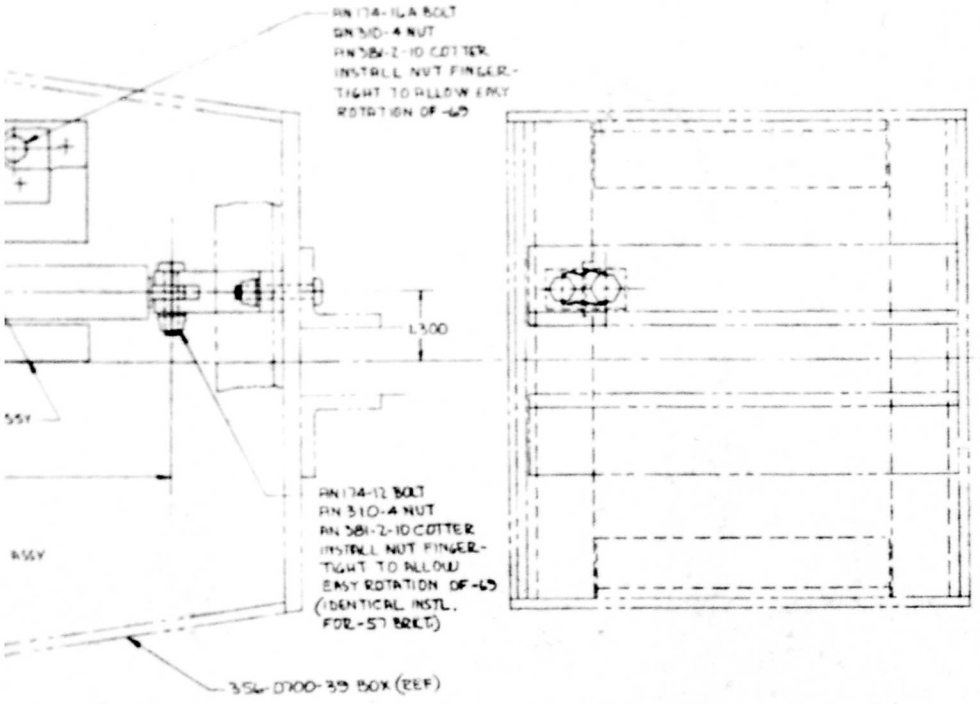
VERTICAL SPLINE FITTINGS
ONR ROTOR-WING
WIND TUNNEL MODEL

SIZE	CODE IDENT NO	DWG NO
D	02731	356-0903

SCALE FULL SHEET 1 OF 1

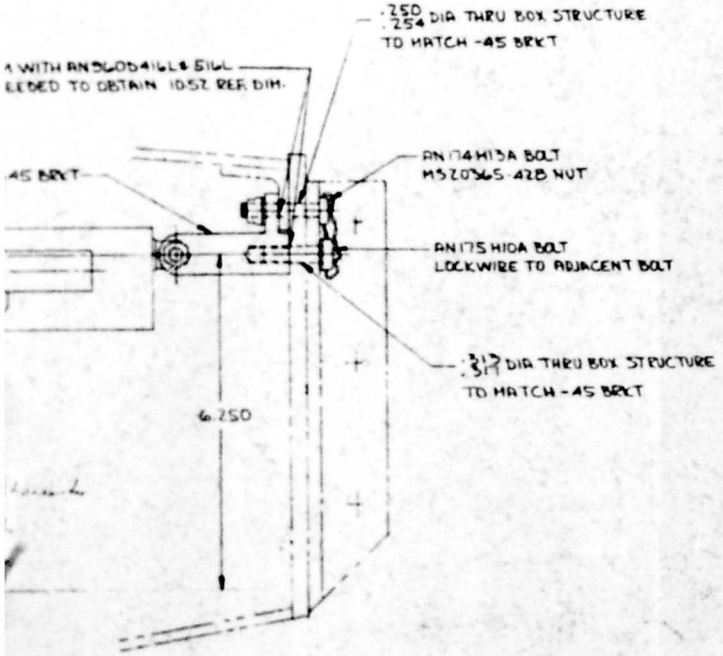

8
7
6
356-0700-75 ANGLE
-63 (REF)
AN509-10R14 SCREW
MS 20365-1032 NUT
.190/.194 DIA IN 356-0700-75 ANGLE
LOCATE FROM -63 BRKT.
CUT OUT ANGLE TO CLEAR
ADJACENT NUTS
-39 BELL CRANK
-37 BELLCRANK
2.650
OILITE #AA-397
AN174-7A BOLT
MS20365-428 NUT
AN174-11
MS 2036
5 PLACES
-39 BELLCRANK
AN174-13A BOLT
MS 20365-428 NUT
3 PLACES
356-0700-77 ANGLE
AN 509-
MS 2036
.190/.194 DIA
LOCATE
CUT OUT
℄ ROTOR
356-0900-19 PITCH ARM
-19 ROD ASSY
TYP. LINKAGE BETWEEN
UPPER SWASH PLATE
& BLADE PITCH ARM
AN174-12 BOLT (6)
AN 310-4 NUT (6)
AN 381-2-10 COTTER (6)
℄ MODEL
-17 ROD ASSY
TYP. LINKAGE BETWEEN
LOWER SWASH PLATE
AND BELLCRANK
-39
-35 LEG
OILITE #FF411-4 (8)
AN175-16A BOLT (8)
MS 20365-524 NUT (8)
VIEW A-A
-85
356-0602 MAST (REF)
8
7
6


6
5
4
-21 ROD ASSY
-71 ACTUATOR ASSY
RN174-12A BOLT (3)
MS20365-428 NUT (3)
RN174-20A BOLT
MS20365-428 NUT
5 PLACES
-57
-69 ACTUATOR ASSY
-41 TABLE ASSY
10.52 REF
RN174-11A BOLT
MS20365-428 NUT
5 PLACES
-33 BEAM
-59 PLATFORM ASSY
-21 ROD ASSY
RN174-7A BOLT (15)
MS20365-428 NUT (15)
.350 / .254 DIA HOLE IN 356-0700-75 & -77
15 PLACES LOCATED FROM -61 PLA
RN508-10R14 SCREW
MS20365-1032 NUT
.150 / .104 DIA IN 356-0700-77 ANGLE
LOCATE FROM -63 BRKT
CUT OUT ANGLE TO CLEAR ADJACENT NUTS.
ALL CONTROLS SHOWN
IN NEUTRAL POSITION
(0° CYCLIC . 0° COLLECTIVE)
RN174-22A BOLT
RN510-6 NUT
AN381-3-12 COTTER
RN174-12A BOLT
MS20365-428 NUT
SHIM WITH AN960D
IF NEEDED TO OBTA
-73
-45 BRKT
-37
BOURNS #15L MODEL POTENTIOMETER
-75
-77
-35
RN174-14 BOLT
AN520-4 NUT
AN381-2-12 COTTER
INSTAL NUT FINGER TIGHT TO
ALLOW -77 FREE ROTATION.
RN515-6RB SCREW (2)
MS21291-06 NUT (2)
-85
RN515-3 NUT
MS20392-1-17 PIN
AN960-6L WASHER
AN381-15-8 COTTER
6
5
4



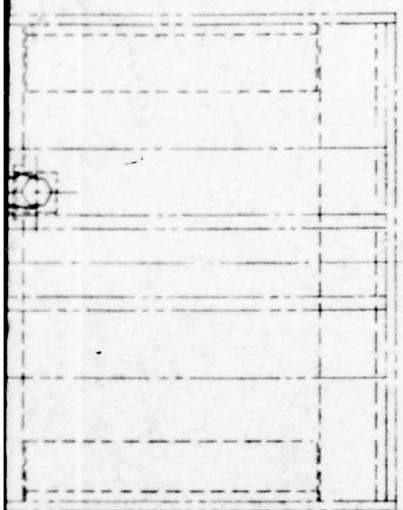
(15)

56-0700-7504-77 ANGLES
D FROM -61 PLATE



3 2 1

REVISIONS					
SYM	E.O.'S	DESCRIPTION	DRWN	APP'D	DATE



UCTURE

AGENT BOLT

BOX STRUCTURE
S BOLT

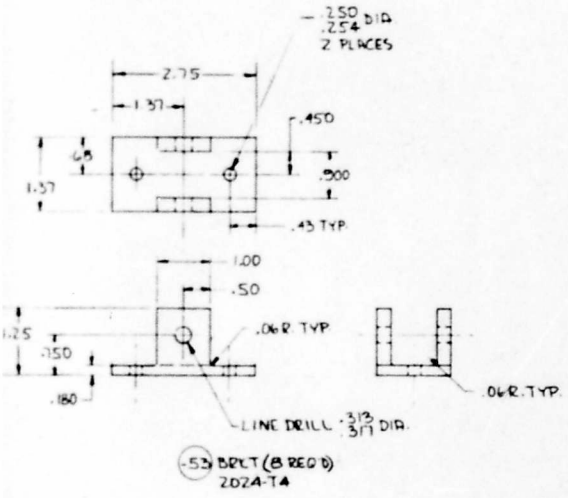
356-1000

CONTROLS-
INR ROTOR WING
WIND TUNNEL MODEL

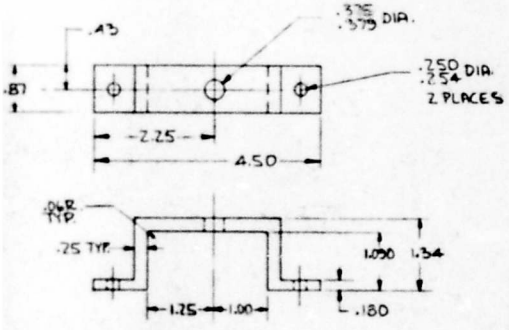
02731

356-1000

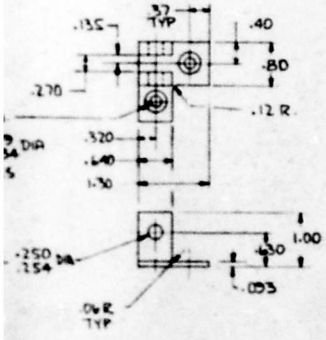
3 2 1



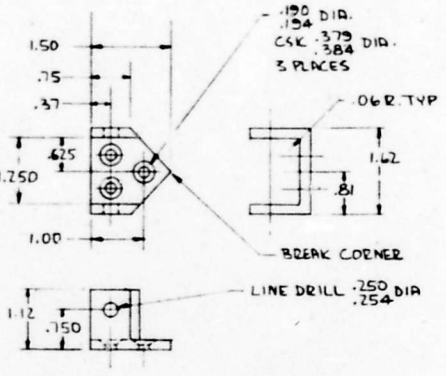
(-53) BRKT (8 REQ'D) 2024-T4



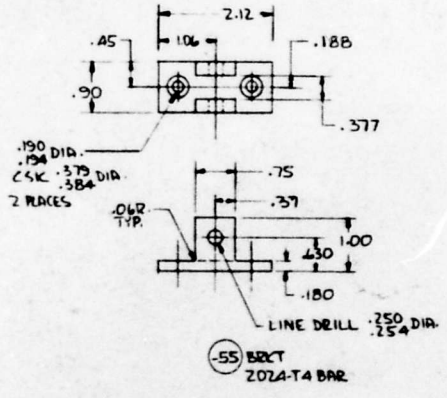
(-51) BRKT 4130 BAR



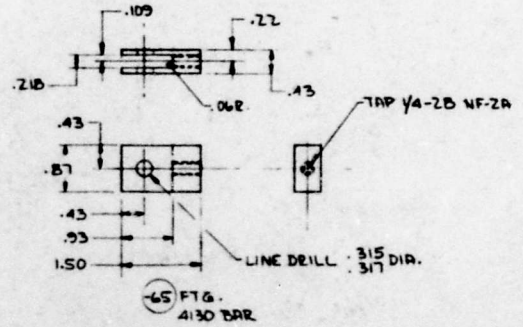
(-57) BRKT 2024-T4 BAR



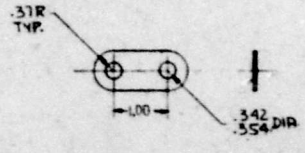
(-63) BRKT (3 REQ'D) 2024-T4 BAR



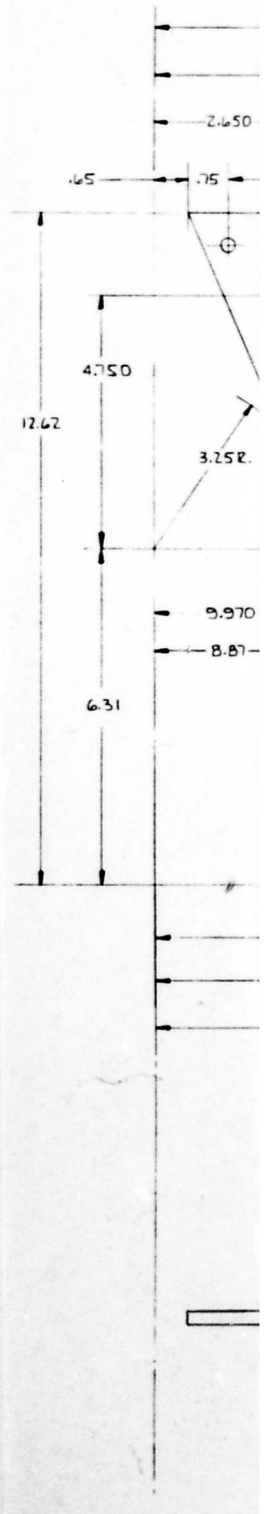
(-55) BRKT 2024-T4 BAR

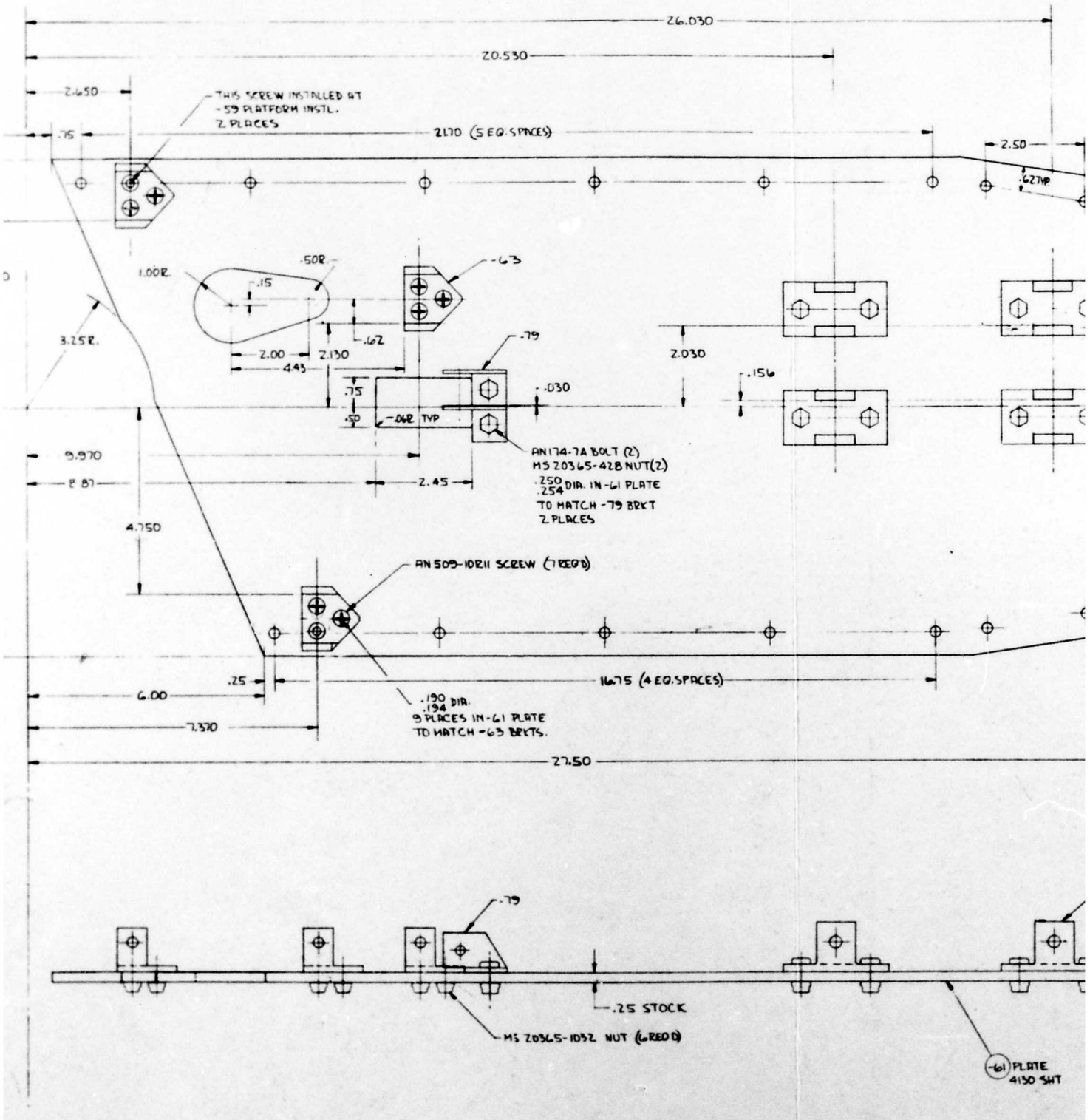


(-65) FTG. 4130 BAR

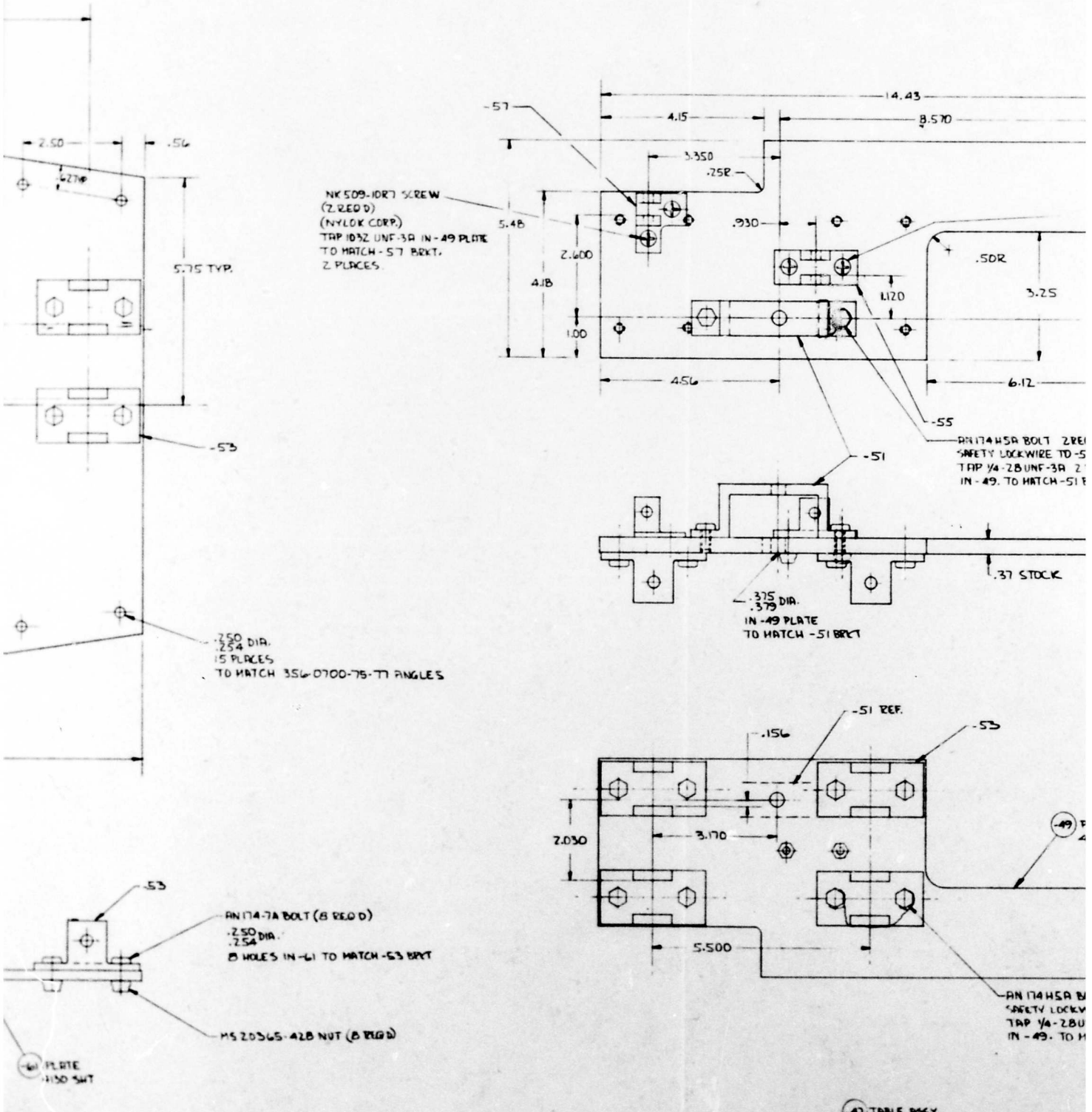


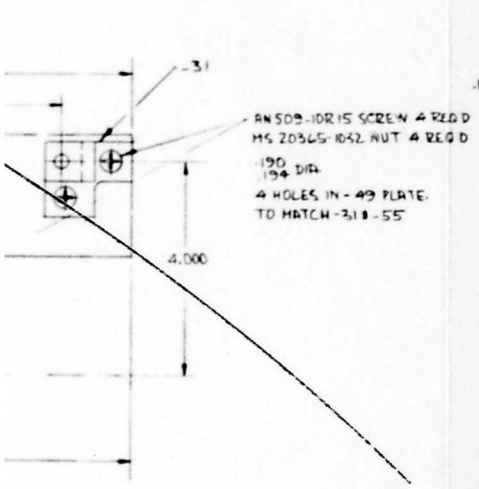
(-67) LINK (3 REQ'D) 4130 SHT.

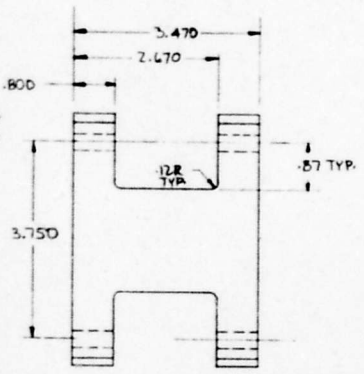


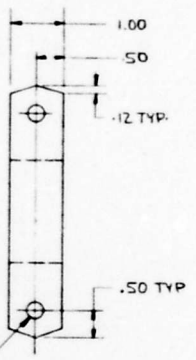


-59 PLATFORM ASSY


2.50
.56
.6270
5.75 TYP.
-53
.750 DIA.
.754
15 PLACES
TO MATCH 356-0700-75-77 ANGLES
-57
14.43
4.15
8.570
3.350
.25R
NK509-10R7 SCREW
(2 REQ'D)
(NYLOK CORP.)
TAP 10-32 UNF-3A IN -49 PLATE
TO MATCH -57 BRKT.
2 PLACES.
5.48
.930
2.600
4.18
.50R
1.120
3.25
1.00
4.56
6.12
-55
AN174H5A BOLT 2 REQ'D
SAFETY LOCKWIRE TO -57
TAP 1/4-28 UNF-3A 2
IN -49. TO MATCH -51
-51
.37 STOCK
.375
.379 DIA.
IN -49 PLATE
TO MATCH -51 BRKT
-51 REF.
.156
-53
2.030
3.170
-49
5.500
.53
AN174-7A BOLT (8 REQ'D)
.750
.754 DIA.
8 HOLES IN -61 TO MATCH -53 BRKT
MS20365-428 NUT (8 REQ'D)
-61 PLATE
.150 THK
-47 TABLE ASSY

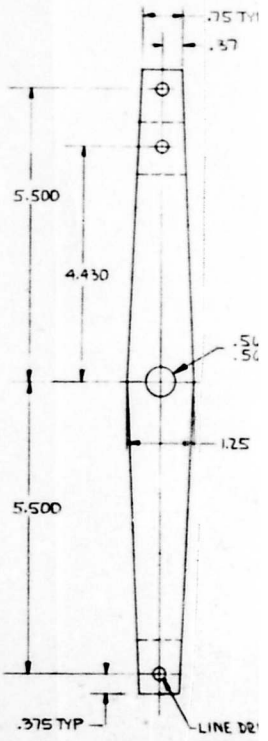




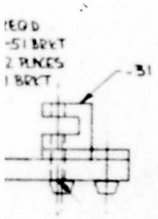


-35 LEG (2 REQ'D)
2024-T4 PLATE

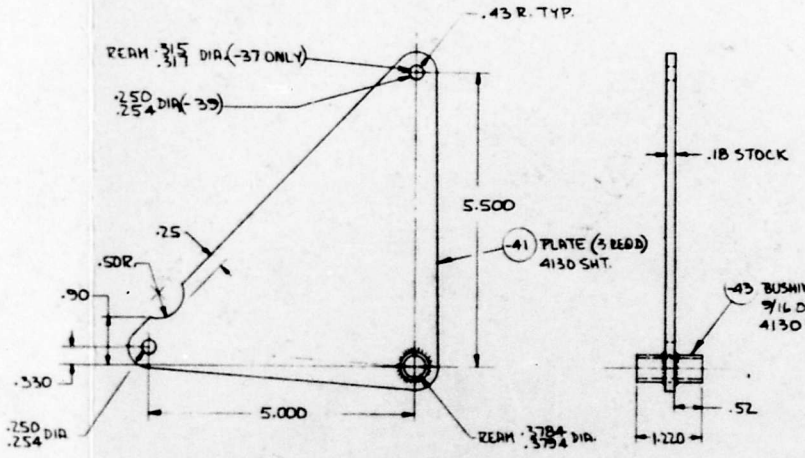
LINE REAM .4387 .4397 DIA
2 PLACES



LINE DR
3 PLACE



.250 .254 DIA IN -49 PLATE
TO MATCH -31



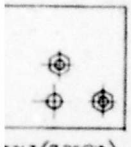
-37 BELLCRANK ASSY (1 REQ'D)

-39 BELLCRANK ASSY (2 REQ'D)

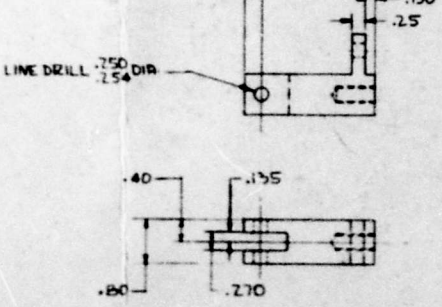
AN 946-RE4M6
BEARING (R.H.)

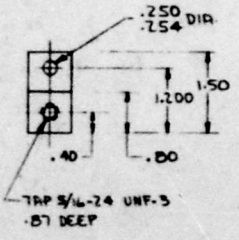
-25 TUBE 2 REQ'D
3/4 O.D.
4130 TUBE

PLATE
4130 SHT

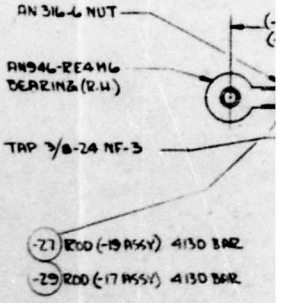


BOLT (8 REQ'D)
WIRE-
UNF-3A 8 PLACES
MATCH -53 BRKT



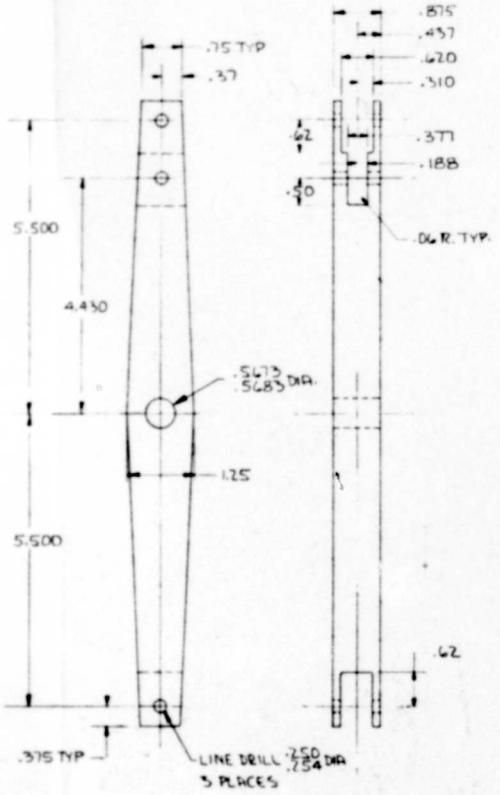


-45 BRKT
4130 BAR

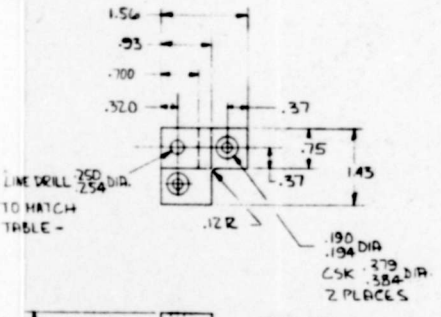


-27 ROD (-19 ASSY) 4130 BAR

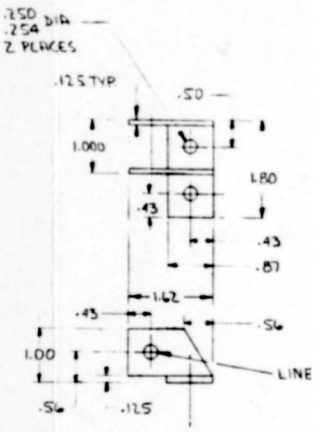
-29 ROD (-17 ASSY) 4130 BAR



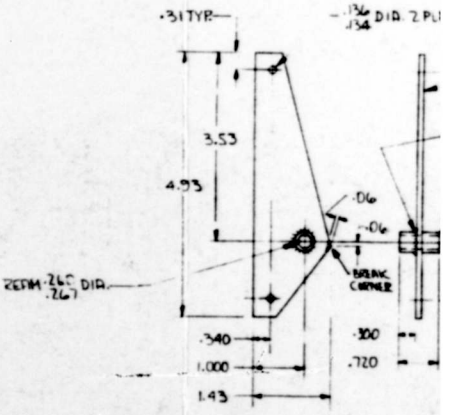
-33 BEAM
2024-T4 BAR



-31 BRKT
2024-T4 BAR

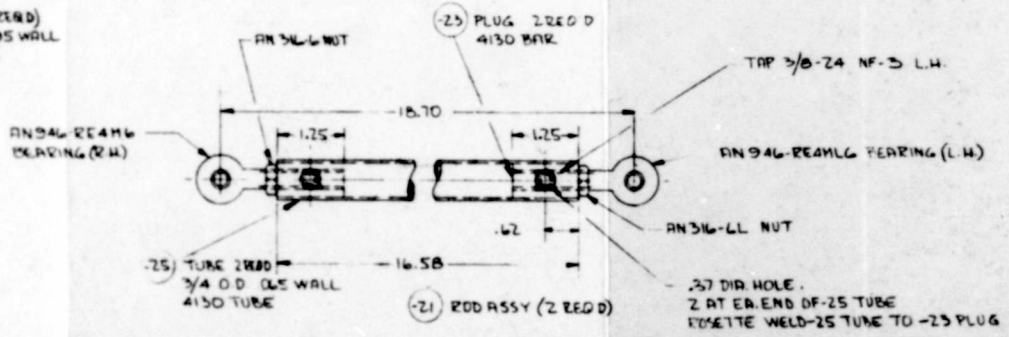


-79 BRKT
2024-T4 BA

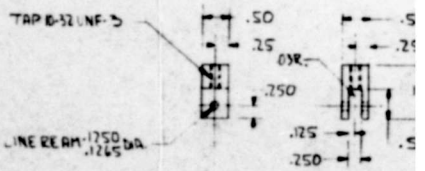


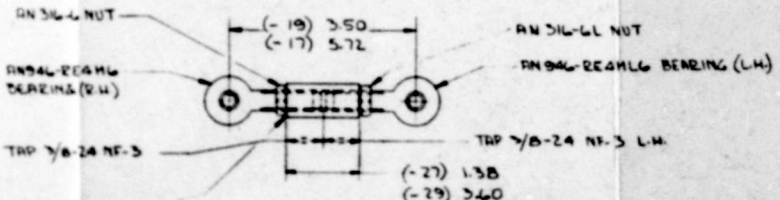
-77 BRKT F

(3 REQ'D)
.095 WALL
UBE



-21 ROD ASSY (2 REQ'D)

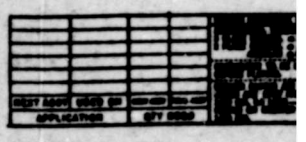




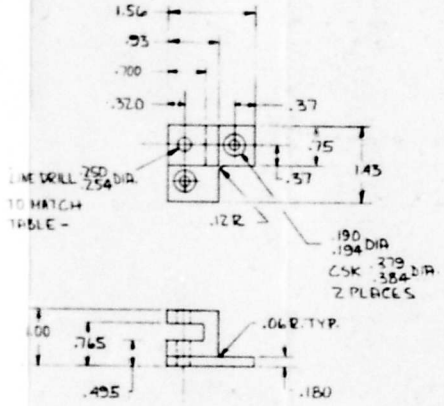
-27 ROD (-19 ASSY) 4130 BAR
-29 ROD (-17 ASSY) 4130 BAR

-17 ROD ASSY (3 REQ'D)
-19 ROD ASSY (3 REQ'D)

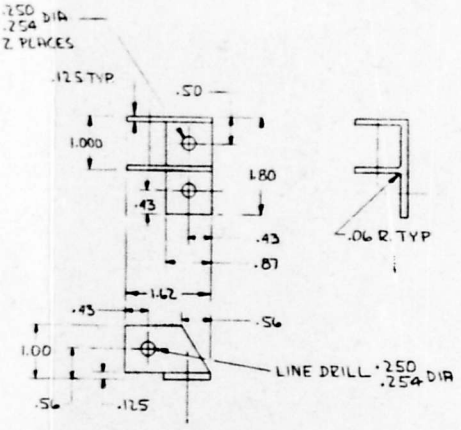
-85 FORK
1020 B



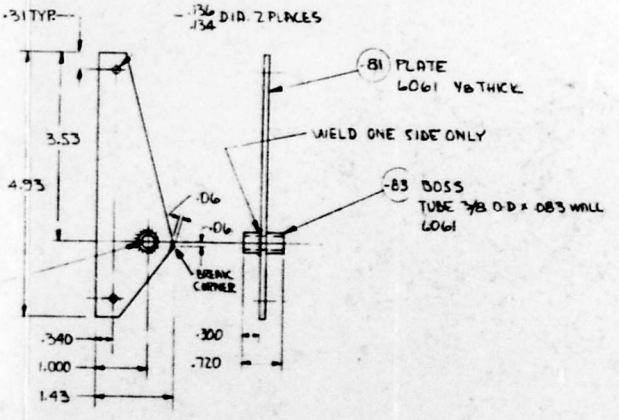
REVISIONS						
SYM	E.O.'S	DESCRIPTION	DRWN	APP'D	DATE	ZONE



-31 BRKT
2024-T4 BAR

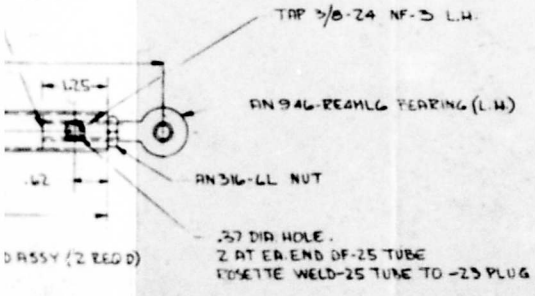


-79 BRKT
2024-T4 BAR

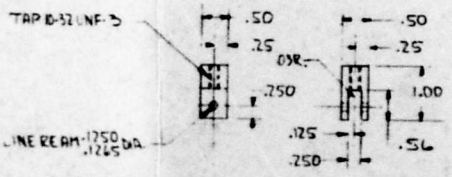


-77 BRKT ASSY

PLUG .222 D
4130 BAR



D ASSY (2 REQ'D)



-85 FORK
1020 BAR

AN 316-6L NUT

AN 946-REAM L6 BEARING (L.H)

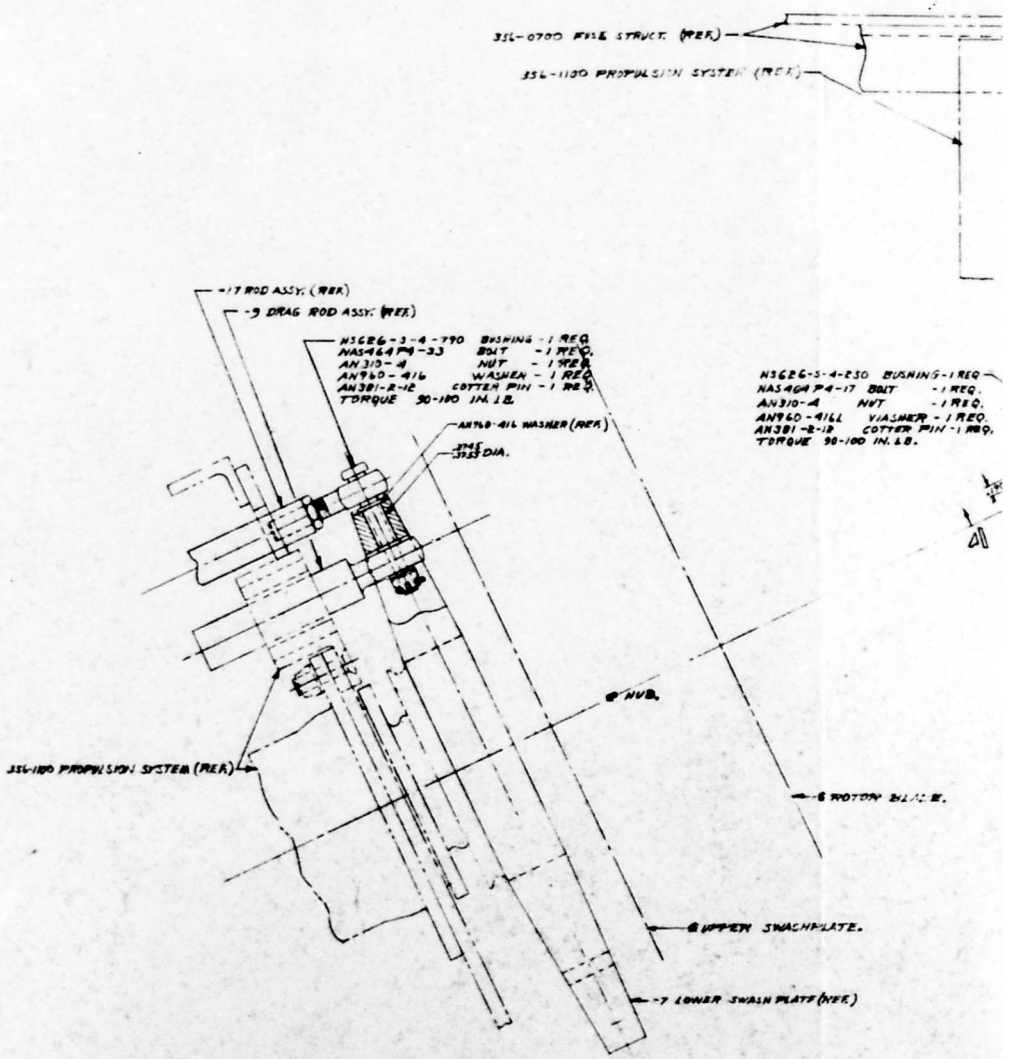
AP 3/8-24 NF-3 L.H.

B
D

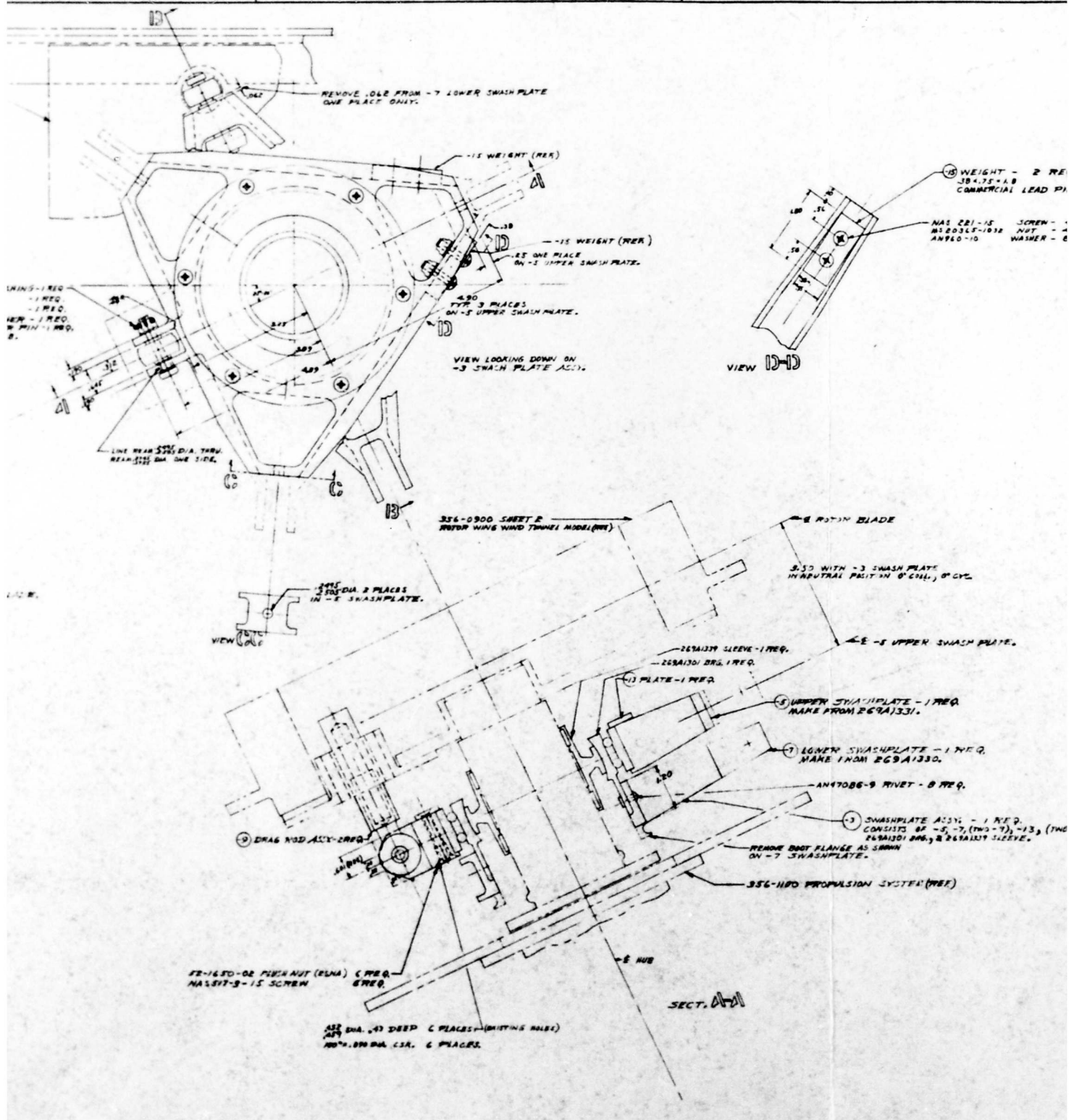
356-1000

CONTROLS-
ONR ROTOR WING
WIND TUNNEL MODEL

356-1000

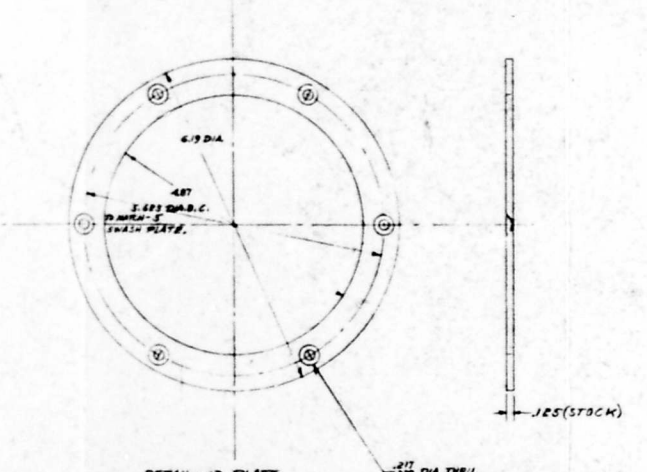

356-0700 FUSE STRUCT. (REF.)
356-1100 PROPULSION SYSTEM (REF.)
-17 ROD ASSY. (REF.)
-9 DRAG ROD ASSY. (REF.)
NSGR6-3-4-790 BUSHING - 1 REQ.
NAS464P4-33 BOLT - 1 REQ.
AN310-4 NUT - 1 REQ.
AN960-416 WASHER - 1 REQ.
AN381-2-12 COTTER PIN - 1 REQ.
TORQUE 90-100 IN. LB.
AN960-416 WASHER (REF.)
.375 DIA.
.373
NSGR6-5-4-230 BUSHING-1 REQ.
NAS464P4-17 BOLT -1 REQ.
AN310-4 NUT -1 REQ.
AN960-416L WASHER - 1 REQ.
AN381-2-12 COTTER PIN - 1 REQ.
TORQUE 90-100 IN. LB.
HUB.
356-1100 PROPULSION SYSTEM (REF.)
ROTOR ASSY.
UPPER SWASHPLATE.
-7 LOWER SWASH PLATE (REF.)

SECT. 1343

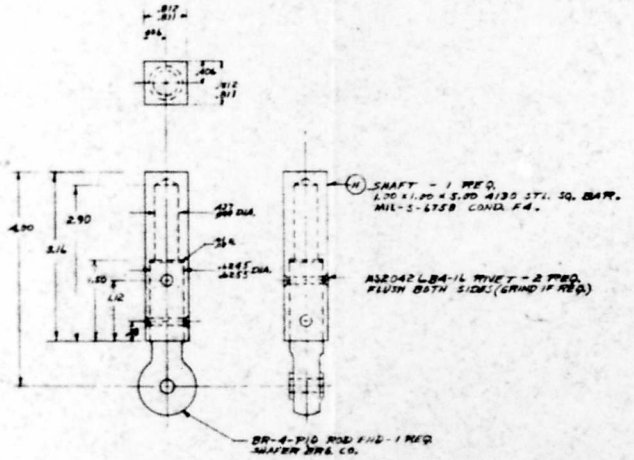

REMOVE .062 FROM -7 LOWER SWASH PLATE ONE PLACE ONLY.
-15 WEIGHT (REF)
-15 WEIGHT (REF)
.83 ONE PLACE ON -5 UPPER SWASH PLATE.
4.90 TYP 3 PLACES ON -5 UPPER SWASH PLATE.
VIEW LOOKING DOWN ON -3 SWASH PLATE ASSY.
-15 WEIGHT - 2 REQ
SB4.75 x 1.8
COMMERCIAL LEAD PI
NAS 221-15 SCREW -
MS20365-1032 NUT -
AN960-10 WASHER -
VIEW
356-0900 SHEET 2
ROTOR WING WIND TUNNEL MODEL(REF)
E ROTOR BLADE
9.50 WITH -3 SWASH PLATE IN NEUTRAL POSITION 0° COLL., 0° CYC.
E -5 UPPER SWASH PLATE.
269A1339 SLEEVE - 1 REQ.
269A1301 BRG. 1 REQ.
-13 PLATE - 1 REQ.
-5 UPPER SWASHPLATE - 1 REQ. MAKE FROM 269A1331.
-7 LOWER SWASHPLATE - 1 REQ. MAKE FROM 269A1330.
AN470B6-9 RIVET - 8 REQ.
-3 SWASHPLATE ASSY. - 1 REQ. CONSISTS OF -5, -7, (TWO -9), -13, (TWO
269A1301 BRG., & 269A1339 SLEEVE.
REMOVE BOOT FLANGE AS SHOWN ON -7 SWASHPLATE.
356-HPO PROPULSION SYSTEM (REF)
-9 DRAG MOD ASSY - 2 REQ
E HUB
FE-1650-08 PEEN NUT (ELNA) 6 REQ.
NAS517-9-15 SCREW 6 REQ.
SECT.
.422 DIA. .47 DEEP 6 PLACES (EXISTING HOLES)
.180"±.010 DIA. C'SK. 6 PLACES.

(G) WEIGHT - 2 REQ.
.38 x .75 x 1.9
COMMERCIAL LEAD PIG.

NAS 221-12 SCREW - 4 REQ.
MS20365F-1032 NUT - 4 REQ.
AN960-10 WASHER - 8 REQ.

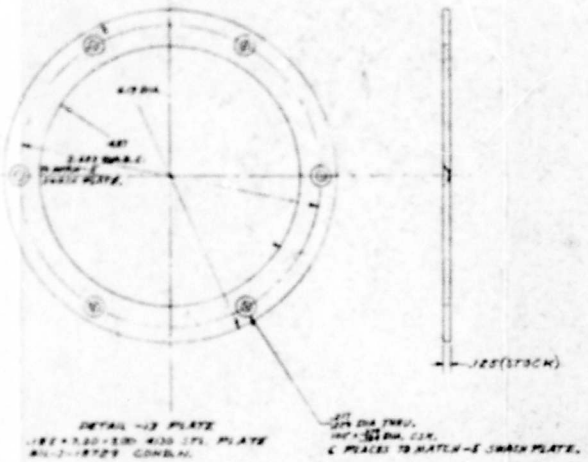


DETAIL -13 PLATE
.125 x 7.00 x 7.00 4130 STL. PLATE
MIL-S-18729 COND. N.



DETAIL -9 DRAG ROD ASSY.

SIZE	PART NO. ASSEMBLY GRP.	SIZE
NEXT ASSY	USED ON APPLICATION	QTY

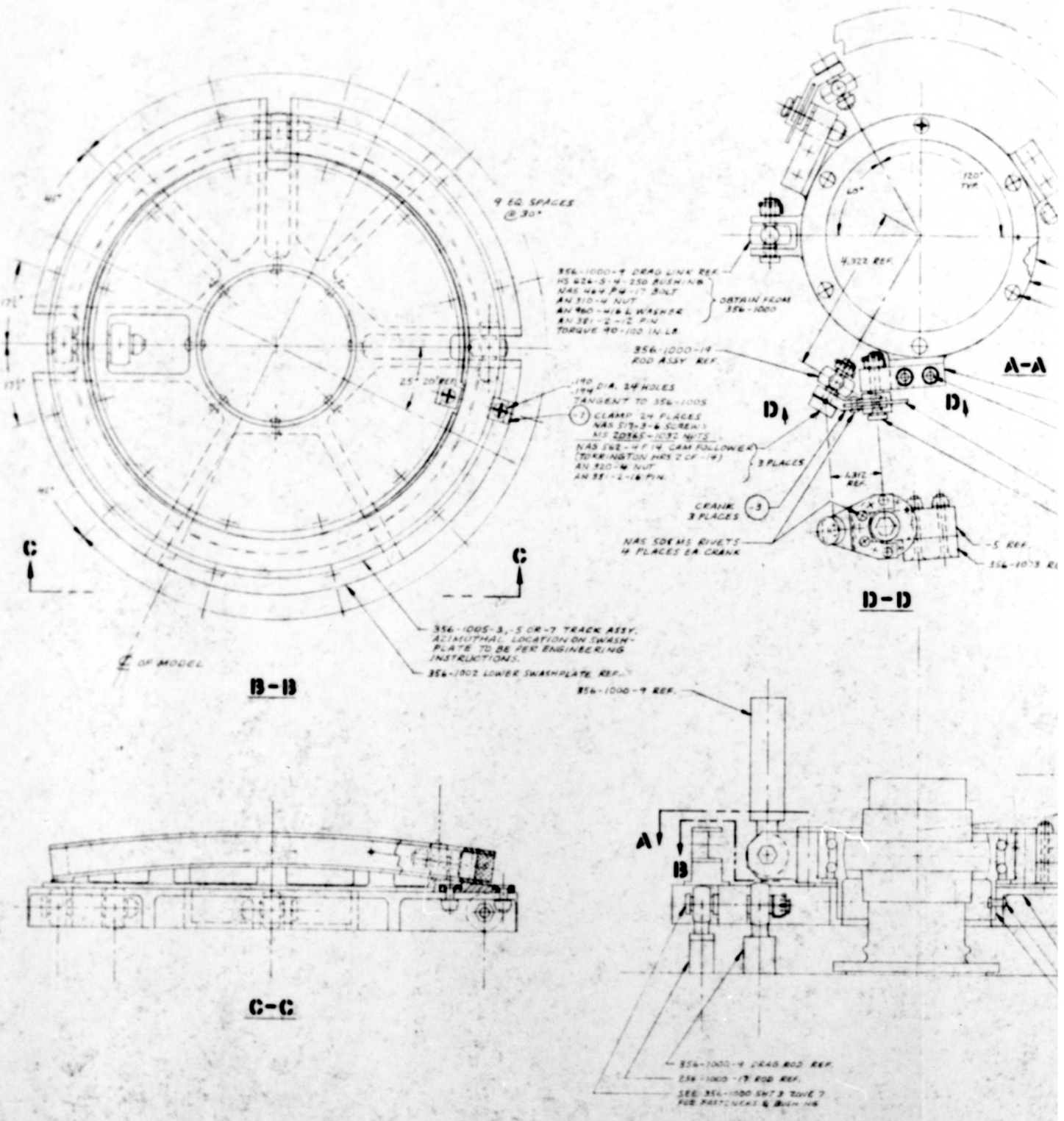


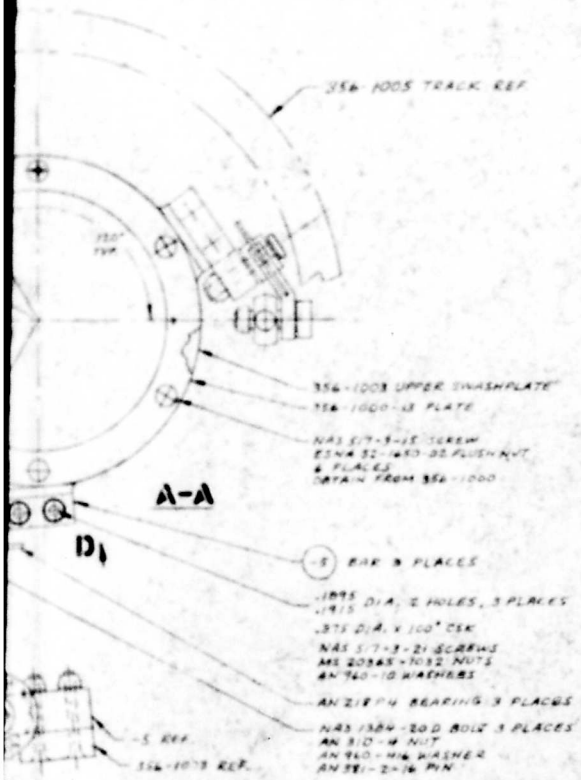
DETAIL -13 PLATE

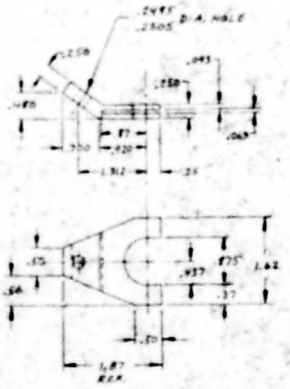
CONTROLS - ONR ROTOR WING WIND TUNNEL MODEL

356-1000

356-1000


9 EQ. SPACES @ 30°
356-1000-9 DRAG LINK REF
HS 624-5-4-250 BUSHING
NAS 464 P8-17 BOLT
AN 310-4 NUT
AN 960-416 L WASHER
AN 381-2-2 PIN
TORQUE 90-100 IN. LB.
OBTAIN FROM 356-1000
356-1000-19 ROD ASSY REF.
.190 DIA. 24 HOLES
.194 TANGENT TO 356-1005
CLAMP 24 PLACES
NAS 517-3-6 SCREWS
MS 20365-1032 NUTS
NAS 562-4 F 14 CAM FOLLOWER (TORRINGTON HRS 2 OF -14)
AN 320-4 NUT
AN 381-2-16 PIN
3 PLACES
CRANK 3 PLACES
NAS 509 MS RIVETS 4 PLACES EA CRANK
356-1005-3, -5 OR -7 TRACK ASSY. AZIMUTHAL LOCATION ON SWASHPLATE TO BE PER ENGINEERING INSTRUCTIONS.
356-1002 LOWER SWASHPLATE REF.
℄ OF MODEL
B-B
C-C
D-D
A-A
356-1000-9 REF.
356-1000-9 DRAG ROD REF.
356-1000-19 ROD REF.
SEE 356-1000 SHT 3 ZONE 7 FOR PARTS LIST & BUSH NO.

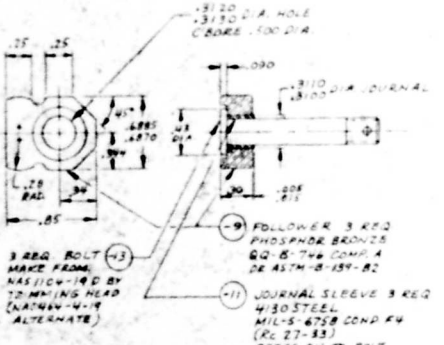




DETAIL -3 CRANK

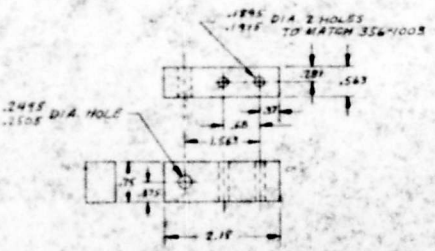
3 REQ

4130 STL MIL S-6758 COND D1



DETAIL OF ALTERNATE CAM FOLLOWER

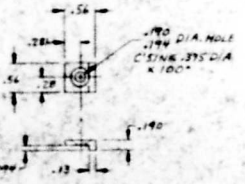
2 X SIZE



DETAIL -5 BAR

3 REQ

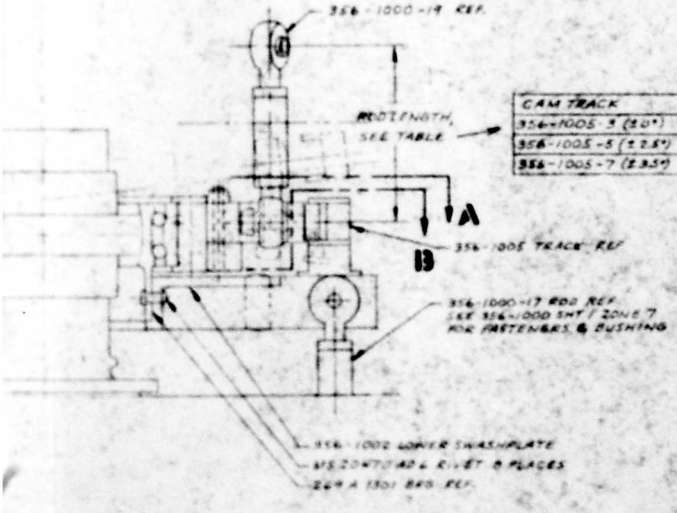
4130 STL MIL-S-6758 COND D1



DETAIL -7 CLAMP

24 REQ.

4130 STL MIL-S-18729 COND N or A
OR MIL-S-6758 COND D1 OR F4



CAM TRACK	ROD LENGTH
356-1005-3 (±0°)	3.29
356-1005-5 (±2.5°)	3.37
356-1005-7 (±3.5°)	3.40

1	356-1002	SWASHPLATE				
1	356-1003	SWASHPLATE				
1	356-1005-3	TRACK				
1	356-1005-5	TRACK				
1	356-1005-7	TRACK				356-1001
3	AN 218 PW	BEARING				
3	NAS 562-416 JH	CAM FOLLOWER				
	SEE FACE OF DRAWING FOR FASTENERS					
3	-13	BOLT	MAKE FROM NAS 1304-19 OR NAS 1304-19			
3	-11	SLEEVE	NOTE 8	4130 STL BAR	MIL-S-6758 COND F4	
3	-9	FOLLOWER	NOTE 9	PHOS BRONZE	QQ-B-746 COMP A OR ASTM-B-139-82	
24	-7	CLAMP	.063 X .750 X 1.5	4130 STL SHEET	MIL-S-18729 COND N OR A	
3	-5	BAR	1.5 X .5 X 3	4130 STL BAR	MIL-S-6758 COND D1	
3	-3	CRANK	1.5 X .5 X 2	4130 STL BAR	MIL-S-6758 COND D1	
QTY	PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE

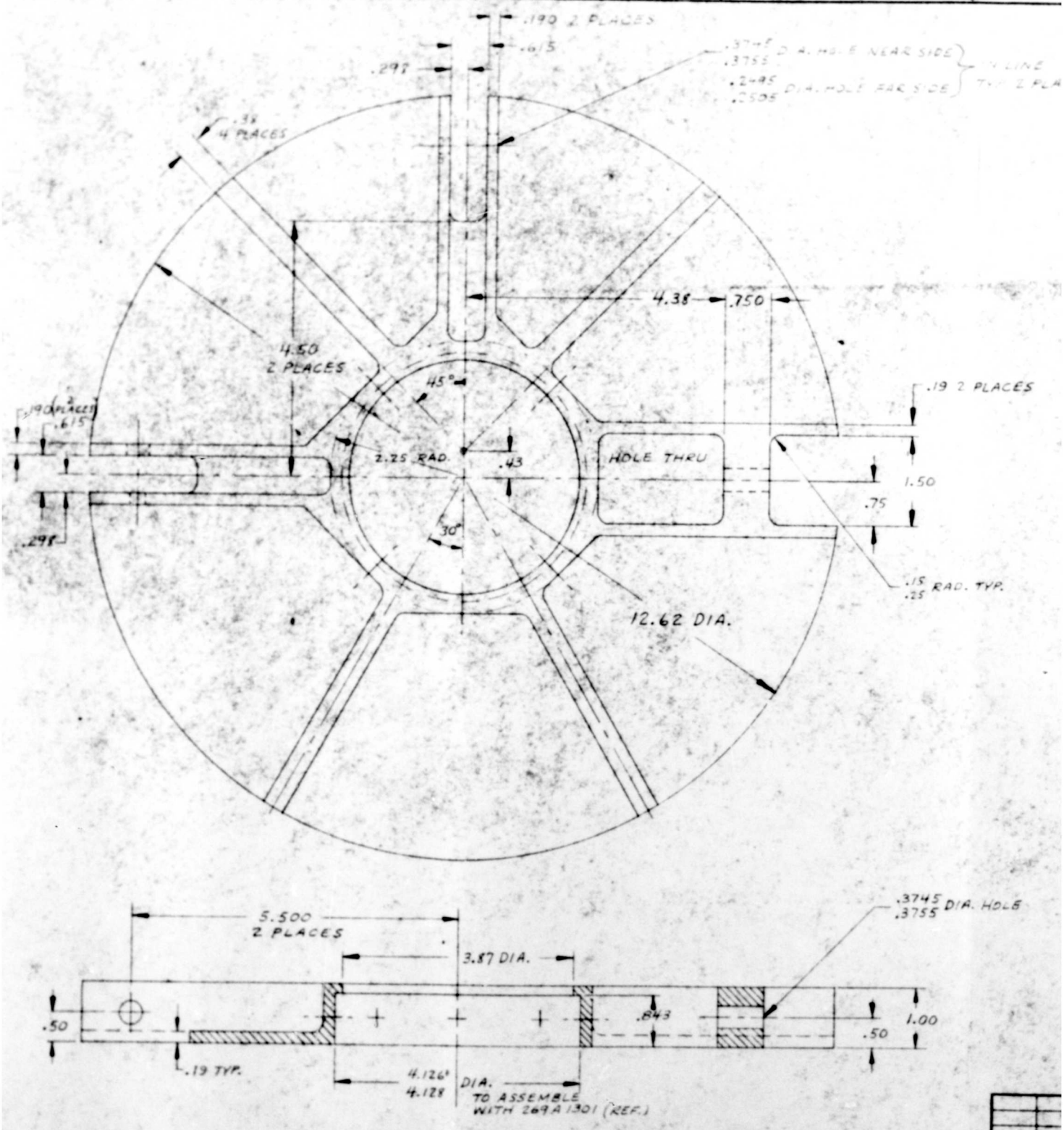
LIST OF MATERIAL

HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

CAM INSTAL-SWASHPLATE, ONR ROTOR/WING WIND TUNNEL MODEL

02731 356-1001

SHT



2. 125 MACH. FINISH ALL OVER

1 MATERIAL AVAILABLE FROM HTCAD STOCK, ACCT # 10513

NOTE:

FROM	THR

4	3	2	1

EFFECTIVE ON	REVISIONS ZONE	LTR	DESCRIPTION	DATE	APPR'VD DATE

-IN LINE
TYP 2 PLACES

2 PLACES

D. TYP.

VR HOLE

D

C

B

356-1002

A

PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE
	PLATE (1)	1¼ x 13 x 13	2024-T351 ALUM.	QQ-A-355	

LIST OF MATERIAL

FROM	THRU	NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
		356-1001	356-0600	1	1
		APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
DIMENSIONAL TOLERANCES
2 PLACE DECIMAL ± .010
3 PLACE DECIMAL ± .03
ANGULAR ± 0° 30'

MATERIAL AND PROCESS

CONTRACT NO.

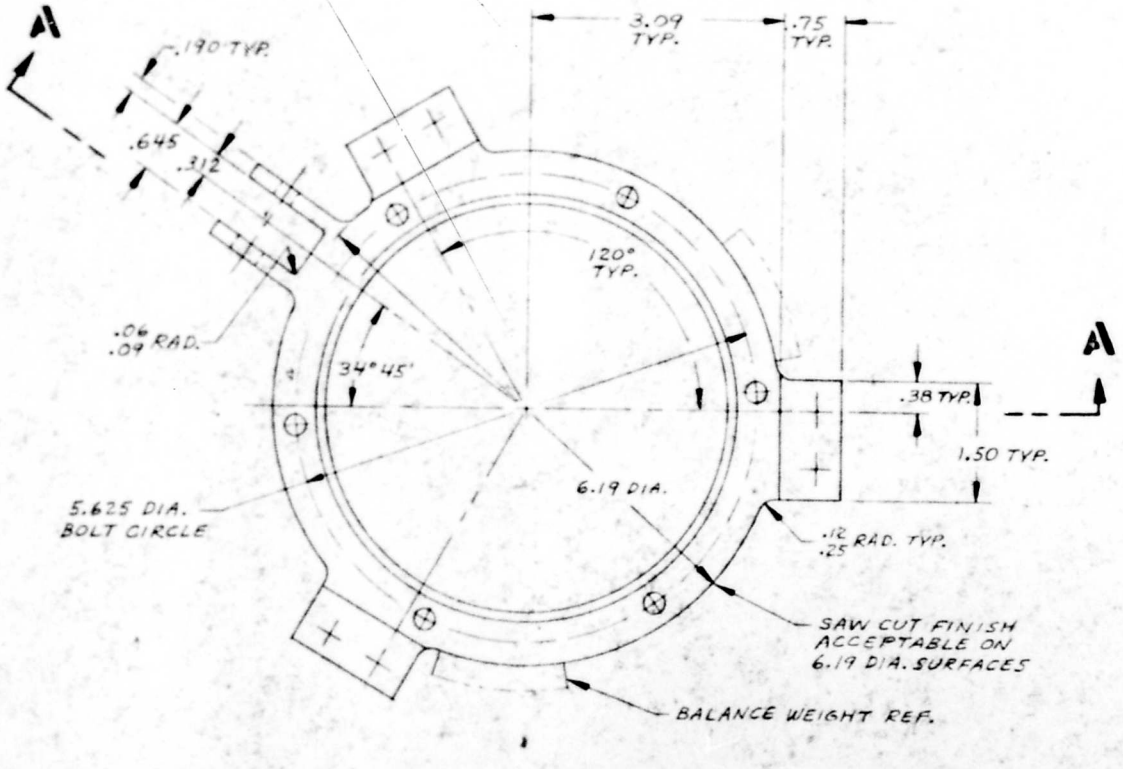
DRWN	O. PLOWE	9 APR. 65
CHK'D		
APP'D		
APP'D		
APP'D		
APP'D		
APP'D	[signature]	4-5-65
HT/CAD APPROVAL		
APPROVAL		

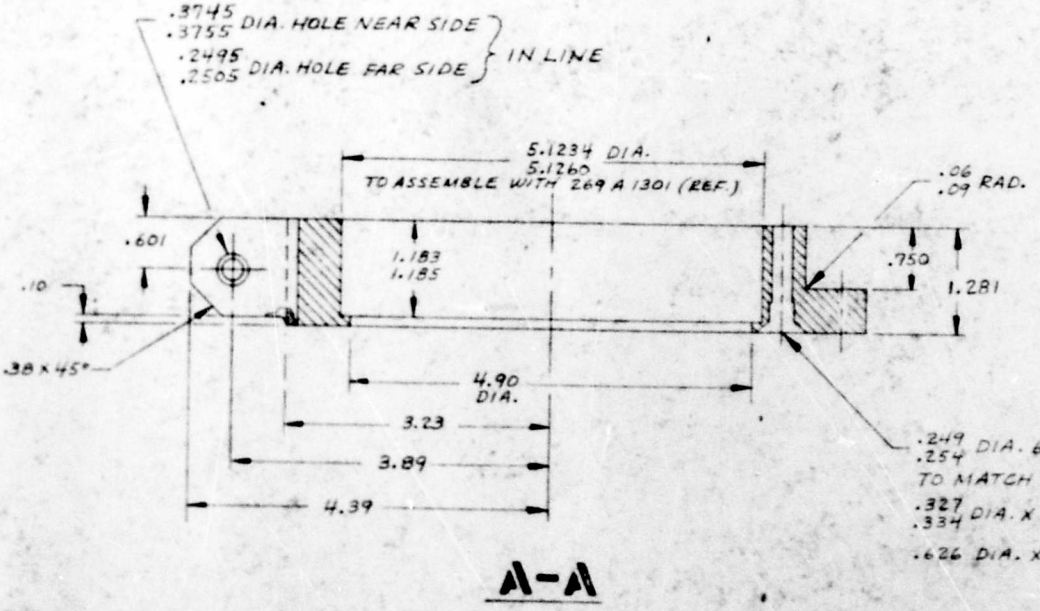
HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

DWG. TITLE
SWASHPLATE - LOWER,
ONR ROTOR/WING
WIND TUNNEL MODEL

SIZE	CODE IDENT NO.	DWG. NO.
D	02731	356-1002

SCALE 1/1 SHEET





A-A

2. 125 MACH. FINISH ALL OVER

[1] MATERIAL AVAILABLE FROM HTCAD STOCK. ACCT # 10513

NOTE: UNLESS SPECIFIED OTHERWISE

4	3	2	1

EFFECTIVE ON	REVISIONS ZONE	LTR	DESCRIPTION	DATE	APPVD DATE

D

C

B

356-1003

A

PART NO	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE
	PLATE (1)	1½ x 9 x 9	2024-T351 OR 2024-T4 ALUM	QQ-A-355	

LIST OF MATERIAL

FOR EINA 52-1650-02 FLUSH NUT

FROM	THRU	NEXT ASSY	USED ON	MFR'S ASSY	THIS ASSY
		356-1001	356-0600	1	1
		APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DIMENSIONAL TOLERANCES
3 PLACE DECIMAL ± .000
2 PLACE DECIMAL ± .01
ANGULAR ± 0° 30'

MATERIAL AND PROCESS

CONTRACT NO.

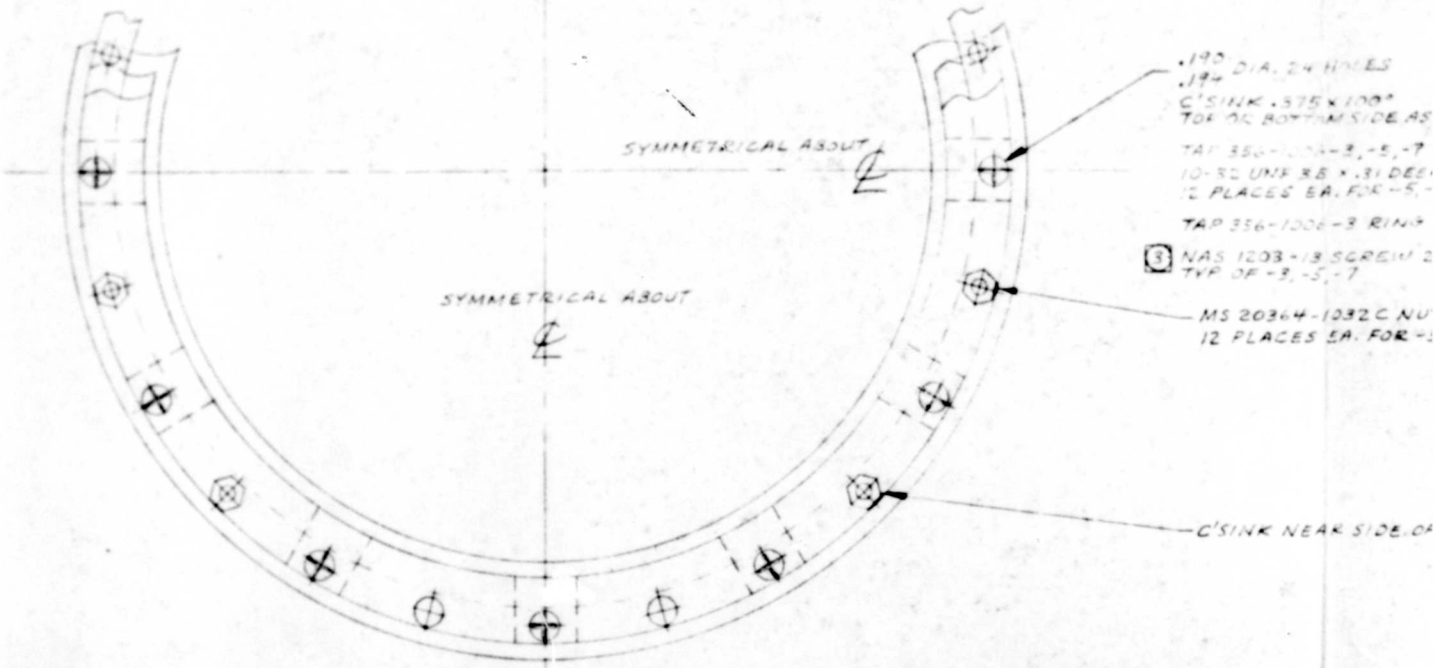
DRWN	D. PLOKE 12 APR 65
CHK'D	
APP'D	
APP'D	
APP'D	
APP'D	
HTCAD APPROVAL	4-12-65
APPROVAL	

HUGHES TOOL COMPANY-AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

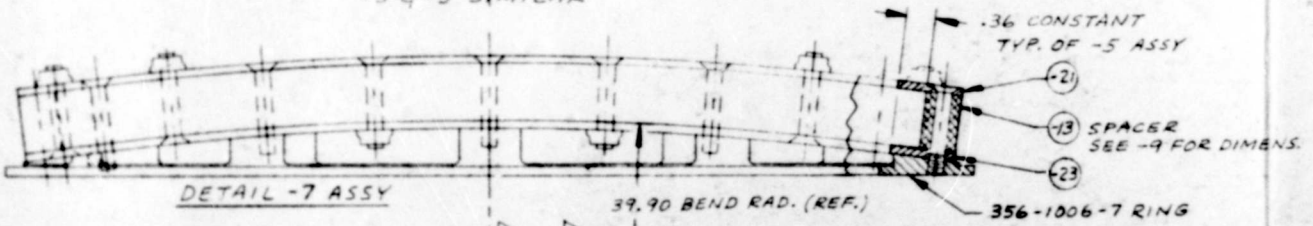
DWG TITLE
SWASHPLATE-UPPER, ONR ROTOR/WING WIND TUNNEL MODEL

SIZE	CODE IDENT NO	DWG NO
D	02731	356-1003

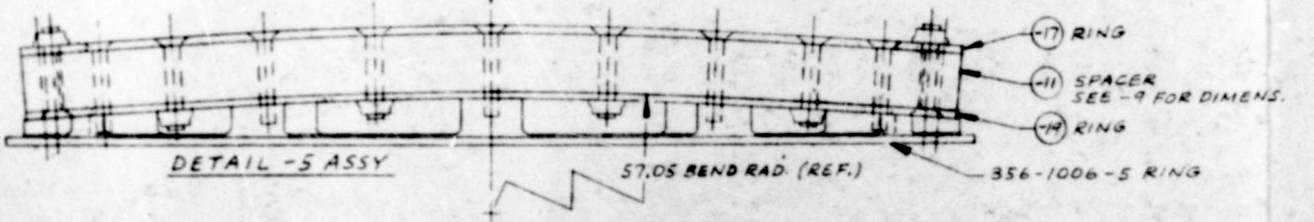
SCALE 1/1 SHEET



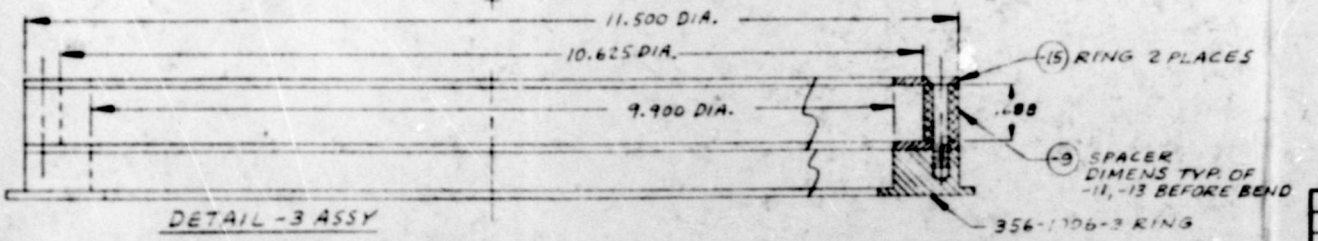
PLAN VIEW OF -7 SHOWN FLAT FOR CLARITY
-3 & -5 SIMILAR



DETAIL -7 ASSY



DETAIL -5 ASSY



DETAIL -3 ASSY

(4) 6061-O MATL MAY BE USED FOR -9, -11, -13

(5) NAS 1203-13 SCREWS USED IN TAPPED HOLES ARE TO HAVE SELF-LOCKING INSERTS PER HP 15-34

2. HEAT TREAT -15, -17, -19, -21, -23 TO 160,000 / 180,000 PS.I. U.T.S. (RC 36-40) PER HP 1-1.

1. $\sqrt{125}$ ALL MACHINED SURFACES

NOTE:

FROM

4	3	2	1

EFFECTIVE ON	REVISIONS ZONE	LTR	DESCRIPTION	DATE	APPROVED DATE

D

C

B

A

			PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE
1			356-1006-7					
	1		356-1006-5					
		1	356-1006-3					
12	12		MS 20364-1032C	NUT				
24	24	24	NAS 1203-13 (3)	SCREW				
							356-1005	
1			-23	RING	.090 X 12 X 12	4130 STL SHT	MIL-S-18729 COND A	
1			-21	RING				
	1		-19	RING				
	1		-17	RING				
		2	-15	RING	.090 X 12 X 12	4130 STL SHT	MIL-S-18729 COND A	
1			-13	SPACER	3/4 X 12 X 12	2024-T351 ALUM	QQ-A-355	
	1		-11 (4)	SPACER	5/4 X 12 X 12	2024-T351 ALUM	QQ-A-355	
		1	-9	SPACER	3/4 X 12 X 12	2024-T351 ALUM	QQ-A-355	
			-7	TRACK ASSY	± 3.5°			
			-5	TRACK ASSY	± 2.5°			
			-3	TRACK ASSY	± 0°			
-7	-5	-3	PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE

SUB ASSEMBLY REQMENTS

LIST OF MATERIAL

FROM	THRU	APPLICATION NEXT ASSY	APPLICATION USED ON	QTY REQ'D -7	QTY REQ'D -5	QTY REQ'D -3
		356-1001	356-0600	1	1	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
2 PLACE DEC. ANG. ± .010
3 PLACE DECIMAL ± .030
ANGULAR ± 0° 30'

MATERIAL AND PROCESS

CONTRACT NO.

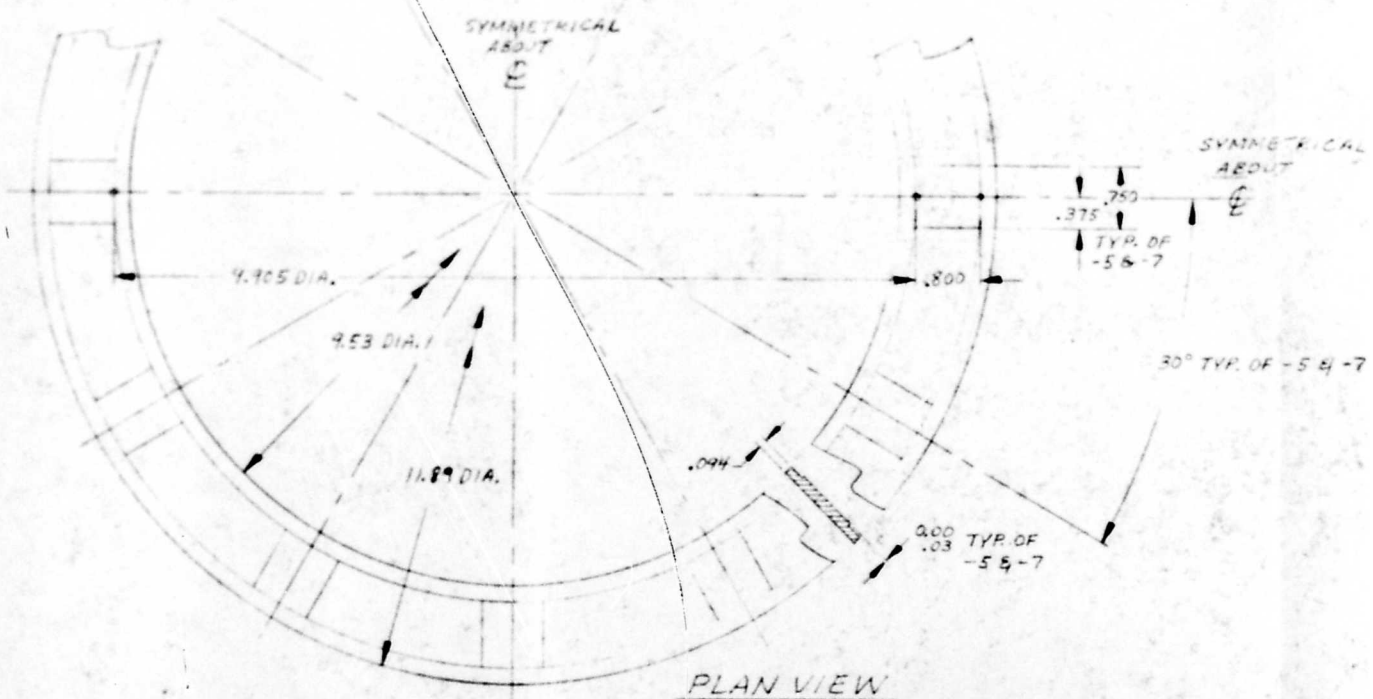
DRWN	O. PLOWMARES
CHK'D	
APP'D	
APP'D	
APP'D	
APP'D	
APP'D	
HTC AD APPROVAL	
APPROVAL	

HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

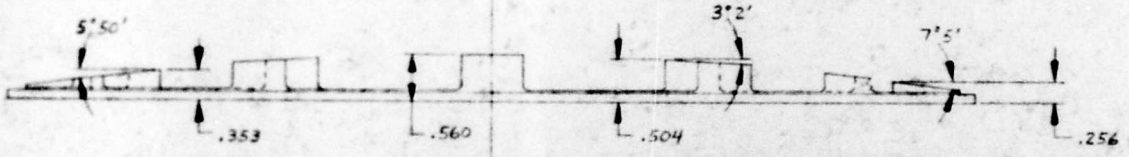
DWG. TITLE
TRACK ASSY-SWASHPLATE CAM, ONR ROTOR/WING WIND TUNNEL MODEL

SIZE	CODE IDENT NO	DWG. NO.
D	02731	356-1005

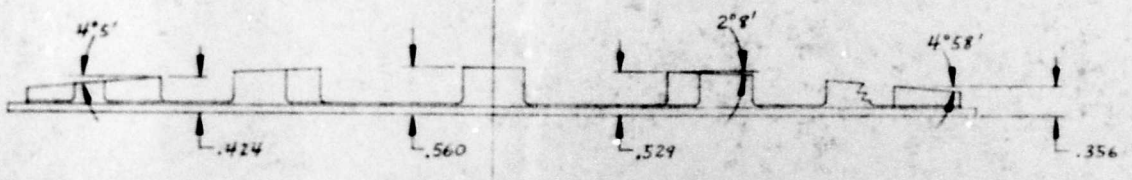
SCALE 1/1 AS NOTED SHEET



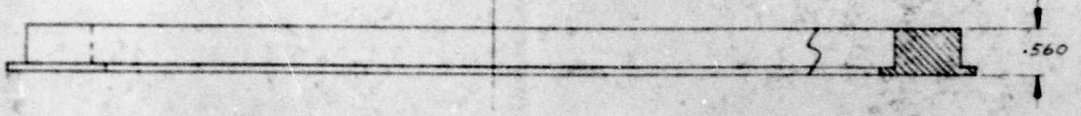
PLAN VIEW
TYP OF -3, -5, -7
EXCEPT AS NOTED



DETAIL -7 (FOR ±3.5° TRACK)



DETAIL -5 (FOR ±2.5° TRACK)



DETAIL -3

NOTE:
1. $\sqrt{125}$ MACH. FINISH ALL OVER

4	3	2	1

EFFECTIVE ON	REVISIONS ZONE	LTR	DESCRIPTION	DATE	APPROVD DATE

D

C

B

356-1006

A

PART NO.	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE
-7	RING	3/4 x 12.5 DIA	STL PLATE	AISI 4018, C1116 OR ASTM-A-7	
-5	RING	3/4 x 12.5 DIA	STL PLATE		
-3	RING	3/4 x 12.5 DIA	STL PLATE		

LIST OF MATERIAL

FROM	THRU	NEXT ASSY	USED ON	QTY REQD
				(-3) (-5) (-7)
				(-3) (-5) (-7)

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES 3 PLACE DECIMAL ± .010 2 PLACE DECIMAL ± .03 ANGULAR ± 1°

MATERIAL AND PROCESS

CONTRACT NO.

DRWN	D. PLOWE
CHK'D	
APP'D	
APP'D	
APP'D	
APP'D	
APP'D	

RTCAD APPROVAL

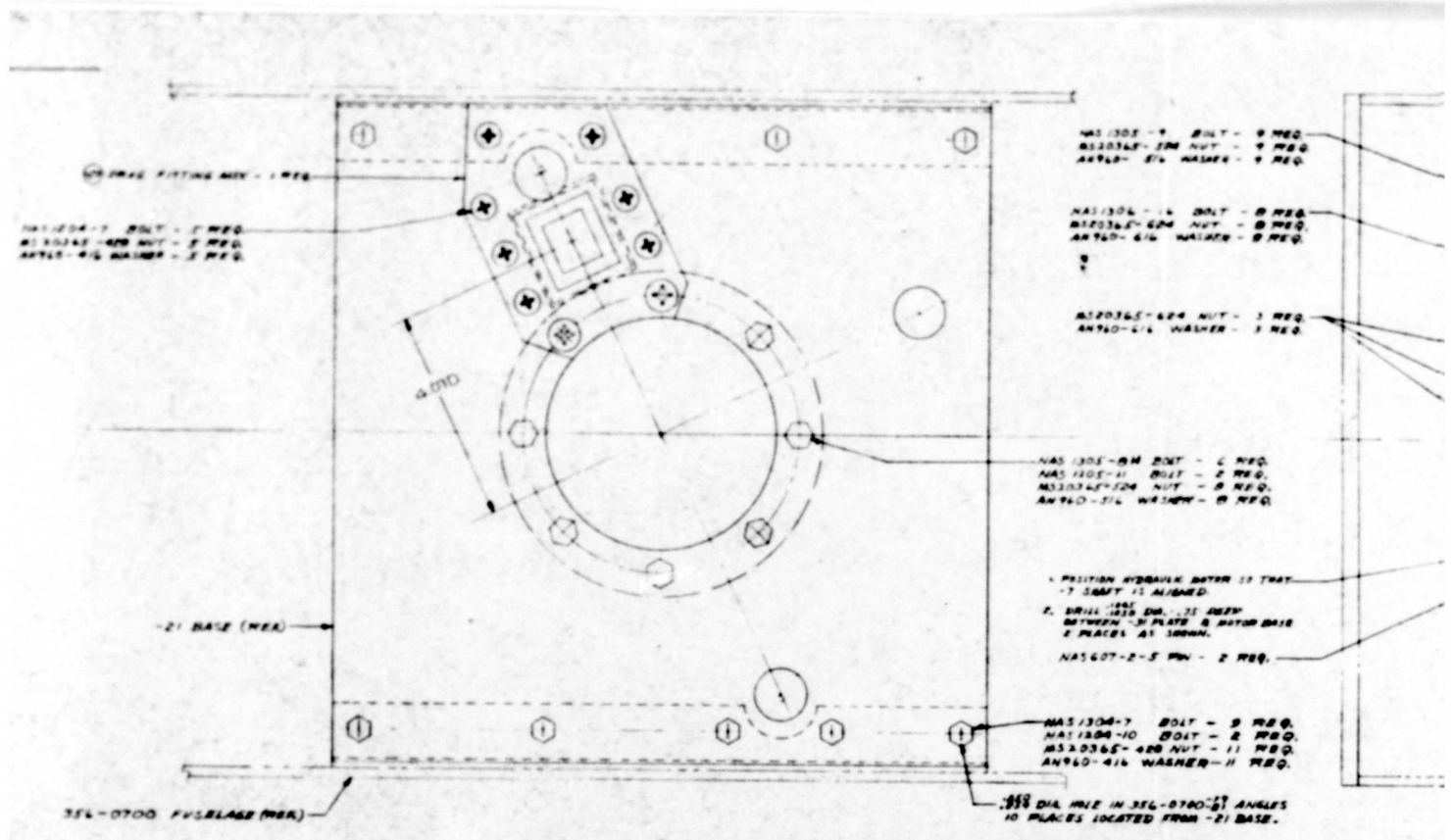
APPROVAL

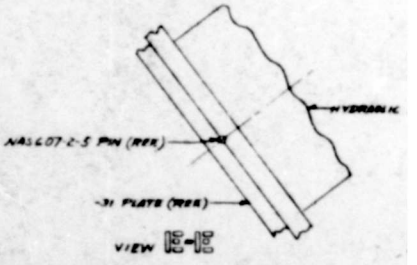
HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

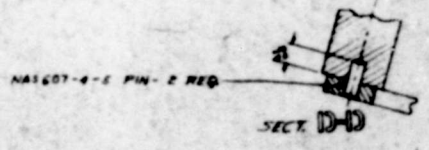
DWG. TITLE
RING - CAM TRACK MOUNT, ONR ROTOR/WING WIND TUNNEL MODEL

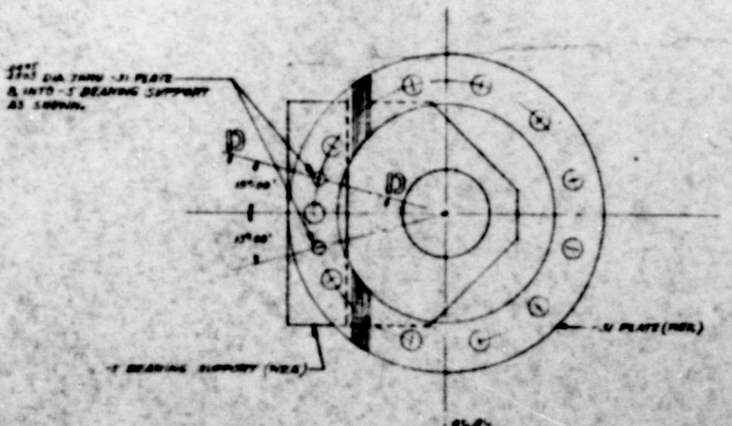
SIZE	CODE IDENT NO	DWG. NO.
D	02731	356-1006

SCALE 1/1 SHEET



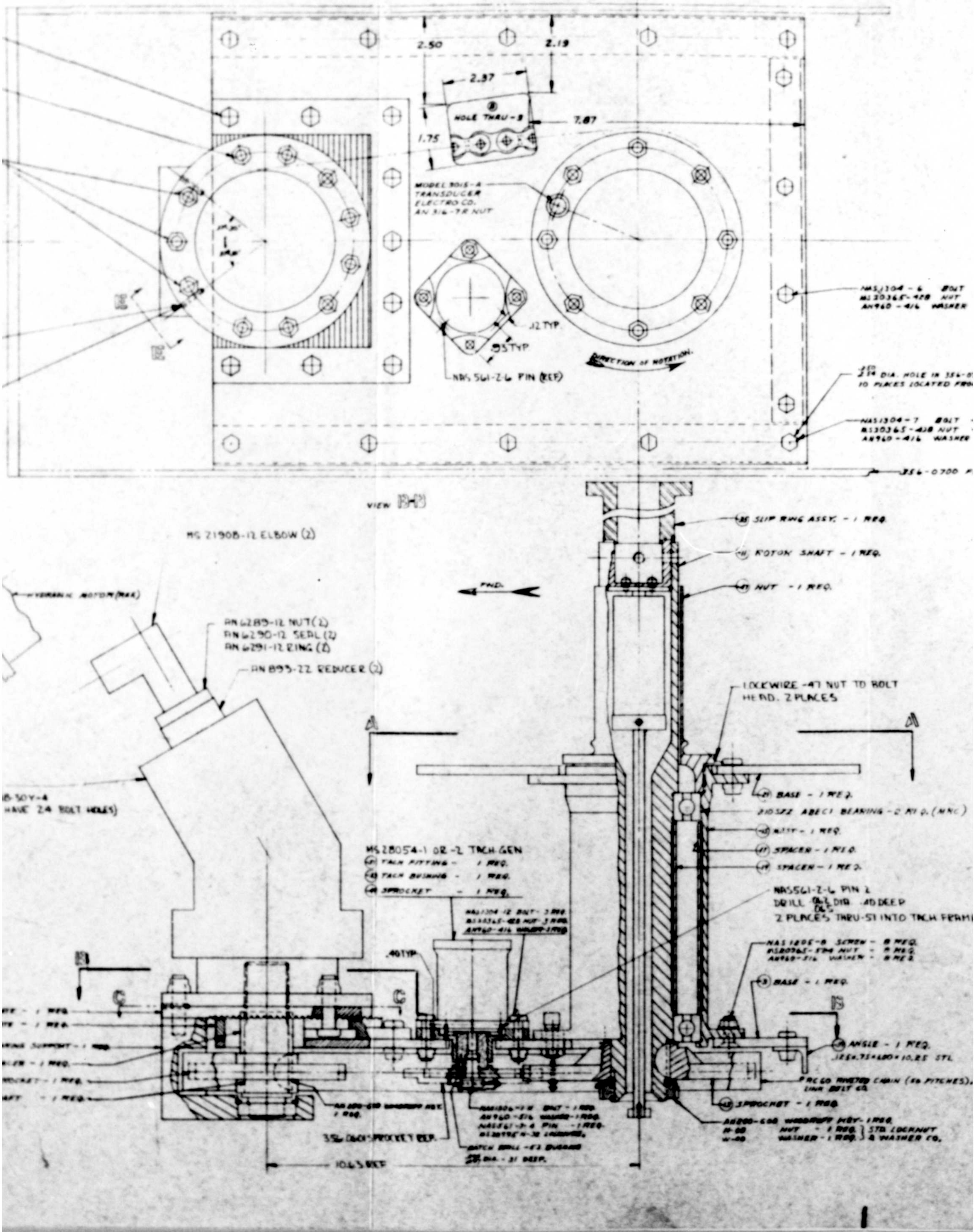






HYDRAULIC MOTOR
VICKERS #MF40-3R8-30Y-4
(FLANGE REVISED TO HAVE 24 BOLT

(32) PLATE - 1 REQ.
(31) PLATE - 1 REQ.
(5) BEARING SUPPORT -
(7) SPACER - 1 REQ.
(6) SPROCKET - 1 REQ.
(4) SHAFT - 1 REQ.



2.50
2.19
2.37
HOLE THRU - 8
1.75
7.87
MODEL 3015-A
TRANSDUCER
ELECTRO CO.
AN 316-7R NUT
.12 TYP.
.95 TYP
NAS 561-2-6 PIN (REF)
DIRECTION OF ROTATION
NAS1304 - 6 BOLT
MS20365 - 428 NUT
AN960 - 416 WASHER
NAS1304 - 7 BOLT
MS20365 - 428 NUT
AN960 - 416 WASHER
356-0700
VIEW
MS 21908-12 ELBOW (2)
SLIP RING ASSY. - 1 REQ.
ROTOR SHAFT - 1 REQ.
NUT - 1 REQ.
FWD.
HYDRAULIC MOTOR (REF)
AN 6289-12 NUT (2)
AN 6290-12 SEAL (2)
AN 6291-12 RING (2)
AN 893-22 REDUCER (2)
LOCKWIRE -47 NUT TO BOLT
HEAD. 2 PLACES
A
A
HAVE 24 BOLT HOLES)
BASE - 1 REQ.
ABEC1 BEARING
SPACER - 1 REQ.
SPACER - 1 REQ.
MS28054-1 OR -2 TACH GEN
TACH FITTING - 1 REQ.
TACH BUSHING - 1 REQ.
SPROCKET - 1 REQ.
NAS561-2-6 PIN 2
2 PLACES THRU-51 INTO TACH FRAME
.40 TYP
B
C
C
B
BASE - 1 REQ.
ANGLE - 1 REQ.
SPROCKET - 1 REQ.
AN200-600 WOODRUFF KEY - 1 REQ.
356-0603 SPROCKET REF.
10.63 REF

REVISIONS						
SYM	E.O.	DESCRIPTION	DRWN	APP'D	DATE	
A		REVISED FIGS AT MOTOR. ADDED 356 CHAIN SPROCKET REF.				
B		ADDED ACCESS HOLE IN -3 BASE FOR SPROCKET CHAIN LOCK LINK				

MS21104-6 BOLT - 4 REQ.
MS20365-428 NUT - 4 REQ.
AN960-416 WASHER - 4 REQ.

DIA. HOLE IN 356-0700-37 ANGLES
10 PLACES LOCATED FROM -3 BASE.

NAS1304-7 BOLT - 10 REQ.
MS20365-428 NUT - 10 REQ.
AN960-416 WASHER - 10 REQ.

356-0700 FUSELAGE (REF.)

- 1 REQ.

- 1 REQ.

T TO BOLT

A

BEARING - 2 REQ. (REF.)

THRU-ST INTO TECH FRAME

ANGLE - 1 REQ.

CHAIN (.. PITCHES), 1 REQ.

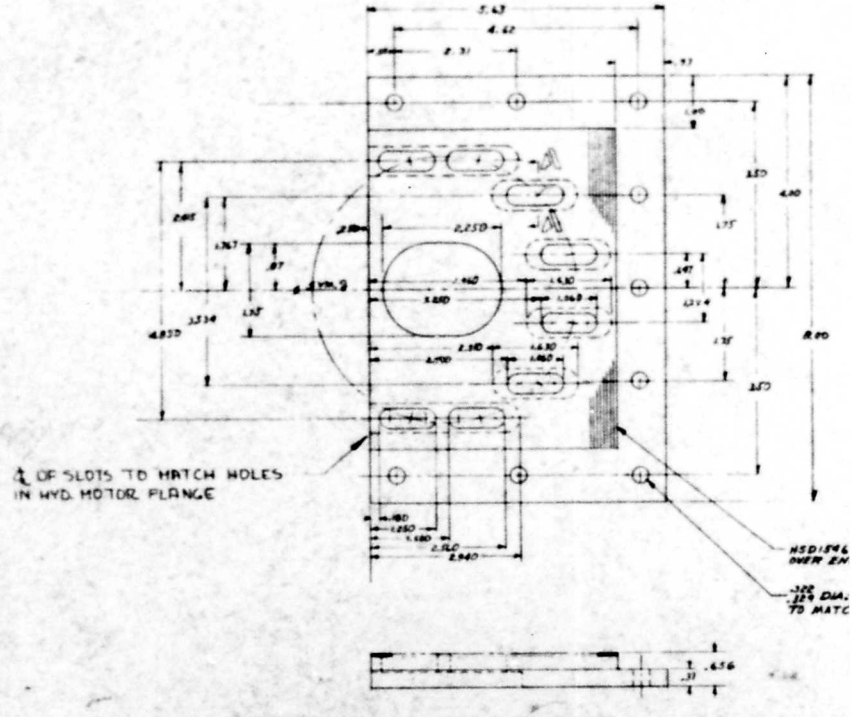
STD LOCKNUT
& WASHER CO.

356-1100
B

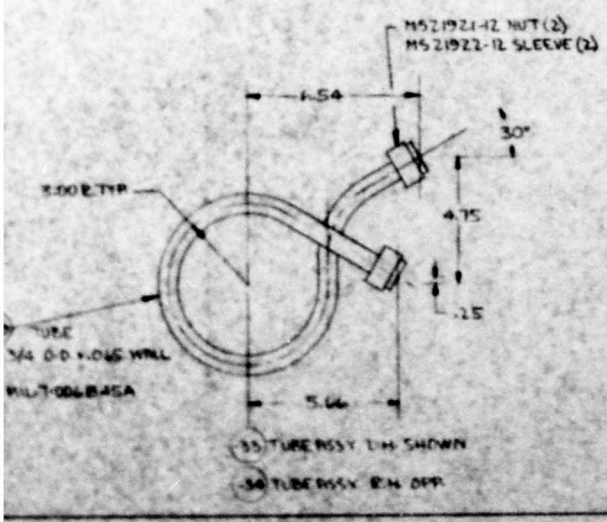
RELEASE FOR FABRICATION 10-15-69
REV. "A" 11-8-69

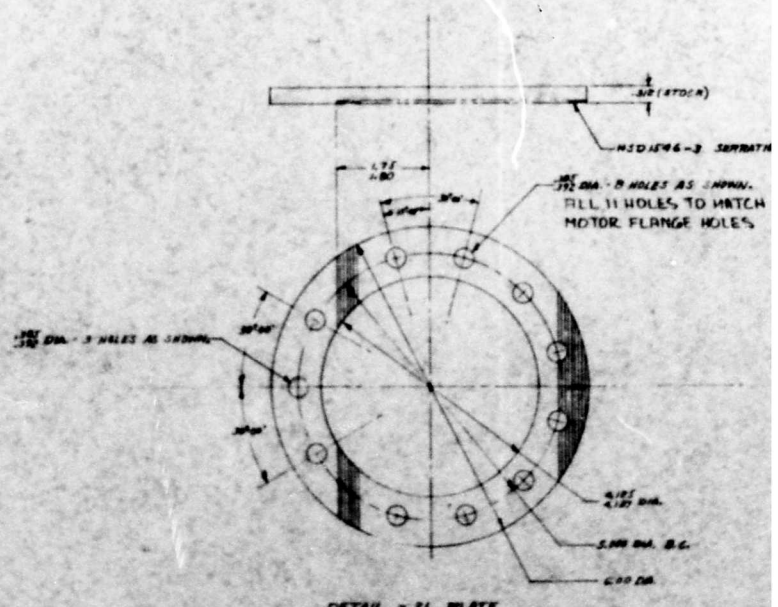
PROPULSION SYSTEM

356-1100

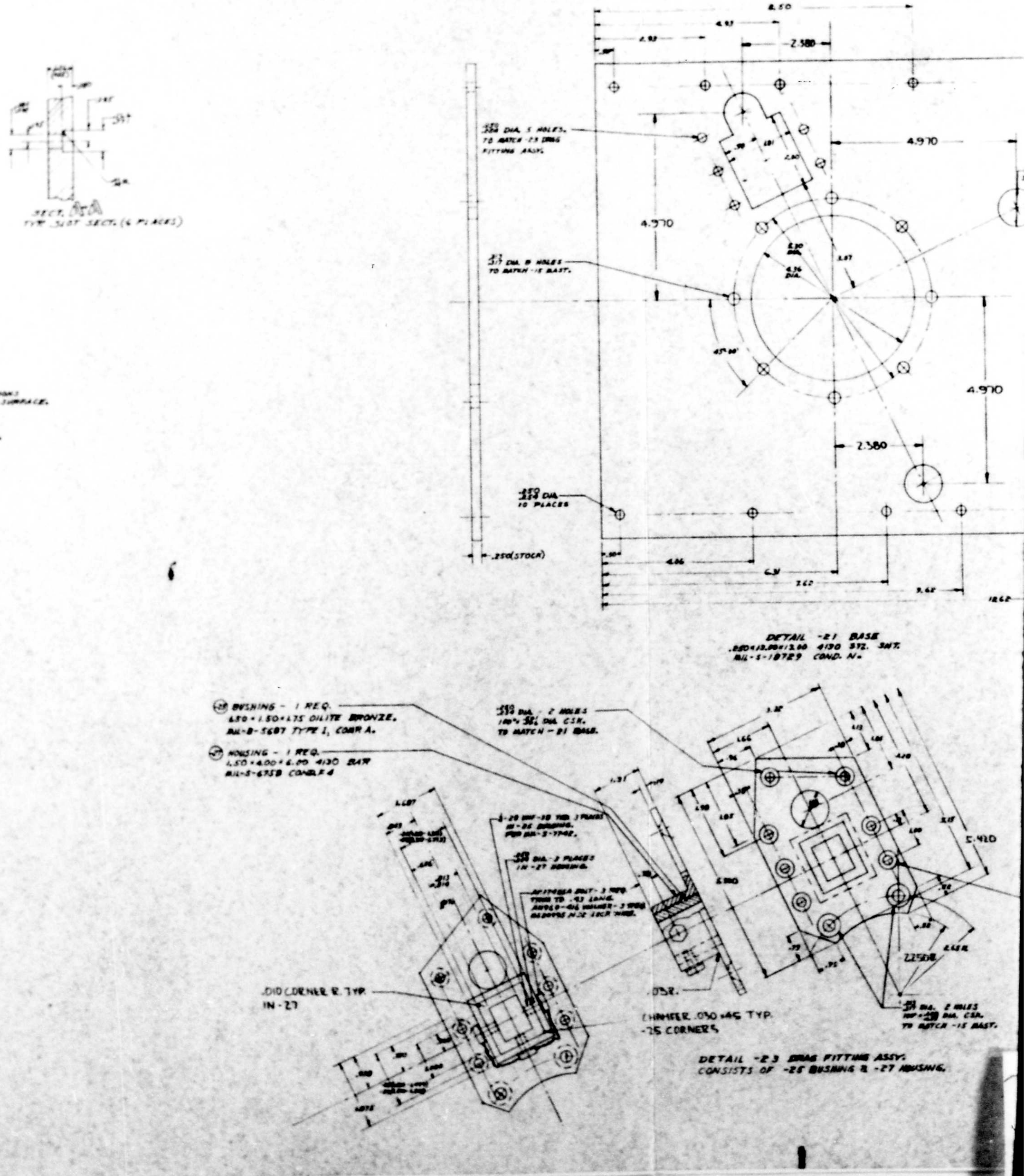


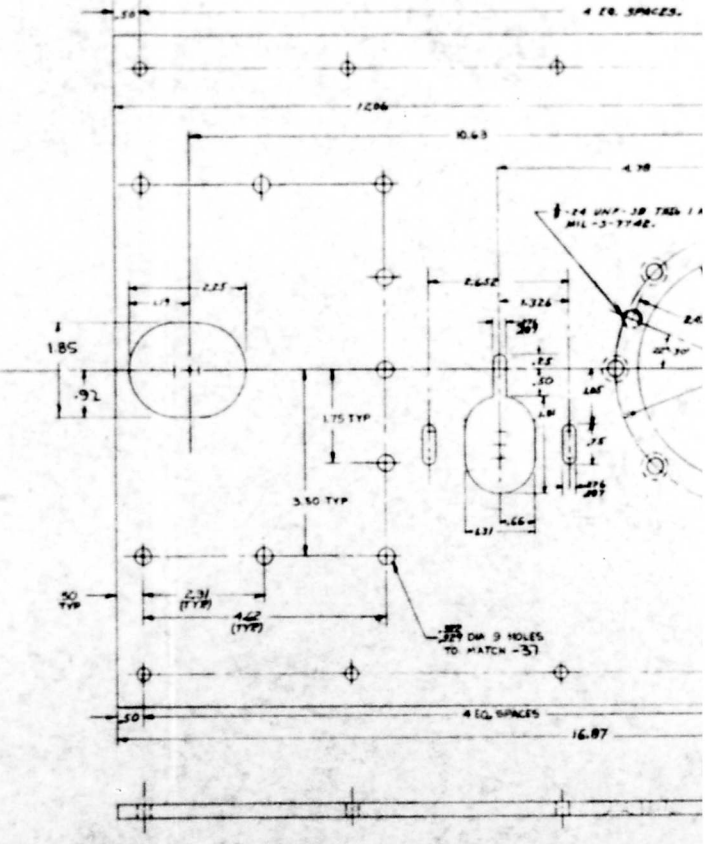
DETAIL -37 PLATE
.750 × 8.00 × 10.00 4130 STL. PLATE
MIL-S-18729 COND N.

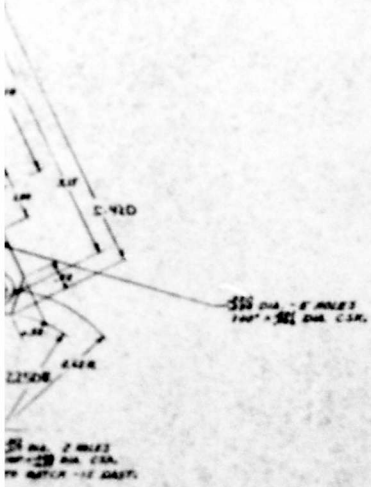




DETAIL -31 PLATE
.312 × 8.00 × 8.00 4130 STL. PLATE.
MIL-S-18729 COND N.

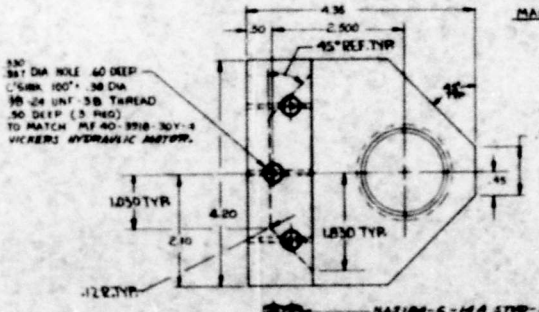

SECT. A-A
TYP. SLOT SECT. (6 PLACES)
DIA. 5 HOLES. TO MATCH -23 DRAG FITTING ASSY.
DIA. 8 HOLES TO MATCH -15 BAST.
DIA. 10 PLACES
.250 (STOCK)
2.380
4.970
8.50
4.06
6.31
9.62
12.62
DETAIL -21 BASE
.250×13.00×13.00 4130 STL. SHT.
MIL-S-18729 COND. N.
-25 BUSHING - 1 REQ.
.650×1.50×.875 OILITE BRONZE.
MIL-B-5687 TYPE I, COMP A.
-27 HOUSING - 1 REQ.
1.50×4.00×6.00 4130 BAR
MIL-S-6758 COND. F4
DIA. - 2 HOLES
100°× DIA. CSK.
TO MATCH - 21 BASE.
IN -25 BUSHING.
IN -27 HOUSING.
.010 CORNER R. TYP.
IN -27
CHAMFER .030×45 TYP.
-25 CORNERS
5.420
2.25 DIA.
TO MATCH -15 BAST.
DETAIL -23 DRAG FITTING ASSY.
CONSISTS OF -25 BUSHING & -27 HOUSING.

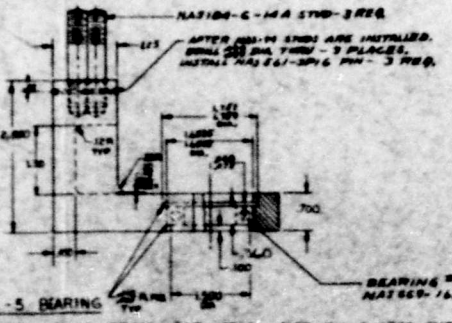




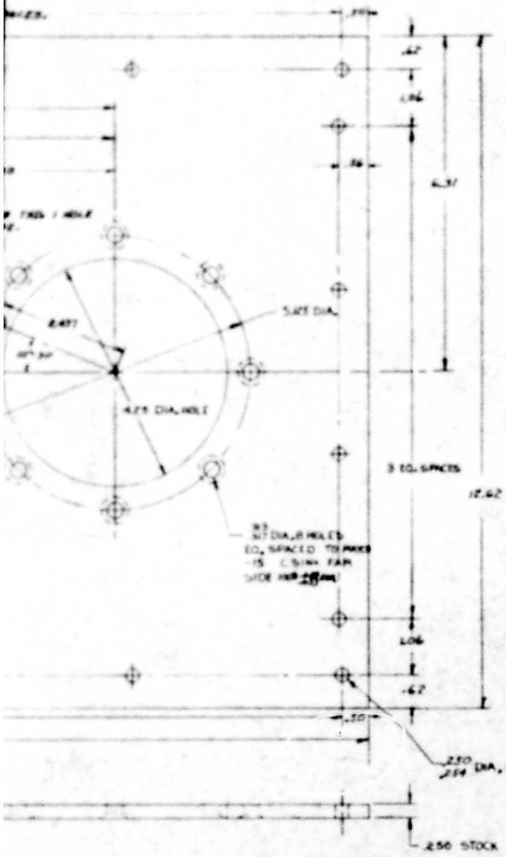
DETAIL - 3 BASE

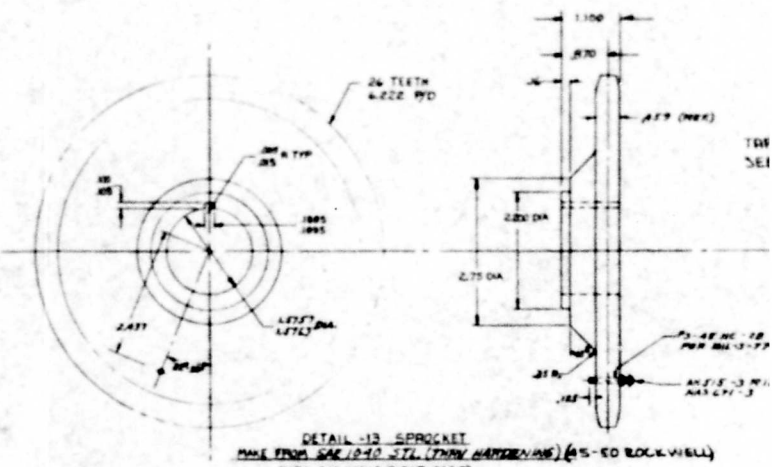
MAKE FROM SHT STEEL 4130



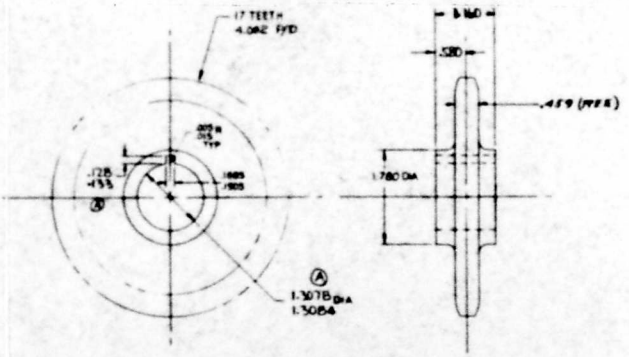


DETAIL - 5 BEARING SUPPORT - MAKE FROM BAR STEEL 4130 MIL-S-6758 COND F4 3.25 - 4.50 -

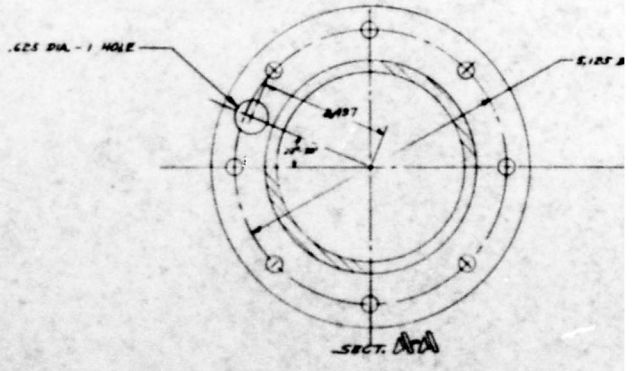


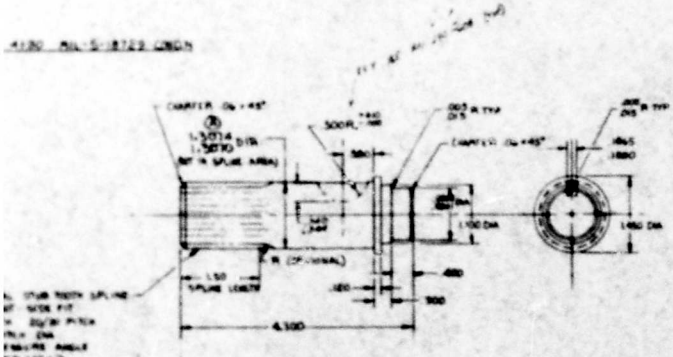


DETAIL -13 SPROCKET
MAKE FROM SAE 1040 STL. (THRU HARDENING) (45-50 ROCKWELL)
(MFG. BY LINK-BELT CORP.)

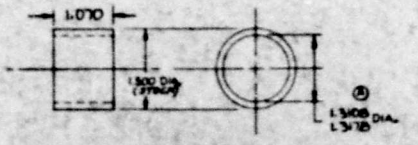


DETAIL -41 SPROCKET
MAKE FROM SAE 1040 STL. (THRU HARDENING) (45-50 ROCKWELL)
(MFG. BY LINK-BELT CORP.)

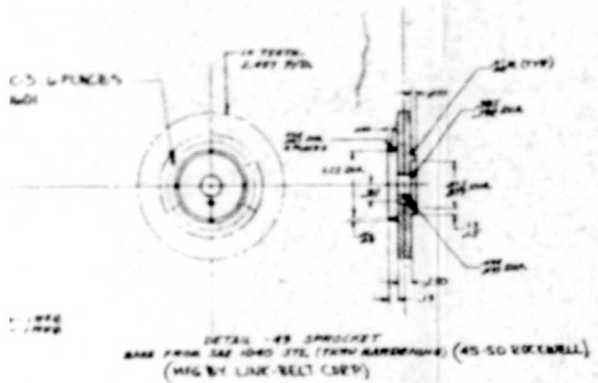




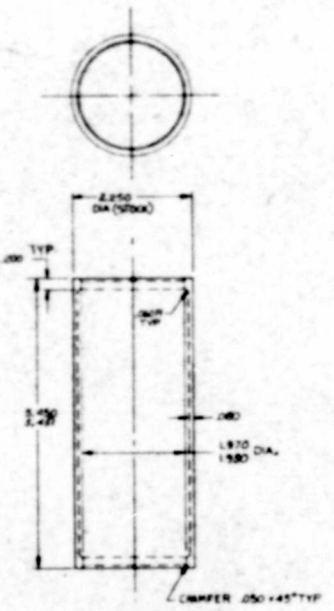
DETAIL - 7 SHAFT
MAKE FROM BAR STEEL 4130 MIL-S-6758 (COND D)
HEAT TREAT TO 125,000 PSI



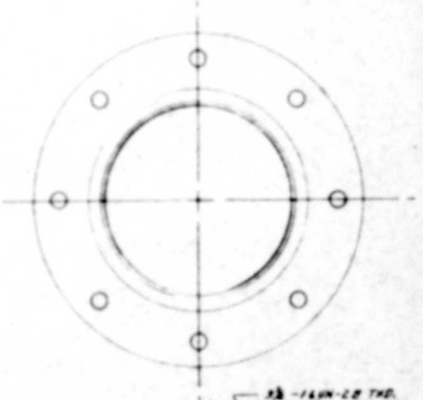
DETAIL - 9 SPACER
MAKE FROM BAR STEEL 4130 MIL-S-6758 COND F4

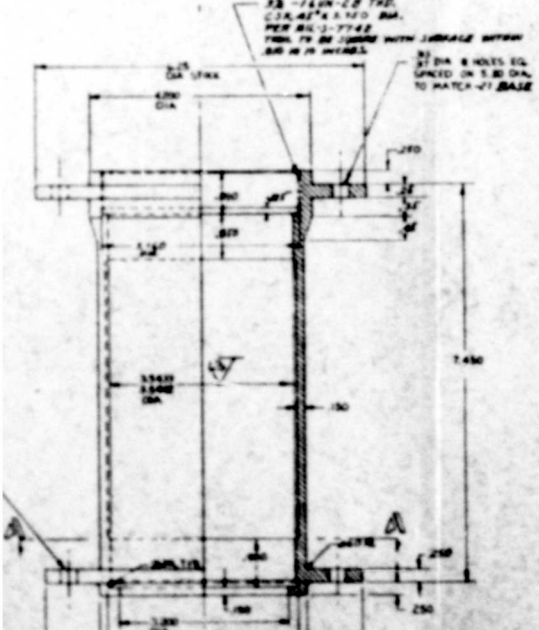


DETAIL - #9 SPROCKET
MADE FROM SAE 1040 STL (THRU HARDENING) (45-50 ROCKWELL)
(MFG BY LINK-BELT CORP)

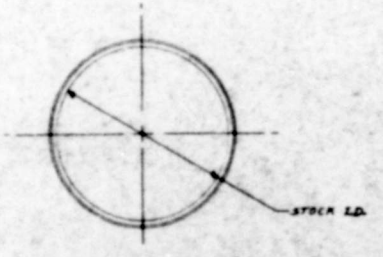


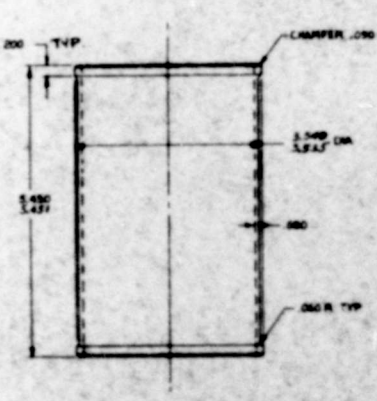
DETAIL - #8 SPACER
MAKE FROM 4130 STEEL TUBING OR EQIV.
2.250 O.D. × .250 WALL
ENDS TO BE PARALLEL & SQUARE WITH SIDES WITHIN .010 IN 10 INCHES.



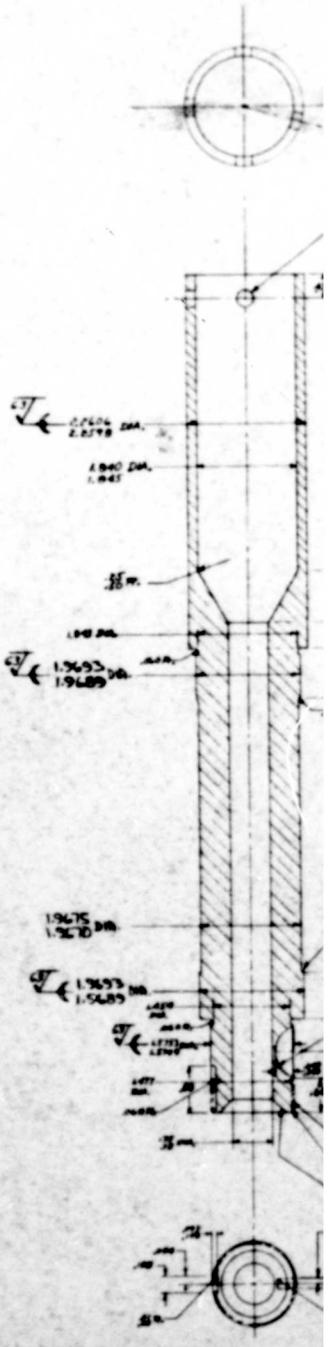


DETAIL - #6 MAST
MADE FROM 4130 STEEL TUBING MFG.

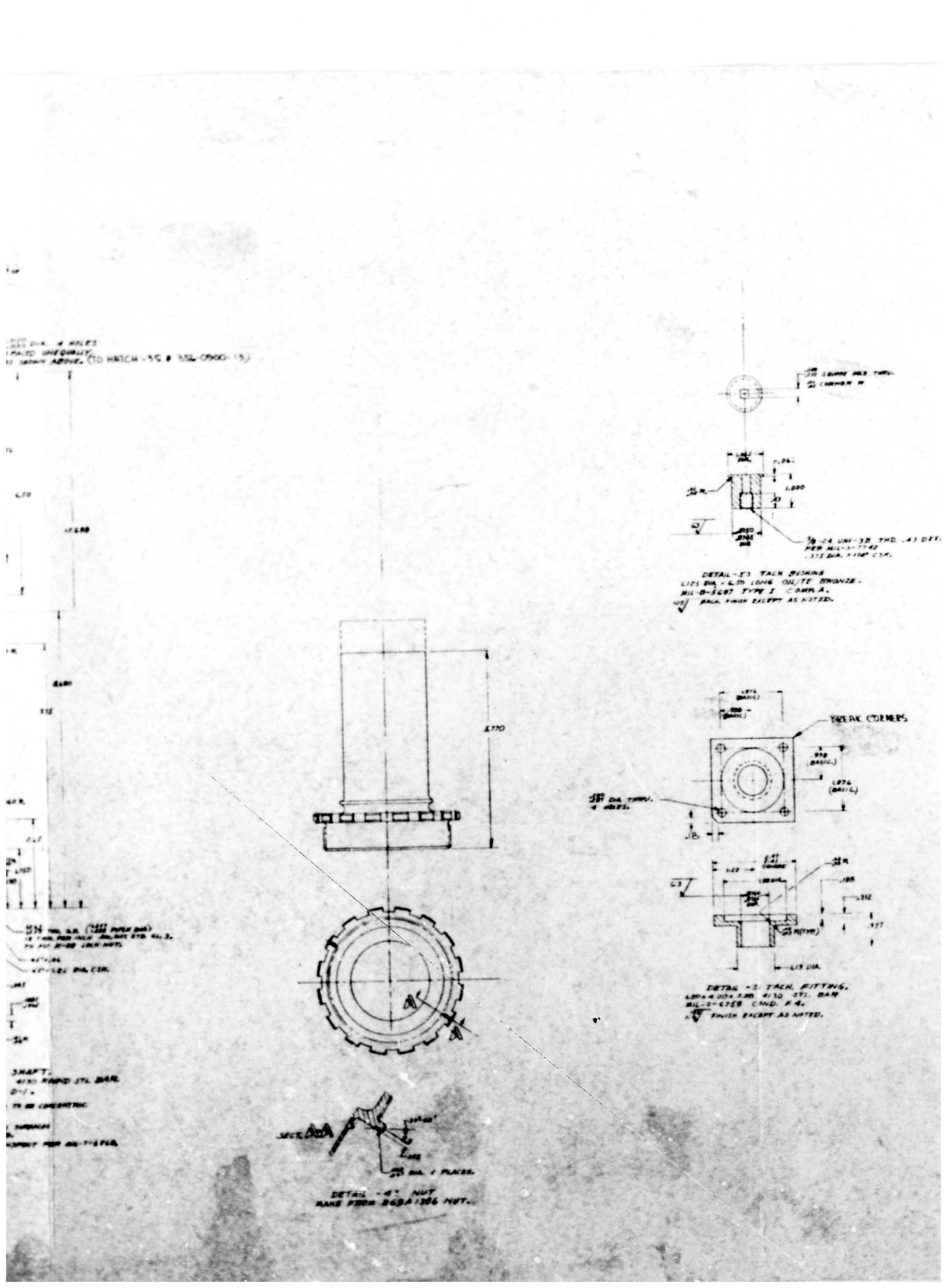


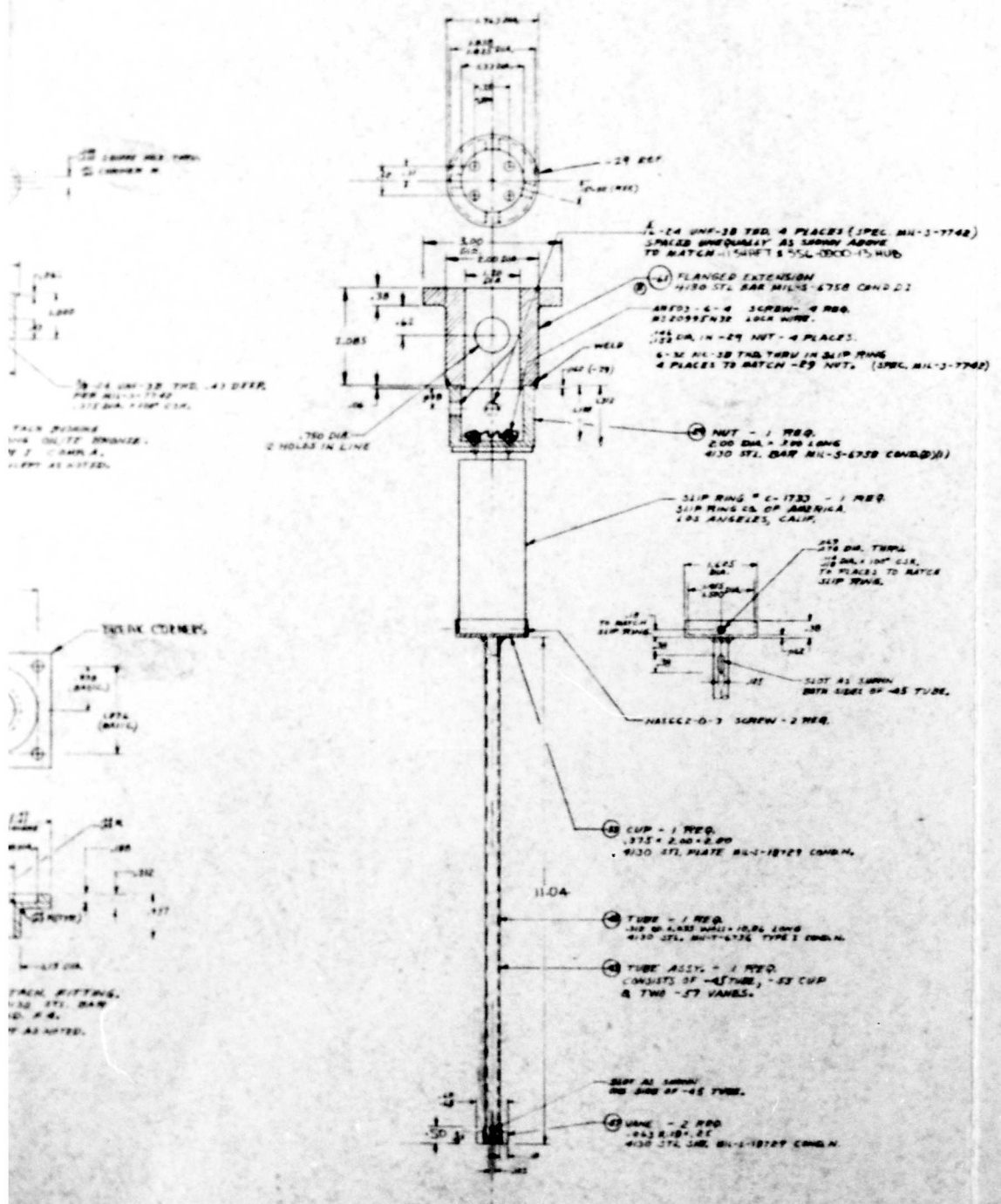


DETAIL - #7 SPACER
MADE FROM 4130 STEEL TUBING OR EQUIV
2.625 I.D. × .120 WALL
ENDS TO BE PARALLEL & SQUARE WITH SIDES WITHIN .010 IN 10 INCHES.



DETAIL - #1 ROTOR
2.500 DIA. × 20.00 LONG
MIL - S - 6758 CONDITION


BREAK CORNERS
DETAIL -3 TACH BUSHING
DETAIL -2 TACH. FITTING.
DETAIL -4 NUT
MAKE FROM BGDA 1306 NUT.



DETAIL -35 SLIP RING ASSY - CONSISTS OF -43 TUBE ASSY., C-1733 SLIP RING & -29 NUT.

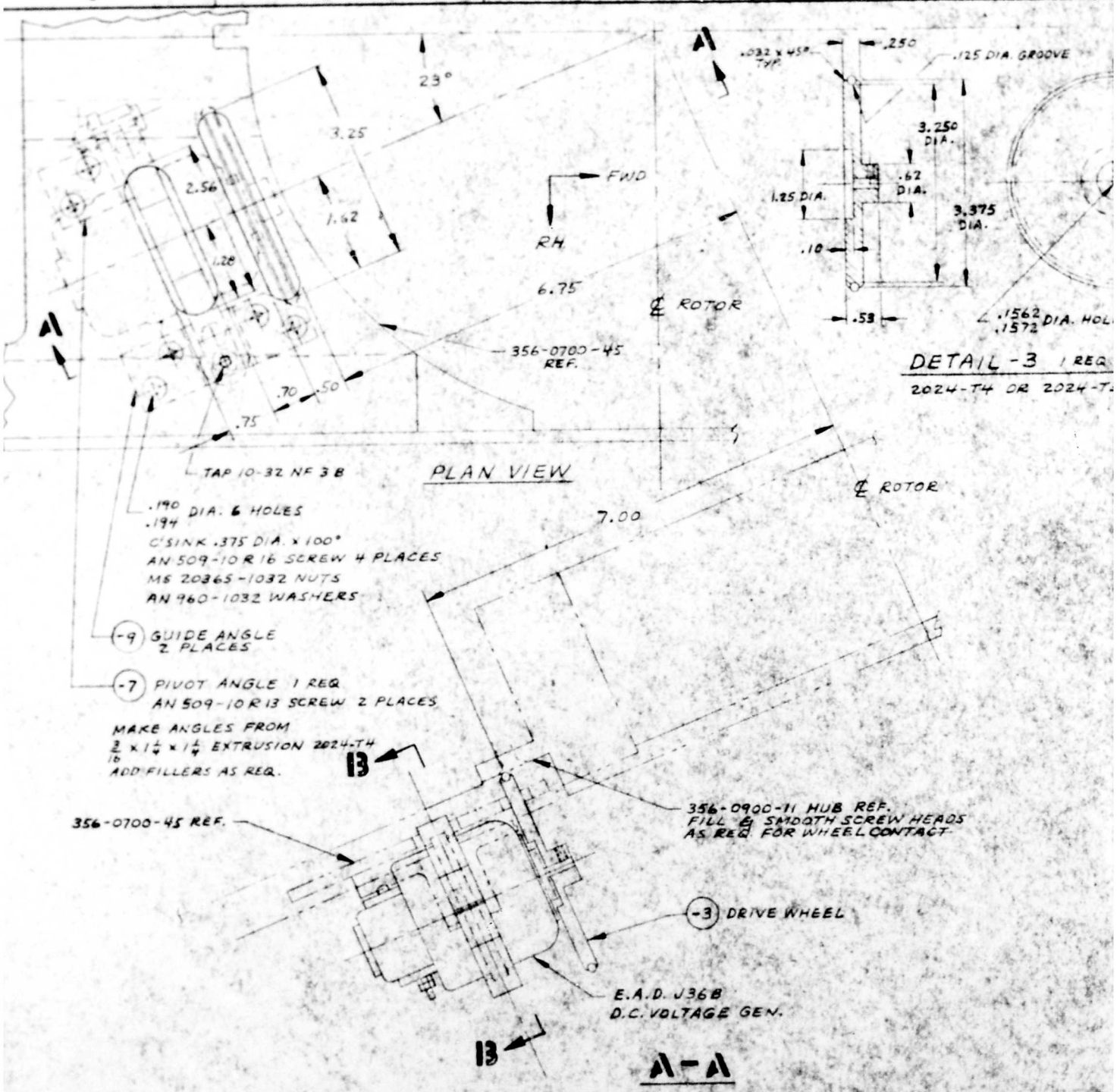
REVISIONS						
SYM	L.D.'S	DESCRIPTION	ORIG	APP'D	DATE	CHG
A		REVISED DIM ON -1-13-41 KEYWAY REVISED ON -41				
B		ADDED -41 FLANGED EXTENSION TO -29 NUT				

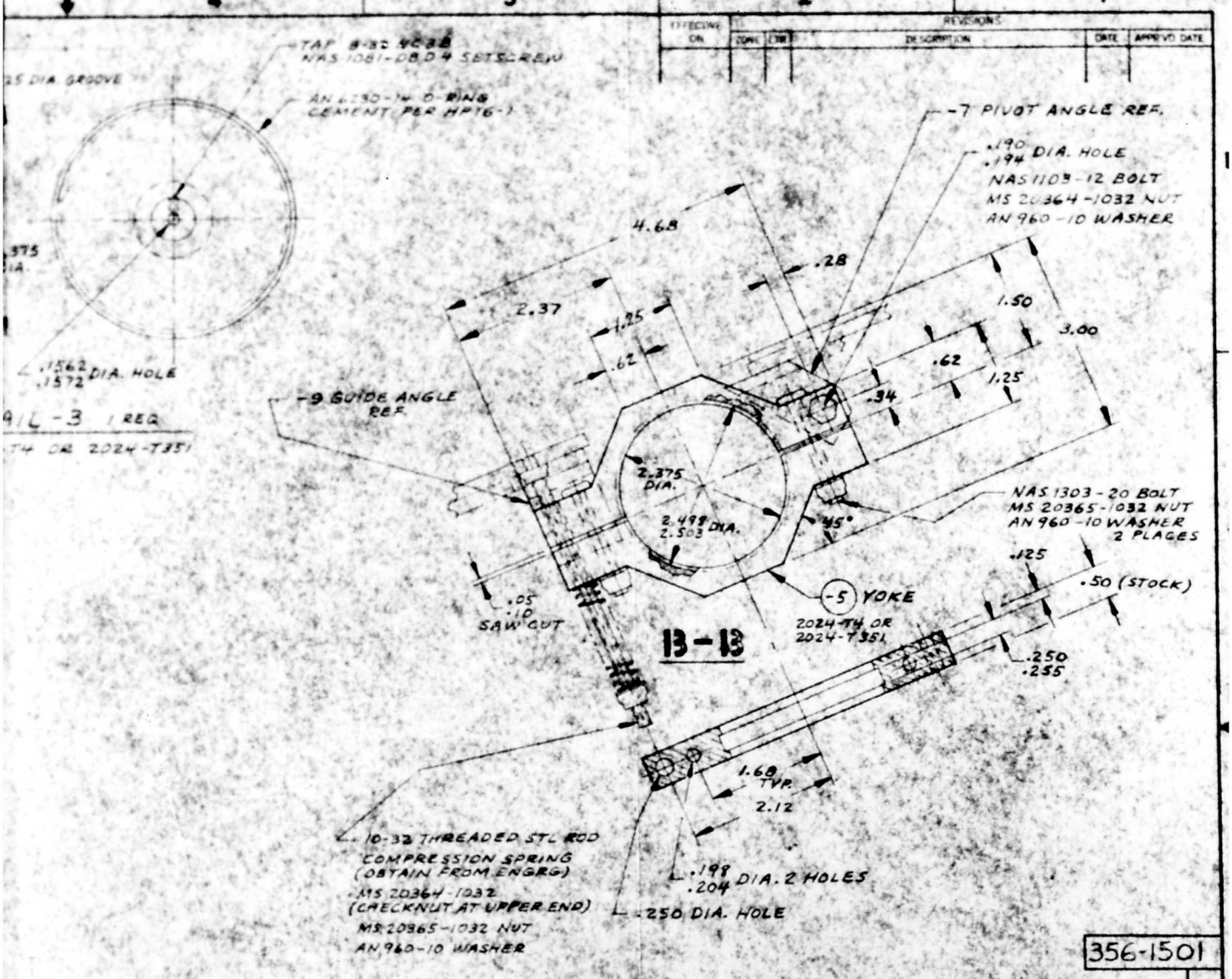
356-1100
B

RELEASE FOR FABRICATION 10-13-67

PROPULSION SYSTEM.	356-1100

8 7 6 5


23°
3.25
2.56
1.62
1.28
FWD
RH
6.75
℄ ROTOR
356-0700-45 REF.
.70
.50
.75
TAP 10-32 NF 3B
PLAN VIEW
.190
.194 DIA. 6 HOLES
C'SINK .375 DIA. x 100°
AN 509-10R16 SCREW 4 PLACES
MS 20365-1032 NUTS
AN 960-1032 WASHERS
-9 GUIDE ANGLE 2 PLACES
-7 PIVOT ANGLE 1 REQ
AN 509-10R13 SCREW 2 PLACES
MAKE ANGLES FROM
3/16 x 1 1/2 x 1 1/2 EXTRUSION 2024-T4
ADD FILLERS AS REQ.
B
356-0700-45 REF.
356-0900-11 HUB REF.
FILL & SMOOTH SCREW HEADS
AS REQ. FOR WHEEL CONTACT
-3 DRIVE WHEEL
E.A.D. J36B
D.C. VOLTAGE GEN.
B
A-A
A
.032 x 45° TYP
.250
.125 DIA. GROOVE
3.250 DIA.
.62 DIA.
1.25 DIA.
3.375 DIA.
.10
.53
.1562
.1572 DIA. HOL
DETAIL-3 1 REQ
2024-T4 OR 2024-T
7.00
℄ ROTOR



PART NO	NAME	SIZE	DESCRIPTION	SPECIFICATION	ZONE

LIST OF MATERIAL

FROM	THRU	NEXT ASSY	USED ON	QTY REQD
		356-0700	356-0600	/
		APPLICATION		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
DIMENSIONS AND TOLERANCES
PER MIL-STD-100
3 PLACE DECIMAL ± .010
2 PLACE DECIMAL ± .030
ANGLES ± 1°
MATERIAL AND PROCESS

CONTRACT NO.

DRWN	G. FLOWE 29 APR 68
CHK'D	
APP'D	
APP'D	
APP'D	
APP'D	
APP'D	

NTCAB APPROVAL

APPROVAL

HUGHES TOOL COMPANY AIRCRAFT DIVISION
CULVER CITY, CALIFORNIA

DWG. TITLE
TACH. GENERATOR INSTAL-
ONR ROTOR/WING
WIND TUNNEL MODEL

SIZE	CODE IDENT NO	DWG. NO
D	02731	356-1501

SCALE 1/1 SHEET

APPENDIX H

STRUCTURAL ANALYSIS

APPENDIX H

STRUCTURAL ANALYSIS

The structural analysis for the Rotor/Wing wind tunnel model is presented in this Appendix. Throughout the analysis, a factor of safety of five has been used.

The maximum loads expected are:

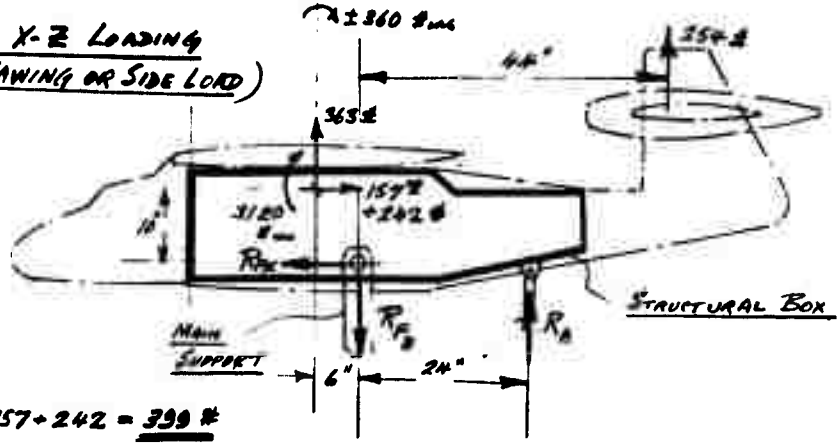
	Wing	Tail	Model Minus Tail
Lift	363	254	- -
Drag	157	- -	242
Side force	- -	73	25
Pitching, steady	260	- -	- -
Moment, alternating	±30	- -	- -
Rolling, steady	87	- -	- -
Moment, alternating	±30	- -	- -
Yawing moment	- -	347	43

Forces in pounds; moments in foot-pounds

WIND TUNNEL MODEL

CG Location ⌀ on ℄ of rotor 18" above hard point

LOADS ARE LIMIT



i) MAX X-Z LOADING
(NO YAWING OR SIDE LOAD)

$R_{FX} = 157 + 242 = \underline{399\ \#}$

$$R_A = \frac{3120 + (363 \times 6) + (399 \times 10) - (254 \times 44)}{24} \pm \frac{360}{24}$$

$$= \underline{79\ \# \pm 15\ \#} \quad \therefore R_{FZ} = 363 - 79 + 254$$

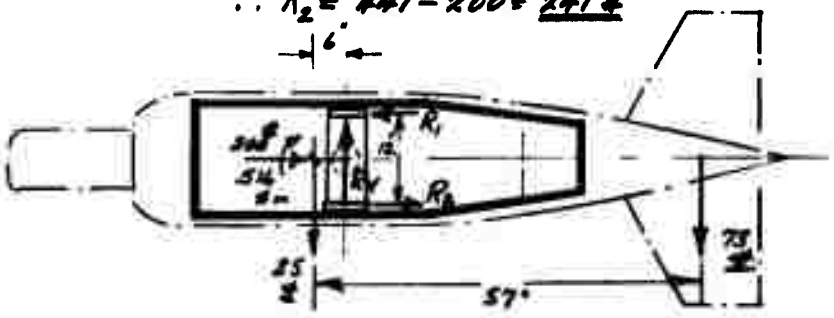
$$= \underline{538\ \# \pm 15\ \#}$$

ii) MAX XY LOADING
(+ ½ VALUES OF X-Z LOADS ABOVE)

$R_Y = 73 + 25 = \underline{98\ \#}$

$$R_1 = \frac{100 + 516 - (25 \times 6) + (73 \times 51)}{12} = \underline{441\ \#}$$

$\therefore R_2 = 441 - 200 = \underline{241\ \#}$



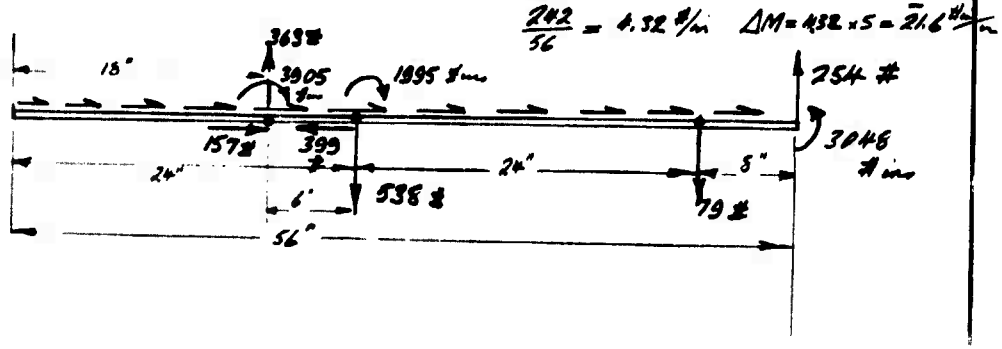
VERTICAL BMs ON STRUCTURAL BOX — LIMIT LOADS

Assumptions :—

i) 363 # LIFT + 3120 #in applied as concentrated loads on shaft

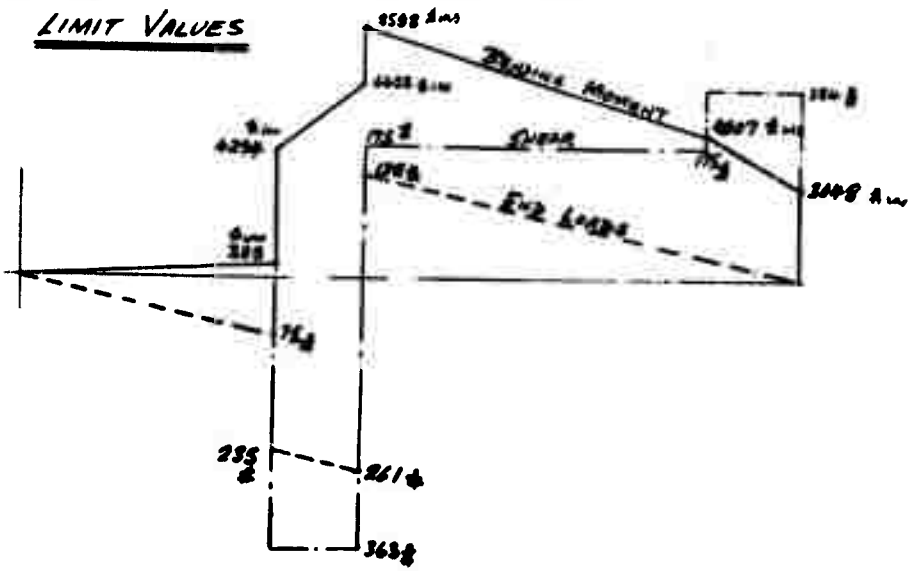
ii) 399# DRAG applied as a concentrated 157# and 242# as a uniform load (5" above N. Axis.)

iii) Time out the cyclic load until later



VERTICAL BMs SHEARS & END LOADS

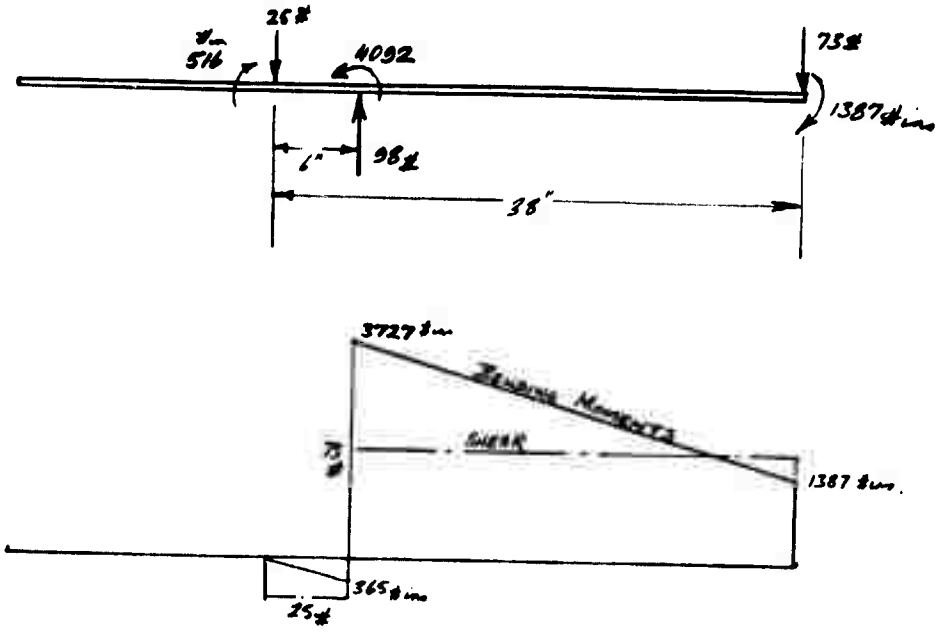
LIMIT VALUES



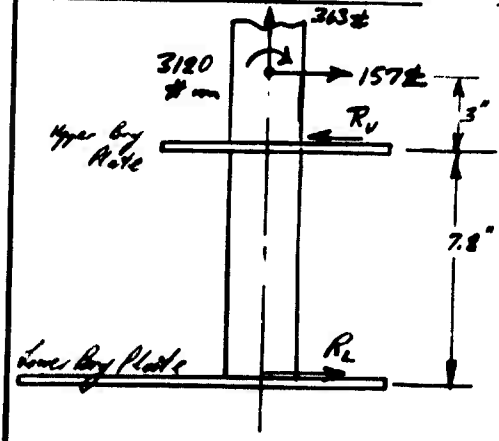
HORIZONTAL BMs ON STRUCTURAL BOX

(APPLIED AT SAME TIME AS ½ MAX. VERTICAL)

LIMIT LOADS



SHAFT BEARING REACTIONS — DUE TO WING LOADS



$$R_U = 157 \times \frac{10.8}{7.8} + \frac{3120}{7.8}$$

$$= \underline{618\#}$$

$$R_L = \underline{360\#}$$

} LIMIT LOADS

9784

SECTION @ MAX. VERTICAL BM.

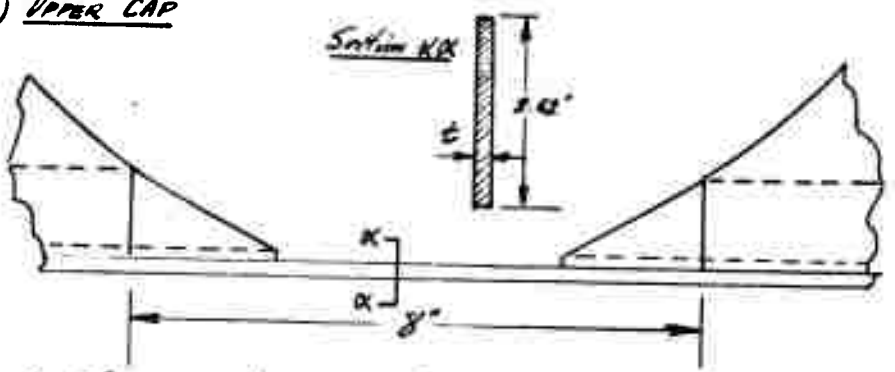
$M = 8{,}600$ lbs. ins. (LIMIT) ULT. FACTOR = 5.0

$= 43{,}000$ " " (ULT.)

TAKE AS A COUPLE $h = 12"$ $\frac{M}{h} = 3{,}580$ lbs.

THIS IS TOTAL (1/4 FOR 2 SIDES) $\therefore P = 1790$ lbs/side

a) UPPER CAP



$L = 8"$ $\rho = \frac{t}{K/2} = .133\,t$ MAT'L = 24ST. $A = 2.62\,t$

TRY $t = .312$ $\rho = .09$ $L/\rho = 89$ $f_{cr} = 12{,}000$ #/in² $A = .819$ in²

$P/A = \frac{1790}{.819} = 2{,}190$ #/in² M.S. HIGH

TRY $t = .25"$ $\rho = .072$ $L/\rho = 111$ $f_{cr} = 7{,}500$ #/in² $A = .656$

$P/A = 1790/.656 = 2{,}730$ #/in² M.S. > 1.0

TRY $t = .187$ $\rho = .054$ $L/\rho = 148$ $I = \frac{2.62 \times .187^3}{12} = .00143$

$P = \frac{\pi^2 EI}{L^2} = \frac{3.14^2 \times 14{,}300}{8 \times 8} = 2{,}200$ lbs **M.S. +.23**

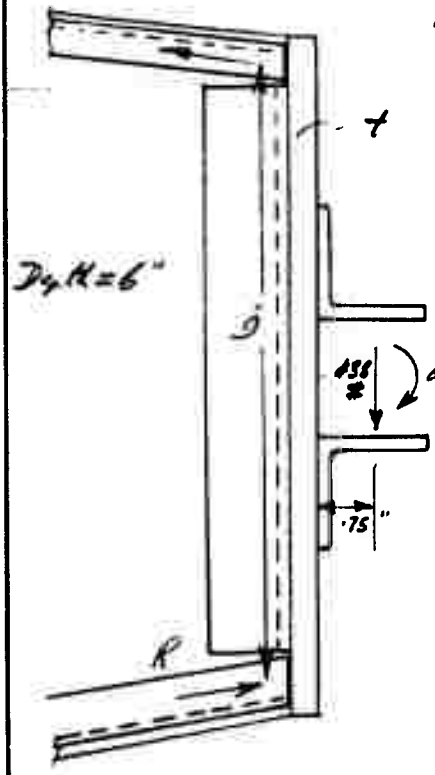
b) LOWER CAP

THIS IS OK by examination, as the lower plate of the shaft support stabilizes it

✓

END PLATE ON TAIL ATT'M

VIEW LOOKING DOWN



LOADS SHOWN ARE ULTIMATE

$$\text{APPROX MAX BM} = \frac{6840 + (.75 \times 438)}{2}$$

$$= 3585 \text{ \#in}$$

$$f = \frac{M}{Z} \qquad Z = \frac{6t^2}{6} - t^2$$

$$\therefore f = \frac{M}{t^2}$$

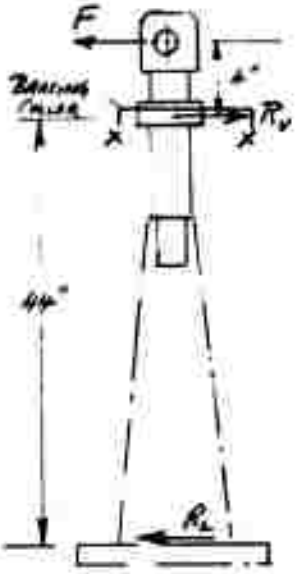
Allowable $f_{tu} = 56{,}000$

$$t^2 = \frac{3585}{56{,}000} = .064$$

$$t = .252"$$

t_1 will be OK as the analysis is conservative.

MOUNTING MAST & BRACING



F = APPLIED LOAD FROM MODEL

$R_V = \frac{48}{44} F = 1.09F$

$R_L = .09F$

MAX. BM ON SECTION XX

CASE (i) $F_x = 399\#$ (LIMIT)

$F_y = 0 \qquad T_o = 0$

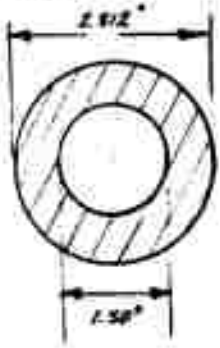
$M = 399 \times 4 = \underline{1596 \#\text{ ins. LIMIT}}$

CASE (ii) $F_x = 200\#$ (LIMIT)

$F_y = 98\#$ (LIMIT) $T_o = 4092 \#\text{in}$ (LIMIT)

$M = \sqrt{200^2 + 98^2} \times 4 = \underline{893 \#\text{ ins LIMIT}}$

SECTION XX



$I_1 = 2.1783$

$I_2 = .3313$

1.8470

$I_p = 2 \times 1.847 = \underline{3.694 \text{ in}^4}$

$Z_{BENDING} = 1.847/1.406 = \underline{1.312 \text{ in}^3}$

$Z_{TORSION} = 3.694/1.406 = \underline{2.625 \text{ in}^3}$

Case (i) $f_b = \frac{5 \times 1596}{1.312} = \underline{6,100 \#/\text{in}^2}$

$f_{tu} = 90,000 \#/\text{in}^2$ M.S. HIGH

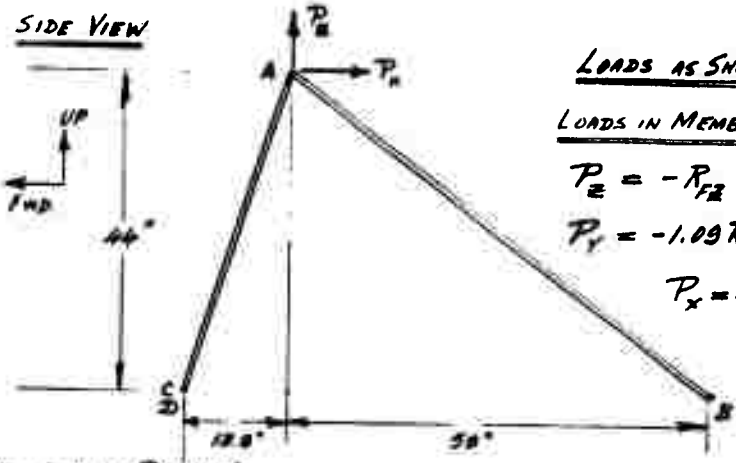
Case (ii) $f_b = \underline{3410 \#/\text{in}^2}$

$f_s = \frac{5 \times 4092}{2.625} = \underline{7,800 \#/\text{in}^2}$

COMBINED M.S. HIGH

MOUNTING MAST & BRACING

SIDE VIEW



LOADS AS SHOWN ARE +Ve

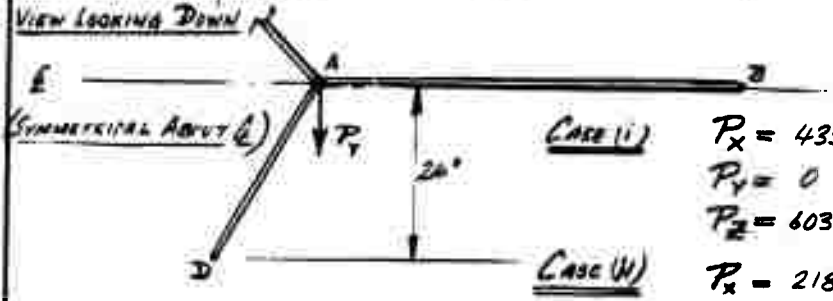
LOADS IN MEMBERS — TENSION = +Ve

$P_z = -R_{FZ}$ (CASE I)

$P_y = -1.09 R_{FY}$

$P_x = -1.09 R_{FX}$

VIEW LOOKING DOWN



(SYMMETRICAL ABOUT ℄)

CASE (I)

$P_x = 435\#$
$P_y = 0$
$P_z = 603\#$

} LIMIT LOADS

CASE (II)

$P_x = 218\#$
$P_y = 108\#$
$P_z = 302\#$

} LIMIT LOADS

GEOMETRY & DIRECTION COSINES.

MEMBER	x	y	z	x^2	y^2	z^2	l^2	l	CosX	CosY	CosZ	Σl_{rs}^2 (CHECK)
AB	59	0	44	3481	0	1936	5417	73.60	.8016	0	.5978	.9999
AC	13.9	24	44	193	576	1936	2705	52.01	.2672	.4614	.8460	1.0000
AD	13.9	24	44	193	576	1936	2705	52.01	.2672	.4614	.8460	1.0000

a) X LOADS.

$$P_x + .8016 P_{AB} - .2672 P_{AD} - .2672 P_{AC} = 0 \quad \text{_____ (1)}$$

& $P_{AC} = P_{AD}$ $\therefore$ $.5978 P_{AB} = -2(.8446) P_{AC}$ $\quad P_{AB} = -2.83 P_{AC}$

PUTTING THIS IN (1) $\quad P_x - 2.265 P_{AC} - .5344 P_{AC} = 0$

X LOADS – Cont'd

$2.799 P_{AC} = P_X$ $\quad P_{AC} = .357 P_X$ $\quad P_{AD} = .357 P_X$

THEN $\quad P_{AB} = -1.010 P_X$

b) Y LOADS

$-.4614 P_{AC} + .4614 P_{AD} + P_Y = 0$ $\quad P_{AC} = -P_{AD}$

$\therefore \quad .9228 P_{AD} = -P_Y$ $\quad P_{AD} = -1.083 P_Y$

$P_{AB} = 0$ $\quad P_{AC} = +1.083 P_Y$

c) Z LOADS

$P_Z - .5978 P_{AB} - .8460 P_{AD} - .8460 P_{AC} = 0$ $\quad P_{AD} = P_{AC}$

$.8016 P_{AB} = 2(.2672) P_{AD}$ $\quad P_{AB} = .666 P_{AD}$

THEN $\quad P_Z - .398 P_{AD} - .846 P_{AD} - .846 P_{AD} = 0$ $\quad P_Z = 2.090 P_{AD}$

$P_{AD} = .478 P_Z$ $\quad P_{AC} = .478 P_Z$ $\quad P_{AB} = .318 P_Z$

TOTALS

$P_{AB} = -1.010 P_X + (0) P_Y + .318 P_Z$

$P_{AC} = +.357 P_X + 1.083 P_Y + .478 P_Z$

$P_{AD} = +.357 P_X - 1.083 P_Y + .478 P_Z$

CASE	$-1.010 P_X$	$\mathcal{C} P_Y$	$+.318 P_Z$	P_{AB}	$+.357 P_X$	$+1.083 P_Y$	$+.478 P_Z$	P_{AC}	$+.357 P_X$	$-1.083 P_Y$	$+.478 P_Z$	P_{AD}
(i) $P_X = 435$, $P_Y = 0$, $P_Z = 603$	−439	0	+192	−247	+155	0	+288	+443	+155	0	+288	+443
(ii) $P_X = 218$, $P_Y = 104$, $P_Z = 302$	−220	0	+96	−124	+78	+117	+144	+339	+78	−117	+144	+105

THESE ARE ALL LIMIT LOADS

LOADING — CONTROL SYSTEM

ONE BLADE — TORQUE AT FEATHERING ARM

$T_0 = 110 \pm 110$ lbs. ins

(NOTE:- THIS VALUE WAS GIVEN BY BOB HEAD & IS A MAX. VALUE. FOR DEFLECTION STUDY AND ALSO FOR FATIGUE ANALYSIS THIS FIGURE WILL BE USED WITHOUT ANY FACTORS. HOWEVER, FOR THE ULTIMATE STRENGTH A FACTOR OF FIVE WILL BE USED)

Feathering Arm radius $r = 1.85"$

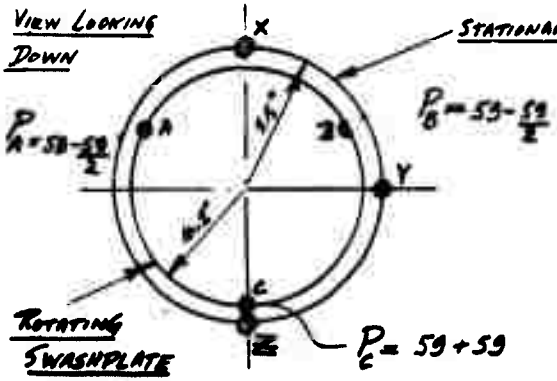
Loads in rods to rotating swashplate:-

$$P_1 = \frac{110 \pm 110}{1.85} = 59 \pm 59 \text{ lbs. (FATIGUE)}$$

$$\& \; P_1 = \frac{220 \times 5}{1.85} = 595 \text{ lbs. (ULTIMATE)}$$

Loads through swashplates:-

a) Consider loaded up with the lateral arms



COLLECTIVE = 5×59

$\Sigma P = 177$ lbs

CYCLIC GIVES STEADY MOMENT

$M_0 = 59 \times 1.5 \times 4.2$

$= 371.7$ lbs. ins

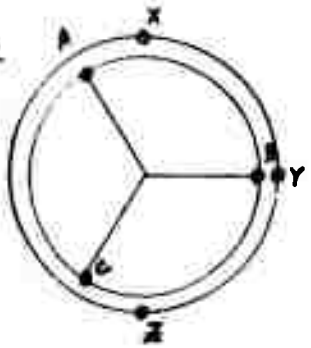
THEN $P_X = \frac{177}{2} - \frac{371.7}{11} = 54.7$ lbs Similarly $P_Z = 122.3$ lbs

& of course $P_Y = 0$

Cont'd

a) P_Z = CRITICAL LOAD = 5×122.8 = 612 lbs. ULT.

b) Booster tested up with Longitudinal arm.



VIEW FROM ABOVE

$P_A = 59 - 59/2$

$P_B = 59 + 59$

$P_C = 59 - 59/2$

$\Sigma P = 177$

$M_o = 371.7$ #cm

$P_X = P_Z = \frac{177}{2} = 88.5$ #

$P_Y = \frac{371.7}{5.5} = 67.6$ #. (LIMIT) = 338 lbs (ULT)

IT CAN BE SEEN FROM THE FOREGOING THAT THE LOADS USED FOR PRELIMINARY ANALYSIS (PAGES 1-6) ARE CONSERVATIVE

STIFFNESS CONSTANTS FOR BLADE SPAR TUBE AND FOR CONTROL SYSTEM

BLADE SPAR TUBE IS 3/4" O/D x .120" WALL — STEEL

FLEXURAL STIFFNESS PER UNIT LENGTH = CONSTANT EI

$EI = 366{,}000$ lbs. in^2

TORSIONAL STIFFNESS PER UNIT LENGTH = CONSTANT GJ

$GJ = 292{,}800$ lbs. in^2

SPRING CONSTANT OF CONTROL SYSTEM:—

AT PITCH ARM $K = 54{,}300$ lbs. ins per radian

(THE ABOVE IS THE ELASTIC DEFLECTION ONLY, NO ACCOUNT IS TAKEN OF SLOP IN SYSTEM)

NOTE:— 68% OF THE DEFLECTION TAKES PLACE IN THE NON-ROTATING PART OF THE CONTROL SYSTEM, THE REMAINING 32% BEING IN THE ROTATING PART.

MOMENT OF INERTIA OF CONTROL SYSTEM

$I_{TOTAL} = .003871$ SLUGS. ft^2

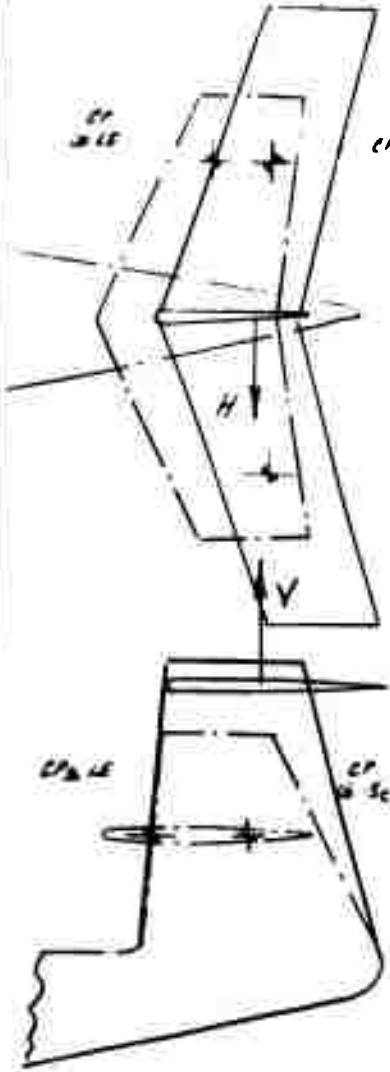
ROTATING SYSTEM $I = .001793$ Slugs ft^2

NON-ROTATING SYSTEM $I = .002078$ Slugs ft^2

REVISED EMPENNAGE

PREVIOUS EMPENNAGE SHOWN CHAIN DOTTED

LOADS WILL BE RATIOED UP AS TEN AREAS



CP 50

OLD HORZ WAS 3.61 ft²
NEW HORZ IS 4.17 ft²

∴ FACTOR = 1.15

MAX LIFT OR DOWN LOAD) ON TAIL

= 254 × 1.15 = 292 # (LIMIT)

OLD VERT WAS 2.10 ft²
NEW VERT IS 2.88 ft²

∴ FACTOR = 1.37

MAX SIDE LOAD ON TAIL

= 1.37 × 73 = 100 # (LIMIT)

CENTERS OF PRESSURE ARE AS MARKED.

ULTIMATE LOAD FACTOR = 3.0

V = 3 × 292 = 876 # (ULT)

& H = 300 #

CONSERVATIVELY, WITH SIDE LOAD TAKE ROLLING MOMENT ON HORZ SURFACE, AS FOLLOWS:—

SYMM. COMPONENT = ⅔ V ASSYMM COMP'T = ⅓ V

9784

CONTINUED UNSYMM $V = 554\#$ $V/2 = 292\#/\text{SIDE}$ (ULTIMATE)

$\therefore$ HLS = 292 + 146 = 438 # (VLT)
LLS = 292 − 146 = 146 # (VLT)

HORIZONTAL SURFACE -

CRITICAL CASE IS UN-SYMM WITH CP$_9$ SC HLS = 438 # (VLT)

ASSUME SPANWISE LOADING IS UNIFORM (CONSERVATIVE)

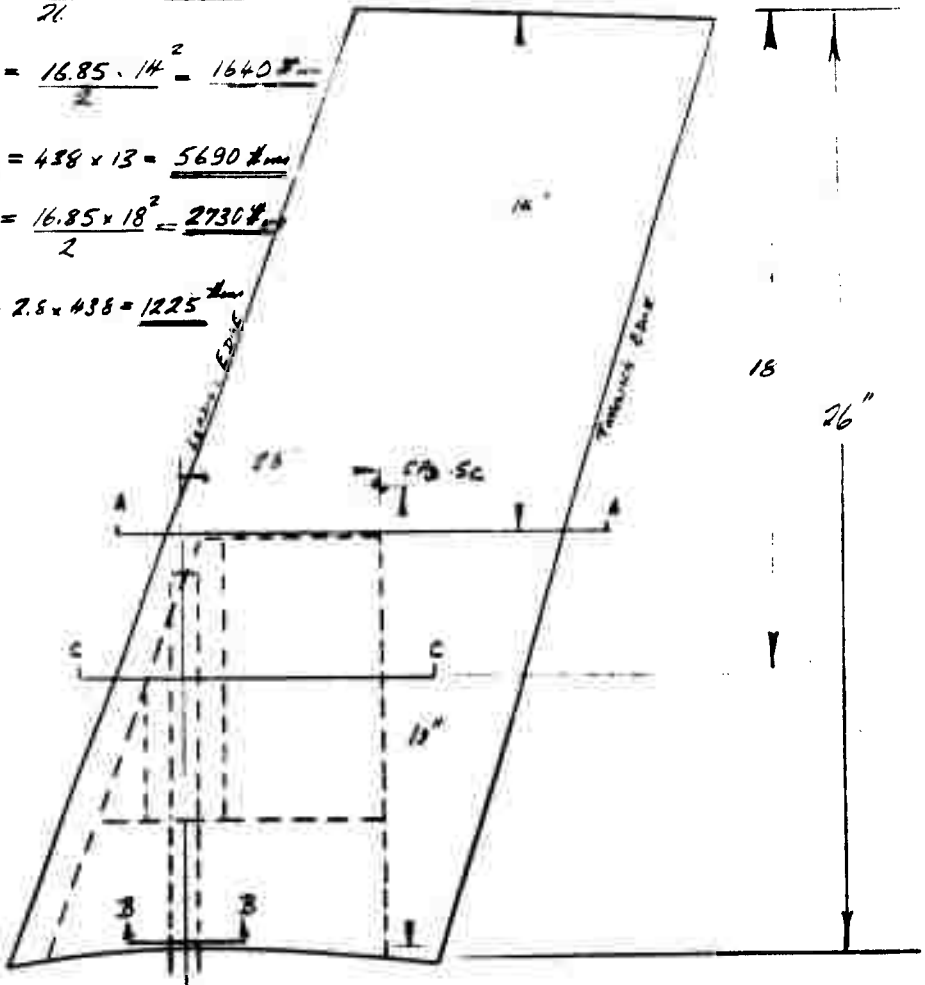
$w = \frac{438}{26} = 16.85\ \#/in$

$M_{AA} = \frac{16.85 \cdot 14^2}{2} = 1640\ \#in$

$M_{BB} = 438 \times 13 = 5690\ \#in$

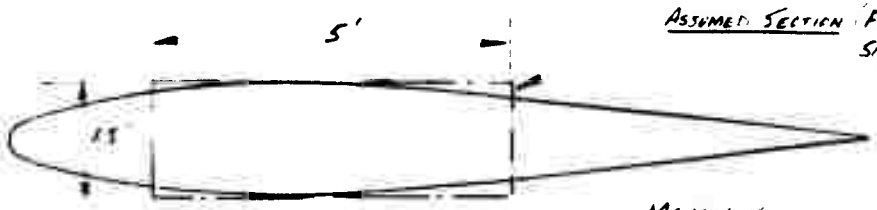
$M_{CC} = \frac{16.85 \times 18^2}{2} = 2730\ \#in$

$T_{o\ BB} = 2.8 \times 438 = 1225\ \#in$



WIND TUNNEL MODEL

SECTION AA



ASSUMED SECTION (FOR SIMPLICITY)

MAHOGANY

$M_{AA} = 1640$ #in, $\quad Z = \frac{5 \times 1.5^2}{6} = 1.875$ $\quad \frac{M}{Z} = 875$ #/in²

M.S. HIGH

SECTION BB

$Z_{BENDING} = .0413$ in³ $\quad Z_{TORSION} = .0521$ in³

$M = 5690$ #in $\quad T_c = 1225$ #in

$\frac{M}{Z} = 138{,}000$ #/in² $\quad \frac{T_c}{Z} = 14{,}800$ #/in²

4130 STEEL

$t_{yp} = 91{,}000$ #/in²

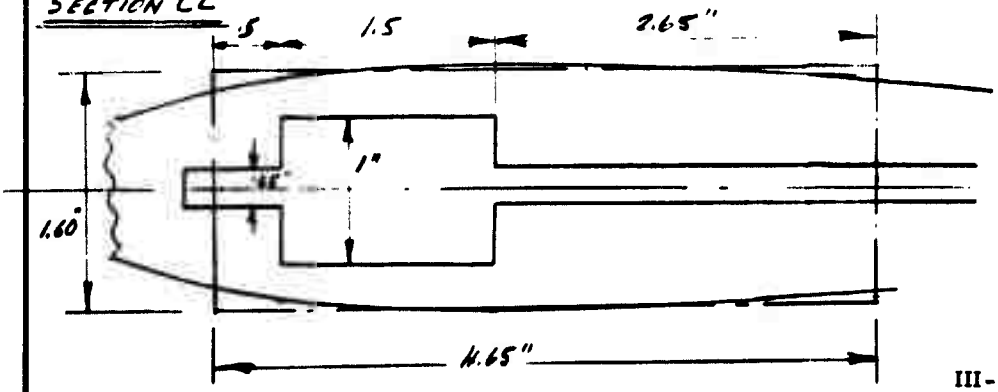
Allowable Stress (Plastic Bending) $\quad t_{bending} = 162{,}000$ #/in² $\quad t_s = 52{,}000$

$R_B = .852$ $\quad R_S = .285$

$$M.S. = \frac{1}{\sqrt{R_B^2 + R_S^2}} - 1 = \frac{1}{\sqrt{.725 + .0815}} - 1$$

M.S. +.10

SECTION CC



SECTION CC – CONT'D

$$\text{NET } I_{NA} = \frac{(1.60^3 \times 4.15) - (.25^3 \times 3.15) - (1^3 \times 1.5)}{12}$$

$$= \frac{19.00 - .05 - 1.5}{12} = \frac{17.45}{12} = 1.45 \text{ in}^4$$

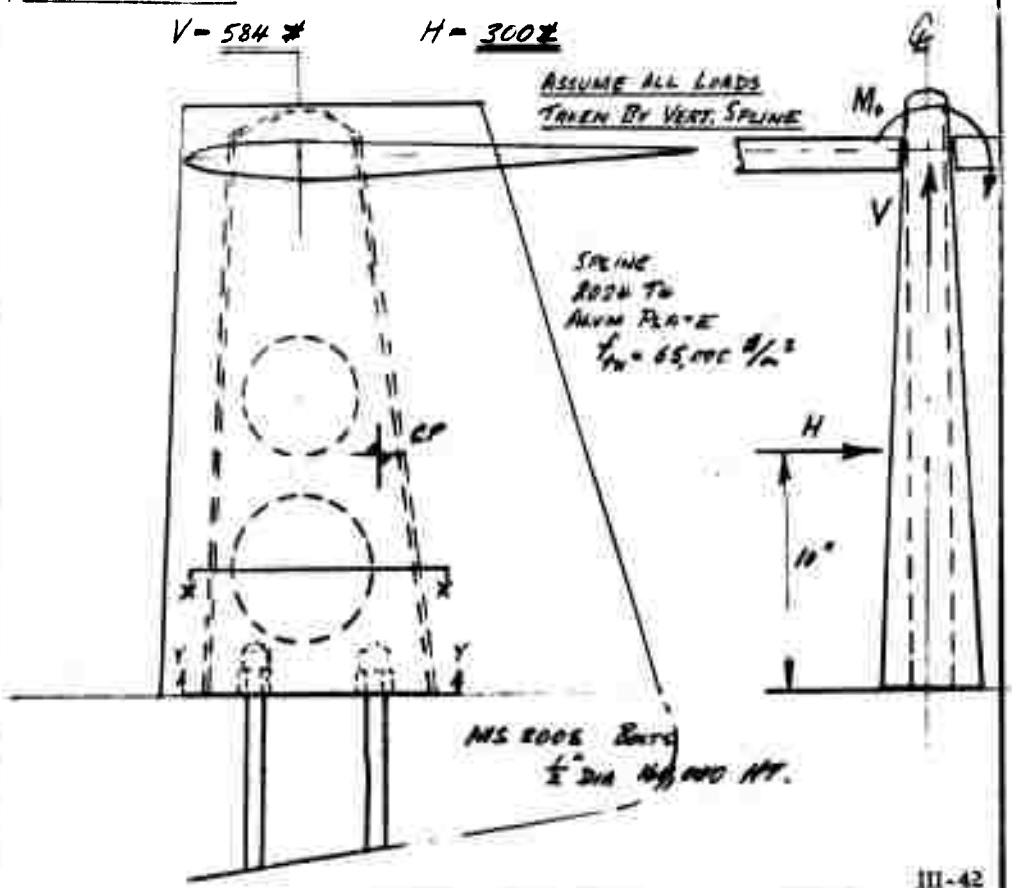
$$Z = \frac{1.45}{.80} = 1.81 \text{ in}^3$$

$$M/Z = \frac{2730}{1.81} = 1500 \text{ \#/in}^2$$

M.S HIGH

VERTICAL SURFACE
(ULTIMATE LOADS)

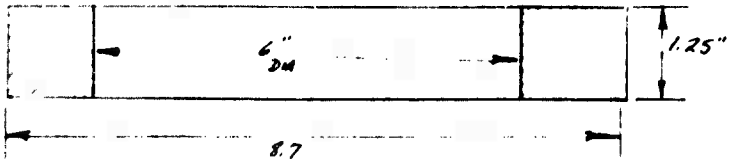
M_o = ROLLING MOMENT (SEE PAGES 1 & 2)
= 146 × 27 = 3950 # in



WIND TUNNEL MODEL

SECTN XX

$$Z = \frac{2.7 \times 1.25^2}{6} = .703 \text{ in}^3 \qquad A = 3.38 \text{ in}^2$$



$$M_{XX} = M_o + 4.6 \times 300 = 3950 + 1440 = 5390 \text{ \#in}$$

$$M/Z = 7,660 \text{ \#/in}^2$$

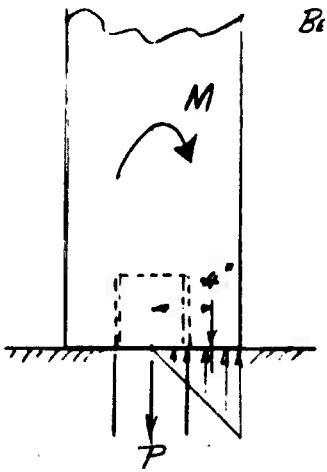
$$V/A = 172 \text{ \#/in}^2$$

M.S. HIGH

SECTION YY (IN ATTCH BOLTS)

½" DIA BOLTS $\quad Z = .00307 \text{ in}^3$, $A = .196 \text{ in}^2$

$$M = 3950 - (10 \times 300) = 6950 \text{ \#in} \qquad V = 584 \text{\#}$$



THE MOMENT IS REACTED BY A COUPLE BETWEEN BOLT & BEARING SURFACE

$$P = \frac{6950}{.40} = 17,300 \text{\#} \; (8,650 \text{ \#/Bolt})$$

BOLT IS GOOD FOR 23,400 #

M.S. HIGH

$$f_{by} = \frac{8650}{.6 \times 1.0} \times 2 = 28,600 \text{ \#/in}^2$$

M.S. HIGH

9704

CONTINUED

THE FOREGOING COMPLETES THE STRUCTURAL ANALYSIS OF THE NEW EMPENNAGE & ATTACHMENTS

CHECK ON OVER-ALL FUSELAGE STRENGTH:-

PREVIOUS ULTIMATE FACTOR USED WAS 5.0 THIS IS ON THE HIGH SIDE, AND 3.0 WOULD BE MORE APPROPRIATE.

MAX BM (V.T) WAS DUE TO TAIL LOAD OF 254 # (NOW 292 #) LIMIT

M.S. WAS +.23 (BASED ON ULT FACTOR 5.0)

$$\text{NEW} \quad M.S. = 1.23 \times \frac{5.0}{3.0} \times \frac{254}{292} = 1.33$$

MS. +.33
(BASED ON ULT FACTOR = 3.0)

BY EXAMINATION, & COMPARISON WITH THE PREVIOUS ANALYSIS, REST OF STRUCTURE HAS ADEQUATE STRENGTH

Unclassified

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U. S. Navy, Office of Naval Research and Bureau of Naval Weapons

13. ABSTRACT

Research work including wind tunnel and whirl test of the Rotor/Wing is described. The Rotor/Wing is a dual-purpose lifting device that is a rotor with an unusually large hub. It acts as a tip-jet powered helicopter for low-speed flight and stops in flight to become a tapered and sweptback low-aspect ratio wing for cruise. Stopping the rotor in flight removes the speed limitations of the helicopter rotor and permits flight speeds up to 500 knots. Research work was supported by the U. S. Navy Office of Naval Research and Bureau of Naval Weapons. Three series of wind tunnel tests demonstrated that the powered-rotor and autorotating-rotor characteristics are similar to those of a high-performance helicopter; that the stopped-rotor characteristics are similar to a conventional low-aspect ratio wing with sweep and taper, and maximum lift/drag ratios of 12 or more should be achievable for full-scale aircraft; and that conversion from stopped- to running- rotor and vice versa is a simple and straightforward procedure.

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Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Wing						
Stopped-rotor						
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