TITLE PAGE

DEVELOPMENT AND BUILD OF PROTOTYPE TOOLS FOR INDUCTION BRAZING OF STAINLESS STEEL TUBING AND FITTINGS FOR NASA APPLICATIONS

Final Report

Prepared for George C. Marshall Space Flight Center, Huntsville, Alabama.

Technical Information Series Report No. R66FPD47
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Prepared under Contract No. NAS8-11554 Control No. 1-4-8-00001 (IF) by the Braze Development Laboratory, Large Jet Engine Department, Flight Propulsion Division, General Electric Co., Evendale, Ohio

D. H. Greisl
Author

FORWARD

This final report covers the work performed under NASA Contract NAS8-11554, Control No. 1-4-8-0000 (IF). The contract work included the design and manufacture of sizing equipment for the tubing to be brazed; the design of couplings, elbows and tee type braze fittings; the development and manufacture of split type induction braze tools for these fittings; the design and manuvacture of debraze tooling; the evaluation of high frequency induction brazing on heavy wall large O.D. tubing; and the training and instruction of Marshall Space Flight Center personnel in the use of these tools.

This program was conducted in the Braze Development Laboratory, Manufacturing Process Applications Development, Large Jet Engine Department, Flight Propulsion Division, General Electric Co., Evendale, Ohio. George F. Albers, Supervisor of the Braze Development Laboratory, was the Program Manager and Don H. Greisl of the Braze Development Laboratory was the Project Engineer for the program.

N67-11687

ABSTRACT

The design and manufacture of sizing tools for the tubing to be brazed; the design of couplings, elbows and tee type fittings; the design and manufacture of split type induction tools to braze these fittings to the tube ends; the design and manufacture of the debrazing tools; and the use of high frequency induction brazing of heavy wall tubing (.188 wall thickness - O.D. 2") are described in this report.

Author

INTRODUCTION

The systems and components of rocket propulsion vehicles must function under severe environmental operating conditions. Rocket propulsion fluid systems, in particular, are subjected to extremes of temperature, pressure and vibration for short periods of time. The standard threaded type aircraft engine fittings currently being used for tubing connections in rocket propulsion fluid systems are inadequate. Leakage can occur when the vehicle is exposed to operating conditions. Advanced tube joining methods are required which will provide zero leakage and light weight with a high degree of operational reliability.

Techniques for making "on engine" tubing connections by induction brazing had been developed by the Brazing Development Laboratory, Large Jet Engine Department, Flight Propulsion Division, General Electric Company, Evendale, Ohio for use on the J93 Engine used to power the XB-70 air vehicle. This technique was considered feasible and worthy of further development for joining advanced rocket propulsion fluid tubing systems.

The purpose of this program was to design, develop, manufacture and demonstrate induction brazing and related tooling and connectors for fluid tubing systems on rocket propulsion vehicles.

TOOLING

The NASA contract required the design and construction of six (6) split coil inductors (one of each size) for brazing 1/4", 3/4", 1 1/4", 1 1/2", 2" and 2 1/2" tubing using a straight coupling: the design and manufacture of five (5) split coil inductors (one of each) for brazing the pre-mentioned tubing sizes except the 2 1/2" for elbow and tee type fittings; the design and building of sizing equipment for sizing tubing to a controlled diameter in the following size tubing: 1/4", 3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2", 2" and 2 1/2"; the design and building of debrazing equipment, (one of each) for 1/4", 3/4", 1 1/4", 1 1/2", 2" and 2 1/2".

The development of each type tool will be reviewed in detail. Each aspect of the process is defined and each applicable tool discussed.

Split Inductors For Straight Couplings

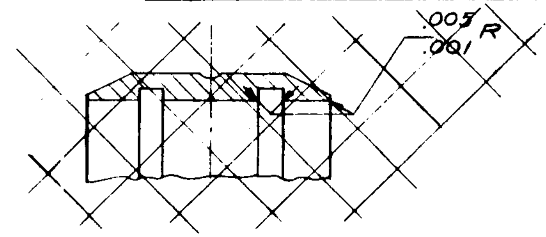
The basic process consists of induction brazing tubing and couplings together to produce a strong, leak-resistant joint. This is accomplished by assembling a coupling, containing pre-placed braze alloy (print 871C234) equally over two tube ends and induction heating the area to the braze alloy flow temperature.

To satisfy these requirements the split coil inductors must exhibit the following characteristics: a split induction heating coil having the effect of one continuous wound coil, a split atmospheric chamber with inert gas inlets and outlets, and a chamber that houses the split coils with an air cooling manifold.

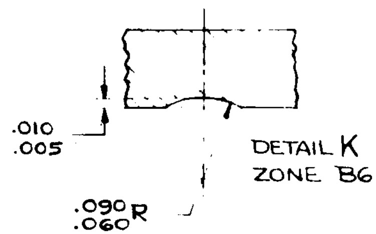
The split atmospheric chamber permits visual observation of the joint during the brazing operation. It also envelopes the joint providing an oxygen free atmosphere. An advantage of being able to see the joint during the brazing operations is that if the automatically alloted time does not produce a good braze joint, manual control of the heating cycle can be assumed until the alloy has flowed and formed a sound joint. Secondly, melting of the braze alloy can be observed or monitored visually. Melting is evident by a dark shadow seen on the coupling representing the braze alloy as it melts and starts to flow.

871C234P04	.250	.332 / .322	.103 / .083	.357 / .352	.307 / .287	.302 / .297	.158 / .138	.063 / .058	.251 / .250
P05	.312	.332 / .322	.111 / .091	.428 / .423	.370 / .350	.365 / .360	.176 / .156	.063 / .058	.313 / .312
P06	.375	.303 / .293	.119 / .099	.499 / .494	.432 / .412	.428 / .423	.194 / .174	.077 / .072	.376 / .375
P07	.438	.332 / .322	.127 / .107	.620 / .615	.496 / .476	.500 / .495	.211 / .191	.063 / .058	.439 / .438
P08	.500	.333 / .323	.135 / .115	.642 / .637	.560 / .540	.572 / .567	.228 / .208	.063 / .058	.501 / .500
P010	.625	.369 / .359	.166 / .146	.781 / .776	.682 / .662	.697 / .692	.260 / .240	.077 / .072	.626 / .625
P012	.750	.400 / .390	.213 / .193	.877 / .872	.807 / .787	.822 / .817	.292 / .272	.092 / .087	.751 / .750
P014	.875	.447 / .437	.236 / .216	1.002 / .997	.932 / .912	.947 / .942	.339 / .318	.101 / .096	.876 / .875
P016	1.000	.495 / .485	.260 / .240	1.127 / 1.122	1.057 / 1.037	1.072 / 1.067	.385 / .365	.111 / .106	1.001 / 1.000

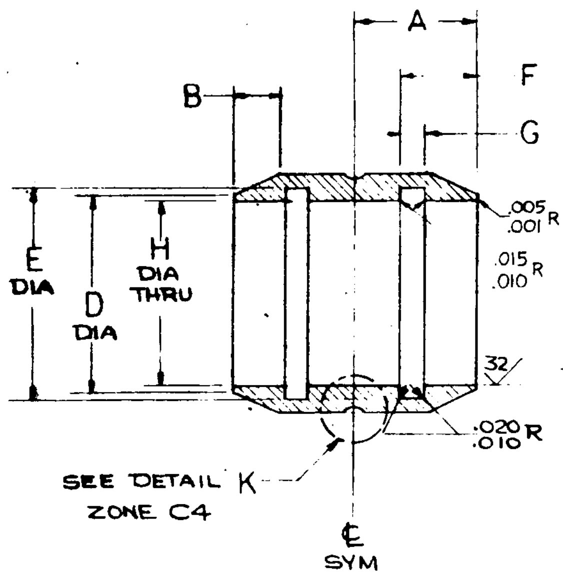
ZONE	SYM	DESCRIPTION	DATE	APPROVAL
		ECN 43880 CIDN 200185		
	C	(1) RETRACED WITH GEN. CHGS CIDN 200460	October 1962	
D2	D	(1) VIEW BEFORE CHANGE CIDN 200558	1962	
	E	(1) P5, P7, & P14 ADDED ECN 130137	1962	
E6	F	1) PART 5 C DIA WAS .423-.438 ECN 44836	1963	
	H	(1) NOTE 2 WAS: MARK CONTAINER OR TAG WITH PART IDENT NO. AND VENDOR CODE IDENT CIDN 201190	Oct 1963	



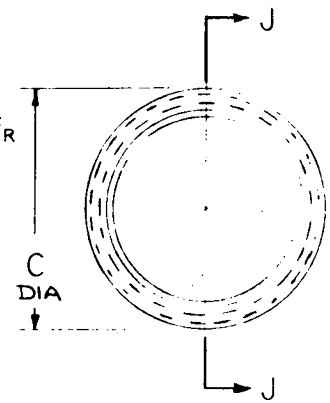
(D1) VIEW BEFORE CHANGE ZONE B6



DETAIL K
ZONE B6



SECT. J-J
ZONE B5



ZONE B6

5 DIA E & H MUST BE CONCENTRIC WITHIN .002 FIR.

⊖ 4 DIA H MUST BE ROUND WITHIN .0004 FIR.

3 COUPLINGS SHALL BE CLEANED IN A MANNER PRIOR TO PACKAGING TO REMOVE ALL DIRT, OIL, GREASE, OR FOREIGN MATERIAL DETRIMENTAL TO THE ULTIMATE BRAZING OPERATION & INDIVIDUALLY PACKAGED IN HEAT SEALED PLASTIC BAG

2 MARK OR TAG EACH INDIVIDUAL HEAT SEALED PLASTIC BAG WITH PART IDENT NO. & VENDOR CODE IDENT

1 MUST CONFORM TO G-E S1-212.010 (INTERPRETATION OF DWG)

85307

PRINTS TO: 70, C, 2, 375

FOR G-E USE ONLY
SIM TO NONE
PROCESS INFO NONE
L/O NO.
CHECKER

JV

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± DECIMALS ± ANGLES ±
ALL SURFACES √
MATERIAL
GOVT OR COML
G.E.

DRAWN
DATE
APPD
ISSUED
APPROVED / DATE
ENGRNG
MFG
MATL

COUPLING-TUBE, BRAZED ENDS

GENERAL ELECTRIC
LJE DEPT
EVENDALE PLANT
LOCATION

SIZE C 871C234

CONT ON SHEET SH NO

SCALE NONE WT

REV H 871C234

7 6 5 4 3 2
A B C D E

Manufacture Of Atmospheric Chamber

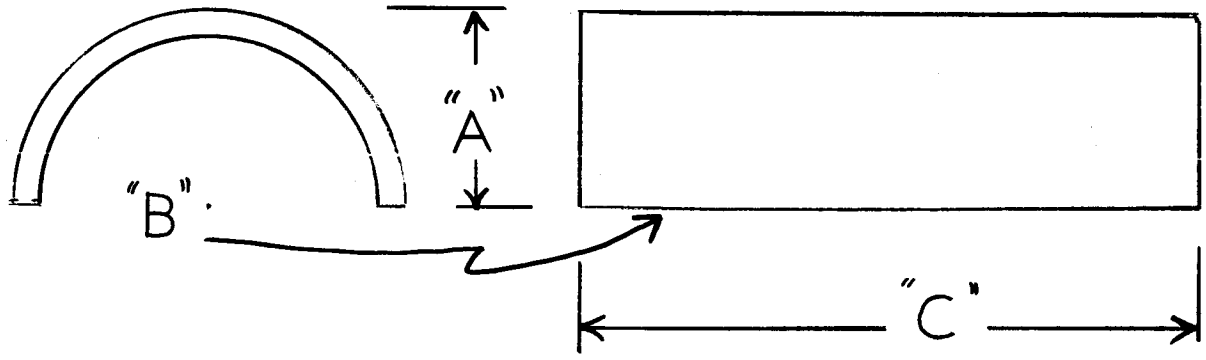
Pyrex tubing of the correct diameter is split off center lengthwise and lapped flat to the correct dimension. One half of the tube is scrapped for being undersize. This is compensated for, by the advantage that matched halves are not a requirement. One half can be replaced with another tube half with the assurance that an adequate atmospheric chamber is being obtained.

A water-cooled metallurgical cut-off machine utilizing a glass cutting wheel, was used to perform the splitting operation. Cutting dimensions were obtained by the use of a plexiglass guide block attached to the travel table on the cut-off machine. Little difficulty resulted with this cutting technique. The split tube contact surfaces were relatively chip free, but untrue. An aluminum oxide (grinding wheel - fine grit) served as the lapping plate to correct the contact surface. Dimensional checks were taken periodically to ascertain the quality of this operation. The lapping method is a light, even hand stroke in one direction at all times. The quality was exceptionally good, chipping was almost negative, and a $\pm$ .002" on altitude and a .005" F.I.R. on surface flatness could be maintained. This method is acceptable for producing the split atmospheric chamber. Table I lists the final configurations and dimensions.

Splitting glass for the elbow and tee type tool is accomplished in the same manner as for the straight coupling tools. One difference exists between the two types of tool glass. For the elbow and tee type tools, the glass is molded to the required diameter by placing the split glass in a ceramic mold and yielding (forming) at a temperature of 1500°F for five (5) minutes.

This molding of the glass insures tighter control on glass dimensions, assuring more efficient sealing at the split line. Standard pyrex tubing in larger diameters has greater tolerances on the O.D. and I.D. than is needed for (split induction braze tools) sealing chambers. Molding of the glass also eliminates the problem of using several different size O'Rings to hold the glass in place. Table II lists the final configurations and dimensions.

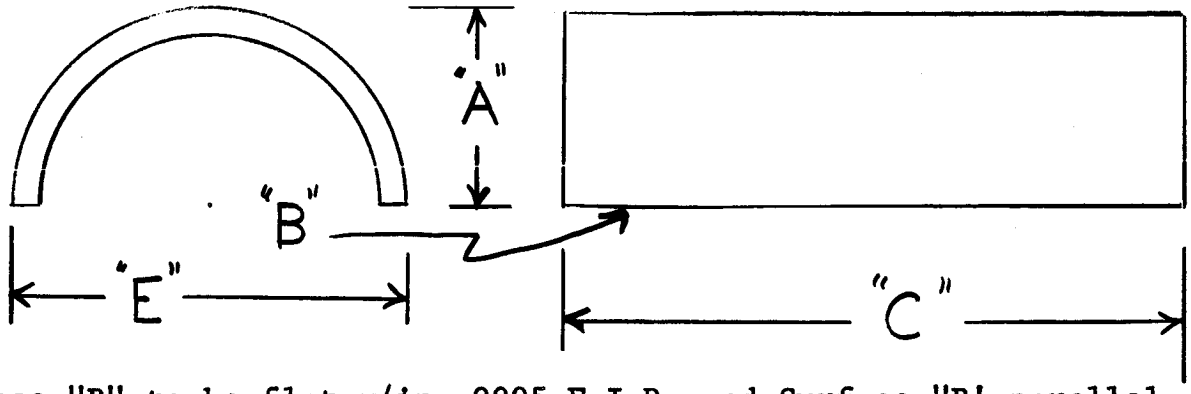
TABLE I. Tolerances For Glass Tools Used In Brazing Straight Couplings



Surface "B" to be flat w/in .0005 F.I.R. and surface "B" parallel to top of tubing w/in 003 in.

O.D. Brazed Tube	Tube O.D. (MM)	Tube Wall (MM)	Dim. "A" Inches	Dim. "C" Inches
250	13.4	1.3	.266	2.26
	12.6	1.1	.251	2.24
750	28.7	1.7	.550	2.26
	27.3	1.3	.535	2.24
1.250	46.0	2.2	.897	3.63
	44.0	1.8	.882	3.61
1.500	52.0	2.2	1.015	3.63
	50.0	1.8	1.000	3.61
2.000	76.3	2.7	1.487	3.63
	73.7	2.1	1.474	3.61
2.500	81.3	2.7	1.536	3.63
	78.7	2.1	1.521	3.61

TABLE II. Glass Tolerances For Elbow And Tee Type Tools



Surface "B" to be flat w/in .0005 F.I.R. and Surface "B' parallel to top of tubing w/in 003 in.

Brazed Tube O.D.	Tube O.D. Nom. (MM)	Tube Wall Nom. (MM)	Dim. "A" Inches	Dim. "C" Inches	Dim. "E" Inches
.250	13.0	1.2	.260 .255	1.32	.520 .510
.750	28.0	1.5	.5675 .5625	1.57	1.135 1.125
1.250	45.0	2.0	.880 .875	1.95	1.760 1.750
1.500	51.0	2.0	1.005 1.000	1.95	2.010 2.000
2.000	70.0	2.4	1.400 1.395	2.32	2.800 2.790

Split Coil Inductors And Housing Block

The coils are supplied in equal halves, but function as one continuous wound coil. Coils are housed in a rigid chamber of RPD 150 (composed of preimpregnated long spinning grade chrysotile asbestos fibers and a high heat resistant phenolic resin system) material and containing an air manifold for cooling of all coil halves. The coil is so constructed that if one portion of the coil were accidently damaged it could easily be replaced, preventing the loss of a complete coil. The individual coil segments are contained and positioned in RPD 150 block by means of two small screws. Between the two screws is an air passage from the manifold to the coil segment, thus cooling each segment separately. Air is discharged on the O.D. of each coil near the split line thru a small hole drilled in the coil segments as seen in Figure 1 and 1.A.

The cooling air in the 1/4" tool enters from one side of the coil and travels through the coil discharging at the opposite opening (See figures 2 & 2A). These particular split coil inductors are for brazing the 1/4", 3/4", 1 1/4", 1 1/2", 2" and 2 1/2" tube joints with straight connectors. Table III lists the split coil data for the above mentioned coils. Several other features of the split coil inductors are:

1. A flexible copper braided joint at the pivot point of the clamp allowing freedom of movement while in operation.

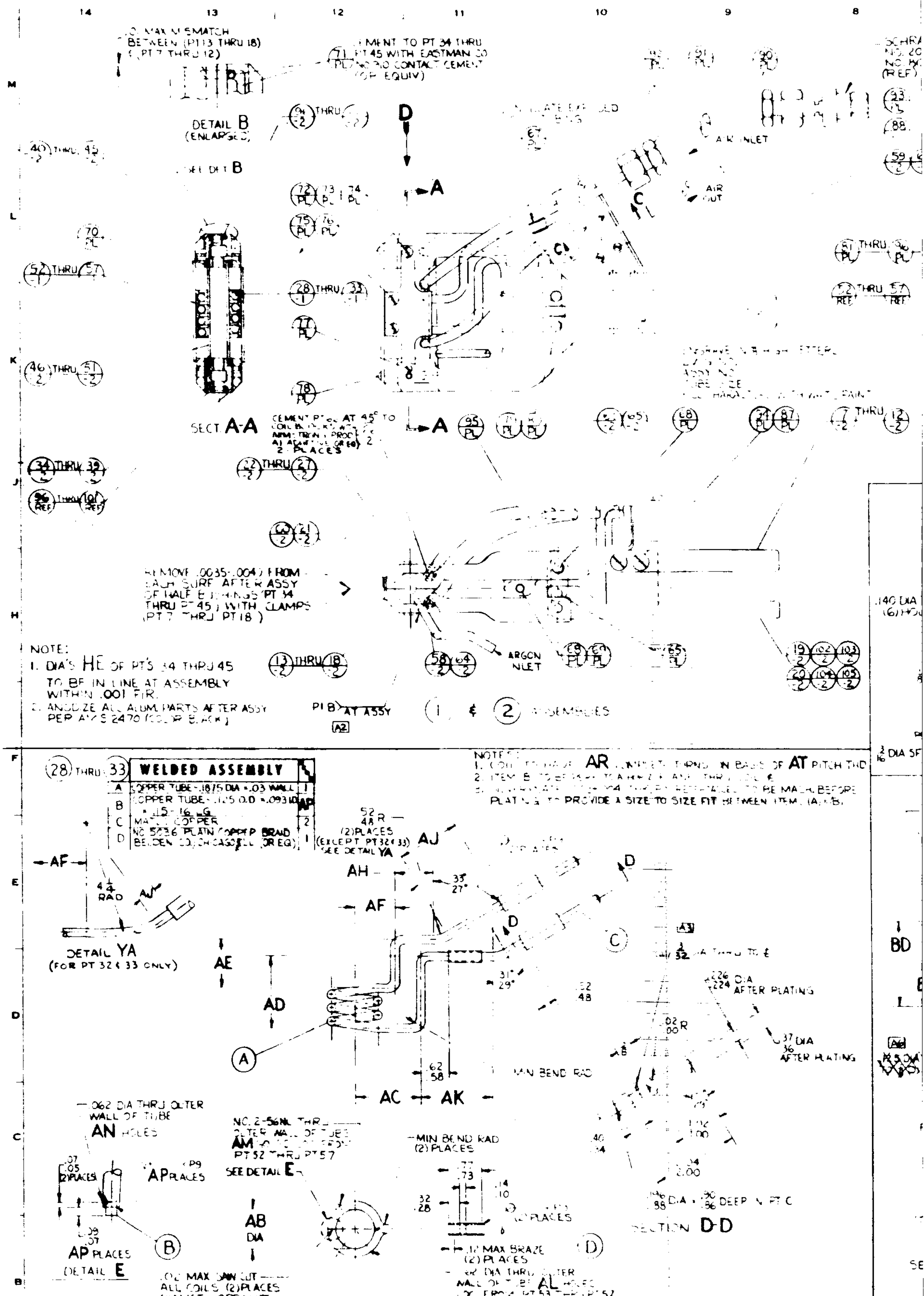
2. A special copper cable connecting pin, silver brazed to the end of each coil lead.

3. A double argon feed system to prevent a heat sink.

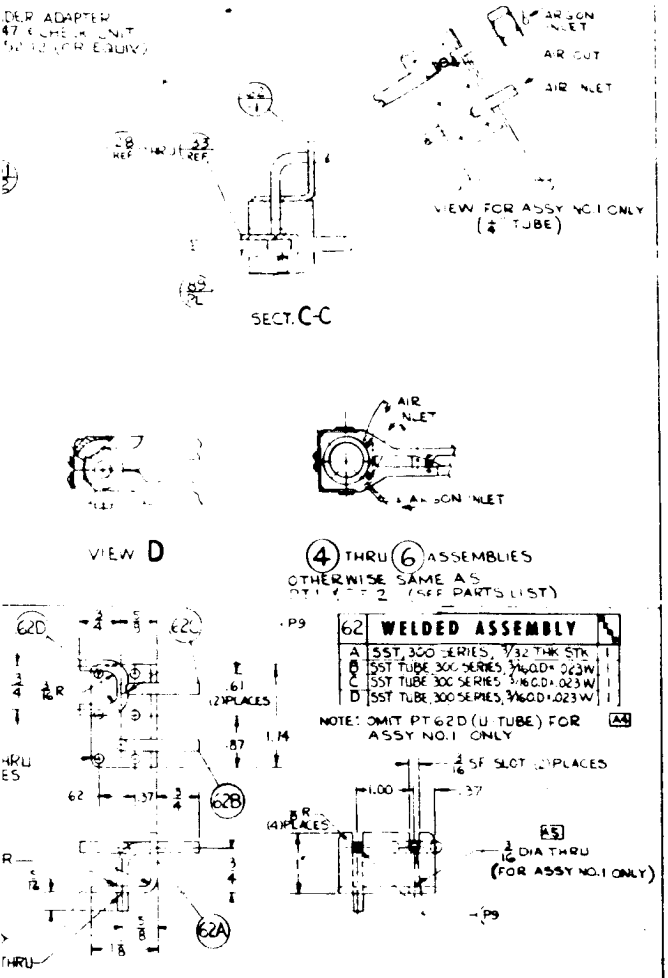
4. Ease of opening and closing of split coil.

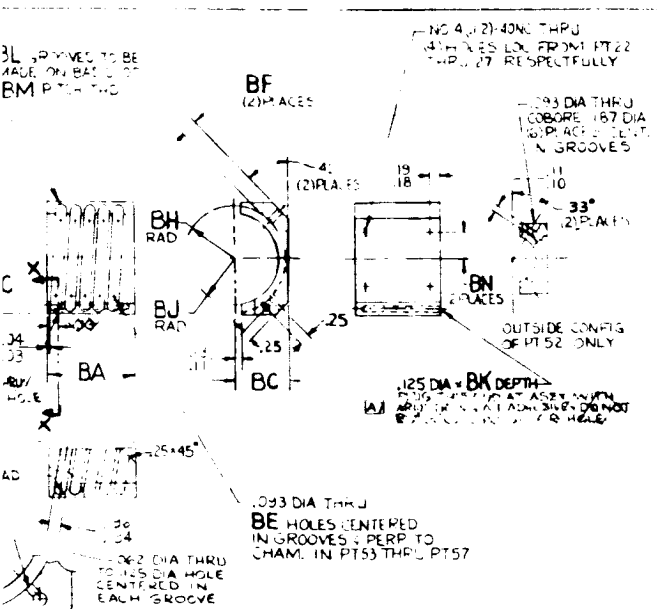
5. Extra argon channel between O'Rings to prevent oxidation.

Figures I through 6A are the split inductors delivered to NASA for use in brazing straight couplings, print 4012180-651.

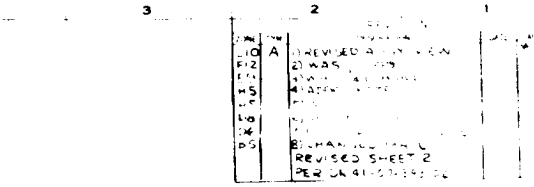


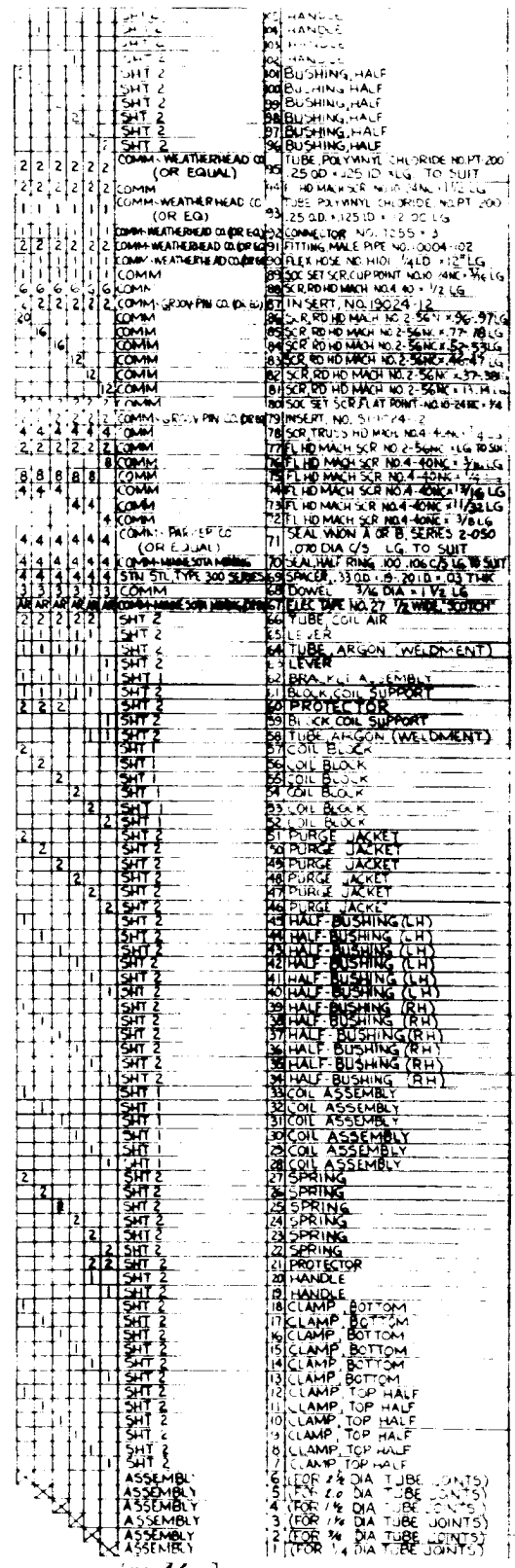
PART NO	AB	AC	AD	AE	AF	AH	AJ	AK	AL	AM	AN	AP	AR	AT
28	.60 .59	1.52 1.48	1.63 1.59	1.16 1.12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	5	3	.56
[illegible]	[illegible]	2.02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	4	[illegible]
[illegible]	1.88 1.87	2.52 2.48	2.08 2.04	1.08 1.04	2.27 2.23	2.16 [illegible]	.48	2.64 2.60	—	20	20	9	5	.375
[illegible]	2.12 2.11	2.52 2.48	2.40 2.36	.90 .86	2.25 2.23	2.4[illegible] 2.42	.52 .48	2.64 2.60		[illegible]	24	11	6	.375
[illegible]	3.07 3.06	3.52 3.48	2.40 2.36	—	[illegible]	—	.52 .48	2.14 2.10	[illegible]	32	32	15	8	.312
[illegible]	3.27 3.26	3.52 3.48	2.64 2.60	—	[illegible]	—	.52 .48	2.14 2.10	[illegible]	[illegible]	[illegible]	15	8	[illegible]





A	BC	BD	BE	BF	BH	BJ	BK	BL	BM	BN
2	.605 .595	.20			.495 .490	.40 .39		3	.78	.93 .92
				.44	.135	1.64	2.04			.88
				.43	.130	1.63	2.00		.375	.93
				.50	.255	1.74	2.41			.88
				.49	.250	1.75	2.37		.375	.87
				.75	.735	1.63	2.66			.93
	1.935			.74		1.66	2.62			.93
	2.120			.44		3.13	3.16			.93
28	2.110	4.21		.93		1.76	3.12	8	.375	1.82





BRAZING FIXTURE, TUBE JOINT

GENERAL ELECTRIC
EVENDALE PLANT

E 4012180-651

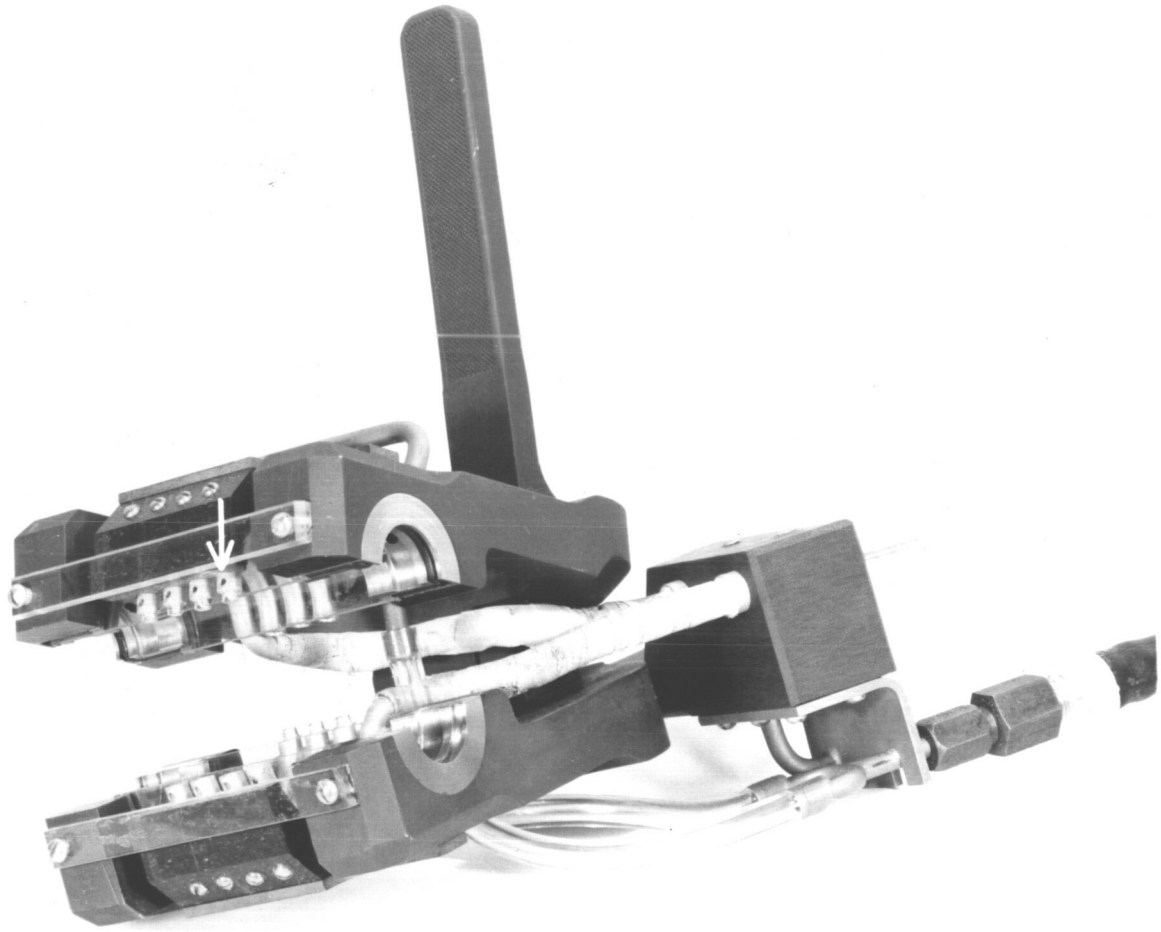


Figure 1 AIR DISCHARGE HOLES

MCh761

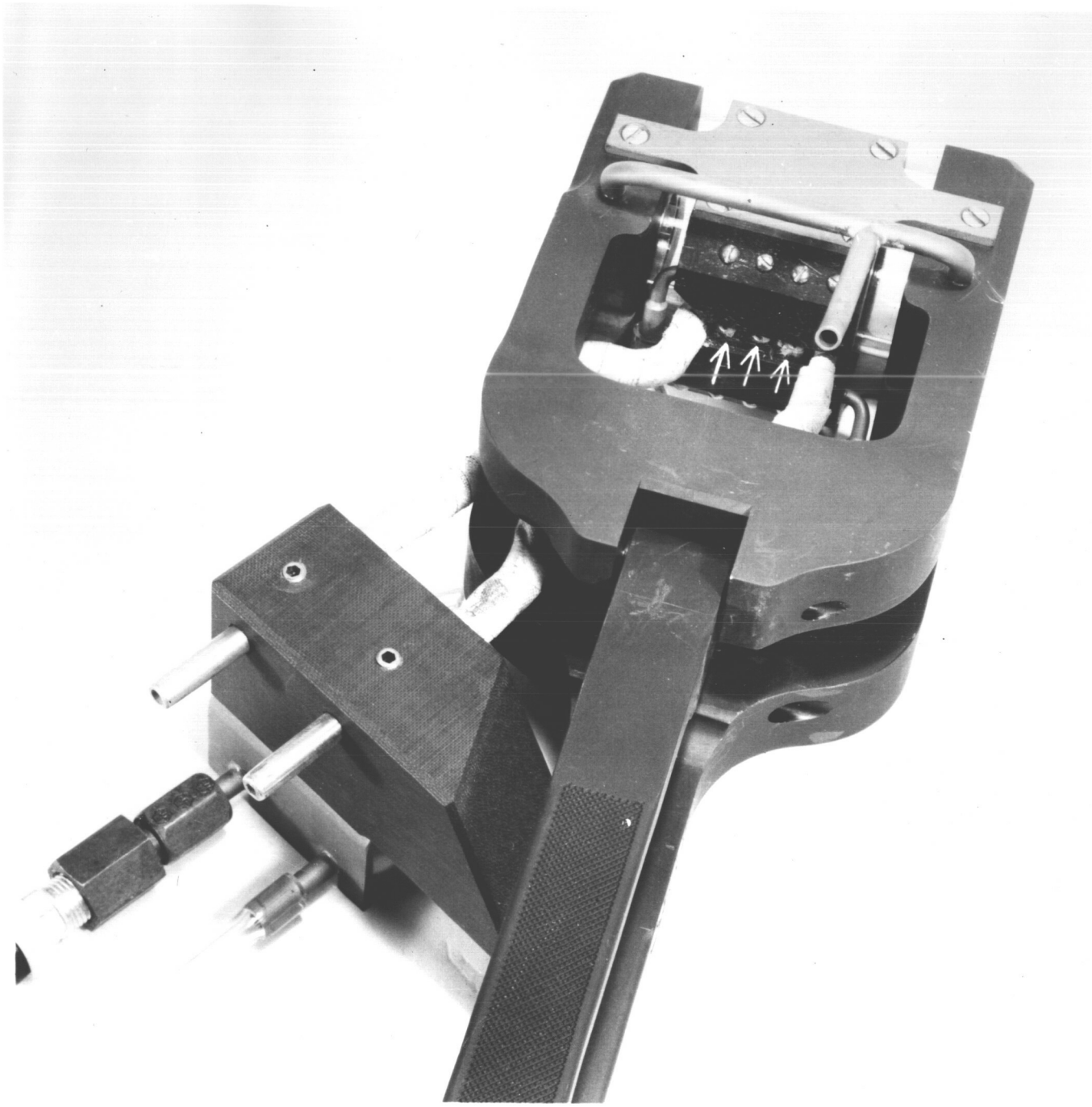


FIGURE 1 A

AIR DISCHARGE HOLES
(3/4"Braze Tool)

M04761

FIGURE 2

1/4" BRAZE TOOL
(A-Air Inlet)

MO4761

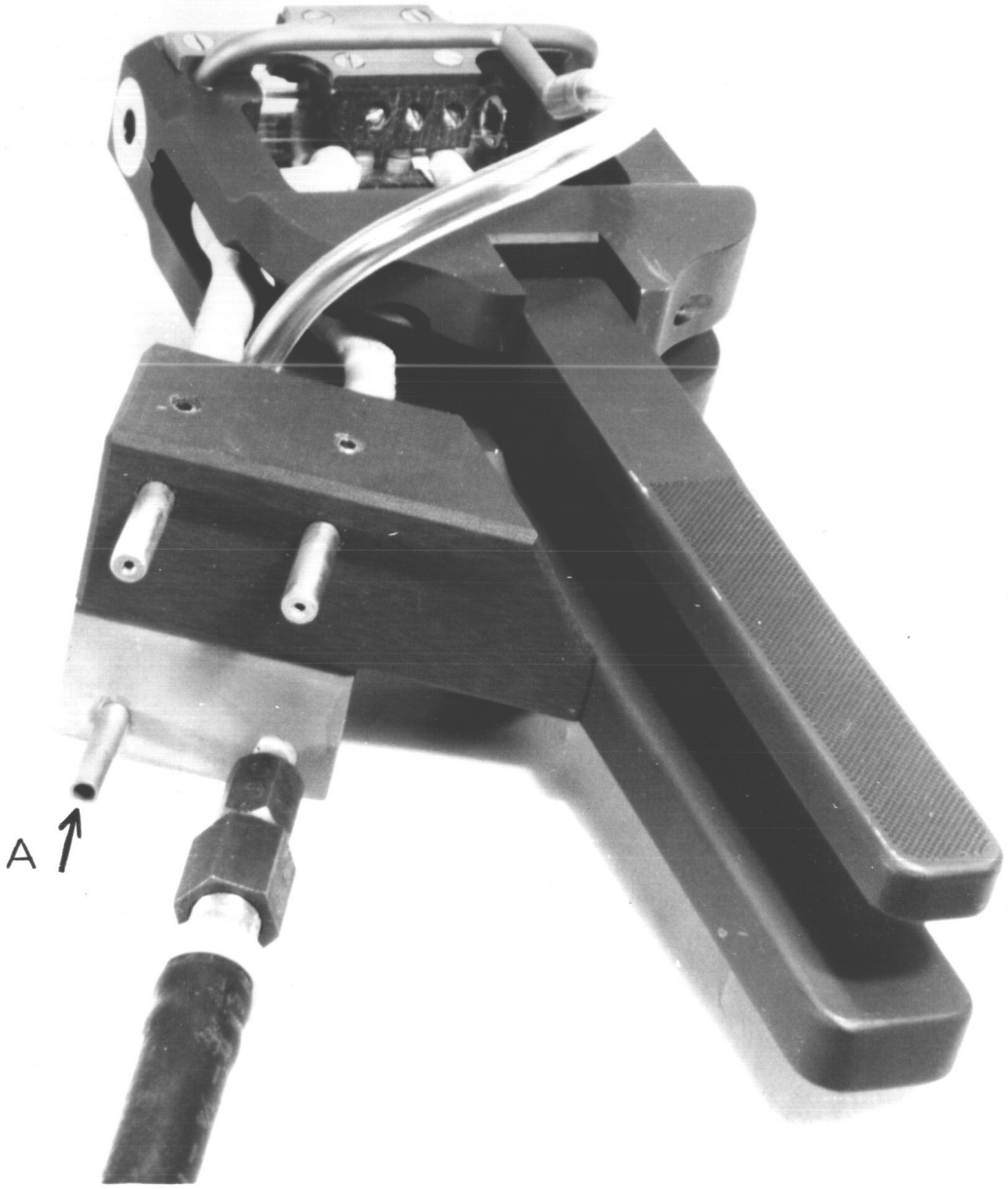


FIGURE 2A

1/4" BRAZE TOOL
(A-Air Discharge)

M04761

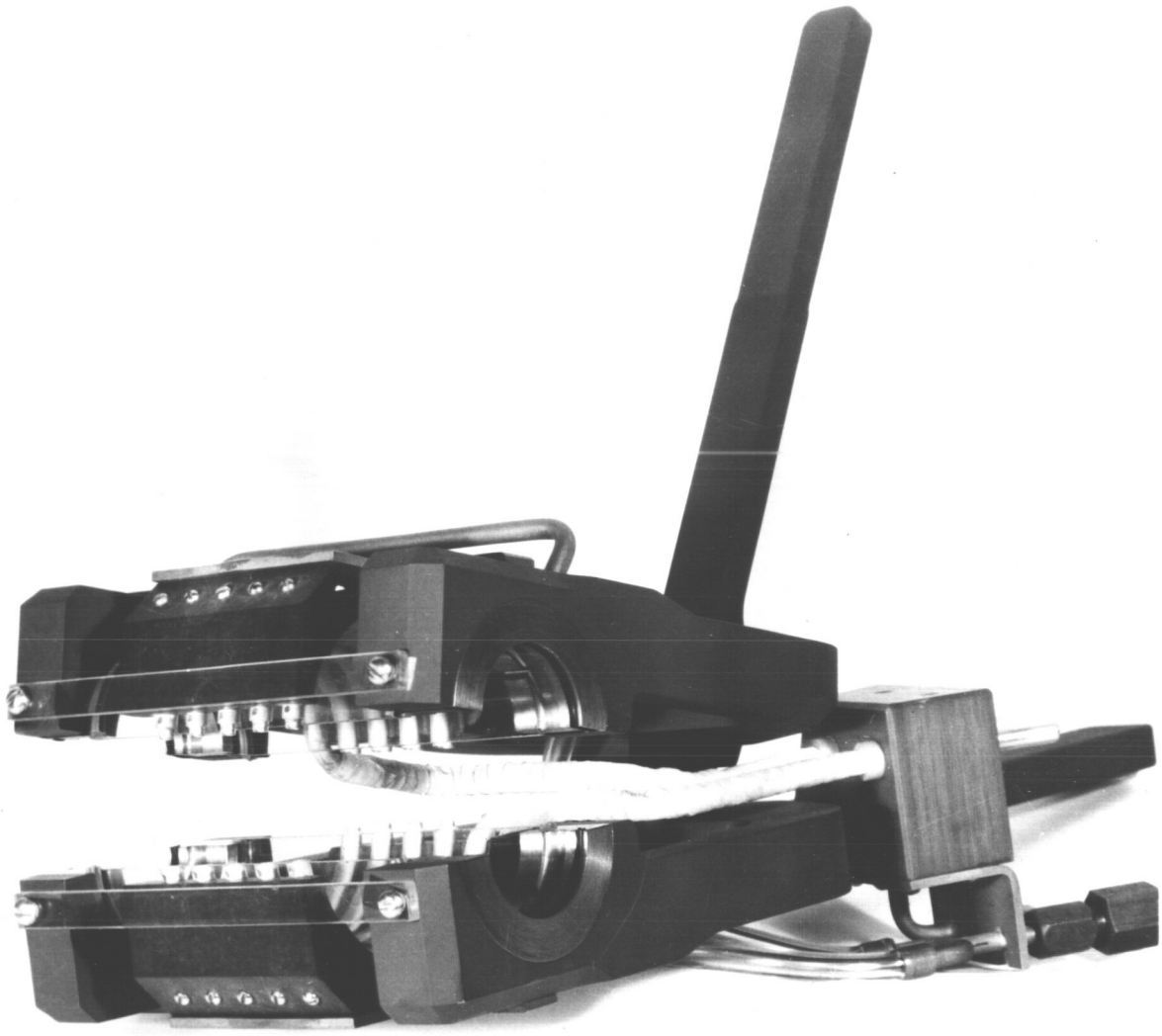


FIGURE 3 1 1/4" BRAZE TOOL

M04761

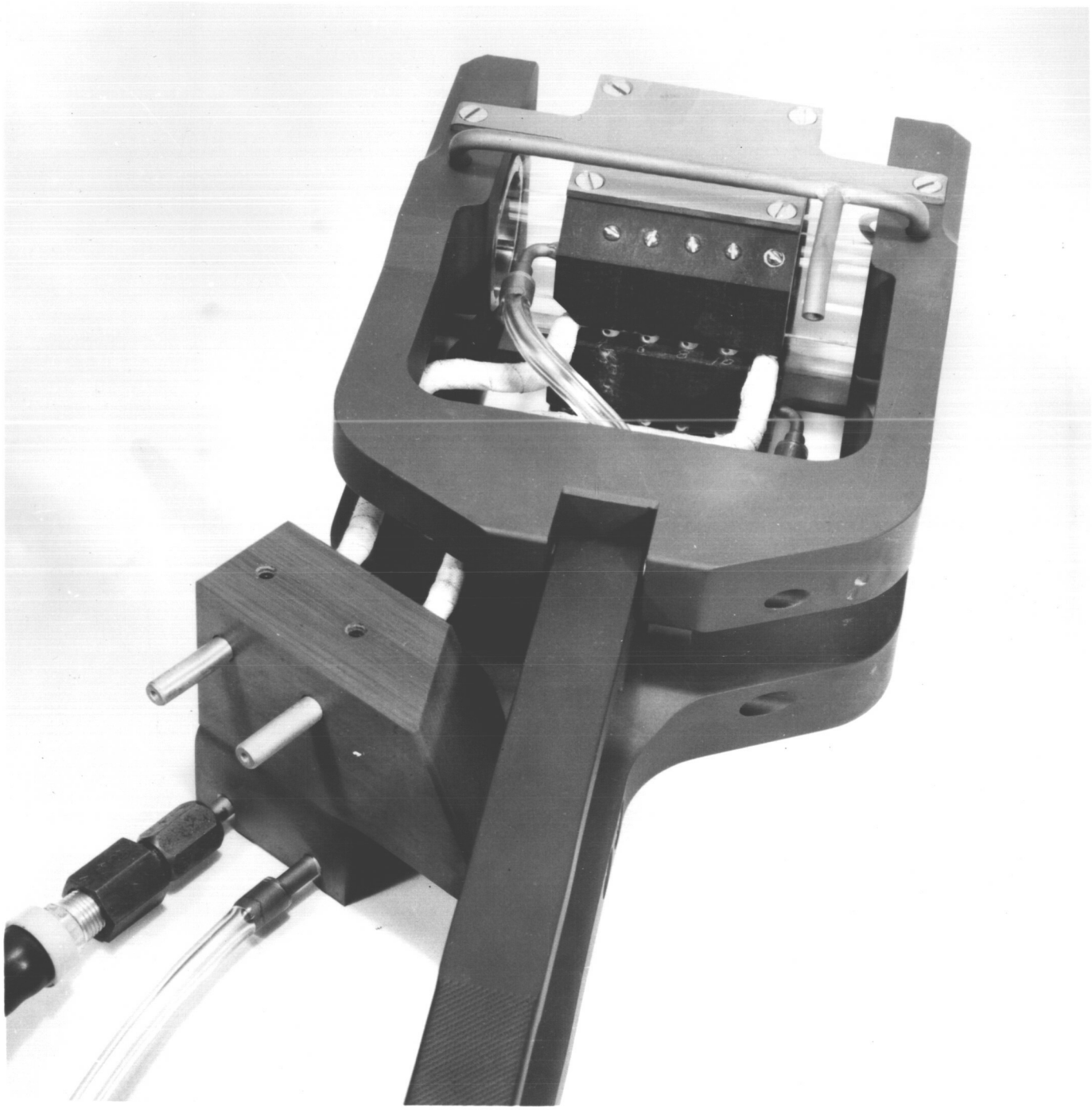


FIGURE 3A

1 1/4" BRAZE TOOL

MOL761

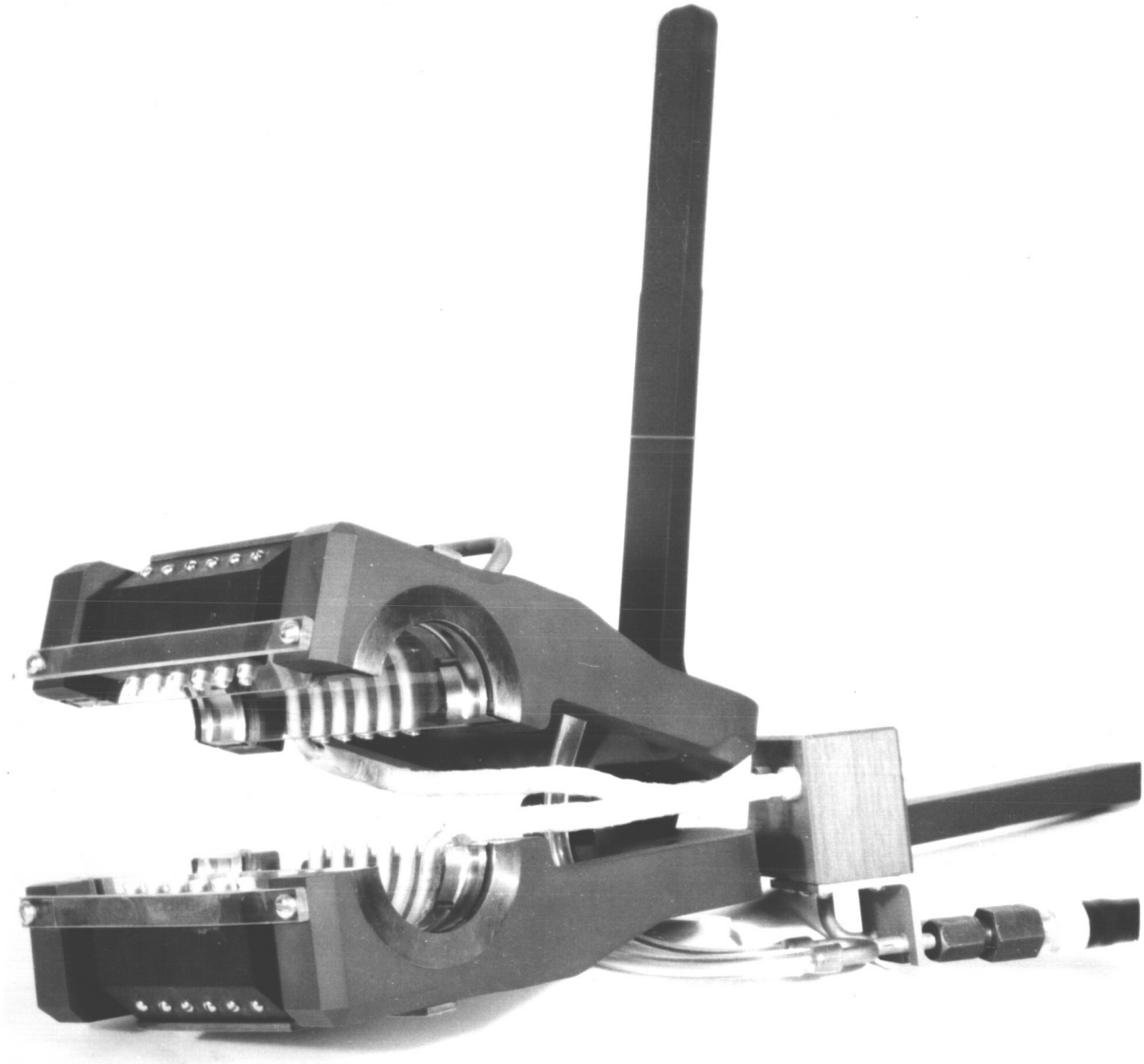


FIGURE 4 1 1/2" BRAZE TOOL M04761

FIGURE 4A

1 1/2" BRAZE TOOL

M04761

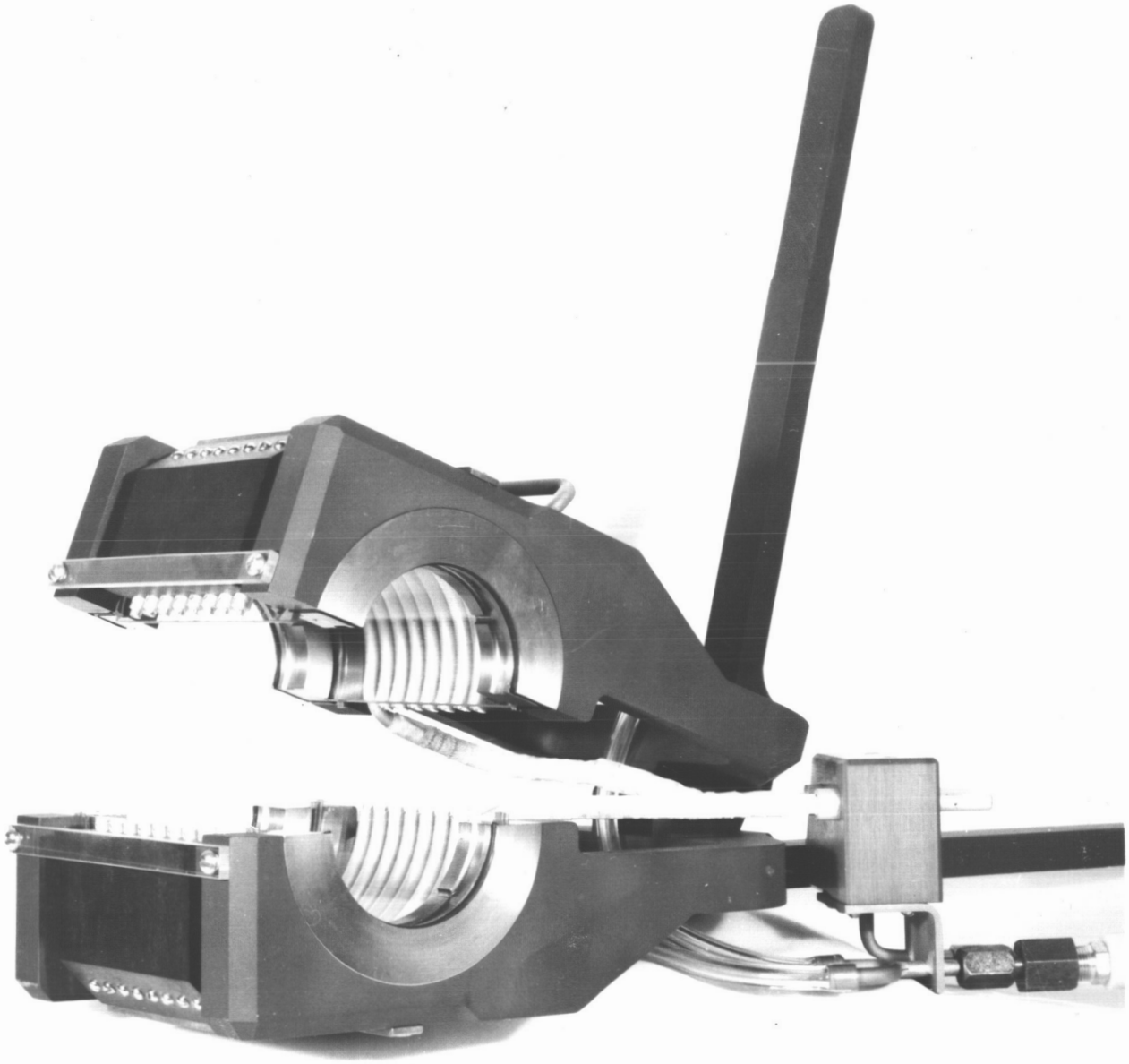


FIGURE 5 2" BRAZE TOOL M04761

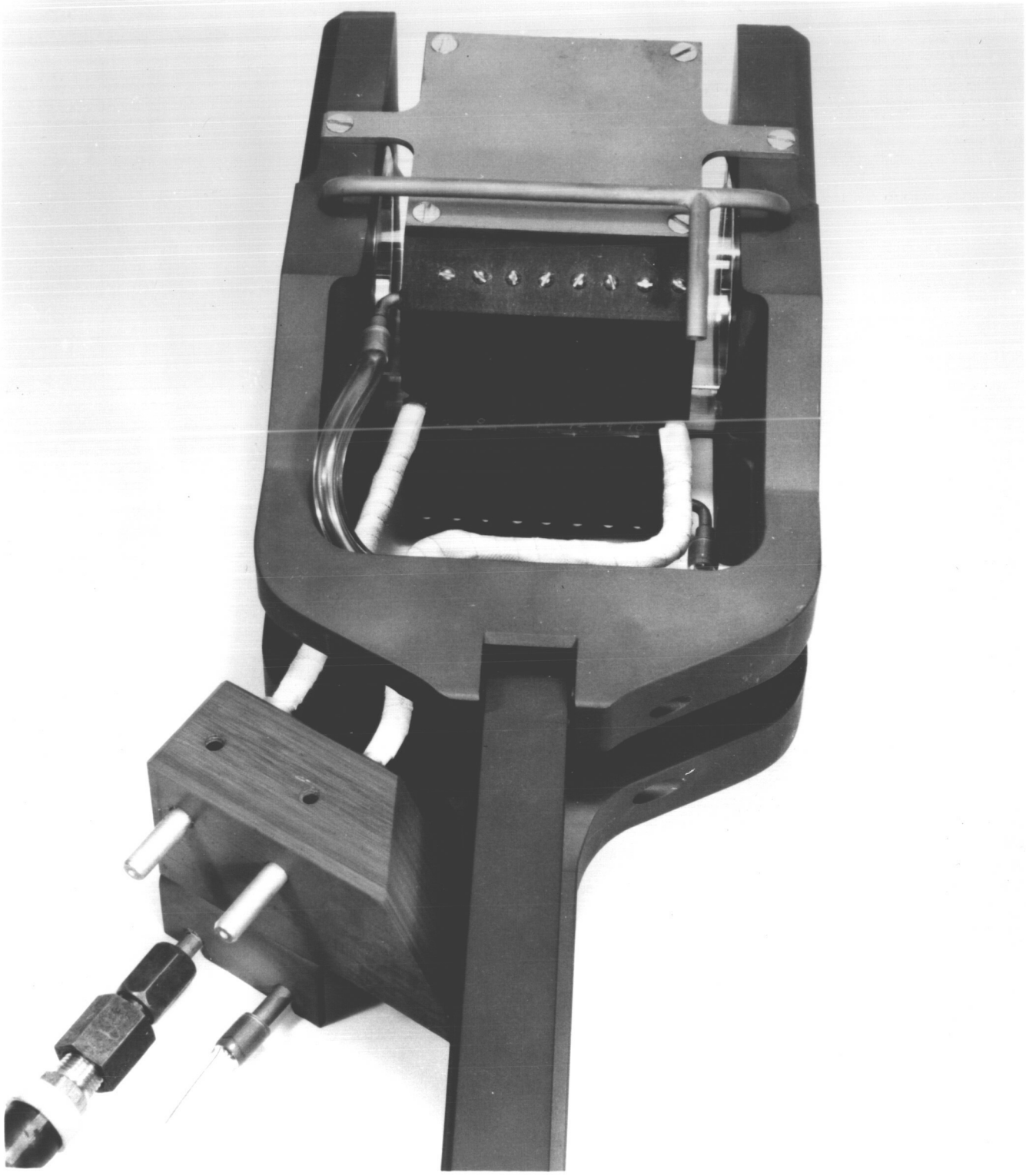


FIGURE 5A 2" BRAZE TOOL

MO4761

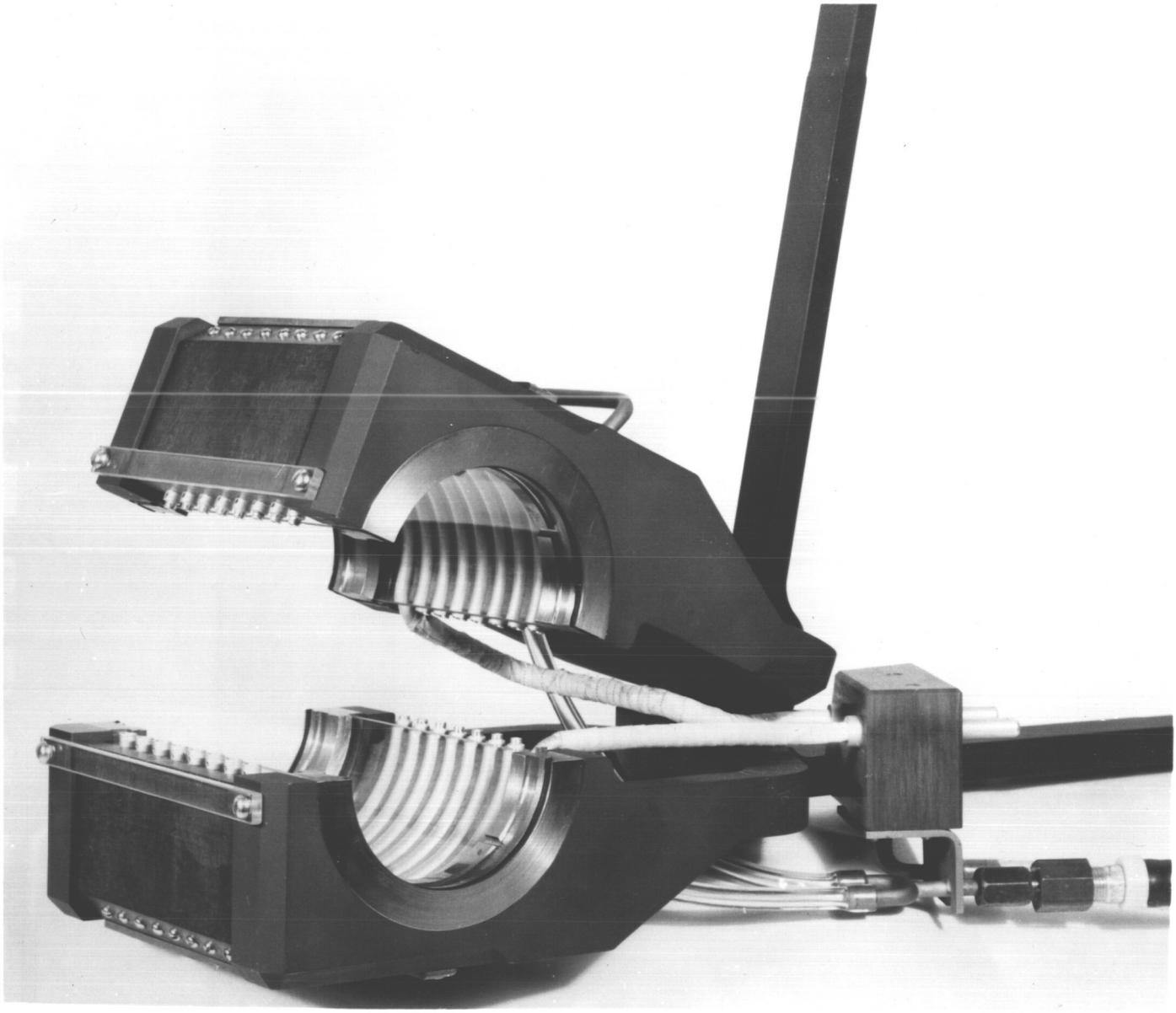


FIGURE 6 2 1/2" BRAZE TOOL

MO4761

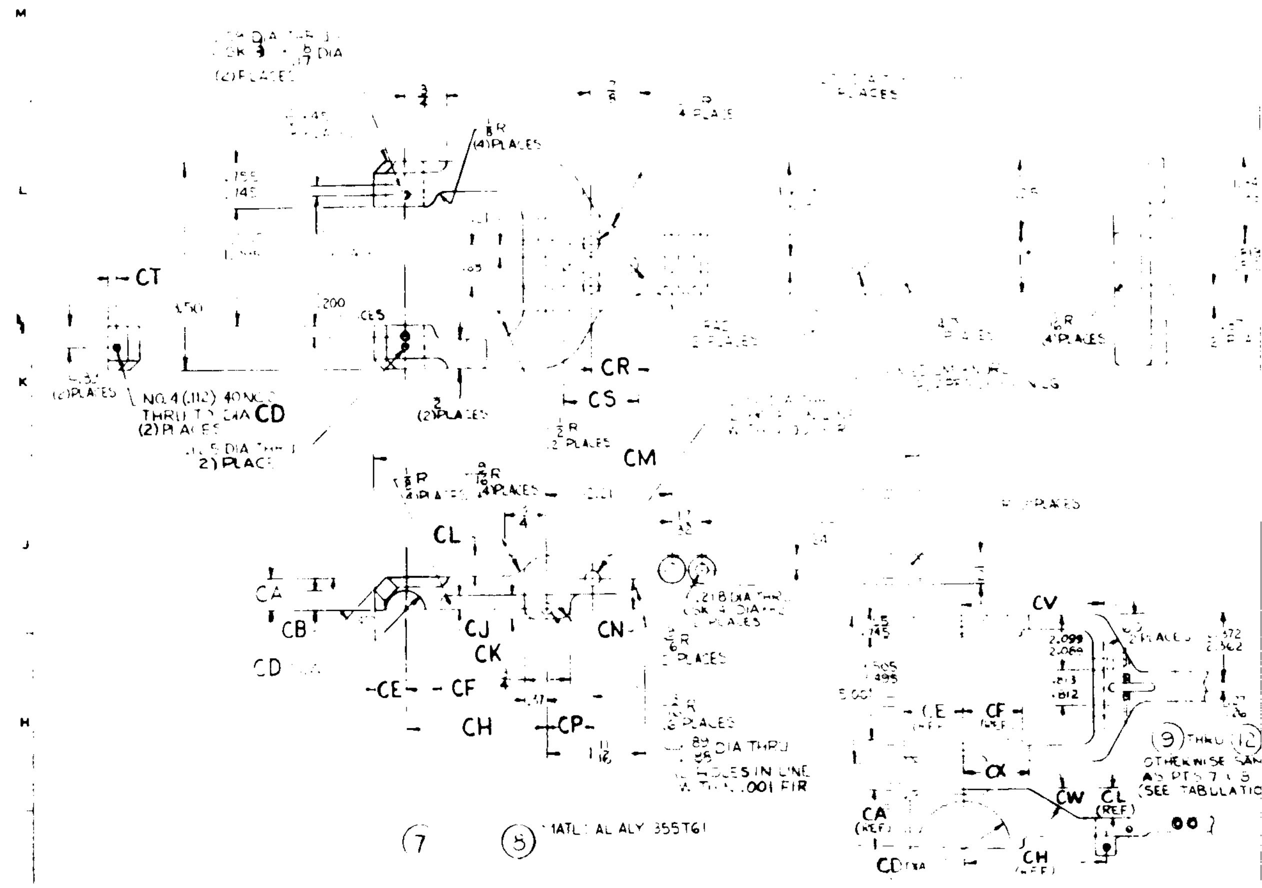
FIGURE 6A

2 1/2" BRAZE TOOL

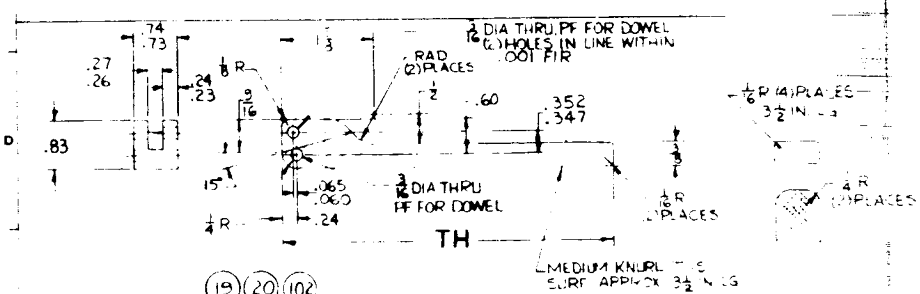
M04761

INDUCTORS FOR ELBOW AND TEE FITTINGS

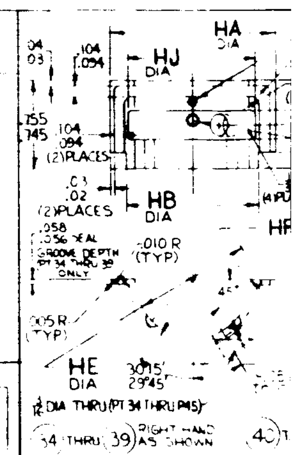
Housing of the split coil inductor for brazing elbow and tee type fittings is similar to that used for the coil for brazing straight couplings. The coil itself is made from square copper tubing instead of round which was used for straight couplings coil. Square copper tubing was used to gain additional surface area needed for efficient heating of these fittings. Greater efficiency could be achieved with coils having a larger surface area, due to the fact that high-frequency currents tend to flow along the surface of the metal. By using square copper tubing the number of turns were reduced, allowing shortening of the straight length required to make a coil for brazing elbow and tee type fittings. The width of the brazing tool was thus reduced. The coil itself has a safety wiper blade attached on the back side of the coil where the coil joins at the split line of the glass chamber. The wiper blade not only insures good electrical contact, but also acts as a shield which prevents back flow of discharged cooling air. As was mentioned previously, the glass for these tools is molded giving tighter control on tolerances and assuring a better atmosphere chamber. The sealing jaws of these tools are made of the RPD 150 material to reduce weight of the tool. The jaws themselves have a double O'Ring groove to insure better sealing. Figure 7 thru 11 show the 1/4" braze tool through the 2" braze tool for brazing the elbow and tee type fittings. Figure 12, 12A and 12B show the braze tools with their carrying case. For details of these tools see prints, 4012180-740 thru 744.

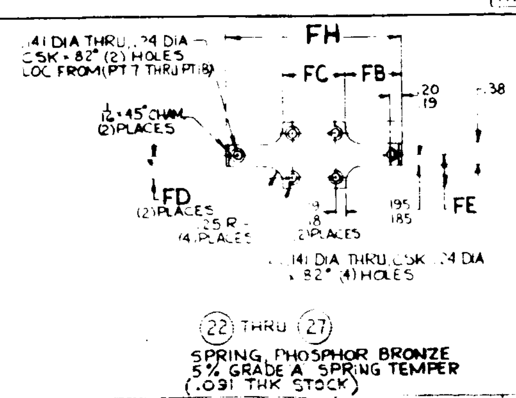


PART NO.	CA	CB	CD	CE	CF	CH	CJ	CK	CL	CM	CN	CP	CR	CS	CT	CV	CW ANGLE
7	.605 .595	5/6	.687	.62	5/32	2.50	7/32	11/32	11/32	[illegible]	.475	[illegible]	.77	1.27	.16		
8	.76 .75	[illegible]	1 7/	1.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
9	[illegible]	3/4	1.959 1.957	1.34	1 5/16	[illegible]	[illegible]	5/32	[illegible]	[illegible]	.640	[illegible]	[illegible]	1.56	.25	4 3/4	
10	1.45 1.44	1	2.194 2.192	1.50	1 1/2	4.50	3/8	9/32	[illegible]	[illegible]	.650 .640	[illegible]	.99	1.56	.25	4 3/4	15°
11	2.01 2.00	1 3/8	3.150 3.148	2.06	2 1/16	5.00	3/8	9/32	[illegible]	[illegible]	.650 .640	.795	.99	1.56	.25	5 3/16	30°
12	[illegible]	1 [illegible]	3.346 3.344	2.18	2 1/8	5.00	3/8	5/32	1/16	1 3/16	.650 .640	.805 .795	.99	1.56	.25	5 3/16	30°



PT NO.	19	20	102	103	104	105
TH	5 7/8	5 7/8	[illegible] 7/16	9 1/2	10	11 7/16



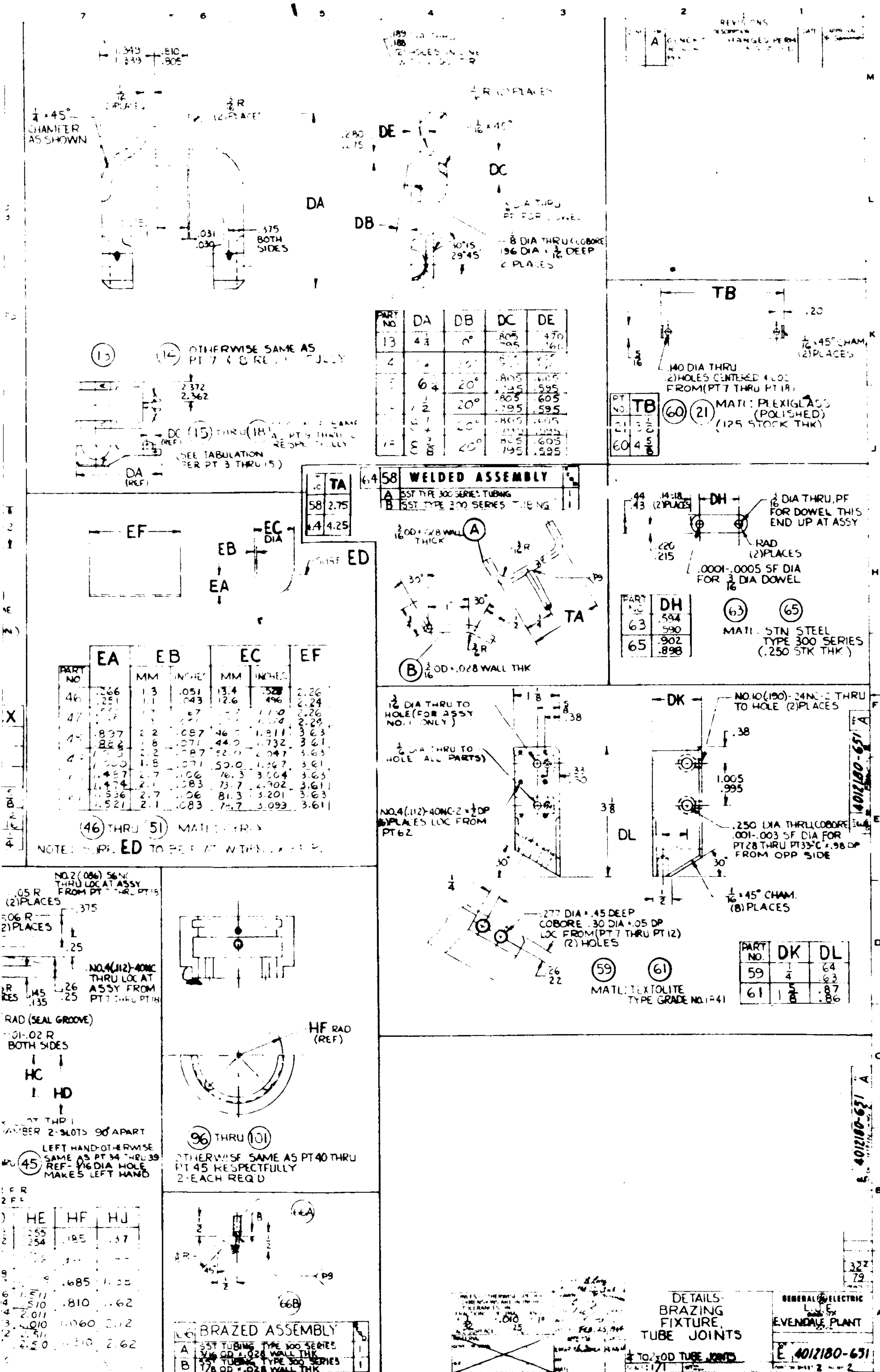


PT NO.	FH	FA	FB	FC	FD	FE
22	3.12	1.08	[illegible]	1.12	[illegible]	.545 [illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	4	1.93	1.24	[illegible]	[illegible]	[illegible]
25	[illegible]	2.12	[illegible]	[illegible]	.57	[illegible]
26	4	[illegible]	.93	[illegible]	.25	[illegible]
27	4	[illegible]	.68	[illegible]	[illegible]	[illegible]

2. DIA HA & HE TO BE PAR WITHIN .00[illegible]
DIA HE & HC TO BE PAR WITHIN .00[illegible]

PART NO.	HA	HB	HC
34 & 40	.687 .685	[illegible] .385	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.957 1.955	[illegible]	.625 .624
[illegible]	2.192 2.190	[illegible]	.750 .749
[illegible] 44	[illegible].148 [illegible].146	[illegible]	1.000 .999
[illegible] 45	3.344 3.342	[illegible] 2.875	.250 .249

MAT [illegible]



PART NO.	DA	DB	DC	DE
13	4 1/4	0°	.805 / .795	.470 / .460
14	[illegible]	20°	[illegible]	[illegible]
[illegible]	6 1/4	20°	.805 / .795	.605 / .595
[illegible]	7 1/2	20°	.805 / .795	.605 / .595
[illegible]	[illegible]	20°	.805 / .795	.605 / .595
18	8 3/8	20°	.805 / .795	.605 / .595

PT NO.	TB
21	3 3/8
60	4 5/8

NO.	TA
58	2.75
64	4.25

64 58	WELDED ASSEMBLY
A	5ST TYPE 300 SERIES TUBING
B	5ST TYPE 300 SERIES TUBING

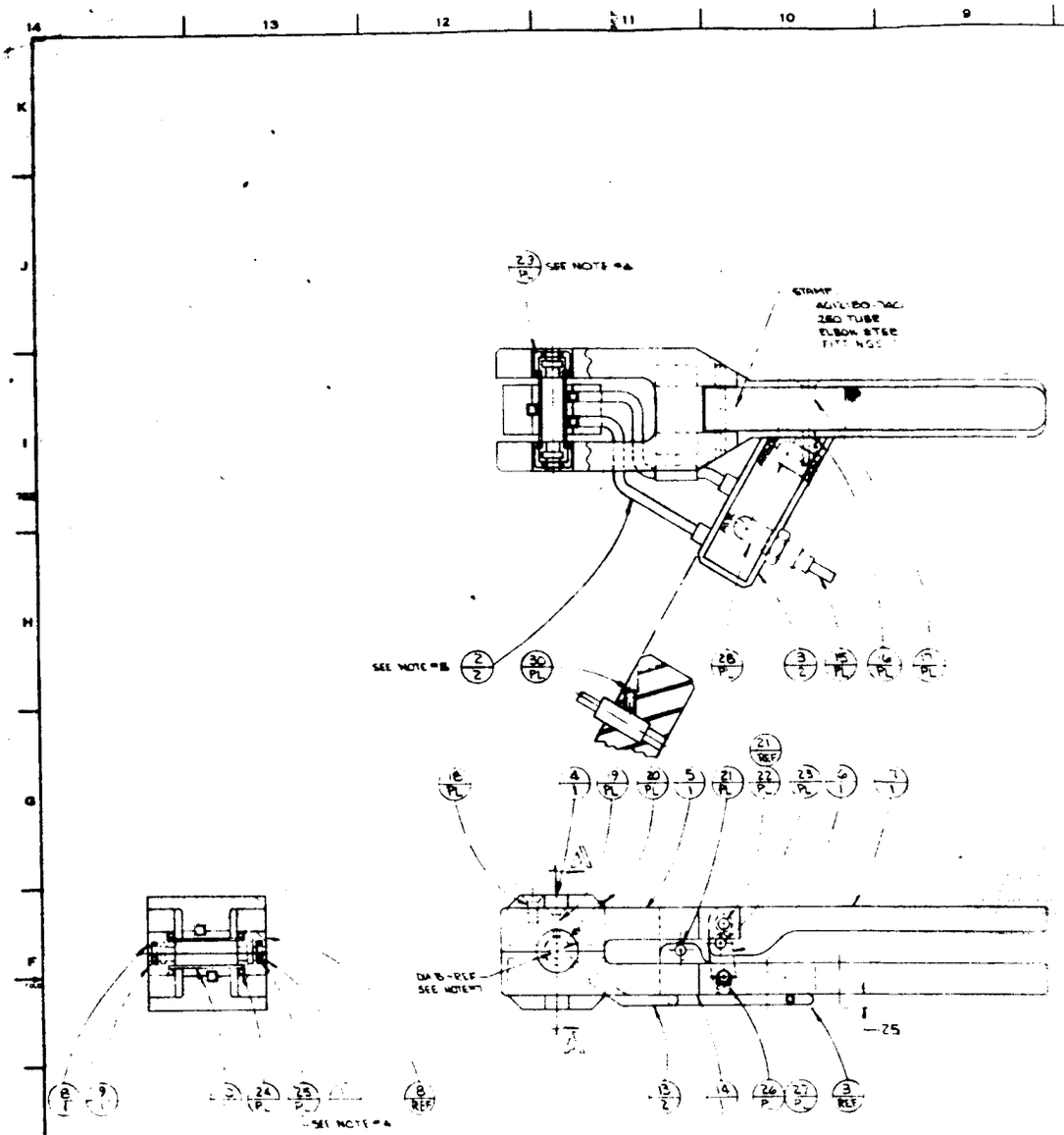
PART NO.	DH
63	.594 / .590
65	.902 / .898

PART NO.	EA	EB MM	EB INCHES	EC MM	EC INCHES	EF
46	.266 / .251	1.3 / 1.1	.051 / .043	13.4 / 12.6	.528 / .496	2.26 / 2.24
47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.26 / 2.24
48	.837 / .822	2.2 / 1.8	.087 / .071	46.0 / 44.0	1.811 / 1.732	3.63 / 3.61
49	[illegible]	2.2 / 1.8	.087 / .071	52.0 / 50.0	2.047 / 1.967	3.63 / 3.61
50	1.467 / 1.474	2.7 / 2.1	.106 / .083	76.3 / 73.7	3.004 / 2.902	3.63 / 3.61
51	1.536 / 1.521	2.7 / 2.1	.106 / .083	81.3 / 78.7	3.201 / 3.093	3.63 / 3.61

PART NO.	DK	DL
59	1/4	.64 / .63
61	1 5/8	.87 / .86

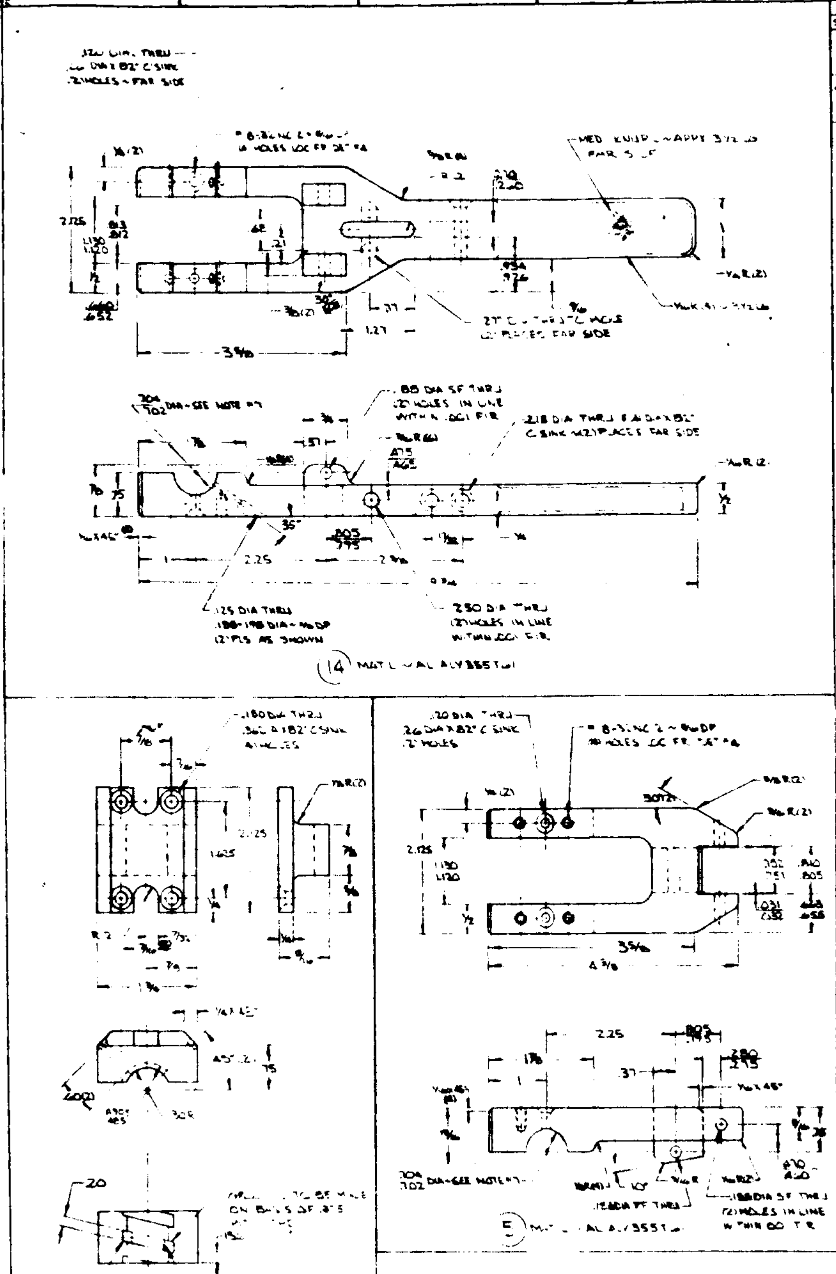
	HE	HF	HJ
[illegible]	.255 / .254	.185	.37
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	.685	1.35
[illegible]	1.511 / 1.510	.810	1.62
[illegible]	2.011 / 2.010	1.060	2.12
[illegible]	2.511 / 2.510	1.310	2.62

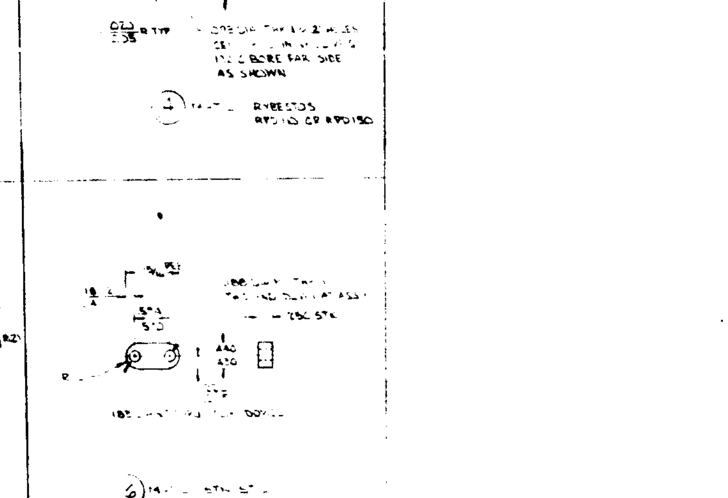
66	BRAZED ASSEMBLY
A	5ST TUBING TYPE 300 SERIES 3/16 OD × .028 WALL THK
B	5ST TUBING TYPE 300 SERIES 1/8 OD × .028 WALL THK


SEE NOTE 4a
SEE NOTE 4b
SEE NOTE 4a
DATUM REF SEE NOTE 4
25
SECTION

(1)

SYM	ZONE	DESCRIPTION	DATE	APPROVED
A		1) SHT-2 REVISED 41-NASA-1749	1965	
B	B3	1) WAS RYBESTOS RPD 110 OR 150 41-1749	1965	





NOTES:

1. BREAK ALL SHARP EDGES .005-.030 R OR [illegible] INSPECT [illegible] TO BE VISUAL OR BY FEEL
2. PROVIDE AREA IN STORAGE CONTAINER FOR (6) PURGE JACKET SETS (DET #10). MARK CONTAINER WITH "BRAZE TOOL FOR .250 TUBE ~ ELBOW & TEE FITTINGS."
3. [illegible] 1.05 93 [illegible] TO SUIT ~ MINNESOTA RUBBER & GASKET CO.
4. BOND [illegible] IN PLACE WITH [illegible] SILICON # SS-4004 PRIME O'RING GROOVE FOR BONDING WITH GE TRANSLUCENT SILICONE RUBBER CLEAR SEAL, GENERAL ELECTRIC PRODUCT DEPT.
5. INSULATE EXPOSED AREA OF COIL DET #2 WITH MINNESOTA MINING & MANUFACTURING CO. SCOTCH ELECTRIC TAPE #27
6. ANODIZE ALL ALUM PARTS PER AMS-2470 (RED)
7. DIA "T" ON DETS #8, 9, 11, & 12 TO BE IN LINE AT ASSY WITHIN .002 FIR

QTY	SOURCE	ITEM	DESCRIPTION
2	COMM	30	#10-24NC-2 x [illegible] LG SOC SET SCR
4	COMM ~ PARKER CO (OR EQ)	29	O RING [illegible]
2	COMM ~ CRANE CO (OR EQ)	28	90° STREET ELBOW [illegible] (BRONZE)
2	COMM ~ [illegible] CO (OR EQ)	27	INSERT # [illegible]
2	COMM	26	#6-24NC-2 x [illegible] LG SOC SET SCR (FLAT POINT)
4	COMM ~ PARKER CO (OR EQ)	25	O RING [illegible] SERIES [illegible] TO SUIT
4	COMM ~ SEE NOTE #3	24	SEAL [illegible] TO SUIT
1	COMM	23	[illegible] DIA x [illegible] LG DOWEL
3	COMM	22	[illegible] DIA x [illegible] LG DOWEL
4	STN STL TYPE 300	21	SPACER ~ .350 DIA [illegible]
6	COMM	20	#2-56NC-2 x [illegible] LG ~ RD HD MACH SCR
4	COMM	19	#4-40NC-2 x [illegible] FLAT HD MACH SCR
8	COMM	18	#8-32NC-2 x [illegible] FLAT HD MACH SCR
2	COMM	17	#6-24NC-2 x [illegible] FLAT HD [illegible] SCR
2	COMM ~ GROOV PIN CO (OR EQ)	16	INSERT # [illegible] 24-12
1	COMM ~ ARC [illegible] (OR EQ)	15	CONNECTOR [illegible]
1	SHT 1	14	CLAMP BOTTOM HALF
1	SHT 2	13	[illegible]
1	SEE NOTE #2	12	STORAGE CONTAINER (TO SUIT)
1	SHT 1	11	HALF BUSHING
2	SHT 1	10	PURGE JACKET
1	SHT 1	9	HALF BUSHING
2	SHT 1	8	HALF BUSHING
[illegible]	SHT [illegible]	7	HANDLE
[illegible]	SHT 1	6	[illegible]
[illegible]	SHT 1	5	CLAMP TOP HALF
2	SHT [illegible]	4	COIL BLOCK
[illegible]	SHT 2	3	COIL SUPPORT BLOCK
[illegible]	SHT [illegible]	2	COIL ASSEMBLY
X		1	ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON [illegible] DECIMALS ± [illegible] ANGLES ± 1° ALL SURFACES

MATERIAL

SIGNATURES	DATE
[signature]	7-13-65
[signature]	7-14-65
[signature]	5-4-65
[signature]	[illegible]

GENERAL ELECTRIC

LJE [illegible] CINCINNATI, OHIO 45215

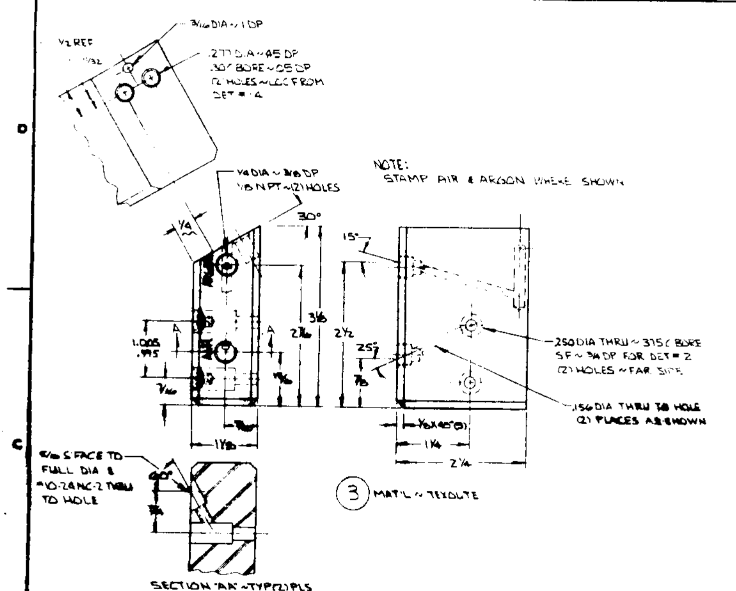
TITLE: BRAZE TOOL FOR .250 TUBE ELBOW & TEE

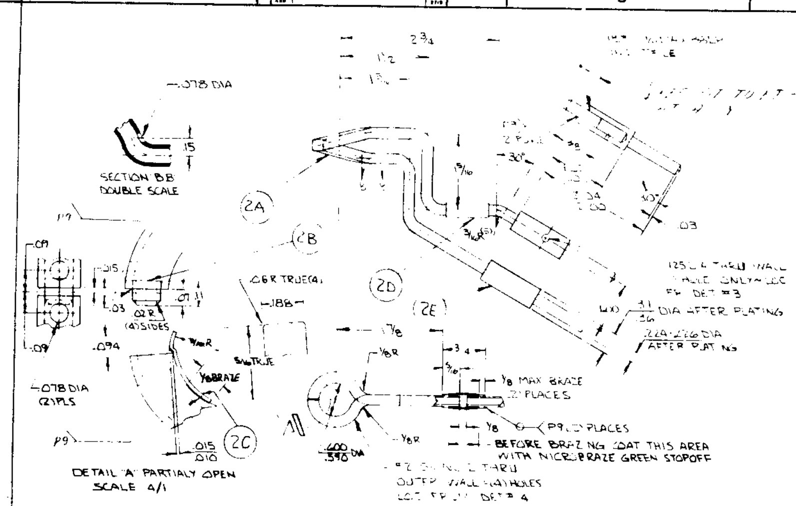
CONTRACT NO

CODE IDENT NO	SIZE	DWG NO
07482	E	[illegible]

SCALE [illegible] SHEET [illegible] OF 2

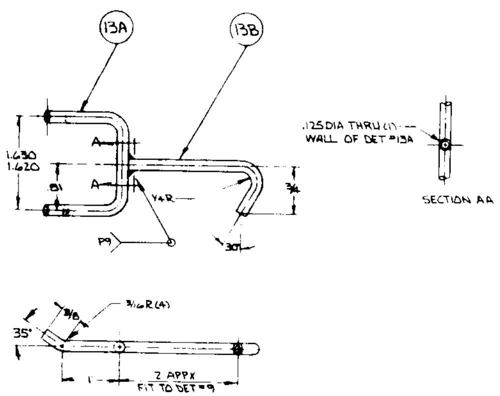
2





4. UPPER & LOWER PORTION OF COIL MUST ALIGN AT ASSY
3. SILVER PLATE .003-.004 THK EXCEPT DET # 2D.
2. DET # 2B TO BE PERP TO A HORIZ PLANE THRU COIL ℄.
1. COIL TO HAVE (1) COMPLETE TURN ON BASIS OF .375 PITCH, MUST FIT DET # 4.
NOTES:

2	BRAZED ASSEMBLY	
A	COPPER TUBING ~ .1875 SQ X .03 WALL	AR
B	COPPER TUBING ~ .125 SQ X .03 WALL	1
C	COPPER BERYLLIUM (.010 THK.)	1
D	#503 PLAIN COPPER BRAID ~ BELDEN CO (OR EQ)	1
E	COPPER	2



13	BRAZED ASSEMBLY	
A	3/16 OD X .028 WALL ~ SS TYPE 300 TUBING	1
B	3/16 OD X .028 WALL ~ SS TYPE 300 TUBING	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: FRAC / DEC / ANGLES ±1°
ALL SURFACES ✓
MATL NOTED

FOR G.E. USE ONLY

DWG TYPE: DETAILS

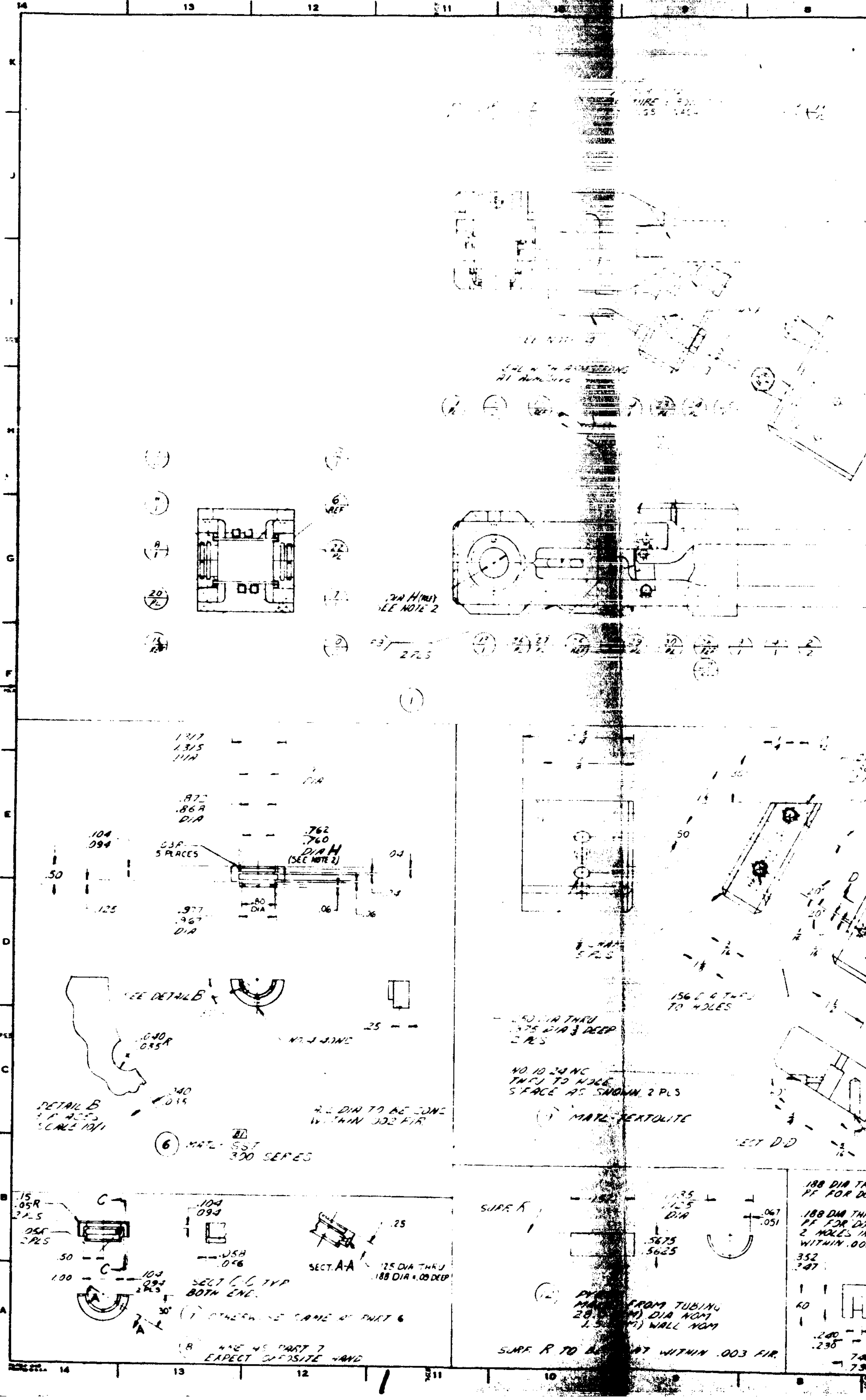
SIGNATURES	MO - DA - YR
DRAWN	8-12-65
CHECKED	
ENGR	
MFG	
MATL	
ISSUED	

GENERAL ELECTRIC
LARGE JET ENGINE DEPT — CINCINNATI, OHIO, U.S.A.

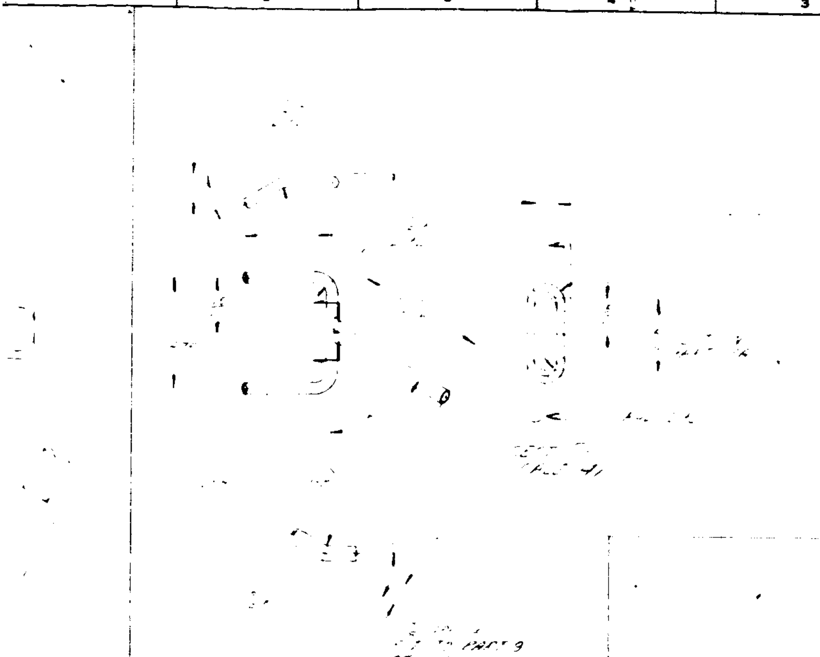
BRAZE TOOL FOR .250 TUBE ELBOWS & TEES

SIZE	CODE IDENT NO.	DWG NO.
D	07482	40-180-740

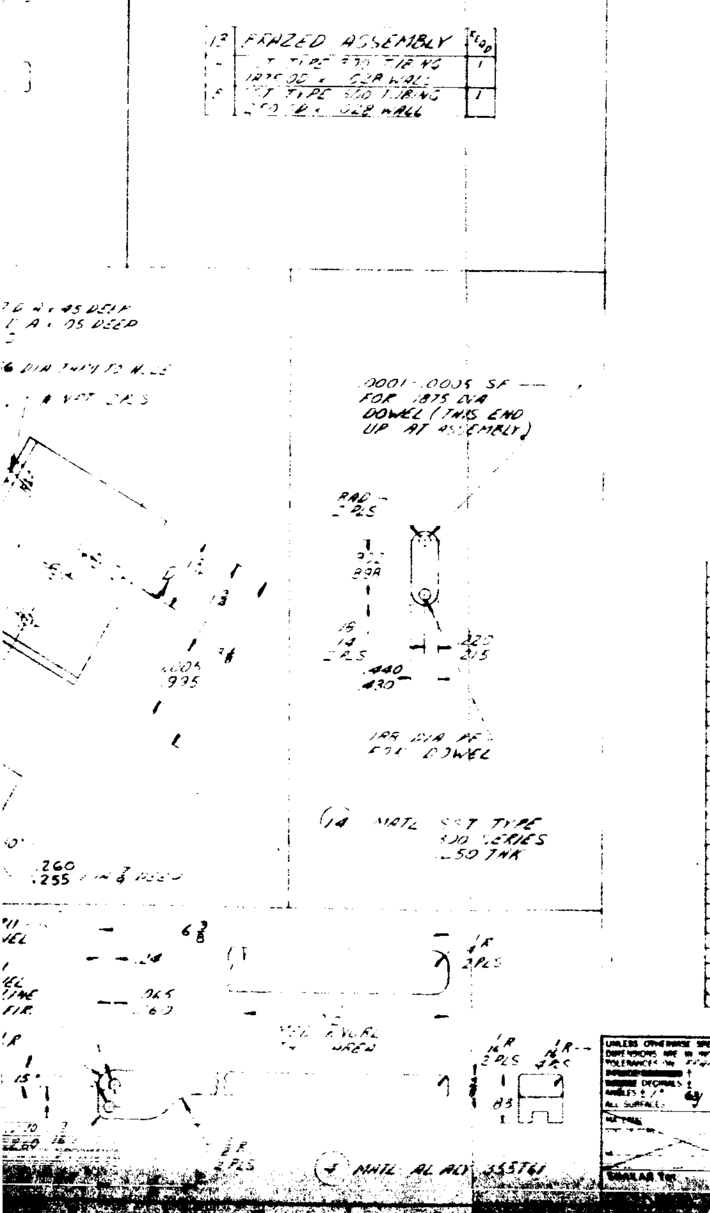
SCALE — WT — SHEET 2 OF 2



SEE DETAIL B
DETAIL B
SCALE 10/1
.040
.035 R
.762
.760
DIA H
(SEE NOTE 2)
.038
5 PLACES
.104
.094
.50
.125
.80
DIA
.06
.877
.868
DIA
.977
.967
DIA
.25
6 MATL - SST 300 SERIES
NO. 10-24 NC
THRU TO HOLE
SPACE AS SHOWN 2 PLS
MATL - TEXTOLITE
.250 DIA THRU
.375 DIA .3 DEEP
2 PLS
SECT D-D
.188 DIA THRU
SURF K
SURF R TO B FLAT WITHIN .003 FIR
.5675
.5625
.067
.051
SECT. A-A
.125 DIA THRU
.188 DIA x .09 DEEP
SECT C-C TYP
BOTH END
OTHERWISE SAME AS PART 6
SAME AS PART 7
EXPECT OPPOSITE HAND
.15
.05R
2 PLS
.05R
2 PLS
.50
1.00
30°
.058
.056
.352
.347
.240
.238



13	BRAZED ASSEMBLY	REQD
-	SST TYPE 300 TUBING .875 OD x .028 WALL	1
5	SST TYPE 300 TUBING .750 OD x .028 WALL	1



REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
[illegible]	[illegible]	[illegible] REVISED	[illegible]	[illegible]

[illegible] STORAGE CONTAINER [illegible] ELBOW & TEE FITTINGS

6 [illegible] A OR B SERIES [illegible] .050 DIA [illegible] SECTION LENGTH TO SUIT [illegible] WITH GE SILICON NO [illegible] PREPARE O RING & GROOVE FOR BONDING WITH GE TRANSLUCENT SILICONE RUBBER [illegible] SEAL GENERAL ELECTRIC PRODUCT DEPT.

5 QUAD RING SEGMENT .103 CROSS SECTION LENGTH TO SUIT MINNESOTA RUBBER & GASKET CO.

4 INSULATE EXPOSED AREA OF COIL PART 10 WITH SCOTCH ELECTRIC TAPE NO. 27 MINNESOTA MIN NG & MFG CO.

3 ANODIZE PART 2, 3 & 4 PER AMS2470 (RED)

2 [illegible] PARTS 5, 6, 7 & 8 TO BE IN LINE AT ASSEMBLY WITHIN .002 FIR

1 BREAK ALL SHARP EDGES

1	COMM	30	DOWEL [illegible] DIA x 1¼ LG
2	1 GROOV PIN	29	INSERT NO. S1902-4-02
2		28	SET SCR (FLAT POINT) NO.10-24NC x ¼ LG
4	SST 300 SERIES	27	SPACER .330 D x .25 ID x .03 THK
3		26	DOWEL [illegible] DIA x 1½ LG
-		25	ST [illegible] (CUP POINT) NO.10-24NC x ¼ LG
1	ARD	24	CONNECTOR NO. A2-07
-	[illegible]	23	STREET ELBOW (90°) ⅛ NPT
4	SEE NOTE 6	22	O RING [illegible] DIA CROSS SECT
3	SEE NOTE 6	21	O RING .070 DIA CROSS SECT
4	SEE NOTE 5	20	QUAD RING .103 CROSS SECT
-	GROOV PIN	19	INSERT NO. 1902-4-12
-		18	FL HD SCR NO.10-24NC x [illegible] LG
8		17	RD HD [illegible] NO.2-56NC x [illegible] LG
4	1	16	FL HD SCR NO.4-40NC x ½ LG
6	COMM	15	FL HD [illegible] NO.8-32NC x ½ LG
1	SHT-1	14	LINK
1	SHT-1	13	TUBE
2	SHT-1	12	PURGE JACKET HALF
3	SHT-2	11	COIL BLOCK
1	SHT-2	10	COIL
1	SHT-1	9	BLOCK
1	SHT-1	8	BUSHING HALF
1	SHT-1	7	BUSHING HALF
2	SHT-1	6	BUSHING HALF
1	SEE NOTE 7	5	STORAGE CONTAINER (TO SUIT)
1	SHT-1	4	HANDLE
1	SHT-2	3	JAW-UPPER
1	SHT-2	2	BASE
		1	ASSEMBLY

ASSEMBLY & DETAILS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64, DECIMALS ± .005, ANGLES ± 1°, ALL SURFACES 63

SIGNATURES | DATE

GENERAL ELECTRIC

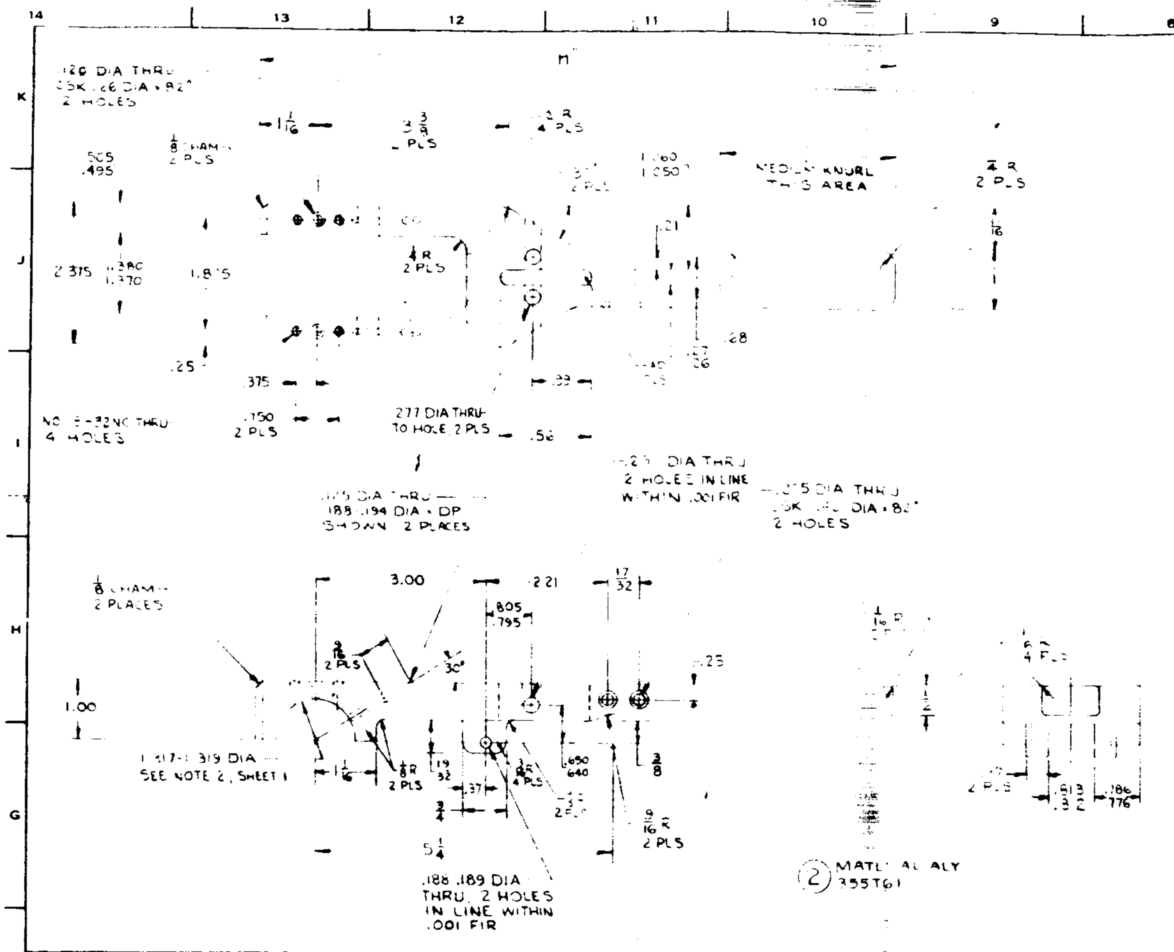
LJE DEPT CINCINNATI

TITLE BRAZE TOOL .750 TUBE, ELBOW & TEE FITTINGS

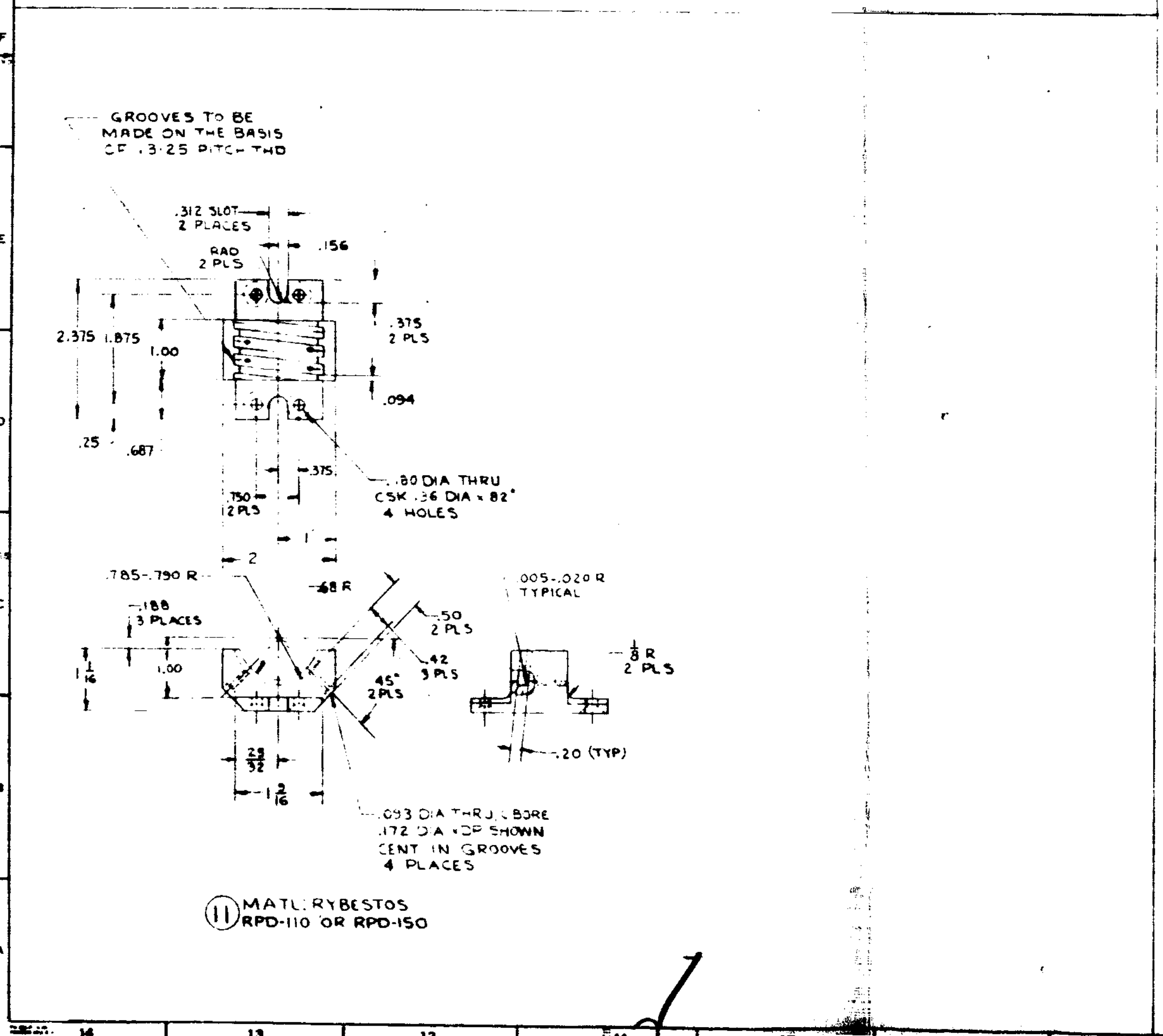
NASA

CONTRACT NO

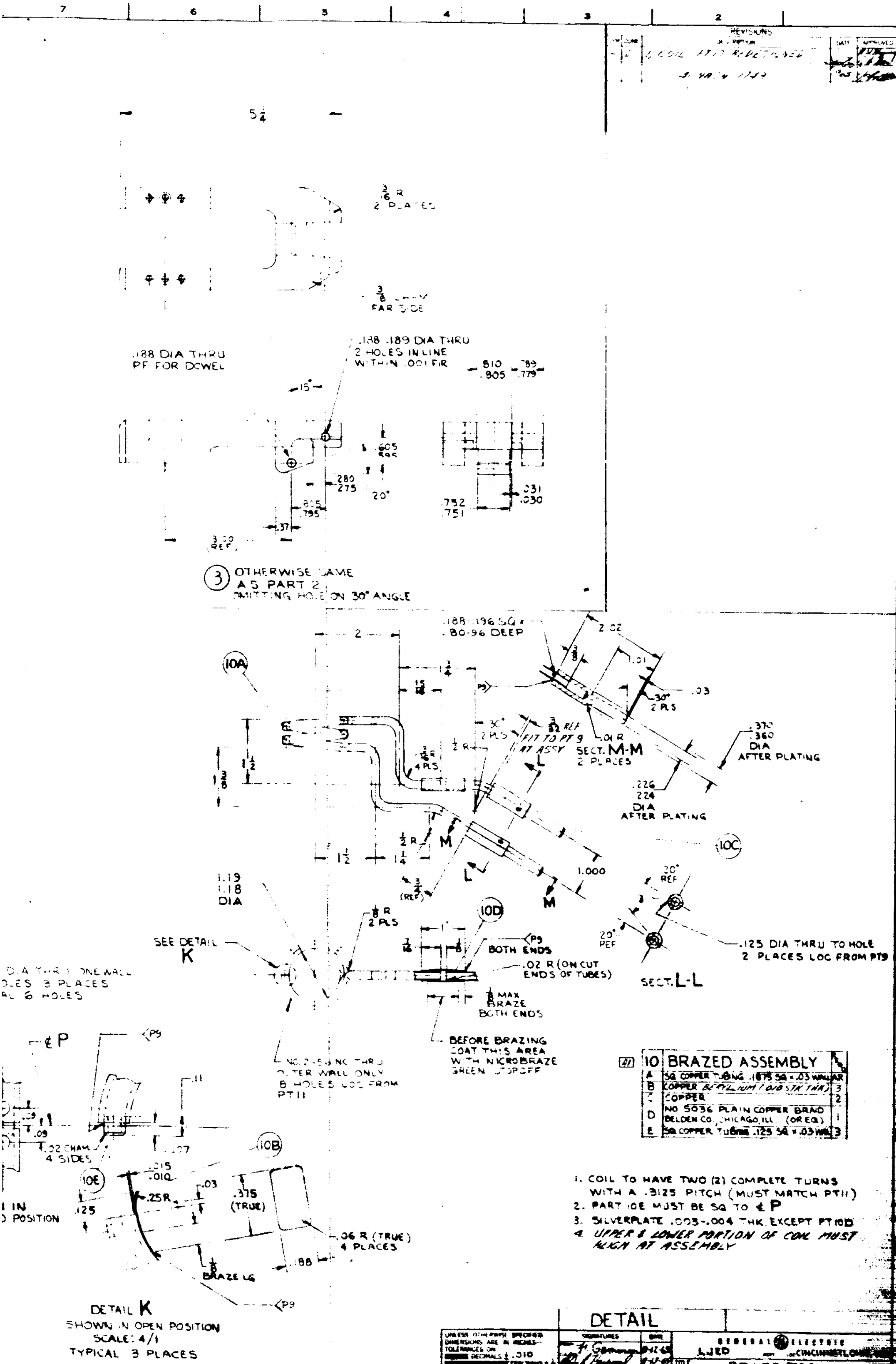
CODE IDENT NO 07482 | SIZE E | DWG NO 402180-741



.120 DIA THRU
CSK .26 DIA x 82°
2 HOLES
NO. 8-32NC THRU
4 HOLES
277 DIA THRU
TO HOLE, 2 PLS
MEDIUM KNURL
THIS AREA
3.00
.805
.795
1.00
1.317-1.319 DIA
SEE NOTE 2, SHEET 1
.188 .189 DIA
THRU, 2 HOLES
IN LINE WITHIN
.001 FIR
MATL: AL ALY
355T61



GROOVES TO BE
MADE ON THE BASIS
OF 13-25 PITCH THD
.312 SLOT
2 PLACES
RAD
2 PLS
.156
2.375
1.875
1.00
.375
2 PLS
.094
.25
.687
.80 DIA THRU
CSK .36 DIA x 82°
4 HOLES
.785-.790 R
.188
3 PLACES
.50
2 PLS
.42
3 PLS
45°
2 PLS
.005-.020 R
TYPICAL
.20 (TYP)
.093 DIA THRU, C BORE
.172 DIA x DP SHOWN
CENT IN GROOVES
4 PLACES
MATL: RYBESTOS
RPD-110 OR RPD-150



10	BRAZED ASSEMBLY	
A	SQ COPPER TUBING .1875 SQ x .03 WALL	AR
B	COPPER BERYLLIUM (.010 STK THK)	3
C	COPPER	2
D	NO 5036 PLAIN COPPER BRAID BELDEN CO., CHICAGO, ILL. (OR EQ)	1
E	SQ COPPER TUBING .125 SQ x .03 WALL	3

1. COIL TO HAVE TWO (2) COMPLETE TURNS WITH A .3125 PITCH (MUST MATCH PT 11)
2. PART 10E MUST BE SQ TO ℄ P
3. SILVERPLATE .003-.004 THK. EXCEPT PT 10D
4. *UPPER & LOWER PORTION OF COIL MUST ALIGN AT ASSEMBLY*

DETAIL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES — TOLERANCES ON DECIMALS ± .010, ANGLES ±, ALL SURFACES 63

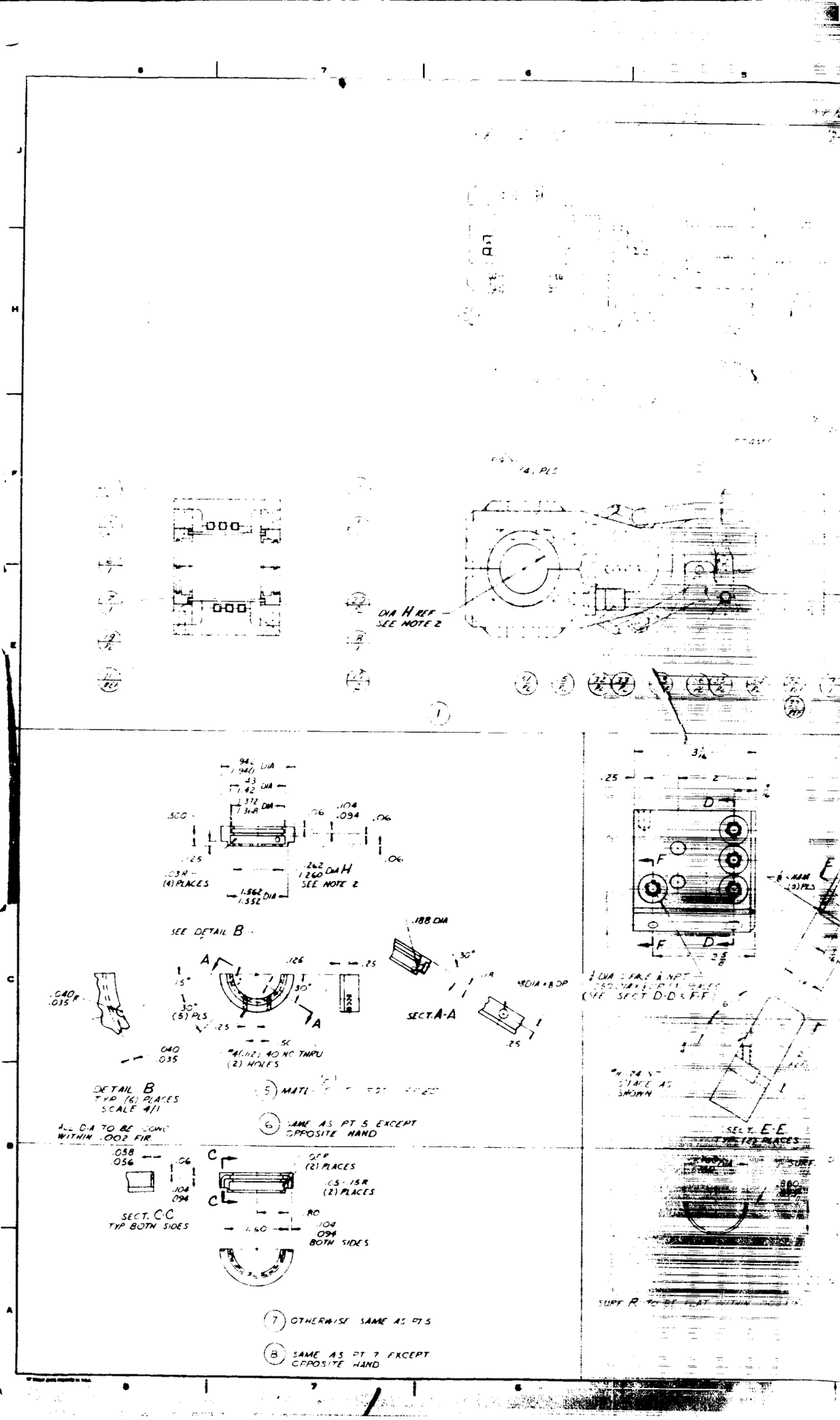
GENERAL ELECTRIC — CINCINNATI, OHIO

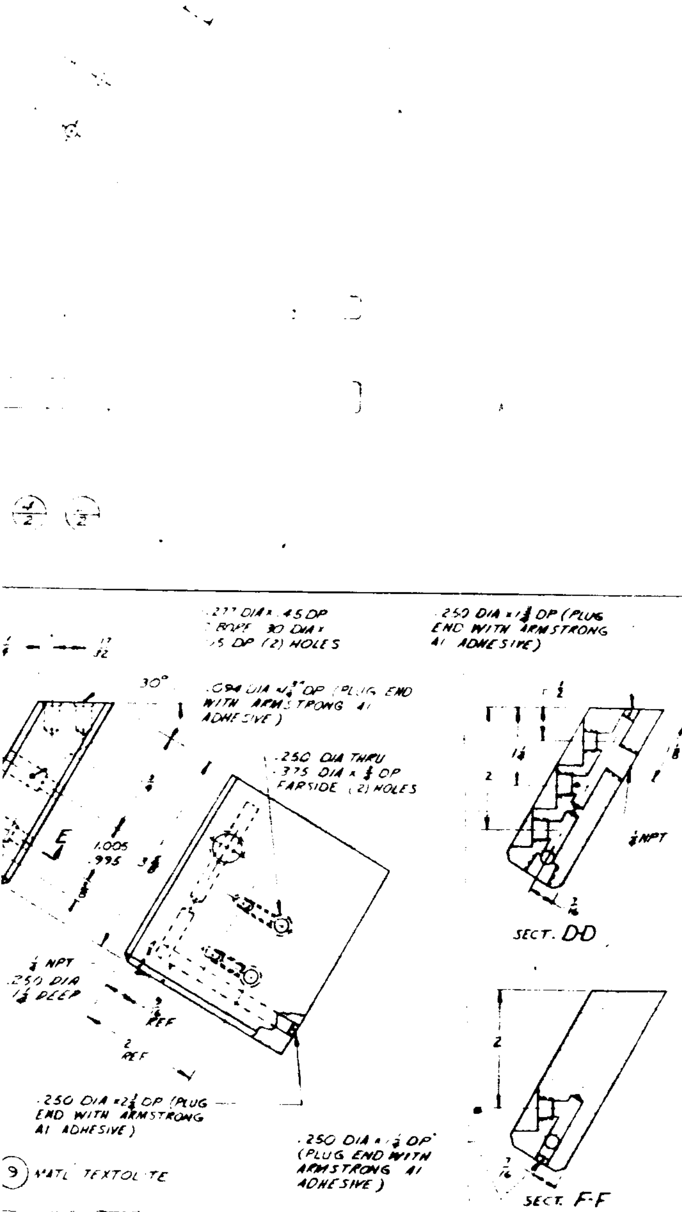
BRAZE TOOL .750 TUBE ELBOW & TEE FITTINGS — NASA

CODE IDENT NO 07482 SIZE E DWG NO 4012180-741

SIMILAR TO: 4012180-

2


DIA H REF SEE NOTE 2
SEE DETAIL B
DETAIL B TYP (6) PLACES SCALE 4/1
SECT. A-A
SECT. C-C TYP BOTH SIDES
SECT. E-E
(5) MATE
(6) SAME AS PT 5 EXCEPT OPPOSITE HAND
(7) OTHERWISE SAME AS PT 5
(8) SAME AS PT 7 EXCEPT OPPOSITE HAND



9 MATL TEXTOLITE

- PYREX TUBE 45.0 MM NOM DIA x 2.0 MM NOM WALL

7 PROVIDE AREA IN STORAGE CONTAINER FOR SIX SPARE PURGE JACKET SETS (PART 12) MARK CONTAINER WITH " BRAZE TOOL FOR 1.250 TUBE - ELBOW & TEE FITTINGS"

6 [illegible] .070 DIA CROSS SECTION LENGTH TO SUIT "PARKER SEAL CO" BOND IN PLACE WITH G-E SILICON NO SS 4004 PREPARE O RING & GROOVE FOR BONDING WITH G E TRANSLUCENT SILICONE RUBBER CLEAR SEAL GENERAL ELECTRIC PRODUCT DEPT"

5 QUAD RING SEGMENT .103 CROSS SECTION LENGTH TO SUIT "MINNESOTA RUBBER & GASKET CO"

4 INSULATE [illegible] AREA OF COIL PART 10 WITH SCOTCH ELECTRIC TAPE NO 27 "MINNESOTA MINING & MFG CO."

3 ANODIZE PART 2,3 & 4 PER AMS 2470 (RED)

2 DIA H PARTS 5,6,7 & 8 TO BE IN LINE AT ASSEMBLY WITHIN .002 FIR.

1 BREAK ALL SHARP EDGES

1	SEE NOTE 7	37	STORAGE CONTAINER (TO SUIT)
2	COMM	36	SET SCR (FLAT POINT) NO.10-24NC x [illegible]
2	"GROOV PIN"	35	INSERT NO. S 19024-12
		34	DOWEL 1/16 DIA x 3/4 LG
3		33	DOWEL 1/16 DIA x 1 1/2 LG
4	SST 300 SERIES	32	SPACER .330D x .20 LG x .03 THK
2	"TUBE TURN"	31	HALF UNION (PVC) 1/4 O.D. TUBE TO 1/4 NPT
	BRONZE	30	STREET ELBOW 90° 1/4 NPT
2		29	SET SCR (CUP POINT) NO.10-24NC x 1/4 LG
1	ARO	28	CONNECTOR NO. A2608
2	GROOV-PIN"	27	INSERT NO. 19024-12
2		26	FLAT HD SCREW NO.10-24NC x 1 [illegible] LG
4	"PARKER" (OR EQ)	25	FITTING NO. 1/4 - 1/4 - 30082 - 4
12		24	RD HD SCR NO.2 56NC x .66 LG
8		23	FLAT HD SCR NO. 4-40NC x 1/4 LG
8		22	FLAT HD SCR NO. 8-32NC x 3/4 LG
4	(SEE NOTE 6)	21	O RING .070 DIA CROSS SECT.
4	(SEE NOTE 6)	20	O RING .070 DIA CROSS SECT.
4	(SEE NOTE 5)	19	QUAD RING .103 CROSS SECT.
1	POLYETHYLENE	18	TUBING 1/4 OD x .062 WALL x LG TO SUIT [illegible]
1	POLYETHYLENE	17	TUBING 1/4 OD x .062 WALL x LG TO SUIT [illegible]
1	POLYETHYLENE	16	TUBING 1/4 OD x .062 WALL x LG TO SUIT (BLUE)
1	POLYETHYLENE	15	TUBING 1/4 OD x .062 WALL x LG TO SUIT (BLUE)
	SHT 2	14	LINK
2	SHT 2	13	TUBE
	SHT-1	12	PURGE JACKET HALF
	SHT 2	11	COIL BLOCK
	SHT-2	10	COIL
	SHT-1	9	BLOCK
	SHT-1	8	BUSHING HALF
1	SHT-1	7	BUSHING HALF
	SHT-1	6	BUSHING HALF
	SHT-1	5	BUSHING HALF
1	SHT-2	3	HANDLE
1	SHT 2	2	JAW UPPER
1	SHT-2	1	BODY
			ASSEMBLY

ASSY & DETAIL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACT. ± 1/32 DEC ±.010 ANGLE ±1°
ALL SURFACES 63√

FOR G.E. USE ONLY

GENERAL ELECTRIC

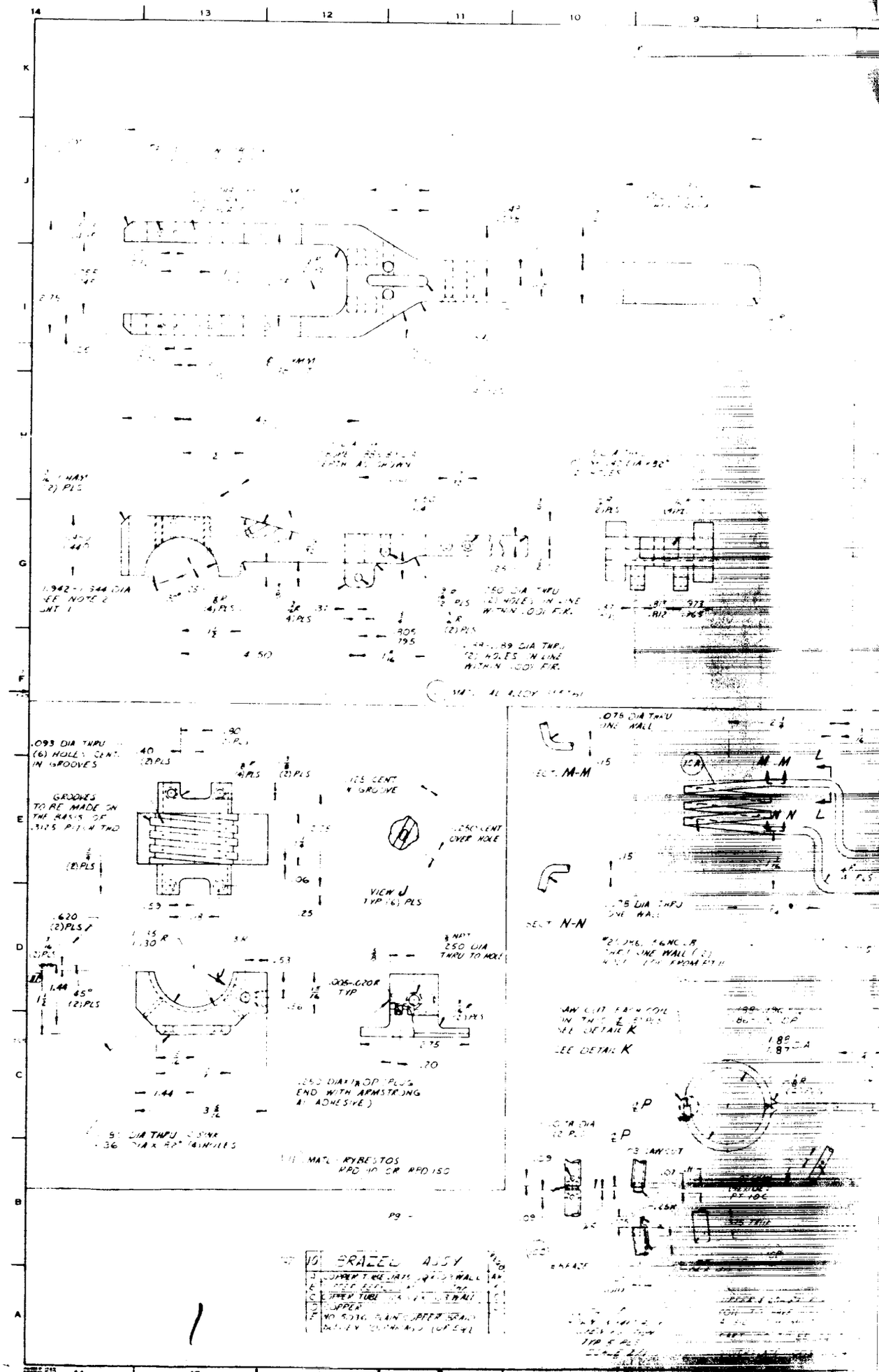
BRAZE TOOL

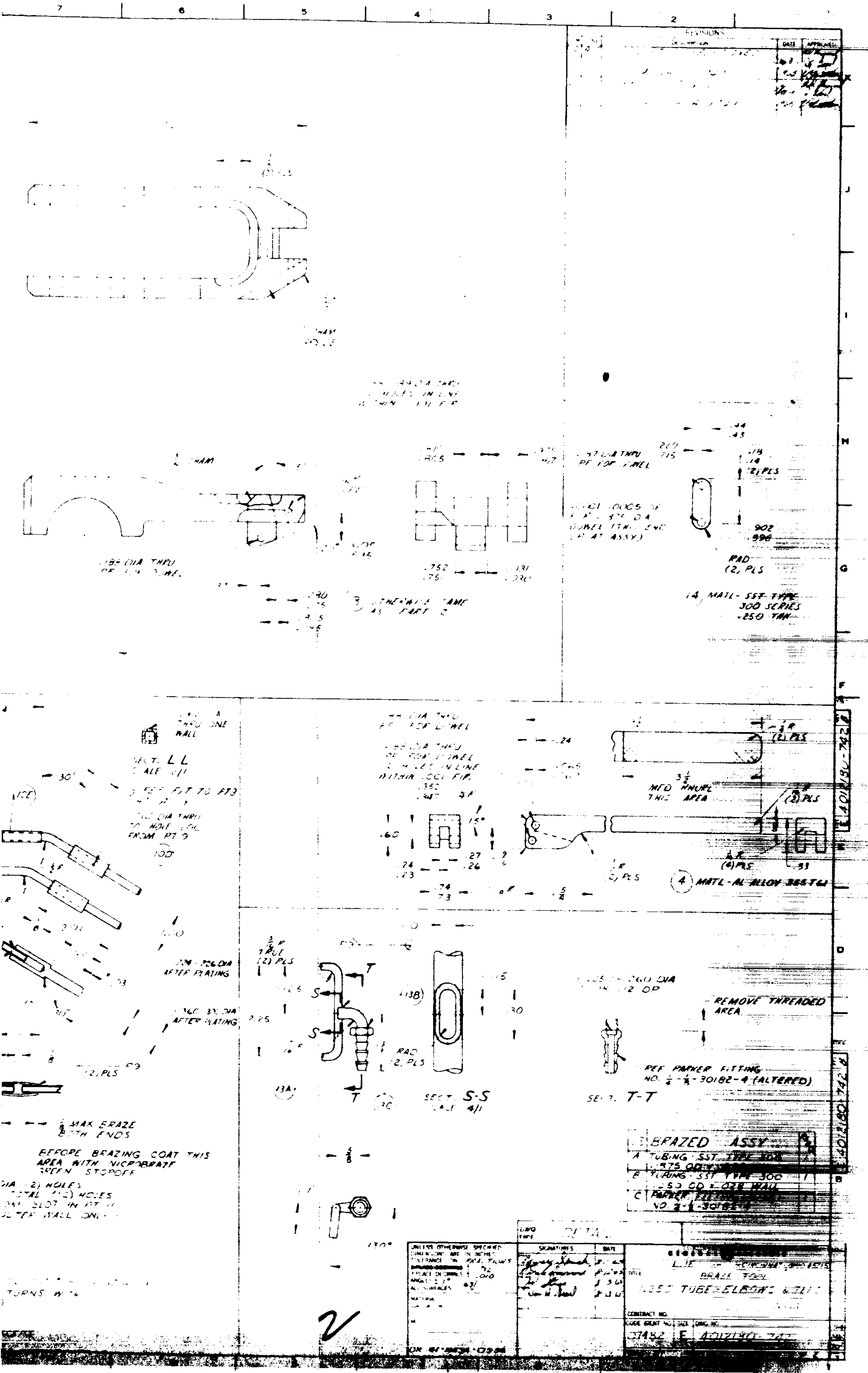
1.250 TUBE-ELBOWS & TEES

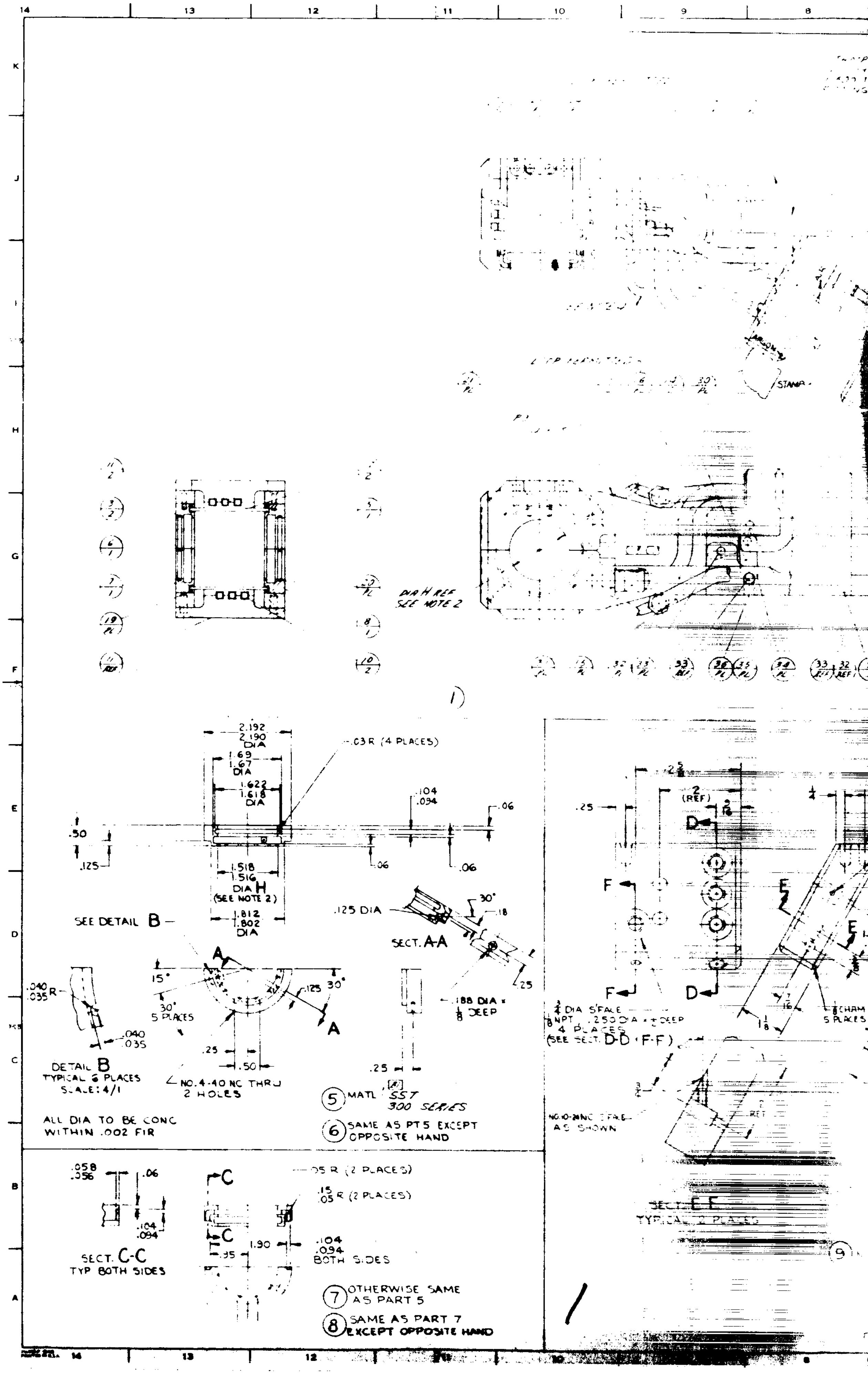
NASA

E 07482 4012180-742

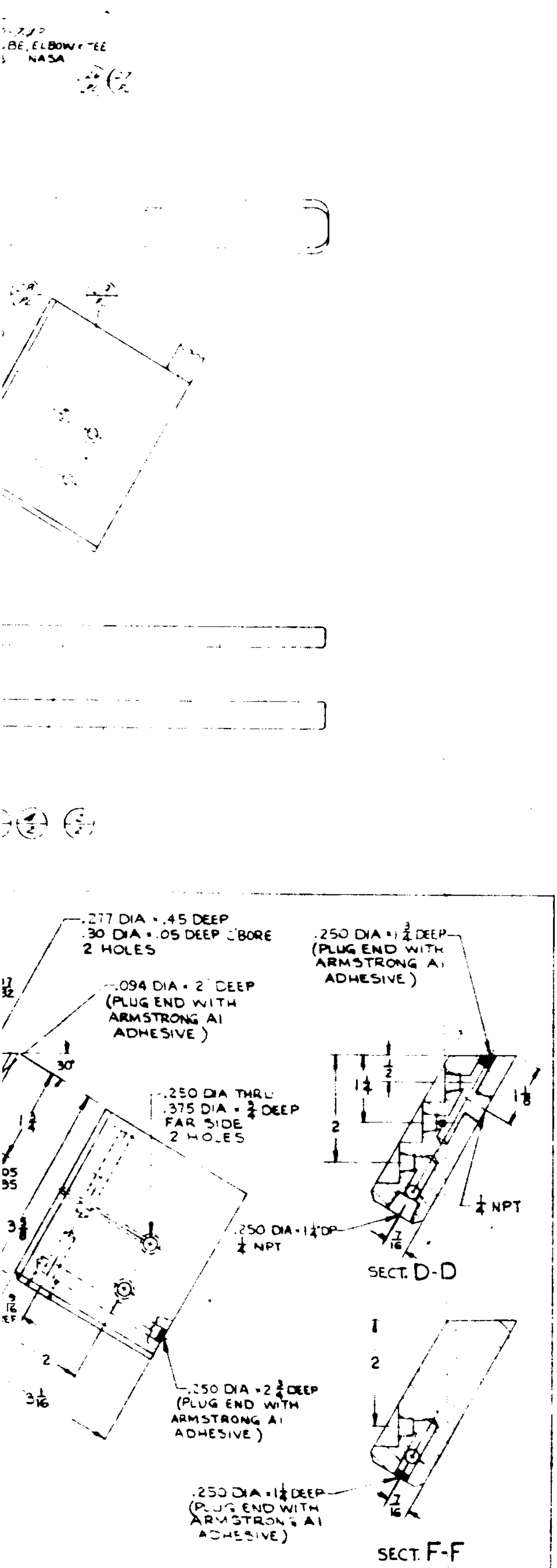
SCALE 1/1 SHEET 1 OF 2


.093 DIA THRU (6) HOLES EQUI SPACED IN GROOVES
GROOVES TO BE MADE ON THE BASIS OF .3125 PITCH DIA
VIEW J TYP (6) PLS
.620 (2) PLS
.005-.020R TYP
.093 DIA THRU (2) HOLES IN LINE WITHIN .005 F.R.
.075 DIA THRU ONE WALL
SECT M-M
SECT N-N
SEE DETAIL K
BRACE ASSY
MATL: KYBESTOS


REVISIONS
SECT. L L
SCALE 4/1
MED KNURL THIS AREA
MATL - AL ALLOY
MATL - SST TYPE 300 SERIES .250 THK
SECT. S-S
SCALE 4/1
SECT. T-T
REMOVE THREADED AREA
REF PARKER FITTING NO. 1/4 - 1/8 - 30182-4 (ALTERED)
AFTER PLATING
MAX BRAZE BOTH ENDS
BEFORE BRAZING COAT THIS AREA WITH NICROBRAZE GREEN STOPOFF
BRAZED ASSY
TUBING - SST TYPE 300
PARKER FITTING
UNLESS OTHERWISE SPECIFIED
SIGNATURES
DATE
BRAZE TOOL
CONTRACT NO.



DIA H REF
SEE NOTE 2
2.192
2.190
DIA
1.69
1.67
DIA
1.622
1.618
DIA
.03 R (4 PLACES)
.104
.094
.06
.50
.125
1.518
1.516
DIA H
(SEE NOTE 2)
1.812
1.802
DIA
SEE DETAIL B
.125 DIA
SECT. A-A
.188 DIA × 1/8 DEEP
15°
30°
5 PLACES
.125
.25
.50
.040
.035 R
DETAIL B
TYPICAL 6 PLACES
SCALE: 4/1
NO. 4-40 NC THRU
2 HOLES
ALL DIA TO BE CONC
WITHIN .002 FIR
5 MATL SST
300 SERIES
6 SAME AS PT 5 EXCEPT
OPPOSITE HAND
.058
.056
.05 R (2 PLACES)
.15
.05 R (2 PLACES)
SECT. C-C
TYP BOTH SIDES
1.90
.104
.094
BOTH SIDES
7 OTHERWISE SAME
AS PART 5
8 SAME AS PART 7
EXCEPT OPPOSITE HAND
2
(REF)
.25
3/4 DIA S'FACE
1/8 NPT .250 DIA × 1/2 DEEP
4 PLACES
(SEE SECT. D-D & F-F)
CHAM
5 PLACES
NO.10-24NC THRU
AS SHOWN
SECT. E-E
TYPICAL 2 PLACES



TL: TEXTOLITE

7. PROVIDE AREA IN STORAGE CONTAINER FOR SIX SPARE PURGE JACKET SETS (PART 12). MARK CONTAINER WITH "BRAZE TOOL FOR 1.500 TUBE ELBOW & TEE FITTINGS"
6. O-RING, VITON A OR B SERIES 2-050 .070 DIA CROSS SECTION, LENGTH TO SUIT. PARKER SEAL CO. BOND IN PLACE WITH G-E SILICON NO. SS4004, PREPARE O-RING & GROOVE FOR BONDING WITH G-E TRANSLUCENT SILICONE RUBBER CLEAR SEAL GENERAL ELECTRIC PRODUCT DEPT."
5. QUAD RING SEGMENT .103 CROSS SECTION, LENGTH TO SUIT "MINNESOTA RUBBER & GASKET CO."
4. INSULATE EXPOSED AREA OF COIL PART 10, WITH "SCOTCH" ELECTRIC TAPE NO. 27 "MINNESOTA MINING & MFG. CO."
3. ANODIZE PART 2, 3 & 4 PER AMS 2470 (RED)
2. DIA H, PARTS 5, 6, 7 & 8 TO BE IN LINE AT ASSEMBLY WITHIN .002 FIR
1. BREAK ALL SHARP EDGES

Qty	Source / Material	No.	Description
1	SEE NOTE 7	37	STORAGE CONTAINER (TO SUIT)
2	COMM	36	SET SCREW (FLAT POINT) NO.10-24NC × 3/16
2	GROOV-PIN (OR EQ)	35	INSERT NO. S19024-12
1		34	DOWEL 3/16 DIA × 3/4 LG
3		33	DOWEL 3/16 DIA × 1 1/2 LG
4	SST TYPE 300 SERIES	32	SPACER .33 O.D. × .201 I.D. × .03 THK
2	TUBE-TURN CO (OR EQ)	31	HALF UNION (PVC) 3/8 O.D. TUBE TO 1/8 MPT
1		30	STREET ELBOW (90°) 1/8 NPT (BRONZE)
2		29	SET SCREW (CUP POINT) NO.10-24NC × 3/8 LG
1	ARO	28	CONNECTOR NO. A2608
2	GROOV-PIN (OR EQ)	27	INSERT NO. 19024-12
2		26	FLAT HD SCR NO.10-24NC × 1 3/8 LG
4	PARKER CO (OR EQ)	25	FITTING NO. 1/4-1/8-30182-4
12		24	RD HD SCR NO.2-56NC × .54 LG
8		23	FLAT HD SCR NO.4-40NC × 3/8 LG
8		22	FLAT HD SCR NO.8-32NC × 3/8 LG
4	(SEE NOTE 6)	21	O-RING .070 DIA CROSS SECT.
4	(SEE NOTE 6)	20	O-RING .070 DIA CROSS SECT.
4	(SEE NOTE 5)	19	QUAD RING .103 CROSS SECT.
1	POLYETHYLENE	18	TUBING 3/8 O.D. × .062 WALL × LG TO SUIT (NATURAL)
1	POLYETHYLENE	17	TUBING 3/8 O.D. × .062 WALL × LG TO SUIT ([illegible])
1	POLYETHYLENE	16	TUBING 3/8 O.D. × .062 WALL × LG TO SUIT (BLUE)
1	COMM-POLYETHYLENE	15	TUBING 3/8 O.D. × .062 WALL × LG TO SUIT ([illegible])
1	SHEET 2	14	LINK
2	2	13	TUBE
2	2	12	PURGE JACKET HALF
2	2	11	COIL BLOCK
1	2	10	COIL
1	1	9	BLOCK
1	1	8	BUSHING HALF
1	1	7	BUSHING HALF
1	1	6	BUSHING HALF
1	1	5	BUSHING HALF
1	2	4	HANDLE
1	2	3	JAW-UPPER
1	SHEET 2	2	BODY
		1	ASSEMBLY

ASSEMBLY & DETAIL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON DECIMALS ±.010, FRACTIONS ±, ANGLES ± 1°, ALL SURFACES 63

SIGNATURES | DATE: 8-9-65

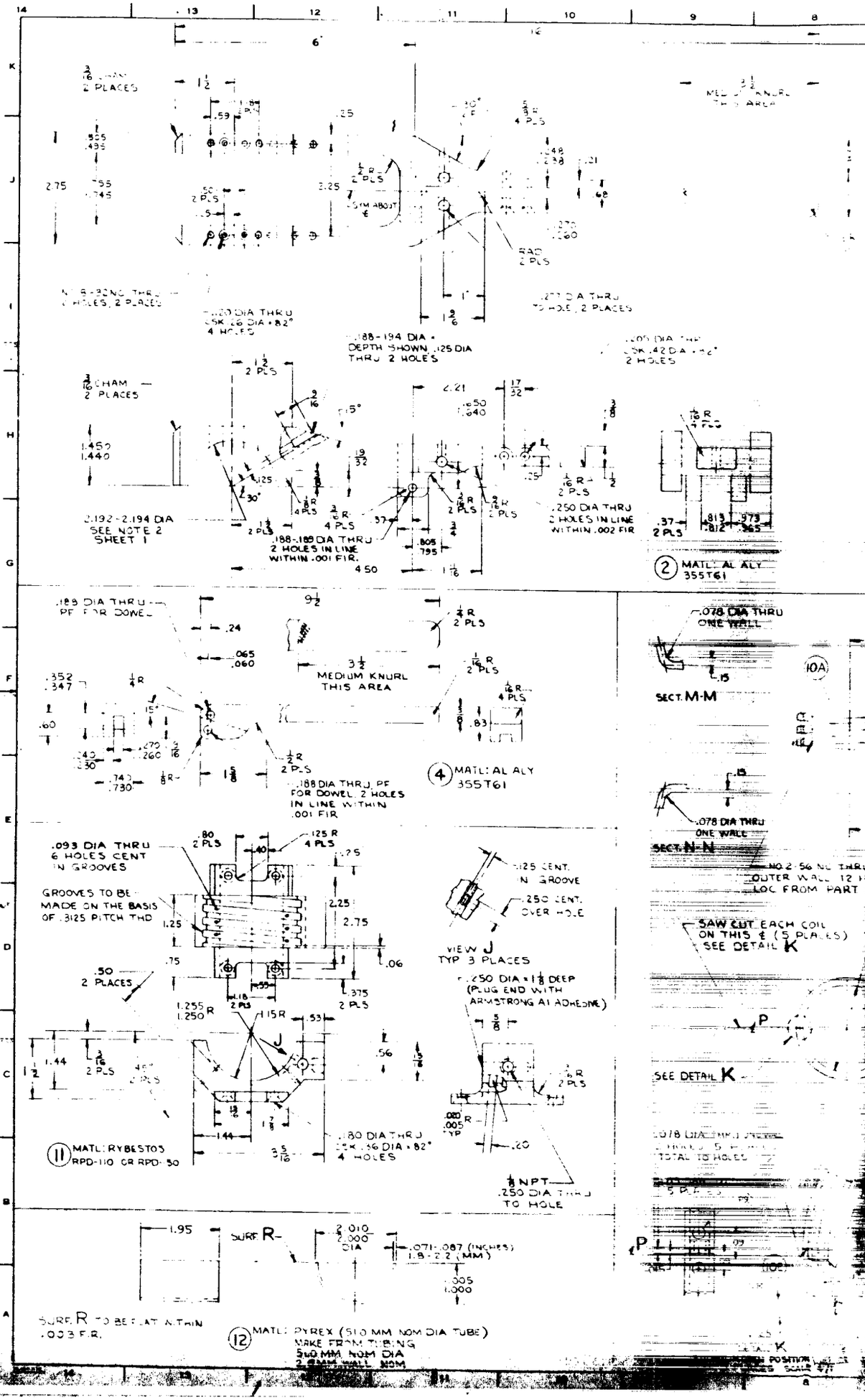
GENERAL ELECTRIC

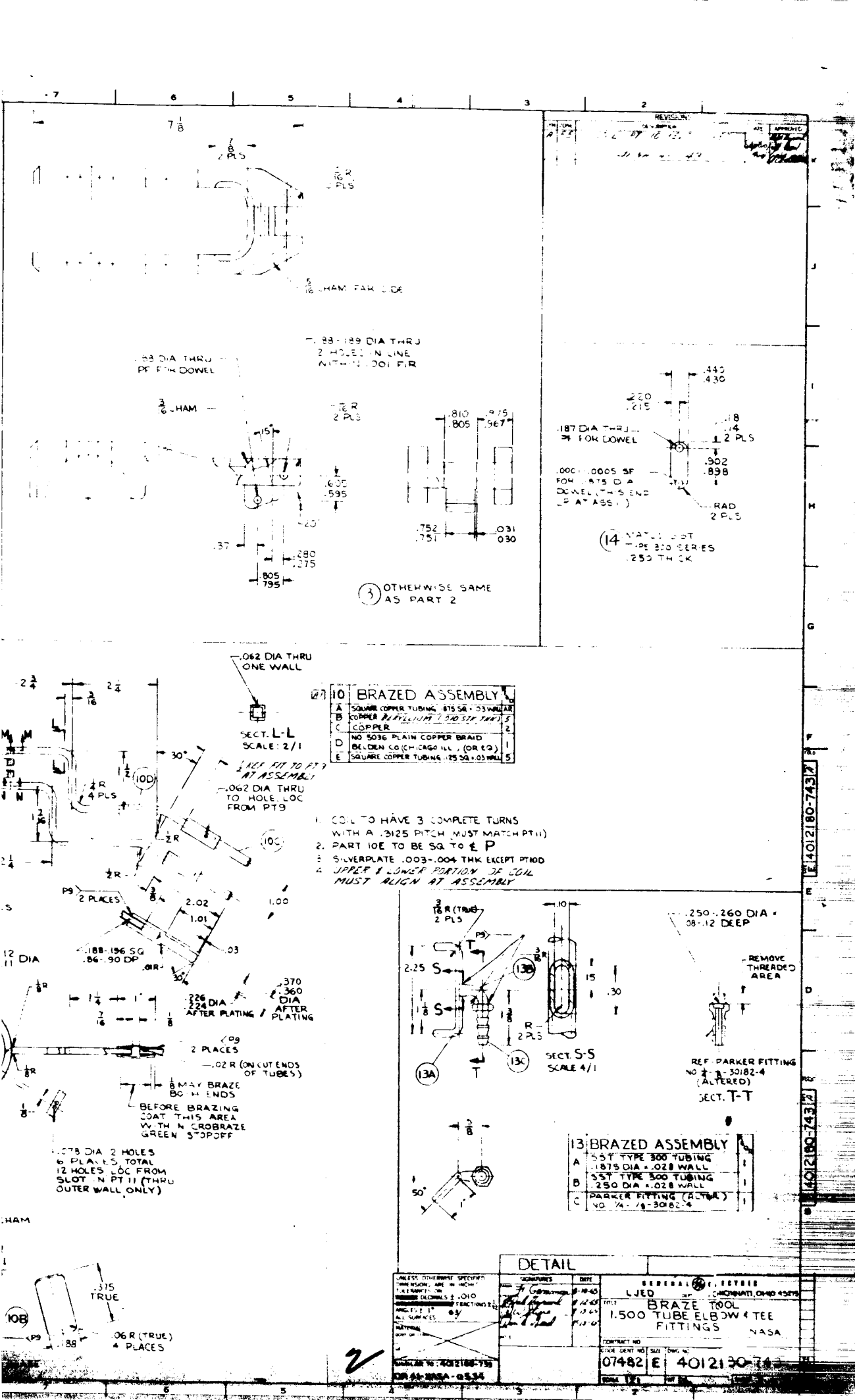
TITLE: BRAZE TOOL, 1.500 TUBE, ELBOW & TEE FITTINGS

NASA

CODE IDENT NO 07482 | DWG NO 4012180-749

2


.188-.194 DIA x DEPTH SHOWN, .125 DIA THRU 2 HOLES
.250 DIA THRU 2 HOLES IN LINE WITHIN .002 FIR
2 MATL: AL ALY 355T61
.188 DIA THRU PF FOR DOWEL
MEDIUM KNURL THIS AREA
4 MATL: AL ALY 355T61
.188 DIA THRU, PF FOR DOWEL, 2 HOLES IN LINE WITHIN .001 FIR
.093 DIA THRU 6 HOLES CENT IN GROOVES
GROOVES TO BE MADE ON THE BASIS OF .3125 PITCH THD
.125 CENT. IN GROOVE
.250 CENT. OVER HOLE
VIEW J TYP 3 PLACES
.250 DIA x 1/8 DEEP (PLUG END WITH ARMSTRONG A1 ADHESIVE)
.80 DIA THRU 82° CSK .56 DIA 4 HOLES
11 MATL: RYBESTOS RPD-110 OR RPD-50
.078 DIA THRU ONE WALL
SECT. M-M
SECT. N-N
SAW CUT EACH COIL ON THIS ℄ (5 PLACES) SEE DETAIL K
SEE DETAIL K
SURF R TO BE FLAT WITHIN .003 F.I.R.
12 MATL: PYREX (510 MM NOM DIA TUBE) MAKE FROM TUBING 500 MM NOM DIA


.062 DIA THRU ONE WALL
SECT. L-L SCALE: 2/1
.062 DIA THRU TO HOLE LOC FROM PT9
10 BRAZED ASSEMBLY
A SQUARE COPPER TUBING .875 SQ x .03 WALL AR
B COPPER 5
C COPPER 2
D NO 5036 PLAIN COPPER BRAID BELDEN CO (CHICAGO ILL.) (OR EQ) 1
E SQUARE COPPER TUBING .25 SQ x .03 WALL 5
1. COIL TO HAVE 3 COMPLETE TURNS WITH A .3125 PITCH (MUST MATCH PT11)
2. PART 10E TO BE SQ TO ℄ P
3. SILVERPLATE .003-.004 THK EXCEPT PT10D
4. UPPER & LOWER PORTION OF COIL MUST ALIGN AT ASSEMBLY
.078 DIA 2 HOLES 6 PLACES TOTAL 12 HOLES LOC FROM SLOT IN PT 11 (THRU OUTER WALL ONLY)
.02 R (ON CUT ENDS OF TUBES)
⅛ MAY BRAZE BOTH ENDS
BEFORE BRAZING COAT THIS AREA WITH NICROBRAZE GREEN STOPOFF
SECT. S-S SCALE 4/1
.250-.260 DIA x .08-.12 DEEP
REMOVE THREADED AREA
REF PARKER FITTING NO ¼-⅛-30182-4 (ALTERED)
SECT. T-T
13 BRAZED ASSEMBLY
A SST TYPE 300 TUBING .1875 DIA x .028 WALL 1
B SST TYPE 300 TUBING .250 DIA x .028 WALL 1
C PARKER FITTING (ALTER) NO ¼-⅛-30182-4 1
.375 TRUE
.06 R (TRUE) 4 PLACES
DETAIL
BRAZE TOOL 1.500 TUBE ELBOW & TEE FITTINGS
NASA
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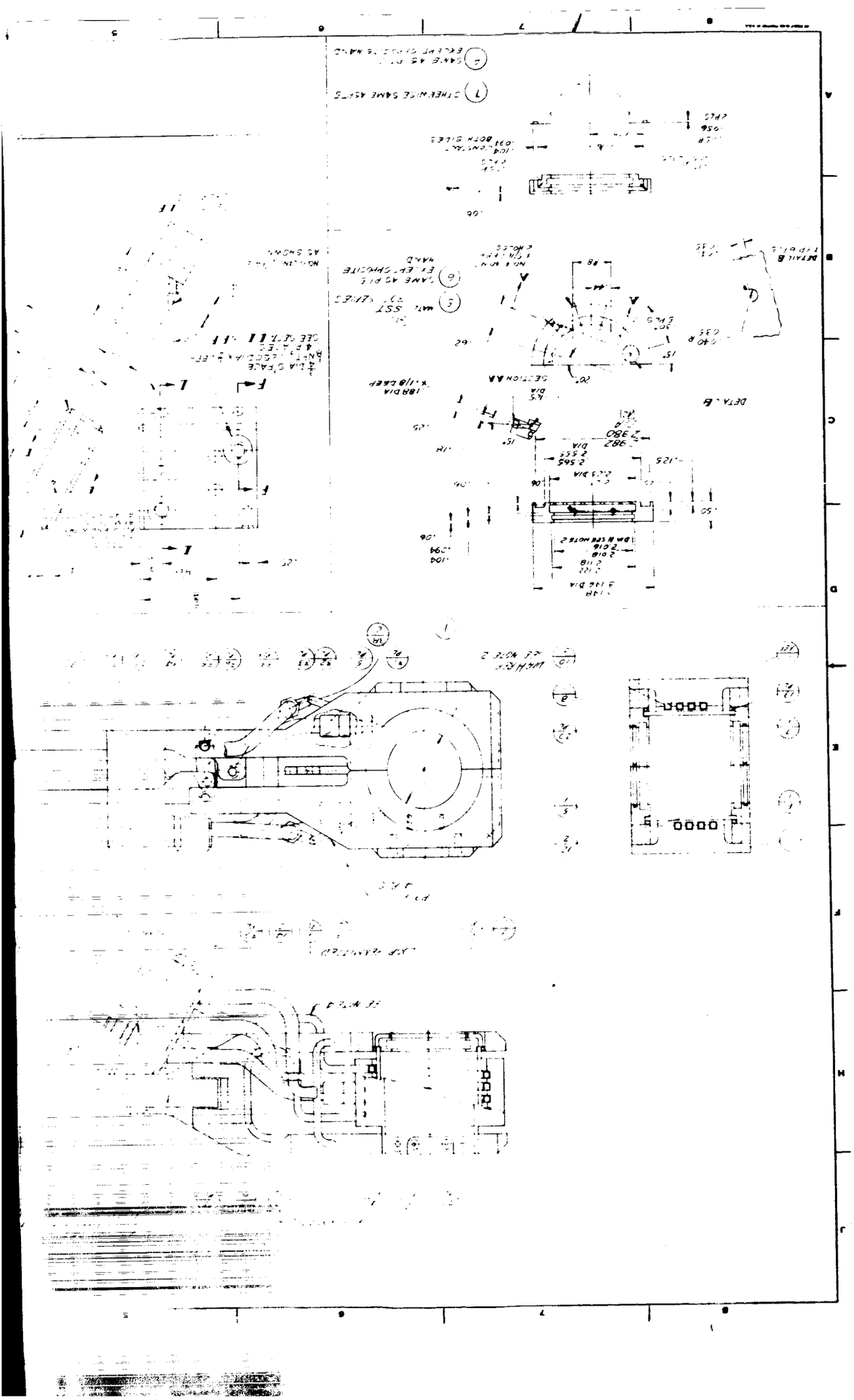
07482 E 401213



7. PROVIDE AREA IN STORAGE CONTAINER FOR SPARE PURGE JACKET SETS (PART ..) MARK CONTAINER WITH "BRAZE TOOL FOR 2.000 TUBE ELBOW & TEE FITTINGS"

6. O-RING VYDN A OR B SERIES 2-257 .070 DIA CROSS SECT IN LENGTH TO SUIT. PARKER SEAL CO. BOND IN PLACE WITH G.E. SILICON NO. SS 4004 PREPARE O RING & GROOVE FOR BONDING WITH G.E. TRANSLUCENT SILICONE RUBBER CLEAR SEAL GENERAL ELECTRIC PRODUCT DEPT

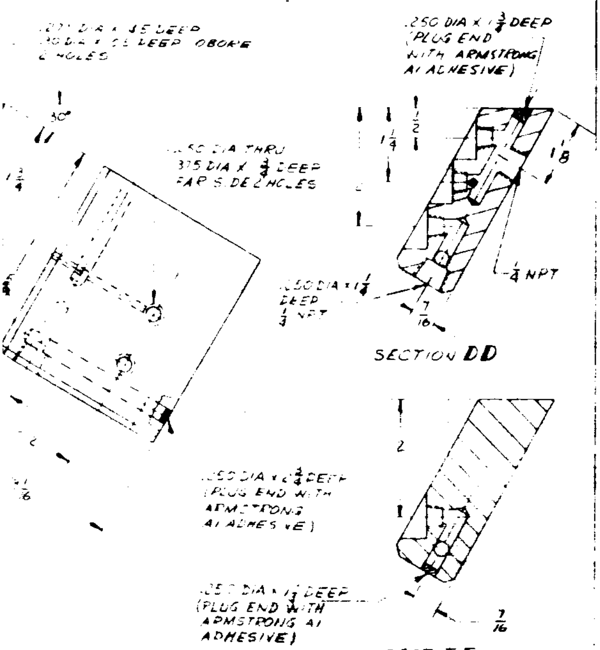
5. QUAD RING SEGMENT .103 CROSS SECTION LENGTH TO SUIT MINNESOTA RUBBER & GASKET CO

4. INSULATE EXPOSED AREA OF COIL PART 10 WITH SCOTCH ELECTRIC TAPE NO. 27 MINNESOTA MINING & MFG CO

3. ANODIZE PART 2 3 & 4 PER AMS 2470 (RED)

2. DIA H PARTS 5,6,7 & 8 TO BE IN LINE AT ASSEMBLY WITHIN .002 FIR

1. BREAK ALL SHARP EDGES



1	SHT 2	38	TUBE
1	(SEE NOTE 7)	37	STORAGE CONTAINER (TO SUIT)
2	COMM	36	SET SCREW (FLAT POINT) NO 10-24NC x 1/4
2	"GROOV-PIN"	35	INSERT NO. S 19024-12
1		34	DOWEL 3/16 DIA x 3/4 LG
3		33	DOWEL 3/16 DIA x 1 1/2 LG
4	... TYPE 300 SERIES	32	SPACER .33 OD x .20 ID x .03 THK
2	"TUBE TURN"	31	HALF UNION (PVC) 3/8 OD TUBE TO 1/4 MPT
1		30	STREET ELBOW (90°) 1/4 NPT (BRONZE)
2		29	SET SCREW (CUP POINT) NO 10-24NC x 3/8 LG
	"AMP"	28	CONNECTOR NO. A2608
2	"GROOV PIN"	27	INSERT NO. 19024-12
2		26	FLAT HD SCR NO 10-24NC x 1 1/4 LG
4	"PARKER"	25	FITTING NO 1/4-1/4 30IRZ-4
16		24	RD HD SCR NO 2-56NC x .92 LG
8		23	FLAT HD SCR NO 8-32NC x 5/16 LG
8		22	FLAT HD SCR NO 4-40NC x 7/16 LG
4	(SEE NOTE 6)	21	'O' RING .070 DIA CROSS SECT.
3	(SEE NOTE 6)	20	'O' RING .070 DIA CROSS SECT.
4	(SEE NOTE 5)	19	QUAD RING .103 CROSS SECT.
1	POLYETHYLENE	18	TUBING 1/4 OD x .062 WALL LG TO SUIT (NATURAL)
1	POLYETHYLENE	17	TUBING 3/8 OD x .062 WALL LG TO SUIT (NATURAL)
1	POLYETHYLENE	16	TUBING 1/4 OD x .062 WALL LG TO SUIT (BLUE)
1	COMM POLYETHYLENE	15	TUBING 3/8 OD x .062 WALL LG TO SUIT (BLUE)
1	SHT 2	14	LINK
1		13	TUBE
2		12	PURGE JACKET HALF
2		11	COIL BLOCK
1	3	10	COIL
1	1	9	BLOCK
1	1	8	BUSHING HALF
1	1	7	BUSHING HALF
1	1	6	BUSHING HALF
1	1	5	BUSHING HALF
1	2	4	HANDLE
1	2	3	JAW UPPER
1	SHT 2	2	BODY
		1	ASSEMBLY

ASSEMBLY & DETAILS

GENERAL ELECTRIC

BRAZE TOOL
2.000 TUBE ELBOW & TEE
FITTINGS

NASA

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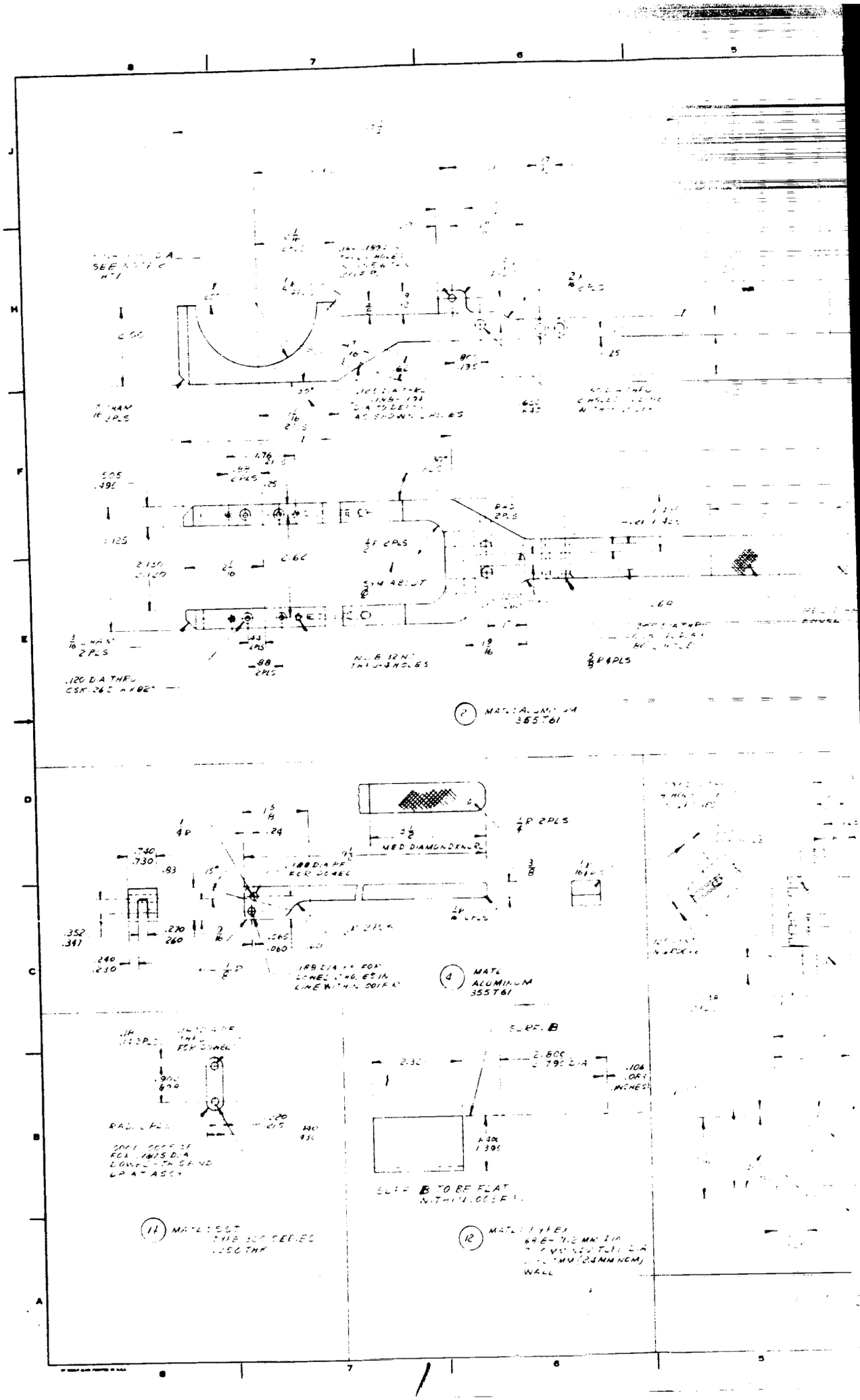
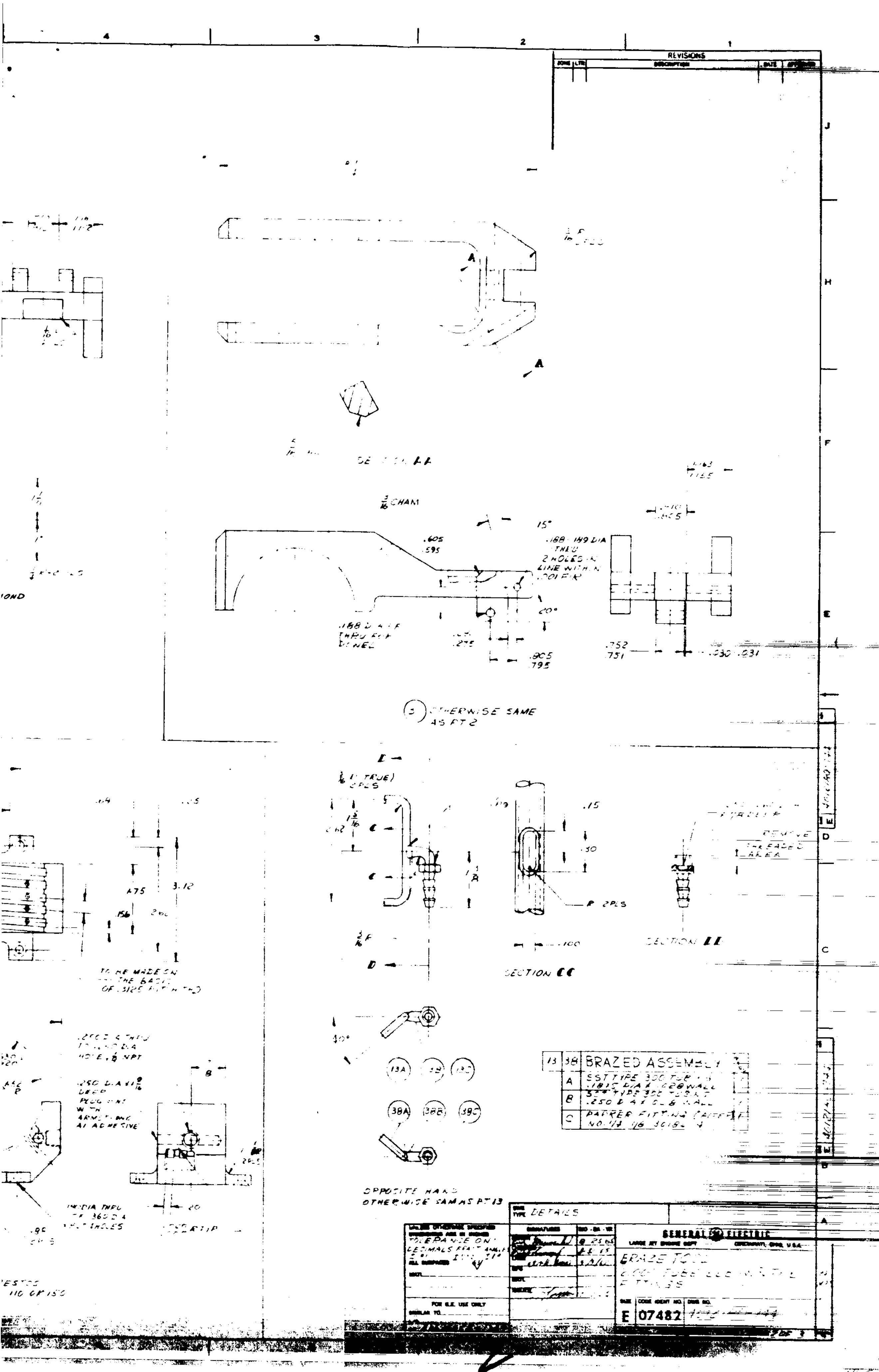
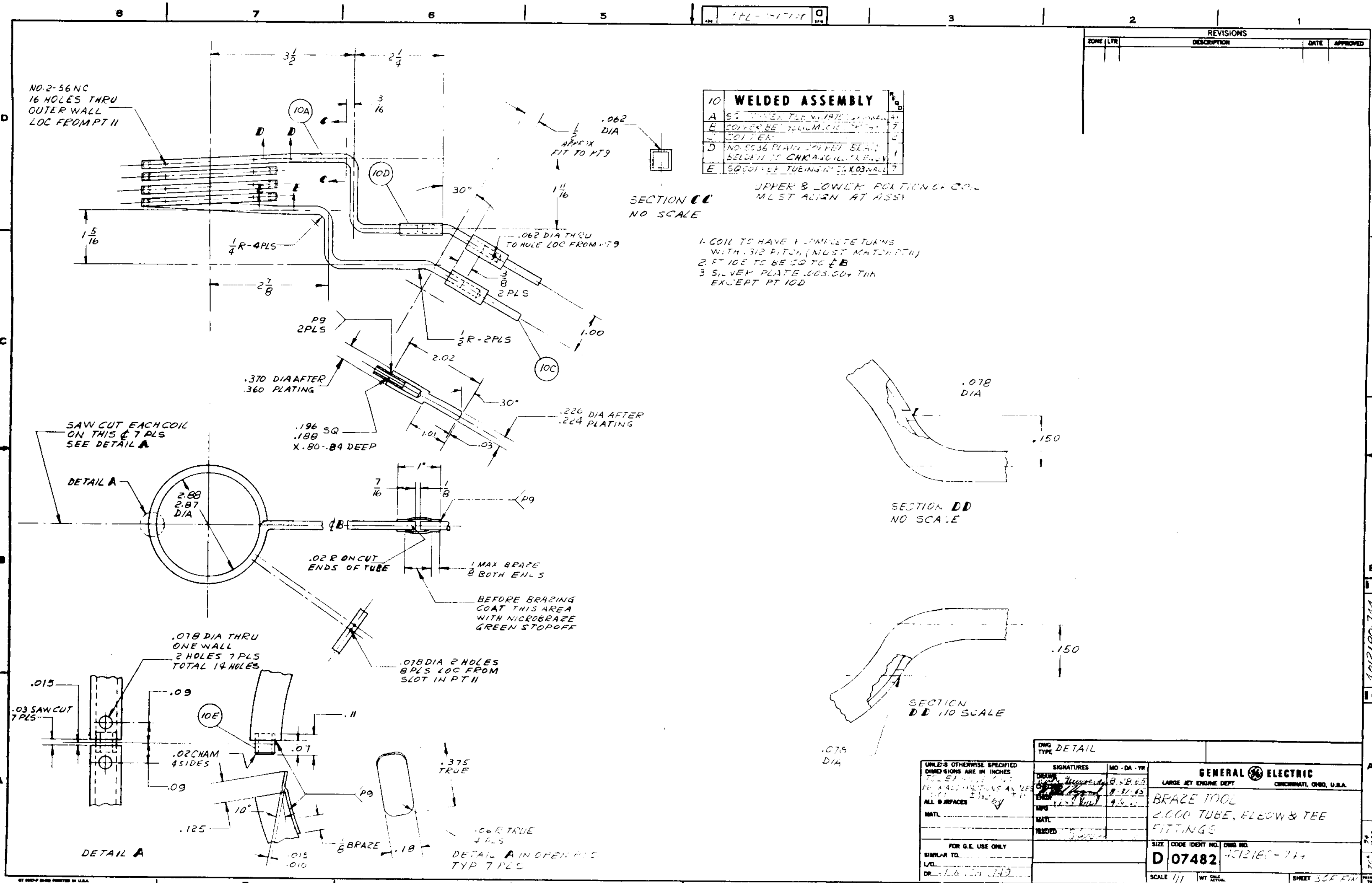



REVISIONS
ZONE
LTR
DESCRIPTION
DATE
SECTION AA
3/16 CHAM
15°
.605
.595
.188 .189 DIA THRU 2 HOLES IN LINE WITHIN .001 FIR
20°
.188 DIA FOR THRU FOR DOWEL
.752
.751
.805
.795
.230 .231
OTHERWISE SAME AS PT 2
SECTION CC
SECTION EE
REMOVE THREADED AREA
.15
.30
.100
3.12
.475
TO BE MADE ON THE BASIS OF .3125 FITTING
30°
13A
13B
13C
38A
38B
38C
OPPOSITE HAND OTHERWISE SAME AS PT 13
13
38
BRAZED ASSEMBLY
A
B
C
DETAILS
GENERAL ELECTRIC
LARGE JET ENGINE DEPT
CINCINNATI, OHIO, U.S.A.
BRAZE TOOL
FOR G.E. USE ONLY
SIMILAR TO
SIZE
CODE IDENT NO.
DWG NO.
E
07482



REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
NO. 2-56NC
16 HOLES THRU
OUTER WALL
LOC FROM PT 11
WELDED ASSEMBLY
UPPER & LOWER PORTION OF COIL
MUST ALIGN AT ASSY
SECTION CC
NO SCALE
.062 DIA
1/2 APPROX
FIT TO PT9
1. COIL TO HAVE 7 COMPLETE TURNS
WITH .312 PITCH (MUST MATCH PT 11)
2. PT 10E TO BE CD TO ℄B
3. SILVER PLATE .003-.004 THK
EXCEPT PT 10D
10A
10D
10C
10E
30°
1 11/16
.062 DIA THRU
TO HOLE LOC FROM PT9
3/8
2 PLS
1.00
1/2 R-2PLS
1/4 R-4PLS
1 5/16
2 7/8
3 1/2
2 1/4
3/16
P9
2PLS
2.02
.370 DIA AFTER
.360 PLATING
.196 SQ
.188
X .80-.84 DEEP
.226 DIA AFTER
.224 PLATING
1.01
.03
SAW CUT EACH COIL
ON THIS ℄ 7 PLS
SEE DETAIL A
DETAIL A
2.88
2.87
DIA
℄B
7/16
1"
1/8
P9
.02 R ON CUT
ENDS OF TUBE
1/8 MAX BRAZE
BOTH ENDS
BEFORE BRAZING
COAT THIS AREA
WITH NICROBRAZE
GREEN STOPOFF
.078 DIA 2 HOLES
8 PLS LOC FROM
SLOT IN PT 11
.078 DIA THRU
ONE WALL
2 HOLES 7 PLS
TOTAL 14 HOLES
.015
.03 SAW CUT
7 PLS
.09
.02 CHAM
4 SIDES
.09
.11
.07
.125
10°
1/8 BRAZE
.015
.010
.18
.375
TRUE
DETAIL A IN OPEN POS
TYP 7 PLS
DETAIL A
.078
DIA
.150
SECTION DD
NO SCALE
.150
SECTION
DD 10 SCALE
.078
DIA
DWG TYPE DETAIL
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
ALL SURFACES
MATL
FOR G.E. USE ONLY
SIMILAR TO
SIGNATURES
MO-DA-YR
DRAWN
CHECKED
ENGR
MFG
MATL
ISSUED
GENERAL ELECTRIC
LARGE JET ENGINE DEPT
CINCINNATI, OHIO, U.S.A.
BRAZE TOOL
2.000 TUBE, ELBOW & TEE
FITTINGS
SIZE
CODE IDENT NO.
DWG NO.
D
07482
SCALE 1/1
WT
SHEET
4012180-744

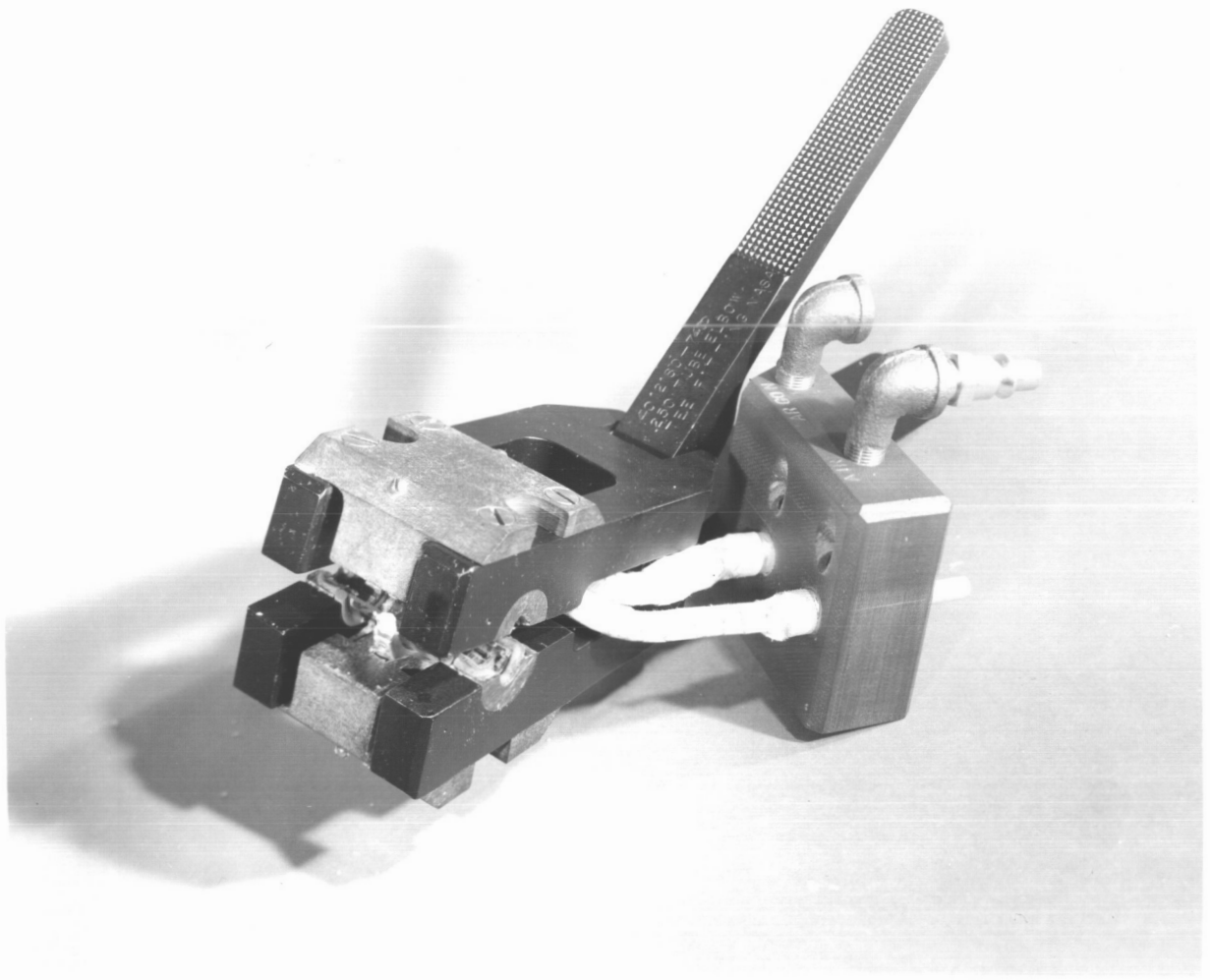


FIGURE 7 1/4" BRAZE TOOL FOR ELBOW & TEE FITTINGS

M04761

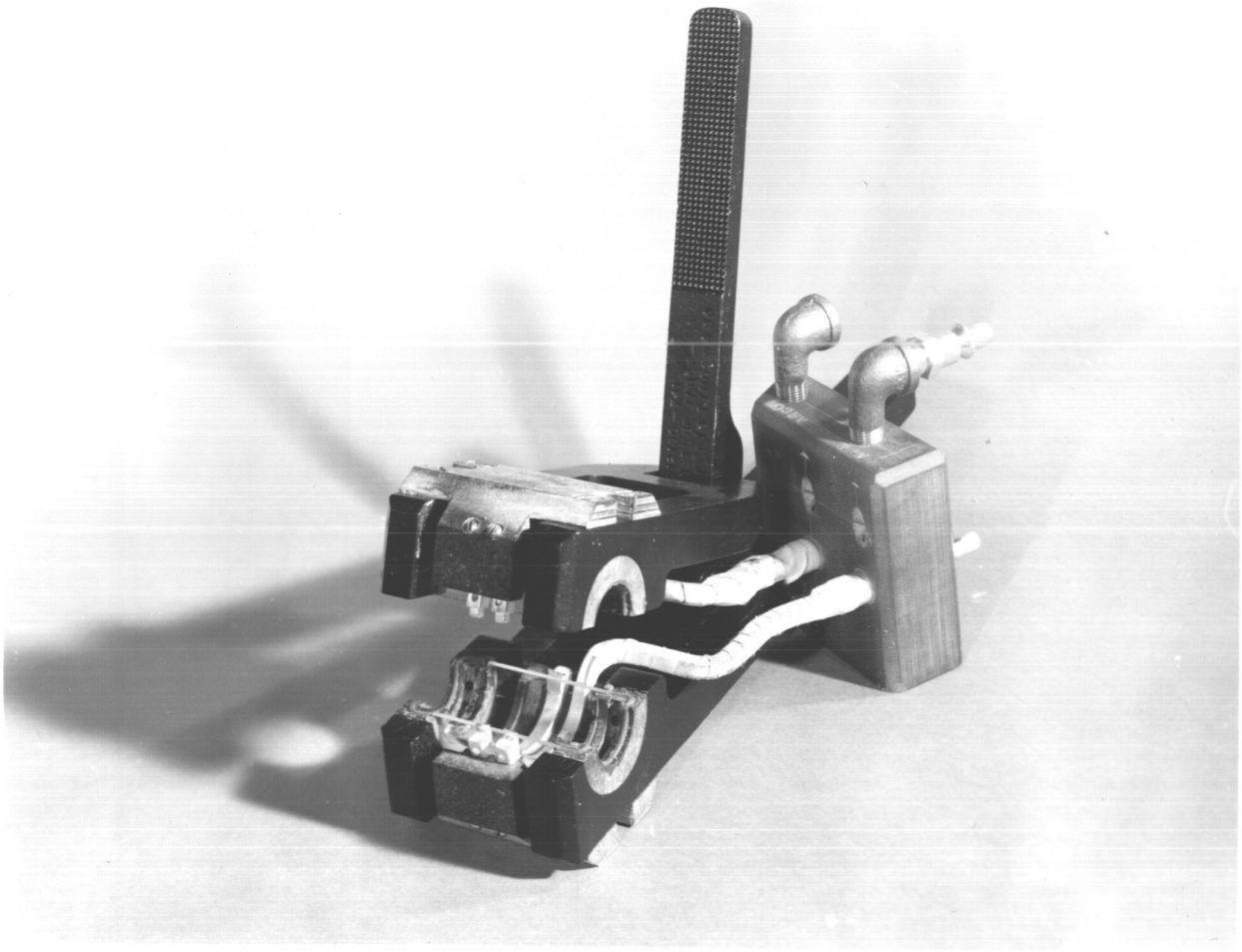


FIGURE 8 3/4" BRAZE TOOL FOR ELBOW & TEE FITTINGS

MO4761

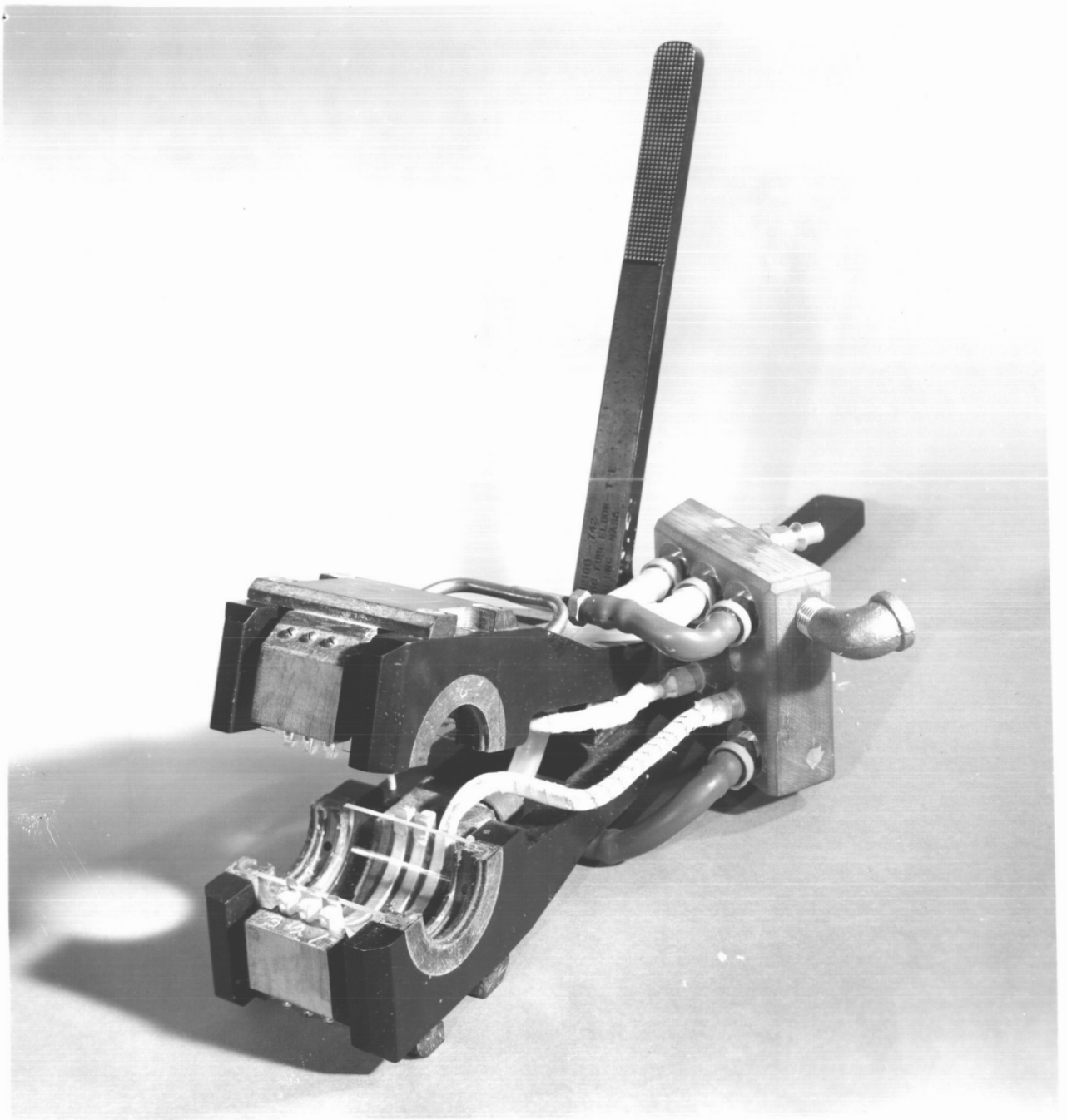


FIGURE 9 1 1/4" BRAZE TOOL FOR ELBOW & TEE FITTINGS

MO4761

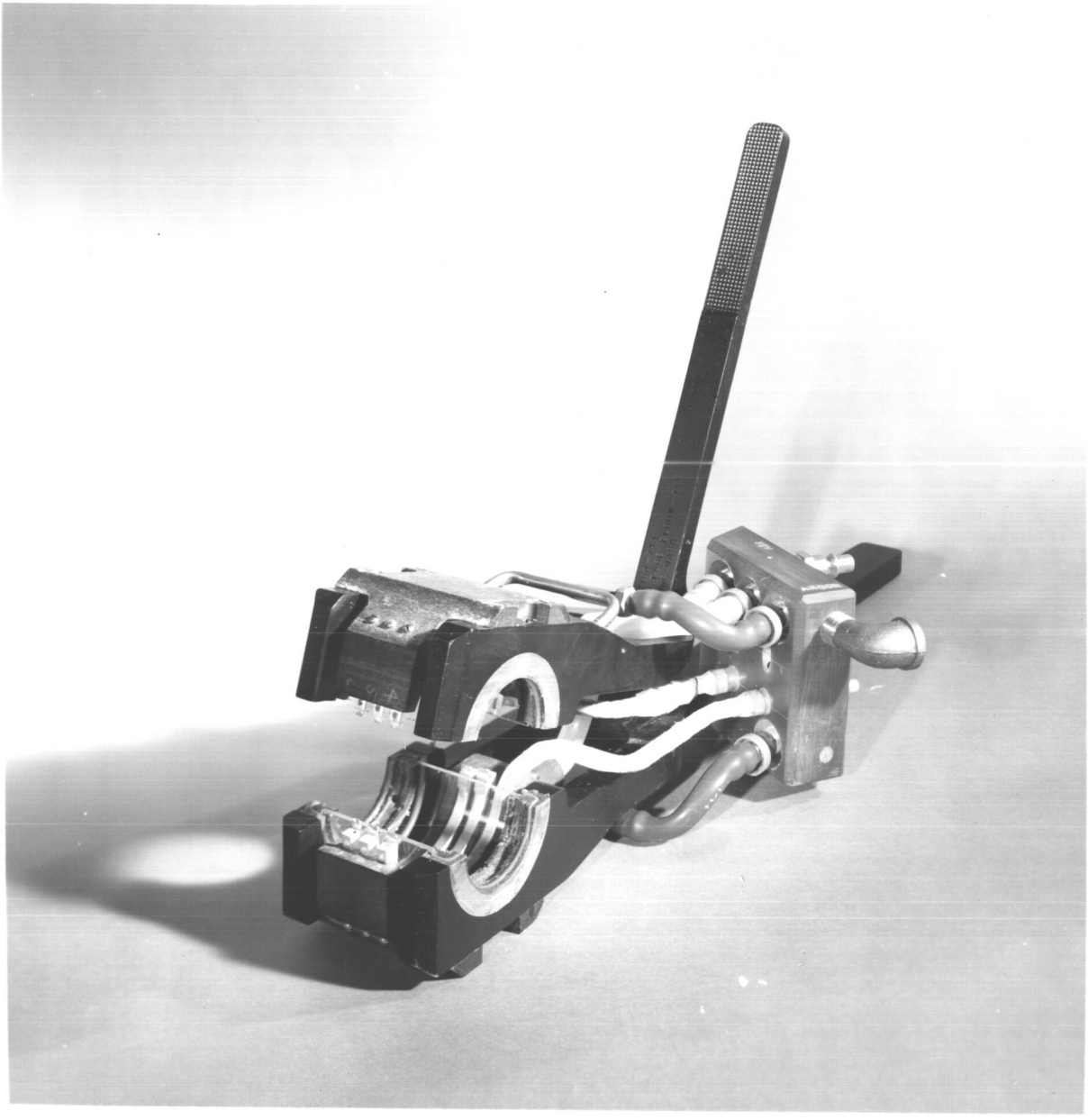


FIGURE 10 1 1/2" BRAZE TOOL FOR ELBOW & TEE FITTINGS M04761

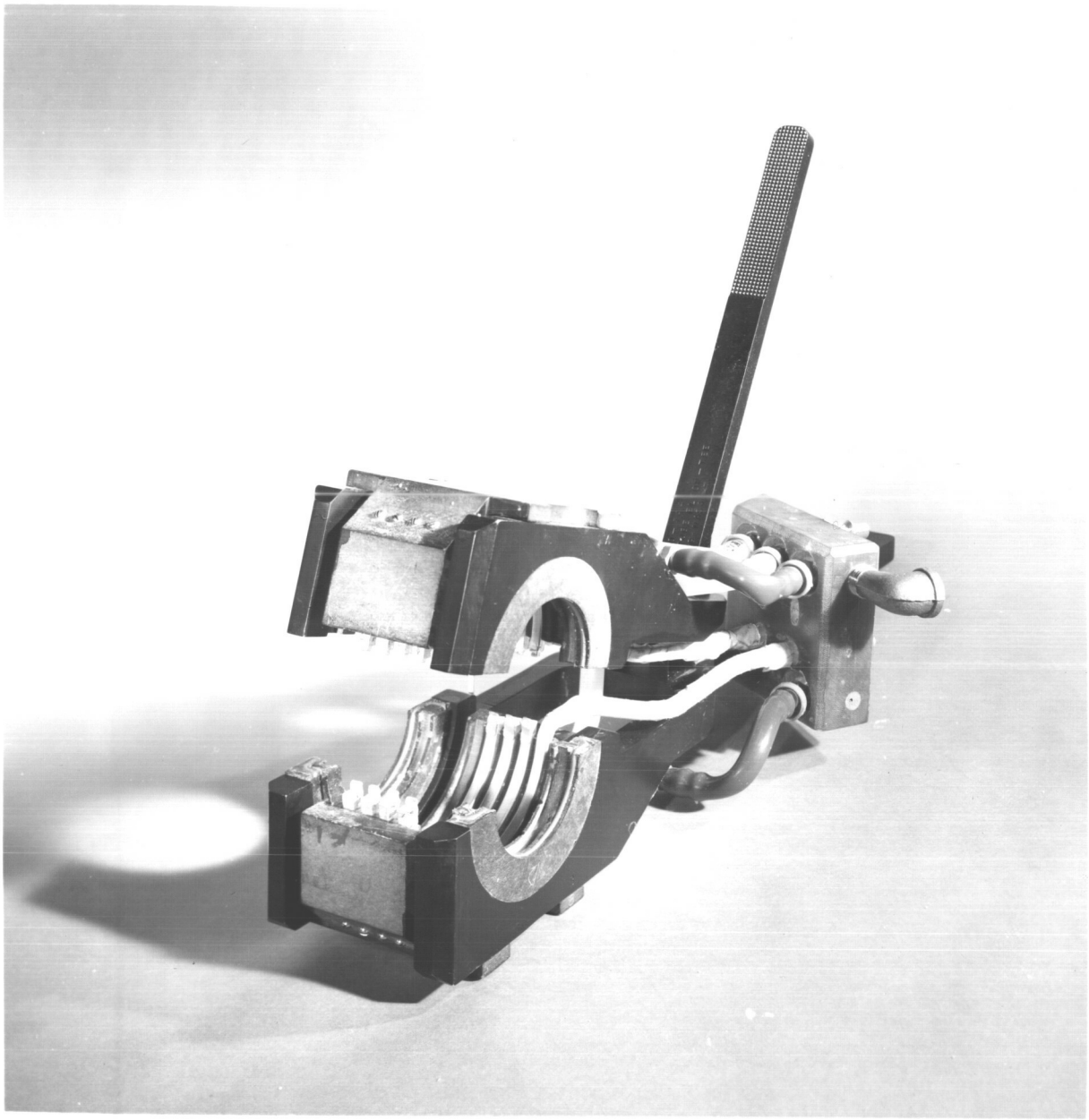


FIGURE 11 2" BRAZE TOOL FOR ELBOW & TEE FITTINGS

M04761

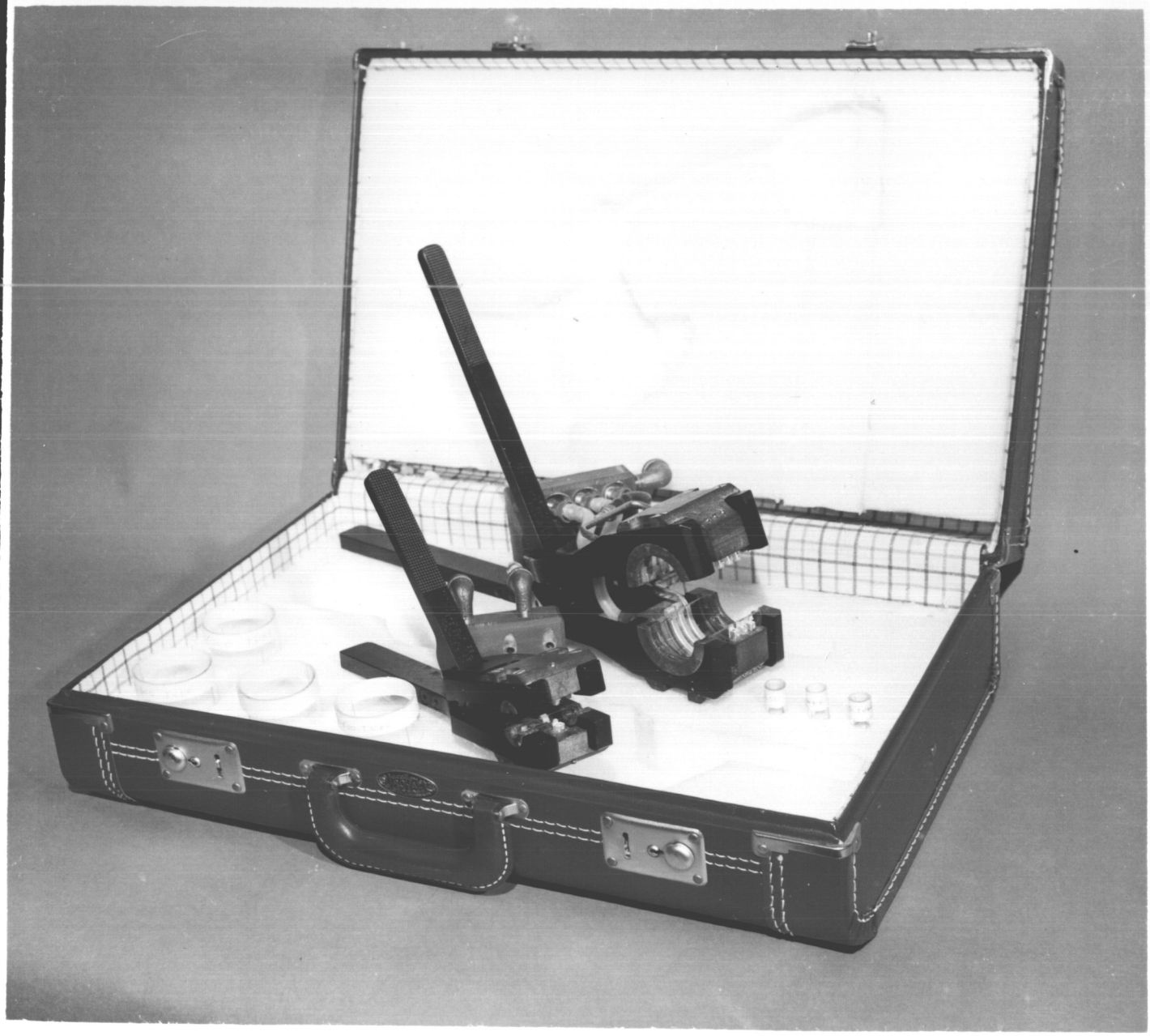


FIGURE 12

CARRYING CASE MO4761

FIGURE 12A

CARRYING CASE MO4761

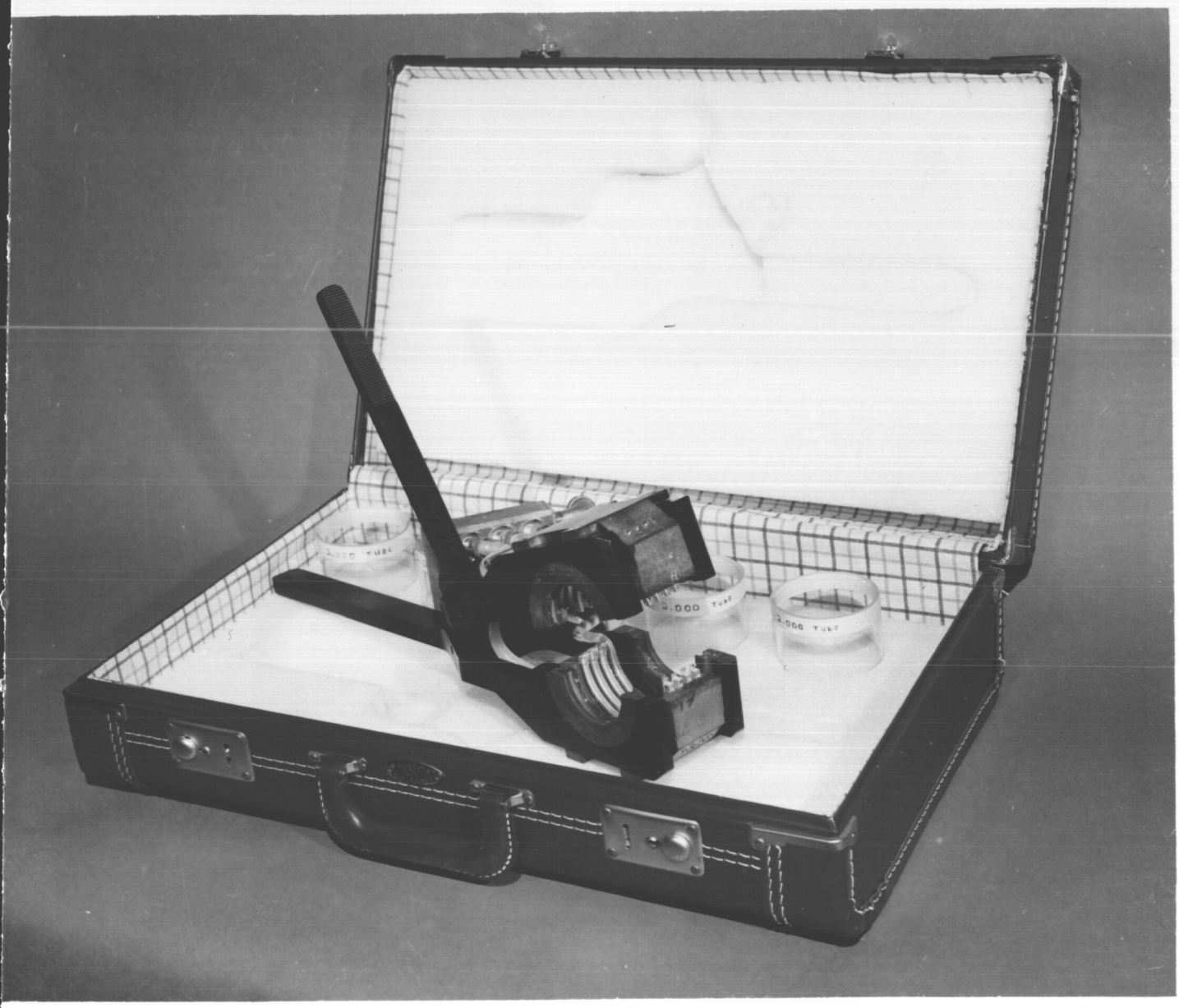


FIGURE 12B

CARRYING CASE

MO4761

TABLE III. Split Coil Data For Straight Connectors

Tube Size	Coil I.D.	Coil Turns	Coil Pitch
.250	.60 .59	3	.286
.750	1.19 1.18	4	.286
1.250	1.88 1.87	5	.375
1.500	2.12 2.11	6	.375
2.000	3.07 3.06	8	.312
2.500	3.27 3.26	8	.375

TABLE IV. Split Coil Data For Elbow And Tee Type Fittings

Tube Size	Coil I.D.	Coil Turns	Coil Pitch
.250	.60 .59	1	.375
.750	1.19 1.18	2	.3125
1.250	1.88 1.87	3	.3125
1.500	2.12 2.11	3	.3125
2.000	2.88 2.87	4	.3125

Debraze Tool

The fitting must first be cut in half, then the debrazing tool is used to remove the remaining half coupling, elbow or tee type fitting. The removal of fittings are necessary when lines must be disconnected to replace a braze fitting, filters, or replace sections of tubing.

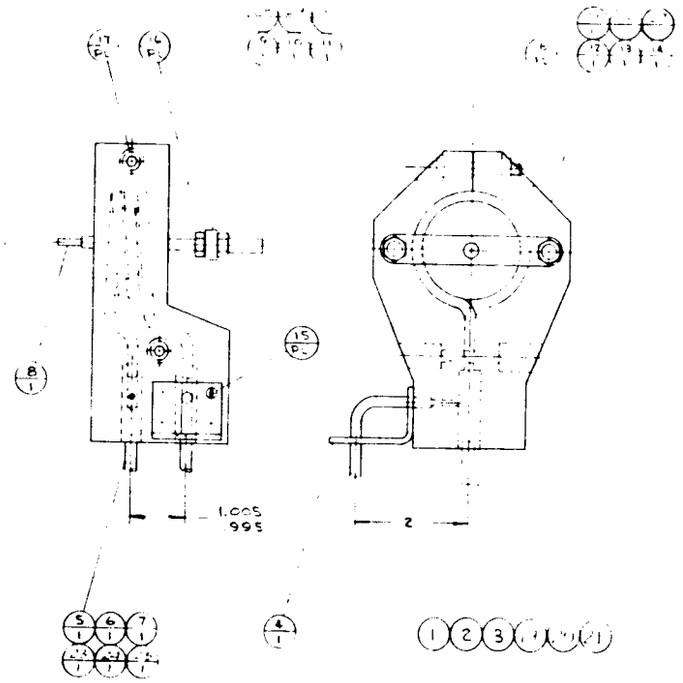
The debrazing fixture, Figure 13 is a semi-automatic tool which works in conjunction with its corresponding heating coil, Figure 14 and 14A. The coil itself is housed in a containing block which has guide sleeves for centering the coil to the fitting, an argon gas outlet that inserts into the tube and acts to catch the hot parted fitting when removed. The continuous wound heating coil for the debrazing fixture is used to remelt the braze alloy. This coil is made from soft copper tubing .187 x 030 wall with sufficient turns to overlap the brazed area by .070 minimum and the I.D. of the coil is at least .120 greater than the O.D. of the fitting.

The other half of the debrazing fixture is air operated. An adjustable hardener split block sets next to the fitting to be removed. The extension to this block has tefelon sleeves to prevent binding when this is moved forward by the striking arm. The tool itself is held to the tubing by an adjustable split brass sleeve. Prints 4012180-728 detail all heating units and prints, 4012180-731 thru 736 detail the debrazing fixture.

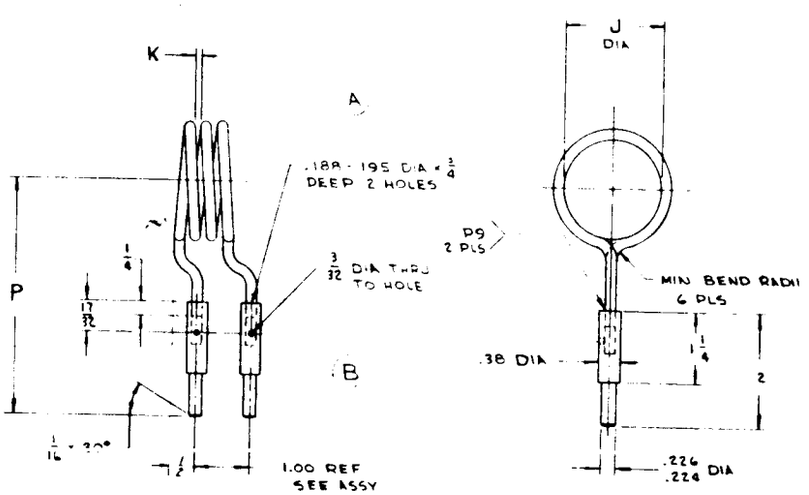
Sizing Tools

There are two methods of sizing tubing - expansion and reduction. Both methods were investigated during the initial braze program and reduction was chosen because closer tolerances could be achieved and it was a much simpler operation. Also, a more practical and compact tool could be designed for the reduction method. The tools designed, Figure 15, attach to a two-directional motor mounted on a table. Each sizing tool is interchangeable with the two-directional motor. Every sizing tool has a matching clamping block which slides on parallel bars and holds the tubing stationary during the sizing operation. Figures 16, 16A and 16B show three different sizing housings and matching clamping blocks. For details see print 4012180-729.

The design of the sizing tools for 1/4", 3/4", 1 1/4", 1 1/2" are all the same. Problems were encountered with the 2" and the 2 1/2" sizing tool, mainly a flaring condition on the end of the tube sized. Design of 2" and 2 1/2" sizing tool was altered to correct this.



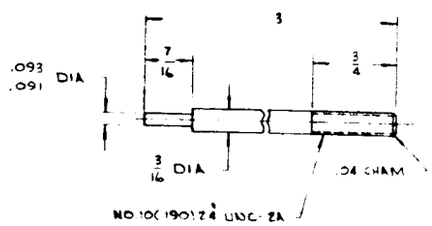
1 COIL TO HAVE L COMPLETE TURNS SPACED K APART.
2 SILVER PLATE .003 - .004 THK



SCALE 1/1

22	23	24	
5	6	7	WELDED ASSEMBLY
			A COIL COPPER TUBE .187 OD x .030 WALL
			B TIP COPPER

PT NO.	J	K	L	P
5	.67	.05	2	4 1/8
6	1.32	.05	3	4 1/8
7	1.90	.05	3	4 1/8
22	2.15	.05	3	4 1/8
23	2.65	.05	4	4 1/8
24	3.15	.05	4	4 1/8

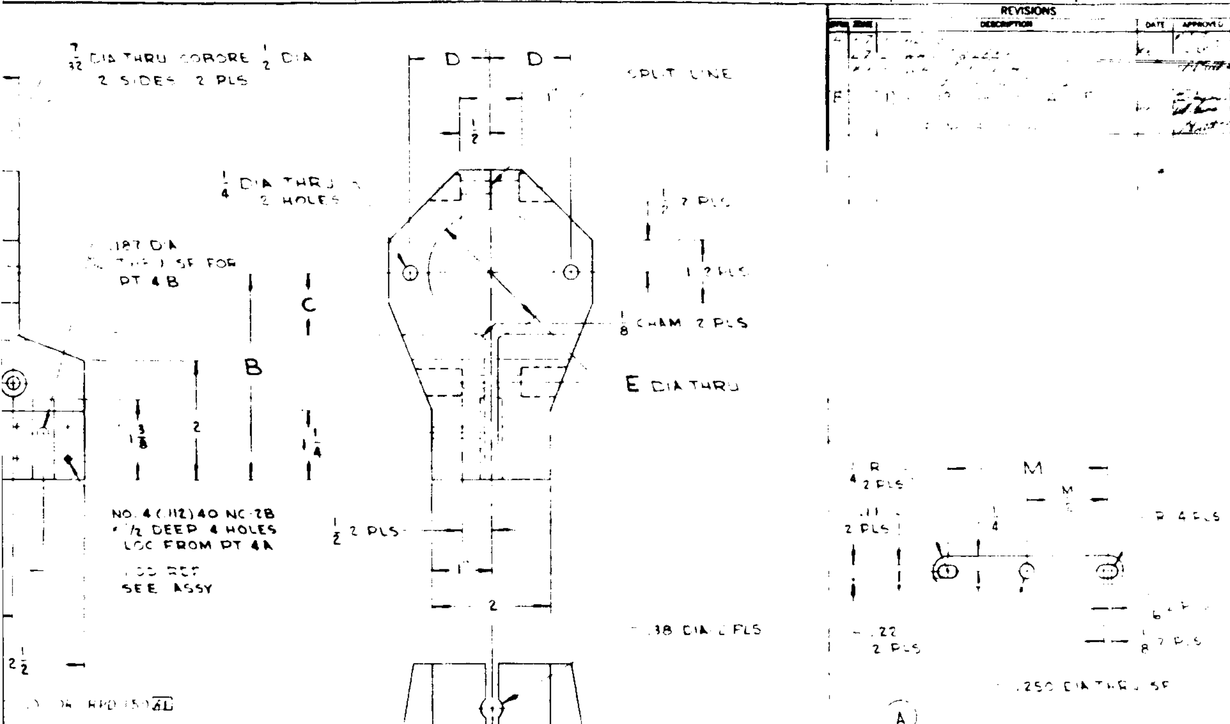


(8) MATL 316 SST
SCALE 2/1

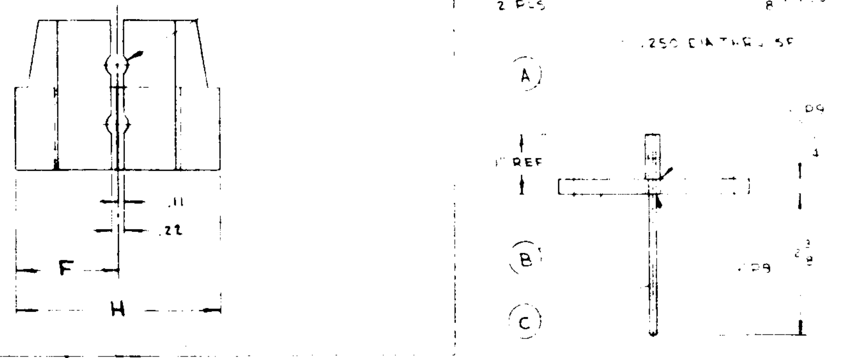
PT NO.	A	B	C
12	4 3/4	3	
13	5 5/8	3 1/2	
14	5 1/4	3 1/2	
25	6 1/4	+1 1/4	
26	7	+1 1/4	
27	6.7	+1.7	

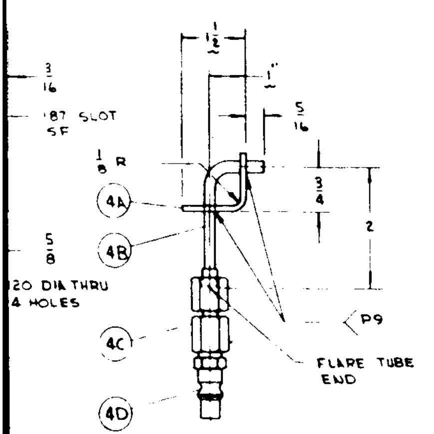
SCALE 1/1

4	WELDED ASSEMBLY
A	300 SST
B	300 SST TUBE
C	CONNECTOR PARKER
	TRIPLE LOK
D	CONNECTOR



D	E	F	H	N
.812	1.070	1 3/16	2 3/8	1 1/8
.187	1.720	1 9/16	3 1/8	1 3/8
.375	2.300	1 3/4	3 1/2	1 3/8
.625	[illegible]	2 1/8	4 1/4	1 3/8
.812	3.050	2 3/8	4 3/4	1 5/8
.094	[illegible]	2 5/8	5 1/4	1 5/8





SCALE 1/1

28	29	30	9	10	11	WELDED ASSEMBLY	
			–	A	–	TUBE NICHROME 1/4 OD × ... LG	1
A	A	A	–	A	A	TUBE NICHROME 1/4 OD × ... LG	1
B	B	B	B	B	B	STRAP 316 SST 1/4 THK	1
–	–	–	C	–	–	TUBE NICHROME 1/8 OD × ... LG	1

PT NO	M
9	1.625
10	2.375
11	2.750
28	3.250
29	3.625
30	4.188

1. BREAK ALL SHARP EDGES
2. STAMP TOOL, ASSY NO., SIZE OD TUBING & NASA.

30	WELDED ASSY
29	WELDED ASSY
28	WELDED ASSY
27	BLOCK
26	BLOCK
25	BLOCK
24	WELDED ASSY COIL
23	WELDED ASSY COIL
22	WELDED ASSY COIL
21	ASSY 1 1/2 OD
20	ASSY OD
19	ASSY OD
18	HEX NUT NO 10 (.190)-24 NC 2 — COMM NYLON
17	HEX HD CAP SCR NO 10 (.190)-24 NC 2 — NYLON
16	HEX JAM NUT NO 10 (.190) 24 NC 2
15	FILLISTER HD MACH SCR NO 4 (.112) 40 NC
14	BLOCK — SHT. 1
13	BLOCK
12	BLOCK
11	WELDED ASSY
10	WELDED ASSY
9	WELDED ASSY
8	GUIDE PIN
7	WELDED ASSY (COIL)
6	WELDED ASSY (COIL)
5	WELDED ASSY (COIL)
4	WELDED ASSY (AIR SUPPLY)
3	ASSY 1/4 OD
2	ASSY 1/4 OD
1	ASSY 1/4 OD

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± 1/32 DECIMALS ± .01 ANGLES ±

GENERAL ELECTRIC
LARGE JET ENGINE DEPT — CINCINNATI 15, OHIO

TITLE: DEPHASING HEATING UNIT
.250, .750, 1.250, ... OD
TUBING ... HALF

NO. 4

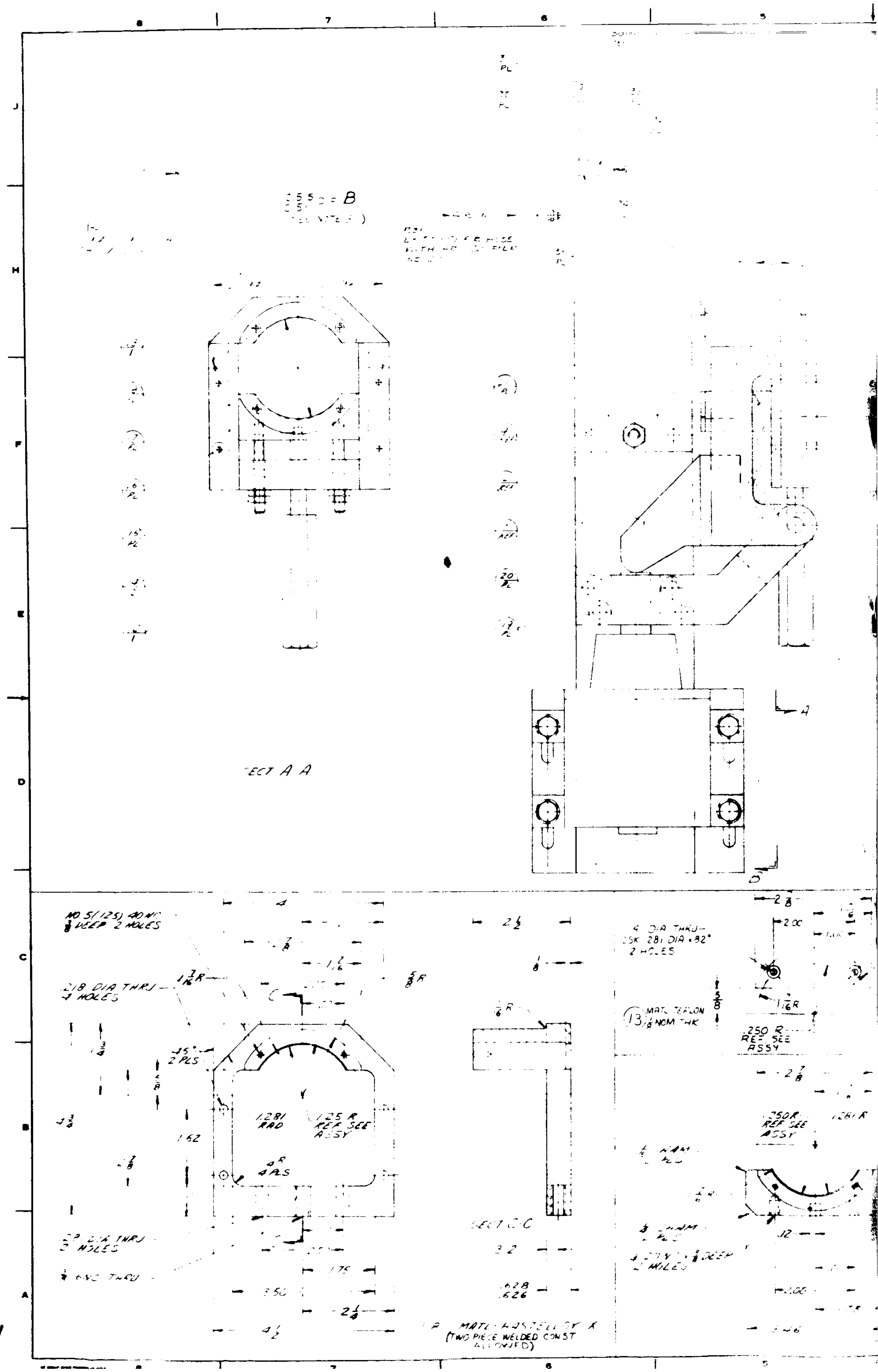
OR 4L-NASA-0534

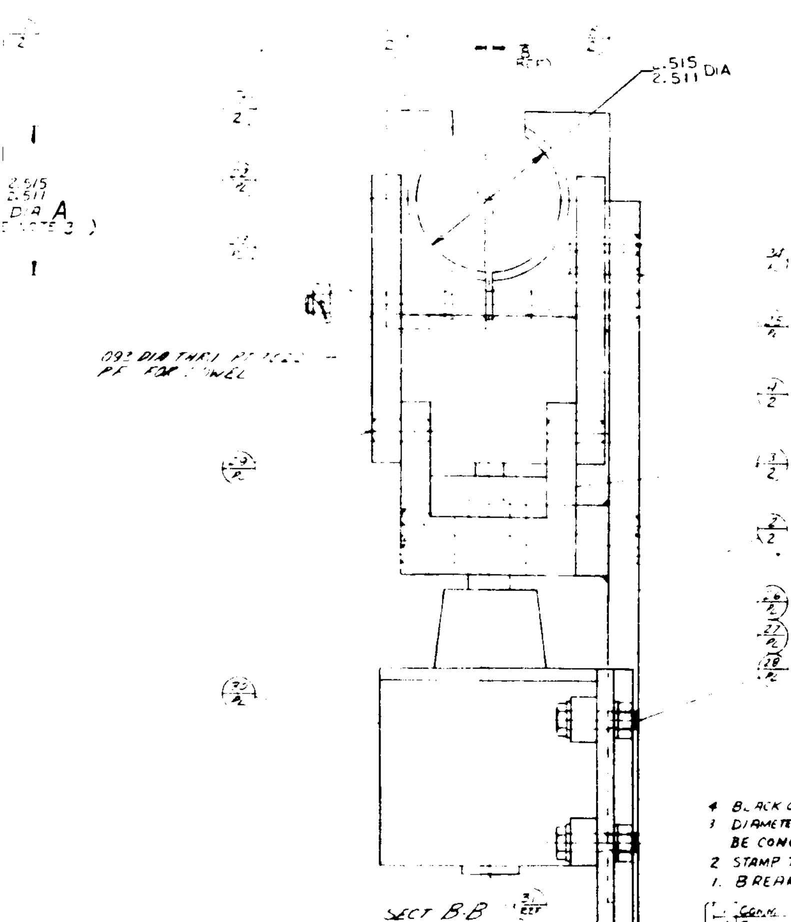
CODE IDENT NO.	SIZE	DWG NO.
07482	E	4012180-728

SHEET 1 OF 1

E 4012180-728

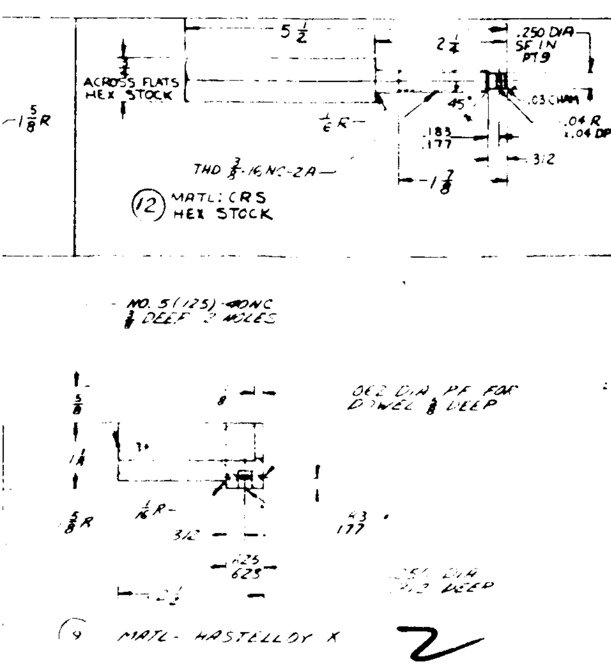
2


SECT A A
NO 5(125) 40 NC
4 HOLES
SECT C-C
MATL TEFLON
250 R REF SEE ASSY
(TWO PIECE WELDED CONST ALLOWED)



4 BLACK OXIDE ALL NON-WORKING SURF. PER AMS 2485
3 DIAMETERS A & B TO BE MACH. AT ASSY & MUST BE CONC WITHIN .002 FIR.
2 STAMP TOOL NO., 2½ O.D. TUBE & NAS8-11554
1. BREAK ALL SHARP EDGES

1	COMM	36	SCHRADER 3 WAY VALVE No 3103
1	COMM	35	"ARO" CONNECTOR No A-2607
1	COMM	34	¼ HOSE 12" LG [illegible]
1	COMM	33	¼ HOSE 12" LG [illegible]
1	COMM	32	"ARO" COUPLER No 210
1	COMM	31	"ARO" CONNECTOR No A-2608
1	COMM "MEAD"	30	CYLINDER NO. H72
2		29	DOWEL 3/8 DIA x 1" LG
8		28	WASHER 5/16 NOM
4		27	HEX NUT 5/16-18NC
4		26	SOC HD CAP SCR 5/16-18NC x 1¾ LG
2		25	DOWEL ¼ DIA x 1" LG
2		24	SOC HD CAP SCR ¼-20NC x ¾ LG
1		23	DOWEL 3/32 DIA x ½ LG
1		22	HEX NUT 5/16-18NC (ALTER)
2		21	DOWEL ¼ DIA x 3¾ LG
2		20	DOWEL 5/16 DIA x 3" LG
2		19	SOC HD CAP SCR ½-13NC x 3½ LG
4		18	FL HD SCR NO 5(.125) 40NC x ⅜ LG
1		17	DOWEL 1/16 DIA x 5/16 LG
4		16	FL HD SCR NO 10(.190) 24NC x 1¼ LG
4	COMM	15	JAM NUT ¼-20NC
2	SHEET 2	14	STUD
2	1	13	GUIDE
1	1	12	ADJUSTING SCREW
2	2	11	PLATE
2	2	10	PLATE
1	1	9	PUSHER PAD
1	1	8	PUSHER BLOCK
1	2	7	CLAMP SCREW
1	2	6	CLAMP BLOCK
1	2	5	CLAMP BLOCK
1	2	4	YOKE
1	2	3	BRACKET
1	SHEET 2	2	WELDED ASSY PLATE
		1	ASSEMBLY



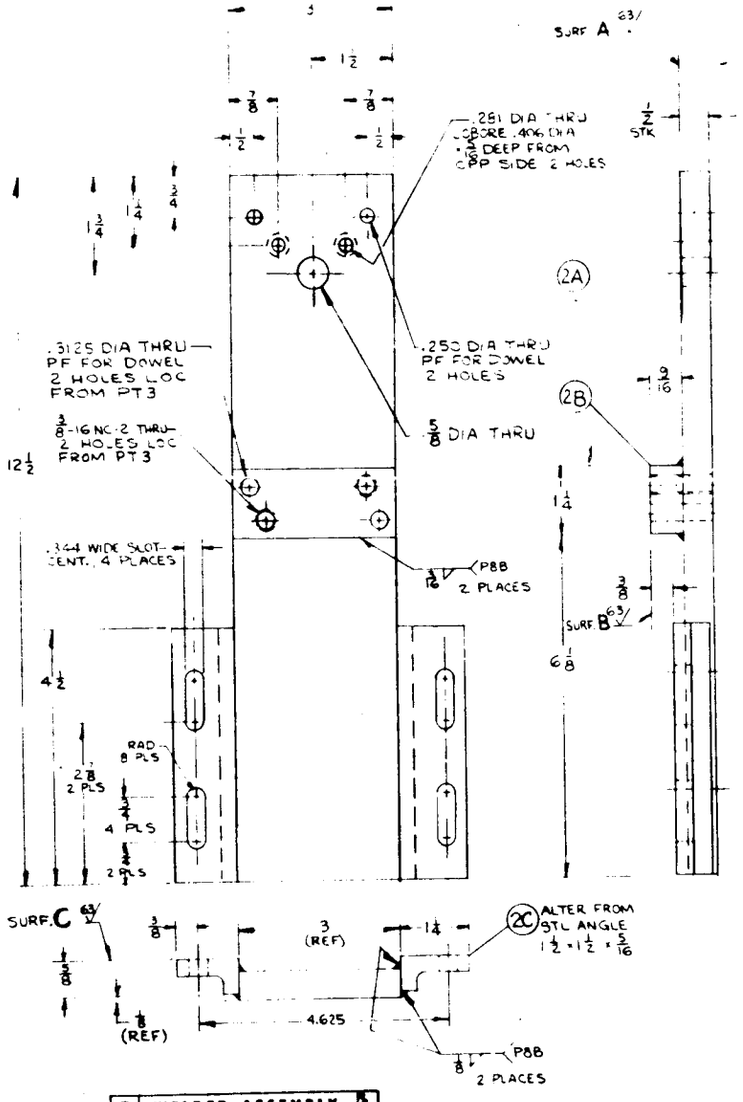
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ±1/32, DECIMALS ±.010, ANGLES ±1°

FOR G.E. USE ONLY
SIMILAR TO 4012180-732
NASA-0534

GENERAL ELECTRIC
LARGE JET ENGINE DEPT CINCINNATI, OHIO, U.S.A.

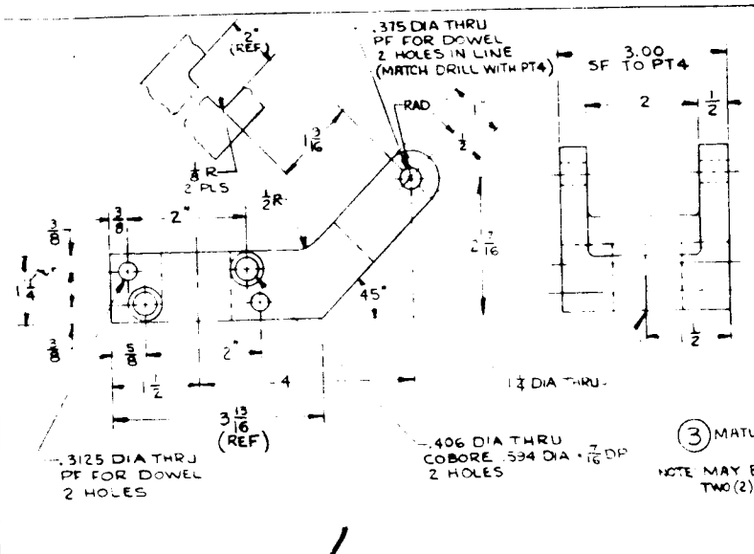
DEBRAZE KNOCKOFF TOOL FOR 2½ O.D. TUBE
NASA

SIZE E | CODE IDENT NO 07482 | DWG NO 4012180-731
SHEET 1 OF 2

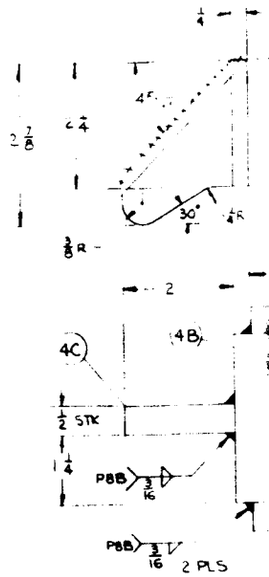


2	WELDED ASSEMBLY	
A	HRS	1
B	HRS	1
C	STL ANGLE	2

NOTES:
1. STRESS RELIEVE BEFORE FIN. MACH.
2. SURF. A, B, & C MUST BE PAR. WITHIN .010 FIR.

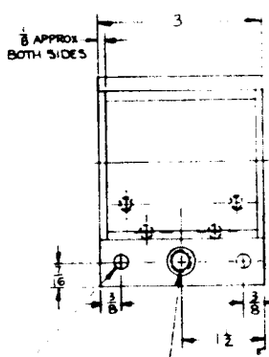


(3) MATL: HRS
NOTE MAY BE MADE FROM TWO (2) PIECE CONST

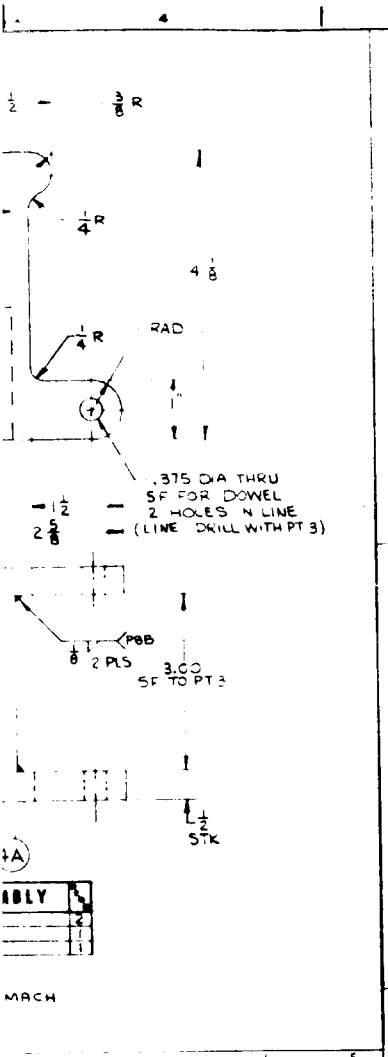


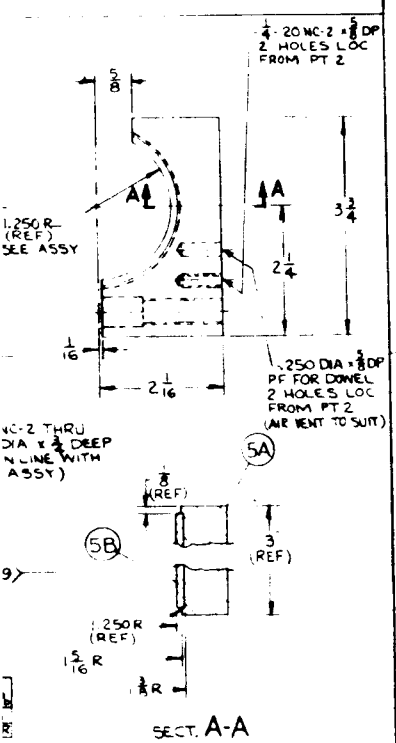
4	WELDED ASSE
A	HRS
B	HRS
C	HRS

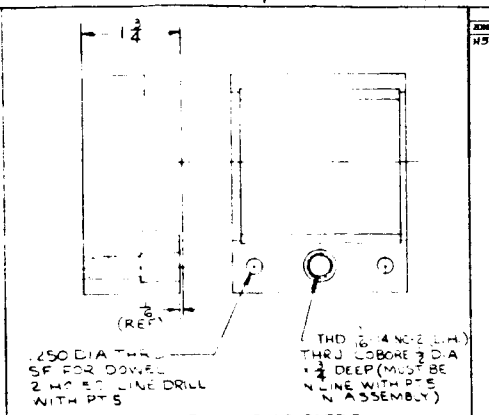
NOTE:
1. STRESS RELIEVE BEFORE F N



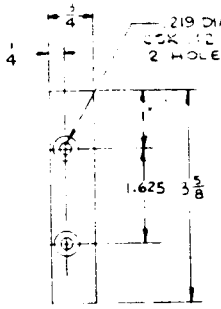
5	WELDED ASSEMBLY
A	HRS
B	BRASS (QUARTER HARD)



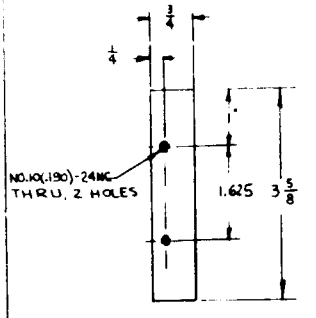




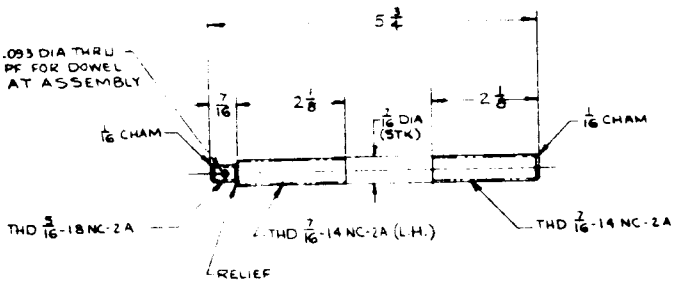
(6) SAME AS PART 5 EXCEPT AS SHOWN



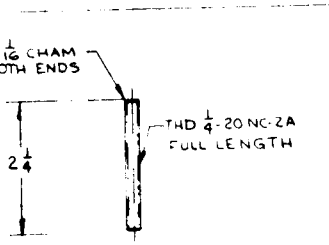
(10) MATL: CRS 1/4 STK THK



(11) MATL: CRS 1/4 STK THK



(7) MATL: CRS



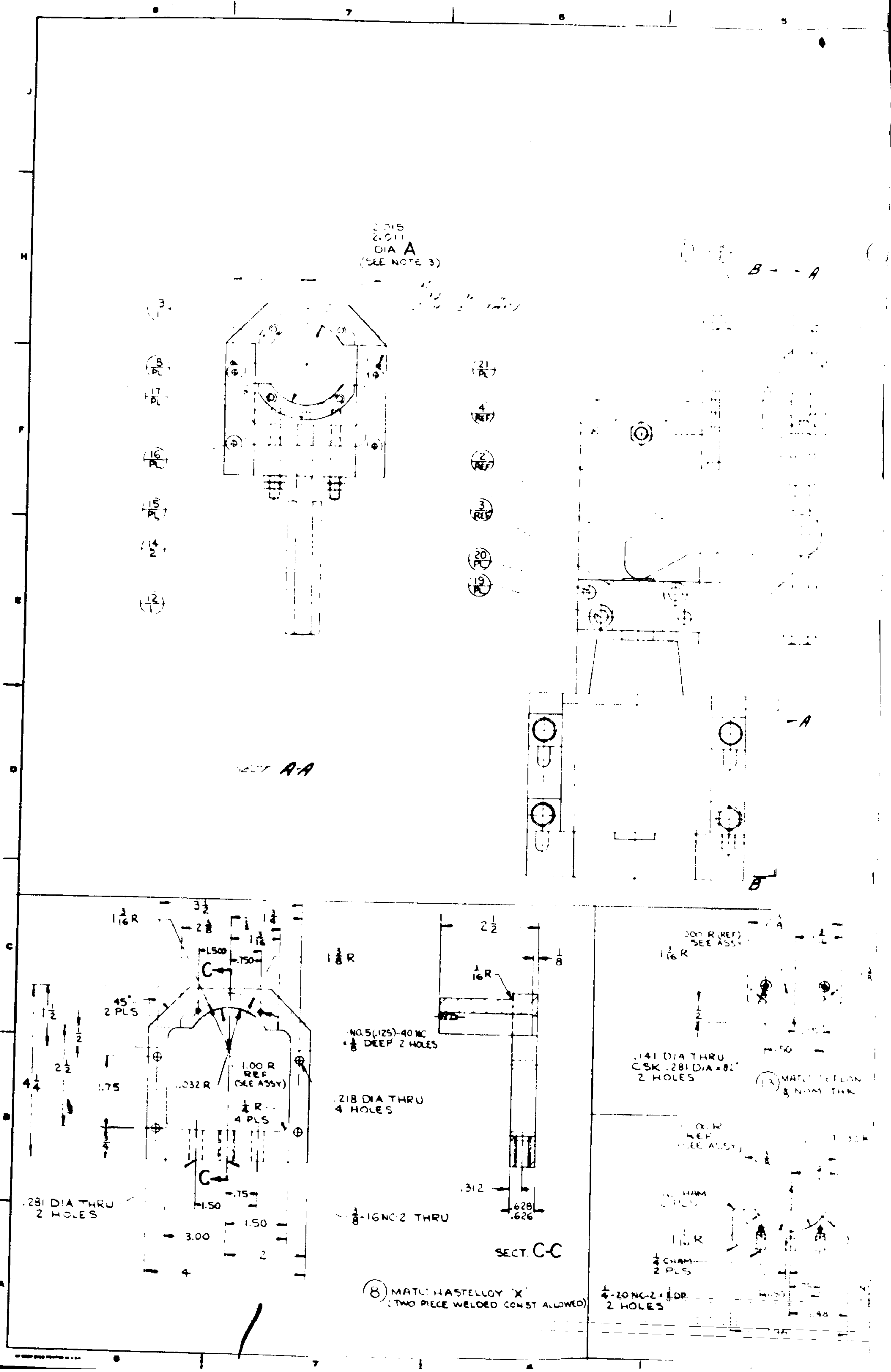
(14) MATL: CRS 1/4 DIA STK

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES ± 1/32 ± .010 ± 1° ALL SURFACES 125		GENERAL ELECTRIC LARGE JET ENGINE DEPT CINCINNATI, OHIO, U.S.A.	
FOR G E USE ONLY SIMILAR TO 4012180-732 I.D. NO 41-NASA-0534		DEBRAZE KNOCKOFF TOOL FOR 2 1/2 O.D. TUBE NASA	
		E 07482	4012180-731
		SCALE 1/1	SHEET 2 OF 2

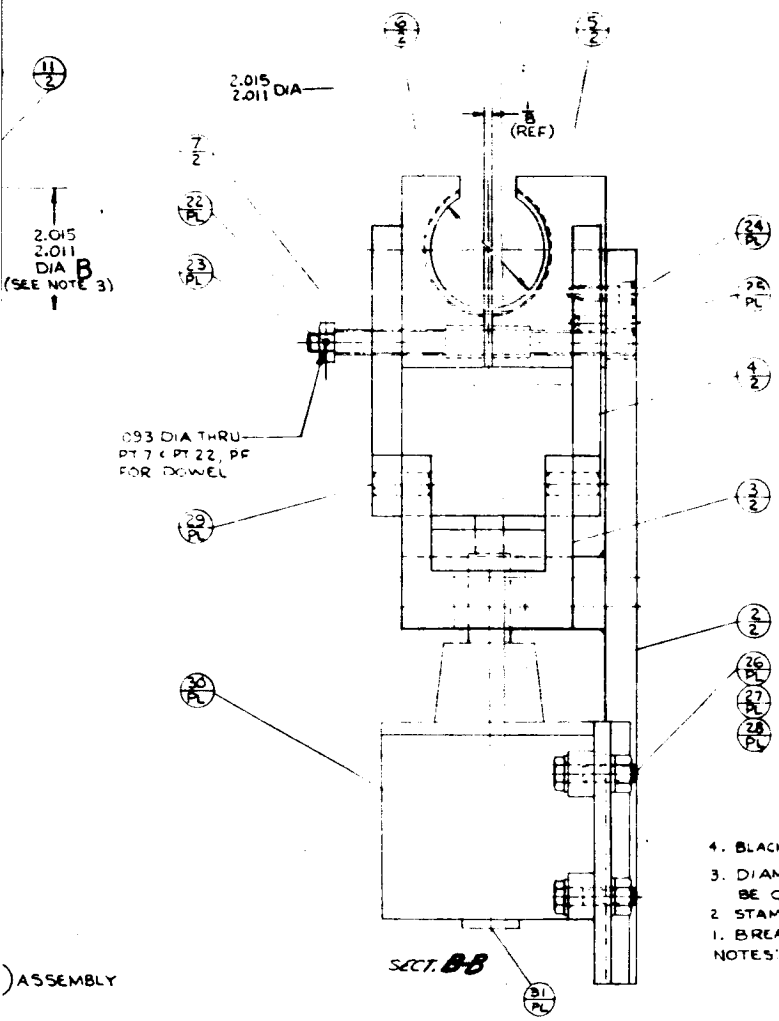
4012180-731 E

4012180-731 E

2


DIA A
(SEE NOTE 3)
SECT A-A
45° 2 PLS
1.00 R REF (SEE ASSY)
.032 R
.218 DIA THRU 4 HOLES
NO.5(.125)-40 NC 1/8 DEEP 2 HOLES
.281 DIA THRU 2 HOLES
3/8-16NC-2 THRU
SECT. C-C
(8) MATL HASTELLOY 'X' (TWO PIECE WELDED CONST ALLOWED)
.141 DIA THRU CSK .281 DIA x 82° 2 HOLES
1/4-20NC-2 x 3/8 DP 2 HOLES

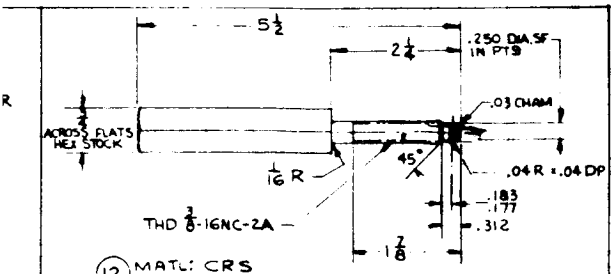
REVISIONS			
SYMBOL	DESCRIPTION	DATE	APPROVED
CE	PT 31 ADDED.		



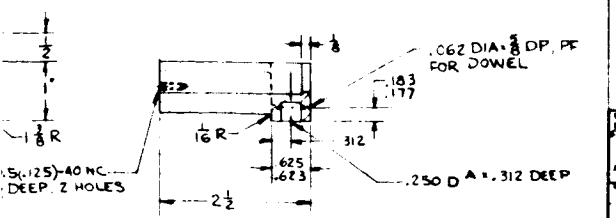
4. BLACK OXIDE, ALL NON-WORKING SURF., PER AMS 2485
3. DIAMETERS A & B TO BE MACH AT ASSY, & MUST BE CONC WITHIN .002 FIR.
2. STAMP TOOL NO., 2" O.D. TUBE, & NAS8-11554
1. BREAK ALL SHARP EDGES

NOTES:

ASSEMBLY



(12) MATL: CRS HEX STOCK



(9) MATL: HASTELLOY 'X'

ALL				
	1	COMM	31	*ARP CONNECTOR NO A-2608
	1	COMM - MEAD CO	30	CYLINDER NO. H72
	2		29	DOWEL 3/8 DIA x 1" LG
	8		28	WASHER 5/16 NOM I.D.
	4		27	HEX NUT 5/16-18 NC-2
	4		26	SOC HD CAP SCR 5/16-18 NC-2 x 1¼ LG
	2		25	DOWEL 1/4 DIA x 2½ LG
	2		24	SOC HD CAP SCR 1/4-20 NC-2 x 1" LG
	2		23	DOWEL 3/32 DIA x 1/2 LG
	1		22	HEX NUT 5/16-18 NC-2 (ALTER)
	2		21	DOWEL 1/4 DIA x 3½ LG
	2		20	DOWEL 5/16 DIA x 3" LG
	2		19	SOC HD CAP SCR 3/8-16 NC x 3½ LG
	4		18	FL HD SCR NO.5 (.125)-40 NC-2 x ⅜ LG
	1		17	DOWEL 1/16 DIA x 5/8 LG
	4		16	FL HD SCR NO.10 (.190)-24 NC-2 x 1¼ LG
	4	COMM	15	JAM NUT 1/4-20 NC-2
	2	SHEET 2	14	STUD
	2	1	13	GUIDE
	1	1	12	ADJUSTING SCREW
	2	2	11	PLATE
	2	2	10	PLATE
	1	1	9	PUSHER PAD
	1	1	8	PUSHER BLOCK
	1	2	7	CLAMP SCREW
	1	2	6	CLAMP BLOCK
	1	2	5	CLAMP BLOCK
	1	2	4	YOKE
	1	2	3	BRACKET
	1	SHEET 2	2	WELDMENT, PLATE
			1	ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. FRACTIONS ±1/32, DECIMALS ANGLES ±.010 ±1°. ALL SURFACES 125

FOR G.E. USE ONLY. SIMILAR TO 4012180-731. DO NOT USE FOR NASA 0534

GENERAL ELECTRIC
LARGE JET ENGINE DEPT. CINCINNATI, OHIO, U.S.A.

DEBRAZE KNOCKOFF TOOL FOR 2" O.D. TUBE

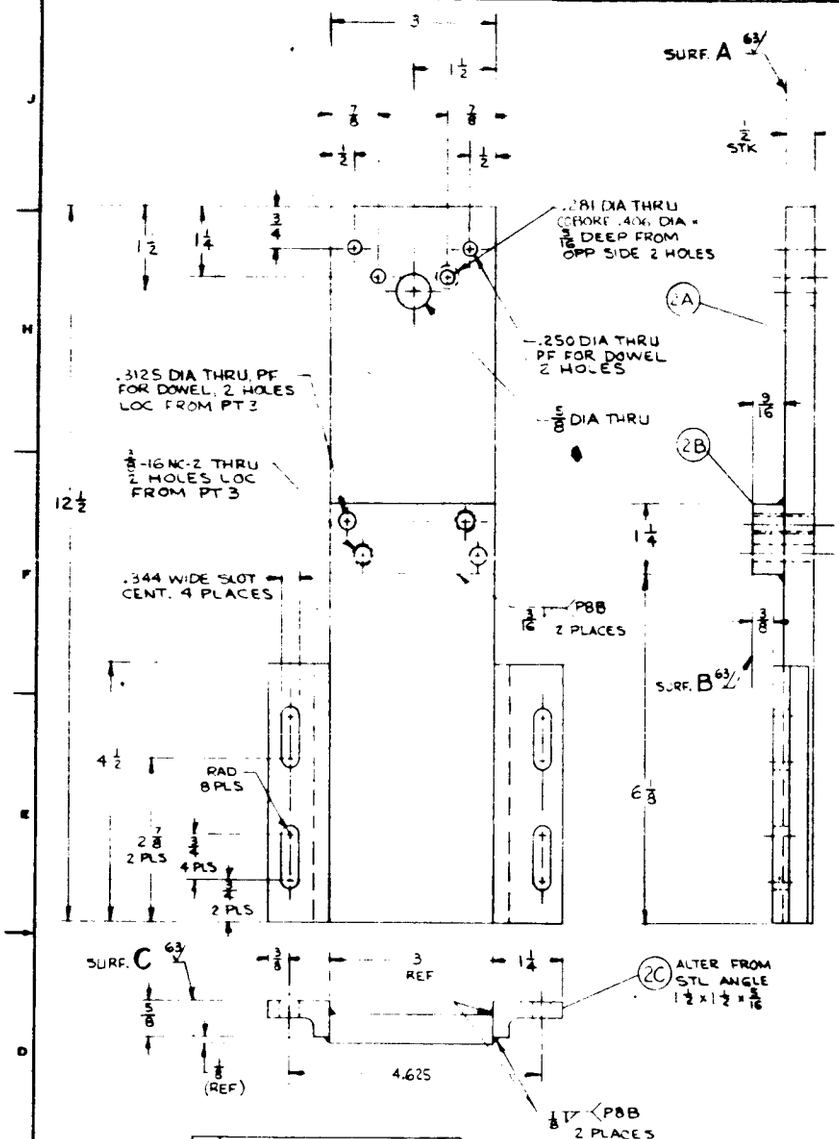
NASA

SIZE	CODE IDENT NO.	DWG NO.	REV
E	07482	4012180-732	

SCALE 1/1 WT SHEET 2 of 2

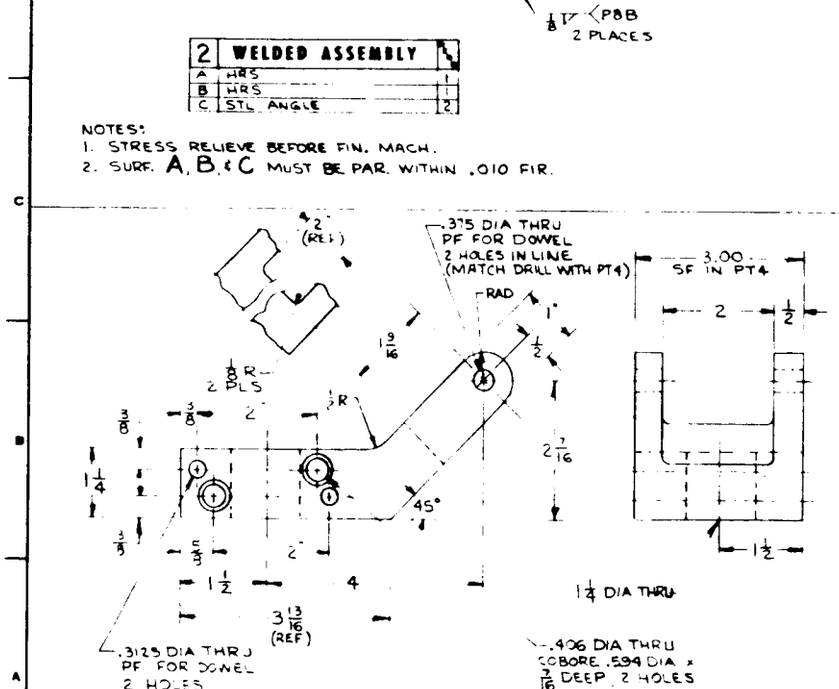
4012180-732 E

4012180-732 E

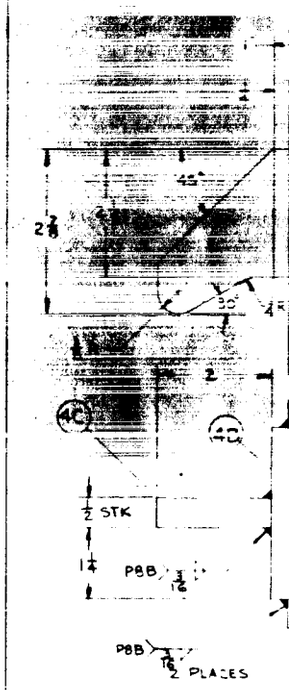


2	WELDED ASSEMBLY	
A	HRS	1
B	HRS	
C	STL ANGLE	2

NOTES:
1. STRESS RELIEVE BEFORE FIN. MACH.
2. SURF. A, B, & C MUST BE PAR. WITHIN .010 FIR.

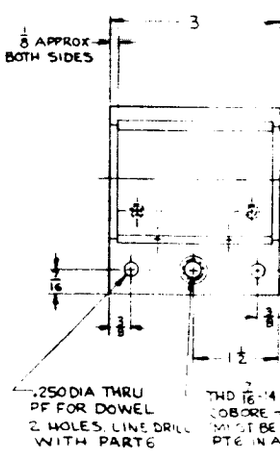


(3) MATL: HRS
NOTE: MAY BE MADE FROM TWO (2) PIECE CONST

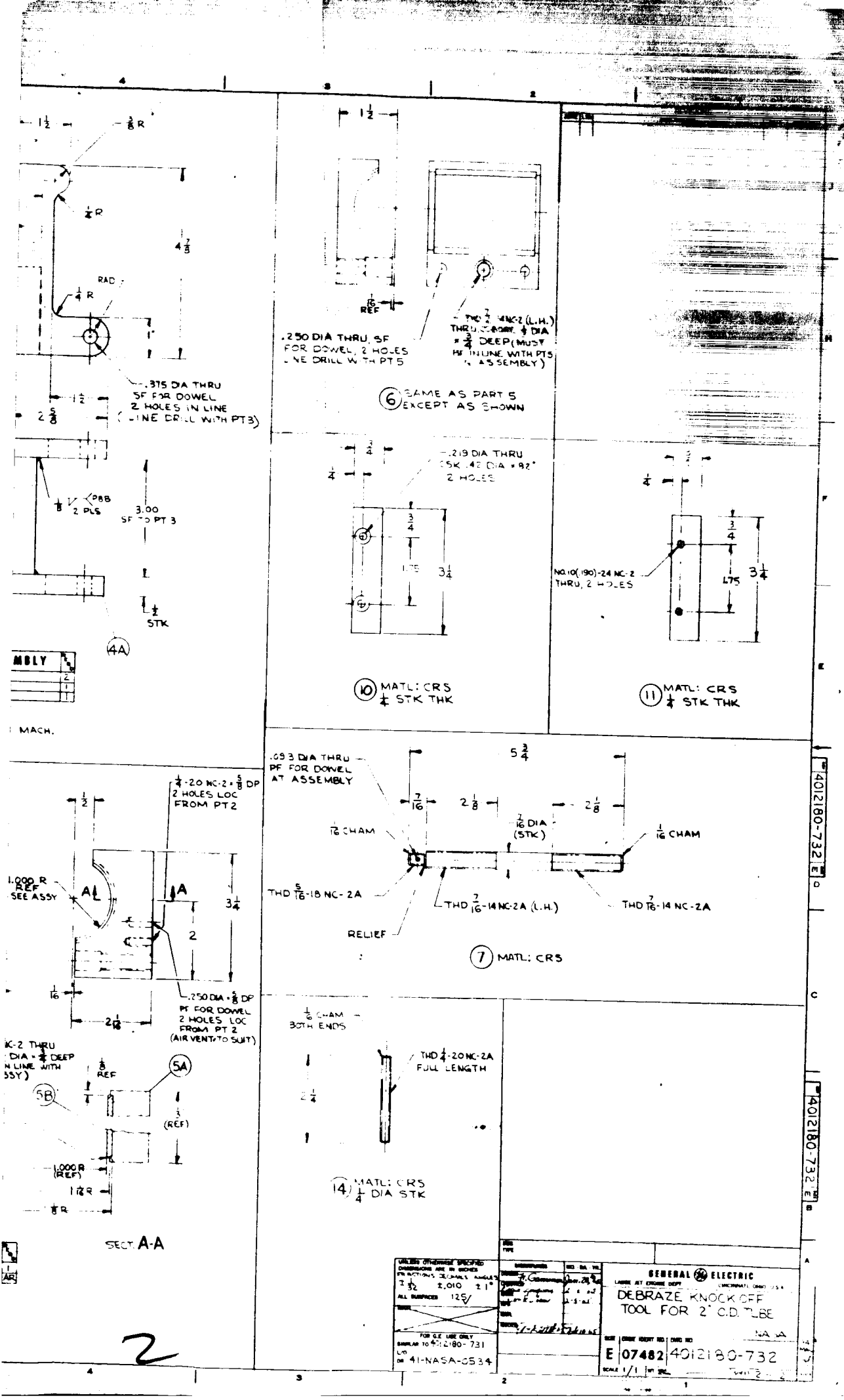


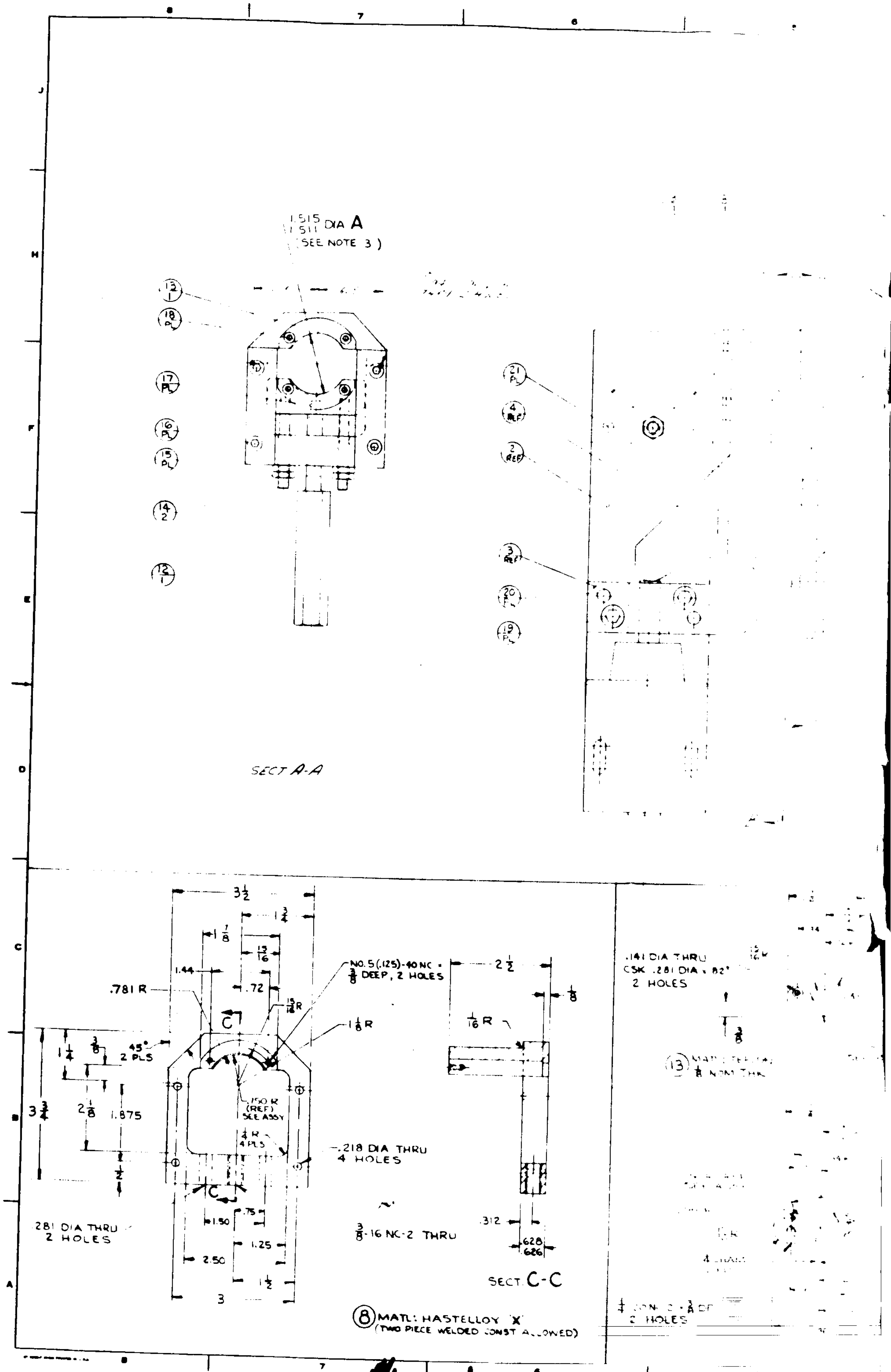
4	WELDED ASS
A	HRS
B	HRS
C	HRS

NOTE:
1. STRESS RELIEVE BEFORE F

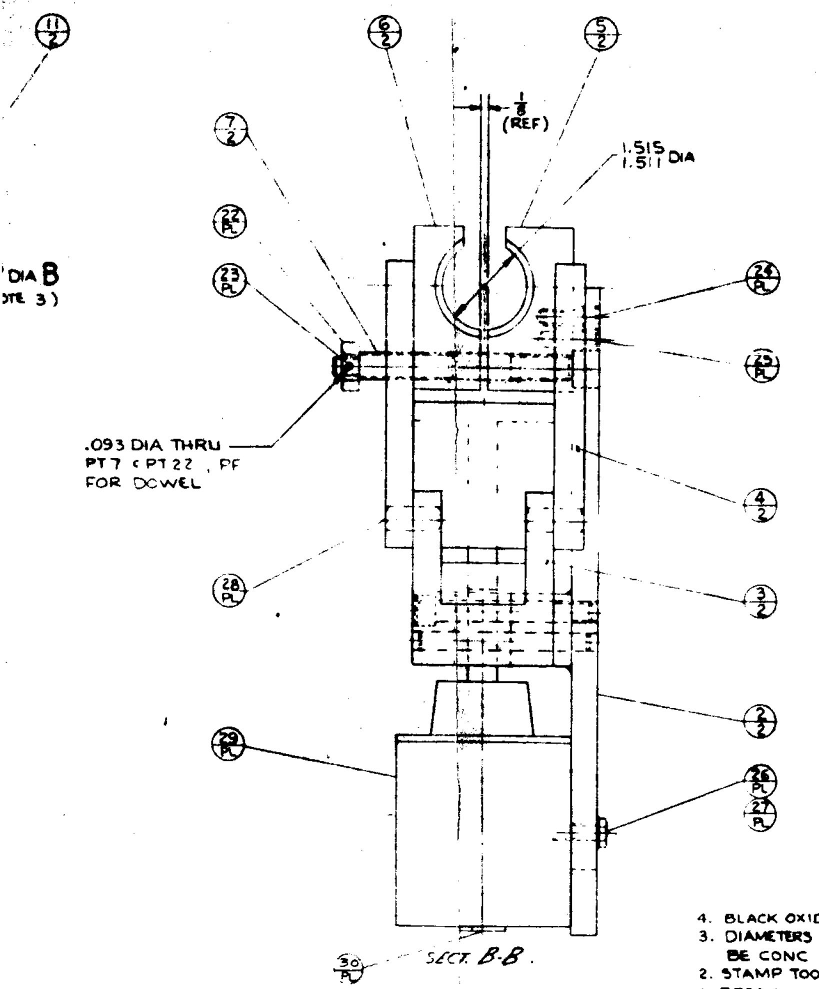


5	WELDED ASSEMBLY
A	HRS
B	BRASS (6 ARTEN HAR


1 1/2
3/8 R
1/4 R
4 7/8
RAD
1/4 R
1"
.375 DIA THRU SF FOR DOWEL 2 HOLES IN LINE (LINE DRILL WITH PT3)
1 1/2
2 5/8
3/8 PBB 2 PLS
3.00 SF TO PT 3
1/2 STK
4A
MBLY
MACH.
1 1/2
1/16 REF
.250 DIA THRU SF FOR DOWEL, 2 HOLES LINE DRILL WITH PT 5
THD 7/16 NC-2 (L.H.) THRU, C'BORE 1/4 DIA x 3/4 DEEP (MUST BE IN LINE WITH PT 5 IN ASSEMBLY)
6 SAME AS PART 5 EXCEPT AS SHOWN
3/4
1/4
.219 DIA THRU CSK .42 DIA x 82° 2 HOLES
3/4
1.75
3 1/4
10 MATL: CRS 1/4 STK THK
1/4
3/4
NO.10(.190)-24 NC-2 THRU, 2 HOLES
1.75
3 1/4
11 MATL: CRS 1/4 STK THK
.093 DIA THRU PF FOR DOWEL AT ASSEMBLY
5 3/4
7/16
2 1/8
2 1/8
7/16 DIA (STK)
1/16 CHAM
1/16 CHAM
THD 5/16-18 NC-2A
THD 7/16-14 NC-2A (L.H.)
THD 7/16-14 NC-2A
RELIEF
7 MATL: CRS
1/4-20 NC-2 x 5/8 DP 2 HOLES LOC FROM PT2
1/2
1.000 R REF SEE ASSY
A
A
3 1/4
2
1/16
2 1/16
.250 DIA x 5/8 DP PF FOR DOWEL 2 HOLES LOC FROM PT 2 (AIR VENT, TO SUIT)
NC-2 THRU DIA x 3/4 DEEP N LINE WITH SSY)
5B
5A
3/8 REF
1/4
3/4 (REF)
1.000 R (REF)
1 1/16 R
1/8 R
SECT A-A
1/16 CHAM BOTH ENDS
2 1/4
THD 1/4-20 NC-2A FULL LENGTH
14 MATL: CRS 1/4 DIA STK
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACTIONS DECIMALS ANGLES
± 1/32 ±.010 ± 1°
ALL SURFACES 125
FOR G.E. USE ONLY
SIMILAR TO 4012180-731
DR 41-NASA-0534
GENERAL ELECTRIC
LARGE JET ENGINE DEPT CINCINNATI, OHIO U.S.A.
DEBRAZE KNOCK OFF TOOL FOR 2" O.D. TUBE
NASA
SIZE E
CAGE CODE NO. 07482
DWG NO. 4012180-732
SCALE 1/1
WT
SHT 2
4012180-732 E D
4012180-732 E B
2

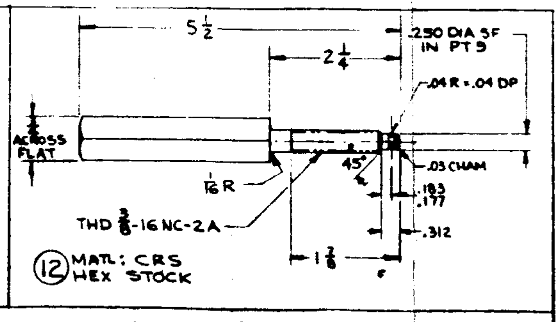


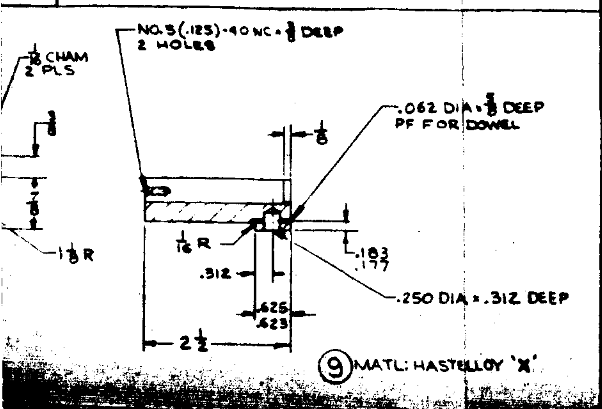
1.515
1.511 DIA A
(SEE NOTE 3)
SECT A-A
3½
1¾
1 7/8
13/16
1.44
.72
.781 R
15/16 R
NO. 5 (.125)-40 NC × 3/8 DEEP, 2 HOLES
1⅛ R
45° 2 PLS
1¼
3/8
3¾
2⅛
1.875
.150 R (REF) SEE ASSY
¼ R 4 PLS
.218 DIA THRU 4 HOLES
½
.281 DIA THRU 2 HOLES
1.50
.75
1.25
2.50
1½
3
3/8-16 NC-2 THRU
2½
1/16 R
1/8
.312
.628
.626
SECT. C-C
MATL: HASTELLOY 'X'
(TWO PIECE WELDED CONST ALLOWED)
.141 DIA THRU
CSK .281 DIA × 82°
2 HOLES
2 HOLES



4. BLACK OXIDE, ALL NON-WORKING SURF., PER AMS 2485
3. DIAMETERS A & B TO BE MACH. AT ASSEMBLY & MUST BE CONC WITHIN .002 FIR.
2. STAMP TOOL NO., 1½ O.D. TUBE, & NAS8-11554
1. BREAK ALL SHARP EDGES

NOTES:

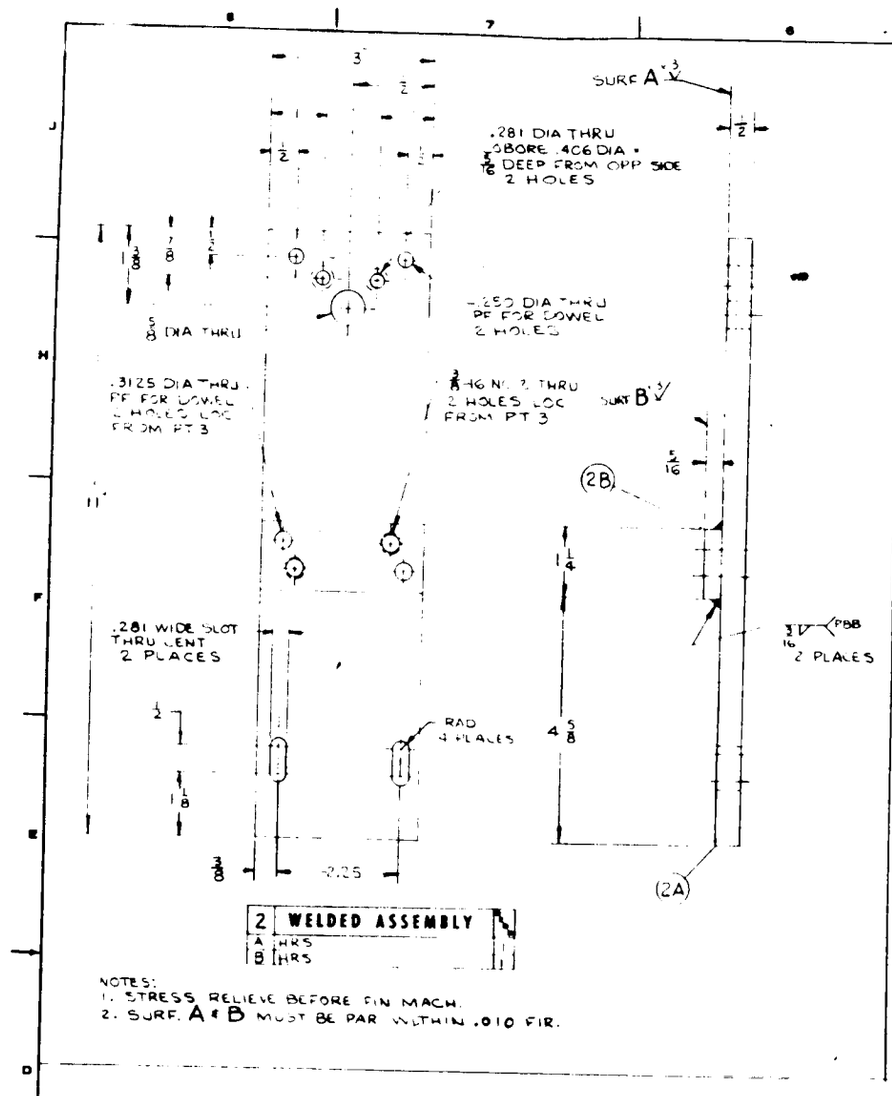


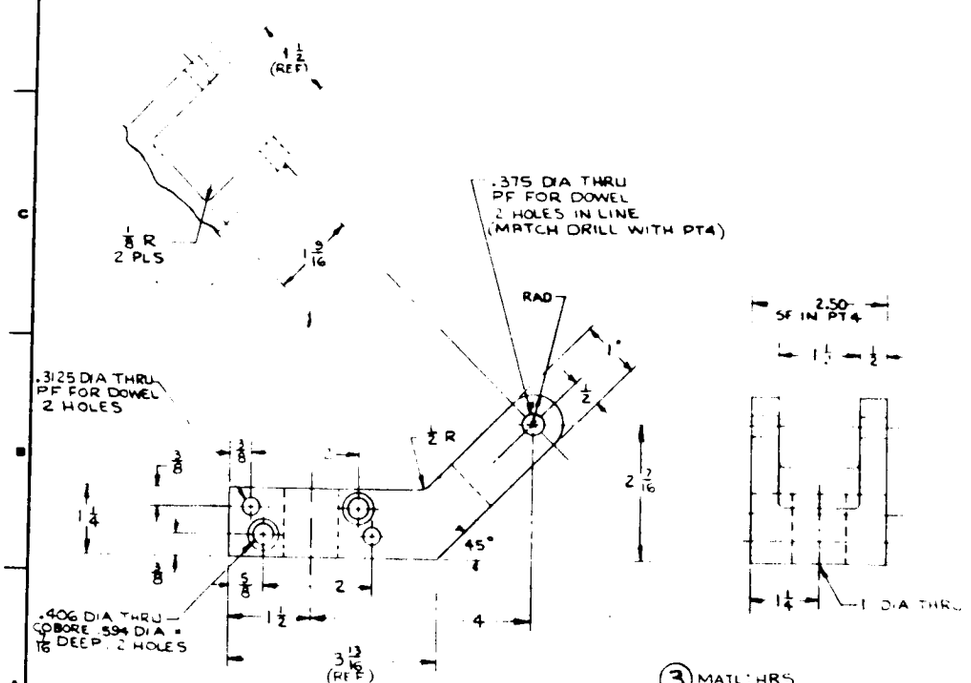


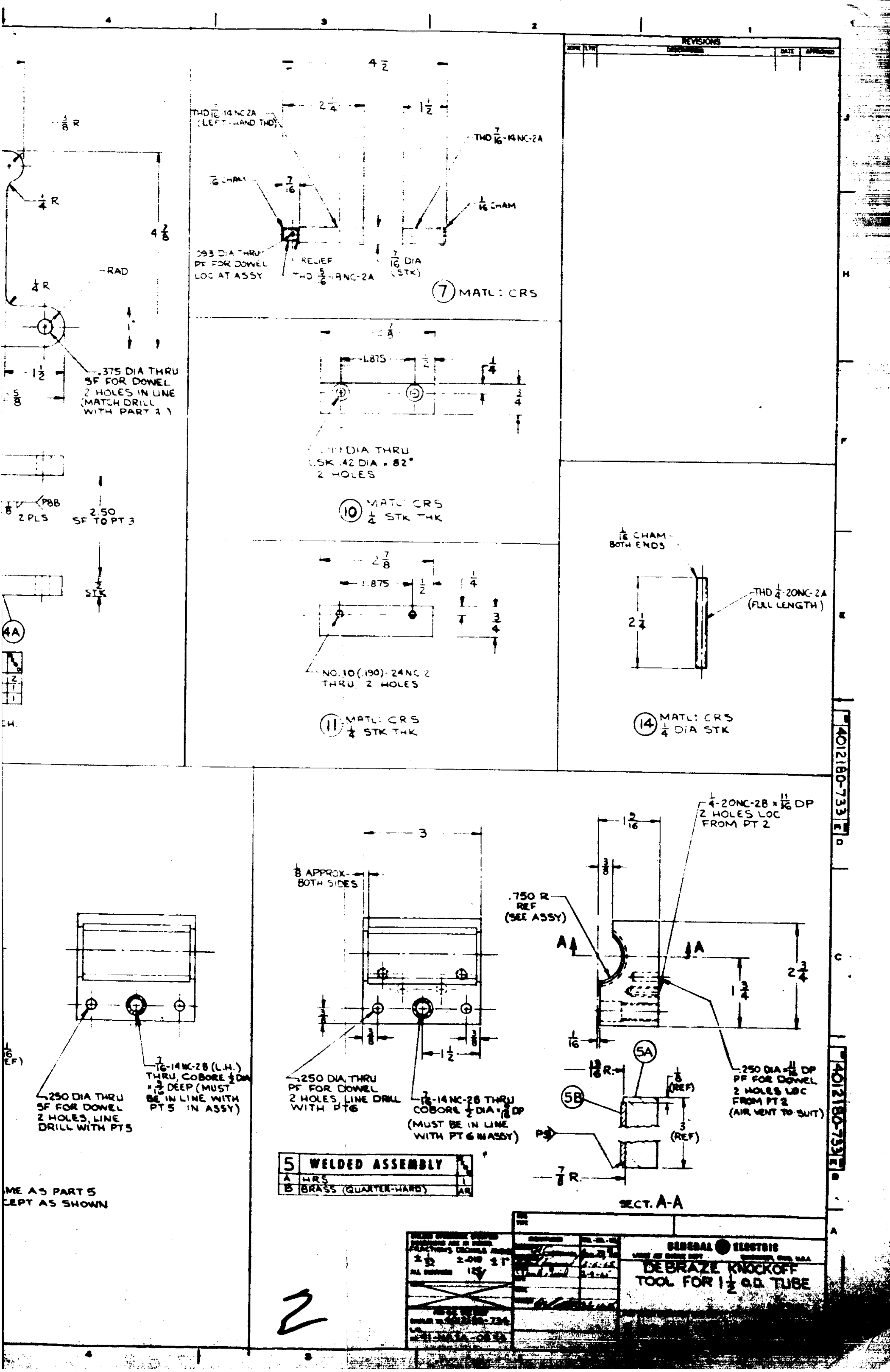
1	COMM	30	"ARO" CONNECTOR NO A [illegible]
1	COMM - MEAD CO.	29	CYLINDER NO. H42
2		28	DOWEL 3/8 DIA × 1" LG
2		27	WASHER 1/4 NOM I.D.
2		26	HEX HD SCREW 1/4-20NC × 1" LG
2		25	DOWEL 1/4 DIA × 1" LG
2		24	SOC HD CAP SCR 1/4-20NC × [illegible]
1		23	DOWEL [illegible] DIA × 1/2 LG
1		22	HEX NUT 5/16-18NC [illegible]
2		21	DOWEL 1/4 DIA × [illegible]
2		20	DOWEL 3/16 DIA × [illegible]
2		19	SOC HD CAP SCR [illegible]
4		18	FL HD SCREW [illegible]
1		17	DOWEL 1/4 DIA × [illegible]
4		16	FL HD SCREW [illegible]
4	COMM	15	JAM NUT 1/2-[illegible]
2	SHEET 2	14	STUD
2		13	GUIDE
1	1	12	ADJUSTING SCREW
2	2	11	PLATE
2	2	10	PLATE
1	1	9	PUSHER PAD
1	1	8	PUSHER BLOCK
1	2	7	CLAMP SCREW
1	2	6	CLAMP BLOCK
1	2	5	CLAMP BLOCK
1	2	4	YOKE
1	2	3	BRACKET
1	SHEET 2	2	WELDMENT (PLATE)
X		1	ASSEMBLY

FRACTIONS ± 1/32 DECIMALS ±.010 ANGLES ± 1°

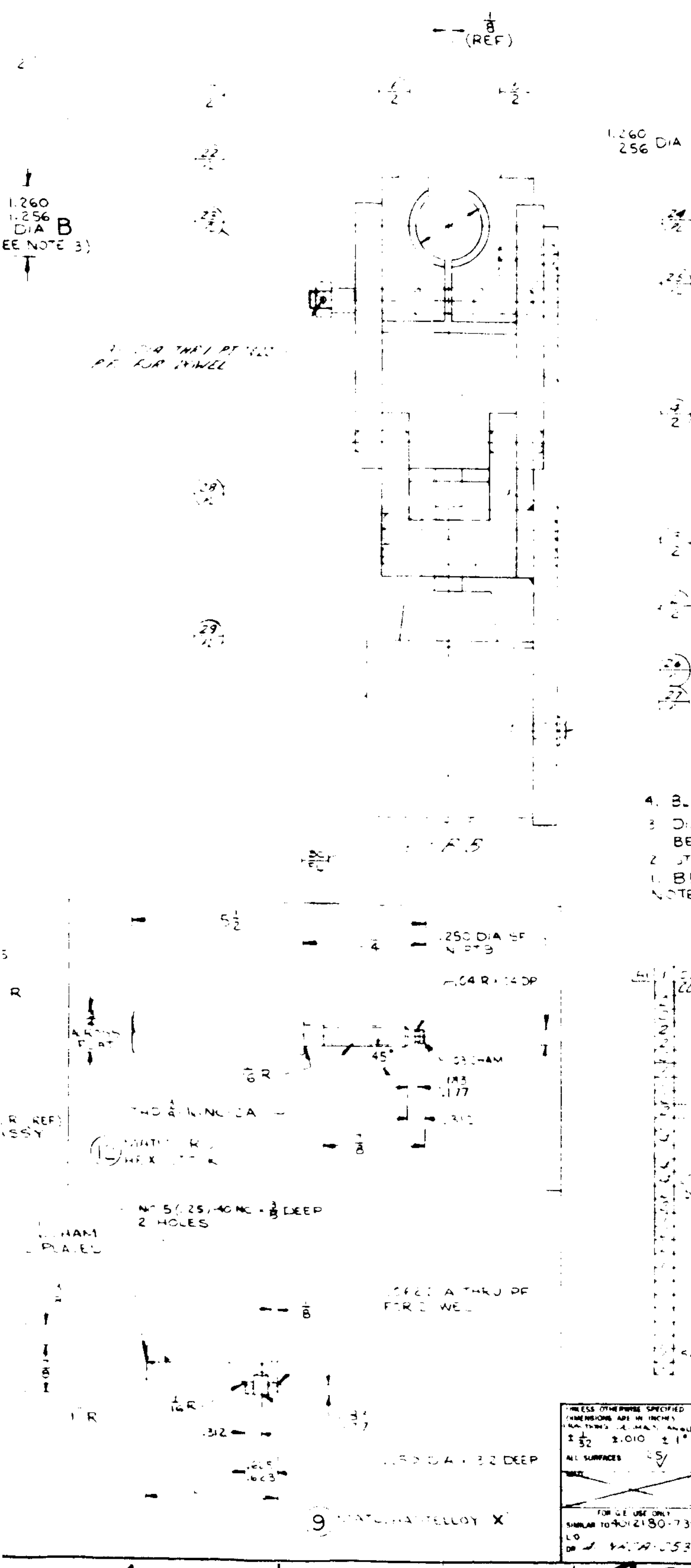
DEBRAZE [illegible]
TOOL 1½ O.D. [illegible]


SURF A
.281 DIA THRU
C'BORE .406 DIA x
5/16 DEEP FROM OPP SIDE
2 HOLES
5/8 DIA THRU
.250 DIA THRU
PF FOR DOWEL
2 HOLES
.3125 DIA THRU
PF FOR DOWEL
2 HOLES LOC
FROM PT 3
3/8-16 NC-2 THRU
2 HOLES LOC
FROM PT 3
SURF B
(2B)
(2A)
.281 WIDE SLOT
THRU CENT
2 PLACES
RAD
4 PLACES
PBB
2 PLACES
2.25
2 WELDED ASSEMBLY
A HRS
B HRS
NOTES:
1. STRESS RELIEVE BEFORE FIN MACH.
2. SURF. A & B MUST BE PAR WITHIN .010 FIR.


(REF)
1/8 R
2 PLS
.375 DIA THRU
PF FOR DOWEL
2 HOLES IN LINE
(MATCH DRILL WITH PT4)
RAD
.3125 DIA THRU
PF FOR DOWEL
2 HOLES
1/2 R
45°
.406 DIA THRU
C'BORE .594 DIA x
7/16 DEEP, 2 HOLES
(REF)
2.50
SF IN PT 4
1 DIA THRU
3 MATL: HRS
MAY BE MADE FROM TWO (2) PIECES



REVISIONS
THD 7/16-14NC-2A (LEFT-HAND THD)
THD 7/16-14NC-2A
1/16 CHAM
.093 DIA THRU PF FOR DOWEL LOC AT ASSY
RELIEF
THD 5/16-18NC-2A
7/16 DIA (STK)
(7) MATL: CRS
.375 DIA THRU SF FOR DOWEL 2 HOLES IN LINE (MATCH DRILL WITH PART 3)
2.50 SF TO PT 3
DIA THRU CSK .42 DIA x 82° 2 HOLES
(10) MATL: CRS 1/4 STK THK
NO. 10 (.190)-24NC-2 THRU 2 HOLES
(11) MATL: CRS 1/4 STK THK
1/16 CHAM BOTH ENDS
THD 1/4-20NC-2A (FULL LENGTH)
(14) MATL: CRS 1/4 DIA STK
1/4-20NC-2B x 11/16 DP 2 HOLES LOC FROM PT 2
1/8 APPROX BOTH SIDES
.750 R REF (SEE ASSY)
7/16-14NC-2B (L.H.) THRU, COBORE 1/2 DIA x 3/16 DEEP (MUST BE IN LINE WITH PT 5 IN ASSY)
.250 DIA THRU SF FOR DOWEL 2 HOLES, LINE DRILL WITH PT 5
.250 DIA THRU PF FOR DOWEL 2 HOLES, LINE DRILL WITH PT 6
7/16-14NC-2B THRU COBORE 1/2 DIA x 3/16 DP (MUST BE IN LINE WITH PT 6 IN ASSY)
.250 DIA x 11/16 DP PF FOR DOWEL 2 HOLES LOC FROM PT 2 (AIR VENT TO SUIT)
5 WELDED ASSEMBLY
A HRS 1
B BRASS (QUARTER-HARD) AR
SAME AS PART 5 EXCEPT AS SHOWN
SECT. A-A
GENERAL ELECTRIC
DEBRAZE KNOCKOFF TOOL FOR 1 1/2 O.D. TUBE
401218O-733



4. BLACK OXIDE ALL NON-WORKING SURF. PER AMS 2485
3. DIAMETERS A & B TO BE MACH. AT ASSEMBLY & MUST BE CONC WITHIN .002 FIR.
2. STAMP TOOL NO. 1 3/4 O.D. TUBE, & NAS8-11554
1. BREAK ALL SHARP EDGES

NOTES:

30	[illegible] CONNECTOR	A-2607
29	[illegible]	NO 442
28	DOWEL	3/8 DIA × 1 LG
27	WASHER	1/4 NOM
26	HEX HD SCREW	1/4-20NC × 1 LG
25	DOWEL	1/4 DIA × 1 LG
24	[illegible] HD CAP SCR	1/4-20NC × 3/4 LG
23	DOWEL	3/32 DIA × 1/2 LG
22	HEX NUT	5/16-18NC (ALTER)
21	DOWEL	1/4 DIA × 2 1/2 LG
20	DOWEL	3/16 DIA × 2 LG
19	[illegible] CAP SCR	3/8-16NC × 2 3/4 LG
18	[illegible] SCR	NO 5(.125)-40NC × 3/8 LG
17	DOWEL	1/16 DIA × 5/8 LG
16	[illegible] SCREW	NO 10(.190)-24NC × [illegible] LG
15	[illegible] NUT	[illegible]

GENERAL ELECTRIC
LARGE JET ENGINE DEPT. CINCINNATI, OHIO, U.S.A.

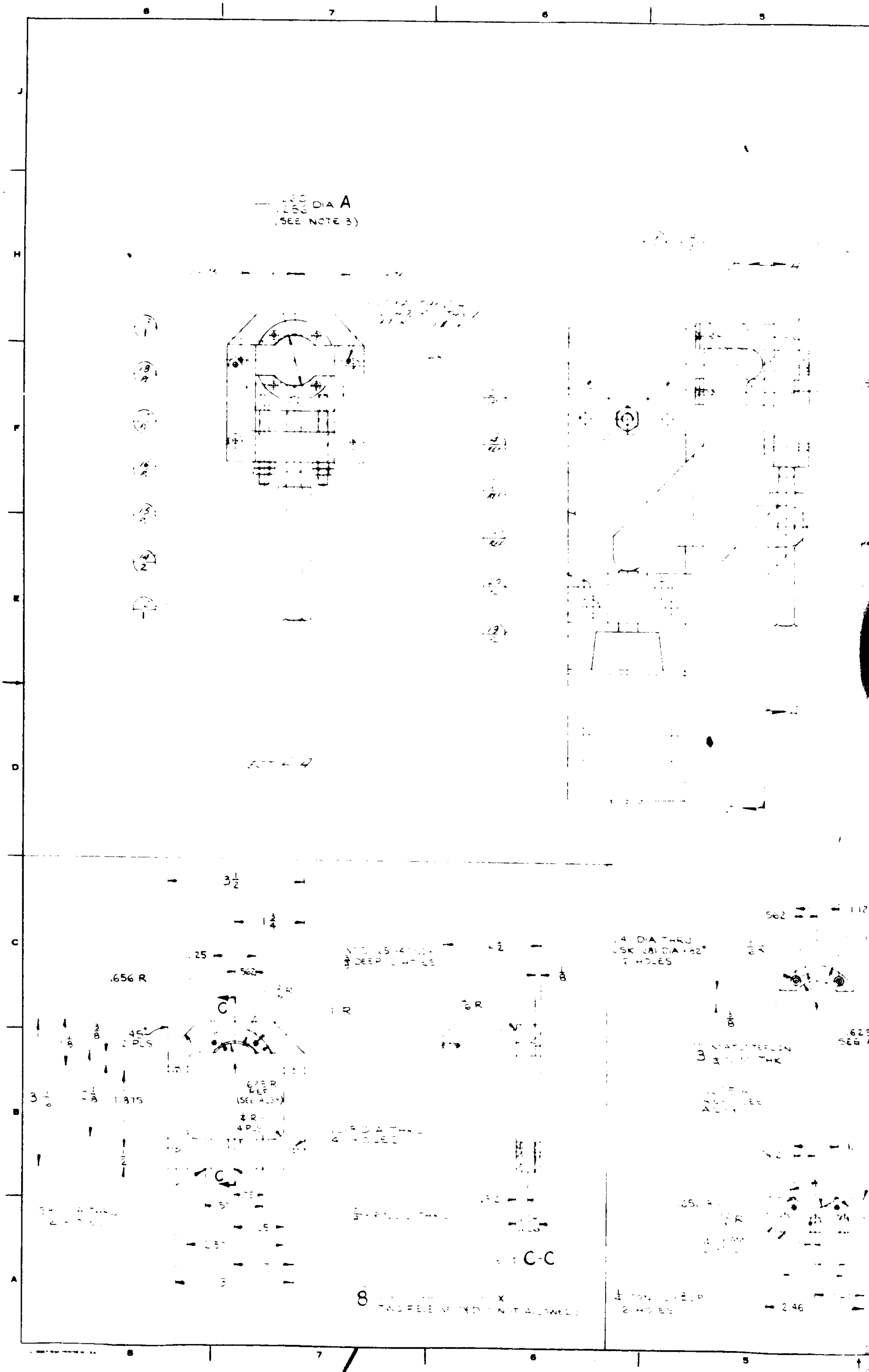
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES: FRACTIONS ± 1/32, DECIMALS ± .010, ANGLES ± 1°
ALL SURFACES 125

SIMILAR TO 4012180-733

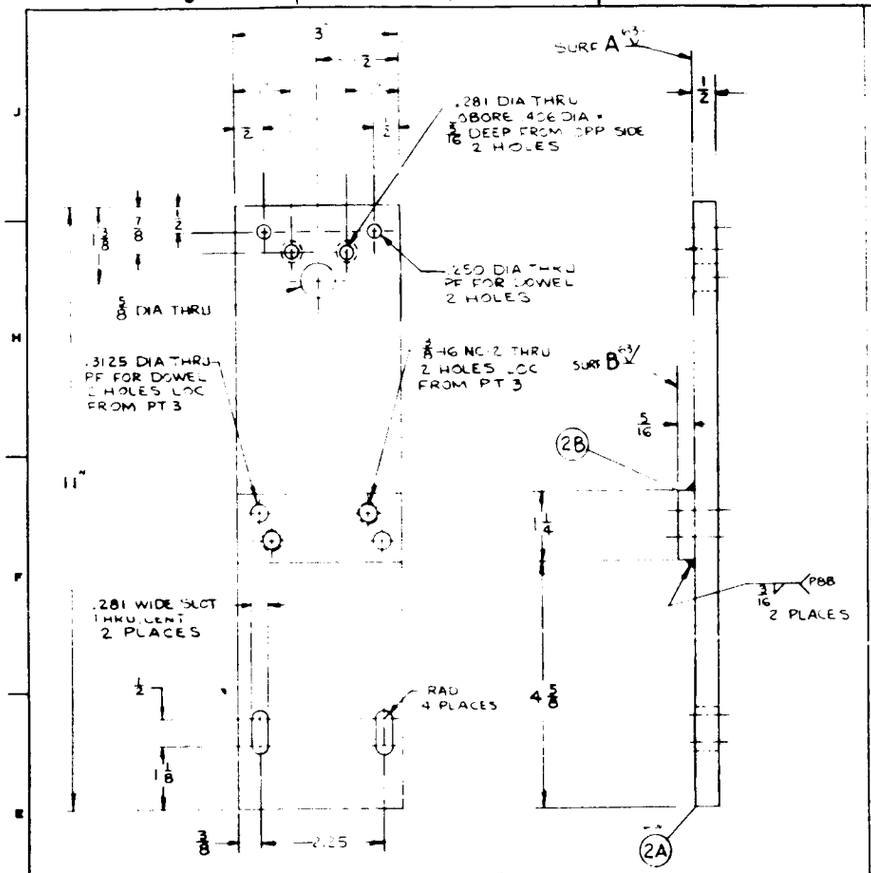
SIZE	CODE IDENT NO	DWG NO
E	07482	4012180-734

SHEET 1 OF 2

E 4012180-734

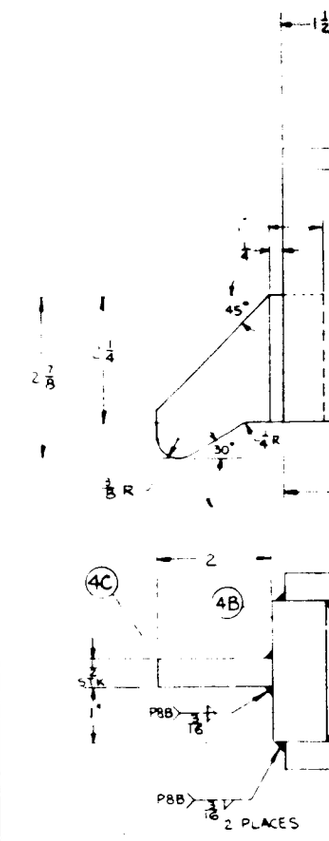


DIA A
(SEE NOTE 3)
3 1/2
1 3/4
.25
.656 R
.562
C
1.875
.41 DIA THRU
2 HOLES
C-C
8
3
THK
2.46



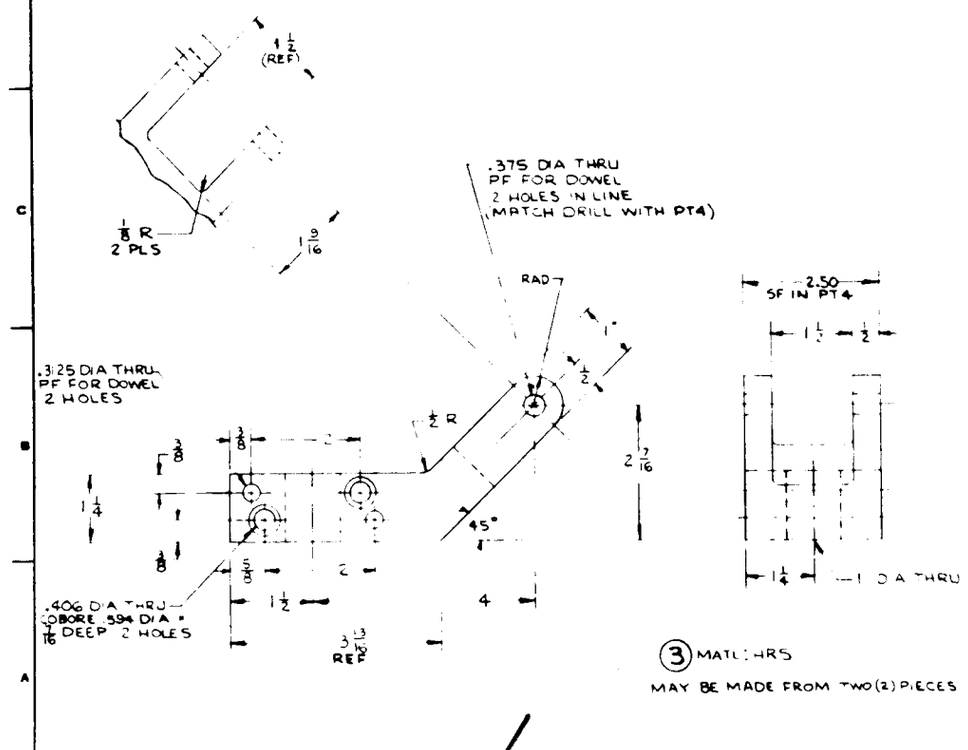
2	WELDED ASSEMBLY
A	HRS
B	HRS

NOTES:
1. STRESS RELIEVE BEFORE FIN MACH
2. SURF. A & B MUST BE PAR WITHIN .010 FIR.



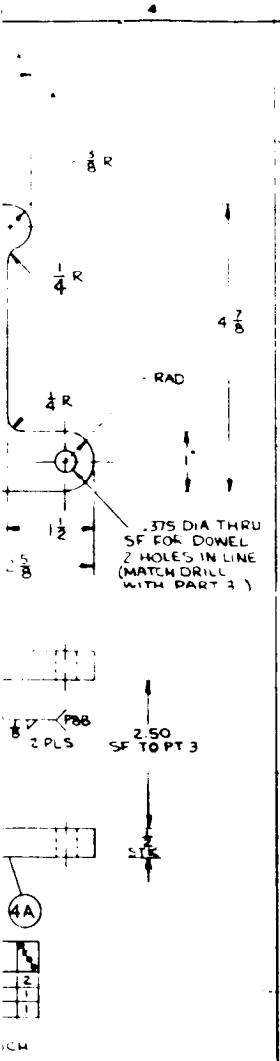
4	WELDED ASSEMBLY
A	HRS
B	HRS
C	HRS

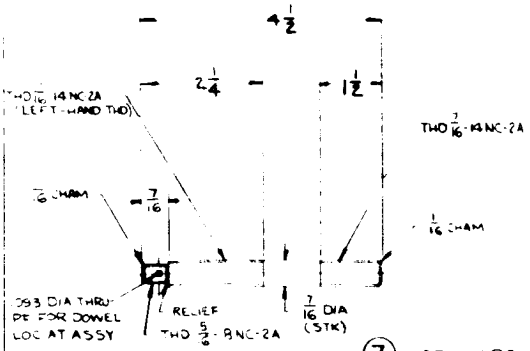
NOTE:
1. STRESS RELIEVE BEFORE FIN. M

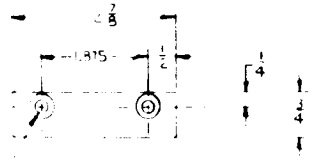


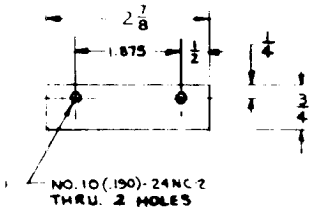
(3) MATL: HRS
MAY BE MADE FROM TWO (2) PIECES

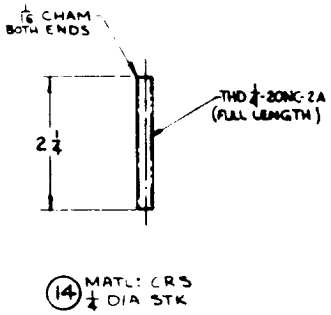
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

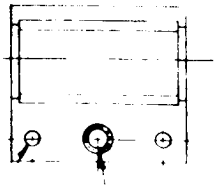


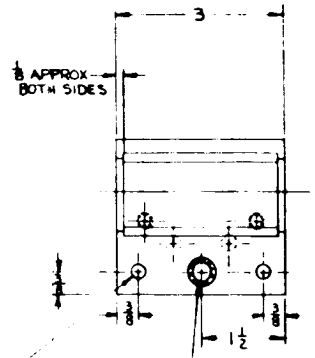


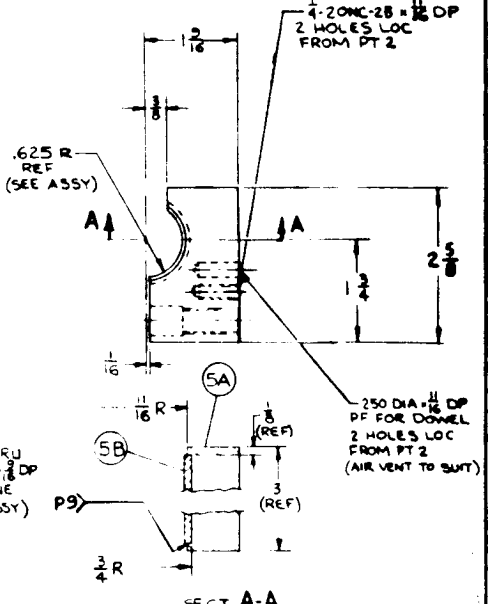












5	WELDED ASSEMBLY	
A	4 HRS	
B	BRAZE (QUARTER-HARD)	AR

SAME AS PART 5 EXCEPT AS SHOWN

DRAWING NO.	4012180-733
CAGE	41-NASA-0534

GENERAL ELECTRIC
LARGE JET ENGINE DEPT. CINCINNATI, OHIO, U.S.A.

DEBRAZE KNOCKOFF TOOL FOR 1 1/4 O.D. TUBE

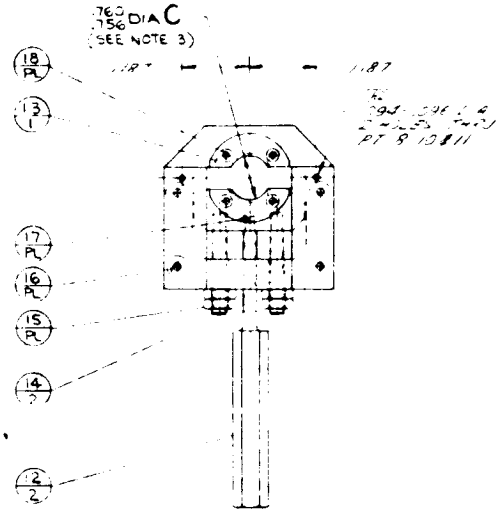
NASA

SIZE	CODE IDENT NO.	DWG NO.
E	07482	4012180-734

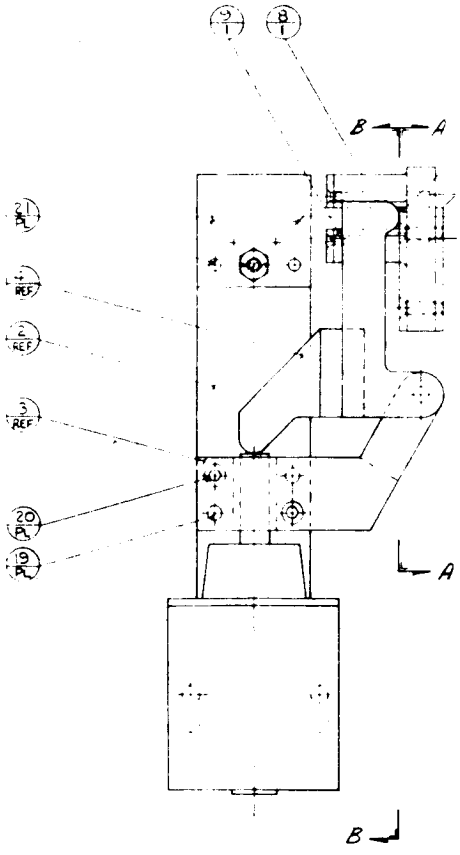
SCALE 1/1 WT (LBS) — SHEET 2 OF 2

4012180-734 REV

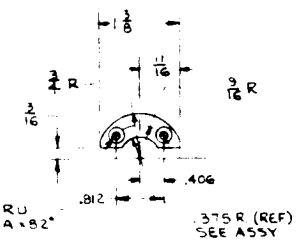
4012180-734 REV



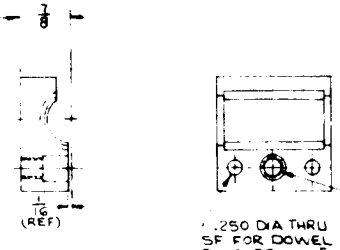
SECT. A-A



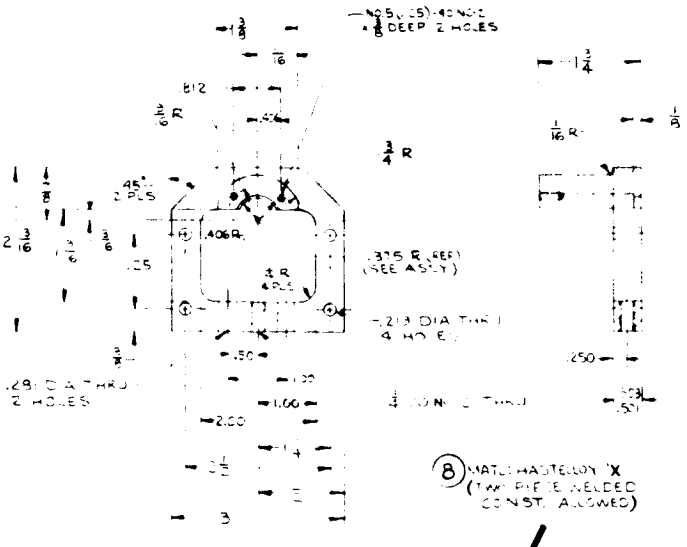
1



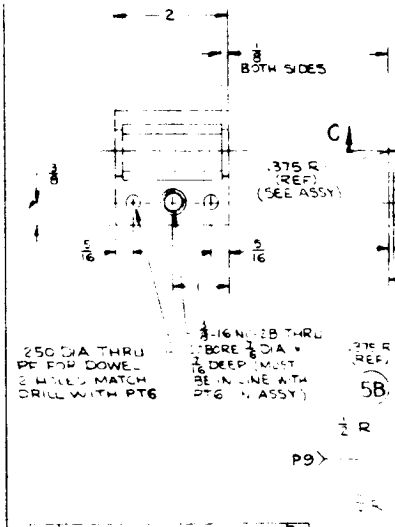
13 MATL: TEFLON
1/8 NOM STK THK



6 SAME AS PART 5
EXCEPT AS SHOWN



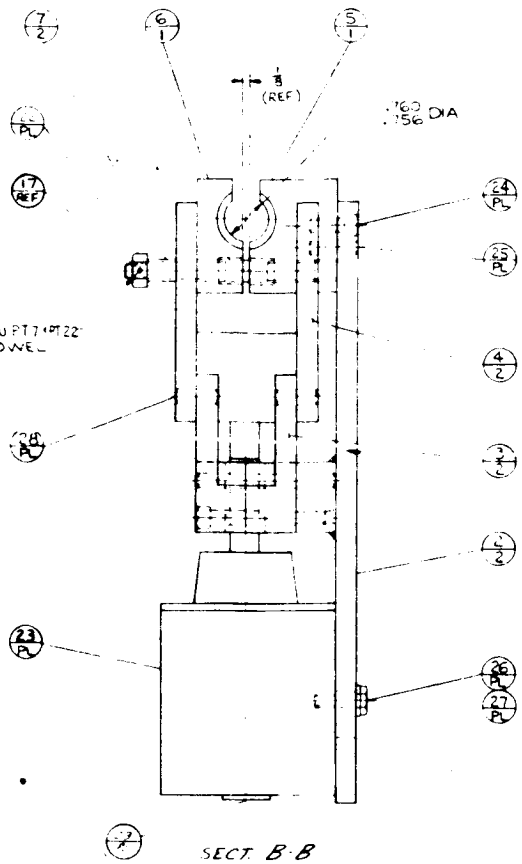
8 MATL: HASTELLOY 'X'
(TWO PIECE WELDED
CONST. ALLOWED)



5 WELDED ASSEMBLY

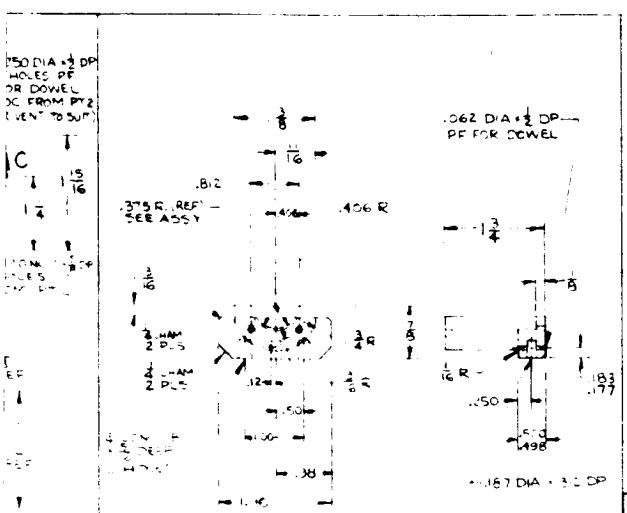
SECT C-C

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPD



4. BLACK OXIDE, ALL NON-WORKING SURF. PER AMS 2485
3. DIAMETERS B & C TO BE MACH. AT ASSEMBLY & MUST BE CONC WITHIN .002 FIR.
2. STAMP TOOL NO. 3/4 O.D. TUBE & NAS8-11554
1. BREAK ALL SHARP EDGES

NOTES:



2	COMM	28	DOWEL 1/4 DIA x 3/4 LG
2		27	WASHER 1/4 NOM I.D.
2		26	HEX HD SCR 1/4-20NC-2 x 3/4 LG
2		25	DOWEL 1/4 DIA x 1/8 LG
2		24	SOC HD CAP SCR 1/4-20NC-2 x 3/4 LG
1	MEAD CO.	23	CYLINDER NO. H42
1		22	HEX NUT 1/4-20NC-2 (ALTER)
2		21	DOWEL 1/4 DIA x 2" LG
2		20	SOC HD CAP SCR 1/4-20NC-2A x 2" LG
4		19	DOWEL 1/4 DIA x 2 1/2 LG
2		18	FL HD SCR NO.5 (.125)-40NC x 3/8 LG
4		17	DOWEL 1/16 DIA x 1/2 LG
2	COMM	16	FL HD SCR NO.10 (.190)-24NC x 3/4 LG
4		15	HEX JAM NUT 1/4-20NC-2
2	SHEET 2	14	STUD
2		13	GUIDE
1		12	ADJUSTING SCREW
2		11	PLATE
2		10	PLATE
1		9	PUSHER PAD
1		8	PUSHER BLOCK
1		7	CLAMP SCREW
1		6	CLAMP BLOCK
1		5	CLAMP BLOCK
1		4	YOKE
2		3	BRACKET
2	SHEET 2	2	PLATE
1		1	ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ± 1/64 DECIMAL .X ± .010 .XX ± .005 ANGLES ± 1° ALL SURFACES 125

SIGNATURES | NO. | DATE | BY

DRAWN | CHECKED | ENGR APPR | MFG APPR | MATL | ISSUED

FOR G.E. USE ONLY SIMILAR TO 40 2 85 736 OR 41 NAGA 5534

GENERAL ELECTRIC
LARGE JET ENGINE DEPT. CINCINNATI, OHIO U.S.A.

DEBRAZE KNOCKOFF TOOL FOR 3/4 O.D. TUBE

NASA

SIZE E | CODE IDENT NO. 07482 | DWG NO. 4012180-735

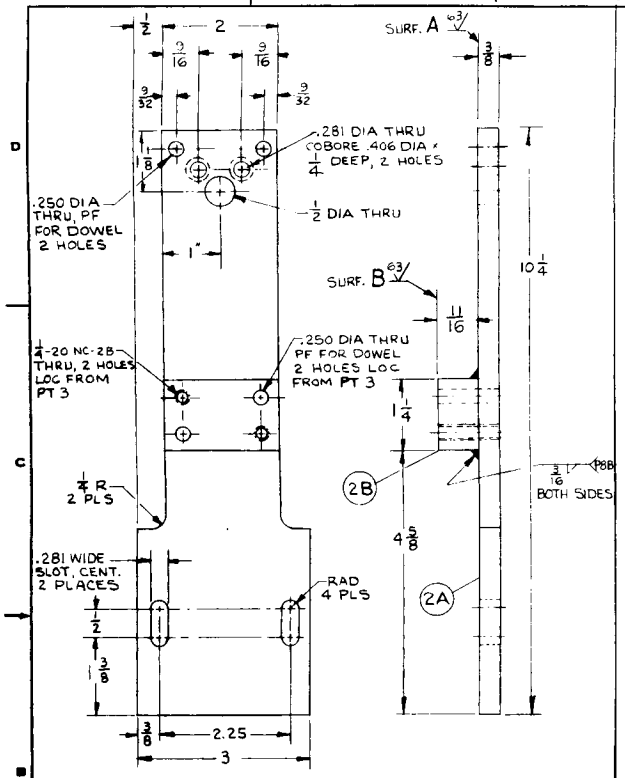
SCALE | WEIGHT | SHEET 2

9 MATL: HASTELLOY X

2

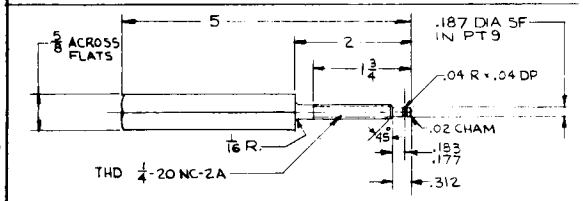
4012180-735 E

4012180-735 E

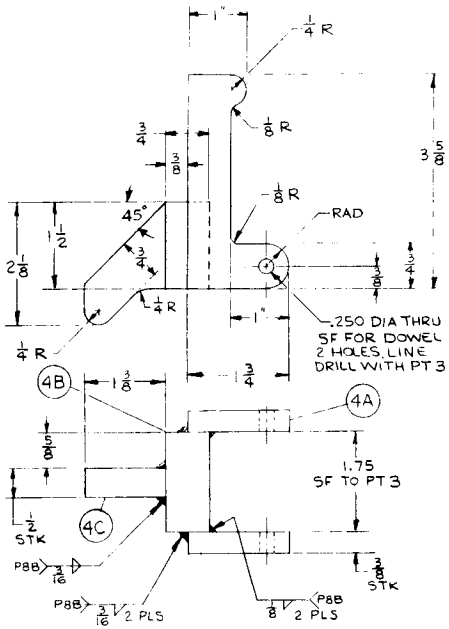


2	WELDED ASSEMBLY	
A	HRS	1
B	HRS	1

NOTES:
1. STRESS RELIEVE BEFORE FIN. MACH.
2. SURF. A & B MUST BE PAR. WITHIN .010 FIR.

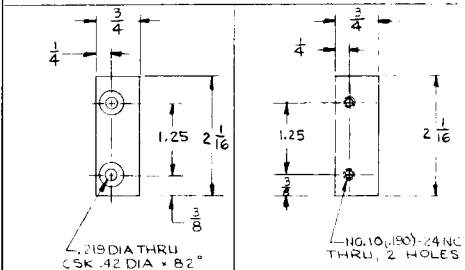


(12) MATL: CRS HEX STOCK



4	WELDED ASSEMBLY	
A	HRS	2
B	HRS	
C	HRS	

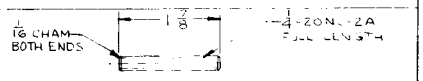
NOTE:
1. STRESS RELIEVE BEFORE FIN. MACH



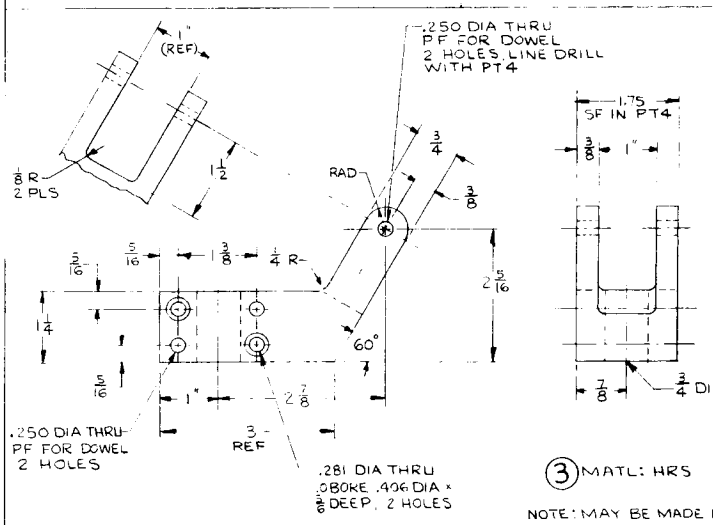
(10) MATL: CRS 1/8 STK THK

(11) MATL: CRS 1/8 STK THK

(7) MATL: CRS



(14) MATL: CRS 1/4 DIA STK



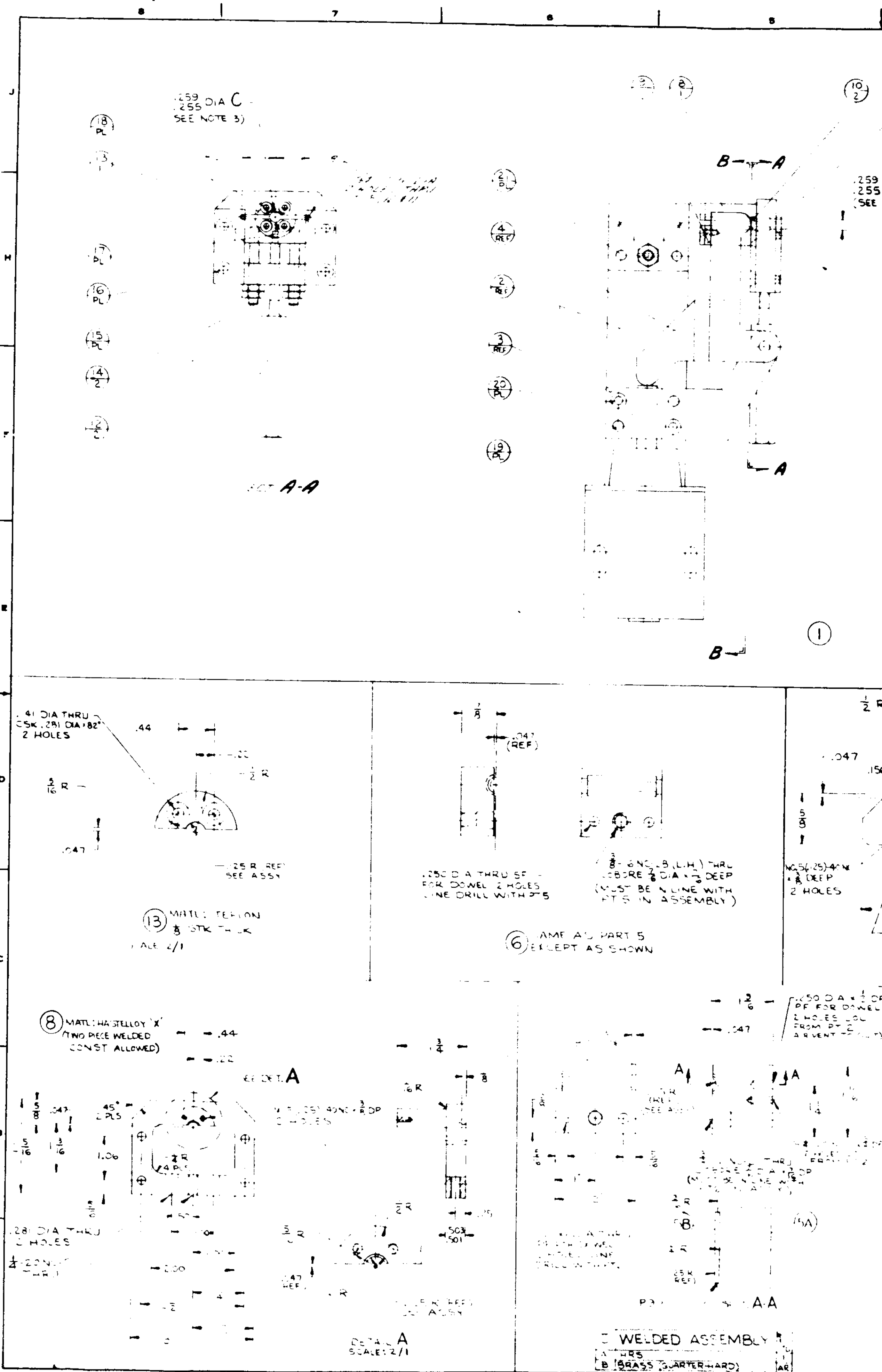
(3) MATL: HRS

NOTE: MAY BE MADE FROM TWO (2) PIECES

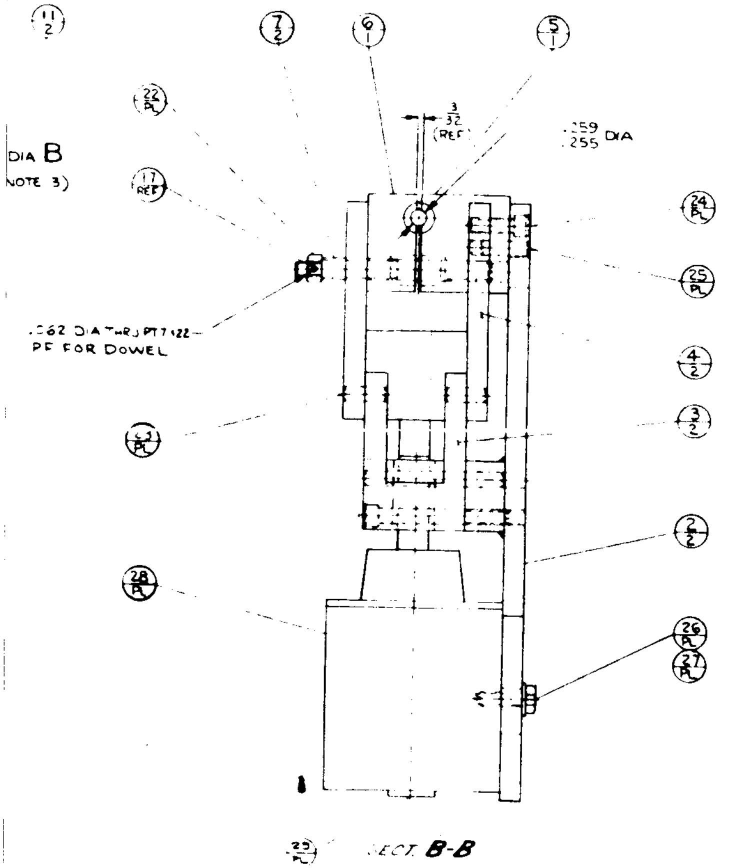
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

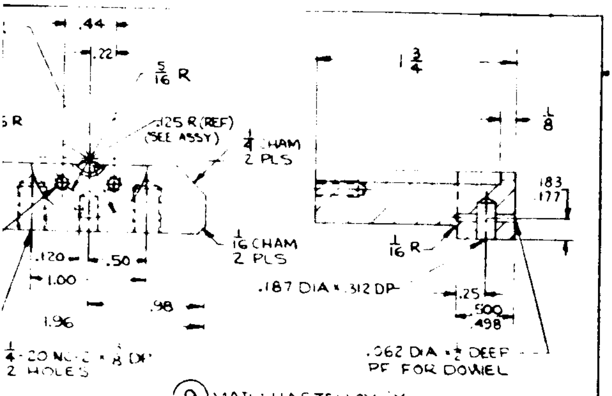
DWG TYPE			
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES ± 1/32 ± .010 ± 1° ALL SURFACES 125 MATL	SIGNATURES	NO. DA YR	GENERAL ELECTRIC LARGE JET ENGINE DEPT CINCINNATI, OHIO, U.S.A.
	DRAWN		DEBRAZE KNOCKOFF TOOL FOR 3/4 O.D. TUBE
	CHECKED		
	ENGR		NASA
	MFG		
	MATL		
	ISSUED		
FOR G.I. USE ONLY SIMILAR TO 4012180-736 L/O DR 41-NASA-534			SIZE D CODE IDENT NO. 07482 DWG NO. 4012180-735 SCALE 1/1 WT SHEET 2 OF 2

D 4012180-735



.259
.255 DIA C
SEE NOTE 3)
SECT A-A
B
A
.41 DIA THRU
CSK .281 DIA×82°
2 HOLES
.44
5/16 R
.047
.25 R (REF)
SEE ASSY
13 MATL: TEFLON
1/8 STK THICK
SCALE 2/1
.047 (REF)
.250 DIA THRU SF
FOR DOWEL 2 HOLES
LINE DRILL WITH PT 5
3/8-16 NC-2B (L.H.) THRU
C'BORE 7/8 DIA × 1/8 DEEP
(MUST BE IN LINE WITH
PT 5 IN ASSEMBLY)
6 SAME AS PART 5
EXCEPT AS SHOWN
NO.5(.125)-40NC
× 3/8 DEEP
2 HOLES
8 MATL: HASTELLOY 'X'
(TWO PIECE WELDED
CONST ALLOWED)
.22
SEE DET. A
45°
2 PLS
1.06
4 PLS
.281 DIA THRU
2 HOLES
1/4-20 NC
THRU
2.00
.503
.501
.047
REF
DETAIL A
SCALE: 2/1
SECT A-A
WELDED ASSEMBLY
A HRS
B (BRASS (QUARTER-HARD)
AR





(9) MATL: HASTELLOY X
SCALE: 2/1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
C2	A	PT 29 ADDED		

NOTES:
1. BREAK ALL SHARP EDGES
2. STAMP TOOL NO. 1/4 OD. TUBE (NASA-...)
3. DIAMETERS B & C TO BE MACH. AT ASSEMBLY & MUST BE CONC WITHIN .002 FIR.
4. BLACK OXIDE ALL NON-WORKING SURF. PER AMS 2485

PT	DESCRIPTION	REMARKS
29	"ARO" CONNECTOR NO. A-2607	COMM
28	CYLINDER NO. 442	COMM - MEAD CO
27	WASHER 1/4 NOM I.D.	
26	HEX HD SCREW 1/4-20NC × 3/4 LG	
25	DOWEL 1/4 DIA × 7/8 LG	
24	SOC HD CAP SCR 1/4-20NC × 3/4 LG	
23	DOWEL 1/4 DIA × 3/4 LG	
22	HEX NUT 1/4-20 NC (ALTER)	
21	DOWEL 1/4 DIA × 2" LG	
20	SOC HD CAP SCR 1/4-20NC × ...	
19	DOWEL 1/4 DIA × 2 1/2 LG	
18	FL HD SCR NO.5 (.125)-40NC × 3/8 LG	
17	DOWEL 1/16 DIA × 1/2 LG	
16	FL HD SCR NO.10 (.190)-24N × 3/4 LG	
15	HEX JAM NUT 1/4-20NC-2	COMM
14	STUD	SHEET 2
13	GUIDE	
12	ADJUSTING SCREW	
11	PLATE	
10	PLATE	
9	PUSHER PAD	
8	PUSHER BLOCK	
7	CLAMP SCREW	
6	CLAMP BLOCK	
5	CLAMP BLOCK	
4	YOKE	
3	BRACKET	
2	PLATE	
1	ASSEMBLY	SHEET 2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ±1/32 DECIMALS ±.010 ANGLES ±1°
ALL SURFACES 125√

FOR G.E. USE ONLY
SIMILAR TO 4012180-735
41-NASA-0534

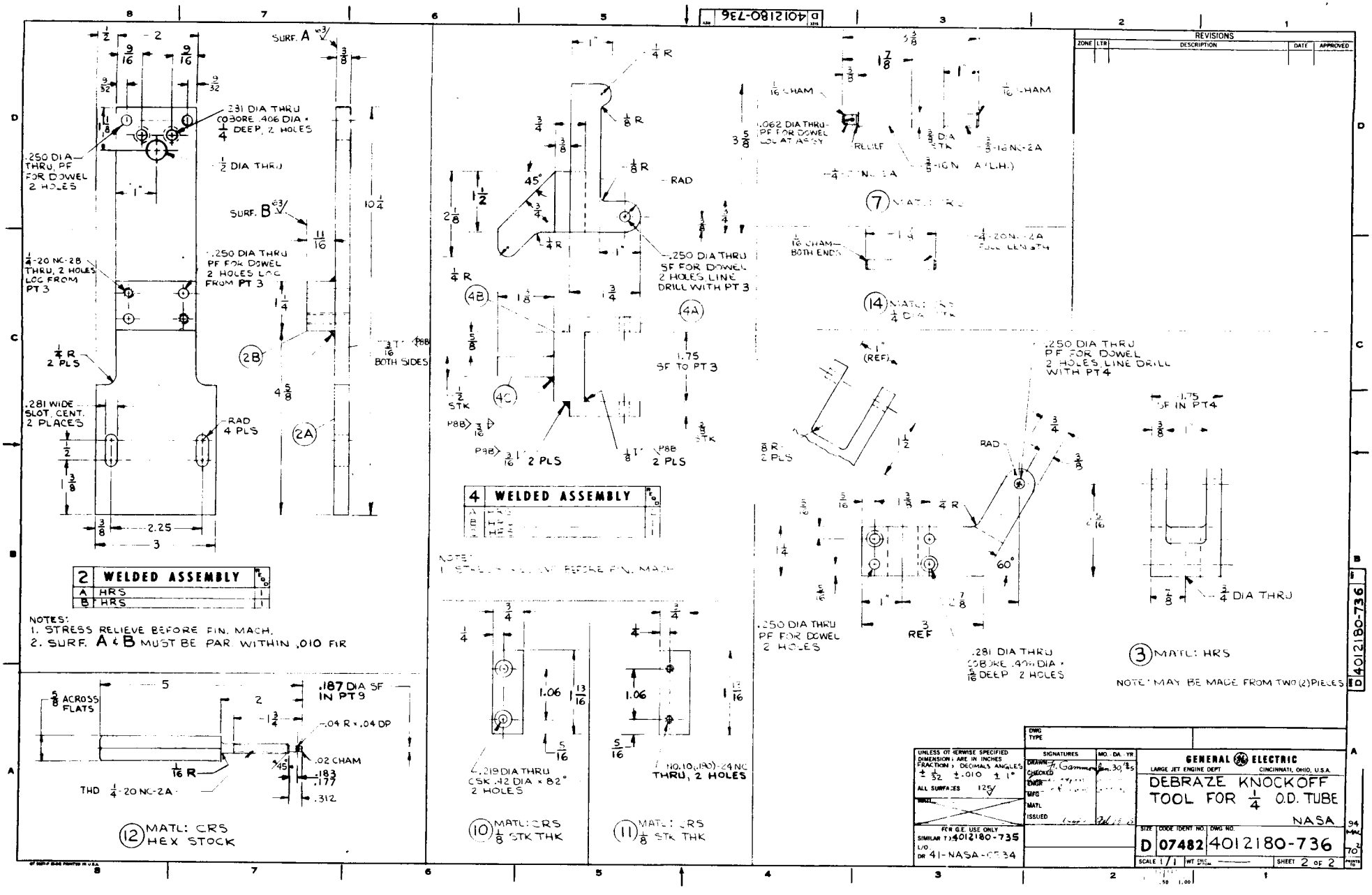
GENERAL ELECTRIC
LARGE JET ENGINE DEPT — CINCINNATI, OHIO U.S.A.

DEBRAZE KNOCKOFF TOOL FOR 1/4 O.D. TUBE
NASA

SIZE E | CODE IDENT NO 07482 | DWG NO 4012180-736
SCALE 1/1 | SHEET 1 OF 2

4012180-736

2



2	WELDED ASSEMBLY	
A	HRS	1
B	HRS	1

4	WELDED ASSEMBLY	
A	HRS	1
B	HRS	1

NOTES:
1. STRESS RELIEVE BEFORE FIN. MACH.
2. SURF. A & B MUST BE PAR WITHIN .010 FIR

NOTE: STRESS RELIEVE BEFORE FIN. MACH.

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
FRACTIONS DECIMALS ANGLES
± 1/32 ± .010 ± 1°
ALL SURFACES 125

FOR G.E. USE ONLY
SIMILAR TO 4012180-735
L/O
DR 41-NASA-CF34

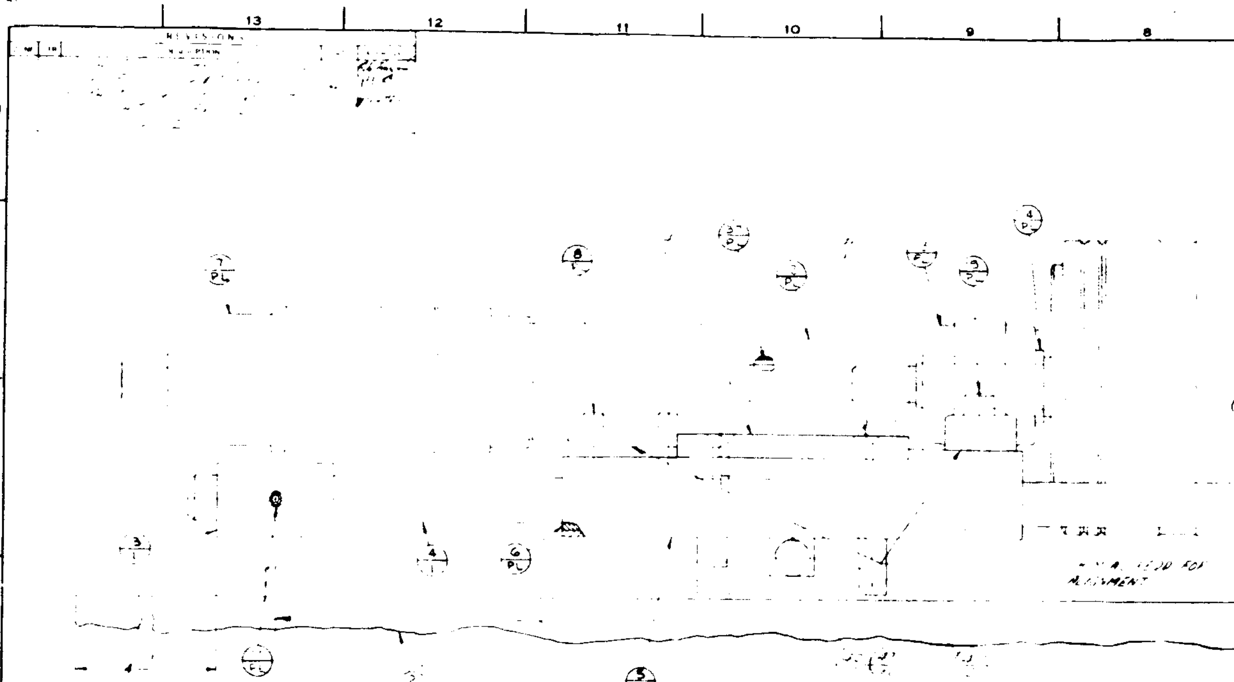
SIGNATURES | MO. DA. YR
DRAWN J. Gammon Jan. 30 '65
CHECKED
ENGR
MFG
MATL
ISSUED

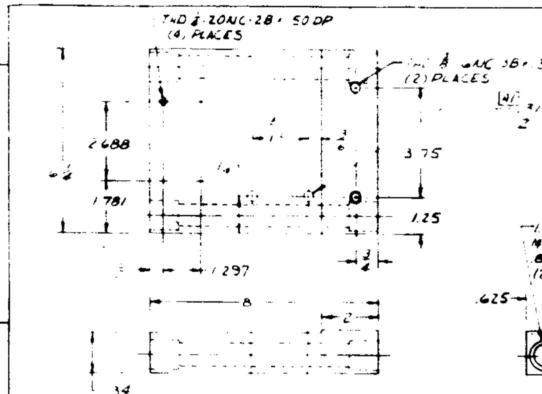
GENERAL ELECTRIC
LARGE JET ENGINE DEPT CINCINNATI, OHIO, U.S.A.

DEBRAZE KNOCKOFF TOOL FOR 1/4 O.D. TUBE
NASA

SIZE D | CODE IDENT NO. 07482 | DWG NO. 4012180-736
SCALE 1/1 | WT | SHEET 2 OF 2

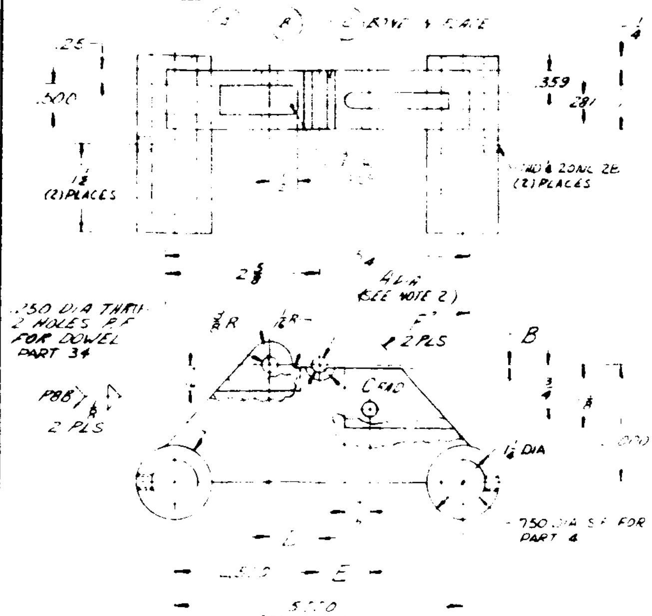
D 4012180-736





(5) MATL. HRS
SCALE 1/2

22 THRU 27, 53,54,55	WELDED ASSEMBLY
A	HRS
B	[illegible]
C	MOLDED ASBESTOS FACING STYLE 75 JOHNS-MANVILLE

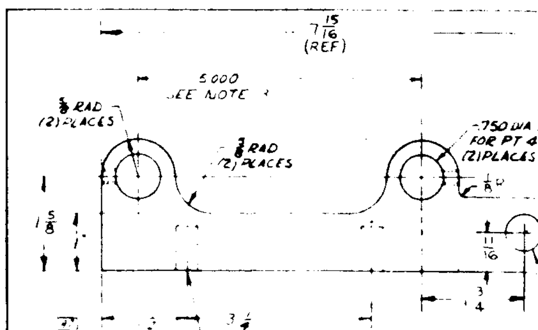


PT NO	A DIA	B	C RAD	D	E	F°
22	[illegible]	[illegible]	.250	.875	.875	[illegible]
23	.256 .255	[illegible]	.500	1.250	1.250	33°
24	.256 .255	[illegible]	.750	1.375	1.375	30°
25	1.512 1.510	.027 .025	.875	1.625	1.625	[illegible]
26	2.012 2.010	.027 .025	1.125	1.875	1.875	13°30'
27	2.512 2.510	.027 .025	1.375	2.250	2.250	0

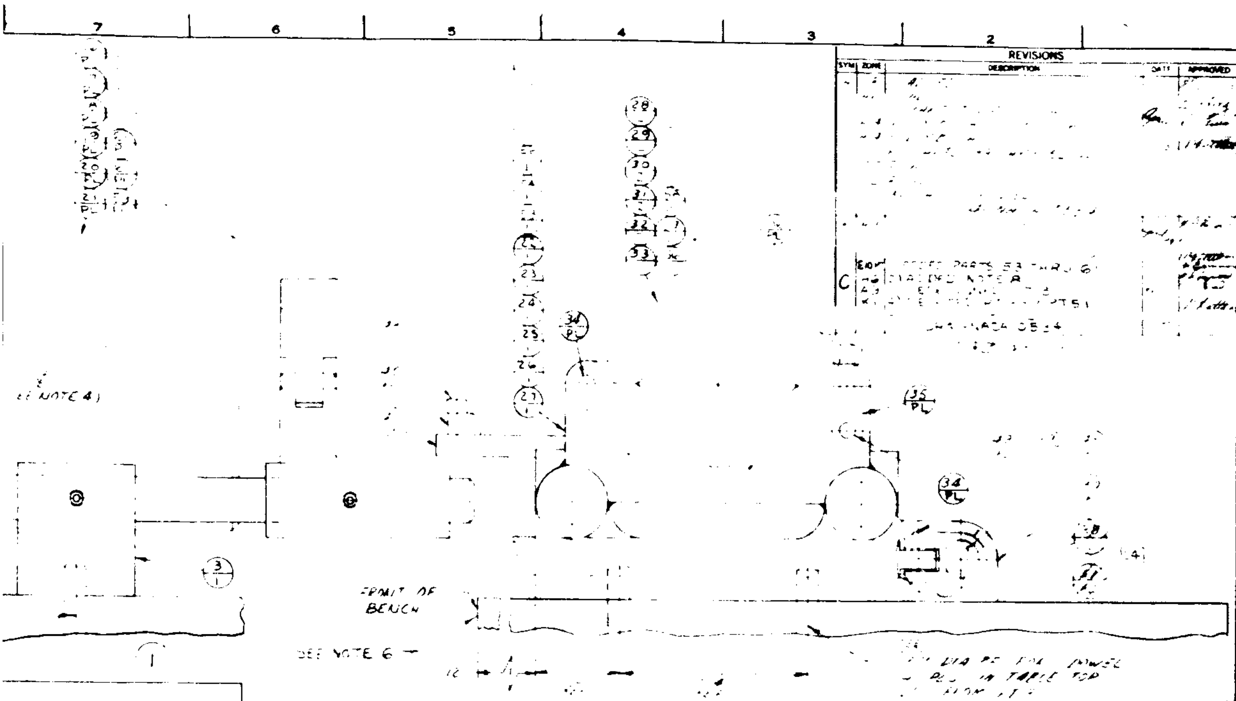
(CONTINUED IN ZONE E9)

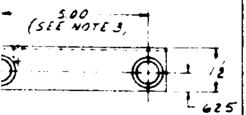
(CONTINUED FROM ZONE A14)

PT NO	A DIA	B	C RAD	D	E
53	.381 .380	.022 .020	.312	1.000	.000
54	.506 .505	.022 .020	.375	1.125	[illegible]
55	1.006 1.005	[illegible]	[illegible]	[illegible]	1.250
[illegible]	[illegible]	[illegible]	.281	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	.022	[illegible]	[illegible]	[illegible]

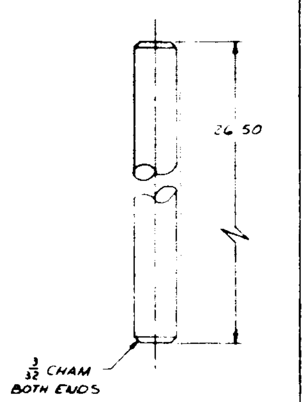


C3 (3) MATL. HRS

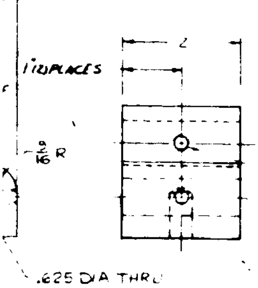




8. IDENTIFY ALL LOOSE PARTS WITH TOOL NO. & TOOL PT NO. IDENTIFY PTS 16 THRU 33 & 53 THRU 61 WITH TUBE SIZE
7. BREAK ALL SHARP EDGES
6. IDENTIFY WITH TOOL NUMBER LATEST TOOL REV LETTER & NASA
5. BLACK OXIDE ALL STEEL PARTS PER AMS 2495
1. HALLOWELL WORK BENCH MODEL NO 603; 60"L × 36"W × 35 7/16 H WITH PRESDWOOD COVERED STEEL TOP NO. 6000-M & DRAWER TIER UNITS NO 320 SIZE 14 × 20 × 6 MOUNTING KITS NO. 24



(4) MATL. .750 DIA DRILL ROD



NO 10-24NC × 3/8 DEEP. 2 HOLES. LOC FROM PART 36

QTY	MATL / SOURCE	PT	DESCRIPTION
1	COMM (COGSDILL TOOLS)	61	EXTERNAL R.A.F. TOOL FOR 1.000 DIA TUBE
1	COMM (COGSDILL TOOLS)	60	EXTERNAL R.A.F. TOOL FOR .500 DIA TUBE
1	COMM (COGSDILL TOOLS)	59	EXTERNAL R.A.F. TOOL FOR .375 DIA TUBE
1	SH 2	58	CLAMP - UPPER (1.000 DIA)
1	SH 2	57	UPPER (.500 DIA)
1	SH 2	56	UPPER (.375 DIA)
1	SH 1	55	LOWER (1.000 DIA)
1	SH 1	54	LOWER (.500 DIA)
1	SH 1	53	CLAMP-LOWER (.375 DIA)
[illegible]	COMM	52	DOWEL 3/8 DIA × 1 LG
4	COMM	[illegible]	SOC HD CAP SCR [illegible]
3	COMM (CUP POINT)	50	SET SCR 1/4-20NC × 1/4 LG
1		[illegible]	DOWEL 1/4 DIA × [illegible] LG
2		48	SOC CAP SCR 1/4-20NC × [illegible]
1	JERGENS	47	PLASTIC BALL KNOB NO. [illegible]
2		46	FL HD SCR 1/4-20NC × 2 LG
1	SCHRADER	45	AIR VALVE [illegible] TYPE - [illegible] 3230 A
2	COMM "PARKER"	44	HOSE NO. [illegible] 24 LG
1	MATL - CRS	[illegible]	ROD [illegible] DIA × 22 LG
1	SHT-2	42	BAR
1		41	BLOCK
1		40	PLATE
1		39	CLAMP
[illegible]	SHT-2	[illegible]	[illegible]
2	COMM	37	SQ KEY .188 × .188 × [illegible]
13	COMM (NORTHWESTERN)	36	HAND KNOB "UNIT"
13	COMM (NORTHWESTERN)	35	LATCH BOLT # 14 LG
26	COMM	[illegible]	DOWEL PIN .2500 DIA × 1.0 LG
1	SH 2	33	CLAMP - UPPER (2.50 DIA)
1	SH 2	32	(2.00 DIA)
1	SH 2	31	(1.50 DIA)
1	SH 2	30	(1.25 DIA)
1	SH 2	29	(.750 DIA)
1	SH 2	28	CLAMP - UPPER (.250 DIA)
1	SH 1	27	CLAMP - LOWER (2.50 DIA)
1	SH 1	26	(2.00 DIA)
1	SH 1	25	(1.50 DIA)
1	SH 1	24	(1.25 DIA)
1	SH 1	23	(.750 DIA)
1	SH 1	22	CLAMP - LOWER (.250 DIA)
1	COMM (COGSDILL TOOLS)	21	EXTERNAL R.A.F. TOOL FOR 2.5 DIA TUBE # E5
1	COMM	20	EXTERNAL R.A.F. TOOL FOR 2.0 DIA TUBE # E5
1	COMM	19	EXTERNAL R.A.F. TOOL FOR 1.5 DIA TUBE # E4
1	COMM	18	EXTERNAL R.A.F. TOOL FOR 1.25 DIA TUBE # E4
1	COMM	17	EXTERNAL R.A.F. TOOL FOR .75 DIA TUBE # E3
1	COMM (COGSDILL TOOLS)	16	EXTERNAL R.A.F. TOOL FOR .25 DIA TUBE # E1
2	COMM	15	SOC HD CAP SCR [illegible]
1	COMM (BOSTON GEAR)	14	FLANGED BEARING # FB-1216-16
1	COMM (BOSTON GEAR)	13	PILLOW BLOCK # PPB16
1	COMM (BOSTON GEAR)	12	COUPLING # FCBB 15 [illegible] BORE
6	COMM	11	SOC SET SCR [illegible]
	COMM (ARO CORP OR EQ)	10	QUICK DISCONNECT # A2608
1	COMM	9	PIPE BUSHING [illegible] NPT × [illegible] NPT
4	COMM	8	SOC HD CAP SCR [illegible] LG
1	COMM (GARDNER-DENVER)	7	AIR MOTOR # [illegible]
4	COMM (BOSTON GEAR)	6	BUSHING # B1216-8
1	SH	5	MOUNT
2	SH 1	4	SHAFT
2	SH 1	3	MOUNTING BLOCK
1	COMM (HALLOWELL)	2	WORK BENCH (SEE NOTE 1)
		1	ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ± 1/64, DECIMALS ± .01, ANGLES ± 1°

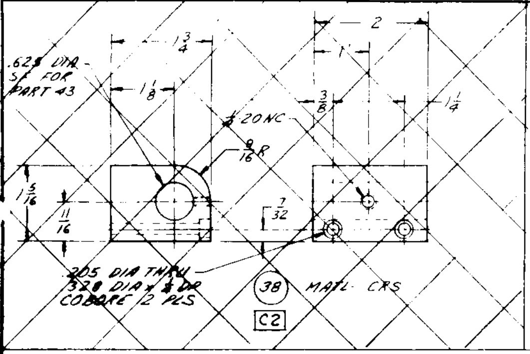
GENERAL ELECTRIC
LARGE JET ENGINE DEPT — CINCINNATI 15, OHIO

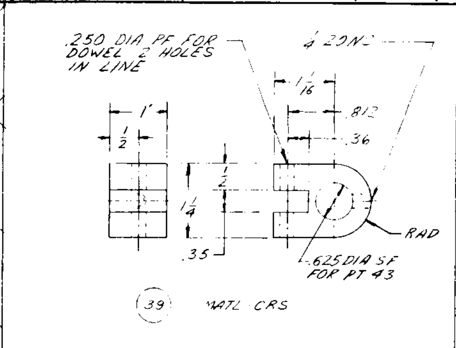
TITLE: SIZING TOOL - TUBE END

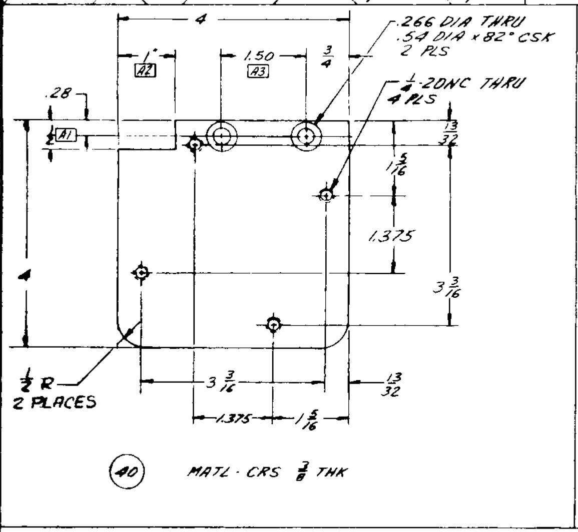
NASA

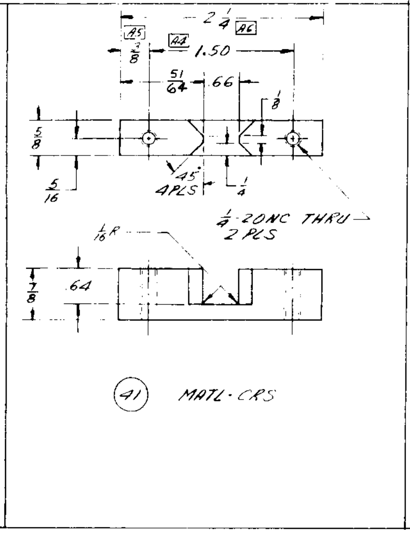
07482 E 4012180-729

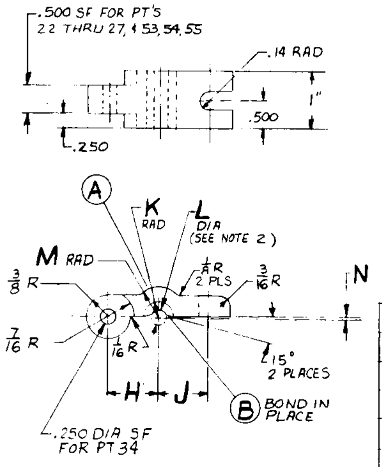
2







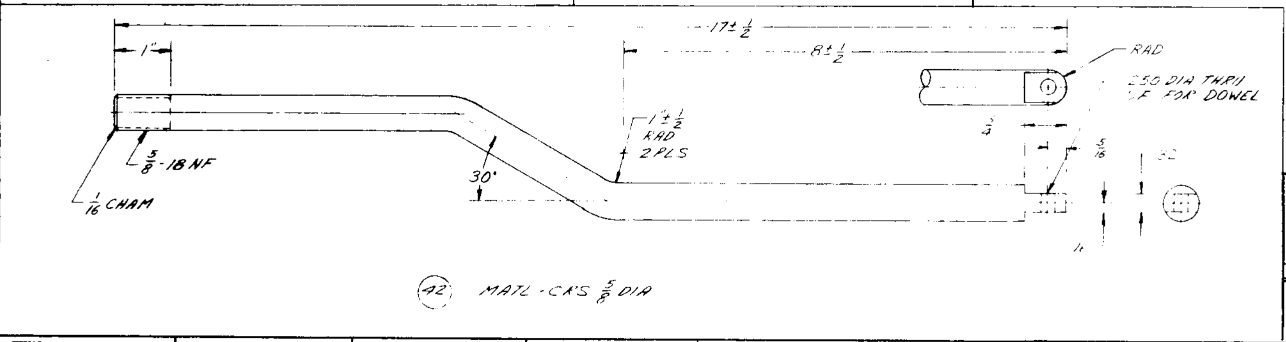




58	57	56		
33	32	31		
30	29	28	BONDED ASSEMBLY	
		A	HRS	1
		B	MOLDED ASBESTOS FACING STYLE 751 JOHNS-MANVILLE CO.	1

PART NO.	H	J	K RAD	L DIA	M RAD	N
28	.875	.875	.250	.256 / .255	.500	.006 / .005
29	1.250	1.250	.500	.756 / .755	.812	.006 / .005
30	1.375	1.375	.750	1.256 / 1.255	1.062	.006 / .005
31	1.625	1.625	.875	1.512 / 1.510	1.250	.011 / .010
32	1.875	1.875	1.125	2.012 / 2.010	1.500	.011 / .010
33	2.250	2.250	1.375	2.512 / 2.510	1.750	.011 / .010
56	1.000	1.000	.312	.381 / .380	.625	.006 / .005
57	1.125	1.125	.375	.506 / .505	.687	.006 / .005
58	1.250	1.250	.625	1.006 / 1.005	.937	.006 / .005
66	1.000	1.000	.281	.3185 / .3175	.625	.006 / .005
67	1.125	1.125	.344	.4435 / .4425	[illegible]	.006 / .005
68	1.125	1.125	.406	.5685 / .5675	[illegible]	.006 / .005
69	1.125	1.125	.438	.6310 / .6300	[illegible]	.006 / .005

C1 (parts 56–58); D (parts 66–69)



REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
C	B4 / F10	1) ADDED DETAILS 56, 57 & 58 2) DELETED DETAIL 38 PER 41-NASA-0534	[illegible]	[illegible]
D		1) PARTS [illegible] ADDED 41-2232	[illegible]	[illegible]

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: FRACTIONS ± 1/32, DECIMALS ± .010, ANGLES ± 2°
ALL SURFACES 125√

GENERAL ELECTRIC — LARGE JET ENGINE DEPT — CINCINNATI 15, OHIO

TITLE: SIZING TOOL TUBE END

CODE IDENT NO. 07482 — SIZE D — DWG NO. 4012180 729

SHEET 2 OF 2

4012180-729 D

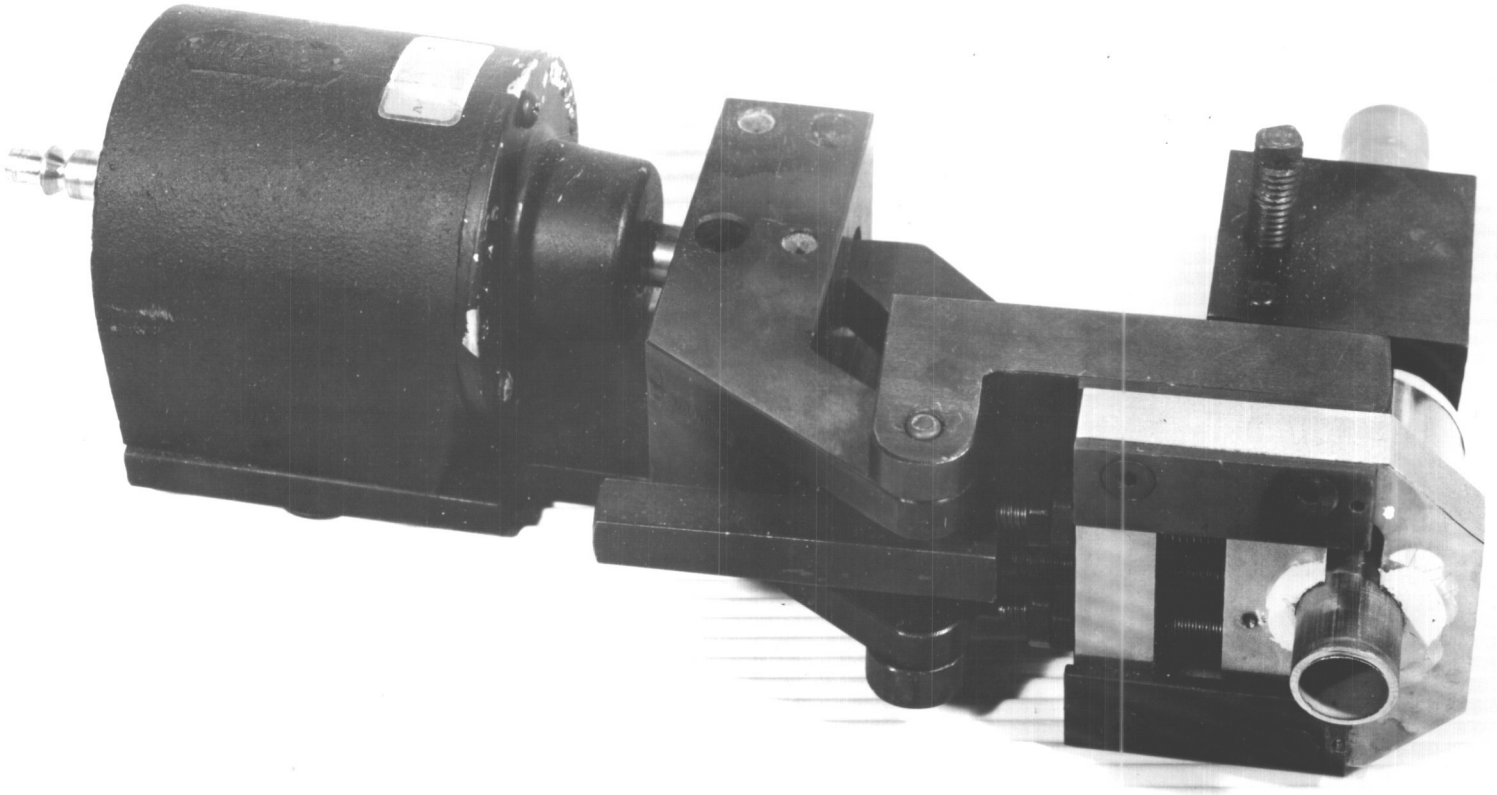


FIGURE 13 DEBRAZING FIXTURE M04761

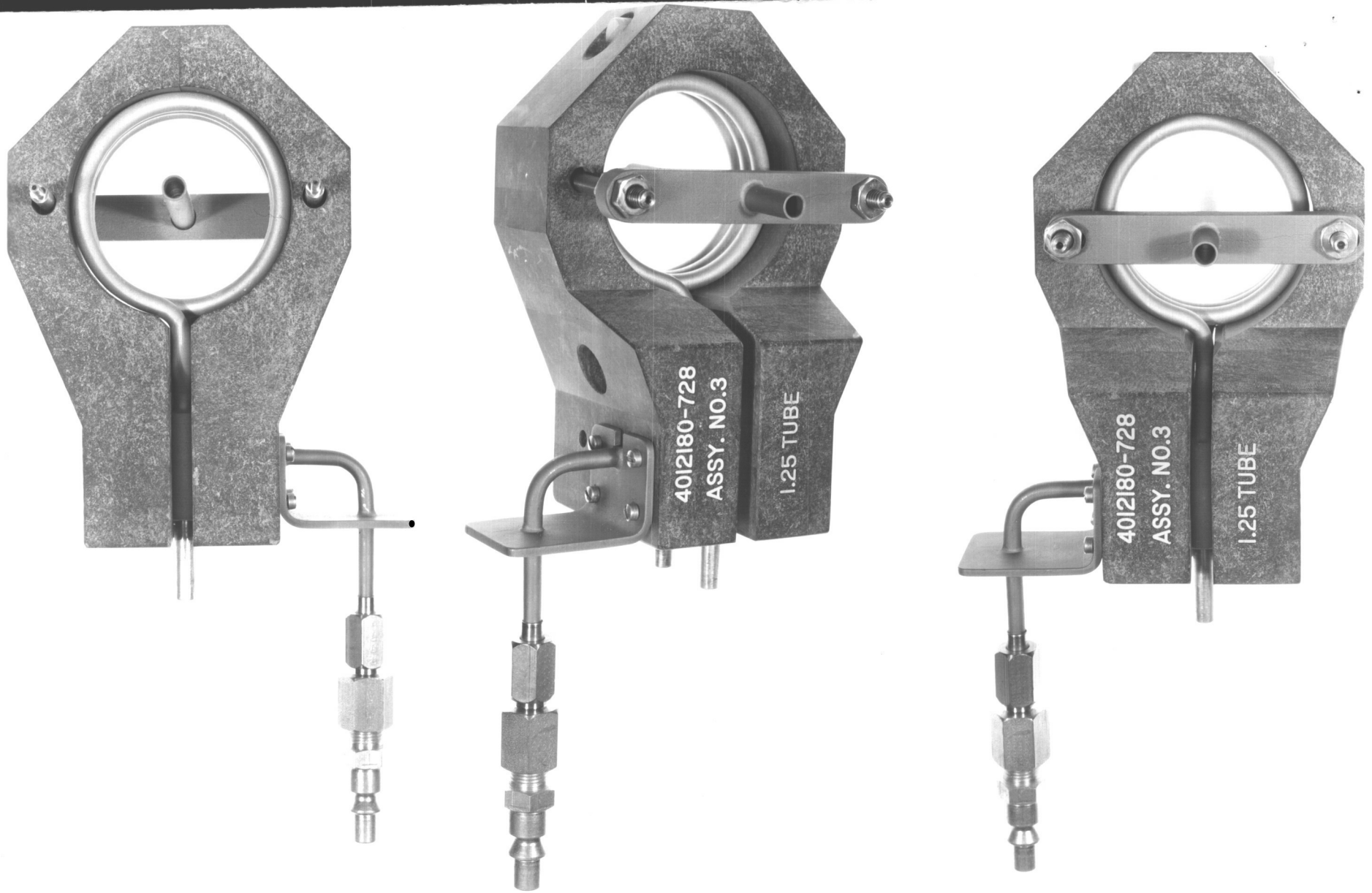


FIGURE 14 HEATING COILS FOR DEBRAZING FIXTURES

M04761

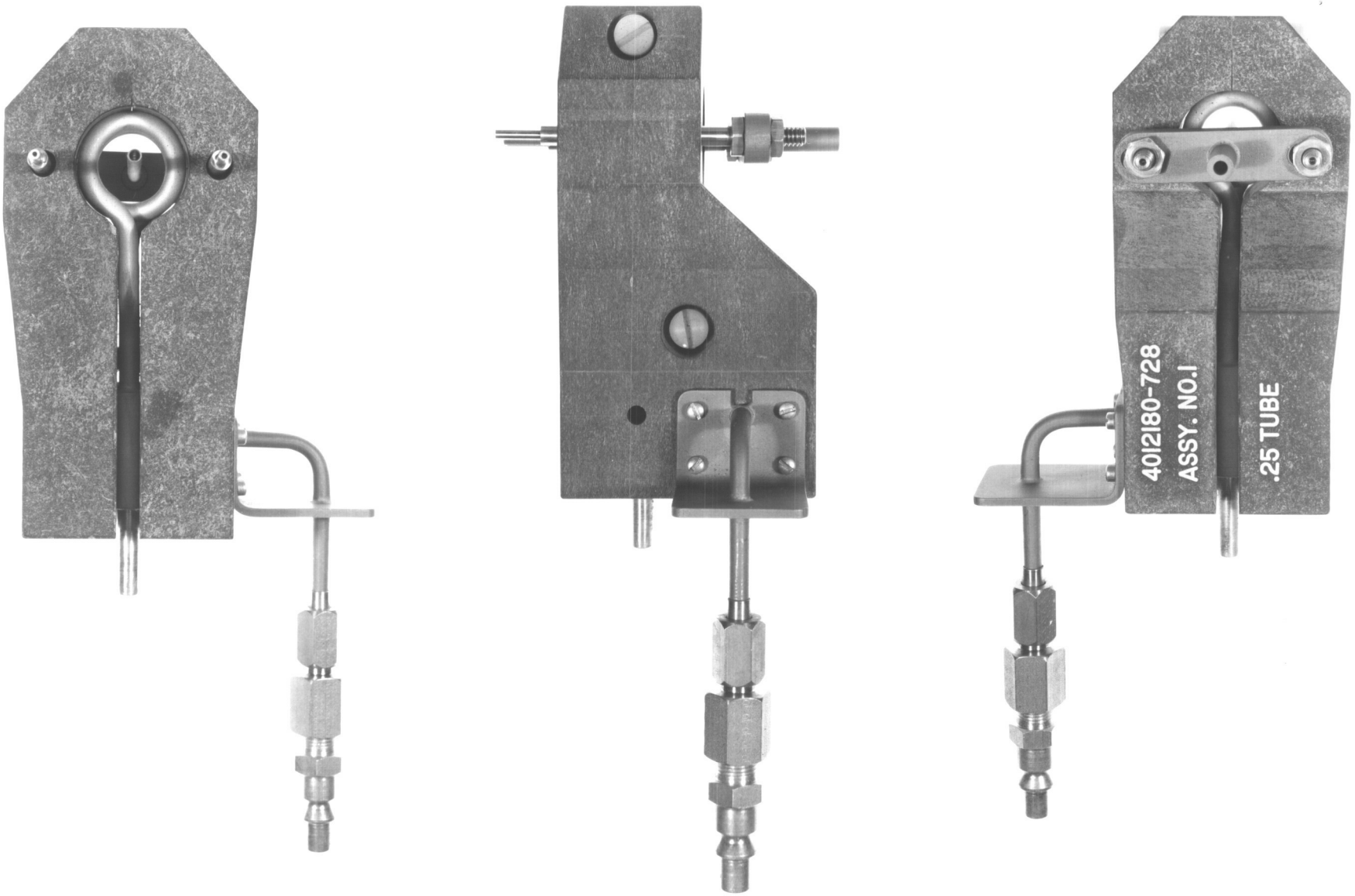


FIGURE 14A HEATING COILS FOR DEBRAZING FIXTURES

M04761

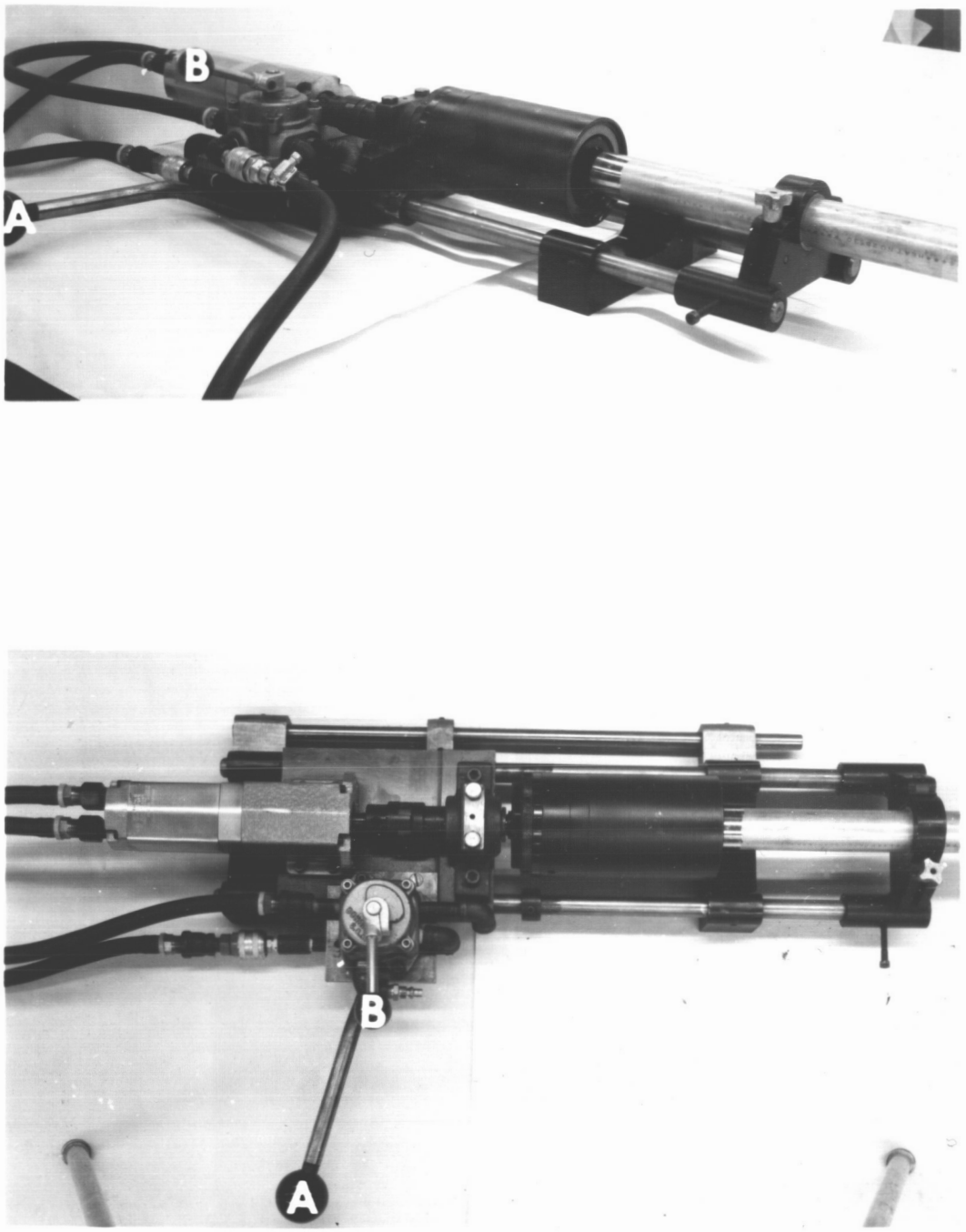


FIGURE 15 TOP & SIDE VIEW OF SIZING TOOL
(A-Lever Arm B-Air Reversing Switch)

M04761

FIGURE 16 1/4" SIZING HOUSING & CLAMPING BLOCK M04761

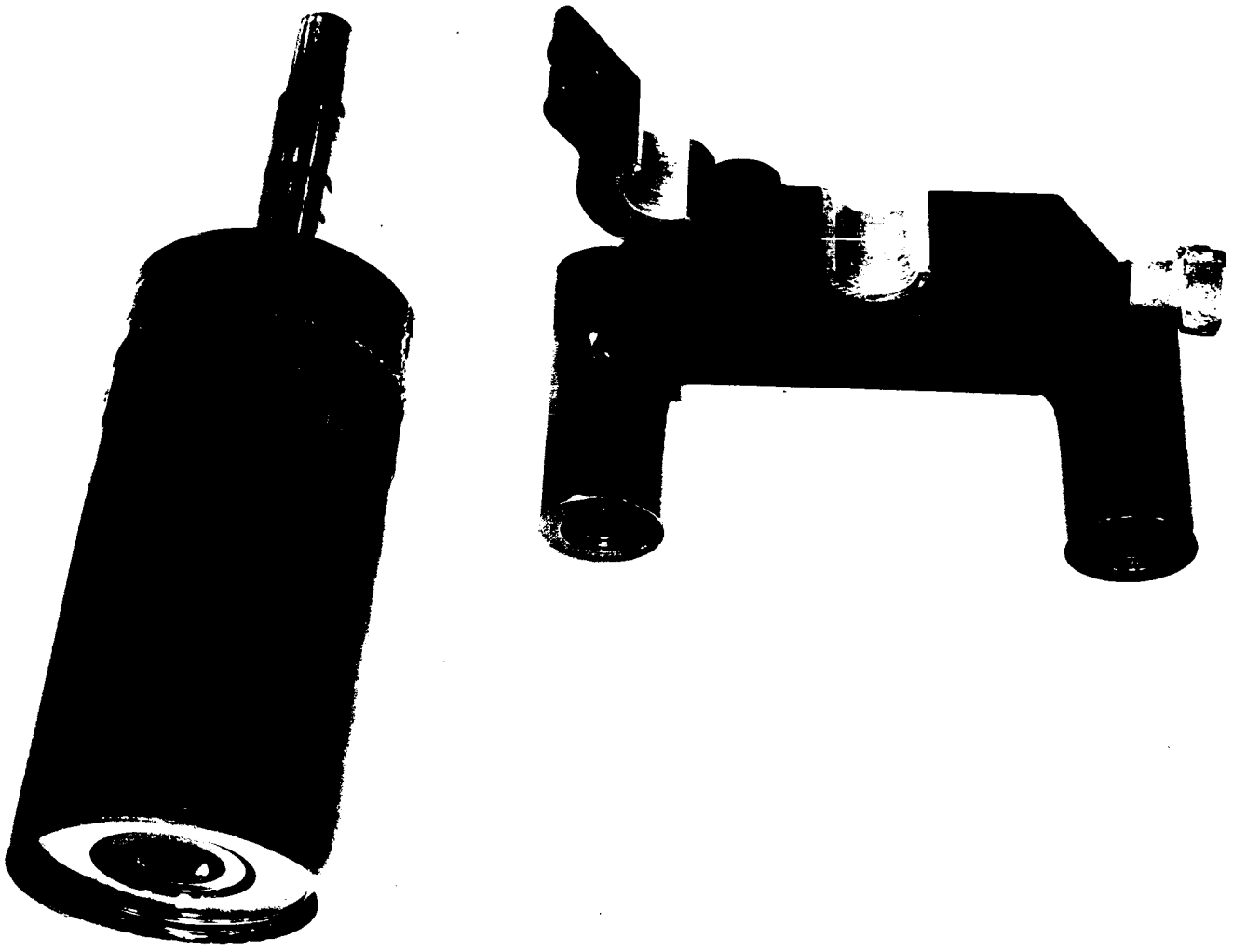


FIGURE 16A 3/4" SIZING HOUSING & CLAMPING BLOCK

M04761

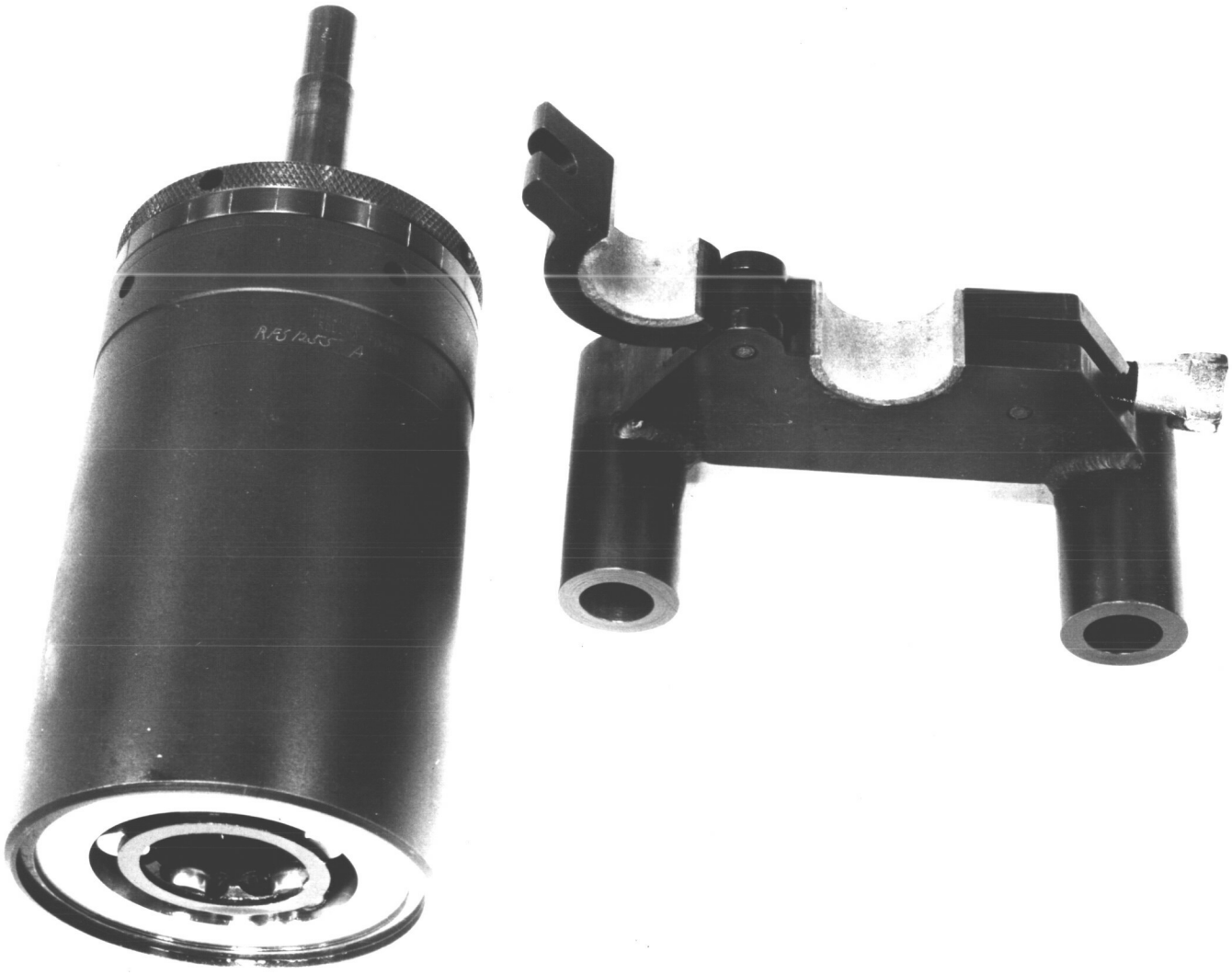


FIGURE 16B 1 1/4" SIZING HOUSING & CLAMPING BLOCK m04761

Sizing Tools (Cont'd)

The sizing of all tubing is accomplished by roll forgings (or forming). When the sizing tools are rotated at relatively high speeds, precision ground and hardened rolls bear on a cammed arbor; the rolls spin, rise and fall rapidly compressing the tube surface. These tools are adjustable in .0001 increments with a range from a nominal tube size dimension to ± .005 inches.

The sizing operation procedure is as follows: Place a tube in the proper holder and tighten the clamp. Activate the motor. Turn to the forward position, which operates the sizing tool in a clockwise motion. The sizing tool is brought forward by means of the handle attached, while it is revolving. After initial engagement the tube will feed itself into the sizing tool. Upon completion of sizing, reverse the sizing tool rotation direction by reversing the air valve. The motor will turn the sizing tool counter clockwise immediately freeing the tubing from the hardened rolls. To disengage, pull the sizing tool back to its original position.

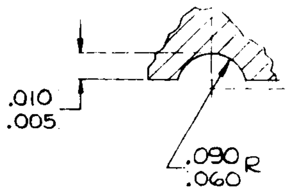
Coupling Elbow And Tee Designs

The design of the coupling, elbow, and tee fittings has evolved primarily from the fitting design used on the J93 Engine which powers the XB-70 aircraft. Sketch I and II are initial designs of a coupling first developed for the J93 fluid system. Drawing 871C234, illustrates the present coupling design for the J93 fluid system. Drawing 4012180-638 is the design of couplings used for NASA applications. The latter drawing is exactly the same as drawing 871C234 except for larger size fittings.

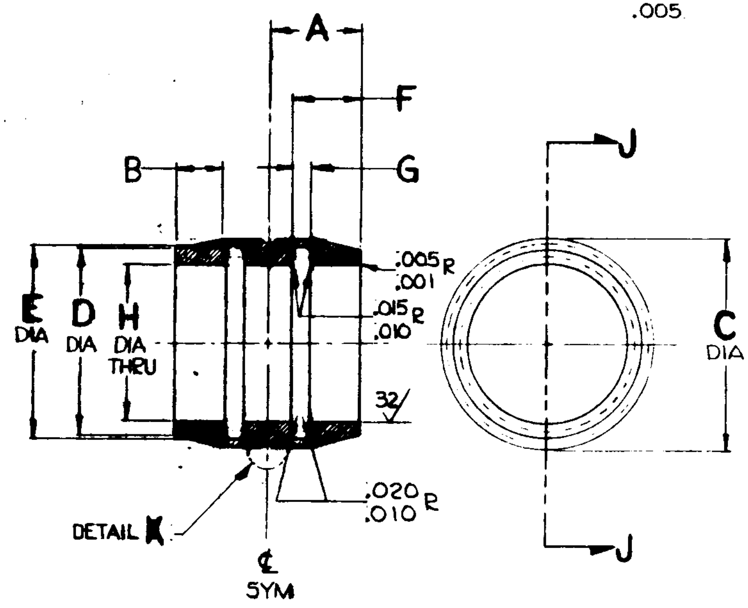
The I.D. of the coupling has a critical dimension of $^{+.0010}_{-.0000}$ to control dimensional gaps with sized tubing. This controlled I.D. dimension is maintained on all fitting designs. Sketch I has spacers at each end of the coupling with a crown dimension of 020 x 030. these spacers are used for alignment. Sketch II shows the same basic design, only the spacers have been replaced with projections thru 120° apart. These projections were also used for alignment. Drawings 871C234 and 4012180-638 show the absence of spacers or projections. Later, it was found that with controlled I.D. dimensions on the coupling and controlled tubing, the brazing alloy acted as the alignment means during braze alloy flow. The recessed groove in each half of the coupling allows for

PART IDENT NO.	TUBE OD	A	B	C	D	E	F	G	H
4012180-638-P1	1.250	.557 .547	.330 .310	1.405 1.400	1.[illegible]07 1.287	1.322 1.317	.445 .425	.085 .080	1.251 1.250
-P2	1.500	.619 .609	.383 .363	1.655 1.650	1.557 1.537	1.572 1.567	.505 .485	.092 .087	1.501 1.500
-P3	2.000	.694 .684	.449 .429	2.155 2.150	2.057 2.037	2.072 2.067	.580 .560	.101 .096	2.001 2.000
-P4	2.500	.787 .777	.528 .508	2.655 2.650	2.557 2.537	2.572 2.567	.670 .650	.112 .107	2.501 2.500
-P5	.250	.332 .322	.103 .083	.357 .352	.307 .287	.302 .297	.158 .138	.063 .058	.251 .250
-P6	.750	.400 .390	.213 .193	.877 .872	.807 .787	.822 .817	.292 .272	.092 .087	.751 .750

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVED



DETAIL K



(1) (2) (3) (4) MATL: AMS 5646

5. DIA E & H MUST BE CONCENTRIC WITHIN .002 FIR.
4. DIA H MUST BE ROUND WITHIN .0004 FIR.
3. COUPLINGS SHALL BE CLEANED IN A MANNER PRIOR TO PACKAGING TO REMOVE ALL DIRT, OIL, GREASE, OR FOREIGN MATERIAL DETRIMENTAL TO THE ULTIMATE BRAZING OPERATION & INDIVIDUALLY PACKAGED IN HEAT SEALED PLASTIC BAG
2. MARK CONTAINER OR TAG WITH PART IDENT. NO. & VENDOR CODE IDENT
1. SEE GE SI-212,010 FOR INTERPRETATION OF DWG

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: FRACTIONS ± DECIMALS ± ANGLES ±
ALL SURFACES √
MATL

FOR G.E. USE ONLY
SIMILAR TO
L/O
DR 41-07-250.01

SIGNATURES: DRAWN — DATE 19, 1963; CHECKED; ENGR; MFG; MATL; ISSUED

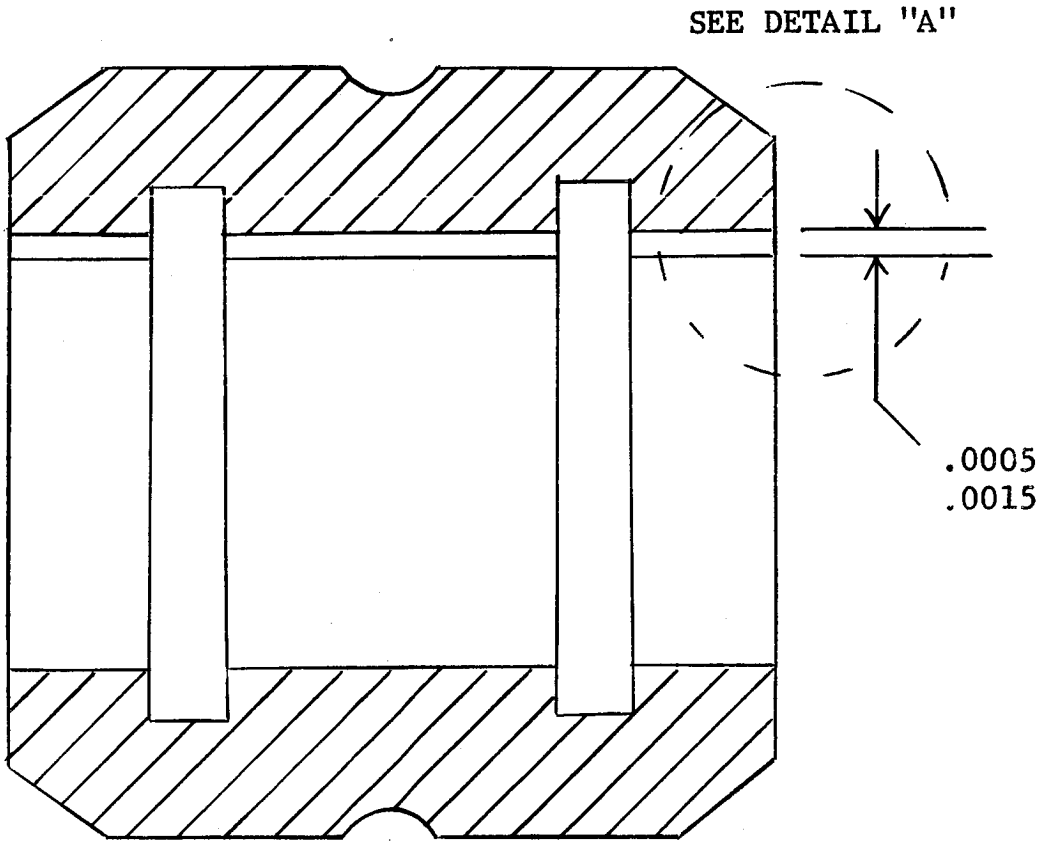
GENERAL ELECTRIC
LARGE JET ENGINE DEPT — CINCINNATI 15, OHIO

TITLE: COUPLING - TUBE, BRAZED ENDS

CODE IDENT NO. 07482 | SIZE C | DWG NO. 4012180-638
SCALE NONE | WT CALC ACTUAL | SHEET OF

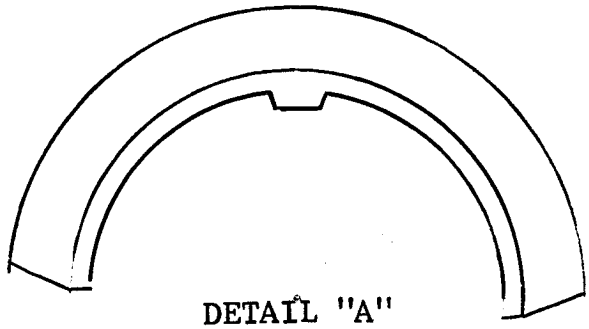
C 4012180-638

SKETCH 1



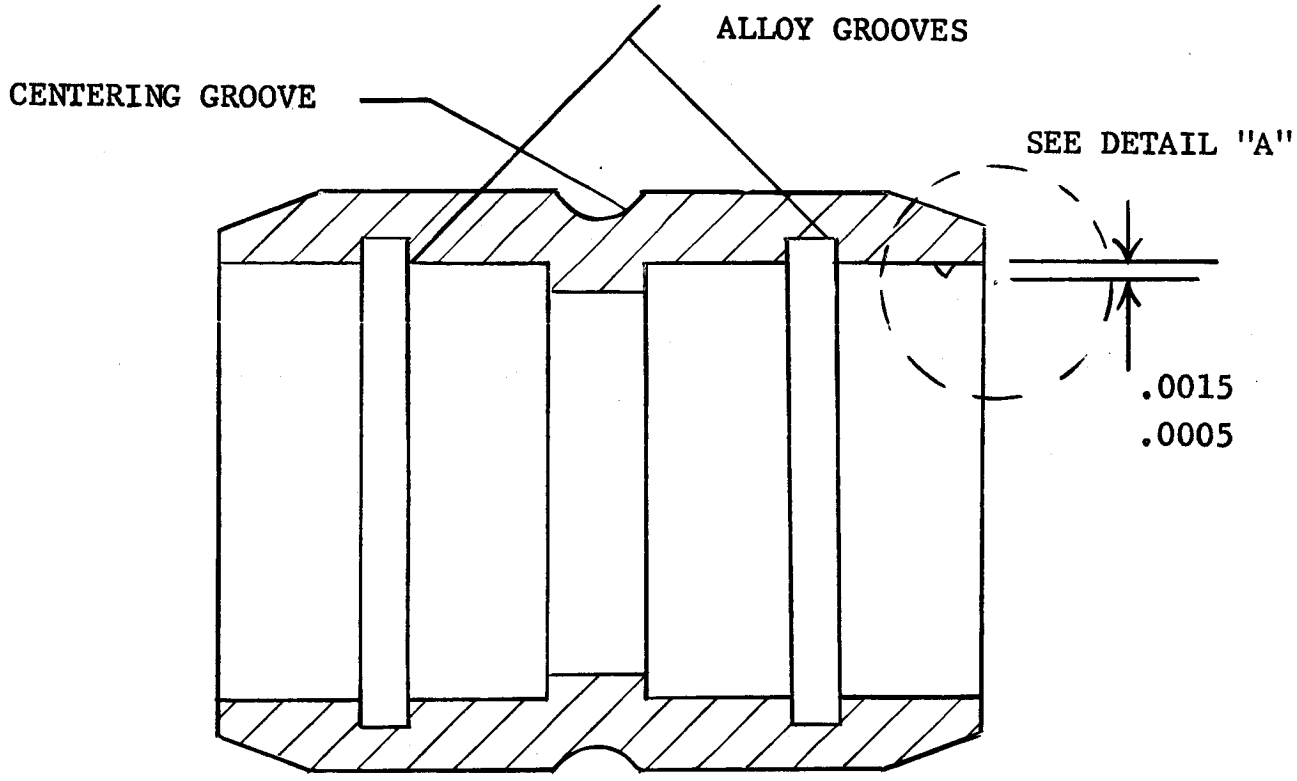
3 PROJECTIONS THRU

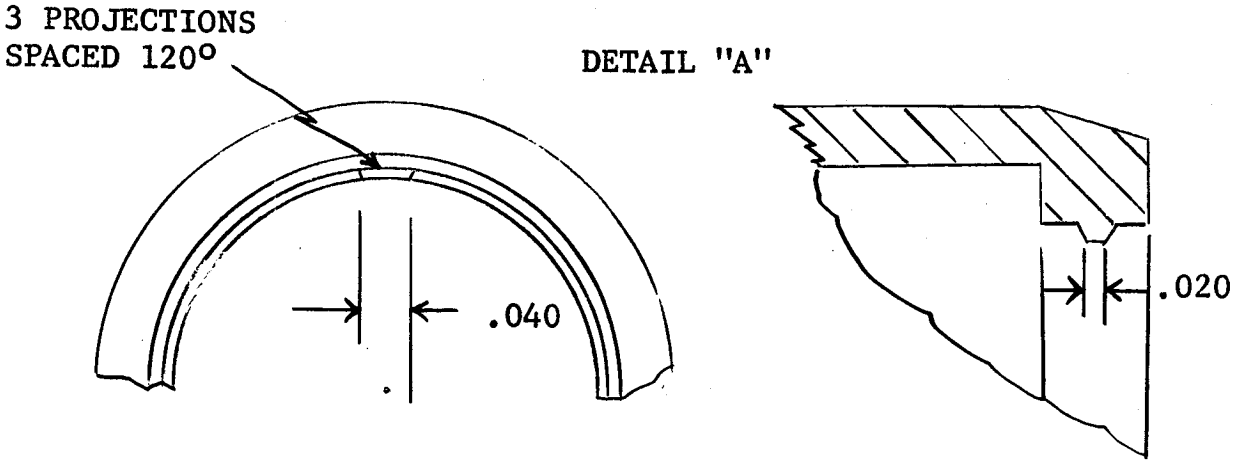
120° APART .040 - .080 WIDE



DETAIL "A"

SKETCH 2



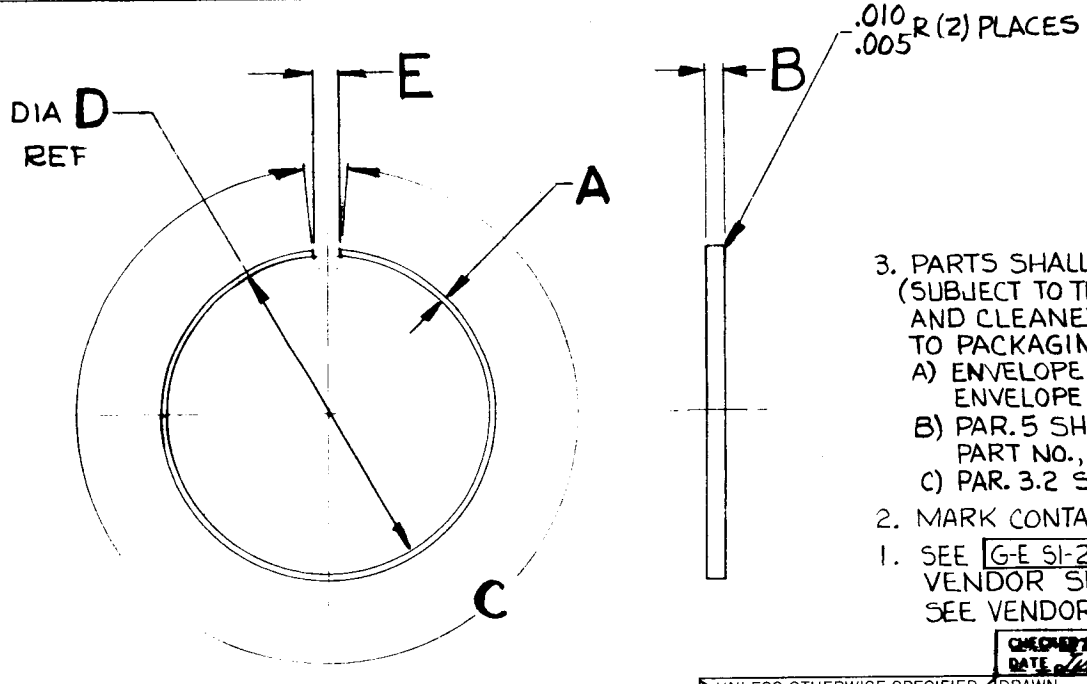


Coupling Elbow And Tee Designs (Cont'd)

rectangular snap rings of braze alloy (print 4012180-639). Preplacing the alloy insures soundly brazed coupling, when the alloy has flowed out and formed a continuous fillet around the periphery of the coupling. If the alloy is preplaced externally there is no assurance that the alloy has flowed into the coupling joint. The shallow centering trough on the outside of the coupling is for parting purposes when it becomes desirable to disassemble. This coupling design is reliable and economical to manufacture compared to the other designs. Print 4012180-638 details production couplings.

Elbow and tee fittings were also evolved from the basic design of the J93 fluid system coupling. Both the elbow and the tee fittings have a internal shoulder to control insertion depth, shown as dimension "L" on print 4012180-671. The area aft of the internal shoulder on the O.D. of the fitting is used as a sealing surface for the braze tool. There is also a shallow trough on these fittings for parting purposes.

PART IDENT NO.	TUBE OD	A	B	C	D	E
4012180-639-P1	1.250	.026 .024	.068 .063	4.05 4.02	1.27	.13 .10
-P2	1.500	.026 .024	.075 .070	4.84 4.81	1.52	.13 .10
-P3	2.000	.026 .024	.084 .079	6.41 6.38	2.02	.13 .10
-P4	2.500	.026 .024	.095 .090	7.98 7.95	2.52	.13 .10



3. PARTS SHALL BE PICKLED IN A 25% NITRIC ACID, OR COMPARABLE SOLUTION (SUBJECT TO THE APPROVAL OF THE PURCHASER) TO REMOVE ALL OXIDATION, AND CLEANED PER CLEANLINESS REQUIREMENTS OF MIL-P-116D PRIOR TO PACKAGING. PACKAGING SHALL BE PER AMS 2817 EXCEPT:
   A) ENVELOPE CONFIGURATION SHALL BE PER FIG. 1, STRIP TYPE PACKAGE ENVELOPE MATERIAL, BOTH FACES, SHALL BE PER MIL-F-22191, TYPE II
   B) PAR. 5 SHALL APPLY EXCEPT ONLY THE FOLLOWING IS REQD: PART NAME, PART NO., MANUFACTURER'S IDENTIFICATION, AND PACKAGED (MONTH & YEAR)
   C) PAR. 3.2 SHALL APPLY EXCEPT PARTS SHALL BE PACKAGED (10) PIECES TO A PACKAGE
2. MARK CONTAINER OR TAG WITH PART IDENT NO. & VENDOR CODE IDENT
1. SEE G-E SI-212,010 FOR INTERPRETATION OF DWG
   VENDOR SUBSTANTIATION REQ'D (REF G-E DWG 105B5338)
   SEE VENDOR SUBSTANTIATION DATA FOLDER FOR APPROVED SOURCES

94 MAT.
70
PRINTS TO

(1) (2) (3) (4) MATL: G.E. SPEC NO. B50T76A

REV	SIZE	4012180-639	CONT ON SHEET ~ SH NO. 1
	B		

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL

SIZE B 4012180-639 CONT ON SHEET ~ SH NO. 1 REV

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± DECIMALS ± ANGLES ±
ALL SURFACES ✓
MATERIAL
GOVT OR COML
G-E

CHECKED B. Koop DATE July 29, 1963
DRAWN C. Patterson
DATE July 29, 1963
APPD E.B. Patterson
ISSUED July 26, 1965

	APPROVED	DATE
ENGR	E.H. Gist	3/4/64
MFG		
MATL		

RING - BRAZING FILLER

GENERAL ELECTRIC
LJE DEPT
EVENDALE PLANT LOCATION

SIZE B 4012180-639

SCALE NONE WT CALC ACTUAL

CONT ON SHEET ~ SH NO. 1

CODE IDENT NO.

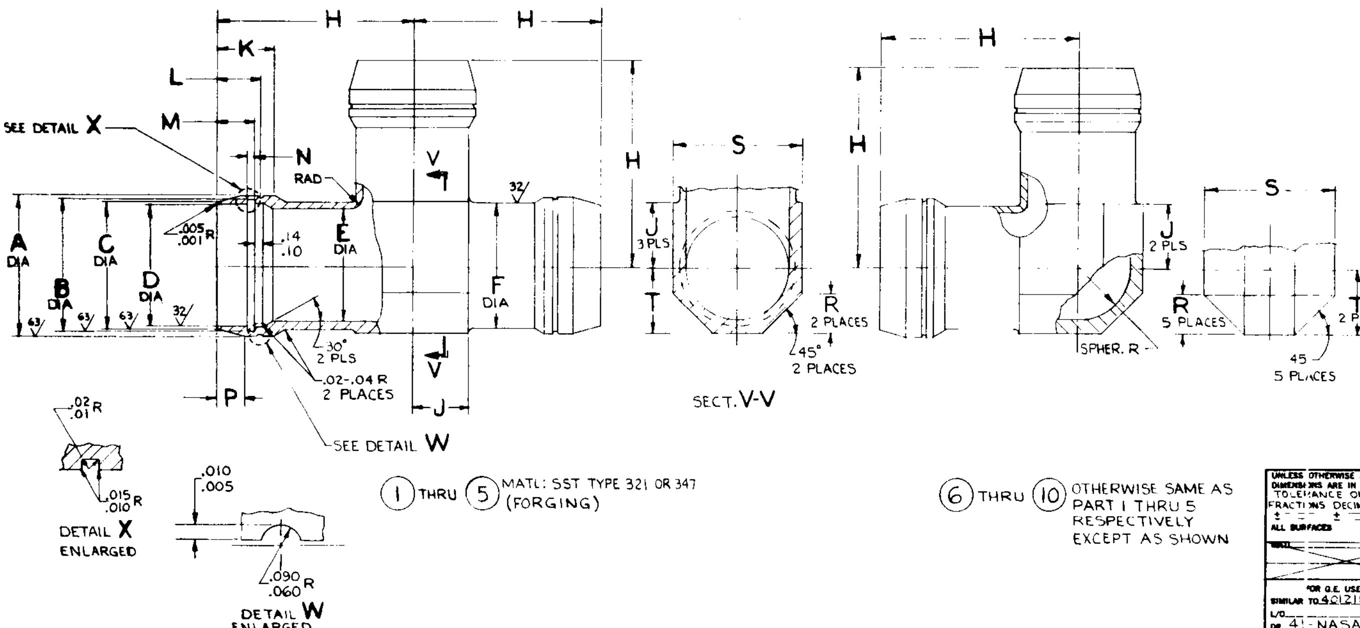
41-07-250.02

FF-752 (5-62) PRINTED IN U.S.A.

ELBOWS PART IDENT. NUMBER	TEES PART IDENT. NUMBER	TUBE O.D. REF	A	B	C	D	E	F	H	J	K	L	M	N	P	R	S	T
4012180-671 P6	4012180-671 P1	.250	.380 .370	.302 .297	.307 .287	.251 .250	.206 .196	.255 .250	1.40 1.36	.15 .13	.40 .36	.290 .270	.158 .138	.063 .058	.103 .083	.14 .10	.46 .42	.23 .21
4012180-671 P7	4012180-671 P2	.750	.957 .947	.822 .817	.807 .787	.751 .750	.652 .642	.755 .750	1.83 1.79	.40 .38	.52 .48	.420 .400	.292 .272	.092 .087	.213 .193	.33 .29	1.02 .98	.51 .49
4012180-671 P8	4012180-671 P3	1.250	1.510 1.500	1.322 1.317	1.307 1.287	1.251 1.250	1.084 1.074	1.255 1.250	2.27 2.23	.65 .63	.69 .65	.580 .560	.445 .425	.085 .080	.330 .310	.52 .48	1.52 1.48	.76 .74
4012180-671 P9	4012180-671 P4	1.500	1.700 1.690	1.572 1.567	1.557 1.537	1.501 1.500	1.310 1.300	1.505 1.500	2.46 2.42	.78 .76	.77 .73	.640 .620	.505 .485	.092 .087	.383 .363	.58 .54	1.77 1.73	.89 .87
4012180-671 P10	4012180-671 P5	2.000	2.200 2.190	2.072 2.067	2.057 2.037	2.001 2.000	1.810 1.800	2.005 2.000	2.80 2.76	1.03 1.01	.83 .79	.720 .700	.580 .560	.101 .096	.449 .429	.71 .67	2.27 2.23	1.13 1.11

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED



(1) THRU (5) MATL: SST TYPE 321 OR 347 (FORGING)

(6) THRU (10) OTHERWISE SAME AS PART 1 THRU 5 RESPECTIVELY EXCEPT AS SHOWN

8. UNSPECIFIED FILLET RADII TO BE .04-.08 R
7. UNSPECIFIED CORNER RADII TO BE .005-.015 R
6. ALL END CONFIGURATION DIMENSIONS TYP 3 PLACES ON PARTS 1 THRU 5 & TYP 2 PLACES ON PARTS 6 THRU 10
5. DIA B & DIA D MUST BE CONCENTRIC WITHIN .002 FIR.
4. DIA D MUST BE ROUND WITHIN .002 FIR.
3. FITTINGS SHALL BE CLEANED PRIOR TO PACKAGING, IN A MANNER TO REMOVE ALL DIRT, OIL, GREASE, OR FOREIGN MATERIAL DETRIMENTAL TO THE ULTIMATE BRAZING OPERATION & INDIVIDUALLY PACKAGED IN HEAT SEALED PLASTIC BAG
2. MARK CONTAINER OR TAG WITH PART IDENT. NO. & VENDOR CODE IDENT.
1. SEE G-E SI-212,010 FOR INTERPRETATION OF DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON: FRACTIONS DECIMALS ANGLES ± ± ± 1°
ALL SURFACES
MATL
FOR G.E. USE ONLY
SIMILAR TO 4012180-689
L/O DR 4 NASA-0524

DWG TYPE DETAIL

SIGNATURES	MO-DA-YR
DRAWN F. Garmon	8-14-65
CHECKED	8-14-65
ENGR	8-16-65
MFG	
MATL	
ISSUED	8-16-65

GENERAL ELECTRIC
LARGE JET ENGINE DEPT CINCINNATI, OHIO, U.S.A.

TUBE BRAZE FITTING, ELBOWS & TEES (FORGED)

NASA

SIZE D | CODE IDENT NO. 07482 | DWG NO. 4012180-671

SCALE: NONE | WT | SHEET 1 OF 1

4012180-671

FEASIBILITY STUDY TO DETERMINE THE EFFECTS OF BRAZING HEAVY WALL TUBING UTILIZING A HIGH FREQUENCY SOURCE INDUCTION GENERATOR

The purpose of this study was to determine if the induction braze tools, the high frequency induction source and related equipment specified for brazing the tubing of the NASA low pressure system (Table V) can be utilized for brazing tubing of wall thicknesses required for the NASA high pressure system (Table VI).

Conditions Of Test

Materials

A.

Tubing Size	Wall Thickness	Designation AMS	Designation SAE
.250	0.026	5570G and 557IB	30321 and 50347
.750	0.075	5570G and 557IB	30321 and 30347
1.250	0.122	5570G and 557IB	30321 and 30347
1.500	0.113	5570G and 557IB	30321 and 30347
2.000	0.151	5570G and 557IB	30321 and 30347
2.500	0.188	5570G and 557IB	30321 and 30347

B. Braze Alloy - Gold 82% - Nickel 18% in round rings of rectangular wire.

C. Purge Gas - High Purity Argon.

D. Fittings - 347 Stainless Steel straight couplings - elbow and tees provided with an internal braze alloy groove. Drawings 4012180-638 and 4012180-629.

TABLE V

Low And High Pressure Systems

Tube O.D.	Pressure System Wall Thickness		Diffuser
	Low	High	
.250	.020	.026	.006
.750	.049	.075	.026
1.250	.083	.122	.039
1.500	.095	.113	.018
2.000	.095	.151	.056
2.500	.120	.188	.068

TABLE VI

POWER TIME CYCLES

Low Pressure Tubing			High Pressure Tubing		
Size	Power Setting	Time Seconds	Size	Power Setting	Time Seconds
.250	12	20	.250	12	24
.750	13	35	.750	.4	60
1.250	15	60	1.250	18	120
1.500	15	60	1.500	20	120

Fixturing

A lab. rig fixture, Figure No. 17-17A & 17B, was used for testing all sizes of tubing. This fixture is designed to provide argon protection during the brazing and cooling operations.

Tests

Sample joints of heavier wall thickness tubing were induction heated in the lab. rig fixture, using the power settings and time cycles previously established for brazing the low pressure system tubing. Two chromel-alumel therocouples were used to determine the temperature of the joint being brazed. Each thermocouple was tweezer weld tacked in place on the I.D. of the tube being brazed. One thermocouple was located at the center of the coupling, the other thermocouple was located at the end of the coupling. Samples were inspected visually for brazing alloy flow. In the event, the joint did not reach braze temperature or braze alloy flow did not occur, the power setting and/or the time was increased in small increments, until a sound braze joint was obtained.

Test Results

The 1/4", 3/4", 1 1/4" and 1 1/2" braze joints exhibited good flow of braze alloy around the periphery of the fittings. The power time cycles used for obtaining these results were somewhat greater than those established for the low pressure system Table V. X-ray examination of these brazed samples revealed 80 to 100% coverage. Peel testing of these same samples verified the x-ray findings. Figure 18 is a 1 1/2" peeled joint. The 2" and 2 1/2" samples exhibited poor alloy flow for all power time cycles attempted. No acceptable couplings were obtained. X-ray and peel testing indicated 40 to 50% coverage. The power-time cycle required to obtain 40-50% braze coverage for the larger samples caused over heating of the power transmission cable. One to two hours was required to cool the cable before it could be used again.

Distortion of the 2" and 2 1/2" couplings occurred during the heating cycles. Figure 19 shows a typical example. The distortion was located near the end of the coupling where the wall is tapered. It was not found at the same point on the periphery of the coupling of all the samples prepared indicating that it was not due to a hot spot during the heating cycle.

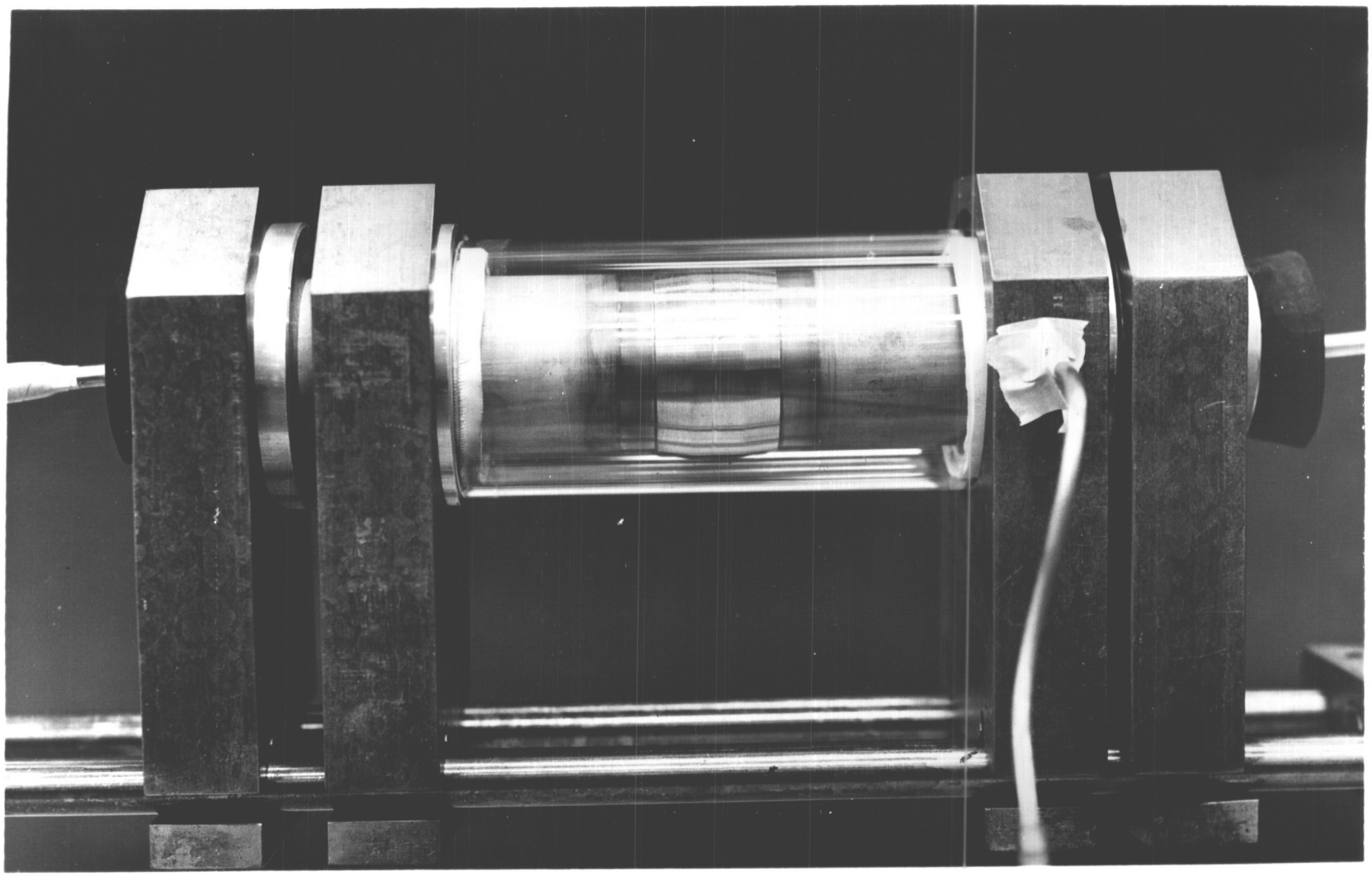


FIGURE 17 LAB BRAZE FIXTURE

M04761

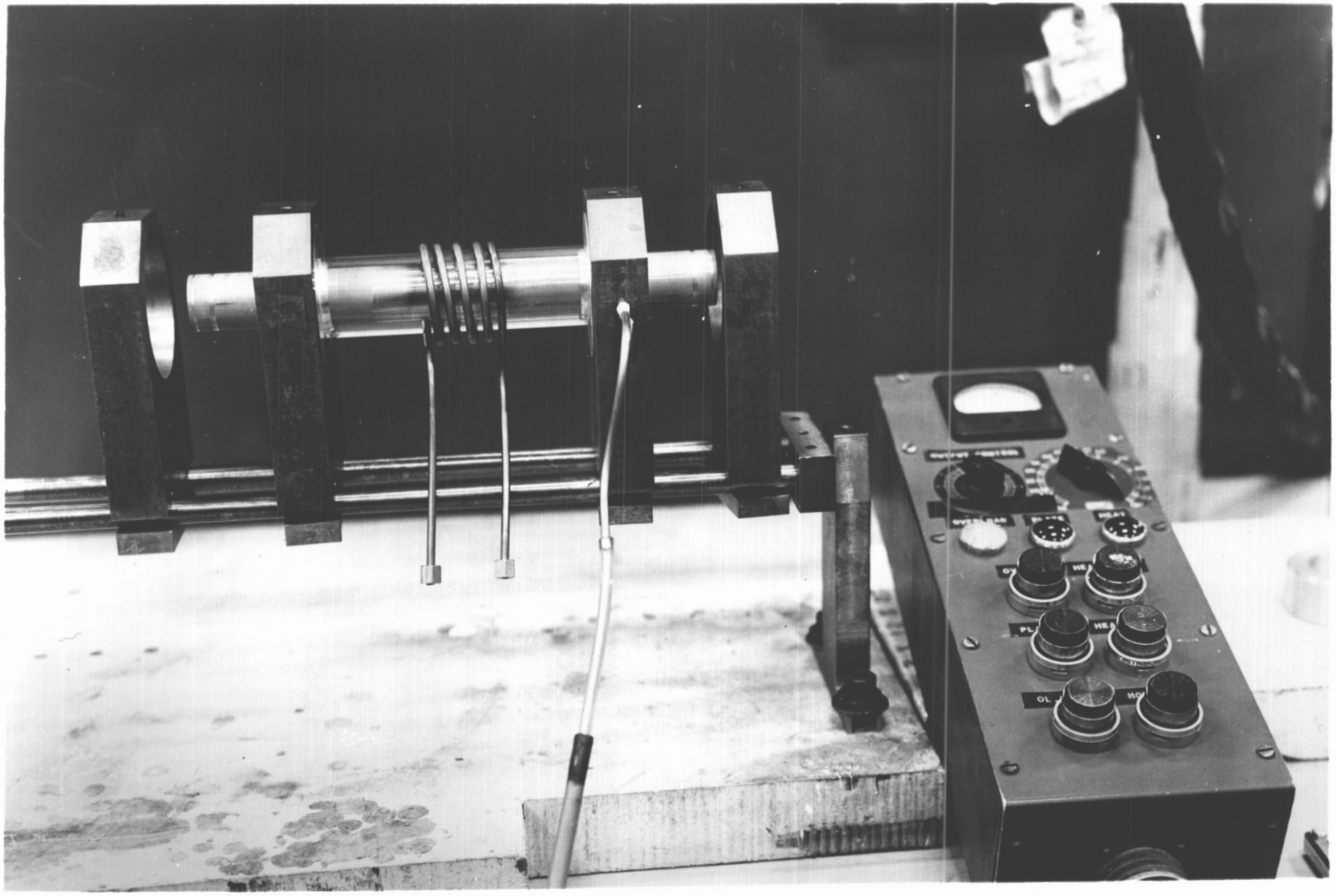


FIGURE 17A IAB BRAZE FIXTURE

M04761

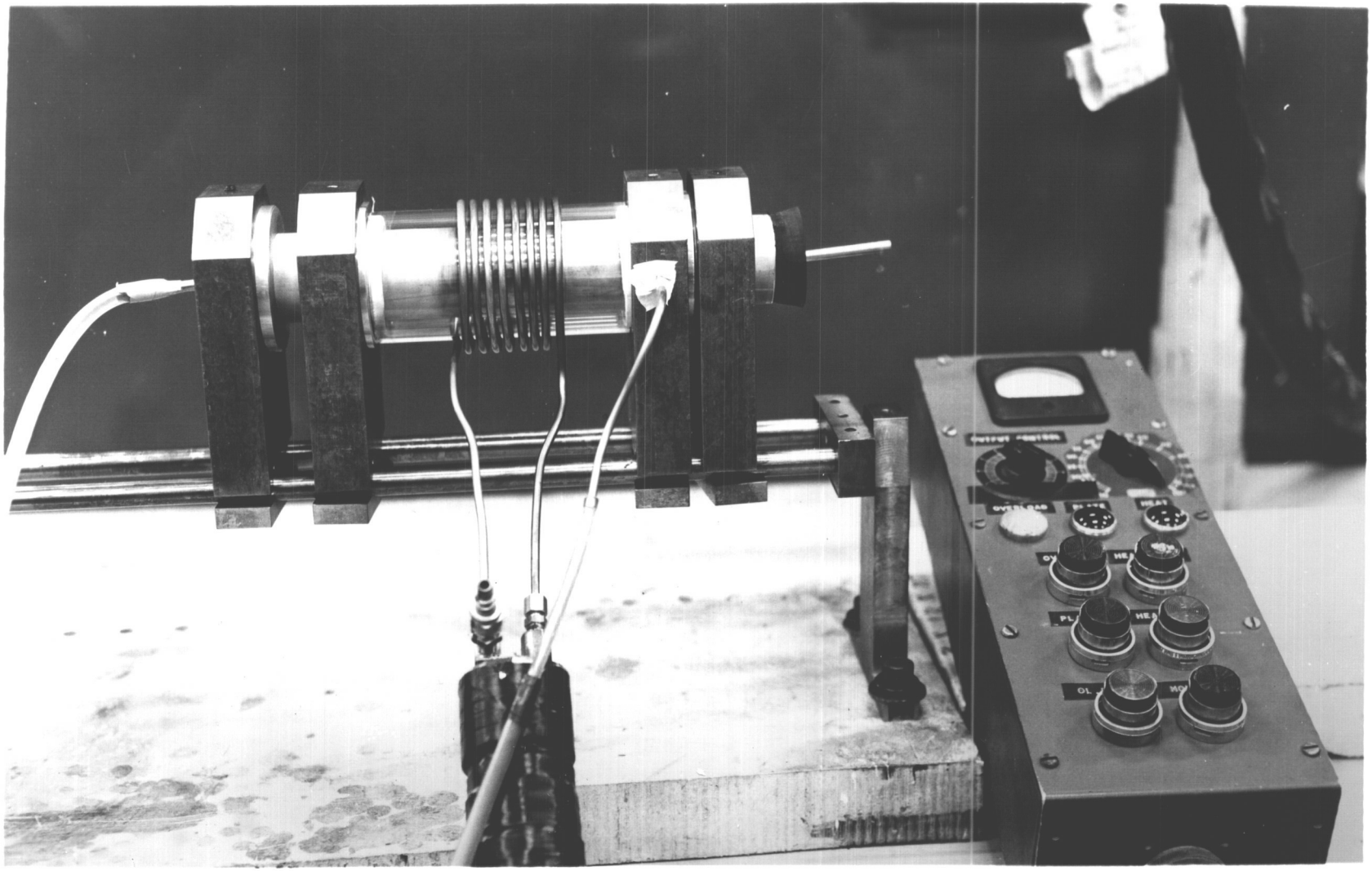


FIGURE 17 B LAB BRAZE FIXTURE M04761

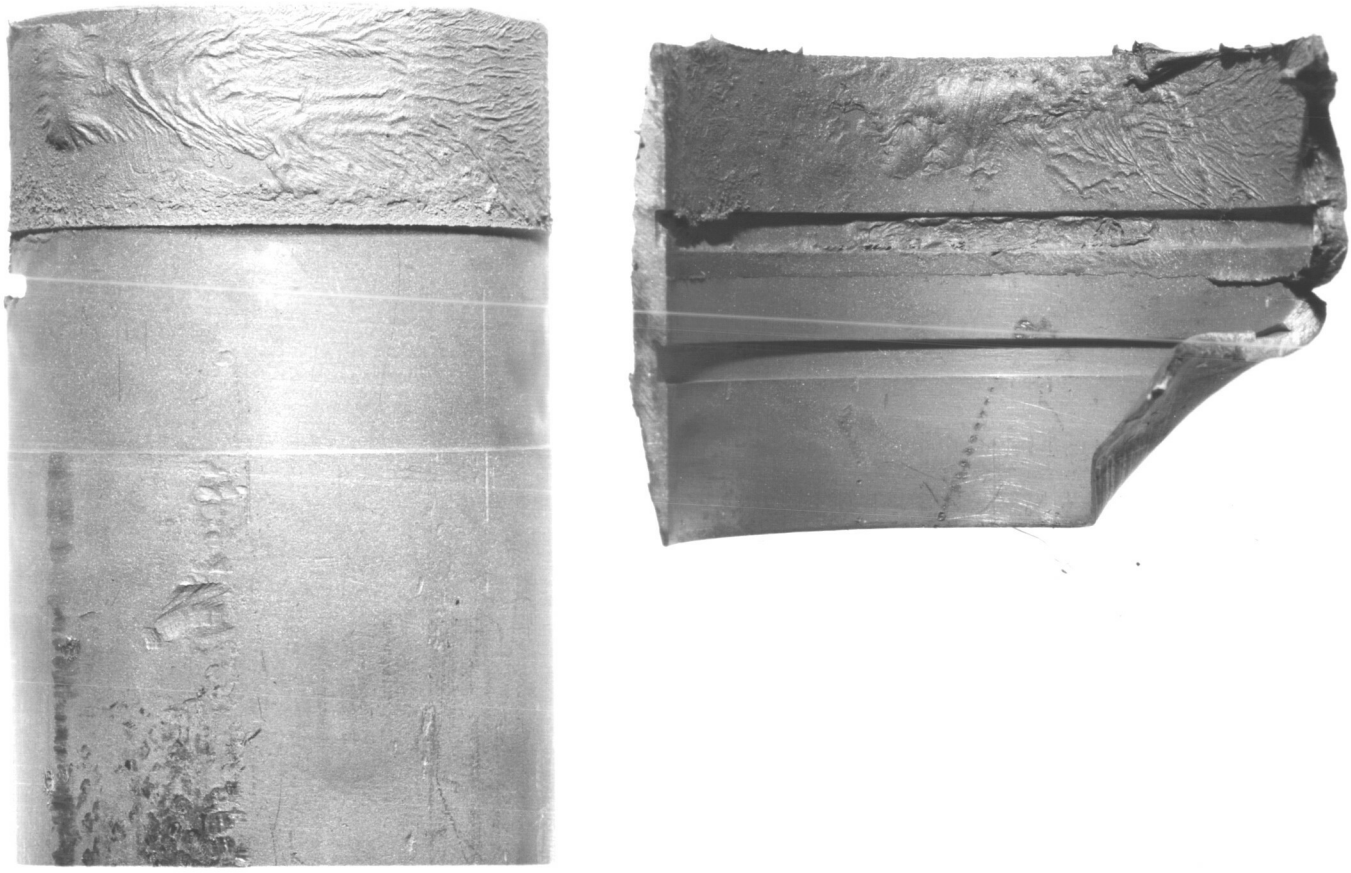


FIGURE 18 1 1/2" PEELED BRAZE JOINT

M04761

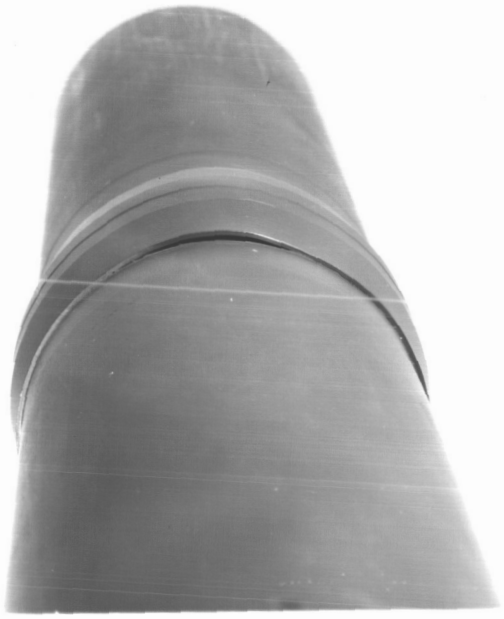


FIGURE 19 COUPLING DISTORTED AREA MC4761

Conclusions

This investigation revealed that sound, high quality braze joints can be obtained in the 1/4", 3/4", 1 1/4" and 1 1/2" high pressure systems utilizing the present induction braze tools and related equipment. The 2" and 2 1/2" joints cannot be produced with our present braze tools and related equipment.

STEEL SEALING JAWS

The RPD 150 sealing jaws in the 1 1/2", 2" and 2 1/2" straight couplings were replaced with a stainless steel jaw. The braze tools for brazing the elbow and tee type fittings were also modified in like manner. Enough heat reached the RPD 150 material to produce outgassing during continued use. The outgassing contaminated the atmosphere inside the chamber resulting in undesireable oxidation. The contamination problem was eliminated by the change to steel. It was felt that with the shorter width of tools for brazing elbow and tee fittings, it would be advisable to replace the plastic sealing jaws with stainless steel also. Replacements of these tools were completed and all tools tested. All braze tools tested satisfactory.

RECOMMENDED OR SUGGESTED BRAZE PROCEDURE

Tubing Fit Up

1.1 Purpose: To cut, trim and align tube ends before the braze operation.

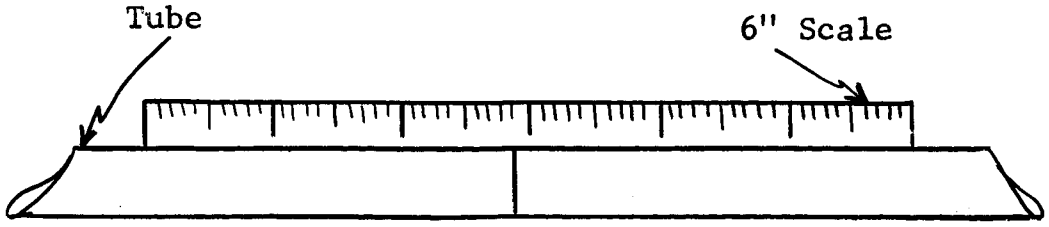
1.2 Set-up and Parts Protection: Using a blue print accumlation list and (if possible) a photo book check for routing, clamping and bracketing of the tubing before fit-up. Keep the tube ends capped at all times, except during brazing. Handle tubing carefully. Avoid unnecessary contact with other piping structural material and tooling.

1.3 When tube fitter has marked the tube or tubes for cut off, remove it if necessary to facilitate cutting. Be sure to plug the tube before cutting.

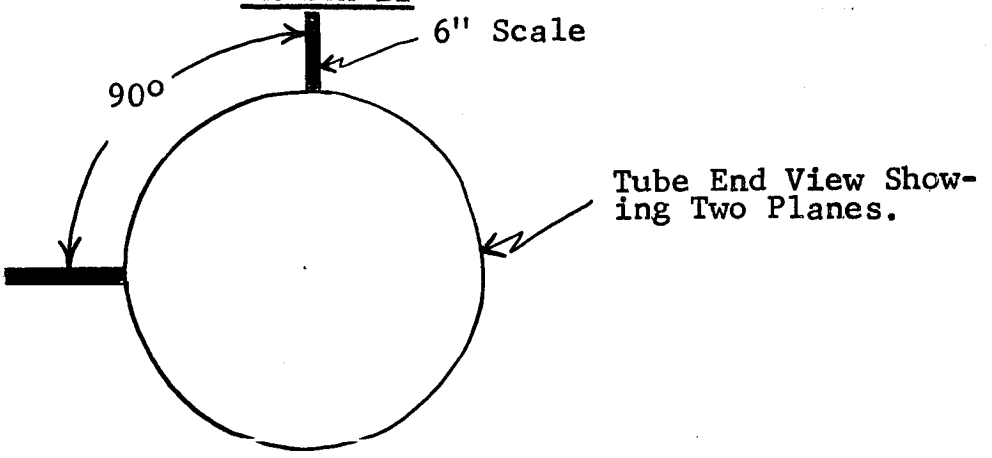
1.4 On final fit tube ends should mate in free state, or maximum gap of .030.

1.5 To determine proper alignment, lay a six inch scale (or straight edge).

SKETCH I

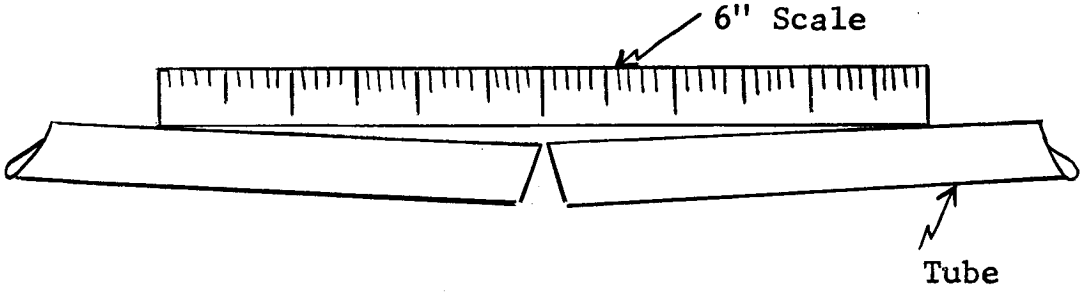


SKETCH II



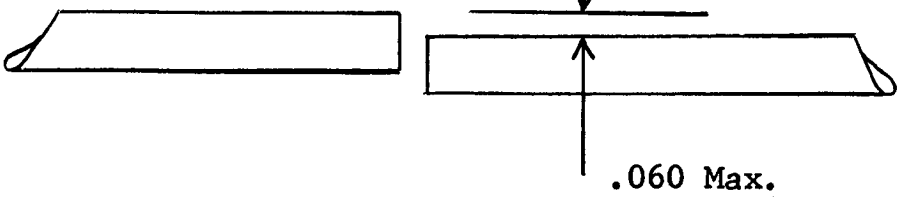
SKETCH III

Warning - Do not assemble joint as shown in Sketch III.



SKETCH IV

1.6 After completion of step 1.5 and with tube ends in free state, misalignment must not exceed .060. See Sketch IV.



1.7 Realign end tube which is removed or disturbed after final alignment.

Tube Preparation

2.1 Purpose: Sizing is required to control the clearance between the coupling and the tube.

Masking is required to center the coupling on the joint and to assure control of the gap between tube ends.

A cleaning process is required to prepare the tube and tube ends for braze.

2.2 Sizing: The proper roll-a-finish size tool and split holding clamp should be set up on the sizing equipment. Secure tube in clamp and size tube ends. (A. sample piece of tubing should be run first to see if the roll-a-finish tool is set correctly to give the required diameter; this is especially true when sizing tubing of the same diameter, but of different wall thickness.)

2.3 Tube end should be wiped clean of all oil.

2.4 Tube end to be brazed should be roughened using 180 emery cloth. Tube end after sizing has too smooth a finish for brazing.

2.5 Some means of marking the tube end prior to final clean should be done now. A suggested method for use is an electric etch similar to that used for putting an identifying number on a tube.

2.6 Tube and tube end should now be cleaned to your specification, capped and bagged for brazing.

Inspection - Visual and Dimensional

3.1 Purpose: To provide the assembly inspector with an instruction by which to interpret and perform the various inspection functions necessary to assure successful processing of high integrity leak proof braze joints.

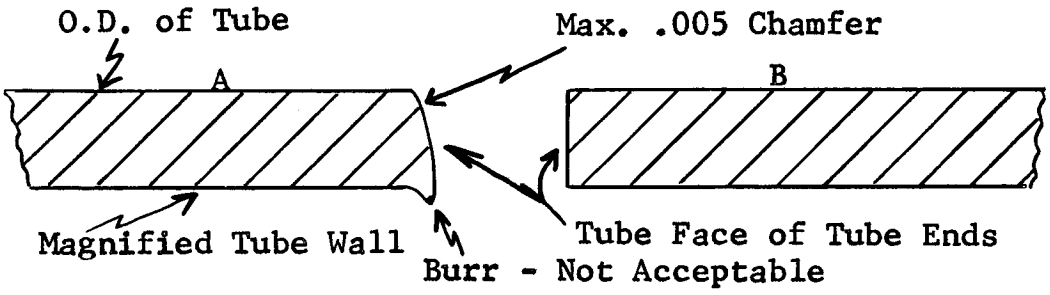
3.2 Preassembly Inspections - Tubing Only: Visual, inspect the tubing for dents. No dents allowed over a 2" length measured from tube end. No radius within the dent or between the dent and its adjacent tube surface shall be less than three times the nominal tube wall-thickness. Depth of dents not to exceed 10% of outside tube diameter. No dents allowed in bend radii or within one tube diameter of tangent points. More than two dents in any given axial inch of tube length is not allowed except on high pressure tubing. On high pressure tubing more than two dents in any given three consecutive axial inches of tube length is not allowed.

3.3 Visual: Inspect the tube ends and tubing for nicks and scratches. Depth of 10% of wall thickness on all but high pressure tubing. On hydraulic tubing, use 5% of wall thickness or .002 whichever is smaller.

3.4 Visual: Out of roundness shall not exceed 10% of the tube diameter over 1.75" length measured from the tube end.

3.5 Visual: Tube End - Inspect the trimmed tube end for squareness of the face, freedom of burrs in the I.D. and a maximum of .005 chamfer on the O.D. of the face. See Sketch V.

SKETCH V



Note: A) Not Acceptable
B) Acceptable

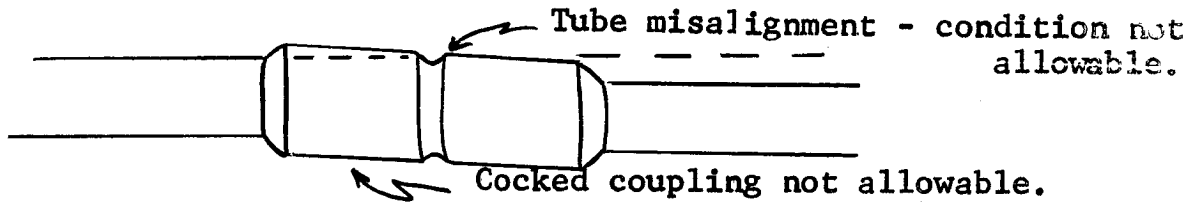
Use a brass scribe on the I.D. of tube ends if necessary to pick up the burr.

3.6 Visual: Corrosion - Inspect for rust or any form of dirty scale on tube O.D. - not allowed.

3.7 Visual: Centering Marks - Inspect the tube O.D. for presence of the coupling and tool centering marks. The marks (one per tube end) must be clear and distinct.

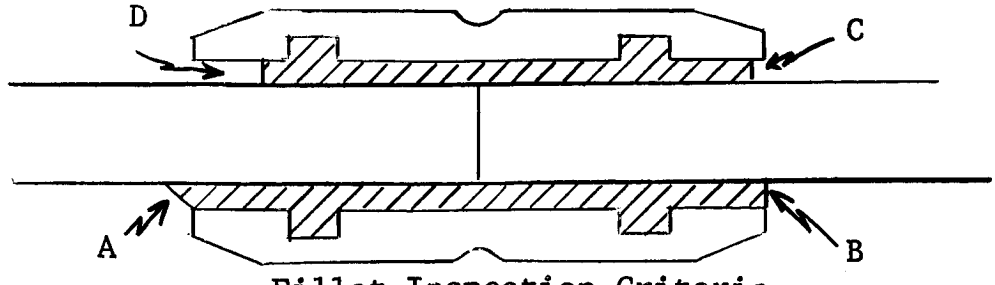
3.8 Final Braze Inspection: Visual - Inspect the brazed joint for tube misalignment and cocked coupling. See Sketch VI.

SKETCH VI



Visual: Using a localized light and a plain or magnifying mirror as needed, inspect the joint for evidence of a braze alloy fillet around the external tube/coupling entrance periphery; no gaps, voids or pinholes allowed. See Sketch VII.

SKETCH VII



Fillet Inspection Criteria

A. Braze alloy extends beyond edge of coupling. Fillet is palinly visible. This is acceptable.

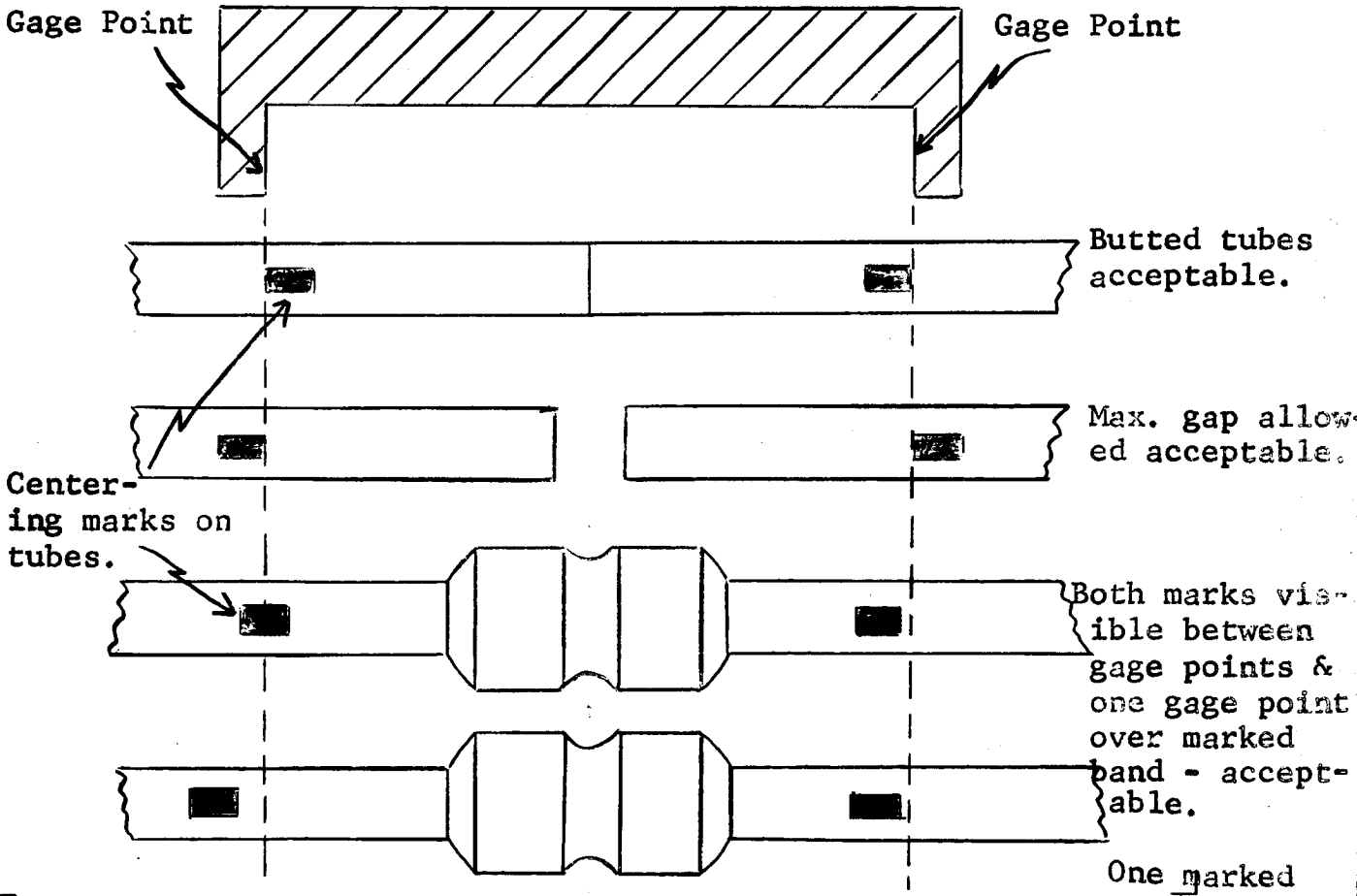
B. Braze alloy extends to the edge of coupling. Fillet is acceptable, if visible through a light and/or 10X glass.

C. Braze alloy extends to the edge of coupling. Fillet requires light and 10X glass to see it. This is acceptable. Under cut must not exceed .03125.

D. Braze alloy is not visible with light and 10X glass. Braze joint is not acceptable.

3.9 Dimensional: On coupling centering and tube gap. Using a fixture as shown in Sketch VIII inspect brazed tube joint.

SKETCH VIII



4.1 Repair Procedure: This suggested repair procedure is for the repair of braze joints which after the first induction cycle with internally preplaced braze rings do not exhibit the presence of braze alloy completely around the tube/coupling interstice.

4.2 By visual inspection and measurements the sum total length of all voids at one coupling tube intersection must be less than the following lengths as measured circumferentially around the tube.

Joint Size	Max. Limit Inches
1/4"	5/32"
3/4"	15/32"
1 1/4"	5/8"
1 1/2"	3/4"
2"	1"
2 1/2"	1"

4.3 Locally clean the voided area - flush with distilled water. Flush with suitable solvent and let dry.

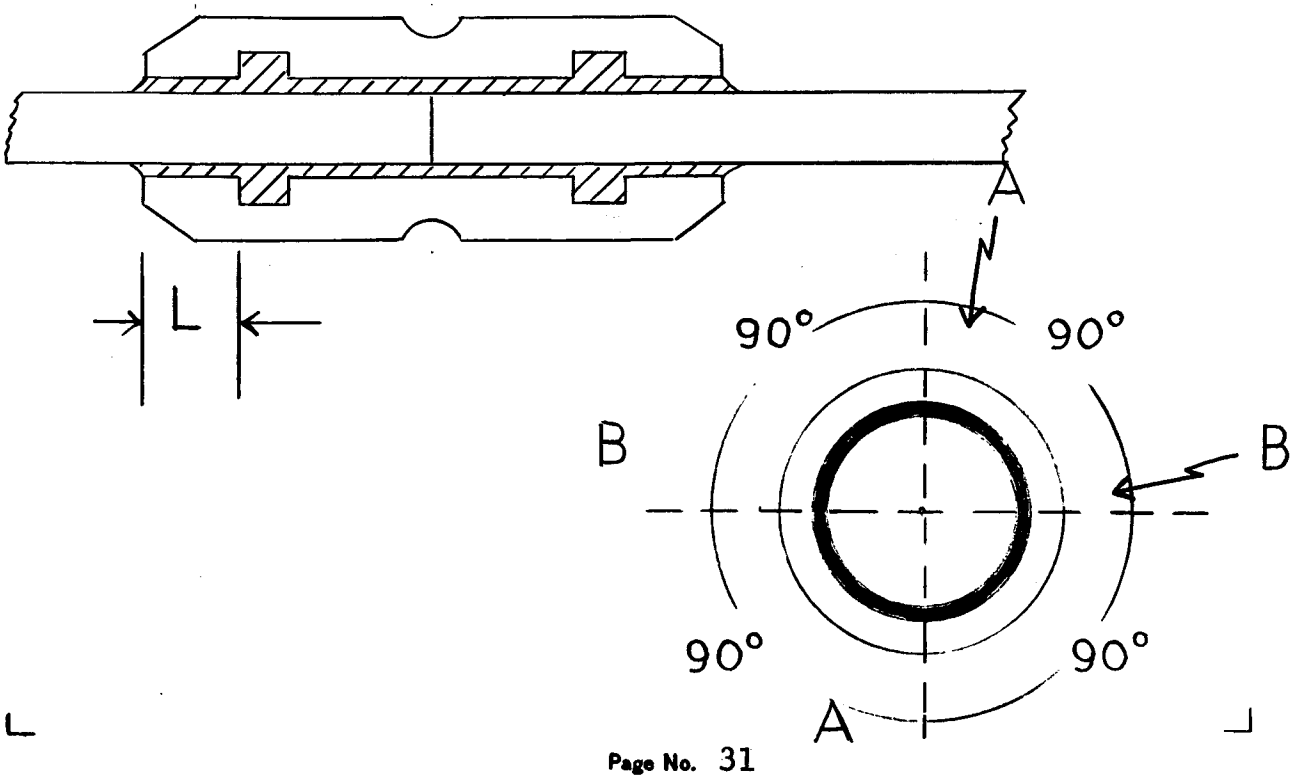
4.4 Wearing clean lint free gloves place a braze ring on the tube adjacent to the coupling side which is voided. No more than one braze ring per coupling side allowed.

4.5 Purge joint in question sufficient time to achieve a good argon atmosphere - being sure all of solvent has evaporated. Repeat the brazing procedure assuring flow of external ring. No more than one reheat per joint allowed.

4.6 Visual Inspection: Visual inspect each joint using a localized light and a magnifying mirror. Joint must show evidence of a braze alloy fillet 360° around the external tube coupling entrance periphery; with no gaps, voids or pinholes. Examine questionable areas with a 10X magnifying glass. See Sketch VII of an acceptable joint.

4.7 X-ray the joint in two planes 90° apart. Inspect for voids in length L shown in Sketch IX. X-ray acceptable limits are defined in Table I.

SKETCH IX



X-ray inspection in plane A-A and B-B. The cumulative length of voids in one length "L" shall be considered one indication in Table I. Joints subjected to repair which do not meet this criteria after repair will be cut out and rebrazed.

TABLE I

Tubing Size	Allowable Limits
1/4" Dia.	One (1) .035" and three (3) .018 indications allowed per coupling end.
3/4" Dia.	One (1) .077" and three (3) .038 indications allowed per coupling end.
1 1/4" Dia.	One (1) .107" and three (3) .053 indications allowed per coupling end.
1 1/2" Dia.	One (1) .137" and three (3) .063 indications allowed per coupling end.
2" Dia.	One (1) .154" and three (3) .080 indications allowed per coupling end.
2 1/2" Dia.	One (1) .171" and three (3) .098 indications allowed per coupling end.

No voids allowed within .015" of outboard ends of coupling.

5.0 Debraze

5.1 Purpose: To facilitate disassembly, repair or replacement of the brazed tubing.

5.2 Cut coupling in half and deburr tube ends.

Note: A nylon brush may be used to prevent entry of chips during the deburring operation.

5.3 Be sure tube is free of all fuel, oil or contaminants. Purge inside of tubing with argon until a good atmosphere is achieved.

5.4 Clamp on debrazing tool and heat coupling until it is hot enough to be removed. After removal of half coupling the

tube end must be cleaned prior to brazing.