Instruction Manual

ELECTRON BEAM SOURCE

MODEL TIH-270

AIRCO® Temescal

2850 Seventh Street, Berkeley, California 94710

ELECTRON BEAM SOURCE

MODEL TIH-270

FOR FOUR POSITION E.B. SOURCES

AIRCO TEMESCAL MODEL NO. 40-6028-550

NOVEMBER 1970

MADE IN U.S.A.

M-155

INSTRUCTION MANUAL
270° SOURCE
MODEL 40-6028-550

CAUTION: DO NOT OPERATE THIS SOURCE AT MORE THAN 5 KW POWER WHEN EVAPORATING ALUMINUM.

- DANGER -

This source is ordinarily connected to a power supply operating at 10,000 volts. Contact with this voltage can be fatal. Refer to power supply instructions for precautions. Before working in high-voltage areas, make sure that main switches are disconnected and grounding hooks are in place.

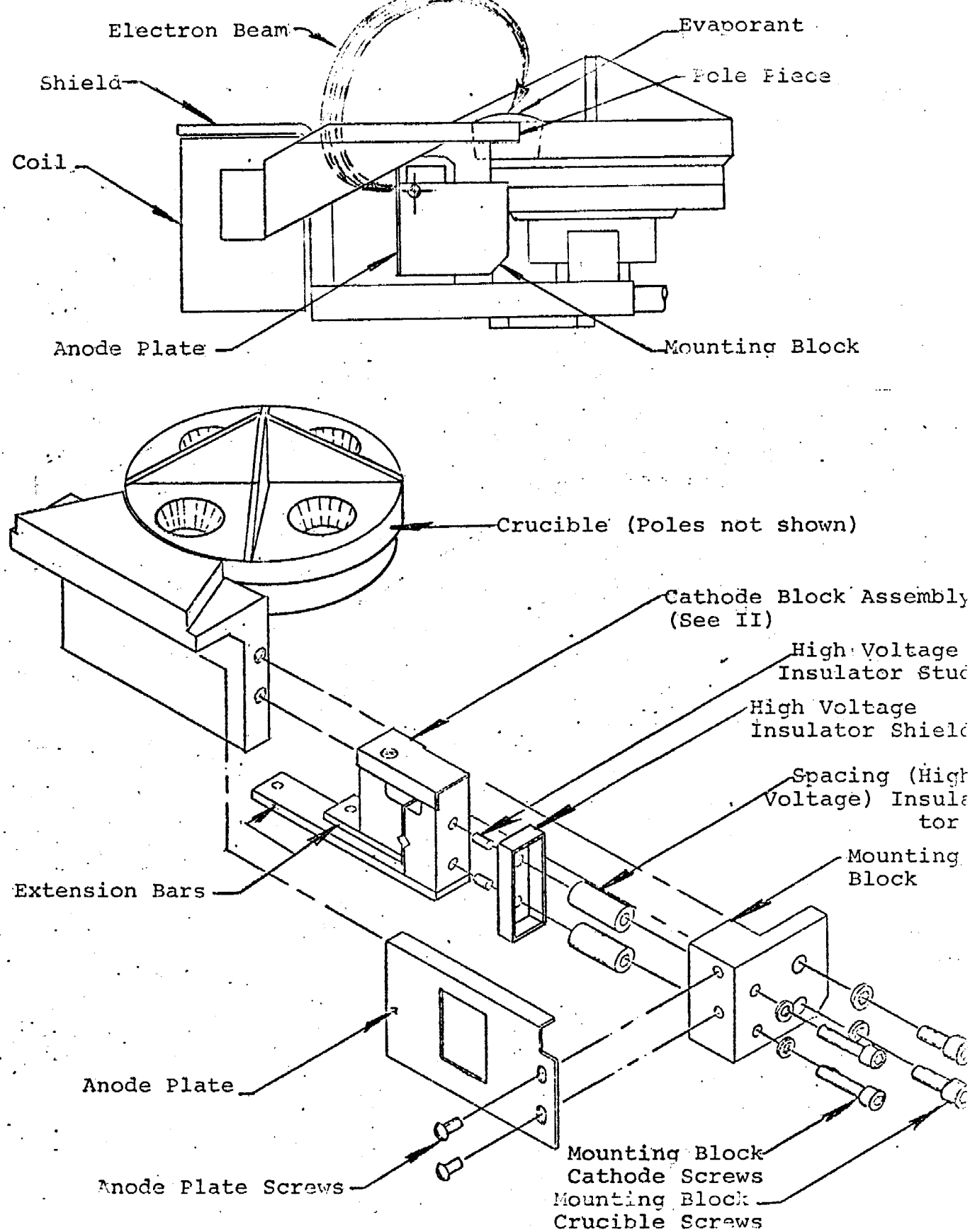
This source is covered by U.S. Patents 3,235,647, 3,177,535, 3,535,428, and 3,390,222.

DANGER

THIS SOURCE IS ORDINARILY CONNECTED TO A POWER SUPPLY OPERATING AT 10,000 VOLTS. CONTACT WITHTHIS VOLTAGE CAN BE FATAL. REFER TO POWER SUPPLY INSTRUCTIONS FOR PRECAUTIONS.

BEFORE WORKING IN HIGH VOLTAGE AREAS, MAKE SURE THAT MAIN SWITCHES ARE DISCONNECTED AND GROUNDING HOOKS IN PLACE.

DANGER



GUN ASSEMBLY

I

I. BASIC PRINCIPLES AND SPECIFICATIONS

A. BASIC PRINCIPLES

The Airco Temescal electron-beam source operates on principles not greatly different from a cathode-ray tube. The cathode (filament) is operated at a negative high-voltage potential; and the electrons are accelerated to the crucible, which is at ground potential. The tungsten filament is heated to incandescence, causing electrons to be emitted in random directions. Thus, emission current is controlled by varying filament current. The filament is set in a cavity bounded by cathode blocks and a beam former, all at cathode potential. Space charges are formed by the emitted electrons at the back, bottom, and top of the cavity, forcing electrons emitted in these directions to return to the filament. Only electrons emitted at the front of the cavity escape. These are accelerated by the anode potential through a hole in the anode plate. During the acceleration they are also focused, the plate operating somewhat as a single aperture lens. Past the anode plate, the electron beam is both deflected and further focused by a magnetic field onto a small spot on the evaporant metal in the crucible.

The full description of this source is: Electron-Beam-Heated Vapor Source with 270° Magnetic Deflection.

B. SPECIFICATIONS

Maximum Accelerating Voltage: 10,000 V DC
Maximum Gun Power: 10KW (1 amp at 10,000 V DC)
Minimum Water Flow @ 25° C: 2 gpm

Maximum Water Pressure: 100 psig
Focus coil Voltage: 18 V DC
Current: 1.2 amp normal
3.0 amp maximum
Lateral sweep (dither) voltage: 28 volts peak-to-peak maximum
current: 2.5 amp maximum

Filament No. 202 - 3231 (.030 in. dia. x 6 turns)
Maximum Voltage: 6 V AC
Current: 28 - 35 amp.
Source is compatible with CV-10 and ES-6 power supplies.

Rotary Drive: 10 in. lb. intermittent torque.

II. INSTALLATION

Electrical conductor sizes below are based on a current density of 1000 amperes/sq. in. in vacuum.

HIGH VOLTAGE LEADS (2 required)

In Vacuum: For .030 in. dia. filament, 35 amp. max. -- Use 1/16 x 1/2 copper strap or 7/32 in. dia. copper bar. Flexible leads of a similar cross-sectional area may be advantageous provided they are properly supported.

In Atmosphere: Size by conventional practice for filament current.

SPACING BETWEEN HIGH-VOLTAGE LEADS AND GROUND

In Vacuum: 1/2 in.

In Atmosphere: 1-1/2 to 2 in. (for 10,000 volts). Use the lower value for dry climates, the higher for humid climates.

COIL LEADS

In Vacuum: Focus Coil Leads (2 required) 3 amp. max. -- Use 16 AWG wire. Dither Coil Leads (2 reqd.) 2.5 amp. max. -- Use 16 AWG wire. Coil Lead Sleeving -- none recommended.

In Atmosphere: Size by conventional practice.

Note: Polarity of focus coil leads is marked on coil "+" and "-" on the "N" end of the coil. Make sure that proper connection is made to the power supply, as reversed polarity will cause beam to reverse and possibly destroy the source.

GROUNDING

The system and power supply must be joined to a good common ground, either earth ground or copper water piping. Galvanized piping is marginal. Ordinarily the crucible is grounded through mounting plate, chamber, and back to power supply through low-impedance grounding strap. Use full filament current in sizing strap.

SHUTTER

The shape of the electron-beam path requires that the shutter be no less than 3 inches above the source A greater distance will result in less heating of the shutter.

III. STARTUP PROCEDURE

There are four controlled variables: emission voltage, emission current, filament current, and focus current. Cooling water to the crucible is not varied, but must be on at all times when the gun is operated to prevent melting the crucible.

Emission voltage may be fixed or variable, depending on the power supply. Focus current (coil current) moves the beam spot closer or further away from the coil. Power in watts is equal to emission volts x emission current.

TO START UP SOURCE:

1. With chamber at atmosphere, place metal in crucible (or rod in mechanism, if rod-fed type). If insufficient metal is in place, beam will melt crucible. The crucible should be at least half full.

2. Check that cooling water is going through the crucible.

3. Evacuate chamber to 1×10^{-4} torr, (0.1 micron) or less. (Source may be operated as high as 10^{-3} torr, but with shortened filament and insulator life.)

4. a. Turn focus current knob to lowest setting.
   b. Turn on focus current.
   c. Adjust focus current to 1.2 amperes, or what experience shows will direct beam to crucible center.

5. a. Turn emission current knob to lowest setting.
   b. Turn on gun filament.

6. a. Turn emission voltage knob to operating voltage.
   b. Turn on emission voltage.

7. Fluorescence should now be seen on or near the evaporant. (If none appears, polarity of coil may have been reversed, causing beam to turn down from filament instead of up. Check whether fluorescence is visible below gun and reverse coil connections if necessary.) Adjust focus current so that fluorescence is centered on evaporant.

8. Increase emission current slowly until a beam spot appears in the fluorescent area. Adjust focus current as necessary so that first fluorescence and then beam spot remain always on evaporant center, not on crucible. A beam spot on the crucible will evaporate metal from crucible. Increasing focus current brings the spot closer to the coil.

9. Increase emission current to desired power level.

Source is now ready to operate. If trouble is experienced at any point, refer to Trouble-Shooting Chart, Section V.

IV. MAINTENANCE CHART
270° SOURCE

1. Each Time Gun Is Brought to Air:

   A. INSPECT HIGH-VOLTAGE INSULATORS.
   B. INSPECT FILAMENT.

2. Periodically:

   A. INSPECT OTHER INSULATORS.
   B. CLEAN GUN.

3. At All Times:

   WHEN REINSERTING THREADED FASTENERS, USE MOLYBDENUM DISULFIDE. (See below for type.)

Explanation

INSULATORS (1A and 2A):

The 2 high-voltage insulators may be inspected visually; it is not necessary to disassemble gun.

The remaining 3 insulators (upper cathode insulator, lower cathode insulator, and cathode block screw insulator) are not exposed to high voltage and need to be inspected only periodically.

If an insulator is cracked, replace it.

If an insulator is fouled, it may be cleaned. The generally preferred method is by air blast with glass-bead honing powder. An alternative is wet-scrubbing with an abrasive cleaner such as "Ajax." (Insulators are vacuum grade and impervious.) Acids are not generally effective except for a mild etch of hydrofluoric.

FILAMENT (1B):

If filament is used up, as evidenced by reduced area at center of turns, replace. High-pressure operation reduces filament life drastically. To replace a filament, see Section VI.

CLEANING (2B)

How often this must be done depends on severity of operation. A metal deposit building up across a close clearance will cause a short circuit. For assembly/disassembly instructions, see Section VI.

THREAD LUBRICATION (3):

Use molybdenum disulfide on all threads each time a fastener is removed and reinserted. This will prevent seizure at the high temperatures involved. Use either (1) dry type, or (2) spray or liquid with water, Freon, or other volatile solvent. AVOID oil-based type, as the oil will create an outgassing problem.

V. TROUBLE-SHOOTING CHART

SYMPTOM			MOST LIKELY TROUBLE	CORRECTION
Emission		Fila.		
KV	AMP	AMP		
	normal:			
4-10	.1-1	28-35		
OK	0	0	1) Filament loose.	1) Check that filament is properly positioned (See Sect. VI, E3), check that cathode block screw is tight.
			or	
			2) Break in filament circuit or power supply.	2) Check filament circuit and power supply.
0	1	OK	High-resistance ground in system or gun.	Check system, starting with feedthroughs.
0	0	OK	Power supply.	Check power supply.
Emission volt. and amp, kicking up and down (plus visible arcing or heat at high-volt. insulators).			High-voltage insulators fouled or failed.	Examine insulators: a) If fouled by metal deposits, clean by glass bead hone. b) If physically damaged, replace.
OK	OK	High	Filament helix shorted.	Replace filament (cannot repair).
OK	OK	OK	Coil current unadjusted.	Adjust coil current.
Beam spot not centered in longitudinal direction.				
OK	OK	OK	1) Parts not in correct alignment.	1) Check that all parts are tight and snug, and that filament is correctly inserted and is not warped or sagging.
Beam spot not centered in lateral direction or tails on one side of the spot.			or	
			2) Pole Pieces or other parts damaged.	2) Repair or replace damaged parts.

NOTE: Apply molybdenum disulfide (see Section IV for type) to all threads whenever a fastener is removed and reinserted.

VI. ASSEMPLY/DISASSEMBLY INSTRUCTIONS

- DANGER -

High voltage can be fatal. Before doing wiring in high-voltage area, make sure that the mainswitch to the power supply is off. Always use grounding hooks.

A. To Detach Cathode Block Assembly from Crucible.
Refer to Sketch I "Gun Assembly."

1. Check that main switch to power supply is off and grounding hooks are in place.

2. Disconnect electrical leads from upper and lower filament extension bars.

3. Detach mounting block from crucible by removing 2 mounting block crucible screws and washers A, as shown.

Gun assembly, comprising mounting block, anode plate, cathode block assembly, and high-voltage insulators, has now been detached from the crucible and may be removed from the vacuum chamber. To detach cathode-block assembly from mounting plate:

4. Remove 2 mounting-block cathode screws and washers B, as shown.

B. To Remove Filament.
Refer to Sketch II "Cathode Block Assembly."

1. Take off beam former by removing beam-former screw. (Observe how filament is held against cathode blocks by upper cathode insulator. When filament is replaced, it must be in the same position.)

2. Loosen cathode-block screw (not necessary to remove).

3. Pull out filament.

C. To Disassemble Cathode-Block Assembly.
Refer to Sketch II "Cathode-Block Assembly"

1. Set assembly on a flat surface.

2. Remove cathode-block screw and cathode-block screw insulator.

3. Pull cathode blocks apart and remove upper and lower cathode insulators.

4. Remove high-voltage insulators from right cathode block by rotating with pliers. (High-voltage insulators are held by cathode studs in right cathode block.)

Disassembly is now complete except for the anode plate which is attached to the mounting block. To detach anode plate:

5. Remove 2 anode-plate screws C, as shown on Sketch I.

D. To Assemble Cathode-Block Assembly.
Refer to Sketch II "Cathode-Block Assembly."

1. Place high-voltage insulator shield on cathode studs.

2. Place high-voltage insulators over shield and screw onto cathode studs by rotating with pliers.

3. Place upper and lower insulators in position, pressing the cathode blocks together by hand.

4. Position cathode-block screw insulator. Insert cathode-block screw and screw cathode blocks together against upper and lower cathode insulators.

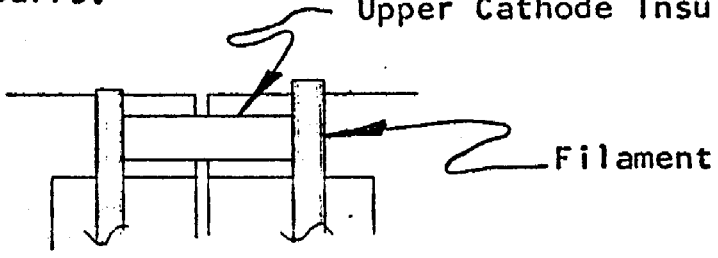
E. To Replace Filament.
Refer to Sketch II "Cathode-Block Assembly."

1. With beam former removed, and upper and lower cathode insulators in slot, adjust cathode-block screw so that the left and right cathode blocks are loosely held together.

2. Insert filament in holes, as shown. (One hole is in left cathode block; one hole in is right cathode block.)

3. Move filament back into holes. HOLD UPPER CATHODE INSULATOR CLEAR SO THAT FILAMENT SLIDES PAST. (It may take a little practice to get this right on the first try.)

NOTE: Make sure that filament ends are parallel and have no burrs.

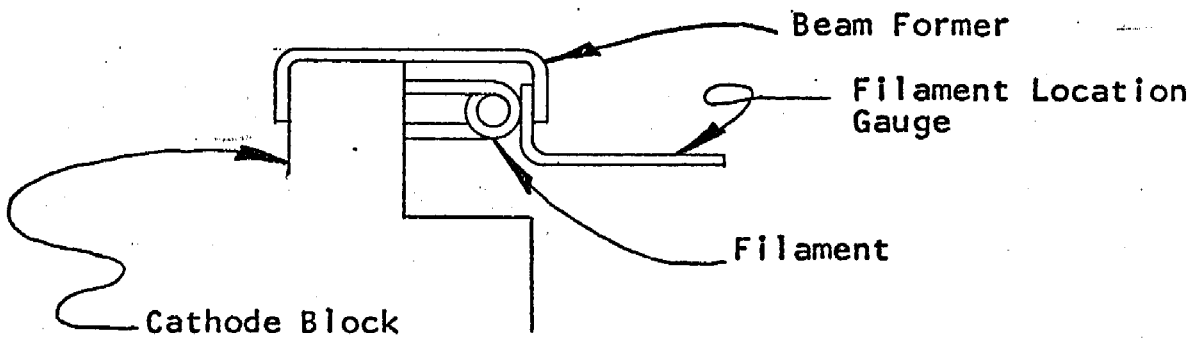


TOP VIEW

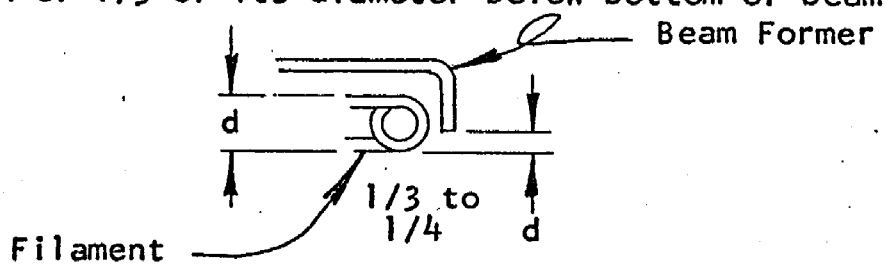
4. Move filament back in its holes until filament ends project past the back of the cathode blocks.

5. Slip beam former onto the left cathode block. Insert beam-former screw and tighten.

6. Use filament location gauge to position filament .015 inches from beam former.



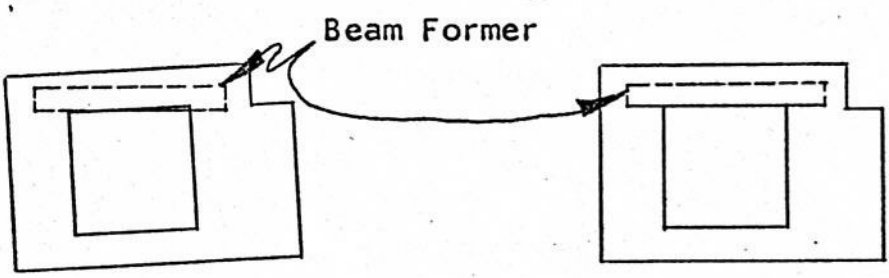
7. Tighten cathode-block screw. Filament should now be 1/4 or 1/3 of its diameter below bottom of beam former.



F. To Attach Cathode Block Assembly to Crucible.
Refer to Sketch I "Gun Assembly."

1. Attach anode plate with two anode-plate screws, as shown.

IMPORTANT -- BEFORE TIGHTENING SCREWS, LINE UP TOP EDGE OF HOLE IN ANODE PLATE WITH BOTTOM EDGE OF BEAM FORMER. ALSO, MAKE CERTAIN THE FILAMENT IS PARALLEL WITH THOSE EDGES.



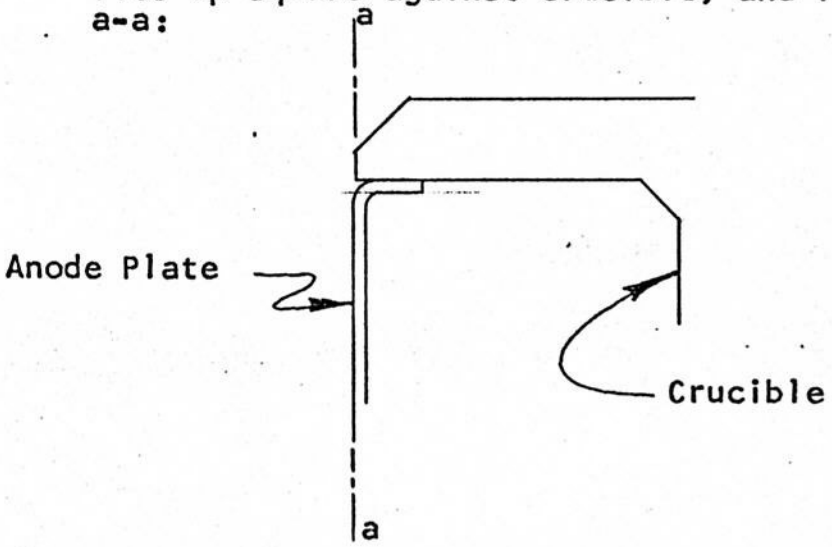
ANODE PLATE COCKED

ANODE PLATE STRAIGHT AND ALIGNED

2. Attach cathode-block assembly to mounting plate. Use 2 mounting-block cathode screws and washers B, as shown.

3. Check that power supply is off.

4. Attach mounting block to crucible. Use 2 mounting-block crucible screws and washers A, as shown. Anode plate fits up square against crucible, and flush along line a-a:



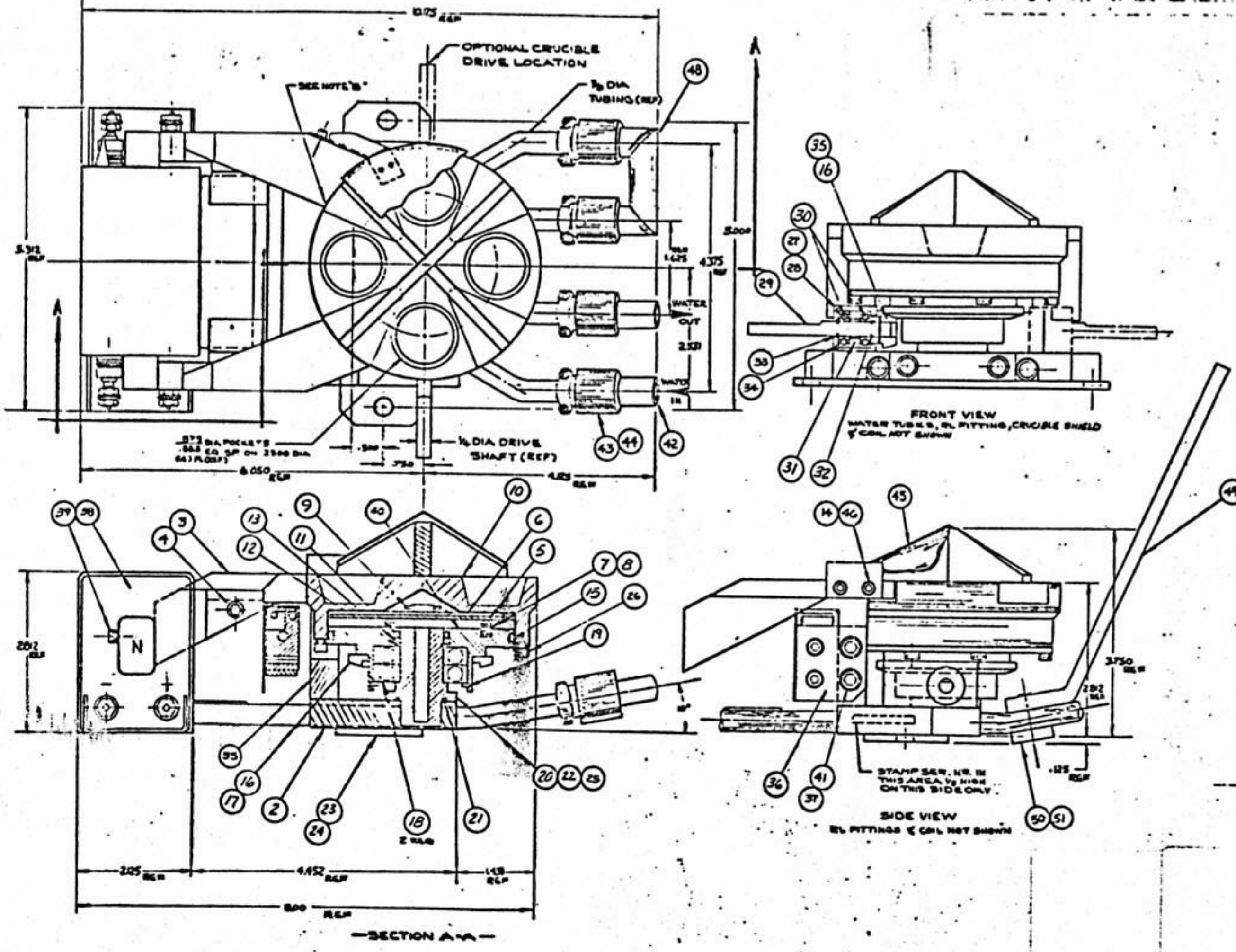
5. Connect electrical leads to upper and lower filament extension bars.

VII. SPARE PARTS

SPARE PARTS KIT (#0202-4321-0)

QUANTITY	PART NO.	DESCRIPTION
5	0202-3231-0	Filament
4	0202-3321-0	Upper Insulator
4	0202-3331-0	Lower Insulator
4	0418-4631-0	Spacing Insulator
2	0202-3341-0	Screw Insulator
1	0202-4121-0	Filament Location Gauge
1	0202-3211-0	Anode Plate
1	0202-3221-0	Beam Former Plate
2	0220-4811-2	3/8 Viton RL Gaskets
1	0202-5051-0	Cathode Block Screw

11/70



ITEM NO.	DWG NO.	DESCRIPTION	MAT'L	QTY
1		TIH 270° EB SOURCE - 4 POCKET		
2	602-8271	BASE ASSY		1
3	602-8173	POST BRAZE ASSY		1
4		SCREW CAP SOC HD 8-32 X 3/8 LG.	SST	2
5	602-7942	WATER PLATE LOWER	SST	1
6	602-7952	WATER DIVERTER	SST	1
7		SPRING LCO32B-1	SST	3
8		FLAT WASHERS	CU	3
9		RETAINING RING TRUARC 5100-37H	SST	1
10	602-8193	CRUCIBLE		1
11		O RING VITON # 210		1
12		RETAINING RING 5100-75H		1
13	302-4611	SPACER		1
14		FLAT WASHER #6-22	SST	4
15		O RING VITON # 234		1
16	302-4662	GEAR MODIFICATION		1
17		SCREW CAP SOC HD 3-48 LG	SST	3
18		BEARING SSR - 12 SPECIALLY CLEANED		2
19		RETAINING RING 5100-162 H	SST	1
20	602-8153	CRUCIBLE SHAFT		1
21		O-RING VITON # 018		1
22		SCREW CAP SOC HD 5-32 - 1/2 LG	SST	3
23	602-8222	MOUNTING BAR		1
24		SCREW FLAT HD 10-32 LG	SST	2
25		SCREW CAP SOC HD 8-32 X 1/2	SST	1
26		SCREW CAP SOC HD 6-32 X LG	SST	8
27	302-4632	DRIVE BLOCK	SST	1
28		SCREW CAP SOC HD 10-32 LG	SST	2
29	302-4621	DRIVE SHAFT		1
30		BEARING SSR - 4 SPECIALLY CLEANED		2
31		SPRING	SST	1
32		RETAINING RING 5100-25H	SST	1
33		RETAINING RING 5103-25A	SST	1
34		RETAINING RING	SST	1
35		ROLL PIN .093 DIA X 1/4 LG	SST	1
36	302-0493	EMITTER ASSY		1
37		FLAT WASHER # 10 - 24 HEAVY	SST	2
38	602-8454	COIL ASSY		1
39		SCREW CAP SOC HD 8-32 X 1 LG	SST	2
40	602-7953	CRUCIBLE BASE		1
41		SCREW CAP SOC HD 10-32 LG	SST	2
42	T364-2	SOLDER NIPPLE	SST	2
43	T4811-2	UNION KNURLED NUT		2
44	T4811-2	GASKET		4
45	302-4633	CRUCIBLE SHIELD	TA	1
46		SCREW CAP SOC HD 6-32 X 1/4 LG	SST	4
47	302-8201	ANGLE BRACKET		1
48	602-8382	WATER CONNECTOR	SST	1
49	302-2432	SECONDARY EMISSION SHIELD		
50	302-2431	NUT PLATE		
51		SCREW CAP SOC HD 8-32 X LG	SST	2
52	[illegible]	SPARE PARTS KIT		1
53		INSTRUCTION MANUAL		
54		POLYETHYLENE BAG 17 X 22		1
55		SCREW CAP SOC HD 10-32 LG	SST	2

NOTES:

1. SLOT ALL SCREWS FULL LENGTH FOR PUMP-OUT & COAT WITH MOLYDISULFIDE
2. VAC-TEST: PUMP OUT THRU WATER TUBE AND CHECK FOR ZERO RESPONSE ON HELIUM LEAK DETECTOR, VAC-TEST AFTER CLEANING, SEE NOTE # 4
3. BEAM-TEST: BEAM "BURN THRU PATTERN" ON GRAPHITE TEST TARGET, NOT TO EXCEED 7/16 DIA USING 2 KW FOR 10 SEC ± 1 SEC
4. CLEAN ASSEMBLED UNIT AFTER BEAM TEST & BEFORE VAC-TEST
5. PLACE (52) (53) & PRINT OF THE ASSY. DWG (602-8554) IN A MANILA ENVELOPE
6. PLACE ASSEMBLED UNIT, W/MANILA ENVELOPE, INTO (54) IN BOX AND PACKAGE FOR SHIPPING
7. BEARINGS TO BE CLEANED PER ES-006
8. GAP BETWEEN ITEMS (5) & (10) SHOULD NOT EXCEED .010" 2 PLACES

APPLIES TO TIH 270 SOURCE - SER # 2162 AND HIGHER
SUPERCEDES DWG 302-4674 - PARTS NOT INTERCHANGEABLE

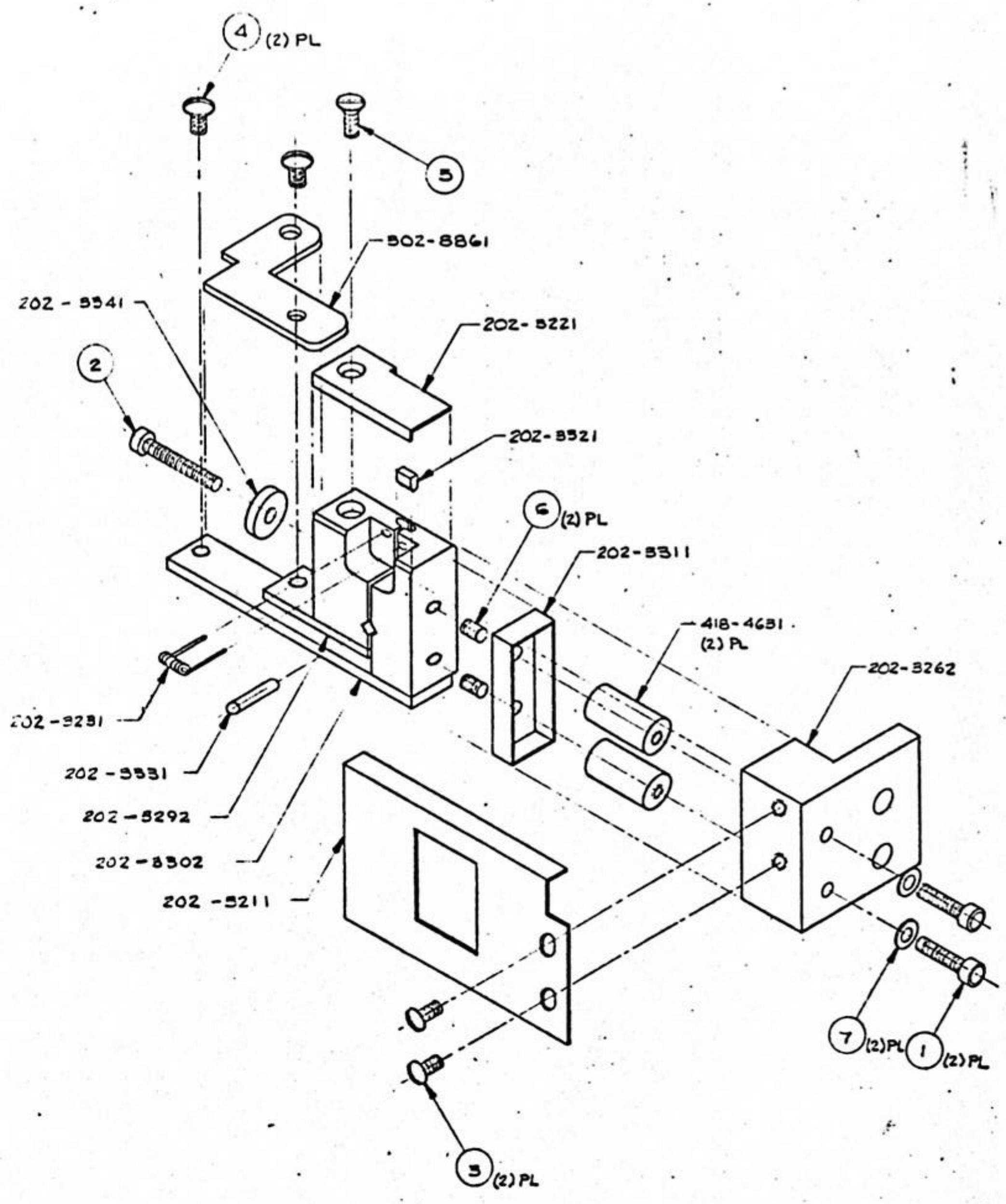
63 ± .005 ± .010

AIRCO Temescal
BERKELEY CALIFORNIA
A DIVISION OF AIR REDUCTION COMPANY INCORPORATED

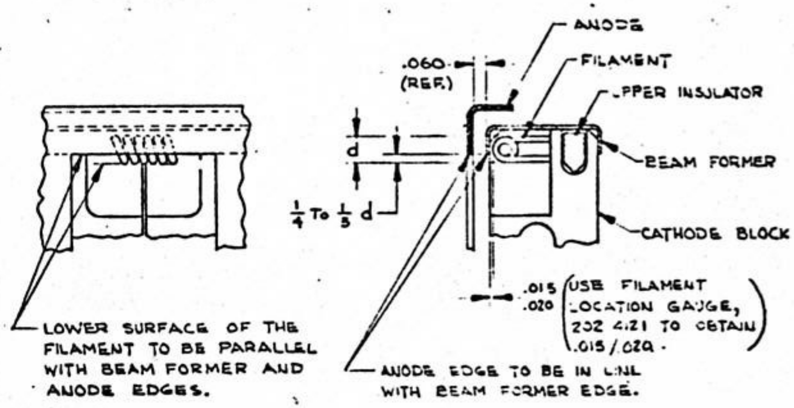
MODEL # 40-6028-550

TIH 270° EB SOURCE - 4 POCKET | 602-855 | 4 | A

A	ECO # 2377			



	202-3211	ANODE PLATE		1
	202-3221	BEAM FORMER		1
	202-3231	FILAMENT		1
	202-3262	MOUNTING BLOCK		1
	202-3292	LEFT CATHODE BLOCK SUB-ASS'Y.		1
	202-3302	RIGHT CATHODE BLOCK SUB-ASS'Y.		1
	202-3311	H.V. INSULATOR SHIELD		1
	202-3321	UPPER INSULATOR		1
	202-3331	LOWER INSULATOR		1
	202-3341	SCREW INSULATOR		1
	302-8861	ANGLE BRACKET		1
	418-4631	SPACING INSULATOR		1
	202-4121	FILAMENT LOCATION GAUGE		REF.
1		SCREW, SOCKET HD. CAP-#6-32NC x 5/8" LG	18-8 SST	2
2		SCREW, SOCKET HD. CAP-#6-32NC x 7/8" LG	18-8 SST	1
3		SCREW, SLOTTED ROUND HD.-#6-32NC x 1/4" LG	18-8 SST	2
4		SCREW, SLOTTED ROUND HD.-#8-32NC x 1/4" LG	18-8 SST	2
5		SCREW, SLOTTED FLAT HD.-#6-32NC x 1/4" LG	18-8 SST	1
6		SET SCREW, HEX SOCKET HD.-#6-32NC x 3/8" LG	18-8 SST	2
7		FLAT WASHER, #6	18-8 SST	2



REV.	DESCRIPTION	BY	DATE	APPVD
D	CHGS MADE PER ECO #... ADD VIEW DEPICTING NECESSARY FILAMENT ADJUSTMENT	RCD	2/14/7?	

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED

FINISH: √ — TOLERANCE: XXX ± ANG ± / XX ± X ± — INTL. RADII — BREAK ALL EDGES — USED ON DWG.: 602-8374, 602-8554

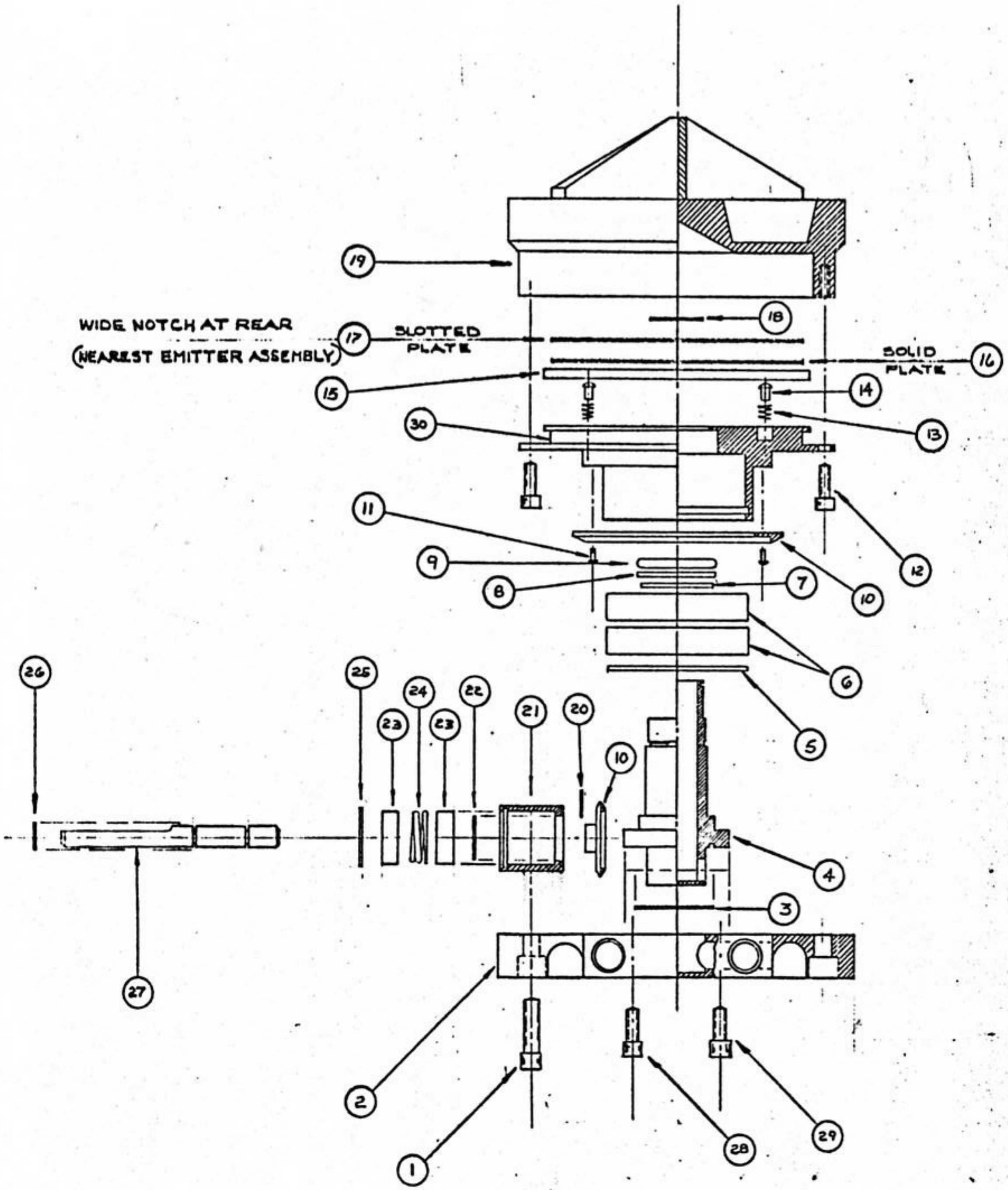
BERKELEY — AIRCO Temescal — CALIFORNIA
A DIVISION OF AIR REDUCTION COMPANY, INCORPORATED

DRAWN BY: R. DERRICK — DATE: 2/14/7? — CHK BY: ET — APP BY: — SCALE: NTS

FIH-270° E B SOURCE

EMITTER ASS'Y

DRAWING NUMBER: 302-0493 — REV: D



1		SCREW CAP SOC HD 6-32 X 5/8 LG	SST	2
2	602-8233	BASE ASS'Y		
3		O-RING - VITON # 018		1
4	602-8153	CRUCIBLE SHAFT		1
5		RETAINING RING # N5000-162 H	SST	1
6		BEARING SSR-12		2
7		RETAINING RING 5108-75 H		1
8	302-4611	SPACER		1
9		O RING VITON # 210		1
10	302-4662	GEAR MODIFICATION		1
11		SCREW CAP SOC HD 3-48 X 5/32 LG	SST	3
12		SCREW CAP SOC HD 6-32 X 3/8 LG	SST	8
13		SPRING .180 DIA X 5/16 LG LC032B-1	SST	3
14		RIVET FLAT HD TINNERS 12 OZ	CU	3
15		O-RING VITON # 244		1
16	602-7942	WATER PLATE LOWER 16 GA (.062) 304	SST	1
17	602-7952	WATER DIVERTER 16 GA (.062) 304	SST	1
18		RETAINING RING TYPE E N5812-43	SST	1
19	602-8193	CRUCIBLE		1
20		ROLL PIN .066 D X 1/2 LG	SST	1
21	302-4652	DRIVE BLOCK	SST	1
22		RETAINING RING 5100-25 H	SST	1
23		BEARING SSR-4		2
24	302-4591	LEE SPRING 7/16 LG # LC035E-1	SST	1
25		RETAINING RING N5000-62 H	SST	1
26		RETAINING RING 5100-25 H	SST	1
27	302-4621	DRIVE SHAFT		1
28		SCREWCAP SOC HD 6-32 X 3/8 LG	SST	3
29		SCREWCAP SOC HD 8-32 X 3/8 LG	SST	1
30	602-7933	CRUCIBLE BASE	SST	1

NOTE:
1. USE LIGHT COATING OF VACUUM GREASE ON O-RINGS
2. SUGGESTED DISASSEMBLY
   A. CRUCIBLE ONLY - REMOVE 8 SCREWS (ITEM 12)
   B. ENTIRE ASSEMBLY - REMOVE 4 SCREWS ITEM 28 & 29

TOLERANCES EXCEPT AS NOTED
INTERNAL RADII — .015 MAX. BREAK ALL EDGES — .005 .015
63 FINISH
DRILLED HOLES UP TO ½ DIA. ±.005 OVER ½ DIA. ±.010
DECIMAL ± FRACTIONAL ± ANGULAR ± ° THREADS CLASS 2
602-8554 USED ON DWG. NO.
DO NOT SCALE DRAWING
BERKELEY AIRCO Temescal CALIFORNIA
A DIVISION OF AIR REDUCTION COMPANY, INCORPORATED
DRAWN BY C. GALINDEZ DATE 2/16/70 CHK'D BY K.S. APP'D BY 125 SCALE FULL
MODEL #40-6028-550
CRUCIBLE & SHAFT ASS'Y
DRAWING NUMBER 602-8369 SIZE 3 REV