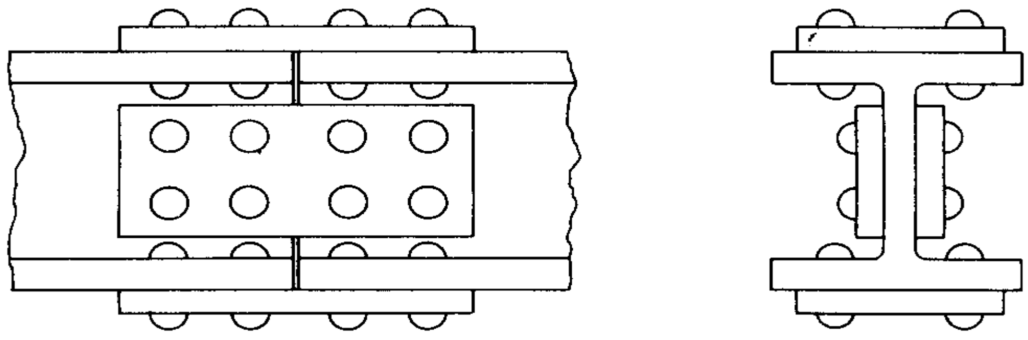
SOLDADURA

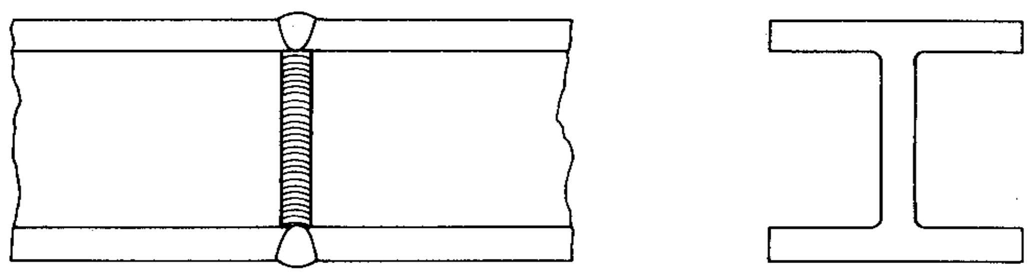
Preparado por

Ing. Boris GUERRERO B.

Soldadura v/s Remaches



RIVETED SPLICE IN WIDE FLANGE MEMBER



WELDED SPLICE IN WIDE FLANGE MEMBER

Unión por Soldadura y por Coplas

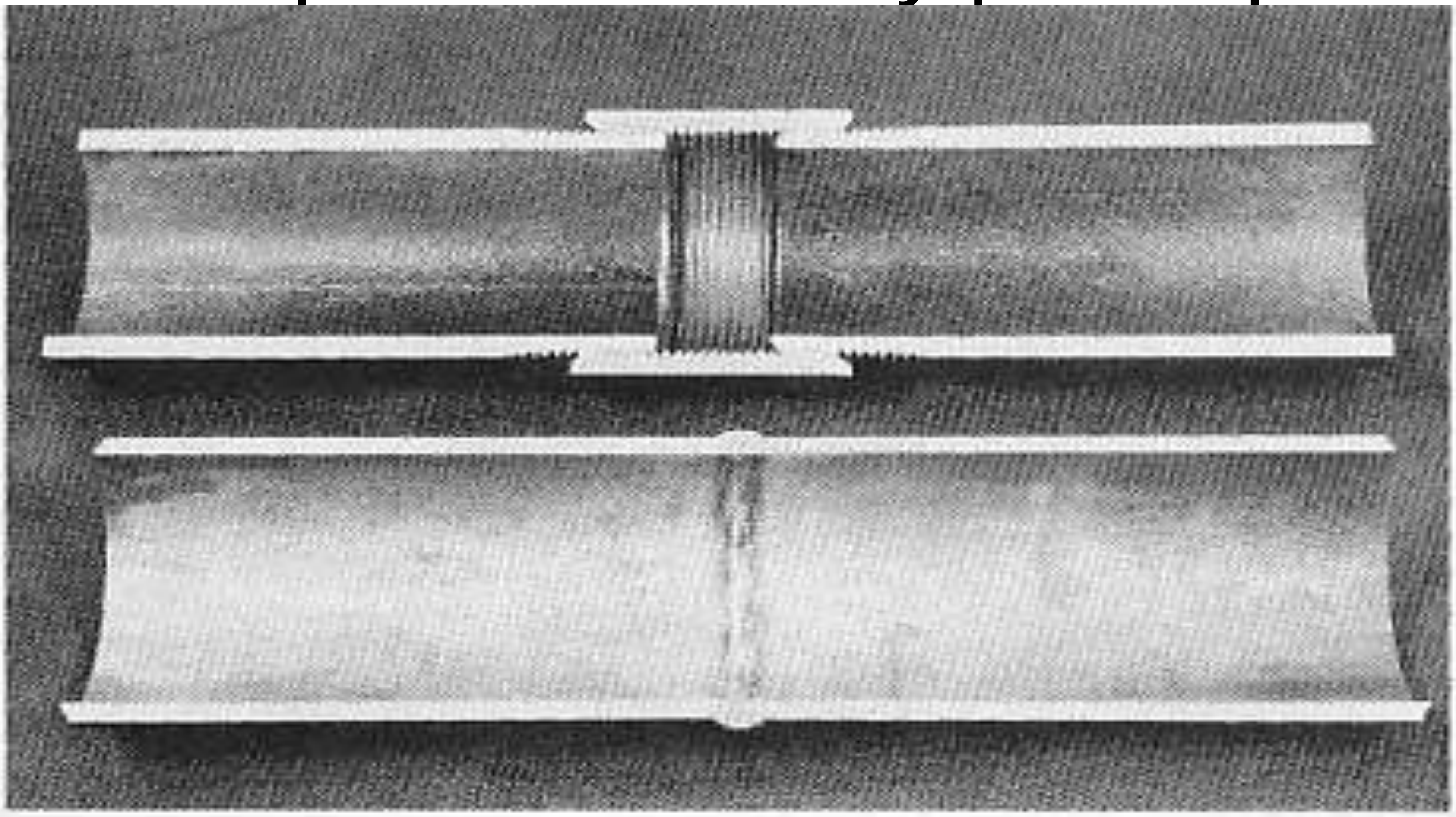
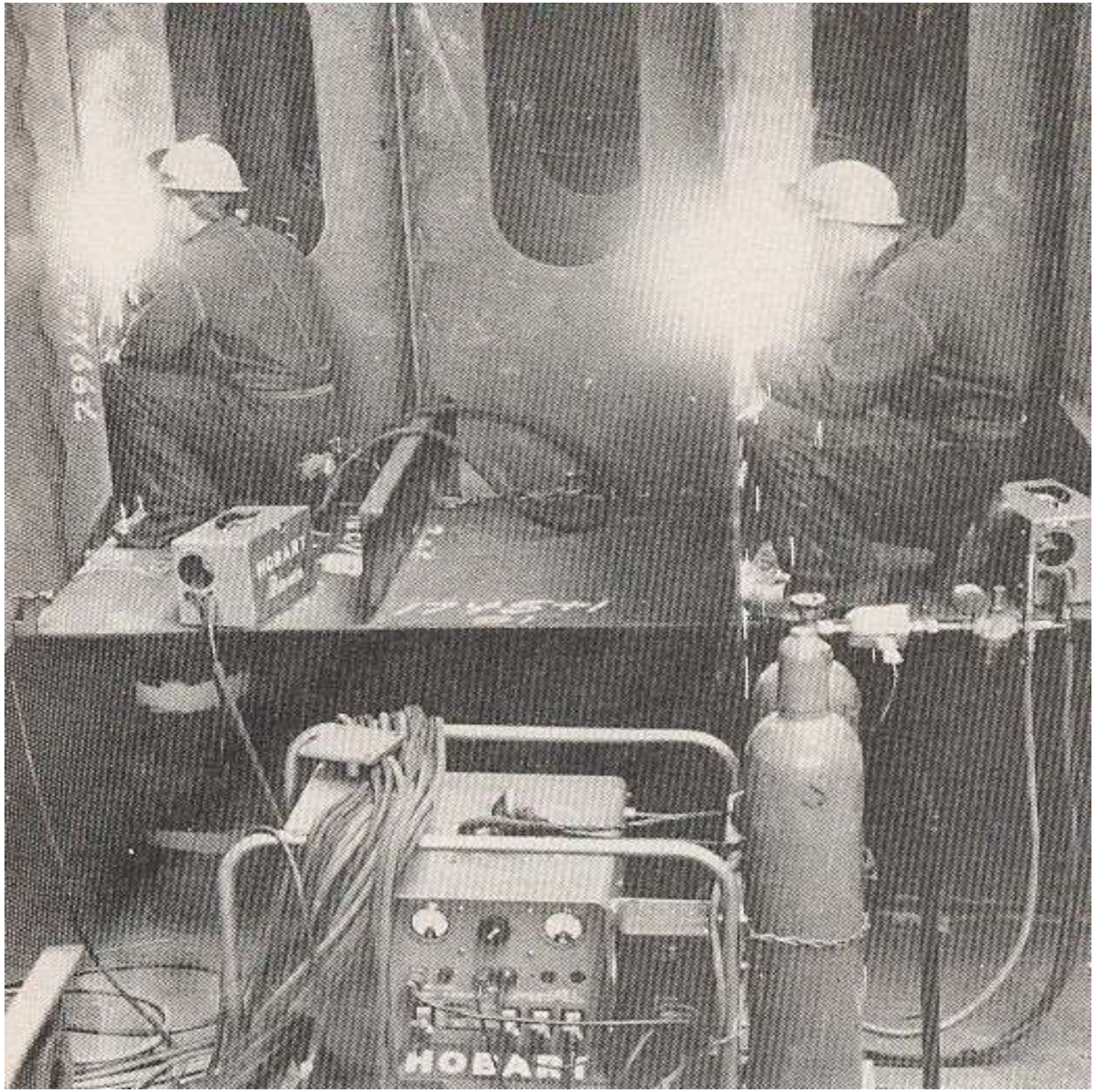
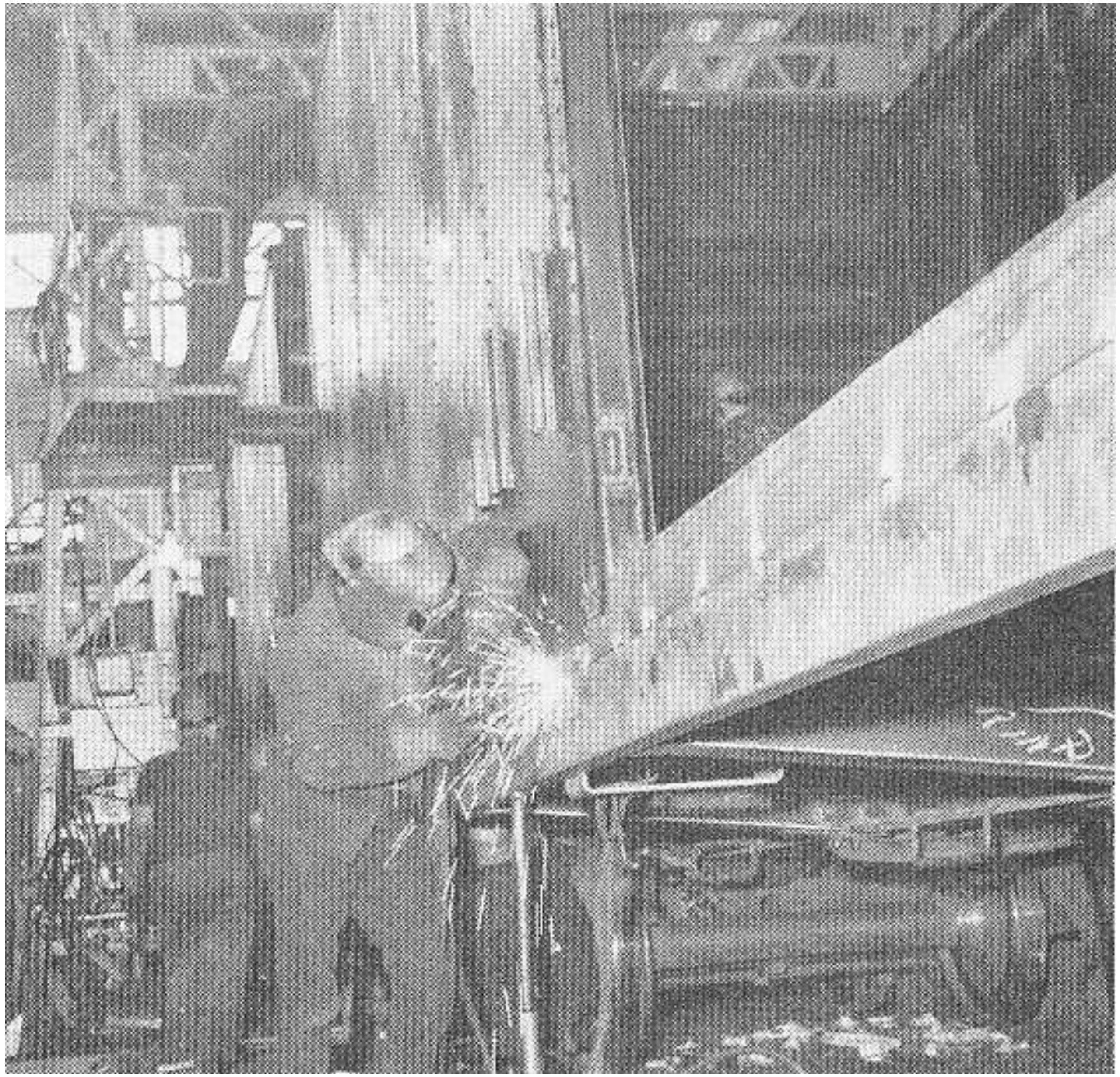
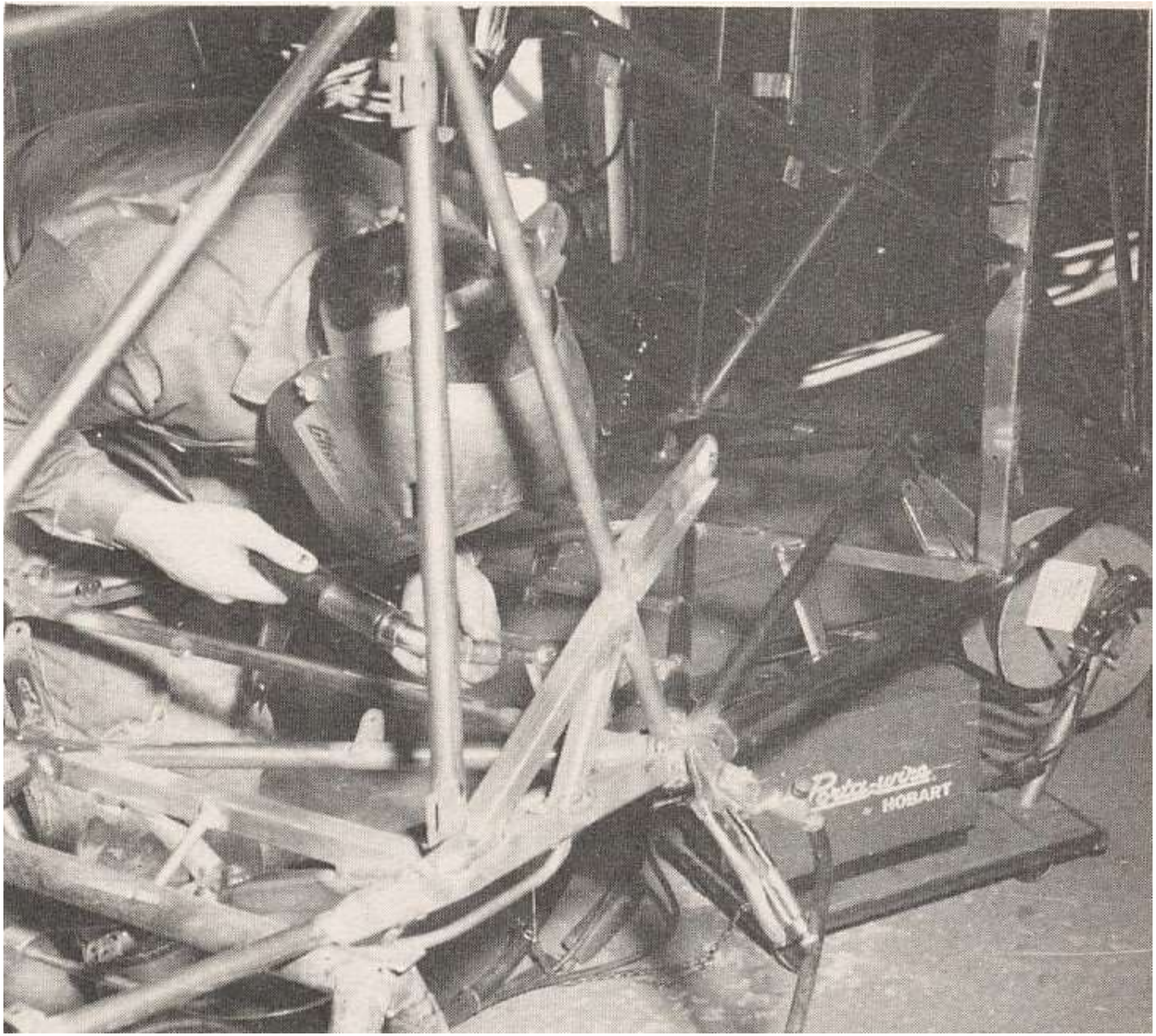


FIGURE 1-2 *Pipe joints welded and threaded.*


HOBART

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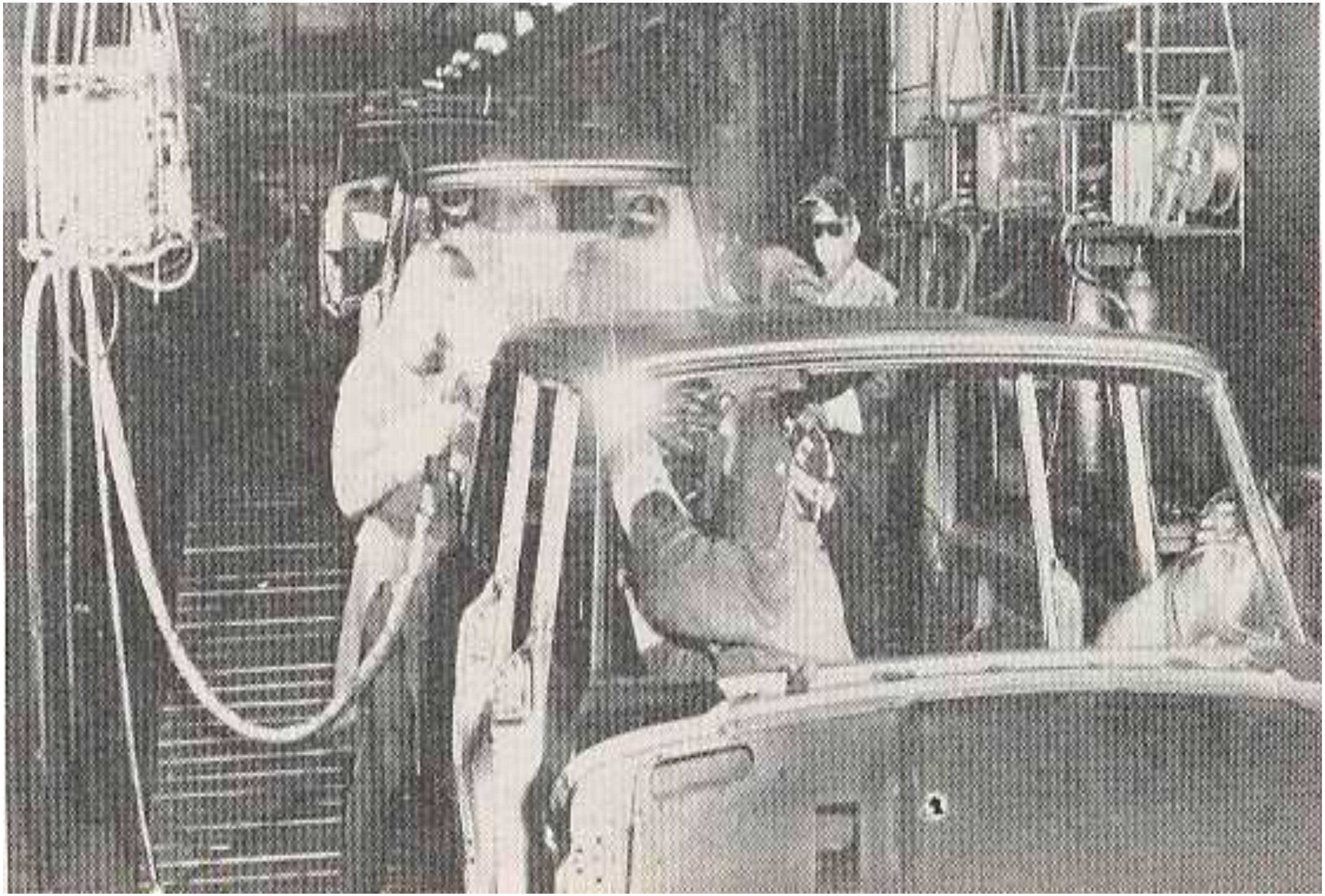


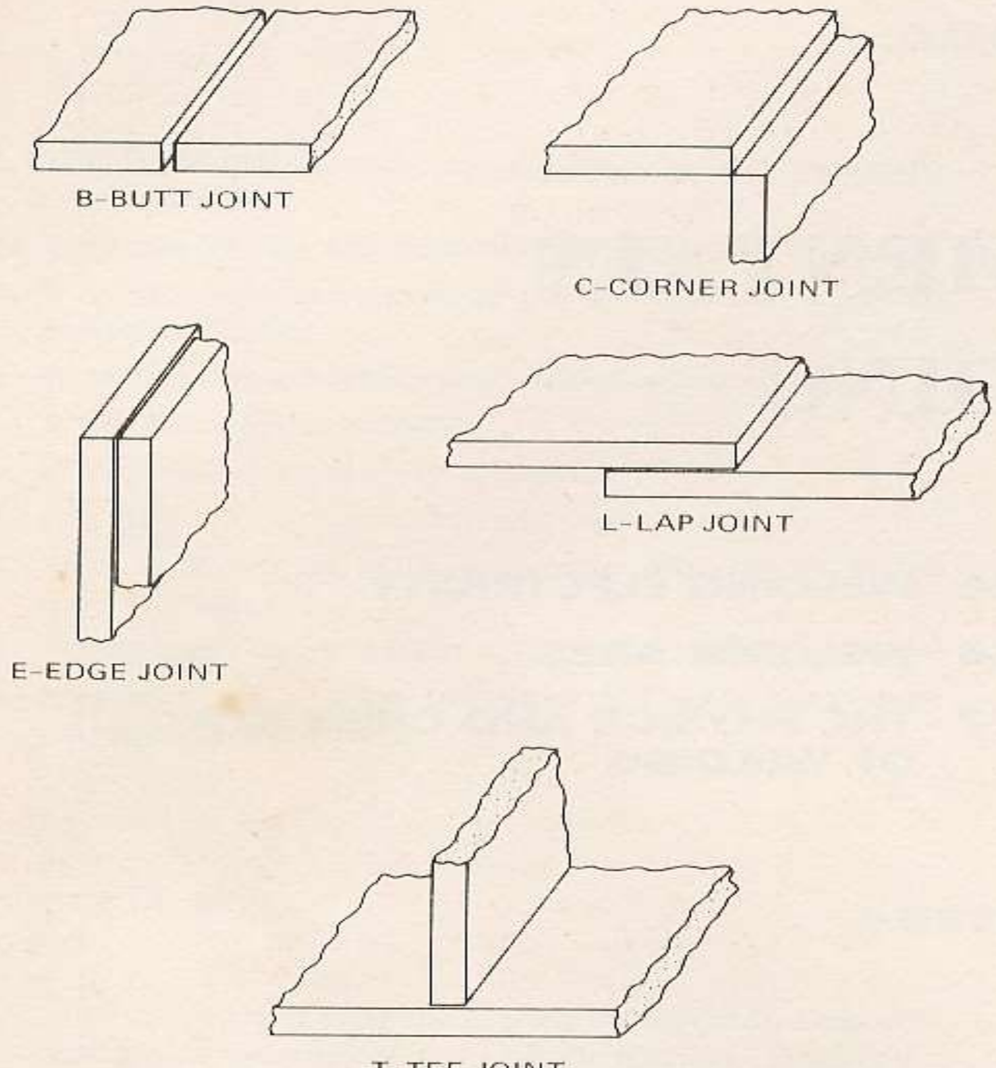


FIGURE 2-1 *The five basic joint designs.*

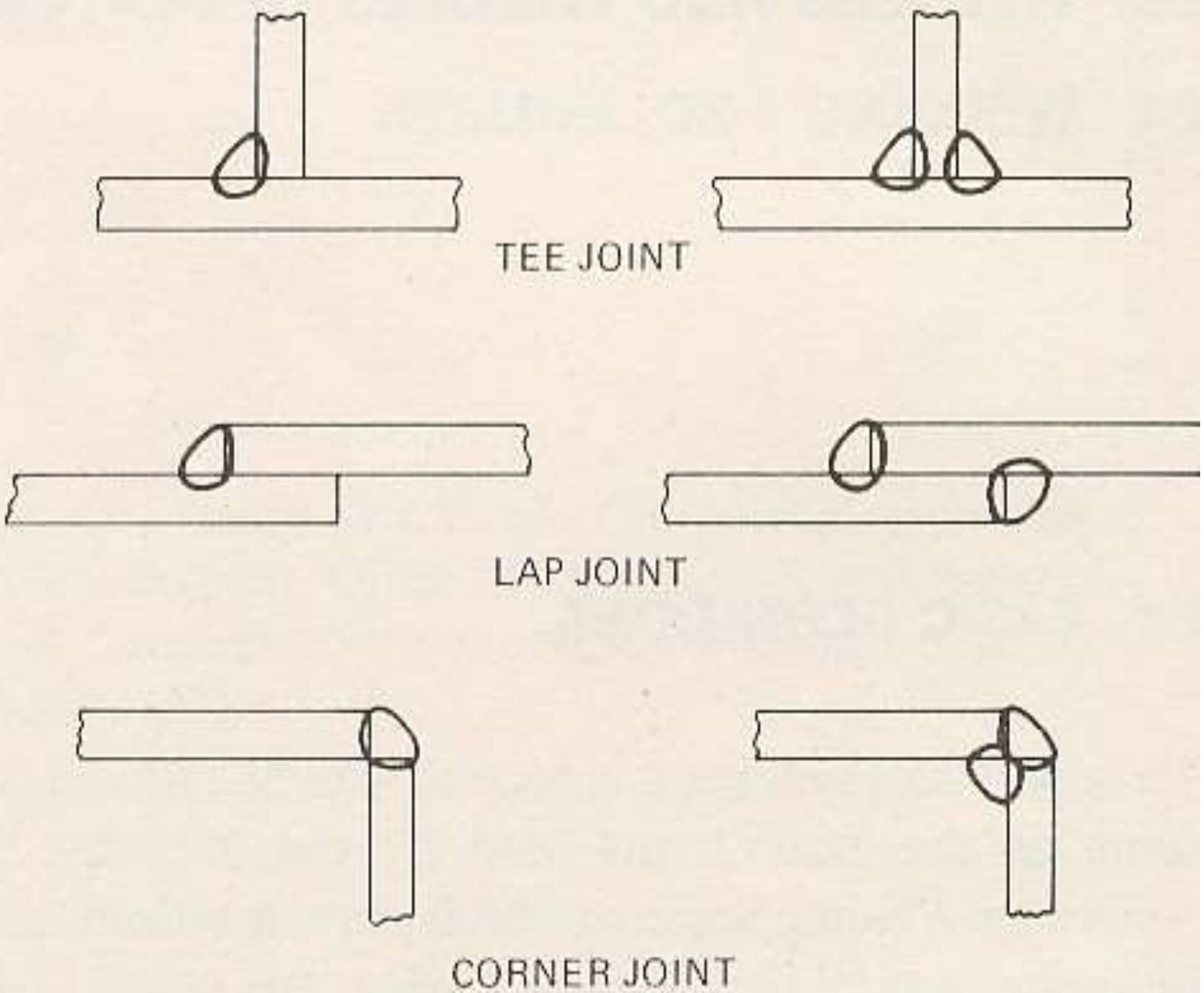


FIGURE 2-2 *Applications of fillet welds—single and double.*

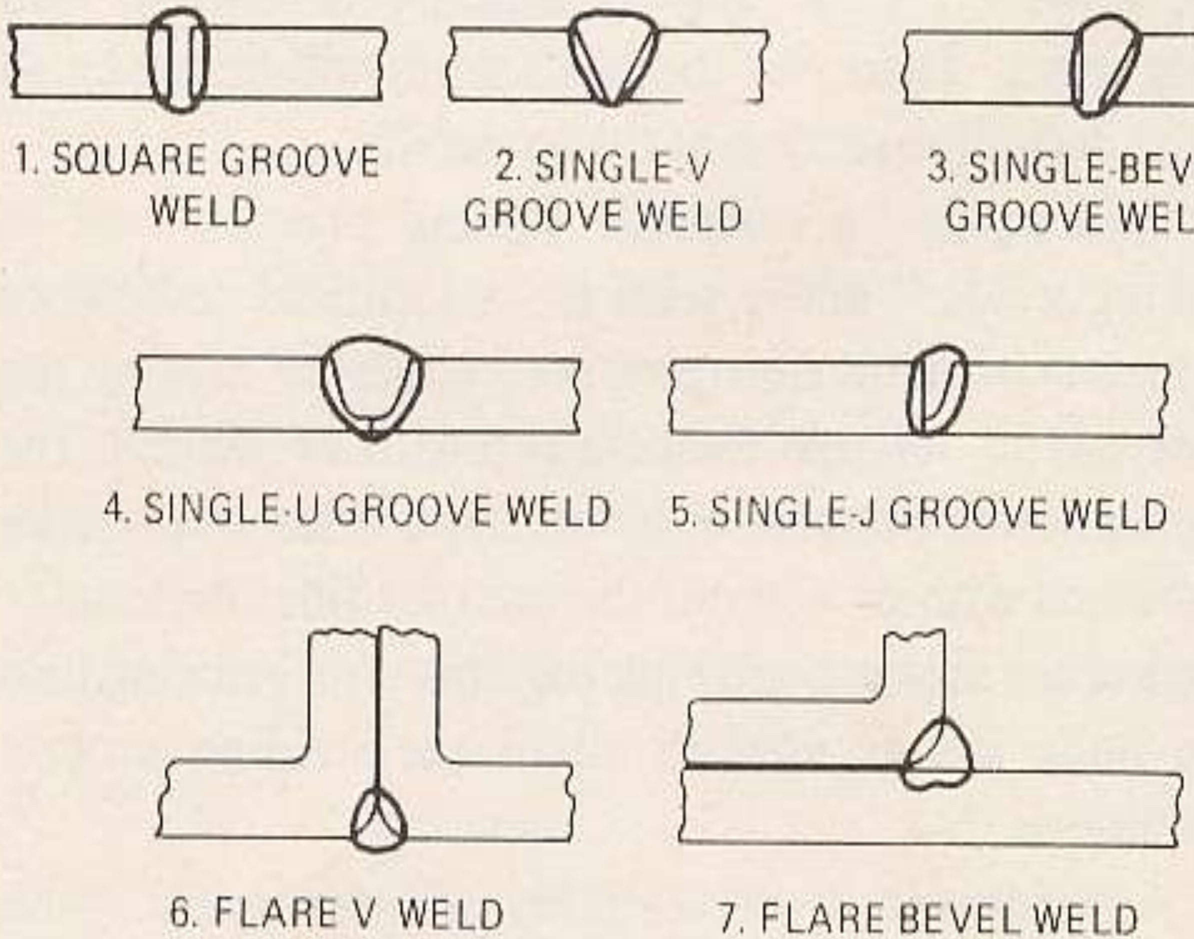


FIGURE 2-3 *The seven basic groove welds.*

Posiciones de Soldaduras

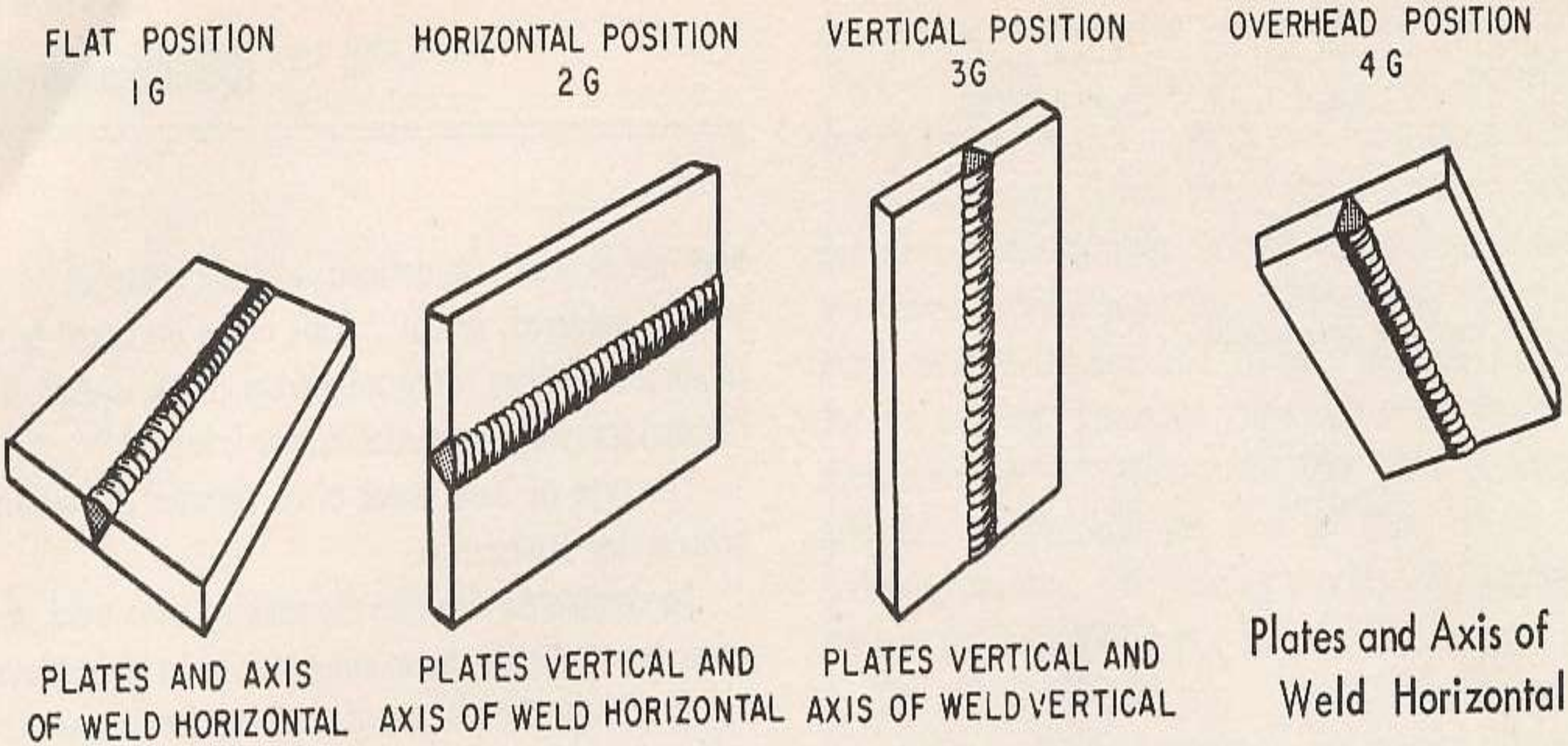


FIGURE 2-5 *Welding positions—groove welds—plate.*

Posiciones de Soldaduras

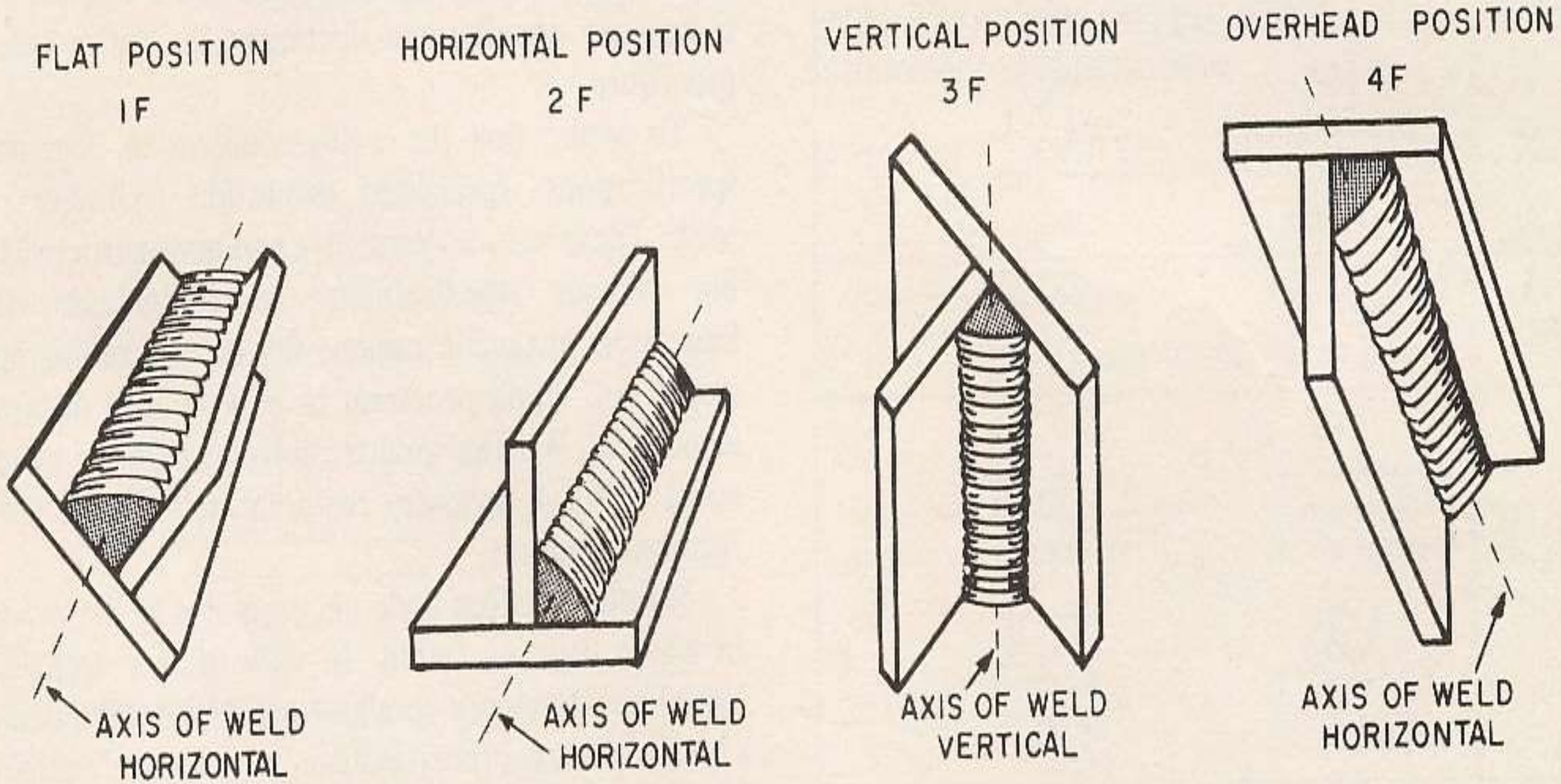


FIGURE 2-6 *Welding positions—fillet welds—plate.*

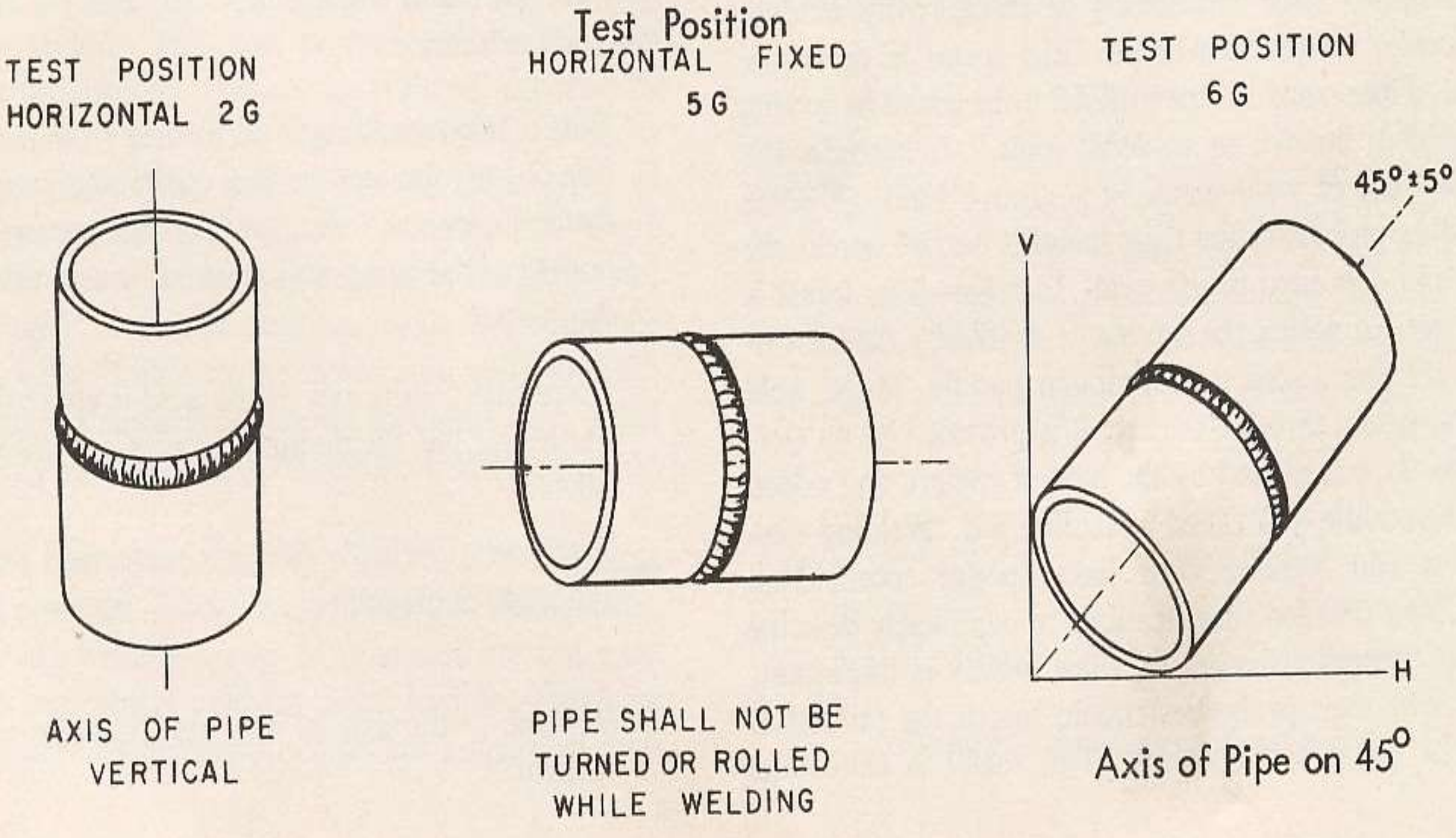


FIGURE 2-7 *Welding positions—pipe welds.*

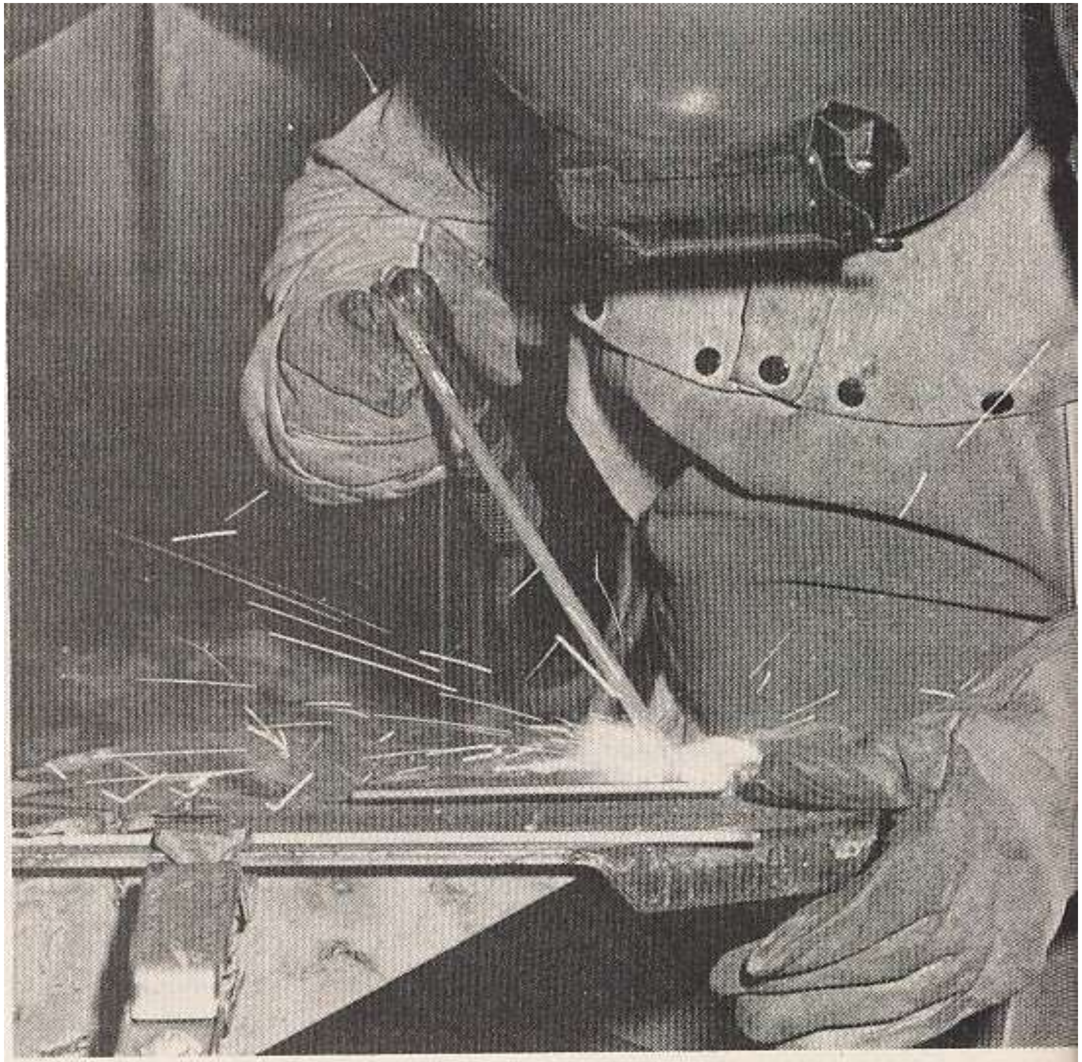


FIGURE 2-10 *Shielded metal arc welding.*

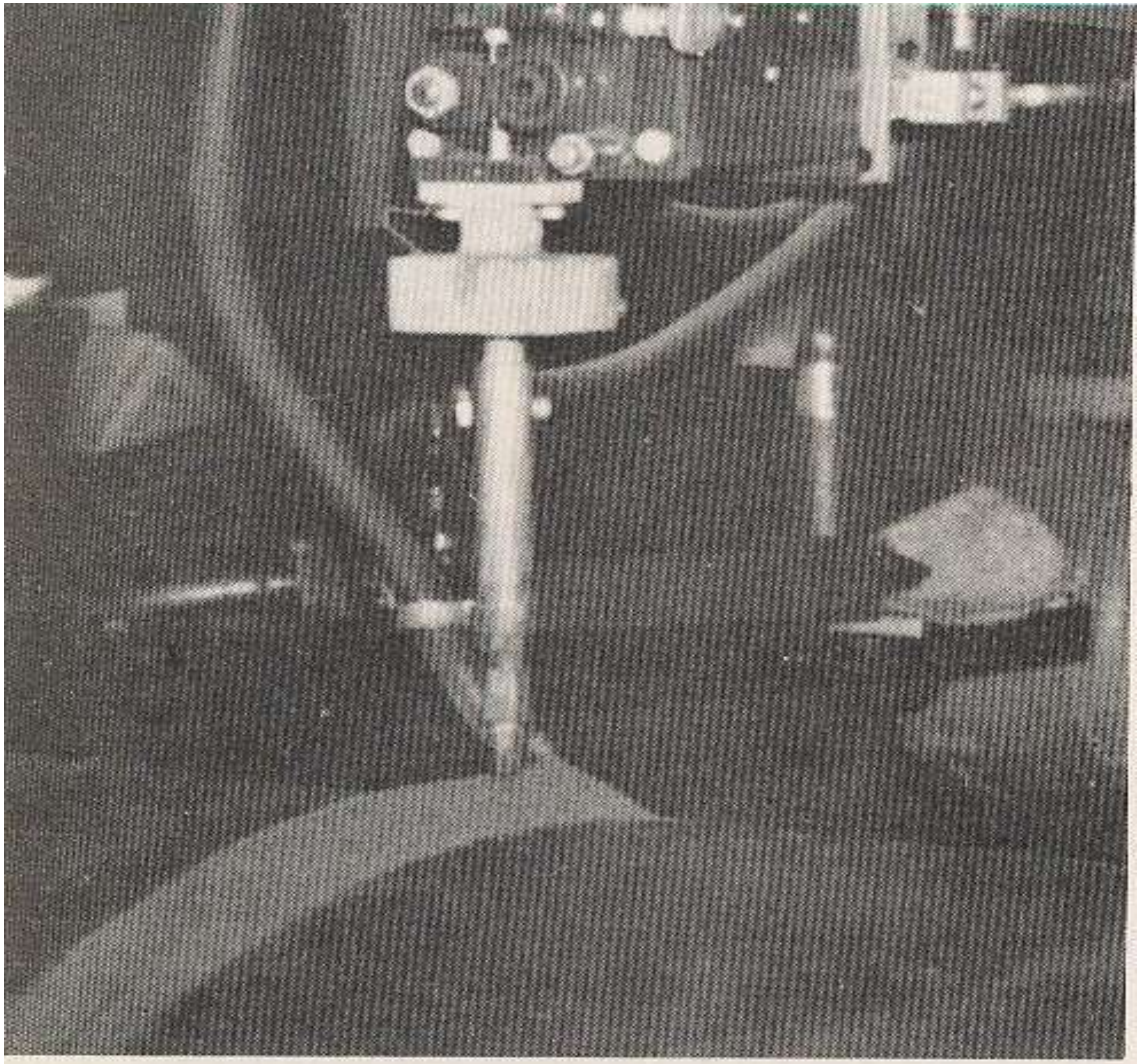


FIGURE 2-11 *Submerged arc welding.*

FIGURE 2-12 *Gas tungsten arc welding.*

FIGURE 2-13 *Plasma arc welding.*

FIGURE 2-15 *Flux-cored arc welding.*

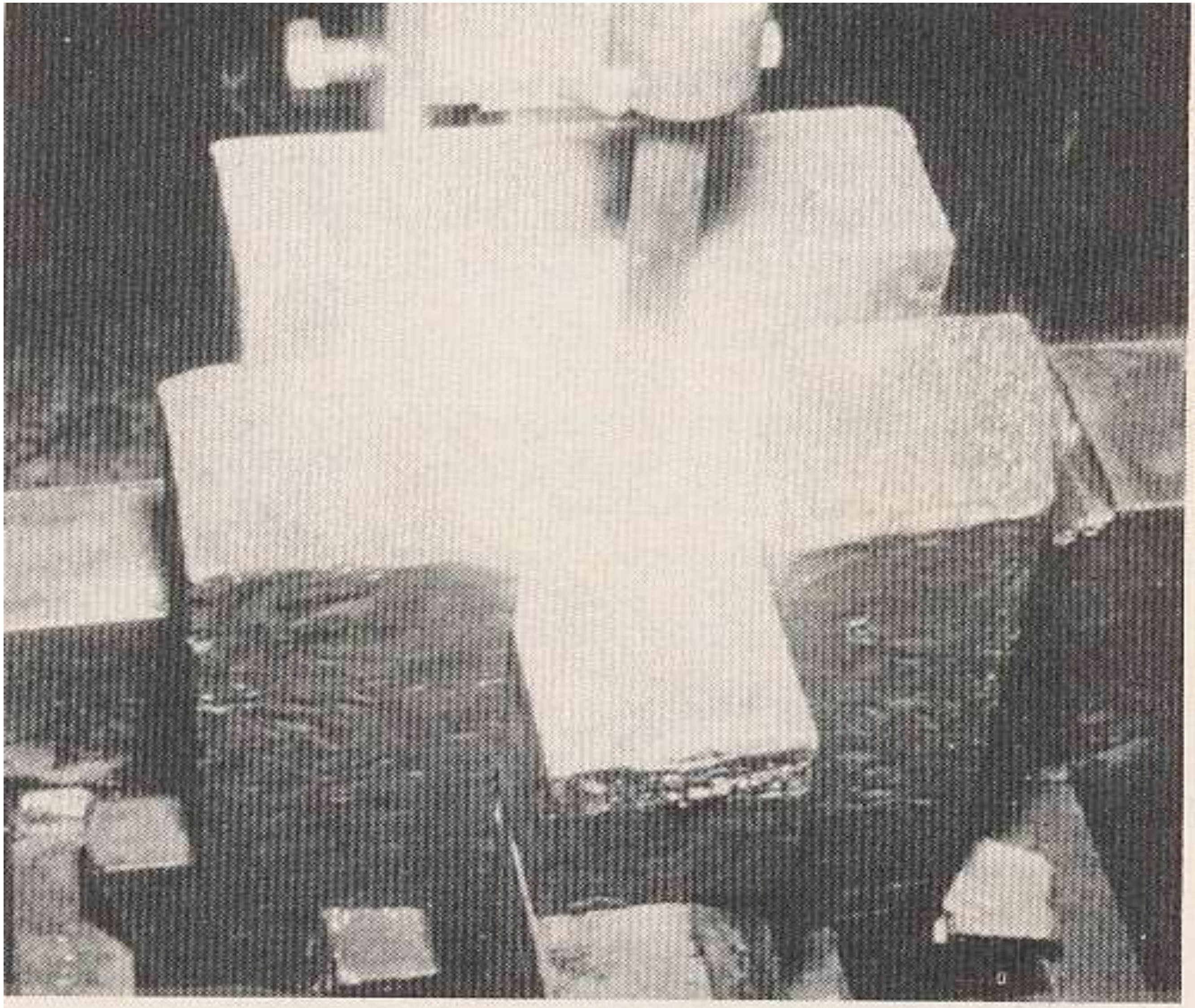
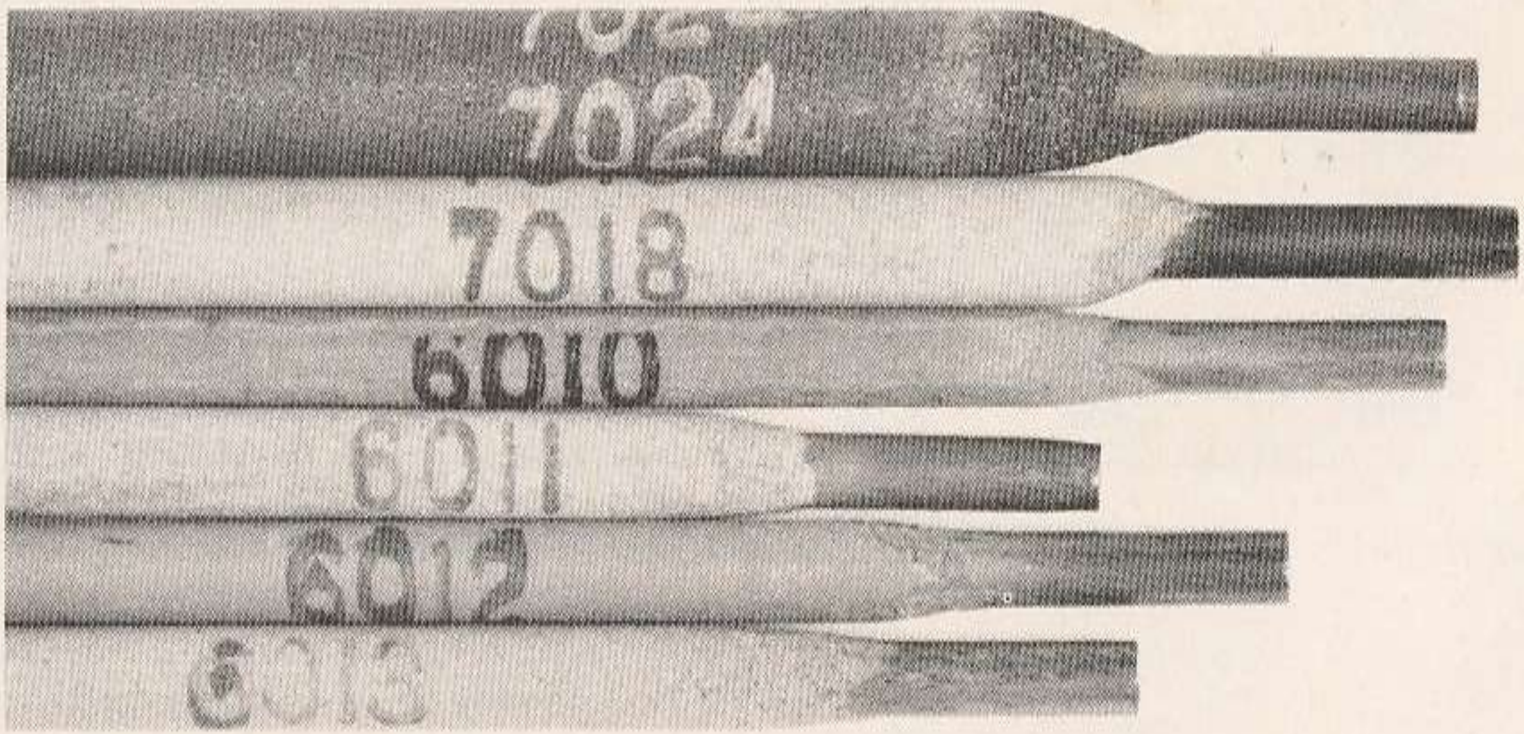


FIGURE 2-17 *Electroslag welding.*

FIGURE 4-18 *Printed type marking on electrodes.*



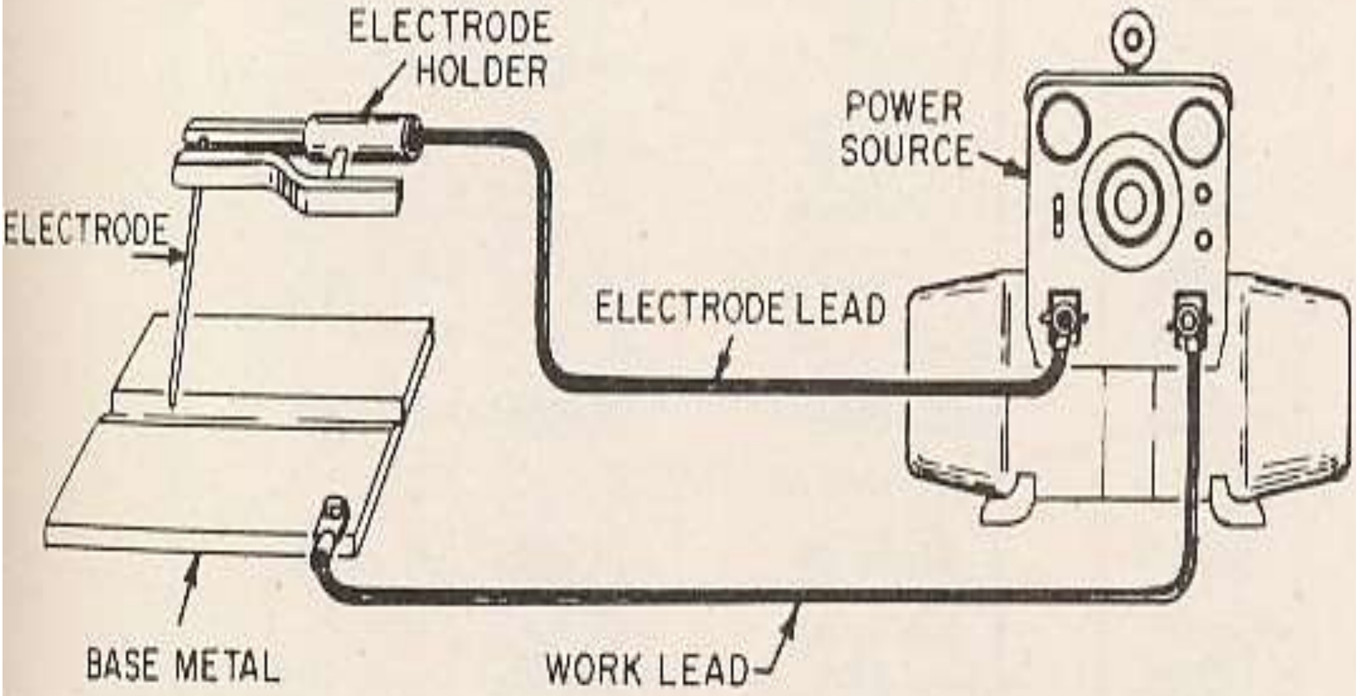


FIGURE 4-13 *Circuit diagram.*

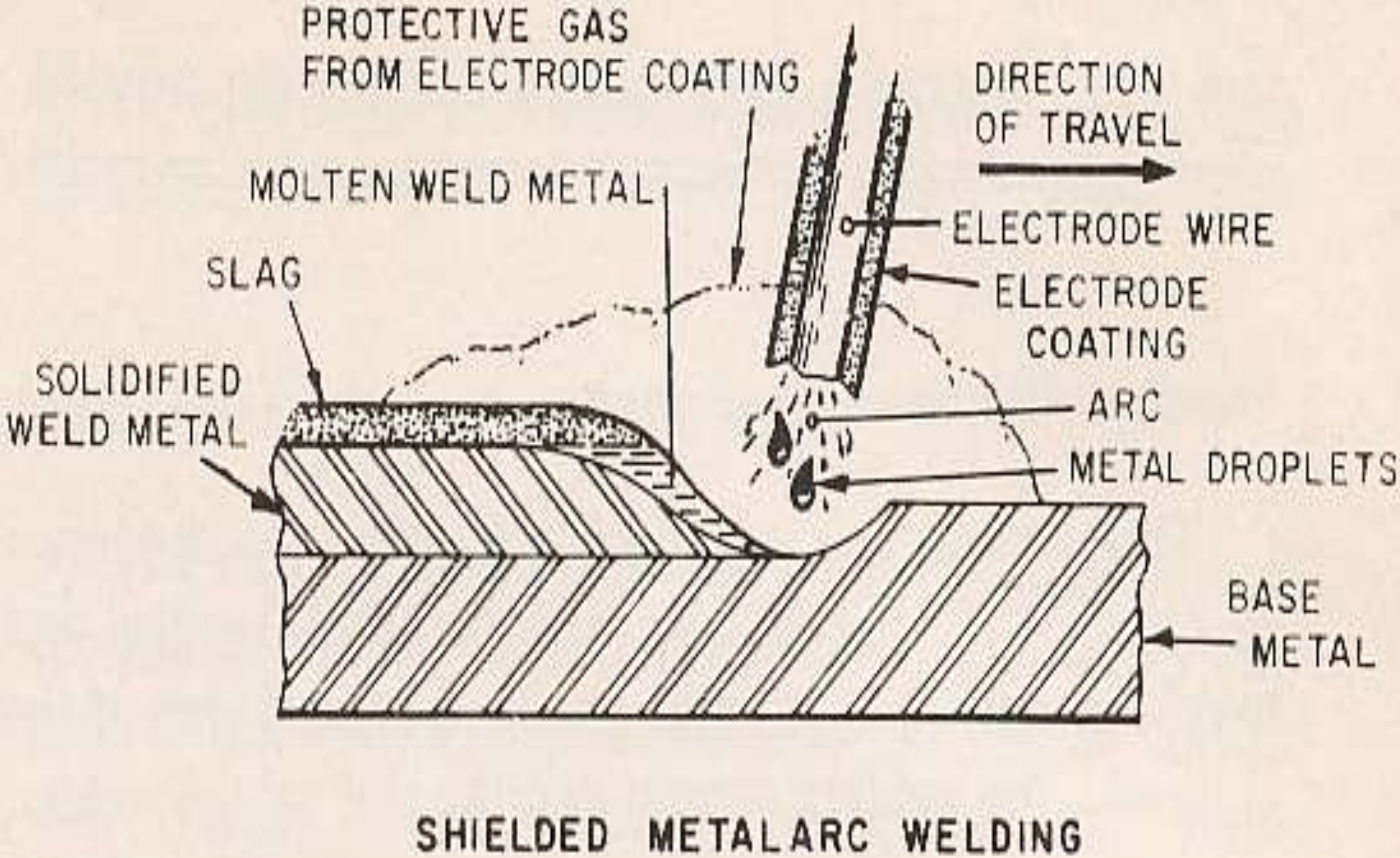


FIGURE 4-8 *Process diagram.*

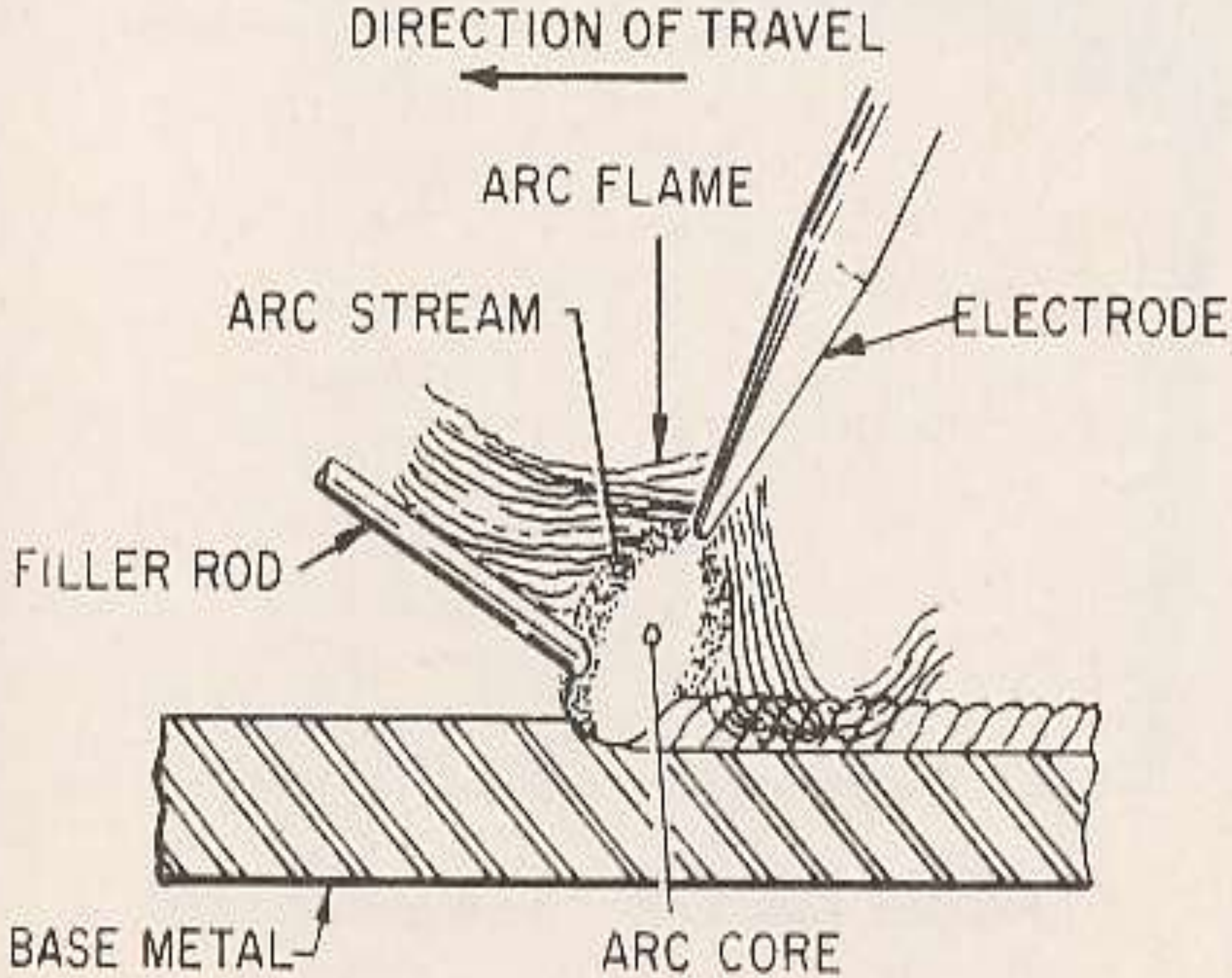
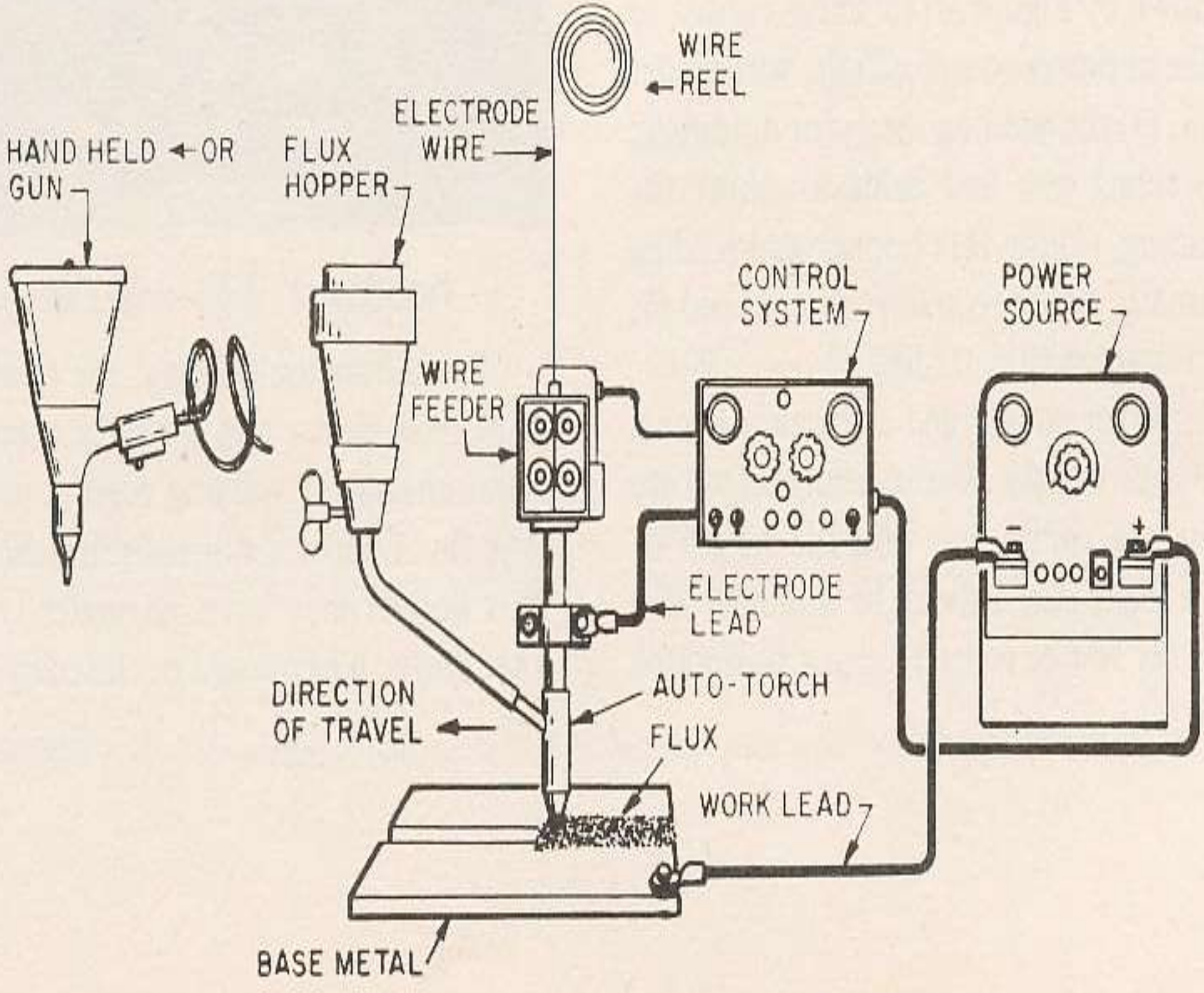


FIGURE 4-63 *Process diagram—CAW.*

FIGURE 5-11 *Block diagram—SAW.*



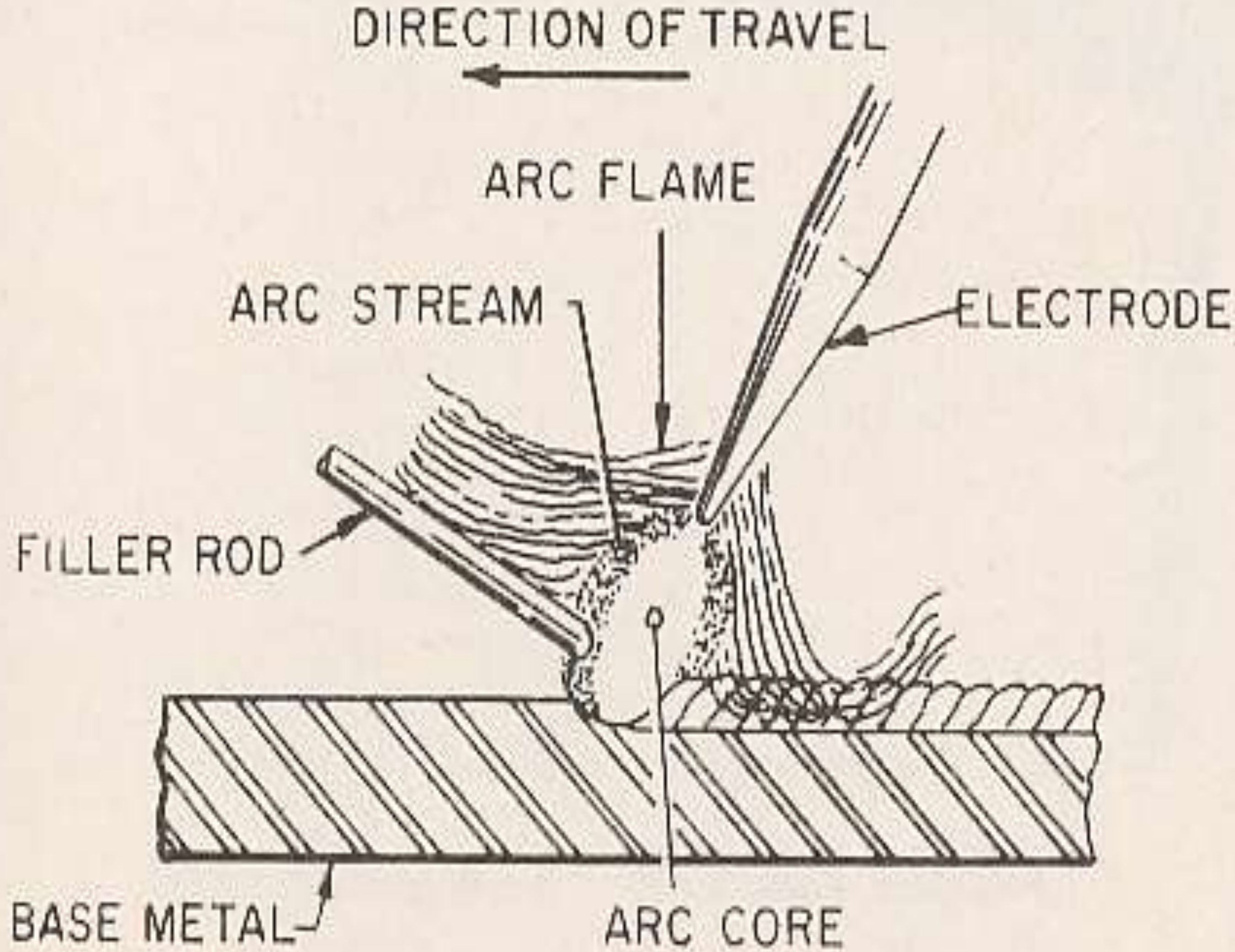


FIGURE 4-63 *Process diagram—CAW.*

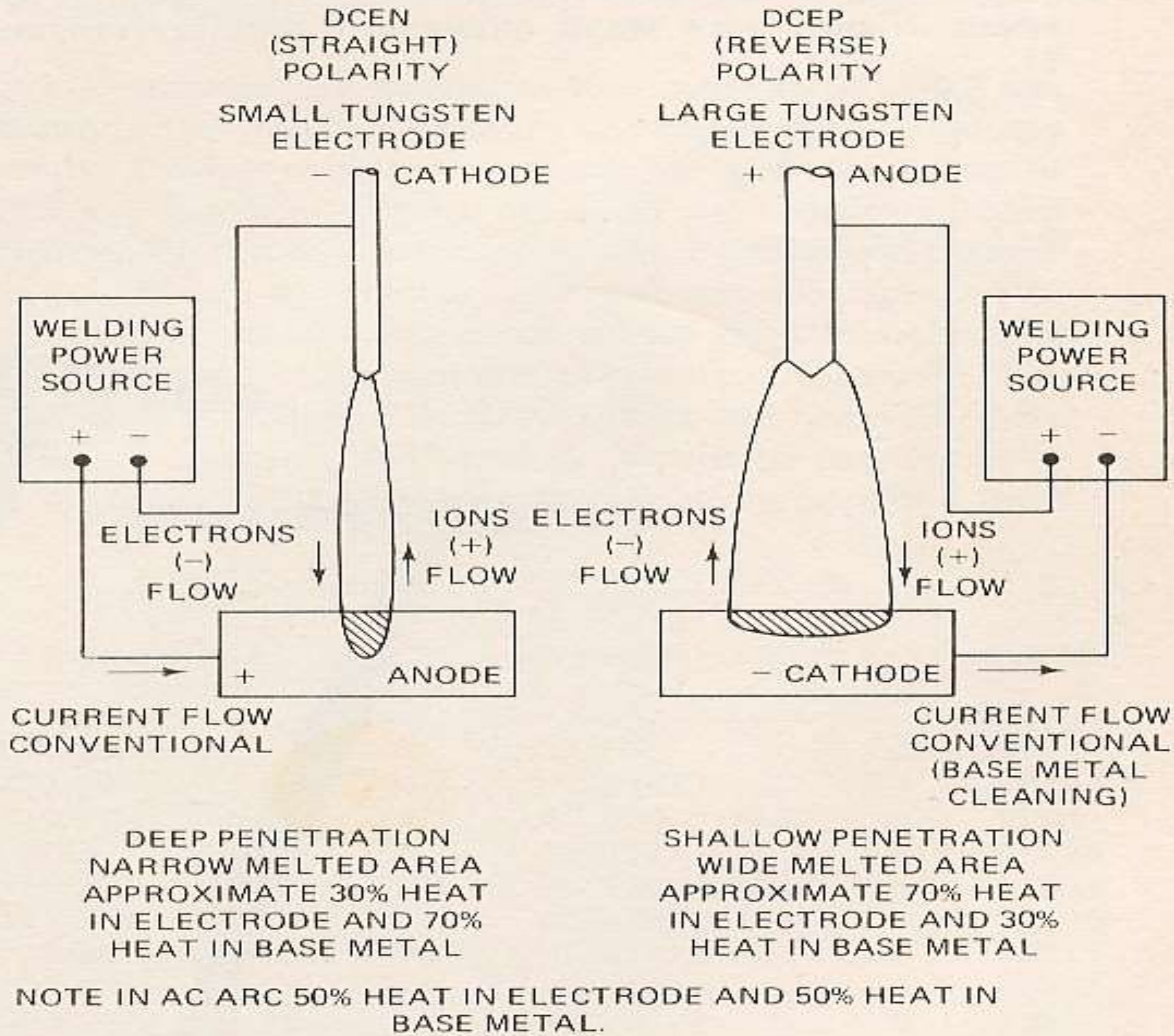


FIGURE 4-36 *The tungsten arc.*

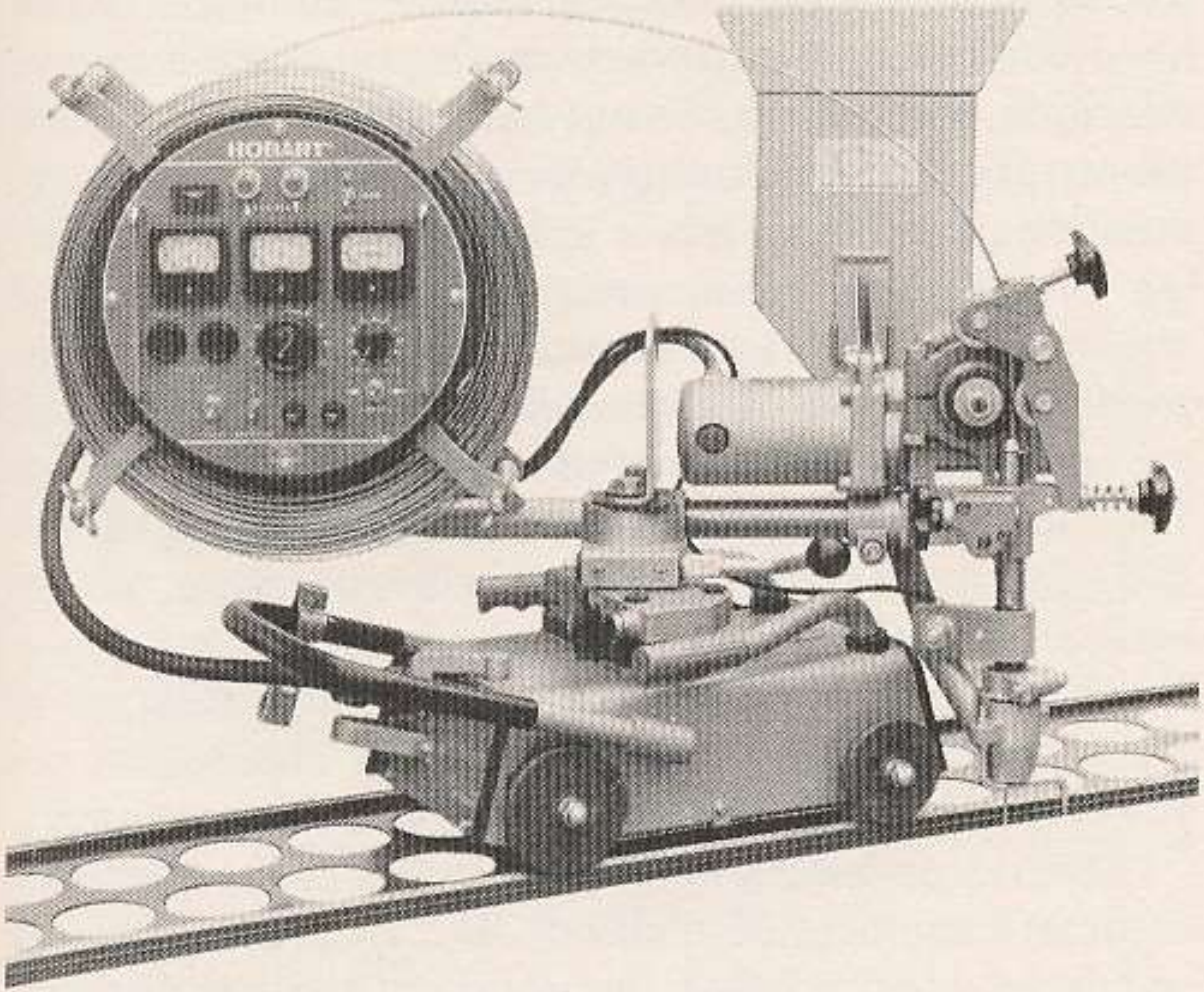


FIGURE 5-13 *Submerged arc head on travel carriage.*

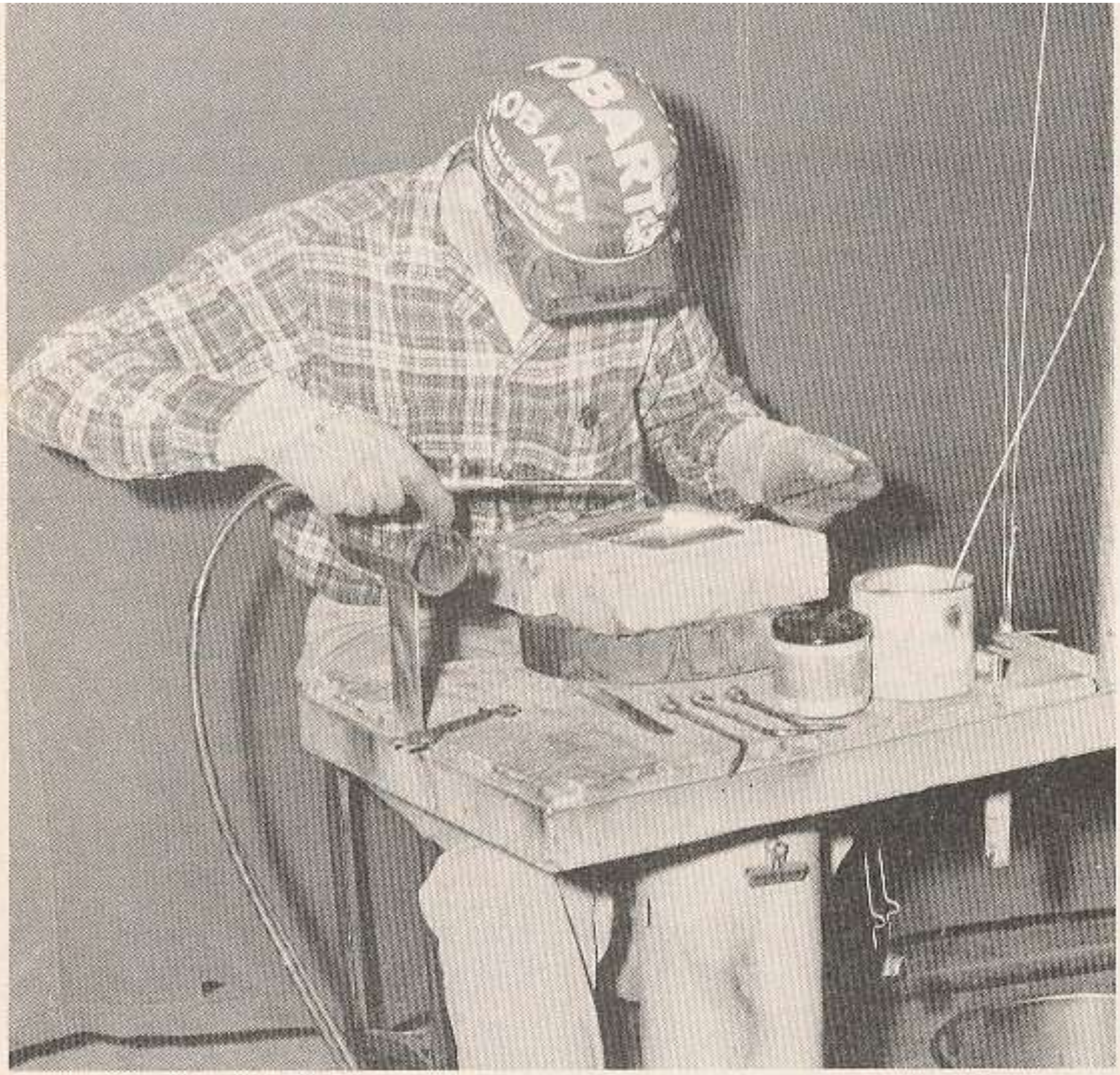


FIGURE 6-1 *Torch brazing—manually applied.*

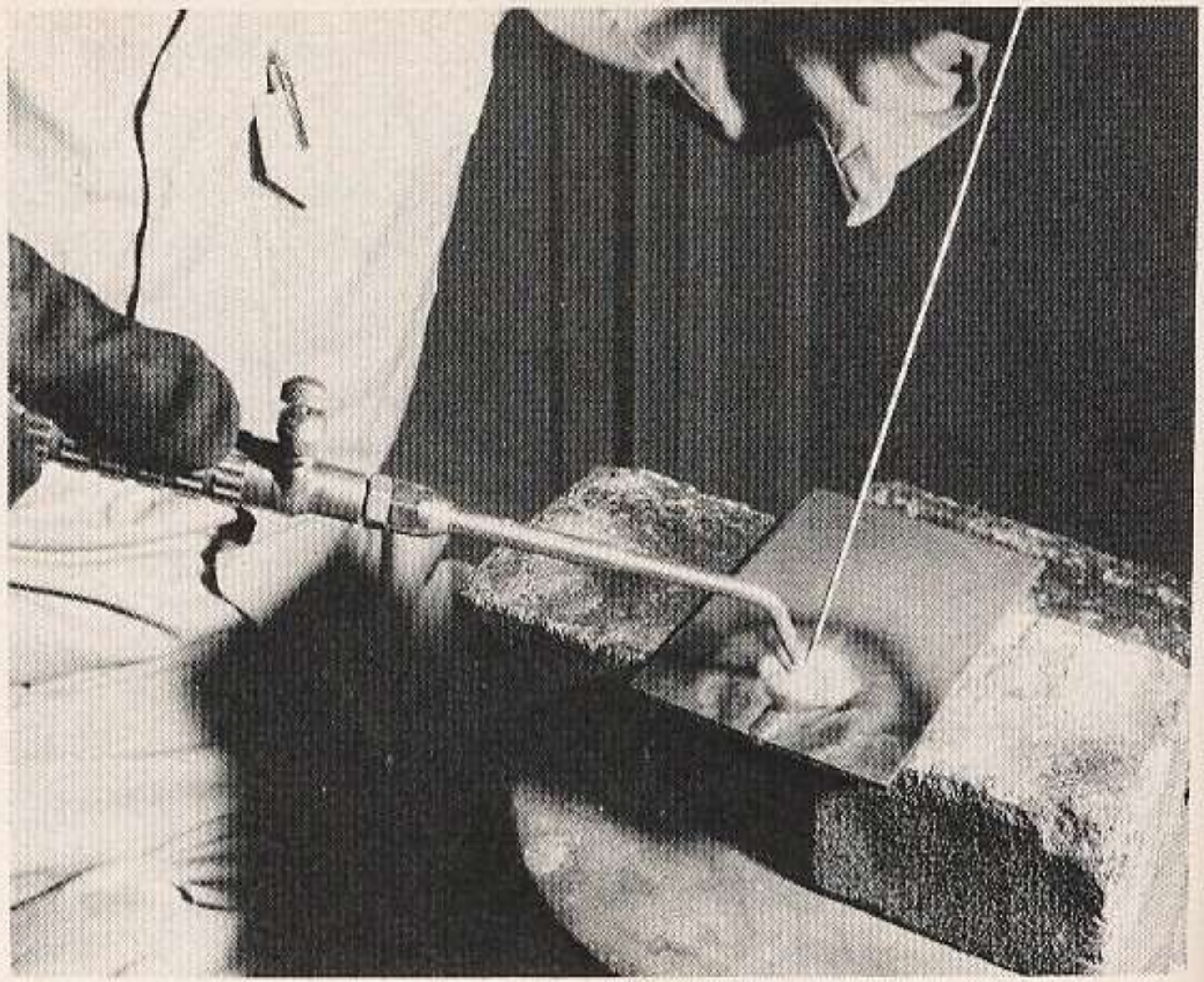


FIGURE 6-9 *Using oxyacetylene welding process.*

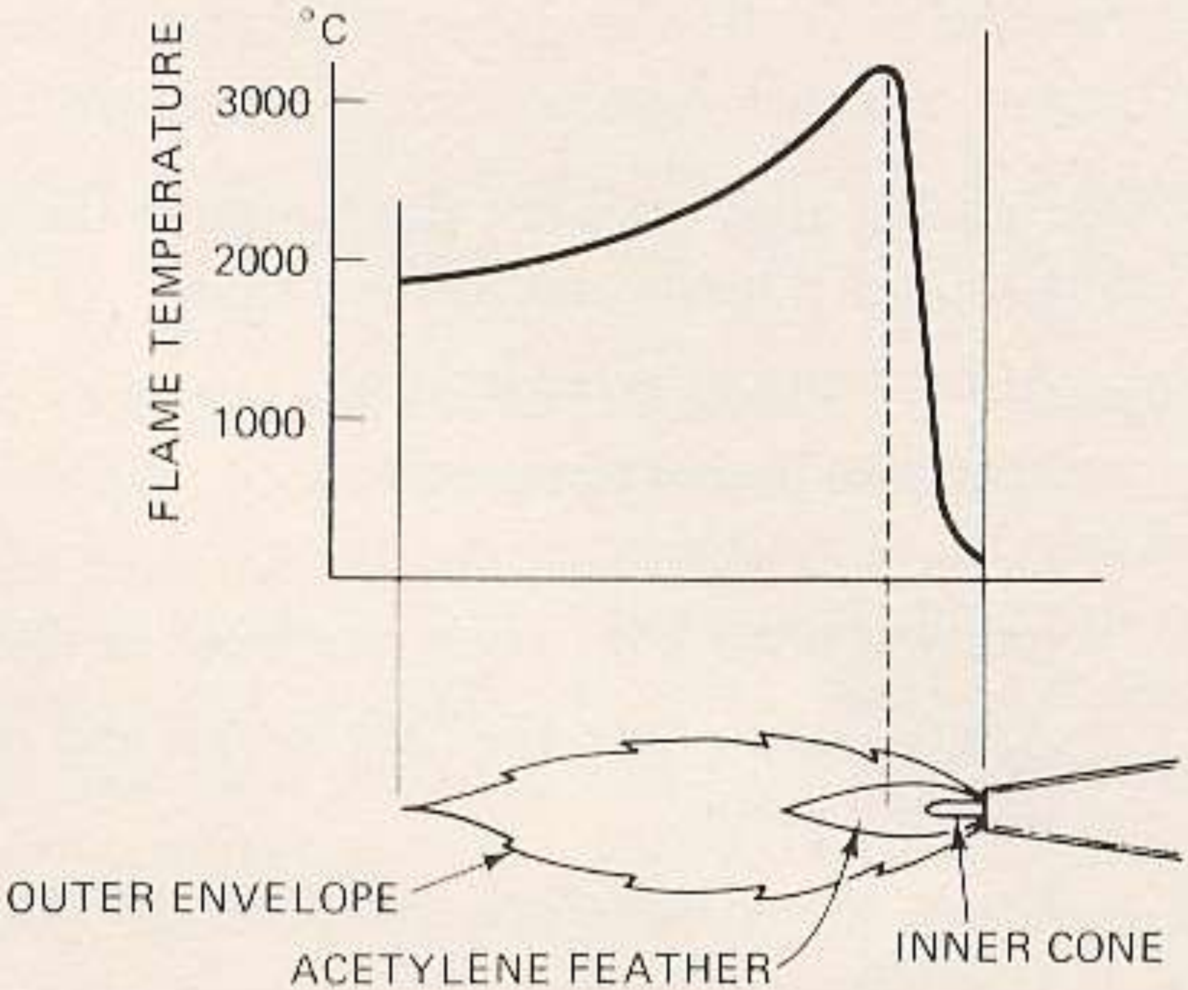


FIGURE 6-10 *The temperature of the flame.*

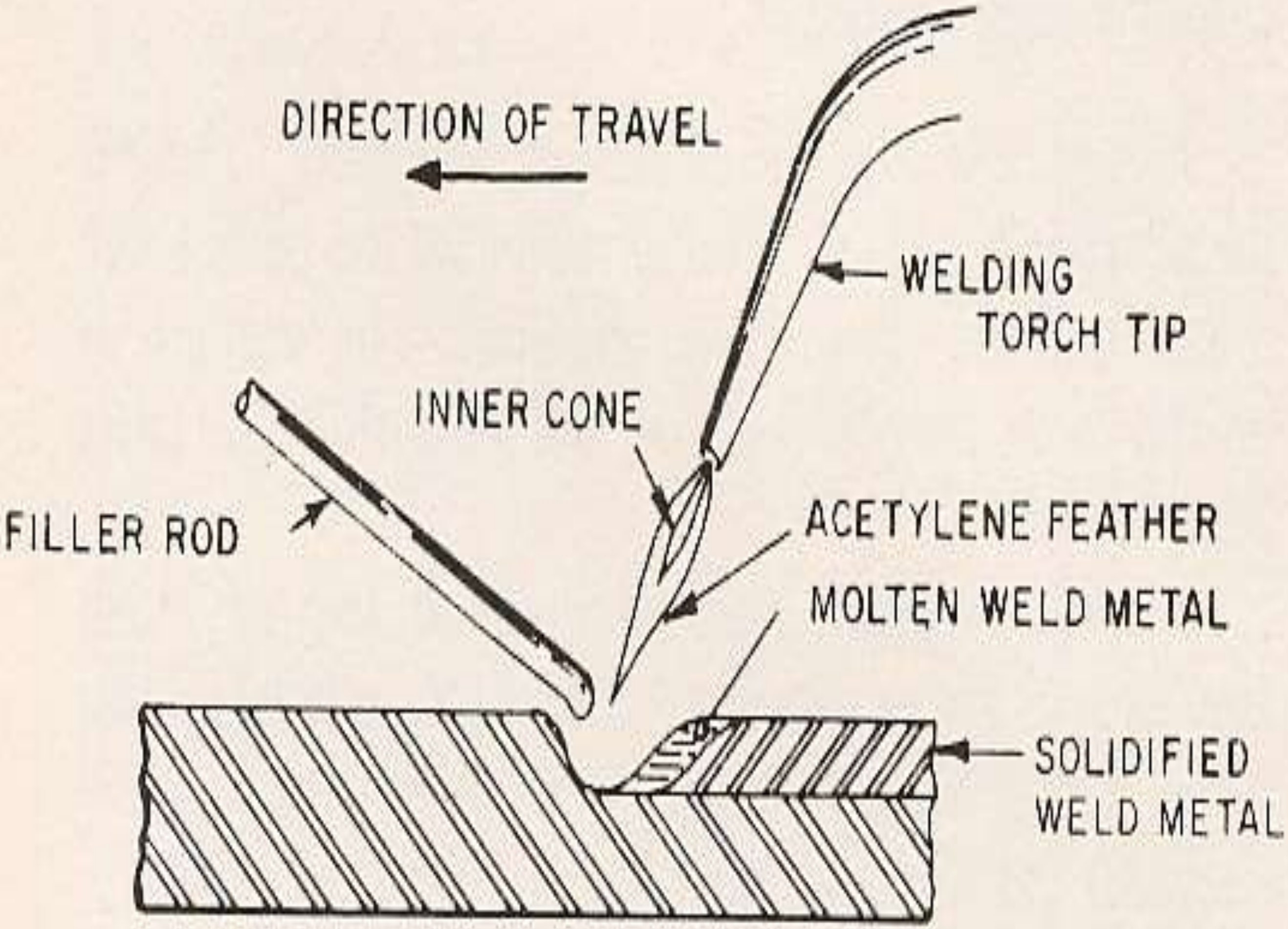


FIGURE 6-8 *Process diagram.*

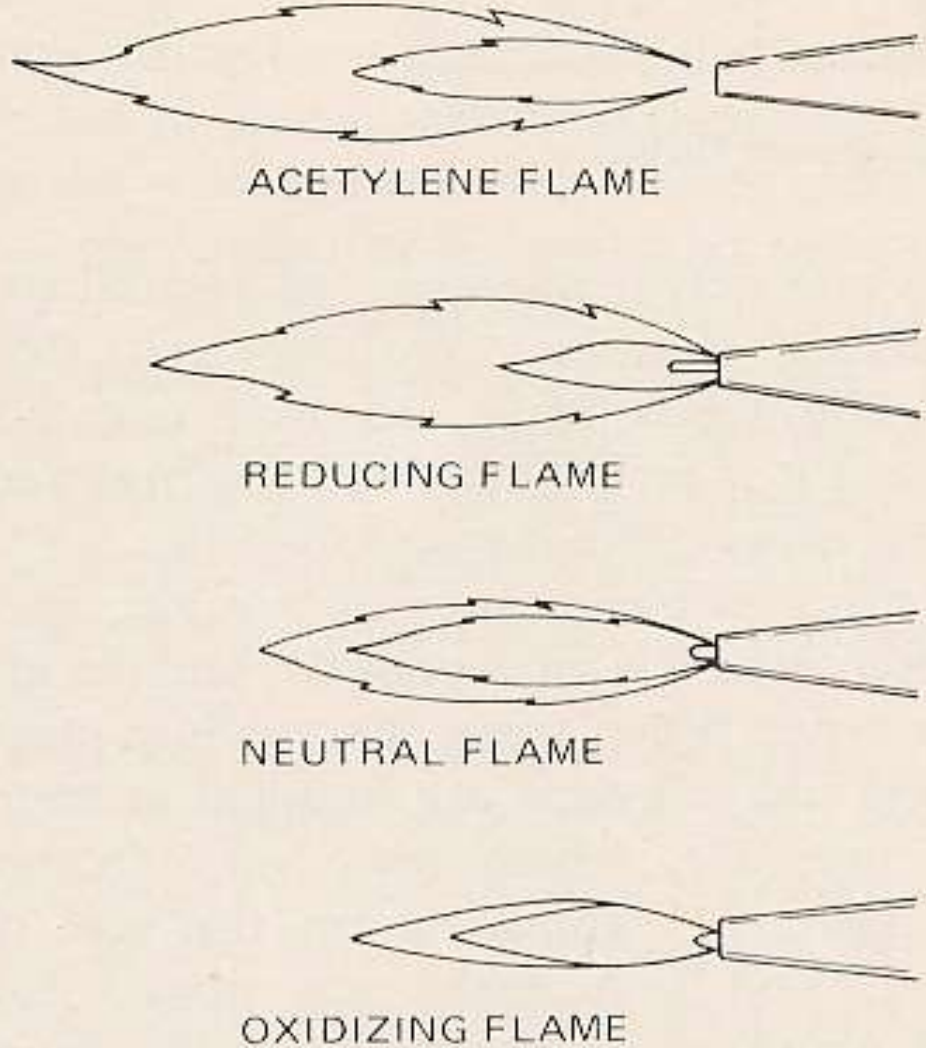


FIGURE 6-11 *The three types of flame.*

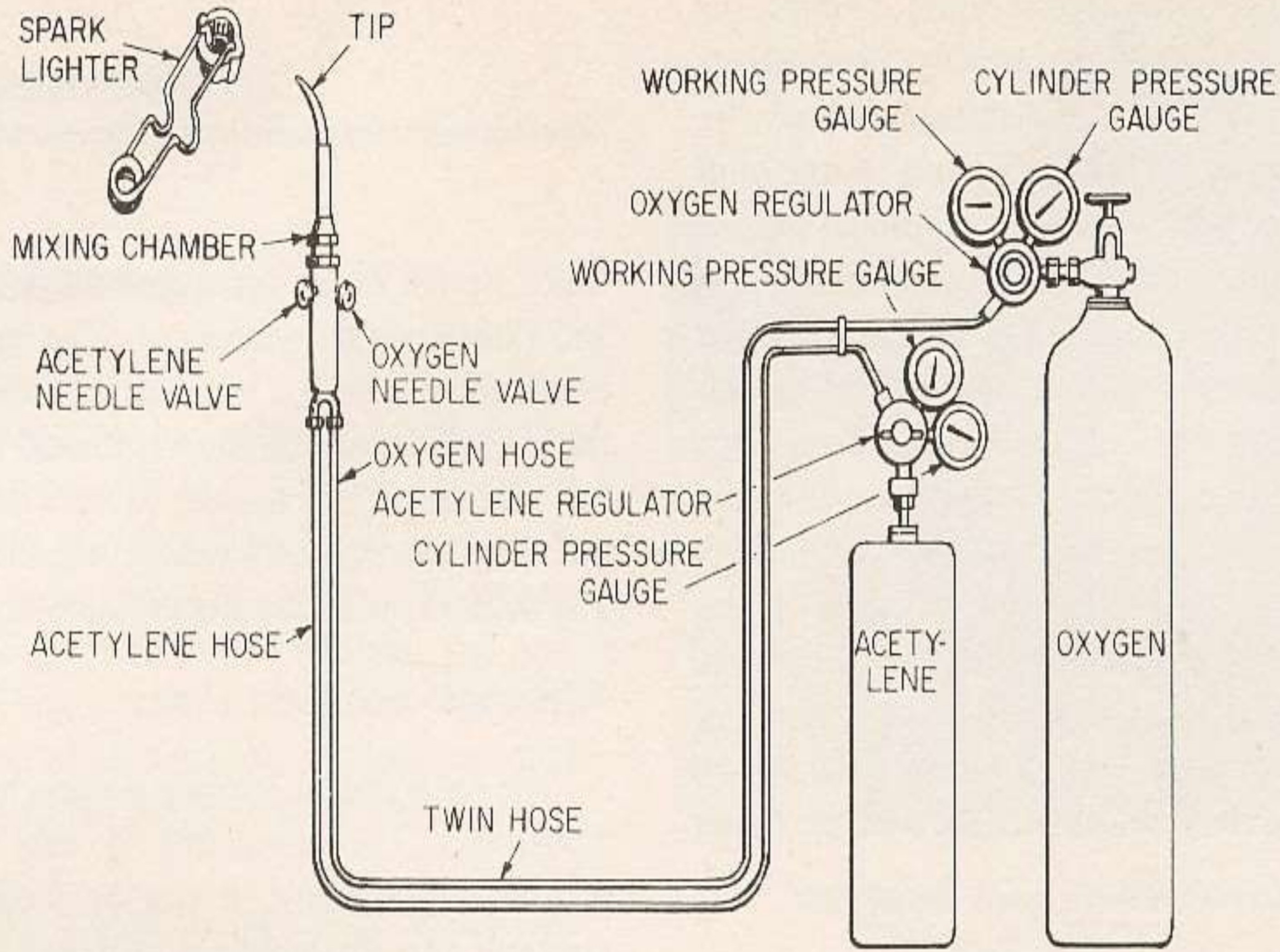


FIGURE 6-13 *The apparatus required for welding with OAW.*

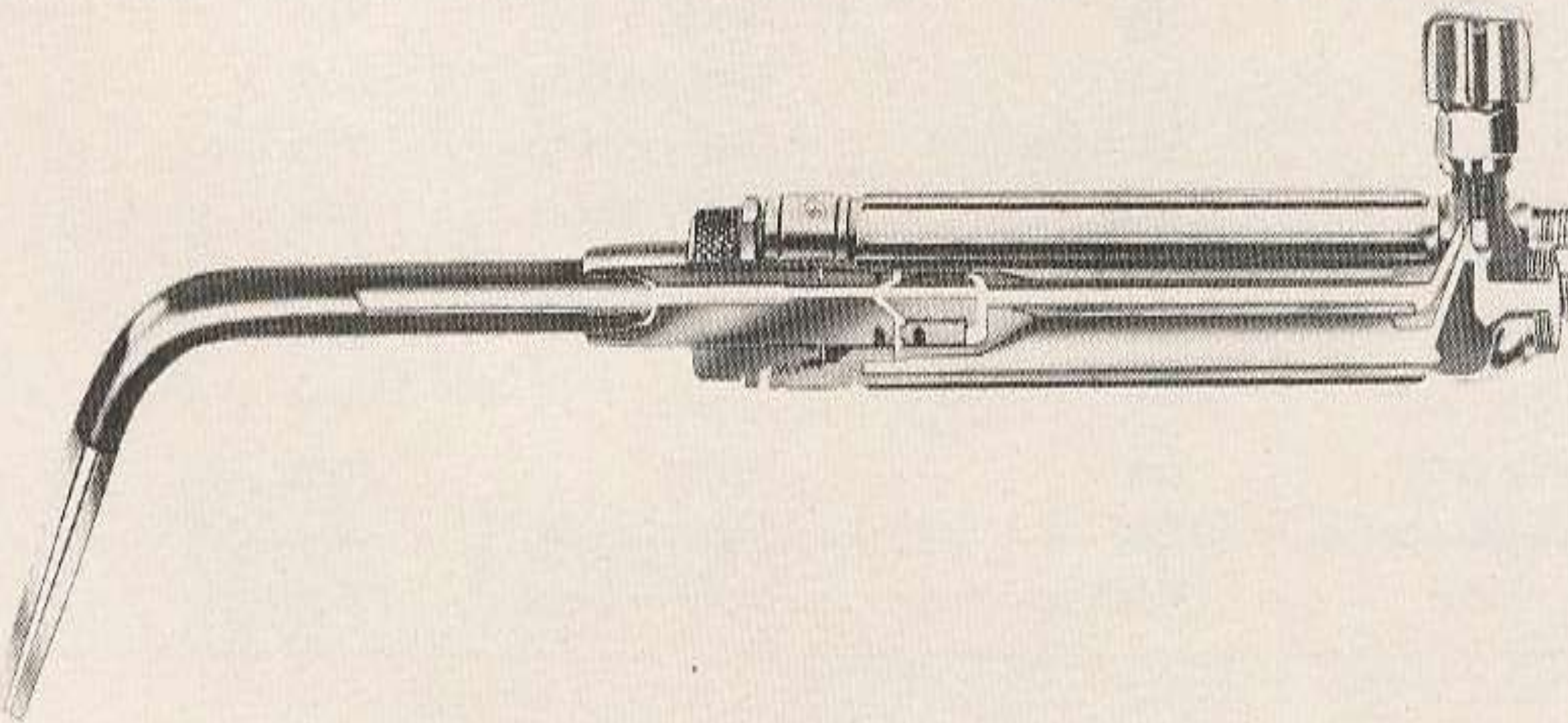


FIGURE 6-14 *Medium pressure oxyacetylene torch.*

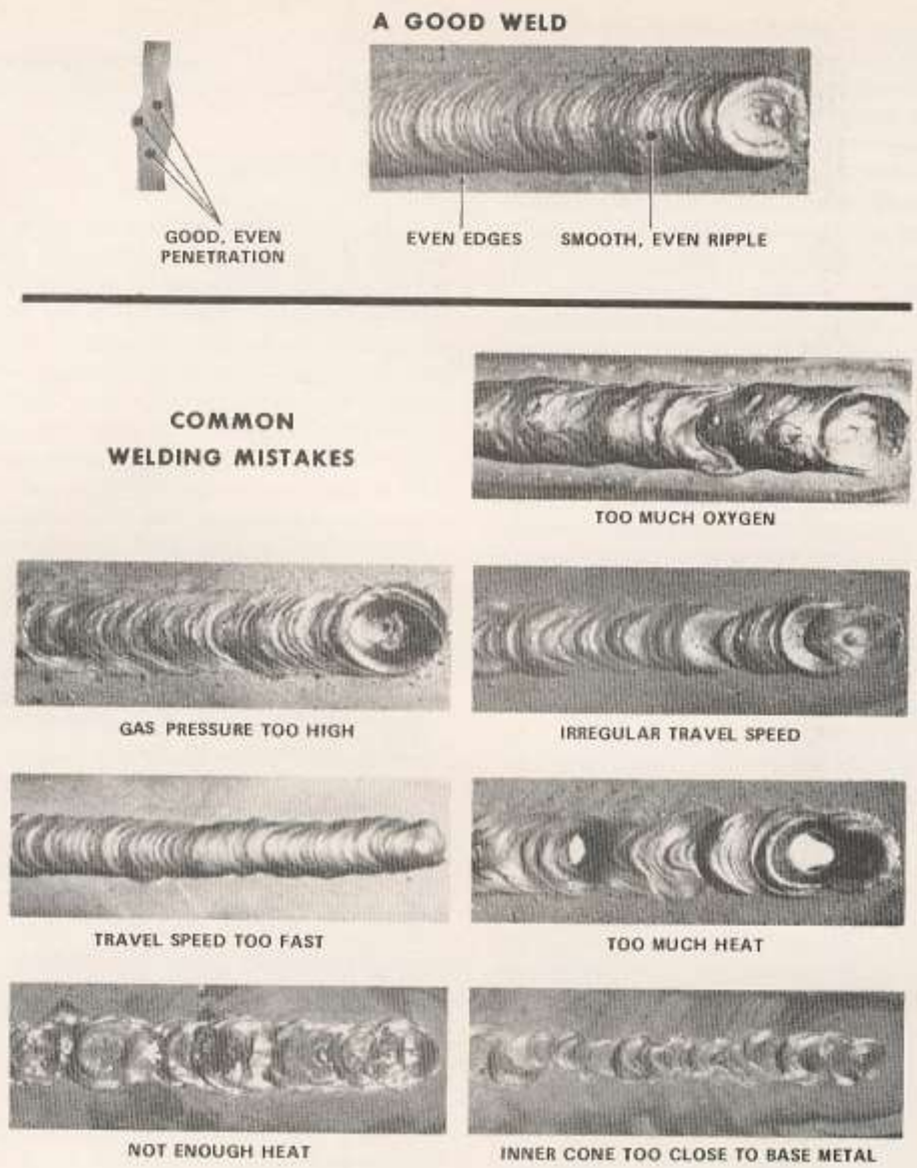


FIGURE 6-18 *Quality of oxyacetylene welds.*

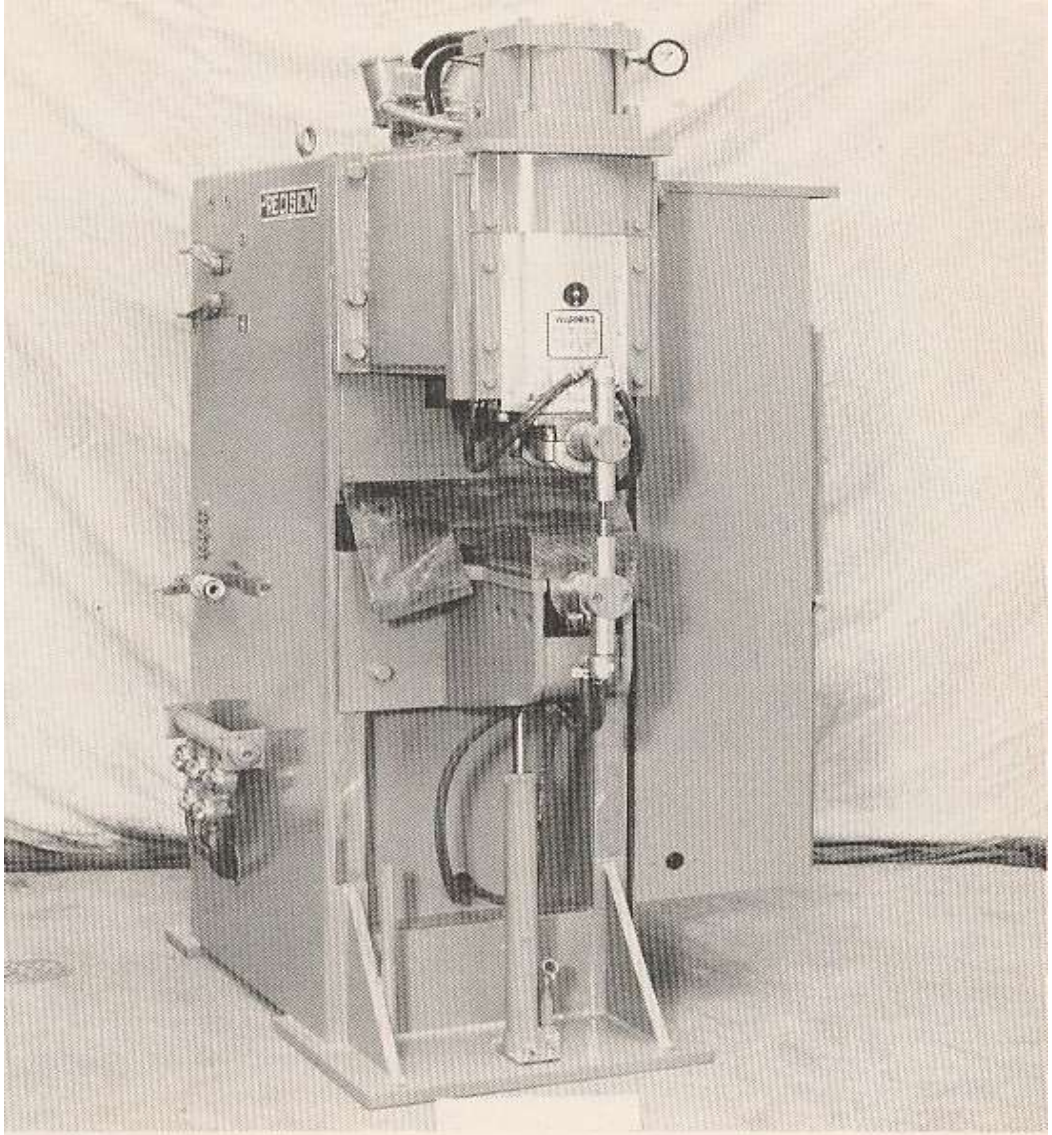


FIGURE 6-23 *Press type spot welding machine.*

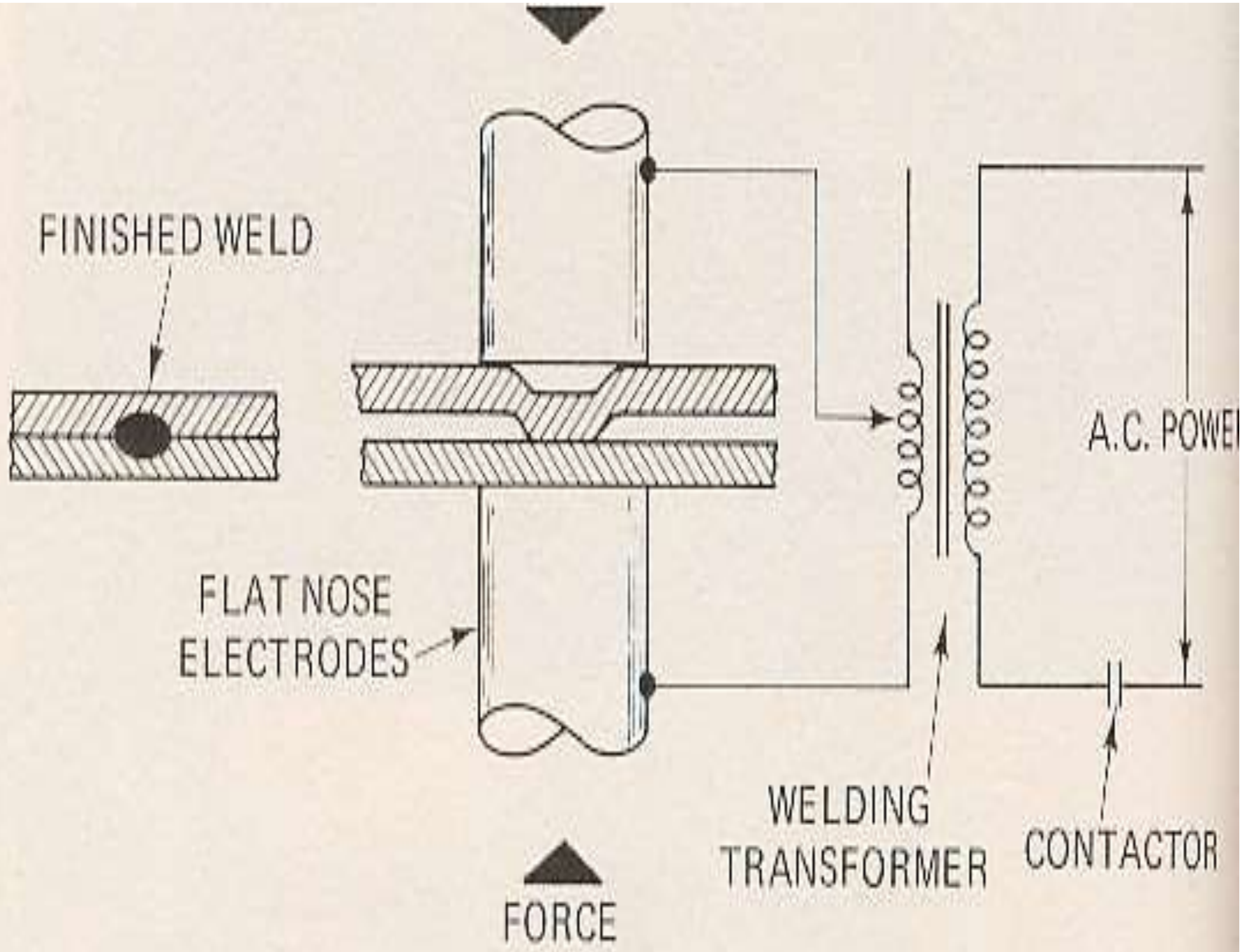


FIGURE 6-27 *Projection welding.*

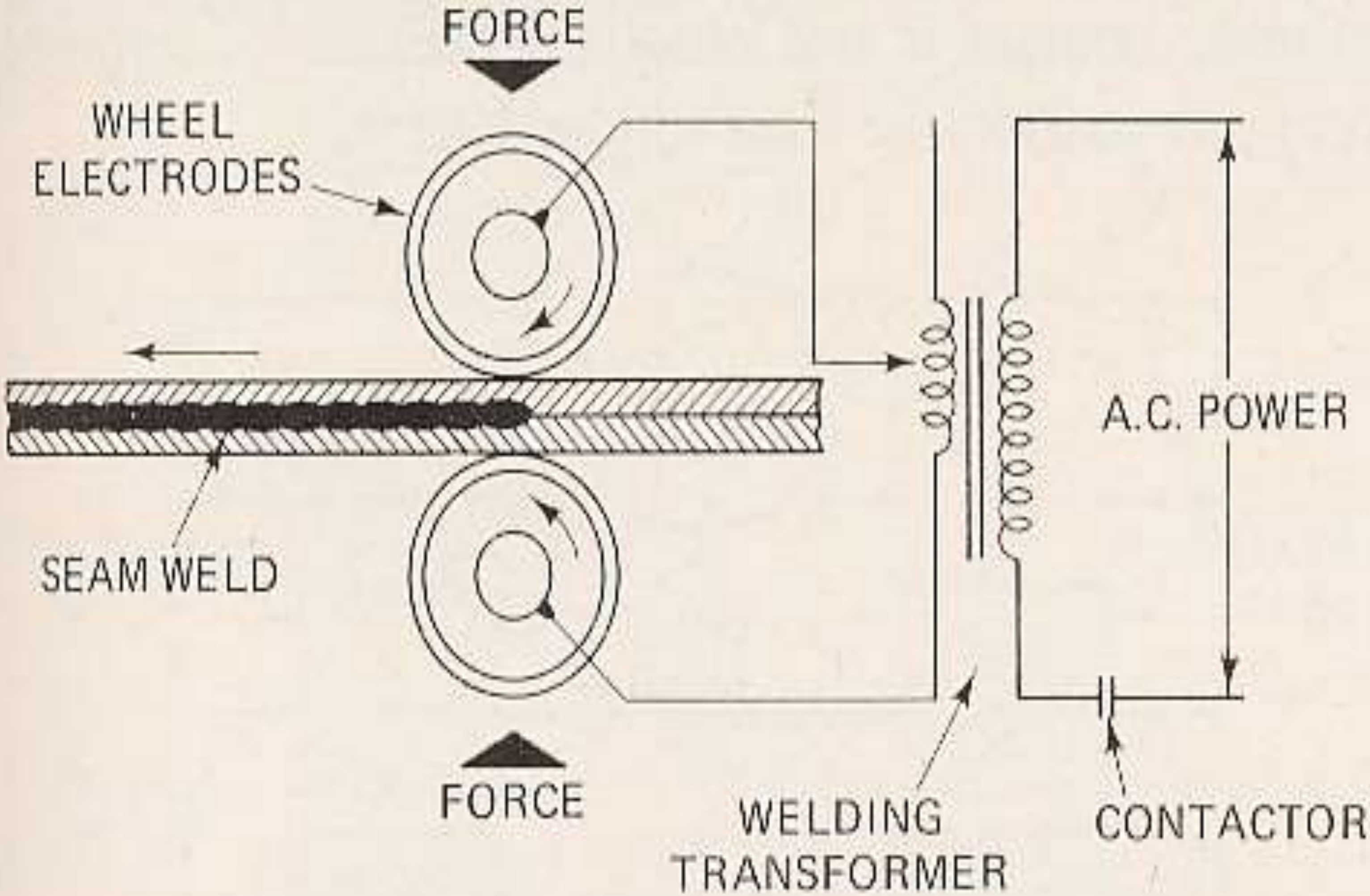


FIGURE 6-28 *Resistance seam welding.*

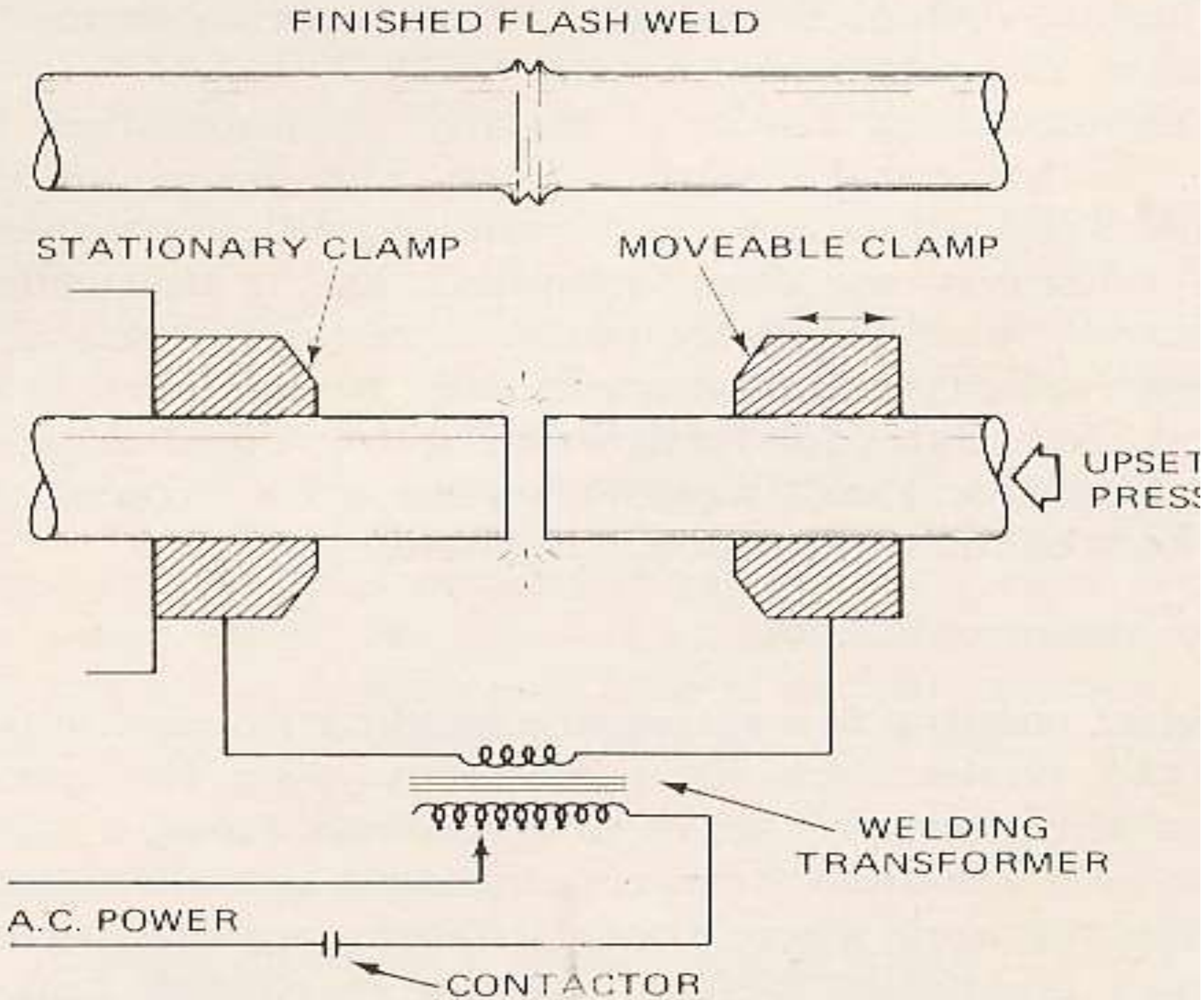


FIGURE 6-29 *Flash welding.*

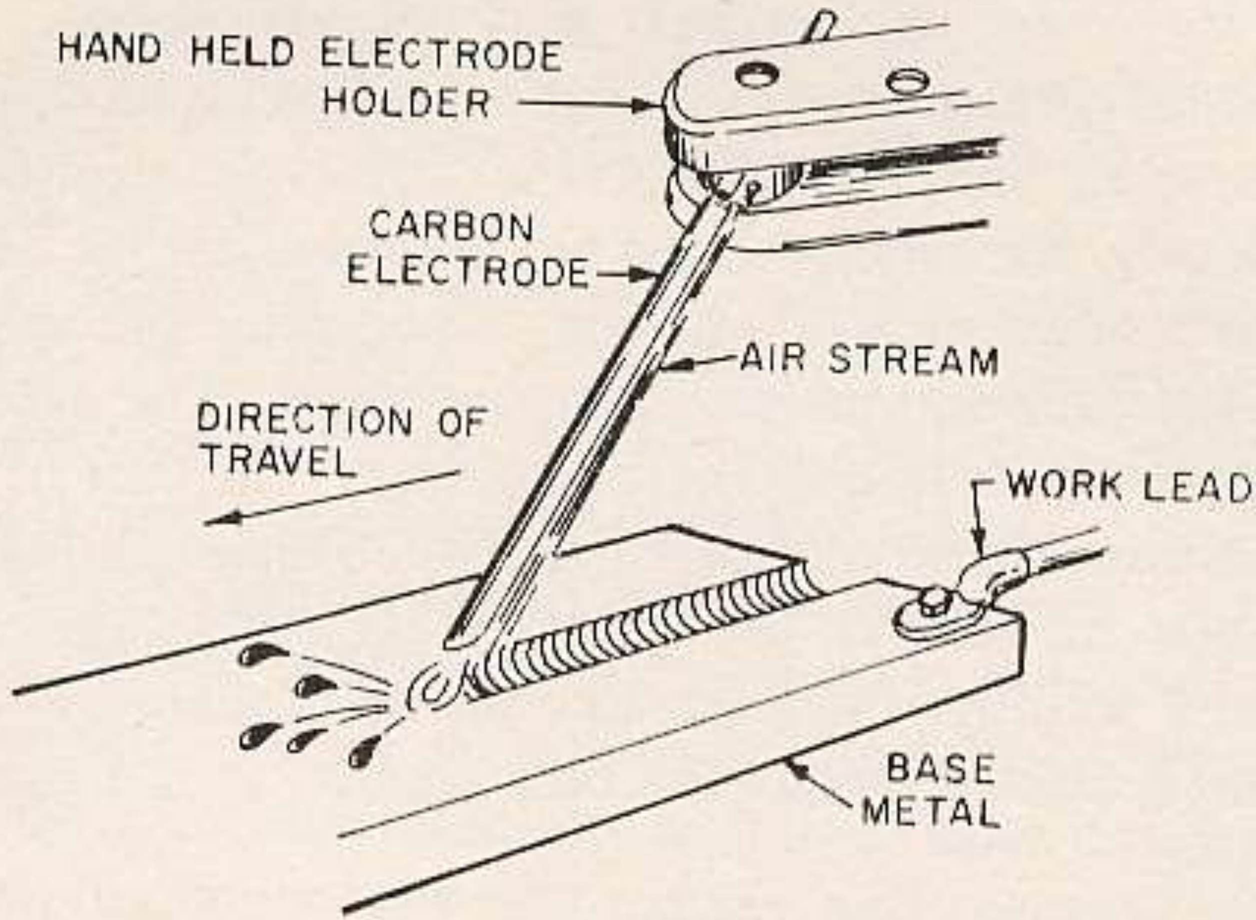


FIGURE 7-2 *Process diagram for air carbon arc cutting.*

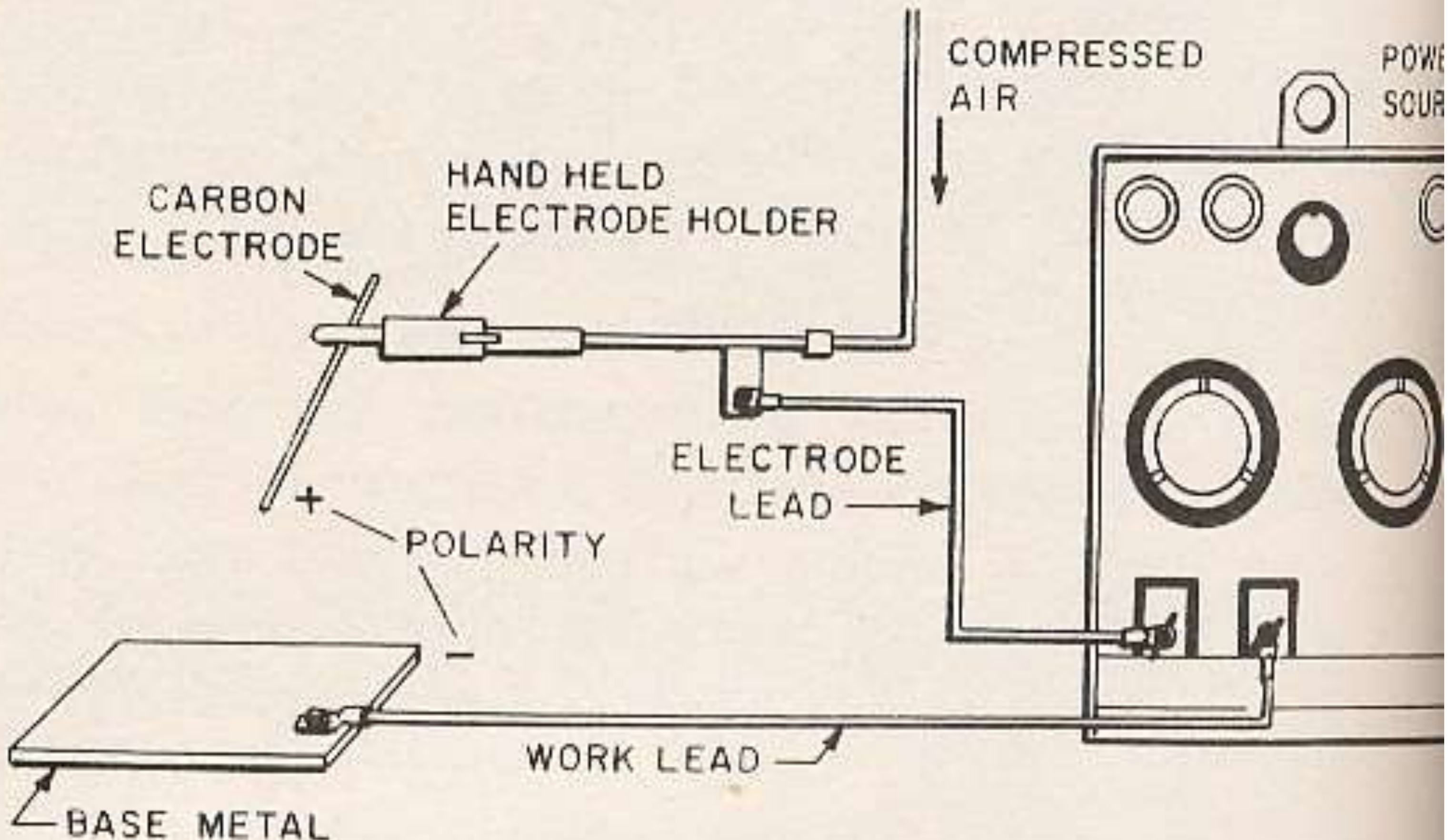


FIGURE 7-4 *Circuit block diagram AAC.*

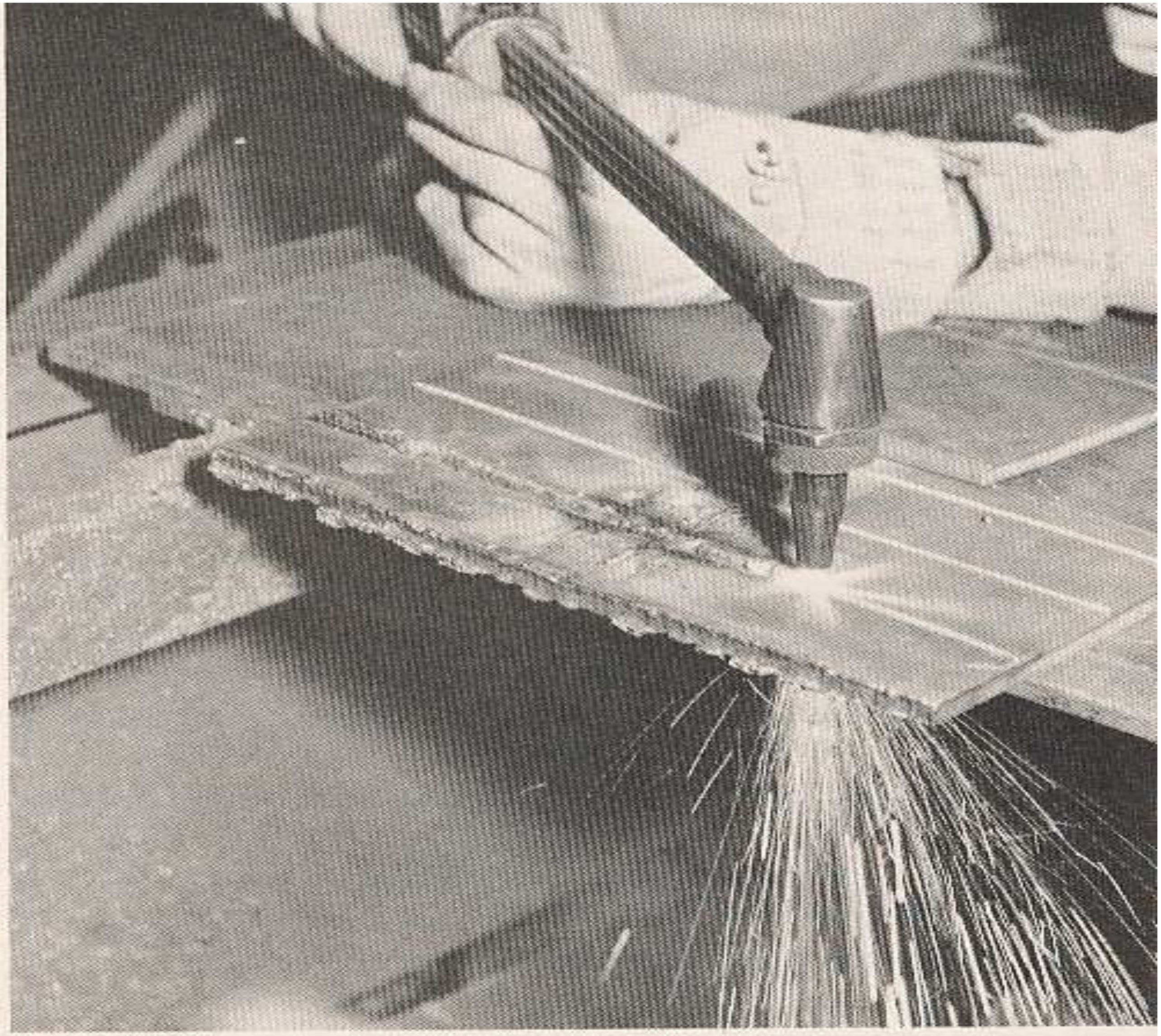


FIGURE 7-11 *Manual oxyacetlyene cutting operation.*

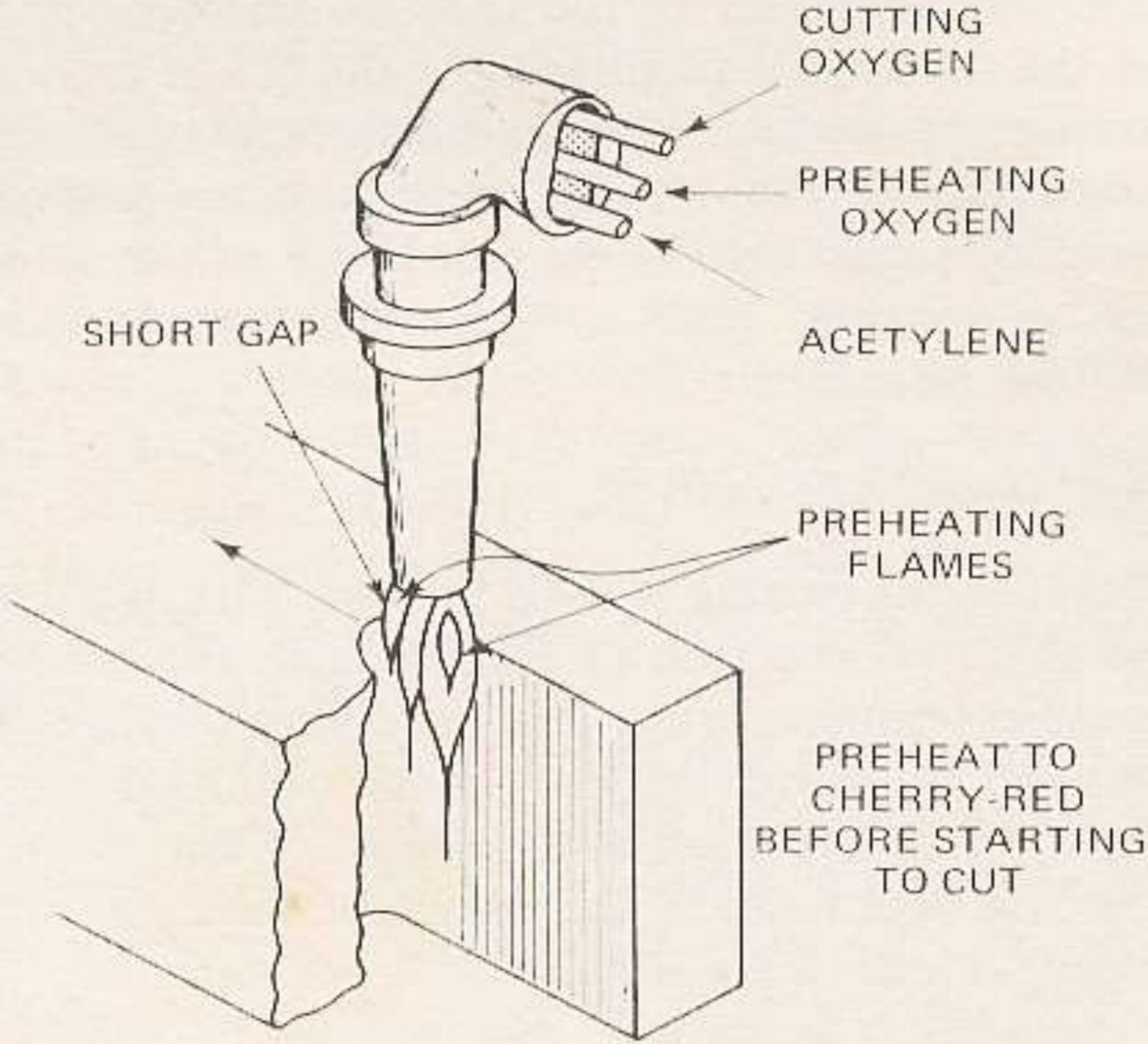


FIGURE 7-10 *Process diagram oxygen cutting.*

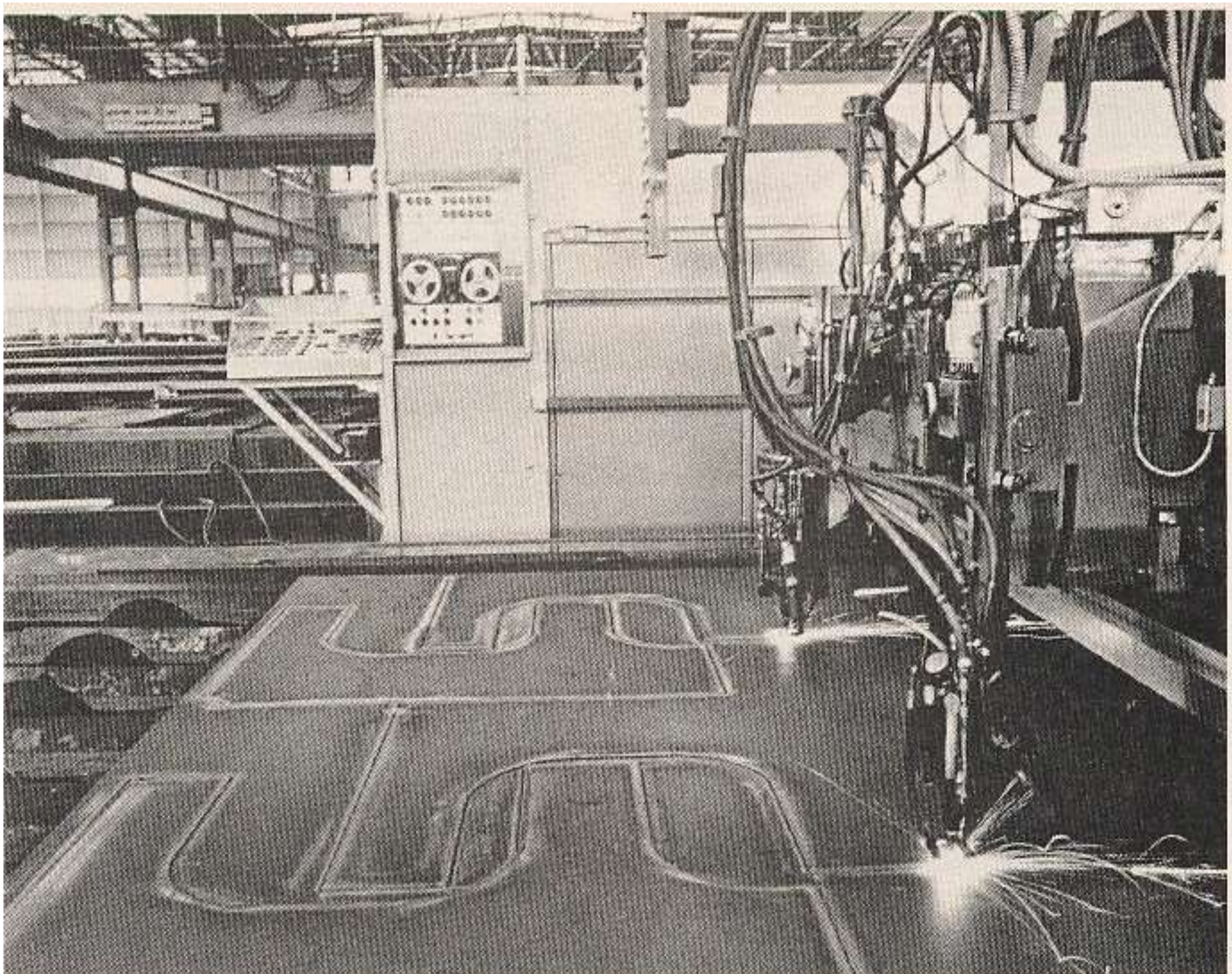
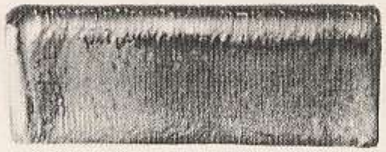


FIGURE 7-17 *Numerical controlled oxygen cutting system.*



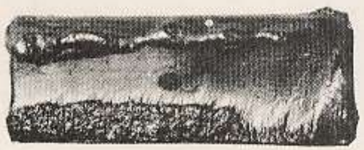
CORRECT CUT

Cutting lines are almost vertical and not very pronounced. Edges are square. Little slag evident.

COMMON CUTTING MISTAKES

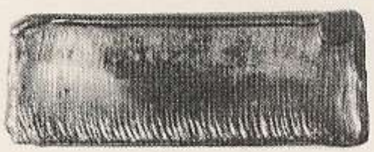
PREHEAT FLAMES TOO SMALL

Bottom half uneven and wavy.



PREHEAT FLAMES TOO LARGE

Top edge badly melted. Middle section is smooth. Slag evident at bottom.



CUTTING SPEED TOO SLOW

Upper edge melted. Cutting lines rather course.

CUTTING SPEED TOO FAST

Cutting lines curve in opposite direction of travel. Cut edge irregular.

OXYGEN PRESSURE TOO LOW

Top edge and cutting lines uneven.

OXYGEN PRESSURE TOO HIGH AND/OR NOZZLE SIZE TOO SMALL

Deep gouges into sides of cut due to lack of control.

TORCH TRAVEL UNSTEADY

Cutting lines erratic and uneven.

CUTTING WAS LOST

Cut stopped at gouged areas. Usually due to excess travel speed or insufficient preheating.

Tips for Welding with the Shielded Metal Arc Process.

There is a definite relationship between the welding current, the size of the welding electrodes, and the welding position. These must be selected so that the welder has the molten weld metal puddle under complete control at all times. If the puddle becomes too large, it becomes unmanageable and molten metal may run out of the puddle, particularly in out-of-position welding.

The welder should maintain the steady frying and crackling sound that comes with correct procedures. The shape of the molten pool and the movement of the metal at the rear of the pool serve as a guide in checking weld quality. The ripples produced on the bead should be uniform and the bead should be smooth with no overlap or undercut. The following seven factors are essential for maintaining high quality welding.

1. Correct Electrode Type: It is important to select the proper electrode for each job. This should be based on information presented in the earlier part of this section.

2. Correct Electrode Size: Electrode size choice involves consideration of the type of electrode, welding position, joint preparation, weld size, welding current, the thickness or mass of the base metal, and the skill of the welder.

3. Correct Current: If the current is too high, the electrode melts too fast and the molten pool is large and irregular and hard to control. If the current is too low there is not enough heat to melt the base metal and the molten pool will be too small and will pile up and be irregular. This is shown by Figure 4-24A.

4. Correct Arc Length: If the arc is too long, the metal melts off the electrode in large globules which wobble from side to side giving a wide, spattered, and irregular bead with poor fusion to the base metal. It may also result in porosity, especially with low hydrogen electrodes. If the arc is too short, there is not sufficient heat in the arc at the start to melt the base metal sufficiently and the electrode often sticks to the work.

FIGURE 4-24 *Welding variables travel speed and current.*

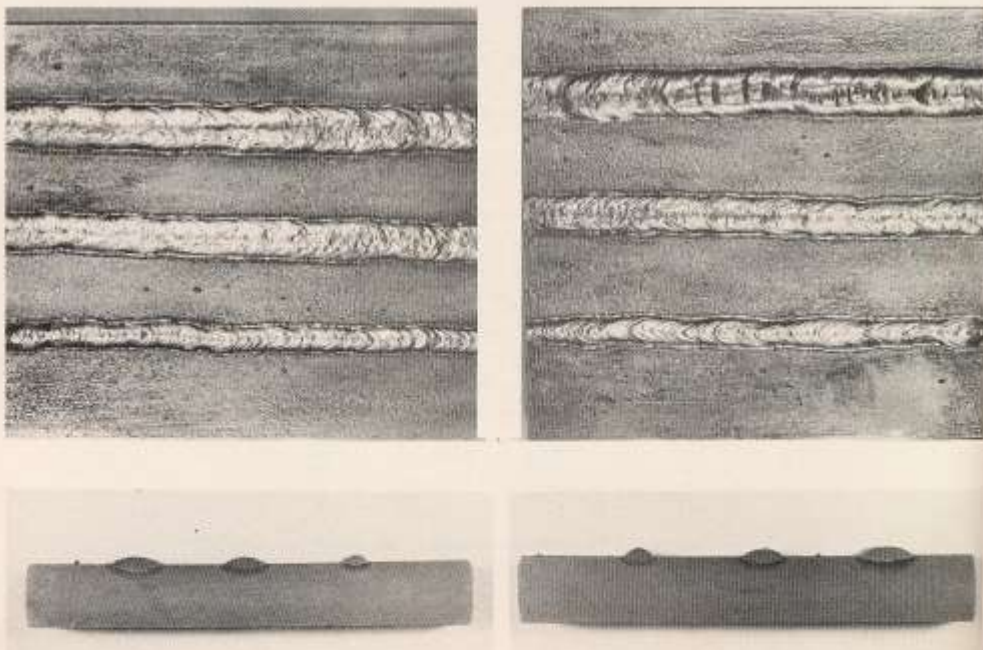
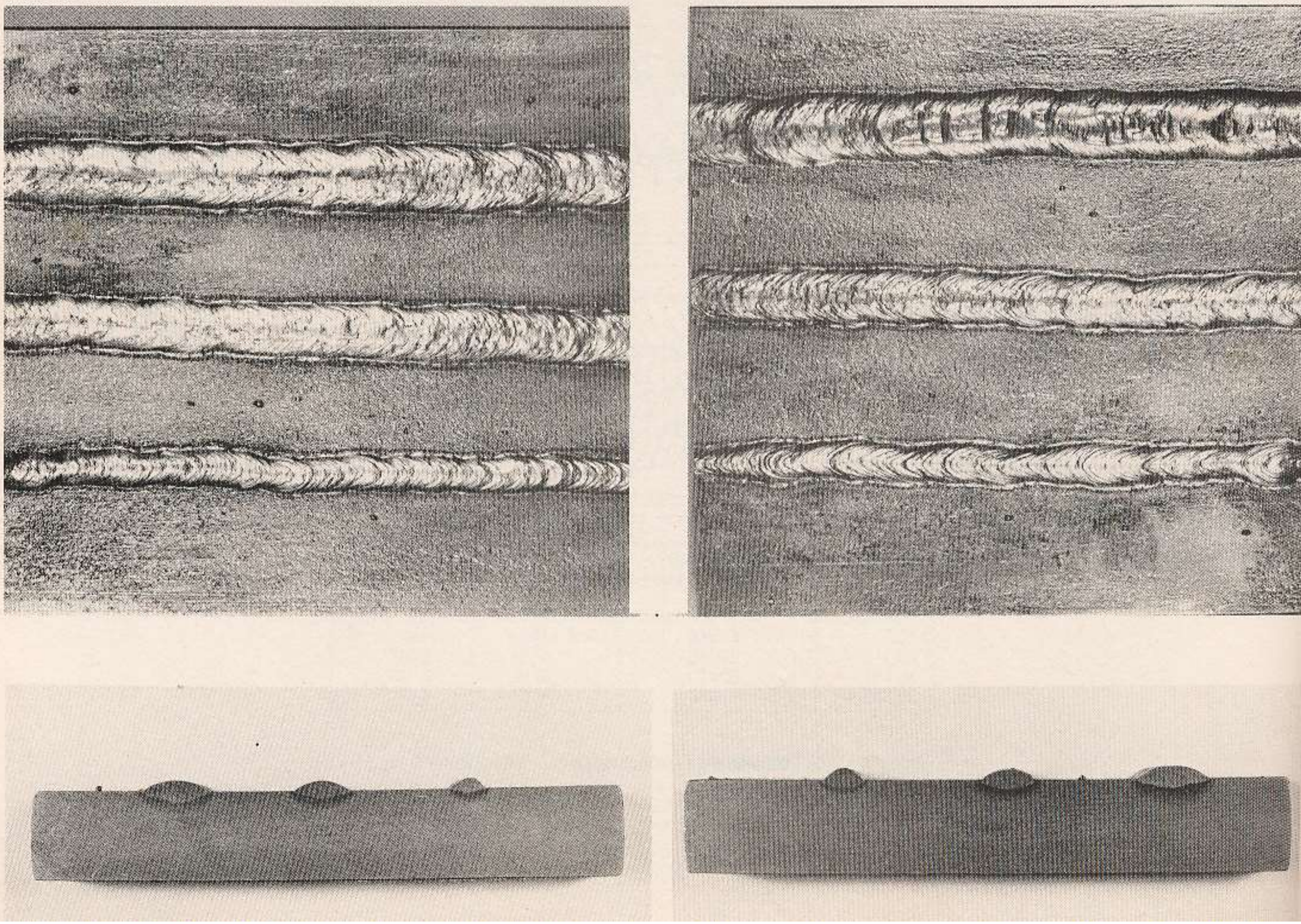


FIGURE 4-24 *Welding variables travel speed and current.*



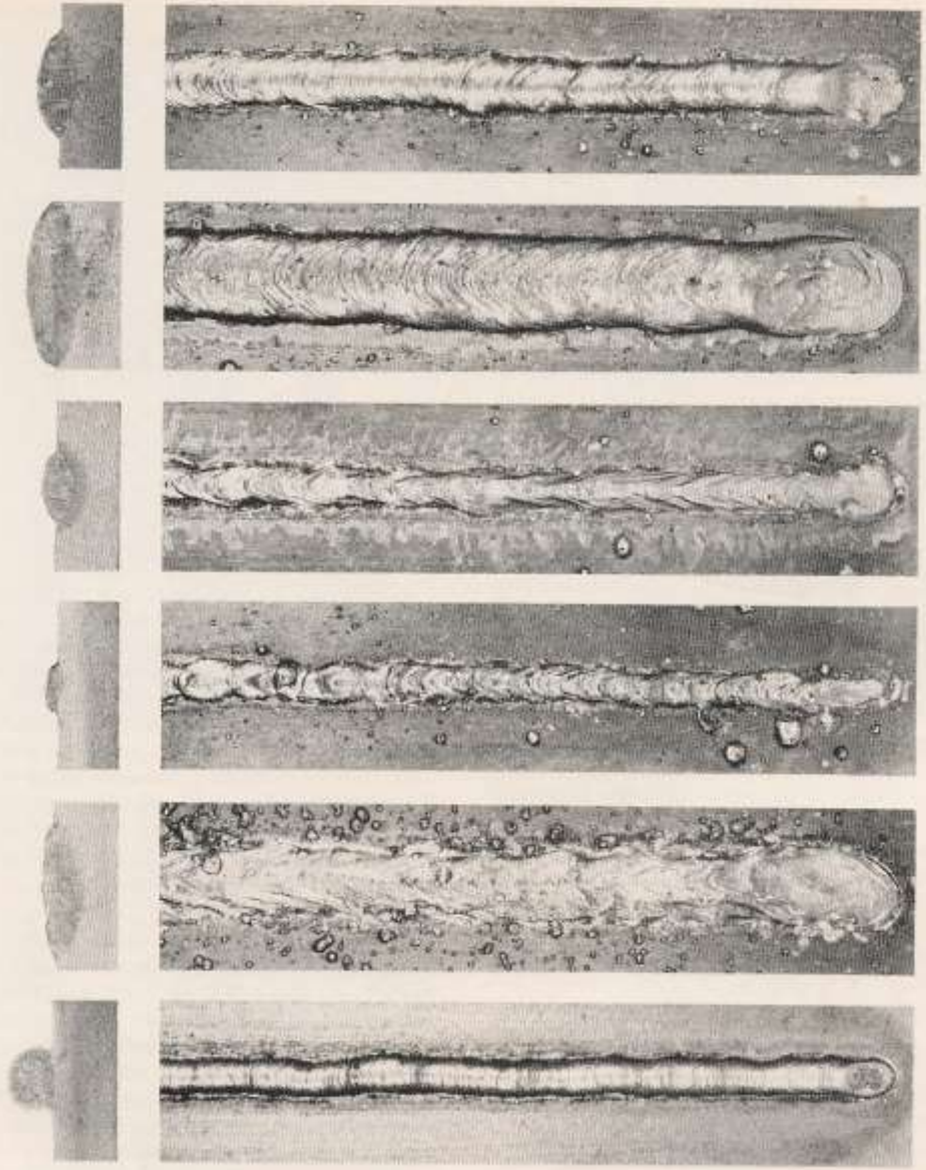


FIGURE 4-25 *Weld examples relating to malpractices.*

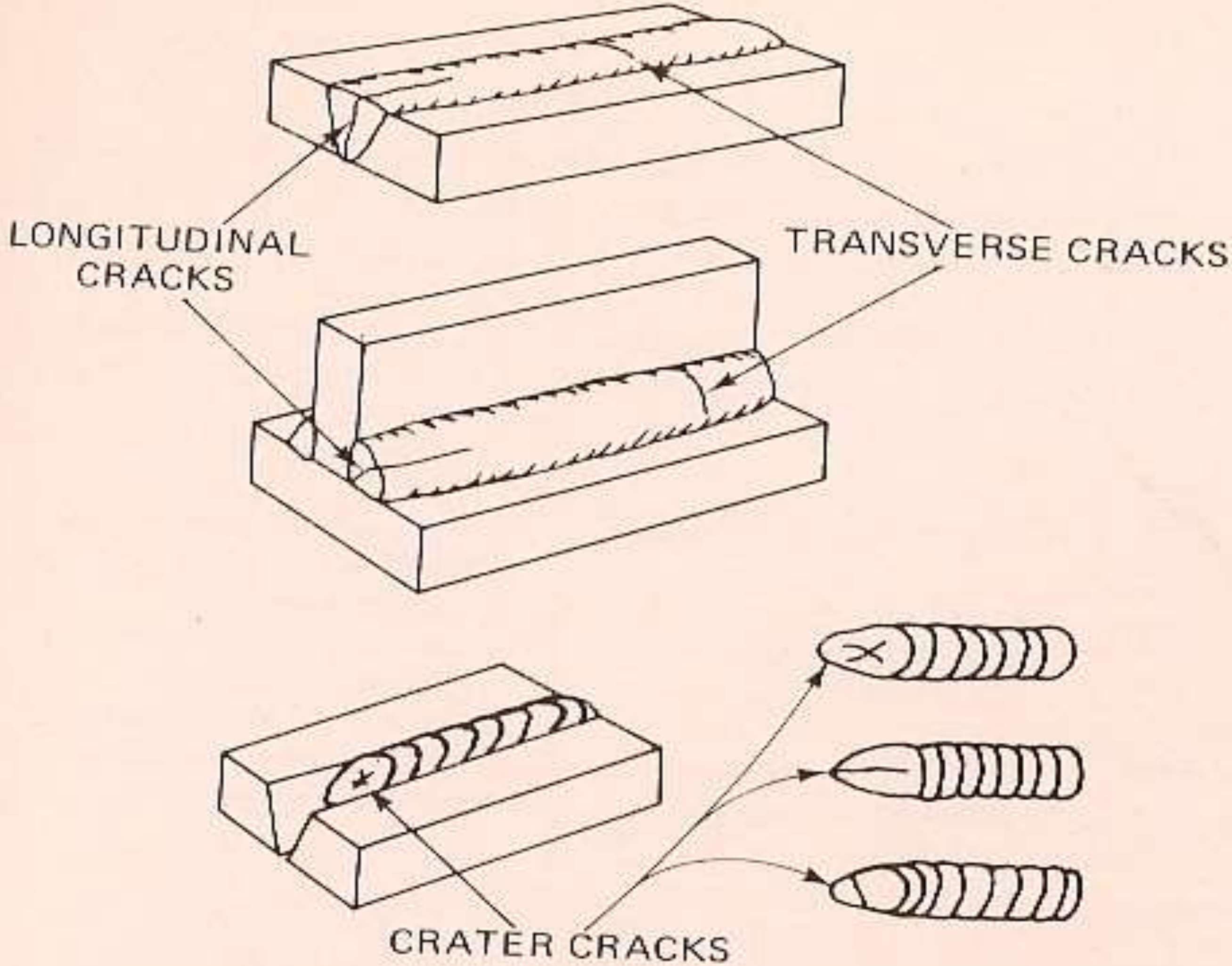


FIGURE 17-47 *Types of surface cracks of welds.*

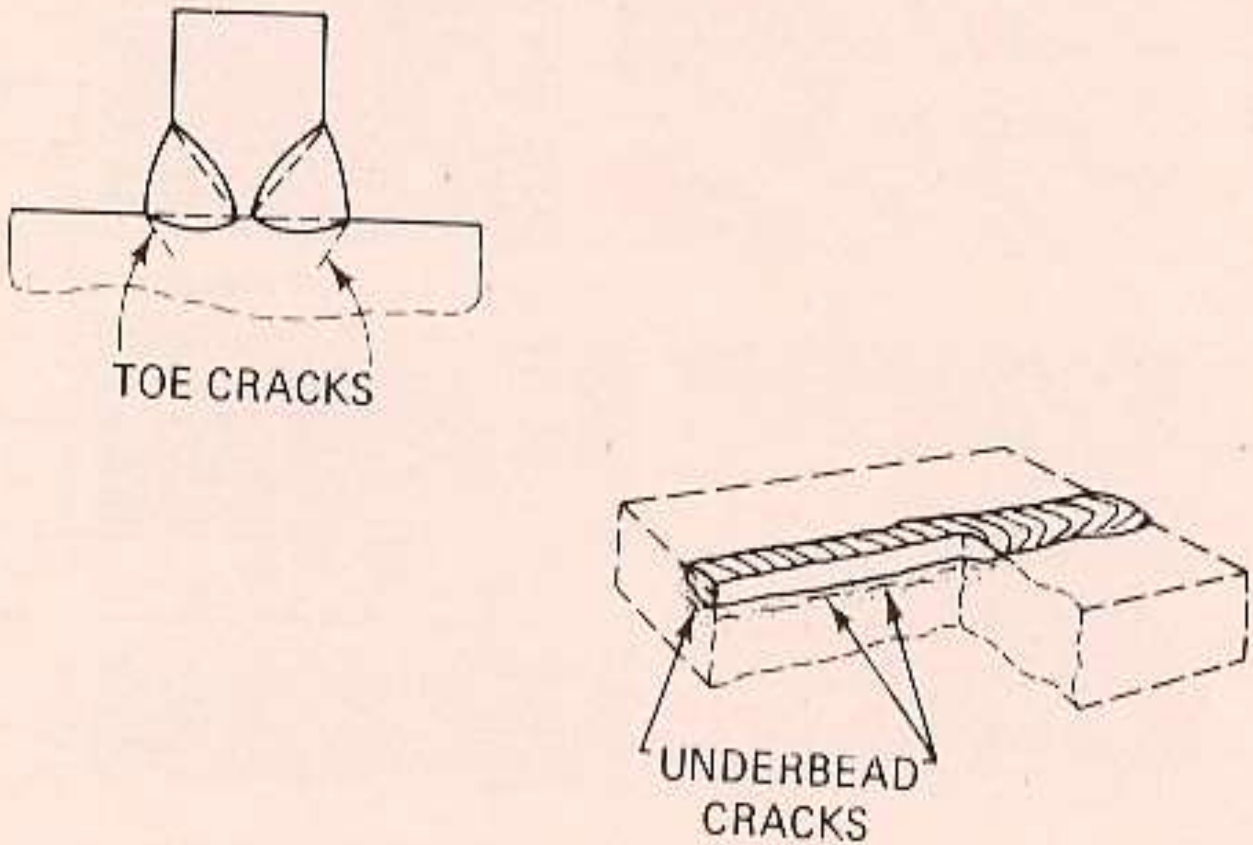


FIGURE 17-48 *Weld toe cracks and underbead cracks.*

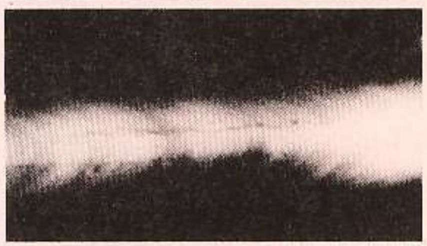
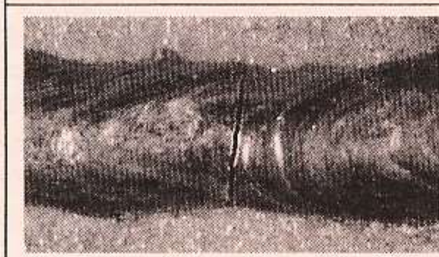
Weld Defect Class — Cracks Appearance or Cross Section or Radiograph Class No. 100	How Defected	Respon-sibility	Probable Cause	Corrective Action
 A Longitudinal Crack	VT X MT X PT X RT X UT X	design X welder X shop	General 1. Incorrect electrode. 2. High restraint of joint. 3. Rapid cooling of weld. 4. Improper joint preparation. 5. Fillet weld longitudinal crack.	1. Use proper or matched electrode. 2. Reduce rigidity of weldment or change welding sequence. Use higher ductility welding filler metal. 3. Use preheat and/or inner pass heat to reduce cooling rate. 4. Use proper joint for welding process. 5. Change center line of weld to avoid interface between parts.
 B Longitudinal Crack	VT MT X PT RT X UT X	design X welder X shop		
 C Crater Crack	VT X MT X PT X RT X UT X	design welder X shop	Crater Crack 1. Unfilled crater. 2. Crater crack in submerged arc welding.	1. Filler crater with proper technique. 2. Utilize run-out-tab.
 D Transverse Crack	VT X MT X PT X RT X UT X	design welder X shop X	Transverse Crack 1. Incorrect electrode. 2. Rapid cooling. 3. Welds too small for size of parts joined.	1. Use proper electrode. 2. Use larger electrode, higher welding current or preheat. 3. Use larger weld possibly larger welding electrode.

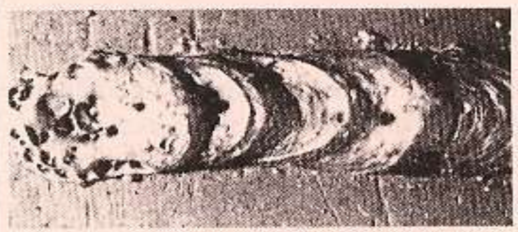
FIGURE 17-49 *Collection of weld defects—cracks.*

Weld Defect Class – Cavities

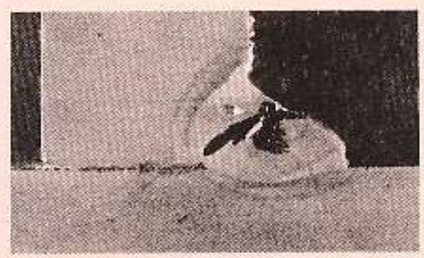
Appearance or Cross Section or Radiograph

Class No. 200

A



B



C

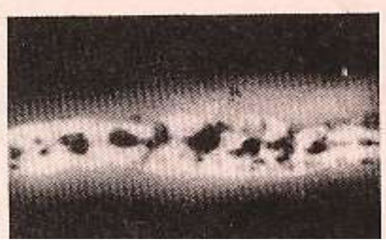
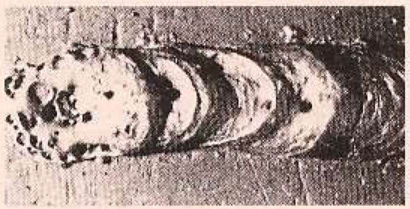
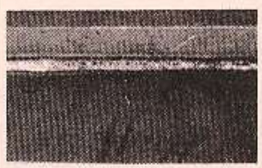
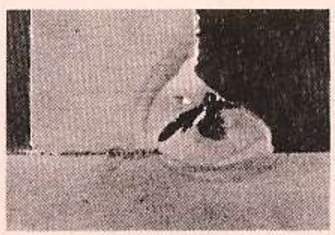
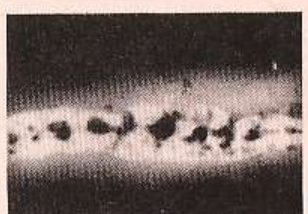


FIGURE 17-52 *Collection of weld defects—cavities.*

Weld Defect Class – Cavities Appearance or Cross Section or Radiograph Class No. 200	How Defected		Respon-sibility
 A	VT	X	design
	MT		
	PT		welder X
	RT		shop
	UT		X
 B	VT	X	design
	MT		
	PT		welder X
	RT		shop
	UT		X
  C	VT	X	design
	MT	X	
	PT	X	welder X
	RT	X	shop
	UT	X	X
  D	VT	X	design
	MT		
	PT		welder X
	RT	X	shop
	UT	X	X

Surface Porosity

Probable Cause	Corrective Action
<u>General</u>	
1. Welding over foreign material on surface such as rust, oil, moisture, paint, etc.	1. Clean weld bevels and area adjacent to weld and keep clean.
2. Damp electrodes.	2. Use fresh dry electrodes or rebake electrodes that have been exposed to dampness.
3. Improper base metals such as free machining or high sulphur.	3. Utilize correct base metal possibility to use low hydrogen type electrodes.
4. Welding current too low.	4. Increase welding current.
<u>Gas Shielded Welding Processes</u>	
1. Incorrect shielding gas type.	1. Use specified shielding gas.
2. Incomplete gas coverage due to breeze, defective gas system, clogged nozzle, etc.	2. Provide windshields, check efficiency of gas system such as broken hoses, gas valves, empty tanks, clean nozzle.
3. Moisture in the shielding system.	3. Check to make sure gas is dry or welding grade. Check for water leaks in water cooled systems.
4. Poor gas coverage.	4. Use proper nozzle to work distance. Check gas flow rate, may be too high or too low.
5. Welding over tack weld made with shielded metal arc process.	5. Utilize gas metal arc for tack welding.
<u>Submerged Arc Welding</u>	
1. Damp submerged arc flux.	1. Utilize fresh dry flux or dry damp flux.
2. Contaminated surface of electrode wire, dirt and/or moisture.	2. Clean surface of electrode wire.
3. Too many fines in flux.	3. Use fresh flux and discard fines.

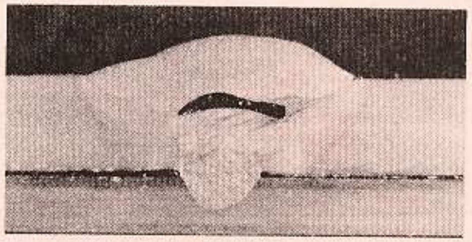
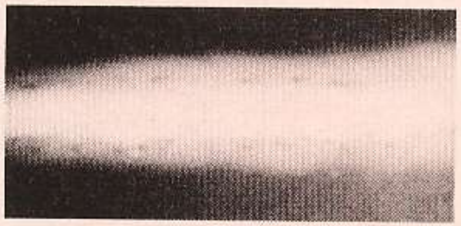
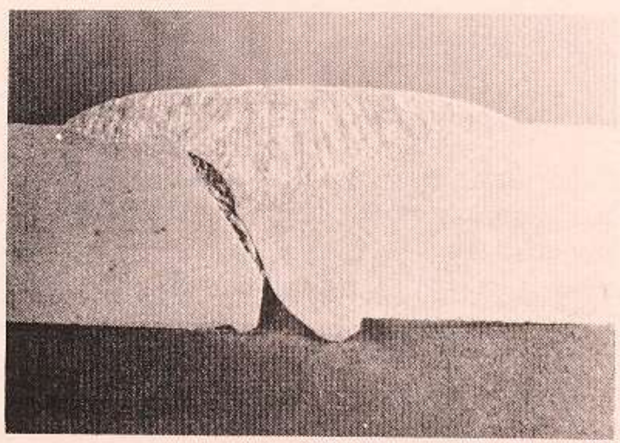
Weld Defect Class — Solid Inclusions Appearance or Cross Section or Radiograph Class No. 300	How Detected		Responsibility	Probable Cause	Corrective Action
 A	VT		design	General 1. Slag inclusion between passes. 2. Intermittent slag inclusion at edge of bead (wagon tracks). 3. Irregular surface of bevels. 4. Incorrect welding technique or wrong current or voltage. 5. Submerged arc welding —flux inclusion.	1. Remove solidified slag after each pass. 2. Remove slag at bead edge. Utilize proper technique to avoid high crowned bead contour. 3. Provide for smooth bevel surface, grind if necessary. 4. Utilize correct welding technique for electrode type and joint design. 5. Improper direction of electrode wire. Welding current too low. Electrode wire misdirected possible correction use wire straightener. Improper joint detail.
	MT				
	PT		welder ×		
	RT	×	shop		
	UT	×			
 B	VT		design		
	MT				
	PT		welder ×		
	RT	×	shop		
	UT	×			
 C	VT		design		
	MT				
	PT		welder ×		
	RT	×	shop ×		
	UT	×			

FIGURE 17-53 *Collection of weld defects—solid inclusions.*

FIGURE 17-54 *Incomplete fusion.*

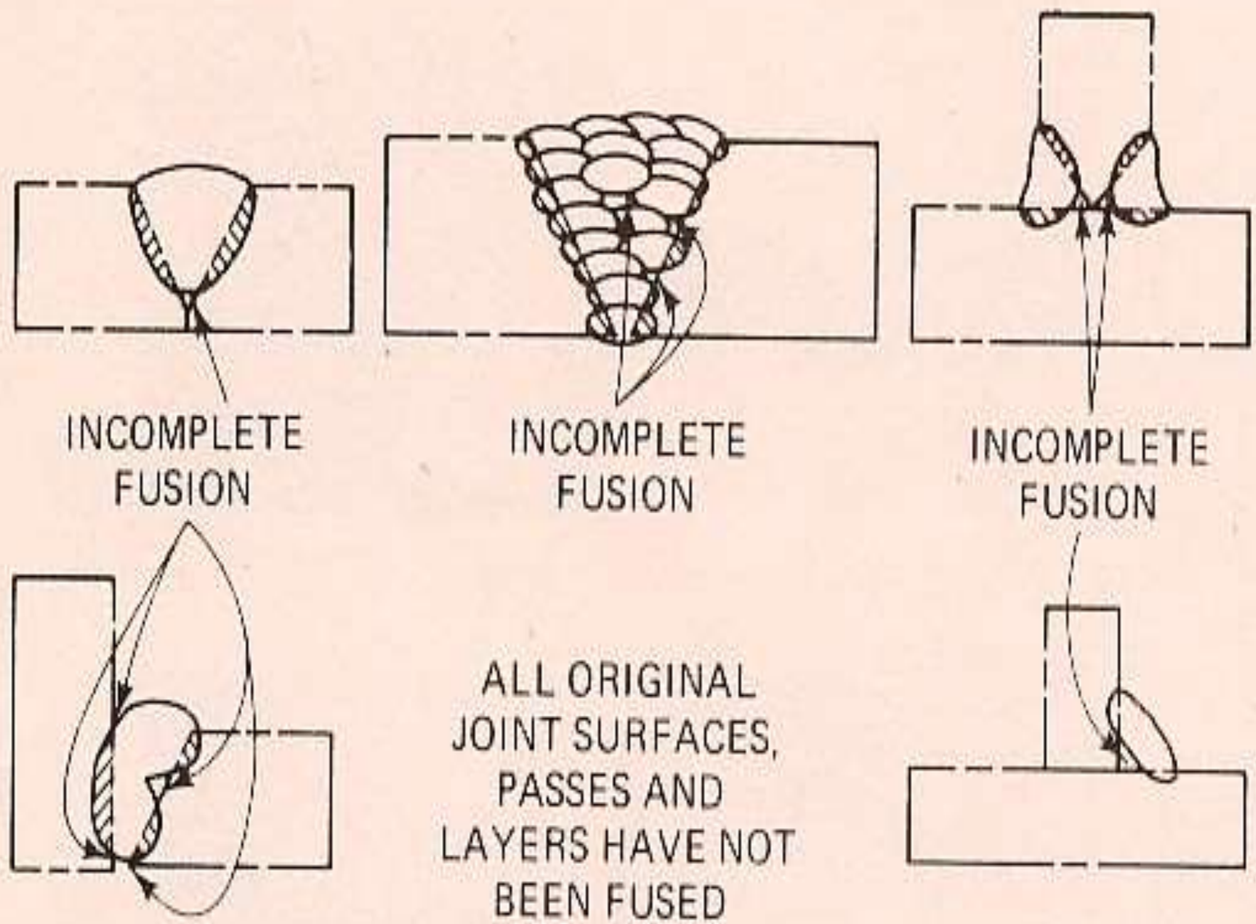
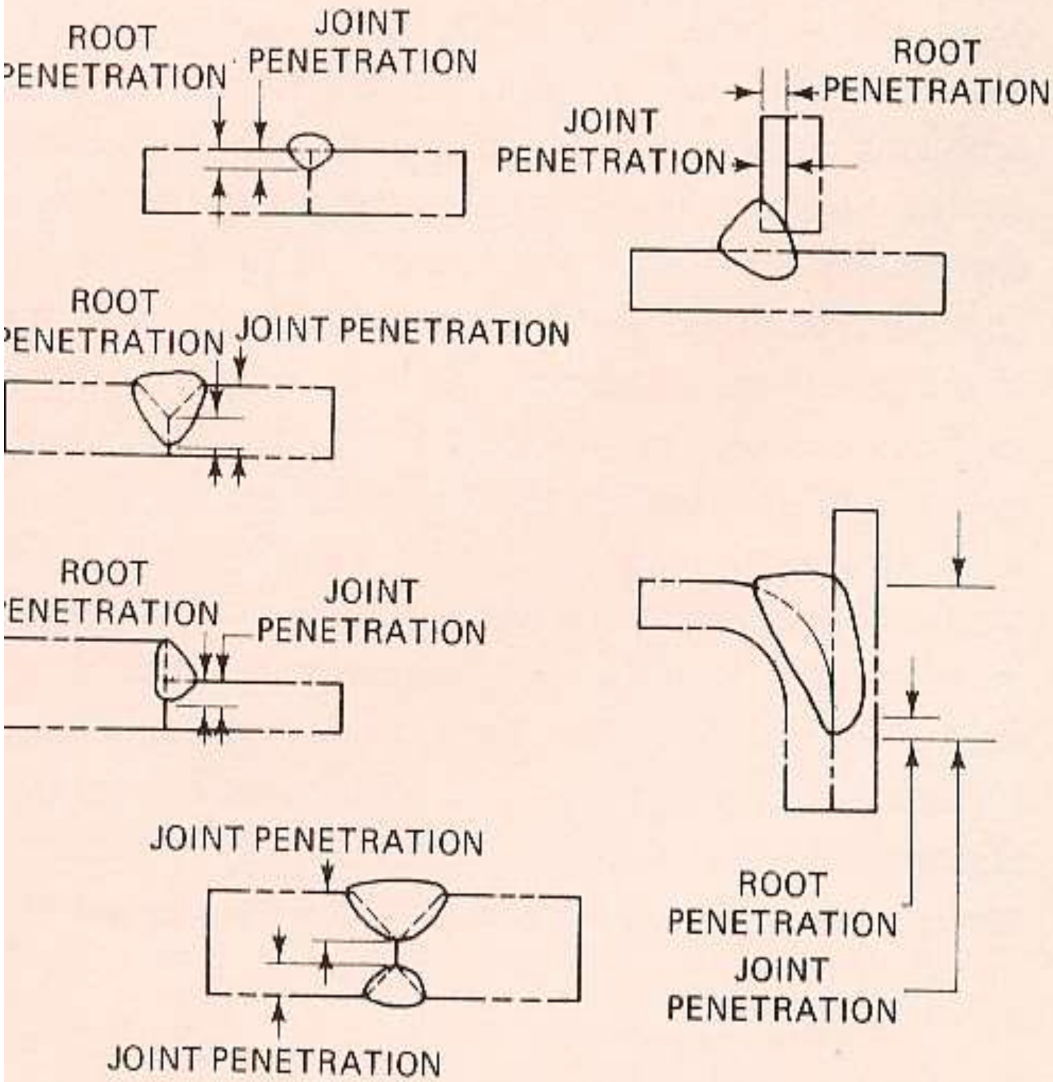
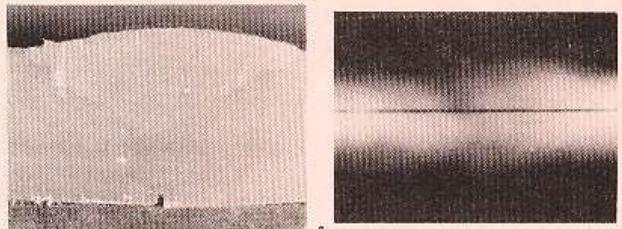
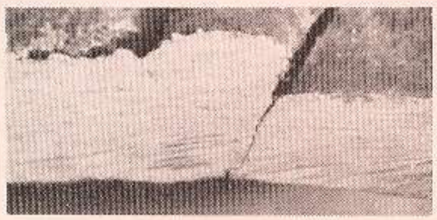
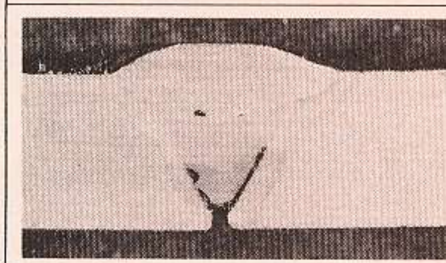


FIGURE 17-55 *Root penetration and joint penetration.*



Weld Defect Class — Incomplete Fusion
Appearance or Cross Section or Radiograph
Class No. 400

Appearance or Cross Section or Radiograph	How Detected: VT	MT	PT	RT	UT	Responsibility: design	welder	shop
 A	X		X	X	X	X	X	
 B	X	X		X	X	X	X	
 C	X	X		X		X	X	X
 D	X			X	X		X	

Probable Cause	Corrective Action
General	
1. Welding speed too fast.	1. Reduce welding speed.
2. Electrode too large for joint detail.	2. Utilize correct size electrode.
3. Welding current too low.	3. Increase welding current for more penetration.
4. Improper joint design such as excessive root face or minimum root opening..	4. Utilize correct joint detail.
5. Improper joint fit-up such as root opening too small.	5. Make setup correct to agree with joint design detail.
Shielded Metal Arc Welding	
1. Irregular travel speed.	1. High speed will reduce complete fusion, lower speed will cause complete fusion.
2. Irregular arc length	2. Maintain proper arc length.
Gas Metal Arc Welding	
1. Incomplete fusion—(cold shut)	1. Direct arc at leading edge of puddle. Current too low, voltage too low, adjust for proper procedure. Pause too short at dwell when weaving. Increase pause to allow melting of base metal.
Submerged Arc Welding—Semiautomatic	
1. Incomplete root fusion.	1. Failure to direct welding electrode to root of weld joint.

FIGURE 17-56 *Collection of weld defects—incomplete fusion.*

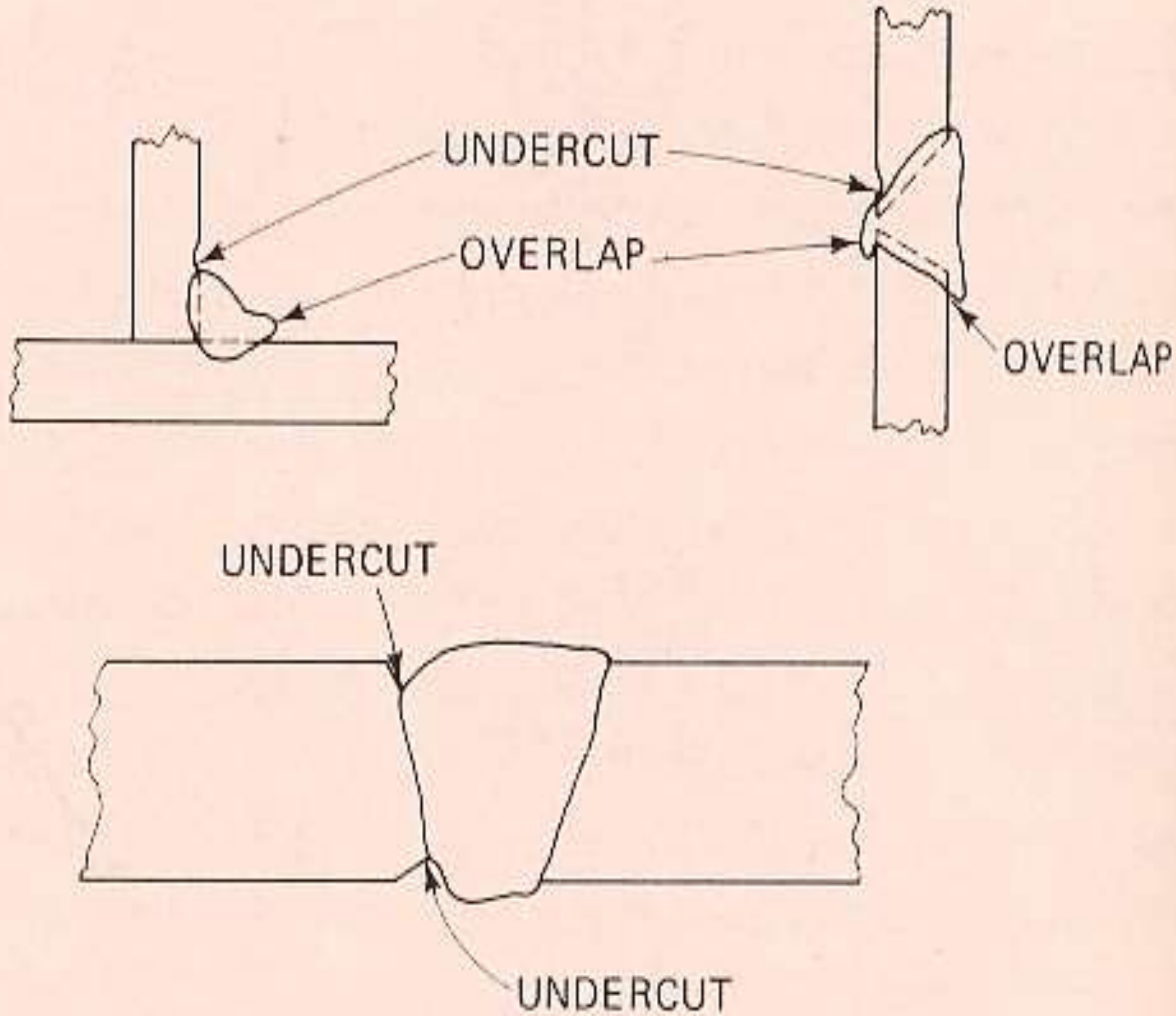


FIGURE 17-57 *Undercut fillet and groove and overlap.*

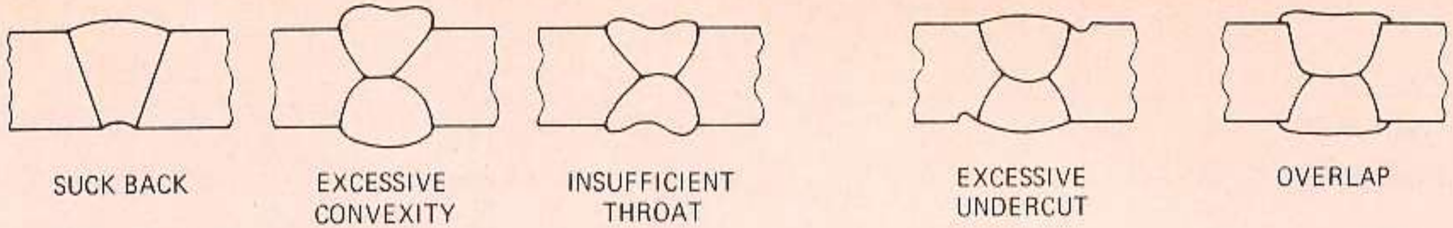


FIGURE 17-58 *Groove welds and various defects.*

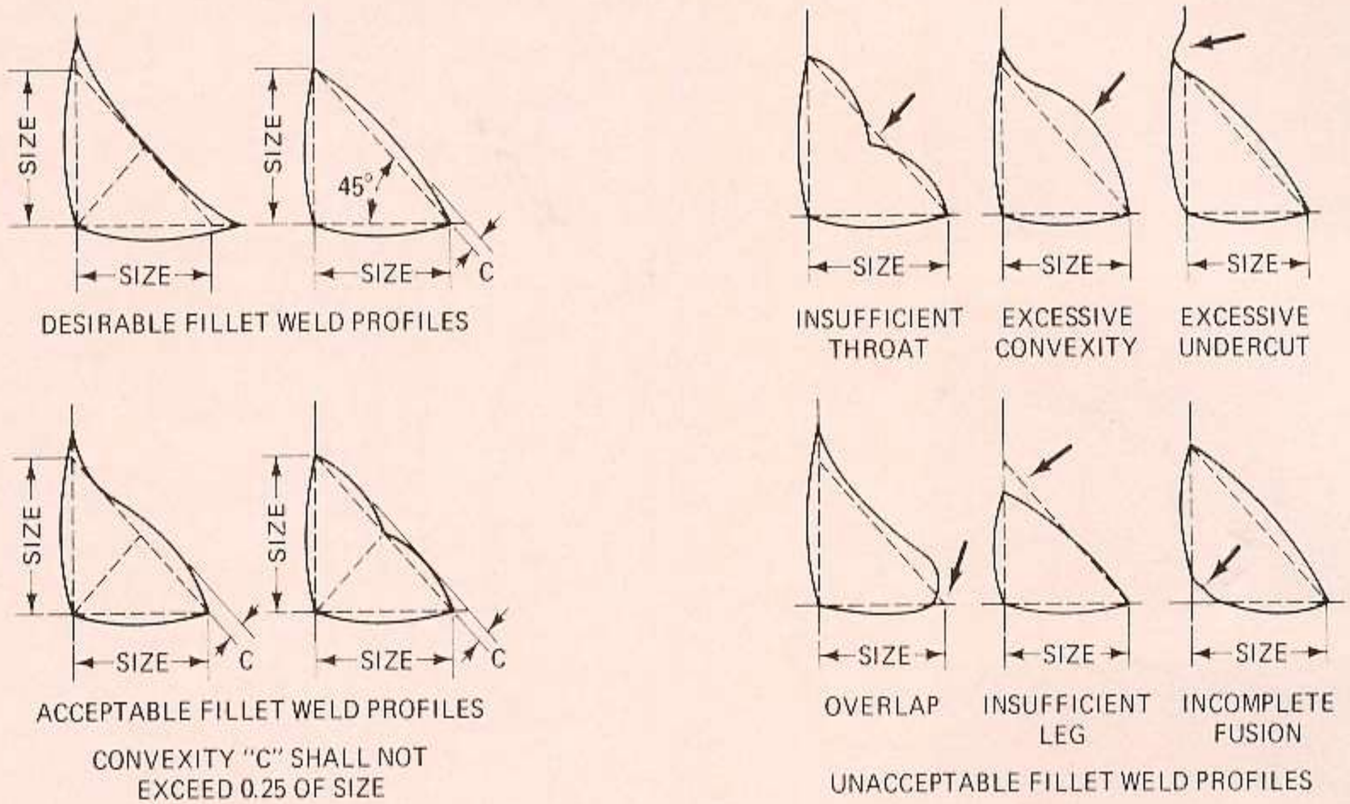
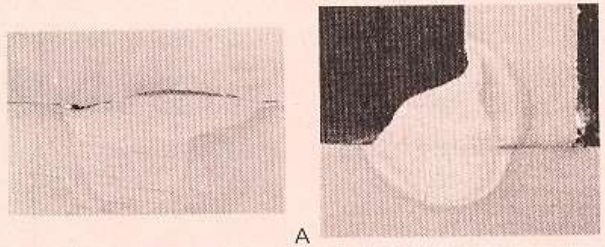
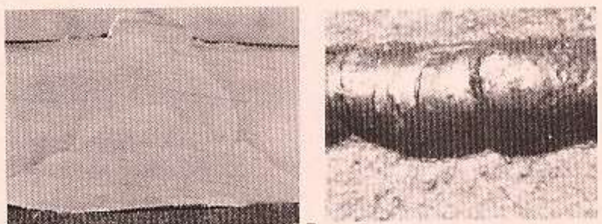
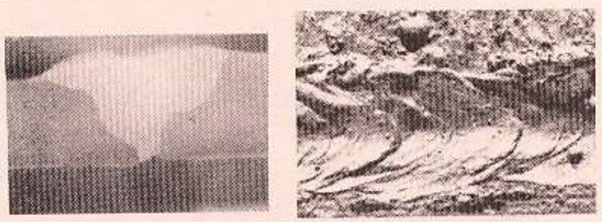
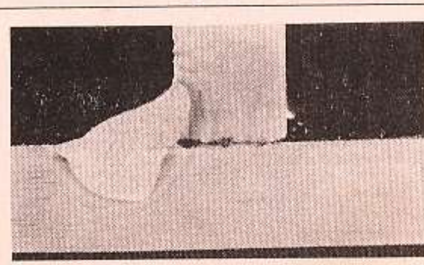


FIGURE 17-59 *Contour of fillet welds.*

FIGURE 17-60 *Collection of weld defects—incorrect shape.*

Weld Defect Class — Imperfect Shape Appearance or Cross Section or Radiograph Class No. 500	How Defected		Respon-sibility	Probable Cause	Corrective Action
 A	VT MT PT RT UT	X X X X X	design welder X shop	Undercutting 1. Faulty electrode manipulation. 2. Welding current too high. 3. Incorrect electrode size (usually too large). 4. Incorrect electrode for welding position. 5. Incorrect electrode angle.	1. Use uniform weave in groove welding pause at edges. 2. Use prescribed welding current for electrode size. 3. Use correct electrode size for size weld being made. 4. Use correct electrode with position capabilities. 5. Adjust electrode angle to fill undercut area.
 B	VT MT PT RT UT	 X X X	design welder X shop		
 C	VT MT PT RT UT	X X X X X	design welder X shop	Incorrect Profile 1. Excessive root penetration. 2. Travel speed too slow. 3. Excessive crown or reinforcement. 4. Incomplete root or negative root reinforcement or "suck back" (internal concavity). 5. Improper fillet contour usually wide on horizontal and not sufficient on vertical leg. 6. Incorrect electrode type.	1. Root opening too wide. 2. Welding current too high. 3. a. Welding speed too slow. b. Welding voltage too high arc length too long, correct arc length. 4. a. Voltage too high. b. Travel speed too fast. c. Root opening too wide. 5. Improper welding technique. Welding current too high. Reduce welding current. Use smaller electrode. 6. Use proper electrode type.
 D	VT MT PT RT UT	X X X X X	design welder X shop		

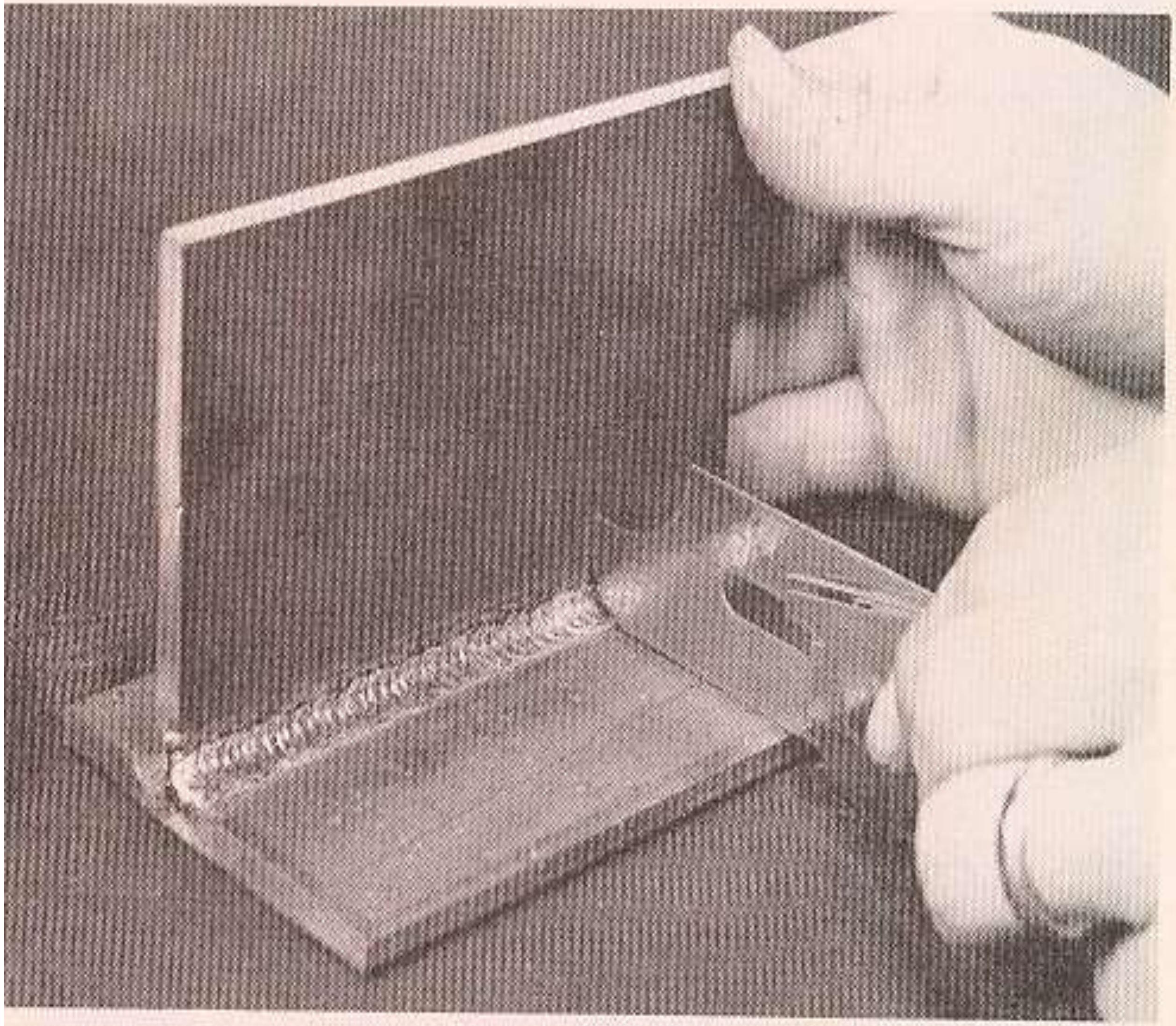


FIGURE 17-30 *Use of standard fillet gage.*

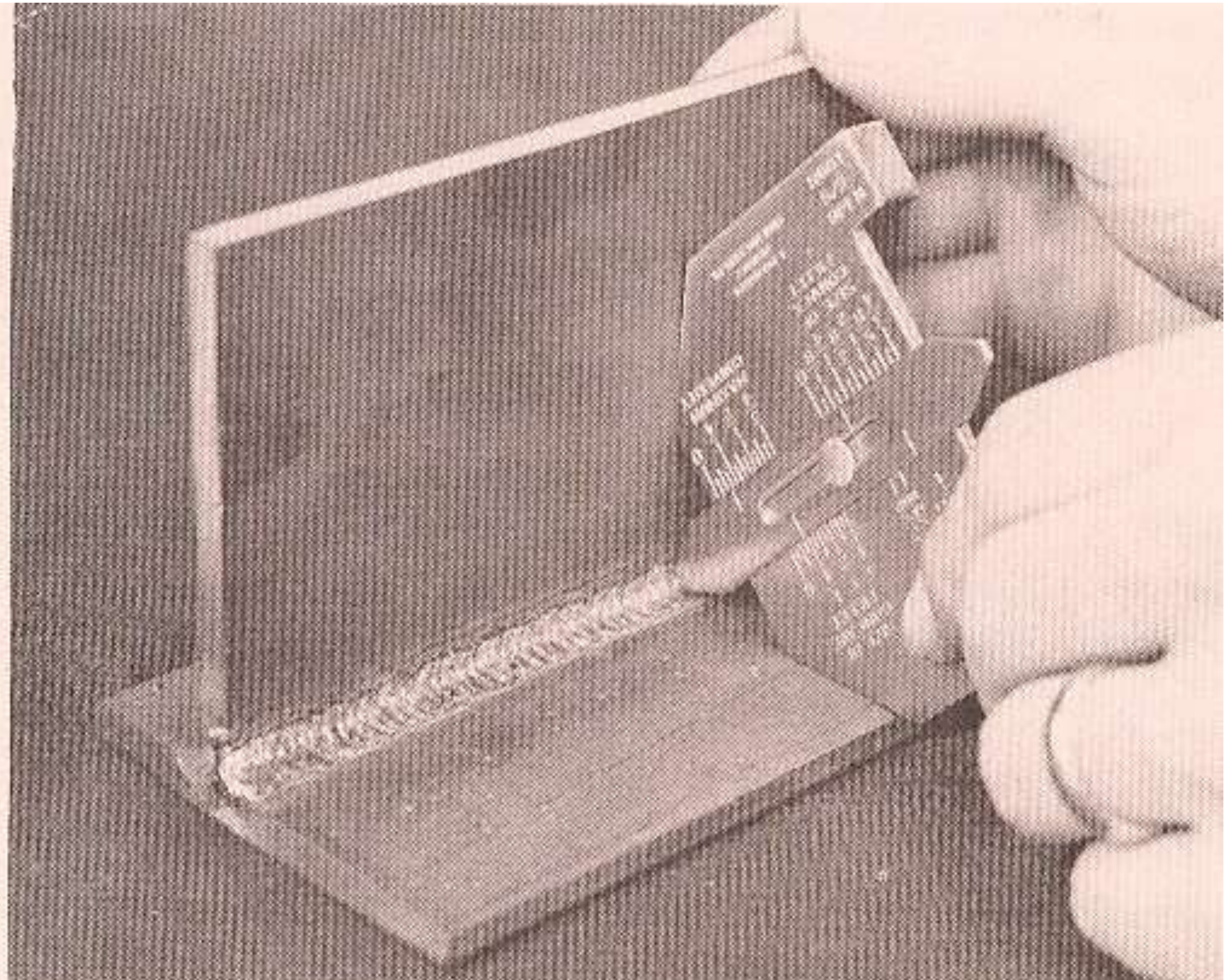


FIGURE 17-32 *Navy type weld gage.*

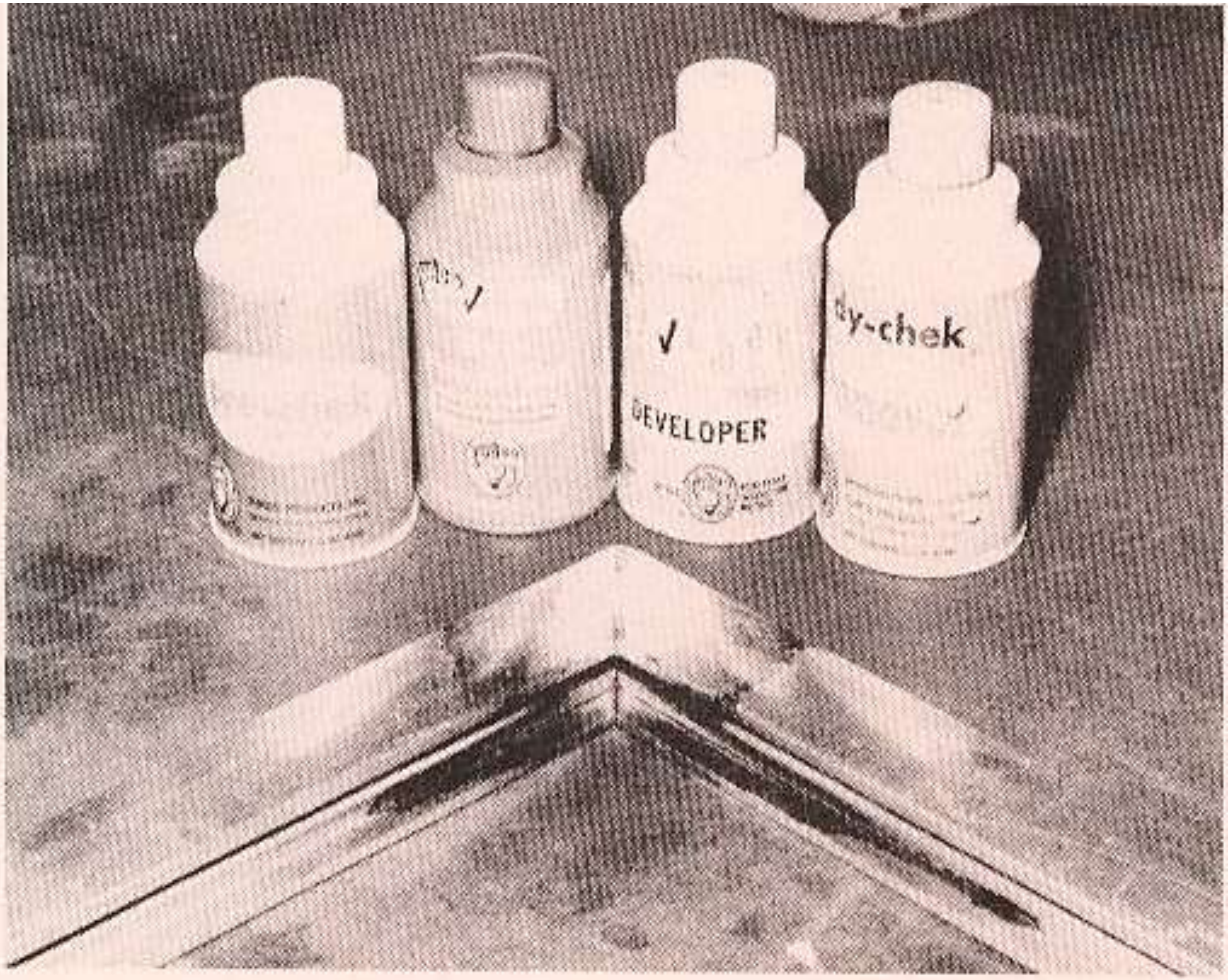


FIGURE 17-35 *Using penetrant on finished weld.*

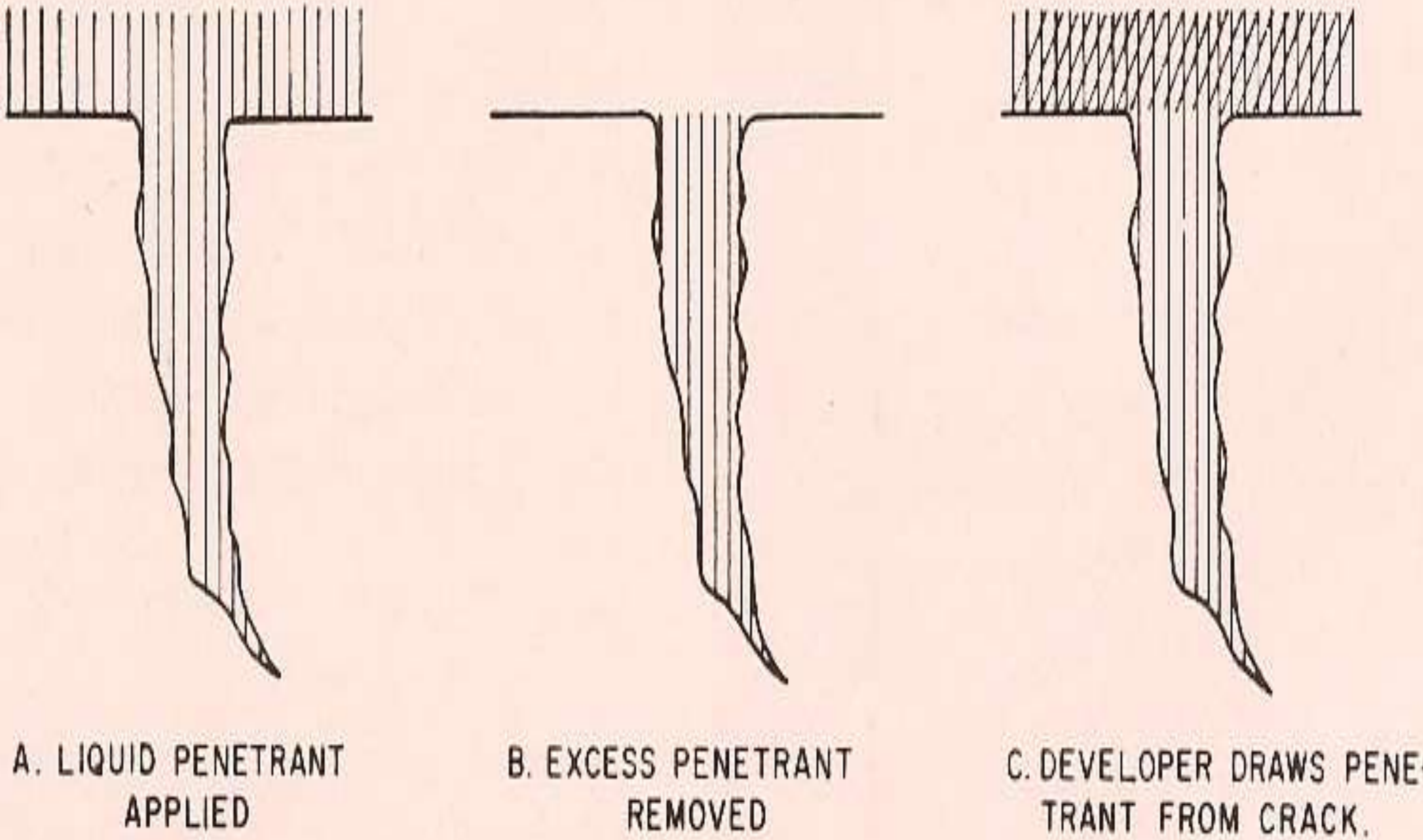


FIGURE 17-34 *Principle of dye penetrant inspection.*

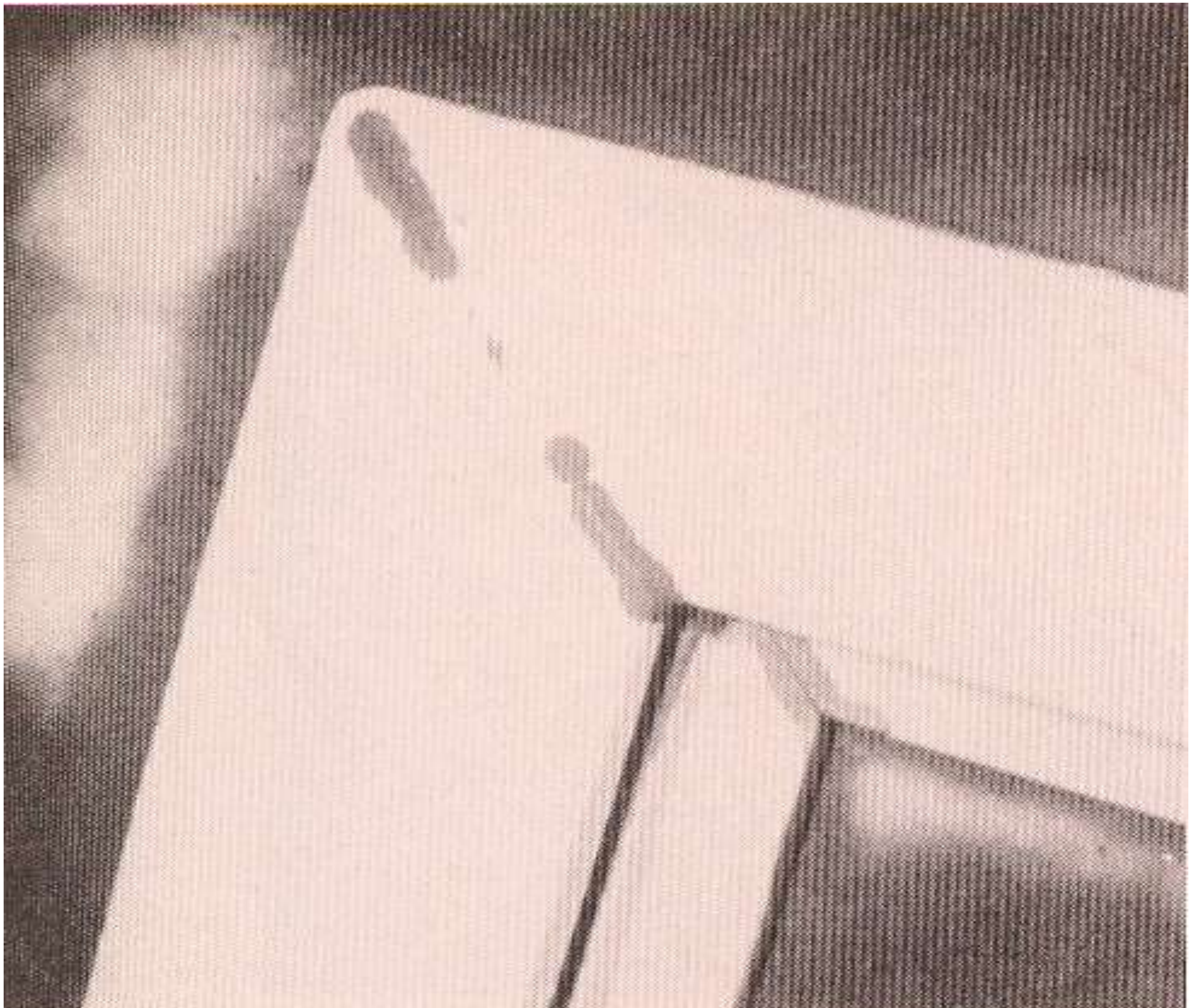


FIGURE 17-36 *Penetrant indication.*

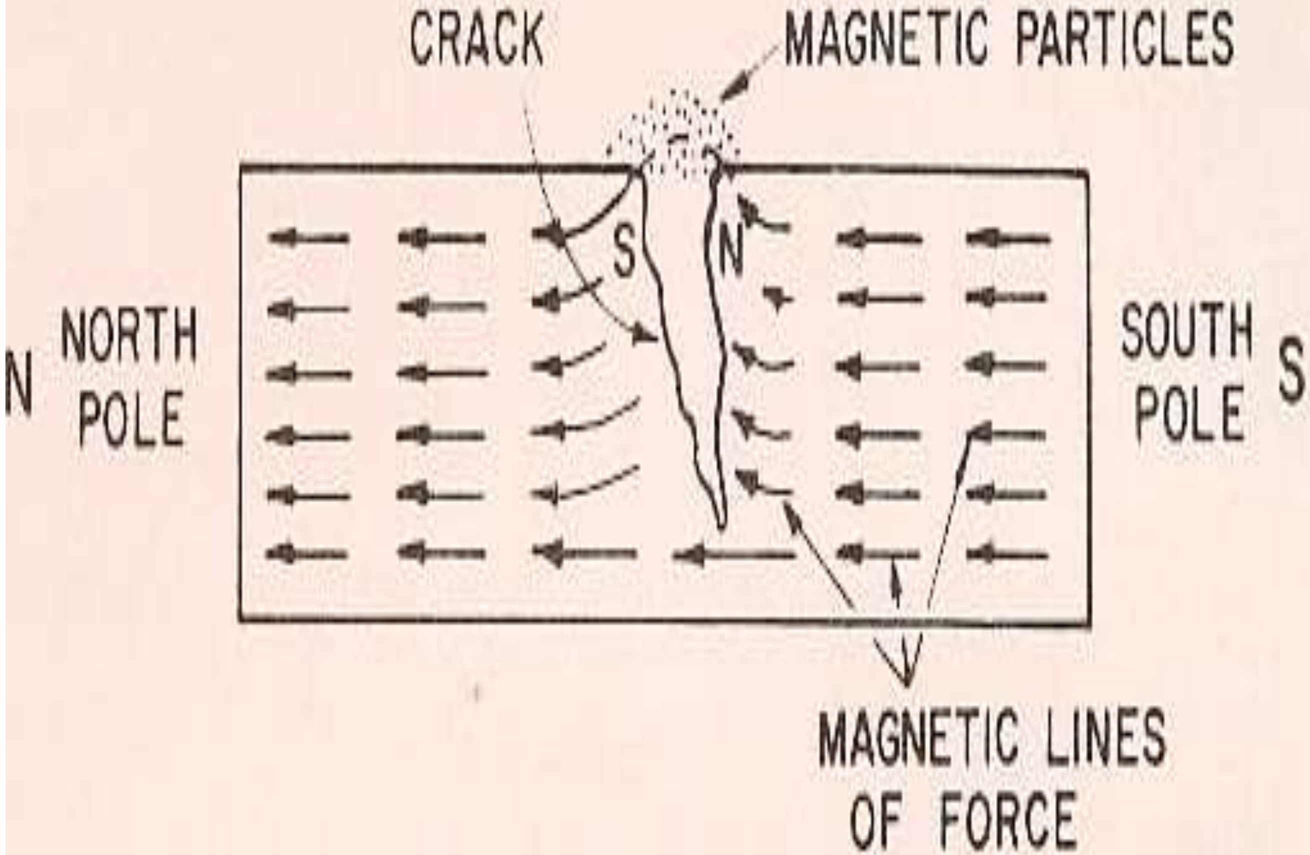


FIGURE 17-37 *Principle of magnetic particle inspection.*

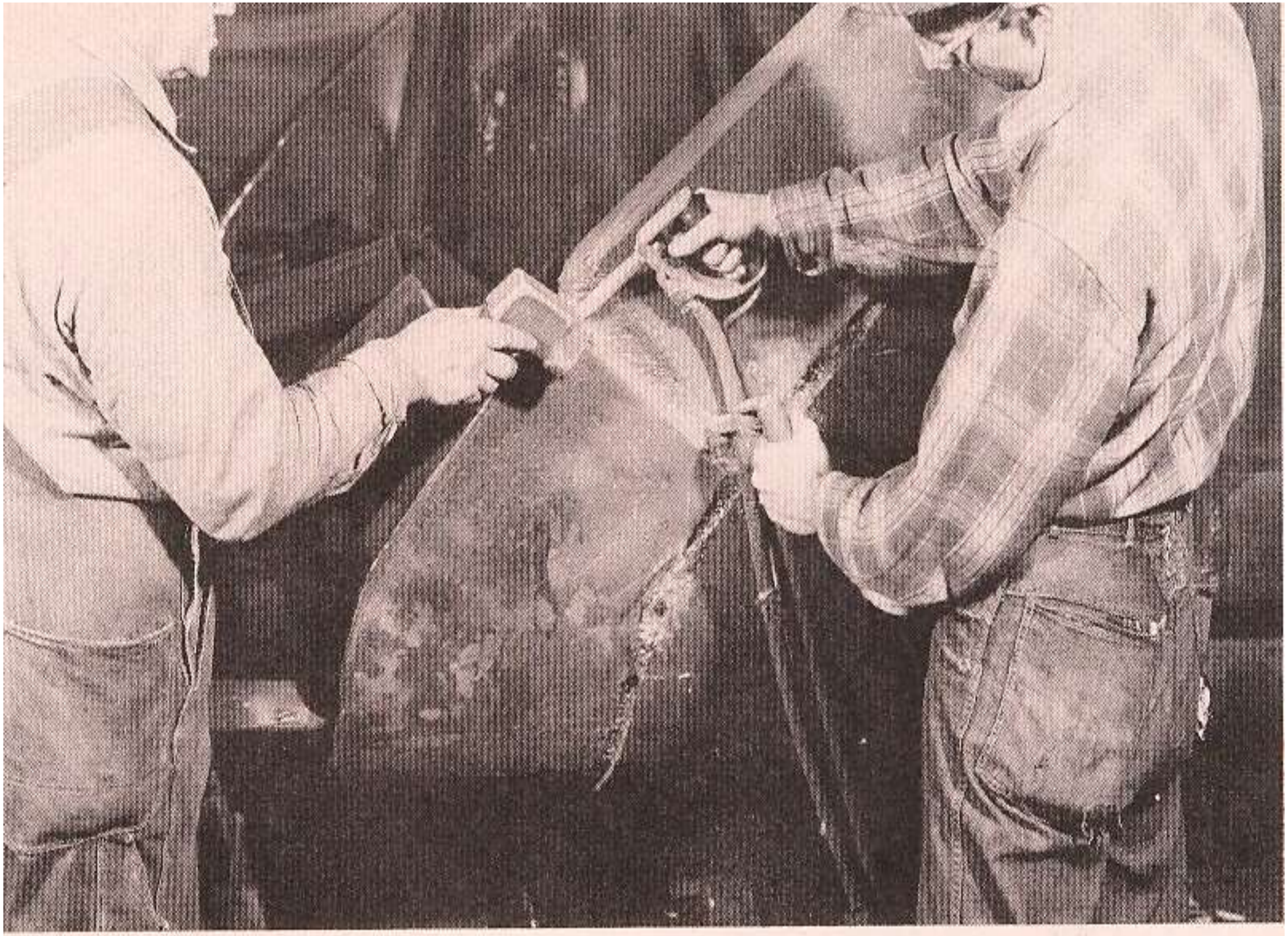


FIGURE 17-38 *Using magnetic particle inspection.*

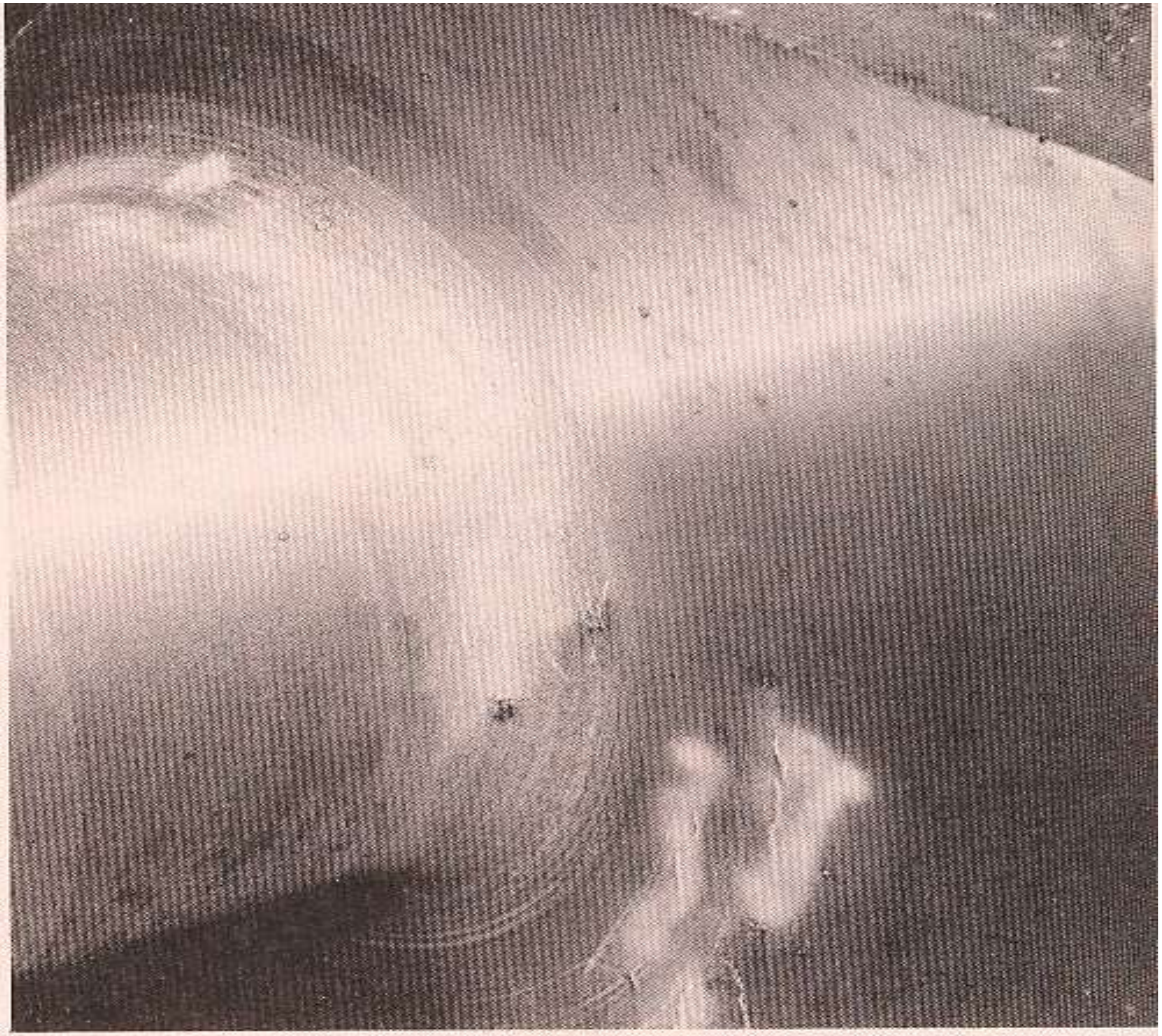


FIGURE 17-39 *Magnetic powder indication.*

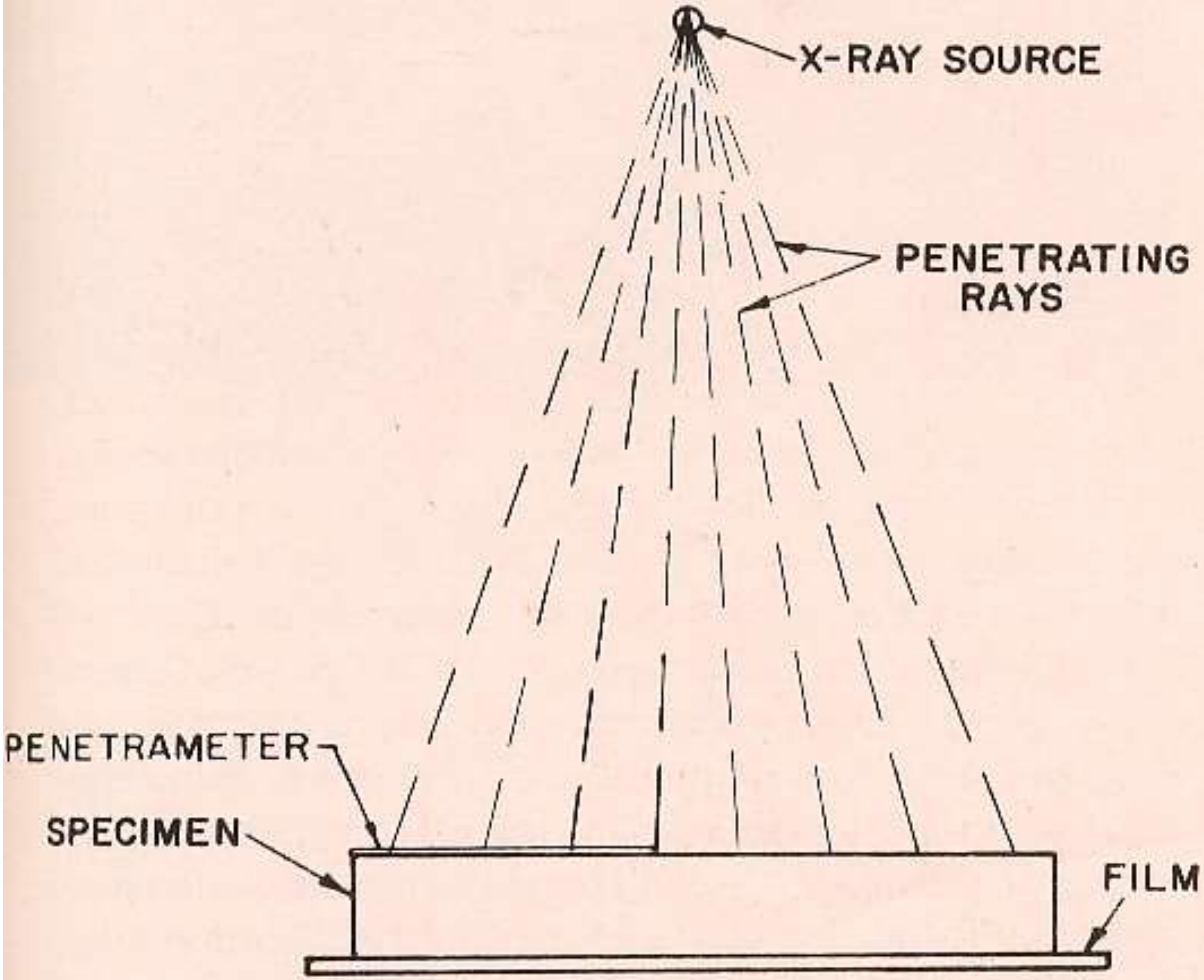


FIGURE 17-40 *Principle of radiographic inspection.*

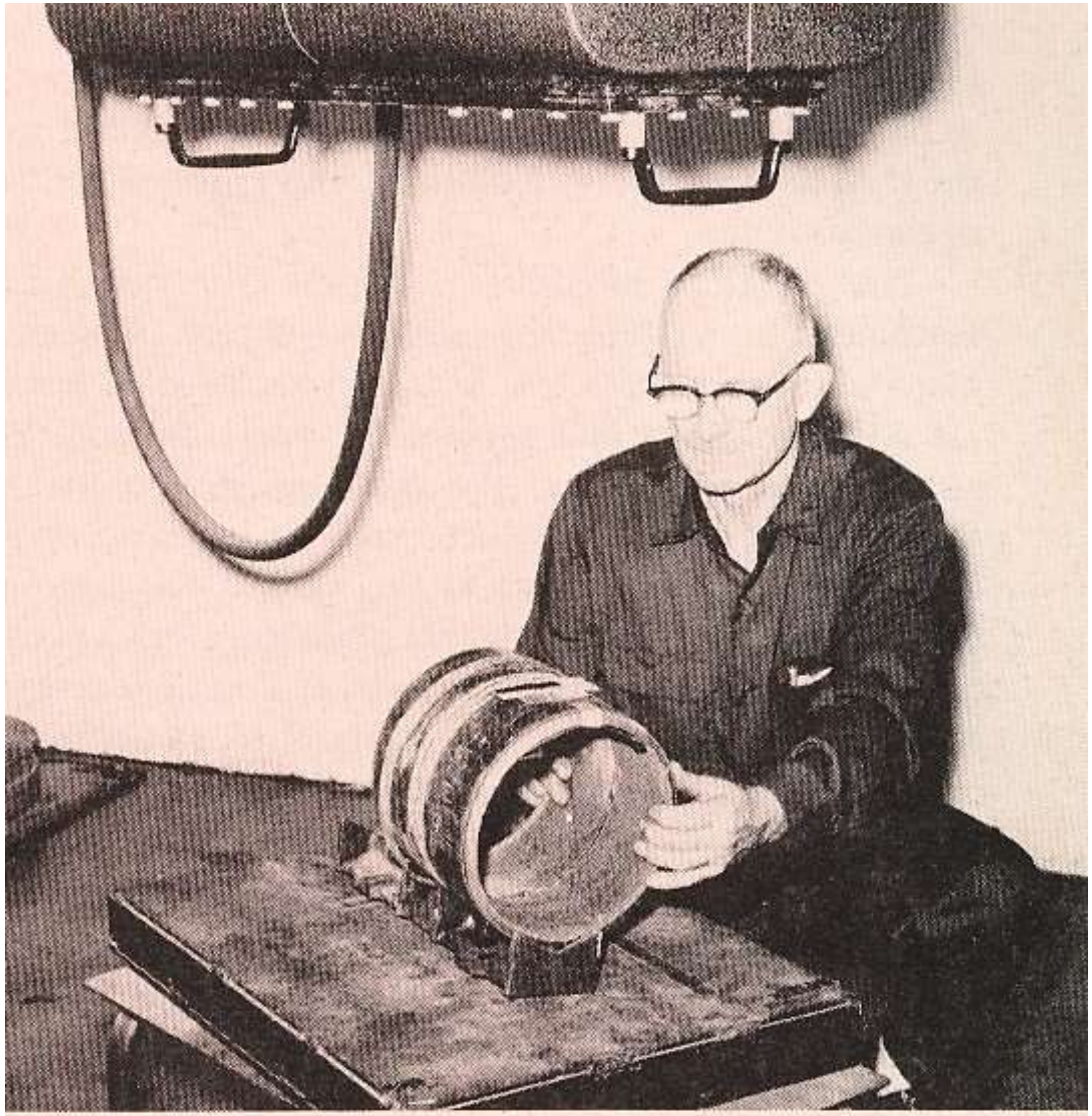


FIGURE 17-41 *Setting up to take radiograph.*

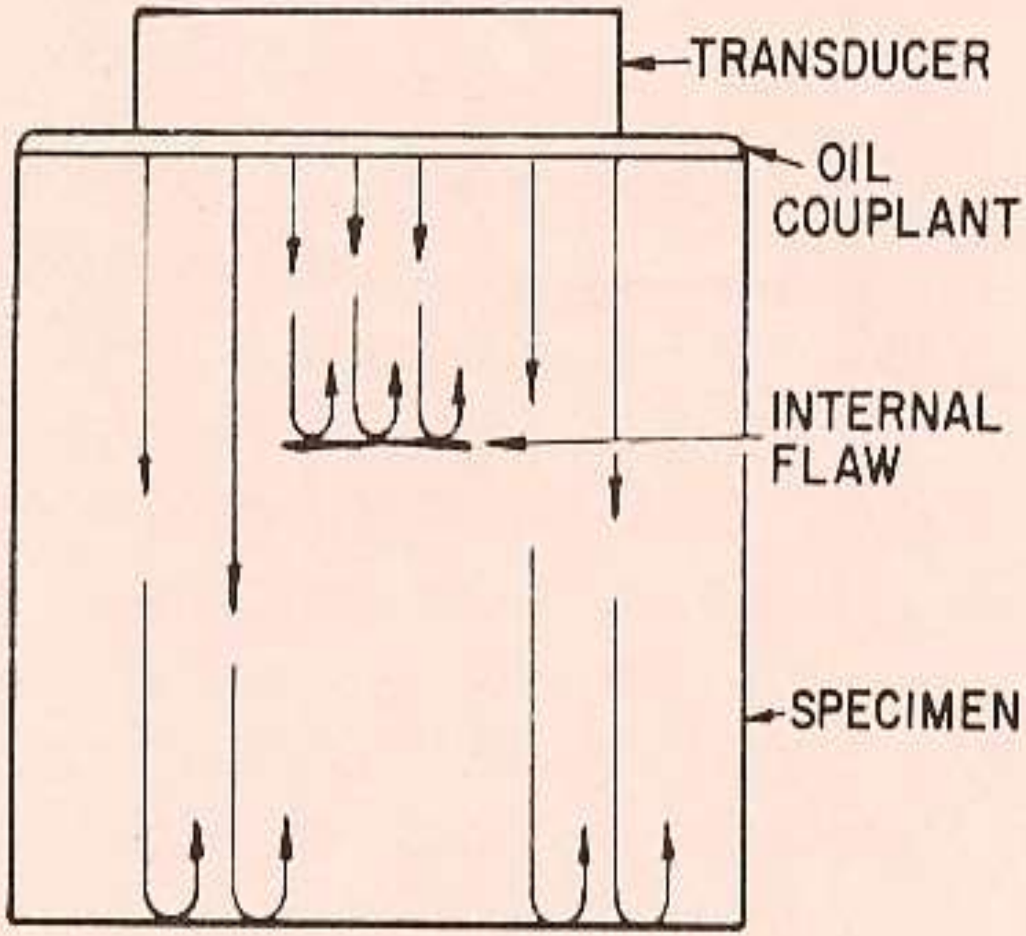


FIGURE 17-43 *Principle of ultrasonic inspection.*

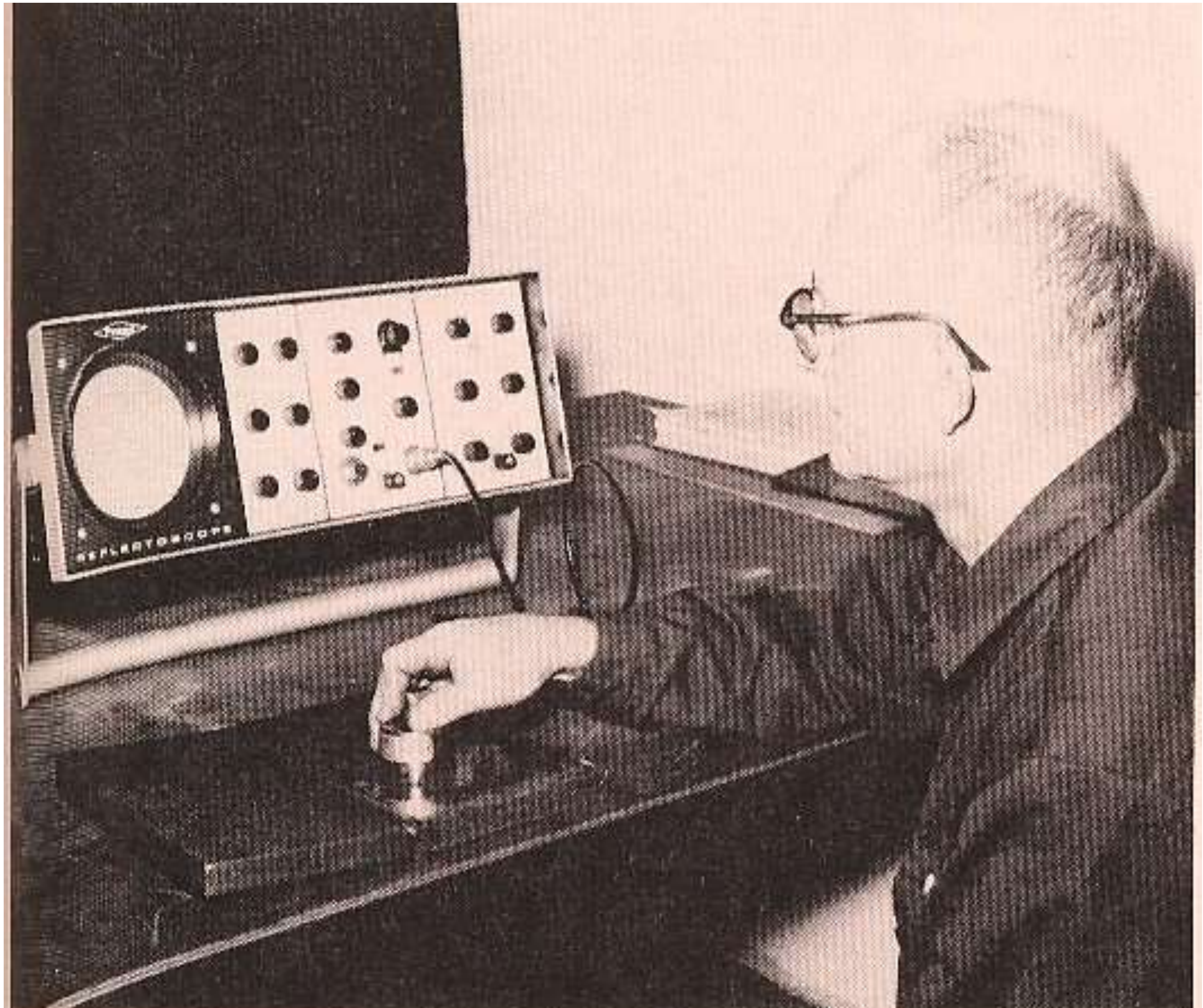


FIGURE 17-44 *Making an ultrasonic inspection of a weld.*

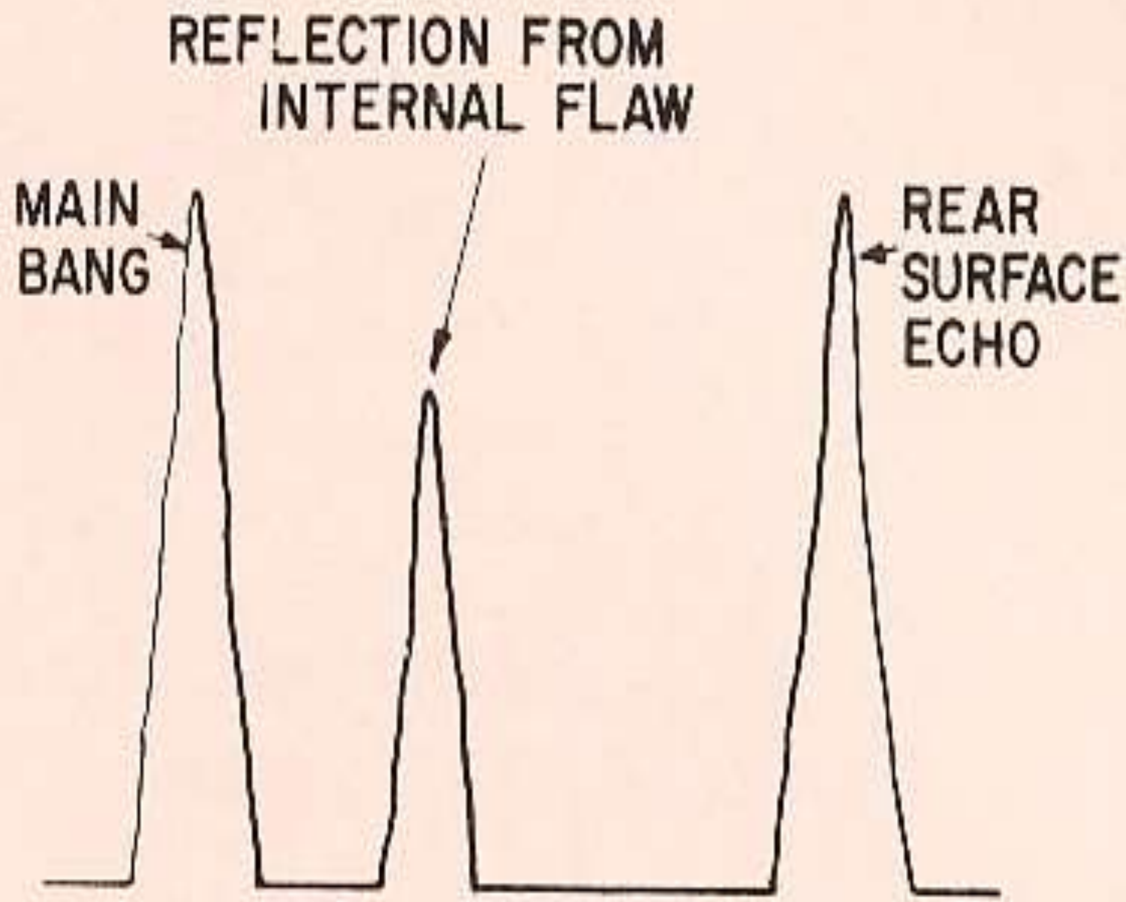


FIGURE 17-45 *Oscillograph display.*

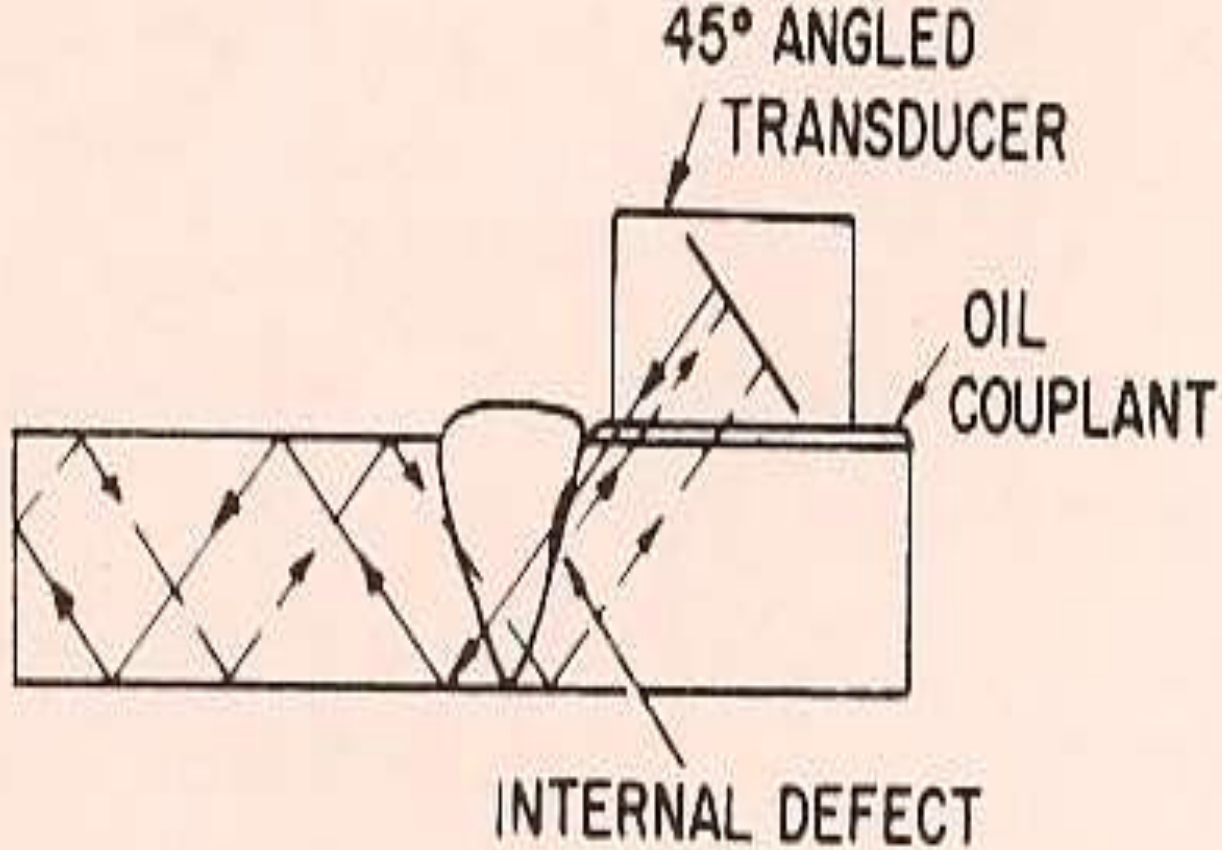


FIGURE 17-46 *45° Use of ultrasonic inspection.*

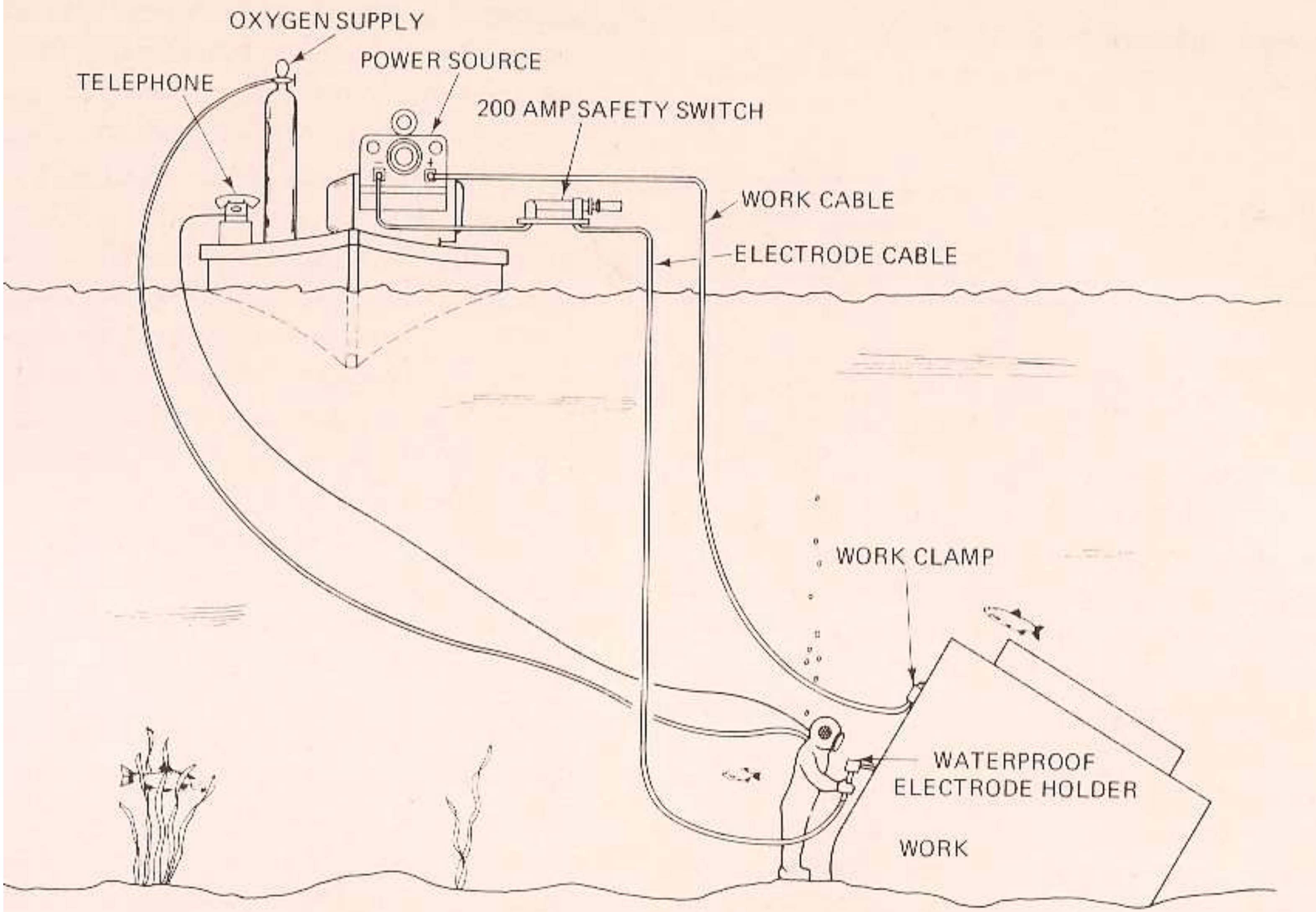


FIGURE 20-24 *Arrangements for underwater welding.*

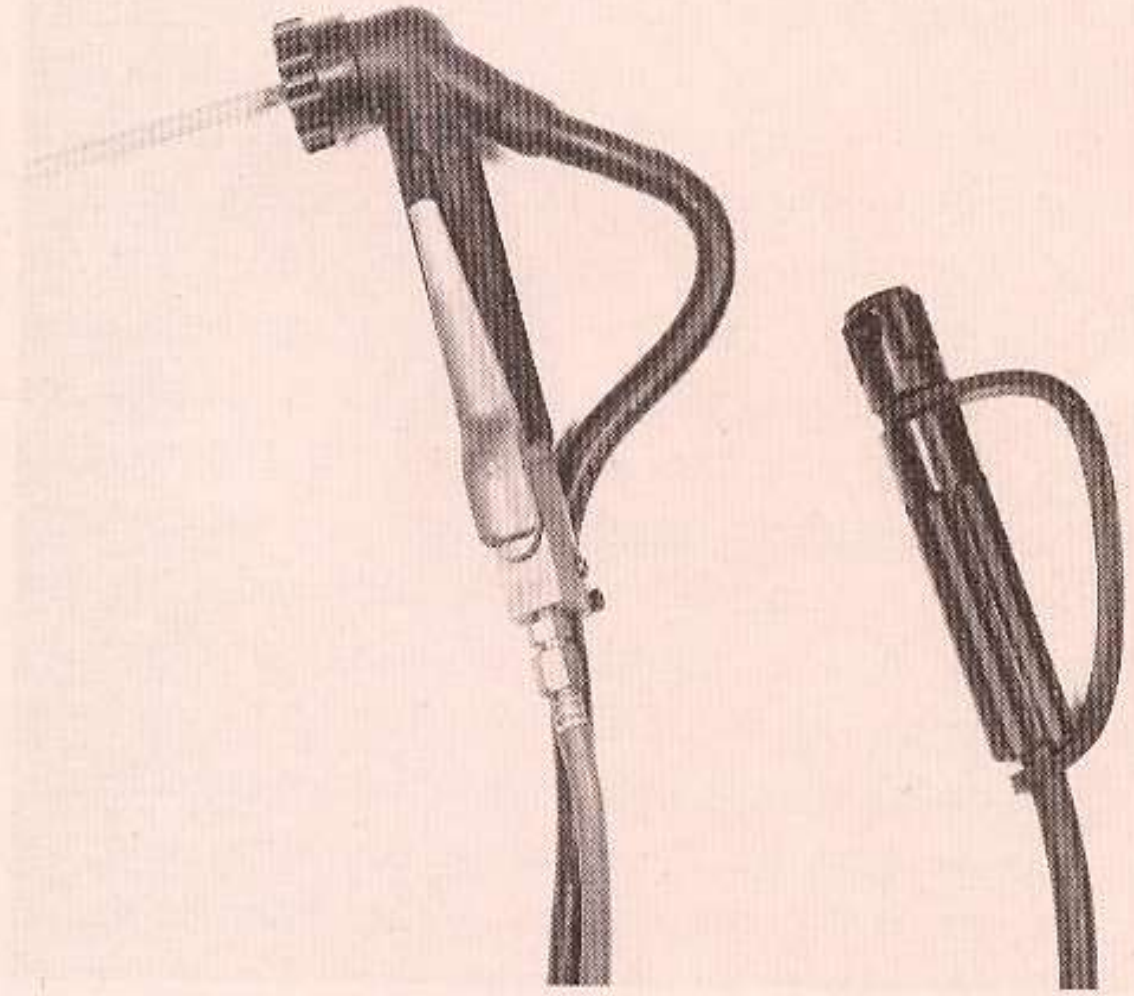
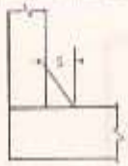
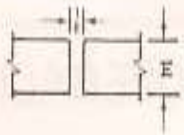
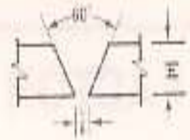
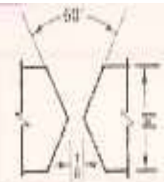
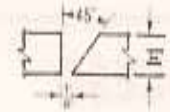
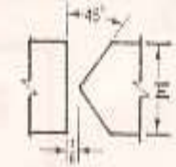


FIGURE 20-25 *Underwater electrode holder for welding and cutting.*


SCUBAPRO

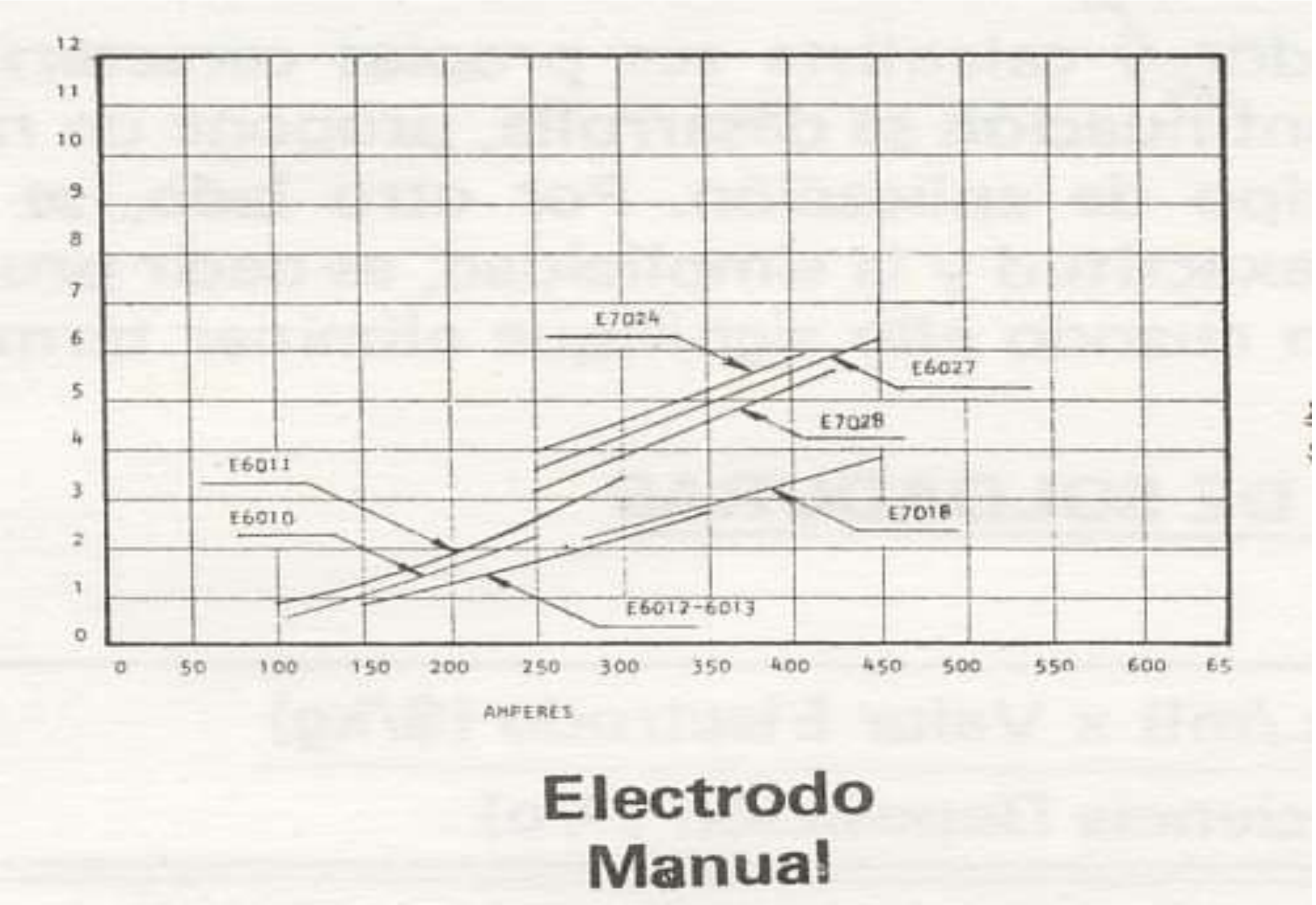
Soldaduras Especiales

Unión de Soldadura							
Espesor (E)		METAL DEPOSITADO (Kg/ml) (Acero)					
pulg.	mm.						
1/8	3.2	0.045	0.098				
1/4	6.4	0.177	0.190	0.380		0.358	
3/8	9.5	0.396		0.638		0.605	
1/2	12.5	0.708		1.168		1.066	
5/8	16	1.103		1.731		1.707	1.089
3/4	19	1.592		2.380	1.049	2.130	1.449
1	25	2.839		3.987	2.578	3.554	2.322
1 1/4	32				3.768		3.380
1 1/2	37.5				5.193		4.648
2	51				8.680		7.736
2 1/2	63,5				13.674		11.617
3	76				18.432		16.253

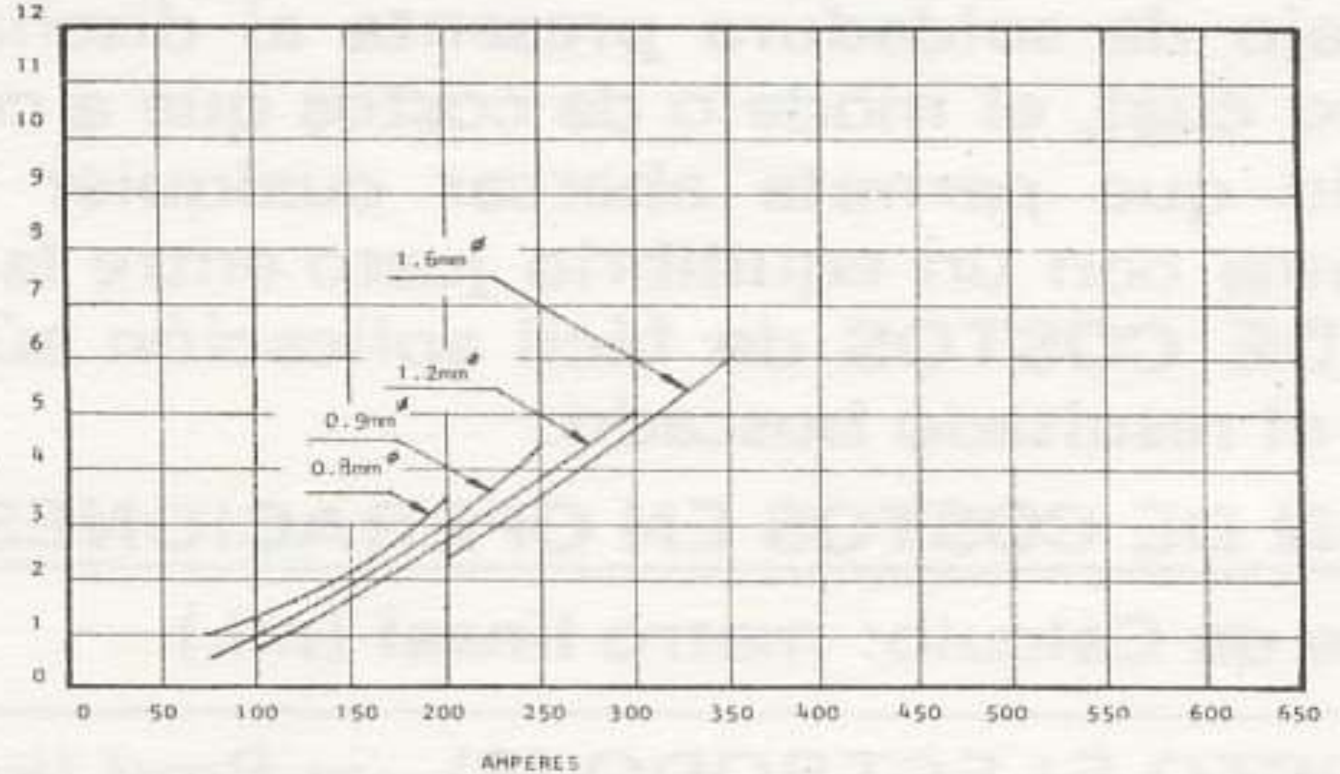
Eficiencia de Deposición
(metal depositado v/s peso electrodo empleado)

PROCESOS	EFICIENCIA DEPOSICION %
Electrodo manual	60 - 70
MIG Sólido	90
MIG Tubular c/protección	83
MIG Tubular s/protección	79
TIG	95
Arco Sumergido	98

Velocidad de Deposición



Velocidad de Deposición



Mig
Sólido

Flujo de Gas

Proceso	Flujo Gas (m^3/hr)
MIG Sólido	0.8 - 1.2
MIG Tubular	1.0 - 1.4
TIG	0.5 - 1.0

Factor de Operación

(Tiempo con arco v/s tiempo pagado)

PROCESO	FACTOR DE OPERACION
Electrodo Manual	5 - 30
Mig Sólido	10 - 60
Mig tubular	10 - 60
Tig	5 - 20
Arco Sumergido	50 - 100

Consumibles

Procesos	Eficiencia Deposición °/o	Pérdida de Electrodos			Consumibles/100 kg. Metal depositado		
		Pérdida por colillas °/o	Total °/o	Eficiencia Electrodo°/o	Electrodo (Kg)	Fundente (Kg.)	Gas (m3)
Electrodo Manual Celulósico	60	12	52	48	155	–	–
Electrodo Manual Rutílico	70 -80	12	32 - 42	68 - 58	145 - 170	–	–
Electrodo Manual Bajo Hidrógeno	72	12	40	60	160-170	–	–
Mig (Cortocircuito)	93	2	9	91	110	–	17 - 42
Mig (Spray)	95	2	7	93	108	–	7 - 11
Tubular c/protección	83	1	18	82	122	–	4 - 20
Tubular s/protección	80	1	21	79	126	–	–
Arco Sumergido	99	1	2	98	102	85-100	–