



AMPCO[®] WELDING PRODUCTS

Welding Wire and Covered Electrodes

- Aluminum Bronze
- Nickel Aluminum Bronze
- Manganese Nickel Aluminum Bronze
- Copper

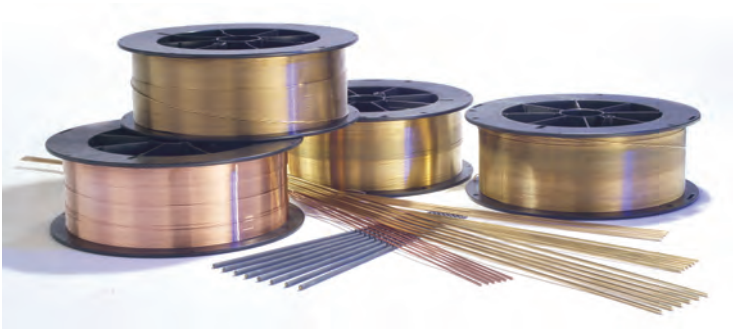


AMPCO METAL **EXCELLENCE IN ENGINEERED ALLOYS**

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Current AMPCO METAL electrodes and wires carry warning information on the package. Material safety data sheets prepared to meet the requirements of OSHA's Hazard Communication Standard, 29 CFR 1910.1200, and a safety health bulletin which provides fundamental information on precautions and safe practices for AMPCO METAL welding products and processes, are available from your welding supply distributor or from AMPCO METAL Inc.



AMPCO Copper & Copper Alloy Welding Products

Since 1914, AMPCO METAL has pioneered in and developed special bronze alloys which today have world-wide use. The development of these alloys and products has given the AMPCO organization a vast accumulation of knowledge in the application and use of copper alloys—all of which is reflected in the development and perfection of bronze welding products. Today, AMPCO METAL is the leader in this specialized field. Behind these products are exceptional plant facilities and highly trained personnel. The AMPCO experienced technicians monitor production and maintain quality control inspection during manufacturing stages. Random samples of the completed products are actually weld tested as a final check of operating performance and weld quality. The latest direct reading spectrographic equipment is utilized to check and control chemical analysis. To ensure high quality and maximum uniformity from heat to heat, AMPCO manufactures all weldrod products exclusively from virgin metals. This assures the user of consistent operating results and reduces defective welds caused by impurities found in recycled materials. Complete qualification tests for all specifications listed on the following pages can be performed. You can thus specify and use AMPCO welding products contact: AMPCO METAL, Inc 800-844-6008, welding@ampcometal.com

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AMPCO-TRODE® 7

Description and Application

AMPCO-TRODE® 7 is an iron-free, aluminum bronze alloy available in spooled wire and 36" bare filler metal rod for use with the gas metal-arc and gas tungsten-arc welding processes respectively.

AMPCO-TRODE® 7 deposits are used primarily to overlay bearing and wear-resistant surfaces requiring a hardness of approximately 125 BHN and to resist corrosion especially from salt water, metal salts and many commonly used acids in varying concentrations and temperatures. This alloy is not recommended for joining since the deposit does have a tendency to be hot short.

Typical Applications

tube sheets
pickling hooks
impellers

valve seats
chemical plants
pulp mills

Limiting Chemical Composition,

% (filler metal)

Copper*balance
Aluminum6.0 - 8.50
Manganese0.50max.
Silicon.....0.10 max.
Others0.50max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi.....68 (469 MPa)
Yield Strength, ksi.....28 (193 MPa)
Elongation, % in 2" (51 mm)47
Reduction of Area, %.....53
BHN (3000 kg.)
1/4" (6.4 mm) deposit.....125

Standard Sizes

	.035" 0.9mm	.045" 1.2mm	1/16" 1.6mm	3/32" 2.4mm	1/8" 3.2mm
36" bare (914 mm)'			*	*	*
30-lb spool (13.6 kg.)	*	*	*		



Aluminum bronze overlays on steel tube sheets reduce corrosive wear.

Standard Sizes

AWS A5.7 Class ER CuAl-Al
ASME SFA 5.7 Class ER CuAl-Al

Description and Application

AMPCO-TRODE® 10 aluminum bronze is the most versatile welding electrode in this family of alloys. It is available in coated electrodes, spooled wire and bare 3/6" rod, and is intended for deposition with SMAW, GMAW, GTAW welding processes.

AMPCO-TRODE® 10 contains an additive to inhibit inter-granular stress corrosion cracking. This is particularly important when welding on C61300 and C61400 base metal.

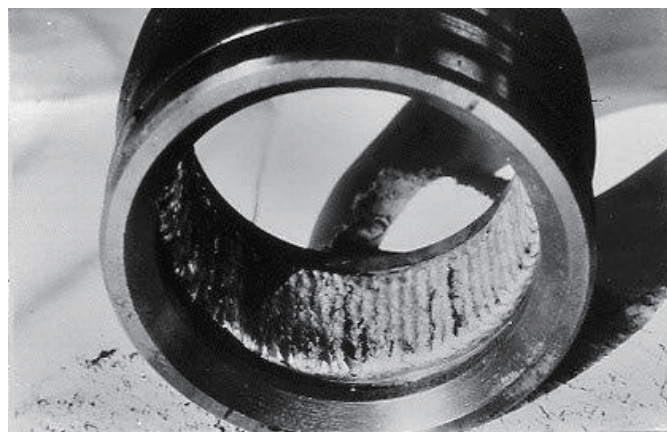
AMPCO-TRODE® 10 will weld and join many ferrous and nonferrous metals and combinations of dissimilar metals. These metals include the more weld-able grades of cast iron, high and low carbon steels, copper, bronzes and copper-nickel alloys.

Applications for AMPCO-TRODE® 10 include: building up bearing surfaces, joining and fabricating copper alloys, overlaying for resistance to corrosion and erosion and general maintenance and repair welding.

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi.....	77 (531 MPa)
Yield Strength, ksi	35 (241 MPa)
Elongation, % in 2" (51 mm)	27
Reduction of Area, %.....	27
BHN (3000 kg.)	
1/4" (6.4 mm) deposit.....	119
* including silver	



Internal Bearing Overlay: Steel overlaid with AMPCO-TRODE® 10 Machined for a bearing surface.

Standard Sizes

	1/8" 3.2mm	5/32" 4.0mm
coated electrodes	*	*
length inches/ mm	12 305	14 356

Specifications

AWS A5.6 Class E CuAl-A2
ASME SFA 5.6 Class E CuAl-A2
AWS A5.13 Class E CuAl-A2

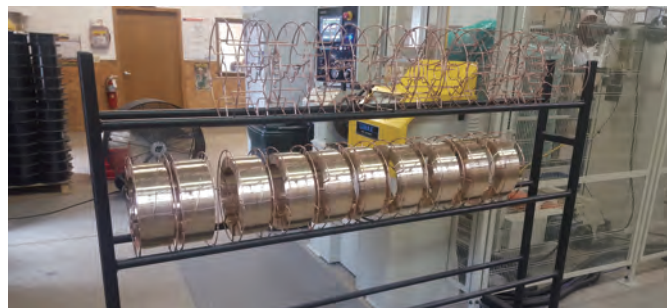
AMPCO-TRODE® 10 Coated

Limiting Chemical Composition

% (deposited weld metal)

Copper*.....	balance
Aluminum.....	8.50-11.0
Iron.....	0.50-5.0
Silicon.....	1.5 max.
Others.....	0.50 max. incl. Tin

* including silver



AMPCO-TRODE® 10

AMPCO-TRODE® 10 Bare

Limiting Chemical Composition % (filler metal)

Copper*	balance
Aluminum	8.50 - 11.0
Iron	0.75-1.50
Silicon	0.10 max.
Others	0.50 max. incl. Tin
*including silver	

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	79 (545 MPa)
Yield Strength, ksi	35 (241 MPa)
Elongation, % in 2" (51 mm)	28
Reduction of Area, %	28
BHN (3000 kg)	
1/4" (6.4 mm) deposit	140

Standard Sizes

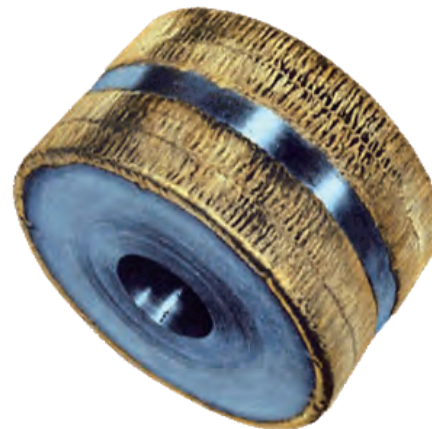
	.030" 0.8mm	.035" 0.9mm	0.45" 1.2mm	1/16" 1.6mm	3/32" 3.2mm	1/8" 3.2mm	5/32" 4.0mm	3/16" 4.8mm
GTAW 36" bare (914mm)		*	*	*	*	*	*	*
GMAW 30-lb. spool (13.6kg.)	*	*	*	*	*			
GMAW 2lb. spool (.68kg.)		*	*					

Specifications

AWS A5.7 Class ER CuAl-A2
ASME SFA 5.7 Class ER CuAl-A2
Certified by ABS



The unique metallurgical characteristics of aluminum bronze enable it to readily join dissimilar metals using both the GTAW and GMAW processes. AMPCO-TRODE® 10 was selected to join the weldment shown here, consisting of aluminum bronze, copper, brass, silicon bronze, mild steel, Copper-nickel, cast iron, galvanized steel and stainless steel plates.



Piston heads in hydraulic jacks last longer when overlaid with aluminum bronze.



Aluminum bronze marine propeller rebuilt with AMPCO-TRODE® 10 and GTAW.

Typical Applications

cast iron	brake drums
malleable iron	tractor gear housings
cast iron to steel	idler pulleys
cast iron to bronze	pickling hooks
steel to bronze	paper mill rolls
aluminum bronze	motor bases
silicon bronze	tin plate mill rolls
manganese bronze	impellers
cupro-nickel	valve seats
tool steel	gears
copper to steel	mixer arms
bearings	press rams
bushings	ship propellers
pump housings	lance heads
condenser boxes	turbine runners adjusting
hydraulic pistons	spindles

Aluminum-
Bronze

AMPCO-TRODE® 40

Description and Application

AMPCO-TRODE®40 manganese-nickel-aluminum bronze is available in coated electrodes, bare filler metal rod and wire for welding cast ship propellers conforming to Alloy 2 for high resistance to corrosion, erosion and cavitation. AMPCO-TRODE® 40 also exhibits good ability to join dissimilar metals.

Typical Applications

ship propellers
marine components
welding cast iron
joining dissimilar metals



Superston ship propeller repair welded with AMPCO-TRODE® 40.

AMPCO-TRODE® 40 Coated

Limiting Chemical Composition,

% (deposited weld metal)

Copper *	balance
Aluminum	7.0 -8.50
Iron	2.0 - 4.0
Nickel	1.5-3.0
Manganese	11.0-14.0
Silicon	1.5 max.
Others	0.50 max.

*including silver

Mechanical Properties

Tensile Strength, ksi	95 (655MPa)
Yield Strength, ksi	56 (386 MPa)
Elongation, % in 2" (51 mm)	27
Reduction of Area, %	38
BHN (3000 kg.)	
1/4" (6.4 mm) deposit	185

Standard Sizes

	1/8" 3.2mm	5/32" 4.0mm
coated electrodes	*	*
Length inches mm	14 356	14 356

Specifications

AWS A5.6 Class ER CuMnNiAl
ASME SFA 5.6 Class E CuMnNiAl

AMPCO-TRODE® 40 Bare

Limiting Chemical Composition,

% (deposited weld metal)

Copper *	balance
Aluminum	7.0-8.50
Iron	2.0-4.0
Nickel	1.5-3.0
Manganese	11.0-14.0
Others	0.50 max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	110 (759 MPa)
Yield Strength, ksi	67 (462 MPa)
Elongation, % in 2" (51 mm)	27
Reduction of Area, %	37
BHN (3000 kg.)	
1/4" (6.4 mm) deposit	217

Standard Sizes

	.045" 1.2mm	1/16" 1.6mm	3/32" 2.4mm	1/8" 3.2mm	5/32" 4.0mm	3/16" 4.8mm
36" bare (1000 mm)		*	*	*	*	*
30-lb spool (13.6 kg.)	*	*				

Specifications

AWS A5.7 Class ER CuMnNiAl
ASME SFA 5.7 Class ER CuMnNiAl
Certified by ABS

AMPCO-TRODE® 46

Description and Application

AMPCO-TRODE® 46 nickel-aluminum bronze spooled wire, bare rod and coated electrodes were developed for the welding of cast and wrought nickel-aluminum bronze.

AMPCO-TRODE® 46 is also recommended for weld repairing NiBral boat propellers.

Typical Applications

ship fittings
ship propellers
power plant valves
piping systems
intake screens
welding AMPCO® 483

welding AMPCO® 45
marine propulsion systems
propeller gear housings
oil recovery pumps

AMPCO-TRODE® 46 Coated

Limiting Chemical Composition,

% (deposited weld metal)	
Copper*	balance
Aluminum	8.50 - 9.50
Iron	3.0 - 6.0
Nickel	4.0 - 6.0
Manganese	0.50 - 3.50
Silicon	1.5max.
Others	0.50max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	99 (683 MPa)
Yield Strength, ksi	58 (400 MPa)
Elongation, % in 2" (51 mm)	25
Reduction of Area, %	22
BHN (3000 kg.) 1/4" (6.4 mm) deposit	187

Standard Sizes

	1/8" 3.2mm	5/32" 4.0mm
coated electrodes	*	*
SMAW length inches mm	14 356	14 356

Specifications

AWS A5.6 Class E CuNiAl
ASME SFA 5.6 Class E CuNiAl



Submarine propulsion unit fabricated with AMPCO-TRODE® 46.

AMPCO-TRODE® 46 Bare

Limiting Chemical Composition,

% (filler metal)	
Copper*	balance
Aluminum	14.0 - 15.0
Iron	3.0 - 5.0
Silicon	0.04max.
Others	0.50max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	104 (718 MPa)
Yield Strength, ksi	59 (407 MPa)
Elongation, % in 2" (51 mm)	23
Reduction of Area, %	22
BHN (3000 kg.) 1/4" (6.4 mm) deposit	196

Standard Sizes

	.035" 0.9mm	.045" 1.2mm	1/16" 1.6mm	3/32" 2.4mm	1/8" 3.2mm	5/32" 4.0mm
GTAW 36" bare (914 mm)			*	*	*	*
GMAW 30-lb. spool (13.6kg.)	*	*	*			

Specifications

AWS A5.7 Class ER CuNiAl
ASME SFA 5.7 Class ER CuNiAl
Certified by ABS

Nickel - Aluminum -
Bronze

Description and Application

AMPCO-TRODE® 150 aluminum bronze spooled wire and bare filler rod produce a deposit of high strength and good ductility with a nominal hardness of 166 Brinell as applied with the inert-gas processes. AMPCO-TRODE® 150 is recommended for welding AMPCO® 18 alloy. It is ideal for piston overlay applications and bearing surfaces requiring high strength and good ductility.

Limiting Chemical Composition,

% (filler metal)	
Copper*	balance
Aluminum	10.0 - 11.50
Iron	2.0-4.50
Silicon	0.10 max.
Others	0.50 inax.
* including silver	

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	90 (621 MPa)
Yield Strength, ksi	40 (276 MPa)
Elongation, % in 2" (51 mm)	20
Reduction of Area, %	22
BHN (3000 kg.)	
1/4" (6.4 mm) deposit	166

Standard Sizes

	.045" 1.2mm	1/16" 1.6mm	3/32" 2.4mm	1/8" 3.2mm
GTAW 36" bare (914mm)		*	*	*
GMAW 30-lb. spool (13.6kg.)	*	*	*	

Specifications

AWS A5.7 Class ER CuAl-A3
ASME SFA 5.7 Class ER CuAl-A3

Typical Applications

hydraulic pistons
bearing overlays
impellers
turbine runners
press rams

cable sheaves
mill slippers
valve seats and
parts
breaker blocks
ceiling machine
mandrels
steel mill rolls
welding AMPCO® 18



Main support shaft of steel mill coiling machine AMPCO-faced to resist abrasion and wear.

AMPCO-TRODE® 160

Description and Application

AMPCO-TRODE® 160 aluminum bronze coated electrodes produce a deposit of high strength and good ductility with a nominal hardness of 160 Brinell as applied by the shielded metal-arc process.

AMPCO-TRODE® 160 is recommended for joining aluminum bronzes (AMPCO® 18), ferrous and dissimilar metals requiring higher strength than produced by AMPCO-TRODE® 10 filler metal.

The deposit has excellent bearing characteristics and is suitable for overlaying bearing surfaces subject to normal wear and shock. The deposit has properties which make it resistant to "squashing out" in bearing service.

Limiting Chemical Composition

% (deposited weld metal)

Copper *	balance
Aluminum	11.0-12.0
Iron	2.50-5.0
Silicon	1.5 max.
Others	0.50 max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	89 (614 MPa)
Yield Strength, ksi	47 (324 MPa)
Elongation, % in 2" (51 mm)	15
Reduction of Area, %	17
BHN (3000 kg.)	
1/4" (6.4 mm) deposit	177

Standard Sizes

	1/8" 3.2mm	5/32" 4.0mm
coated electrodes	*	*
SMAW Length inches mm	14 356	14 356

Specifications

AWS A5.6 Class E CuAl-B
ASME SFA 5.6 Class E CuAl-B



Propulsion Gear: Aluminum Bronze cast & wrought components fabricated into a 4000 lb. propulsion gear for a minesweeper using AMPCO-TRODE® 10. Aluminum Bronze & AMPCO-TRODE® 10 was used for its non-corrosive properties.

Typical Applications

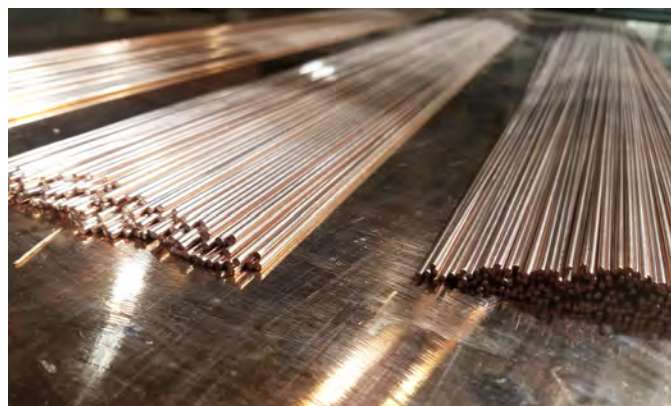
bronze castings	gate valves
strip mill guides	sheaves
bearing overlays	pistons
crane contact shoes	mill slippers
driving sprockets	turbine runners packing
drop hammers	glands valve seat
manipulator slides	overlays

AMPCO-TRODE® 940

Description and Application

AMPCO-TRODE® 940 is an alloy developed to provide an effective alternative to beryllium copper. One of its principle applications is for molds and mold components in the plastics industry. Because of its excellent thermal conductivity, thermal diffusivity, wear resistance and corrosion resistance, AMPCO-TRODE® 940 filler metal is specified for the repair of complex AMPCO® 940 molds used in forming plastic parts.

AMPCO-TRODE® 940 is applied with both the gas tungsten-arc and gas metal-arc welding processes.



Typical Applications

mold cores and pins
repair of blow molds and injection molds

Limiting Chemical Composition,

Copper*	balance
Nickel	2.0-3.0
Silicon	0.4-0.8
Chromium	0.10-0.60
Others	0.50 max.

*including silver

Standard Sizes

	.045" 1.2mm	1/16" 1.6mm	1/8" 3.2mm
GTAW 36" bare (1000 mm)		*	*
GMAW 30-lb spool (13.6 kg.)	*		

Note: AMPCO-Trode® 940 filler metal should only be used for minor weld repair of AMPCO® 940 base material.

COPR-TRODE®

Description and Application

COPR-TRODE® is a deoxidized copper alloy developed to provide dense, high quality deposits with relatively high electrical conductivity for use in joining and overlay with the inert-gas processes.

COPR-TRODE® spooled wire and filler metal rod are used primarily to fabricate deoxidized copper and repair weld copper castings with the gas metal-arc and gas tungsten-arc processes. It may also be used to weld galvanized steel and deoxidized copper to mild steel where high strength joints are not required. COPR-TRODE® spooled wire and filler metal rod are used to overlay surfaces to resist corrosion.

Unlike competitive sources of deoxidized copper wire, COPR-TRODE® is produced completely from virgin copper. This eliminates the undesirable residual impurities which are found in recycled copper and which drastically reduce conductivity and overall weld deposit quality. In addition, a final scalping operation removes any trace of scale from the wire surface. These "extra measure" efforts assure trouble-free wire feeding efficiency and highest quality weld deposits.

Limiting Chemical Composition,

% (deposited weld metal)

% (filler metal)

Copper*	98.0min
Tin	1.0max.
Manganese	0.50max.
Silicon	0.50max.
Phosphorus	0.15max.
Others	0.50max.

*including silver

Mechanical Properties

(nominal all-weld metal values)

Tensile Strength, ksi	29 (200 MPa)
Yield Strength, ksi	8 (55 MPa)
Elongation, % in 2" (51 mm)	29
Reduction of Area, %	45
BHN(500 kg.)	
1/4"(6.4 mm) deposit	54
Electrical Conductivity, %LACS	40

Standard Sizes

	.035" 0.9mm	.045" 1.6mm	1/16" 1.6mm	3/32" 2.4mm	1/8" 3.2mm
GTAW 36" bare (914 mm)			*	*	*
GMAW 30-lb spool (13.6 kg.)	*	*	*		



Specifications

AWS A5.7 Class ER Cu

Typical Applications

billet molds
conductor rolls
heater elements
copper sculptures

steel mill electrode holders
bus bars
copper connectors

Welding Formulas

Method of Calculating Pounds Required for Welding Groove or Overlay

Pounds Required = Deposit (CU. IN.) X Density (LBS/CU. IN.)
Density of AMPCO-TRODES® = 0.27 LBS./CU. IN.

Deposition of AMPCO-TRODE® Aluminum Bronze Spooled Wire

Formula:
Diameter² x .7854 x Density x IPM x 60 = LBS/HR

AMPCO-TRODE® Electrode Melting Rates and Efficiencies (SMAW)

Dia. (inches)	AMPS	Melt Rate (IPM)	Melt Rate (LBS/HR)	Efficiency (%)
1/8	125	20	5.7	75.6
5/32	150	17	4.6	73.7
3/16	185	16	8.7	68.5
1/4	235	13	12.1	75.9

Approximate Feet Per Pound Bare Rod or Wire

Dia. (inches)	FT/LB	IN/LB
.035	316	3,792
.045	191	2,292
1/16	101	1,212
3/32	46	552

Metric Conversion Chart (Approximate Conversion Factors)

To Convert From	To	Multiply By
in.....	m.....	.0254
in.....	mm.....	.254
in ²	mm ².....	.645.2
mm ²	in ².....	.00155
lb.....	kg (kilo).....	.454
kg (kilo).....	lb.....	2.2
ton (2,000 lbs.).....	kg (kilo).....	.908
kg (kilo).....	ton (2,000 lbs.).....	.0011
metric ton (2,200 lbs.).....	kg (kilo).....	.998.8
kg (kilo).....	metric ton.....	.0010
lb./hr.....	kg/hr.....	.454
kg/hr.....	lb./hr.....	2.2
litres/min.....	cu. ft./hr.....	.2.119
cu. ft./hr.....	litres/min.....	.4719
psi.....	KPa.....	.6.895
K Pa.....	psi.....	.145
M Pa.....	psi.....	.145
psi.....	M Pa.....	.0069
ipm.....	mm./sec.....	.423
ft. lbs.....	Joule (J).....	.1.356
Joule (J).....	ft. lbs.....	.737

Electrode Diameters	Approximate Equivalents in mm for standard AWS Electrode Diameters												
in	.030	.035	.045	.052	1/16	5/64	3/32	7/64	1/8	5/32	3/16	7/32	1/4
mm	.8	.9	1.2	1.3	1.6	2.0	2.4	2.8	3.2	4.0	4.8	5.6	6.4

AMPCO-TRODE® 521

SG- CuNi30Fe

Rod/wire electrode for copper

Classification

ISO 24373 S Cu 7158
(CuNi30Mn1FeTi)
DIN 1733 SG-CuNi30Fe
Material No. 2.0837
AWS A 5.7 ER CuNi
BS 2901 part 3 C 18

Base materials

Particularly suitable for high stressed corrosion resistant weld surfacing on cast iron and on unalloyed and low- alloyed steel as well as seawater resistant CuZn alloys. Suitable for welding on CuNi

Physical properties (Approx. values)

Electrical conductivity [S^*m/mm^2] 2
Therm. conductivity [W/m K] 30
Density [kg/dm^3] 8,9
Melting temperature [$^{\circ}C$] 1.210
Tensile strength Rm [MPa] 400
Elongation A5 (Lo=5d0) [%] 35

Typical composition in %

Ni 29,0 - 32,0
Fe 0,4 - 1,0
C < 0,05
Mn 0,5 - 1,5
Si < 0,2
Ti 0,2 - 0,5
S < 0,015
P < 0,02
Pb < 0,02
Others total < 0,5

Shielding gas

Argon, Helium or Argon/Helium-mixtures



AMPCO-TRODE® 522

ML CuNi10Fe

Rod/wire electrode for copper

Classification

ISO 24373 S Cu 7061 (CuNi10)
DIN 1733 SG-CuNi10Fe
Material No. 2.0873
BS 2901 part 3 C 16

Base materials

Particularly suitable for highly stressed corrosion resistant weld surfacing on cast iron and on unalloyed and low-alloyed steel, seawater resistant CuZn alloys. Appropriate to joining/surfacing on Cu-Ni material. Especially recommended for plant engineering.

Physical properties (Approx. values)

Electrical conductivity [S^*m/mm^2] 5
Therm. conductivity [W/m K] 45
Density [kg/dm^3] 8,9
Melting temperature [$^{\circ}C$] 1.150
Tensile strength Rm [MPa] 350
Elongation A5 (Lo=5d0) [%] 40
Modulus of elasticity [MPa] 126.000

Typical composition in %

Ni.....9,0 - 11,0
Fe.....0,5 - 2,0
C.....< 0,03
Mn.....0,5 - 1,5
Si.....< 0,2
Ti.....0,2 - 0,5
Al.....< 0,03
S.....< 0,02
P.....< 0,007

Shielding gas

(Argon, Helium or Argon/Helium-mixtures)

AMPCO-CORE® 200

Description and Application

AMPCO-CORE® 200 is an aluminum bronze flux core wire for use with the Gas Metal Arc Welding process.

AMPCO-CORE® 200 is primarily an overlay filler metal. The high strength values of the deposit combined with excellent wear-resisting characteristics make this alloy unsurpassed for bearing overlays where extreme wear and high pressures are encountered in service.

Typical Applications

Gear teeth, pump shafts, stripper columns, wear plates. Also, friction plates, bearings, sliders, high speed bearings, etc.

Operating conditions

Current type
DC+ (DCEP)
Gas flow rate
25 - 46 cfh (12-22 L/min)
Intensity [A]
0.045" (1.2 mm) 200-300
0.062" (1.6 mm) 360-400
Voltage [V]
All diameters 28-30
Stick-out [inch (mm)]
All diameters 5/8-1" (15-25)

Limiting Chemical Composition

% (filler metal)	
Copper.....	balance
Aluminum.....	9.0
Iron.....	4.0

Mechanical Properties*

BHN (3000kg.)	
Three layer deposit on mild steel.....	183

Product availability and packaging

AMPCO-CORE® 200 is available from stock in two diameters: 0.045" (1.2mm) and 0.062" (1.6mm). Both sizes are available in 12" (300mm) spools weighing 33lb (15kg) each. Other diameters are available upon request.

*Hardness will vary depending on quality of the weld and experience and knowhow of the welder.

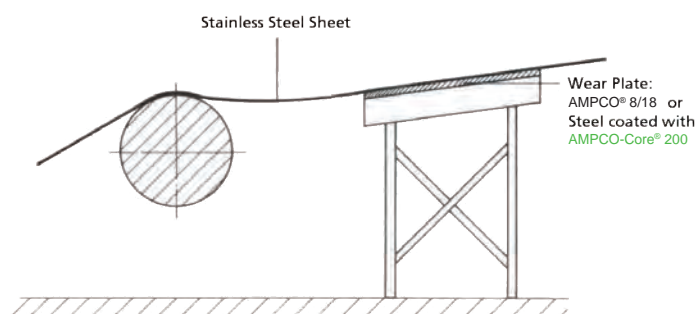
Welding position and deposits

The flat welding position is recommended. Backhand (trailing) welding is preferred rather than forehand (pushing) to make either stringer or weaved beads.

Shielding gas

100% Argon

Steel Mill Wear Plate



AMPCO® 200 overlaid for a wear friction plate in the steel industry.



Wire

AMPCO-CORE® 250

Description and Application

AMPCO-CORE® 250 is an aluminum bronze flux core wire for use with the Gas Metal Arc Welding process.

AMPCO-CORE® 250 is primarily an overlay filler metal. The characteristics of this filler metal make the deposit adaptable for use in those extreme bearing applications where very high pressures are encountered operating against hardened steel surfaces.

AMPCO-CORE® 250 often use for overlaying in applications where it unusual wear-resistant qualities increase service life of wearing parts.

Typical Applications

Friction plates, bearings, sliders, high speed bearings, etc.

Limiting Chemical Composition

% (filler metal)	
Copper.....	balance
Aluminum.....	9.0
Iron.....	4.0

Mechanical Properties*

(Nominal all-weld metal value)

BHN (3000kg.)	
Three layer deposit on mild steel.....	250

**Hardness will vary depending on quality of the weld and experience and knowhow of the welder.*

Product availability and packaging

AMPCO-CORE® 250 is available from stock in two diameters: 0.045" (1.2mm) and 0.062" (1.6mm). Both sizes are available in 12" (300mm) spools weighing 33lb (15 kg) each. Other diameters are available upon request.

Welding position and deposits

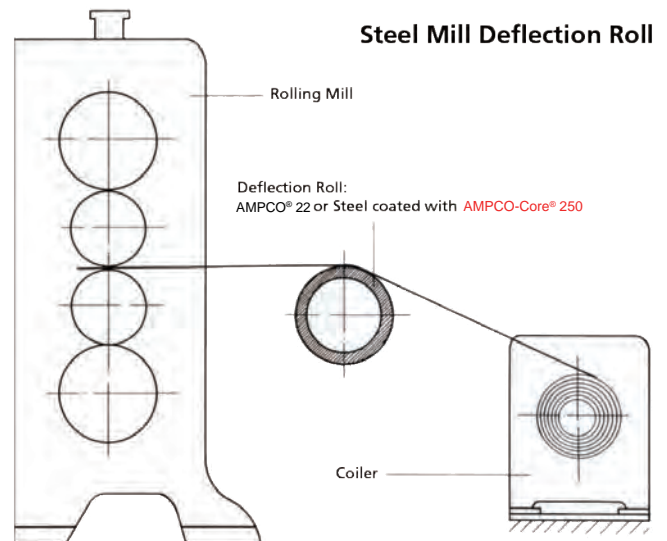
The flat welding position is recommended. Backhand (trailing) welding is preferred rather than forehand (pushing) to make either stringer or weaved beads.

Shielding gas

100% Argon

Operating conditions

Current type	
DC+ (DCEP)	
Gas flow rate	
25 - 46 cfh (12-22 L/min)	
Intensity [A]	
0.045" (1.2 mm)	200-300
0.062" (1.6 mm)	360-400
Voltage [V]	
All diameters	28-30
Stick-out [inch (mm)]	
All diameters	5/8-1" (15-25)



Deflecting Roll: AMPCO® 250 overlaid for a wear surface on a deflecting roll for the steel industry.

AMPCO-CORE® 250S

Description and Application

AMPCO-CORE® 250S is a nickel aluminum bronze metal core wire for use with the Gas Metal Arc Welding process producing sound, pore free deposits.

AMPCO-CORE® 250S is primarily an overlay filler metal for aluminum bronzes and ferrous materials. The characteristics of this filler metal make a good choice for overlaying components used in bearing applications where very high pressures are encountered operating against hardened steel surfaces.

AMPCO-CORE® 250S is especially suited for marine environments due to its Ni content which increases corrosion resistance in brackish seawater. It also exhibits resistance to cavitation and stress corrosion.

Shielding gas

100% Argon



Typical Applications

Shafts, guide grooves, marine applications, overlaying steel parts without a buffer layer

Limiting Chemical Composition

% (filler metal)	
Copper.....	Balance
Aluminum.....	11.5
Nickel.....	4.8
Iron.....	2.0
Manganese.....	1.0

Mechanical Properties*

(Nominal all-weld metal value)

BHN (3000kg.)	
Three layer deposit on mild steel.....	320

**Hardness will vary depending on quality of the weld and experience and knowhow of the welder.*

Product availability and packaging

AMPCO-CORE® 250S is available in two diameters: 0.045" (1.2mm) and 0.062" (1.6mm). Both sizes are available in 12" (300mm) spools weighing 33lb (15 kg) each. Other diameters are available upon request.

Welding position and deposits

Flat position welding is recommended. Backhand (trailing) welding is preferred rather than forehand (pushing) to make either stringer or weaved beads.

Operating conditions

Current type	
DC+ (DCEP), continuous or pulsed	
Gas flow rate	
25 - 42 cfh (12-20 L/min)	
Intensity [A]	
0.045" (1.2 mm)	150-320
0.062" (1.6 mm)	200-350
Voltage [V] (all diameters)	
Continuous	27-31
Pulsed	22-25
Stick-out [inch (mm)]	
All diameters	5/8" - 3/4" (10-20)

NB. Higher intensities and voltages can be used but will result in increased element burn-off (particularly Al) and dilution, leading to lower hardness levels. Preheating and working temperatures of up to 300°C are recommended to avoid cracking.

AMPCO-CORE® 300

Description and Application

AMPCO-CORE® 300 is an aluminum bronze flux core wire for use with the Gas Metal Arc Welding process.

AMPCO-CORE® 300 is primarily an overlay filler metal. In addition to high hardness, the deposit also has excellent bearing and wear-resistant qualities.

These characteristics – hardness, bearing properties and wear resistance all combine to make AMPCO-CORE® 300 ideal for surfacing iron and copper-base materials. Dies overlaid with AMPCO-CORE® 300 have surprising freedom from scratching and galling; die marks are almost completely eliminated.

Typical Applications

Fabrication of new, or rebuilding of worn, ferrous dies, used for forming or drawing titanium, stainless steel and low to medium carbon steel.

Limiting Chemical Composition

% (filler metal)	
Copper.....	balance
Aluminum.....	13.5
Iron.....	4.0

Mechanical Properties*

(Nominal all-weld metal value)

**Hardness will vary depending on quality of the weld and experience and knowhow of the welder.*

BHN (3000kg.)	
Three layer deposit on mild steel.....	364

Product availability and packaging

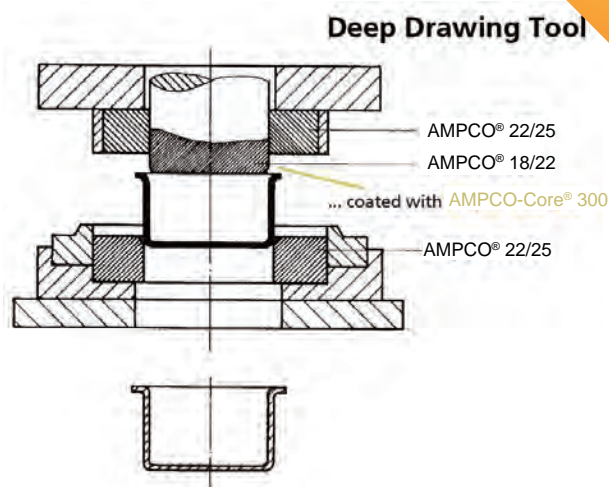
AMPCO-CORE® 300 is available from stock in two diameters: 0.045" (1.2mm) and 0.062" (1.6mm). Both sizes are available in 12" (300mm) spools weighing 33lb (15 kg) each. Other diameters are available upon request.

Welding position and deposits

The flat welding position is recommended. Backhand (trailing) welding is preferred rather than forehand (pushing) to make either stringer or weaved beads.

Shielding gas

100% Argon



Deep drawing Tool: AMPCO-TRODE® 300 for repair or build-up of deep draw dies for the manufacture of stainless sinks.

Operating conditions

Current type	
DC+ (DCEP)	
Gas flow rate	
25 - 46 cfh (12-22 L/min)	
Intensity [A]	
0.045" (1.2 mm)	200-300
0.062" (1.6 mm)	360-400
Voltage [V]	
All diameters	28-30
Stick-out [inch (mm)]	
All diameters	5/8-1" (15-25)

Surfacing & Overlaying

Surfacing or overlaying with aluminum bronze or copper is extensively practiced to obtain corrosion resistance or to build up a bearing surface. Also known as weld cladding, this technique offers benefits in reducing materials costs and, in salvage applications, enables an expensive or difficult-to-replace part to be reclaimed and restored to operation with minimum of downtime.

Selection of a welding process is determined largely by the equipment available and the desired deposition rate. Gas metal-arc welding is the most widely selected process for surfacing with AMPCO-TRODE®. When the job dictates, gas tungsten-arc or shielded metal-arc welding may be used satisfactorily. The higher current densities associated with the inert-gas processes give deep penetration into the base metal. To reduce base metal pickup when overlaying iron or steel, apply the first layer with low amperage and use a weave technique. Excessive base metal dilution would result in difficult machinability and reduced service performance.

Experience has demonstrated that four weld layers to obtain a finish machined deposit of 1/4" (6.4 mm) provide the best performance and mechanical properties of the weldrod with the GMAW process. A finish thickness of 3/16" (4.8mm) would be considered a minimum satisfactory buildup. In cases where the dimensional geometry does not allow a 1/4" (6.4 mm) deposit to be added on, undercut the area to be overlaid and proceed to build up with weld metal.

Machine or grind base metal prior to first pass and wire brush or grind weld deposit between passes. Oil, cutting fluids, etc. must be removed before welding.

Apply first pass at low side of amperage range to minimize dilution.

Bearing surface overlays are often designed with preferential wear requirements. To do this with AMPCO-TRODE® alloys, select a filler metal and associated welding process that will result in a weld deposit of 50 to 75 points Brinell softer than the mating surface. This will assure a preferential wear system.

Careful application of the first layer is important to obtain a smooth, uniform contour without crevices. A weave bead or oscillated torch head produces the best results with consistent deposit thickness. Subsequent passes may be applied practicing the same technique. Welding in the flat position is recommended.

Repair of AMPCO Die Alloys

AMPCO® 21, 22 and 25 aluminum bronze die alloy castings are used in many industries for the precision forming and deep drawing of stainless and mild steel, aluminum, magnesium, titanium and prefinished metals where the finished product requires a highly polished surface. Such dies have less tendency to scratch, seize and gall than ferrous dies, therefore, product finishing time and scrap are reduced.

And, although these dies do have longer life expectancy, they do become worn and occasionally broken in service, requiring repair.

Recommended Filler Metal

AMPCO-TRODE® 300 / AMPCO-TRODE® 250 with gas tungsten-arc welding.

AMPCO-TRODE® 300 or AMPCO-CORE® 300

AMPCO-TRODE® 200 or AMPCO-CORE® 200

AMPCO-TRODE® 250 or AMPCO-CORE® 250

Preheat

Preheat and interpass temperature of 1150°F (621°C).

Welding Procedure

For a complete fracture, crack should be ground from both sides to form a double U-groove having a 70-90° included angle with 3/16" (4.8 mm) radius at bottom with 1/8" to 3/16" (3.2 to 4.8mm) lip to maintain dimension. Apply AMPCO-TRODE® 10 deposit with either shielded metal-arc or gas tungsten-arc, alternating from side to side to control distortion to within two layers of the finished draw surface. Finish by applying either AMPCO-TRODE® 250 with the gas tungsten-arc process or AMPCO-TRODE® 300.

For complete build-up of a worn die, grind the surface to remove all oxides. If the depth of overlay exceeds 1/4" (6.4 mm), apply a buffer layer of AMPCO-TRODE® 10 deposit. Subsequent layers can be applied with AMPCO-TRODE® 300 or AMPCO-TRODE® 250 and the gas tungsten- arc process. If the build-up is less than 1/4" (6.4mm), the buffer layer of AMPCO-TRODE® 10 deposit is not required.

Postheat

To remove stresses and avoid deposit cracking, hold die in furnace at 1150°F (621°C) for one hour per inch of thickness and cool rapidly in air blast.

Welding Composite Dies

AMPCO-TRODE® 200, 250 and 300 filler metal rod are used extensively to fabricate new forming and drawing dies by overlaying S.A.E. 1030 or 1040 steel and for the resurfacing of used cast iron and alloy steel dies where the superior qualities of AMPCO-TRODE® deposits are required to eliminate seizing, galling and scratching of the blanks in forming stainless steel, mild steel, aluminum, magnesium and titanium. In addition to providing lower finishing costs and scrap losses, such dies require less redressing and last longer.

Recommended Filler Metal

AMPCO-TRODE® 300 AMPCO-TRODE® 250 with gas tungsten-arc welding; AMPCO-TRODE® 200 with gas tungsten-arc and gas metal-arc welding.

AMPCO-TRODE® 300 or AMPCO-CORE® 300 / AMPCO-TRODE® 200 or AMPCO-CORE® 200 / AMPCO-TRODE® 250 or AMPCO-CORE® 250

Preheat

For the initial layer on mild steel, none required. For cast iron and alloy steels, use a 400°F (204°C) preheat. With all subsequent layers, a 600-700°F (315-371°C) interpass temperature is required.

Welding Procedure

Surfaces must be clean. Undercut for a minimum finished deposit thickness of 3/16" (4.8mm)... 1/4" (6.4mm) preferred.

Edges or shoulders should have no less than a 1/4" (6.4 mm) radius to avoid excessive base metal pickup. Deposits must be applied with a minimum of three layers. Weld using the gas metal-arc processes, apply the initial layer at lowest amperage to reduce base metal dilution. Wire brush or grind between passes. Subsequent layers can be applied at higher amperage. No special technique is required with the gas tungsten-arc process.

Postheat

None required—air cool.

Welding AMPCO® 8 Alloy

AMPCO®8 aluminum bronze sheet and plate conforming to C61300 are used extensively in welded fabrications to resist various corrosive media. This alloy is readily weldable with the inert-gas and shielded metal-arc welding processes.

Recommended Filler Metal

AMPCO-TRODE® 10

Preheat

Preheating is not essential when using the inert-gas processes. With the shielded metal-arc process, use 300°F (149°C). Interpass temperature should not exceed 600°F (315°C).

Welding Procedure

AMPCO® 8 is a single-phase alloy and is not subject to undesirable microstructure changes caused by welding.

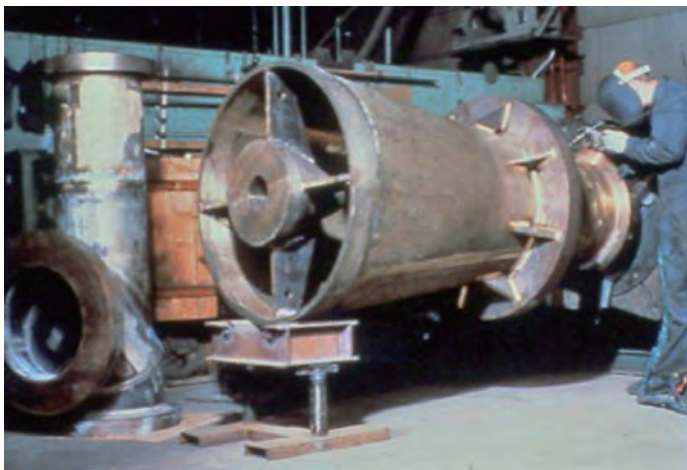
Proper preparation of the base metal is essential to obtain satisfactory welding results. The base metal in the weld area must be free of any surface oxide. To remove this oxide layer, a mechanical grinding operation is recommended and can be easily performed. Welding should only be attempted on bright gold base metal.

Wide grooves are essential. Tack with 3/4" (19.1 mm) welds at intervals of 4" to 8" (102 to 203 mm) on reverse side of plate when possible and remove when back chipping for root pass. String and small-to-moderate weave beads are preferred when using the gas metal-arc and shielded metal-arc processes.

Although flat position welding is preferred to obtain highest quality deposits, AMPCO®8 plate can be welded in the vertical and overhead positions by skilled operators with the gas tungsten-arc process and with the pulsed-arc methods using .035" (.9 mm) and .045" (1.2mm) diameter AMPCO-TRODE®10 spooled wire.

Postheat

Generally, none required. For complicated weldments, consult AMPCO METAL.



AMPCO® 8 Fabrication, power plant water component.



AMPCO® 8 Fabrication, Potash industry.

Welding AMPCO® 18 Alloy

AMPCO® 18 is a popular aluminum bronze which offers good bearing qualities with resistance to wear, abrasion and fatigue. Highly resistant to deformation under load, this alloy is available as sand, centrifugal and shell mold castings, extruded rod and bar, and continuous cast shapes.

Recommended Filler Metal

AMPCO-TRODE® 150 with gas tungsten-arc or gas metal- arc welding; AMPCO-TRODE 160 with shielded metal-arc welding.

Preheat

Generally, no preheat is necessary. However, when joining AMPCO® 18 to a ferrous metal with the shielded metal-arc process, it may be necessary to slightly preheat the ferrous metal.

Welding Procedure

For joining AMPCO® 18 to itself, apply either AMPCO- TRODE® 150 or AMPCO-TRODE® 160, using a wide groove appropriate to the thickness. Proper restraint will help minimize warpage and distortion when joining pieces end to end.

Postheat

None required except for corrosion service; then a temper anneal is recommended.

Welding Cast Iron

Cast iron is a generic term describing a variety of iron- base alloys containing 1.7% to 4.5% carbon. The high carbon content of cast iron increases welding difficulty compared to welding steels which possess a lower carbon content.

The most common cast irons are the gray irons although malleable and nodular types are often encountered. Malleable and nodular cast iron offer more ductility than gray iron since they include a round graphite structure whereas gray iron contains graphite in flake form which results in brittleness.

Because welding on these cast irons does create undesirable metallurgical changes in the heat-affected zone, every procedure imaginable has been written for cast iron welding. The procedure listed here is successful in most cases. However, it should be pointed out that some cast irons are virtually unweldable.

Recommended Filler Metal

AMPCO-TRODE® 10 and AMPCO-TRODE® 40

Preheat

300° to 600°F (149° to 315°C) depending on type and mass.

Welding Procedure

Small size electrodes are used with the shielded metal- arc process since they prevent localized overheating which may cause cracking. The weld metal should be deposited in stringer beads by the skip welding technique, depositing welds three to five inches long to prevent localized overheating. If the part being welded is of such a construction that its ends are not free to expand or contract, it is advisable to peen the weld immediately after depositing to remove the stresses.

In the case of objects that do not permit preheating, smaller sized electrodes should be used with the lowest possible amperage in order to obtain a good bond. In some cases, welds of only one inch long can be deposited without overheating the part. On some grades of cast iron, AMPCO-TRODE® 10 will do a better job while on others, AMPCO-TRODE® 40 will perform better.

Postheat

A postheat equal to or slightly higher than the preheat temperature is recommended followed by slow cooling, often using a welding blanket.

Welding Galvanized and Aluminized Steel

Galvanized and aluminized steel can be successfully welded using AMPCO-TRODE® 10 and the shielded metal-arc or gas metal-arc welding processes.

AMPCO-TRODE® 10 offers advantages in welding these coated materials because it provides high strength with corrosion resistance. No post weld painting or coating is necessary and the corrosion resistance of the base metal is retained because coating burn-off is minimized.

Recommended Filler Metal

AMPCO-TRODE® 10

Preheat

None required.

Welding Procedure

All welding should be done in the flat position, using the low side of the recommended amperage ranges (see page 18). Stringer beads should be used at a rapid rate of travel since bronze electrode melting points are much lower than those for steel electrodes.

Postheat

None required.

Welding Copper

Most commercially available copper falls into three basic categories: (1) oxygen-bearing copper, (2) deoxidized copper, (3) oxygen-free copper.

The most widely used grade is the oxygen-bearing copper, commonly referred to as ETP or electrolytic tough pitch copper (C11000). Welding on ETP copper reduces the strength and ductility of the material because of cuprous oxides in the grain boundaries.

Deoxidized copper (COPR-TRODE®) is the most desirable and successfully welded copper since it does not have the detrimental presence of cuprous oxide.

Recommended Filler Metal

COPR-TRODE® (for higher electrical conductivity).

Preheat

Depends upon material thickness, the welding process and heat input. In many cases, preheat could range from 700° to 1000°F (360° to 540°C).

Welding Procedure

Deposit weld metal by means of stringer beads or narrow weave beads, using spray transfer. Wide weave beads may result in oxidation at the edges of the bead. With the gas metal-arc welding process, the forehand welding technique should be used.

Postheat

None required.

Welding Recommendations

AMPCO-CORE® Cored Wires

AMPCO METAL is now offering new hardfacing cored MIG wire with various degrees of hardness for the welding of AMPCO® alloys or for overlay welding on steel.

We have made extensive tests and trials with our new AMPCO-CORE® alloys. We would like to share our experiences with you, which are in some aspects significantly different to welding with our well known AMPCO-TRODE® solid wires.

Welding Parameters

MIG process	
Wire diameter:	1.2 / 1.6 mm
Shielding gas:	100 % Argon
Flow rate:	17 - 22 L/min
Welding current:	DCEP (DC+)
Welding voltage:	28-30 Volts
Welding amperage:	360 - 400 A
Wire feed speed:	6-7 m/min

Welding Procedure

- Preheat: Steel - 300°C may be recommended, depending on size and chemical composition
- Preheat: Bronze - 300°C is required
- On steel – a buffer layer of AMPCO-TRODE® 10 is required before applying the AMPCO-CORE® material.
- Wire stick-out: approx. 15 mm
- Direction of gun travel: Dragging (trailing) the gun is better than pushing the gun even if the surface after pushing looks nicer, more glossy
- Grinding away the oxidized surface after each layer is necessary. Brushing with a stainless steel brush isn't enough!

Interpass temperature: maintain an interpass temperature between 280 and 350°C during the entire welding process. If the part gets too hot, wait until the work piece temperature comes down before continuing to deposit weld metal.

- Post weld treatment: cool part slowly with a welding blanket or other similar method

- Always use sufficient exhaust to extract the welding smoke and fumes. Use enough ventilation, exhaust at the arc, or both, to keep fumes and gases from your breathing zone and the general area. Always follow your employer's safety practices.

Shielded Metal-Arc Welding

The shielded metal-arc welding process (SMAW) is a long-standing favorite in the industry. Probably one of the most familiar of the processes, SMAW is a first choice for many welders involved with maintenance and repair applications. The process is portable and the equipment necessary is commonly available. Preheating is often recommended with this welding process, especially on heavy section thicknesses, or when welding on cast iron. The presence of moisture may introduce porosity. Use deep and maintain a short arc length.

Joint design information is described on page 20.

Good preparation of the base metal to clean and remove surface oxidation and contamination is necessary to obtain best weld

results. Do not weld on a scaly or greasy surface.

Either stringer or weave beads may be used in joining with equal success. However, weave beads are preferred because slag entrapment is minimized. To deposit a weave bead, oscillate the electrode approximately three times the electrode diameter, hesitating at the sidewalls to fill undercutting. Upon completion of depositing a weld, thoroughly remove all slag before applying successive layers. For overlays, apply the first layer using a low amperage to minimize base metal dilution. Best results are obtained when three layers are deposited.

As with any welding process, optimum results are obtained when good welding practices are observed.

Gas Tungsten-Arc Welding

The gas tungsten-arc welding process (GTAW) is recommended when the operator requires the utmost in deposit quality and precision control of the weld metal. The GTAW process is often employed to repair castings, construct or repair forming dies, fabricate copper alloy piping systems and for code work weldments. Direct current electrode negative (dcen) is preferred with this process although alternating current high frequency (achf) can be used. For most applications, 100% helium is recommended. Refer to page 19 for additional gas information. A sharp pointed tungsten electrode is the preferred style.

Tungsten electrodes with 2% thorium are preferred to deposit copper and copper alloys since 2% thoriated tungsten electrodes have higher electron emissivity, longer life and are easier to start than pure tungsten electrodes.

To deposit AMPCO-TRODE with GTAW, a dip technique is recommended similar to the technique used to deposit aluminum rod. Care must be exercised to avoid melting off the end of the filler rod with the arc, as this will result in an oxidized ball on the end of the filler rod and impair "wettability" of the filler rod.

The tungsten should extend from 1/4" to 3/8" (6.4 to 9.5 mm) beyond the cup of the welding torch. Maintain an arc length of 1/16" to 3/16" (1.6 to 4.8 mm).

RECOMMENDED WELDING AMPERAGE

Shielded	Electrode Diameter	Amperes*	Gas	Filler Diameter	Amperes*	Amperes*
Metal-arc	3/32"	50-110	Tungsten-		(achf)	(achf)
(dcep)-Positive	1/8"	90-160	arc	1/16"	70-120	70-150
	5/32"	130-180		3/32"	120-160	140-230
	3/16"	150-225		1/8"	170-230	225-320
				5/32"	220-280	175-300
				3/16"	280-330	200-320
Gas	Wire Diameter	Voltage	Amperes*	*Use low side of range for iron- or nickel-base alloys; middle of range for bronze alloys; high side for copper.		
Metal-arc	.035"	20-26	100-200			
(dcep)-Positive	.045"	22-28	100-250			
	1/16"	29-32	250-400			
	3/32"	32-34	350-500			

Gas Metal-Arc Welding

The gas metal-arc welding process (GMAW) is the most popular process for depositing AMPCO-TRODE® and COPR-TRODE® alloys. GMAW affords high deposition rates, increased efficiency, high quality and reduced operator fatigue. In many cases, it eliminates the necessity to preheat the work.

To insure a bright clean weld deposit, the gas flow rate should be set on 45-50 cfh (21.2-23.6 L/min.). The direction of travel and angle of the gun are very important in obtaining a smooth bright deposit (see photo). The presence of a black oxide on the surface of the weld indicates an unsatisfactory gas coverage situation. For most applications, 100% argon gas is suggested. When sustained use of the equipment is anticipated, a water-cooled torch performs best due to cooler operation. This is especially true with 1/16" and 3/32" diameter wire. Most of the current efficient air-cooled torches will perform satisfactorily with .035" and .045" diameter wire. Arc length within normal limits does not seem to affect deposit quality.

The power source should be set on deep. Best results are obtained with the machine settings operating in the spray transfer range. As with all welding, the flat position is preferred. However, out-of-position welding may be performed with a pulsed-type of power source. Suggested joint designs may be found on page 20.

GAS SELECTION

Proper shielding gas selection is one of the most important single factors to consider when welding with copper-base alloys. In most cases, 100% argon or 100% helium will provide best results. If desired, a mixture of 75% argon, 25% helium may be used with the gas metal-arc welding process when welding on high-conductivity base metal. The accompanying table shows recommended gas type and flow rates.

Argon provides a soft arc and is good for welding on thin section thickness. Helium has more current-carrying ability and provides a hot arc with greater speed and more penetration.

GTAW	100% helium	40-55 cfh	(19.0-26.0 L/min.)
	100% argon	40-55 cfh	(19.0-26.0 L/min.)
GMAW	100% argon	45-55 cfh	(21.2-26.0 L/min.)
	75% argon- 25% helium	45-55 cfh	(21.2-26.0 L/min.)

PREHEATING

Preheating copper-base alloys is frequently unnecessary when using the gas tungsten-arc or gas metal-arc welding processes provided section thicknesses are not unusually heavy. When welding on copper, preheating and maintenance of interpass temperature to 1000°F (538°C) is often required, regardless of welding process. Preheating is suggested when using the shielded metal-arc process. The following recommendations are only suggestions and will often vary depending on section thicknesses, selected welding process and other variables.

PREHEATING RECOMMENDATIONS

1. Low carbon and mild steels up to 0.29 C — none required.
2. Medium carbon steels 0.30 C to 0.59 C — 300°F to 600°F (149°C to 315°C), depending on carbon content.
3. Low alloy steels — same as low carbon and mild steel.
4. Gray cast iron 400°F to 600°F (204°C to 315°C), slow cool.
5. Nodular and malleable cast iron — 300°F to 400°F (149°C to 204°C), post weld annealing is advisable.
6. Cupro-nickel and silicon bronze — no preheat, interpass temperature — 200°F (93°C) maximum.
7. Aluminum bronze — alloys up to 10% aluminum — no preheat, 300°F (149°C) maximum interpass.
Alloys exceeding 10% aluminum — 300°F and 600°F (149°C and 315°C) maximum interpass.
8. Manganese bronze — 300°F (149°C) for inert gas and 500°F (260°C) for shielded metal-arc.
9. Copper — 1000°F (538°C).

Welding Copper-Tin Alloys (Phosphor Bronze)

Copper-tin alloys, commonly called phosphor bronze, have tin contents in the range of 1 to 10%. The two commonly-used welding filler metals are ER CuSn-A which contains about 5% tin and ER CuSn-C which contains about 8% tin. Tin strengthens the alloy and phosphorus is added as a deoxidizer.

Copper-tin alloys have rather wide freezing ranges. They solidify with coarse, dendritic grain structures. In weld metal, these grain structures have a tendency to crack unless

the welding procedure is designed to prevent it. Hot peening of each layer of multiple-pass welds will reduce welding stresses, resulting in a fine grained structure possessing increased tensile strength and ductility.

Recommended Filler Metal

Phosphor bronze grade A or C; AMPCO-TRODE®10

Preheat

On light sections, none required. However, preheat and interpass temperatures up to 300°F (149°C) are recommended for heavy sections if the shielded metal-arc welding process is used. Preheat is not essential when gas metal-arc welding with spray transfer.

Welding Procedure

Gas metal-arc process is suggested for welding on large and thick phosphor bronze fabrications. Direct current electrode positive (deep) and argon shielding gas are normally used. The molten weld pool should be kept small and the travel speed rather high. Stringer beads should be used in order to obtain a dense, fine grain deposit. Hot peening of each layer will reduce welding stresses.

In gas tungsten-arc welding, use alternating current high frequency (achf) or direct current electrode negative (dcen) and helium or argon gas shielding. Hot peening of each layer of weld metal is beneficial. The base metal should be preheated to the 300°F to 400°F (149°C to 204°C) range and the travel speed should be as fast as practical.

Postheat

Ordinarily, for most service requirements, postheating is not essential. However, if maximum ductility in the deposit is required, a postheat treatment of 900°F (482°C) with fast cooling is recommended.

Welding Copper-Silicon Alloys (Silicon Bronze)

The copper-silicon alloys, commonly referred to as silicon bronzes, contain small additions of iron, manganese and tin. The silicon content in bare ER CuSi-A filler metal is between 2.8 to 4.0% and is the primary hardening element in the composition. Silicon bronze filler metal is used for welding silicon bronzes and brasses and to weld galvanized steel.

These bronzes are extremely hot short and care must be exercised to avoid overheating the joint which tends to cause cracking.

Recommended Filler Metal

Silicon bronze or AMPCO-TRODE® 10

Preheat

Preheat slightly to remove moisture. Interpass temperature should not exceed 150°F (66°C).

Welding Procedure

With gas metal-arc welding, the weld metal should be deposited in stringer beads, maintaining a small molten pool to avoid overheating the hot short base metal. Use argon shielding gas and relatively high welding travel speed.

With the gas tungsten-arc process, welding is accomplished with dcen (dcsp) and argon or helium gas shielding. ACHF with argon gas shielding may be used to take advantage of the arc cleaning action.

In applications where steel is joined to silicon bronze, use AMPCO-TRODE® 10 and the gas metal-arc or gas tungsten-arc welding processes. Position the work so that the steel is in the vertical plane and the bronze is in the horizontal plane to avoid undercutting.

Postheat

None required.

	AMPCO®8 C613 C614	AMPCO®18 C954	COPPER C110 C122 C102	PHOSPHOR BRONZE	SILICON BRONZE	MANGANESE BRONZE C861	CUPRO-NICKEL	NICKEL ALUMINUM BRONZE. C958	MANGANESE NICKEL ALUM. BRONZE	LOW ALLOY STEEL	LOW CARBON STEEL	MEDIUM CARBON STEEL	HIGH CARBON STEEL	CAST IRON
AMPCO®8 C613 C614	1,B	1,B	1,G	1,7,C	1,A	1,B	1,B	1,5,B	1,4,B	1,B	1,B	1,B	1,B	1,C
AMPCO®18 C954	1,B	2,3,B	1,G	1,7,C	1,A	1,A	1,A	1,5,B	1,B	1,B	1,A	1,C	1,D	1,C
COPPER C110 C122 C102	1,G	1,G	8,G	7,8,G	1,8,G	1,8,G	1,8,G	1,5,8,G	1,4,8,G	1,G	1,G	1,G	1,G	1,G
PHOSPHOR BRONZE	1,7,C	1,7,C	7,8,G	7,8,C	7,A	1,7,C	7,1,C	7,C	7,C	7,1,C	7,1,C	7,1,C	7,1,D	7,1,C
SILICON BRONZE	1,A	1,A	1,8,A	7,A	6,A	1,6,A	1,A	1,A	1,A	1,C	1,A	1,A	1,C	1,6,B
MANGANESE BRONZE C861	1,A	1,A	1,8,G	1,7,C	1,6,A	1,B	1,B	1,B	1,B	1,C	1,A	1,C	1,D	1,C
CUPRO-NICKEL	1,B	1,A	1,8,G	7,1,C	1,A	1,B	9,10,B	1,A	1,4,A	1,C	1,A	1,C	1,D	1,C
NICKEL ALUMINUM BRONZE. C958	1,5,B	1,5,B	1,5,8,G	7,C	1,A	1,B	1,A	5,B	4,B	1,C	1,B	1,C	1,D	1,C
MANGANESE NICKEL ALUM. BRONZE	1,4,B	1,B	1,4,8,G	7,C	1,A	1,B	1,4,A	4,B	4,B	1,C	4,B	4,C	4,D	4,C
LOW ALLOY STEEL	1,B	1,B	1,G	7,1,C	1,A	1,C	1,C	1,B	1,C	...	...	...	...	...
LOW CARBON STEEL	1,B	1,A	1,G	7,1,C	1,A	1,B	1,A	1,B	4,B	...	...	...	...	...
MEDIUM CARBON STEEL	1,B	1,C	1,G	7,1,C	1,A	1,B	1,A	1,C	1,C	...	...	...	...	...
HIGH CARBON STEEL	1,B	1,D	1,G	7,1,D	1,C	1,D	1,D	1,D	1,D	...	...	...	...	...
CAST IRON	1,C	1,C	1,G	7,1,C	1,6,B	1,C	1,C	1,C	4,C	...	...	...	...	...

How to Use the Chart

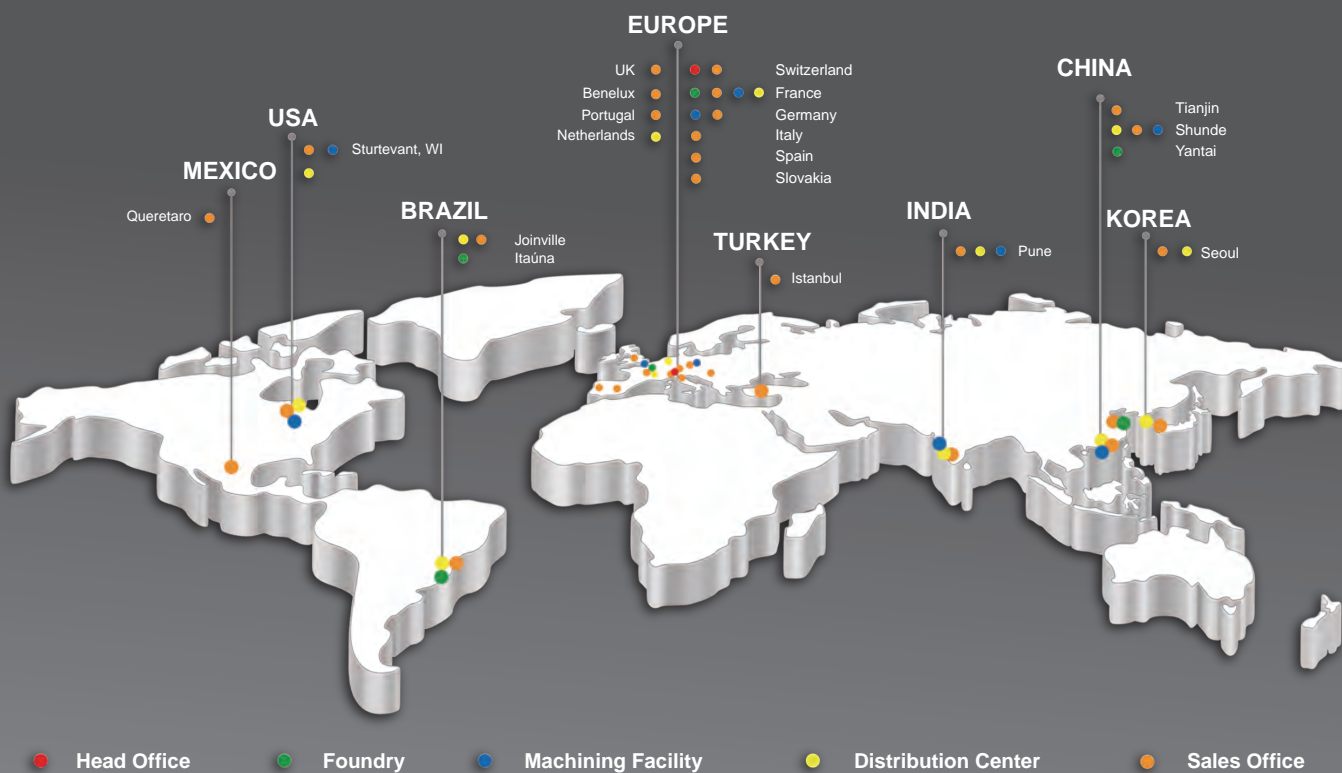
Suggested AMPCO® filler metal for welding like and dissimilar metals are coded by numbers. The selected filler metals are based on using the inert-gas welding processes. Covered electrodes are selected according to weldability except in those cases where mechanical properties are considered of more importance.

Preheat and interpass temperatures are coded by letters. Preheat and interpass temperature shown for joining dissimilar metals is that suggested for the metal or alloy requiring the highest temperature of the two. Temperatures also vary with the mass and shape of the weldment. See page 19 for additional preheating information.

Fill Metal Designation Preheat & Interpass Temperature

- 1 -AMPCO -TRODE®10
- 2 -AMPCO -TRODE®150
- 3 -AMPCO -TRODE®160
- 4 -AMPCO -TRODE®40
- 5 -AMPCO -TRODE®46
- 6 -SILICON BROZE
- 7 -PHOSPHOR BROZE
- 8 -COPR -TRODE®
- 9 -AMPCO-TRODE®521
- 70/30 Copper/Nickel
- 10- AMPCO-TRODE®522
- 90/10 Copper/Nickel

- A-150°F Max.(66°C)
B-300°F (149°C)
C-400°F (204°C)
D-500°F (260°C)
E-600°F (315°C)
F-1000°F (538°C)



AMPCO METAL is proud to participate into saving natural resources by using mostly recycled metal!



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