



# CopperHead<sup>®</sup> Orbital Weldhead Owner's Manual

Product:	Weldhead
Manual:	091-0448
Serial:	01120001
Voltage Rating:	N/A
Revision:	Feb 2009 Rev D
Model Number:	5001 5002 5003






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# *Declaration of Conformity for European Community (CE) Products*

**Note**  This information is provided for units with CE certification (see rating label on unit).

*Manufacturer's Name:* **MK Products, Inc.**

*Manufacturer's Address:* 16882 Armstrong Ave.  
Irvine, CA 92606

*Declares that the product:* **CopperHead®**

*conforms to the following Directives and Standards:*

## **Directives**

Low Voltage Directive: 73/23/EEC

Electromagnetic Compatibility (EMC) Directive: 89/336/EEC

## **Standards**

Arc Welding Equipment Part I: Welding Power Sources: IEC 60974-1  
(September 1998 – Second Edition)

Arc Welding Equipment: Wirefeed Systems: IEC 974-5  
(September 1997 – Draft Revision)

Degrees of Protection Provided By Enclosures (IP Code): IEC 529:1989  
(November 1989 - First Edition)

Insulation Coordination For Equipment With Low-Voltage Systems:  
Part I: Principles, Requirements and Tests: IEC 664-1: 1992  
(October 1992 – First Edition)

Electromagnetic Compatibility, (EMC): EN 50199  
(August 1995)

Torches And Guns For Arc Welding, EN 50078

# SAFETY CONSIDERATIONS

## ELECTRIC ARC WELDING EQUIPMENT

### CAUTION : READ BEFORE ATTEMPTING INSTALLATION, OPERATION OR MAINTENANCE OF THIS EQUIPMENT

#### 1-1 INTRODUCTION

This equipment is intended for ultimate application by commercial/industrial users and for operation by persons trained and experienced in the use and maintenance of welding equipment. Operation should not be undertaken without adequate training in the use of such equipment. Training is available from many public and private schools or similar facilities.

Safe practices in the installation, operation and maintenance of this equipment requires proper training in the art, a careful study of the information provided with the equipment, and the use of common sense. Rules for safe use are generally provided by suppliers of welding power sources, compressed gas suppliers, and electrode suppliers. Careful compliance with these rules will promote safe use of this equipment.

The following Safety Rules cover some of the more generally found situations. READ THEM CAREFULLY. In case of any doubt, obtain qualified help before proceeding.

#### 1-2 GENERAL PRECAUTIONS

##### A. Burn Prevention

ELECTRIC ARC WELDING PRODUCES HIGH INTENSITY HEAT AND ULTRAVIOLET RADIANT ENERGY WHICH MAY CAUSE SERIOUS AND PERMANENT EYE DAMAGE AND WHICH MAY DAMAGE ANY EXPOSED SKIN AREAS.

Wear helmet with safety goggles or glasses with side shields underneath, appropriate filter lenses or plates (protected by clear cover glass). This is a must for welding or cutting (and chipping) to protect the eyes from radiant energy and flying metal. Replace cover glass when broken, pitted, or spattered.

Medical first aid and eye treatment. First aid facilities and a qualified first aid person should be available for each shift unless medical facilities are close by for immediate treatment of flash burns of the eyes and skin burns.

Wear protective clothing - leather (or asbestos) gauntlet gloves, hat, and high safety-toe shoes. Button shirt collar and pocket flaps, and wear cuffless trousers to avoid entry of sparks and slag.

Avoid oily or greasy clothing. A spark may ignite them.

Flammable hair preparations should not be used by persons intending to weld or cut.

Hot metal such as electrode stubs and

work pieces should never be handled without gloves.

Ear plugs should be worn when working on overhead or in a confined space. A hard hat should be worn when others work overhead.

##### B. Toxic Fume Prevention

WARNING: The use of this product may result in exposure to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Adequate ventilation. Severe discomfort, illness or death can result from fumes, vapors, heat, or oxygen enrichment or depletion that welding (or cutting) may produce. Prevent them with adequate ventilation. NEVER ventilate with oxygen.

Lead-, cadmium-, zinc-, mercury-, beryllium-bearing and similar materials, when welded or cut, may produce harmful concentrations of toxic fumes. Adequate local exhaust ventilation must be used, or each person in the area, as well as the operator, must wear an air-supplied respirator. For beryllium, both must be used.

Metals coated with or containing materials that emit toxic fumes should not be heated unless coating is removed from the work surface, the area is well ventilated, or the operator wears an air-supplied respirator.

Work in a confined space only while it is being ventilated and, if necessary, while wearing an air-supplied respirator.

Gas leaks in a confined space should be avoided. Leaked gas in large quantities can change oxygen concentration dangerously. Do not bring gas cylinders into a confined space.

Leaving confined space, shut OFF gas supply at source to prevent possible accumulation of gases in the space if downstream valves have been accidentally opened or left open. Check to be sure that the space is safe before reentering it.

Vapors from chlorinated solvents can be decomposed by the heat of the arc (or flame) to form PHOSGENE, a highly toxic gas, and other lung and eye irritating products. The ultraviolet (radiant) energy of the arc can also decompose trichloroethylene and perchloroethylene vapors to form phosgene. DO NOT WELD or cut where solvent vapors can be drawn into the welding or cutting atmosphere or where the radiant energy can penetrate to atmospheres containing even minute amounts of trichloroethylene or perchloroethylene.

##### C. Fire and Explosion Prevention

Causes of fire and explosion are: combustibles reached by the arc, flame, flying

sparks, hot slag, or heated material, misuse of compressed gases and cylinders, and short circuits.

BE AWARE THAT flying sparks or falling slag can pass through cracks, along pipes, through windows or doors, and through wall or floor openings, out of sight of the goggled operator. Sparks can fly many feet.

To prevent fires and explosion:

Keep equipment clean and operable, free of oil, grease, and (in electrical parts) of metallic particles that can cause short circuits.

If combustibles are in area, do NOT weld or cut. Move the work if practicable, to an area free of combustibles. Avoid paint spray rooms, dip tanks, storage areas, ventilators. If the work cannot be moved, move combustibles at least 35 feet away, out of reach of sparks and heat; or protect against ignition with suitable and snug-fitting, fire-resistant covers or shields.

Walls touching combustibles on opposite sides should not be welded on (or cut). Walls, ceilings, and floor near work should be protected by heat-resistant covers or shields.

Fire watcher must be standing by with suitable fire extinguishing equipment during and for some time after welding or cutting if:

1. Appreciable combustibles (including building construction) are within 35 feet.
2. Appreciable combustibles are further than 35 feet, but can be ignited by sparks.
3. Openings (concealed or visible) in floors or walls within 35 feet may expose combustibles to sparks.
4. Combustibles adjacent to walls, ceilings, roofs, or metal partitions can be ignited by radiant or conducted heat.

Hot work permit should be obtained before operation to ensure supervisor's approval that adequate precautions have been taken.

After work is done, check that area is free of sparks, glowing embers, and flames.

An empty container that held combustibles, or that can produce flammable or toxic vapors when heated, must never be welded on or cut, unless container has first been cleaned in accordance with industry standards.

This includes: a thorough steam or caustic cleaning (or a solvent of water washing, depending on the combustible's solubility), followed by purging and inerting with nitrogen or carbon dioxide, and using protective equipment.

Water-filling just below working level may substitute for inerting.

A container with unknown contents should be cleaned (see paragraph above). Do NOT depend on sense of smell or sight to determine if it is safe to weld or cut.

Hollow castings or containers must be vented before welding or cutting. They can explode.

Explosive atmospheres. NEVER weld or cut where the air may contain flammable dust, gas, or liquid vapors (such as gasoline).

#### **D. Compressed Gas Equipment**

The safe handling of compressed gas equipment is detailed in numerous industry publications. The following general rules cover many of the most common situations.

##### **1. Pressure Regulators**

Regulator relief valve is designed to protect only the regulator from overpressure; it is not intended to protect any downstream equipment. Provide such protection with one or more relief devices.

Never connect a regulator to a cylinder containing gas other than that for which the regulator was designed.

Remove faulty regulator from service immediately for repair (first close cylinder valve). The following symptoms indicate a faulty regulator:

Leaks - if gas leaks externally.

Excessive Creep - if delivery pressure continues to rise with downstream valve closed.

Faulty Gauge - if gauge pointer does not move off stop pin when pressurized, nor returns to stop pin after pressure release.

Repair. Do NOT attempt repair. Send faulty regulators for repair to manufacturer's designated repair center, where special techniques and tools are used by trained personnel.

##### **2. Cylinders**

Cylinders must be handled carefully to prevent leaks and damage to their walls, valves, or safety devices:

Avoid electrical circuit contact with cylinders including third rails, electrical wires, or welding circuits. They can produce short circuit arcs that may lead to a serious accident. (See 1-3C)

ICC or DOT marking must be on each cylinder. It is an assurance of safety when the cylinder is properly handled.

Identifying gas content. Use only cylinders with name of gas marked on them; do not rely on color to identify

gas content. Notify supplier if unmarked. NEVER DEFACE or alter name, number, or other markings on a cylinder. It is illegal and hazardous.

Empties: Keep valves closed, replace caps securely; mark MT; keep them separate from FULLS, and return promptly.

Prohibited use. Never use a cylinder or its contents for other than its intended use, NEVER as a support or roller.

Locate or secure cylinders so they cannot be knocked over.

Passageways and work areas. Keep cylinders clear of areas where they may be stuck.

Transporting cylinders. With a crane, use a secure support such as a platform or cradle. Do NOT lift cylinders off the ground by their valves or caps, or by chains, slings, or magnets.

Do NOT expose cylinders to excessive heat, sparks, slag, and flame, etc. that may cause rupture. Do not allow contents to exceed 55° C (130° F.) Cool with water spray where such exposure exists.

Protect cylinders, particularly valves from bumps, falls, falling objects, and weather. Replace caps securely when moving cylinders.

Stuck valve. Do NOT use a hammer or wrench to open a cylinder valve that cannot be opened by hand. Notify your supplier.

Mixing gases. NEVER try to mix any gases in a cylinder.

NEVER refill any cylinder.

Cylinder fittings should never be modified or exchanged.

##### **3. Hose**

Prohibited use. Never use hose other than that designed for the specified gas. A general hose identification rule is: red for fuel gas, green for oxygen, and black for inert gases.

Use ferrules or clamps designed for the hose (not ordinary wire or other substitute) as a binding to connect hoses to fittings.

No copper tubing splices. Use only standard brass fittings to splice hose.

Avoid long runs to prevent kinks and abuse. Suspend hose off ground to keep it from being run over, stepped on, or otherwise damaged.

Coil excess hose to prevent kinks and tangles.

Protect hose from damage by sharp edges, and by sparks, slag, and open flame.

Examine hose regularly for leaks, wear, and loose connections. Immerse pressured hose in water; bubbles indicate leaks

Repair leaky or worn hose by cutting area out and splicing. Do NOT use tape.

##### **4. Proper Connections**

Clean cylinder valve outlet of impurities that may clog orifices and damage seats before connecting regulator. Except for hydrogen, crack valve momentarily, pointing outlet away from people and sources of ignition.

Wipe with a clean, lintless cloth.

Match regulator to cylinder. Before connecting, check that the regulator label and cylinder marking agree, and that the regulator inlet and cylinder outlet match. NEVER Connect a regulator designed for a particular gas or gases to a cylinder containing any other gas.

Tighten connections. When assembling threaded connections, clean and smooth seats where necessary. Tighten. If connection leaks, disassemble, clean, and retighten, using properly fitting wrench.

Adapters. Use a CGA adapter (available from your supplier) between cylinder and regulator, if one is required. Use two wrenches to tighten adapter marked RIGHT and LEFT HAND threads.

Regulator outlet (or hose) connections may be identified by right hand threads for oxygen and left hand threads (with grooved hex on nut or shank) for fuel gas.

##### **5. Pressurizing Steps:**

Drain regulator of residual gas through suitable vent before opening cylinder (or manifold valve) by turning adjusting screw in (clockwise). Draining prevents excessive compression heat at high pressure seat by allowing seat to open on pressurization. Leave adjusting screw engaged slightly on single-stage regulators.

Stand to side of regulator while opening cylinder valve.

Open cylinder valve slowly so that regulator pressure increases slowly. When gauge is pressurized (gauge reaches regulator maximum) leave cylinder valve in following position: for oxygen and inert gases, open fully to seal stem against possible leak; for fuel gas, open to less than one turn to permit quick emergency shut-off.

Use pressure charts (available from your supplier) for safe and efficient recommended pressure settings on regulators.

Check for leaks on first pressurization and regularly thereafter. Brush with soap solution. Bubbles indicate leaks. Clean off soapy water after test; dried soap is combustible.

##### **E. User Responsibilities**

Follow all Safety Rules.

Remove leaky or defective equipment from service immediately for repair. Read and follow user manual instructions.

##### **F. Leaving Equipment Unattended**

Close gas supply at source and drain gas.

##### **G. Rope Staging-Support**

Rope staging-support should not be used for welding or cutting operation; rope may burn.

### 1-3 ARC WELDING

Comply with precautions in 1-1, 1-2, and this section. Arc Welding, properly done, is a safe process, but a careless operator invites trouble. The equipment carries high currents at significant voltages. The arc is very bright and hot. Sparks fly, fumes rise, ultraviolet and infrared energy radiates, weldments are hot, and compressed gases may be used. The wise operator avoids unnecessary risks and protects himself and others from accidents.

#### A. Burn Protection

Comply with precautions in 1-2.

The welding arc is intense and visibly bright. Its radiation can damage eyes, penetrate lightweight clothing, reflect from light-colored surfaces, and burn the skin and eyes. Skin burns resemble acute sunburn; those from gas-shielded arcs are more severe and painful. **DON'T GET BURNED; COMPLY WITH PRECAUTIONS.**

#### 1. Protective Clothing

Wear long-sleeve clothing in addition to gloves, hat, and shoes. As necessary, use additional protective clothing such as leather jacket or sleeves, flameproof apron, and fire-resistant leggings. Avoid outer garments of untreated cotton.

Bare skin protection. Wear dark, substantial clothing. Button collar to protect chest and neck, and button pockets to prevent entry of sparks.

#### 2. Eye and Head Protection

Protect eyes from exposure to arc. Eyes may be damaged by radiant energy when exposed to the electric arc, even when not looking in the direction of the arc. Never look at an electric arc without protection.

Welding helmet or shield containing a filter plate shade no. 12 or denser must be used when welding. Place over face before striking arc.

Protect filter plate with a clear cover plate.

Cracked or broken helmet or shield should NOT be worn; radiation can be passed through to cause burns.

Cracked, broken, or loose filter plates must be replaced IMMEDIATELY. Replace clear cover plate when broken, pitted, or spattered.

Flash goggles with side shields MUST be worn under the helmet to give some protection to the eyes should the helmet not be lowered over the face before an arc is struck. Looking at an arc momentarily with unprotected eyes (particularly a high intensity gas-shielded arc) can cause a retinal burn that may leave a permanent dark area in the field of vision.

#### 3. Protection of Nearby Personnel

Enclose the welding area. For production welding, a separate room or enclosed bay is best. In open areas, surround the operation with low-reflec-

tive, noncombustible screens or panels. Allow for free air circulation, particularly at floor level.

Viewing the weld. Provide face shields for all persons who will be looking directly at the weld.

Others working in area. See that all persons are wearing flash goggles.

Before starting to weld, make sure that screen flaps or bay doors are closed.

#### B. Toxic Fume Prevention

Comply with precautions in 1-2B.

Generator engine exhaust must be vented to the outside air. Carbon monoxide can kill.

#### C. Fire and Explosion Prevention

Comply with precautions in 1-2C.

Equipment's rated capacity. Do not overload arc welding equipment. It may overheat cables and cause a fire.

Loose cable connections may overheat or flash and cause a fire.

Never strike an arc on a cylinder or other pressure vessel. It creates a brittle area that can cause a violent rupture or lead to such a rupture later under rough handling.

#### D. Compressed Gas Equipment

Comply with precautions in 1-2D.

#### E. Shock Prevention

Exposed electrically hot conductors or other bare metal in the welding circuit, or in ungrounded, electrically-HOT equipment can fatally shock a person whose body becomes a conductor. **DO NOT STAND, SIT, LIE, LEAN ON, OR TOUCH** a wet surface when welding without suitable protection.

To protect against shock:

Keep body and clothing dry. Never work in damp area without adequate insulation against electrical shock. Stay on a dry duckboard, or rubber mat when dampness or sweat cannot be avoided. Sweat, sea water, or moisture between body and an electrically HOT part - or grounded metal - reduces the body surface electrical resistance, enabling dangerous and possibly lethal currents to flow through the body.

#### 1. Grounding the Equipment

When installing, connect the frames of each unit such as welding power source, control, work table, and water circulator to the building ground. Conductors must be adequate to carry ground currents safely. Equipment made electrically HOT by stray currents may shock, possibly fatally. **DO NOT GROUND** to electrical conduit, or to a pipe carrying ANY gas or a flammable liquid such as oil or fuel.

Three-phase connection. Check phase requirement of equipment before installing. If only three-phase power is available, connect single-phase equipment to only two wires of the three-phase line. **DO NOT** connect the equipment ground lead to the third (live) wire, or the equipment will become electrically HOT - a dangerous condition

that can shock, possibly fatally.

Before welding, check ground for continuity. Be sure conductors are touching bare metal of equipment frames at connections.

If a line cord with a ground lead is provided with the equipment for connection to a switch box, connect the ground lead to the grounded switch box. If a three-prong plug is added for connection to a grounded mating receptacle, the ground lead must be connected to the ground prong only. If the line cord comes with a three-prong plug, connect to a grounded mating receptacle. Never remove the ground prong from a plug, or use a plug with a broken ground prong.

#### 2. Connectors

Fully insulated lock-type connectors should be used to join welding cable lengths.

#### 3. Cables

Frequently inspect cables for wear, cracks, and damage. **IMMEDIATELY REPLACE** those with excessively worn or damaged insulation to avoid possibly lethal shock from bared cable. Cables with damaged areas may be taped to give resistance equivalent to original cable.

Keep cable dry, free of oil and grease, and protected from hot metal and sparks.

#### 4. Terminals and Other Exposed Parts

Terminals and other exposed parts of electrical units should have insulating covers secured before operation.

#### 5. Electrode Wire

Electrode wire becomes electrically HOT when the power switch of gas metal-arc welding equipment is ON and welding gun trigger is pressed. Keep hands and body clear of wire and other HOT parts.

#### 6. Safety Devices

Safety devices such as interlocks and circuit breakers should not be disconnected or shunted out.

Before installation, inspection, or service of equipment, shut OFF all power, and remove line fuses (or lock or red-tag switches) to prevent accidental turning ON of power. Disconnect all cables from welding power source, and pull all 115 volts line-cord plugs.

Do not open power circuit or change polarity while welding. If, in an emergency, it must be disconnected, guard against shock burns or flash from switch arcing.

Leaving equipment unattended. Always shut OFF, and disconnect all power to equipment.

Power disconnect switch must be available near the welding power source.

# Thank You

For selecting a quality product. We want you to take pride in operating this product...as much pride as we have in bringing the product to you!

## **Please Examine Carton and Equipment For Damage Immediately**

When this equipment is shipped, title passes to the purchaser upon receipt by the carrier. Consequently, claims for material damaged in shipment must be made by the purchaser against the transportation company at the time the shipment is received.

Please record your equipment identification information below for future reference. This information can be found on your machine nameplate.

Model Name & Number \_\_\_\_\_

Code & Serial Number \_\_\_\_\_

Date of Purchase \_\_\_\_\_

Whenever you request replacements parts for, or information on this equipment always supply the information you have recorded above.

Read this Owner's Manual completely before attempting to use this equipment. Save this manual and keep it handy for quick reference. Pay particular attention to the safety instructions we have provided for your protection.



## Section A



## Installation

### Technical Specifications

#### Electrical

The CopperHead® uses a 24VDC motor with TACH feedback. It is controlled by an orbital power-supply motor-control circuit, to turn the rotor at the precise speed to create a near perfect weld.

#### Mechanical

Power Cable Size: ..... #6, 75A, 600V.  
Twist-lock cable-end connectors.

Gas/Water Hose Size: ..... Nylon Tube, ¼" OD x 0.17 ID  
Double-end shut-off coupler

Control Cable Specification: ... 20AWG, 12 conductor

#### Models

Each weldhead has been designed for optimum performance in specific applications according to specific diameter ranges. While each weldhead has a maximum size capacity, it is always best to utilize the next larger size weldhead when operating near its maximum operating capacity. Although they may perform satisfactorily in these applications, the maximum productivity will be achieved where the weldhead is matched to the job. See Appendix A for reference dimensions of each weldhead.

#### Model 5001 - CopperHead® I

The Model 5001 weldhead was designed for precision welding of small diameter tubes and fittings. The 5001 weldhead is capable of welding 1/8" to 1" OD tubes and associated fittings and 1/8 - 1/2 NP.

#### Model 5002 - CopperHead® II

The Model 5002 weldhead was designed for precision welding of small to medium size diameter tubes and fittings. The 5002 weldhead is capable of welding 1/4" to 2" OD tubes and associated fittings and 1/8 - 1 1/2 NP.

#### Model 5003 - CopperHead® III

The Model 5003 weldhead was designed for precision welding of medium size diameter tubes and fittings. The 5003 weldhead is capable of welding 1/2" to 3" OD tubes and associated fittings and 1/4 - 2 1/2 NP.

#### Weldhead Connections

The weldheads come equipped with an integrated 25' cable, which connects directly to the CobraTig® 150 orbital power-supply and CobraCooler™. The cable assembly provides a path for weld power, operator control and motor signals, inert gas flow, and recirculating coolant flow (see Figure 1).

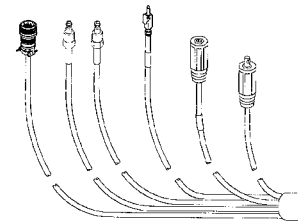


Figure 1

#### Welding Leads

The two welding Power Leads use a twist-lock type of power connector. These are designed to attach directly to the rear panel of the CobraTig® 150. The male connector connects to the receptacle labeled "ELECTRODE". The female connector connects to the receptacle labeled "GROUND".

### Control Cable

The 24 MS-type pin connector attaches to the mating receptacle on the rear panel of the orbital welding power-supply. All of the Control, Feedback and Welding functions of the weldhead transfer through this connector.

### Operator Controls

The operator controls are on the weldhead handle. The controls include the following:



#### START/STOP

The [START/STOP] button first starts the program. If pressed a second time, it will stop the program.

#### NEXT LEVEL/GAS TEST

If the [NEXT LEVEL/GAS] button is pressed during the welding or testing of the welding program, the program will jump from its current program level to the next program level. Subsequent pressing of this button will continue to jump to the next levels of the program.

If pressed any other time, the gas function is enabled: if pressed once, the gas will 'flow' (assuming the inert gas supply and the weldhead gas lines are connected), if pressed again the 'flow' of gas will stop.

#### MOTOR JOG

The [MOTOR JOG] button is used to jog the rotor either prior to starting the program for setup, or after running the program.

#### FINAL SLOPE/HOME

If the [FINAL SLOPE/HOME] button is pressed during the welding or testing of the welding program, the unit will skip all level and initiate the final slope. If pressed at any time, the rotor will move (jog) to its home position at the high calibration speed value. If the rotor is already at home position, the rotor will then backup several degrees, then forward again to home.

### Gas Hose

The gas connector is a double-end shut-off valve type that prevents flow or leakage out of either the unit or the gas hose if the connection is broken.

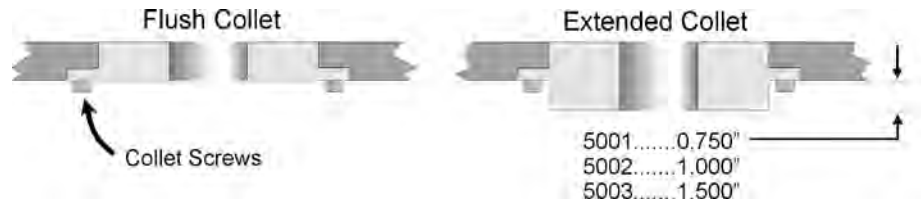
The gas hose connector from the weldhead plugs into the "GAS OUT" receptacle.

### Water Hoses

The water connectors are a quick-release type that prevent flow or leakage out of either the CobraCooler™ or the water hose if the connection is broken.

The water hose connectors from the weldhead plug into the "WATER IN" & "WATER OUT" receptacles on the rear panel of the CobraCooler™.

## Collet Selection



**Figure 2**

The Collets mount to the side-plates of the weldhead and maintain the weld joint alignment of the parts to be welded. The Collets are manufactured to correspond with the outside diameter of the material to be welded. Each set of Collets has two Collet halves; top and bottom. Two sets of Collets are needed to weld two tubes together.

The Collet halves are identified "TOP" and "BOT". The top Collet-half is distinguished by adjustable brass-tipped plungers. (See Collet Adjustment Section for proper setting of these setscrews).

Collets are available in many different sizes and configurations.

When axial clearance is of prime importance; Flush Collets should be used. Flush Collets attach to the weldhead side-plates and add no additional width to the weldhead. Flush Collets are most widely used where space around the weldhead is limited or when welding fittings with odd-shaped bodies that are close to the weld joint.

Where possible, Extended Collets should be used since they provide better alignment control of the parts to be welded. When using two sets of Extended Collets, the width of the Collets may add up to 1.5 inches to each side of the weldhead (See Figure 2).

Custom Collets and fitting holders can be adapted to fit on the CopperHeads®; depending on the dimensions of fittings, ferrules, valve bodies and/or special tube-bends. Contact the factory for information on Specialty Collets.

## Collet Adjustment

The parts to be welded are held in place by the Collets. The tolerance of the outside diameter of tubes and pipes vary, so these variations are handled through the use of brass-tipped setscrews, referred to as plungers, in the top Collet halves. These plungers not only make up the diameter difference between the Collet and the part to be welded, but they also act as an aid in the grounding path between the weldhead and the tube or pipe to be welded. The tube or pipe is forced down into the bottom halves of the Collets, which are screwed to a line-bored concentric face in the weldhead side-plates.

The plungers are adjusted as follows:

1. Back the plungers out until the brass tip is flush or below the surface of the bored Collet surface.
2. Place the parts to be welded into the Collets and clamp down the latches.

Adjust the latching mechanism of the weldhead to ensure a tight, but not overly-tight clamping of the Side Plate Clamp.

3. Alternately adjust the plungers on one side of the weldhead until contact is made, and then add about 1/4 turn more.

If using Extended Collets, adjust the outboard plungers only until contact is made and no more.

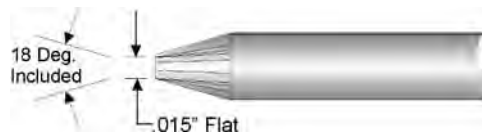
4. At this point the tube should be firmly held in place. The tube should not turn if attempting to rotate it by hand.

5. Repeat the process for the opposite side of the weldhead.
6. Once completed, check the alignment of the parts. A misalignment may be corrected by moving the left or right plunger in or out by a fraction of a turn and then repeating the opposite action to the opposing plunger on the same Collet.

### Tungsten Electrode

The recommended tungsten type to be used in the CopperHead® and the MK orbital welding system is 2% Ceriated, 1/16" diameter and .040" diameter.

Appendix E gives the MK part numbers for pre-ground tungsten electrodes.

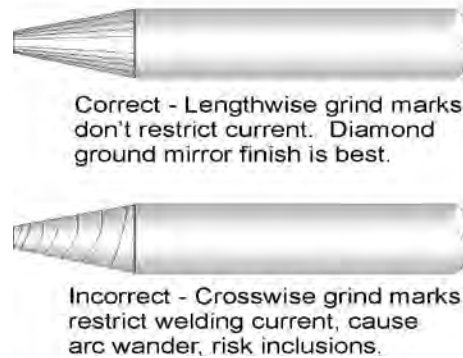


**Figure 3**

These lengths of tungsten are long enough to allow the setscrew to securely hold the tungsten while maintaining a relatively close arc gap, and keep the tungsten from sticking out the back of the rotor while using a large arc gap.

### Tungsten Geometry

The recommended grind angle and shape for tungsten is 18° included angle and a .015" flat (Figure 3). Regardless of the electrode tip geometry selected; it is important that consistent electrode geometry be used once a welding procedure is established.



**Figure 4**

Changes in electrode geometry can significantly influence the weld bead shape and size; therefore, electrode tip configuration is a welding variable that should be defined during procedure development.

### Tungsten Preparation

Tungsten electrodes should be properly ground for consistent results. If the electrode is to be hand ground, use a dedicated diamond wheel. The grinding marks should be perpendicular to the tungsten electrode or poor arc starts, arc wander and inclusions occur (See Figure 4). No other parts should be ground with these wheels, since contamination of the electrode could result and create problems with arc initiation, arc wander during the weld and tungsten inclusions in the weld bead.

All tungsten supplied by MK Products, Inc. is prepared using the latest manufacturing techniques in order to meet the geometry specifications as described above.

### Installing the Tungsten Electrode

The electrode is mounted in the rotor and held in place with a setscrew. There are up to three tungsten holes: .040", 1/16" and 3/32". Typically, the

3/32" hole is used for tungsten tooling (holders and extenders) however, a tungsten electrode can also be used.

To insert the electrode, jog the rotor around until the setscrew is exposed (approximately at the twelve-o'clock position), and loosen the setscrew. Insert a properly prepared electrode from the top of the rotor and tighten the setscrew. Be sure to set the appropriate arc gap prior to welding.

### Recommended Arc Gap

The proper arc gap is an important part of the proper use of your orbital welding equipment. Improper arc gap can cause arc strikes to occur to your Collets or to the Side Plate Clamp.

Be sure the arc gap is as short as possible, consistent with the process and weld current level, but not so short as to 'crash' or touch the weld being made.

If no arc gap is known when designing a weld procedure a good rule-of-thumb is as follows:

**For on-site field welding applications;** match the arc gap to the wall thickness of the tube/fitting being welded, with a maximum arc gap of .090". For example, if the tube wall thickness is .035", then start with an arc gap of .035".

**For in-house manufacturing;** add 1/2 the wall thickness plus .010", with a maximum arc gap of .070".

### Setting the Arc Gap

1. Place the part to be welded on the lower Collets with the clamps in the upright open position.
2. Jog the rotor until the tungsten hole in the rotor is sitting directly over the part with access to the tungsten set screw, approximately at twelve-o'clock.
3. Prepare the tungsten electrode with the right length and shape as explained in the Tungsten Geometry and Tungsten Preparation sections.
4. Put the tungsten electrode through the appropriate hole on the top of the rotor.
5. Place the appropriate thickness gauge between the tungsten electrode and the part to be welded so that the tungsten electrode is at the correct gap.

Be certain the thickness gauge is perpendicular to the tungsten electrode.

6. Tighten the setscrew to secure the tungsten electrode in the rotor.

### CAUTION

Do not over-tighten the tungsten set screw. Over-tightening the setscrew can crack and splinter the tungsten causing errant starts and arc wander.

Be sure that the tungsten does not extend into the rotor teeth. Also, be sure that both set screws are screwed into the rotor.

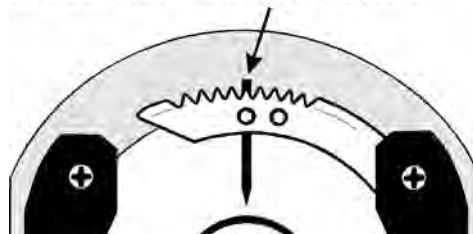


Figure 5

Be sure that the tungsten does not extend into the rotor teeth and that both setscrews are flush with the rotors surface (see Figure 5).

Any length of tungsten that is protruding out the back of the rotor will jam with the meshing gears inside the weldhead. This will push the tungsten into the weld being made and inevitably cause an ARC FAULT.

If the weldhead becomes jammed, a "Motor Stall" will result. Usually, some foreign matter, or a piece of tungsten electrode has fallen within the gear mechanism of the weldhead, hindering the rotation of the gears.

### **Clearing a Jammed Weldhead**

In order to clear the jam, turn the weldhead upside-down and vigorously shake the weldhead. If this fails to clear the foreign matter; while still inverted, briefly push the red "Reverse" button located in the bottom of the handle.

Before turning the weldhead right side up, attempt to locate the foreign object. If the jam cannot be cleared in this manner, the weldhead must be disassembled and the objects removed.

See **WELDHEAD DISASSEMBLY** in the Maintenance section for detailed information on dismantling the CopperHead®

### **Extenders**

The Extenders are designed to fit in the large tungsten hole in the rotor. They have a 3/32" diameter hole, with an accompanying setscrew in the end to allow for the tungsten holder.

### **Holders**

Once the holder is locked into the extender, the holders are designed to hold the tungsten electrode at a place that is somewhere outside the normal confines of the weldhead. There are three angles at which the tungsten can be set in the holder: 20° and 30° from vertical, or a single angle setting of 90° from horizontal.

Both the extender and the holder are made in different lengths, depending on tube diameter and joint offset. In some cases, special Collets are also needed when having to use this type of tungsten tooling. Contact the factory for Specialty Tooling.

### **Tungsten Tooling**

As mentioned above, the larger of two tungsten holes is primarily used for tungsten tooling: Holders and Extenders. The extender is a tool for the holder; without it, the holder has nothing to fit into. These two must be used together.

### **Gas Flow Rates**

<b>Weldhead Model</b>	<b>Gas Flow Rates</b>	<b>Minimum Pre &amp; Post Purge Times</b>
5001	15-20 CFH	10 Seconds
5002	20-25 CFH	20 Seconds
5003	25-30 CFH	30 Seconds

Recommended arc gas flow rate is the same for the ACL® and the CobraTig®. Flow rates higher than 35 CFH can create turbulence within the weldhead chamber and blow the arc about.

Back-up gas flow rates are typically between 5 and 20 CFH, depending on internal volume and component configuration. Typically, when welding components with relatively large internal volumes, a separate source for backup purge gas is recommended.

## Section B

### **Weldhead Coolant**

Use Cobra Coolant (Aluminum Protection), P/N 931-0060. Cobra Coolant does not contain reactive sulphur or chlorine and does not react with copper, brass or aluminum.

*DO NOT USE AUTOMOTIVE ANTI-FREEZE*

*This may contain additives that are not compatible with this equipment and will void the warranty.*

### **Operations**

#### **Weldhead Calibration**

The software program in the orbital welding power-supply provides for weldhead rotor speed and motor controller calibration. This calibration program consists of driving the rotor at predetermined speeds for a set number of revolutions, depending on the welding power supply used. The start and end of each rotation are detected by the passage of the reed switch or "home" sensor in the weldhead. The rotation is clocked by the computer and, by process of adjusting and recalculating, provides very accurate and consistent speeds.

#### **WARNING**

*Always perform a motor calibration when changing weldheads or powering up the power source. Leaving the same calibration coefficient corrections with a different weldhead may give erroneous speed results.*

#### **Weldhead Calibration Sequence – ACL®**

Due to small variations among weldheads and because the ACL® uses a tachometer feedback control system, there are small but significant variations in speed among the weldheads for the same command from a particular ACL®. There are also slight drift effects within the same weldhead when used over a long time frame mainly caused by temperature build up in the weldhead motor case.

To account for these variations, the ACL® provides two functions to measure the variation and then to factor out the variation so that the weldhead can maintain absolute and repeatable results: 1) the first function is a Full Motor Calibration sequence performed from the Main Menu, 2) the second function is a quick update that is performed before each weld if the pre-weld homing function is programmed into the weld procedure. For programming information for the Motor Calibration Update, please refer to the ACL® Owner's Manual.

The first function is performed to take out gross variations between weldheads. The second function is a shortened update of the full calibration procedure performed to take into account any drift that may occur over a long time frame with the same weldhead.

#### **Full Motor Calibration Sequence**

Upon initiation of the calibration sequence, if the rotor is at home position, it starts rotating in its normal welding direction for at least two complete revolutions from home switch closure to home switch closure at a default low speed setting of 2 rpm. Once complete, the weldhead rotor changes speeds and continues in its normal welding direction for at least two complete revolutions from home switch closure to home switch closure at a default high speed setting of 6 rpm.

The ACL® uses the home switch closure as an absolute indicator of rotor position and times the duration between switch closures as one complete revolution. Dividing this time into 60 seconds gives the rotor speed in rpm.

The ACL® uses two samples of data (hence two complete revolutions) at

two different speeds to get two times at high speed and two times at low speed. This raw data is displayed under the column "Measured". The two readings per speed are averaged together to produce an average time. This is displayed under the column "Actual". The expected values are under the column "Cal". The corresponding speeds derived by the above-mentioned method are displayed under the column "Actual" for the test results and under the column "Cal" for the expected results.

column "Measured". The two readings per speed are averaged together to produce an average time. This is displayed under the column "Actual". The expected values are under the column "Cal". The corresponding speeds derived by the above-mentioned method are displayed under the column "Actual" for the test results and under the column "Cal" for the expected results.

Using this information the ACL<sup>®</sup> calculates the two sets of error parameters: Gain and Zero. The Gain parameter is a measure of the multiplying factor error on the speed. The Zero parameter is the error of the speed where it should be going at zero rpm but in actually it is slightly non-zero. The ACL<sup>®</sup> then calculates the adjustment coefficients based upon these error parameters to properly adjust the motor speed commands in order to give the correct weldhead rotor speed.

The second set of parameters is the "Tach" error. The motor speed is directly read by the ACL<sup>®</sup>, using the tachometer feedback from the weldhead motor, in two ways: 1) the analog tachometer signal is used by the analog closed loop motor servo to control to the commands provided from the ACL<sup>®</sup> control system. 2) The analog tachometer signal is converted to a digital signal, using an analog multiplex analog to digital converter technique, and then Interpreted by the digital ACL<sup>®</sup> control system. It compares on what it has calculated from its timing data versus what the tachometer is giving corrected by the same coefficients mentioned above. Similarly, a gain error, "Gain", and an off-set error, "Zero", are derived. Reference the Sample ACL<sup>®</sup> Calibration Printout in Table 1.

*Sample ACL<sup>®</sup> Calibration Printout*

<b>Motor Calibration Data</b>						
08/07/01 15:45:04 / 08/07/01 15:45:04						
Gain Error = 3.5% / Zero error = 0.05 RPM						
<i>Cal</i>	<i>Actual</i>	<i>Cal</i>	<i>Actual</i>	<i>Measured</i>		<i>Update</i>
<i>RPM</i>	<i>RPM</i>	<i>Sec</i>	<i>Sec</i>	<i>Sec</i>	<i>Sec</i>	<i>Sec</i>
6.00	5.84	10.00	10.27	10.27	10.26	0.00
2.00	1.98	30.00	30.36	30.60	30.05	
Tachometer: Gain error= -4.1% / Zero error = 0.13 RPM						
<i>Actual</i>	<i>Read</i>	<i>Measured</i>		<i>Update</i>		
<i>RPM</i>	<i>RPM</i>	<i>RPM</i>	<i>RPM</i>	<i>Sec</i>		
5.84	5.96	5.96	5.96	0.00		
1.98	1.93	1.91	1.94			

**Table 1**



What does all this mean to the operator? It means that the ACL<sup>®</sup> will calibrate the weldhead to its own motor voltage output and compensate for calculated errors derived during the Motor Calibration Sequence.

The Motor Gain Error percentage is exactly how much the ACL<sup>®</sup> will compensate for with a particular weldhead connected.

When a new or repaired weldhead is received, a calibration should be run to “benchmark” its performance. This initial “benchmark” calibration check can then be used to compare prior calibration reports to determine the condition of the weldhead. If the ‘Gain error’ is more than 10% and ‘Zero error’ more than 0.5 rpm off of the benchmark calibration then the weldhead should be disassembled and cleaned.

If the ‘Gain error’ reaches 50% or the ‘Zero error’ reaches 2 rpm during a calibration check, the computer will state “DO NOT WELD”. At this point, however, the weldhead may have sustained considerable damage. Therefore, it is important to monitor the ‘Gain error’ and ‘Zero error’ and provide maintenance as necessary. Reference the Sample ACL<sup>®</sup> Calibration Error Printout in Table 2.

*Sample ACL<sup>®</sup> Calibration Error Printout*

<b>Motor Calibration Data</b>						
08/07/01 15:45:04 / 08/07/01 15:45:04						
Gain Error = -. % / Zero error = --- RPM						
<i>Cal RPM</i>	<i>Actual RPM</i>	<i>Cal Sec</i>	<i>Actual Sec</i>	<i>Measured Sec</i>	<i>Update Sec</i>	
6.00	0.00	10.00	0.00	0.00	0.00	0.00
2.00	1.98	30.00	30.36	30.60	30.05	
Tachometer: Gain error = -4.1% // = 0.13 RPM						
<i>Actual RPM</i>	<i>Read RPM</i>			<i>Measured RPM</i>	<i>Update RPM</i>	<i>Sec</i>
0.00	0.00			0.00	0.00	0.00
1.98	1.93			1.91	1.94	
<b>Cal Time Error: *DO NOT WELD*</b>						

**Table 2**

**Weldhead Calibration Sequence – CobraTig<sup>®</sup>**

Due to small variations among weldheads and because the CobraTig<sup>®</sup> uses a tachometer feedback control system, there are small but significant variations in speed among the weldheads for the same command from a particular CobraTig<sup>®</sup>.

To account for these variations, the CobraTig<sup>®</sup> provides procedure to measure the variation and then to factor out the variation so that the weldhead can maintain absolute and repeatable results: a Motor Calibration sequence performed from the Calibration Menu.

**Motor Calibration Sequence**

Upon initiation of the Motor Calibration sequence, if the rotor is at home position, it backs up slightly then starts rotating in its normal welding direction for one complete revolution from home switch closure to home switch closure at a default low speed setting of 2 rpm. Once complete, the weldhead rotor again backs up slightly, increases speed and continues in its normal welding direction for one complete revolution from home switch closure to home switch closure at a default high speed setting of 6 rpm.

The CobraTig® uses the home switch closure as an absolute indicator of rotor position and times the duration between switch closures as one complete revolution. Dividing this time into 60 seconds gives the rotor speed in rpm.

Using this information the CobraTig® calculates the two sets of error parameters: Gain and Zero Offset for both Motor and Tach. For the Motor parameters, the Gain is a measure of the multiplying factor error on the speed. The Zero Offset is the error of the speed where it should be going at zero rpm but in actuality it is slightly non-zero. The CobraTig® then calculates the adjustment coefficients based upon these error parameters to properly adjust the motor speed commands in order to give the correct weldhead rotor speed.

For the Tach parameters, the motor speed is directly read by the CobraTig®, using the tachometer feedback from the weldhead motor, in two ways: 1) The analog tachometer signal is used by the analog closed loop motor servo to control to the commands provided from the CobraTig® control system. 2) The analog tachometer signal is converted to a digital signal, using an analog multiplex analog to digital converter technique, and then Interpreted by the digital CobraTig® control system. It compares on what it has calculated from its timing data versus what the tachometer is giving corrected by the same coefficients mentioned above. Similarly, a gain error, "Gain", and an off-set error, "Zero", are derived. Reference the Sample CobraTig® Calibration Printout in Table 3.

*Sample CobraTig® Calibration Printout*

<b>MK Products. CobraTig 150</b>			
<b>MOTOR Calibration report</b>			
MOTOR gain:	-4.6%	Zero offset:	0.30 RPM
TACH gain:	1.9%	Zero offset:	0.02 RPM
<b>WELDER Calibration Report</b>			
CURRENT D/A converter gain:	3.1%	DAC offset:	-1
CURRENT D/A converter gain:	3.6%	DAC offset:	4
CURRENT A/D converter gain:	-2.1%	ADC offset:	0
VOLTAGE A/D converter gain:	-0.3%	ADC offset:	0

**Table 3**

What does all this mean to the operator? It means that the CobraTig® will calibrate the weldhead to its own motor voltage output and compensate for calculated errors derived during the Motor Calibration Sequence.

The Motor Gain percentage is exactly how much the CobraTig® will compensate for with a particular weldhead connected.

Should these MOTOR & TACH gain values return with number of 0.00% and 0.00 RPM, the calibration is considered invalid and should be re-run.

## Section C

### Accessories

Other than Collets, tungsten holders/extenders, and a cooler, there are no other items needed to operate the weldhead with the orbital power supplies. There are however, accessories available that enhance the operation of the weldheads so that they may be more widely used with other orbital equipment supplied by MK Products, Inc.

### Benchmark

The CopperHead® weldheads can be used while held in the operator's hand. However, at times it may be necessary for the operator to use both

## Section D

hands to manipulate parts within the weldhead, which requires the use of a Benchmark. This Benchmark (P/N 005-0634) can be affixed to any table or counter edge and can hold any 5001, 5002, or 5003 CopperHead® as well as the 4000 MiniMicro and 5000 Mr. Micro™ orbital weldhead.

### Extension Cable

When longer weldhead cables are needed, a weldhead extension cable is also available in a 25' length. The extension cable (P/N 005-0635) has all the necessary connections needed to connect a CopperHead® to the CobraTig® 150: welding leads, gas, coolant supply and return and control interface, or to an ACL® using the Pig Tail Kit (P/N 005-0619).

### Pig Tails

The CopperHead® cable ends are designed to fit directly to the CobraTig® 150 using twist-lock type connectors. In order to connect the CopperHead® to the older ACL® Orbital Power-supplies, an adapting Pig Tail Kit (P/N 005-0619) may be required. This Pig Tail Kit mates the twist-lock type connectors of the CopperHead® to the push-in type connectors of the ACL®. The CobraCooler™ can also be utilized on the ACL®, allowing for a complete water-cooled orbital welding system.

### Collets

A set of Collets is defined as top and bottom halves for each side of the weldhead. Typically, 2 sets are required per each weldhead. Locating mandrels are used to mechanically position the tub or weld fitting directly in line with the tungsten electrode.

## Maintenance

### Preventative Maintenance

Prior to performing any maintenance, the weldhead should be tested to "benchmark" its performance. A normal calibration should be run and the required correction noted. If the weldhead is running slowly, this usually indicates that there is an excessive load on the drive motor, and that maintenance is required.

### Rotor Accuracy

Weld uniformity depends on the accuracy of the position of the rotor during welding. Rotor motion should be circular in motion in a plane at right angles to the tube and concentric with the center of the tube to be welded. Any deviation from the proper tracking or discontinuity in the rotor will appear in the weld.

Problems in the plane of rotation are usually associated with Collets and can be corrected by Collet modification. Discontinuities with rotor motion are more serious and may require replacement of the rotor, the Teflon race, or both. Proper replacement requires factory tooling and is not a field repair.

### Cable Assembly

An electrical measurement should be made to determine continuity from the positive cable connector to the rotor and from the negative cable to the spring loaded connector block on the weldhead.

Resistance measurements should be less than 0.1 ohms.

A measurement should also be made to verify that no conductivity exists between the positive and negative power cables. Any measurable conductivity through the weldhead will severely reduce arc start reliability. The resistance measurement must be greater than 20 MΩ.

A visual inspection should be made to determine the condition of the weldhead, the cable assembly and the cartridge. If there are damaged or worn items, they should be replaced or returned for factory service.

## Potentiometer

The handle contains a trim potentiometer that is located on the Printed Circuit Board. This pot affects the tachometer calibration of the unit and only should be adjusted in the event of a major component change (such as the motor, PCB, etc.)

To adjust the pot:

1. Remove the right cover of the Cable Assembly with Handles.
2. Using the Amphenol Connector, connect the Weldhead to either a CobraTig® 150 or an ACL®.
3. CobraTig® 150:
  - 3.1 Perform a Manual Motor Calibration Test and make sure that the Rotor returns to Home Position. If it does not return to "Home", refer to Troubleshooting section. Otherwise, print the results.
    - 3.1.a Examine the MOTOR gain percentage. If it is  $\pm 0.00\%$ , there is no need to adjust the pot; go to step 5.
    - 3.1.b If the MOTOR gain percentage is  $+0.01\%$  or more (positive), turn the pot approx 1 turn Clockwise for each 10% that it is out of calibration. For example, if the printout reads MOTOR gain percentage =  $+15\%$ ; turn the pot at least 1.5 full turns clockwise. If the printout reads MOTOR gain percentage =  $-0.01\%$  or more (negative), turn the pot approx 1 turn Counter-Clockwise for each 10% that it is out of calibration. For example, if the printout reads MOTOR gain percentage =  $-15\%$  = turn the pot a full 1.5 turns counter-clockwise.
    - 3.1.c Perform another Manual Motor Calibration Test. Print the results and go to step 3.1.a.
4. ACL®:
  - 4.1 Press the [PRINT MENU] button on the HHC or the "P" on the keyboard. This will shift the PRINT MENU on the screen to the front of the others and allow full viewing of all options and functions.
  - 4.2 Perform an Option [5 Calibrate Data] that provides the Motor Calibration results of the latest calibration sequence.
    - 4.2.a Examine the MOTOR gain percentage. If it is  $\pm 0.00\%$ , there is no need to adjust the pot; go to step 5.
    - 4.2.b If the MOTOR gain percentage is  $+0.01\%$  or more (positive), turn the pot approx 1 turn Clockwise for each 10% that it is out of calibration. For example, if the printout reads MOTOR gain percentage =  $+15\%$ ; turn the pot at least 1.5 full turns clockwise. If the printout reads MOTOR gain percentage =  $-0.01\%$  or more (negative), turn the pot approx 1 turn Counter-Clockwise for each 10% that it is out of calibration. For example, if the printout reads MOTOR gain percentage =  $-15\%$  = turn the pot a full 1.5 turns counter-clockwise.
    - 4.2.c Perform another Manual Motor Calibration Test. Print the results and go back to step 4.2.a.
5. The test and calibration of the pot is now complete.

## Weldhead Disassembly

1. Lay the weldhead on a workbench with the latch side up.
2. Remove the screws from the top handle half and remove handle. Once the handle is off, remove the top right motor mount screw.

3. Remove the two screws from the water-return/grounding bar and remove the bar. Some coolant fluid that is in this bar and the side-plate may leak out.
4. Remove the Side Plate Assembly by taking out the six mounting screws.
5. Remove the six screws from the Cover Assembly, lift the cover off and lay it on the bench. Once the cover is off, this will expose the brush plate, reed switch, and gear mechanism of the weldhead.
6. Remove the brush plate and then remove the two small spur gears that make contact with the rotor. Turn the rotor until the rotor opening is at 6 o'clock. Lift the brush plate up slightly and remove the rotor.
7. Loosen the screw that holds the clamp on the reed switch. Note the relative position of the switch. Remove the reed switch by sliding it out of the clamp.
8. Inspect all gears for wear and obstructions. The bevel-slip gear, the main gear and the miter gear (on the motor coupler shaft) are most susceptible to wear and damage.
9. Inspect the gear-motor output shaft for alignment. Inspect the coupler shaft for integrity and inspect each gear bushing for gouging and marks.
10. Clean the weldhead with a denatured alcohol dampened swab. DO NOT IMMERSE any non-metallic parts in any solvent. Wipe the surfaces only as required to remove accumulated dirt and foreign particles.

#### **Weldhead Reassembly**

1. Replace the reed switch; sliding it into the clamp and tightening the clamp screw.
2. Replace all of the gears onto their shafts.
3. Replace the rotor and rotate it so that the opening is at 12 o'clock. Align the brush plate over the rotor and check that the brass tube of the reed switch is not touching the brush plate.
4. Place a small amount of silicon sealant on the face surface of the weldhead cover housing. This will seal any gaps between the pieces when it is assembled.
5. Align the weldhead cover housing with the base. Check the alignment of the pins in the cover with the holes in the brush plate. When the pieces close together with no obstructions, replace the screws and seal.
6. When tightening the screws on the cover, some silicon sealant may be pressed out the sides. Wipe off any excess sealant or wait until it dries and then cut it off.
7. Replace the aluminum side cover.
8. Locate the water-return/grounding bar and inspect the four o-rings. Replace o-rings if necessary. Otherwise coat the o-rings with an o-ring lubricant and replace them between the two aluminum side plates.
9. Perform a Weldhead Calibration to ensure its operation.
10. When the calibration is complete, replace the weldhead handle.

## Section E

### Troubleshooting

#### Arc Start Troubleshooting

*If you experience intermittent arc start problems or strikes to the Collet or Side Plate Clamp instead of the part to be welded, check for the following:*

1. Proper arc gap is an important part of the proper use of your MK Orbital equipment. An improper arc gap can cause errant arc strikes to occur to other places within the weldhead.
2. Be sure that the tungsten is ground properly, (18° included angle and a .015" - .017" flat at the end of the tip). Sharpening should be accomplished with the grind marks parallel to the longitudinal axis of the tungsten, not around the tungsten.
3. Parts must be clean with no oxidation, oils or other insulating surface contaminant.
4. If the tungsten is contaminated at any time, it should be replaced. Dirty tungsten can cause poor arc starts and tungsten inclusions.
5. Make sure that the part to be welded is tight in the Collets, or a loose ground will result. If the part to be welded can be turned in a latched Collet, adjust the Collet plungers accordingly.
6. When using tungsten extenders and holders, be sure that the gap between either of these parts and the Collets is greater than the gap between the tungsten and the tube.
7. Avoid any tooling that might have sharp edges or points or this will cause an arc strike to the Collets or the Side Plate Clamp.
8. To insure reliable arc starting and extended tungsten life, the pre-purge settings should be determined by the size of the tube and weldhead size: the smaller the tube in a given size weldhead; the longer the pre-purge time.
9. If an arc strike occurs to the Collet or Side Plate Clamp, the resulting arc spot may induce future arc strikes. Be sure to smooth out any arc spots with a fine abrasive pad or cover it with appropriate insulating tape.
10. Be sure that there is a tube in the weldhead before trying to make a weld.
11. Insufficient or unstable input-power line-voltage can affect the intensity of the arc start as well as reduce the quality of the weld. When using extension cords with your orbital power supply, use the guidelines from the Maximum Allowable Extension Cord Length chart found in Appendix.
12. The use of a generator as input-power for the orbital welding power supply is generally not recommended. However, if a generator must be utilized, be certain the Volt-Ampere performance is sufficient and that its output operating frequency does not interfere with the orbital power supply digital controller.

#### Operational Troubleshooting

At times, certain pieces of equipment may need to be serviced. Many times the components in question are not easily accessible and necessitate some sort of product disassembly.

Refer to the Weldhead Disassembly section or contact MK Technical Customer Service Department for further troubleshooting and/or instruction.

**Section F**

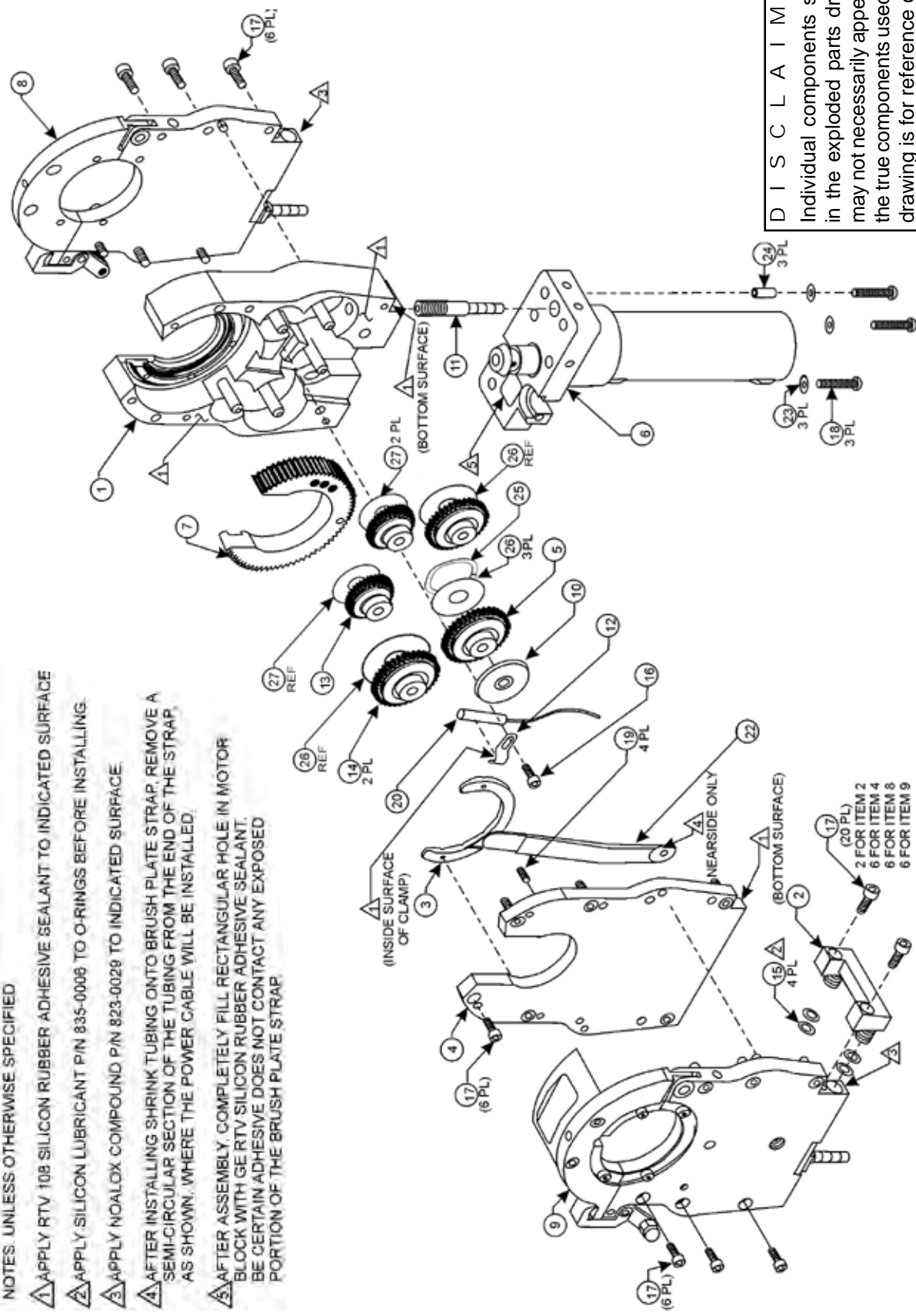
**Drawings**

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# CopperHeads® I-III Head Assembly

**D I S C L A I M E R**  
 Individual components shown in the exploded parts drawing may not necessarily appear like the true components used. This drawing is for reference only.

- NOTES: UNLESS OTHERWISE SPECIFIED**
- ▲ **APPLY RTV 108 SILICON RUBBER ADHESIVE SEALANT TO INDICATED SURFACE**
  - ▲ **APPLY SILICON LUBRICANT P/N 835-0008 TO O-RINGS BEFORE INSTALLING.**
  - ▲ **APPLY NOALOX COMPOUND P/N 823-0029 TO INDICATED SURFACE.**
  - ▲ **AFTER INSTALLING SHRINK TUBING ONTO BRUSH PLATE STRAP, REMOVE A SEMI-CIRCULAR SECTION OF THE TUBING FROM THE END OF THE STRAP AS SHOWN, WHERE THE POWER CABLE WILL BE INSTALLED.**
  - ▲ **AFTER ASSEMBLY, COMPLETELY FILL RECTANGULAR HOLE IN MOTOR BLOCK WITH GE RTV SILICON RUBBER ADHESIVE SEALANT. BE CERTAIN ADHESIVE DOES NOT CONTACT ANY EXPOSED PORTION OF THE BRUSH PLATE STRAP.**

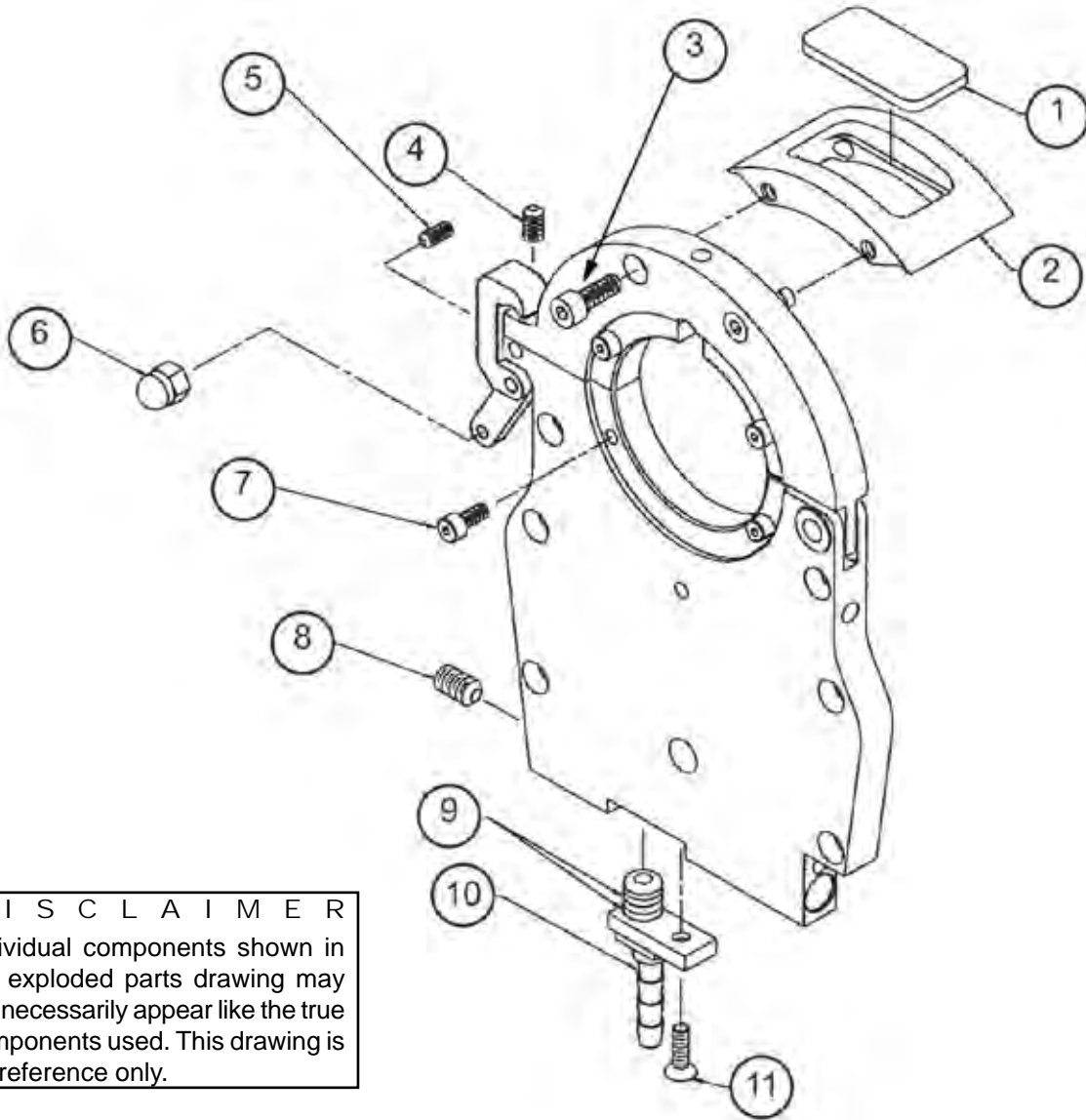




**CopperHead® I-III Assembly**

No.	Qty	Description	COPPERHEAD I	COPPERHEAD II	COPPERHEAD III
1	1	ASSY BASE	005-0720	005-0721	005-0722
2	1	ASSY BRZ BAR GROUND	002-0613	002-0614	002-0612
3	1	ASSY BRUSH PLATE	002-0494	002-0503	002-0506
4	1	ASSY COVER HOUSING	003-2045	003-2052	003-2042
5	1	ASSY MAIN GEAR	003-1366	003-1386	003-1387
6	1	ASSY MOTOR STANDARD	003-1391		003-2058
7	1	ASSY ROTOR	507-0148	507-0228	507-0142
8	1	ASSY SIDE PLATE BASE	003-2048	003-2055	003-2044
9	1	ASSY SIDE PLATE COVER	003-2047	003-2054	003-2043
10	1	ASSY SLIP BEVEL GEAR		507-0143	
11	1	FITTING GAS BARBED		431-1522	
12	1	CLAMP REED SWITCH		435-3893	
13	2	ASSY GEAR	507-0144 (24T)		507-0349 (27T)
14	2	ASSY GEAR	002-0738 (34T)	002-0739 (45T)	002-0740 (59T)
15	4	O-RING 0.176 ID X 0.276 OD		303-0081	
16	1	SCR SHC 4-40 X 1/4 SS		328-0237	
17	20	SCR SHC 6-32 X 3/8 SS		338-0022	
18	3	SCR PN SLOT 4-40 X 3/4 SS		325-0426	
19	*	SPRING COMP 1/8 OD X 17/64LG SST	419-0063 (*QTY 4)	419-0063 (*QTY 5)	419-0063 (*QTY 7)
20	1	SWITCH REED	003-1393	003-1392	
21	-	---	---	---	---
22	0.25 ft	TUBING HT SHRK 3/8 BLK		739-0007	
23	3	WSHR FLAT 0.125 X 0.250 X 0.022 SST		331-0264	
24	3	SLEEVE MOTOR MOUNT		431-1595	
25	1	SPR WAVE 3 WAVE	419-0106 (1.00 DIA)	419-0108 (1.25 DIA)	
26	3	SHIM GEAR	435-1210	435-1203	
27	2	SHIM GEAR BRS		435-1215	

# CopperHead® Side Plate Cover Assembly

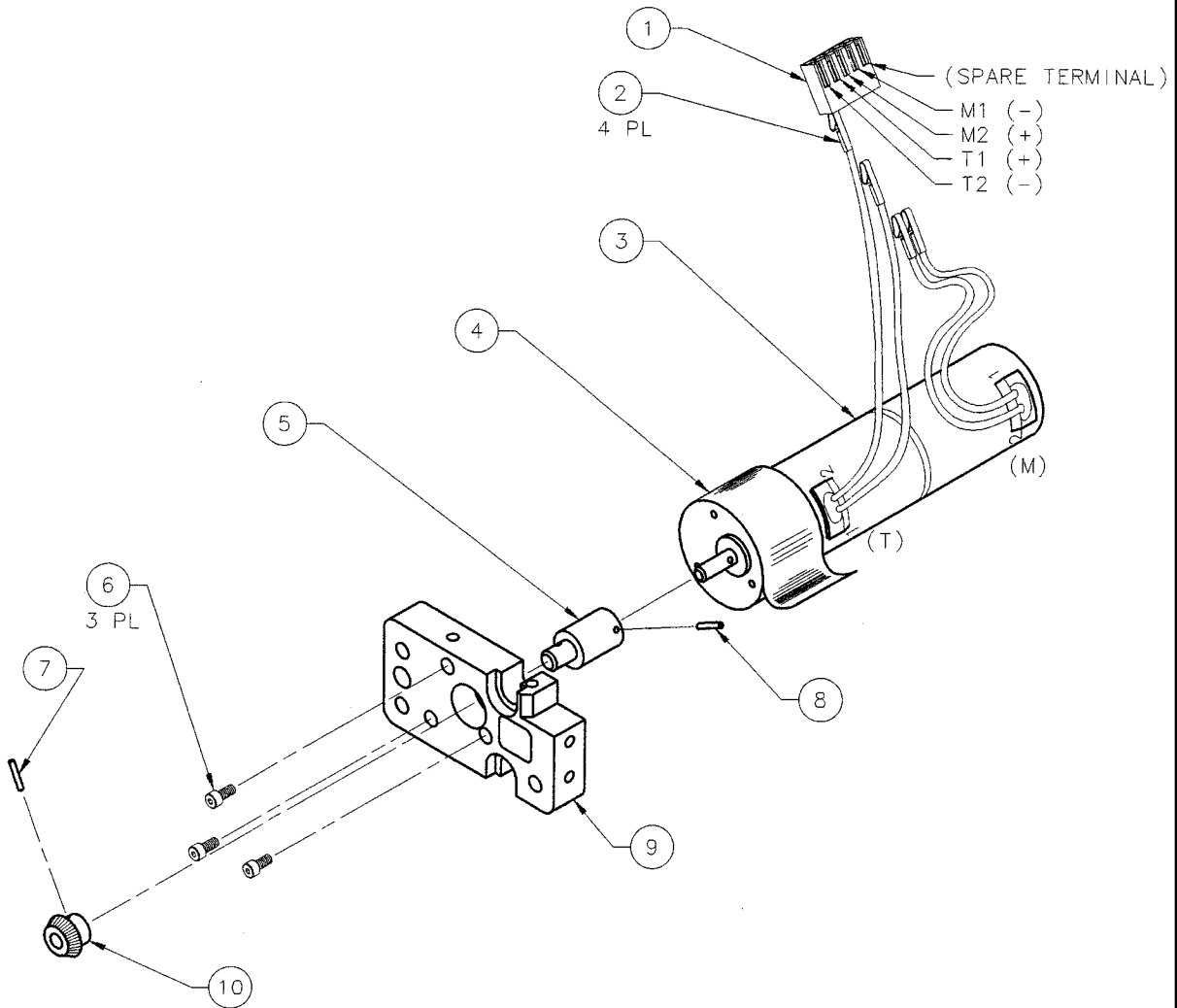


**DISCLAIMER**  
Individual components shown in the exploded parts drawing may not necessarily appear like the true components used. This drawing is for reference only.

Side Plate Cover Assembly					
No.	Qty.	Description	COPPERHEAD I	COPPERHEAD II	COPPERHEAD III
1	1	TINTED WELDING LENS		435-0933	
2	1	TEFLON LENS BEZEL	431-1527	431-1525	431-1526
3	2	SCR 6-32 X 3/8		338-0022	
4	1	SSCR 6-32 X 1/4		321-1266	
5	1	SSCR 4-40 X 1/4 W/NYLON		321-1093	
6	1	NUT CAP 4-40		345-0050	
7	*	SCR 4-40 X 1/4	328-0237 (*QTY 4)	328-0237 (*QTY 6)	
8	1	SET SCR CUP	321-1286 (10-32 x 5/16)		321-1287 (10-32 x 3/8)
9	1	O-RING .176 ID X .050WT		303-0081	
10	1	BARBED WATER CONNECTION		002-0611	
11	1	SCR 4-40 X 3/8		319-0254	

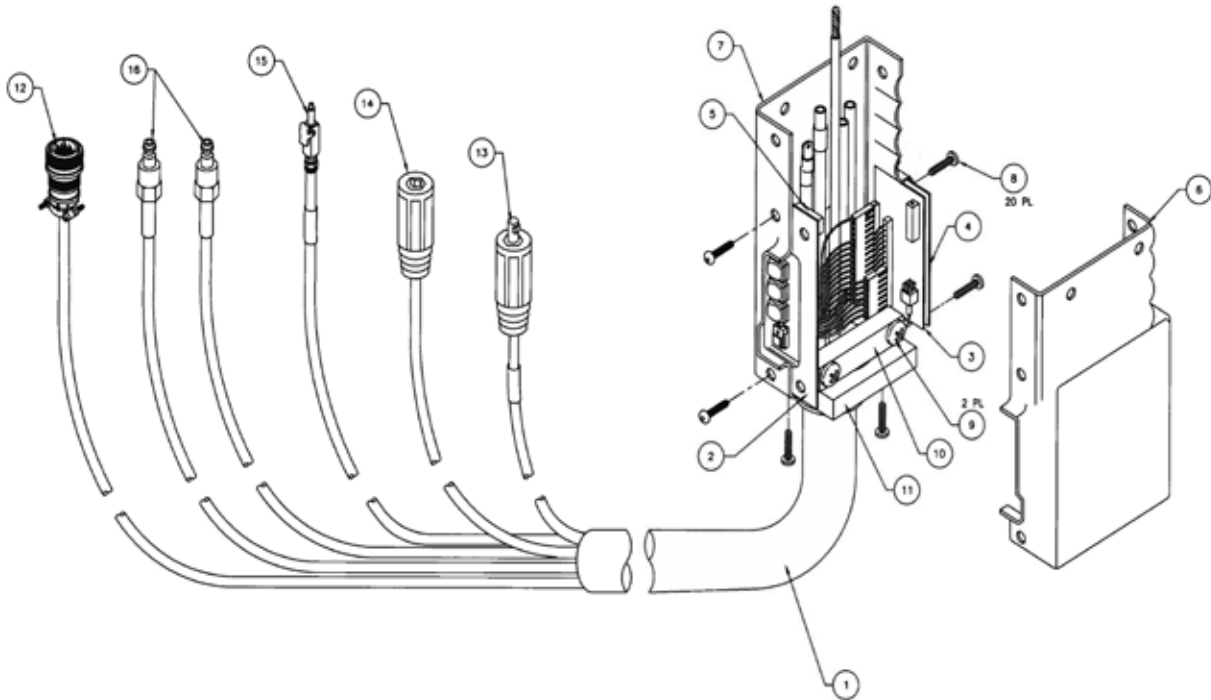
Only those available parts for this assembly are shown in the above table.  
Contact factory for additional information.

# CopperHead® Standard Motor Assembly



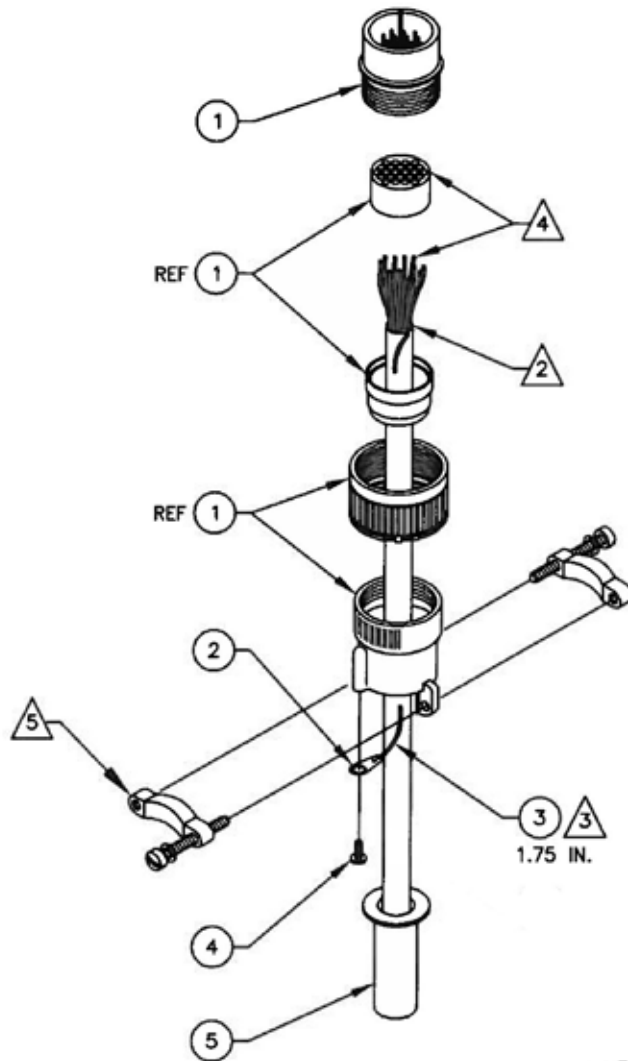
Standard Motor Assembly					
No.	Qty.	Description	COPPERHEAD I	COPPERHEAD II	COPPERHEAD III
1	1	CON HSG RECPT 5POS 0.156CTRS		153-0008	
2	4	TERM CRIMP FEMALE 18-24GA		153-0304	
3	1	MOTOR MODIFIED WELDHEAD		211-0066	
4	0.5 FT	TAPE KAPTON		261-0518	
5	1	SHAFT COUPLER	311-0002		311-0008
6	3	SCR SHC 4-40 X 1/4 SST		328-0237	
7	1	PIN SPRING 0.063 X 0.375		421-0128	
8	1	PIN SPRING 0.063 X 0.437		421-0129	
9	1	BLOCK MOTOR MOUNT	431-0802		431-4013
10	1	GEAR MITTER 32T		507-0147	

# CopperHead® Cable Assembly with Handles 003-2050



Cable Assembly with Handles			
No.	Qty.	Part No.	Description
1	1	931-0122	SNAKE SKIN 25 FT
2	1	003-1389	SWITCH PLATE ASSY, WELDHEAD CABLE
3	1	003-1390	PC BOARD STD ASSY, WELDHEAD
4	1	261-0615	INSULATOR PC BOARD, WELDHEAD
5	2	435-0931	THREADED PLATE (SMALL)
6	1	437-0189	HANDLE CABLE, RIGHT WELDHEAD
7	1	437-0190	HANDLE CABLE, LEFT WELDHEAD
8	20	320-0085	SCR B SKT 6-32 X 1/4 SS
9	2	336-0064	SCREW PANHEAD PHIL 6-32 X 3/4 ST
10	1	411-0197	CLAMP CABLE STRAIN RELIEF
11	1	411-0196	STRAIN RELIEF
12	1	003-1396	ASSY CABLE CONTROLLER
13	1	843-0691	ASSY CBL POWER ELECTRODE
14	1	843-0690	ASSY CBL POWER GROUND
15	1	552-0221	ASSY HOSE GAS 25 FT
16	2	552-0220	ASSY HOSE WATER 25 FT

# CopperHead® 24 Pin Standard Cable Sub Assembly 003-1396

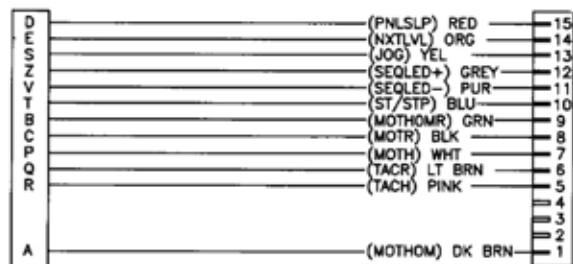


## Wire Table & Functions

- REVERSE GROUNDED SIDE OF CLAMP TO PREVENT CABLE MOVEMENT.
  - FEED WIRE THROUGH APPROPRIATE HOLES STRIP 1/4" FOR SOLDERING TO TERMINAL
  - PUT SHRINK TUBING ON BARE GROUND WIRE BEFORE SOLDERING TO ITEM #2 (185-0384).
  - STRIP CABLE CASING 2". PUT BUSHING, CABLE CLAMP, THREADED RING AND PLASTIC INSERT ON BEFORE SOLDERING.
- DO NOT SCREW TOGETHER UNTIL IN-PROCESS INSPECTION IS COMPLETED.

NOTES: UNLESS OTHERWISE SPECIFIED

## WIRING DIAGRAM



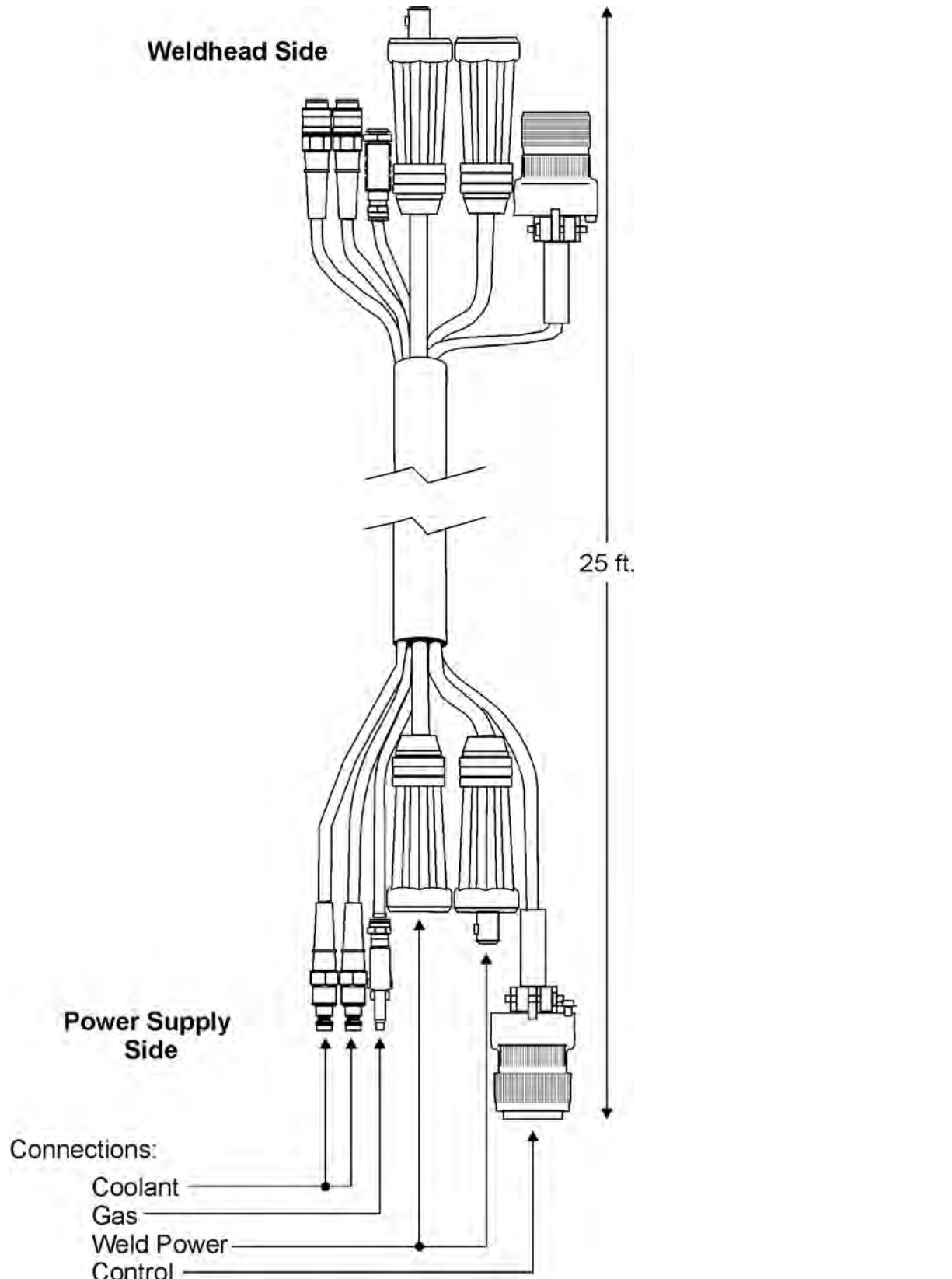
## 24 Pin Standard Cable Sub Assembly

No.	Qty.	Part No.	Description
1	1	153-0556	PLUG, 24P, SHELL 24
2	1	185-0384	WASHER, LOCK, TERMINAL #6
3	0.15 FT	739-0002	TUBING, HEAT SHRINK 1/16"
4	1	336-0013	SCREW, 6-32 X 1/4"
5	1	301-0059	BUSHING, CABLE AMP #8

# CopperHead® Extension Cable Assembly

005-0635 (25 ft Extension)  
005-0635-50 (50 ft Extension)

The maximum length between the weldhead and the power supply is 75 feet (two Extension Cables.)

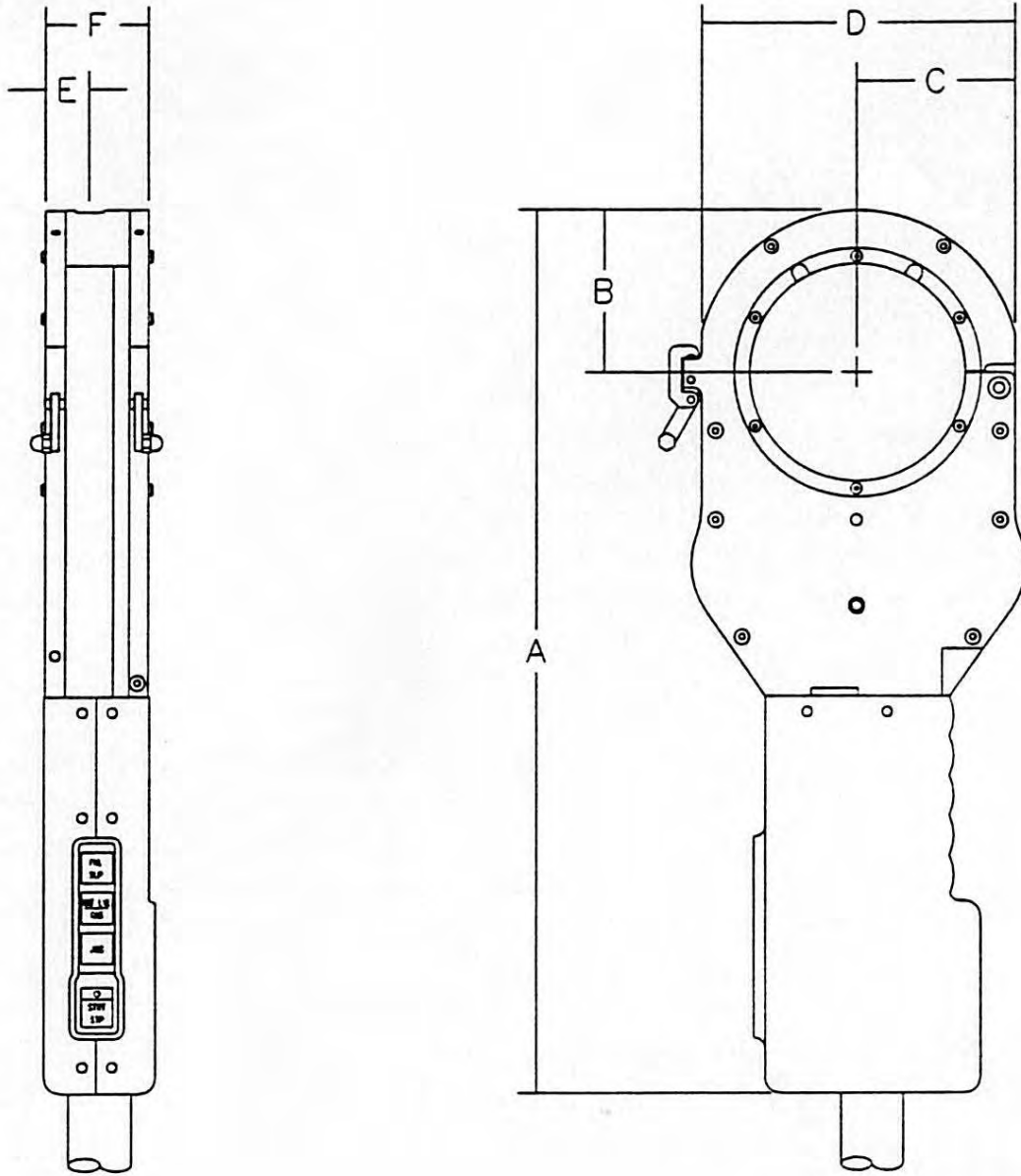


## Section G

### Appendixes

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Appendix A  
CopperHead® Reference Dimensions



Dimension Reference (in.)						
Model	A	B	C	D	E	F
5001	11.5	1.50	1.48	2.96	0.67	1.62
5002	13.20	2.20	2.05	4.10	0.67	1.62
5003	14.18	2.62	2.54	5.08	0.67	1.62



## Appendix B Limitations on Allowable Extension Cord Length

<b>Cord Lengths for 120 Volt Loads</b>							
If unit does not have GFCI receptacles, use GFCI-protected extension cord.							
Current (amps)	Load (Watts)	Maximum Allowable Cord Length in ft. (m) for Conductor Size (AWG)*					
		4	6	8	10	12	14
5	600			350 (106)	225 (68)	137 (42)	100 (30)
7	840		400 (122)	250 (76)	150 (46)	100 (30)	62 (19)
10	1200	400 (122)	275 (84)	175 (53)	112 (34)	62 (19)	50 (15)
15	1800	300 (91)	175 (53)	112 (34)	75 (23)	37 (11)	30 (9)
20	2400	225 (68)	137 (42)	87 (26)	50 (15)	30 (9)	
25	3000	175 (53)	112 (34)	62 (19)	37 (11)		
30	3600	150 (46)	87 (26)	50 (15)	37 (11)		
35	4200	125 (38)	75 (23)	50 (15)			
40	4800	112 (34)	62 (19)	37 (11)			
45	5400	100 (30)	62 (19)				
50	6000	87 (26)	50 (15)				

\* Conductor size is based on maximum 2% voltage drop across length

<b>Cord Lengths for 240 Volt Loads</b>							
If unit does not have GFCI receptacles, use GFCI-protected extension cord.							
Current (amps)	Load (Watts)	Maximum Allowable Cord Length in ft. (m) for Conductor Size (AWG)*					
		4	6	8	10	12	14
5	1200			700 (213)	450 (137)	225 (84)	200 (61)
7	1680		800 (244)	500 (152)	300 (91)	200 (61)	125 (38)
10	2400	800 (244)	550 (168)	350 (107)	225 (69)	125 (38)	100 (31)
15	3600	600 (183)	350 (107)	225 (69)	150 (46)	75 (23)	60 (18)
20	4800	450 (137)	275 (84)	175 (53)	100 (31)	60 (18)	
25	6000	350 (107)	225 (69)	125 (38)	75 (23)		
30	7000	300 (91)	175 (53)	100 (31)	75 (23)		
35	8400	250 (76)	150 (46)	100 (31)			
40	9600	225 (69)	125 (38)	75 (23)			
45	10,800	200 (61)	125 (38)				
50	12,000	175 (53)	100 (31)				

\* Conductor size is based on maximum 2% voltage drop across length

## Appendix C Collets

Part #	Description	Part #	Description
<b>5001 CopperHead®</b>		<b>5002 CopperHead®</b>	
328-0237	SCR SHC 4-40X1/4 SS	328-0237	SCR SHC 4-40X1/4 SS
623-0151	COL 5001 FLS BLANK	623-0152	COL 5002 FLS BLANK
623-0110-0.125	COL 5001 FLS 1/8 IN OD	623-0210-0.250	COL 5002 FLS 1/4 IN OD
623-0110-0.188	COL 5001 FLS 3/16 IN OD	623-0210-0.313	COL 5002 FLS 5/16 IN OD
623-0110-0.250	COL 5001 FLS 1/4 IN OD	623-0210-0.375	COL 5002 FLS 3/8 IN OD
623-0110-0.313	COL 5001 FLS 5/16 IN OD	623-0210-0.500	COL 5002 FLS 1/2 IN OD
623-0110-0.375	COL 5001 FLS 3/8 IN OD	623-0210-0.625	COL 5002 FLS 5/8 IN OD
623-0110-0.500	COL 5001 FLS 1/2 IN OD	623-0210-0.750	COL 5002 FLS 3/4 IN OD
623-0110-0.625	COL 5001 FLS 5/8 IN OD	623-0210-0.875	COL 5002 FLS 7/8 IN OD
623-0110-0.750	COL 5001 FLS 3/4 IN OD	623-0210-1.000	COL 5002 FLS 1 IN OD
623-0110-0.875	COL 5001 FLS 7/8 IN OD	623-0210-1.250	COL 5002 FLS 1-1/4 IN OD
623-0110-0.938	COL 5001 FLS 15/16 IN OD	623-0210-1.500	COL 5002 FLS 1-1/2 IN OD
623-0110-1.000	COL 5001 FLS 1 IN OD	623-0210-1.750	COL 5002 FLS 1-3/4 IN OD
623-0110-1/2NP	COL 5001 FLS 1/2 IN NP	623-0210-1.875	COL 5002 FLS 1-7/8 IN OD
623-0110-1/4NP	COL 5001 FLS 1/4 IN NP	623-0210-1/2NP	COL 5002 FLS 1/2 IN NP
623-0110-1/8NP	COL 5001 FLS 1/8 IN NP	623-0210-1/4NP	COL 5002 FLS 1/4 IN NP
623-0110-3/8NP	COL 5001 FLS 3/8 IN NP	623-0210-1/8NP	COL 5002 FLS 1/8 IN NP
623-0110-10.0MM	COL 5001 FLS 10.0 MM OD	623-0210-1-1/2NP	COL 5002 FLS 1-1/2 IN NP
623-0110-10.2MM	COL 5001 FLS 10.2 MM OD	623-0210-1-1/4NP	COL 5002 FLS 1-1/4 IN NP
623-0110-12.0MM	COL 5001 FLS 12.0 MM OD	623-0210-1NP	COL 5002 FLS 1 IN NP
623-0110-13.5MM	COL 5001 FLS 13.5 MM OD	623-0210-2.000	COL 5002 FLS 2 IN OD
623-0110-14.0MM	COL 5001 FLS 14.0 MM OD	623-0210-3/4NP	COL 5002 FLS 3/4 IN NP
623-0110-15.0MM	COL 5001 FLS 15.0 MM OD	623-0210-3/8NP	COL 5002 FLS 3/8 IN NP
623-0110-16.0MM	COL 5001 FLS 16.0 MM OD	623-0210-10.0MM	COL 5002 FLS 10.0MM OD
623-0110-16.5MM	COL 5001 FLS 16.5 MM OD	623-0210-10.2MM	COL 5002 FLS 10.2 MM OD
623-0110-17.2MM	COL 5001 FLS 17.2 MM OD	623-0210-12.0MM	COL 5002 FLS 12.0 MM OD
623-0110-18.0MM	COL 5001 FLS 18.0 MM OD	623-0210-13.5MM	COL 5002 FLS 13.5 MM OD
623-0110-19.1MM	COL 5001 FLS 19.1 MM OD	623-0210-14.0MM	COL 5002 FLS 14.0 MM OD
623-0110-20.0MM	COL 5001 FLS 20.0 MM OD	623-0210-14.33MM	COL 5002 FLS 14.33MM OD
623-0110-21.3MM	COL 5001 FLS 21.3 MM OD	623-0210-14.5MM	COL 5002 FLS 14.5MM OD
623-0110-23.0MM	COL 5001 FLS 23.0 MM OD	623-0210-15.0MM	COL 5002 FLS 15.0 MM OD
623-0110-25.0MM	COL 5001 FLS 25.0 MM OD	623-0210-16.0MM	COL 5002 FLS 16.0 MM OD
623-0110-6.0MM	COL 5001 FLS 6.0 MM OD	623-0210-16.5MM	COL 5002 FLS 16.5MM OD
623-0110-8.0MM	COL 5001 FLS 8.0 MM OD	623-0210-17.2MM	COL 5002 FLS 17.2 MM OD
<b>Extended Collets</b>		623-0210-18.0MM	COL 5002 FLS 18.0 MM OD
624-0161	COL 5001 EXT BLANK	623-0210-20.0MM	COL 5002 FLS 20.0 MM OD
624-0110-0.125	COL 5001 EXT 1/8 IN OD	623-0210-21.2MM	COL 5002 FLS 21.2MM OD
624-0110-0.188	COL 5001 EXT 3/16 IN OD	623-0210-21.3MM	COL 5002 FLS 21.3 MM OD
624-0110-0.250	COL 5001 EXT 1/4 IN OD	623-0210-21.4MM	COL 5002 FLS 21.4MM OD
624-0110-0.313	COL 5001 EXT 5/16 IN OD	623-0210-22.4MM	COL 5002 FLS 22.4MM OD
624-0110-0.375	COL 5001 EXT 3/8 IN OD	623-0210-23.0MM	COL 5002 FLS 23.0 MM OD
624-0110-0.500	COL 5001 EXT 1/2 IN OD	623-0210-25.0MM	COL 5002 FLS 25.0 MM OD
624-0110-0.625	COL 5001 EXT 5/8 IN OD	623-0210-26.0MM	COL 5002 FLS 26.0 MM OD
624-0110-0.750	COL 5001 EXT 3/4 IN OD	623-0210-26.9MM	COL 5002 FLS 26.9 MM OD
624-0110-0.875	COL 5001 EXT 7/8 IN OD	623-0210-28.0MM	COL 5002 FLS 28.0 MM OD
624-0110-0.938	COL 5001 EXT 15/16 IN OD	623-0210-30.0MM	COL 5002 FLS 30.0 MM OD
624-0110-1.000	COL 5001 EXT 1 IN OD	623-0210-32.0MM	COL 5002 FLS 32.0 MM OD
624-0110-1/2NP	COL 5001 EXT 1/2 IN NP	623-0210-33.7MM	COL 5002 FLS 33.7 MM OD
624-0110-1/4NP	COL 5001 EXT 1/4 IN NP	623-0210-35.0MM	COL 5002 FLS 35.0 MM OD
624-0110-1/8NP	COL 5001 EXT 1/8 IN NP	623-0210-36.0MM	COL 5002 FLS 36.0MM OD
624-0110-3/8NP	COL 5001 EXT 3/8 IN NP	623-0210-36.5MM	COL 5002 FLS 36.5MM OD
624-0110-6.0MM	COL 5001 EXT 6.0 MM OD	623-0210-38.0MM	COL 5002 FLS 38.0 MM OD
624-0110-8.0MM	COL 5001 EXT 8.0 MM OD	623-0210-40.0MM	COL 5002 FLS 40.0 MM OD
624-0110-10.0MM	COL 5001 EXT 10.0 MM OD	623-0210-42.4MM	COL 5002 FLS 42.4 MM OD
624-0110-10.2MM	COL 5001 EXT 10.2 MM OD	623-0210-43.0MM	COL 5002 FLS 43.0 MM OD
624-0110-12.0MM	COL 5001 EXT 12.0 MM OD	623-0210-44.0MM	COL 5002 FLS 44.0MM OD
624-0110-13.5MM	COL 5001 EXT 13.5 MM OD	623-0210-44.5MM	COL 5002 FLS 44.5 MM OD
624-0110-14.0MM	COL 5001 EXT 14.0 MM OD	623-0210-45.1MM	COL 5002 FLS 45.1MM OD
624-0110-15.0MM	COL 5001 EXT 15.0 MM OD	623-0210-48.3MM	COL 5002 FLS 48.3 MM OD
624-0110-16.0MM	COL 5001 EXT 16.0 MM OD	623-0210-5.1MM	COL 5002 FLS 5.1MM OD
624-0110-16.5MM	COL 5001 EXT 16.5 MM OD	623-0210-6.0MM	COL 5002 FLS 6.0MM OD
624-0110-17.2MM	COL 5001 EXT 17.2 MM OD	623-0210-6.6MM	COL 5002 FLS 6.6MM OD
624-0110-18.0MM	COL 5001 EXT 18.0 MM OD	623-0210-8.0MM	COL 5002 FLS 8.0MM OD
624-0110-20.0MM	COL 5001 EXT 20.0 MM OD	624-0210-10.2MM	COL 5002 FLS 10.2 MM OD
624-0110-21.3MM	COL 5001 EXT 21.3 MM OD	<b>Extended Collets</b>	
624-0110-23.0MM	COL 5001 EXT 23.0 MM OD	624-0210-0.313	COL 5002 EXT 5/16 IN OD
		624-0210-0.375	COL 5002 EXT 3/8 IN OD
		624-0210-0.500	COL 5002 EXT 1/2 IN OD

## Appendix C Collets

Part #	Description	Part #	Description
624-0210-0.625	COL 5002 EXT 5/8IN OD	623-0310-2.000	COL 5003 FLS 2 IN OD
624-0210-0.750	COL 5002 EXT 3/4IN OD	623-0310-2.250	COL 5003 FLS 2-1/4 IN OD
624-0210-0.875	COL 5002 EXT 7/8IN OD	623-0310-2.500	COL 5003 FLS 2-1/2 IN OD
624-0210-1.000	COL 5002 EXT 1 IN OD	623-0310-2.750	COL 5003 FLS 2-3/4 IN OD
624-0210-1.250	COL 5002 EXT 1-1/4 IN OD	623-0310-3.000	COL 5003 FLS 3 IN OD
624-0210-1.500	COL 5002 EXT 1-1/2 IN OD	623-0310-1/2NP	COL 5003 FLS 1/2 IN NP
624-0210-1.750	COL 5002 EXT 1-3/4 IN OD	623-0310-1/4NP	COL 5003 FLS 1/4 IN NP
624-0210-1.875	COL 5002 EXT 1-7/8 IN OD	623-0310-1-1/2NP	COL 5003 FLS 1-1/2 IN NP
624-0210-2.000	COL 5002 EXT 2 IN OD	623-0310-1-1/4NP	COL 5003 FLS 1-1/4 IN NP
624-0210-1/2NP	COL 5002 EXT 1/2 IN NP	623-0310-1NP	COL 5003 FLS 1 IN NP
624-0210-1/4NP	COL 5002 EXT 1/4 IN NP	623-0310-2NP	COL 5003 FLS 2 IN NP
624-0210-1/8NP	COL 5002 EXT 1/8 IN NP	623-0310-3/4NP	COL 5003 FLS 3/4 IN NP
624-0210-1-1/2NP	COL 5002 EXT 1-1/2 IN NP	623-0310-3/8NP	COL 5003 FLS 3/8 IN NP
624-0210-1-1/4NP	COL 5002 EXT 1-1/4 IN NP	623-0310-13.5MM	COL 5003 FLS 13.5 MM OD
624-0210-1NP	COL 5002 EXT 1 IN NP	623-0310-14.0MM	COL 5003 FLS 14.0 MM OD
624-0210-3/4NP	COL 5002 EXT 3/4 IN NP	623-0310-15.0MM	COL 5003 FLS 15.0 MM OD
624-0210-3/8NP	COL 5002 EXT 3/8 IN NP	623-0310-16.0MM	COL 5003 FLS 16.0 MM OD
<b>Extended Collets (MM)</b>			
624-0210-10.0MM	COL 5002 EXT 10.0MM OD	623-0310-17.2MM	COL 5003 FLS 17.2 MM OD
624-0210-12.0MM	COL 5002 EXT 12.0 MM OD	623-0310-18.0MM	COL 5003 FLS 18.0 MM OD
624-0210-13.5MM	COL 5002 EXT 13.5 MM OD	623-0310-20.0MM	COL 5003 FLS 20.0 MM OD
624-0210-14.0MM	COL 5002 EXT 14.0 MM OD	623-0310-21.3MM	COL 5003 FLS 21.3 MM OD
624-0210-15.0MM	COL 5002 EXT 15.0 MM OD	623-0310-2-1/2NP	COL 5003 FLS 2-1/2 IN NP
624-0210-16.0MM	COL 5002 EXT 16.0 MM OD	623-0310-23.0MM	COL 5003 FLS 23.0 MM OD
624-0210-17.2MM	COL 5002 EXT 17.2 MM OD	623-0310-26.0MM	COL 5003 FLS 26.0 MM OD
624-0210-18.0MM	COL 5002 EXT 18.0 MM OD	623-0310-26.9MM	COL 5003 FLS 26.9 MM OD
624-0210-20.0MM	COL 5002 EXT 20.0 MM OD	623-0310-28.0MM	COL 5003 FLS 28.0 MM OD
624-0210-21.2MM	COL 5002 EXT 21.2 MM OD	623-0310-30.0MM	COL 5003 FLS 30.0 MM OD
624-0210-21.3MM	COL 5002 EXT 21.3 MM OD	623-0310-32.0MM	COL 5003 FLS 32.0 MM OD
624-0210-22.4MM	COL 5002 EXT 22.4 MM OD	623-0310-33.7MM	COL 5003 FLS 33.7 MM OD
624-0210-23.0MM	COL 5002 EXT 23.0 MM OD	623-0310-35.0MM	COL 5003 FLS 35.0 MM OD
624-0210-25.0MM	COL 5002 EXT 25.0 MM OD	623-0310-38.0MM	COL 5003 FLS 38.0 MM OD
624-0210-26.0MM	COL 5002 EXT 26.0 MM OD	623-0310-40.0MM	COL 5003 FLS 40.0 MM OD
624-0210-26.9MM	COL 5002 EXT 26.9 MM OD	623-0310-42.4MM	COL 5003 FLS 42.4 MM OD
624-0210-28.0MM	COL 5002 EXT 28.0 MM OD	623-0310-43.0MM	COL 5003 FLS 43.0 MM OD
624-0210-30.0MM	COL 5002 EXT 30.0 MM OD	623-0310-44.0MM	COL 5003 FLS 44.0 MM OD
624-0210-32.0MM	COL 5002 EXT 32.0 MM OD	623-0310-44.5MM	COL 5003 FLS 44.5 MM OD
624-0210-33.7MM	COL 5002 EXT 33.7 MM OD	623-0310-48.3MM	COL 5003 FLS 48.3 MM OD
624-0210-35.0MM	COL 5002 EXT 35.0 MM OD	623-0310-51.0MM	COL 5003 FLS 51.0 MM OD
624-0210-36.0MM	COL 5002 EXT 36.0 MM OD	623-0310-53.0MM	COL 5003 FLS 53.0 MM OD
624-0210-36.5MM	COL 5002 EXT 36.5 MM OD	623-0310-54.0MM	COL 5003 FLS 54.0 MM OD
624-0210-38.0MM	COL 5002 EXT 38.0 MM OD	623-0310-57.0MM	COL 5003 FLS 57.0 MM OD
624-0210-40.0MM	COL 5002 EXT 40.0 MM OD	623-0310-60.3MM	COL 5003 FLS 60.3 MM OD
624-0210-42.4MM	COL 5002 EXT 42.4 MM OD	623-0310-63.5MM	COL 5003 FLS 63.5 MM OD
624-0210-43.0MM	COL 5002 EXT 43.0 MM OD	623-0310-68.0MM	COL 5003 FLS 68.0 MM OD
624-0210-44.0MM	COL 5002 EXT 44.0 MM OD	623-0310-70.0MM	COL 5003 FLS 70.0 MM OD
624-0210-44.5MM	COL 5002 EXT 44.5 MM OD	623-0310-76.1MM	COL 5003 FLS 76.1 MM OD
624-0210-45.1MM	COL 5002 EXT 45.1 MM OD	<b>Extended Collets</b>	
624-0210-48.3MM	COL 5002 EXT 48.3 MM OD	624-0163	COL 5003 EXT BLANK
624-0210-8.0MM	COL 5002 EXT 8.0MM OD	624-0310-0.313	COL 5003 EXT 5/16 IN OD
<b>5003 CopperHead®</b>			
328-0237	SCR SHC 4-40X1/4 SS	624-0310-0.500	COL 5003 EXT 1/2 IN OD
623-0153	COL 5003 FLS BLANK	624-0310-0.625	COL 5003 EXT 5/8 IN OD
623-0310-0.313	COL 5003 FLS 5/16 IN OD	624-0310-0.750	COL 5003 EXT 3/4 IN OD
623-0310-0.500	COL 5003 FLS 1/2 IN OD	624-0310-0.800	COL 5003 EXT 0.800 IN OD
623-0310-0.625	COL 5003 FLS 5/8 IN OD	624-0310-0.830	COL 5003 EXT 0.830 IN OD
623-0310-0.750	COL 5003 FLS 3/4 IN OD	624-0310-0.875	COL 5003 EXT 7/8 IN OD
623-0310-0.800	COL 5003 FLS 0.800 IN OD	624-0310-0.910	COL 5003 EXT 0.910 IN OD
623-0310-0.830	COL 5003 FLS 0.830 IN OD	624-0310-0.955	COL 5003 EXT 0.955 IN OD
623-0310-0.875	COL 5003 FLS 7/8 IN OD	624-0310-1.000	COL 5003 EXT 1 IN OD
623-0310-0.910	COL 5003 FLS 0.910 IN OD	624-0310-1.250	COL 5003 EXT 1-1/4 IN OD
623-0310-0.955	COL 5003 FLS 0.955 IN OD	624-0310-1.500	COL 5003 EXT 1-1/2 IN OD
623-0310-1.000	COL 5003 FLS 1 IN OD	624-0310-1.750	COL 5003 EXT 1-3/4 IN OD
623-0310-1.125	COL 5003 FLS 1-1/8 IN OD	624-0310-1.875	COL 5003 EXT 1-7/8 IN OD
623-0310-1.250	COL 5003 FLS 1-1/4 IN OD	624-0310-2.000	COL 5003 EXT 2 IN OD
623-0310-1.375	COL 5003 FLS 1-3/8 IN OD	624-0310-2.250	COL 5003 EXT 2-1/4 IN OD
623-0310-1.500	COL 5003 FLS 1-1/2 IN OD	624-0310-2.500	COL 5003 EXT 2-1/2 IN OD
623-0310-1.750	COL 5003 FLS 1-3/4 IN OD	624-0310-2.750	COL 5003 EXT 2-3/4 IN OD
623-0310-1.875	COL 5003 FLS 1-7/8 IN OD	624-0310-3.000	COL 5003 EXT 3 IN OD
		624-0310-3.188	COL 5003 EXT 3-3/16 IN OD
		624-0310-1NP	COL 5003 EXT 1 IN NP
		624-0310-2NP	COL 5003 EXT 2 IN NP

Part #	Description	Diameter	Description	Part #
624-0310-3/4NP	COL 5003 EXT 3/4 IN NP			
624-0310-3/8NP	COL 5003 EXT 3/8 IN NP			
624-0310-1/2NP	COL 5003 EXT 1/2 IN NP			
624-0310-1/4NP	COL 5003 EXT 1/4 IN NP			
624-0310-1-1/2NP	COL 5003 EXT 1-1/2 IN NP			
624-0310-1-1/4NP	COL 5003 EXT 1-1/4 IN NP			
624-0310-2-1/2NP	COL 5003 EXT 2-1/2 IN NP			
<b>Extended Collets (MM)</b>				
624-0310-13.5MM	COL 5003 EXT 13.5 MM OD			
624-0310-14.0MM	COL 5003 EXT 14.0 MM OD			
624-0310-15.0MM	COL 5003 EXT 15.0 MM OD			
624-0310-16.0MM	COL 5003 EXT 16.0 MM OD			
624-0310-17.2MM	COL 5003 EXT 17.2 MM OD			
624-0310-18.0MM	COL 5003 EXT 18.0 MM OD			
624-0310-20.0MM	COL 5003 EXT 20.0 MM OD			
624-0310-21.3MM	COL 5003 EXT 21.3 MM OD			
624-0310-23.0MM	COL 5003 EXT 23.0 MM OD			
624-0310-26.0MM	COL 5003 EXT 26.0 MM OD			
624-0310-26.9MM	COL 5003 EXT 26.9 MM OD			
624-0310-28.0MM	COL 5003 EXT 28.0 MM OD			
624-0310-30.0MM	COL 5003 EXT 30.0 MM OD			
624-0310-32.0MM	COL 5003 EXT 32.0 MM OD			
624-0310-33.7MM	COL 5003 EXT 33.7 MM OD			
624-0310-35.0MM	COL 5003 EXT 35.0 MM OD			
624-0310-38.0MM	COL 5003 EXT 38.0 MM OD			
624-0310-40.0MM	COL 5003 EXT 40.0 MM OD			
624-0310-42.4MM	COL 5003 EXT 42.4 MM OD			
624-0310-43.0MM	COL 5003 EXT 43.0 MM OD			
624-0310-44.0MM	COL 5003 EXT 44.0 MM OD			
624-0310-44.5MM	COL 5003 EXT 44.5 MM OD			
624-0310-48.3MM	COL 5003 EXT 48.3 MM OD			
624-0310-51.0MM	COL 5003 EXT 51.0 MM OD			
624-0310-53.0MM	COL 5003 EXT 53.0 MM OD			
624-0310-54.0MM	COL 5003 EXT 54.0 MM OD			
624-0310-57.0MM	COL 5003 EXT 57.0 MM OD			
624-0310-60.3MM	COL 5003 EXT 60.3 MM OD			
624-0310-63.5MM	COL 5003 EXT 63.5 MM OD			
624-0310-68.0MM	COL 5003 EXT 68.0 MM OD			
624-0310-70.0MM	COL 5003 EXT 70.0 MM OD			
624-0310-76.1MM	COL 5003 EXT 76.1 MM OD			
626-0503	COL 5003 SFER 1&1-1/2 IN			
<b>APPENDIX D - LOCATING MANDRELS</b>				
025-0025	LOCATING MANDREL 1/4			
025-0026	LOCATING MANDREL 5/16			
025-0027	LOCATING MANDREL 3/8			
025-0028	LOCATING MANDREL 1/2			
025-0029	LOCATING MANDREL 5/8			
025-0030	LOCATING MANDREL 3/4			
025-0031	LOCATING MANDREL 1.00			
025-0036	LOCATING MANDREL 1/8			
025-0038	LOCATING MANDREL 3/16			
025-0039	LOCATING MANDREL 7/8			
025-0040	LOCATING MANDREL 1 1/2			
025-0041	LOCATING MANDREL 2			
025-0042	LOCATING MANDREL 2 1/2			
025-0045	LOCATING MANDREL 1 1/8			
025-0048	LOCATING MANDREL 1 1/4			
025-0050	LOCATING MANDREL 1 3/8			
025-0051	LOCATING MANDREL 1 5/8			
025-0052	LOCATING MANDREL 1 3/4			
025-0059	LOCATING MANDREL 2 1/4			
025-0063	LOCATING MANDREL 2 3/4			
025-0065	LOCATING MANDREL 3.00			
025-0078	LOCATING MANDREL 4.00			
<b>APPENDIX E - TUNGSTEN ELECTRODES</b>				
<b>5001 CopperHead®</b>				
1/8	TUNG 040 5001 1/8 OD			635-040-0.984
3/16	TUNG 040 5001 3/16 OD			635-040-0.953
1/4	TUNG 040 5001 1/4 OD			635-040-0.922
5/16	TUNG 040 5001 5/16 OD			635-040-0.891
3/8	TUNG 040 5001 3/8 OD			635-040-0.859
1/2	TUNG 040 5001 1/2 OD			635-040-0.797
5/8	TUNG 040 5001 5/8 OD			635-040-0.734
3/4	TUNG 040 5001 3/4 OD			635-040-0.672
7/8	TUNG 040 5001 7/8 OD			635-040-0.609
15/16	TUNG 040 5001 15/16 OD			635-040-0.578
1	TUNG 040 5001 1 OD			635-040-0.547
1/8 NP	TUNG 040 5001 1/8 NP			635-040-0.844
1/4 NP	TUNG 040 5001 1/4 NP			635-040-0.766
3/8 NP	TUNG 040 5001 3/8 NP			635-040-0.703
1/2 NP	TUNG 040 5001 1/2 NP			635-040-0.625
6.0 MM	TUNG 040 5001 6.0 MM OD			635-040-0.922
8.0 MM	TUNG 040 5001 8.0 MM OD			635-040-0.891
10.0 MM	TUNG 040 5001 10.0 MM OD			635-040-0.844
10.2 MM	TUNG 040 5001 10.2 MM OD			635-040-0.844
12.0 MM	TUNG 040 5001 12.0 MM OD			635-040-0.813
13.5 MM	TUNG 040 5001 13.5 MM OD			635-040-0.781
14.0 MM	TUNG 040 5001 14.0 MM OD			635-040-0.766
15.0 MM	TUNG 040 5001 15.0 MM OD			635-040-0.750
16.0 MM	TUNG 040 5001 16.0 MM OD			635-040-0.734
16.5 MM	TUNG 040 5001 16.5 MM OD			635-040-0.719
17.2 MM	TUNG 040 5001 17.2 MM OD			635-040-0.703
18.0 MM	TUNG 040 5001 18.0 MM OD			635-040-0.688
19.1 MM	TUNG 040 5001 19.1 MM OD			635-040-0.672
20.0 MM	TUNG 040 5001 20.0 MM OD			635-040-0.656
21.3 MM	TUNG 040 5001 21.3 MM OD			635-040-0.625
23.0 MM	TUNG 040 5001 23.0 MM OD			635-040-0.594
25.0 MM	TUNG 040 5001 25.0 MM OD			635-040-0.547
<b>5002 CopperHead®</b>				
1/4	TUNG 1/16 5002 1/4 OD			635-063-1.609
5/16	TUNG 1/16 5002 5/16 OD			635-063-1.578
3/8	TUNG 1/16 5002 3/8 OD			635-063-1.547
1/2	TUNG 1/16 5002 1/2 OD			635-063-1.484
5/8	TUNG 1/16 5002 5/8 OD			635-063-1.422
3/4	TUNG 1/16 5002 3/4 OD			635-063-1.359
7/8	TUNG 1/16 5002 7/8 OD			635-063-1.302
1	TUNG 1/16 5002 1 OD			635-063-1.238
1-1/8	TUNG 1/16 5002 1-1/8 OD			635-063-1.171
1-1/4	TUNG 1/16 5002 1-1/4 OD			635-063-1.102
1-3/8	TUNG 1/16 5002 1-3/8 OD			635-063-1.047
1-1/2	TUNG 1/16 5002 1-1/2 OD			635-063-0.984
1-5/8	TUNG 1/16 5002 1-5/8 OD			635-063-0.922
1-3/4	TUNG 1/16 5002 1-3/4 OD			635-063-0.859
1-7/8	TUNG 1/16 5002 1-7/8 OD			635-063-0.797
2	TUNG 1/16 5002 2 OD			635-063-0.734
1/8 NP	TUNG 1/16 5002 1/8 NP			635-063-1.531
1/4 NP	TUNG 1/16 5002 1/4 NP			635-063-1.453
3/8 NP	TUNG 1/16 5002 3/8 NP			635-063-1.391
1/2 NP	TUNG 1/16 5002 1/2 NP			635-063-1.313
3/4 NP	TUNG 1/16 5002 3/4 NP			635-063-1.203
1 NP	TUNG 1/16 5002 1 NP			635-063-1.073
1-1/4 NP	TUNG 1/16 5002 1-1/4 NP			635-063-0.891
1-1/2 NP	TUNG 1/16 5002 1-1/2 NP			635-063-0.781
5.1 MM	TUNG 1/16 5002 5.1 MM OD			635-063-1.625
6.0 MM	TUNG 1/16 5002 6.0 MM OD			635-063-1.625
6.6 MM	TUNG 1/16 5002 6.6 MM OD			635-063-1.609
8.0 MM	TUNG 1/16 5002 8.0 MM OD			635-063-1.578
10.0 MM	TUNG 1/16 5002 10.0 MM OD			635-063-1.531
10.2 MM	TUNG 1/16 5002 10.2 MM OD			635-063-1.531
12.0 MM	TUNG 1/16 5002 12.0 MM OD			635-063-1.500
13.5 MM	TUNG 1/16 5002 13.5 MM OD			635-063-1.469
14.0 MM	TUNG 1/16 5002 14.0 MM OD			635-063-1.453

*Tungsten and collets are a partial listing - contact factory for diameters not listed.*

## Appendix E Tungsten

Diameter	Description	Part #	Diameter	Description	Part #
14.33 MM	TUNG 1/16 5002 14.33 MM OD .....	635-063-1.453	26.0 MM	TUNG 1/16 5003 26.0 MM OD .....	635-063-1.625
14.5 MM	TUNG 1/16 5002 14.5 MM OD .....	635-063-1.453	26.9 MM	TUNG 1/16 5003 26.9 MM OD .....	635-063-1.609
15.0 MM	TUNG 1/16 5002 15.0 MM OD .....	635-063-1.438	28.0 MM	TUNG 1/16 5003 28.0 MM OD .....	635-063-1.594
16.0 MM	TUNG 1/16 5002 16.0 MM OD .....	635-063-1.422	30.0 MM	TUNG 1/16 5003 30.0 MM OD .....	635-063-1.547
16.5 MM	TUNG 1/16 5002 16.5 MM OD .....	635-063-1.413	32.0 MM	TUNG 1/16 5003 32.0 MM OD .....	635-063-1.516
17.2 MM	TUNG 1/16 5002 17.2 MM OD .....	635-063-1.391	33.7 MM	TUNG 1/16 5003 33.7 MM OD .....	635-063-1.469
18.0 MM	TUNG 1/16 5002 18.0 MM OD .....	635-063-1.386	35.0 MM	TUNG 1/16 5003 35.0 MM OD .....	635-063-1.453
20.0 MM	TUNG 1/16 5002 20.0 MM OD .....	635-063-1.343	38.0 MM	TUNG 1/16 5003 38.0 MM OD .....	635-063-1.391
21.2 MM	TUNG 1/16 5002 21.2 MM OD .....	635-063-1.316	40.0 MM	TUNG 1/16 5003 40.0 MM OD .....	635-063-1.359
21.3 MM	TUNG 1/16 5002 21.3 MM OD .....	635-063-1.316	42.4 MM	TUNG 1/16 5003 42.4 MM OD .....	635-063-1.302
21.4 MM	TUNG 1/16 5002 21.4 MM OD .....	635-063-1.316	43.0 MM	TUNG 1/16 5003 43.0 MM OD .....	635-063-1.295
22.4 MM	TUNG 1/16 5002 22.4 MM OD .....	635-063-1.295	44.0 MM	TUNG 1/16 5003 44.0 MM OD .....	635-063-1.277
23.0 MM	TUNG 1/16 5002 23.0 MM OD .....	635-063-1.277	44.5 MM	TUNG 1/16 5003 44.5 MM OD .....	635-063-1.266
25.0 MM	TUNG 1/16 5002 25.0 MM OD .....	635-063-1.238	48.3 MM	TUNG 1/16 5003 48.3 MM OD .....	635-063-1.187
26.0 MM	TUNG 1/16 5002 26.0 MM OD .....	635-063-1.228	51.0 MM	TUNG 1/16 5003 51.0 MM OD .....	635-063-1.136
26.9 MM	TUNG 1/16 5002 26.9 MM OD .....	635-063-1.203	53.0 MM	TUNG 1/16 5003 53.0 MM OD .....	635-063-1.095
28.0 MM	TUNG 1/16 5002 28.0 MM OD .....	635-063-1.187	54.0 MM	TUNG 1/16 5003 54.0 MM OD .....	635-063-1.073
30.0 MM	TUNG 1/16 5002 30.0 MM OD .....	635-063-1.136	57.0 MM	TUNG 1/16 5003 57.0 MM OD .....	635-063-1.020
32.0 MM	TUNG 1/16 5002 32.0 MM OD .....	635-063-1.102	60.3 MM	TUNG 1/16 5003 60.3 MM OD .....	635-063-0.953
33.7 MM	TUNG 1/16 5002 33.7 MM OD .....	635-063-1.073	63.5 MM	TUNG 1/16 5003 63.5 MM OD .....	635-063-0.891
35.0 MM	TUNG 1/16 5002 35.0 MM OD .....	635-063-1.047	68.0 MM	TUNG 1/16 5003 68.0 MM OD .....	635-063-0.797
36.0 MM	TUNG 1/16 5002 36.0 MM OD .....	635-063-1.020	70.0 MM	TUNG 1/16 5003 70.0 MM OD .....	635-063-0.766
36.5 MM	TUNG 1/16 5002 36.5 MM OD .....	635-063-1.020	76.1 MM	TUNG 1/16 5003 76.1 MM OD .....	635-063-0.641
38.0 MM	TUNG 1/16 5002 38.0 MM OD .....	635-063-0.984			
40.0 MM	TUNG 1/16 5002 40.0 MM OD .....	635-063-0.938			
42.4 MM	TUNG 1/16 5002 42.4 MM OD .....	635-063-0.891			
43.0 MM	TUNG 1/16 5002 43.0 MM OD .....	635-063-0.891			
44.0 MM	TUNG 1/16 5002 44.0MM OD .....	635-063-0.859			
44.5 MM	TUNG 1/16 5002 44.5 MM OD .....	635-063-0.859			
45.1 MM	TUNG 1/16 5002 45.1 MM OD .....	635-063-0.844			
48.3 MM	TUNG 1/16 5002 48.3 MM OD .....	635-063-0.781			
<b>5003 CopperHead®</b>					
1/2	TUNG 1/16 5003 1/2 OD .....	635-063-1.891			
5/8	TUNG 1/16 5003 5/8 OD .....	635-063-1.828			
3/4	TUNG 1/16 5003 3/4 OD .....	635-063-1.766			
0.800	TUNG 1/16 5003 0.8 OD .....	635-063-1.734			
0.830	TUNG 1/16 5003 0.83 OD .....	635-063-1.719			
7/8	TUNG 1/16 5003 7/8 OD .....	635-063-1.703			
0.910	TUNG 1/16 5003 0.910 OD .....	635-063-1.688			
0.955	TUNG 1/16 5003 0.955 OD .....	635-063-1.656			
1	TUNG 1/16 5003 1 OD .....	635-063-1.641			
1-1/8	TUNG 1/16 5003 1-1/8 OD .....	635-063-1.578			
1-1/4	TUNG 1/16 5003 1-1/4 OD .....	635-063-1.516			
1-3/8	TUNG 1/16 5003 1-3/8 OD .....	635-063-1.453			
1-1/2	TUNG 1/16 5003 1-1/2 OD .....	635-063-1.391			
1-5/8	TUNG 1/16 5003 1-5/8 OD .....	635-063-1.332			
1-3/4	TUNG 1/16 5003 1-3/4 OD .....	635-063-1.266			
1-7/8	TUNG 1/16 5003 1-7/8 OD .....	635-063-1.203			
2	TUNG 1/16 5003 2 OD .....	635-063-1.136			
2-1/4	TUNG 1/16 5003 2-1/4 OD .....	635-063-1.020			
2-1/2	TUNG 1/16 5003 2-1/2 OD .....	635-063-0.891			
2-3/4	TUNG 1/16 5003 2-3/4 OD .....	635-063-0.766			
3	TUNG 1/16 5003 3 OD .....	635-063-0.641			
1/4 NP	TUNG 1/16 5003 1/4 NP .....	635-063-1.859			
3/8 NP	TUNG 1/16 5003 3/8 NP .....	635-063-1.797			
1/2 NP	TUNG 1/16 5003 1/2 NP .....	635-063-1.719			
3/4 NP	TUNG 1/16 5003 3/4 NP .....	635-063-1.609			
1 NP	TUNG 1/16 5003 1 NP .....	635-063-1.469			
1-1/4 NP	TUNG 1/16 5003 1-1/4 NP .....	635-063-1.302			
1-1/2 NP	TUNG 1/16 5003 1-1/2 NP .....	635-063-1.187			
2 NP	TUNG 1/16 5003 2 NP .....	635-063-0.953			
2-1/2 NP	TUNG 1/16 5003 2-1/2 NP .....	635-063-0.688			
13.5 MM	TUNG 1/16 5003 13.5 MM OD .....	635-063-1.875			
14.0 MM	TUNG 1/16 5003 14.0 MM OD .....	635-063-1.859			
15.0 MM	TUNG 1/16 5003 15.0 MM OD .....	635-063-1.843			
16.0 MM	TUNG 1/16 5003 16.0 MM OD .....	635-063-1.828			
17.2 MM	TUNG 1/16 5003 17.2 MM OD .....	635-063-1.797			
18.0 MM	TUNG 1/16 5003 18.0 MM OD .....	635-063-1.781			
20.0 MM	TUNG 1/16 5003 20.0 MM OD .....	635-063-1.750			
21.3 MM	TUNG 1/16 5003 21.3 MM OD .....	635-063-1.719			
23.0 MM	TUNG 1/16 5003 23.0 MM OD .....	635-063-1.688			

			
<b>WARNING</b>	<ul style="list-style-type: none"> <li>Do not touch electrically live parts or electrode with skin or wet clothing.</li> <li>Insulate yourself from work and ground.</li> </ul>	<ul style="list-style-type: none"> <li>Keep flammable materials away.</li> </ul>	<ul style="list-style-type: none"> <li>Wear eye, ear and body protection.</li> </ul>
Spanish <b>AVISO DE PRECAUCION</b>	<ul style="list-style-type: none"> <li>No toque las partes o los electrodos bajo carga con la piel o ropa mojada.</li> <li>Aislese del trabajo y de la tierra.</li> </ul>	<ul style="list-style-type: none"> <li>Mantenga el material combustible fuera del área de trabajo.</li> </ul>	<ul style="list-style-type: none"> <li>Protéjase los ojos, los oídos y el cuerpo.</li> </ul>
French <b>ATTENTION</b>	<ul style="list-style-type: none"> <li>Ne laissez ni la peau ni des vêtements mouillés entrer en contact avec des pièces sous tension.</li> <li>Isolerez-vous du travail et de la terre.</li> </ul>	<ul style="list-style-type: none"> <li>Gardez à l'écart de tout matériel inflammable.</li> </ul>	<ul style="list-style-type: none"> <li>Protégez vos yeux, vos oreilles et votre corps.</li> </ul>
German <b>WARNUNG</b>	<ul style="list-style-type: none"> <li>Berühren Sie keine stromführenden Teile oder Elektroden mit Ihrem Körper oder feuchter Kleidung!</li> <li>Isolieren Sie sich von den Elektroden und dem Erdboden!</li> </ul>	<ul style="list-style-type: none"> <li>Entfernen Sie brennbares Material!</li> </ul>	<ul style="list-style-type: none"> <li>Tragen Sie Augen-, Ohren- und Körperschutz!</li> </ul>
Portuguese <b>ATENÇÃO</b>	<ul style="list-style-type: none"> <li>Não toque partes elétricas e electrodos com a pele ou roupa molhada.</li> <li>Isol-se da peça e terra.</li> </ul>	<ul style="list-style-type: none"> <li>Mantenha inflamáveis bem guardados.</li> </ul>	<ul style="list-style-type: none"> <li>Use proteção para a vista, ouvido e corpo.</li> </ul>
Japanese <b>注意事項</b>	<ul style="list-style-type: none"> <li>送電中の電気部品、又は溶材にヒフやぬれた布で触れないこと。</li> <li>施工物やアースから身体が絶縁されている様にして下さい。</li> </ul>	<ul style="list-style-type: none"> <li>燃えやすいものの側での溶接作業は絶対にしてはなりません。</li> </ul>	<ul style="list-style-type: none"> <li>目、耳及び身体に保護具をして下さい。</li> </ul>
Chinese <b>警告</b>	<ul style="list-style-type: none"> <li>皮肤或湿衣物切勿接触带电部件及焊条。</li> <li>使你自已与地面和工件绝缘。</li> </ul>	<ul style="list-style-type: none"> <li>把一切易燃物品移离工作场所。</li> </ul>	<ul style="list-style-type: none"> <li>佩戴眼、耳及身体劳动保护用具。</li> </ul>
Korean <b>위험</b>	<ul style="list-style-type: none"> <li>전도체나 용접봉을 젖은 장갑 또는 피부로 절대 접촉치 마십시오.</li> <li>모재와 접지를 접촉치 마십시오.</li> </ul>	<ul style="list-style-type: none"> <li>인화성 물질을 접근 시키지 마십시오.</li> </ul>	<ul style="list-style-type: none"> <li>눈, 귀와 몸에 보호장구를 착용하십시오.</li> </ul>
Arabic <b>تحذير</b>	<ul style="list-style-type: none"> <li>لا تلمس الاجزاء التي يسري فيها التيار الكهربائي أو الأقطاب وهدج الجسد أو بالماء المبللة بالماء.</li> <li>ضع عازلا على جسمك خلال العمل.</li> </ul>	<ul style="list-style-type: none"> <li>ضع المواد القابلة للاشتعال في مكان بعيد.</li> </ul>	<ul style="list-style-type: none"> <li>ضع أدوات وملابس واقية على عينيك وأذنيك وجسمك.</li> </ul>

READ AND UNDERSTAND THE MANUFACTURER'S INSTRUCTION FOR THIS EQUIPMENT AND THE CONSUMABLES TO BE USED AND FOLLOW YOUR EMPLOYER'S SAFETY PRACTICES.

SE RECOMIENDA LEER Y ENTENDER LAS INSTRUCCIONES DEL FABRICANTE PARA EL USO DE ESTE EQUIPO Y LOS CONSUMIBLES QUE VA A UTILIZAR, SIGA LAS MEDIDAS DE SEGURIDAD DE SU SUPERVISOR.

LISEZ ET COMPRENEZ LES INSTRUCTIONS DU FABRICANT EN CE QUI REGARDE CET EQUIPMENT ET LES PRODUITS A ETRE EMPLOYES ET SUIVEZ LES PROCEDURES DE SECURITE DE VOTRE EMPLOYEUR.

LESEN SIE UND BEFOLGEN SIE DIE BETRIEBSANLEITUNG DER ANLAGE UND DEN ELEKTRODENEINSATZ DES HERSTELLERS. DIE UNFALLVERHÜTUNGSVORSCHRIFTEN DES ARBEITGEBERS SIND EBENFALLS ZU BEACHTEN.

			
<ul style="list-style-type: none"> <li>● Keep your head out of fumes.</li> <li>● Use ventilation or exhaust to remove fumes from breathing zone.</li> </ul>	<ul style="list-style-type: none"> <li>● Turn power off before servicing.</li> </ul>	<ul style="list-style-type: none"> <li>● Do not operate with panel open or guards off.</li> </ul>	<b>WARNING</b>
<ul style="list-style-type: none"> <li>● Los humos fuera de la zona de respiración.</li> <li>● Mantenga la cabeza fuera de los humos. Utilice ventilación o aspiración para gases.</li> </ul>	<ul style="list-style-type: none"> <li>● Desconectar el cable de alimentación de poder de la máquina antes de iniciar cualquier servicio.</li> </ul>	<ul style="list-style-type: none"> <li>● No operar con panel abierto o guardas quitadas.</li> </ul>	Spanish <b>AVISO DE PRECAUCION</b>
<ul style="list-style-type: none"> <li>● Gardez la tête à l'écart des fumées.</li> <li>● Utilisez un ventilateur ou un aspirateur pour ôter les fumées des zones de travail.</li> </ul>	<ul style="list-style-type: none"> <li>● Débranchez le courant avant l'entretien.</li> </ul>	<ul style="list-style-type: none"> <li>● N'opérez pas avec les panneaux ouverts ou avec les dispositifs de protection enlevés.</li> </ul>	French <b>ATTENTION</b>
<ul style="list-style-type: none"> <li>● Vermeiden Sie das Einatmen von Schweißrauch!</li> <li>● Sorgen Sie für gute Be- und Entlüftung des Arbeitsplatzes!</li> </ul>	<ul style="list-style-type: none"> <li>● Strom vor Wartungsarbeiten abschalten! (Netzstrom völlig öffnen; Maschine anhalten!)</li> </ul>	<ul style="list-style-type: none"> <li>● Anlage nie ohne Schutzgehäuse oder Innenschutzverkleidung in Betrieb setzen!</li> </ul>	German <b>WARNUNG</b>
<ul style="list-style-type: none"> <li>● Mantenha seu rosto da fumaça.</li> <li>● Use ventilação e exaustão para remover fumo da zona respiratória.</li> </ul>	<ul style="list-style-type: none"> <li>● Não opere com as tampas removidas.</li> <li>● Desligue a corrente antes de fazer serviço.</li> <li>● Não toque as partes elétricas nuas.</li> </ul>	<ul style="list-style-type: none"> <li>● Mantenha-se afastado das partes moventes.</li> <li>● Não opere com os painéis abertos ou guardas removidas.</li> </ul>	Portuguese <b>ATENÇÃO</b>
<ul style="list-style-type: none"> <li>● ヒュームから頭を離すようにして下さい。</li> <li>● 換気や排煙に十分留意して下さい。</li> </ul>	<ul style="list-style-type: none"> <li>● メンテナンス・サービスに取りかかる際には、まず電源スイッチを必ず切して下さい。</li> </ul>	<ul style="list-style-type: none"> <li>● パネルやカバーを取り外したまま機械操作をしないで下さい。</li> </ul>	Japanese <b>注意事項</b>
<ul style="list-style-type: none"> <li>● 頭部遠離煙霧。</li> <li>● 在呼吸區使用通風或排風器除煙。</li> </ul>	<ul style="list-style-type: none"> <li>● 維修前切斷電源。</li> </ul>	<ul style="list-style-type: none"> <li>● 儀表板打開或沒有安全罩時不準作業。</li> </ul>	Chinese <b>警告</b>
<ul style="list-style-type: none"> <li>● 얼굴로부터 용접가스를 멀리하십시오.</li> <li>● 호흡지역으로부터 용접가스를 제거하기 위해 가스제거기나 통풍기를 사용하십시오.</li> </ul>	<ul style="list-style-type: none"> <li>● 보수전에 전원을 차단하십시오.</li> </ul>	<ul style="list-style-type: none"> <li>● 판넬이 열린 상태로 작동치 마십시오.</li> </ul>	Korean <b>위험</b>
<ul style="list-style-type: none"> <li>● بعد رأسك بعيداً عن الدخان.</li> <li>● استعمل التهوية أو جهاز ضغط الدخان للخارج لكي تبعد الدخان عن المنطقة التي تتنفس فيها.</li> </ul>	<ul style="list-style-type: none"> <li>● قطع التيار الكهربائي قبل القيام بأية صيانة.</li> </ul>	<ul style="list-style-type: none"> <li>● لا تشغل هذا الجهاز إذا كانت الاغطية الحديدية الواقية ليست عليه.</li> </ul>	Arabic <b>تحذير</b>

**LEIA E COMPREENDA AS INSTRUÇÕES DO FABRICANTE PARA ESTE EQUIPAMENTO E AS PARTES DE USO, E SIGA AS PRÁTICAS DE SEGURANÇA DO EMPREGADOR.**

使う機械や溶材のメーカーの指示書をよく読み、まず理解して下さい。そして貴社の安全規定に従って下さい。

請詳細閱讀並理解製造廠提供的說明以及應該使用的銀焊材料，並請遵守貴方的有關勞動保護規定。

이 제품에 동봉된 작업지침서를 숙지하시고 귀사의 작업자 안전수칙을 준수하시기 바랍니다.

اقرأ بتمعن وافهم تعليمات المصنع المنتج لهذه المعدات والمواد قبل استعمالها واتبع تعليمات الوقاية لصاحب العمل.

# LIMITED WARRANTY

Effective August 1, 2008

This warranty supersedes all previous MK Products warranties and is exclusive, with no other guarantees or warranties expressed or implied.

**LIMITED WARRANTY** - MK Products Inc., Irvine, California warrants that all new and unused equipment furnished by MK Products is free from defects in workmanship and material as of the time and place of delivery by MK Products. No warranty is made by MK Products with respect to trade accessories or other items manufactured by others. Such trade accessories and other items are sold subject to the warranties of their respective manufacturers, if any.

MK Products' warranty does not apply to components having normal useful life of less than one (1) year, such as relay points, wire conduit, tungsten, and welding gun parts that come in contact with the welding wire, including gas cups, gas cup insulators, and contact tips where failure does not result from defect in workmanship or material.

MK Products shall, exclusively remedy the limited warranty or any duties with respect to the quality of goods, based upon the following options:

- (1) repair
- (2) replacement
- (3) where authorized in writing by MK Products, the reasonable cost of repair or replacement at our Irvine, California plant.

As a matter of general policy only, MK Products may honor an original user's warranty claims on warranted equipment in the event of failure resulting from a defect within the following periods from the date of delivery of equipment to the original user:

- 1. Power Supplies and Wire Feed Cabinets ..... 3 years
- 2. Weldheads, CobraCooler, Positioners, Prince XL and Prince XL Spool Guns, Python, CobraMAX, Cobra SX, Cobra MX ..... 1 year
- 3. Sidewinder Spool Gun, Prince SG Spool Guns, Modules ..... 180 days
- 4. Repairs/Exchanges/Parts/Accessories ..... 90 days

Classification of any item into the foregoing categories shall be at the sole discretion of MK Products. Notification of any failure must be made in writing within 30 days of such failure.

A copy of the invoice showing the date of sale must accompany products returned for warranty repair or replacement.

All equipment returned to MK Products for service must be properly packaged to guard against damage from shipping. MK Products will not be responsible for any damages resulting from shipping.

Normal surface transportation charges (one way) for products returned for warranty repair or replacement will be borne by MK Products, except for products sold to foreign markets.

ANY EXPRESS WARRANTY NOT PROVIDED HEREIN AND ANY IMPLIED WARRANTY, GUARANTY, OR REPRESENTATION AS TO PERFORMANCE, AND ANY REMEDY FOR BREACH OF CONTRACT WHICH, BUT FOR THIS PROVISION, MIGHT ARISE BY IMPLICATION, OPERATION OF LAW, CUSTOM OF TRADE, OR COURSE OF DEALING, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR PARTICULAR PURPOSE, WITH RESPECT TO ANY AND ALL EQUIPMENT FURNISHED BY MK PRODUCTS, IS EXCLUDED AND DISCLAIMED BY MK PRODUCTS.

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USE OF OTHER THAN *GENUINE* MK PRODUCTS' CONSUMABLES, PARTS, AND ACCESSORIES MAY INVALIDATE YOUR PRODUCT WARRANTY.



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