Spot Weld, Inc. Machinery Manual

SPOT WELD, INC.
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www.spotweldinc.com

Excellence
In Resistance Welding

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Resistance Welding Equipment

Spot Welding Electrodes

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Bar Stock

Holders

Special Forgings

Elconite

Ignitron Tubes

Seam Welder Wheels

C.D. Studs

ARC Studs

Concrete Anchors

Controls

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Educational Programs

Customer:
Model Number:
Serial Number:
Machine Type:
Voltage:
Hertz:
Phase:
Fuse Rating:

This manual must be completely read and understood before operating the welder.

1. Level and firmly anchor the welder.

2. Connect welder to electrical service of primary voltage specified on the nameplate using appropriately sized copper wire per the table "Recommended Wire Sizes, Fuse and Disconnect Sizes" on the next page. All wiring is to conform to local codes and regulations. Primary line terminals on welder terminal plates are marked for easy identification.

   Warning: It is mandatory that the welder be grounded according to all local safety codes and regulations. It is recommended that you ground the frame to an earth ground. Remember, paint is an insulator, so strip that portion of the frame, as well as the earth ground. Check with your electrician to find a good ground for you. Failure to ground this machine may result in severe injury or death.

3. Connect air supply line to the input fitting on the Filter/Regulator assembly. The assembly includes a filter station, however individual plant conditions could warrant additional traps and/or filters to avoid unnecessary damage due to moisture condensation or other foreign material.

4. Connect all water inlets and drains, furnish a water supply which will maintain sufficient cooling. Welders with water-cooled electrode holders require a minimum of 1.5GPM. Welders with water-cooled SCR contactors require a recommended 5GPM.

5. After the completion of the installation, the welder should first be sequenced through it's various functions without application of any weld current. When the welder performs this satisfactorily, then it can be setup for production runs.

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Recommended Wire Sizes, Fuse and Disconnect Sizes

WELDER KVA	WIRE USE	WIRE SIZE @208/230V	DISCON SWITCH RATING @250V	FUSE RATING @250V	WIRE SIZE @460V	DISCON SWITCH RATING @600V	FUSE RATING @600V	WIRE SIZE @550V	DISCON SWITCH RATING @600V	FUSE RATING @600V
5	SPOT	#6	30A	30A	#12	30A	15A	#12	30A	10A
10	SPOT	#4	60A	40A	#10	30A	20A	#10	30A	15A
15	SPOT	#2	60A	50A	#8	30A	30A	#8	30A	25A
20	SPOT	#1	100A	70A	#6	60A	40A	#6	30A	30A
25	SPOT	1/O	100A	80A	#4	60A	50A	#6	60A	40A
30	SPOT	2/O	100A	100A	#2	60A	60A	#4	60A	50A
35	SPOT	3/O	200A	125A	#1	100A	70A	#3	60A	60A
40	SPOT	3/O	200A	150A	#1	100A	80A	#3	60A	60A
50	SPOT	4/O	200A	150A	#1	100A	90A	#2	60A	60A
50	PROJ	250MCM	200A	150A	1/O	100A	90A	#1	60A	60A
65	SPOT	250MCM	200A	175A	1/O	100A	100A	#1	100A	80A
65	PROJ	300MCM	200A	175A	2/O	100A	100A	1/O	100A	80A
75	SPOT	350MCM	400A	250A	1/O	200A	125A	#1	100A	100A
75	PROJ	400MCM	400A	250A	2/O	200A	125A	1/O	100A	100A
100	SPOT	500MCM	400A	350A	2/O	200A	175A	1/O	200A	125A
100	PROJ	600MCM	400A	350A	3/O	200A	175A	2/O	200A	125A
150	SPOT	600MCM	600A	500A	250MCM	400A	250A	4/O	200A	200A
150	PROJ	750MCM	600A	500A	350MCM	400A	250A	250MCM	200A	200A
200	SPOT	2X400MCM	600A	600A	350MCM	400A	350A	250MCM	400A	300A
200	PROJ	2X500MCM	600A	600A	400MCM	400A	350A	350MCM	400A	300A
300	SPOT	2X600MCM	CONSULT		500MCM	600A	500A	400MCM	400A	400A
300	PROJ	2X750MCM			600MCM	600A	500A	500MCM	400A	400A

NOTE 1.) For seam welders use the equivalent projection welder recommendations.

NOTE 2.) Above wire sizes are based on a 100-foot run. Furthermore, it is assumed that the allowable voltage drop takes place in this cable and that the user's power supply is inherently stiff. The next smaller size wire may be used for runs shorter than 50 feet.

NOTE 3.) All values are recommended only. Installation must be done in accordance to all local codes.

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Safety

The text you are about to read is only to be used as a general guideline. Each plant and machine having unique characteristics. Use your experience to apply this guide to your application.

Resistance Welding Guarding

1. Welder manufacturers do not know and cannot foresee the magnitude of potential danger when welders are improperly utilized. It is the responsibility of user management to make certain that all OEM operating instructions and/or personnel training is complied with and to furnish other safety instructions according to application. The welder must be setup so that it is impossible for the operators to place their hands or any other body part in any pinch point or moving area. A pinch point is explained on a separate page and can be identified by a warning label.

2. Guards or other devices to keep the operators hands out of danger should be furnished by user management and maintained operational.

3. Management must schedule periodic checks to insure safe and proper operation of the welder.

Resistance Welders are designed to the highest performance and safety standards known to the resistance welding industry. However, the installation, usage, suitability and fitness of our equipment can be overcome by improper usage.

General

1. The operator of this equipment must read and thoroughly understand this section prior to the operation or repair of this equipment.

2. Company management and supervision has the responsibility to insure that all personnel operating this machine are properly trained and is judged competent and physically able to operate this equipment.

3. Using the documentation and the warning labels the operator must be alerted by his supervisors of the safety hazards that can occur if precautions are not taken.

4. Users of the equipment are responsible for full compliance of all safety and operating procedure as well as with all Federal, State and Local codes.

5. The user is responsible for insuring that all non-English speaking personnel understand all instructions and safety procedures.

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6. The user should conform to **OSHA** regulation 29 CFR 1910 in the installation, operation and maintenance of this equipment.

7. The user should institute a periodic safety inspection to insure proper and safe operation of the equipment.

8. All repairs or modifications should be performed or authorized

9. Operators of this equipment must be instructed as to the proper procedure to follow in the event of an emergency.

10. First aid equipment must be readily available at all times when operating this equipment.

Electrical

1. High voltage is present in the controls, tap switch, terminal blocks and by transformers. All the necessary precautions are to be observed.

2. Installation of the main disconnect and main power connections to the machine are to be made by a licensed electrician. All local codes must be observed.

3. All HIGH VOLTAGE power wiring must be properly sized.

4. The equipment and cabinets must be properly grounded. The ground lead should be sized sufficiently.

5. Failure to follow electrical safety precautions could result in serious injury or death.

Pneumatic and Water

1. The operator must monitor the equipment upon start up for air and water leaks.

2. The air filter must be bled regularly and air lines must be kept clean.

3. Insure that the air pressure is adequate and consistent for the welder.

4. Insure that the water flow is not hampered or obstructed.

5. In the event of an air or water leak, remove all power from the machine before qualified personnel attempt to correct the problem.

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CONNECTING COMPRESSED AIR

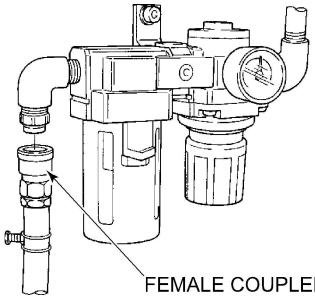
NOTICE

- When new air piping (especially metal piping) :hips and other foreign matter may remain in the piping, causing trouble later. Before connecting compressed air, be sure to clean the piping with compressed air.

1 Insert the preset female coupler into the compressed air inlet (male coupler).

NOTE

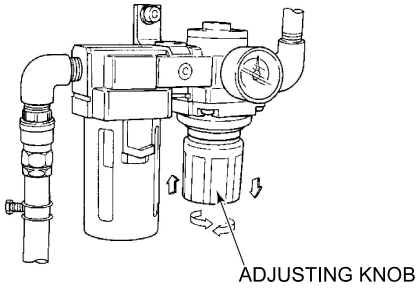
- Prepare the female coupler (Nitto Koki 40SH) and 3/8" primary rubber hose.



SUPPLYING COMPRESSED AIR

1 Pull down the adjusting knob of the regulator until the orange line appears.

2 Turn the adjusting knob until the air pressure gauge reads 0.5 MPa {71 psi}. Turn the adjusting knob clockwise to increase the air pressure and counterclockwise to decrease the air pressure.



3 Push in the adjusting knob until the orange line disappears.

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Operator Precautions

1. A daily safety check should be made prior to powering up the welder. If a problem is found, it should be corrected before proceeding with the work.

2. Only properly trained personnel should operate this equipment. Only qualified maintenance personnel should attempt to repair this welder.

3. No modification of the safety devices shall be made without the written authorization

4. Keep all body parts clear of all moving parts.

5. Heed all Warning or Caution labels.

6. The operator should be aware of the function and operation of the Emergency Stop buttons.

7. Do not leave the welder unattended with the power on for any extended period of time.

8. It is the user's responsibility that proper safety equipment is used when the welder is being operated. These include but are not limited to:

   Protective glasses
   Protective shoes
   Non flammable outer garments

9. Initiation should normally be made by only one person unless other safety designs have been incorporated by the manufacturer to allow multiple initiations.

10. Operators should be aware of the magnetic fields generated by the welder. The fields can play havoc with watches and other electromechanical devices.

11. If a welder malfunctions or operates in an unusual manner, the equipment should be powered down and corrected by qualified personnel.

- Any questions should be routed to your local distributor

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Setup and Operating Instructions

It is the purpose of this manual to provide information on the proper installation, operation and maintenance of equipment. However, it is the obligation of the user to properly instruct all personnel to insure that all operational and safety procedures are understood fully and complied with.

REGULATOR AND GAUGE

The air pressure regulators are of the self-bleeding, spring loaded, diaphragm type and are used to adjust the air pressure to the air operated welding head for development of electrode force. The electrode force is calculated by using the multiplication factor of the air cylinder bore times the weld pressure gauge setting. welders have affixed to the welder and located in the area of the lubro unit an "Electrode Force Chart" which gives the actual force at different gauge settings for press welders only.

LUBRICATOR

This pulsating type lubricator functions only when the welder is in operation and injects sufficient oil into the air stream to create an oil fog which travels with the air stream to lubricate the internal working parts of the pneumatic system.

Adjust the needle valve on top of the lubricator, when the welder is in operation, for one drop to about every 100 to 200 strokes of the welder.

AIR FILTER

The air filter eliminates most particles of grit, pipe, scale, condensation and other foreign matter from entering the air stream to the pneumatic system. Opening the waste petcock for cleaning purposes should be done weekly or as often as required. Periodically remove the plug on top of the filter then remove the screen and clean it. Replace components when completed.

SOLENOID AIR VALVE

The solenoid air valve is operated by a single electric solenoid integrally mounted. This valve is actuated by the footswitch and controls the flow of air to the air operated welding head during the weld sequence.

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PRESSURE SWITCH

When used, the pressure switch is connected to the air operated welding head. When pressure on the air cylinder reaches a predetermined setting, the normally open contacts of the pressure switch will close to energize the welder control circuit for a weld sequence.

The procedure for adjusting the pressure switch is as follows:

Adjust the pressure switch by turning adjuster knob clockwise to set pressure higher than pressure reading on regulator gauge. Set Weld/No Weld switch to weld position. Place material between welding electrodes and depress footswitch. After the welding head contacts the material, rotate adjuster knob counter clockwise slowly until the weld current is applied. The function of the pressure switch is to insure that proper pressure is applied before current flows. Improper adjustment can cause a pre-fire condition. If the period of delay is longer than desired, make the necessary adjustments by further counter clockwise rotating the adjuster knob.

HEAT REGULATOR

The heat regulator is a heavy-duty tap switch properly rated for the KVA capacity of the welder and is used to pre-select the current required. This switch must not be adjusted during the weld cycle.

SPEED CONTROLS

Speed controls are used to adjust the speed of the travel of the welding heads. When properly adjusted excessive hammering of the weld head will be avoided. After setting these controls be sure to lock all adjusters. Refer to parts diagram of your welder for location of these speed controls.

MECHANICAL SETUP

Position arms and electrodes according to the work to be done. On rocker arm welders check that the arms are parallel and the electrodes face diameter is correct. The electrodes must be clean and be accurately aligned with each other.

When the arms are closed during welding they must be parallel. This can be accomplished by adjustment of your electrode holders or stroke adjustment depending on your welder.

Check the pneumatic operation while in no weld operation by means of the footswitch.

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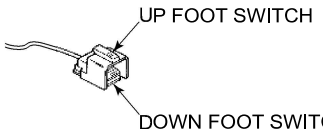
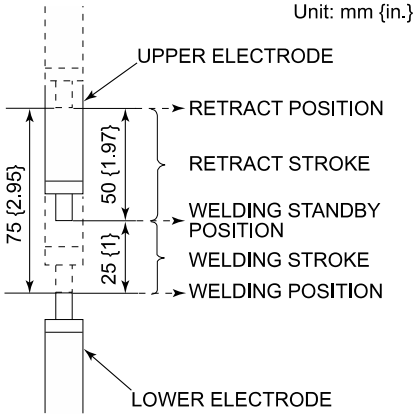
FOOT SWITCH UNIT

When the upper electrode is in the welding standby position, press the down foot switch to move down the upper electrode to the welding position for the welding operation. When the welding operation is completed, the upper electrode automatically returns to the welding standby position.

When the upper electrode is in the retract position, pressing the down foot switch returns the upper electrode to the welding standby position.

When the upper electrode is in the welding standby position, pressing the up foot switch moves up the upper electrode by 50 mm {1.97 in.} to the retract position.





NOTE

- Adjust the welding standby position of the upper electrode to a maximum of 25 mm {1 in.} from the lower electrode.

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INITIAL TRYOUT OF WELDER

1. Turn on air, power and water.
2. Select two pieces of weldable material of a gauge for the welder KVA capacity.
3. Set weld time control to three cycles.
4. Select low tap on heat regulator.
5. Adjust air regulator for electrode force.
6. Adjust pressure switch per instructions. (if used)
7. Place Weld/No Weld switch to WELD position.
8. Actuate welder by depressing footswitch.
9. Test welds and adjust weld time and/or heat regulator.

WELDING CONTROLS

Weld controls are available in many different forms. From the basic Non-Synchronous to the Solid State / Binary count controls, all the way to the precision Microprocessor controls. The one thing that they have in common is that they regulate your welding. The Non-Synchronous gives you the basic functions you need while the Microprocessor on the other end of the spectrum gives you a full function of features. We will cover the most basic functions while you will have to go to the control manual for more detailed explanations.

SQUEEZE TIME

The Squeeze Time is the time interval between the initiation and the beginning of the welding cycle. The set value should be long enough to allow the electrodes to reach the correct force before the beginning of the welding cycle. Too little squeeze time can cause pre-firing between the electrodes and the workpiece at the beginning of the welding cycle, this can lead to a poor weld quality. Too much squeeze time can slow down production.

WELD TIME

Weld Time is the period weld current is applied. It starts at the conclusion of squeeze time and times the duration of the current flow through the work.

CURRENT

The value expressed in CURRENT indicates the percent of welding operating power for the current tap setting.

HOLD

The Hold Time is used to remove heat from the workpiece by keeping the electrodes closed causing the nugget to cool rapidly or opening the electrodes to cool the nugget more slowly.

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OFF TIME

Off Time is the time between the de-energizing and energizing of the weld valve during the auto repeat mode. It must be set to a time, which allows you to safely move your workpiece during production.

WELD / NO WELD

The Weld / No Weld switch allows you to sequence the control without passing actual weld current. This can be useful when sizing up your workpiece to plan production.

PULSATION

Pulsation allows the use of multiple pulses of the preset current percent and time values. This is used for coated and for metals which may exceed the KVA rating of the welder.

COOL TIME

The Cool Time function is used when you require multiple pulses. It is the time elapsing between one welding pulse and the next one.

See the manufacturers manual for additional instructions on their specific control.

OPERATING ADJUSTMENTS

After the welder is installed and the proper connections are made and mechanical setup is performed, it is desirable to determine if the welder sequences properly. Check to determine if the welder is installed properly and connected to the proper voltage. Certain models are capable of running on 220 or 440 volts, you can find the instructions to change these voltages elsewhere in this manual. Make sure the welder is properly fused according to the wire chart enclosed in this manual. Make sure it is in compliance with all local codes and regulations.

Check that all air and water connections are installed properly. First apply air to the welder, then apply water and electrical power to the welder. Check the air and water flow. Set the air pressure regulator to the required air pressure to obtain desired electrode force.

Turn on power. Set the squeeze time to insure that enough time is set to avoid a pre-fire condition. Set the weld time or weld count to the recommended setting for the type and thickness of the material to be welded. Set the transformer tap switch and heat control percent for the required current. The heat control adjuster is the percent of current output for any given tap of the weld transformer. Refer to the weld schedules listed in most electrode and accessory catalogs. The hold time should initially be set to five cycles and adjusted as needed. Put the control into Non-Repeat operation and no weld. This will permit the welder to cycle without welding.

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CAUTION: Be sure that hands, fingers, clothing or other items are clear of electrodes.

Initiate the welder by depressing the footswitch only to the first stage pedal position. The electrodes should come together and remain closed. Check electrode alignment for squareness. Release the footswitch and the electrodes should return to an open position. Adjust the electrode alignment if necessary. Depress the footswitch all the way down to initiate the second stage position. The welder arms should then close, sequence and open automatically. Your machine may be equipped with a single stage footswitch or palm button initiation system. If that is the case your machine will react in a different manner.

If the welder operates satisfactory then you can try to weld. Set the weld current to 20% if it is a solid state or microprocessor type control. If it is the Non-Synchronous type, adjust your dial in small increments because the data plate is not 100% accurate. This is 20% of the available welding current produced by the weld transformer. Keep the tap switch (if available) at a low setting to start. A tap switch is a coarse adjustment of the weld current. The weld current percent control adjusts the current output for the selected tap setting of the transformer. Obtain sample pieces of metal (usually equal to your workpiece) to be welded, and insert them between the electrodes. If necessary insert samples into the throat of the welder to simulate actual conditions encountered on your application.

CAUTION: Be sure hands, fingers or other items are not between the electrodes and free from any moving parts.

Depress the footswitch completely into the second stage. Initiate and sequence the welder as above. The welder will pass current through the workpiece. Test the weld using a peel test or a tensile shear test machine. If the pieces did not make a good weld, adjust the weld current in low increments to avoid weld splash and expulsion.

Repeat until a good weld is obtained. Weld time and weld current may be “fine tuned” to obtain desired combination of weld strength and appearance. Excessively long weld times should be avoided. You can reference a resistance welding manual or the Resistance Welding video from your local OEM to assist you in your welding. The squeeze time may now be reduced to a shorter time. Be careful to make sure that sufficient time is allowed for the electrodes to travel together and apply a clamping force on the weld parts before the weld time begins. Inadequate squeeze time can result in expulsion or sparking causing electrode wear. Excessive squeeze time will also slow down production.

Adjust the hold time to permit the weld nugget to solidify and cool sufficiently. Inadequate hold time can cause expulsion or sparking. Excessive hold time can also slow down production. If automatic repeat spotwelding is desired, set the off time to a sufficient time to permit the work piece to be moved into position for the next weld. Excessive off time will slow down production. See repeat below.

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REPEAT / NON-REPEAT SWITCH

Non-Repeat Position

The welder will go through one sequence of squeeze, weld and hold time even though the initiation switch is closed momentarily. This is the inherent NON-REPEAT feature of this control initiation. The welder will go through only one sequence even if the initiation switch is held closed after the completion of the cycle.

Repeat Position

The welder will continue to go through sequence cycles of squeeze, weld, hold and off times as long as the initiation switch is held closed. The welder will finish the sequence in which the initiating switch is opened and then stop.

Off time should be set long enough to allow the operator to reposition the piece for the next weld. The automatic operation resulting from the "Repeat" position is normally used only when the spot welds are closely spaced and it takes about the same interval of time to reposition them.
All of the above functions have been described on the assumption that Single Stage Initiating Switch Operation has been used. This means that once the initiating or pilot switch is closed the complete sequence starts.

TWO STAGE INITIATING SWITCH OPERATION

When the first stage is initiated, the electrodes close on the work pieces. However, the remainder of the cycle of weld and hold times will not begin until the second stage is initiated. With this arrangement the operator can reopen the electrodes by releasing the first stage again. Providing he is satisfied with the work position, the operator will then proceed to the second stage, which will allow the control to go through the remainder of the sequence. The second stage initiation need only be momentary.

FOOTSWITCH / PALM BUTTON OPERATION

It is often recommended that for safety your welder be equipped with hand initiation. Hand initiation prevents the operator's hands from entering the weld area pinch points. Two hands must trigger the hand initiation system simultaneously. This prevents accidental initiation. Older systems use the mechanical palm buttons. exclusively uses soft touch initiation buttons. This helps to cut down on fatigue and eliminate Carpal Tunnel Syndrome.

Some machines may be equipped with both a footswitch and hand initiation. The operating mode can be changed by a switch, usually key operated, to switch from one system to the other.

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MAINTENANCE

Proper maintenance consists of the following:

1. The timer should be kept clean by periodically blowing out the dirt with a low-pressure dry airline. Care should be taken to use dry air. A portable type vacuum cleaner is suitable also.
2. Relay maintenance consists primarily of occasionally dressing (with power off) the contacts with fine crocus cloth or equivalent. DO NOT USE FILES OR ABRASIVES, which can remove the non-corrosive plating. DO NOT OIL ANY MOVING PARTS ON THE RELAY.
3. Inspect all wires and pluggable components occasionally to make sure that they are secure in place. It is recommended that you have some spare components available for replacement if necessary.

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Troubleshooting

As with any welding process you may sometimes encounter difficulty. If you stop to examine what you are doing, you will usually find that the problem can be corrected. The most common cause of spotwelding problems is the failure to properly select and maintain the electrodes. Poor electrode life is usually traced to improper water cooling and/or incorrect weld schedules. Excessive weld times do not make better welds and will result in poor weld appearance, as well as, shorter electrode life.

Refer to the chart below for a general troubleshooting guide, which lists some resistance welding problems and their possible causes. A better understanding of the resistance welding process and how to use it will enable you to increase your spotwelding productivity and improve the quality of your welded assemblies.

♣Primary Cause ♦Secondary Cause	TYPE OF WELD DEFECTS						
Possible Cause of Weld Defect		Weak Weld	Expulsion or Weld Splash	Electrode Mushrooming	Excessive Weld Marking	Electrode Sticking	No Weld
Weld Current	LOW	♣			♦		♣
	HIGH		♣	♦	♣	♦	
Weld Time	SHORT	♣					♣
	LONG		♣	♣	♣	♦	
Weld Force	LOW	♦	♣		♦	♦	
	HIGH			♣	♣		♦
Short Squeeze Time			♣		♦	♣	♦
Incorrect Follow Up			♦			♦	
Inadequate Cooling		♦		♣	♦	♦	
Electrode Face Diameter	SMALL	♣	♦		♦	♦	
	LARGE	♣					♦
Poor Metal Fit Up		♣	♣		♣		♣
Dirty or Scaley Metal		♦	♦			♦	♣
Too Close Weld Spacing		♣					♦
Incorrect Weld Tooling Setup		♦	♦				♦
Incorrect Electrode Alloy		♦		♦		♦	

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Correcting weld defects

When a weld defect has occurred, reset the welding conditions by referring to the table given below.

Weld defect	Correction
Insufficient strength	Increase electrode force Increase weld time Increase welding current
Spatter generation	Increase electrode force Decrease weld time Decrease welding current Dress electrode tip
Workpiece sticking to electrode	Increase electrode force Dress electrode tip Decrease welding current
Explosive spatter generation	Increase electrode force Change gap between upper and lower electrode tips Decrease welding current Clean surface of workpiece
Dent or burn	Increase welding current and decrease weld time Increase electrode force Dress electrode tip Clean surface of workpiece Check center alignment and tip flatness of upper and lower electrodes

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Preventive Maintenance

Excuse me sounding like an old cliché but "A Clean Machine Is A Happy Machine" and happy machines make happy users. If properly maintained your welder will keep up production, save you money and function flawlessly. Not only do you want to keep the welder cleaned and properly maintained but you also want to keep the surrounding area properly maintained. A clean shop results in your expensive machinery operating much more efficiently. This especially holds true for today's modern microprocessor controls.

Your welding machine or any equipment for that matter should never be used as tool cribs, clothing racks, ashtrays, coffee tables or sort. Not only will this hamper your machine performance but can result in a safety hazard.

CAUTION: Before performing any preventive maintenance be sure to remove all power and air to the welder.

The points outlined in this section are not intended as a detailed schedule for preventive maintenance on all types of resistance welders. You can however use this as a guideline and adapt it to your production. The suggested intervals are based on an eight-hour day. If you use your equipment on multiple shifts adjust your procedure accordingly.

Records

Each welder should have a separate equipment history book. This book should have tabulations of all maintenance problems and solutions occurred. This will become a valuable aid when troubleshooting and result in greater up time.

This book is an excellent place to log your preventive maintenance schedules and results.

Daily

- Wipe all surfaces clean of dirt, dust, grease, oil and water. Pay particular attention to cleaning clamp surfaces.
- Clean up work area.
- Check the water flow.
- Check for air and water leaks and repair if needed.

CAUTION: Use a mild detergent for cleaning paintwork or Lucite windows.

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EVERY DAY

Perform the following items of maintenance on the machine every day for its safe and trouble-free operation.

Machine

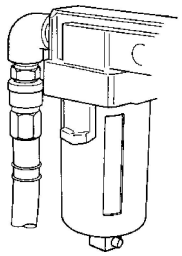
Check for abnormal vibration, noise, and odor.

Check that the air pressure is 0.5 MPa {71 psi}.

If not, adjust the air pressure as described in “Connecting compressed air” in Part II, Installation.

Check the air filter for drain.

If drain is collected in the air filter, press the white button at the lower part of the air filter to remove the drain.



Check for abnormal overheating.

Check the power cable for damage.

Check for water leakage.

Check the machine and electrode cooling water hose connections for water leakage.

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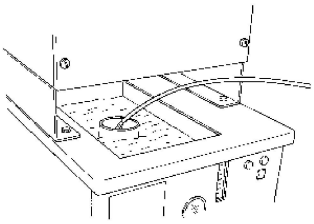
Chiller unit

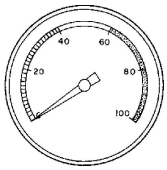
Check that the water level is proper.

If the water level is low, remove the top cover of the chiller unit, and add water through the water filler opening to a level between the H and L marks. (Add 20 parts water to 1 part cooling water additive.)



Check that the water temperature is proper.

The faceplate of the water temperature gauge is divided into the following zone:



Green zone: 0 to 40°C

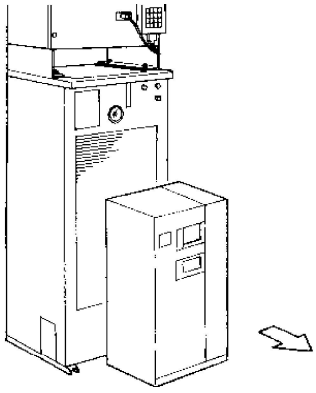
Yellow zone: 40 to 50°C

Red zone: 50 to 100°C

The green, yellow, and red zones indicate normal, caution, and abnormal (dangerous), respectively. When the pointer is in the yellow or red zone, it may indicate an excessive duty cycle, low water level, or clogged filter, among other conditions. Check and remove the cause, and stop the welding operation until the cooling water temperature drops to normal.

Check that no obstacles are placed before and after the chiller unit.

Remove such obstacles. They may raise the water temperature or cause the chiller unit to fail.



Check for water leakage.

Check the radiator and pump of the chiller unit for water leakage.

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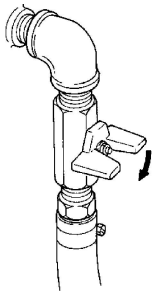
Chiller unit

Check that cooling water is not dirty.

Remove the top cover of the chiller unit, and check the cooling water in the tank. If it is dirty, change it. Deposit of foreign matter in the tank obstructs the follow of the cooling water.

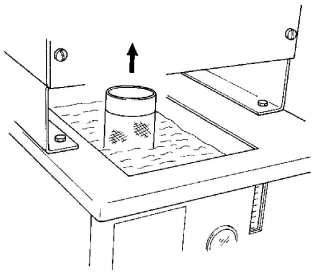


1 Turn the cock at the top rear of the tank to drain the tank.

2 Clean the tank, and close the cock. Add water to the tank (20 parts water to 1 part cooling water additive).

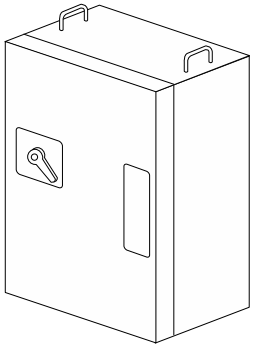
Check that the filter is not dirty.

Remove the top cover of the chiller unit, and check the filter in the tank. If it is dirty, remove it upward, clean it, and replace it in the tank.



Check the non-fused circuit breaker.

Check that the handle of the non-fused circuit breaker properly moves.



1 Check that when the handle of the non-fused circuit breaker is turned to OPEN, the door of the inverter control unit opens and the non-fused circuit breaker switch in the inverter control unit turns to OFF.

2 Check that when the door of the inverter control unit is open, the non-fused circuit breaker switch does not turn to ON.

Check the terminals and connectors for looseness.

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With power on and in setup mode…

- Listen for any abnormal noises coming from the control area.
- Check timers and control for proper dial settings according to schedule chart.
- Check for malfunctioning interlocks or safety devices.
- Sequence machine and check for abnormalities.

With power off…

- Clean electrode or die holders and clamps.
- Check for misalignment and realign if needed.

Weekly

- Check relays for wear or looseness.
- Check for burned out indicator lights and other display functions.
- Clean nameplates.
- Check cylinder rod locking nuts.
- Remove sample of oil from lubricator unit and test for deterioration or contamination.
- Check fluid filters if applicable.
- Check cylinder for air leaks and mounting.

Monthly

- Flush the entire system or reverse to remove any accumulation of foreign matter. If you notice a build up you may want to flush it with a solution of vinegar and water.
- Remove and clean any strainers or filters.
- Replace worn or cracked hoses.
- Tighten all hose clamps.
- Check and correct water temperature and pressure.
- Make sure that shutoff solenoids and valves are operating correctly.
- Check ground connections on your separate earth ground.
- Tighten all terminal connections and visually examine all solder connections.
- Check line voltage with and without welder load. Voltage should not vary more than 10%.
- Make sure all air vents are free.
- Check wire insulation for cracks and dirt accumulation. Replace if needed.
- Vacuum or blow out control unit, be sure to cover any electronic components when blowing out control.
- Remove air filter and clean.
- Check for loose cylinder bolts or hold down plates.
- Inspect shock blocks for secure weldments.
- Check cylinders for air leaks and rods for score marks.
- With the air removed check for sluggishness or sticking of cylinders. All cylinders should move freely without air connected.
- Check air gauge for excessive pressure drops during operations.

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- Check all speed control setting, adjust and lock.

Quarterly

- Use master level and check machine. Re-level if needed.
- Check water system thoroughly and replace components, which show wear or corrosion.
- Polish all secondary contact surfaces to remove corrosion or oxidation. Use a very fine sandpaper and steel wool. Avoid using tetrachloride in poorly ventilated areas.
- Tighten all secondary contact connections.
- Check protective and overload devices.
- Check air gauges and regulators with pressure indicator. Replace damaged regulators and gauges or those that are sluggish or need calibrations.
- Replace worn or cracked air hoses, air mufflers, lubricators or filters.
- Replace oil in lubricator unit and change or clean oil filters.

Annually

- Remove all grease and rust from the welder and apply a coat of machinery paint.
- Check for extensive wear of trunnions, bearing, brushed, etc. and replace worn or damaged parts.
- Reverse flush water system and replace hoses where required.
- Check and replace air hoses and piping where required.
- Check and replace over temperature switch or flow switch if needed.

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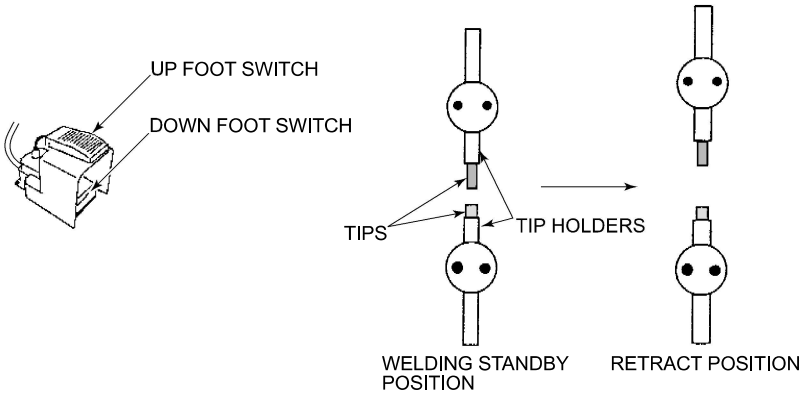
Changing electrodes

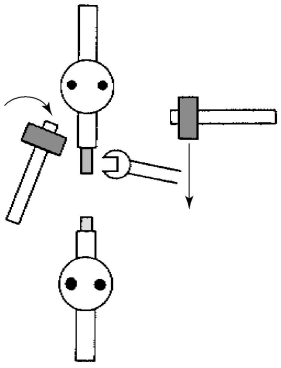
Change the electrode tip or holder as described below.

Changing electrode tip

1 Press the up foot switch to move up the upper electrode to the retract position.



2 Apply a wrench to the tip of the upper electrode, and strike it vertically with a plastic hammer to remove it.



NOTICE

- If you forcibly remove the tip of the upper electrode with a wrench or the like, you damage the taper portion of the tip or tip holder. The tip can be easily removed by striking its taper portion with a plastic hammer.

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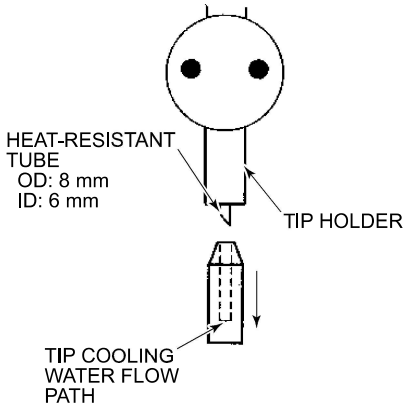
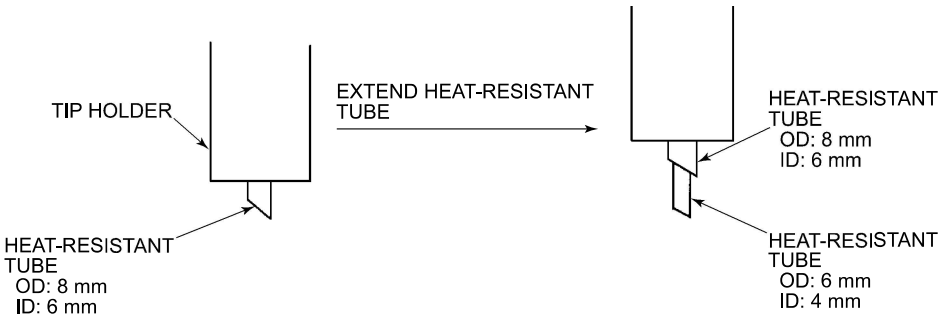
3 Check that the heat-resistant tube (cooling water tube) is brought close to the cooling water flow path of the tip to be changed.

NOTE

- When the end of the heat-resistant tube is not close enough to the end of the water flow path of the tip, the cooling water does not circulate at a high enough rate to cool the tip, resulting in improper welding. When use a long tip, extend the heat-resistant tube to ensure the circulation of cooling water to the end of the tip.





4 Insert the new tip into the tip holder.

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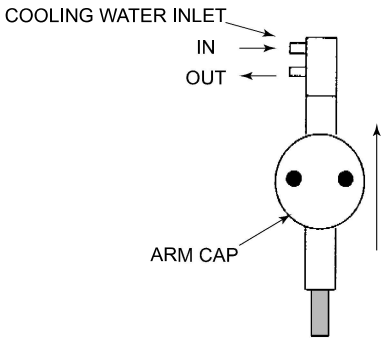
Changing tip holder

1 Loosen the two socket head bolts of the arm cap, and pull out the tip holder. (The outside diameter of the tip holder is 32 mm.)

NOTE

- Be sure to connect the cooling water hose to the tip holder for its cooling.

2 Install the new tip holder, and securely tighten the two socket head bolts of the arm cap.

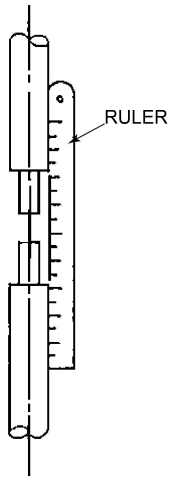


MAINTENANCE AFTER ELECTRODE CHANGE

Centering electrode holders

1 Apply a ruler to the upper and lower electrode holders as shown at right, and check that there is no clearance.

2 If there is clearance, loosen the four bolts of the arm or the two bolts of the arm cap, and center the upper and lower electrode holders.



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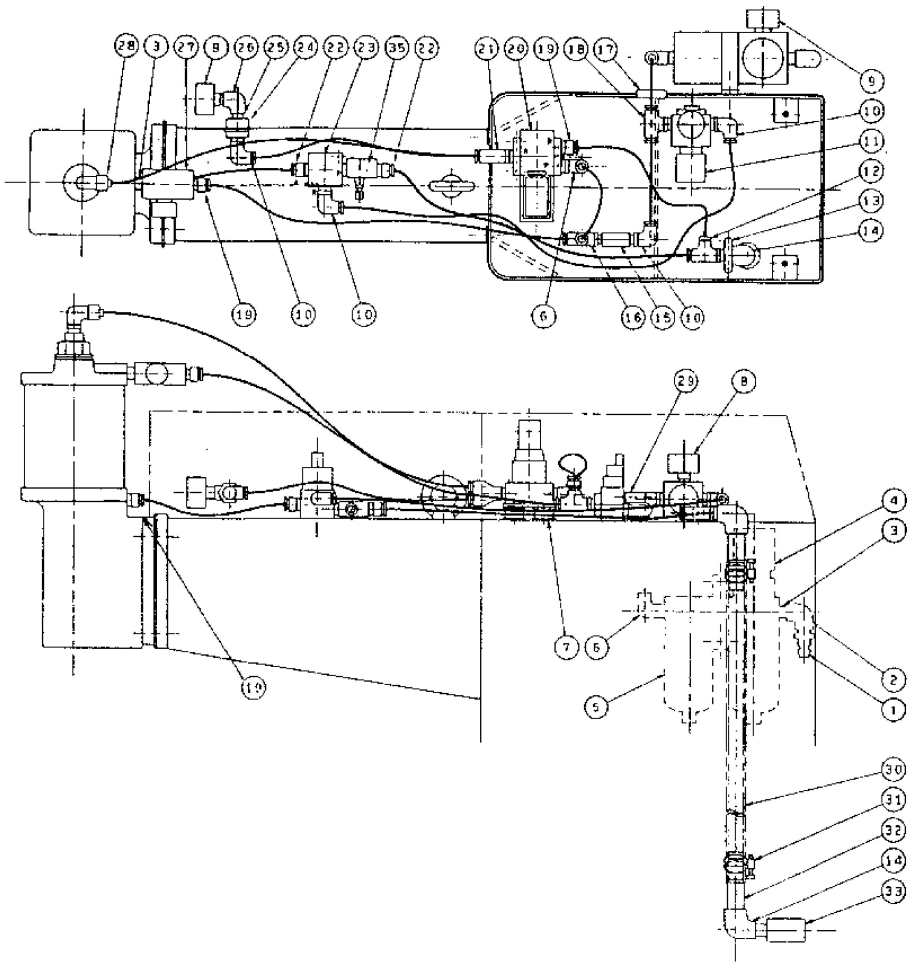
PNEUMATIC PIPING DRAWING



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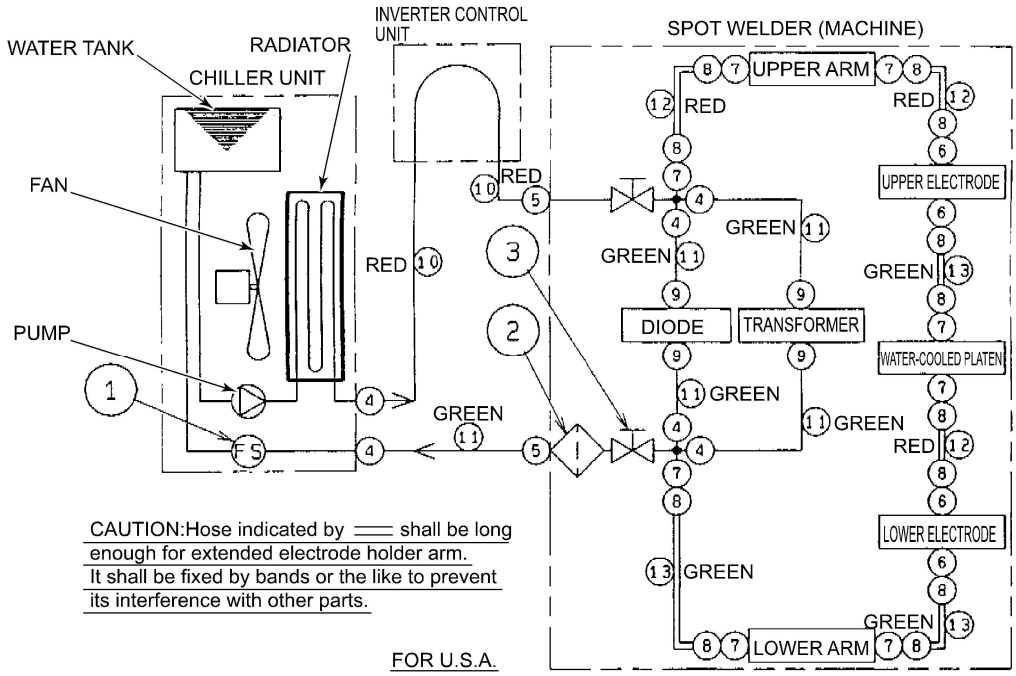
COOLING WATER SYSTEM DIAGRAM



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Machine Parts List

REFERENCE	PART NUMBER	DESCRIPTION	QTY.

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Model 108 Weld Control Form

Job #:		Date:	
Group			
Weld Schedule #:			
Squeeze Delay			
Squeeze Time			
Impulse			
Cool Time			
Heat Time			
Heat %			
Quench Time			
Temper Time			
Temper %			
Hold Time			
Off Time			
Upslope Steps			
% Heat / Step			
Material 1 Type			
Thickness			
Material 2 Type			
Thickness			
Transformer #:			
Transformer Tap			

Manual Valves (*9)	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Valve Mode															

Control Mode (*1,*2, None)		Chained		Chained		Chained
		Successive		Successive		Successive
		None		None		None

Upper Tip Material and Size	
Lower Tip Material and Size	
Electrode Pressure	
Clamp Pressure	
Upset Pressure	

Comments:

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Model 108B Weld Control Form

Job #:		**Date:**	
Group			
Weld Schedule #:			
Squeeze Delay			
Squeeze Time			
Impulse			
Cool Time			
Heat Time			
Heat %			
Quench Time			
Temper Time			
Temper %			
Hold Time			
Off Time			
Upslope Steps			
% Heat / Step			
Material 1 Type			
Thickness			
Material 2 Type			
Thickness			
Transformer #:			
Transformer Tap			

Manual Valves 1-8 (*9)	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Valve Mode																								

Manual Valves 9-16 (9)**	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Valve Mode																								

Limit Switch (5)**	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Limit Switch Mode																								

Control Mode (*1,*2, None)		**Chained**		**Chained**		**Chained**
		Successive		**Successive**		**Successive**
		None		**None**		**None**

Comments:

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Model 108B Weld Control Form

Job #:									Date:													
Group																						
Weld Schedule																						
Squeeze Delay																						
Squeeze Time																						
Impulse																						
Cool Time																						
Heat Time																						
Heat %																						
Quench																						
Temper Time																						
Temper %																						
Hold Time																						
Off Time																						
Upslope Steps																						
% Heat / Step																						
Material 1 Type																						
Thickness																						
Material 2 Type																						
Thickness																						
Transformer #																						
Transformer Tap																						
Manual Valves 1–8 (* 9)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Valve Mode																								
	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
Manual Valves 9–16 (** 9)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Valve Mode																								
	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
Limit Switch 1-8 (**5)	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Limit Switch Mode																								
	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8	5	6	7	8
Control Mode		Chained		Chained		Chained		Chained		Chained		Chained		Chained		Chained		Chained		Chained				
(* 1 Chained, *2 Successive or None)		Successive		Successive		Successive		Successive		Successive		Successive		Successive		Successive		Successive		Successive				
		None		None		None		None		None		None		None		None		None		None				
COMMENTS:																								

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EN1000 Weld Control Form

EN1000 Worksheet

Schedule	Squeeze	Weld/ Heat	Percent Current	Hold	Off	Imp.	Cool	Valve Select	Cycle Mode	Slope Mode	Slope Count	Comment	Instruct-ion
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

EXTENDED FUNCTIONS

SEAM/SPOT	00	00=SPOT 01=SEAM
SCHEDULE SELECT		00=INTERNAL 01=EXTERNAL 02=ANTI-TIE DOWN
AVC	00	00=OFF 01=120 02=240 03=380 04=480 (VOLTS)
BACK STEP	00	00=TEMP LIMIT SWITCH 01=BACK STEP
PROCESS OUTPUT		00=NONE 01=WELD 02=WELD & HOLD 03=HOLD 04=OFF 05=AFTER OFF 06=EOP 11=TLS
BEAT (b.E.)	04	00=NOW BEAT 01=BEAT IN SQUEEZE 02=BEAT IN SQUEEZE & WELD
87 DEGREE	00	04=BUTT WELD
POWER FACTOR	00	00=OFF 01=ON
		00=OFF 99-MAXIUM

MODES

CYCLE MODE
00=NON-REPEAT
01=REPEAT
02=CHAINED
03=SUCCESSIVE

SLOPE MODE
00=NONE
01=UPSLOPE
02=DOWNSLOPE

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How To Set Up A Resistance Spot Welder

Fabricators who are concerned with producing consistent quality welds should understand that electrode force, weld time duration and weld current intensity are closely related and a change in one parameter will affect the others. Increasing only the current without adequate weld force could result in severe expulsion or weld splash. A change in force without corresponding changes in current and weld time can also result in poor welds.

Since the majority of resistance welders are of single phase AC type, it is important to consider the effects of electrical impedance when setting up a resistance welder. Due to reduced efficiency caused by an impedance, a single phase AC type welder with a long throat depth and/or a wide throat gap may not have the same capacity as a short throat/short gap welder of equal KVA rating. When any magnetic material, such as mild steel, is placed into a throat of a welder, the impedance is increased, further reducing weld current at the electrodes. For this reason, weld samples should always duplicate actual workpieces in terms of mass and resultant impedance.

Consult the recommended weld schedules included in this catalog to help determine the required electrode force, weld current (secondary amperage) and weld times necessary to achieve the weld quality classification specified for the application. **Note:** *that while weld schedules may list permissible variations which show a 10 to 30 percent reduction in weld strength for a specific type and thickness of material, an even greater difference may occur in weld appearance*. Be sure to select the schedule which provides the strength and cosmetics required for the application.

While it is possible to set up a resistance spot welder without instrumentation, a weld current and time analyzer and an accurate weld force transducer with analog or digital readout should be employed for best results.

SET-UP PROCEDURES

As with all machinery, a safety inspection should be made to assure proper installation and use of the welder. Operators must wear suitable eye protection and shop clothing. The manufacturer's operating manual should be reviewed to familiarize operating personnel with the functioning of the welder as well as any special features.

If the welder OEM has provided a Set-Up/Run switch on the control unit, be sure to place the switch in the set up position. This will disengage the initiation switch (usually an electric foot switch or palm buttons) and provide an additional safeguard when aligning or changing tooling and electrodes. If a selector switch has been provided for the foot switch mode of operation (single stage/double stage), you may choose either position.

The following procedures are based on use of a pneumatically operated, single-phase AC spot welder equipped with a NEMA type S2H four sequence control with phase shift current selection.

1. Turn on the compressed air and water to the welder. Check for adequate water flow and air pressure, then turn on the electrical power to the welder. **NOTE:** Air and water should be turned on before power. Some installations may incorporate an electronically operated solenoid valve which turns on the water only when the power to the welder has been turned on.
2. Adjust the air pressure regulator to the required air pressure to obtain the desired electrode force. Some welders may have a force chart attached to the machine to indicate weld force based on the air cylinder size and incoming air pressure. Rocker-arm type spot welders may not have a force chart as the force may decrease according to the throat depth. Actual weld force should be verified with a weld force transducer or gauge.
3. Energize the welder control panel if a separate switch was provided for this purpose.
4. Set "Squeeze" time to the maximum setting.

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5. Adjust "Weld" time (also referred to as weld count or heat time) sequence to the recommended setting for the type and thickness of material to be welded.

6. Set "Hold" time sequence to provide adequate time for the hot weld nugget to cool while held under the electrode force.

7. Set "Repeat" switch to non-repeat position.

8. Consult welder OEM's operating manual or specification sheet to determine nominal maximum weld current which can be produced at the throat depth you are using. The maximum rated current should exceed the amount needed to produce the weld quality specified for your application. The actual maximum current will be affected by any increase or decrease in primary line voltage. Connecting a 220 volt welder to a 208 volt primary electrical supply would decrease the rated maximum weld current by 5%.

9. If the welder transformer is equipped with a tap switch, adjust the tap to the position which approximates the required weld current output and set phase shift at 50%.

If a tap switch is not provided (controls that contain phase shift weld current regulation have in many cases, eliminated the need for tap switches and series parallel switches), adjust the control's phase shift to the percentage which corresponds to the weld current needed. **CAUTION: Since welder OEM's usually measure maximum weld current output in short circuit without a workpiece between the electrodes, actual "working weld current" will be less and should be verified with a weld current analyzer,**

10. Place the "Weld/No Weld" switch into the "No-Weld" position.

11. If so equipped, use the electrode alignment valve to bring the electrodes together without air pressure. Check the electrode alignment and stroke. Electrodes should meet squarely. Unlike other metal working machinery, a resistance welder should not operate at the end of it's stroke. A short stroke will deliver full force in accordance with the cylinder size and air line pressure. The stroke should be set as short as possible to minimize pinch points, yet allow the workpiece to be fed into the welder.

NOTE: IT IS THE RESPONSIBILITY OF THE USER TO PROVIDE ALL NECESSARY GUARDS AND SHIELDING. MAKE SURE THAT FINGERS, CLOTHING OR OTHER ITEMS ARE IN THE CLEAR AND AWAY FROM ALL PINCH POINTS.

12. If applicable, place the welders "Run/Set-up" switch in the "Run" position.

13. Initiate and operate the welder through a complete sequence with parts between the electrodes. Check tip alignment, downstroke and upstroke speeds and adjust the speed control valve if necessary. Excessively fast downstroke speeds can cause "hammering" of the electrodes resulting in the deformation of the electrode face and reduce tip life. Slow speeds may require longer squeeze time and will in turn slowdown operation.

14. Place the "Weld-No Weld" switch in the "Weld" position.

15. Place a sample workpiece between the electrodes, exercising care to keep fingers, clothing, etc. in the clear. The sample should duplicate the actual welding conditions regarding material type, thickness and impedance in the welder throat.

16. Initiate and sequence the welder. Check the weld current and time analyzer to determine actual current and time. If the analyzer shows a lower or higher current than desired, adjust the phase shift accordingly. Increase in 1% increments. Repeat this step until you obtain as close as possible the required weld current. Do not weld over a previous weld. Use a different sample workpiece.

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17. Remove and examine welded sample. Indentation should not exceed 10% of the material thickness.
18. If testing discloses a weak weld or a no weld condition, it will be necessary to increase weld current intensity as in step #16. If, on welders having transformer taps and phase shift, and 99%/100% is reached before a good weld is obtained, advance the tap switch one step and reduce the phase shift to approximately 80% and repeat step #16.
19. When satisfactory welds have been made, the squeeze and hold sequence times may be adjusted to optimum settings. Consult weld schedules for recommended hold times.
20. If automatic repeat welding is required, place the "Repeat/Non-Repeat" switch into the "Repeat" mode and adjust the "Off or Interval" time sequence to a sufficient length of time to permit the workpiece to be moved into position for the next weld. When welding in "Repeat" mode, a spotwelder will continue to sequence and weld for as long as the operator continues to keep the initiation circuit energized.

As with any welding process you may sometimes encounter difficulty. If you stop to examine what you are doing, you will usually find that the problem can be corrected. The most common cause of spotwelding problems is the failure to properly select and maintain the electrodes. Poor electrode life is usually traced to improper water cooling and/or incorrect weld schedules. Excessive weld times do not make better welds and will result in poor weld appearance, as well as, shorter electrode life.

Refer to the chart below for a general trouble shooting guide, which list some resistance welding problems and their possible causes. A better understanding of the resistance welding process and how to use it will enable you to increase your spotwelding productivity and improve the quality of your welded assemblies.

✻ PRIMARY CAUSE ◆ SECONDARY CAUSE		TYPE OF WELD DEFECTS					
POSSIBLE CAUSE OF WELD DEFECT		WEAK WELD	EXPULSION OR WELD SPLASH	ELECTRODE MUSHROOMING	EXCESSIVE WELD MARKING	ELECTRODE STICKING	NO WELD
WELD CURRENT	LOW	✻			◆		✻
	HIGH		✻	◆	✻	◆	
WELD TIME	SHORT	✻					✻
	LONG		✻	✻	✻	◆	
WELD FORCE	LOW	◆	✻		◆	◆	
	HIGH			✻	✻		◆
SHORT SQUEEZE TIME			✻		◆	✻	◆
INCORRECT FOLLOW UP			◆			◆	
INADEQUATE COOLING		◆		✻	◆	◆	
ELECTRODE FACE DIAMETER	SMALL	✻	◆		◆	◆	
	LARGE	✻					◆
POOR METAL FIT UP		✻	✻		✻		✻
DIRTY OR SCALY METAL		◆	◆			◆	✻
TOO CLOSE WELD SPACING		✻					◆
INCORRECT WELD TOOLING SETUP		◆	◆				◆
INCORRECT ELECTRODE ALLOY		◆		◆		◆	

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RESISTANCE WELDER SAFETY

All welding department supervisors, plant safety officers and other personnel whose responsibilities include plant safety and/or installation, operation and maintenance of resistance welding equipment must take care to thoroughly familiarize themselves with all applicable codes, regulations and standards regarding the safe installation, use and maintenance of such equipment.

resistance welders are designed to meet or exceed the Resistance Welding Manufacturers Association standards for high performance and safety. They comply with all current interpretations of OSHA regulations at time of manufacture. Whenever practical and/or available they incorporate UL and CSA listed electrical components. However, since welder manufacturers do not know and cannot foresee the magnitude of potential hazards when welders are improperly utilized, current OSHA regulations state that it is the responsibility of the user management to assure that any and all necessary guards and shielding be installed and maintained and that installation, operating and maintenance personnel are competent, properly trained with respect to the subject equipment and comply with all applicable safety codes and OSHA regulations.

The following is a general guideline only. Each user plant and machine may have unique characteristics. Use your knowledge, experience and common sense to apply these guideline where applicable.

RESISTANCE WELDING GUARDING

1. It is the responsibility of user management to ascertain that all OEM installation and operating instructions and/or personnel training is complied with and to furnish other safety instructions according to the application.
2. The welder must be set-up in order that it is impossible for personnel to place their hand or any other body part in any pinch point or moving area. All pinch points must be identified with a warning label or sign.
3. Guards, shields or other devices to keep the operator's hands or other body parts out of danger must be furnished by user management and maintained in a safe, operating condition.
4. User management must schedule and ascertain that periodic inspections are conducted to assure safe and proper operation of the welder and collateral tooling and equipment.

GENERAL

1. Installation, operating and maintenance personnel must read and thoroughly understand all welder OEM instructions, cautions and warnings prior to the installation, use, maintenance or repair of resistance welding equipment.
2. User management and supervision must assure that all personnel operating resistance welders are properly trained and are judged competent and physically able to operate such equipment.
3. Using the OEM documentation and warning labels, where applicable, user supervision must alert an operator of the safety hazards which can occur if proper precautions are not followed.
4. Users of resistance welding equipment are responsible for full compliance with all applicable safety and operating procedures, as well as, with all applicable governmental laws and codes.
5. When the OEM documentation, instructions and safety information are provided in the English language, the user supervision is responsible for assuring that all non-English speaking personnel thoroughly understand all instructions and safety procedures.
6. The user should comply with OSHA Regulation 29CFR1910 regarding the installation, operation and maintenance of resistance welding equipment.
7. The user should institute a periodic safety inspection to assure proper and safe operation of resistance welders.
8. All repairs or modifications should be performed by or authorized by the welder OEM.
9. Operators must be instructed in the proper procedures to follow in the event of an emergency.
10. First Aid equipment must be readily available at all times when operating welding equipment.

ELECTRICAL

1. High voltage is present in the controls, tap switch, terminal blocks and transformers. All the necessary precautions are to be observed.
2. Installation of the main disconnect and main power connections to the machine are to be made by a licensed electrician. All local codes must be observed.

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3. All HIGH VOLTAGE power wiring must be properly sized.
4. All resistance welding equipment must be grounded with a separate earth ground. The ground lead should be sized sufficiently.
5. Failure to follow electrical safety precautions could result in serious injury or death.

PNEUMATIC AND WATER

1. The operator must monitor the equipment upon start up for air or water leaks.
2. The air filter must be bled regularly and air lines kept clean.
3. Assure that the air pressure is adequate and consistent for the welder.
4. Assure that the water flow is not hampered or obstructed.
5. In the event of an air or water leak, remove all power from machine before qualified personnel attempt to correct problem.
6. Never use electrically conductive water hoses on resistance welders or controls.

OPERATOR PRECAUTIONS

1. A daily safety check should be made prior to powering up the welder. If a problem is found, it should be corrected before proceeding with the work.
2. Only properly trained personnel should operate a welder. Only qualified maintenance personnel should attempt to repair a welder.
3. No modification of the safety devices shall be made without the written authorization of the welder OEM.
4. Keep all body parts clear of all moving parts.
5. Heed all Warning or Caution labels.
6. The operator should be aware of the function and operation of the Emergency Stop switches if so equipped.
7. Do not leave the welder unattended with the power on.
8. It is the user's responsibility that proper safety equipment is used when welder is being operated. These include but are not limited to:
   - Protective glasses
   - Protective shoes
   - Non-flammable outer garments
9. Initiation should normally be made by only one person unless other safety designs have been incorporated by the manufacturer to allow multiple initiations.
10. Operator should be aware of the magnetic fields generated by the welder. The fields can play havoc with watches and other electro-mechanical devices.
11. If a welder malfunctions or operates in an unusual manner, the equipment should be switched off and corrected by qualified personnel.

NOTE: In order to properly correct resistance welding safety problems, it may be necessary to apply a thorough understanding of the resistance welding process and welding machine operation, as well as, applicable safety standards.

EXAMPLE: A supervisor notices that one spotwelder produces severe expulsion or weld splash with each weld. The supervisor's solution is to place several movable partitions around the spotwelding work station to shield personnel from the weld splash.

Subsequent investigation by a resistance welding specialist discloses that the weld splash is caused by inadequate electrode force resulting from severe leakage of compressed air from the welder's air cylinder. Replacement of worn seals in the air cylinder will stop the air leak, restore normal electrode force and eliminate both the weld splash and the need for the shielding partitions, as well as, improve weld quality.

As demonstrated in the example, when dealing with safety hazards it is necessary to examine not only the effect of the problem but also the cause if one is to find the total solution.

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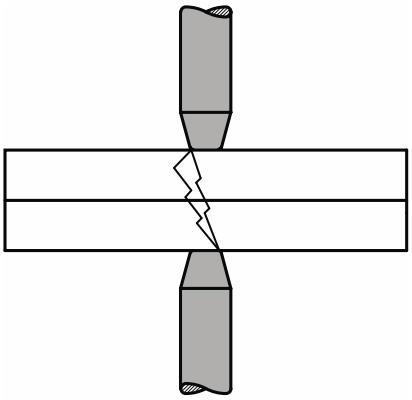
What You Should Know About Resistance Welding

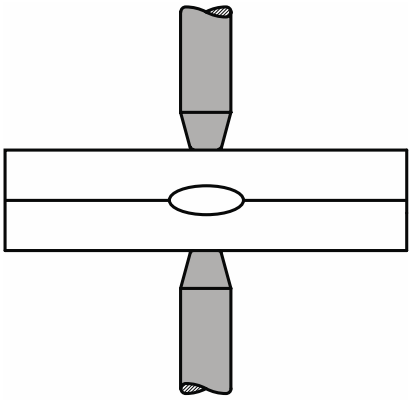
Most welding applies heat to join two pieces of metal. Gas welding produces molten metal through the use of a gas flame. When the molten metal cools, the pieces are joined. Arc welding uses an electric arc between the electrode and the work to melt the metal. Both processes use "consumables" such as gasses, fluxes, electrodes, etc. and add metal to make the weld.

Resistance welding joins two pieces of sheet metal without adding anything. Resistance welding relies on the application of heat (electrical current), time and pressure to make a weld. When an electrical current is applied to the work pieces, for a predetermined time a nugget of molten metal is created between the two pieces. When the nugget cools, the pieces are joined.

The electrical current is transmitted through two copper alloy electrodes, as shown:



When the electrical current is applied, the electricity goes through two electrodes and creates the nugget of molten metal as shown:



The nugget is created at the point where the two pieces interface because this is the point of maximum heat generation. The heat producing the melting process is caused by the metals' electrical resistance to the current flow.

The word "resistance" in Resistance Welding describes the characteristic reaction of the metal to electricity. For example, copper has a lower resistance to electricity than steel. Most Resistance Welding electrodes are made of copper alloys to permit good current flow. The pieces to be joined (generally steel) have a higher resistance to electricity. As the current is applied, the electricity goes through the copper electrodes easily, but encounters resistance as it passes through the steel. The resistance is usually highest at the interface of the two pieces to be joined. This causes the steel at the point of contact to melt, creating the nugget of molten metal mentioned above. In addition to the flow of electrical current, the copper alloy electrodes also transmit a mechanical force or pressure. This force is necessary for a number of reasons, the most important being to prevent the expulsion of molten metal from the weld nugget.

The time involved is very brief. The thickness and type of material to be joined determine the amount of time required for the flow of electrical current. Usually this "weld time" is less than one second.

Resistance welding equipment consists of all or most of the following:

1. A rigid frame which houses a welding transformer to convert high primary voltage and low primary amperage to low secondary voltage and high secondary amperage needed for welding.

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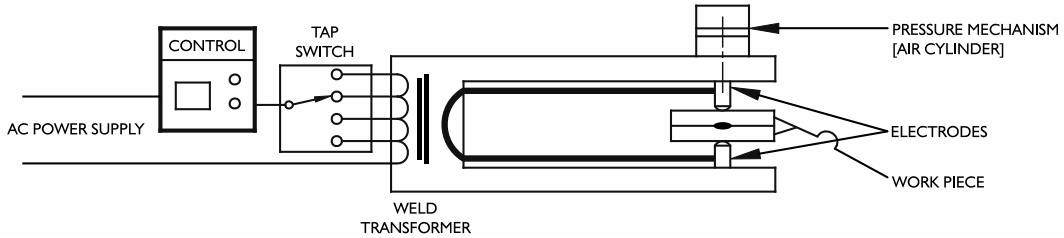
2. The electrodes for passing the current through the work pieces.
3. The conductors which connect these electrodes to the welding transformer.
4. A device for exerting electrode force on the work.
5. A method of regulating the electrical current.
6. A contactor to interrupt the power to the welder transformer.
7. A timer which is capable of controlling the action of the contactor within the limits of accuracy required to produce the desired weld characteristics.
8. A method of cooling the electrodes with water.

Following is a schematic drawing of these components:



Every metal has its own characteristic resistance to electrical current. The amount of heat generated by a given resistance is expressed by this formula:

$$W = I^2Rt$$

"W" is the heat in Watt seconds
"I" is the current Ampere flowing through the work
"R" is the resistance of the metal in ohms
"t" is the time in seconds

The amount of heat required to make a weld could also be expressed by a formula, but the important thing to remember is that the heat is directly proportional to the material's resistance, the time of current flow, and the square of the amount of current.

TIME

In resistance welding, there are four basic stages of time:

1. **Squeeze time** - The time between the initial application of the electrode force on the work and the first application of electrical current.
2. **Weld time** - The time that welding current is applied to the work.
3. **Hold time** - The time during which force is applied at the point of welding after the last pulse of current ceases.
4. **Off time** - The time during which the electrodes are off the work. ("Off Time" is an optional timing function used for automatic-repeat operation and is not necessary to produce a weld.)

Other timing sequences and control functions may be required for specific applications.

ALTERNATING CURRENT

The majority of resistance welding machines operate on single phase, alternating current of the power line frequency, usually 60Hz (cycles per second). This method incorporates a single phase welding transformer to convert the high power line voltage to a low secondary voltage, normally in the range of 1.0 to 25.0 volts. Depending on the thickness and type of material to be welded, secondary current may be from 1,000 to as much as 100,000 amperes or more.

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DIRECT CURRENT

Some resistance welders are designed to operate on a 3-Phase primary electrical service and will rectify the current from alternating current (AC) to direct current (DC). A 3-Phase DC resistance welder is electrically more efficient than a single phase AC resistance welder. This is because it usually produces more welding amperage per KVA and requires less demand on the primary electrical service. Due to significantly higher costs, 3-phase resistance welders account for only a small percentage of new resistance welder sales.

TIME CONTROL

The duration of current application referred to as time, weld time, heat time, weld count or current count, is generally controlled by electronic, mechanical or manual means. Times ranging down to one half-cycle of 60-cycle frequency are used for the thinnest sheets, and longer for thicker plates, depending also on the metal being welded. The best welds are made in relatively short times, usually less than one second. Weld times of more than one second indicate, in most cases, too small a welder is being used.

ELECTRODE FORCE

Completion of the electrical circuit between the electrodes and through the work is assured by the continuous application of pressure. For a given material's composition and thickness, the higher the magnitude of the applied force the more it serves to:

1. Bring the two surfaces into close contact.
2. Reduce initial contact resistance between the surfaces and the contacting electrodes.
3. Permit the use of higher secondary current.
4. Reduce internal cracking of the "nugget" between the joined metals.
   Too great a force will produce excessive marking of the material surfaces and, ultimately, produce a weaker weld.

ELECTRICAL CHARACTERISTICS

Most equipment is rated at a certain KVA (such as 30 KVA). The KVA (kilo-volt-amp) rating is a measure of the amount of power the equipment can handle without excessive internal heating. In most cases, the welding transformer is the limiting factor in the equipment and determines the KVA rating. It is standard practice to rate a welding transformer at a 50% duty cycle. The duty cycle of a transformer is defined as the percentage of time on in each one minute period the transformer is actually carrying current. It is expressed in this formula:

$$\%\ \text{DUTY CYCLE} = \frac{\text{WELD TIME} \times \#\ \text{WELDS PER MINUTE}}{3600} \times 100$$

In most resistance welding applications, actual duty cycle is much less than the 50% duty cycle used for rating the machine. The higher the KVA, the more power the transformer can carry. The actual welding current produced by a transformer is not directly related to its KVA rating. Transformers made by different manufacturers, but with the same KVA rating, may produce widely different amounts of welding current. It is important to compare not only KVA rating, but welding current when comparing resistance welding machines.

Selecting resistance welding equipment must take all of the following factors into consideration:

1. The amount of voltage and current available in the user's plant.
2. The type and thickness of metal to be welded.
3. The amount of heat to be applied.
4. The amount of weld time necessary to weld the two pieces of metal.
5. The total time required (weld cycle) to apply pressure, flow welding current, forge the weld and open the electrodes.

EFFECTS OF MATERIAL

Cold Rolled Steel (CRS) - Cold rolled steel is the ideal metal for spot welding. Cold rolled steel is not an exact specification for material but is generally taken to mean a clean, non-alloyed, low carbon steel which is free from any surface coatings, rust, scale or any other foreign material on the surface. A light oil coating is not detrimental. All capacities and capabilities quoted for resistance welders refer to cold rolled steel unless otherwise indicated.

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Elconite

Ignitron Tubes

Seam Welder Wheels

C.D. Studs

ARC Studs

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Stainless Steel - Most stainless steels are readily welded by spot welding. For equivalent thicknesses of stainless steel compared to CRS, stainless steel requires less weld time (or weld heat where adjustable) and more tip pressure. A few grades of stainless steel will produce poor or brittle welds. When in doubt, make a test weld or consult a material supplier.

Aluminum - Aluminum is more difficult to weld because it is a good conductor of electricity and produces relatively little heat. Depending upon the alloy grade and required weld quality, aluminum alloys may require two to five times the secondary welding amperage needed to weld an equivalent thickness of mild steel. This may dictate the use of a larger, higher KVA rated resistance welder than required for welding steel. Some aluminum alloys are not suitable for resistance welding and will produce poor welds even in thin gauges. Consult your material supplier or make a test weld.

Copper, Brass, Etc. - Copper usually cannot be welded because its electrical conductivity is better than aluminum. Some copper alloys can be welded in thin gauges. Appropriate tests are required.

Coated Steel - To weld a coated steel, the coating must be electrically conductive. Thus, pre-painted or vinyl coated steel for example, cannot be welded without removing the coating at the point of welding.

The most common coating given to steel is a zinc or zinc alloy (galvanized, for example). Other metallic coatings such as tin are also used. Any coating will reduce the capacity of the steel to be welded. In other words, you will not be able to weld a coated heavy material as well as one that is not coated. Actual capabilities must be determined by test. As a rule of thumb, welding capabilities of electro-galvanized steels are reduced by at least 25%. Hot-dipped galvanized reduces welding capacity even more. Regardless of the type of coating or its thickness, it will adhere to and contaminate the electrodes. This will require more frequent electrode dressing than when welding uncoated steel.

Guidelines for Successful Resistance Welding Applications

1. The pieces to be joined should be of compatible metals. Joining dissimilar metals (such as mild steel to aluminum) becomes very difficult because each of the metals has its own resistance factor. These factors cannot be averaged. Like oil and water, some metals or alloys do not mix. Therefore joining dissimilar metals is a very complex process.
2. The primary advantage of resistance welding is in its ease of use and speed. Resistance welding is commonly employed to weld sheet metal of 11 gauge x 11 gauge or lighter. Heavier gauges may be welded but may require a larger, higher KVA rated welder and special techniques.
3. The amount of electrode force is important. Too great a force may damage the material. Too light a force may cause expulsion of the “nugget” producing a weak weld. “Just right” is the force which helps create the nugget of molten metal without excessive marking on the surface of the metal.
4. Before resistance welding, metal surfaces should be cleaned to obtain best results. Dirt or rust on the welding surfaces may not allow the full amount of welding current to pass through the work pieces.

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ELECTRODE MAINTENANCE

This Chart graphically shows the importance of Electrode maintenance. This is not only important from the quality of the weld, which is of the first importance, but also the extra load added to the welding machine and equipment. Read the data on the chart, you can then draw your own conclusions.

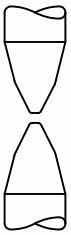
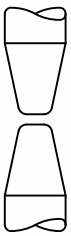
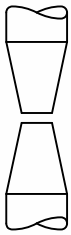
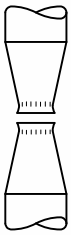
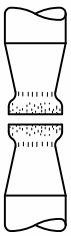
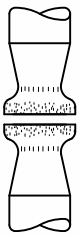
YOU CAN'T AFFORD TO NEGLECT YOUR ELECTRODES!

We can supply you with Tip Files, hand operated Tip Dressers or Pneumatic Power Driven Dressers. Design or type will depend on your production requirements.

A TIP DRESSER WILL PAY DIVIDENDS!

Keep your Electrodes dressed for maximum production and quality welds.

RESISTANCE WELDING

400% TOO SMALL **(A)**	PROPER NEW TIPS **(B)**	56% TOO LARGE **(C)**	125% TOO LARGE **(D)**	300% TOO LARGE **(E)**	525% TOO LARGE **(F)**	800% TOO LARGE **(G)**
						
Approx. $\frac{1}{8}$ th sq. in. at $\frac{1}{8}$" Dia.  2,460 Amperes only would be required (†)	Approx. $\frac{1}{20}$ th sq. in. at $\frac{1}{4}$" Dia.  9,823 Amperes only would be required (†)	Approx. $\frac{1}{13}$ th sq. in. at $\frac{5}{16}$" Dia.  15,337 Amperes only would be required (†)	Approx. $\frac{1}{9}$ th sq. in. at $\frac{3}{8}$" Dia.  22,100 Amperes only would be required (†)	Approx. $\frac{1}{5}$ th sq. in. at $\frac{1}{2}$" Dia.  39,300 Amperes only would be required (†)	Approx. $\frac{1}{3}$ rd sq. in. at $\frac{5}{8}$" Dia.  61,350 Amperes only would be required (†)	Approx. $\frac{1}{2}$ sq. in. at $\frac{3}{4}$" Dia.  88,500 Amperes only would be required (†)
127,640 lbs. sq. in. Pressure (*)	31,960 lbs. sq. in. Pressure (*)	20,470 lbs. sq. in. Pressure (*)	14,200 lbs. sq. in. Pressure (*)	7,990 lbs. sq. in. Pressure (*)	5,120 lbs. sq. in. Pressure (*)	3,500 lbs. sq. in.. Pressure (*)
RESULT: Four times too much pressure & current. Very severe indentation and splitting from high current density. **CORRECTION:** Cut pressure to ¼ Cut current to ¼	**RESULT:** Correct pressure, current & tips. Excellent weld. This is the size tip (new) for which the pressure time and current are adjusted.	**RESULT:** Only 60% of proper pressure & current. Borderline weld. Lower strength. Last diameter size tolerated unless current & pressure were set between the ¼ and $\frac{5}{16}$ size tips.	**RESULT:** Only 45% of the required pressure and current. Welds would be unacceptable. If the current or time were increased with tips in this condition a large weak weld would result.	**RESULT:** Only 25% of the required pressure and current. No weld would be made if tips were left in this condition.	**RESULT:** Only 16% of the required pressure and current. This is a very serious condition and the only cure is to dress the tips back to (B) condition.	**RESULT:** Only 11% of the required pressure and current. This is an absurd (though often seen) condition that only heats a spot.

(†) Current density required for this gauge to be 200,000 amps. per square inch. Setting is 9,900 amps. for condition (B).
(*) Five inch diameter air cylinder A, 80 Lbs. air pressure - 1,570 Lbs. on ram.

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Proper Maintenance of Spot and Projection Welding Electrodes

ELECTRODES FOR PROJECTION WELDING

To insure accurate alignment for good contact and quality welds, electrodes for projection welding should be located directly on the center-line of pressure application. In addition to producing faulty welds, misaligned electrodes can result in damage to the electrode face (Figure 1).

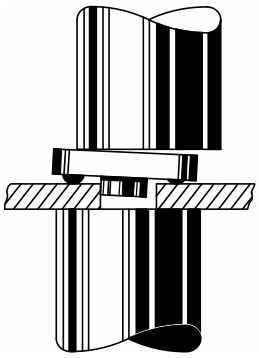


Fig. 1

Misaligned electrodes cause unbalanced pressure which results in a poor weld.

Another major contributor to a bad weld is non-parallel electrode faces. They cause unbalanced pressure on electrodes which results in expulsion of weld metal during weld cycle. This damages threads and can burn electrode insulation when welding screws through the parent metal. In addition, non-parallel faces cause weld nuts to skid against parent metal during weld, resulting in a burned pilot with distorted threads and possible misalignment with mating parts (Figure 2).

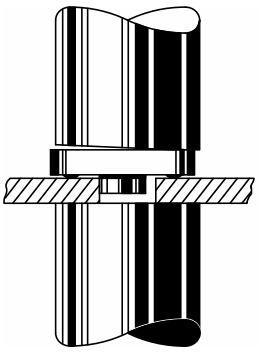


Fig. 2

Non-parallel electrodes cause skidding of the part which results in burned pilot with distorted threads.

MAINTENANCE TIPS

DO ... maintain a standby supply of electrodes at the welder to minimize downtime due to electrode change.
... dress the face of electrodes on a lathe.
... use an RWMA, Group A, Class 3 copper on the sheet side.

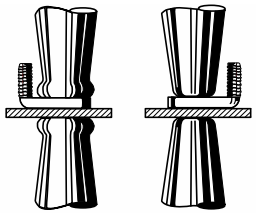
DON'T ... use a file to dress electrodes (uneven face will result in either a limited weld or expulsion of weld metal).
... store electrodes where face damage can result.
... use a pipe wrench to remove the electrodes.

ELECTRODES FOR SPOT WELDING

In spot welding, the heat concentration depends on the size and shape of the electrode tips. The weld is made by passing current through the entire area under the electrode tip. The smaller spotweld electrode tip diameters erode or mushroom much faster than projection weld electrodes; consequently, they must be dressed regularly to maintain proper contact (See Figure 3).

Fig. 3

Mushroomed tips produce poor, weak welds.



Electrodes properly dressed to insure uniform contact and sound welds.

MAINTENANCE TIPS

DO ... maintain a standby supply of electrodes at the welder.
... dress electrodes periodically with an approved spotweld tip dresser.
... change tip diameters to adjust to each thickness of metal to be welded.

DON'T ... use a file to dress electrodes (distorted face will lead to faulty weld).
... store electrodes where face damage can result.
... use a pipe wrench to remove the electrodes.

GENERAL TIPS

- To assure perfect alignment, both the faces and the axis of the electrodes must be parallel. This can be checked by inserting between the electrodes a piece of carbon and a piece of plain white paper and applying pressure. The resulting impression on the plain paper will indicate the extent and uniformity of the surface contact between the two faces.
- Utilize a water jacket when necessary and locate it as close to the welding surface as possible.
- Keep material to be welded free of oil, film, dirt and other foreign matter
- Follow the correct weld schedule.

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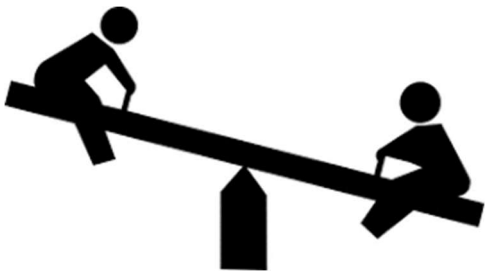
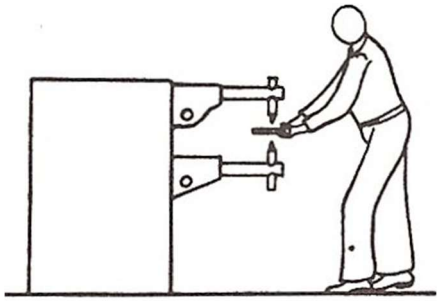
Important Notes When Setting Up a Rocker Arm Spot Welder

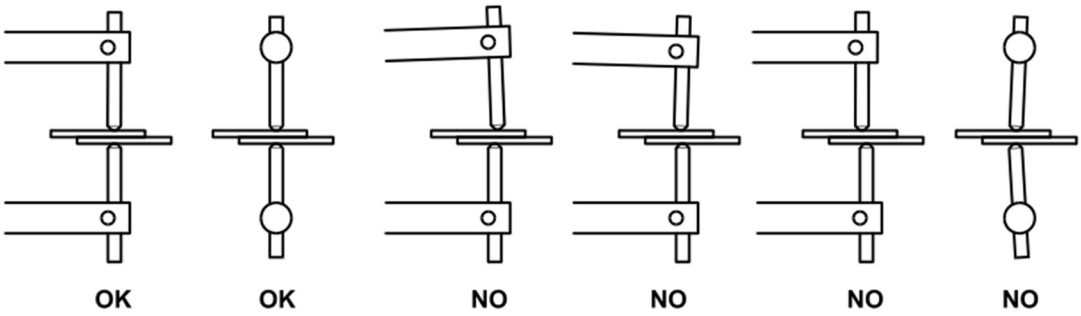
With a Rocker Arm style spot welder, the upper arm "rocks" into place, like a teeter-totter from the school yard.



What this means to the end user is that the upper electrode approaches the material to be welded in an arc.



If the weld arms are not parallel to one another, and "clocked" in the correct orientation, you will never get a good quality weld. The following diagram shows many of the common pitfalls of setting up a rocker arm welder.



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DO'S	DON'TS
1. Use the proper electrode material for the job you are doing.	1. Never use unidentified electrodes or electrode material.
2. Use standard electrodes whenever possible.	2. Avoid special, offset or irregular tips when the job can be done with a standard straight tip.
3. Use the most suitable tip diameter for the thickness of stock being welded.	3. Don't use small tips on heavy gauge welding jobs or large tips on small work.
4. Use open sight drains to observe more readily the water flow through the holders.	4. Don't forget to turn on the cooling water full force before starting to weld.
5. Connect the water inlet hose to the proper holder inlet so that the water flows through the center cooling tube first.	5. Never use water hose that will not fit the holder water connection nipples snugly.
6. Internally cool the spot welding tips with cool water flowing at a rate of at least 1½ gallons per minute through each tip.	6. Do not allow water connections to become leaky, clogged or broken.
7. Be sure the internal water cooling tube of the holder projects into the tip water hole to within ¼" of the tip hole bottom.	7. Avoid using holders with leaking or deformed tapers.
8. Adjust the internal water cooling tube of the holder to the proper height when changing to a different length tip.	8. Never use electrode holders that do not have an adjustable internal water cooling tube.
9. Be sure top end of adjustable water cooling tube in holders is cut at an angle so as to avoid jamming tip down and shutting water off.	9. Do not permit adjustable water tube to be "frozen" by accumulation of deposits. A few drops of oil periodically will keep the tube free.
10. Place a thin film of Koperkote® grease on the tip taper prior to inserting in the holder, to make it easier to remove.	10. Do not allow electrodes to remain idle in tapered holder seats for extended periods.
11. Use ejector type holders for easy removal of tips and to avoid damage to tip walls.	11. Don't use pipe wrenches or similar tools to remove electrodes.
12. Keep the tip taper and holder taper clean, smooth and free of foreign deposits.	12. Avoid using white lead or similar compounds to seal a leaking taper.
13. Dress spot welding electrodes frequently enough to maintain the weld quality.	13. Never permit a spot welding tip to mushroom enough to make dressing difficult.
14. Dress electrodes in a lathe to their original contour whenever possible.	14. Never use a coarse file to dress electrodes.
15. Use a rawhide or rubber mallet for striking holder or tips in aligning operations.	15. Don't pound on the holder or tip with a steel hammer in aligning the welder arms.
16. Provide flood cooling on both sides of the seam welding wheel.	16. Avoid the use of seam welder wheels too thin to stand the heat or pressure of the job.
17. Use properly designed knurling wheels to maintain proper seam welding wheel shape.	17. Do not permit seam welding wheel to run off the corners of the work being welded.

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Typical Physical and Mechanical Properties of CMW® Copper Based Alloys

CMW ALLOY	Condition	Principal Elements	Class #	R.W.M.A. Alloy Number	Hardness Rockwell	Electrical Conductivity %I.A.C.S.	Ultimate Tensile Strength, psi	Elongation % in 2"	Permanent Softening Begins at °C	Permanent Softening Begins at °F
CMW® 28	Wrought**	Copper, Zirconium	1	1.15000	70 B	90	66,000	10	500	930
CMW® 3	Cast Wrought***	Copper, Chromium	2	2.18200	70 B 83 B	80 85	50,000 75,000	20 15	500 500	930 930
CMW® 328	Wrought***	Copper, Chromium, Zirconium	2	2.18150	83 B	85	75,000	15	500	930
CMW® 353	Wrought Cast	Copper, Nickel, Silicon, Chromium	3	3.18000	94 B 90 B	48 48	100,000 85,000	13 10	455 455	850 850
CMW® 100	Wrought	Copper, Nickel, Beryllium	3	3.17510	100 B	48	110,000	10	455	850
CMW® 73	Cast Wrought	Copper, Beryllium	4	4.17200	38 C 38 C	20 23	110,000 170,000	2 4	375 375	710 710
ELKALOY® D	Cast	Copper, Aluminum	5	5.95300	92 B	13	85,000	15	620	1150
Copper	Cast Wrought	Pure Copper		—	30 B 40 B	95 100	25,000 40,000	50 35	200 200	390 390
ELKALOY®20	Wrought	Copper, Al_2O_3	20	—	75 B	85	54,000	25	800	1475

Note: All properties shown are TYPICAL and should not be used for specifications
** Cold drawn bars up to 5/8" diameter
*** Heat treated and cold drawn bars up to 1" diameter

TYPICAL USAGE

CMW® 28 material is recommended for spot welding of coated steels and high conductivity materials, excluding copper and silver.

CMW® 3 material is recommended for spot and seam welding cold and hot-rolled steels and coated materials as well as current carrying shafts and arms, back-up bars for both resistance and arc welding and electrical current carrying structural parts and springs.

CMW® 328 material is recommended for spot and seam welding cold and hot rolled steels. There is some evidence that CMW® 328 outperforms CMW® 3 material when welding coated or galvanized steels.

CMW® 353 material is recommended for heavy duty offset holders, back-up bars, flash welding dies, current carrying structural members, shafts and bushings in combination with CMW® 3.

CMW® 100 material is recommended for spot and seam welding stainless steel and high temperature heat resisting alloys requiring high weld forces, flash welding dies, back-up bars, projection welding electrodes, and high strength, high conductivity electrical components and springs.

CMW® 73 material is recommended for flash welding dies, springs, electrical components, high strength backing material for brazed assemblies and wire guides.

ELKALOY® D material is recommended for butt and flash welding dies and clamps for cold rolled and stainless steel, current carrying structural parts, jigs and fixtures, pickling racks and baskets.

ELKALOY® 20 material has exceptional resistance to deformation when welding, and is highly recommended for welding caps for welding coated and galvanized steels. It allows a stable start-up, and generally outlasts other cap materials when welding parameters are not carefully controlled. The material requires upset cold work to develop its properties, and is therefore only available as caps or cap blanks.

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Typical Physical and Mechanical Properties of CMW® Refractory Based Materials

CMW GRADE	Type of Material	Class #	R.W.M.A. Group B Material	Hardness Rockwell	Electrical Conductivity %I.A.C.S.	Ultimate Tensile Strength, psi	Cross Breaking Strength psi
ELKONITE® 1W3	Tungsten-Copper	10	10.74450	77 B	53	63,000	110,000
ELKONITE® 3W3	Tungsten-Copper		—	90 B	50	75,000	130,000
ELKONITE® 5W3	Tungsten-Copper		—	95 B	48	85,000	140,000
ELKONITE® 10W3	Tungsten-Copper	11	11.74400	98 B	45	90,000	150,000
ELKONITE® 30W3	Tungsten-Copper	12	12.74350	103 B	41	98,000	170,000
ELKONITE® 3W53	Tungsten-Copper Alloy		—	105 B	30	120,000	180,000
ELKONITE® 10W53*	Tungsten-Copper Alloy		—	109 B	28	160,000	200,000
ELKONITE® TC5	Tungsten Carbide-Copper		—	94 B	45	70,000	140,000
ELKONITE® TC10	Tungsten Carbide-Copper		—	100 B	42	75,000	160,000
ELKONITE® TC20	Tungsten Carbide-Copper		—	37 C	30	85,000	180,000
ELKONITE® TC53*	Tungsten Carbide-Copper Alloy		—	47 C	18	150,000	220,000
ELKON® 100W	Tungsten	13	13.74300	39 C	30	150,000	200,000
ELKON® 100M	Molybdenum	14	14.42300	90 B	30	80,000	120,000
ANVILOY® 1150**	Tungsten-Nickel-Iron-Molybdenum		—	34 C	13	140,000	280,000

Note: All properties shown are TYPICAL and should not be used for specifications
* Properties are in fully heat treated condition
** Hardness is 56 HRA at 1475 °F (800°C)

TYPICAL USES

ELKONITE® 1W3 and **3W3** alloys are generally used for flash and butt welding die inserts where higher electrical and thermal conductivity is necessary and where a degree of malleability is desirable. These materials are also used for spot welding (as a radius faced electrode) low conductivity ferrous metals such as stainless steel.

ELKONITE® 5W3 and **TC5** alloys are normally used for light duty projection welding dies where welding pressures are not extreme.

ELKONITE® 10W3 alloy is used for electrode and die inserts in most flash and butt welding dies and for projection welding dies where welding pressures are moderate. It is also used for light electrical upsetting, electroforging dies and seam welder bushing inserts.

ELKONITE® 30W3 and **TC10** alloys are recommended for volume projection welding dies where the pressures involved are relatively high. Electrical upsetting of non-ferrous metals and low carbon steel is usually accomplished by the use of such ELKONITE® materials as die facings. Cross-wire welding of large, diameter wire and rod is accomplished with such ELKONITE® materials.

ELKONITE® 3W53 and **10W53** are heat treatable grades of ELKONITE® materials supplied in the fully heat treated condition. If silver brazed to a die backing, such ELKONITE® materials should be heat treated after brazing. These harder grades are used primarily for electroforging and electrical upsetting dies, where temperatures and pressures are comparatively high.

ELKONITE® TC20 and **TC53** materials are extremely hard and wear resistant. ELKONITE® TC20 material, while somewhat difficult to machine, may be machined using carbide tipped tools. ELKONITE® TC53 material is a heat treatable grade of such high hardness that machining operations are impractical and the material must be ground. Such ELKONITE® materials are customarily used for special applications of electrical upsetting and electroforging.

ELKON® 100W is extremely hard and its ductility is relatively low. It cannot be machined but may be ground to the required shape. It does not alloy appreciably with nonferrous materials and is used for cross-wire welding of metals such as copper and brass. It is also used for electrobrazing electrode material and for some electrical upsetting operations.

ELKON® 100M is used principally for electrobrazing electrode material and for cross-wire welding of nonferrous metals. It is not as hard as ELKON® 100W material and may be machined or drilled to fit the parts to be joined. A typical application of this material, as an electrode, is the welding or brazing of braided or solid copper conductors to ferrous or nonferrous terminals, lugs or fittings.

ANVILOY® 1150 material is used in electrobrazing applications where heat balance is important. The ANVILOY® 1150 material also has good anti-sticking qualities and good high temperature abrasion and hardness properties. The oxidation resistance of both materials is excellent up to 1100°F.

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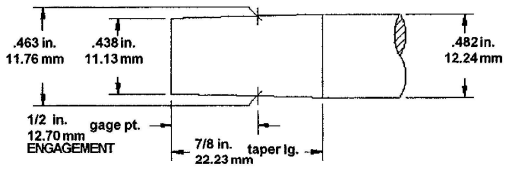
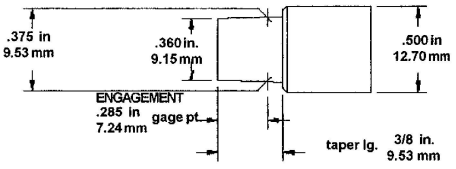
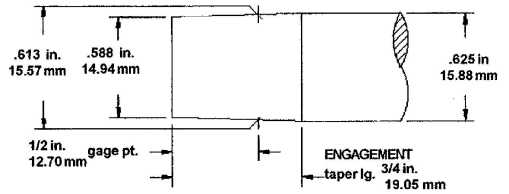
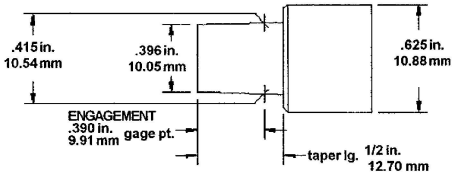
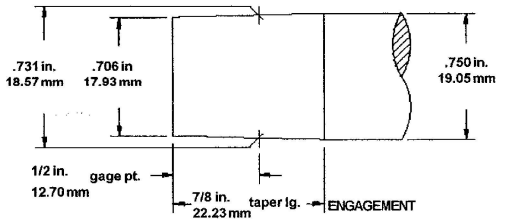
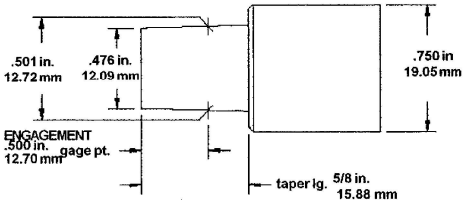
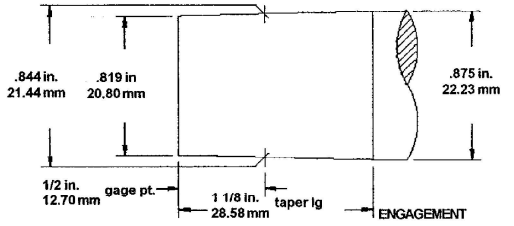
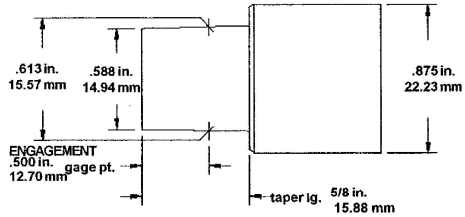
Standard Tapered Electrode Theoretical Dimensions	Taper Size	Standard Male Taper Cap taper Dimensions
	4RW 1MT	
	5RW 2MT	
	6RW	
	7RW 3MT	

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SPOT WELDING DATA

OPTIMUM CONDITIONS

SCHEDULES FOR SPOT WELDING LOW CARBON STEEL—SAE 1010

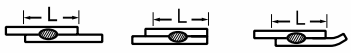
Thickness of Thinnest Outside Piece (Inches)	Electrode Diameters and Shape* Flat Face Maximum d (Inches)	Flat Face Min. D (Inches)	Radius Face Radius R (Inches)	Recommended Minimum Standard Electrode Size	Weld Force (Lbs.)	Weld Time (Cycles) (60 Cycles per Sec.)	Hold Time (Cycles) Min.	Welding Current (Amps.) (Approx.)	Weld Shear Strength (For Steels Having Ultimate Tensile Strength of 90,000 psi and below) Minimum Strength (Lbs/Weld)	Diameter of Fused Zone (Approx.) Dw (Inches)	Minimum Weld Spacing S (Inches)	Minimum Contacting Overlap L (Inches)
0.010	0.125	1/2	2	4RW 1MT	160	4	5	4,000	130	0.113	1/4	3/8
0.021	0.187	1/2	2	4RW 1MT	244	6	8	6,500	300	0.139	3/8	7/16
0.031	0.187	1/2	2	4RW 1MT	326	8	10	8,000	530	0.161	1/2	7/16
0.040	0.250	5/8	3	5RW 2MT	412	10	12	8,800	812	0.181	3/4	1/2
0.050	0.250	5/8	3	5RW 2MT	554	14	16	9,600	1,195	0.210	7/8	9/16
0.062	0.250	5/8	3	5RW 2MT	670	18	20	10,600	1,717	0.231	1	5/8
0.078	0.312	5/8	3	5RW 2MT	903	25	30	11,800	2,365	0.268	1-1/8	11/16
0.094	0.312	5/8	4	7RW 3MT	1,160	34	35	13,000	3,054	0.304	1-1/4	3/4
0.109	0.375	7/8	4	7RW 3MT	1,440	45	40	14,200	3,672	0.338	1-5/16	13/16
0.125	0.375	7/8	4	7RW 3MT	1,760	60	45	15,600	4,300	0.375	1-1/2	7/8
0.156	0.500	7/8	6	Male or Female Threaded	2,500	93	50	18,000	6,500	0.446	1-3/4	1
0.187	0.625	1	6	Male or Female Threaded	3,340	130	55	20,500	9,000	0.516	2	1-1/2
0.250	0.750	1-1/4	6	Male or Female Threaded	5,560	230	60	26,000	18,000	0.660	4	1-1/2

PERMISSIBLE SCHEDULE VARIATIONS FOR SPOT WELDING LOW CARBON STEEL

Low Carbon Steel Spot Welding Data Chart—Single Impulse Welding

DATA COMMON TO ALL CLASSES OF SPOT WELDS					WELDING SET-UP FOR BEST QUALITY—CLASS A WELDS					WELDING SET-UP FOR MEDIUM QUALITY—CLASS B WELDS					WELDING SET-UP FOR GOOD QUALITY—CLASS C WELDS				
Thickness of Each of the Two Work Pieces Inches	Electrode Diam. & Shape Min. D Inches	Max. d Inches	Min. Weld Spacing (Note 4) Inches	Min. Contacting Overlap (Note 6) Inches	Weld Time (Note 7) Cycles	Electrode Force Pounds	Welding Current Amps.	Diam. of Fused Zone Dw Inches	Average Tensile Shear Strength ±14% Pounds	Weld Time (Note 7) Cycles	Electrode Force Pounds	Welding Current Amps.	Diam. of Fused Zone Dw Inches	Average Tensile Shear Strength ±17% Pounds	Weld Time (Note 7) Cycles	Electrode Force Pounds	Welding Current Amps.	Diam. of Fused Zone Dw Inches	Average Tensile Shear Strength ±20% Pounds
.010	1/2	1/8	1/4	3/8	4	200	4000	.13	235	5	130	3700	.12	200	15	65	3000	.11	160
.021	1/2	3/16	3/8	7/16	6	300	6100	.17	530	10	200	5100	.16	460	22	100	3800	.14	390
.031	1/2	3/16	1/2	7/16	8	400	8000	.21	980	15	275	6300	.20	850	29	135	4700	.18	790
.040	5/8	1/4	3/4	1/2	10	500	9200	.23	1305	21	360	7500	.22	1230	38	180	5600	.21	1180
.050	5/8	1/4	7/8	9/16	12	650	10300	.25	1820	24	410	8000	.23	1700	42	205	6100	.22	1600
.062	5/8	1/4	1	5/8	14	800	11600	.27	2350	29	500	9000	.26	2150	48	250	6800	.25	2050
.078	5/8	5/16	1-1/8	11/16	21	1100	13300	.31	3225	36	650	10400	.30	3025	58	325	7900	.28	2900
.094	5/8	5/16	1-1/4	3/4	25	1300	14700	.34	4100	44	790	11400	.33	3900	66	390	8800	.31	3750
.109	7/8	3/8	1-5/16	13/16	29	1600	16100	.37	5300	50	960	12200	.36	5050	72	480	9500	.35	4850
.125	7/8	3/8	1-1/2	7/8	30	1800	17500	.40	6900	60	1140	12900	.39	6500	78	570	10000	.37	6150

NOTES:

1. Low Carbon Steel as hot rolled, pickled, and slightly oiled with an ultimate strength of 42,000 to 45,000 PSI Similar to SAE 1005—SAE 1010.
2. Electrode Material is CMW® 3.
3. Surface of steel is lightly oiled but free from grease, scale or dirt.
4. Minimum weld spacing is that distance for which no increase in welding current is necessary to compensate for the shunted current effect in adjacent welds.
5. Radius Face electrodes may be used:
   0.010 to 0.031 — 2" Radius
   0.031 to 0.078 — 3" Radius
   0.078 to 0.125 — 4" Radius
6. 

7. Weld time is indicated in cycles of 60 cycle frequency.
8. Tensile shear strength values are based on recommended test sample sizes:

   Direction of Force

Thickness	Width	Length
.000" to .029"	5/8"	3"
.030" to .058"	1"	4"
.059" to .115"	1-1/2"	5"
.116" to .190"	2"	6"

9. Tolerance for machining of electrode diameter "d" is ±.015" of specified dimension.
10. Electrode force does not provide for force to press ill-fitting parts together.

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PROJECTION WELDING DATA

DESIGN AND WELDING DATA FOR PROJECTION WELDING LOW CARBON STEELS

Thickness of Thinnest Outside Piece Inches	PROJECTION DESIGN: Base Diameter of Projection Dp Inches	PROJECTION DESIGN: Height of Projection H Inches	ELECTRODE DIAMETERS (d=2 x Projection Diameter): Minimum d Inches	ELECTRODE DIAMETERS (d=2 x Projection Diameter): Minimum D Inches	Electrode Force Pounds	Weld Time (Cycles) 60 Cycles per Sec.	Hold Time (Cycles) Minimum	Welding Current Amperes (Approx.)	Diameter of Fused Zone Dw Inches	Minimum Shear Strength (Single Projection Only) (For Steels Having Strength of 100,000 psi and below) Pounds	Minimum Contacting Overlap L Inches
0.010	0.055	0.015	0.125	1/2	50	3	3	2,800	0.112	150	1/8
0.012	0.055	0.015	0.125	1/2	80	3	3	3,100	0.112	200	1/8
0.014	0.055	0.015	0.125	1/2	100	3	3	3,400	0.112	250	1/8
0.016	0.067	0.017	0.187	1/2	115	4	4	3,600	0.112	285	5/32
0.021	0.067	0.017	0.187	1/2	150	6	6	4,000	0.140	380	5/32
0.025	0.081	0.020	0.187	1/2	200	6	8	4,500	0.140	525	3/16
0.031	0.094	0.022	0.187	1/2	300	8	8	5,100	0.169	740	7/32
0.034	0.094	0.022	0.187	1/2	350	10	10	5,400	0.169	900	7/32
0.044	0.119	0.028	0.250	5/8	480	13	14	6,500	0.169	1,080	9/32
0.050	0.119	0.028	0.250	5/8	580	16	16	7,100	0.225	1,500	9/32
0.062	0.156	0.035	0.312	7/8	750	21	20	8,400	0.225	2,100	3/8
0.070	0.156	0.035	0.312	7/8	900	24	24	9,200	0.281	2,550	3/8
0.078	0.187	0.041	0.375	7/8	1,050	26	30	10,500	0.281	2,950	7/16
0.094	0.218	0.048	0.500	7/8	1,300	32	30	11,800	0.281	3,700	1/2
0.109	0.250	0.054	0.500	7/8	1,650	38	36	13,300	0.338	4,500	5/8
0.125	0.281	0.060	0.500	7/8	1,800	45	40	15,000	0.338	5,200	11/16
0.140	0.312	0.066	0.625	1	2,300	60	45	15,700	0.437	6,000	3/4
0.156	0.343	0.072	0.625	1	2,800	80	50	17,250	0.500	7,500	13/16
0.171	0.375	0.078	0.750	1	3,300	105	50	18,600	0.562	8,500	7/8
0.187	0.406	0.085	0.750	1	3,800	125	50	20,000	0.562	10,000	15/16
0.203	0.437	0.091	0.875	1-1/4	4,500	145	55	21,500	0.625	12,000	1
0.250	0.531	0.110	1.000	1-1/4	6,600	230	60	26,000	0.687	15,000	1-1/4

NOTES:

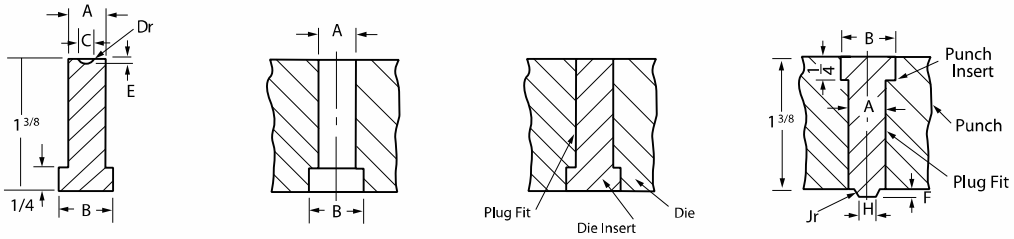
1. Type of Steel—Low Carbon SAE 1010—0.15% Carbon Maximum.
2. Material free of scale, oxide, paint, dirt, etc.
3. Size of projection determined by thickness of thinnest piece and projection should be on thickest piece.
4. Data is based on thickness of thinnest sheet for two thicknesses only. Maximum ratio between two thicknesses = 3 to 1.
5. See TABLE BELOW for design of punch and die for making projections.
6. Contacting overlap does not include any radii from forming.
7. Projection should be located in center of overlap.
8. Tolerance for Projection Dimensions:

Dimension	Thickness Up to 0.050"	Thickness Over 0.050"
Diameter "D"	±0.003"	±0.007"
Height "H"	±0.002"	±0.005"

9. Electrode Material:
CMW®100 ELKONITE®TC-10 ELKONITE®10W3

From American Welding Society "Recommended Practices for Resistance Welding"

PUNCH AND DIE DESIGN FOR FORMING WELDING PROJECTIONS



Mat Thickness	Pt. No.	A	B	±.002 C	Dr	±.001 E	±.001 F	±.001 H	Jr
0.010-0.015	1	3/8	9/16	.055	.033	.015	.015	.035	.005
0.016-0.021	2	3/8	9/16	.067	.042	.017	.020	.039	.005
.025	3	3/8	9/16	.081	.050	.020	.025	.044	.005
.031	4	3/8	9/16	.094	.062	.022	.030	.050	.005
.034	5	3/8	9/16	.094	.062	.022	.030	.050	.005
.044	6	3/8	9/16	.119	.078	.028	.035	.062	.005
.050	7	3/8	9/16	.119	.078	.028	.035	.062	.005
.062	8	3/8	9/16	.156	.105	.035	.043	.081	.005
.070	9	3/8	9/16	.156	.105	.035	.043	.081	.005
.078	10	3/8	9/16	.187	.128	.041	.055	.104	.010

Mat Thickness	Pt. No.	A	B	±.002 C	Dr	±.001 E	±.001 F	±.001 H	Jr
.094	11	1/2	11/16	.218	.148	.048	.065	.115	.010
.109	12	1/2	11/16	.250	.172	.054	.075	.137	1/64
.125	13	1/2	11/16	.281	.193	.060	.085	.154	1/64
.140	14	1/2	11/16	.312	.217	.066	.096	.172	1/64
.156	15	5/8	13/16	.343	.243	.072	.107	.191	1/64
.171	16	5/8	13/16	.375	.265	.078	.118	.210	1/64
.187	17	5/8	13/16	.406	.285	.085	.130	.229	1/64
.203	18	11/16	7/8	.437	.308	.091	.143	.240	.020
.250	19	13/16	1	.531	.375	.110	.175	.285	.025

Material: Tool Steel. Finish all over and harden to 65-68 Rockwell "C" scale. Note: All working surfaces of die unit must be polished.

From American Welding Society "Recommended Practices for Resistance Welding"

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SCHEDULE FOR SPOT WELDING STAINLESS STEEL

THICKNESS "T" of THINNEST OUTSIDE PIECE (See Notes 1, 2, 3 and 4 Below) INCHES	ELECTRODE DIAMETER AND SHAPE (See Note 5) D, IN., Min.	d, IN., Max.	ELECTRODE FORCE LB.	WELD TIME CYCLES (60 Per Sec.)	WELDING CURRENT (Approx.) AMPS Tensile Strength Below 150000 Psi	Tensile Strength 150000 Psi and Higher	MINIMUM CONTACTING OVERLAP IN.	MINIMUM WELD SPACING (See Note 6 Below) ℄ to ℄ IN.	DIAMETER OF FUSED ZONE Dw IN. Approx.	MINIMUM SHEAR STRENGTH LB. Ultimate Tensile Strength of Metal 70000 Up to 90000 Psi	90000 Up to 150000 Psi	150000 Psi and Higher
0.006	3/16	3/32	180	2	2000	2000	3/16	3/16	0.045	60	70	85
0.008	3/16	3/32	200	3	2000	2000	3/16	3/16	0.065	150	170	210
0.012	1/4	1/8	260	3	2100	2000	1/4	1/4	0.076	185	210	250
0.014	1/4	1/8	300	4	2500	2200	1/4	1/4	0.082	240	250	320
0.016	1/4	1/8	330	4	3000	2500	1/4	5/16	0.088	280	300	380
0.018	1/4	1/8	380	4	3500	2800	1/4	5/16	0.093	320	360	470
0.021	1/4	5/32	400	4	4000	3200	5/16	5/16	0.100	370	470	500
0.025	3/8	5/32	520	5	5000	4100	3/8	7/16	0.120	500	600	680
0.031	3/8	3/16	650	5	6000	4800	3/8	1/2	0.130	680	800	930
0.034	3/8	3/16	750	6	7000	5500	7/16	9/16	0.150	800	920	1100
0.040	3/8	3/16	900	6	7800	6300	7/16	5/8	0.160	1000	1270	1400
0.044	3/8	3/16	1000	8	8700	7000	7/16	11/16	0.180	1200	1450	1700
0.050	1/2	1/4	1200	8	9500	7500	1/2	3/4	0.190	1450	1700	2000
0.056	1/2	1/4	1350	10	10300	8300	9/16	7/8	0.210	1700	2000	2450
0.062	1/2	1/4	1500	10	11000	9000	5/8	1	0.220	1950	2400	2900
0.070	5/8	1/4	1700	12	12300	10000	5/8	1-1/8	0.250	2400	2800	3550
0.078	5/8	5/16	1900	14	14000	11000	11/16	1-1/4	0.275	2700	3400	4000
0.094	5/8	5/16	2400	16	15700	12700	3/4	1-1/2	0.290	3550	4200	5300
0.109	3/4	3/8	2800	18	17700	14000	13/16	1-1/2	0.290	4200	5000	6400
0.125	3/4	3/8	3300	20	18000	15500	7/8	2	0.300	5000	6000	7600

NOTES:

1. Types of Steel—301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347 & 349
2. Material should be free from scale, oxides, paint, grease and oil.
3. Welding conditions determined by thickness of thinnest outside piece "T."
4. Data for total thickness of pile-up not exceeding 4 "T". Maximum ratio between two thicknesses 3 to 1.
5. Electrode Material, CMW® 3, CMW® 100, or ELKONITE® 10W3
6. Minimum weld spacing is that spacing for two pieces for which no special precautions need be taken to compensate for shunted current effect of adjacent welds. For three pieces increase spacing 30 per cent.

SCHEDULE FOR SEAM WELDING STAINLESS STEEL

THICKNESS "T" OF THINNEST OUTSIDE PIECE (See Notes 1, 2, 3 and 4 Below) INCHES	ELECTRODE WIDTH AND SHAPE (See Note 5 Below) W, IN., Min.	ELECTRODE FORCE LB.	ON TIME CYCLES (60 Per Sec.)	OFF TIME FOR MAXIMUM SPEED (Pressure-Tight) CYCLES 2 "T"	4 "T"	MAXIMUM WELD SPEED IN. PER MINUTE 2 "T"	4 "T"	WELDS PER INCH 2 "T"	4 "T"	WELDING CURRENT (Approx.) AMPS.	MINIMUM CONTACTING OVERLAP (See Note 6 Below) IN.
0.006	3/16	300	2	1	1	60	67	20	18	4000	1/4
0.008	3/16	350	2	2	2	67	56	18	16	4600	1/4
0.010	3/16	400	3	2	2	45	51	16	14	5000	1/4
0.012	1/4	450	3	2	2	48	55	15	13	5600	5/16
0.014	1/4	500	3	2	3	51	46	14	13	6200	5/16
0.016	1/4	600	3	2	3	51	50	14	12	6700	5/16
0.018	1/4	650	3	2	3	55	50	13	12	7300	5/16
0.021	1/4	700	3	2	3	55	55	13	11	7900	3/8
0.025	3/8	850	3	3	4	50	47	12	11	9200	7/16
0.031	3/8	1000	3	3	4	50	47	12	11	10600	7/16
0.040	3/8	1300	3	4	5	47	45	11	10	13000	1/2
0.050	1/2	1600	4	4	5	45	44	10	9	14200	5/8
0.062	1/2	1850	4	5	7	40	41	10	8	15100	5/8
0.070	5/8	2150	4	5	7	44	41	9	8	15900	11/16
0.078	5/8	2300	4	6	7	40	41	9	8	16500	11/16
0.094	5/8	2550	5	6	7	36	38	9	8	16600	3/4
0.109	3/4	2950	5	7	9	38	37	8	7	16800	13/16
0.125	3/4	3300	6	6	8	38	37	8	7	17000	7/8

NOTES:

1. Types of Steel—301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347 & 349.
2. Material should be free from scale, oxides, paint, grease and oil.
3. Welding conditions determined by thickness of thinnest outside piece "T."
4. Data for total thickness of pile-up not exceeding 4 "T" . Maximum ratio between two thicknesses 3 to 1.
5. Electrode material, CMW® 100
6. For large assemblies minimum contacting overlap indicated should be increased 30 per cent.

From American Welding Society "Recommended Practices for Resistance Welding"

SPOT WELD, INC.

2290 Wycliff St., St. Paul, MN 55114
(Ph.) 651-646-1393, (Fax) 651-646-3616
www.spotweldinc.com

Excellence In Resistance Welding

Spot welding galvanized low-carbon steel

Material Thickness notes 1, 2, & 3	Electrode Diameter And Shape note 4 D	Electrode Diameter And Shape note 4 d	Electrode Diameter And Shape note 4 Oc	Net Electrode Force	Welding Current (Approx.)	Weld Time	Weld Nugget Size	Minimum Tension-Shear Strength	Minimum Weld Spacing	Minimum Contacting Overlap
Inches	In.	In.	Deg.	Lb.	Amps.	Cycles	In.	Lb.	Inches	Inches
0.022	5/8	3/16	120	300	13000	8	0.15	550	5/8	5/8
0.030	5/8	3/16	120	400	13000	10	0.16	1000	5/8	5/8
0.036	5/8	1/4	120	500	13500	12	0.19	1180	3/4	5/8
0.039	5/8	1/4	120	650	14000	13	0.21	1400	3/4	5/8
0.052	5/8	1/4	120	725	14500	18	0.22	1700	7/8	11/16
0.063	3/4	1/4	120	850	15500	22	0.24	2500	1-1/8	3/4
0.078	3/4	5/16	120	1200	19000	24	0.28	3200	1-1/4	7/8
0.093	3/4	3/8	120	1400	21000	30	0.34	4200	1-1/2	1
0.108	7/8	3/8	120	1750	20000	37	0.40	5900	1-3/4	1-1/8
0.123	7/8	3/8	120	2000	20000	42	0.48	7200	2	1-1/8

NOTES:

1. Material must be free from dirt, grease, paint etc. prior to welding, but may have light oil.
2. Two equal metal thicknesses of each gage.
3. Commercial coating weight is 1.25 oz. per square foot.
4. Electrode Material-RWMA Group A, Class 2. CMW® 3.
5. Water Cooling: 2 gallons per minute.

Projections should be larger in diameter for galvanized than for uncoated material.

Projection welding galvanized low-carbon steel

Material Thickness notes 1, 2, & 3	Electrode Diameter And Shape note 4 D	Electrode Diameter And Shape note 4 d	Net Electrode Force	Welding Current (Approx.)	Weld Time	Weld Nugget Size	Minimum Tension-Shear Strength (For Single Projections Only)	Projection Size Diameter	Projection Size Height
Inches	In.	In.	Lb.	Amps.	Cycles	In.	Lb.	In.	In.
0.039	5/8	3/8	250	10000	15	0.15	925	0.187	0.041
0.063	5/8	7/16	400	11500	20	0.25	2050	0.218	0.048
0.078	3/4	1/2	550	16000	25	0.25	2700	0.250	0.054
0.093	3/4	1/2	750	16000	30	0.30	4300	0.250	0.054
0.108	7/8	1/2	950	22000	33	0.31	4900	0.250	0.054

NOTES:

1. Material must be free from dirt, grease, paint etc. prior to welding, but may have light oil.
2. Two equal metal thicknesses of each gage.
3. Commercial coating weight is 1.25 oz. per square foot.
4. Electrode Material-RWMA Group A, Class 2. CMW® 3.
5. Pressure-tight joints require stripping the zinc coating prior to welding.
6. Nominal electrode diameter ranges between 8 to 10 inches.

From American Welding Society "Recommended Practices for Resistance Welding."

Seam welding galvanized low-carbon steel

Material Thickness notes 1, 2, & 3	Electrode Width And Shape note 4 W	Electrode Width And Shape note 4 E	Net Electrode Force	Welding Current (Approx.)	Weld Time Heat Time	Weld Time Cool Time	Welding Speed	Welds Per Inch	Minimum Contacting Overlap
Inches	In.	In.	Lb.	Amps.	Cycles	Cycles	In./Min.	W/In.	Inches
0.015	3/8	1/4	900	15000	2	2	120	7.5	3/8
0.036	1/2	1/4	1100	18000	4	2	60	10.0	1/2
0.039	1/2	1/4	1200	19000	4	3	60	9.0	1/2
0.052	1/2	1/4	1350	20000	5	1	90	7.0	9/16
0.063	1/2	5/16	1500	19800	8	2	54	7.0	5/8
0.078	5/8	5/16	1850	23000	10	7	30	7.0	11/16

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Excellence In Resistance Welding

RECOMMENDED ELECTRODE MATERIALS

The process of resistance welding makes it possible to join most metals, similar or dissimilar. Bonds of adequate strength are obtainable for an extremely wide range of applications. Selecting electrodes of the proper alloy is a most important consideration in producing good welds at the required speed. The chart below is a valuable guide to this selection.

The weldability of two materials as expressed in the following chart has been derived after careful laboratory study and field survey of many factors which influence the welding or resultant weld of the metals. The factors include:

1. Thermal and electrical conductivity
2. Metallurgical properties
3. Nature of resultant weld or alloy
4. Weld strength
5. Relative accuracy in control of welding conditions necessary

The weldability of metals as shown in the chart applies only when conventional spot welding methods are used on similar thicknesses of material. However, many metal combinations which are listed as having a "poor weldability" may be satisfactorily joined by using a special setup or procedure.

There is a CMW® Alloy for each specific welding application. Experienced CMW engineers will provide assistance with special problems.

Electrode Materials For SPOT WELDING Similar and Dissimilar Metals

	Tungsten Molybdenum	Magnesium	Nickel Alloys	Nickel	Stainless Steel	Chrome Steel	Cadmium Plate	Galvanized Steel Zn. Plate	Terne Plate	Tin Plate	Scaly Steel	C. R. Steel	Phosphor Bronze	Silicon Bronze	Nickel Silver	Cupro Nickel	Brass Yellow	Brass Red	Copper	Aluminum Alloys	Aluminum	C. P. Titanium
Commercially Pure Titanium																						A I(ⓘ) II(ⓘ) 1
Aluminum 2S-3S			C I 1 5	E II 2 5	E II 2 3	H I 2 3 4	H II 3 8	E I 3 4 9	D I 3 4 9	D I 3 4 9	D I 3 4 9		E II 3 4	D II 2 5	D II 2 5			D II 5	E II 2	H V 2	C I 1	C I 1
Aluminum Alloys Duralumin 52S-17S-24S			C I 1 5	E II 2	E II 2 3	H I 2 3 4	H II 3 8	E I(ⓘ) 3 4 9	D I 3 4 9	D I 3 4 9	D I 3 4 9		E II 3 4	D II 2 5	D II 2 5			D II 6	E II 2	E V 2	D 1	
Copper—Pure	H II V 3	H V 5	E II V	E II V 3 6	H V 2 3 4	H II V 3 4	H I(ⓘ) V 3 9	H I V 3 4 9	H I V 3 4 9	H I V 3 4 9			H II V 3 4	D II V 5 6	D II V 5 6	D II V 5 6	D II D 5 6	D II V 6	E II V 6	K V V 2		
Brass—Red 5-25% Zinc			H I II 5	D II V 6	D II V 6	H II V	H II V	H I(ⓘ) V 6	H I(ⓘ) V 6	H I(ⓘ) V 6			H II II 3 4	D II V 6	D II V 6	D II V 6	D II V	D II II	E II II 5 6			
Brass—Yellow 25-40% Zinc			E I II 5	D II IV 6	D II II 6	H II IV	H II IV	E I(ⓘ) IV 6	E I IV 6	E I(ⓘ) IV 6			E II IV 3 4	C II IV 1	C II IV 1	C II IV 1	C II IV 1	C II IV 1	C II II 1			
Cupro-Nickel			D I II 2 5	C II II	C VI II	E I(ⓘ) II 2	E II II 2 8	E I(ⓘ) II 2	E I(ⓘ) II 2	E I(ⓘ) II 2	H I(ⓘ) II 7	E II II 3	C II II 1	C II II 1	C II II	B II II 1						
Nickel Silver			D I II 2 5	C II II	C VI II	E I(ⓘ) II 2	E II II 2 8	E I(ⓘ) II 2	E I(ⓘ) II 2	E I(ⓘ) II 2	H I(ⓘ) II 7	E II II 3	C II II 1	C II II 1	B II II 1							
Silicon Bronze			D I II 2 5	C II II	D II II	E I(ⓘ) II	E II II 8	E I(ⓘ) II	E I(ⓘ) II	E I(ⓘ) II	H I(ⓘ) II 7	D II II 3	C II II 1	B II II 1								
Phosphor Bronze Grades A, C, & D			E I II 2 5	D II II	D II II	E I(ⓘ) II	E II II 8	E I(ⓘ) II	E I(ⓘ) II	E I(ⓘ) II	H I(ⓘ) II 7	D II II 3	B II II 1									
C. R. Steel H. R. Steel—Clean	D II II 3		D II II 3	D II II 3	B II III	B II II 8	C II II	C I II	B I(ⓘ) II 6	C I II	E I(ⓘ) II 7	A II II 1										
Scaly H. R. Steel	H II I(ⓘ) 3 7				D I(ⓘ) I(ⓘ) 7	D II I(ⓘ) 7 8	D II I(ⓘ) 7	D I I(ⓘ) 6 7	D I(ⓘ) I(ⓘ) 6 7	D I(ⓘ) I(ⓘ) 6 7	E I(ⓘ) I(ⓘ) 7											
Tin Plate	E II 9	E I 5 9	D I 3 9	D II I 9	C I(ⓘ) I	C II I 8	D I(ⓘ) I 9	C I I 6 9	D I(ⓘ) I 6 9	D I(ⓘ) I 6 9												
Terne Plate	E II I(ⓘ) 9	E I 5 9	D I 3	D II I 9	C II I	C II I 8	C I(ⓘ) I	C I I 6	C I I 6													
Galvanized Steel Zinc Plate	E II 9	E I I(ⓘ) 5 9	D II I(ⓘ) 3	D II II 9	C II I	C II I 8 9	C I I 9	C I(ⓘ) I(ⓘ) 9														
Cadmium Plate	E II 9	E I 5	D I 3	D II I 9	C II I	C II I 8	C I I 9															
Chrome Plate	D I I I 8		D II II 8	D II II 8	B III(ⓘ) II 8	B II II 8																
Stainless Steel 18-8 Type	D I I 2 5		D II II	D II I①	D III II	A II(ⓘ) I(ⓘ) 1																
Nickel Grade A	D II II 2 5		C II II 1	B II II 1																		
Nickel Alloys Monel Nichrome (High Res.)	D II II 2 5		B II II 1																			
Magnesium Alloys		D I I 1 5																				
Molybdenum Tungsten	D II II 2 5																					

WELDABILITY
As a basis for comparison cold rolled (mild) steel has been chosen and its weldability designated as "excellent."
A - Excellent E - Poor
B - Very Good H - Very Poor
C - Good K - Impractical
D - Fair

ELECTRODES
I - CMW® 28
II - CMW® 3
III - CMW® 100
IV - ELKONITE® 10W3
V - ELKON® 100M*
VI - ELKONITE® 1W3Δ or TC-5

*ELKON® 100 W may be substituted.
Δ ELKONITE® 10W3 or TC-10 may be interchanged.
○Electrode materials in circles are second choice.

BLOCK INTERPRETATION

WELD-ABILITY	ELECTRODE AGAINST
ELECTRODE AGAINST	SPECIAL INFORMA-TION

ELECTRODES
I - CMW® 28
II - CMW® 3
III - CMW® 100
IV - ELKONITE® 10W3
V - ELKON® 100M*
VI - ELKONITE® 1W3Δ or TC-5

*ELKON® 100 W may be substituted.
Δ ELKONITE® 10W3 or TC-10 may be interchanged.
○Electrode materials in circles are second choice.

SPECIAL INFORMATION
1. Good weld strength.
2. May be welded under special conditions.
3. Low weld strength.
4. No actual weld nugget occurs, a "stick" is obtained.
5. Welding conditions must be accurately controlled.
6. Keep electrode clean to prevent sticking to the work.
7. Good practice recommends cleaning steel before welding.
8. Use one flat tip to minimize distortion or discoloration.
9. Coating may dissolve in other metals or burn away.

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Excellence In Resistance Welding

Common Valves Used on Spot Weld, Inc. Machinery

Numatics brand

153SA43AK000030 3/8" NPT valve

Mark 15 & PA 15 SERIES

numatics

How to Order

Valves

153 SA 4 15 K 0 000 30

Valve Series & Port Size
152* = 1/4
153 = 3/8
*Valve unit only.

Valve Type
SA = Single Solenoid, Spring Return W/Flush Non-locking Override
SS = Double Direct Solenoid w/Flush Non-locking Override (Standard)
JA = Single Air Pilot, Spring Return w/Flush Non-Locking Override (Std.)
JJ = Double Air Pilot w/Flush Non-Locking Override
JK = Double Air Pilot, Spring Return w/Flush Non-Locking Override
PA = Single Air Pilot, Spring Return w/out Override
PP = Double Air Pilot w/out Override

Function
4 = 2 Position, 4-Way
5 = 3 Position, 4-Way Open Center
6 = 3 Position, 4-Way Closed Center
7 = 3 Position 4-Way (5/3), Pressure Center
0 = Manifold Block w/o Valve
P = Manifold Block, w/Blank Station Plate

Mounting
00 = Valve Unit, w/o Mounting
01 = Valve Unit, Speed Control, w/o Mounting
02 = Valve Unit w/ Long Screws for Speed Control
15 = Manifold Block, Side and Bottom Cylinder Ports
16 = Manifold Block, Side and Bottom Cylinder Ports, Auxiliary Inlet
1B = Manifold Block, Side and Bottom Cylinder Ports, Alternate Outlet
18 = Manifold Block, Side and Bottom Cylinder Ports, Alternate Outlet & Auxiliary Inlet
25 = Manifold Block, Side and Bottom Cylinder Ports, Speed Control
3A = Plug-in Base, Individual Exhaust, Side Cylinder Ports, (Mark 15 only)
3B = Plug-in Base, Individual Exhaust, Side and Bottom Cylinder Ports, (Mark 15 only)
3C = Plug-in Base, Individual Exhaust, Side Cylinder Ports, Speed Control (Mark 15 only)
3D = Plug-in Base, Individual Exhaust, Side and Bottom Cylinder Ports, Speed Control (Mark 15 only)
31 = Plug-in Base, Common Exhaust, Side Cylinder Ports (Mark 15 only)
32 = Plug-in Base, Common Exhaust, Side and Bottom Cylinder Ports (Mark 15 only)
35 = Plug-in Base, Common Exhaust, Side Cylinder Ports, Speed Control (Mark 15 only)
36 = Plug-in Base, Common Exhaust, Side and Bottom Cylinder Ports, Speed Control (Mark 15 only)
41 = Base, Individual Exhaust, Side Cylinder Ports (PA15 only)
43 = Base, Individual Exhaust, Side and Bottom Cylinder Ports (PA15 only)
44 = Base, Common Exhaust, Side Cylinder Ports (PA15 only)
46 = Base, Individual Exhaust, Side Cylinder Ports, Speed control (PA15 only)
48 = Base, Individual Exhaust, Side and Bottom Cylinder Ports, Speed Control (PA15 only)
49 = Base, Common Exhaust, Side Cylinder Ports, Speed Control (PA15 only)
54 = Base, Common Exhaust, Side and Bottom Cylinder Ports (PA15 only)
55 = Base, Common Exhaust, Side and Bottom Cylinder Ports, Speed Control (PA15 only)

Voltage
00 = Manifold Block, w/o Valve
20 = 24 VAC, 50-60 Hz
30 = 110-120 VAC, 50-60 Hz
40 = 220-240 VAC, 50-60 Hz
60 = 12 VDC
61 = 24 VDC

Options
000 = No Options
11B = Flush Locking Manual Override
11Y = Extended Non- Locking Manual Override
11Z = Extended Locking Manual Override
12A = FKM Seals on Sleeve Assembly
12B = Lubricant Free Assembly
13A = 4 Foot Leads
15W = 5-Pin Straight Mini Connector in Mounting; Pin 1=A+(14+), 2=A-(14-), 3=Gnd, 4=B+(12+), 5=B-(12-)
16T = Adds Bottom P (1) Port to Mounting
17N = Surge Suppression (DC Only)
19M = Terminal Block in Mounting
46T = Zinc Plated Solenoid Armature (A C Only)
47J = 5-Pin Straight Mini Connector in Mounting; Pin 1=B+(12+), 2=A-(14-), 3=Gnd, 4=A+(14+), 5=B-(12-)
56Y = 4 Pin Straight Micro Connector in Mounting; Pin 1=Not Used, 2=12+(B+), 3=Com, 4=14+(A+)

Combination Options
41W = (11B) Flush Locking Manual Override & (17N) Surge Suppression (DC Only)
48S = (11B) Flush Locking Manual Override & (19M) Terminal Block in Mounting
26K = (11B) Flush Locking Manual Override & (46T) Zinc Plated Solenoid Armature (A C Only)
46Z = (11Z) Extended Locking Manual Override & (17N) Surge Suppression (DC Only)
26C = (11Z) Extended Locking Manual Override & (19M) Terminal Block in Mounting
48Q = (11Z) Extended Locking Manual Override & (46T) Zinc Plated Solenoid Armature (A C Only)
46P = (17N) Surge Suppression (DC Only) & (19M) Terminal Block in Mounting

Port Type
0 = NPTF Pressure Ports w/NPTF Conduit Ports or Valve Unit w/o Mounting
G = ISO228/1-G Pressure Ports w/ ISO Metric - 1.5mm Pitch Conduit Ports

Wiring Option
K = Plug-in, w/ Light, VAC
M = Plug-in, w/ Light, VDC
2 = DIN Plug-in Solenoid, VAC
4 = DIN Plug-in Solenoid, VDC
6 = DIN Plug-in Solenoid, w/ Light, VAC
O = Non Plug-in (hardwired), VAC or Mounting Only w/ Electrical Receptacle
B = Non Plug-in (hardwired), VDC or Mounting Only w/o Electrical Receptacle

Resistance Welding Equipment

Spot Welding Electrodes

Special Tooling

Bar Stock

Holders

Special Forgings

Elconite

Ignitron Tubes

Seam Welder Wheels

C.D. Studs

ARC Studs

Concrete Anchors

Controls

Stud Welding Equipment

Repair and Service

Educational Programs

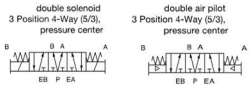
Numatics brand
153SA43AK000030 3/8" NPT valve (cont'd)

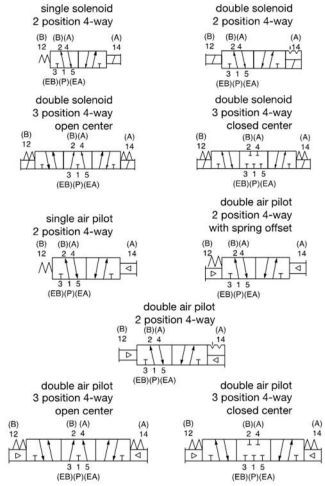
numatics

Mark 15 & PA 15 SERIES

5 Ported, 2 and 3 position, 4-way, Spool & Sleeve
Cv: 1.5

- Direct solenoid or air pilot actuated
- Plug-in solenoid with indicator light
- Unlubricated or lubricated service
- Integral speed control available
- Integral regulators available
- NEMA 4
- Body to base plug-in





Technical Data

Valve Data		English		Metric Mark 15 Only	
Cv		1/4 NPTF = 1.4	3/8 NTPF = 1.5	1/4 G Tap = 1.4	3/8 G Tap = 1.5
Flow Capacity		65 SCFM	69 SCFM	1379 Nl/m	1477 Nl/m
		Upstream pressure to atmosphere @80 PSIG		@ 6 bar upstream/5 bar downstream	
Operating Pressure Range		28" Hg. Vacuum to 150 PSIG		Vacuum to 10 bar	
Temperature Range (Ambient)		-10°F to +115°F		-23°C to +46°C	
Pilot Pressure Range (PA15)	2-Position, Spring Return 2-Position, Detented 3-Position	20 to 125 PSIG 15 to 125 PSIG 20 to 125 PSIG			

Operating Data

All Solenoids Are Continuous Duty Rated		12 VDC	24 VDC	24 VAC 50 Hz	24 VAC 60 Hz	115 VAC 50 Hz	120 VAC 60 Hz	230 VAC 50 Hz	240 VAC 60 Hz
Power (Watts)		6.0	6.0	N/A	N/A	N/A	N/A	N/A	N/A
Holding Current (Amps.)		0.500	0.250	0.590	0.420	0.110	0.090	0.070	0.050
Inrush Current (Amps.)		N/A	N/A	2.850	2.530	0.630	0.580	0.310	0.290
Energize in seconds	2-Position, Single, Spring Return	0.038	0.034	0.010	0.010	0.010	0.010	0.010	0.010
	2-Position, Double, Detented	0.035	0.035	0.010	0.010	0.010	0.010	0.010	0.010
	3-Position, Spring Centered	0.040	0.040	0.010	0.010	0.010	0.010	0.010	0.010
De-energize in seconds	2-Position, Single, Spring Return	0.016	0.011	0.015	0.015	0.015	0.015	0.015	0.015
	2-Position, Double, Detented	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3-Position, Spring Centered	0.010	0.010	0.012	0.012	0.012	0.012	0.012	0.012

Information subject to change without notice. For ordering information or regarding your local sales office visit www.numatics.com.

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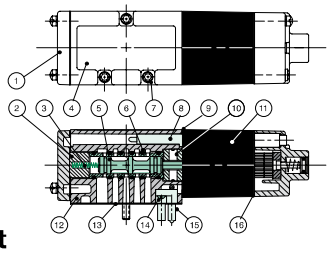
Numatics brand
153SA43AK000030 3/8" NPT valve (cont'd)

numatics

Service Kits and Parts

Kit No. MK15-K1* (For Models 152SA4, 153SA4)



Parts List

Det. No.	No. Req'd	Part Name	Part No.
1	1	End Plate Assembly	204-215
2*	1	Spring Retainer	116-286
3*	1	Spring	115-214
4	1	Nameplate	122-941
5	1	Sleeve Assembly w/seals	209-246**
6*	6	Seal	126-202
7	3	Screw	127-294
8	1	Electrical Receptacle	125-309
9*	2	Gasket solenoid/valve	113-268
10*	1	Detented Body	110-113
11	1	Solenoid Capsule Assembly	See p. 21
12	1	Valve Body (not sold separately)	
13*	1	Gasket body/base	113-264
14	1	Screw	127-169
15	1	3-Wire Plug Assembly	230-233
16*	1	Gasket solenoid/end cap	113-267

Kit No. MK15-K3* (For Models 152SS5, 153SS5)

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Resistance Welding Equipment

Spot Welding Electrodes

Special Tooling

Bar Stock

Holders

Special Forgings

Elconite

Ignitron Tubes

Seam Welder Wheels

C.D. Studs

ARC Studs

Concrete Anchors

Controls

Stud Welding Equipment

Repair and Service

Educational Programs

Numatics Brand
554SA43AK000030 ½" NPT valve

numatics

Mark 55, SPA55 & PA55 Series

How to Order

Valves 553 SA 4 15 K 0 000 30

Valve Series & Port Size
553 = 3/8
554* = 1/2
555 = 3/4
*Valve unit only.

Valve Type
SA = Single Direct Solenoid, Spring Return w/Flush Non-Locking Override (Std.)
SS = Double Direct Solenoid w/Flush Non-Locking Override (Standard)
BA = Single Solenoid Pilot, Spring Return w/Flush Non-Locking Override
BB = Double Solenoid Pilot w/Flush Non-Locking Override
JA = Single Air Pilot, Spring Return
JJ = Double Air Pilot
JK = Double Air Pilot, Spring Return w/Flush Non-Locking Override (2 position Only)
PA = Single Air Pilot, Spring Return w/out Override
PP = Double Air Pilot w/out Override

Function
4 = 2 Position, 4-Way
5 = 3 Position, 4-Way Open Center
6 = 3 Position, 4-Way Closed Center
7 = 3 Position 4-Way (5/3), Open to 4 (A) and 2 (B) in Center

Mounting
00 = Valve Unit Only
01 = Valve Unit Only w/Speed Control
2A = 15 w/Compact Manifold Block
2B = 2A w/Speed Control
2C = 2A w/Auxiliary Inlet
2E = 2A w/Alternate Outlet
2G = 2A w/Alternate Outlet & Auxiliary Inlet
3A = Individual Base, Side Ports, Individual Exhaust
3B = Individual Base, Side and Bottom Ports, Individual Exhaust
3C = 3A w/Speed Control
3D = 3B w/Speed Control
15 = Manifold Block w/Side and Bottom Cylinder Ports
25 = 15 w/Speed Control
31 = Plug-In Base, Side Ports, Common Exhaust
32 = Individual Base, Side and Bottom Ports, Common Exhaust
35 = 31 w/Speed Control
36 = 32 w/Speed Control

Wiring Option
J = Plug-in AC w/Light and Speed Control (Use only with 01 mounting)
K = Plug-in AC w/Light
M = Plug-in DC w/Light (SPA 55 only)
O = Not Applicable (Used for Air Pilot)
Q = Plug-in DC w/Light and Speed Control (Use only with 01 mounting)
6 = DIN Plug-in AC w/Light (Mark 55 only)

Port Type
0 = NPTF
G = G Tap
U = G Tap (Solenoid Pilot Valves)
T = NPTF (Solenoid Pilot Valves)

Options
11B = Flush Locking Override
11Z = Extended Locking Override (Mark 55 & PA 55)
13A = 48" Leads (Mark 55 & SPA 55)
14B = Internal Pilot Supply from P if Not Standard (SPA 55 only)
14C = Internal Pilot Supply from EB (3) (SPA 55 only)
14D = Internal Pilot Supply from EA (5) (SPA 55 only)
14X = External Pilot Supply Through Manifold (SPA 55 only)
16T = Bottom P Ports
19M = Terminal Block in Conduit Area (Mark 55 & SPA 55 only)
46T = Zinc Plated T Armature (Mark 55 only)

Voltage
00 = Air Pilot
20 = 24/50-60 VAC
30 = 110-120/50-60 VAC
40 = 220-240/50-60 VAC
61 = 24 VDC (SPA only)

NOTE: For SPA Series valves, internal pilot supply is standard as follows:
BA4 = internal from port P
BB4 = internal from port P
BB5 = internal from port EB
BB6 = internal from port P

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Numatics Brand
554SA43AK000030 ½" NPT valve (cont'd)

numatics

Mark 55, SPA55 & PA55 Series

Technical Data

VALVE DATA		ENGLISH			MARK 55 ONLY METRIC		
Cv		3/8 NPTF = 4.0	1/2 NPTF = 5.0	3/4 NPTF = 5.5	G3/8 = 5.0	G1/2 = 5.0	G3/4 = 5.5
Flow capacity		185 SCFM	232 SCFM	255 SCFM	3940 Nl/m	4925 Nl/m	5417 Nl/m
		Upstream pressure to atmosphere @80 PSIG			@ 6 bar upstream/5 bar downstream		
Operating Pressure Range		28" Hg. Vacuum to 150 PSIG					
Pilot Pressure Range	2-Position, Single, Spring Return	20 to 125 PSIG					
	2-Position, Double, Detented	15 to 125 PSIG					
	3-Position, Spring Centered	20 to 125 PSIG					
Temperature Range (ambient)	Mark 55	-10°F to +115°F			-23°C to +46°C		
	SPA 55	-10°F to +115°F					
	PA 55	-10°F to +150°F					

Operating Data - Mark 55

ALL SOLENOIDS ARE CONTINUOUS DUTY RATED		24 VAC 60 Hz.	115 VAC 50 Hz.	120 VAC 60 Hz.	230 VAC 50 Hz.	240 VAC 60 Hz.
Power (Watts)	Single Solenoid	N/A	13.0	11.5	19.0	15.0
	Double Solenoid	N/A	6.2	5.6	7.2	6.7
Holding Current (Amps.)	Single Solenoid	1.8	0.40	0.28	0.30	0.20
	Double Solenoid	1.3	0.18	0.24	0.08	0.07
Inrush Current (Amps.)	Single Solenoid	13.0	2.8	2.5	2.0	1.50
	Double Solenoid	12.4	1.75	2.1	0.90	0.80
Energize in seconds	2-Position, Single, Spring Return	0.015	0.015	0.015	0.015	0.015
	2-Position, Double, Detented	0.018	0.018	0.018	0.018	0.018
	3-Position, Spring Centered	0.015	0.015	0.015	0.015	0.015
De-energize in seconds	2-Position, Single, Spring Return	0.030	0.030	0.030	0.030	0.030
	2-Position, Double, Detented	N/A	N/A	N/A	N/A	N/A
	3-Position, Spring Centered	0.030	0.030	0.030	0.030	0.030

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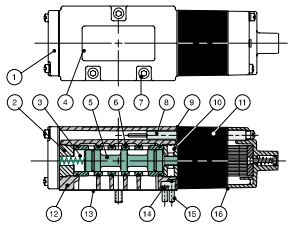
554SA43AK000030 ½" NPT valve (cont'd)

Service Kits and Parts

Kit No. MK55-K1* (For Models 553SA4, 554SA4, 555SA4)



Parts List

DET. NO.	NO. REQ'D	PART NAME	PART NO.
1	1	Sprint Cover Assembly	204-311
2 *	1	Spacer	116-317
3 *	1	Spring	115-165
4	1	Nameplate	122-935
5	1	Sleeve Assembly w/seals	209-285**
6 *	6	Seal	126-209
7	3	Screw Assembly	127-334
8	1	Electrical Receptacle	125-309
9 *	1	Gasket solenoid/valve	113-293
10 *	1	Detented Body	110-115
11	1	Solenoid Capsule Assembly	*See p. 23*
12	1	Valve Body (not sold separately)	
13 *	1	Gasket valve/base	113-292
14	1	Screw	127-169
15	1	3-Wire Plug Assembly	230-328
16 *	1	Gasket solenoid/end cap	113-294

Excellence
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Common Footswitches Used on Spot Weld, Inc. Machinery

Linemaster 534-SWHOX Hercules Foot Switch

- Two stage footswitch
- Rugged cast metal enclosure has sufficient weight to keep the switch from sliding when being operating
- All models have a neoprene cover gasket plus O-rings on the activating shaft and a separate ground screw
- In all maintained contact models the release is accomplished by simply pressing the latch with a light forward movement of the toe. The release is placed under the full shield so falling objects cannot easily release it
- Oversize "O" and "OX" shield models accept oversized safety shoes and metatarsal foot guards. The "OX" shield has an additional 3/4inch (19.1 mm) opening height as compared to the "O" shield
- Painted alert orange
- single 3/4″ -14 NPT threaded conduit entry is standard
- 3 holes provided for rigid mounting to the floor or equipment

Linemaster 575-DWHOXA

- 3-stage footswitch
- Rugged cast metal enclosure has sufficient weight to keep the switch from sliding when being operating
- All models have a neoprene cover gasket plus O-rings on the activating shaft and a separate ground screw
- In all maintained contact models the release is accomplished by simply pressing the latch with a light forward movement of the toe. The release is placed under the full shield so falling objects cannot easily release it
- Oversize "O" and "OX" shield models accept oversized safety shoes and metatarsal foot guards. The "OX" shield has an additional 3/4inch (19.1 mm) opening height as compared to the "O" shield
- Painted alert orange
- single 3/4″ -14 NPT threaded conduit entry is standard
- 3 holes provided for rigid mounting to the floor or equipment

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- Resistance Welding Equipment
- Spot Welding Electrodes
- Special Tooling
- Bar Stock
- Holders
- Special Forgings
- Elconite
- Ignitron Tubes
- Seam Welder Wheels
- C.D. Studs
- ARC Studs
- Concrete Anchors
- Controls
- Stud Welding Equipment
- Repair and Service
- Educational Programs

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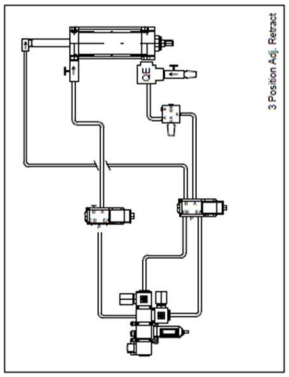
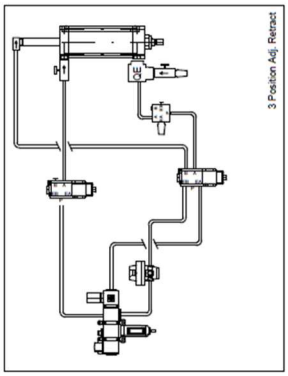
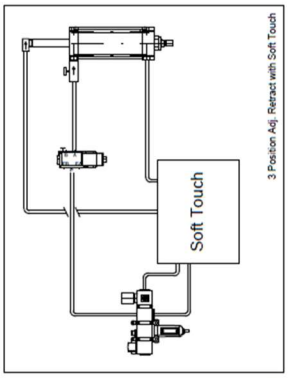
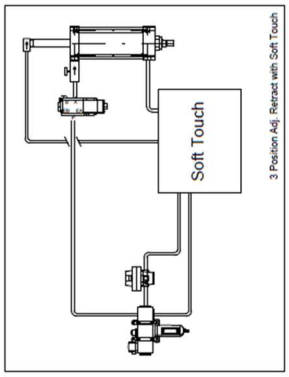
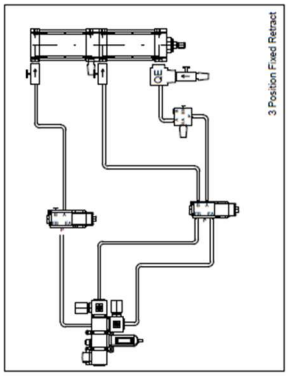
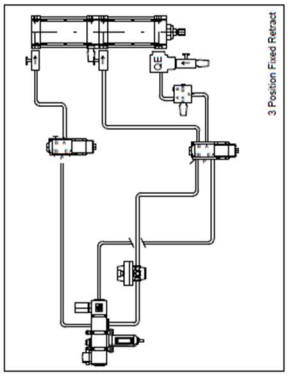
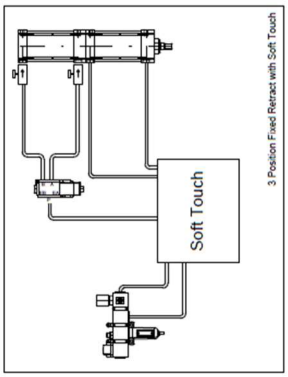
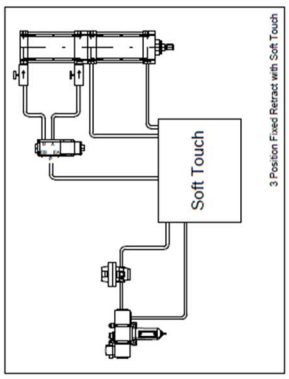
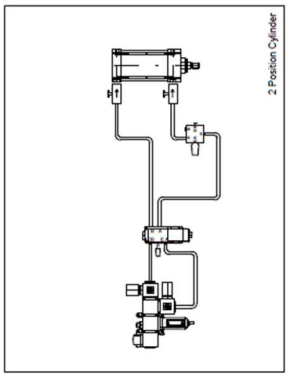
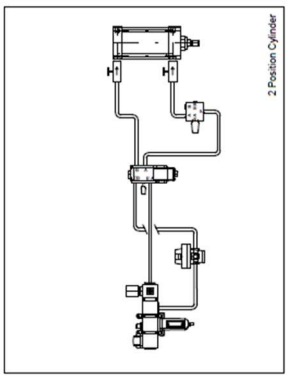
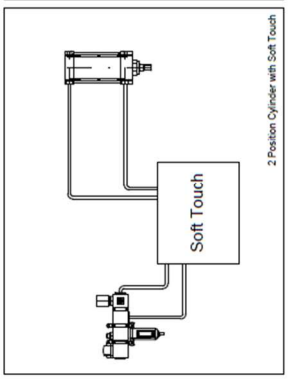
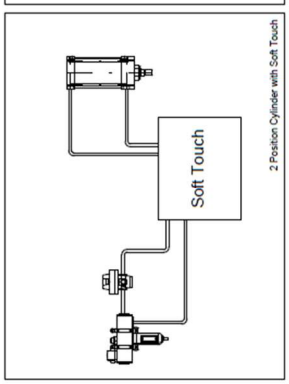
	652-SFDRR	652-SFDR	652-SFDR	652-SFD
Soft Touch - NO Electronic Air - NO				
Soft Touch - NO Electronic Air - YES				
Soft Touch - YES Electronic Air - NO				
Soft Touch - YES Electronic Air - YES				