P280 CONTROLLER

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OUR HANDSHAKE IS AS STRONG AS OUR BOND

NOTICE

FOR: CUSTOMER, MAINTENANCE & MACHINE OPERATORS

TIP CLEARANCE NOT TO EXCEED 1/8"

For Human Safety
One eighth of an inch clearance above material to be welded.

This notice is posted with every sale, delivery of Every welder machine and or equipment

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MACHINE SAFETY:

It is the user's responsibility to provide proper safety devices and equipment to safeguard the operator from harm for any particular use, operation of set up, and adequately safeguard the machine or machines, to conform to all Federal, State, and Local Government Safety Standards and All Industrial Safety Standards.

INDEMNIFICATION:

User agrees to indemnify and hold harmless Seller of and from any and all claims or liabilities from accidents involving these machines caused by failure of user, his employees, or agents to follow instructions, warnings, or recommendations available from the manufacturer, or by failure of user to comply with Federal, State, and Local laws, applicable to such equipment.

S A F E T Y P R E C A U T I O N S:

When welder machine is unattended, and/or during week-ends….POWER IS TO BE TURNED OFF!

H&H Resistance Welders Incorporated Warranty

The Model P280 Welding Controller has a limited warranty of five (5) years from date of installation and/or shipment, of parts, FOB: Afton, Oklahoma. [The (5) year warranty was incorporated 5/15/07]

During that period, upon prepaid return to the distributor or factory, equipment proving to be defective will be repaired (or at our option, replaced), without charge for material. Freight will be charged for shipment back to the customer. <u>Should you require to return the unit for repairs, you must ship both the PSIO and the Mother Board – as a UNIT.</u>

No responsibility of H&H Resistance Welders will be assumed for damage to equipment through improper installation, or through attempts to operate control above it"s capacity, intentional or otherwise.

This warranty does not include SCR Contactors.

This warranty is void if an earth ground is not supplied to the machine and control.

In addition, the warranty does not cover any customer equipment to which the Model P280 has been installed.

D E S C R I P T I O N:

The P280 is a single phase welding control, manufactured exclusively by H&H Resistance Welders, a division of ERON Corporation, Afton, Oklahoma. Utilizing the latest in Large Scale Integration (LSI) digital circuitry, the entire control has been kept under 60 cubic inches in volume which includes solid state relays and power transformer.

The heart of the P280 is a Motorola Micro Controller, running at an operating speed of four million cycles per second. Using a sophisticated computer language, the Micro Controller is capable of thousands of decisions in a fraction of a second, thus, allowing itself to stay well ahead of possible problems.

Some of the special circuitry and software which has been designed into the P280 has to do with power line monitoring. The software constantly monitors the incoming voltage level to allow itself time to respond to variations which could cause problems. The P280 will not take away the final control of the welding sequence, nor does it modify the heat depending on line voltage variations. The P280 does have circuitry to constantly search phase shift variations for either 50 or 60 cycles/second. An extremely valuable monitor circuit is the power input fluctuation monitor, which has a convenient indicator located on the Power Supply Input Output (PSIO) board on the rear of the CPU. At any time, it can be observed for line drops, spikes, or noise. Although the P280 has extremely good digital noise filters, it gives the customer an additional analytical tool to prepare for future electrical problems.

The use of LSI hardware has resulted in a very small Central Processor Unit (CPU). The CPU board measures 4 x 4.25 x 1.5 inches. The inputs and outputs are accomplished through a screw type barrier terminal on the rear of the PSIO board. 18 gauge wire can be used for all interconnections to the welder. Fuses are supplied for separate protection of 120 vac and CPU power.

The P280 can be mounted in any position and in any cabinet using the pre-punched chassis or panel. The standard stand alone cabinet is 8 inches wide, 10 inches high and 6 inches deep. This cabinet houses the control with PSIO board and required step down transformer and firing board be mounted externally. The SCR fired system can be housed in one cabinet, which will include the PT500/IF500 firing board, SCR pack, Step down transformer, and line board. The dimensions of this assembly are 16 inches wide, 14 inches high and 6-3/4 inches deep.

I N S T A L L A T I O N:

The control is usually mounted on the right side of the machine on the upper head or beside the main transformer to maintain high quality earth ground on both machine and controller. The earth ground is best achieved when an eight foot copper rod is driven into wet earth and #6 solid copper wire connects the rod with the controller cabinet.

The P280 was designed with a PSIO board, which can be mounted piggy-back on the rear of the controller or mounted externally, using the ribbon cable. (The revised versions have deleted the ribbon cable). A small transformer is mounted on the PSIO board to allow only 120 volts AC to be present on the terminal strip, not 240 or 480 volts AC. The higher voltage levels can now be kept away from the control and away from operators when they enter the controller area.

The Interconnecting cables normally pass through the head of side skin. Therefore, no holes are punched in the cabinet so each installation can be flexible. For control unit only, a 1.5 inch hole is ample for passage. Control with SCR pack will require at least a 3 inch hole for signal cables as well as #4 cable or larger to connect SCR, transformer, and line power input.

In the SEAM mode, an isolation relay will be required and may be mounted in the P280 cabinet or externally. The relay must have a 120 vac coil and contacts capable of the requirements as needed for the seam drive motor.

The signal and control wires for interconnections may be in the range of 22 to 18 gauge and stranded. These circuits will require small current levels in the range of 5 vac. to 120 vac. The current required through the firing device and the welding transformer will demand such larger cables and the correct size can be obtained from the H&H Service Department. All wiring should avoid pinching or rubbing against moving parts.

A key operated Program Lock can be provided to prevent unauthorized access to programs in memory.

CONTROLLER STRUCTURE

The P280 is constructed around a Micro Controller chip and the rest of the electronic components are only to support the chip. The physical boards and their components are referred to as HARDWARE and the program that operates the controller and resides in the chip is called the SOFTWARE. The variables which make up the weld schedules are stored in MEMORY and can be viewed and/or changed. There are two clocks in the system. One clock is crystal controlled and operates at 4 million cycles per second and is the time base for all the welding functions.

The SOFTWARE has been written to operate in a fixed manner and must use the values that the programmer/operator has placed in the weld schedules. A weld schedule may contain up to 15 variables and there are 100 possible schedules. So, with 100 schedules and 15 variables, there has to be 1500 memory locations or boxes, where a number or command can be kept.

The SOFTWARE will allow the operator to look at the contents of any box, or memory, and leave it alone or change the controls. When the controller has been placed in the WELD schedule position (Home) and the footswitch first stage is depressed, the control will move to the SQUEEZE mode. It will use the value in that memory location to set the timer. NOTE: The SQUEEZE function is pre-set at (2).

When the second footswitch stage is depressed, the software will sequence through each step using the values found in each appropriate box.

Three other variables that are stored for each schedule are REPEAT, WELD and SEAM. Repeat is used in spot welding mode when automatic repeating is used for rapid consecutive welds by holding down the footswitch. Weld, and therefore, No Weld, can be used for sequencing the control, checking weld pressure, material positioning and timing without weld current. Seam will force the control to use Squeeze and then cycle through the Cool/Up Slope/Heat Down Slope sequence continuously until the footswitch is released. At this point, the Hold and Off will complete.

The memory locations are stored in a system that does not require a battery to energize; therefore, schedules can be kept indefinitely. When power is applied to the control the Software is loaded into RAM (Random Access Memory), which is the area where the operating program must reside in order to function. Once the software is loaded, it is started by an external signal called the RESET pulse. In rare cases, tremendous input power line surges or spikes, might upset the software causing the program to “glitch”, and by cycling the power OFF and ON, the software is reloaded and any possible errors are removed.

O P E R A T I O N:

The P280 is industry’s most user friendly welding controller to be found, because that is exactly how it was designed. Tactile touch means you can feel the key depression by means of a mechanical “thump” sensation. Program variables are stored in EPROM (No Battery Required) and are called for viewing by depressing the “B” button. Each depression will advance the program location one position. The WELD Schedule indicator, when illuminated, notifies the programmer that the number in the window at the top of the panel is the weld schedule selected for use or observation. This light also indicated the control is in HOME position and ready to weld.

The dual digit display at the top of the front panel is capable of displaying several different outputs. The following is a complete listing of displays:

Weld Schedule	00-99	Schedule #
Cool Time	00-99	0 to 1.65 second
Impulses	00-99	Quantity per weld
Up% / Cycle	0.1-9.9	% step each 1/60 second
Up Max %	00-99	% full power
Heat Time	00-99	% of cycles of weld
Heat %	00-99	% of full power
Down % / Cycle	0.1-9.9	% step each 1/60 second
Down Min %	00-99	% full power
Hold Time	00-99	0 to 1.65 second
Off Time	00-99	0 to 1.65 second
Power Up Display	Line Frequency displayed for 1 second	
Footswitch Down	88 displayed until released.	

A N T I – T I E – D O W N

With this mode active, FS1 must be made first. The FS2 must follow within 10 milliseconds to 500 milliseconds after. If switch closures occur before or after this operational window, the control will lock up until both switches are reset or cleared.

Once squeeze mode has begun timing, the weld valve output will activate. If either FS1 or FS2 is opened during squeeze, the weld valve output will shut off. The squeeze time indicator will remain on. Both FS1 and FS2 must be cleared before sequence can be restored.

A N T I – T I E – D O W N, T I M E M A I N T A I N E D

With ANTI-TIE-DOWN , selected, a time variable can be set to maintain the FS1 and FS2 inputs for a pre-set time once both FS inputs are made (within the operational window).

This feature is operational in seam and repeat spot modes

The timer "latches" and begins timing after the initial squeeze time completes. If in repeat mode, subsequent squeeze times are included in the pre-set latching time. If the repeat and seam modes are off, then timer defaults and acts like a normal anti-tie-down mode.

To set the timer register, advance to the IMPULSES register with the "B" key. Then press and hold the "F" key for 2 seconds. The display will start flashing. The units and tens of seconds are entered (00-99). Press the "A" key to allow tenths of a second entry (.0 to .9) as indicated with a decimal point. The total range of the timer is .1 to 99.9 seconds. Pressing the "B" key again will exit the timer register.

If the timer register is left at 0 (default), the control responds directly to the FS inputs.

L I N E V O L T A G E M O N I T O R

Circuitry will monitor the line voltage continuously. Operation of the P280 will be inhibited if the line voltage drops below 90 vac for a period exceeding 30 cycles of 60 hz, and an audible alarm will sound. The control will not resume operation until the line voltage raises above 93 vac and the control is reset by either the reset button (S1) located on the PSIO board, or power to the control is cycled off and back on. A normal POWER ON action will not cause lockup. A "ragged" or "jittery" POWER ON may cause lockup and require use of the reset button.

SEAM MOTOR DELAY TIMER

The MR/RV output, when FSA option is not used, can be set to start at the beginning of squeeze time from 0 to 99 cycles later. This means you can start the motor before, at the instant the weld begins, or after.

For this option SEAM Function must be activated.

The time delay is set by advancing to the squeeze time register with the "B" key. Then press and hold the "D" key for 1 seconds, the display will flash and any value from 0 to 99 cycles may be entered. Press the "B" key to return to the squeeze time register.

If squeeze time is greater than the delay time, the operator could release the FS inputs before the cycle is "latched". If this occurs, the motor will shut off.

NOTE: FOR SAFETY REASONS, ANY TIME A CHANGE IS MADE TO THE SQUEEZE TIME, THE MOTOR DELAY VALUE WILL REST TO THE VALUE LAST ENTERED INTO THE SQUEEZE TIME. THE P280 HAS A PRESET SETTNG OF (2) FOR THE SQUEEZE TIME, AND THE 'AOC' DEFAULT SETTING ID (20).

This means any time the operator changes squeeze time, he should also check the time delay register. Caution should be used when setting the motor delay. If the delay value is much greater than the combined value of squeeze time + cool time, the weld will occur before the seam motor starts advancing the material. This could result in massive surface expulsion.

PROGRAM LOCKOUT

Provided in the chassis of the P280 is a key-operated switch. In the program position, the operator can program the control. In the lockout position, access to be program is denied.

NEXT WELD

This feature causes the weld schedule to alternate between adjacent odd and even schedule numbers:0-1,2-3,4-5……..28-29. When switch is made, the current schedule will change to the alternate, and the P280 display will indicate the change. When the FS inputs are made, the displayed schedule will run. At the end of that schedule when the off time LED turns off, the selected schedule will change to the alternate. Opening the switch will not change the schedule.

A new schedule can be selected with the keypad, or values in an existing schedule can be modified independent of the next weld feature.

R E T R A C T

This feature cannot be used of the MR/RV output is used to drive a motor speed control or other device in seam weld operation. A factory installed jumper will determine if either retract or motor out put is selected.

Supplied in our three stage footswitch is a locking mechanism. This locking stage is referred to as FSA. This switch must be made and maintained before FS1 and FS2. If this does not happen, the P280 will not sequence. If FSA is made at POWER ON, P280 will lock up, displaying "88", as with FS1 and FS2. If FS inputs are cleared, the P280 will function.

The 16 button keypad is simple in operation, as the executive program stored in an EPROM controls all key strokes. If an illegal number is entered for a particular memory location, the software will not allow the information to move out of the keypad, thus, protecting memory. Each memory location has a specific format as shown above. The numeric keys are self-explanatory. The letter keys are as follows:

A	Skip-Advance to home position
B	Enter-Advance to next skip
C	Tip Dress-Lower tip to clean (Optional)
D	Seam-Configure control for seam welding
E	Weld-Weld current On/Off
F	Repeat-Repeat sequence until footswitch is (Spot ONLY)

I N D I C A T O R D E F I N I T I O N / F U N C T I O N

1. Dual 7 Segment Display – A two digit display reading weld schedule number or program data in memory. The following LEDs define what information is displayed in the Dual Display.
2. Weld Schedule LED – The weld schedule number selected for current use (0-99).
3. Squeeze Time LED – The number of cycles of time to allow the electrodes to engage and stabilize weld pressure (0-99).
4. Cool Time LED – The number of cycles of time following each welding period.
5. Impulses – The number of welding period. (Up % + Heat Time +Dn % + Cool Time) to be accomplished during one weld sequence. (0-99).
6. Up % / Cycle LED – The percentage (0.1 to 9.9) of the Up Max. % value the heat will increase for each 1/60th of a second until Up Max % is reached.
7. Up Max % LED – Percent of maximum heat to be reached after delay of Up % / Cycle value. (0-99%)
8. Heat Time LED – The number of cycles of applied heat for each impulse. (0-99).
9. Heat % LED – Validity of available heat for each heat time. (0-99)
10. Dn % / Cycle LED – The percentage (0.1 to 9.9%) of the Dn Min. % value the heat will decrease for each 1/60th of a second until Dn Min, % is reached.
11. Dn Min % LED – Percent of minimum heat to be reached after delay of Dn % / Cycle value. (0-99%)
12. Hold Time Led – The number of cycles of time maintaining weld pressure without weld current (0-99).

13. Off Time LED – The number of cycles of time after release of weld pressure until sequence is complete. (0-99)

STATUS INDICATOR: (Front Panel)

1. Repeat LED – When illuminated, the weld sequence will keep repeating as long footswitch stages 1 and 2 are depressed. When dark, the sequence will operate one time only.
2. Weld LED – When illuminated, the pulse will be sent to the firing board. When dark, no pulse is sent.
3. Seam LED – When illuminated, the weld cycles (Up % + Heat Time + Dn % + Cool Time) will repeat as long as footswitches 1 and 2 are depressed. When dark, the controller is in spot mode.
4. Tip Dress LED – When illuminated, the air pressure is removed from the bottom of the weld piston causing the head to lower due to it's own weight.
5. ST1 LED – When illuminated, the first stage of the footswitch has been activated.
6. ST2 LED – When illuminated, the second stage of the footswitch has been activated.

STATUS INDICATORS (PSIO Board)

1. LED D7 – When illuminated, the 5 vdc command to operate has been given to relay K1. (Weld solenoid 120 vac output).
2. LED D8 – When illuminated, the 5 vdc command to operate has been given to relay K2. (Mtr On solenoid 120 vac output).
3. LED D9 – When illuminated, the 4 vdc command to operate has been given to relay K3. (Tip Dr solenoid 120 vac output).
4. LED D4 – Will pulse ON if the line frequency varies from the programmed value. (Set for 60 c.p.s.).
5. LED D5 – Will pulse ON if the line voltage fluctuates above or below specified limits. (To monitor power input disturbances).

FUSES

1. F1 - Fuses one side of the incoming 120 vac. (1A 250V 312).
2. F2 – Fuses the 16 vac to CPU power supply. (1A 250V 312)

B A S I C   S E Q U E N C E

The following is one complete pass through a weld schedule. To be complete we will begin with Power to the Machine turned OFF.

1. **TURN ON THE POWER -** The P280 will remain dark for about 1-2 seconds, the line frequency (60) will be displayed for 1 second, and then the display will either be "00" or "88". The "00" indicates the first weld schedule. The "88" indicates the footswitch is depressed.

2. **WELD SCHEDULE # (0-99)** – Enter the number of the desired weld schedule in display window. Depress Key B one time to advance the control to the next location. The **WELD SCHEDULE LED** will light.

3. **SQUEEZE (0-99)** – The time allowed to lower the upper electrode to the material and stabilize the weld pressure is **SQUEEZE**. One cycle is 1/60th of one second or .0167 seconds. Enter the number of cycles desired. Depress Key B. **SQUEEZE OFF. IMPULSES ON.**

4. **COOL TIME (0-99) –** A cooling period, measured in cycles, occurring between each impulse, when using multiple impulses.

5. **IMPULSES (0-99)** – The weld cycle consists of a sequence of heating and cooling commands and the command **IMPULSES**, then determines the number of times the heat/cool sequence occurs for the weld schedule. Depress Key B. **IMPULSES OFF. UP% CYCLES OFF, UP MAX% ON.**

6. **UP % / Cycle (0.1 to 9.9)** – The **UP%** parameter is also called **UPSLOPE.** The control will start this command at zero % heat and increase at the rate selected by this parameter. For further discussion of this variable, refer to end of the section. Depress Key B. **UP % / CYCLE OFF, UP MAX % ON.**

7. **UP MAX % (0-99)** – This is the percent of weld power to be reached at the end of the UP Slope. Depress Key B. **UP MAX. OFF, HEAT % ON.**

8. **HEAT % (0-99) –** This is the number of cycles of weld current in one heat/cool cycle Depress Key B. **HEAT OFF, HEAT% ON.**

9. **HEAT % (0-99)** – 0 TO 99 percent of available current is selected in this parameter. Depress Key B. **HEAT % OFF, DN% / CYCLE ON.**

10. **DOWN % / Cycle (0.1 to 9.9)** – This is a Down Slope parameter. It operates the same as Up Slope, except it begins with **HEAT %** value and slopes down to the **DOWN MIN %** value. The percent per cycle step works the same. Depress Key B, **DN MIN %, HOLD ON.**

11.**HOLD TIME (0-99)** – This timing function allows the weld pressure to remain after the current is removed for cooling. Depress Key B. **HOLD OFF, OFF ON.**

12. **OFF TIME (0-99)** – This timing function holds the return to **HOME** position for a fixed time. This time is useful in the **REPEAT** mode. Depress Key B. **OFF, WELD SCHEDULE ON.**

T R O U B L E S H O O T I N G

1. CHECK CPU & PSIO BOARDS VISUALLY
   a. Check CPU board to insure all integrated circuits are seated properly. Check for broken leads on individual components. Insure ribbon cable is seated properly. (Newer version does not have a ribbon cable.)
   b. Check PSIO board for fuses in both positions. Check integrated circuit for proper seating. Check component leads for breakage.
2. CHECK BASIC POWER REQUIREMENTS
   a. Check for 110 vac input at the rear terminal strip on PSIO board.
   b. Check fuse F1 (1A 250V) on PSIO board.
   c. Check fuse F2 (1A 250V) on PSIO board.
   d. Check for 16-18 vac from the top of D2 to the top of D3 on the PSIO board.
   e. Check the 5 vdc to ground at the top left front of CPU board at JP4 test point.
3. CHECK BASIC CONTROL START UP
   a. Power ON.
   b. All displays dark for 1 to 2 seconds.
   c. Line frequency displayed for 1 second.
   d. Weld Schedule #in window and Weld Schedule LED lit or “88” if footswitch closed. (Check ST1 and/or ST2 if lit).
   e. Weld Schedule LED lit all others OFF. (Repeat, Weld, Seam & Dress LEDs independent operation.
4. CHECK CONTROLLER INPUTS
   a. Verify Weld Schedule LED lit and no 110 vac output on Air, Mtr. & Tip terminals. (Outputs must have loads) (Mtr. and tip only if options installed.)
   b. Depress footswitch, first position and verify LED D8 lights and 110 vac appears at WELD terminals.
   c. With Weld Off, depress second position and verify LED D7 lights and 110 vac at Mtr., terminal with SEAM option.
   d. Release footswitch. Depress Key C and verify LED D9 lights and 110 vac at Tip terminal with DRESS option.

I N I T I A L C H E C K

1. Voltages

All voltages are referenced to ground.

PSIO

JP1 11,12	Ground
JP1-13,14	12 VDC to 14 VDC
	1 VAC. Max.
JPT-9	10 VAC +/- 1 VAC, 60 HZ
TBI-9	11 VDC to 13 VDC

CPU

JP4-3	5VDC +/- 0.25
	5 VAC Max.

2. CLOCK

Test Point	Function	Value
JP2-4	Line Sync	5 V 60 Hz, 50% Duty Cycle square wave
JP3-8	Line Sync	5V 60 Hz pulse normally low Active on JP2-4 rising edge
U5-38	Microprocessor Clock	4MHz +/- 440 Hz

3. SYNC

Test Point	Function	Value
JP3-7	Sync lost	5V active when sync lost
JP3-6	Search	5V active when searching

4. ADJUST

Adjust R22 to set the intensity of the LEDs

CAUTION

The SCR Contactors can be damaged if you attempt to fire this welder without sufficient electrode force. The use of squeeze time in quantities sufficient to allow the air cylinder to actuate the electrodes and sufficient air pressure to establish the appropriate tip force is required to insure against damage caused by an open firing. It is further recommended that the two stage footswitch be used to insure that the welding electrodes have reached the appropriate position before the activation of the second stage of the footswitch used to activate the welding program once the program has been initiated it cannot be aborted. If an SCR contactor has been damaged, it is recommended to discontinue operating the welder, and immediately disconnect the main power until proper repairs have been made. Damage to the main welding transformer can occur if the main power is not disconnected. The damage caused by an open firing is not limited to the SCR contactor and is not covered by the warranty, nor is any damage which might be caused to the welding electrodes or to the part which is being welded. While it is not generally dangerous to the operator, you can be injured by material expelled by an open firing. Safety glasses and a welding apron are highly recommended for safe operation of any resistance welder. Please observe all recommended safety precautions included in this manual and your company safety procedures. H&H Resistance Welders will not be held responsible for any damaged caused by careless operations of this equipment.

O P E R A T I O N A L   D E S C R I P T I O N

INTRODUCTION

Resistance welding is a process where metals are joined by clamping the material between two electrodes and then passing enough current through the material to heat and fuse it. Electrodes are used to both clamp and to pass the current through the work. Since all metals have some resistance, current passing through the material generates heat. However, since most metals are reasonably good conductors of current, the currents used must be moderately held under force to provide a good mechanical fit, for good electrical contact between the materials and electrodes, and to aid in the fusing process.

The area heated to the fusing level is referred to as the “nugget”. In a good weld, the nugget will be pliable enough and for force level will be such that the material is joined with a minimum of distortion while providing a good bond.

SPOT WELDING METHOD

Spot welding is one of the most widely methods of resistance welding. To perform this process, the work is clamped between two copper electrodes. Shape of electrode face helps determine size and shape of nugget. Typical uses is to join two over lapping sheets. Main consideration is joining strength.

MACHINE CLASSIFICATION

A FURTHER CLASSIFICATION CAN BE MADE OF RESISTANCE WELDING EQUIPMENT. And that classification is SINGLE PHASE and THREE PHASE. Single phase, three phase refers to the type of input power that must be supplied for your machine. However, each of these two classes has characteristics that you should be aware of when applying your machine.

As the term applies, the single phase machine is only connected across one phase of the input line. Since most resistance welders draw a reasonable amount of current, this may unbalance your input line causing problems. However, this problem can be overcome if the remaining plant load is properly distributed across the other two phases. In addition to the input problem, the secondary output of a single phase is more sensitive to load changes than a three phase machine. Any change in the secondary load; throat depth; resistance, etc., will cause a greater change in the output current that for a similar change with a three phase machine.

Since the three phase machine is connected across all three input phases, it provides better input power distribution than the single phase machine. Additionally, the three phase machine provides better power control in the secondary circuit. This type of machine is primarily resistance sensitive and is not affected as greatly by changes in the secondary as the single phase machine.

PRESS TYPE RESISTANCE WELDERS

The press type refers to how the electrode force is applied to the work. The press type machine has advantages for certain shapes of work, as it is usually used for all purpose type applications. The press type machine is equipped with an in-line cylinder that moves an electrode up and down through a ram. This type of welder has the advantage that the electrodes are always in line providing fewer misalignment problems as the electrodes wear.

HEAT PATTERN

An ideal welding condition is obtained when all of the resistance is concentrated at only one point; the faying area clamped by the electrodes. However, in a typical weld situation there are several series resistances.

1. Upper electrode.
2. Contact between upper electrode and upper sheet.
3. Upper sheet.
4. Contact surfaces between upper and lower sheets.
5. Lower sheet.
6. Contact between lower sheet and lower electrode.
7. Lower electrode.

DESCRIPTION OF WELD RESISTANCE

In the typical heat pattern, the heat should be concentrated at point 4, our highest level of resistance. The next highest level of resistance is a points 2 and 6. The heat level at these points should rise slower that at pint 4. One heat at 2 and 6 is dissipated by the electrodes and cooling water of 1 and 7, while the heat at point 4 is trapped. Therefore, as the weld goes on, we can expect the rate of temperature rise to be much greater at point 4, than any other points.

In an ideal weld, the weld temperature will be reached in an instant at the clamped faying surfaces and then grow into a nugget as the weld time progresses.

CONTACTING SURFACES

Contacting surfaces consist of the electrodes and the material being welded. To reduce the resistance at the electrode tips, both the electrode and the material must be reasonably clean. Dirt or scale at the material to electrode surface, can cause spitting, burning and pitting of the electrode at loss of heat at the nugget area.

In addition to reducing the resistance at electrode tips in between the contacting metal surfaces, electrode force also forms a pressure vessel to contain the weld nugget. Since we are trying to concentrate the greatest resistance between the two contacting metal surfaces, it might seem that electrode force could work against a correct weld. However, since the electrodes are usually softer than the metals being welded, better contact is made at the tip points than between the surfaces being welded. Additionally, while the scale can increase the resistance between the sheets being welded, if the scale and dirt are absorbed into the weld, it will usually be weakened. Scale and dirt also make it difficult to control the weld parameters.

TIME

Correct time in a weld is important to enable the weld to reach the correct temperature and to grow the desired size. We can view current as being the main factor in how pliable the weld can be made and time as assuring that the weld nugget will be the current size. Both, too short and too long heat times will cause weld problems.

Up to a point, current and time can affect the weld in the same way. However, with the given amount of current, after a period of time elapses, the heat affected zone increases to a ping where all of the heat is being radiated, and no additional heat is being applied to the nugget. Correct balance between current and time is very important for a good weld.

If the weld time is made too short for a given current level, the weld will be undersize and weak. Up to a point, current can be increased to make up for time. However, excessive heat from either too long weld time of current levels will cause problems.

For example, the weld nugget size may exceed the hold-down ring of pressure causing expulsion at the faying surfaces. This in turn, could lead to porosity in the weld, sheet separation and even damage to the electrodes, due to pitting and spitting.

DEFINITIONS OF TERMS

ARM
The extension from frame to hold the electrode assembly.

COOL TIME
Current off cooling time in an impulse.

ELECTRODE
Device to apply force and carry current to work piece. Shape can be tubular, similar to a die, or a circular wheel.

ELECTRODE FORCE
Force between the electrodes.

FAYING SURFACES
Mating contacting surfaces of the metals to be joined.

HEAT TIME
Weld power on this time in an impulse.

HORN
Device to hold and align electrode; fits into a arm assembly. Slides in and out to adjust alignment of Electrode.

IMPULSE
A single cool plus heat time. Weld current is applied as a single impulse, or a series of impulses.

K FACTOR
Constant used to determine if weld transformer is operating within acceptable saturation limits.

PULSATION WELD
Number of impulses applied during weld power on time.

RETRACTION/STROKE
Stroke that opens electrodes or maximum clearance.

SECONDARY CIUCUIT
Current path in secondary output from weld transformer.

THROAT DEPTH
Clearance distance from center line of electrodes to frame of machine.

WELD STAND BY
Machine in ready to weld condition; power on, sequence reset, pneumatic and electrical controls adjusted for weld, and electrodes open but brought down to weld stroke opening.

WELD STROKE
Stroke that opens electrodes for minimum clearance, typically just enough to allow work to be moved to next weld location.

TYPICAL SEQUENCE

A resistance welding sequence consists of two associated sub-sequences; electrode force and weld current. Each consists of timed intervals. The main difference between the spot and seam weld sequences occurs at the beginning and near the end of the sequence. The actual weld current part of the sequence is similar.

The basic weld sequence consists of three timed intervals; SQUEEZE, WELD and HOLD. Intervals in the weld sequence can also be referred to as functions. Squeeze provides time for the electrode force to be applied and for the pressure system to stabilize before a weld current is applied. Weld is the Interval during which the main weld current is applied; the nugget is formed and parts fused. Hold is a current off interval for the part to cool before the electrode force is released. A fourth interval is added if more than one weld is to be made. During OFF time, the electrodes are opened allowing the work piece to be moved to the next location.

SEQUENCE OPTIONS

Precompression, pre-heat, quench and temper are four typical optional intervals or functions that may be supplied with your sequence. The sequence will consist of the following intervals in the indicated order; Squeeze, Pre-Heat, Weld Time, Quench, Temper, Hold and OFF.

CONTROLLING ELECTRODE FORCE

Electrode force is controlled by pressurizing one, or both sides of the weld cylinder. Pressure applied to the upper chamber of the weld cylinder provides the main electrode force. Pressure applied to the lower part of the cylinder provides a bucking force. Total electrode force results from the difference between these pressures.

In this arrangement, maximum electrode force is obtained when the lower chamber exhausted and the upper chamber is pressurized; such as during recompression and forge. When electrode force drops to the lower weld level, both sides of the weld cylinder are pressurized.

The arrangement of pressurizing both sides of the weld cylinder to control electrode force is used in machines with Variable Pressure/Constant Pressure selection. In these machines, the arrangement is used in Variable Pressure and Constant Low modes. Bucking pressure can be used in these modes to reduce the electrode force to a minimum level. However, this level should be lower than the pressure applied to the upper chamber to allow the head to be brought down.

In a Constant High mode, the lower chamber of the weld cylinder is exhausted and pressure is applied to only the upper chamber. This arrangement provides the maximum electrode force.

Pressure to the two chambers of the weld cylinder is controlled through the regulators with associated gauges. If a Variable Pressure Option is supplied, the welder will be equipped with two pressure regulators. One regulator is used to set the main and the other the bucking electrode force levels.

To assure that the electrode force levels are at an acceptable level before the sequence is initiated, a control type contact gauge is supplied. This gauge only allows the sequence to be initiated when a pre-set pressure level is reached.

If precompression end is off, the sequence starts with precompression. When this interval is initiated, electrode force rises to the high level. When Squeeze interval is initiated the pressure then goes to the low forge pressure. If Forge is used , it allows the electrode force to once again rise to the high level at the beginning of a selected interval. Electrode force remains at this level until forge times out and it drops to the lower level, or if hold is initiated, it will remain at the high level. In Variable Pressure, electrode force rises to the high level at the beginning of hold.

Variable Pressure machines can also be used in the Constant Low and Constant High modes. In these two latter modes, only one level of electrode force is obtained. The main difference between these modes is that in Constant Low electrode force is the result of the main and bucking pressures. In Constant High, electrode force is the result of only the main, high pressure setting.

CONSTANT PRESSURE ONLY AND SEQUENCE

Constant Pressure only machines are equipped with a pressure gauge in addition to a contact gauge. The pressure gauge monitors pressure in the lower chamber of the weld cylinder. A sequence is only initiated when the contact gauge and pressure switch are closed: Upper chamber pressurized, Lower chamber exhausted.

ELECTRODE FORCE CHARGE

Cyl.	Cyl.			PRESSURE—PSI GUAGE			
Dia.	Area	30	40	50	60	70	80
2”	3.14	95	125	157	188	220	250
2 ½”	4.91	147	196	246	294	344	392
3”	7.07	212	283	354	424	495	565
3 ½”	9.62	288	385	481	576	675	770
4”	12.57	377	500	629	754	878	1000
4 ½”	15.90	477	635	795	954	1115	1270
5”	19.64	590	735	982	1180	1375	1570
6”	28.27	848	1130	1414	1696	1978	2260
8”	50.27	1515	2010	2514	3030	3525	4020

P R E V E N T A T I V E   M A I N T E N A N C E

S C H E D U L E

SINGLE PHASE

Monthly: Check connections at Electrical input lines.	Make sure all connections are tight. WARNING: Turn input power OFF before checking.
3 Months: Clean secondary	Remove upper electrode holder and clean surfaces between holder and head lug. Remove lower head of horn from lower arm and clean contact surfaces. Clean with steel wool or fine emery cloth. Do not clean silver plated surfaces or use solvents.
3 Months: Inspect entire pneumatic system.	Inspect all air lines and connections for leaks. Replace any worn or damaged hoses. Use certified tip force gauge in lieu of calibration of gauges, monthly.
3 Months: Inspect entire	Inspect all water lines and connection cooling system for leaks. Replace any worn of damaged hoses.
6 Months: Check operation of pressure regulators.	Check pressure readings at gauges for various settings of each regulator. full line pressure indicates a ruptured diaphragm or worn valve parts. Unstable regulation or poor low pressure control indicated dirty or worn parts. Clean and replace any worn or damaged parts.

Schedule	Operation	Description
Daily	Lubricate electrode head. (Only at Seam Welders.)	Add lube through grease fittings at electrode head assy. Grease only with **Chemplex 825**
Weekly	Lubricate Conductor Bars. (Only a welders w/conductor bars.)	Add lube through grease fittings at each pivot point. Grease only with **Chemplex 825**
Weekly	Lubricate linkage assy. (Only at Rocker Arm	Remove lube plus, fill cavity with SAE 10 mineral oil and replace plug.
Two Weeks	Lubricate diaphragm	Add lube through grease fitting at guide Guide of head assembly; access provided in the guard around head
	(Only at PMCO welders w/diaphragm head assy.)	Use general purpose lithium grease.
Monthly	Clean air element	Turn off air supply and remove element at air filter from filter housing. Clean with clear warm water or recommended solvent. Blow out with compressed air After cleaning. Replace if clogged.
Monthly	Check felt wiper	Check and replace if worn or excessively dirty. Keep light film of oil on ram to assembly. Prevent rust and/or corrosion.
Monthly	Check connections	Make sure all connections are tight. Electrical input lines.

WARNING: Turn input power OFF Before checking.

Schedule	Operation	Description
Monthly	Lubricate rod of Retraction cylinder. (Only at welders with Separate retract cyl.)	Add lube through grease fitting. Use a general purpose lithium grease.
Monthly	Lubricate pivot bearing Of upper arm and retract Cylinder. (Only at Rocker Arm Welders.)	Use general purpose lithium grease

QUALITY CONTROL

In any types of welding operation, whether it is pots and pans or airplanes, the manufacturer is interested in obtaining a quality of weld consistent with his product.

The machine, after all, is a machine. It cannot think. The machine control has the responsibility of producing identical timing, current and pressure on each weld. However, the same problem must be presented to the machine on each weld. Some of these include, material thickness, cleanliness, of the part fit-up. Other problems are the maintenance of electrode contour, electrode material, proper water flow and water temperature and material cleaning. These are the responsibility of the Quality Control Department.

It is also the responsibility of Quality Control to establish the machine settings for each material combination to be welded, and check the machines to see that the operators maintain these settings.

FLATNESS

Formed parts, when assembled, must be in contact in those areas to be spot welded. This spot welding machine is not a forming machine. If a portion of the machine pressure is utilized to bring the parts into intimate contact, then there will be a sufficient pressure to contain a molten metal. The expulsion will result. Inadequate forging pressure after welding may lead to cracking problems.

SPOT SPACING

If spots are located too close to each other, a large portion of the welding current to produce the second or subsequent spots will shunt through the spot or spot already made. This will result in the formation of a small nugget or no nugget at all. The single good weld and subsequent poor welds may not be strong enough to support the load for which the structure was designed.

CLEANLINESS CONSIDERATIONS

In resistance welding any metallic material or alloy, in the presence of foreign matter on the surface, such as oxides, oil, grease, paint and dirt, It is a source of difficulty due to the high resistance of such material to the passage of an electrical current. The need for cleanliness before attempting to weld cannot be over emphasized.

All metals oxidize in air. The oxide film so formed has high unit electrical resistance, but the total resistance of an oxide film is largely dependent on it's thickness. Chemical pickling will be found to be the most satisfactory method of removing oxides. This is particularly true of aluminum, where the resistance of the oxide varies across the sheet. On steel, the oxide would be in the form of rust, which should be removed before welding, if best welding conditions are to be maintained after sheering a weld, a round spot will be seen if the material was clean when welded. If the edges of the spot are ragged or star shaped, it indicates that the material was not cleaned.

DEFECTS

Any good manufacturing process requires a good inspection and control system to judge the quality and consistency of results and to take appropriate action when quality falls below a pre-set standard. Spot welding is a good production tool which will yield consistency of result in the same order of magnitude as results for latches, screw machines or punch presses. Unfortunately, the means of testing spot welds are not as simple as the use of a micrometer caliper and the results noted are not as easy to interpret and to correct for.

Under certain conditions, the following defects can be found in spot welds:

1. Surface burning or spitting.
2. Expulsion.
3. Excessive indentation.
4. Distortion.
5. Porosity.
6. Cracking.
7. Intergranular melting (coring)
8. Mis-placed nugget.
9. Mis-shaped nugget.
10. Low strength.

SURFACE BURNING CAN BE CAUSED BY:

1. Dirty material or fouled electrodes.
2. Too much penetration of nugget.
3. Improper machine sequence.

Usually simple visual inspection will be sufficient to observe surface burning. To eliminate, clean the material or replace the electrode, or reduce the current, or see that the current is turned off before the machine pressure is released.

EXPULSION CAN BE CAUSED BY:

1. Welding to near edge.
2. Welding on dirty material.
3. Welding with too little pressure or too much current.
4. Using the machine pressure to form the parts.

Simple visual examination, particularly at the time of welding, will disclose expulsion, although it can be seen and tensile shear teats and in other destructive tests. To eliminate, use a wider flange and be careful of fit of parts; clean the material, decrease the current or increase the pressure and use the proper electrode diameter and contour for the material being welded

EXCESSIVE INDENTATION CAN BE CAUSED BY:

1. Too long of welding time.

2. Too much machine pressure.
3. The result of expulsion.

Visual examination of measurement with the micrometer depth gauge is sufficient to detect excessive indentation. Zero indentation is extremely difficult to achieve since some of the indentation is caused by shrinkage of the weld nugget. Indentation can be minimized by decreasing the welding time, welding pressure, (but only if this pressure is very excessive).

DISTORTION CAN BE CAUSED BY:

1. Excessive indentation.
2. Expulsion.
3. Mis-alignment of the electrodes or excessive welder arm deflection.

Distortion can be measured by sectioning the pieces of measuring the width of the gap between sheets.

POROSITY CAN BE CAUSED BY:

1. Expulsion.
2. Dirty Material.
3. Insufficient pressure.
4. A combination of materials which is prone to cause porosity.

Porosity will be found in a certain percentage of all spot welding. Usually this percentage is around 5 through 10 percent of the welds. If the cavity is small, round and nearly central to the weld, there is no evidence that such porosity will adversely affect the mechanical properties of the weld. Only when the porosity is large with respect to the weld, or when it has sharp irregular outlines will it tend to affect the mechanical properties of the weld. To minimize porosity, use clean material and avoid expulsion. Unit pressure must be high. Some times a combination of dissimilar metals will be prone to give porosity. Usually, it is possible to find a machine setting which will minimize this condition.

CRACKING CAN BE CAUSED BY:

1. Expulsion.
2. Insufficient pressure.
3. A combination of metals tending to be hot, short (narrow plastic range).

Cracking in spot welds usually is contained entirely within the weld. Radiographic examination will disclose a “crows-foot” in the center of the weld. Sectioning and etching will show one or more cracks normal to the surface. Usually a magnification of about 100% is required to identify a crack positively. A crack in a spot weld may tend to propagate and lead to ultimate failure of the structure. Cracking can be eliminated by removing porosity, using high unit pressure to forge the weld during nugget solidification and exceptional cases where sufficient pressure cannot be employed, or where the metal combination has an unusually cracking tendency by using pulsation welding, or by following the weld period with an additional pulse of power of lower current to spread the heat over a larger area in order that shrinkage stresses will not be so greatly localized.

A MISPLACED NUGGET MAY BE CAUSED WHEN:

1. Welding dissimilar thicknesses of the same metal.
2. Welding dissimilar metals.
3. Too much tip radius.

Sectioning and etching will disclose the presence of mis-shaped welds in a plane normal to that of the sheet. To eliminate mis-shaped nuggets, use only electrodes that have been machine cut. Do not dress electrodes with a file. Be sure the electrodes are properly aligned, and be sure that too small a radius is not used.

LOW STRENGTH IN A SPOT WELD CAN BE CAUSED BY:

1. Too small a weld for the sheet thickness.
2. No fusion, but only a “stick”.
3. Defects such as expulsion, cracking, or major indentation.

TESTS FOR WELDS

The above discussion of defects in welds has mentioned several tests of spot welds that are used to discover defects and to evaluate the welds. The following tests are used on the welding floor and in the laboratory:

1. Visual inspection.
2. Peel test.
3. Twist test.
4. Macro test

Visual inspection will disclose defects on the surface such as surface burning, indentation and expulsion near an edge, but it is never sufficient to evaluate the quality of a weld.

The peel test is a common test used in many shops where spot welding is done. This test consists of prying the sheets apart and peeling one sheet back over the other, in “can opener” fashion. If failure occurs by shearing through the nugget, the weld is considered unsatisfactory. If failure occurs by tearing a button from the sheet, the weld is considered satisfactory.

The twist test consists of twisting the two sheets apart about an axis perpendicular to the sheet and at the center of the weld. The torque required and the angle of twist attained before final separation are approximate measures of the strength results can be expected in the tensile shear test.

The macro test is very simple and extremely useful in evaluating the quality of weld. The procedure is to:

1. Scribe a line through the center of the weld to be examined.
2. Cut to one side of the line, with a hack saw, power saw, cut off wheel of other means.
3. File to the tie, then polish with fine emery cloth.

The degree of smoothness required will depend on the amount of magnification used in examining the section. For visual or low magnification, a good fine file finish is usually satisfactory. For higher magnification a greater degree of polish is desirable.

Etch the surface with a suitable etchant, which will disclose the structure of the weld with sufficient contact for satisfactory visual examination. Sometimes too drastic an etch will produce “defects” which are not there. The degree of etch is somewhat dependent on the power of magnification to be used in inspecting the weld.

THE NEED FOR TESTS

The actual test employed depends upon the importance of the structure being welded. As pointed out at the beginning of this discussion, quality welds may only be obtained from a machine having the necessary functions, the machine must be kept in good working order and the same problem must be presented to the machine on each weld (same material, contour & cleanliness). Obviously, the degree of quality control desired will depend upon the product being weld, but sufficient control must be used to insure the desired quality or the welds may fall apart.

If the above is to be accomplished, the control of these items must be delegated to someone in the organization. In an aircraft plant, this might be a large department, while in the small plant, it might be vested in the Foreman having charge of the welding department. In any case, the following points should be considered in rules set up to govern them. Once set up, the rules should be enforced. They will result in a superior product at a lower production cost in the long run.

THE POINTS TO BE CONSIDERED ARE:

A. Establish weld settings for each part produced. Once established, make a record on a suitable form-listing ALL other control settings, electrode contour and the part number. When welding this part on future production, he machine should reproduce the weld on the same setting, or a setting with minor variation. The percentage allowable variation should be stated.
B. Establish what size, class and contour electrodes are to be used with each weld setting, and specify how often the operator is to replace electrodes.
C. Establish procedure for checking the weld quality before starting a production run, and at predetermined intervals during the production run.
D. Determine that the air line pressure and line power supplies to the machine are adequate, and that other equipment is not added to the lines after installation, which affects the supplies to the machine.
E. Determine that the air line supplies clean air to the machine and establish responsibility for bleeding the water filter (s) each day or more frequently, if found necessary.
F. Establish the responsibility for lubricating the machine with the proper oil and/or grease, including adjustment of the air line lubricator.
G. Establish responsibility for seeing that the parts are cleaned properly, as such is necessary.
H. Establish responsibility for part fit up including periodic inspection.
I. Establish a training program for both operators and maintenance persons so that they may be thoroughly familiar with the machine. Write ups such as this one are available to assist in this program period. When H&H Resistance Welders personnel are at your facility, plan on having your personnel spend the entire time with them to absorb as much knowledge as possible. Although a machine may look complicated to those who are unfamiliar with it, most troubles encountered are of a minor nature and can be repaired by a trained man in a short time, thus, eliminating “down time” in production to a great extent.