DESCRIPTION of
CONTROL CIRCUITS for
HELIARC
Trade-Mark

WELDING

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I. SELECTING A "HELIARC" CONTROL CIRCUIT

A. Introduction

In order to obtain a maximum in economy and effective operation from any process, it is essential that suitable means for controlling the process be available. The controls selected should be effective and suited to the particular job to be done.

The purpose of this booklet is to acquaint you with the various methods available for controlling HELIARC welding. There are three primary purposes for the control circuits: to control the power supply delivering welding current to the HELIARC torch, to control the flow of shielding gas delivered to the torch, and to control the flow of cooling water delivered to the torch.

There are many ways of setting up these controls. The illustrations in this booklet are intended only to give you an idea of the simplest means of acquiring the necessary controls for HELIARC welding. Many of the circuits illustrated are available as built-in units with modern power supplies. Before an attempt is made to build these circuits yourself, you should first ascertain whether the particular control circuit desired, or its equivalent, is available with a particular power supply.

B. Factors Affecting Selection of Control Circuits

The type of control circuit selected for a particular HELIARC welding application will be largely determined by the following factors:

1. ARGON CONSERVATION -- The cost of this protective gas is relatively high and waste is expensive. Devices to prevent waste can save their own cost in a short time. By such conservation measures, the process will have lower costs and, consequently, a wider field of application.

2. SAFETY -- No particular hazard exists in most applications. However, as with other welding methods, automatic controls for safety are important when welding in wet locations or on scaffolding.

3. RADIO INTERFERENCE -- In some installations, high-frequency signal broadcast is strongest when the high-frequency generator is on during non-welding periods. If a circuit is provided to turn on the high-frequency generator at the start of the weld and shut it off at the end, the signal will be minimized.

4. CRATER CONTROL -- Some materials (HASTELLOY C, STELLITE 21, MULTIMET, and inconel alloys) will develop a slag coating if air strikes the weld puddle before solidification is complete. This can be avoided if the argon flow continues after the welding current is broken. The continued argon protection will reduce crater cracking and make restarting easier.

5. PROTECTION OF EQUIPMENT -- If the torch is placed on a grounded surface when high-frequency current is in use, arcing through the gas cup will occur. If an insulated resting place is not provided for the torch, an automatic means for turning off the power is highly desirable.

6. WATER SHUTOFF -- If cooling water is allowed to run during non-welding periods when atmospheric temperature and humidity are high, and cooling-water temperature is low, water will condense on equipment. Where these conditions exist, the installation of equipment to turn the water "on" or "off" is recommended.

7. CONVENIENCE -- Control of operation should be convenient. If it is not, carelessness or improper operation of a control circuit may result.

C. Recommendations

In order to obtain the best process operation, all users of the HELIARC process are urged to use electrical controls, particularly for argon conservation.

In the following sections several types of controls are suggested so that the simplest and least expensive control unit for a particular operation can be obtained. Where such control units cannot be procured from vendors, the customer is urged to build the unit himself.
II. CONSTRUCTION OF CONTROL CIRCUITS

A. General Features

1. Circuit Parts and Symbols
In the circuits shown in the following sections, some component parts of one circuit are common to other circuits. For this reason, the general information given for one circuit can be applied to all circuits. The circuits are numbered and titled with standard electrical symbols for easy reference.

2. The Hand Torch Switch

a. Description and Operation
In the circuits illustrated in this booklet, a torch switch is shown for the initial control of the various functions. If the customer prefers, a foot switch may be substituted in the place of the torch switch.

The torch switch is in the torch handle. For safety reasons, it is operated at low voltage rather than at the 115 volts used for the other parts of the circuit. A value of 28 volts was chosen to operate the switch because transformers for this voltage are more readily available.

Circuits 1, 2, and 3 illustrate the torch switch (TS) in series with the trigger switch relay, TSR. In this way the operating relays within the control circuit all depend on the operation of the torch switch. With the torch switch open, the control relays are inoperative. NOTE: The control voltage in any HELIARC pilot or control circuit should not exceed 28 volts. This applies to hand or foot switch control.

b. Installation
The switch used is a commercial type adapted for the standard HELIARC torch and is not provided; it must be purchased separately and installed in the handle.

The switch may be fastened to the side of the handle with screws or it may be installed on top in a notch cut in the torch handle. When the notching method is used, insulating tape is wrapped around the internal copper body shell on which the switch will rest. In both cases the switch and torch handles are covered with insulating tape after the installation. The tape should not interfere with operation of the switch button. Any possible strain on the wires leading into the switch is relieved by running the cable through holes drilled in the torch handle.

3. Shielding Gas and Cooling Water Flow Control
All of the control circuits, (Circuits 1 through 4), are designed for feeding shielding gas and cooling water prior to starting the weld and for continuing the flow for a short period after the completion of the weld. In this way, adequate gas shielding of the weld, as well as cooling of the torch, is ensured.

In all of the circuits pictured in this booklet, a motorized time-delay relay is employed for the post weld flow of the shielding gas and cooling water. A second type of relay, a pneumatic time-delay relay is equally satisfactory for this control function. Both types are listed in the Material Requirements lists for your convenience.

If the pneumatic time-delay relay is preferred, slight alteration in each of the circuits is necessary. Refer to Figure 6 for an illustration of the substitution of this relay.

Positive protection against torch and cable overheating can be provided with the application of a water flow switch (Torch Saver). The flow switch contains a set of normally open contacts, 1FS-1 in the circuit diagrams), which are placed in series with the welding contactor coil or the generator field relay coil. Contact 1FS-1 closes when the proper quantity of water is flowing to the torch and opens if the flow of cooling water fails. Thus, if the torch is not receiving the correct amount of water the welding current is stopped, preventing the torch and cables from overheating.

Two types of flow switches are available: a medium-duty and a heavy duty. The flow switches are treated
4. High-Frequency Control

Circuits 2, 3, and 4, include the application of superimposed high-frequency for starting purposes when using D.C. power supplies, and for both starting and stabilization when using A.C. power supplies. Since the arc is inherently stable when welding with d.c., the retention of the high-frequency during welding would only be a waste of power. For this reason, a high-frequency relay, designed to introduce the high-frequency on open circuit voltage, and to cut it off once the arc has been established, is included in Circuits 2b and 4a.

B. Control Circuits for HELIARC Welding

CIRCUIT NO. 1

1. CIRCUIT NO. 1 - Manual Switch Control, Using Generator Field Interruption or Welding Circuit Interruption.

Description

Two variations of this circuit are shown, one for field interruption of the power supply, and the other for welding circuit interruption. When the torch switch is depressed, a contactor closes the circuit in the field circuit of the welding generator, or in the armature circuit (welding circuit) of the generator. The argon and water solenoid valves, ASV and WSV respectively, are energized initially by the closing of the Main Line Switch, MLS, and are kept energized by the action of the Trigger Switch Relay, TSR.

When the torch switch is released, the contactor (GFR or WC) shuts off the welding current. The Time Delay Relay (TDR) holds the argon and water valves open for a short period after the torch switch is released. The timer then times out and causes the valves to close.

The torch switch is of the momentary contact type -- that is, it remains "on" only while it is held depressed. A torch switch of the maintained contact type (one that remains "off" or "on" without being held) is not recommended for this circuit. Failure by the operator to turn off the switch at the end of a weld would defeat the primary purpose of the circuit -- that of argon conservation.

This unit is low in cost and satisfactory for argon and water conservation, safety, equipment protection, and crater control. It is recommended for short downhand welds. The torch switch must be held in the closed position while welding. It is, therefore, not recommended for long welds or welds in awkward positions.

Refer to Table I in the rear of this book for ordering information on the components of Circuit No. 1.

CIRCUIT NO. 2

2. CIRCUIT NO. 2 - Manual Switch Control, Using Rectified D.C.

Description

Two variations of this circuit are shown, one for scratch-starting, the other for high-frequency starting. With the mainline switch closed, depressing the torch switch TS causes a welding contactor to close and thus energizing the welding rectifier. The argon and water solenoid valves are energized initially by the closing of the main line switch and are kept energized through the action of the trigger switch relay, TSR, as long as the torch switch is closed.

At the end of the weld, the torch switch is released and the contactor WC breaks the welding circuit, shutting off all welding power. Both the argon and water valves are held open through the action of the time delay relay TDR, and after a short time are closed as the relay times out.

Figure 2a illustrates scratch-starting wherein contact between the torch and the workpiece initiates the welding action. Figure 2b illustrates high-frequency starting with rectified power. As the rectifier becomes energized, the open-circuit relay contact 1OCR-1 closes energizing the high-frequency generator. The application of the high-frequency discharge between the torch electrode and the workpiece starts the arc and welding current flows. At this point, 1OCR-1 contact opens removing the high-frequency unit from the welding circuit.

This circuit is satisfactory from the standpoint of equipment protection and the minimizing radio interference due to high-frequency applications. It also has the advantage of low cost.

Refer to Table I in the rear of this book for ordering information on the circuit components.
CIRCUIT NO. 3

3. CIRCUIT NO. 3 — Manual Switch Control, Using High-Frequency Stabilized A.C.

Description

The sequence of operations for Circuit 3 is much the same as that described for Circuits 1 and 2. Closing MLS starts the argon and water, and pressing TS keeps them flowing. Welding contactors in the primary of the welding transformer are closed as soon as TS is closed and the high-frequency generator is activated. The high-frequency discharge starts the arc, welding current flows, and the high-frequency remains on throughout the welding cycle stabilizing the arc.

Releasing TS cuts off the welding transformer and high-frequency generator and the welding current stops. Argon and water continue to flow until TDR times out.

Refer to Table 1 in the rear of this book for ordering information on the circuit components.

CIRCUIT NO. 4

4. CIRCUIT No. 4 — Automatic Push-Button Control, Using Rectified D.C. with High-Frequency Starting or High-Frequency Stabilized A.C. Power.

Description

In circuit No. 4, the torch switch is replaced by push-button start and stop switches. As before, the argon and water valves are originally opened as soon as the main line switch is closed. By pressing the weld start push-button switch, WSPB, the welding transformer and high-frequency generator, or the Motor-Generator or Rectifier and High-Frequency generator, are energized, and the argon and water valves are kept open through the action of the starting relay, ASR.

For d.c. welding, an open-circuit relay, 1OCR-1 on the output side of the d.c. source is energized by the open circuit voltage condition. The relay’s contact 1OCR-1 closes, energizing the high-frequency generator, and a high-frequency discharge is made between the torch and the workpiece. The arc is thus initiated and welding current flows. 1OCR-1 then de-energizes and cuts out the high-frequency generator.

For a.c. welding, contactors 2WC-1 and 2WC-2 close as soon as WSPB is depressed and the primary of the welding transformer as well as the high-frequency generator are energized. The high-frequency discharge initiates the arc, welding current starts, and the high-frequency remains on to stabilize the welding arc.

In both circuits, pressing WFPB at the end of the weld disconnects the welding power supply and stops all the welding current. Argon and water continue to flow until the time delay relay, TDR, times out.

The weld start and weld finish push-button may be replaced very easily by cam-operated limit switches for completely mechanized HELIARC welding.

Refer to Table I in the rear of this book for ordering information on circuit components.

(Continued on page 14)
**TO START**

1) Close Main Line Switch

TR1-1P1 energized  | TDR energized  | ASV energized  | WSV energized  
argon flows    | water flows   | 1FS-1 closes 

after short delay, 1TDR-1 opens, shutting off the argon and water 
1FS-1 opens

2) Close TS

TSR energized

2TSR-1 (N.O.) closes

GFR energized
3GFR-1, 3GFR-2, and 3GFR-3 close
WGF energized

Generator Field Interruption

Welding Circuit Interruption

electrode contacts work
short-circuit current flows
electrode withdrawn, arc established
welding current flows

**TO STOP**

1) Release TS

TSR de-energized

2TSR-1 (N.O.) opens

GFR de-energized
3GFR-1, 3GFR-2, and 3GFR-3 open
WGF de-energized

welding current stops
arc is broken

after short delay 1TDR-1 opens

ASV de-energized
argon flow stops

WSV de-energized
water flow stops
1FS-1 opens

2) Open Main Line Switch

all control power off

Sequence of Operations for Circuit No. 1 (Fig. 1)
FIG. 1a. – Generator Field Interruption

FIG. 1b – Welding Circuit Interruption

FIG. 1 – Circuit No. 1 – HELIARC Manual Switch Control with D.C. Power (Welding Generator)
TO START

1) Close Main Line Switch

TR1P1 energized TDR energized ASV energized WSV energized
argon flows water flows
after time delay, 1TDR-1 opens shutting off the argon and water
1FS-1 closes
1FS-1 opens

2) TS closed

TSR energized

2TSR-1 (N.O.) closes 2TSR-1 (N.C.) opens 2TSR-2 closes
WC energized TDR de-energized ASV and WSV remain energized after 1TDR-1 opens
3WC-1, 3WC-2, and 3WC-3 close 1TDR-1 closes argon and water continue to flow
1FS-1 remains closed

electrode contacts workpiece rectifier activated
rectifier delivers short-circuit current OCR energized
electrode withdrawn, arc is established 1OCR-1 closes
welding current flows high-frequency generator initiates arc

D.C. Power, Scratch Starting OCR de-energized
welding current delivered by rectifier 1OCR-1 opens

TO STOP

1) Release TS

TSR de-energized

2TSR-1 (N.O.) opens 2TSR-1 (N.C.) closes 2TSR-2 opens
WC de-energized TDR energized
3WC-1, 3WC-2, and 3WC-3 open rectifier de-activated
welding current stops welding current delivered by rectifier
arc is broken high-frequency generator de-activated

after short time delay, 1TDR-1 opens

ASV de-energized
argon flow stops

WVS de-energized water flow stops
1FS-1 opens

2) Open Main Line Switch

all control power off

Sequence of Operations for Circuit No. 2 (Fig. 2)
NOTE:

IF A MOTOR-GENERATOR IS USED IN PLACE OF THE RECTIFIER ILLUSTRATED THE WELDING CONTACTOR, (WC) NEED BE ONLY A ONE-POLE CONTACTOR. THE POLE IS THEN PLACED IN THE POSITIVE LEG LEADING FROM THE RECTIFIER TO THE TORCH. (PRECEDING THE BALLAST LAMP (BL) AND OPEN CIRCUIT RELAY (OCR) IF HIGH FREQUENCY IS BEING USED.)

CONTROL CIRCUIT, POWER, ARGON & WATER

Fig. 2a - D.C. Power with Scratch Starting

Fig. 2b - D.C. Power with H-F Starting

Fig. 2 - Circuit No. 2 - HELIARC Manual Switch Control with D.C. Power (Rectifier)
TO START
1) Close Main Line Switch

TR1-1P1 energized  TDR energized  ASV energized  WSV energized
argon flows     water flows
1FS-1 closes
after short delay, 1TDR-1 opens, shutting off the argon and water
1FS-1 opens

2) Depress TS
TSR energized

2TSR-1 (N.O.) closes  2TSR-1 (N.C.) opens  2TSR-2 closes
WC energized
TDR de-energized
1TDR-1 closes
ASV and WSV remain energized even though 1TDR-1 opens
argon and water continue to flow
1FS-1 remains closed

welding transformer activated  high-frequency generator activated
arc is established
welding current flows

TO STOP
1) Release TS
TSR de-energized

2TSR-1 (N.O.) opens  2TSR-1 (N.C.) closes  2TSR-2 opens
WC de-energized
TDR energized

welding transformer deactivated  high-frequency generator deactivated
arc is broken
welding current stops
after short delay, 1TDR-1 opens

ASV de-energized  WSV de-energized
argon flow stops  water flow stops
1FS-1 opens

2) Open Main Line Switch
all control power off

Sequence of Operations for Circuit No. 3 (Fig. 3)
FIG. 3 – Circuit No. 3 – HELIARC Manual Switch Control with A.C. Power (High-Frequency Stabilized)
TO START

1) Close Main Line Switch

TDR energized
ASV energized
argon flows
WSV energized
water flows

after short delay, 1TDR-1 opens and argon and water ceases to flow
IFS-1 opens

2) Depress WSPB

SR energized

2SR-1 closes
2SR-2 (N.O.) closes
2SR-2 (N.C.) opens
1ASR-1 closes
open-circuit created by release of 1WSPB-1 is bypassed
circuit remains energized
WC energized
TDR de-energized
ASV and WSV energized
1TDR-1 closes
argon and water flow

3WC-1, 3WC-2, and 3WC-3 close
rectifier energized
OCR energized
1OCR-1 closes
high-frequency generator activated
arc is initiated
rectifier delivers welding current
OCR de-energized
1OCR-1 opens
high-frequency generator de-activated
welding continues

2WC-1 and 2WC-2 close
welding transformer high-frequency generator
energized activated
transformer delivers welding current

D.C. Power with High-Frequency Starting

TO STOP

1) Depress WFPB

SR de-energized

2SR-1 opens
2SR-2 (N.O.) opens
2SR-2 (N.C.) closes
1ASR-1 opens
bypass of open 1WSPB-1 is broken
WC de-energized
TDR energized

3WC-1, 3WC-2, and 3WC-3 open
rectifier de-energized
flow of welding current stops

Welding transformer high-frequency generator
dee-energized de-activated
flow of welding current stops
arc is broken

ASV de-energized
argon flow stops
WSV de-energized
water flow stops
IFS-1 opens

2) Open Main Line Switch

all controls disconnected
from power source

Sequence of Operations for Circuit No. 4 (Fig. 4)
FIG. 4 – Circuit No. 4 – HELIARC Automatic Pushbutton Control with D.C. (High-Frequency Starting), or A.C. (High-Frequency Stabilized)
C. Selection of Argon Control Relay

All of the circuits, Figs. 1 through 4, illustrate the use of a motorized time delay relay for controlling the flow of shielding gas and cooling water. It is possible in each of these circuits to substitute a pneumatic time delay relay for the motorized relay. The choice is yours to make. Each relay is listed in Table 1.

If the pneumatic relay is preferred, a slight alteration must be made in each of the control circuits. For your convenience, the segment of the control circuit utilizing the motorized relay is illustrated in Figure 5 below. Figure 6 indicates the circuit required if the pneumatic time delay relay is used. The substitution can be made in any of the circuits treated in this booklet.

![Diagram of Motorized Time Delay Relay](image1)

**FIG. 5 – Motorized Time Delay Relay for Argon and Water Control**

![Diagram of Optional Water Control with Pneumatic Time Delay](image2)

**FIG. 7 – Optional Water Control with Pneumatic Time Delay**

![Diagram of Pneumatic Time Delay Relay](image3)

**FIG. 6 – Pneumatic Time Delay Relay for Argon and Water Control**

![Diagram of Optional Water Control with Motorized Time Delay](image4)

**FIG. 8 – Optional Water Control with Motorized Time Delay**

D. Continuous Water Flow

Each of the circuits illustrated in this booklet shows the water solenoid valve, (WSV), as the automatic shut-off type. At the end of a short time interval, both the argon and water are shut off.

If the customer prefers to have continuous water feed, without any interruption in the water flow from one welding sequence to the next, he can do so through use of the circuits illustrated in Figures 7 and 8 below.

Two types of circuits are illustrated; one for use with the motorized time delay relay, and one for the pneumatic time delay relay. Through the use of the switch WS the flow of water can be either stopped automatically at the end of the welding period, or stopped at any time by manually opening the switch.
<table>
<thead>
<tr>
<th>PART NO.</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>08W69</td>
<td>C1</td>
<td>Condenser, 0.5 mfd., 600-volt</td>
</tr>
<tr>
<td>90W46</td>
<td>F1, F2</td>
<td>Fuse-3AG, 10 Amp. - Glass Tube Type</td>
</tr>
<tr>
<td></td>
<td>ASV</td>
<td>Argon Solenoid Valve - Automatic Switch Co., Solenoid Valve Cat. #82623, 115-volt, 60-cycle.</td>
</tr>
<tr>
<td></td>
<td>WSV</td>
<td>Water Solenoid Valve - Automatic Switch Co., Solenoid Valve Cat. #82623, 115-volt, 60-cycle.</td>
</tr>
<tr>
<td>95W20</td>
<td>TDR</td>
<td>Time Delay Relay (Motorized) - Hayden Mfg. Co., #5901-2 Adj. Reset Timer, 60-seconds Normally Closed, 115-volt, 60-cycle</td>
</tr>
<tr>
<td>96W81</td>
<td>PTD</td>
<td>Time Delay Relay (Pneumatic) - Square “D” Type R09D, Adj. between 0.2 to 3.0 minutes.</td>
</tr>
<tr>
<td></td>
<td>WC</td>
<td>Welding Contractor - 115-volt a.c. (number of contacts as required)</td>
</tr>
<tr>
<td></td>
<td>ASR</td>
<td>Starting Relay - Potter and Brumfield, PR11A, 115-volt a.c., Double-Pole, Double-Throw</td>
</tr>
<tr>
<td></td>
<td>TSR</td>
<td>Trigger Switch Relay - Potter and Brumfield, PR11A 28-volt a.c., Double-Pole, Double-Throw</td>
</tr>
<tr>
<td></td>
<td>TS</td>
<td>Torch Switch - General Electric Co., Switchette Size 1, No. CR1070-C-12213B3 (Momentary Contact Type).</td>
</tr>
<tr>
<td>96W14</td>
<td>WSPB</td>
<td>Weld Start Push Button - Square “D” Class 9001 Black Operator Type “TR-1”</td>
</tr>
<tr>
<td>96W11</td>
<td>WFPB</td>
<td>Weld Finish Push Button - Square “D” Class 9001 Red Operator Type “TR-2”</td>
</tr>
<tr>
<td>89W48</td>
<td>GFR</td>
<td>Generator Field Relay - Square “D” Class 8502, Type BO-30, 115-volt, 60-cycle.</td>
</tr>
<tr>
<td>80N21</td>
<td>OCR</td>
<td>Open-Circuit Relay</td>
</tr>
<tr>
<td>95W10</td>
<td>BL</td>
<td>Ballast Lamp - General Electric Co., Frosted, 115-volt, 15-watt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or</td>
</tr>
<tr>
<td>40V51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15
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