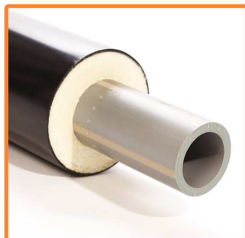


Hiline Steel DT Jointing



 **CPV-HILINE**

Pre-insulated Pipe Systems

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1. Introduction

This manual presents a description of assembly, placement of thermal insulation and sealing of a DT joint, which is a heat shrinkable sleeve made from HDPE polyethylene electrically welded.

The application of the new technology in electrically welded joints results in increased quality and durability of joints on preinsulated utilities.

This is true in particular in cases of:

- pipelines laid in unfavourable terrain conditions, as heat shrinkable joints electrically welded provide higher pressure and durability compared to traditionally made joints (joined with sleeves, heat shrinkable joints where the joints are sealed with glue);
- preinsulated pipelines of large diameters where electrically welded heat shrinkable joints can withstand heavier loads as regards friction and shear forces.

Electric welding (fusion) consists in taking advantage of heat emitted when electric current flows through a heating element placed between the HDPE pipe of the preinsulated section and a HDPE heat shrinkable sleeve. Heating up the elements to be welded above the melt temperature (of internal joint surface and external casing pipe surface) and subsequent pressing of each against the other by means of clamping belts placed on the external side of the joint results in a permanent bonding of the elements.

The whole fusion process is carried out by a microchip controlled welding machine which automatically controls the parameters set up by the operator.

2. General Conditions of DT Joint Assembly

2.1 Thermal insulation, fusion and sealing of a joint can only be started once:

- a pipe pressure test has been positive;
- joints welded in compliance with EN 970:1999 ("External visual checks of welded joints"), EN 1435:2001 ("Radiographic tests on welded joints"), EN 1714:2002/A2:2005 (U) (Non-destructive tests of welded joints. Ultrasonic tests of welded joints"), EN 25817:1997 (Arc-welded steel joints. Guidelines on determining quality levels with reference to welding distortions"), EN - 26520:1997 ("Classification of welding distortions in welded joints and reference descriptions);
- in cases where the pipeline carries leak detection system wiring complete technical test as described in the following manuals:

"Connection of Pulse Monitoring System in Thermal Utilities for Detection of Pipe Leaks"

"Assembly of BRANDES System on Pipeline with Plastic Casing Pipe"

- 2.2 Thermal insulation and its sealing should only be made in favourable weather conditions:

- in a dry and sunny weather;
- ambient temperature above +5°C and not exceeding +35°C;
- a windless weather condition.

Should there be need to proceed with insulation and welding works at unfavourable temperatures, increased air moisture (rainfalls, thick fog), or strong winds, works should be performed under mobile roofing structures (e.g. a tarpaulin tent).

- proper pressure exerted by clamp belts on the surfaces being welded;
- 2.3 Welding parameters:

Of decisive importance to the strength and quality of polyethylene welded joints are;

- cleanliness of the areas to be joined (no sand, dirt, fat or other impurities);
- dryness (no moisture on surfaces to be joined);
- correct welding temperature;
- correct welding temperature time;
- proper pressure exerted by clamp belts on the surfaces being welded;
- temperature of free cooling down.

Once these conditions (process parameters) have been met, the quality and durability of the welded joint is almost equal to that of the native casing pipe material.

- 2.4 Heat shrinkable joints welded after the DT method can be assembled only by skilled personnel trained and certified to perform such jobs by CPV Ltd with its registered office at Woodington Road, East Wellow, Romsey, Hampshire, SO51 6DQ, UK.
- 2.5 The safety conditions to be observed during the performance of the assembly of heat shrinkable joints welded after DT method are presented in “Manual of safety, technical and performance requirements in assembling heat shrinkable joints welded electrically Type DT in thermal utilities” – Annex No. 1. It makes auxiliary materials to be used by trained personnel and has been drawn up by CPV Ltd.
- 2.6 Polyurethane foam placed on ends of preinsulated pipes should be dry; on both ends of the pipe should be stripped over 15 mm.
- 2.7 The casing pipe in the joint unit must be cleaned from dirt, impurities, etc.
- 2.8 Surfaces of the casing HDPE pipe on both preinsulated elements over 30 cm measured from the edge of the casing pipe next to the joint, and over a distance of 1 m of one of the preinsulated elements onto which a heat shrinkable sleeve is to be pulled prior to welding should be cleaned from impurities and dry up.
- 2.9 The trench in the place where the joint is insulated and sealed has to be widened and deepened by 500mm.

2.10 The heat shrinkable sleeve (joint cover-piece) prior to commencement of welding works on the steel carrier pipes has to be pulled off the HDPE pipe onto one of the ends of the preinsulated pipe. The internal surface of the heat shrinkable sleeve and the section of the casing pipe over a distance of 1 m onto which the sleeve will be pulled have to be cleaned with acetone. Moreover, the internal surface of the sleeve over the planned seam with the casing pipe should be ground 0.1-0.25 mm deep with sand paper grade 50-70.

2.11 DT joints should be optimally assembled by a team of installers

3. Assembly of DT joints

3.1 Basic tools and materials

3.1.1. Basic tools required to lay insulation, weld and seal the joint union:

- a HG-2 computer controlled welding machine to weld heat shrinkable joints – 1 set;
- a set of wide clamp belts to tighten welded joints – 1 set (2 pieces);
- steel tightening separators – 1 set (2 pieces);
- teflon foil – 1 set (2 pieces);
- electric belt grinder – 1 piece;
- soldering gun 150 W – 1 piece;
- combination pliers – 1 piece;
- wire cutters – 1 piece;
- wire brush – 1 piece;
- foot pump – 1 piece;
- knife or scraper – 1 piece;
- hammer – 1 piece;
- LPG burner – 1 piece;
- pyrometer to measure heat shrinkable sleeve external temperature – 1 piece;
- battery powered drill (recommended) or electric one to make holes, bore bit 25 mm in diameter – 1 piece;
- plug welder – 1 piece;
- ohmmeter – 1 piece;
- universal tool to mount heating elements – 1 piece;
- foaming tool if joint space is to be filled up mechanically – 1 piece.

Below are shown typical tools:



Photo 1 HG-2 Computer controlled welding machine to weld heat shrinkable joints



Photo 2 A set of clamp bands for electrically welded joints



Photo 3 steel tightening separators



Photo 4 soldering gun 150 W



Photo 5 combination pliers



Photo 6 wire cutters



Photo 7 foot pump



Photo 8 knife or scraper



Photo 9 hammer



Photo 10 LPG burner



Photo 11 pyrometer to measure heat shrinkable sleeve external temperature - recommended



Photo 12 battery powered drill (recommended) or electric one to make holes, bore bit 25 mm in diameter



Photo 13 plug welder



Photo14 electric belt grinder



Photo 15 ohmmeter



Photo 16 wire brush



Photo 17 teflon foil



Photo 19 universal tool to mount heating elements

3.1.2 Materials necessary to assemble heat shrinkable sleeves electrically welded (DT jointing method) are presented in the CPV product catalogue.

The main components of a DT joint unit are:

- a heat shrinkable sleeve – 1 piece;
- a heating element – 2 pieces;
- PUR foam – components A and B – 1 set.



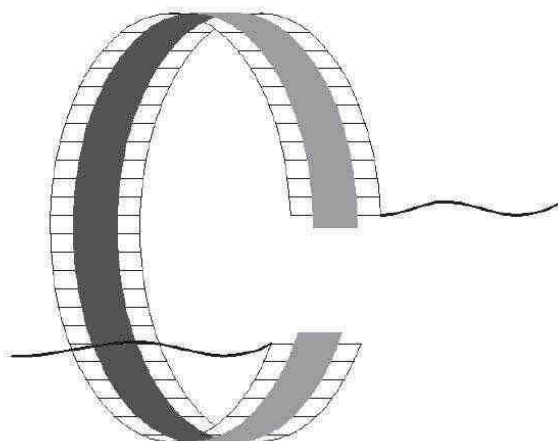
Photo 20 a heat shrinkable sleeve



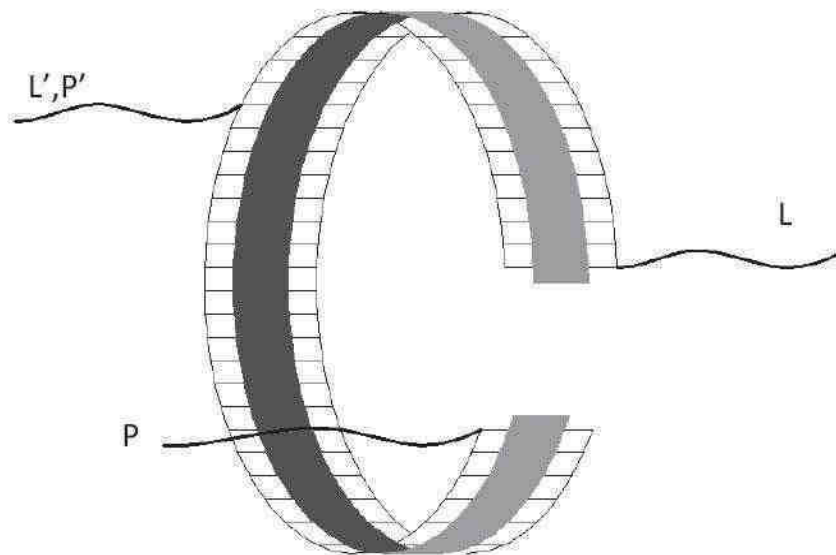
Photo 21 a heating element

Depending on the external diameter of the HDPE casing pipe the following heating elements are to be used:

- single-section (see *general arrangement drawing 1*) for HDPE pipe $\varnothing \leq 400$ mm;
- double-section (see *general arrangement drawing 2*) for HDPE pipe $\varnothing 450 \leq 630$ mm;
- triple-section (see *general arrangement drawing 3*) for HDPE pipe $\varnothing 710 \leq 1200$ mm;



General arrangement drawing 1. Single-section heating element for HDPE pipe $\varnothing \leq 400$ mm



Singular heating sections are marked with the same letters:
– L-L'
– P-P'

General arrangement drawing 3. Triple-section heating element for HDPE pipe
 $\varnothing 710 \leq 1200 \text{ mm}$



Photo 22 PUR foam (components A+B)



Photo 23 Sunk and welded plugs and venting plugs or FOPS patches and venting plugs

3.1.2.1 Auxiliary materials:

- felt cloth;
- acetone;
- sand paper;
- sponge or cloth;
- propane-butane gas;
- aluminum or wood wedges;
- protective gloves.



Photo 24 Aluminium wedges

3.2 Preparatory and auxiliary activities

3.2.1. To obtain a correctly executed joint the following requirements have to be met:

ends of casing pipes prepared for welding should be protected against excessive sunrays. In order to achieve that on sunny days the ends of casing pipes should be wrapped in aluminum foil. This has to be done in the morning before the sun starts shining on the day heat shrinkable sleeves are planned to be applied;

the casing pipe should be cleaned from dust or dirt or fat, and if the weld was covered with grease when it was being tested, the area should be defatted; polyurethane foam placed on ends of preinsulated pipes should be stripped with a knife or scraper over 15 mm from the heads of the preinsulated elements to be joined;

external surfaces of the HDPE casing pipe of both preinsulated elements to be jointed should be cleaned from contamination with acetone over a distance of some 30 cm measured from the edge of the casing pipe near the joint over a distance of 1 m of one of the preinsulated elements onto which a sleeve will be pulled.

3.2.2 In areas adjacent to the weld (where the heating element is placed) the surface of the casing pipe should be ground 0.1-0.25 mm deep and over a distance of 250 mm from the insulation end with sand paper.

This applies to both ends of the casing pipe ready to be joined by means of a heat shrinkable sleeve welded electrically.

Grinding should be carried out with a hand held electric belt grinder with sand paper grade 50-70.



Photo 25 Cleaning casing pipe of a preinsulated element with a hand held electric belt grinder

- 3.2.3 The surface of the casing HDPE pipe in the place where the HDPE pipe is to be joined with the heat shrinkable sleeve over a distance of 30 cm measured from the edge of the casing pipe next to the joint, and, additionally, over a distance of 1 m onto which a heat shrinkable sleeve is to be pulled should be cleaned from impurities with acetone and dried up with a piece of cloth (Photo 26).



Photo 26 Cleanin the casing pipe of a preinsulated element with acetone

- 3.2.4 Connect the alarm system wires (the tinned copper one with another copper tinned, and the copper wire with another copper wire) as indicated in the respective manual by CPV Ltd. The wires should be connected with clamps and then soldered, each time checking the quality of the connection (wire continuity and the resistance of the PUR foam insulation between the wires and the steel pipe).
- 3.2.5 Using a steel tightening separator included in the set of clamp belts and a felt tip pen or white fluid corrector mark the placement of the external edges of the heat shrinkable sleeve (Photo 27 and 28).
- measure the sleeve length (e.g. 600 mm);
 - measure the total length of steel pie ends not insulated (e.g. 300 mm);
 - deduct the length of bare pipe ends from the sleeve length, and the result divide into two (e.g. $600 - 300 = 300\text{mm}/2 = 150\text{ mm}$);
 - the dimension obtained in this way (150 mm) to be used to locate the position of the external edges of the heat shrinkable sleeve, should be measured off the edge of the casing pipe of the preinsulated elements to be joined and marked with white pen (correcting liquid) circumferentially around the casing pipe along the steel separator of the clamp belt. ;



Photo 27 Marking the calculated dimensions in tracing the location of the edge of the heat shrinkable sleeve



Photo 28 Tracing the location of the external edges of the heat shrinkable sleeve

3.3 Sequence of steps – placing thermal insulation

Before a heating element (heating tape) is assembled, its condition has to be checked: if not damaged (folds, bends, broken circuits or loose terminals). Under no circumstances can heating tapes be repaired on the construction site.

3.3.1. Assembly of a heating tape – heating element

The heating tape should be attached on both ends of the casing pipe of the preinsulated elements to be joined as indicated in Fig. 1 in the following sequence, having previously removed the carrier tape.

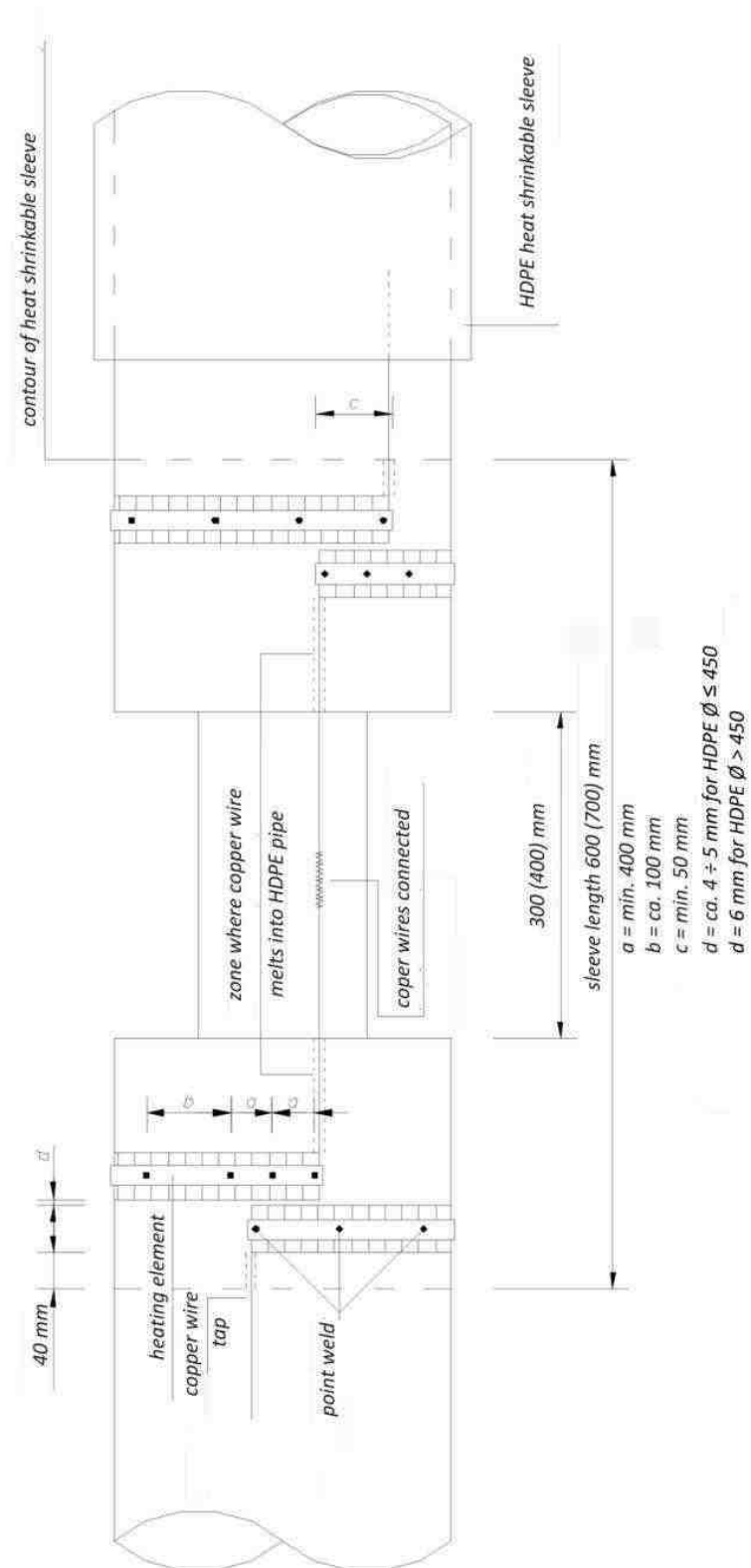


Fig. 1 Placement of heating elements on the joint

- 3.3.1.1. On one of the preinsulated element end, from the contour of the external edges of the heat shrinkable sleeve marked with felt tip pen or white correction liquid, measure out and mark a line distanced ca. 40 mm with the universal tool to attach the heating element (Photo 29) the place where the heating tape is to be attached. Note: Do not mark with a sharp object like a nail tip.



Photo 29 Tracing the location of the heating tape

- 3.3.1.2. In the marked place, with hot soldering gun tip attach the heating tape to the preinsulated element casing pipe by melting down and pressing down the heating tape point by point at the same time detaching the adhesive. The copper wire, the so called tap, terminating the heating element should be outside the line marking the edge of the heat shrinkable sleeve. The beginning of the heating tape should be attached to the HDPE casing pipe at three point welds distanced every 4 cm from each other (Photo 30).



Photo 30 A heating element is fixed to the casing pipe by means of a hot soldering gun tip while the adhesive is gradually detached

- 3.3.1.3. The heating element should be attached circumferentially round the preinsulated pipe by performing point welds with hot soldering gun tip every 10 cm and pressing it down with the with the universal tool to press the weld so that the tape closely adheres with all its surface to the preinsulated element casing pipe (Photo 31).

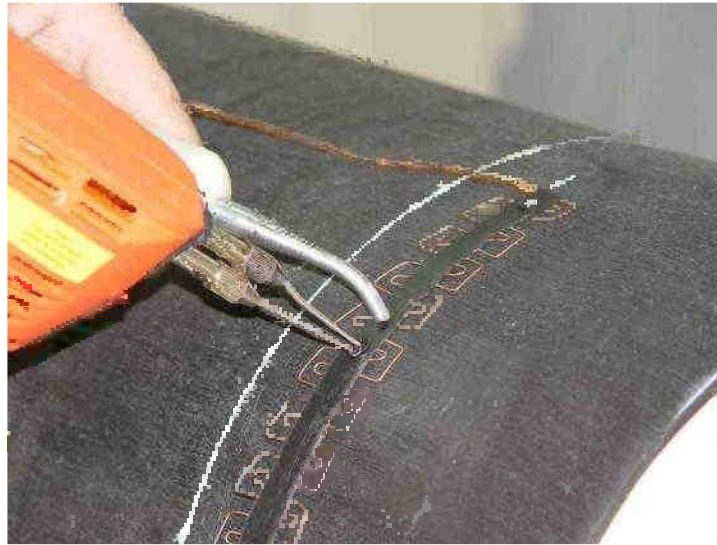


Photo 31 Fixing the heating element around the circumference of the preinsulated element

- 3.3.1.4. Then the heating tape should be wound and formed round the casing pipe so that it adheres closely to the casing pipe along its whole circumference without any clearance. The other end of the heating tape should be fixed some 4-5 cm on HDPE pipes $\varnothing < 450\text{mm}$ and some 6mm on HDPE pipes $\varnothing > 450\text{mm}$ within the clearance formed by the copper wires sticking out from the heating tape measured out from the first end of the tape. (Photo 32). The displacement of the heating tape ends should not be greater than 4 cm (Photo 33). A detailed placement of the heating element for a DT joint is shown in Fig. 1.

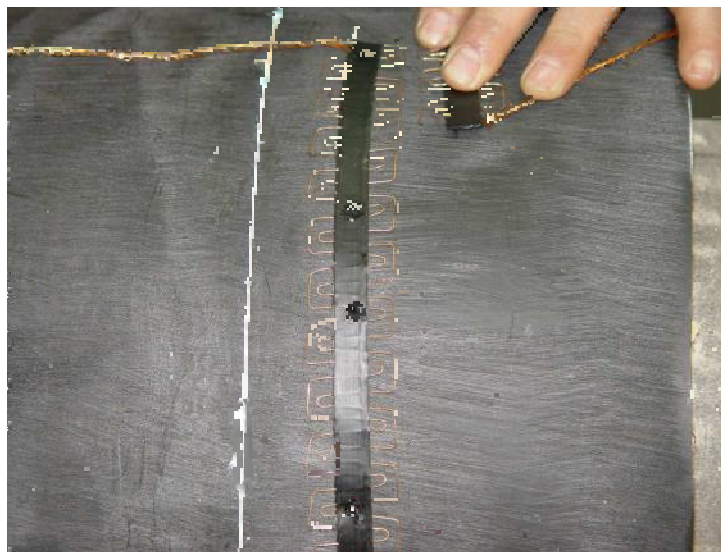


Photo 32 Placing and fixing the other end of the heating tape

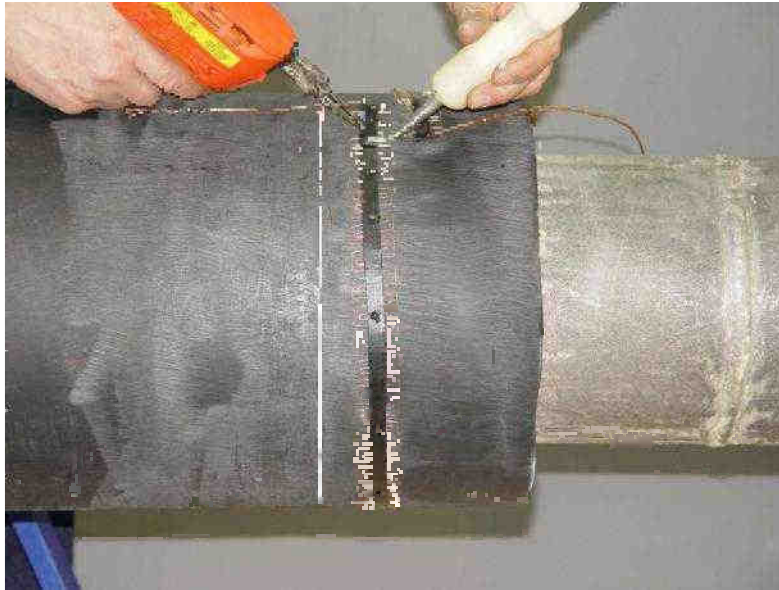


Photo 33 Fixing the heating element around the circumference of the preinsulated element casing pipe

- 3.3.1.5. The copper wire – that is a tap on the heating element should be welded (melted into) the HDPE casing pipe below the external generating line of the casing pipe of the preinsulated element so that it extends outside the contour of the heat shrinkable sleeve (Photo 34) in such a manner that the surface of the casing pipe is flat, without a longitudinal rib.

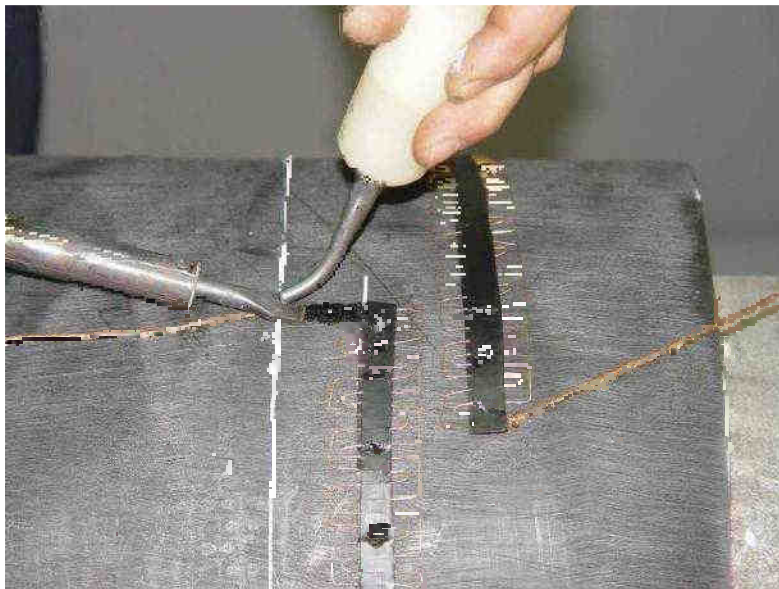


Photo 34 Melting a heating element copper wire into a casing pipe outside the contour of the heat shrinkable sleeve

- 3.3.1.6. Then the copper wire on the other end of the heating element should be melted into the pipe by means of a hot soldering gun tip (Photo Photo 35 and 36).

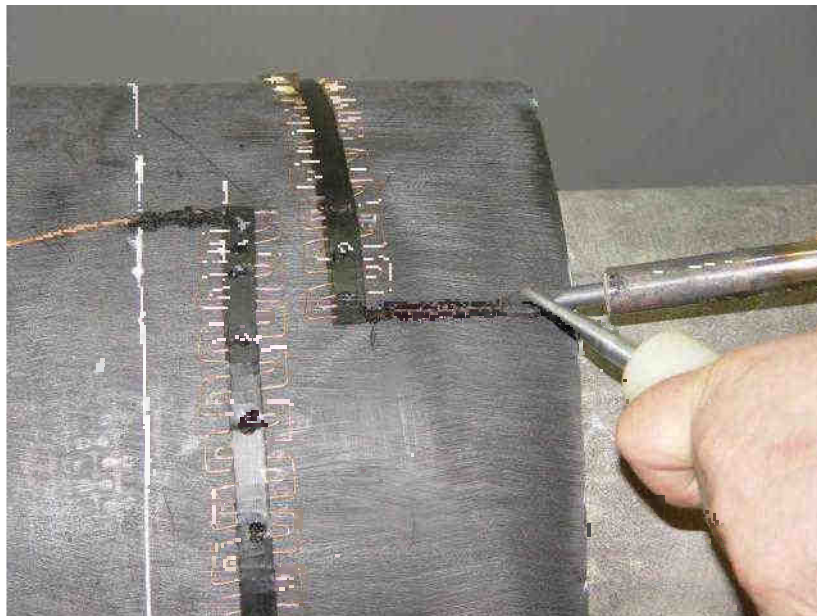


Photo 35 Melting in a heating element copper wire directed towards the middle of the joint

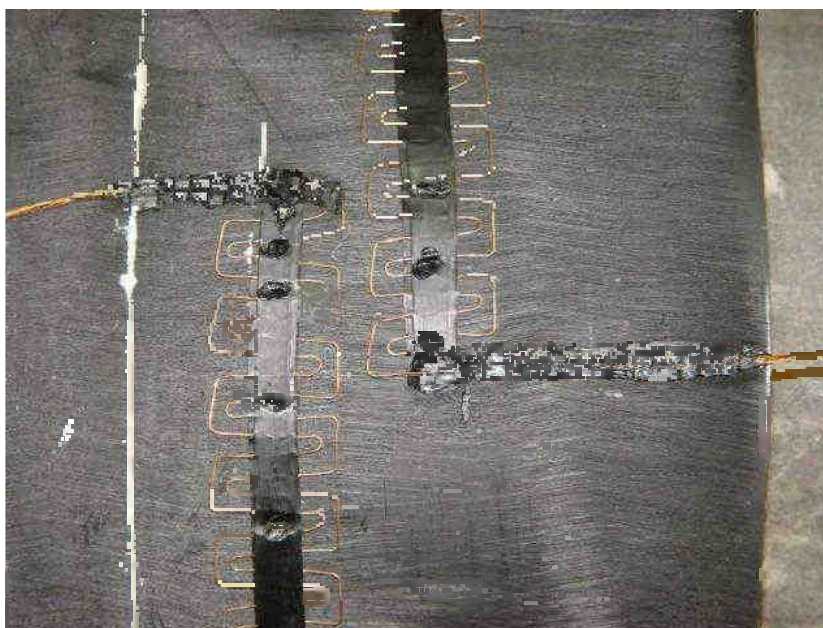


Photo 36 A view of embedded wires from the heating element on the joint

- 3.3.1.7. In a similar manner the other heating element should be attached to the other end of the preinsulated element.

- 3.3.1.8. The copper terminals of the heating element directed towards the middle of the joint (towards bare steel ends of the preinsulated pipes) should be connected by having them twisted together (Photo 37). The copper terminals of the heating tape should be connected in such a way so that they could not come into contact with bare ends of the steel carrier pipe (and the warning system wires if the preinsulated elements have such a moisture detection warning system embedded in the insulation).



Photo 37 Copper wires of the heating elements connected

- 3.3.1.9. Once heating elements have been attached on both ends of the joint, the placement of the heating tape copper wires should be inspected visually seeing to it that the copper wires are not broken or deformed.

- 3.3.2. Lead-in melting of a heating tape into the casing pipe of the preinsulated element

- 3.3.2.1. The heating elements initially fixed with a hot soldering gun tip should be wrapped in a teflon foil (Photo 38).



Photo 38 The heating elements wrapped in a teflon foil

- 3.3.2.2. The heating tape should be tightly wrapped with a teflon foil, then the belts should be wound around them and tightened by twisting the clips (Photo 39).



Photo 39 Placing clamp belts over the heating elements wrapped in a teflon foil

- 3.3.2.3. The HG-2 welding machine should be connected to the copper wires on the heating tape as shown in the electric diagram of the HG-2 fig. Photo 2 and 7.1; 7.2 and 7.3 and Photo 40).



Photo 40 Terminals connected with the heating element wires

- 3.3.2.4. Connect the HG-2 to a single phase nominal voltage $U_f \approx 230V$, +5% -10%, 50 Hz (maximum deviation +0.2/-0.5 Hz) power supply furnished with a fuse $I_b = 40A$ or a power generator.
- 3.3.2.5. See to that the terminals fixed on the heating element wires do not pull them down under their own weight while the heating elements are being point welded. They should be secured against spontaneous slipping.
- 3.3.2.6. Carry out welding on the individual sections in the sequence presented in Fig. No. 7.1, 7.2 and 7.3 (depending on the number of sections – joint diameter) as indicated in the HG-2 Operating Manual, and in accordance with the description presented in Point 4 of this Manual. The heating coil should be heated initially for 2 minutes in the case of single-section joints, and for each other section if there are more than one.
- 3.3.2.7. A welding report has to be filled in entering: welding time, welding number, operator's identification and other data included in the Welding Machine Operating Manual.
- 3.3.2.8. Once the heating coil (element) has been melted into the casing pipe of the preinsulated element, the clamp belts should be released and the teflon foil unwrapped.

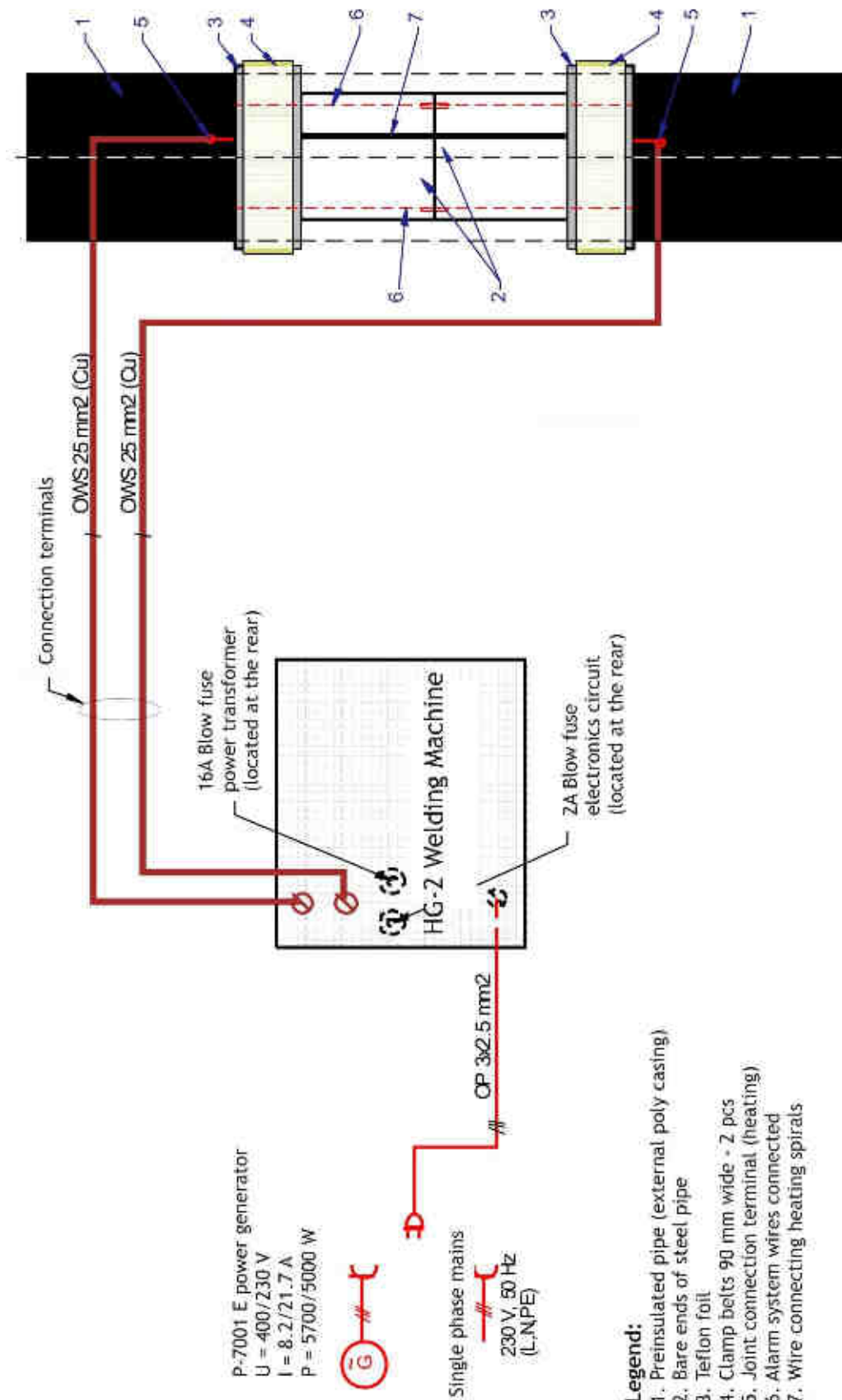


Fig. 2. Schematic diagram of electrical prewelding of heating elements on a DT series joint

3.3.3. Assembly of a heat shrinkable sleeve

3.3.3.1. Shrinking the ends of a heat shrinkable sleeve

1. Having melted in the heating tape and prior to the imposition of a sleeve the placement of the heating tape and continuity of the wires should be checked again by an ohmmeter.
2. On the cleaned section over a distance of 1 metre of the casing pipe of the preinsulated element remove the foil from the heat shrinkable sleeve.
3. The ends of the heat shrinkable sleeve and the area of the heating tape have to be thoroughly cleaned with a piece of cloth soaked with acetone or ethanol (or any other defatting agent neutral to polyethylene).
4. Pull the heat shrinkable sleeve onto the joint symmetrically so that it overlaps the casing pipe equally at both ends and aligned with the previously made markings. The heat shrinkable sleeve has to be pulled onto the welded joint very cautiously so that the copper wires sticking out from the heating element are not bent. The sleeve should be pulled onto the joint by at least two people in cases of joints of diameters of casing pipes $\varnothing \geq 450$ mm, and by one person, if the diameter is below 450 mm.



Photo 41 The manner in which a heat shrinkable sleeve has to be propped with wedges before the sleeve starts being shrunk

5. Once the heat shrinkable sleeve has been pulled onto the joint, aluminium wedges have to be inserted to rise the sleeve upwards, which will make it possible to shrink equally it on both ends of the sections of preinsulated elements (Photo 41 and 42).



Photo 42 A detail – inserting aluminium wedges

6. Both ends of the heat shrinkable sleeve have to be shrunk over a distance of 10-15 cm with a soft flame from a LPG burner (Photo 43). Heating should start with a low flame outwardly from its middle and circumferentially around its edges until it starts to adhere tightly. Shrinking should be carried out uniformly, with a soft flame seeing to that the sleeve is not overheated. To that end a pyrometer has to be used throughout the process to control the external sleeve surface temperature. The sleeve temperature should not exceed 130°C.



Photo 43 Shrinking a heat shrinkable sleeve ends with a soft flame from an LPG burner

3.3.3.2. Preparing a joint to be welded

1. Once the heat shrinkable sleeve has been shrunk, proceed with welding the joint with a HG-2 welding machine (Photo 44). To accomplish that place a set of clamp belts on the sleeve immediately after it has shrunk.



Photo 44 A view of a heat shrinkable sleeve after it has been shrunk

Steel tightening separators used in circumferential welding should be wound up round the joint, aligned with the sleeve contour (Photo 45), the clamp belts positioned and centred on the circumferential metal separators, and then tightened with the belt fastener (Photos 46 and 47).



Photo 54 A heat shrinkable sleeve and a metal separator



Photo 46 A view of a heat shrinkable, metal separator tightened together with a belt fastener



Photo 47 A view of a heat shrinkable, metal separator tightened together with a belt fastener ready for welding operation

NOTE: THE WELDING CYCLE MUST BE INITIATED AS SOON AS POSSIBLE AFTER COMPLETION OF THE HEAT SHRINK PROCESS AND WHILE THE CASING JOINT STILL RETAINS SOME HEAT. THE WELDING CYCLE MUST NOT BE CARRIED OUT IF THE CASING JOINT IS COLD. IF IT HAS BEEN ALLOWED TO COOL IT CAN BE REHEATED WITH THE GAS BURNER

2. The joint so prepared should be connected to the welding machine as indicated in the diagram as shown in Fig. 3, 7.1, 7.2 and 7.3.

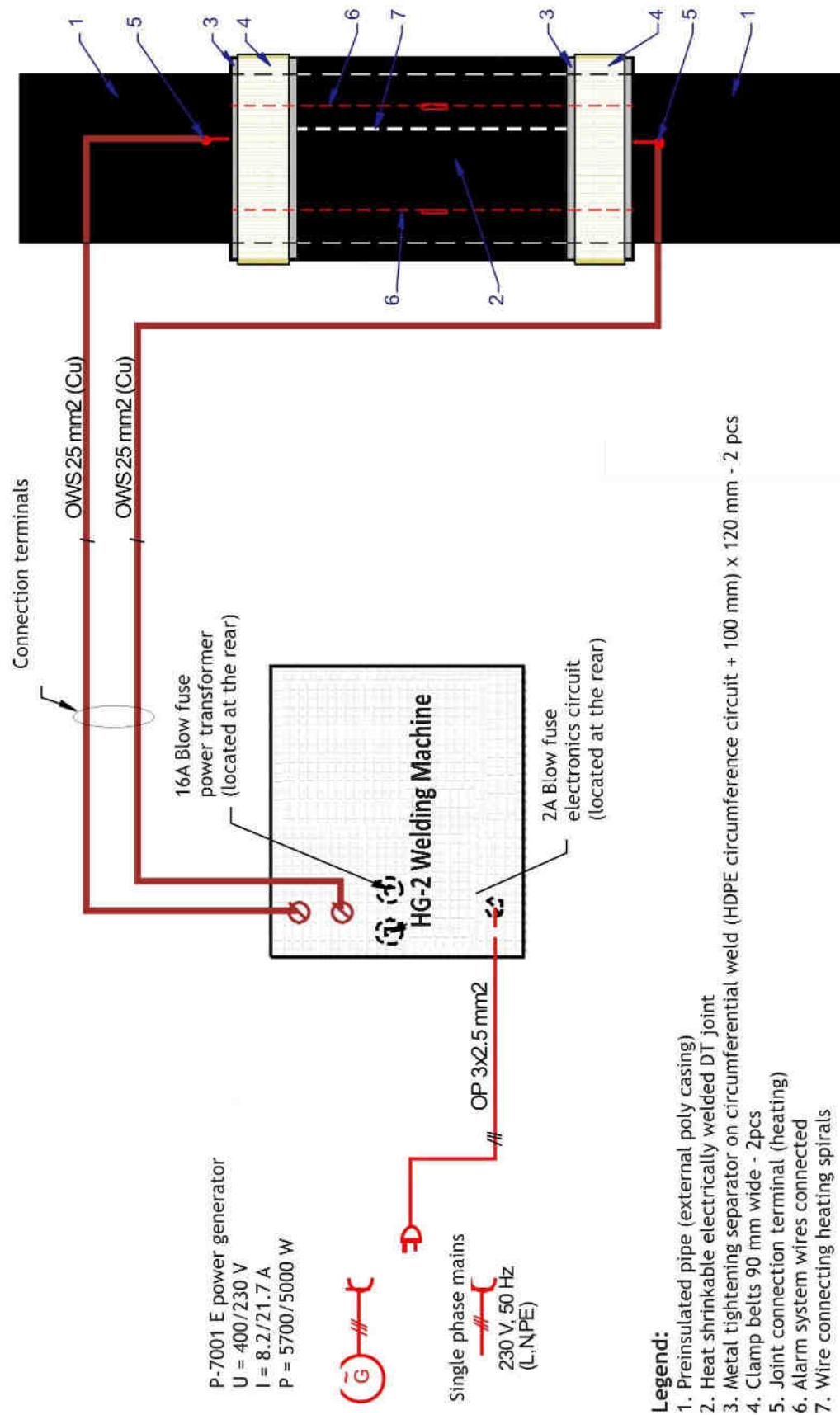


Fig. 3. Schematic diagram of electrical welding of a DT series joint

4. A DT Joint Welded Electrically

An example of how to weld electrically a DT heat shrinkable joint is shown in pictorial diagram 3.

- 4.1. Connect the HG-2 welding machine to a single phase power supply source of the nominal voltage of $U_f \approx 220V +5\% - 10\%$; 50 Hz, a maximum deviation of $+ 0.2$ Hz, $- 0.5$ Hz, protected with a fuse $I_b = 20$ A or a power generator.
- 4.2. Connect a DT heat shrinkable joint to the HG-2 welding machine as shown in Fig 3, 7-1, 7-2 and 7-3.

A single section joint

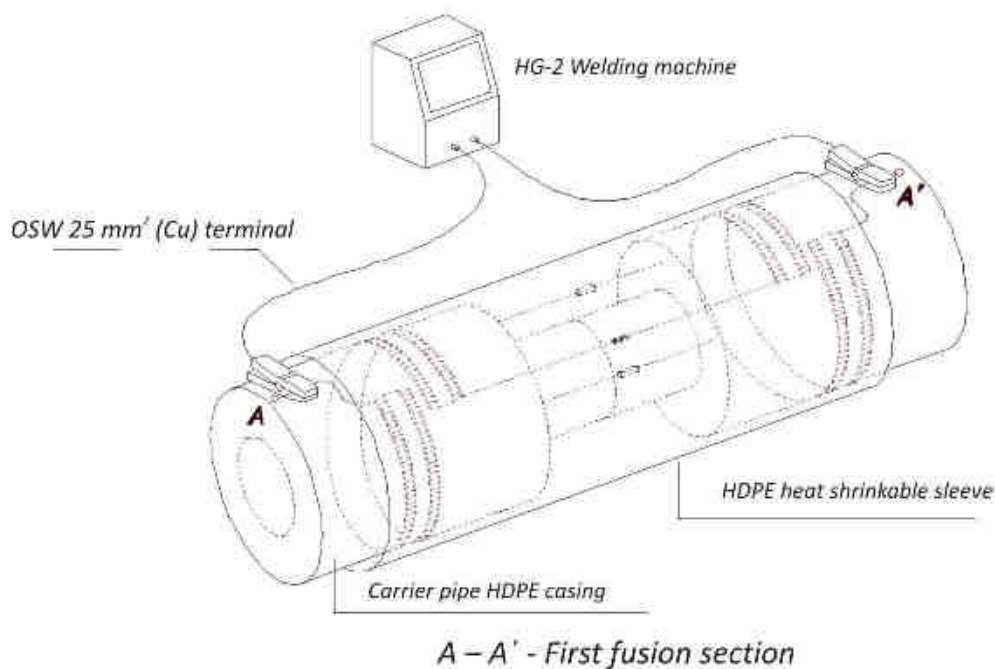


Fig. 7.1 Connection of heat element terminals on a DT joint to a HG-2 welding machine (single-section joint for HDPE pipes of a diameter ≤ 400 mm)

A double-section joint

In double-section joint the connecting terminals inside the joint have to be output through a 25 mm hole made in the heat shrinkable sleeve. The welding sequence in the individual sections has to be followed in accordance with Fig 7.2. On completion of welding and a positive tightness pressure test, the output terminals can be cut off with wire cutters.

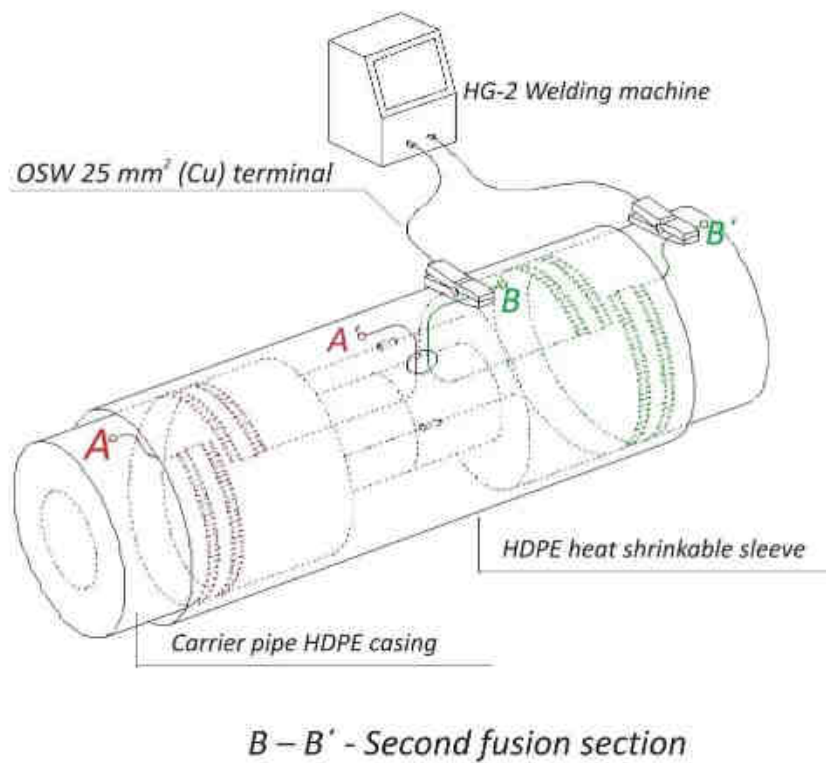
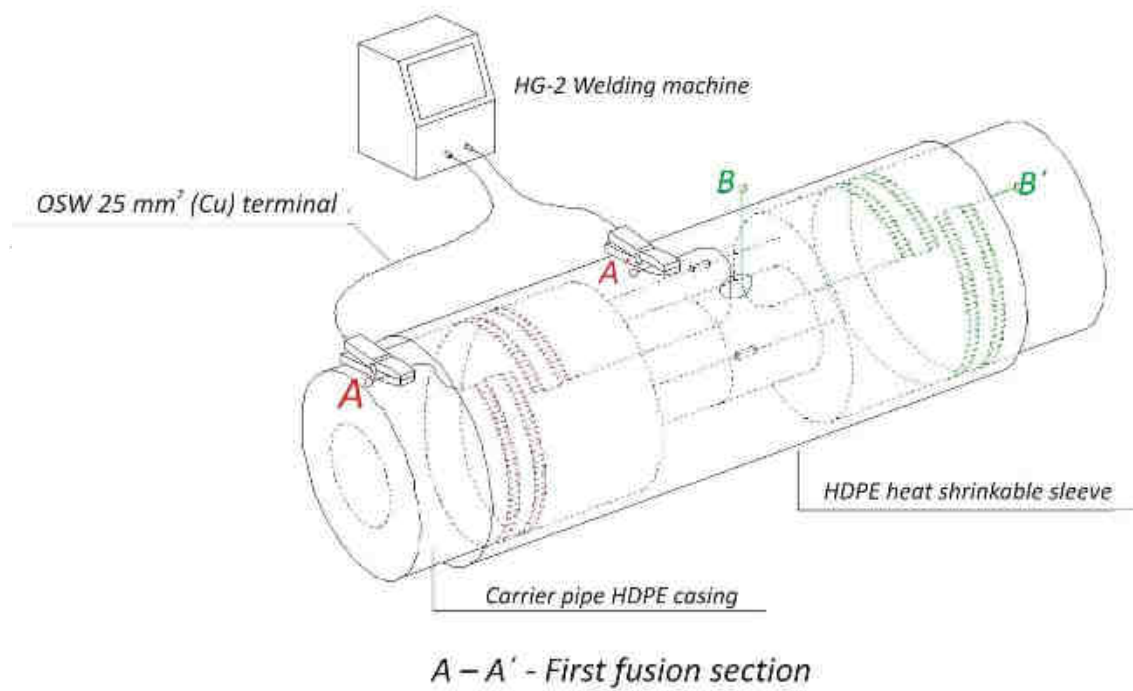
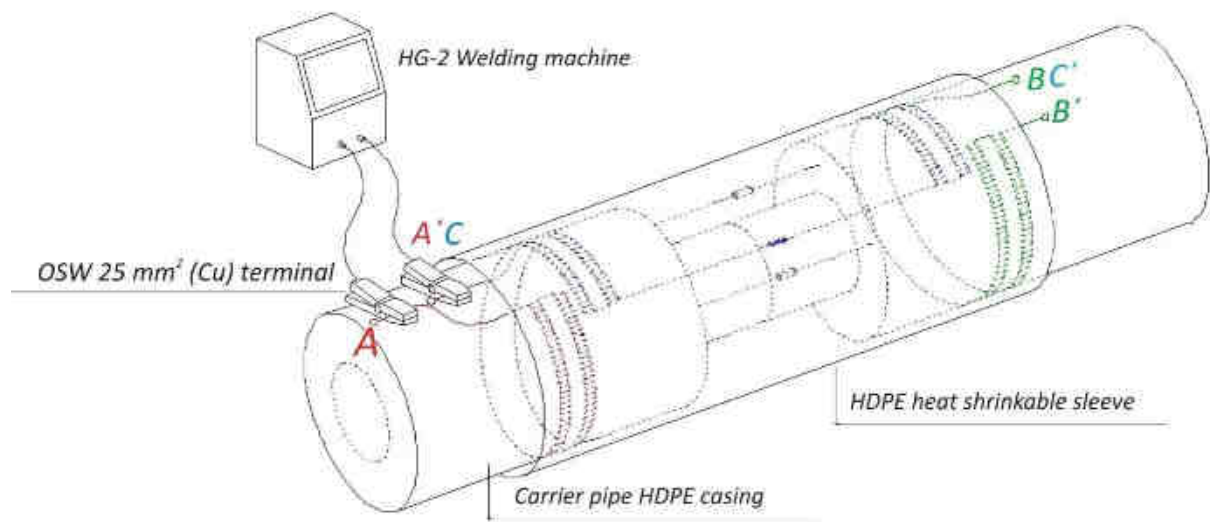
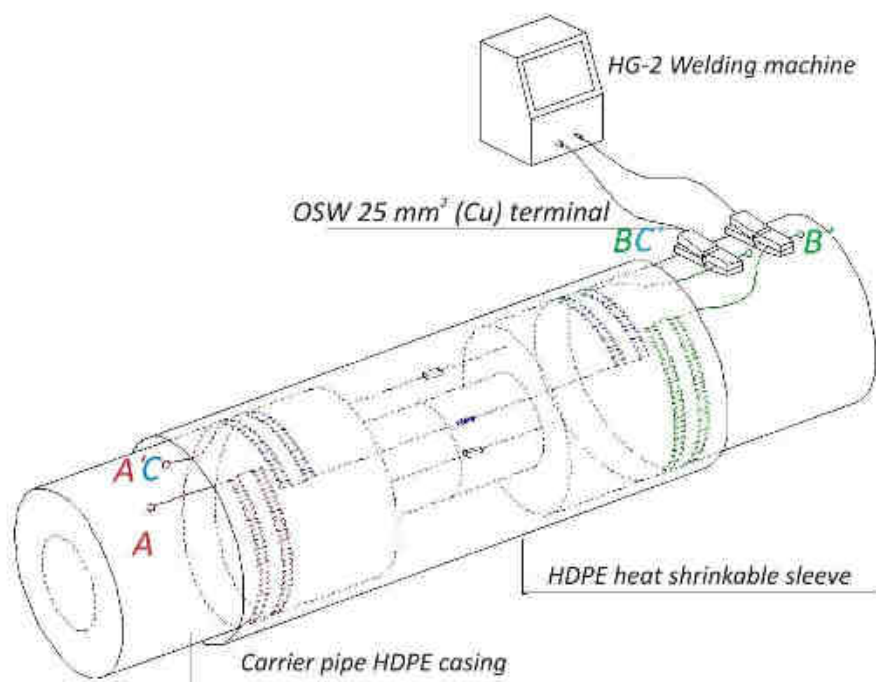
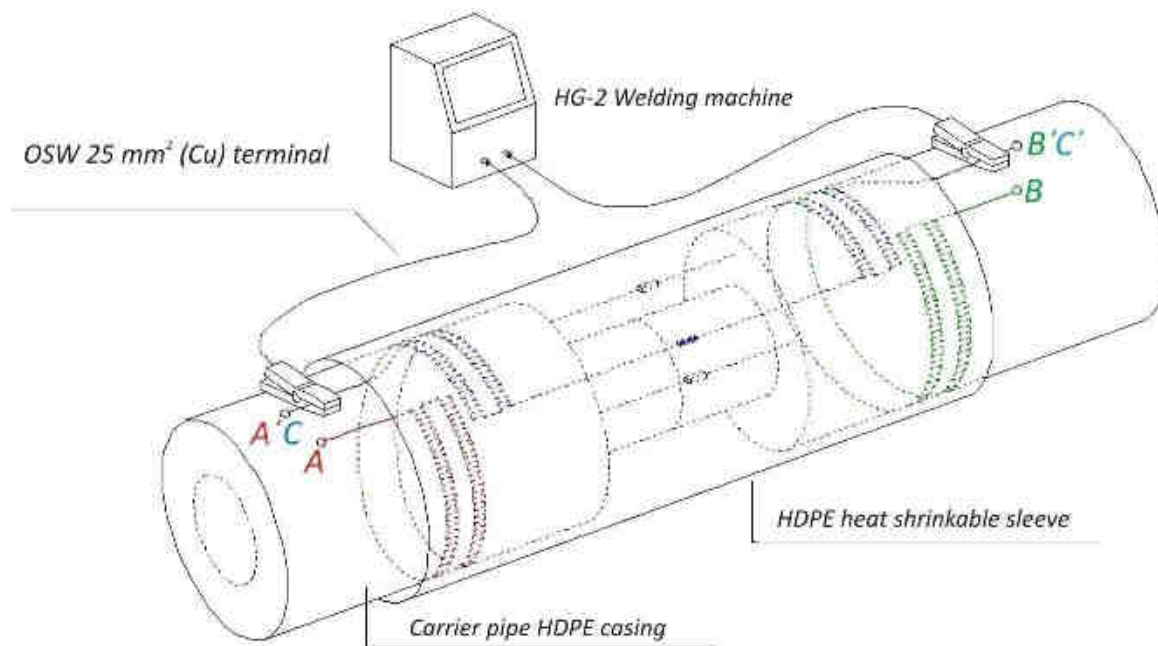


Fig 7.1 Connection of heating element terminals on a DT joint to a HG-2 welding machine (double-section joint for HDPE pipes of a diameter $\leq 450 \leq 630$ mm)

A triple-section joint

*A – A' - First fusion section**B – B' - Second fusion section*



C – C' - Third fusion section

Photo 7.3 Connection of heat element terminals on a DT joint to a HG-2 welding machine (triple-section joint for HDPE pipes of a diameter $\leq 710 \leq 1200$ mm)

- 4.3 See to that the terminals fixed on the heating element wires do not pull them down under their own weight while the heating elements are being point welded.
They should be secured against spontaneous slipping.
- 4.4 Carry out welding as indicated in the HG-2 Operating Manual.
The welding time depends on:
 - joint diameter;
 - ambient temperature and atmospheric conditions such as wind, sunray exposure, ambient temperature;
 - experience of the welder.
 Approximate heating temperatures for each section of a DT joint:
 - 5-6 minutes for a casing pipe $\varnothing \leq 400$ mm;
 - 6-10 minutes for a casing pipe $400 < \varnothing < 800$ mm;
 - 8-13 minutes for a casing pipe $\varnothing \leq 800 \leq 1200$ mm.
- 4.5 A welding report has to be filled in entering: welding time, welding number, operator's identification and other data included in the Welding Machine Operating Manual.
- 4.6 Once the heating coil (element) has been naturally cooled down to 60°C (after approximately 1-2 hours), proceed with dismantling the clamp belts and metal tightening separators.

5. Testing a DT joint tightness

The quality of the weld on a DT heat shrinkable joint depends on all the factors present in the process (that is cleanliness and dryness of the surfaces to be welded proper pressing force, welding time, welding temperature, cooling down time and the welder's experience).

Checking the tightness of a DT joint should follow this sequence:

- 5.1. Inspect visually and by touching the external length of the whole joint.
Note that:
 - contraction in the welded area
 - dull or partly gray tarnish area over the welded seamare natural phenomena, resulting from the applied process and do not mean impaired quality not durability of the welded DT joint whatsoever.
- 5.2. Depending on the joint diameter drill a 25 cm hole in the joint with a flat drill seeing the that the pulse alarm system wires remain untouched.
The hole should be placed at 12 o'clock some 80 mm from the middle of the joint.



Photo 48 A 25 mm hole drilled with a flat drill and drilling machine

- 5.3. Set up a control pressure gauge equipped with a venting plug.



Photo 49 A control pressure gauge set up

- 5.4. Fill up the joint with air or any other neutral gas (N_2 or CO_2) to obtain a pressure of at least 2.5 m of column of water (0.25 bar).



Photo 50 A joint being filled up with air

- 5.5. The tightness of welded joints in a DT joint has to be checked with a water soap solution (that is a solution of deionised water with a 3% content of detergent). First, the joint should be filled with air or another neutral gas (N₂ or CO₂) up to a positive pressure of 2.5 m of H₂O (0.25 bar). Unless pressure gauge readout drops by one interval within two minutes the condition has been met. Then, the prepared solution has to be applied with a brush or a sprayer on areas adjacent to the weld seam, edges and fillet over their whole lengths. The joint tightness has to be checked visually – the joint is tight if neither soap bubbles are formed on the sprayed areas nor the foam volume increases. Once the tightness check has proved positive, the joint is ready for operation.

6. Insulating a DT joint

- 6.1. On completion of a positive pressure test of a DT joint the terminals should be cut off next to the joint edge minding not to damage the surface of the casing pipe or welded joint.
- 6.2. To insulate a joint of HDPE pipes of diameters above 250 mm an additional 25 mm hole has to be drilled. Another runner hole has to be drilled with a flat drill about 80 mm from the middle of the joint paying attention not to damage the alarm system wires. In the case of HDPE casing pipes of diameters smaller than or equal 250 mm there is no need to drill an extra hole (a hole used in the pressure test can be used).
- 6.3. Then the liquid components of PUR foam have to be prepared. The components A and B are supplied separately in plastic bottles depending on the nominal diameters of pipes to be joined. Every bottle is labelled which specifies the type of the component and pipe nominal diameter.

Example:

Component A DN 65

Refers to Component A (light colour) a joint of Nominal Diameter of 65 mm

Component B DN 65

Refers to Component B (dark colour) a joint of the same diameter.

The two components A and B for the same nominal diameters of carrier pipes make up one set of PUR components for a given joint.

Before starting work on joints check whether the batched components (container A – light colour, component B – dark colour) match the same nominal diameter and if the container contents match each other. Then pour the content of the container B into the container A. The order of pouring, that is whether A into B or B into A, is irrelevant, it has, however, to be remembered that both components should fit one container when mixed. Once the components have been poured into a container, and the container tightly closed, they should be mixed, and subsequently poured through a V-

cut into the joint to be sealed. The time the components are poured, mixed and poured into a V-cut should not exceed 40 seconds.

- 6.4. Immediately after the components A and B in liquid state have been poured in, the drilled holes should be stopped with venting plugs deep to the first notch, while the venting opening remains unobstructed.
- 6.5. The foam has to be left for 3 to 6 hours to cure and bind.
- 6.6. Then plugs electrically welded in and FOPS patches have to be used to complete the sealing.

Variant A: joints with welded in plugs

After venting and degassing the PUR foam the venting plugs have to be removed manually from the runners, and then the openings should be cleaned from the residual foam and the sleeve edges have to be thoroughly cleaned with sand paper and a scraper. Cleaning is substantial to plug heating and therefore it has to be performed with utmost attention.

Then by means of a plug welder - a specialist tool to be purchased from CPV Ltd - the external edge of the hole and the cone of the plug have to be heated up until they start to show signs of melting and then the plug has to be pressed down into the venting hole and kept there until it cools down and the melted surfaces harden. A properly welded plug must closely adhere to the sleeve material and stick to 1 to 2 mm above its surface.

Variant B: joints with welded in plugs and FOPS patches

After venting and degassing the PUR foam the venting plugs have to be driven in completely with a hammer. Then foam flashes have to be removed and the area surrounding the plug cleaned. Once the area around the plug has been cleaned the plug holder has to be cut off and the very plug has to be sealed with a FOPS patch.

- 6.7. The joint cannot be loaded mechanically until the area cools down to a temperature of 25-30°C, that is allowing to be touched safely.

7. Important information

- 7.1. This manual does not contain all necessary information on the assembly of heat shrinkable electrically welded DT joints, and furthermore it does not substitute training at CPV Ltd as regards to their assembly and does not release the user to take part in such training.
- 7.2. Persons in charge of assembling heat shrinkable electrically welded DT joints have to be suitable qualified and technically knowledgeable in a scope sufficient to properly complete the operations.

8. A HG-2 Welding Machine

8.1. Description of the welding machine.

The welding machine is used to weld polyethylene pipe DX joints on preinsulated pipe of the diameter up to Ø 1200mm supplied by CPV Ltd.

Welding is automatic, while temperature, welding current and time are controlled by a microchip.

The HG-2 welding machine front control panel is shown in Fig. 4.

The HG-2 rear panel is shown in Fig. 5.

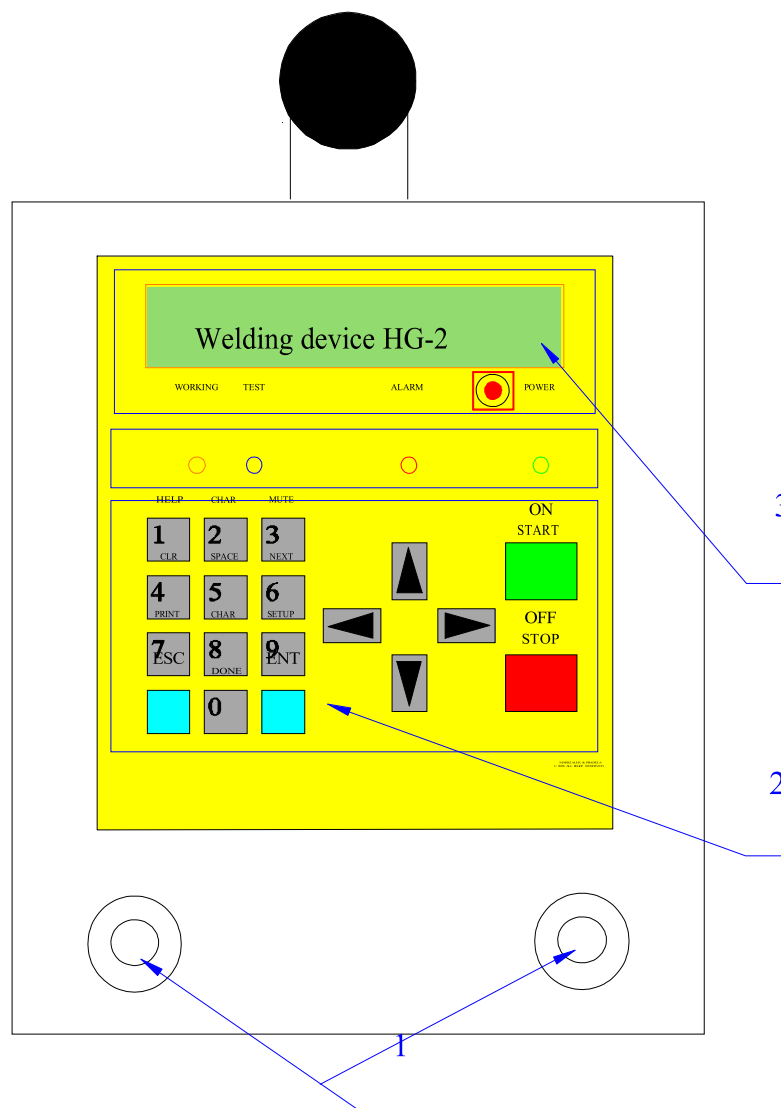


Fig. 4 HG-2 front control panel

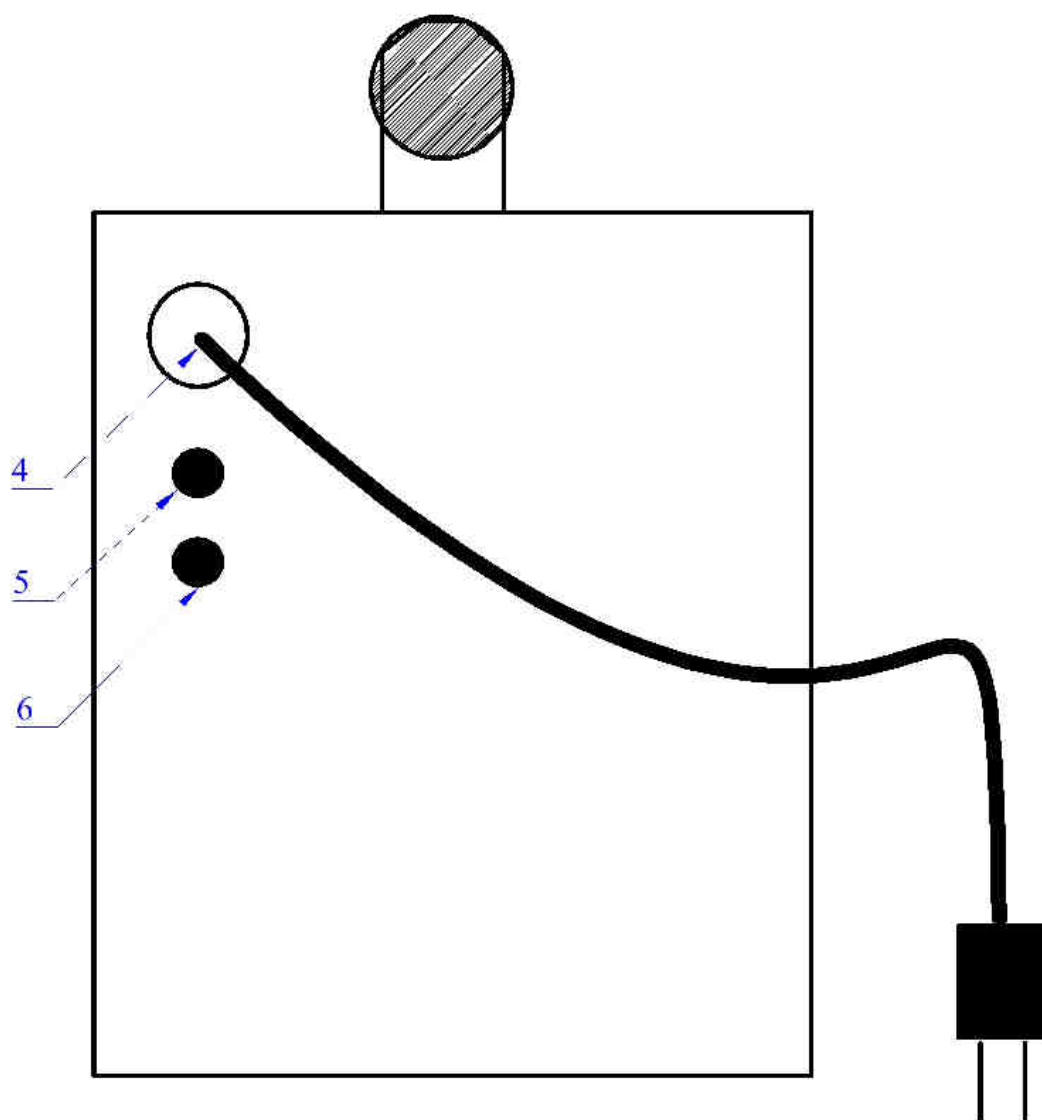


Fig. 5 HG-2 rear panel

Front panel layout:

- 1 – Outlets („power”)
- 2 – Keyboard
- 3 – LCD display
- 4 – Power supply cord
- 5 – Power fuse
- 6 – Low current fuse (electronics)

Press button function:

<i>ON / OFF</i>	Device On/off
0 ... 9	Data input
ESC	Function cancelled
ENT	Function accepted
 	Function or setup selection
 	Enter (selection accepted)

Functionalities:

the welding machine can be powered from a single phase mains 220V, 50Hz or by a generator;
the outlet is short circuit protected;
small size;
complete wiring included;
simple operation;
large easy to read LCD.

8.2. Technical data:**Powersupply:**

Voltage	230 V (+5% -10%) single phase
Power consumed	< 2700 VA
Power supply frequency	50 Hz, maximum deviation +0.2 -0.5 Hz
Protection class	IP 40

Climaticdata:

Operating temperature	5...50°C
Storage temperature	-10...70°C
Air relative humidity	25...95%

Otherdata:

Onboard memory capacity	255 welds
Weight (without wiring)	Ca 25 kg

8.3. Preparing the machine for operation:**Warning!**

Before the machine is put into operation, check the condition of the connecting wires. Under no circumstances should the welding machine be operated if the wires are damaged (e.g. insulation torn, broken plug or socket)!!!

Set up the welding machine on stable and dry ground. Connect the power supply cables to the machine and the terminals of the heating tape set on the plate.

The machine should be turned on only when the power supply cable has been connected with the 230 V 50 Hz mains or a power generator.

To depose a weld follow the algorithm presented in Fig. Structure of Welding Machine Programme.

A list of messages that may appear during welding

Message	Description
MEMORY FULL!!!	Weld registration memory full. The EEPROM chip memory has to be erased
SHORT-CIRCUIT!!!	The heating circuit shorted. Check the heating circuit and the condition of clamps supplying power
OPEN-CIRCUIT!!!	The heating circuit broken. Check it and the connection of clamps supplying power. Disconnect the power supply cord for about 5 seconds. If the error recurs, contact service.
DEVICE NOT READY!!	The device not ready for operation. Has to be initiated.
RESISTANCE OVERSIZE!!!	The heating circuit resistance too high. Heating process should be done section by section.
RESISTANCE TOO SMALL!!!	The heating circuit resistance too low.
PROCESS IMPOSSIBLE!!! FAILURE	Internal error. Contact service

Note:

In the event of the welding machine powered by a generator, first start the generator and then connect the welding machine.

If the power source is at a distance from the welding position and extension cables are used, keep their length:

- 50 metres for OW (OP) wires 3×2.5 mm²;
- 80 metres for OW (OP) wires 3×4 mm².

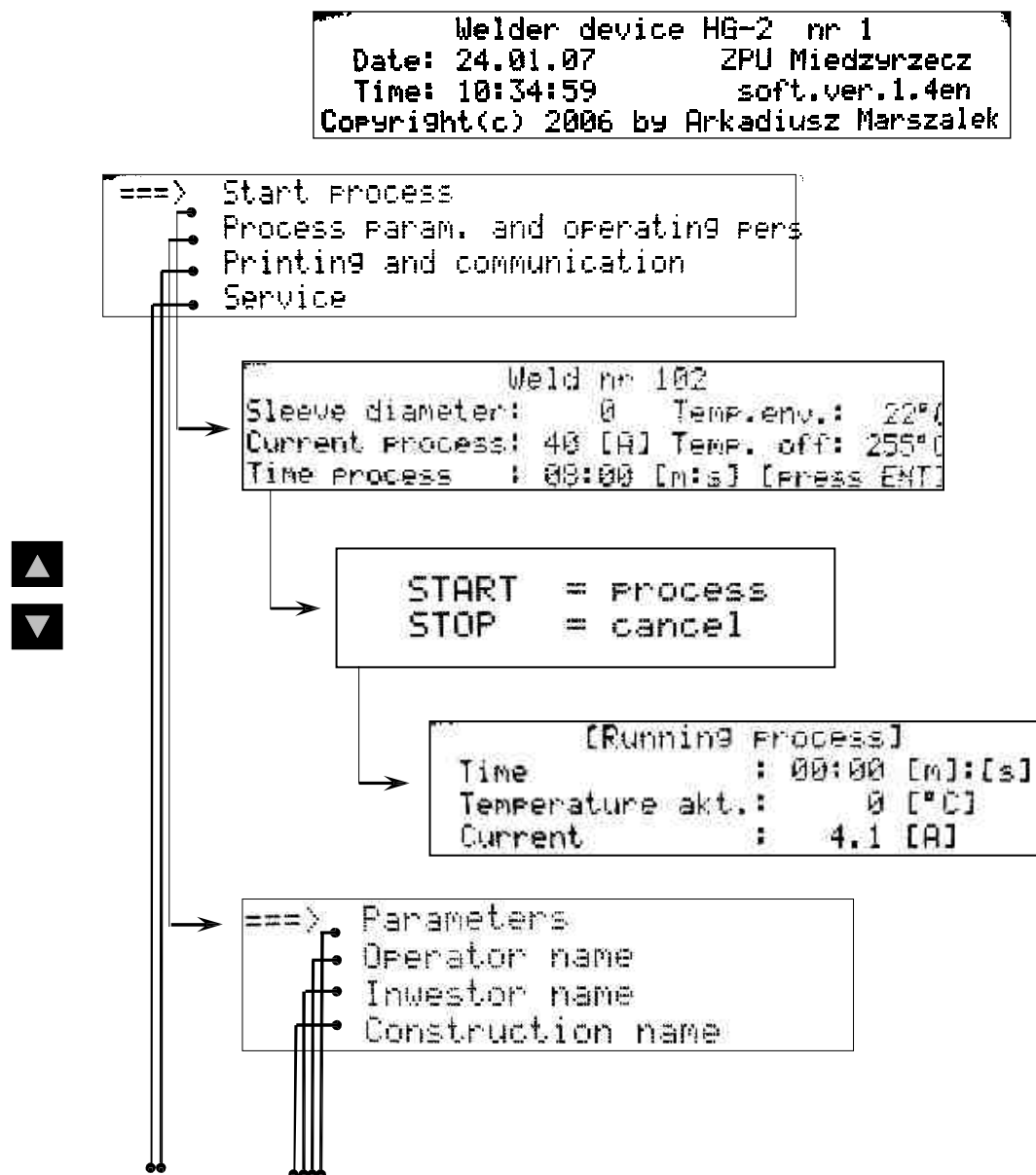
8.4. Maintenance and repairs:

Keep the machine in a clean condition, seeing to that the terminals are clean and the wires are in good repair.

In the case of a fault, repair only with an authorised service centre.

8.5. Structure of Program of Welding Machine Operations

Below is the program structure



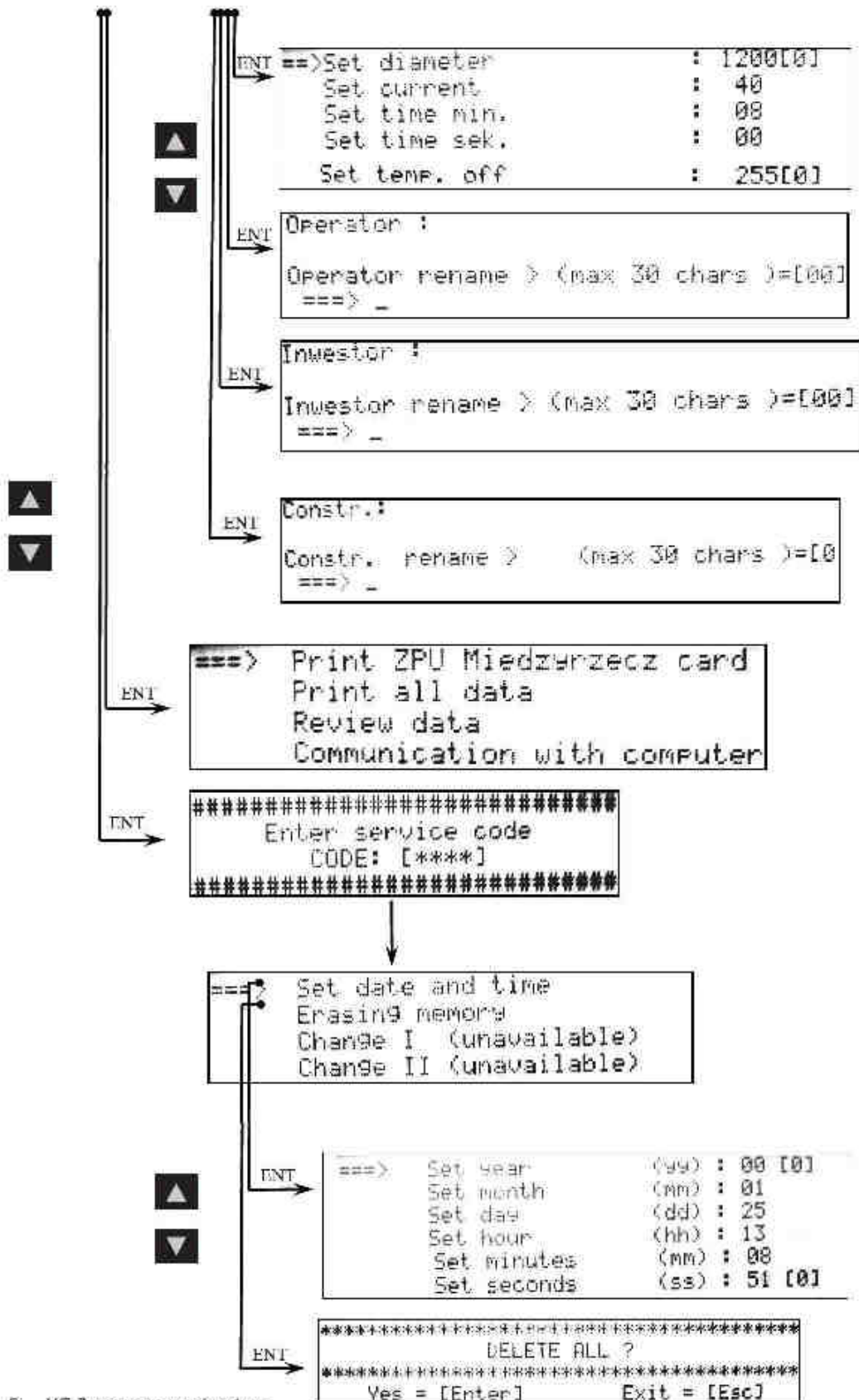


Fig. 6 HG-2 programme structure

9. Storage

- 9.1. All materials used in forming insulation, welding and sealing a joint have to be stored in closed rooms.
- 9.2. the components A and B of PUR foam are dosed in plastic bottles each set for a separate joint, and have to be stored in temperatures above +15°C but not exceeding +30°C.

MANUAL

Safety, technical and performance requirements to be observed in assembling heat shrinkable electrically welded DT joints in preinsulated thermal utilities
(Auxiliary training materials)

I. HG-2 welding machine

1. Power supply parameters:

single phase mains, 3 wires (L + N + P)

$U = 230 \text{ V}$, 50 Hz , $P_{\max} = 3 \text{ kVA}$

fuse $I_b = 16 \text{ A}$.

Note: The welding machine should be provided with a PE protective wire!

2. Output parameters:

- $U_{\max} = 52 \text{ V}$, 50 Hz , $I_{\max} = 40 \text{ A}$

3. Other data:

dimensions $36 \times 30 \times 35 \text{ cm}$

weight ca 20 kg .

II. Work safety rules to be observed while DT joints are assembled

During assembly works carried out on DT joints certain factors may affect labour safety and hygiene. These are among others:

a risk of electric shock during welding works;

burns if works are carried out on hot pipelines or on heating elements and heat shrinkable sleeves.

Therefore, the following cautionary measures have to be undertaken:

1. When welding devices are in operation regulations contained in respective operating manuals supplied by manufacturers have to be strictly observed.
2. Cables connecting the welding machine with a 230 V power supply must be of OW or OP type and meet respective standards. The cross section of copper wires supplying power to the welding machine cannot be smaller than 2.5 mm^2 .
The welding machine should be connected to the mains with OW or OP $3 \times 2.5 \text{ mm}^2$ flexible cords with a plug supplied with a PE protective pin.
For safety reasons a PE protective wire (grounding) has to be connected to the welding machine in order to avoid a risk of electrical shock.
The PE wire should be marked with green-yellow colour strip insulation to make it possible to distinguish it from other cables.
3. If the power supply source is placed at a distance or extension cables are used the cross section of these cables should be at least one grade higher (e.g. $3 \times 4 \text{ mm}^2$).
4. if the welding machine is to be powered by a generator it can only be used if capable of supplying undisturbed sine voltage.
The power generator must be thoroughly grounded and operated as indicated in its Operating Manual.
5. The lengths and cross sections of cables attached to the welding machine should meet nominal welding currents and secure lowest electrical losses.

6. Wires through which the welding machine is to be powered should be protected against mechanical damage (suspended, protected with proper guards, etc.)
7. The welding machine should preferably be situated as close as possible to the welding station.
8. Welding machine operations should be stopped immediately in case the operator's safety is endangered or a risk to the environment becomes imminent or if faults are found, especially if:
 - the machine becomes excessively hot;
 - signs of smoke, fire, and a smell of burning insulation can be detected;
 - excessive vibrations and noise levels;
 - damaged controls and automatic voltage and current controls.
9. The welding machine and its equipment should be kept in good repair by being periodically maintained, fixed and repaired.
10. Results of performed revisions and scopes of maintenance and repair operations have to be recorded in the respective documentation.
11. External visual inspections as required by the manufacturer have to be carried out while the machine is working and idle, no less than once a month.
12. Inspections: as specified by the manufacturer but at least once in 6 months.
13. Measurements:
 - Measurements made while the machine is working should be considered satisfactory if:
 - resistance of the transformer insulation separating the primary and secondary winding, and between the primary winding and the machine housing measured with a 1000 V megaohmmeter is not lower than 2 MΩ.
14. Anti shock protection should meet the requirements set out in respective regulations on electrical shock protection for power equipment, and additional requirements set out by the manufacturer and the actual conditions under which the machine is operated.
15. Workers performing DT joint assembly should be provided with personal protection gear like: clothes, gloves, head gear and protective shoes.

III. Excavations

1. Excavations deeper than 1 metre should be shuttered (boarding) or graded at safe angles.
 - Moreover, they should be provided with safe entrance (exits) for workers.
 - The distance between successive service entries (exits) should not exceed 20 m.
2. Each time works are to be commenced the walls of the excavations have to be inspected.
3. Neither material nor equipment can be stored:
 - closer than 1 metre to the excavation edge if its walls are shuttered;
 - within the limits of the soil wedge if the walls are not protected.
4. Excavations in places where DT joints are to be assembled should be suitable widened and deepened.
 - HG-2 welding machine operators should be provided with sufficient area (a niche), that is the distance between the poly casing pipe and the excavation

bottom should be at least 60 cm. The niche length should not be shorter than 190 cm.

5. Pipelines on which DT joints are to be assembled have to be dry in the designated places, and cannot come into contact with ground waters.
6. DT joints are suggested to be assembled in favourable weather conditions.
In case of rainfall the assembly places should be protected by covers, e.g. foil tents.
7. Workers in excavations should pay attention to the uncovered utilities there (power cables, telecommunication lines, gas pipe, etc.)
They should not be touched unnecessarily.
The gas pipe uncovered in excavations should be tested as regards their tightness with gas detectors.

IV. Central heating chambers, manholes and conduits

1. Prior to entry into chambers, manholes and central heating conduits gas concentrations there and sufficient supply of air oxygen should be checked.
2. Workers carrying out works in central heating conduits, manholes and closed chambers should be equipped with gas detectors and alarm sounders.
3. In works carried out inside central heating chambers at least one person should be on the look out to secure those at work.

V. General remarks

1. Work places and equipment should be cared about.
2. Do not expose yourself or your colleagues to unnecessary risks.
3. In cases of doubt as regards safety of work the worker has the right to cease operations performed and address his superior to clarify the situation.



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