

**PLASMA 56 COMPRESSOR INVERTER**

**POWER SOURCE art. 471 and art.471.48**

**SERVICE MANUAL**



art.471 (Fig.1 3.2.1)



art.471.48 (Fig.2 3.2.1)

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## **1 - GENERAL INFORMATION**

### **1.1 - Introduction.**

The purpose of this manual is to train personnel assigned to carry out maintenance on the power source art. 471 for plasma cutting systems.

The power source exists in two variants:

- art. 471 (3.2.1-Fig.1)
- art. 471.48 (3.2.1-Fig.2)

Art. 471 is equipped with a 4 m, ECF-71 torch with direct connection consisting of:

- power source start contact
- negative potential (-) eyelet
- Gas hose

Art. 471.48 is equipped with 8-pin Easy Fit fixed adapter (48), where:

- 1-2 pin torch button
- 7-8 pin torch recognition
- 4-5 pin pilot arc current

### **1.2 - General service policy.**

It is the responsibility of the customer and/or operator to use the equipment appropriately, in accordance with the instructions in the Instruction Manual, as well as to maintain the equipment and related accessories in good working condition, in compliance with the instructions provided in the Service Manual.

Any internal inspection or repairs must be carried out by qualified personnel who are responsible for any intervention on the equipment.

It is forbidden to attempt to repair damaged electronic boards or modules; replace them with original ELETTRO CF s.r.l. spare parts.

### **1.3 - Safety information.**

The safety notes provided in this manual are an integral part of those given in the Instruction Manual. Therefore, before working on the machine, please read the paragraph on safety instructions in the aforementioned manual.

Always disconnect the power cord from the mains, and wait for the internal capacitors to discharge (1 minute) before accessing the interior of the equipment.

Some internal parts, such as terminals and swirl rings, may be connected to mains or otherwise hazardous potentials. It is therefore forbidden to work with the safety guards removed from the machine unless strictly necessary. In this case, take special precautions such as wearing insulating gloves and footwear, and working in a perfectly dry environment with dry clothing.

### **1.4 - Electromagnetic compatibility.**

Please read and observe the instructions provided in the paragraph "Electromagnetic compatibility" of the Instruction Manual.

## **2 - SYSTEM DESCRIPTION**

### **2.1 - Introduction.**

The PLASMA 56 COMPRESSOR is a plasma arc system for cutting electrically conductive materials.

It is made up of an electronic power source (art. 471 or art. 471.48) with three-phase compressor and a set of accessories for use in manual applications.

The power source is controlled by microprocessor circuits, which manage the operative functions of the cutting system and operator interface.

### **2.2 - Technical specifications.**

To verify the technical specifications, see the machine plate, Instruction Manual, and Sales Catalogue.

### **2.3 - Description of power source art. 471**

Art. 471 is a controlled current direct current power source composed of a three-phase compressor and made up of a three-phase rectifier bridge, a DC/AC converter (inverter) and an additional rectifier bridge.

It may be powered at 400 Vac.

Referring to the electrical diagram, you can identify the main blocks that make up the power source.

The main switch (58) powers the filter board (10) which contains the filter to reduce conducted interferences reflected in the mains and the compressor (4) through the remote-control switch (6).

The integrated circuit U1 on igbt board (46) generates the 13.8 Vdc service voltage to power the electronic boards; the transformer TF1, together with the rectifier D1, generates the isolated supply voltage for the torch start button circuit, on the panel board (60).

The relay K2 drives the coil of remote-control switch (6) based on the commands received from the control board (63). The remote-control switch (6) brings power to the compressor (4) that produces the compressed air required to power the torch.

The coil of remote-control switch (6), as well as the fans (9) are always powered at 230 Vac.

The rectifier bridge (13) is connected to the output of the filter board (10), and rectifies the mains voltage at the filter board (10) output into direct current equivalent to 560 Vdc, approximately. This voltage, applied to the inverter, made up of the igbt board (46) and the igbt modules (44), is converted once again into square-wave alternating voltage, suitable for powering the power transformer(53).

The 4 resistors (42) connected to J2 of igbt board (46) limit the current in the electrolytic capacitors on the igbt board (46), which in turn level the direct current rectified by the bridge (13).

Their interruption makes these capacitors isolated and useless, while a short-circuit will damage the capacitors.

The igbt board (46) contains the TA to detect the current at the primary circuit of the transformer (53). Its signal is used by the control board (63) to adjust the pilot arc and cutting current.

The secondary transformer circuit (53) is made up of 4 separate identical windings, connected to a shared point on the terminal S2-S5 of the secondary board (70), to form a dual central socket winding. The other ends of the 4 windings are connected to terminals of the diode (68) to rectify the alternating current generated by the inverter (46). Inserted between the + output of the diode and the + terminal of the secondary board (70) (terminal L2), the inductor (52) is connected to

level the power source output current.

In this way the direct current voltage at the output of the secondary board (70) and present at its terminals (-) and (+) is available for the power source output.

The resistor (72) connected to CN2 of secondary board (70) helps balance the currents between the secondary windings of the transformer (53).

If interrupted, it may cause unstable operation both in the pilot arc and while cutting, while a short-circuit will definitely damage the secondary board (70).

The secondary board (70) includes the nozzle relays RL1 and RL3 to enable the nozzle voltage, and the solenoid with reed bulb RL2 to detect the cutting current on the earth conductor of the power source (workpiece potential).

When the two relays are in resting condition (thus with power source on or with pilot arc), they provide on terminal F1, corresponding to the torch nozzle terminal, the same voltage present on terminal L2 of the secondary board (70), corresponding to the + output of the power source.

When the torch with pilot arc lit is moved close to the workpiece, the solenoid with reed bulb detects the current passing through the earth conductor of the power source, and commands the switch from pilot arc to transfer arc, by means of the nozzle relays RL1 and RL3, which cut off voltage on the nozzle terminal F1.

The reed RL2 simultaneously sends the same signal to the control board (63), which starts the transfer arc working mode (cutting).

The secondary board (70) includes the Hall-effect current transducer to detect the cutting current. Its signal is used by the control board (63) to limit the maximum output current of the power source.

The cutting current is adjusted by the inverter, made up of the igbt board (46) and igbt modules (44), appropriately controlled by the control board (63).

The control board (63) contains the main power source microprocessor, and supervises management of the other boards.

It adjusts the cutting current, generates the PWM signal to be sent to the igbt (44) through the isolated drive circuits built into the same board, and also handles diagnostics of the power source, managing the control panel consisting of the panel board (60).

**Given the particular configuration of the inverter (control board (63) with built-in drive circuits connected directly to the igbt (44)), quite these drive circuits suffer damage following an igbt (44) fault. For this reason we recommend simultaneously replacing the control board (63) along with the igbt (44). Otherwise, the new igbt controlled by defective drive circuits would again be damaged. Similarly, should it be necessary to replace the control board (63) following a fault in the igbt drive circuits, we recommend that you also replace the igbt (44) at the same time.**

The panel board (60), mounted on the front panel, acts both as a control panel for the power source, and as an input and conditioning interface for those signals especially affected by disturbances because they arrive from critical areas of the system.

These signals include:

- Start power source,
- Torch type recognition (only art. 471.48)

The panel board (60) contains the following control elements:

- Potentiometer to adjust the cutting current.
- A set of leds to indicate the operating status.

The signals processed by the electronic boards and present at their connectors are listed in the table in chapter five of this manual.

## **3 - MAINTENANCE**

### **WARNINGS**

**ANY INTERNAL INSPECTIONS OR REPAIRS MUST BE CARRIED OUT BY QUALIFIED PERSONNEL.**

**BEFORE BEGINNING MAINTENANCE OPERATIONS, UNPLUG THE POWER SOURCE FROM THE MAINS AND WAIT FOR THE INTERNAL CAPACITORS TO DISCHARGE (1 MINUTE).**

#### **3.1 - Periodic inspection, cleaning.**

Periodically open the power source grids and check inside the aeration tunnel.

Remove any dirt or dust to ensure smooth air flow, and thus adequate cooling of the internal parts of the power source.

Check the condition of the output terminals, output and power supply cables of the power source; replace if damaged.

Check the condition of the internal power connections and connectors on the electronic boards; if you find “loose” connections, tighten or replace the connectors.

#### **3.2 - Operating sequence (fig. 3.2.1).**

The following sequence represents correct functioning of the machine. It may be used as a guiding procedure for troubleshooting.

It must be carried out after each repair without any errors.

3.2.1 - Power source commands and signals.

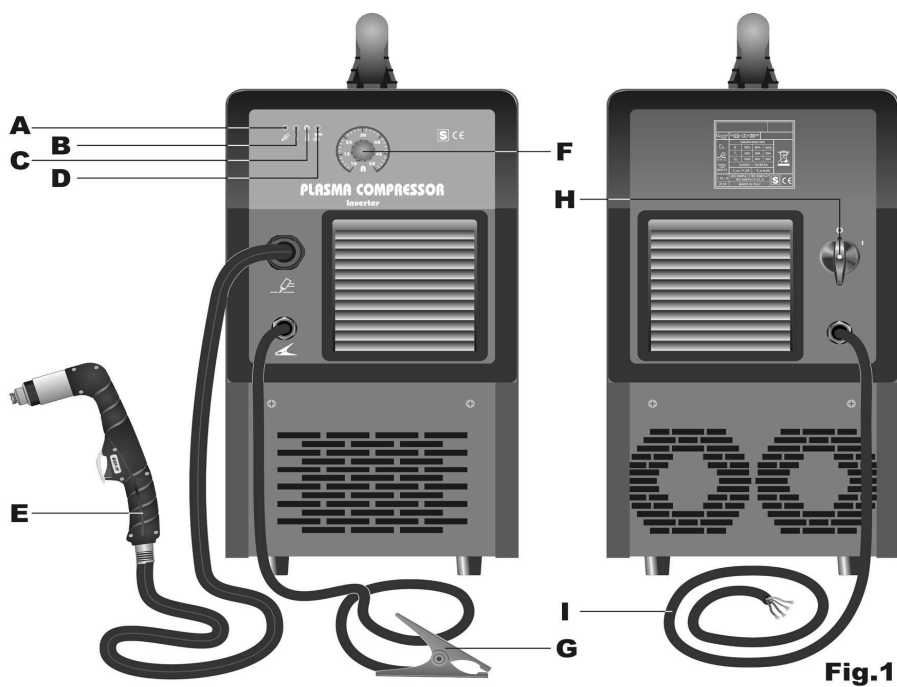


Fig.1

Fig.1 (Art.471)



Fig.2

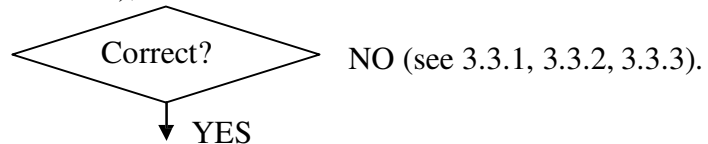
Fig.2 (Art.471.48)



## 3.2.2 - Power source operation.

### NOTE

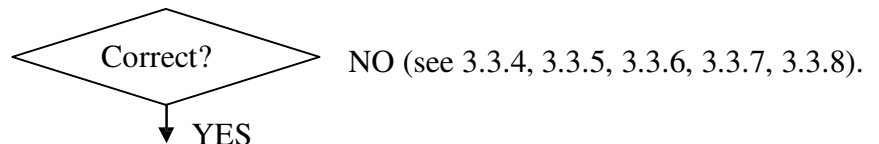
- Operations marked with this symbol refer to operator actions.
- ◆ The operations marked with this symbol refer to machine responses that must occur following an operator action.
  
- System shut off and unplugged from the mains.
- Connect the torch to the power source (only art. 471.48)
- Connect the cable of the positive pole of the power source to the workpiece.
- Connect the power source to the mains.
- Close the switch (O) on the power source.
  - ◆ System powered, led (A) lit, fan running.
  - ◆ On front panel, leds (C) and (D) off; led (B) lit for the first 5 seconds (mains voltage analysis and selection), then off.



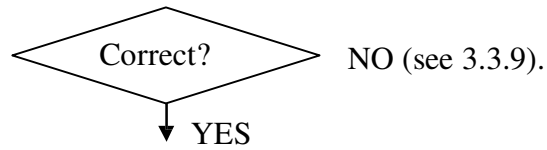
### WARNING

DURING THE FOLLOWING TESTS, DO NOT POINT THE TORCH AT PEOPLE OR PARTS OF THE BODY, BUT ALWAYS TOWARDS AN OPEN SPACE OR THE WORKPIECE.

- Press the torch start button and hold it down.
  - ◆ Gas flows from the torch and the pilot arc starts for the maximum pilot arc time (2 sec.). The gas continues to flow for approximately another 100 sec. after the start button is released (post-gas time).

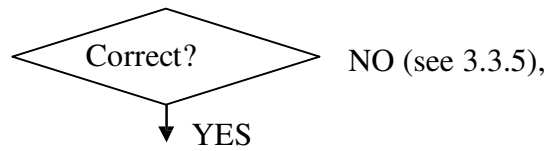


- With pilot arc lit, place the torch near the workpiece.
  - ◆ Begin cutting. Adjust the knob (F) to the current level suited to the kind of cutting.



□ Release the torch start button.

- ◆ The arc shuts off immediately. The gas continues to flow for the post-gas time (approximately 100 seconds after the start button is released) to cool the torch.



REGULAR OPERATION.

### 3.3 - Troubleshooting.

#### WARNINGS

ANY INTERNAL INSPECTIONS OR REPAIRS MUST BE CARRIED OUT BY QUALIFIED PERSONNEL.

BEFORE REMOVING THE PROTECTIVE GUARDS AND ACCESSING INTERNAL PARTS, DISCONNECT THE POWER SOURCE FROM THE MAINS AND WAIT FOR THE INTERNAL CAPACITORS TO DISCHARGE (1 MINUTE).

#### NOTE

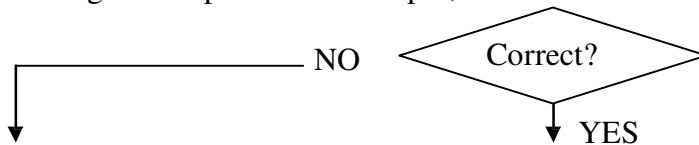
Items in **boldface** describe problems that may occur on the machine (symptoms).

- Steps marked with this symbol refer to situations for which the operator must determine the causes (causes).
- ◆ Operations preceded by this symbol refer to actions the operator must perform in order to solve the problems (solutions).

#### 3.3.1 - **The power source does not start, led (A) off.**

MAINS SUITABILITY TEST.

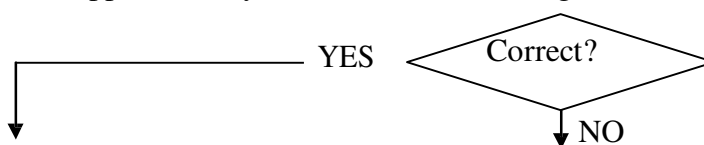
- No voltage at the power source input, because the mains surge protector is tripped.



- ◆ Eliminate any short-circuits in the connections between the power cable, switch (58), filter board (10) and igbt board (46).
- ◆ Make sure that the terminals U, V and W on filter board (10) are not short-circuited between themselves or towards earth. If short-circuited, disconnect the wires from terminals U, V and W of filter board (10) from the terminals of the rectifier bridge (13) and repeat the tests. If the short-circuit is still present, replace the filter board (10). If the short-circuit has been removed, make sure the rectifier bridge (13), igbt (44) and igbt board (46) are intact, and replace any defective components.
- ◆ Mains not suited to power the power source (ex.: insufficient installed power).

MAINS CONNECTION TEST.

- Rectifier bridge (13) input terminals (wires from terminals U, V and W of filter board (10)) = approximately 3 x 400 Vac, according to mains voltage, with switch (58) closed.

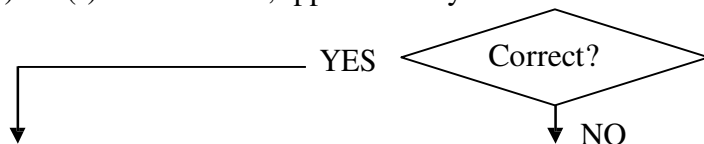


- ◆ Check power cable and plug and replace if necessary.
- ◆ Check the switch (58) and replace if defective.
- ◆ Check the mains voltage conditions, and especially that none of the power supply three phases is missing.

- ◆ Check the integrity of the rectifier bridge (13), igbt (44) and the igbt board (46) and replace any defective components.
- ◆ Replace the filter board (10).

## SERVICES POWER SUPPLY TEST.

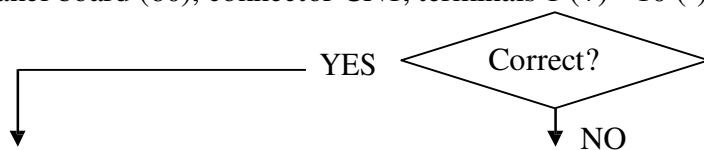
- Igbt board (46), connector J3, terminals 1 (+) - 5 (-) = +25 Vdc, approximately; terminals 4 (+) - 5 (-) = +13.8 Vdc, approximately.



- ◆ Check the wiring between J3 igbt board (46) and CN9 control board (63).
- ◆ With the power source off, temporarily disconnect the connector CN1 on secondary board (70), and repeat the test of the voltages on the connector J3 of igbt board (46). If the values are correct, replace the secondary board (70). If incorrect, with the power source off, also disconnect CN9 on control board (63) and repeat the test of the voltages on the connector J3 of igbt board (46). If the values are correct, replace the control board (63). If incorrect replace the igbt board (46).

## PANEL BOARD (60) POWER SUPPLY TEST.

- Panel board (60), connector CN1, terminals 1 (+) - 10 (-) = +5 Vdc.

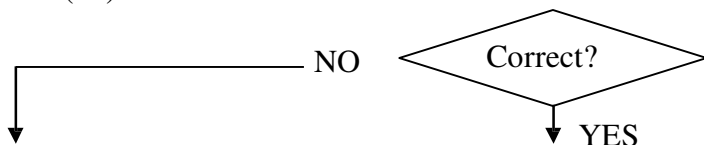


- ◆ Check the wiring between CN1 panel board (60) and CN2 control board (63).
- ◆ With the power source off, temporarily disconnect the connector CN1 on panel board (60) and make sure that the voltage on connector CN2, control board (63), terminals 1 (+) - 10 (-) = +5 Vdc. If the result is correct replace the panel board (60); if incorrect replace the control board (63).
- ◆ Replace the control (63) and/or panel boards (60).
- ◆ Check the wiring between CN1 panel board (60) and CN2 control board (63).
- ◆ Replace the control (63) and/or panel boards (60).

### 3.3.2 - Power source powered, led (A) lit, fan (9) stopped.

#### FAN (9) TEST.

- Fan (9) fast-on terminals = 230 Vac, approximately, with mains at 230 Vac, after closing switch (58).

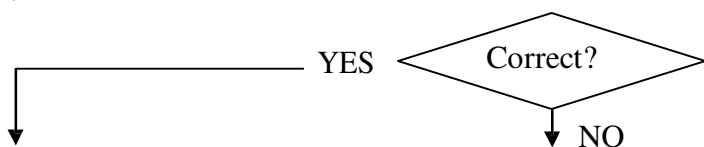


- ◆ Make sure that there are no mechanical impediments blocking the fan (9).
- ◆ Replace the fan (9).
- ◆ Check the wiring between fan (9) and connector J1, terminals 2 and 6 on igbt board (46).
- ◆ Check the presence of the power supply three phases on terminals U, V and W on filter board (10), with a voltage value equivalent to the supply voltage of the power source. If incorrect, check the cable, power plug and switch (58) and replace if defective.
- ◆ Check the presence of 400V approx. on connector J6, terminals 1 and 4 on igbt board (46).
- ◆ Replace filter board (10).
- ◆ Replace igbt board (46).

### 3.3.3 - Power source powered, the signals do not indicate correct values.

#### INITIAL TEST.

- Upon start-up, green led (A) lit, leds (C) and (D) off, led (B) lit for the first 5 seconds, then off.

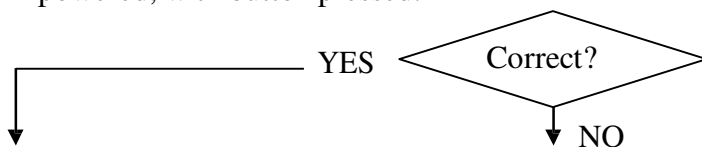


- ◆ See Alarm signals, par. 3.4.
- ◆ Carry out the SERVICES POWER SUPPLY TEST and PANEL BOARD (60) POWER SUPPLY TEST in par. 3.3.1.
- ◆ Replace the control (63) and/or panel boards (60).
- ◆ Correct operation.

### 3.3.4 - The start button produces no effect.

#### START BUTTON TEST.

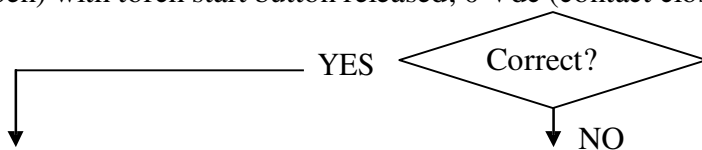
- Panel board (60), terminals CN4 (+) and CN3 (-) = +24 Vdc (button contact open) and RL1 on panel board (60) resting, with start button on torch released; 0 Vdc (contact closed) and RL1 powered, with button pressed.



- ◆ Check the wiring between torch and terminals CN3 and CN4 of panel board (60) (art. 471).
- ◆ Check the wiring between terminals CN3 and CN4 of panel board and terminals 1 and 2 fixed adapter (art. 471.48).
- ◆ Check the wiring between connector CN2, terminals 2, 4 of panel board (60) and terminals 7, 8 of the central adapter on power source (art. 471.48).
- ◆ For art. 471 make sure that the torch recognition jumper is present on pin 2,4 of connector CN2 panel board (60).
- ◆ Make sure that the nozzle guard is correctly mounted on the torch and in good working order. If defective or showing signs of wear, replace.
- ◆ Check torch button. If defective, replace.
- ◆ Make sure that connector CN8, on panel board (60), terminals 1 (+) and 2 (-) = +24 Vdc, approximately, with power source powered. If correct, replace the panel board (60). If incorrect, with power source off temporarily, disconnect the connector CN8 from panel board (60) and make sure that the voltage on connector J7 of igbt board (46), terminals 1 (+) and 2 (-) = +24 Vdc approximately. If correct check the wiring between CN8 panel board (60) and J7 igbt board (46), or replace the panel board (60). If incorrect check the power supply conditions of the power source (see par. 3.3.1) and/or replace the igbt board (46).

#### START COMMAND TEST.

- Control board (63), connector CN2, terminals 11 (+) and 12 (-) = +13.8 Vdc, (RL1 contact open) with torch start button released; 0 Vdc (contact closed) with button pressed.

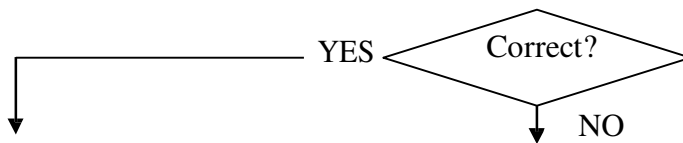


- ◆ Check the wiring between CN1 panel board (60) and CN2 control board (63).
- ◆ Temporarily disconnect, with power source off, connector CN1 from panel board (60) and check the resistance between terminals 11 and 12 of CN2 control board (63) = approximately 25 Kohm. If incorrect, replace control board (63). If correct replace relay RL1 on panel board (60) or panel board (60).
- ◆ Replace control board (63).

## 3.3.5 - No gas flows from the torch.

### COMPRESSOR TEST.

- Terminals of remote control switch coil (6) = 230 Vac, approximately, with torch button pressed. The time of the operation control of the compressor depends on the pre-gas and post-gas times and on the testing conditions.



- ◆ Check the wiring between coil (A1-A2) of the remote-control switch (6) and J1 igt board (46).
- ◆ Check the wiring between J3 igt board (46) and CN9 control board (63).
- ◆ Make sure that the supply voltage to the fan (9) is correct, see par. 3.3.2. (this voltage is the same that powers the coil of the remote-control switch (6)).
- ◆ With power source off, check the resistance between the terminals (A1-A2) of the remote-control switch (6) = 500 ohm, approximately. If 0 ohm (short-circuit), replace remote-control switch (6) and filter board (10).
- ◆ Replace the control (63) and/or igt (46) boards.
- ◆ With power source off, check the resistance between the terminals (A1-A2) of the remote-control switch coil (6) = 500 ohm, approximately. If > Mohm (winding broken), replace remote control switch (6).
- ◆ Make sure there are no occlusions in the gas hoses coming out of the compressor.
- ◆ Replace the compressor (4).

### 3.3.6 - Gas flows from the torch, the pilot arc does not light (contact tip voltage missing).

**NOTE**

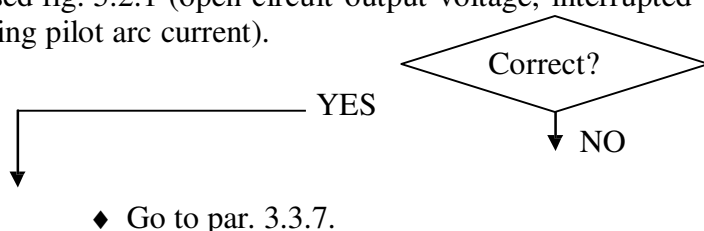
Some of the following tests may be checked only in the second after pressing the torch start button, due to failure by the pilot arc to strike.

**WARNING**

FOR THE FOLLOWING TESTS UNSCREW THE NOZZLE HOLDER (26) FROM THE TORCH, REMOVE THE ELECTRODE (23), THE DIFFUSOR (24), THE NOZZLE (25) AND AT LAST REASSEMBLE THE NOZZLE HOLDER (26).

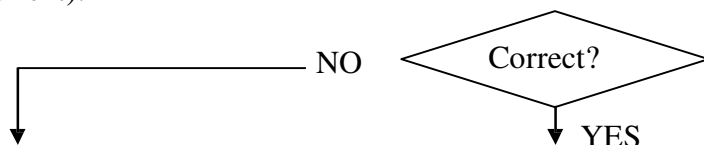
#### POWER SOURCE OUTPUT VOLTAGE TEST.

□ Front panel output (G) and output “-” “secondary board (gnd) = fig. 5.2.1 with start button pressed fig. 5.2.1 (open-circuit output voltage, interrupted after approximately 300 msec., for missing pilot arc current).



#### NOZZLE VOLTAGE TEST.

□ Secondary board (70), terminal F1 and “-” (gnd) = fig. 5.2.1, with start button pressed (open-circuit output voltage, interrupted after approximately 300 msec., for missing pilot arc current).



- ◆ Check connections between torch and boards of the power source; more specifically, between terminals 5 and 6 of the fixed torch fitting and terminal F1 on secondary board (70) (nozzle potential); between the central terminal of fixed torch fitting and terminal (-) on secondary board (70).  
If you find loose connections, tighten them and replace any damaged components (art. 471.48).
- ◆ Check the conditions of the torch cables and their correct connection on the secondary boards (70) and on the panel board (60) (art.471).
- ◆ Check the condition of the fixed adapter (48), torch cable and torch, especially make sure there are no short-circuits or isolation leaks between the conductors or between the contacts of the fixed adapter (48). Replace any worn or damaged components (art. 471.48).
- ◆ With the power source off, temporarily disconnect terminal F1 from secondary board (70) and check the resistance between the terminals F1 and L2 on secondary board (70). Correct value = 0 ohm (N.C. contacts of the relays RL1 and RL3, serial connected). If > Mohm (circuit broken), replace RL1 and/or RL3 on secondary board (70) or replace the secondary board (70).
- ◆ Replace the panel board (60).



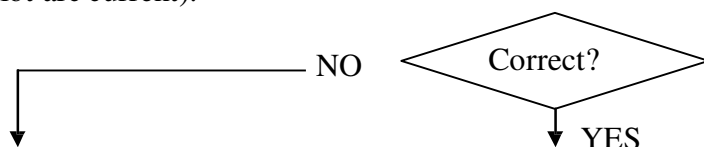
## 3.3.7 - In open circuit operation, the output voltage is not regular.

### WARNING

FOR THE FOLLOWING TESTS UNSCREW THE NOZZLE HOLDER (26) FROM THE TORCH, REMOVE THE ELECTRODE (23), THE DIFFUSOR (24), THE NOZZLE (25) AND AT LAST REASSEMBLE THE NOZZLE HOLDER (26).

### SECONDARY CIRCUIT RECTIFIER OUTPUT VOLTAGE TEST.

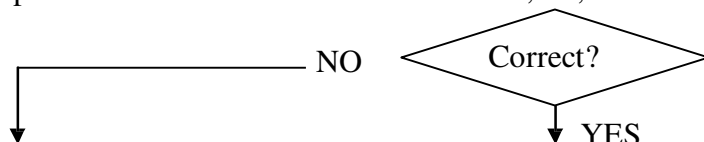
- Secondary board (70), terminals L1 and S2-S5 (gnd) = fig. 5.2.2, with start button pressed (open-circuit rectifier output voltage, interrupted after approximately 300 msec., for missing pilot arc current).



- ◆ Check the connection of the choke (52) with the terminals L1 and L2 on secondary board (70).
- ◆ Make sure the reed bulb RL2 is properly mounted between the L2 and (+) terminals on secondary board (70).
- ◆ Check the continuity between the terminals S2-S5 and (-) and that the Hall-effect current transducer (SH1) is properly mounted on secondary board (70).
- ◆ Check the wiring between output (G), and the terminal (+) of the secondary board (70).
- ◆ Replace the secondary board (70).

### INVERTER OUTPUT VOLTAGE TEST.

- Secondary board (70), terminals S1 and S2-S5 (gnd) = fig. 5.2.3, with start button pressed (open-circuit inverter output voltage, interrupted after approximately 300 msec., for missing pilot arc current).
- Repeat the measurement with terminals S3, S4, and S6 in place of S1 = same waveform.



- ◆ Make sure the connections of the secondary windings of the transformer (53) are correct and intact on terminals S2-S5, S1, S3, S4, and S6 of secondary board (70). If you find loose connections, tighten and replace any components with damaged terminals.
- ◆ Replace the secondary board (70).
- ◆ Check the wiring between J7 igbt board (46) and CN8 control board (63).
- ◆ With the power source off, temporarily disconnect the secondary windings of the transformer (53) from terminals S1, S3, S4 and S6 of secondary board (70), and check the integrity of the secondary rectifier, testing the resistance between each of the terminals S1, S3, S4 and S6 of secondary board (70) and terminal L1 (“+” rectifier potential) and terminal 1 of CN2 on secondary board (70) (“-” rectifier potential). For each measurement point, the correct value = diode joint in one direction and > Mohm with the instrument probes reversed. If short-circuited or low-resistance replace the defective diodes or replace the secondary board (70).

- ◆ Check the wiring and integrity of the resistor (72) with connector CN2 on secondary board (70). Correct value of the resistor (72) = 10 Kohm.
- ◆ Check conditions of the transformer (53). Replace if damaged or showing signs of burns.
- ◆ Make sure the connections are correct and intact in the primary windings of the transformer (53) on terminals Q1 and Q2 on igbt board (46). If you find loose connections, tighten and replace any components with damaged terminals.
- ◆ With the power source off, temporarily disconnect the terminals of the primary windings of the transformer (53) from terminals Q1 and Q2 on igbt board (46), and check the resistance between the terminals Q1 and Q2 on igbt board (46). Correct value = >Mohm in all measurements. If you find a short-circuit or low resistance, replace the igbt board (46).
- ◆ Check the integrity of the igbt modules (44), checking the resistance between each of the terminals Q1 and Q2 of igbt board (46) with the (+) and (-) terminals of igbt board (46). For each measurement point, the correct value = diode joint in one direction and > Mohm with the instrument probes reversed. If short-circuited or low-resistance replace the defective igbt module (44) and/or replace the igbt board (46).
- ◆ Check the wiring between drive terminals of the igbt modules (44) and connectors CN3, CN4, CN5 and CN6 on control board (63), taking care to observe the polarity of these connections.

### **WARNING**

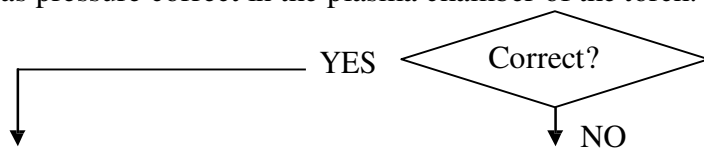
**In the case of a fault of an igbt module (44) or a drive section of the control board (63), we recommend that you also replace both the igbt module (44) and the control board (63) at the same time.** An igbt fault quite frequently damages the drive section to which it is connected. Similarly, a drive section fault quite frequently damages the igbt to which it is connected.

- ◆ Check the wiring and integrity of the resistors (42) with connector J2 on igbt board (46). Correct value of the resistors (42) = 6 ohm.
- ◆ Check the presence of the power supply three phases on terminals U, V and W of filter board (10).
- ◆ Check the presence of approximately 560 Vdc, on the (+) and (-) terminals on igbt board (46). If incorrect, carry out the MAINS CONNECTION TEST, par. 3.3.1.
- ◆ Replace the filter (10) and/or igbt (46) and/or control (63) and/or secondary board (70).

### 3.3.8 - Irregular pilot arc starts, unstable pilot arc.

#### PLASMA GAS PRESSURE TEST.

- Gas pressure correct in the plasma chamber of the torch.



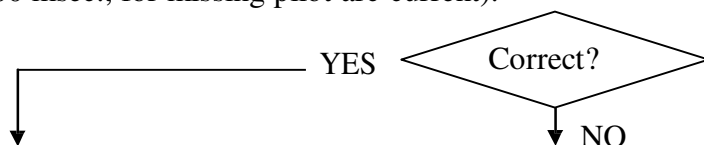
- ◆ Check obstructions and/or presence of gas in the gas hose coming out of the compressor (4).
- ◆ Replace compressor (4).

#### WARNING

FOR THE FOLLOWING TESTS UNSCREW THE NOZZLE HOLDER (26) FROM THE TORCH, REMOVE THE ELECTRODE (23), THE DIFFUSOR (24), THE NOZZLE (25) AND AT LAST REASSEMBLE THE NOZZLE HOLDER (26).

#### PILOT ARC VOLTAGE TEST.

- Secondary board (70), terminal F1 and output “-” (gnd) = fig. 5.2.1, with start button pressed (open-circuit output voltage, interrupted after approximately 300 msec., for missing pilot arc current).



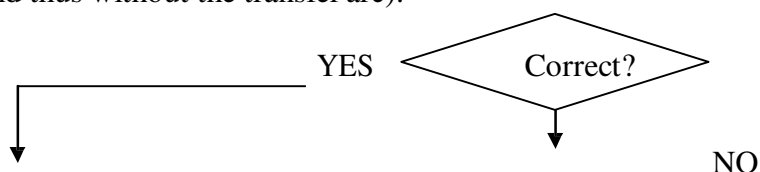
- ◆ Check the presence of the power supply three phases on terminals U, V and W of filter board (10).
- ◆ Go to par. 3.3.6.

#### WARNING

Due to lighting the pilot arc, some instruments may not be suitable for measuring signals in the following tests. Given the sensitivity of the measuring points, we urge you to use the utmost care and precision, scrupulously following the instructions provided in the present manual and using only instruments certified compatible with these phenomena.

## PILOT ARC CURRENT TEST.

- Control board (63), connector CN10, terminals 2 – 3 (gnd) = fig. 5.2.4, with pilot arc lit (pilot arc current signal for its maximum time, approximately 2 sec., with the torch free in the air and thus without the transfer arc).



- ◆ Check the wiring between CN10 control board (63) and CN1 secondary board (70).
  - ◆ Make sure the current transducer SH1 is properly mounted on secondary board (70).
  - ◆ Check the supply voltage of current transducer SH1 on secondary board (70), connector CN1, terminals 1 (+) and 3 (-) = +13.8 Vdc, approximately. If incorrect, with power source off, temporarily disconnect connector CN10 from control board (63) and check the resistance between the terminals 1 and 3 of CN1 secondary board (70) = approximately 2.7 Kohm. If 0 ohm (short-circuit) replace the secondary (70) and control (63) boards. If >Mohm (circuit broken) replace the secondary board (70).
  - ◆ With power source off, temporarily disconnect CN1 from secondary board (70) and check the resistance between terminals 2 and 3 of CN10 on control board (63). Correct value = two diodes junction in one direction and >Mohm with the instrument probes reversed. If incorrect, replace control board (63).
  - ◆ Make sure the TA SH1 is properly mounted on igbt board (46), and check its wiring with terminals FS3 and FS4 on control board (63).
  - ◆ With the power source off, temporarily disconnect the wires from terminals FS3 and FS4 on control board (63) and check the resistance between the terminals FS3 and FS4 on control board (63). Correct value = two diodes junction in both directions. If incorrect, replace control board (63).
  - ◆ Make sure that the power source regularly delivers open-circuit output voltage, performing if necessary, the tests in par. 3.3.7.
  - ◆ Replace the control (63) and/or igbt (46) and/or secondary boards (70).
- 
- ◆ For art. 471: check the conditions of the torch cables and their correct connection on the secondary boards (70) and on the panel board (60) and check the integrity of the gas hose and its connection with the compressor (4).
  - ◆ For art. 471.48: check the integrity and the continuity of wiring of the terminals 4 and 5 of the fixed connection for torch (E-fig.2) and terminal F1 on secondary board (70). Check the conditions of fixed connection and torch cable; replace if aged or damaged.
  - ◆ Check the electrode, swirl ring and torch nozzle; replace if worn or damaged.
  - ◆ Make sure the internal parts of the torch are properly insulated, including cables; if in doubt, replace the entire torch.
  - ◆ Replace the control (63) and/or igbt (46) and/or secondary board (70).

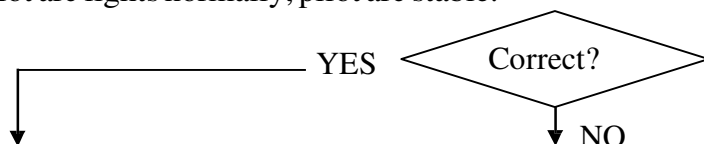
## 3.3.9 - Transfer arc does not take place or is too weak for cutting.

### WARNING

Due to lighting the pilot arc, some instruments may not be suitable for measuring signals in the following tests. Given the sensitivity of the measuring points, we urge you to use the utmost care and precision, scrupulously following the instructions provided in the present manual and using only instruments certified compatible with these phenomena.

#### OPERATING TEST IN PILOT ARC.

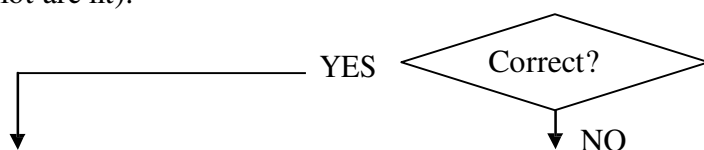
- Pilot arc lights normally, pilot arc stable.



- ◆ Go to par.3.3.8.

#### TRANSFER ARC SWITCHING TEST.

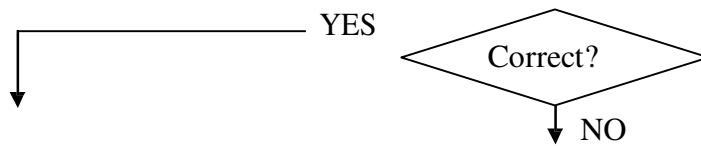
- Control board (63), connector CN10, terminals 6 (+) and 5 (-) = 0 Vdc, (reed contact RL2 on secondary board (70) closed) with torch close to the workpiece and transfer arc lit (thus while cutting), (approximately +25 Vdc, reed contact RL2 open, with power source powered or with pilot arc lit).



- ◆ Check connections between torch, earth cable and boards of the power source.
- ◆ For item 471.48: check continuity of central terminal of fixed connection for torch and terminal "-" on secondary board (70), (electrode potential); between output (G) of the power source and terminal (+) on secondary board (70) (earth potential). If you find loose connections, tighten and replace any damaged components.
- ◆ Make sure the reed bulb RL2 is properly mounted in the solenoid provided on secondary board (70).
- ◆ Make sure that, with power source off, the switch in the reed bulb RL2 works properly: move a magnet near the bulb and check the resistance between the terminals 6 and 5 of CN10 on control board (63) = 0 ohm (reed contact closed). Move the magnet away from the bulb, resistance = >1 Kohm (reed contact open). If incorrect replace the reed bulb and solenoid, or the complete secondary board (70).
- ◆ Check the presence of the power supply three phases on terminals U, V and W of filter board (10).
- ◆ Check the wiring between CN10 control board (63) and CN1 secondary board (70).
- ◆ With power source off, temporarily disconnect connector CN1 from secondary board (70) and turn the power source back on. Make sure that voltage on control board (63), connector CN10 terminals 6 (+) and 5 (-) = approximately +25 Vdc. If correct, replace the secondary board (70). If incorrect check the wiring between terminals 1, 5 and 10 of CN9 control board (63), with terminals 1, 5 and 10 of J3 igbt board (46).
- ◆ Replace the control (63) and/or secondary (70) and/or igbt (46) boards.

## COMPRESSOR POWER SUPPLY TEST

- Terminals A1-A2 remote control switch = approximately 230 Vac, with torch close to the workpiece and transfer arc lit (thus while cutting).



- ◆ Check the wiring between contacts A1-A2 of remote-control switch (6) and J1 IGBT board (46).
- ◆ Check the wiring between J3 IGBT board (46) and CN9 control board (63).
- ◆ Make sure that the supply voltage to the fan (9) is correct, see par. 3.3.2. (this voltage is the same that powers the contacts A1-A2 of the remote-control switch (6)).
- ◆ With power source off, check the resistance between the contacts A1-A2 of the remote-control switch (6) = approximately 500 ohm. If 0 ohm (short-circuit), replace remote-control switch (6) and IGBT board (46).
- ◆ Replace the control (63) and/or IGBT (46) boards.
- ◆ With power source off, check the resistance between the remote-control switch contacts A1-A2 = approximately 500 ohm. If >Mohm (interrupted coil), replace remote control switch (6).
- ◆ Check connections between torch, earth cable and boards of the power source; if the power source is equipped with Easyfit connection, check the central terminal fixed torch fitting, and terminal “-” on secondary board (70), (electrode potential); between output (G) of the power source, and terminal (+) on secondary board (70) (earth potential).  
If you find loose connections, tighten and replace any damaged components.
- ◆ For item 471: Check the condition of the torch body and of the torch; especially make sure there are no short-circuits or isolation leaks between the conductors. Replace any worn or damaged components.
- ◆ For art. 471.48: Check the condition of fixed adapter (48), torch body and body; especially make sure there are no short-circuits or isolation leaks between the conductors or between the contacts of the fixed adapter (48). Replace any worn or damaged components.
- ◆ Check the condition of electrode, nozzle, nozzle holder and swirl ring of the torch. Replace if they show signs of wear.
- ◆ Check the presence of the power supply three phases on terminals U1, V1 and W1 of IGBT board (46).
- ◆ Make sure that there are no occlusions in the gas hoses coming out of the compressor (6).
- ◆ Replace the compressor (6).
- ◆ Replace the control (63) and/or panel (60) and/or secondary board (70).

## 3.4 - Alarm signals.

### 3.4.1 - Led (C) lit = temperature outside limits.

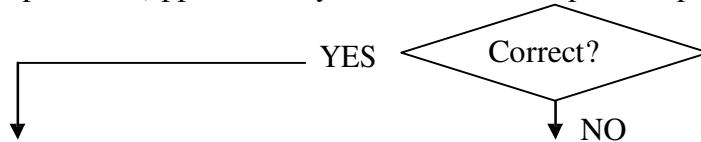
This alarm indicates that the temperature of the igbt (44) has risen beyond the allowed limits.

In this situation we recommend that you not shut off the power source, to keep the fan (9) running and thus allow rapid cooling.

This is reset automatically when the temperature returns within the allowed limits.

#### THERMOSTAT TEST.

- Control board (63), terminals FIS2 (+) and FIS1 (-) = 0 Vdc, contact closed, appropriate temperature (approximately +7 Vdc, contact open, temperature outside limits).



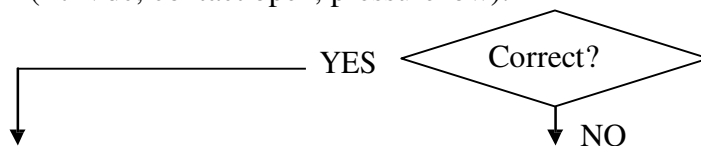
- ◆ Check the wiring between FIS1 and FIS2 on control board (63) and the thermostat located on the igbt dissipater (44).
- ◆ Replace thermostat or control board (63).
- ◆ Make sure the fan (9) is working properly (see par. 3.3.2).
- ◆ Make sure that air flows smoothly, and there is no dust or other impediments to cooling in the aeration tunnels.
- ◆ Make sure that the working conditions comply with the specified values, especially observing the “duty cycle”.
- ◆ Replace the control board (63).

### 3.4.2 - Led (D) lit = low gas pressure.

This alarm indicates that the gas pressure in torch is insufficient. This is automatically reset when the pressure returns within the allowed limits.

#### GAS PRESSURE TEST.

- Control board (63), connector CN1, terminals 3 (+) - 4 (-) = 0 Vdc, contact closed, pressure OK (+7 Vdc, contact open, pressure low).



- ◆ Check the wiring between CN1 control board (63) and compressor thermostat cables
- ◆ Check the power supply of compressor (6) on outputs 2-4-6 of the remote-control switch (4) with excited remote-control switch.
- ◆ Replace control board (63).

### **3.4.3 - Led (B) steadily lit = power source blocked.**

This indicator indicates that the power source is in a check process, in the first 5 seconds after closing the switch (58), or, thereafter, is blocked due to a hazardous condition.

To identify the cause seek out the possible error conditions among those described in the following chapters.

#### **- Phase missing in the power supply line of the power source.**

In special conditions, a missing phase will not stop the power source, but only cause operating problems such as an unstable pilot arc or failing to cut. In these cases, make sure the three phases of the power mains are properly connected, and check their voltage.

#### **- Incorrect supply voltage of the electronic boards (13.8 Vdc).**

If an unexpected value of the electronic boards power supply (13.8 Vdc) is detected, this control blocks the power source, with the red led (B) lit.

This voltage generated by U1 on igbt board (46) may be measured on J3, terminals 4 (+) and 5 (-).

Its rated value is 13.8 Vdc, and the alarm thresholds are: <12 Vdc, >17 Vdc

Proper operation is automatically restored when the voltage returns within the allowed limits for at least 3 seconds.

To test this alarm, perform the SERVICES POWER SUPPLY TEST, par. 3.3.1.

#### **- Start button pressed during power source start-up.**

See par. 3.3.4.

#### **- Contact of the reed bulb RL2 on secondary circuit board (70) closed upon power source start-up.**

#### **- Gas flows from the torch as soon as the power source is powered.**

If the reed contact RL2 on secondary board (70) is found closed upon start-up, the power source remains blocked, without delivering current and with the led (B) on.

To analyze the problem, carry out the TRANSFER ARC SWITCHING TEST, par. 3.3.9.



## **4 - COMPONENTS LIST**

### **4.1 - Power source art. 471 and 471.48**

### **4.2 - Table of components**

### **4.3 - List of spare parts.**

#### **Essential spare parts.**

<b>Ref.</b>	<b>Description</b>	<b>Qty.</b>
63	control board	1
10	filter board	1
60	panel board	1
70	secondary board	1
46	igbt board	1

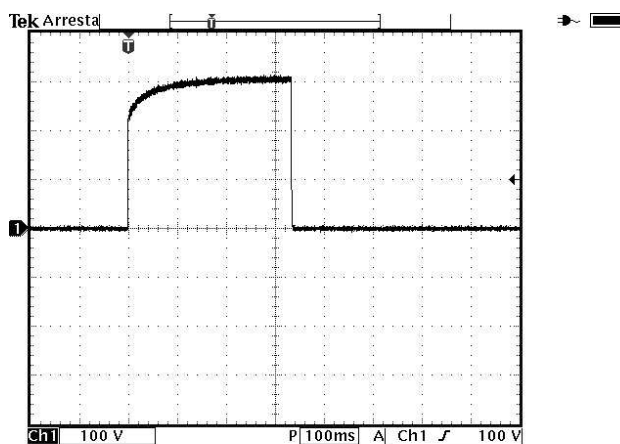
#### **Recommended spare parts.**

<b>Ref.</b>	<b>Description</b>	<b>Qty.</b>
09	fan	1
52	inductance	1
53	power transformer	1

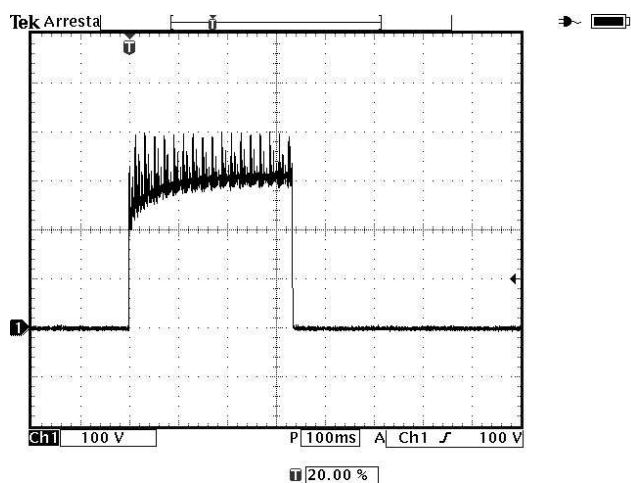
**5 - ELECTRICAL DIAGRAMS**

**5.1 - Power source art. 471 and 471.48**

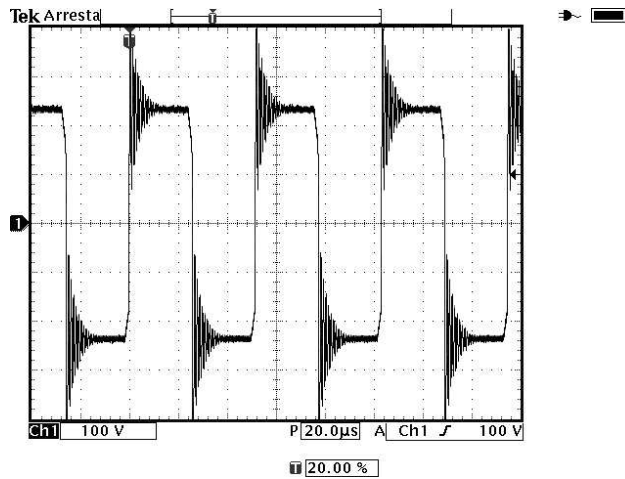
**5.2 - Waveforms.**



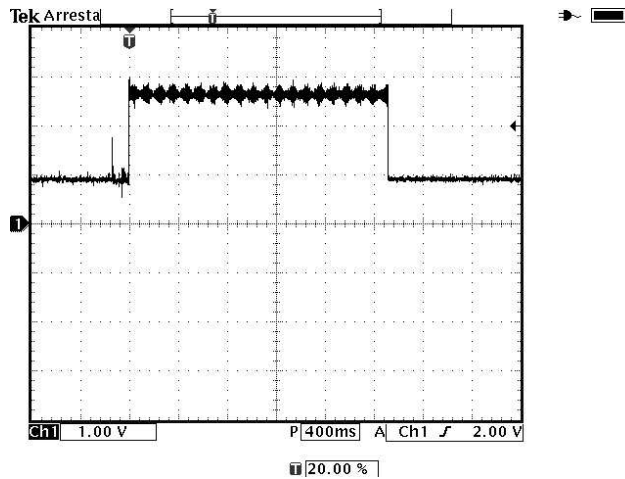
**5.2.1 - Open-circuit output voltage, interrupted after approximately 300 msec. for missing pilot arc current (par. 3.3.6, 3.3.8).**



**5.2.2 - Open-circuit rectifier output voltage, interrupted after approximately 300 msec., for missing pilot arc current (par. 3.3.7).**



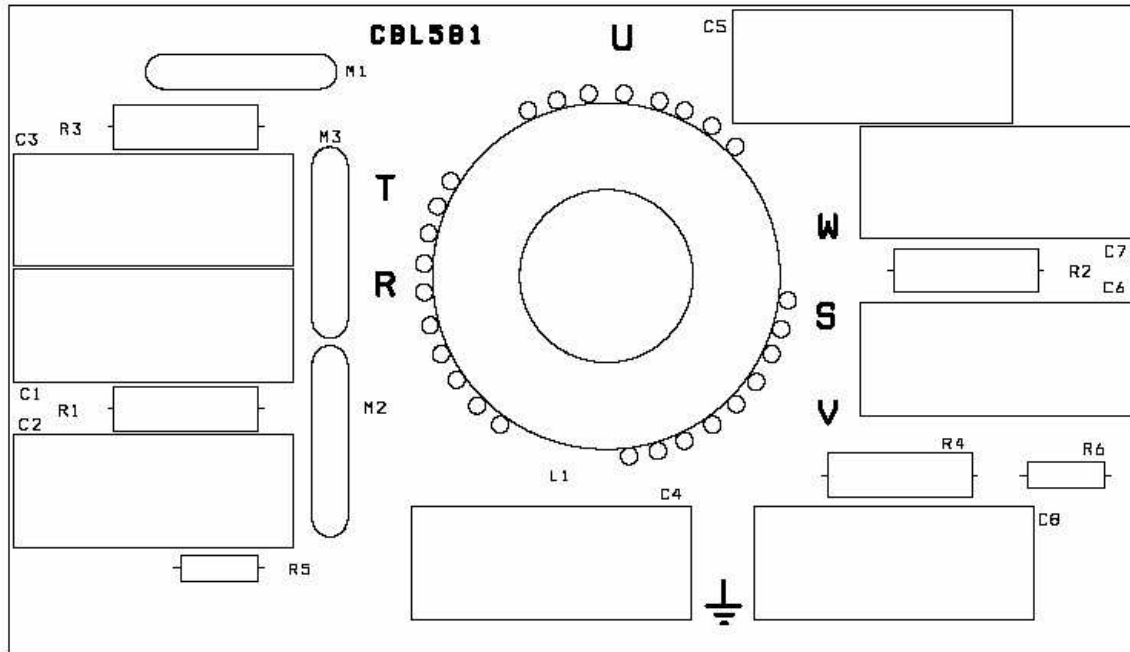
5.2.3 - Open-circuit inverter output voltage, interrupted after approximately 300 msec. for missing pilot arc current (par. 3.3.7).



5.2.4 - Pilot arc current signal for its maximum time, approximately 2 sec., with the torch free in the air and thus without transfer arc (par. 3.3.8).

## 5.3 - Filter board (10)

### 5.3.1 - Topographical drawing.

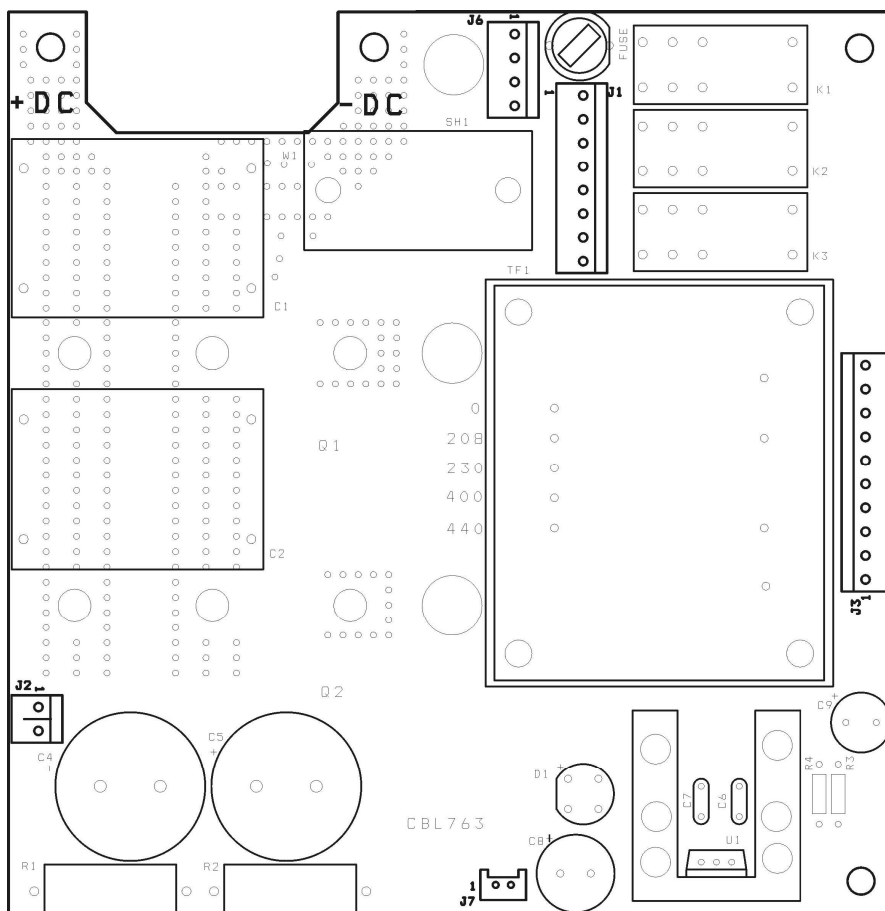


### 5.3.2 - Connector table.

Conn.	Terminals	Function
-	R-S-T	three-phase mains voltage input.
-	U-V-W	three-phase mains voltage output.

## 5.4 - IGBT board (46)

### 5.4.1 - Topographical drawing.

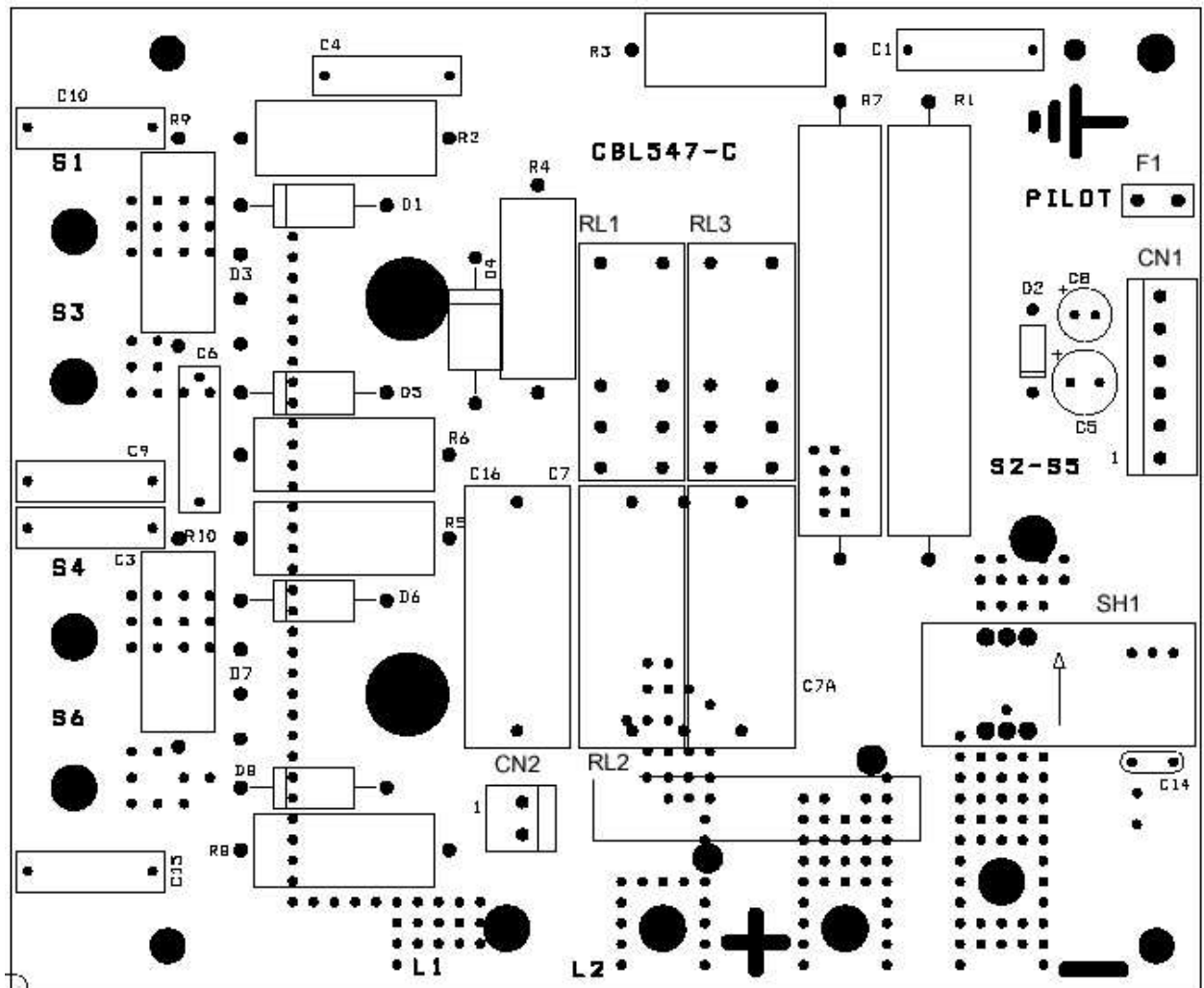


### 5.4.2 - Connector table.

Connector	Terminals	Function
-	Q1 - Q2	output for transformer (53) primary winding.
-	"+" - "-"	direct current input 560 Vdc, approximately for inverter power supply
J1	2 - 6	output for fan (9).
J1	1 - 7	output for remote-control switch coil (6).
J1	4 - 5	NU
J2	1 - 2	connection to current limiting resistors for the DC capacitors.
J3	1	+25 Vdc on boards relay power supply output.
J3	2	NU
J3	3	NU
J3	4	+13,8 Vdc boards power supply.
J3	5	0 Vdc boards power supply.
J3	6	"enable" signal output.
J3	7	NU
J3	8	Remote-control switch coil (6) command input.
J3	9	NU
J3	10	NU
J6	1 - 4	400V power supply input
J7	1(+) - 2(-)	25 Vdc on panel board (60) start button circuit power supply output.

5.5 - Secondary board (70)

5.5.1 - Topographical drawing.

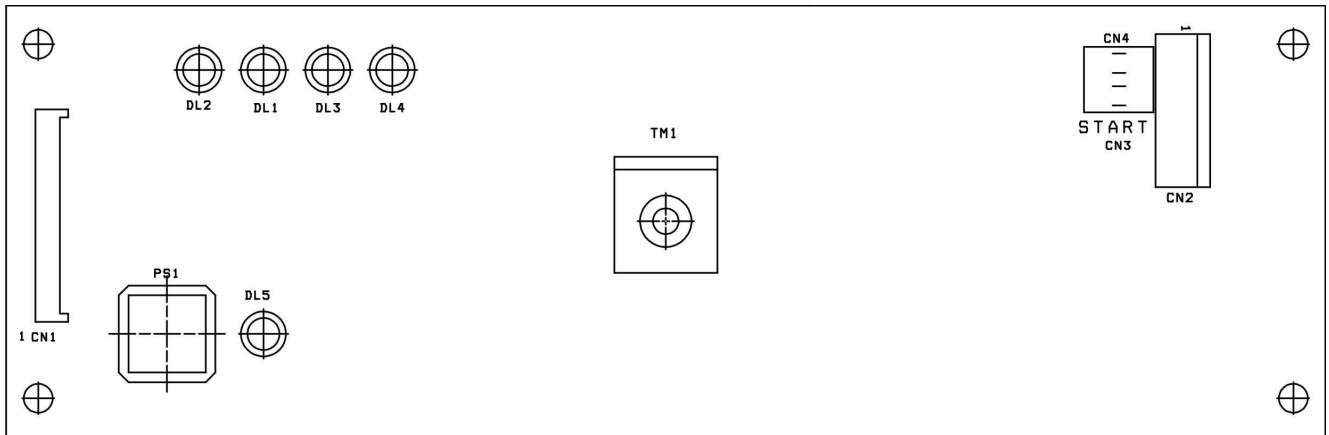


5.5.2 - Connector table.

Connector	Terminals	Function
CN1	1(+)- 3(-)	13.8 Vdc power supply input for power source output current transducer.
CN1	2	power source output current signal output.
CN1	4(+)- 5(-)	25 Vdc power supply input for pilot arc/transfer arc switching relay.
CN1	6	pilot arc/transfer arc signal output from reed RL2.
CN2	1 - 2	connection to secondary circuit rectifier load resistors.
-	L1 - L2	output current leveling choke (52) connection.
-	S2 - S1	transformer (53) secondary winding 1 connection.
-	S2 - S3	transformer (53) secondary winding 2 connection.
-	S5 - S4	transformer (53) secondary winding 3 connection.
-	S5 - S6	transformer (53) secondary winding 4 connection.
-	"-"	output - secondary board (70) (electrode potential).
-	"+"	output + secondary board (70) (potential of the workpiece, earth).
-	F1	output + secondary board (70) (nozzle potential).

## 5.6 - Panel board (60)

### 5.6.1 - Topographical drawing.

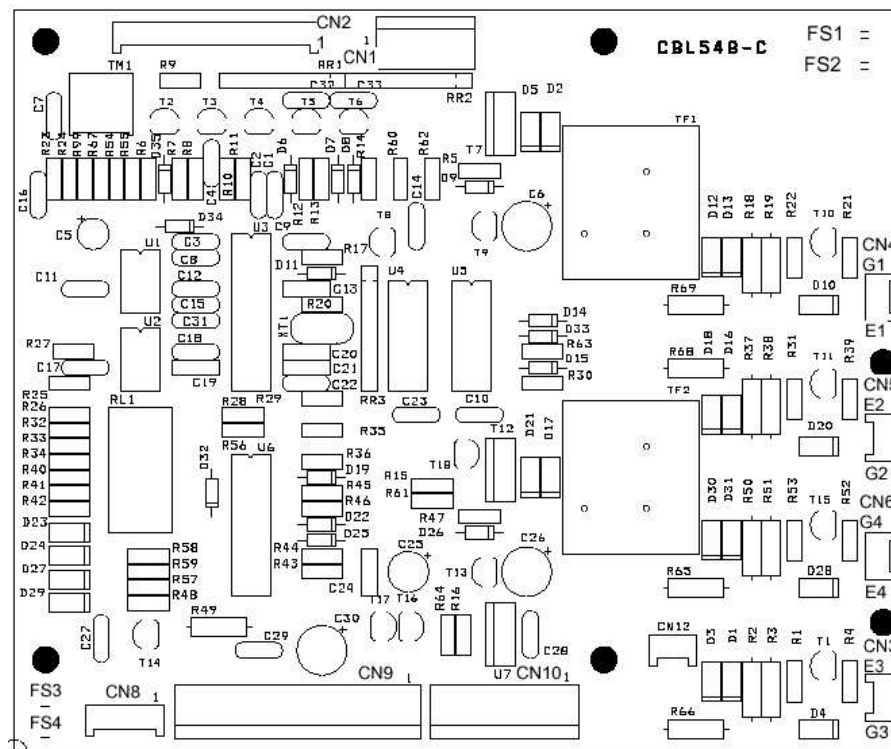


### 5.6.2 - Connector table.

Connector	Terminals	Function
CN1	1(+) - 10(-)	5 Vdc panel board (60) power supply input.
CN1	2(+) - 4(-)	cutting current potentiometer power supply input.
CN1	3	“cutting current reference” signal output from potentiometer cursor.
CN1	5	“pressure low” signal input.
CN1	6	“temperature high” signal input.
CN1	7	“grid/continuous” signal input and output from self-restart pilot button.
CN1	8	“power source blocked” signal input.
CN1	11 - 12	“start” command output for control board(63).
CN2	1-3-5-6	NU
CN2	2 - 4	“torch recognition” signal input.
-	CN3 - CN4	“start” signal input from torch button.
CN8	1(+) - 2(-)	35 Vdc power supply input for start button circuit on panel board (60).

## 5.7 - Control board (63)

### 5.7.1 - Topographical drawing.

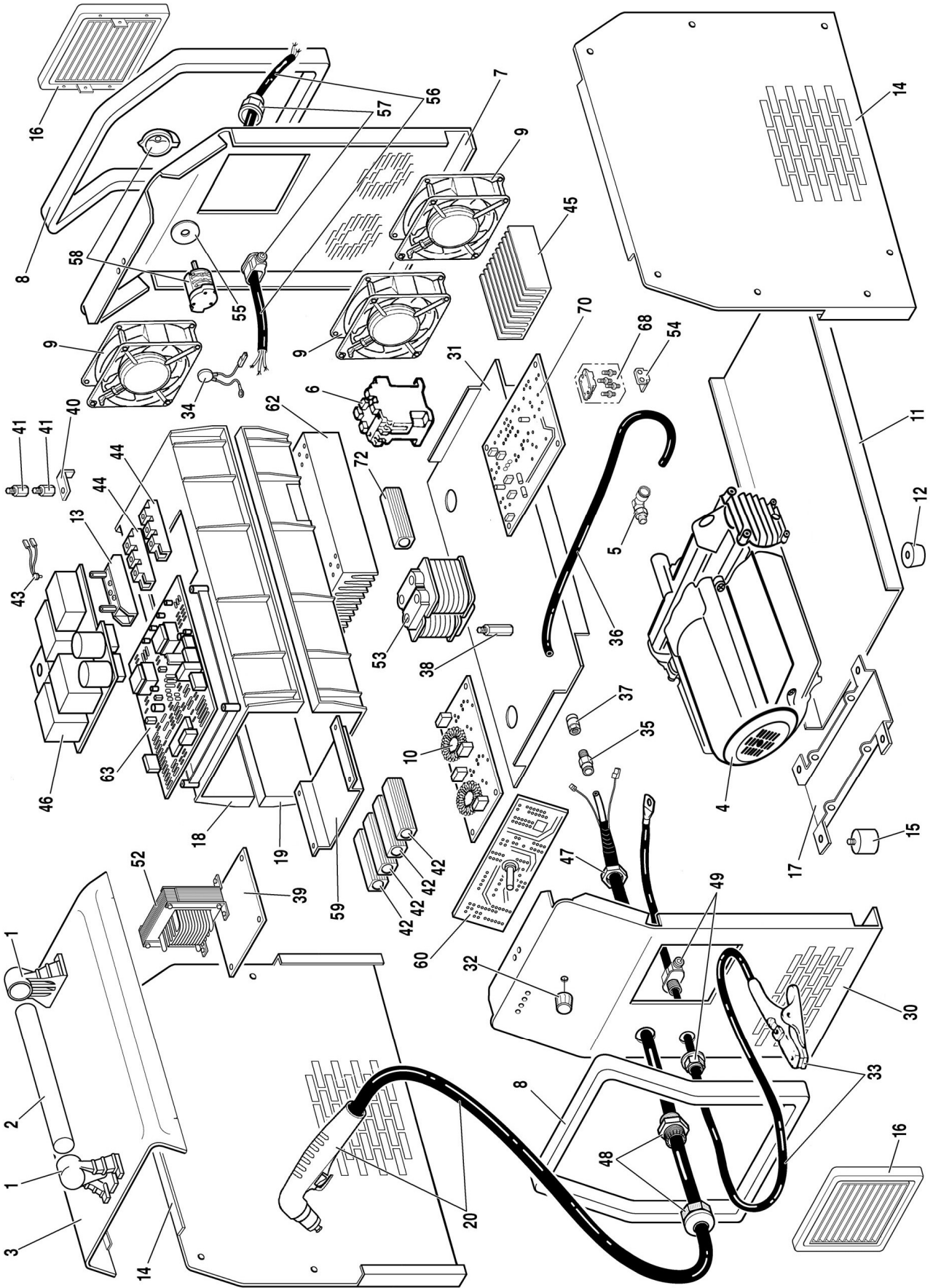


### 5.7.2 - Connector table.

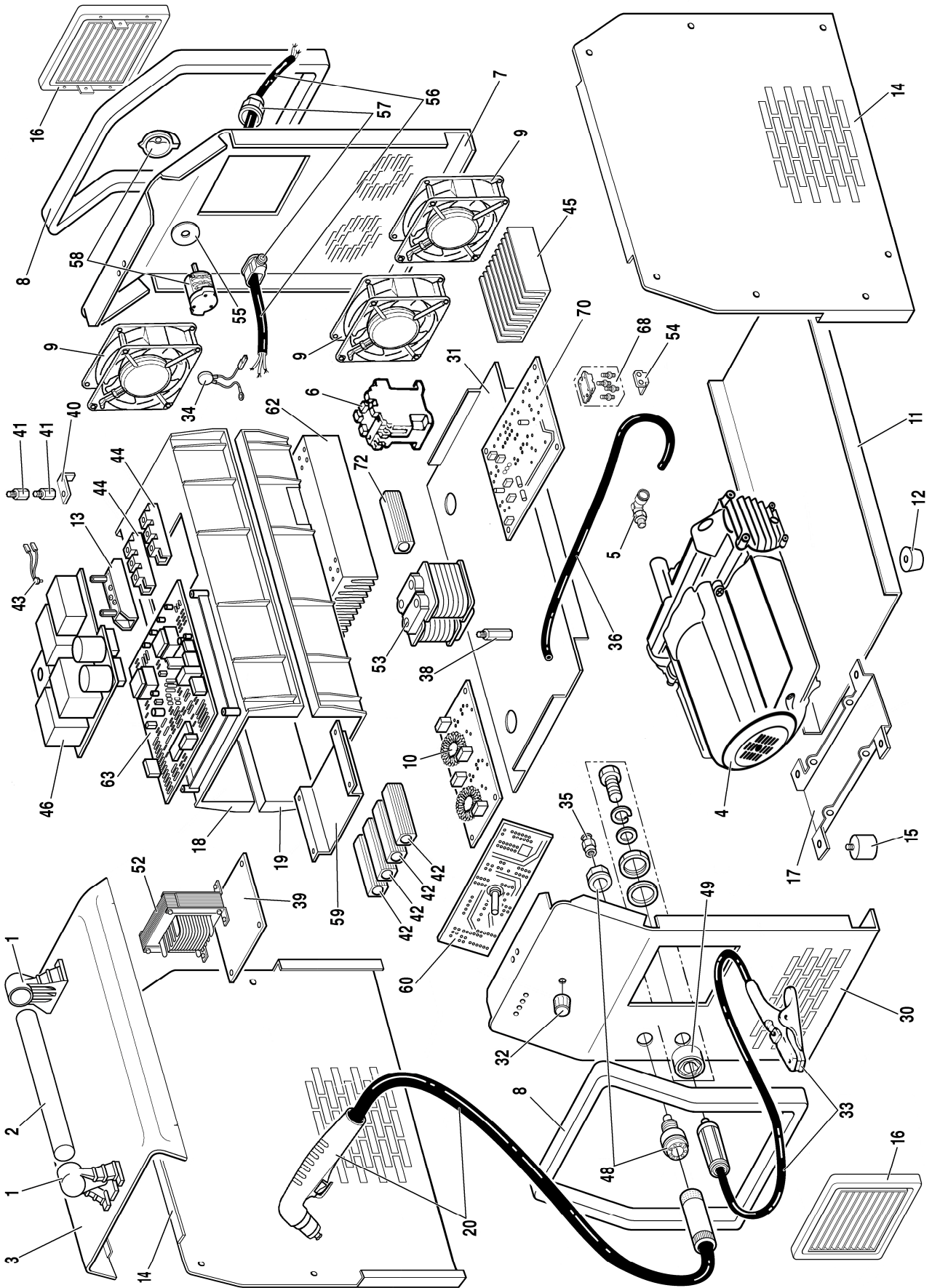
Conn.	Terminals	Function
CN1	1 - 2	input compressor thermostat
CN1	3 - 4	NU.
CN2	1(+) - 10(-)	5 Vdc panel board (60) power supply output.
CN2	2(+) - 4(-)	cutting current potentiometer power supply output.
CN2	3	“cutting current reference” signal input from potentiometer cursor.
CN2	5	“pressure low” signal output.
CN2	6	“temperature high” signal output.
CN2	7	“grid/continuous” signal output and input from self-restart pilot button.
CN2	8	“power source blocked” signal output.
CN2	11 - 12	“start” command input.
CN3	1(G) - 2(E)	command output for gate igbt3.
CN4	1(G) - 2(E)	command output for gate igbt1
CN5	1(G) - 2(E)	command output for gate igbt2
CN6	1(G) - 2(E)	command output for gate igbt4.
CN8	1 - 4	NU
CN8	2 - 3	NU
CN9	1	+25 Vdc on boards relay power supply input.
CN9	2	NU
CN9	3	NU
CN9	4	+13.8 Vdc boards power supply input.
CN9	5	0 Vdc boards power supply input.
CN9	6	“enable” signal input.
CN9	7	NU
CN9	8	Remote control switch coil (6) command output.
CN9	9	NU
CN9	10	NU
CN10	1(+) - 3(-)	13.8 Vdc power supply output for power source output current transducer.
CN10	2	power source output current signal input.
CN10	4(+) - 5(-)	25 Vdc power supply output for pilot arc/transfer arc switching relay.
CN10	6	pilot arc/transfer arc signal input from reed RL2.
-	FIS1 - FIS2	input from thermostat on igbt (44) dissipater.
-	FIS3 - FIS4	transformer (53) primary winding current signal input, from TA SH1 on igbt board (46).



Art./Item 471

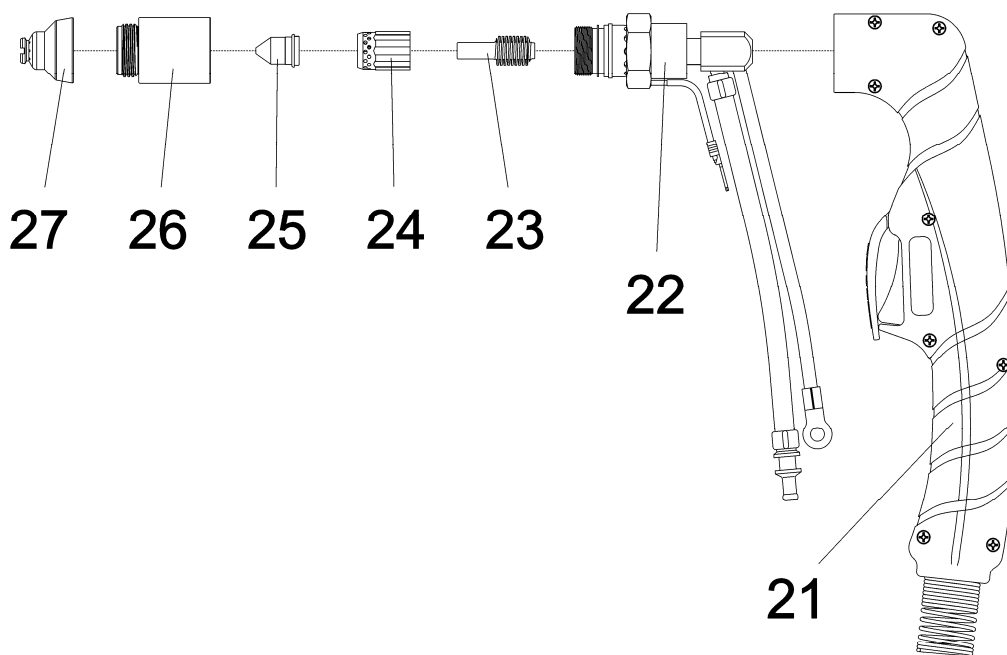


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POS.	DESCRIZIONE	DESCRIPTION	STÜCKLISTE	DESIGNATION	DENOMINACIÓN	DESCRIÇÃO
1	SUPPORTO MANICO	HANDLE HOLDER	GRIFF HALTER	SUPPORT MANCHE	SOPORTE MANIJA	SUPORTE PEGA
2	MANICO	HANDLE	GRIFF	MANCHE	MANGO	PEGA
3	TETTUCCIO	TOP PANEL	OBERE PLATTE	PANNEAU SUPERIEUR	PANEL SUPERIOR	PAINEL SUPERIOR
4	COMPRESSORE	COMPRESSOR	KOMPRESSOR	COMPRESSEUR	COMPRESOR	COMPRESSOR
5	RACCORDO	FITTING	ANSCHLUSS	RACCORD	EMPALME	ACOPLAMENTO
6	TELERUTTORE	REMOTE CONTROL SWITCH	STEUERSCHÜTZ	TELERUPTEUR	TELERUPTOR	TELERRUPTOR
7	PANNELLO POSTERIORE	BACK PANEL	RÜCKWAND	PANNEAU ARRIERE	PANEL POSTERIOR	PAINEL POSTERIOR
8	CORNICE	FRAME	RAHMEN	CADRE	MARCO	CAIXILHO
9	VENTILATORE	FAN	VENTILATOR	VENTILATEUR	VENTILADOR	VENTAROLA
10	CIRCUITO FILTRO/SERVIZI	AUXILIARY/FILTER CIRCUIT	HILF/FILTERPLATINE	CIRCUIT AUXILIAIRE/FILTRE	CIRCUITO DE SERVICIO/FILTRO	CIRCUITO DE SERVIÇO/FILTRO
11	FONDO	BOTTOM	BODENBLECH	FOND	FONDO	BASE
12	PIEDINO	SUPPORT	HALTERUNG	SUPPORT	SOPORTE	SUPORTE
13	RADDRIZZATORE	RECTIFIER	GLEICHRICHTER	REDRESSEUR	RECTIFICADOR	RECTIFICADOR
14	FASCIONE LATERALE	SIDE PANEL	SEITENWAND	PANNEAU LATERAL	PANEL LATERAL	PAINEL LATERAL
15	SUPPORTO ANTIVIBRANTE	SHOCK ABSORBER	ANTIVIBRATIONSPUFFER	TAMPON ANTI-VIBRATIONS	APOYO ANTIVIBRACIÓN	APOIO ANTI-VIBRAÇÃO
16	GRIGLIA	GRID	GITTER	GRILLE	REJILLA	GRELHA
17	SUPPORTO COMPRESSORE	COMPRESSOR HOLDER	KOMPRESSORTRÄGER	SUPPORT COMPRESSEUR	SOPORTE COMPRESOR	SUPORTE COMPRESSOR
18	SEMICANALE SUPERIORE	TOP HALF DUCT	OBERE TUNNELHÄLFTE	DEMI-CANAL SUPERIEUR	SEMICONDUCTO SUPERIOR	SEMICANAL SUPERIOR
19	SEMICANALE INFERIORE	LOWER HALF DUCT	UNTERE TUNNELHÄLFTE	DEMI-CANAL INFÉRIEUR	SEMICONDUCTO INFÉRIOR	SEMICANAL INFÉRIOR
20	TORCIA COMPLETA	COMPLETE TORCH	BRENNER	TORCHE COMPLETE	ANTORCHA COMPLETA	TOCHA COMPLETA
21	IMPUGNATURA	HANDGRIP	GRIFF	POIGNEE	EMPUÑADURA	EMPUNHADURA
22	TESTINA	HEAD	BRENNERKOPF	TETE	CABEZA	CABEÇA
23	ELETTRODO	ELECTRODE	ELEKTRODE	ELECTRODE	ELECTRODO	ELÉCTRODO
24	DIFFUSORE ISOLANTE	INSULATING DIFFUSOR	ISOLIERENDER DIFFUSOR	DIFFUSEUR ISOLANT	DIFUSOR AISLANTE	DIFUSOR ISOLADOR
25	UGELLO	NOZZLE	DÜSE	BUSE	INJECTOR	INJECTOR
26	PORTAUGELLO	NOZZLE HOLDER	DÜSENHALTER	PORTE-BUSE	PORTA - INJECTOR	PORTA INJECTOR
27	DIFFUSORE IN OTTONE	BRASS DIFFUSOR	MESSINGDIFFUSOR	DIFFUSEUR EN LAITON	DIFUSOR DE LATÓN	DIFUSOR EM LATÃO
30	PANNELLO ANTERIORE	FRONT PANEL	VORDERWAND	PANNEAU AVANT	PANEL ANTERIOR	PAINEL ANTERIOR
31	INTERMEDIO	INTERMEDIATE PANEL	ZWISCHENPLATTE	PANNEAU INTERMEDIAIRE	PANEL INTERMEDIO	PAINEL INTERMEDIO
32	MANOPOLA	KNOB	DREHKNOPF	BOUTON	MANOPLA	BOTÃO
33	CAVO MASSA	EARTH CABLE	MASSEKABEL	CABLE DE TERRE	CABLE MASA	CABO MASSA
34	FILTRO	FILTER	FILTER	FILTRE	FILTRO	FILTRO
35	RACCORDO	CONNECTOR	VERBINDUNGSSTÜCK	RACCORD	EMPALME	LIGAÇÃO
36	TUBO TEFLON	TEFLON TUBE	TEFLONROHR	TUBE TEFLON	TUBO TEFLON	TUBO TEFLON
37	RACCORDO	JOINT	VERBINDUNGSSTÜCK	ACCOUPEMENT	UNIÓN	ACOPLAMENTO
38	DISTANZIALE	SPACER	DISTANZSTÜCK	ENTRETOISE	DISTÁNCIALE	ESPAÇADOR
39	ISOLANTE	INSULATOR	ISOLATOR	ISOLANT	AISLANTE	ISOLADOR
40	SUPPORTO	HOLDER	HALTER	SUPPORT	SOPORTE	SUPORTE
41	DISTANZIALE	SPACER	DISTANZSTÜCK	ENTRETOISE	DISTÁNCIALE	ESPAÇADOR
42	RESISTENZA	RESISTANCE	WIDERSTAND	RESISTANCE	RESISTENCIA	RESISTÊNCIA
43	TERMOSTATO	THERMOSTAT	THERMOSTAT	THERMOSTAT	TERMOSTATO	TERMÓSTATO

POS.	DESCRIZIONE	DESCRIPTION	STÜCKLISTE	DESIGNATION	DENOMINACIÓN	DESCRIÇÃO
44	IGBT	IGBT	IGBT	IGBT	IGBT	IGBT
45	DISSIPATORE	DISSIPATOR	VERZEHRER	DISSIPATEUR	DISIPADOR	DISPERSADOR
46	CIRCUITO IGBT	IGBT CIRCUIT	IGBT-KREIS	CIRCUIT IGBT	CIRCUITO IGBT	CIRCUITO IGBT
47	GHIERA	RING NUT	GEWINDERING	COLLIER	ABRAZADERA	VIROLA
48 art.471	PRESSACAVO	STRAIN RELIEF	ZUGENLASTUNG	SERRE-CABLE	PRENSA - CABLE	FIXADOR DO CABO
48 art.471.48	ADATTATORE FISSO	FIXED ADAPTER	ZENTRALANSCHLUSS	ADAPTATEUR FIXE	ADAPTADOR FIJO	ADAPTADOR FIXO
49	BLOCCACAVO	CABEL LOCK	KABELSCHLOSS	SERRURE DE CABLE	BLOQUEO DE CABLE	FECHO DO CABO
52	IMPEDENZA	IMPEDANCE	DROSSEL	IMPEDANCE	IMPEDANCIA	IMPEDIMENTO
53	TRASFORMATORE DI POTENZA	POWER TRANSFORMER	LEISTUNG-TRASFORMATOR	TRANSFORMATEUR PUISSANCE	TRANSFORMADOR DE POTENCIA	TRANSFORMADOR DE POTÊNCIA
54	CAVALLOTTO	JUMPER	BRÜCKE	BARRE EN FORME DE "U"	EMPALME EN FORMA DE "U"	UNIÃO EM "U"
55	PROTEZIONE	PROTECTION	SCHUTZ	PROTECTION	PROTECCIÓN	PROTECÇÃO
56	CAVO RETE	MAINS INPUT CABLE	NETZ-ANSCHLUSSLEITUNG	CABLE - RESEAU	CABLE RED	CABO DE ALIMENTAÇÃO
57	PRESSACAVO	STRAIN RELIEF	ZUGENLASTUNG	SERRE-CABLE	PRENSA - CABLE	FIXADOR DO CABO ELÉCTRICO
58	INTERRUPTORE	SWITCH	SCHALTER	INTERRUPTEUR	INTERRUPTOR	INTERRUPTOR
59	SUPPORTO RESISTENZE	RESISTANCE HOLDER	WIDERSTAND HALTER	PORTE RESISTANCE	SOPORTE RESISTENCIA	SUPORTE RESISTÊNCIA
60	CIRCUITO PANNELLO	PANEL BOARD	WANDPLATINE	CIRCUIT PANNEAU	CIRCUITO PANEL	CIRCUITO PAINEL
62	DISSIPATORE	DISSIPATOR	VERZEHRER	DISSIPATEUR	DISIPADOR	DISPERSADOR
63	CIRCUITO DI CONTROLLO	CONTROL CIRCUIT	STEUERPLATINE	CIRCUIT DE CONTROLE	CIRCUITO DE CONTROL	CIRCUITO DE CONTROLO
68	DIODO	DIODE	DIODE	DIODE	DIODO	DÍODO
70	CIRCUITO SECONDARIO	SECONDARY CIRCUIT	SEKUNDÄRKREIS-PLATINE	CIRCUIT SECONDAIRE	CIRCUITO SECUNDARIO	CIRCUITO SECUNDÁRIO
72	RESISTENZA	RESISTANCE	WIDERSTAND	RESISTANCE	RESISTENCIA	RESISTÊNCIA



	<b>Codifica colori cablaggio elettrico</b>	<b>Wiring diagram colour code</b>	<b>Farben-Codierung elektrische Schaltplan</b>	<b>Codification couleurs schéma électrique</b>	<b>Codificación colores cableado eléctrico</b>	<b>Codificação cores conjunto eléctrico de cabos</b>
<b>A</b>	Nero	Black	Schwarz	Noir	Negro	Negro
<b>B</b>	Rosso	Red	Rot	Rouge	Rojo	Vermelho
<b>C</b>	Grigio	Grey	Grau	Gris	Gris	Cinzento
<b>D</b>	Bianco	White	Weiss	Blanc	Blanco	Branco
<b>E</b>	Verde	Green	Gruen	Vert	Verde	Verde
<b>F</b>	Viola	Purple	Violett	Violet	Violeta	Violeta
<b>G</b>	Giallo	Yellow	Gelb	Jaune	Amarillo	Amarelo
<b>H</b>	Blu	Blue	Blau	Bleu	Azul	Azul
<b>K</b>	Marrone	Brown	Braun	Marron	Marron	Castanho
<b>J</b>	Arancione	Orange	Orange	Orange	Nardnja	Alaranjado
<b>I</b>	Rosa	Pink	Rosa	Rose	Rosa	Rosa
<b>L</b>	Rosa-nero	Pink-black	Rosa-schwarz	Rose-noir	Rosa-negro	Rosa-negro
<b>M</b>	Grigio-viola	Grey-purple	Grau-violett	Gris-violet	Gris-violeta	Cinzento-violeta
<b>N</b>	Bianco-viola	White-purple	Weiss-violett	Blanc-violet	Blanco-violeta	Branco-violeta
<b>O</b>	Bianco-nero	White-black	Weiss-schwarz	Blanc-noir	Blanco-negro	Branco-negro
<b>P</b>	Grigio-blu	Grey-blue	Grau-blau	Gris-bleu	Gris-azul	Cinzento-azul
<b>Q</b>	Bianco-rosso	White-red	Weiss-rot	Blanc-rouge	Blanco-rojo	Branco-vermelho
<b>R</b>	Grigio-rosso	Grey-red	Grau-rot	Gris-rouge	Gris-rojo	Cinzento-vermelho
<b>S</b>	Bianco-blu	White-blue	Weiss-blau	Blanc-bleu	Blanco-azul	Branco-azul
<b>T</b>	Nero-blu	Black-blue	Schwarz-blau	Noir-bleu	Negro-azul	Negro-azul
<b>U</b>	Giallo-verde	Yellow-green	Gelb-gruen	Jaune-vert	Amarillo-verde	Amarelo-verde