MANUAL BOOK

WP 40 A

DC INVERTER AIR PLASMA
CUTTING MACHINE

ANUGRAH DUTA NIAGA

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1-GENERAL REMARKS

1-1 Cutting machine features

This CUT series inverter air plasma cutter is kind of energy-saving metal cutting equipment with high efficiency and light weight, adopts single tube IGBT HF inverter and advanced control technology. Its advantages are fast speed, narrow & clean cut, small heat-affected zone, slightly deforming, material-saving, low cost, simple operation and so on. These cutterspossess good static and dynamic characteristics, perfect control function, and high-frequencyarc starting function. The characteristics are as follows:

- Single phase power supply, small size, light weight and easy to operate;
- Air filter pressure-reducing valve is built-in type, portable and easy to use;
- Highly centralized arc energy, good stability, strong cutting ability;
- Fast cutting speed (3~5 times of gas cutting), low cost;
- Narrow, burnished, clean and almost vertical cutting edge;
- Less work piece deformation;
- Continuous adjustment of cutting current;
- HF arc ignition, easy arc starting;
- Strong power grid adaptability and low noise;
- Multiple patented technology, high reliability and durability.1-2 Functional

principle

This series of cutting machines adopts HF inverter technology. 1- phase input volt is rectified by rectifier, inverted by inverter composed of single tube IGBT into HF AC, reduced by HF transformer, rectified and filtered by HF rectifier, then output DC power suitable for cutting. This progress increases the dynamic response capability, reduces the weight and the size of the transformer and the reactor, improves the efficiency of the machine, realizes energy-saving.

The special design of control circuit makes the machines enjoy high cutting performance despite of changes like power grid voltage fluctuation, cutting cable length. Features include easy arc starting, narrow, burnished and clean cutting edge, and continuously adjustable cutting current.

Schematic diagram is shown in Fig. 1-2-1:

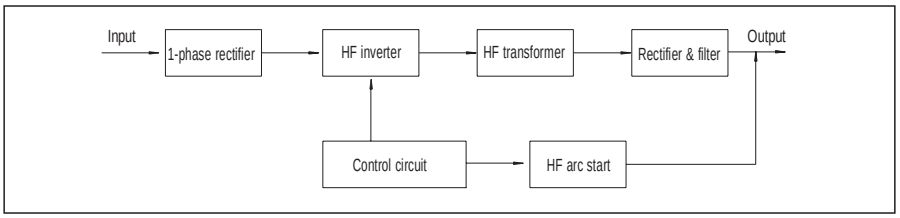


Fig. 1-2-1: Schematic diagram

1-3 Output characteristics

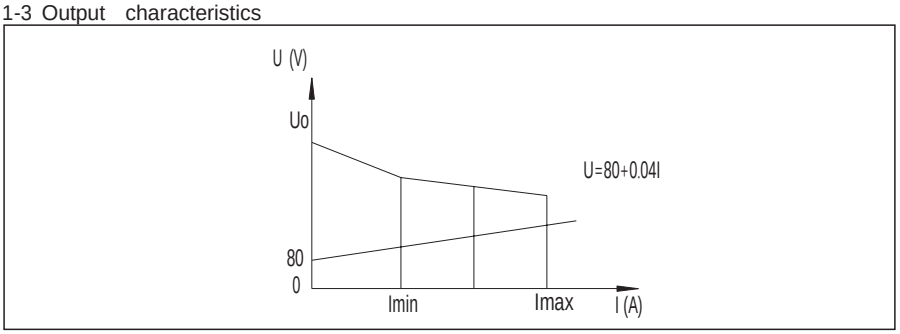


Fig.1-3-1: Output characteristics

1-4 Duty cycle

Duty cycle is percentage of 10 minutes that a machine can weld at rated load without overheating. If overheats, thermostat(s) will close, output stops. Wait for fifteen minutes for themachine to cool down. Reduce amperage or duty cycle before welding.

NOTE! Exceeding duty cycle can damage unit and void warranty.

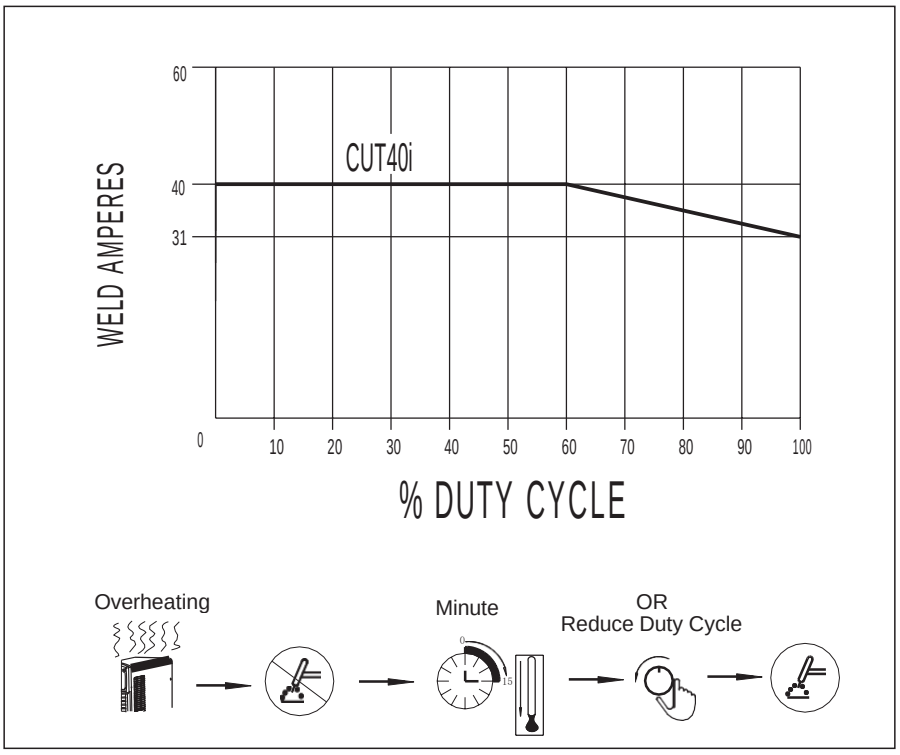


Fig. 1-4-1: Duty cycle

1-5 Applications

It can cut stainless steel, carbon steel, alloy steel, aluminum, copper, nickel and titanium.

The cutting machine is designed for the following recommend areas:
- Maintenance and repair
- Steel construction
- Metal shop
- Office furniture supplies
- Daily civil occasions

1-6 Warning label

The warning label is affixed onto the top of the cutting machine, and it must not be removed or painted over.

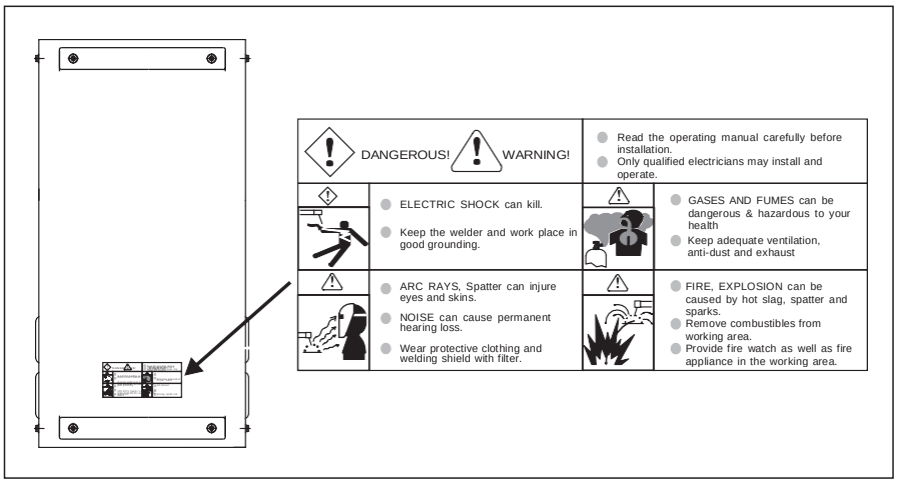


Fig. 1-6-1: Warning label

2- VERSIONS BRIEFS

Professional cutting of special materials requires special cutting parameters. Different models of the power sources are matched to different cutting.

CUT40i
This series of cutting machine is small, light and portable. Adopt single tube IGBT HF inverter technology, can perform fast speed cutting with clean and almost vertical cutting edge.

3 - BEFORE COMMISSIONING

Warning! Operating the equipment incorrectly can cause serious injury and damage. Do not use the machine until you have read "Safety rules".

3-1 Utilization for intended purpose only

The cutting machine may only be used for cutting. Utilization for any other purpose, or in any other manner, shall be deemed to be “not in accordance with the intended purpose”. The manufacturer shall not be liable for any damage resulting from such improper use.

Utilisation in accordance with the “intended purpose” also comprises:
-following all the instructions given in this manual;
-performing all stipulated inspection and servicing work.

3-2 Machines set-up regulations

According to test, protection degree of this power source is IP23S. However, the internal key components must be protected from direct soaking.

Warning! A machine that topples over or falls from its stand can easily kill someone. Place machine on an even, firm floor in such a way that it stands firmly.

The venting duct is a very important safety feature. When choosing the machine location, make sure it is possible for the cooling air to enter and exit unhindered through the louvers on the front and back of machine. Any electroconductive metallic dust from e.g. grinding-work must not be allowed to get sucked into the machine.

3-3 Cutting machine connection

- The cutting machine is designed to run on the mains voltage given on nameplate.
- The mains cables and plugs must be mounted in accordance with the relevant technical standard.
- The power supply socket come with power source is designed to use strictly according to the marked voltage.

Note! Incorrect electrical installations can lead to protection fails or partial fails. The mains plug and socket, and its fuse protection, must be suitable for local power suppl

4- CUT40i

4-1 System components

This series of cutter can be equipped with many different accessories and can be used in various sites with different configurations. (Refer to Fig. 4-1-1)

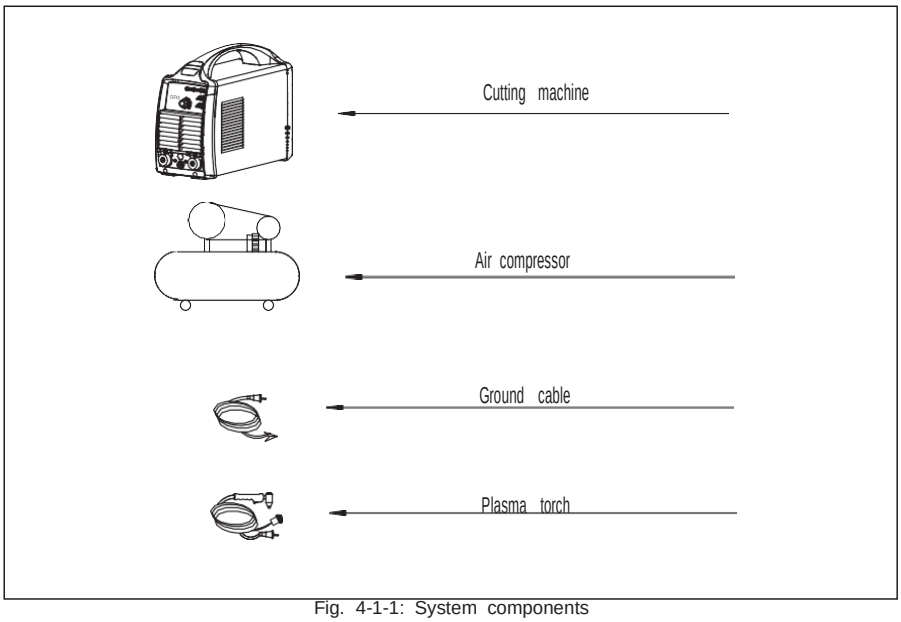


Fig. 4-1-1: System components

4-2 Basic equipments for cutting

Basic equipments are needed for normal cutting. Below are the lists:

CUT
- Cutting machine
- Ground cable
- Plasma torch
- Air compressor

4-3 Interface

The functions on the control panel are all arranged in a very logical way. The various parameters needed for cutting are easy to select by pressing the appropriate button. (Refer to Fig. 4-3-1)

Note! Your machine has certain functions that are not in accordance with this operating manual, or vice versa. Also, certain illustrations may be slightly different from the actual controls on your machine. However, these controls function in exactly the same way.

Warning! Operating the equipment incorrectly can cause series injury and damage. Do not use the functions described here until you have read and completely understood this operating manual.

Front panel

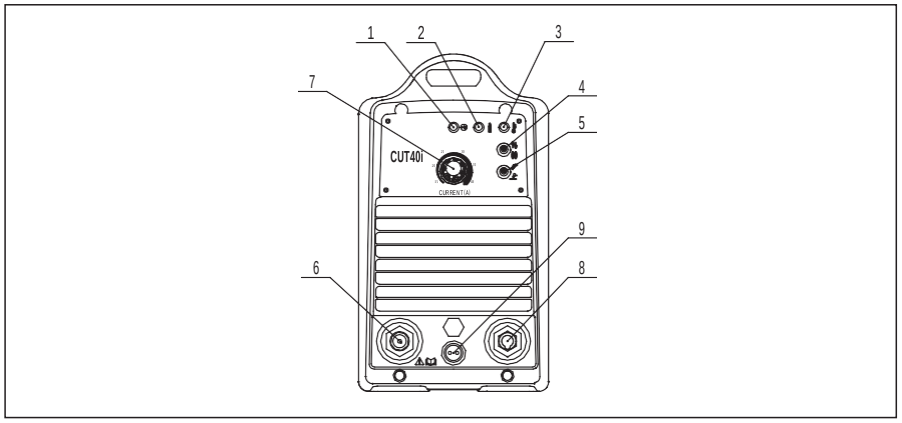


Fig. 4-3-1: Front panel

1. Power on indicator
It is green light, indicates whether cutting machine is connected well to power supply. It lights up when power on.
2. Gas pressure indicator
It is yellow light, does not light up during normal cutting; when input gas pressure of cutting machine is lower than 0.35MPa, cutting machine will stop working automatically, protection indicator lights up.
3. Over heat/fan locked-rotor protection indicator
It is yellow light, does not light up when cutting machine works normal. It lights up when inner temperature is too high or fan is locked-rotor, and cutting machine will stop work automatically.
4. 2 step/4 step switch
On 2 step mode, press torch trigger to start cut, release to stop, suit for short cut seam. On 4 step mode, can release torch trigger to perform cut after pressing torch trigger and starting arc, re-press and release torch trigger to stop cutting, suit for long cut seam.
5. Gas test/cut switch
On gas test mode, check whether gas circuit is normal. On cut mode, start normal cut.
6. Protective cover of negative output terminal and gas-electric connector (-)
Connect gas-electric connector of cutting torch.
7. Current adjustment knob
For regulating the cutting current.
8. Protective cover of positive output terminal and ground cable quick socket (+)
Connect with work piece via ground cable.
9. Control socket
Connect with control connector of cutting torch.

Rear panel

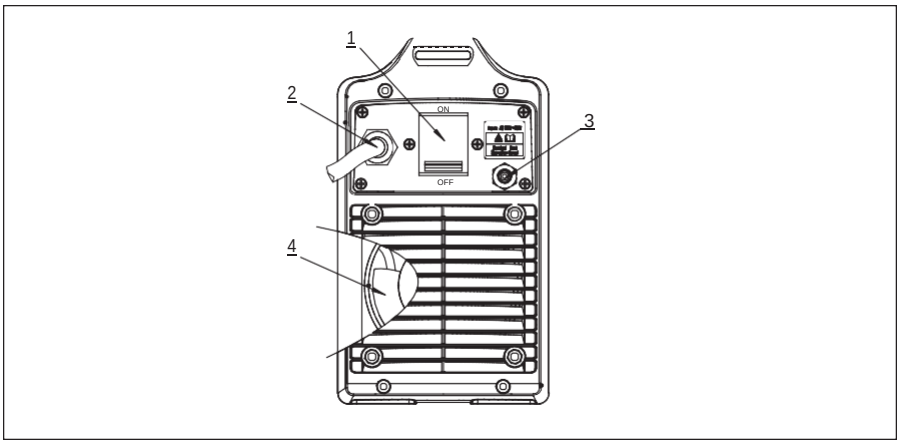


Fig. 4-3-2: Rear panel

1. Circuit breaker
Switch for single-phase AC220V±15% power. Turn on this switch (on the position: “ON”), then the power on indicator lights up, and the fan runs.
2. Power supply cable
Three pin wires, the mixed-colored wire must be firmly grounded; the rest 2 wires connect to 1- phase AC 220V±15% 50/60Hz power supply.
3. Gas inlet
Connect with compress gas source by gas hose.
4. Fan
Cool down the heat components in the cutting machine.

4-4 Connections

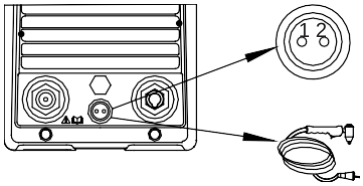
Control socket 	Socket Pin	Description
	1, 2	Torch trigger

Table 4-4-1: Connections

Output socket
The output socket of this cutting machine is fast plug-in type.

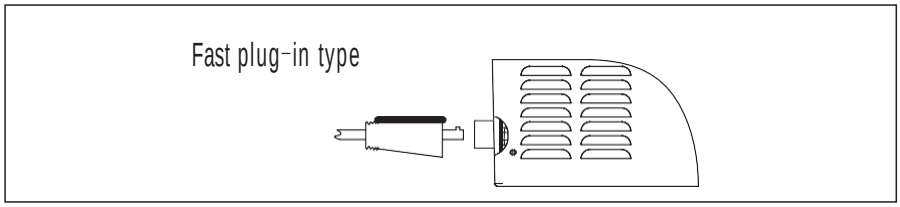


Fig. 4-4-1: Output socket

4-5 Installation and operation

Warning! An electric shock can be fatal. If the machine is plugged into the mains electricity supply during installation, there is high risk of very serious injury and damage. Do not use the functions described here until you have read and completely understood “Safety Rules” in the beginning. Only carry out work on the machine when
- the mains switch is in turn-off position,
- the machine is unplugged from the mains.

CUT40i cutting machine wire diagram as Fig. 4-5-1:

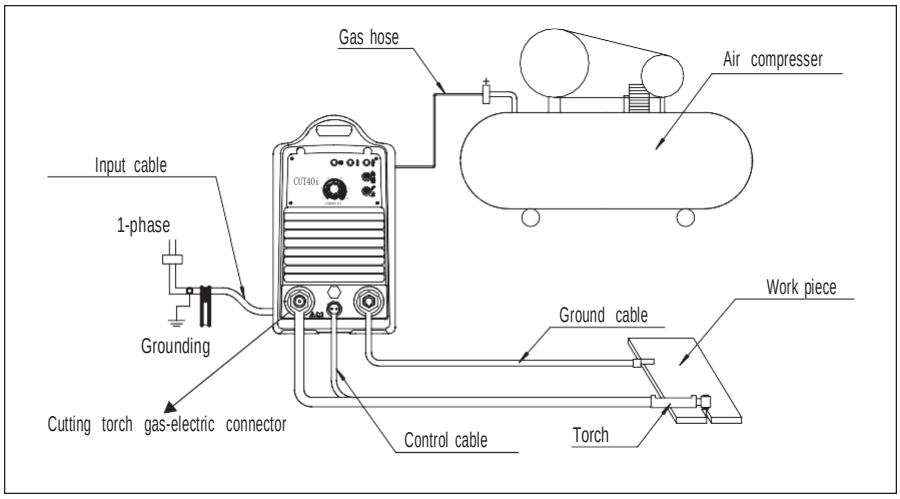


Fig. 4-5-1: Installation of CUT40i

Input power supply cable installation
Please note the size of fuse and circuit breaker in the table below are for reference only.

Model		CUT40i
Power supply		1- phase AC 220V±15%, 50/60Hz
Min. power capacity (KVA)		9
Input volt. protection (A)	Fuse	50
	Circuit breaker	60
Min. cable size (mm^2)	Input cable	2.5
	Output cable	16
	Protective GND wire	2.5

Table 4-5-1: Input power supply cable installation

The connection between input cable and distribution box (Fig. 4-5-2)

Warning!
- Never connection when equipment is power on!
- The connection must be carried out by a qualified electrician!
- Do not connect two units of power sources to the same circuit breaker!
- Connected to the correct input voltage, circuit breaker, input cable as per the specification on Table 4-5-1.

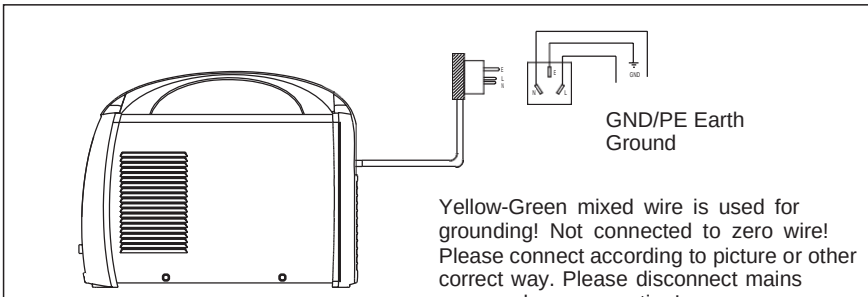


Fig. 4-5-2: Connection between input power supply cable and switch box

Power socket and using region

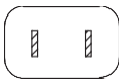
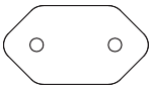
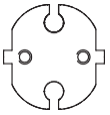
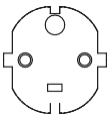
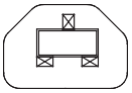
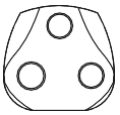
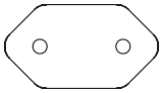
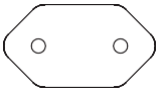
		
A: 2-plug flat type	B: 2-plug flat + GND round hole type	C: 2-plug flat 8 type
		
D: 3-plug flat 8 type	E: 2-plug round (4.0mm) type	F: 2-plug round (4.0mm) type
		
G: 2-plug round + GND round hole type	I: 3-pin flat type	K: 3-pin round type
		
M: Switzerland type	N: Italy type	O: Denmark type

Table 4-5-2: Power socket selection

Country	Type	Country	Type
Asian-Pacific region			
Hong-Kong	I	Macau	E, G
Vietnam	A, B, E, G	Thailand	A, B
Malaysia	I	Singapore	I
Indonesia	E, G	India	I, K
Australia	C, D	New-Zealand	C, D
Japan	A, B	Korea	E, G

Country	Type	Country	Type
Middle East region			
Saudi Arabia	A, B, I	Iran	E
Dubai	G		
Europe region			
Italy	E, N	Austria	E, F, G
Poland	E, F, G	Hungary	F, G
Greece	E, F, G	Belgium	E, F, G
Netherlands	E, F, G	United Kingdom	I
France	E, F, G	Switzerland	E, M
Spain	E, F, G	German	E, F, G
Finland	E, F, G	Denmark	E, F, G, O
Russia	E, F, G	Turkey	E, F
America region			
United States	A, B	Canada	A, B
Mexico	A, B	Columbia	A, B
Venezuela	A, B	Brazil	A, B, E
Peru	A, B, E	Argentina	C, D
Chile	E, N	Uruguay	E
Africa region			
Rep. South Africa	K		

Table 4-5-3: Using region selection

Cutting

Warning! Operating the equipment incorrectly can cause serious injury and damage. Do not use the functions described here until you have read and completely understood the following documents:
- “Safety rules”
- “Before commissioning”

Warning! Preparing when plug is on and power switch is in turn-on position may cause danger. Switch it off and unplug it from the mains when preparing.

1. Plug the ground cable into output socket (+), and tighten it firmly;
2. Connect the other end of the ground cable to the work piece;
3. Plug the 2-pin plug of torch into the cutting machine control socket;
4. Plug gas-electric connector of torch to cutting machine gas-electric socket, and tighten it firmly;

Note! When connect ground cable, power off cutting machine, align plug lug boss with socket gap, insert and rotate in clockwise direction until fix well. Must ensure good connection between plug and socket, otherwise high heat may burn plug and socket.
5. Air filter pressure-reducing valve is installed inside of cutting machine, connect its gas inlet with gas outlet of air compressor;
Note! Max. working pressure of air compressor is 0.8Mpa, min. is 0.6 Mpa, gas flow rate ⩾ 250L/min.
6. Connect with single phase 220V power supply;
7. Turn on the power switch of the cutting machine, power on indicator lights up;
8. Open air valve of air compressor, gas flows;
9. Pull up gas adjustment knob of pressure-reducing valve to adjust pressure, press torch trigger, rotate knob to adjust pressure to 3.5-5 bar, and press down the knob to lock the adjusted value;
10. Adjust proper cutting current according to work piece thickness;
11. Contact torch nozzle with work piece arc starting point;
Note! Usually start cutting at edge of work piece, also can start cutting at any point of work piece, at this time, should incline torch so as to blow off molten metal, and form original cut.
12. Press torch trigger to start arc;
On 2 step mode: press torch trigger-gas feeds-HF arc start-arc starts-start cutting-release torch trigger-gas post flows-stop cutting;
13. Release torch trigger to stop cutting, and then remove torch after gas stops feeding;
14. Close air valve of compressor.

4-6 Technical data

Note! Please use the machine under the allowed power supply voltage range marked in the nameplate. The technical data with the basic input voltage are listed as the Table 4-6-1.

Model	CUT40i
Input volt/frequency	Single phase AC220V±15%/50/60HZ
Rated input capacity (KVA)	7
Rated input current (A)	32
Rated duty cycle (%)(40℃)	60
Output current range (A)	15~40
Output open circuit voltage (V)	285
Max. carbon steel cutting thickness (mm)	12
Optimal carbon steel cutting thickness (mm)	1~7
Weight (Kg)	9
Dimension (cm3)	39×16×30
Insulation class	F
Post-gas time (S)	30
Arc-starting type	Contact
Standard cutting torch	PT31

Table 4-6-1: Technical data

4-7 Main components list

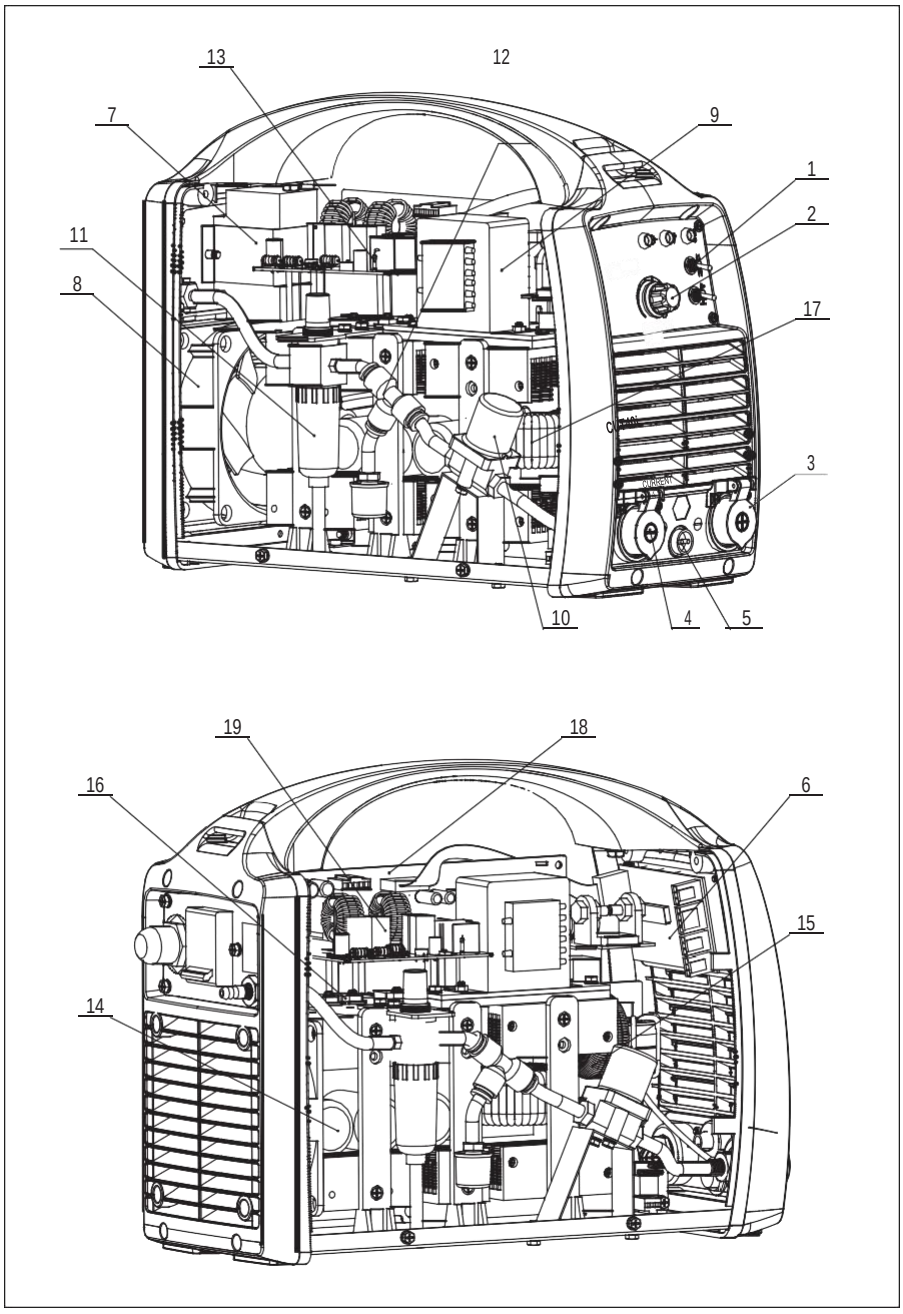


Fig. 4-7-1: Inner structure

No.	Item	Stock no.	Remark
1	Knob	745003-00034	220V, 50Hz
2	Potentiometer	720031-00105	220V, 50Hz
3	Quick socket	740002-00079	220V, 50Hz
4	Socket copper core with gas hole	766001-01690	220V, 50Hz
5	Aviation socket	740001-00214	220V, 50Hz
6	Display board	220503-00126	220V, 50Hz
7	Circuit breaker	745011-00068	220V, 50Hz
8	Fan	746002-00025	220V, 50Hz
9	Power transformer	220179-00616	220V, 50Hz
10	Solenoid valve	752001-00037	220V, 50Hz
11	Pressure-reducing valve	766003-02164	220V, 50Hz
12	Rectifier bridge	735004-00005	220V, 50Hz
13	Fuse	745007-00045	220V, 50Hz
14	Aluminum electrolytic capacitor	722004-00105	220V, 50Hz
15	Output reactor	763004-00159	220V, 50Hz
16	IGBT single tube	735003-00011	220V, 50Hz
17	Main transformer	763002-00024	220V, 50Hz
18	Main control drive board	210580-00644	220V, 50Hz
19	Over voltage protection board	220900-00242	220V, 50Hz

Table 4-7-1: Main components list

Note: If no special remarks, the input voltage mentioned in above table is single phase.

5- TROUBLE SHOOTING

Note! The following troubles and causes are uncertain. However, during the process of normal using conditions, that might happen.

NO.	TROUBLE	CAUSES	REMEDY
1	Power on indicator does not light up, fan does not run, no output when machine switches on	1) Power switch is damaged 2) No electricity on the electricity grid 3) Connect to 380V power	1) Check power switch, fan connection between main control board and display board 2) Check power supply on the electricity grid 3) Check
2	Power on indicator lights up, but protection on indicator does not light, and no output	1) Output cable does not connect well 2) Bad connection of joints, especially torch trigger cable connection 3) Display board is damaged	1) Check output cable connection 2) Check connection 3) Check and repair
3	Protection on indicator lights up	1) Inner temperature is too high 2) Temperature relay is broken 3) Fan is locked-rotor, fan cable is broken 4) Gas shortage	1) Let the machine cool down 2) Replace 3) Check 4) Check gas pressure
4	Circuit breaker on the switchboard trips while in cutting	1) The following devices may be damaged: power IGBT tube, output diode, input rectifier bridge, thermistor, electrolytic capacitor	1) Check and replace
5	The cutting current is unstable	1) Potentiometer is broken 2) Current sensor is damaged 3) Bad connection of joints	1) Check and replace 2) Check and replace 3) Check and replace
6	Cutting current is not adjustable	1) Current adjustment potentiometer on front panel is damaged	1) Check and replace

NO.	TROUBLE	CAUSES	REMEDY
7	No gas flows out during cutting	1) Solenoid valve is damaged 2) Gas flow is blocked 3) The output air pressure of air filter pressure-reducing valve is too high	1) Check and replace 2) Check gas flow 3) Regulate pressure knob on the filter to reduce air pressure
8	Too wide cut	1) Slow cutting speed 2) Nozzle is burn out	1) Increase cutting speed 2) Replace
9	Non-vertical cut	1) Nozzle is burn out 2) Non-alignment of nozzle to electrode 3) Cutting torch is not vertical to work piece surface	1) Replace 2) Align the nozzle and the electrode 3) Adjust to vertical position

Table 5-1: Trouble shooting

6 - CARE AND MAINTENANCE

Before open the machine

Warning! An electric shock can be fatal. Before doing any work on the machine:
- Switch it off and unplug it from the mains
- Put up a clearly legible and easy-to-understand warning sign to stop anybody inadvertently switching it back on again
- Discharge the capacity if necessary
- Bolt in outer case also works for ground connection. Never use other bolt which cannot work for ground connection

Maintenance of cutting machine

Please follow the instructions as below to ensure normal use of cutting machine
- Conduct safety check at regular intervals (see “Safety rules”)
- Dismantle machine side panels and clean machine inside with clean and low-pressure compressed air by professional technician, not less than twice per year. Clean the components at a certain distance only
- If a lot of dust has accumulated, clean the cooling-air ducts

Daily maintenance

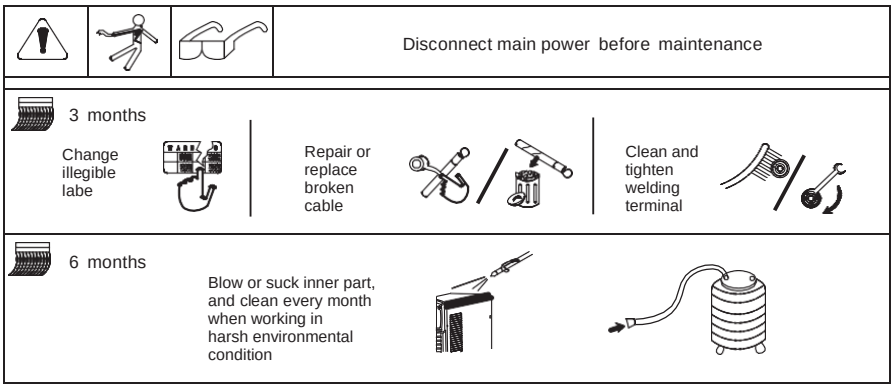


Fig. 6-1: Daily maintenance

7 - BASIC CUTTING TECHNIQUE

Note! This section being general welding technique guide is for reference only. Specific functions of your machine please refer to previous chapters.

Air plasma cutting is a cutting method using plasma arc thermal energy. When cutting, use plasma arc to melt work piece, blow molten metal by jet stream to form cut. Air plasma cutting can cut almost all metal materials, especially for high alloy steel and nonferrous metal which cannot be cut by flame cutting. Advantages are as follows: highly centralized arc energy, good stability, strong cutting ability; high cutting speed (3~5 times of gas cutting); low cost; arrow, burnished, clean and almost vertical cutting edge; less work piece deformation.

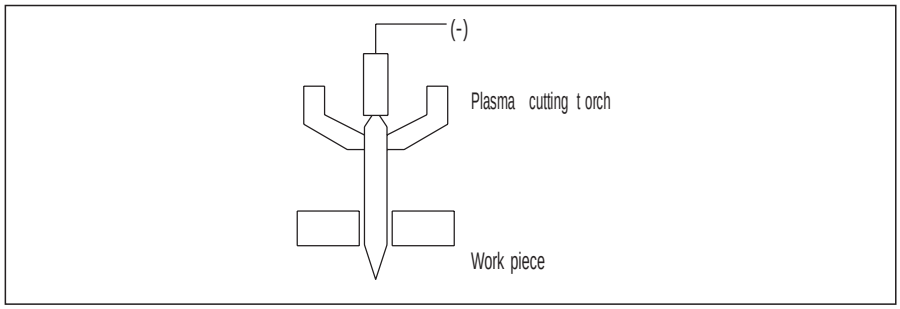


Fig. 7-1: Cutting process

1. Plasma arc type
According to power source connecting method, there are two kinds: transferred arc and non-transferred arc.
(1) Transferred type
Power source negative output terminal is connected with electrode; positive terminal is connected with work piece. Plasma arc is generated between electrode and work piece. First, it needs to ignite plasma flame flow between electrode and nozzle, and plasma airflow makes plasma flame flow contact with work piece to form plasma arc. Plasma arc formed by this transferred method is called transferred arc. Transferred arc can reduce nozzle burning caused by arc starting or liquid metal spatter.

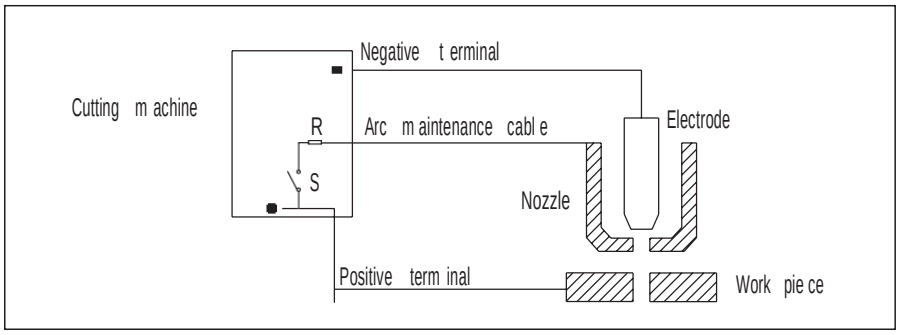


Fig. 7-2: Transferred type

(2) Non-transferred arc
Power source negative output terminal is connected with electrode; positive terminal is connected with work piece. Contact nozzle with work piece firstly, then plasma flame flow will be generated between electrode and nozzle after power on. Spray arc out of nozzle by plasma airflow which goes through nozzle, then plasma arc is formed.

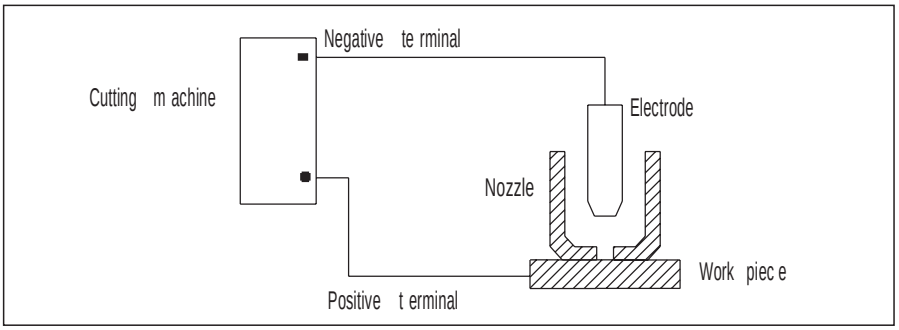


Fig. 7-3: Non-transferred arc

2. Plasma cutting technological parameter
Parameters include cutting current, cutting voltage, cutting speed, gas flow and distance between nozzle and work piece.

(1) Cutting voltage: though we can increase cutting thickness and cutting speed by increasing current, but arc will become thicker and cut become wider. So for thick plate cutting, better to increase cutting voltage. High open circuit voltage is easy to start arc. Increase gas flow rate and change gas composition can increase cutting voltage. But if cutting voltage is over 2/3 of open circuit voltage, arc will be no stable, and blow out easily. In order to increase cutting voltage, need to use power source with high open circuit voltage. So open circuit voltage of plasma cutting machine is no less than 15V, and 2 times of cutting voltage.

(2) Cutting current: current and voltage decide power of plasma cutting machine. As power increases, cutting speed and cutting thickness will increase correspondingly. Normally choose cutting current according to plate thickness and cutting speed. For same thick plate, the larger the current is, the quicker of cutting speed is. But too large of cutting current may burn electrode and nozzle, cause double arc easily. So proper current is needed for electrode and nozzle. Cutting current also influences cutting speed and cut width. Larger cutting current may make arc become thicker, and cut become wider, and form “V” type cut. Below table is relationship about cutting current and cut width.

Cutting current/A	20	60	120	250	500
Cut width/mm	1.0	2.0	3.0	4.5	9.0

Table 7-1: Relationship about cutting current and cut width

Current (A)	High-quality cutting thickness		
	Material		
	Stainless steel/ Low-carbon steel	Aluminum and Al. Alloy	Brass
30	5	3	3
40	6	4	3
45	6	6	4
60	10	10	6
100	25	16	8
120	30	20	10

Table 7-2: Relationship about current and cutting thickness

3. Compressed air: gas flow should match with nozzle pore diameter. High gas flow is helpful for compressing arc, centralizing plasma energy, increasing working voltage and cutting speed, and blowing off molten metal in time. But if gas flow is too high, it will take away too much heat from arc, and reduce cutting ability and arc stability. Pressure of compressed air should be ⩾8bar, gas flow rate ⩾250L/min. When cutting, air compressor pressure should be over 6bar, and compressed air should be between 3~5.5bar.

4. Nozzle height: distance between nozzle and work piece becomes larger, then arc voltage will increase, that is effective power of arc increases. Length of plasma arc stream appears in space increases, energy of plasma arc stream loses in space increases. This makes effective heat decreases, blow force to molten metal decreases, so tumor in bottom cut increases, cutting quality becomes bad, and double arc occurs often. Distance between nozzle and work piece is 3~5mm, also can contact nozzle and work piece. Cutting thickness of contact cutting mode is half of normal cutting mode.

5. Nozzle angle: keep vertical position between nozzle and work piece to ensure vertical cut.

6. Cutting speed: cutting speed is relative move speed between torch and work piece during cutting, also a major indicator of cutting productivity. Cutting speed has big influence to cutting quality. Proper cutting speed is important condition to form straight cut. On condition that cutting power is unchanged, improve cutting speed will cause non-straight cut, tumor in bottom of cut becomes more, hard to clean, also heat affected zone and cut width will increase.
Plate thickness, cutting current, gas type&flow rate, nozzle and drag back quantity will influence cutting speed. On condition of same power, increase cutting speed will lead inclined cut. Cutting torch needs to be vertical to work piece, also can leave torch a certain caster angle in order to eliminate slag. Normally caster angle is no more than 3°. In order to improve productivity, higher cutting speed is much better as long as the work piece can be cut through.

Material current thickness	Carbon steel			Stainless steel			Aluminum		
	40A	60A	80A	40A	60A	80A	40A	60A	80A
1	8.5			9			10		
1.5	6	7.2	8	6	8	8.5	6	11	9
2	4.5	7		3	7.5		5	11	
3	3	4.5	5.5	0.8	3.8	7	2.5	6	7.5
5	1.5	2.4	3.2	0.5	2	3	2	3	4.5
6	1	2	2.5	0.4	1.6	2.5	1.2	2	2.7
10	0.4	1.2	1		0.5	1		1	1.2
12		0.7	0.8		0.3	0.7		0.5	1
16			0.5			0.5			0.6
20			0.4			0.25			0.5

Table 7-3: Cutting speed table

Note! This table is for reference only, the actual shall prevail.