

RIVER 3

OPERATION MANUAL



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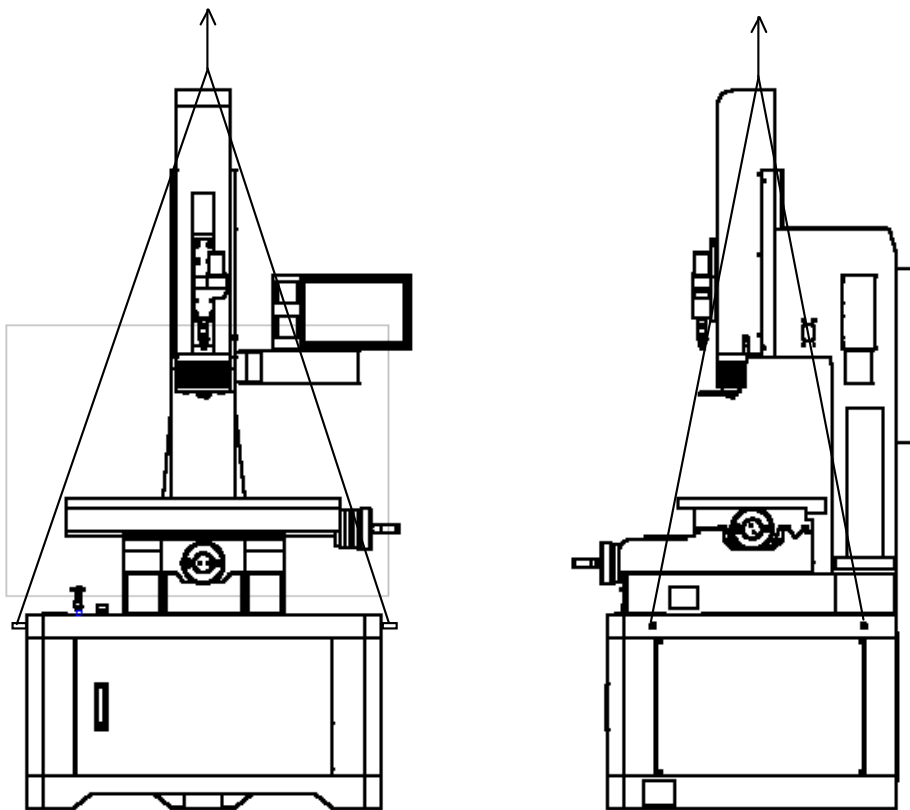
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1. MACHINE MOVING.

1.1 The machine life up and moving:

Please see below drawing for the machine life up and moving, please pay attention for the ropes at 4 corners, they must have same straightness when machine lifted up.

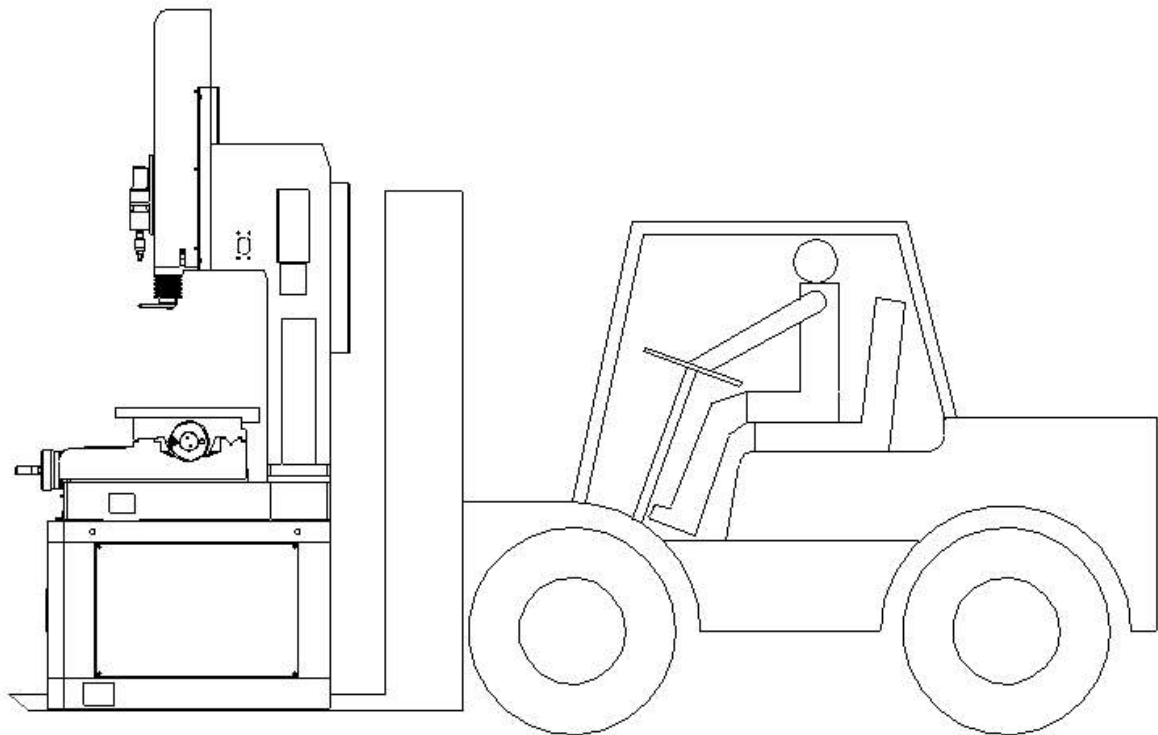
The loading limit of lift rope must over 1000 kgs.



1.2 MACHINE MOVING BY FORKLIFT

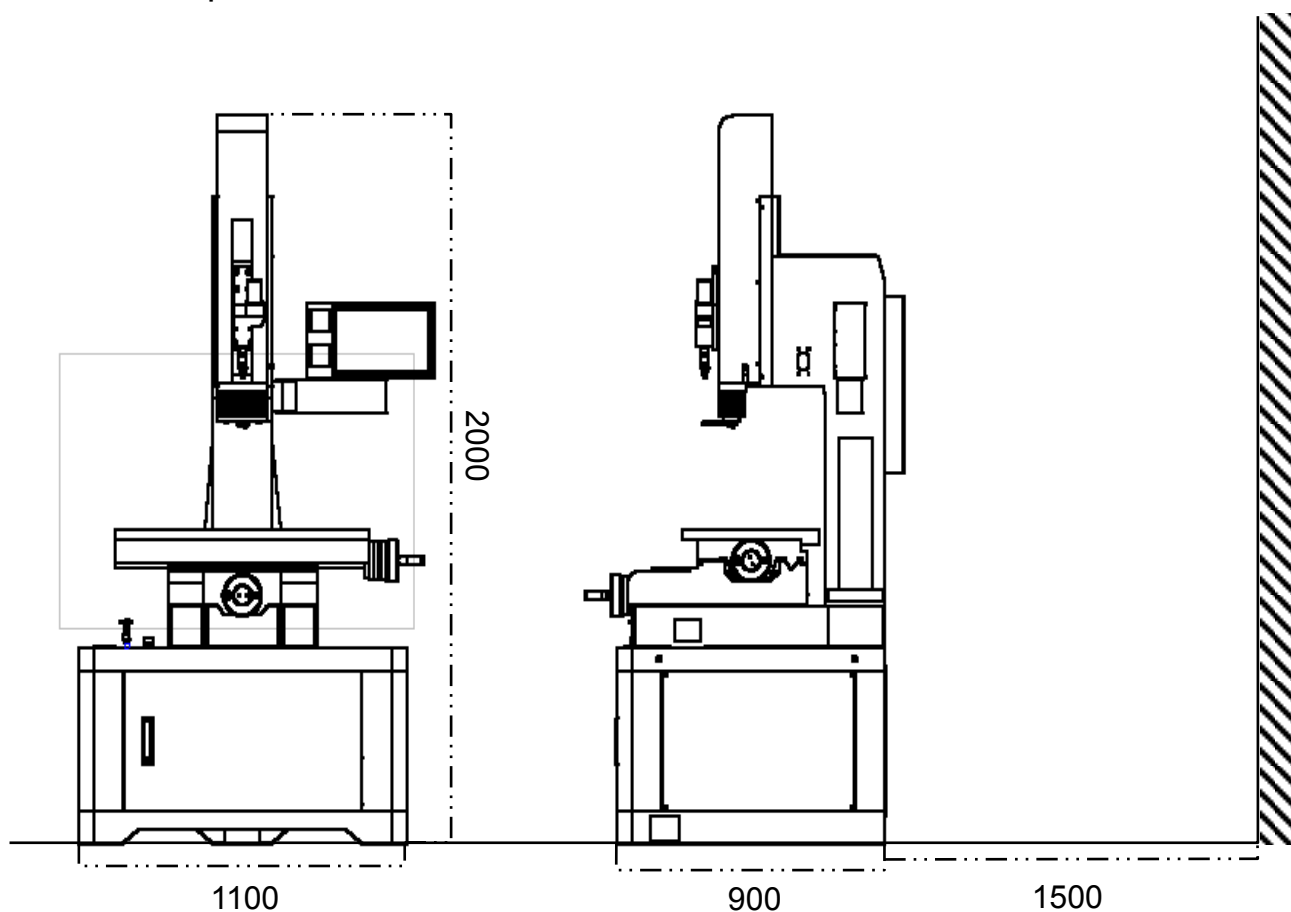
Please see below drawing for moving by forklift. The teeth of forklift need to through over the machine base.

The loading limit of forklift must over 1000 kgs.



2. The installation space and environment requirement

2.1 Installation space environment



Attention:

- @ Machine needs to be installed as above drawing for the air cooling. If the space too small, machine might get poor air cooling, and it will cause machine abnormal.
- @ The machine should be installed on the stable ground, DO NOT installed on the unstable environment.
- @ Please do the machine leveling at once after machine set at right position.
- @ Keep machine installed away from dirty or dusty environment. Please keep proper distance away from other machines.

2.2 Power environment

- a 、 The power supply **MUST** be same as the nameplate of the machine.
- b 、 Please check and make sure the 3 phase power supply of factory side before machine connected to the power source. You also can check with the nameplate which behind the machine to make sure machine is suit for your power supply or not. Also, please make sure the error range of power source **MUST stay in $\pm 10\%$. If the power source not stays in this range, WE RECOMMEND YOU TO INSTALL THE A.V.R. DEVICE TO AVOID THE DAMAGE OF THE MACHINE. IF THE MACHINE WAS DAMAGED OR CAUSED ANY PROBLEM BY UNSTABLE POWER SOURCE, THIS RESPONSIBILITY WILL BE VESTED TO THE CUSTOMER.** If the power source can not match the machine needs, please contact with your machine supplier or OCEAN's AGENCY or OCEAN, we will give the suitable suggest or solution to you.
- c 、 The power cable from generator to the circuit breaker at the power source CAN NOT over 5 meters. If customer has the special require, please contact with your machine supplier or OCEAN's AGENCY or OCEAN.
- d 、 **The power supply of chiller MUST be connected with independent circuit breaker.**
- e 、 The specification of the circuit breaker is 32A. You also can check with the nameplate to find out the capacity of the machine.

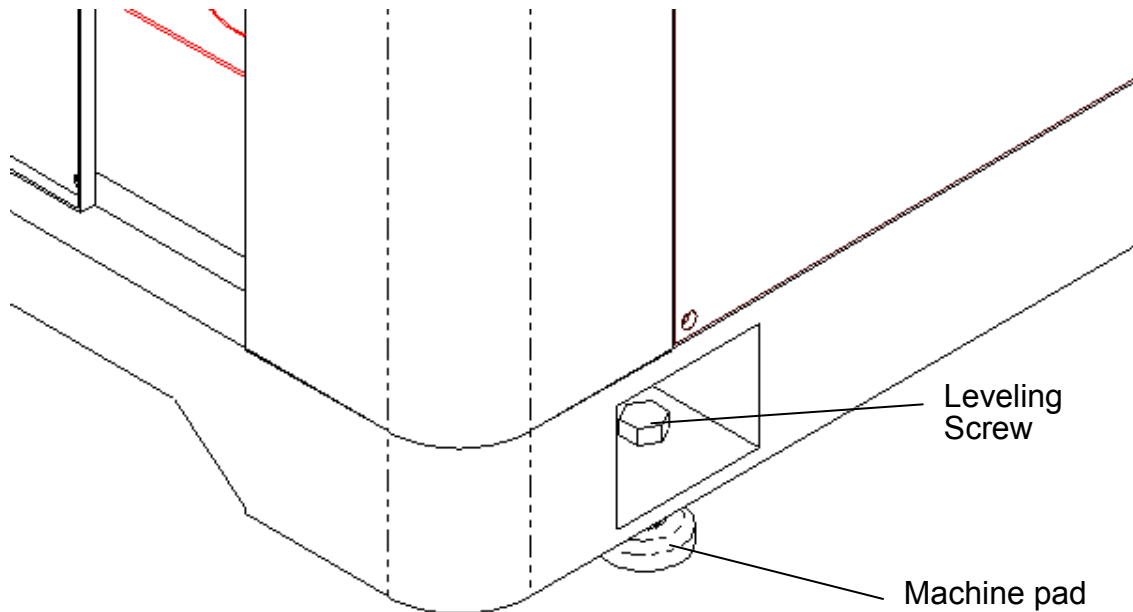
2.3 The explanation for main power of machine:

The cable of power supply of the machine has 4 wirings which are R, S, T and E. The E is yellow/green and it MUST connect to the Ground/Earth/E at the power source side. For R, S and T, you just only need to connect in sequence to the power source. Please check and make sure the 3 phase power supply of factory side before machine connected to the power source.

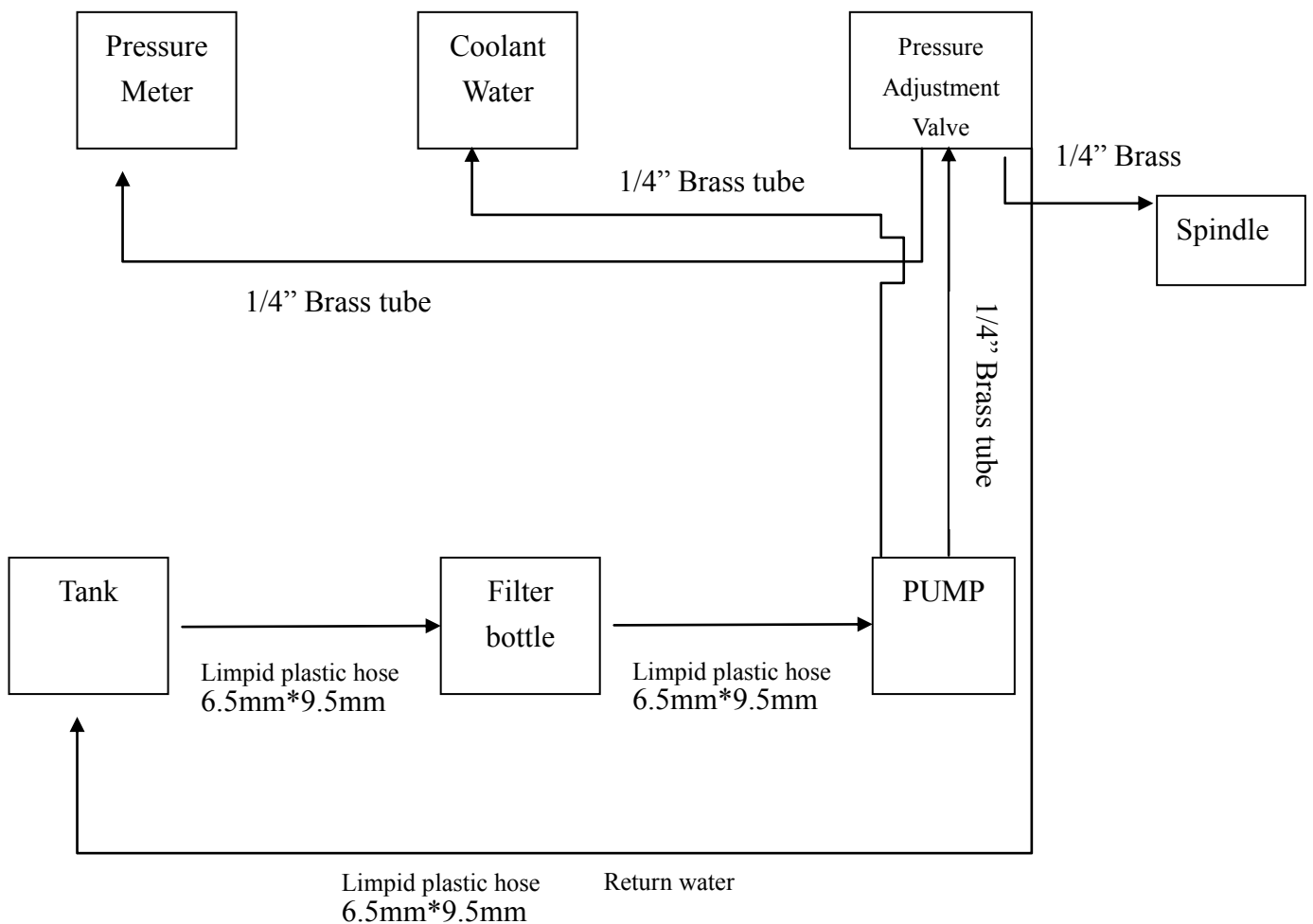
Between the power source of factory and the power supply of machine, it NEEDS an **independent circuit breaker**. The specification is 32A.

3. Machine leveling adjustment

After machine got the right place, please DO the machine leveling adjustment with leveling screws. You will need to put a leveling gauge on the work-table, through adjust the leveling screws to check the machine leveling. The machine leveling error range should be stay in 0.06mm/1M.

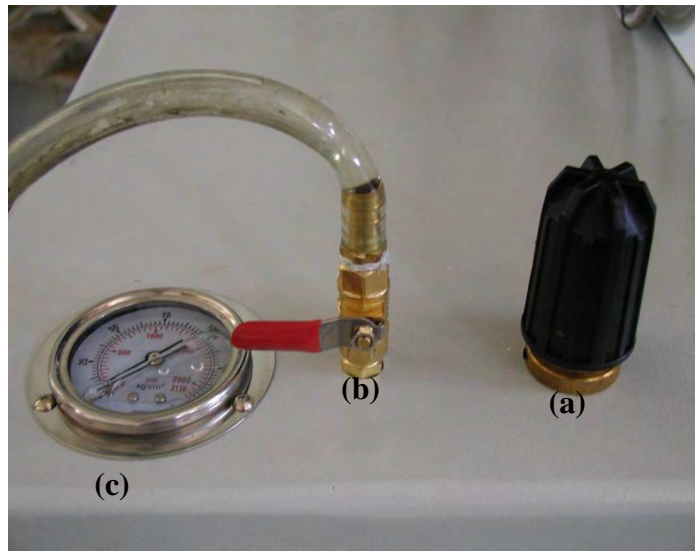


4. Electric pump system



5. Water pressure adjustment and explanation for other switches:

Water pressure adjustment explanation:



(1) (a) is pressure adjustment valve.

It can adjust the pressure of working liquid; turn it with clockwise to get higher pressure; turn it with counter-clockwise to reduce the pressure.

(2) (b) is control valve for coolant.

Through this valve to control the flushing of coolant, sometimes with good flushing can speed up the drilling efficiency.

If the machine has equipped with coolant or filter system, please turn on the coolant function on the operation panel, then use this valve to control the flushing.

(3) (c) is the pressure meter.

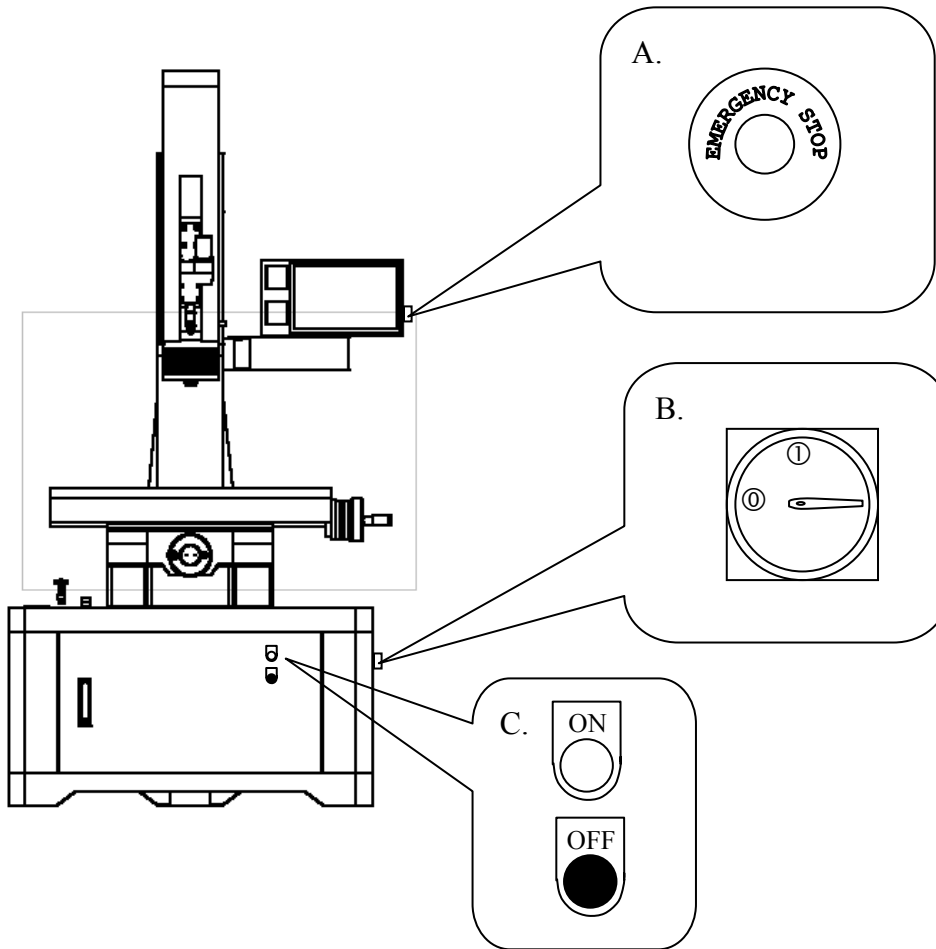
This meter shows the pressure of the working liquid. Generally to say, the big electrode tube uses smaller pressure; the smaller electrode tube uses higher pressure.

(4) Please exchange the lubrication oil every 1500 working hours. Please check the stick on the pump for the oil specification. Please fill up #30~#40 lubrication oil in the pump.

Please kindly be noticed with the wrong lubrication oil will cause damage of the pump.

5.2 Explanation for other switches:

The positions of other switches show as below:



A. Emergency switch: Press this switch to shut down machine right away.

B. Main power: 0 for turn off the main power, 1 for turn on the main power.

If operator needs to check inside of the machine, please TURN OFF main power, then he can continue to check machine.

C. ON switch: Turn on the machine.

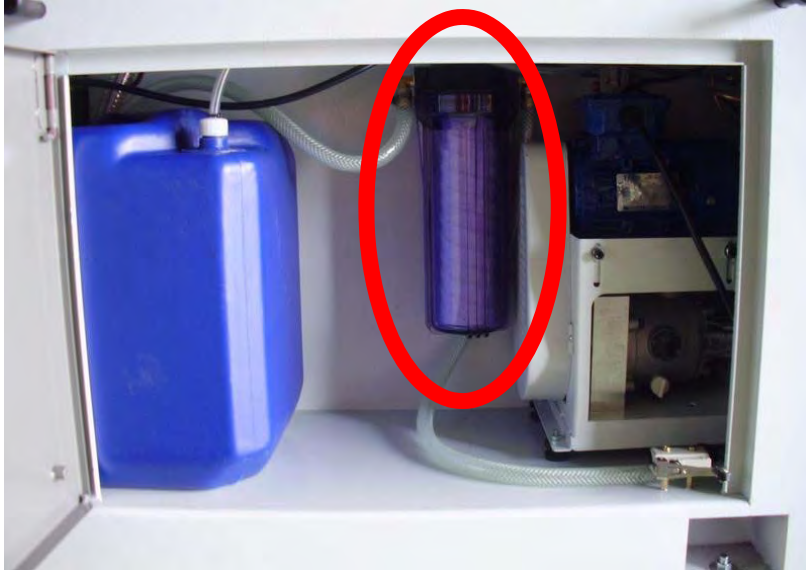
OFF switch: Turn off the machine.

5.3 Other information:

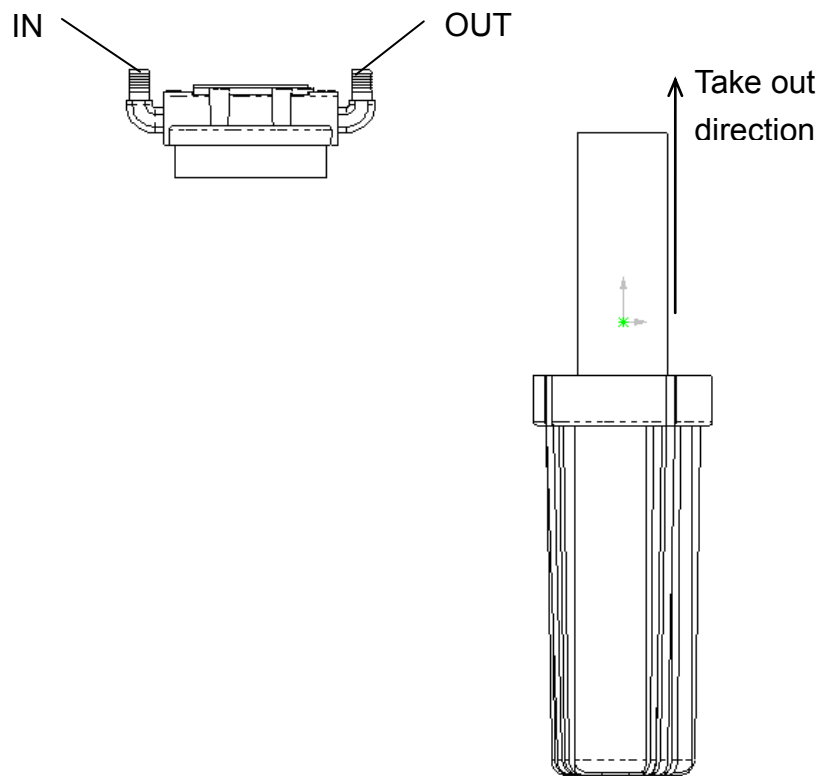
1. There is a stainless steel water tank in the left side of the machine. Please full fill the water before start working.
2. There is a compressed air connector at the left and back side of the machine, please provide a 6~7kg/cm² compressed air for machine.

6. The filter replacement steps:

6.1. Please open the left door of the machine, and look inside of it. You will see as below picture. The filter is in the center.



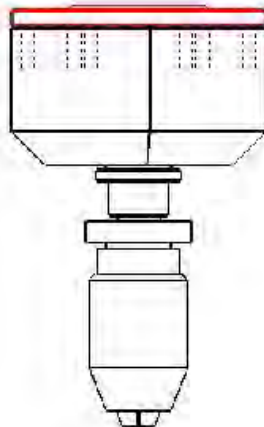
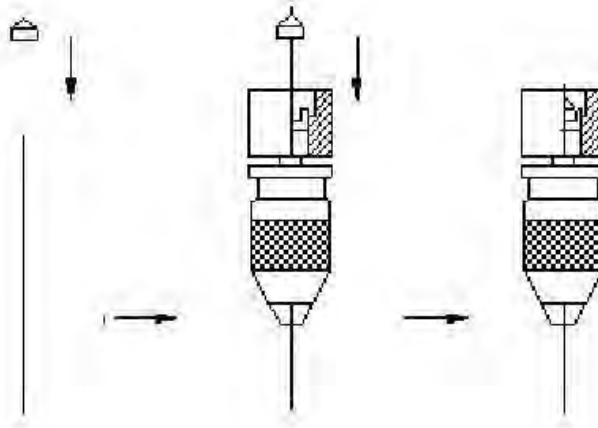
6.2. Please follow below drawing to take out and replace the filter.



7. The electrode tube installation explanation

Please follow below drawing to install the electrode tube.

(1) Quick change electrode holder system (Pneumatic type)



Pneumatic type change electrode holder:

1. Please press unclamp button at the right side of the column.

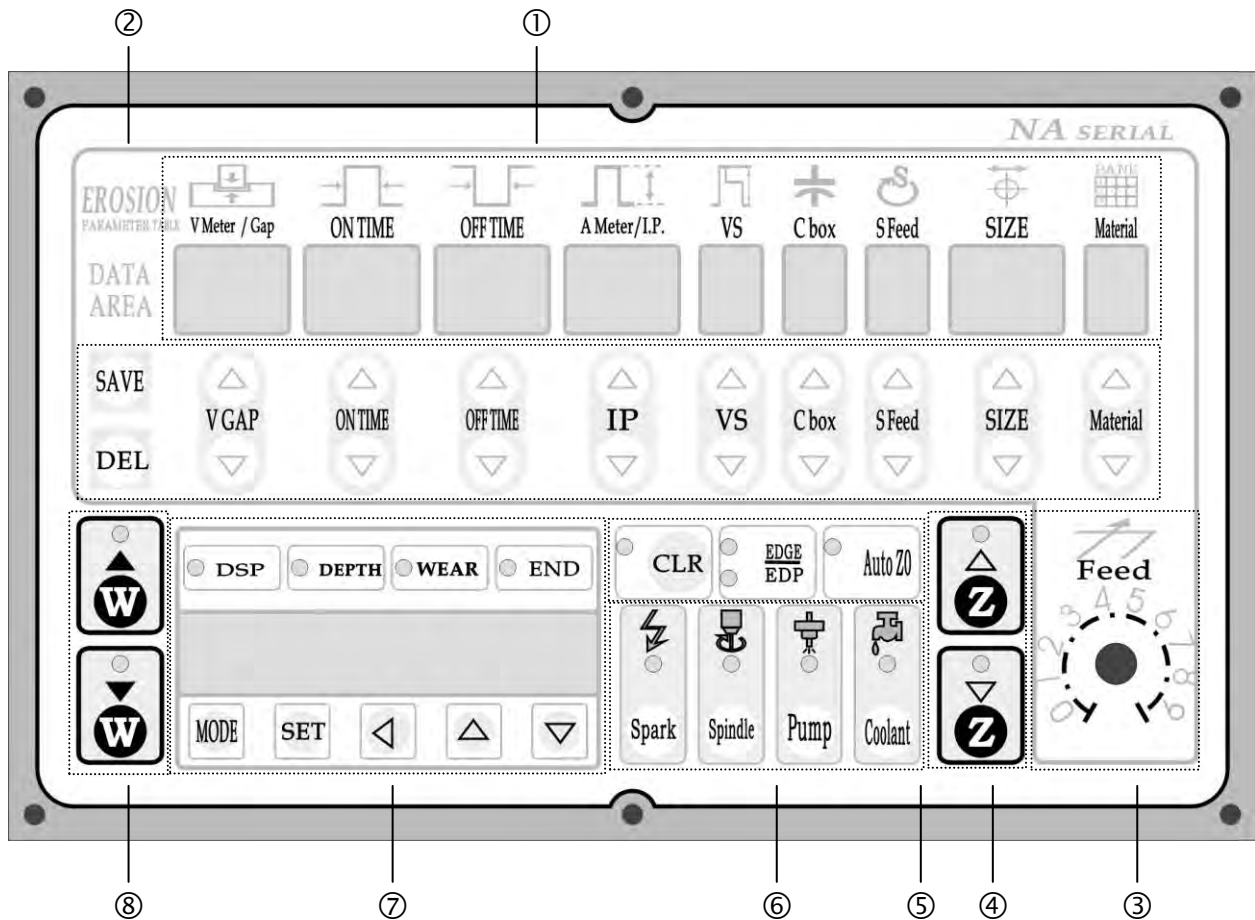


CAUTION

Please follow below steps to take out electrode holder/chuck:

1. **MAKE SURE** the pressure meter at 0 kg/cm².
2. Hold the electrode holder/chuck tightly, then press unclamp button.
3. If customer uses the electrode holder/chuck which not produced by OCEAN TECHNOLOGIES, it will cause Quick Change Electrode Holder System leaking or other problems. OCEAN TECHNOLOGIES has no responsibility for the machine damage or the safety of operators.

8. PANEL OPERATION EXPLANATION:



(1) Working parameter setting display area:

a. V METER / GAP display area:

This area value is setting value for GAP voltage. It is one of working parameter. The value is between 00~99.

b. ON-Time display area:

This area display ON-Time with present value. The steps range is 5~99.

c. OFF-Time display area:

This area display OFF-Time with present value. The steps range is 5~99

d. A METER / I.P. display area:

This area value is working peak current. It is one of working parameter. The value is between 0~25 steps.

e. VS display area: working voltage step display area

This area display present using working power step, the steps range is 1~3.

f. C BOX display area :

Rapid capacitor steps display area. It can display range 0~F 16 steps.

g. S-Feed speed of spindle display area:

This area displays the spindle speed. There are 0~F total 16 steps.

h. SIZE display area

This area can display present diameter of electrode tube.

i. Material display area: Material data code

This area display present select material data code. It can save 0~1, total 2 kinds of material. Such as :

0→ steel (SKD-11)

1→ For user

P.S.: It can be magnified to 10 kinds of materials. (Optional function)

(2) Working parameter setting area:

- a. SAVE KEY: To save working data.
- b. DEL KEY: To delete working data without save, to return beginning working data.
- c. V GAP KEY : sparking gap voltage setting key.
- d. ON-TIME KEY: working sparking ON TIME setting key.
- e. OFF-TIME KEY: working sparking OFF TIME setting key.
- f. IP KEY : sparking current setting key.
- g. VS KEY : working power energy selecting setting key.
- h. C-BOX KEY: rapid capacitor setting key.
- i. SPINDLE FEED KEY: working spindle speed setting key.
- j. SIZE KEY : electrode tube diameter setting key (auxiliary parameter)
- k. MATERIAL KEY : material setting key.(auxiliary parameter)

(3) FEED KEY: To move Z axis or working axis speed.

This button display present moving speed of working axis, there are 0~10 steps.

(4) Z AXIS UP / DOWN MOVE KEY: Working axis up/down move key and indicate lamp.

(5) WORKING SETTING AREA:

a. AUTO Z0: Z axis auto zero

When this lamp is lighting, there is auto wear compensation function during working. It can change to “Lights go out” condition when no using. (“Light” was set at inside). This function is auto start after open machine. The lamp is lighting, It’s mean the machine has auto Z-axis surface return zero function during working, and working depth arrival, the Z-axis auto up function; Opposition, the machine has no auto Z-axis surface return zero function during working, and working depth arrival, the Z-axis do not auto up function, it suitable for working blind hole.

b. EDGE/EDP : Auto edge finding & point sparking change key and indicated lamp:

When EDGE indicated lamp, its mean edge finding by automatically at Auto Z0=light with Auto zero.

When EDP indicated lamp, Press SPARK, machine will do point sparking(a signal point deep around 0.3mm)

c. CLR : Z axis coordinated rapid clear key. This function can be fast clear Z axis present coordinated in using. (This function under DSP condition.)

(6) WORKING KEY:

- a. COOLANT KEY AND INDICATE LAMP: coolant working liquid start / stop.
When starting with lamp light. (Optional function)
- b. PUMP KEY AND INDICATE LAMP: High pressure pump start / stop.
When starting with lamp light.
- c. SPINDLE KEY AND INDICATE LAMP: spindle start / stop. When starting with lamp light.
- d. SPARK KEY AND INDICATE LAMP : sparking start / stop. When starting with lamp light.

(7) Z axis function setting and display area (system parameter):

- a. Function display area: To display this area setting value and Z axis coordinated value.
- b. Reduction key: To press this key can reduce a unit value when setting parameter.
- c. Increasing key: To press this key can increase a unit value when setting parameter.

-
- d. Moving key: To press this key can move cursor position by forward / back when setting value.
 - e. Set key: To edit and save display mode contents, then exit edit mode.
 - f. Mode key (To display MODE setting selection): Z axis setting and system parameter setting exchange key. According with different press time appear below function parameter:
 - i) Pn: System parameter (Mechanical parameter). (Appendix A)
 - ii) END: When the lamp was light, the value at display area is Z axis working total depth. (DEPTH + WEAR). This function displays the total depth only, can't change manually.
 - iii) WEAR: When the lamp was light, the value at display area is Wear value of electrode tube. (The user can modify by himself).
 - iv) DEPTH: When the lamp was light, the value at display area is working Depth value of your request. (The user can modify by himself.)
 - v) DSP: When the lamp was light, the value at display area is Z axis coordinated value.

(8) W axis up /down move key and indicate lamp (reservation)

Appendix A: System parameter

Unit 1: Pn0 setting and analysis,

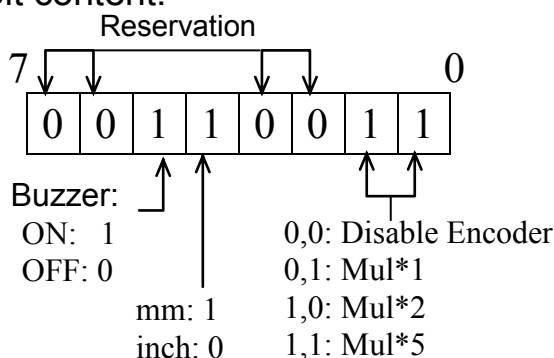
Pn0 is password setting.

Under Pn0 condition to input below value, it can execute below action:

Inside parameter	Analysis
168	Clear/pre-set memories
0	Prohibit editing system parameter
255	Editing system parameter enter Pn1

Unit 2: Pn1 content and example

a. Bit content:



Value	Content
0	Without Z axis Encoder ; Encoder Disable
1	Z axis resolution *1 μ m
2	Z axis resolution *2 μ m
3	Z axis resolution *5 μ m
8	CE enable
16 / 0	mm display 16 , inch display 0
32	Buzzer ON
64	Coolant ON

b. Example:

This machine setting is 51. The content as below:

Z axis resolution + Unit display + Buzzer ON

mm unit => 3 + 16 + 32 = 51 (No CE function)

mm unit => 3 + 16 + 32 = 51 + 8 = 59 (CE function)

inch unit => 3 + 0 + 32 = 35

inch unit => 3 + 0 + 32 = 35 + 64 = 99

9. Working parameter steps explanation:

Figure	Explanation	Steps
V GAP	Setting working Gap range.	0 ~ 99
ON-Time	ON-Time	5 ~ 99: 95 steps
OFF-Time	OFF-Time	5 ~ 99: 95 steps
IP	Setting working current range.	0 ~ 25
VS	Power energy selection	1 ~ 3: 3 steps
C-BOX	Rapid capacitor	0 ~ F: 16 steps
Spindle Feed	Spindle Feed	0 ~ F: 16 steps
SIZE	Electrode tube diameter	0.2 ~ 3.0 0.2 ~ 6.3(Optional)
Material	Material	0 ~ 1: 2 steps ; It can save 2 kinds material. (It can be magnified to 10 kinds of material. (for optional function)).
Feed Rate	Feed Rate	0 ~ 10: Knob turning.

10. Operation steps:

- A 、 Please open main power switch and ON key.
- B 、 To select Material and Size
- C 、 To install electrode tube and ceramic guide.
- D 、 To start PUMP and adjust water pressure, to ensure the water Come out from tube.
- E 、 To set correct DEPTH / WEAR
- F 、 To start PUMP 、 SPINDLE and SPARK. That's OK.

Attention: (Working hole in/ out)

When the drilling EDM working, please be should working Quality.

Example: the working hole in / out if happen extend Hole, or when machine sparking to cause tumor sharp. If machine has extended hole, it might get follow reason:

- a. The distance too far for ceramic guide and workpiece.
- b. The electrode tube was bent.
- c. The working liquid has too high conductivity.

11. TROUBLE SHOOTING

(1) Working at unstable condition:

- a. The working condition if setting proper or not?
- b. The servo speed if proper or not?
- c. The workpiece if fix or not?
- d. Working liquid (distill water) if enough or not?
- e. The distill water quality if proper or not?
- f. The electrode tube and ceramic guide if same size or not?

(2) Abnormal wear for electrode tube:

- a. The electrode tube and ceramic guide if same size or not?
- b. The electrode tube material if select mistake or not?
- c. The electrode tube if bend with no straight or not?
- d. The working condition if setting proper or not?
- e. The working liquid if enough or not?
- f. The working liquid quality if good or not?

(3) The electrode tube happen heat during working:

- a. The water pressure if enough or not?
- b. The electrode tube bottom if come out the water or not?
- c. The working condition if setting proper or not? (Over power or short (electrode tube / workpiece))

(4) The electrode tube bend during working:

- a. The ceramic guide if clear or not?
- b. The workpiece if fix or not?
- c. The working condition if setting proper or not?

(5) The Z-axis was shake during working:

- a. The electrode tube if bend, no straight, or poor install or not?
- b. The electrode tube center if something block or not? To cause poor flushing.
- c. The electrode tube and ceramic guide if same size or not?
- d. The working condition if setting proper or not?

-
- (6) The Z-axis without balance :
- The servo p.c. board VR (balance) in generator without adjust proper to cause offset.
- (7) The working hole serious become conical hole (the top hole Bigger than bottom hole):
- The electrode tube material if select mistake or not?
 - The working condition if setting proper or not ?
 - The working liquid conductive rate if proper or not?
- (8) The working hole bottom hole bigger than top hole:
- The electrode tube if bend without straight or not?
 - The ceramic guide or workpiece if fix or not?
- (9) The pneumatic pump no work (no water pressure):
- The cylinder air input hole was broken or without air input.
 - The cylinder limit switch was broken.
 - The cylinder piston bar without fully moving. In order to let piston bar move to proper position, it can use screw to touch limit switch.
 - The pressure valve without open. (The turn clockwise, the pressure increasing.)
- (10) The pneumatic pump running without function or no water Come.
- The anti-valve was broken?
 - The seal in cylinder was broken?
 - The water pipe was broken or not enough working liquid?
- (11) Insufficient water pressure, and the pump come/go moving fast.
- Vent pressure valve abnormal?
 - Not enough working liquid in water tank?
 - The anti-valve was broken at two sides of copper piece?

12. Maintenance, consumption and suggestion:

(1) The leveling checking

After installation machine, first, third, sixth month need to check and correct leveling.

(2) Daily maintenance

To clear worktable, electrode holder, clamp plate for workpiece Waterproof cover. Due to this machine use water to be Working liquid, it easy cause the metal rusting, therefore, it is Necessary put the oil or rust-proof oil on metal.

(3) Weekly maintenance

Please check the filter every weekly, if the filter too dirty, it need To clean or replace, with change working liquid. Please check Machine lubrication system and lubrication oil of pump if enough or not?

(4) Monthly maintenance

It is necessary to adjust ceramic guide anchor with correct the Vertical.

(5) Consumption and suggestion

- a. ceramic guide
- b. electrode tube (brass / copper)
- c. filter
- d. rubber seal
- e. Immersing guide cover

◎Due to the electrode tube material can be effected working quality and speed, therefore, the different workpiece material, it need to select different electrode tube. Our suggestion as below:

- a. The workpiece : steel ; The electrode tube : brass
- b. The workpiece : tungsten carbide or copper ; The electrode tube : Copper.

(6) Maintenance list

Item	Day	Week	Month	Season	Two season	Year
Work table	●	◎				
Parallel Plate	●	◎				
Guide	●	◎				★
Electrode holder	●	◎				
Water filter for pump	●		★1			
Air filter for Fan		●	◎			
Water filter for tank		●	◎		★	
Container for Air pressure filter, ◆		●	◎			
Axes lubrication		●◎				
Oil level of manual lubricator		●◎				
Waste oil collector(backside of Y axis)		●		◎		
Exterior of generator, ◆					●◎	
Exterior of machine					●◎	
Vertical accuracy of spindle			●			
Vertical accuracy of Guide holder plate			●			
Dust inside of generator, ◆					●◎	
Dust inside of bottom space of machine					●◎	
Machine Leveling				●		◎
Water filter made with metal, ▲				◎2		

Optional : ▲

CA Serial : ◆

Check & Act : ●

Maintenance & Clean : ◎

Replace : ★

★1 :

Depend on working hours, if the filter becomes all black then user needs to replace with new one.

◎2 :

Depend on working hours, if the bubbles came out from 2/3 height of filter then user needs to replace with new one. If machine equipped with additional pressure gauge, when the pressure gauge reaches 2kg/cm², the filter must be replaced.

13. The electrode tube specification and tolerance.

All the electrode tube size, the tolerance within $\pm 1\text{mm}$.

Copper					Brass					
OD.		ID.		Length	OD.		ID.		Length	
Tube	Tol.	Tube	Tol.	mm	Tube	Tol.	Tube	Tol.	mm	
0.2	-0.01	0.1	±0.02	200	0.2	-0.01 -0.02	0.08	±0.02	200	
0.3		0.12		300	0.3		0.11		300	
0.4	-0.02	0.15		300	0.4		0.2		300	
0.5		0.18		400	0.5		0.2		300	
0.6	-0.01 -0.02	0.2	±0.02		0.6		-0.01 -0.02	0.2	±0.02	400
0.7		0.2			0.7			0.2		
0.8		0.3			0.8			0.3		
0.9		0.3			0.9			0.3		
1.0		0.3			1.0			0.3		
1.1		0.3			1.1	-0.01 -0.03	0.4	±0.03		
1.2		0.4			1.2		0.4			
1.3		0.4			1.3		0.4			
1.4		0.4			1.4		0.5			
1.5		0.5			1.5		0.5			
1.6	0.5	1.6			0.5					
1.7	0.5	1.7			0.5					
1.8	0.6	1.8			0.6					
1.9	0.6	1.9			0.6					
2.0	0.6	2.0			-0.01		0.6			
2.1	-0.01 -0.03	0.7			-0.03	0.7				
2.2		0.7				0.7				
2.3		0.7				0.7				
2.4		0.8				0.8				
2.5		0.8				0.8				
2.6		0.8				0.8				
2.7		0.9				0.9				
2.8		0.9				0.9				
2.9		0.9				0.9				
3.0		1.0				3.0		1.0		

14. Machining Condition

Built in data:

File name:			Material:0			Tube:Brass			
Size	ON-T	(SKD11)	OFF-T	VS	GAP	F	C	S	
0.2	8	IP15	1	5	24	25	2	F	
0.3	18		15	1	6	24	25	0	F
0.4	20		15	1	8	24	20	0	F
0.5	25	20	1	11	22	25	0	F	
0.6	25	20	1	13	22	25	0	F	
0.7	25	20	1	15	22	25	0	F	
0.8	25	20	1	18	22	30	0	F	
0.9	30	20	1	18	22	30	0	F	
1.0	30	20	1	18	22	30	0	F	
1.1	30	20	1	18	22	30	0	F	
1.2	30	20	1	18	22	30	0	F	
1.3	30	20	1	18	22	30	0	F	
1.4	30	20	1	18	22	30	0	F	
1.5	30	20	1	18	22	30	0	F	
1.6	30	20	1	18	22	30	0	F	
1.7	30	20	1	18	22	30	0	F	
1.8	30	20	1	18	22	30	0	F	
1.9	30	18	1	19	22	30	0	F	
2.0	40	30	1	25	24	30	0	F	
2.1	40	30	1	25	24	30	0	F	
2.2	40	30	1	25	24	30	0	F	
2.3	40	30	1	25	24	30	0	F	
2.4	50	40	1	25	24	30	0	F	
2.5	50	40	1	25	24	30	0	F	
2.6	50	40	1	25	24	30	0	F	
2.7	50	40	1	25	24	30	0	F	
2.8	50	40	1	25	24	30	0	F	
2.9	50	40	1	25	24	30	0	F	
3.0	50	40	1	25	24	30	0	F	

Note: F is the knob turning, and the setting example as below:

Data is 30, then the knob set to 3

Only for reference, different materials have different results.

File Name:			Material: (Carbide)			Tube: Copper		
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	5	25	1	8	22	3.0	2	F
0.3	6	25	1	12	22	3.0	2	F
0.4	8	25	1	15	22	3.0	1	E
0.5	15	22	1	15	20	3.0	1	E
0.6	15	22	1	25	20	3.0	2	E
0.7	15	25	1	25	20	3.0	2	E
0.8	15	22	1	25	20	3.0	2	E
0.9	15	22	1	25	20	3.0	2	E
2.1	35	20	1	24	20	4.0	2	C
2.2	35	20	1	25	20	4.0	2	C
2.3	35	20	1	25	20	4.0	2	C

Unit : mm

File Name:			Material: (SUS)				Tube: Brass	
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	8	45	1	6	22	3.5	2	F
0.3	18	25	2	5	22	3.0	1	F
0.4	20	30	3	8	22	3.0	1	F
0.5	25	20	2	10	22	3.0	0	F
0.6	30	20	2	17	22	3.0	0	F
0.7	30	20	2	19	22	3.0	0	F
0.8	30	20	2	21	22	3.0	0	F
0.9	30	20	2	23	22	3.0	0	F
1.0	30	20	3	18	22	4.0	0	F
1.1	30	20	3	18	22	4.0	0	F
1.2	35	20	3	18	22	4.0	0	F
1.3	35	20	3	18	22	4.0	0	F
1.4	45	20	3	19	22	4.0	0	F
1.5	45	20	3	19	22	4.0	0	F
1.6	50	25	3	19	22	4.0	0	F
1.7	50	25	3	19	22	4.0	0	F
1.8	50	25	3	19	22	4.0	0	F
1.9	50	25	3	20	22	4.0	0	F
2.0	55	25	3	24	25	3.5	0	F
2.1	55	25	3	24	25	3.5	0	F
2.2	55	25	3	25	25	3.5	0	F
2.3	55	25	3	25	25	3.5	0	F

Unit : mm

File Name: E0			Material: (Aluminum)			Tube: Brass		
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	8	45	2	6	22	3.5	2	F
0.3	18	40	3	6	22	3.0	3	F
0.4	20	30	2	8	22	3.0	1	F
0.5	25	20	2	10	22	3.0	0	F
0.6	30	20	2	17	22	3.0	0	F
0.7	30	20	2	19	22	3.0	0	F
0.8	30	20	2	18	24	3.0	2	F
0.9	30	20	2	23	22	3.0	0	F
1.0	30	20	3	18	22	4.0	0	F
1.1	30	20	3	18	22	4.0	0	F
1.2	35	20	3	18	22	4.0	0	F
1.3	35	20	3	18	22	4.0	0	F
1.4	45	20	3	19	22	4.0	0	F
1.5	45	20	3	19	22	4.0	0	F
1.6	50	25	3	19	22	4.0	0	F
1.7	50	25	3	19	22	4.0	0	F
1.8	50	25	3	19	22	4.0	0	F
1.9	50	25	3	20	22	4.0	0	F
2.0	55	25	3	24	25	2.5	0	F
2.1	55	25	3	24	25	3.5	0	F
2.2	55	25	3	25	25	3.5	0	F
2.3	55	25	3	25	25	3.5	0	F

Unit : mm

File Name: E0			Material: (Inconel)				Tube: Brass	
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	8	20	2	6	22	1.5	2	F
0.3	10	20	2	7	22	1.5	2	F
0.4	25	20	2	10	22	2.0	1	F
0.5	25	20	2	15	22	3.0	1	F
0.6	25	20	2	15	22	4.0	1	F
0.7	25	20	2	15	22	4.0	1	F
0.8	25	20	2	15	22	4.0	1	F
0.9	25	20	2	15	22	4.0	1	F
1.0	35	25	3	15	22	4.0	1	F
1.1	35	25	3	15	22	4.0	1	F
1.2	35	25	3	16	22	4.0	1	F
1.3	35	25	3	17	22	4.0	1	F
1.4	35	25	3	18	22	4.0	1	F
1.5	35	25	3	20	22	4.0	1	F
1.6	35	25	3	20	22	4.0	1	F
1.7	35	25	3	20	22	4.0	1	F
1.8	35	25	3	20	22	4.0	1	F
1.9	35	25	3	20	22	4.0	1	F
2.0	40	25	3	22	22	4.0	1	F
2.1	40	25	3	22	22	4.0	1	F
2.2	40	25	3	22	22	4.0	1	F
2.3	40	25	3	22	22	4.0	1	F
2.4	40	25	3	22	22	4.0	1	F
2.5	50	40	3	25	22	4.0	1	F
2.6	50	40	3	25	22	4.0	1	F
2.7	50	40	3	25	22	4.0	1	F

File Name: E0			Material: (Titanium)			Tube: Brass		
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	40	40	1	6	24	1.5	10	C
0.3	50	50	2	8	24	2.0	10	F
0.4	50	50	2	10	24	2.0	12	F
0.5	50	80	2	14	24	3.0	12	F
0.6	50	80	2	15	24	3.0	12	F
0.7	50	80	2	15	24	3.0	12	F
0.8	50	80	3	15	24	3.0	12	F
0.9	50	80	3	18	24	3.0	12	F
1.0	60	80	3	18	24	4.0	15	F
1.1	60	80	3	18	24	4.0	15	F
1.2	60	80	3	18	24	4.0	15	F
1.3	60	80	3	18	24	4.0	15	F
1.4	60	80	3	18	24	4.0	15	F
1.5	60	80	3	22	24	4.0	15	F
1.6	60	80	3	22	24	4.0	15	F
1.7	60	80	3	22	24	4.0	15	F
1.8	60	80	3	22	24	4.0	15	F
1.9	60	80	3	22	24	4.0	15	F
2.0	80	90	3	25	24	4.0	15	F
2.1	80	90	3	25	24	4.0	15	F
2.2	80	90	3	25	24	4.0	15	F
2.3	80	90	3	25	24	4.0	15	F
2.4	80	90	3	25	24	4.0	15	F

Unit : mm

File Name: E0			Material: (Copper)				Tube: Copper	
SIZE	ON-T	OFF-T	VS	IP	GAP	F	C	S
0.2	5	25	1	12	22	4.0	0	E
0.3	14	25	2	8	22	4.0	10	E
0.4	20	30	2	8	22	4.0	0	E
0.5	25	20	2	10	22	4.0	0	E
0.6	30	20	2	17	22	4.0	0	E
0.7	30	20	2	19	22	4.0	0	E
0.8	30	20	2	21	22	4.0	0	E
0.9	30	20	2	23	22	4.0	0	E
1.0	60	20	2	24	22	4.0	0	C
1.1	30	20	2	24	22	4.0	0	C
1.2	30	20	2	24	22	4.0	0	C
1.3	30	20	2	24	22	4.0	0	C
1.4	30	20	2	25	22	4.0	0	C
1.5	35	20	3	18	22	4.0	0	C
1.6	35	20	3	19	22	4.0	0	C
1.7	35	20	3	19	22	4.0	0	C
1.8	35	20	3	19	22	4.0	0	C
1.9	35	20	3	20	22	4.0	0	C
2.0	35	20	3	24	22	3.0	0	C
2.1	35	20	3	24	22	3.0	0	C
2.2	35	20	3	25	22	3.0	0	C
2.3	35	20	3	25	22	3.0	0	C

Test data:

Unit : mm

File Name:			Material: SKD-11					Tube: Brass				
SIZE	Thickness	ON-T	OFF-T	VS	IP	GAP	F	C	S	WEAR (%)	TIME	Kg/cm ²
0.2	10	8	17	1	7	22	2.0	1	F	100	33"	100
0.2	25	8	17	1	7	22	2.0	1	F	120	3'30"	100
0.3	25	15	25	2	6	22	2.5	0	F	108	1'30"	70
0.3	25	15	25	2	6	22	2.5	0	F	180	1'00"	70
0.4	25	20	10	2	5	22	2.5	1	F	76	1'47"	65
0.4	25	20	10	2	6	22	2.5	1	F	90	1'16"	65
0.5	25	25	20	2	12	22	3.0	0	F	156	43"	50
0.5	50	25	22	2	14	22	3.0	0	F	200	1'30"	50
0.6	50	30	20	3	12	22	3.0	0	F	150	1'50"	50
0.6	50	30	20	2	18	22	3.0	0	F	100	2'30"	50
0.7	25	30	20	3	15	22	2.5	0	F	120	44"	50
0.7	50	35	20	3	15	22	2.5	0	F	160	1'15"	50
0.8	25	30	20	2	21	22	3.0	0	F	106	42"	50
0.8	50	35	20	3	18	22	3.0	0	F	150	1'36"	50
0.9	25	30	20	2	21	22	3.0	0	F	105	43"	50
0.9	50	35	20	3	18	22	3.0	0	F	145	1'45"	50
1.0	25	30	20	3	18	22	3.0	0	F	96	45"	50
1.0	50	35	20	3	18	22	3.0	0	F	102	1'30"	50
1.5	25	45	20	3	19	22	3.0	0	F	100	1'25"	50
1.5	50	45	20	3	19	22	3.0	0	F	110	2'10"	50
3.0	25	30	20	3	22	22	3.0	0	A	58	3'07"	25

Unit : mm

File Name:			Material: Carbide					Tube: Copper				
SIZE	Thickness	ON-T	OFF-T	VS	IP	GAP	F	C	S	WEAR (%)	TIME	Kg/cm ²
0.2	10	5	25	1	8	22	3.0	2	F	20	10'00"	75
0.2	10.5	5	20	1	7	22	3.0	3	F	30	10'30"	75
0.2	8	6	40	1	8	22	1.5	2	F	150	8'30"	60
0.3	4.5	10	20	2	5	22	2.0	1	F	45	1'36"	60
0.3	10	8	45	2	6	22	2.0	1	F	51	4'67"	60
0.3	10	8	40	1	12	22	1.5	1	F	150	6'30"	50
0.4	10	8	25	1	15	22	3.0	1	F	28	2'15"	60
0.4	25	8	25	1	15	22	3.0	1	F	35	4'40"	60
0.4	20	10	40	1	16	22	1.5	3	F	120	7'00"	50
0.5	10	15	22	1	15	22	3.0	1	F	25	2'40"	60
0.5	25	18	25	1	18	22	2.0	1	F	150	5'00"	60
0.5	20	10	40	1	18	22	1.5	3	F	90	6'50"	50
0.8	10	15	25	1	22	22	3.0	1	F	3.8	3'40"	50
0.8	27	15	25	1	22	22	3.0	1	F	7.5	7'53"	50
0.8	20	12	30	1	25	22	2.0	1	F	100	10'00"	50
1.0	10	15	22	1	24	22	3.0	1	F	10	2'15"	50
1.0	27	15	25	1	24	22	3.0	1	F	4.8	7'35"	50
1.0	88	15	25	2	13	18	2.0	2	F	40	21'45"	65
1.0	20	12	25	1	25	22	2.0	1	F	5	8'30"	50
1.0	50	12	30	2	18	22	2.0	1	F	50	16'10"	50
1.5	20	10	25	2	18	22	2.0	1	F	75	11'00"	50

Unit : mm

File Name:			Material: Copper					Tube: Copper				
SIZE	Thickness	ON-T	OFF-T	VS	IP	GAP	F	C	S	WEAR (%)	TIME	Kg/cm ²
0.2	7	8	25	2	4	22	2	2	F	200	6'30"	60
0.3	7	18	16	2	10	22	2	1	F	210	1'50"	60
0.3	25	18	16	2	10	22	2	1	F	500	8'30"	60
0.4	25	20	18	2	12	22	2	1	F	200	4'00"	60
0.4	18	20	17	2	12	22	1.6	1	F	183	1'22"	75
0.4	25	20	17	2	13	22	1.0	1	F	200	4'29"	75
0.4	63	20	17	2	12	25	1.6	1	F	165	7'07"	75
0.5	63	20	17	3	12	25	1.6	1	F	153	6'27"	60
0.5	25	20	18	2	12	22	2	1	F	100	3'30"	60
0.7	18	20	18	3	15	22	2.0	1	F	105	1'23"	50
0.7	25	20	18	3	15	22	2.0	1	F	110	2'00"	50
0.7	63	20	18	3	15	25	2.0	1	F	98	4'55"	50
0.8	25	20	18	3	15	22	2	1	F	100	3'00"	60
1.0	25	20	18	3	15	22	2	1	F	60	1'50"	60
1.0	38	20	20	2	23	22	0.8	1	F	95	3'00"	50
1.0	63	25	25	3	14	25	2.5	1	F	60	7'24"	50



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