

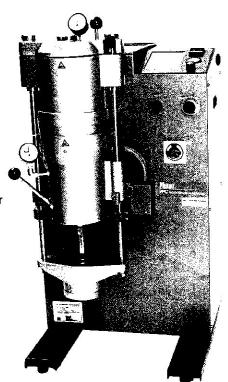
CASTING MACHINE *VPC*MODEL *K3*

INSTRUCTIONS

This instructions manual is for Production Serial No. E001 and later.

Patent China ZL98803885.4, U.S. 6,253,828 B1 Patent pending in other countries under International No. PCT/CH98/00103 Int. Publication No. WO 98/45071

Patent U.S. 5,948,351 Utility Model China 97231790.2, Germany 297 22 779 U1



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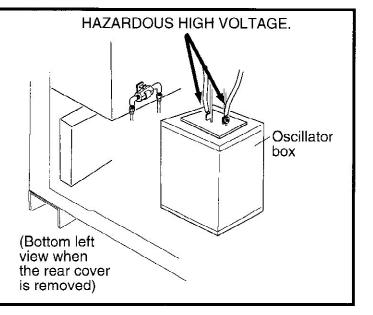
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1. SAFETY INSTRUCTIONS

⚠ ⚠ DANGER

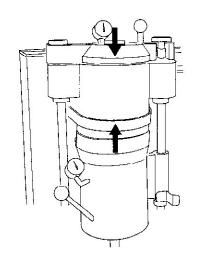
Do not open the panel unless instructed in this manual, because hazardous voltage is flowing inside the machine. When it is necessary to open the panel, always turn power off before opening the panel for safety, otherwise hazardous voltage can shock, burn or cause death.



⚠ WARNING

1. When you press the START button, do not place fingers, hands, a part of body, or an article between the bottom of the lid and the top of the melting chamber or between the bottom of the melting chamber and the top of the mold chamber.

When you press the START button, the lid will move downwards and the mold chamber will move upwards to close with pressure. Their pressing force to close is very strong.



IMPORTANT:

When you need to release the lid or the chamber, press (RESET) key immediately.



The lid of the chamber does not open by pressing the EMERGENCY STOP button.

If you release the START button while the lid is lowering, the lid moves upward to its original position.

If you release the START button in one second after the lid starts to close, the lid moves upward to its original position.



2. When you check, replace, or clean the crucible, the heating coil and the mold chamber and their surrounding area, after heating has been applied, wait until they are at room temperature, otherwise your may suffer burns.



3. Do not place any material on the operation panel because misoperation of equipment may be caused. Do not place any material on the lid and its surrounding area.



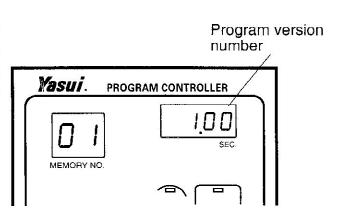
CAUTION



- 1. Do not look into the molten metal continuously for a long time. Wear protection glasses.
- 2. Check that no crack or breakage is observed on the crucible, protection crucible, before their setting. Do not push the crucible body, or metal in the crucible, strongly. When the crucible has a crack, molten metal may leak through it, resulting damage of the machine.
- 3. Crucibles have their casting lives. Do not use a deteriorated crucible. Check condition of the crucible before use.
- 4. Do not leave the machine running unattended.

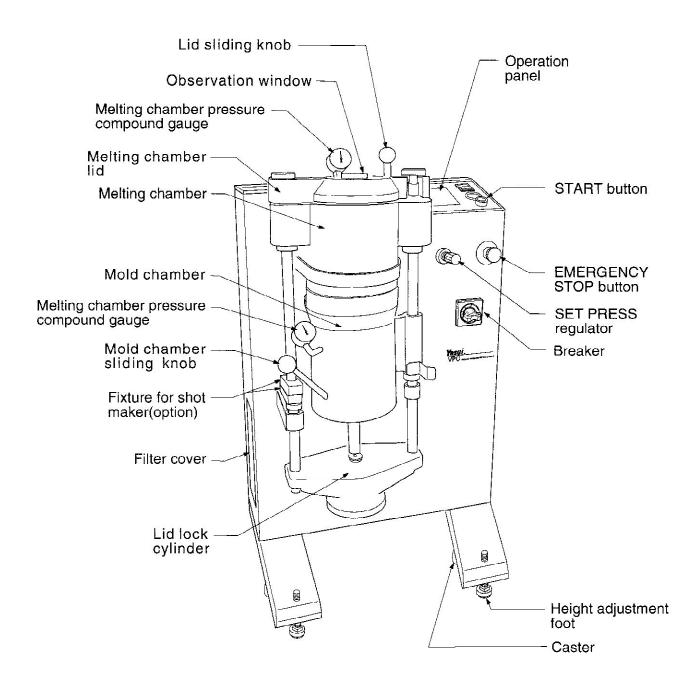
- THE MANUFACTURER SHALL IN NO EVENT BE LIABLE FOR ANY DAMAGE RESULTING FROM IMPROPER USE, NEGLIGENCE TO FOLLOW THE WARNINGS AND CAUTIONS IN THE INSTRUCTIONS MANUAL OR THE LABELS ON THE MACHINE, UNSKILLFULNESS, USE OF NON-ORIGINAL OPTIONAL/CONSUMABLE ACCESSORIES/ SPARE PARTS, NON-AUTHORIZED MODIFICATION.
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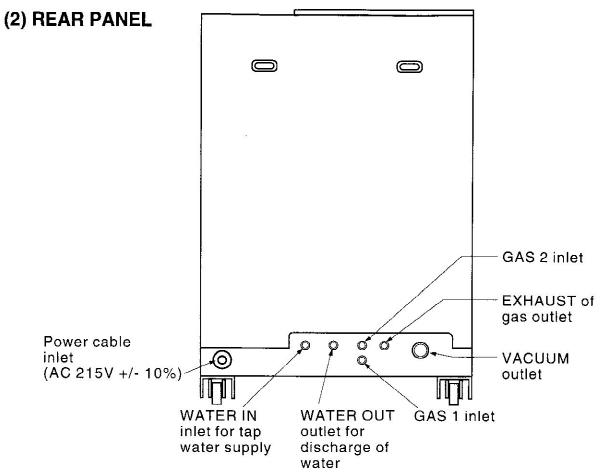
This manual is for the machine whose program version number is <u>1.00 or later</u>. The program version number is displayed at the operation panel as the figure just after power is turned ON.

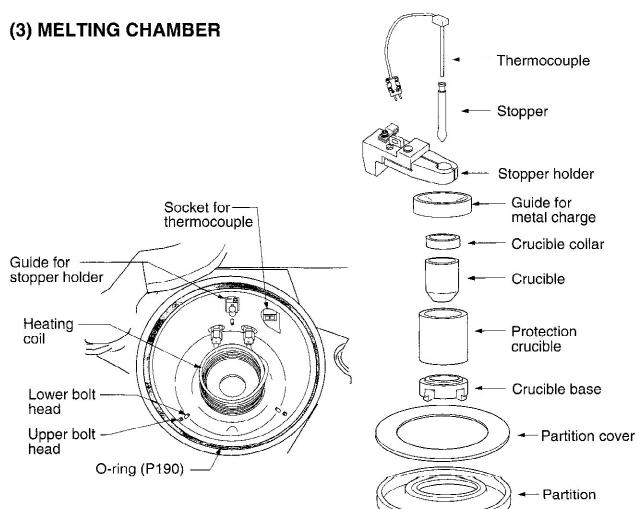


2. NOMENCLATURE

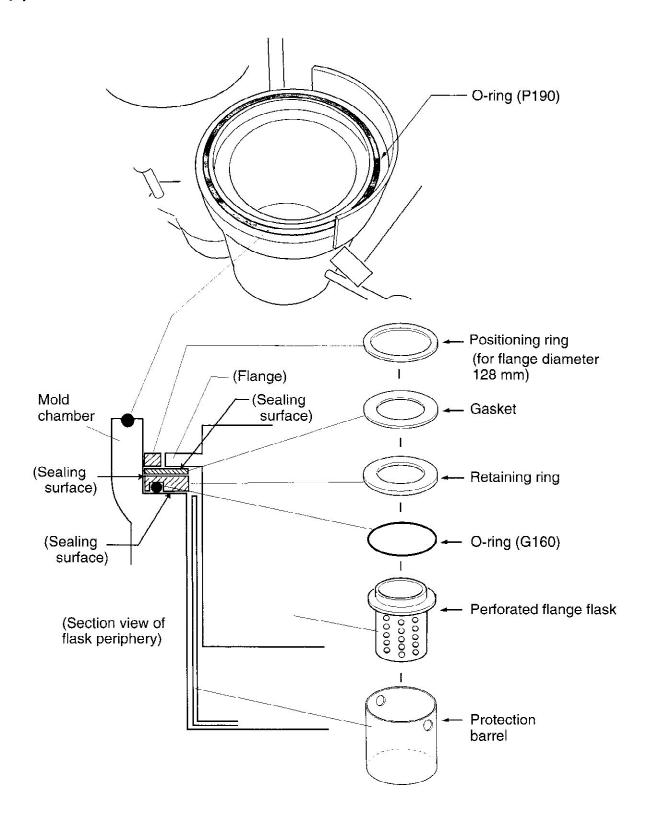
(1) MAIN BODY







(4) MOLD CHAMBER



3. PREPARATION BEFORE CASTING

3-1. CHECKING POINTS BEFORE POWER ON

Check the below points prior to power ON.

- (1) Connection of vacuum pump and its rotation direction
- (2) Pressure of supply inert gas
- (3) Connection of hose to WATER IN
- (4) Connection of hose to WATER OUT

ACAUTION

Make sure before starting heating the coil that the faucet of water is turned on and the tap water is running inside machine.

3-2. SETTING CRUCIBLE AND OTHER PARTS

Set up the below items.

Melting chamber

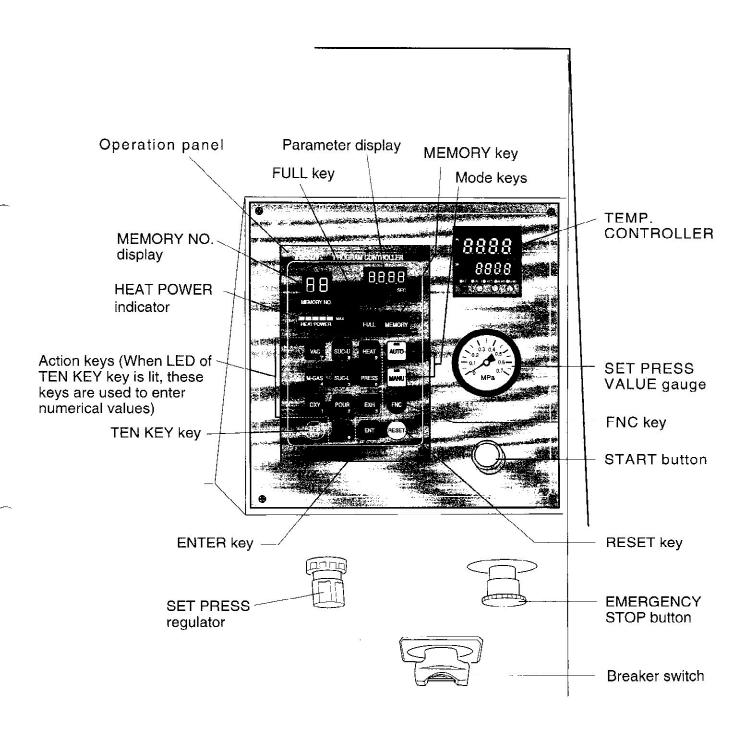
- (1) Crucible, crucible base, protection crucible, crucible collar, guide for metal charge (P.8)
- (2) Partition, partition cover (P.8, 77)
- (3) Stopper holder, stopper (P.8, 78-79)
- (4) Thermocouple (P.8, 78-79)

Mold chamber

- (1) Protection barrel, retaining ring with O-ring, gasket, positioning ring (P.9) Below mold chamber
 - (1) Cover for cylinder rod (P.77)

4. OPERATION-1 (BASIC OPERATION)

4-1. OPERATION PANEL



(1) START button

- If you press and hold the START button for more than one second during the AUTO mode, the lid will move downward and locked, then casting process is started automatically.
- If you press and hold the START button for more than one second during the MANUAL mode, the lid will move downward and locked.



- By pressing (RESET) key, you can stop operation. After pressure in the melting chamber

has returned to one atmospheric pressure, the lid opens.

- This key is used to stop casting operation.
- This key is also used to open the lid in emergency.

(3) EMERGENCY STOP button

In the case of emergency, press the EMERGENCY STOP button to stop all of the functions.

- To recover, turn it clockwise. To release the lid-lock state, press (RESET



(4) TEMP. CONTROLLER

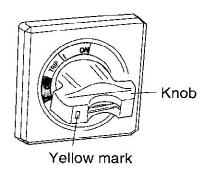
- The TEMP. CONTROLLER is used to set casting temperature. Casting temperature is registered to each Memory No. as parameter. At the time of starting, this registered value (degrees Celsius) replaces the set value (SV=casting temperature) of the TEMP. CONTROLLER.
- In the case of MANUAL mode, heating is applied after lid-lock to SV as the target temperature, then it is possible to change setting of SV freely.

(5) SET PRESS Regulator and SET PRESS VALUE Gauge

- Turn the SET PRESS regulator knob to set the final pressurization value of the internal pressurization tank.
- Set value is indicated by the SET PRESS VALUE gauge on the operation panel.
- Maximum pressure value of this machine is 0.1 MPa (100 kPa). When you finish turning the knob, push the knob in for locking.

4-2. POWER ON

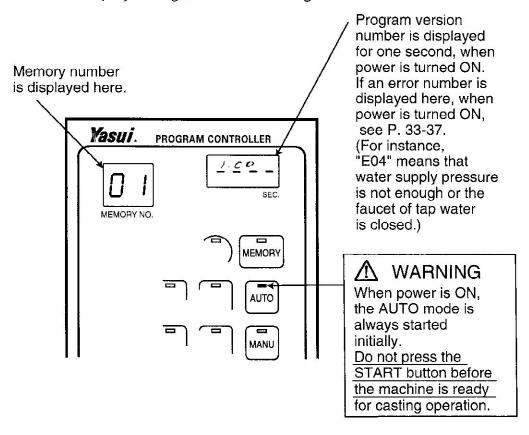
Turn the knob of the BREAKER switch until its yellow mark is set to ON position. Power is supplied to all necessary parts.



IMPORTANT: Turn the knob securely until it clicks into place.

IMPORTANT: When the yellow mark of the BREAKER switch moved to TRIPPED position during use of the machine, overcurrent has flown inside the machine (the machine became TRIPPED condition by overcurrent). In this case, turn the knob to OFF position. Then, check the cause and take necessary action. Next, turn the knob to ON.

Program version number of the machine is displayed on the operation panel for one second, and then the display changes as the below figure.

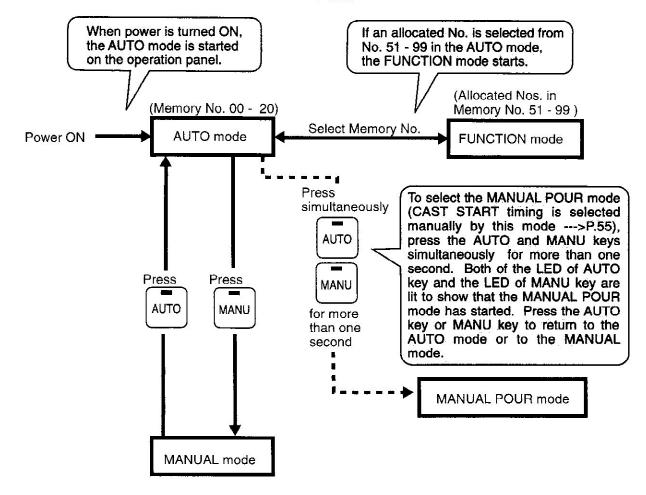


4-3. MODE SELECTION

There are three main modes;

- AUTO mode
- MANUAL mode
- FUNCTION mode

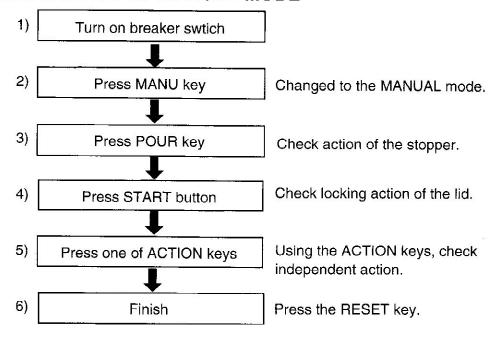
Those modes can be selected as the below chart.



4-4. BASIC OPERATION (QUICK REFERENCE)

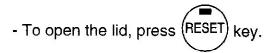
4-4-1. MANUAL MODE

4-4-1-1. SEQUENCE OF MANUAL MODE



4-4-1-2. OPERATION TEST OF MANUAL MODE

- 1) Turn the BREAKER switch to turn power ON. LED of AUTO key is lit.
- 2) Press MANU key.
- 3) While the lid is opened, press POUR key to check up and down movement of the stopper.
- The LED of key is lighted during action.
- When the stopper is lowered, check that the lower end of the stopper is pressed fittingly against the inside bottom of the crucible.
- 4) Slide the lid to the position just above the melting chamber, and then press the START button to lock the lid.
 - Actions of VAC M-GAS OXY are possible during the lid-lock state only.



- 5) Using the ACTION keys, check independent action.
 - 5-1) Press and hold VAC key. While pressing and holding this key, the chambers are evacuated.

If you wish to continue evacuation for a long time, first press FNC key, and second press VAC key.

- 5-2) Suspend evacuation when vacuum level becomes 98 to 100 kPa. Vacuum level is shown at the parameter display.
 - Vacuum level can also be shown at the gauge on the lid.
 - If you press (RESET) key, air is introduced into the chamber and the lid is opened.
- 5-3) Under vacuum, check the below functions.
 - 5-3-1) When you press and hold M-GAS key, inert gas is introduced into the chambers.

Gas introduction will stop when you release the key.

5-3-2) When you press and hold OXY key, air is introduced into the chambers.

(When the pressure inside the chambers is above one atmospheric pressure, inert gas inside goes out.)

5-3-3) When you press and hold EXH key, air is introduced into the chambers.

(When the pressure inside the chambers is above one atmospheric pressure, inert gas inside goes out)

5-3-4) Press HEAT key to start heating. At trial heating, it is better to set the SV of

the TEMP. CONTROLLER lower than 400 degrees centigrade to protect crucible and other surrounding parts. The PV window of the TEMP. CONTROLLER displays the present process temperature value of the thermocouple (thermo sensor). Check that PV value in the window shows increase. The HEAT POWER indicator on the operation panel shows the output power status of the built-in oscillator.

5-3-5) Press SUC-U key and SUC-L key to confirm by sound that the built-in electromagnetic valves are activated.

5-3-6) Press PRESS key and check pressurization function.

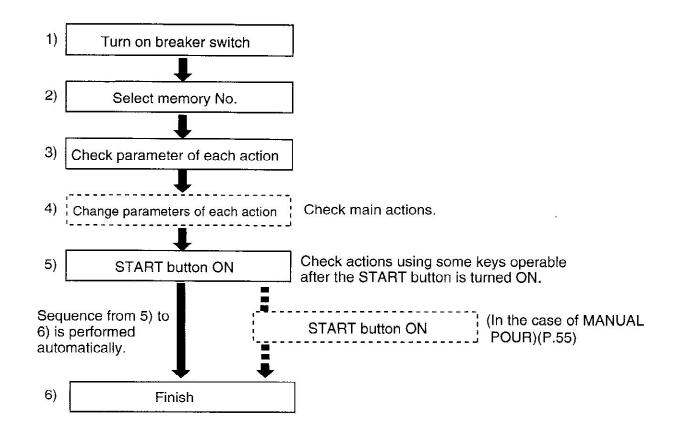
Check that pressure value is set to the desired level (P.12 (5)) by the SET PRESS regulator.

5-3-7) Press EXH key to check that pressure inside the chamber becomes atmospheric value.

6) Press (RESET) key to finish the operation test of the MANUAL MODE.

4-4-2. AUTO MODE

4-4-2-1. SEQUENCE OF AUTO MODE



4-4-2-2. OPERATION TEST OF AUTO MODE

1) Turn the BREAKER switch to turn power ON. LED of AUTO key is lit.

2) Select Memory No.

Example: to select Memory No. 01

Note: When you wish to enter numeric values, you need to press (TEN KEY) key so that

each action key works as a numerical key.

3) Checking parameters

Check parameters of principal actions.

3-1) Press VAC key. Then, LED of VAC key is lit and latest data is shown on the parameter display window.

- 3-2) Press SUC-U key to check the parameter of SUC-U.
- 3-3) Press (HEAT 9) key to check the parameter of SV.

4) Changing parameters

Turn on the LED of an action key whose parameter is to be changed. Next, press



key, so that each action key works as a numerical key. Then parameter of that key can be changed by input of numerical value.

Example:

$$\begin{array}{c} - \\ VAC_{7} \end{array}$$
 ---> $\begin{array}{c} - \\ TEN \\ KEY \end{array}$ ---> $\begin{array}{c} - \\ 0 \end{array}$ to $\begin{array}{c} - \\ HEAT \\ 9 \end{array}$ (0 - 9) ---> $\begin{array}{c} - \\ ENT \end{array}$

- Each action key has a limit range of input numerical value.
- Decimal point is automatically inserted, so you need to press the numerical keys only to enter parameters.

Example: To input "5.5" for M-GAS

5) START

Check the action process after pressing the START button.

When the START button is pressed, the lid automatically moves down and is locked, then evacuation process is started first.

Note: If LED of (TEN) or any action key is lit at the time of pressing the START

button, the casting process can not be started.

- Parameter value, which corresponds to a process just in action, is displayed on the parameter display window.

Parameters corresponding to \underbrace{VAC}_{7} and \underbrace{EXH}_{3} keys are displayed by countdown. See the flow chart in P.52 for details of actions.

- After the START button is pressed, you may activate functions of VAC M-GAS

OXY FULL keys manually within the limited time (P.52) only.

- After the START button is pressed, SV value of the TEMP. CONTROLLER is overwritten by parameter which is already set by HEAT key, but it is possible to change this value by the TEMP. CONTROLLER before CAST START (C) (P.52) is started. (However this change by the TEMP. CONTROLLER will not be stored into the parameter memory.)

↑ CAUTION

During sequence of action process, you can break the sequence by pressing (RESE



key. Then, the lid opens and the sequence will return to the initial condition. By pressing the EMERGENCY STOP button, process is suspended, however the lid does not open. Use the EMERGENCY STOP button in the case of emergency only.

6) Finish of Operation Test of AUTO MODE

When time set by EXH key is counted, the lid opens automatically to finish the automatic sequence.

Before starting next casting, be sure to perform trial action of the stopper to check that the lower end of the stopper makes contact with the hole at the bottom of crucible properly. Clean slag on the surface of crucible and stopper with a hard brass-wire brush or the like (P.28 "7-3. CRUCIBLE AND STOPPER").

POUR action is possible independent of the lid action.

In the case of AUTO mode: FNC ---> POUR

In the case of MANU mode: POUR

4-4-2-3. PARAMETERS PRESET AT FACTORY

Factory preset values are registered in Memory Nos. 00, 01, 02 and 03.

Parameters of No. 00 can not be changed, however it is possible to use by copying from another Memory No.

Parameters of K3 Preset at Factory

| MEM | ORY NO. | 00 | | 01 | | 02 | | 03 | |
|------|---------|-----------------|-------|---|-------|---|-------|--------------------------------------|-------|
| V | AC | 60 | sec | 30 | sec | 30 | sec | 10 | sec |
| M | I-GAS | 4 | sec | 8 | sec | 0 | sec | 4 | sec |
| 0 | XY | 0 | sec | 0 | sec | 3 | sec | 0 | sec |
| S | UC-U | 0 | sec | 2 | sec | 0 | sec | 0 | sec |
| SI | UC-L | 10 | sec | 10 | sec | 10 | sec | 10 | sec |
| P | OUR | 1 | sec | 1 | sec | 1 | sec | 1 | sec |
| ► PI | RESS | 1 | sec | 1 | sec | 1 | sec | 1 | sec |
| E | XH | 180 | sec | 180 | sec | 180 | sec | 180 | sec |
| Н | EAT | 1000 | deg.C | 1000 | deg.C | 1000 | deg.C | 1000 | deg.C |
| M | lethod | General casting | | Casting for metal which contains much amount of zinc | | Casting for metal which contains anti-oxidation agent | | Casting b "mold-in a preheatin | after |

IMPORTANT

- [1] VAC parameter is for use of vacuum pump whose capability is about 300 liters per minute.
- [2] Adjust the flowing speed of M-GAS in accordance with manual instructions.
- [3] Increase the PRESS parameter value as metal amount becomes larger.
- For example, in the case of 14 K gold, "400 grams 1 second" or "800 grams 2 seconds" is standard.
- [4] If longer EXH value is set, oxidation of the crucible will be smaller, which will result in extended life of the crucible.
- [5] Adjust the HEAT parameter depending upon metal.
- [6] Set the pressure of the internal pressure tank by adjusting the SET PRESS regulator so that pressure inside the melting chamber after metal pouring will be within from 0.08 to 0.1 MPa (in case almost maximum pressure is used).

The above parameters are for standard casting process.

It is necessary to modify the parameters, depending upon kind, shape, size and amount of metal.

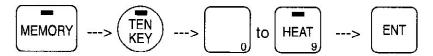
4-4-3. FUNCTION MODE

The FUNCTION mode uses the allocated numbers in Nos. 51 - 99.

Action parameters commonly used by all Memory Nos. for the AUTO mode are set in the FUNCTION mode. See P.58 - 67 for details.

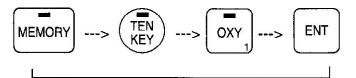
4-4-4. COPY OF PARAMETERS

1) Input Memory No. from which copy is taken.

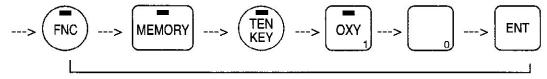


2) Input FNC key and Memory No. to which copy is sent.

Example: To copy parameters from Memory No. 01 to Memory No. 10



Copying from Memory No. 01

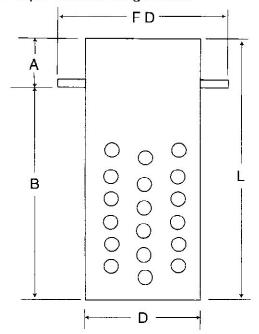


Copying to Memory No. 10

5. FLASK

5-1. FLASK TO BE USED

Use a perforated flange flask.



<Size of usable flask>

F D = 128 mm
(when the standard positioning ring
provided is used)
D = 89 mm (3 1/2 inches) to 125 mm (5 inches)
L = Max. 230 mm (9 inches)

A = less than 30 mm and B = less than 200 mm

When FD, or D is larger than the above standard value, a speical positioning ring (option) is necessary.

5-2. SETTING FLASK

Set the peripheral parts of flask as shown in P.9.

IMPORTANT:

The underside of the flange part of the flange flask should be sealed, otherwise casting results may be affected. Always check it.

- 1. Do not use a flask whose flange has scratches or deformation.
- 2. Scrape spilled investment or the like adhered to the underside of the flange before burnout.





Do not slide the mold chamber toward the machine body too fast.

5-3. GASKET CONDITIONS

As the gasket is used for times, its sealing capability may be weakened, and casting result may be affected. When deterioration of the gasket is found, replace into a new one. The gasket has its life. It is recommended to keep its spares in your stock.

NOTE:

In one of the below cases, it is possible that the gasket is deteriorated or the investment mold inside the flask may be cracked.

- [1] Pressure of melting chamber indicates rapid decrease suddenly after pressurization.
- [2] Pressure increase is slower than usual at the time of pressurization.
- [3] Suction speed (after cast start) is slower than usual.

6. PRESSURE DISPLAY

The pressure gauge of the machine is indicated by "Gauge Pressure".

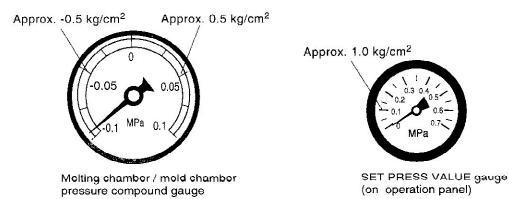
"Gauge Pressure display" is preset on the assumption that ambient atmospheric pressure at the factory is "0".

Therefore, when starting to use the machine just after its installation, pressure display value may become lower than zero depending upon ambient air atmosphere where the machine is installed, at highland for example. In this case, the below zero-adjustment is necessary before starting to use the machine.

AUTO MODE ---> Press the START button ---> Immediately press (RESET) key so that operation is stopped.

The machine automatically performs zero-adjustment at the time of starting casting by the AUTO MODE, so it is not necessary to do zero-adjustment, except zero-adjustment for the first time use just after installation at highland place.

| | Kg/d | cm ² | MP | а | | | |
|--------------|---------------------|--------------------|--------|----------------|------|-----|--|
| | 2.03944 | Kg/cm ² | 0.2 | MPa | | | |
| | 2 | Kg/cm ² | 0.196 | MPa | | | |
| 1 | 1.0197 | Kg/cm ² | 0.1 | МРа | | | Maximum pressurizaton level of the machine |
| | 1 | Kg/cm ² | 0.098 | MPa | 98 | kPa | 10 FOI OF THE MICEONING |
| | | | | | | | |
| Ĭ | Atmospl pressure | neric | 0 | MPa | 0 | kPa | |
| | <u> </u> | * | | 18 - 5275-2976 | | _ | |
| Vacuum. | -1 | Kg/cm ² | -0.098 | MPa | -98 | kPa | |
| Va | -1.0197 | Kg/cm ² | -0.1 | MPa | -100 | kPa | Near perfect vacuum |



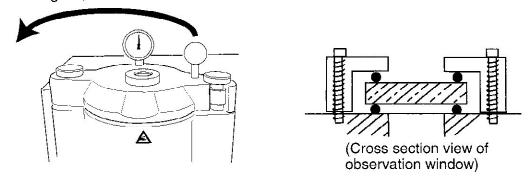
7. MAINTENANCE

MARNING

- [1] Before starting maintenance or checking, be sure to turn the BREAKER switch OFF for safety. Be careful that electric current continues flowing in some part of the machine even when the BREAKER switch was turned OFF, unless the power supply cord is unplugged from the power outlet.
- [2] Care should be taken so that the skin is protected from direct contact with heated parts after heating is applied, because it requires some time for each part to cool down.

7-1. CLEANING OBSERVATION WINDOW

When the inside surface of observation window for melting became dirty, rotate the lid to left side as the figure, and then clean the surface of the lens from beneath.



IMPORTANT:

- [1] When removing the glass casing for replacement of glass, take special care not to drop the glass.
- [2] It might be better not to remove the lens from the casing except for replacement of glass, because vacuum leakage might be caused.

7-2. GAS CYLINDER

Replace a gas cylinder early when remaining amount in the cylinder became small. Take enough care during replacement of gas cylinder, so that any dust will not enter the inside of gas tube.

7-3. CRUCIBLE AND STOPPER

1. After casting, slag sticks on the surface of crucible and stopper. Always clean it with a hard brass-wire brush or the like before next casting.

↑CAUTION

When those parts are not cleaned, leakage of molten metal may be caused, resulting inferior casting. Further, a trouble which hinders normal operation of the machine may be caused, so take deliberate care about leakage of molten metal.

2. Shape of the crucible and the stopper will transform after long time use. That's why you need to check every time before casting to see whether the lower end of the stopper and the inside bottom opening of the crucible are securely fitted for perfect sealing.

7-4. FILTERS FOR CHAMBERS

7-4-1. CLEANING

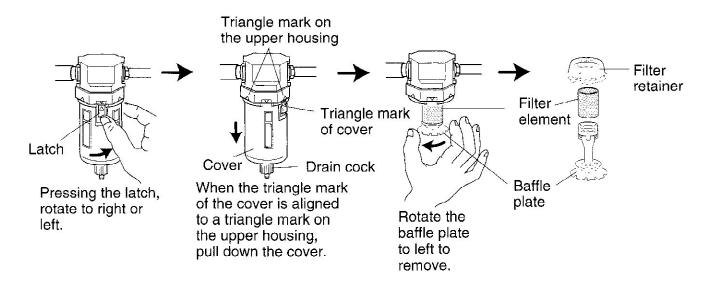
Two filters are installed inside the panel for filter.

- Clean the filter for mold chamber after every daily work.
- Cleaning of the filter for melting chamber depends on amount of zinc contained in the molten metal you use, however, it is better to clean that filter frequently.

Condition of the filter is likely to affect casting results. When the mesh of the filter element in the vacuum filter is clogged, it may be better to replace the element with a new one.

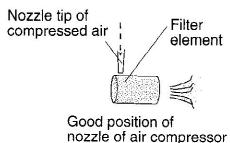
7-4-2. DISASSEMBLING FILTER UNIT

Open the filter panel on the left side of the machine. You will see similar two filters. Both two filters should be frequently checked and cleaned.



7-4-3. CLEANING FILTER

Press the tip of the air compressor nozzle on the outer surface of the filter. If you place the tip of nozzle of a vacuum cleaner (available in the market) inside the filter, cleaning will be more effective. When it is difficult to remove clogged dusts, use an ultrasonic cleaner available in the market for cleaning.

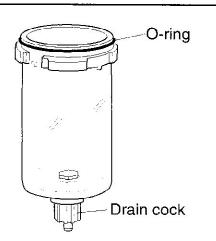


7-4-4. REASSEMBLING

Check that the O-ring is put back in place at the time of reassembling. Apply grease on the surface of the O-ring for better sealing.

IMPORTANT:

- [1] Take care at the time of reassembling the filter element that dust or investment particles shall not enter inside.
- [2] Drain cock should be always tightened. Do not loosen it.



[3] Use only grease made for exclusive use for vacuum sealing. Do not use grease which is available for general mechanical use etc.

7-5. THERMOCOUPLE

7-5-1. DETERIORATION OF THERMOCOUPLE

- -The thermocouple is a consumable accessary which deteriorates by use. Deterioration speed depends on frequency of use and surrounding circumstances.
- When it further deteriorates, temperature value displayed on the temperature controller becomes lower in comparison with actual metal temperature and crucible temperature normally.
- So, it is necessary to check the thermocouple periodically. If temperature error is large, it is necessary to replace the thermocouple with a new one.

7-5-2. CHECKING METHOD

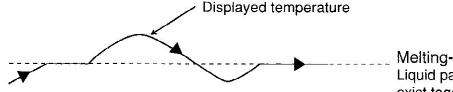
7-5-2-1. MELTING TEMP. MEASURING METHOD

Using the *K3* machine, measure melting temperature of the metal whose melting point is already known as physical property value. Then, compare measured melting temperature with the physical property value to find deterioration state. Pure silver is recommended for this method, because handling is easy (melting temperature of pure silver : approximately 962 degrees Celsius).

Method of measuring melting-down temperature

- 1) Apply heating by MANUAL mode. Raise SV value from low value slowly. Melt the metal down once, and then adjusting the SV up and down find a point where liquid part and solid part is half and half.
 - When the thermocouple deterioration is much, melting-down temperature display value is lower than physical property value normally.
 - When the thermocouple is further deteriorated, display temperature value fluctuates largely up and down, and the thermocouple wiring is broken later.

Finding melting-down point



Melting-down temperature Liquid part and solid part exist together.

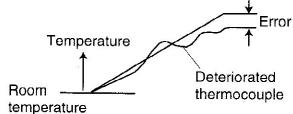
- 2) Determine permissible range by yourself to such degrees that casting is not affected.
 - In the case of normal condition, it will be within about 10 degrees Celsius, when instrumental error of the thermocouple installed in the machine and error caused by other factors are taken into consideration.
 - If melt-down display is lower than permissible value (for example, 952 degrees centigrade), replace the thermocouple with a new one.
 - As far as deviation is small, it is possible to continue to use it by setting bias value to the temperature controller. However, in this case, bias value is added to room

temperature too as shown in the below figure.

Bias compensation

temperature

*Error caused by deterioration becomes larger when temperature is higher. Generally, display value is lower than actual temperature value. ---- R-type thermocouple (Note that in the case of K-type thermocouple, display value may be higher than actual value)



7-5-2-2. COMPARISON METHOD

If an external temperature controller for calibration (not supplied from the manufacturer) and a new thermocouple can be arranged, measurement will be carried out easily. Know-how about identifying melting-down point is no more necessary. So, this comparison method is simple for usual daily maintenance. However, measurement variation is comparatively larger, depending on instrumental error of the temperature controller and measurement position.

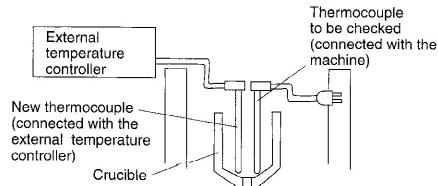
Method of measuring thermocouple



ELECTRIC SHOCK HAZARD: High voltage current flows on the crucible and heating coil during heating. Only qualified service personnel should perform this measurement method. Improper measurement could result in serious injury or death.

- 1) Put a new thermocouple in the same crucible. Connect the new thermocouple with the external temperature controller for calibration. Instrumental error of the temperature controller is approximately +/- 3 degrees Celsius.
- 2) Place the two thermocouples side by side near the center in the crucible. (Stopper is not used.)

 Thermocouple



- 3) Slide the lid to just above the melting chamber (However, do not look the lid at this time. The wire from the new thermocouple passes through the a few millimeter gap between the lid and melting chamber.) (It is not necessary to charge metal.) Apply heating by MANUAL mode.
- 4) Watch deviation in proper temperature zone (about 1000 degrees Celsius).
- 5) When difference between displayed temperature values of the two thermocouples are more than specified range, replace the thermocouple connected to the machine. Determine replacement timing by yourself, considering casting results.

7-5-2-3. REFERENCE DATA

- Tolerance of the temperature controller used in the K3 machine is \pm -3 degrees Celsius at the time of shipment from factory.
- Tolerance of the thermocouple used in the K3 machine at the time of shipment from factory is shown in the table.

| K type | 0.0075 [t] | IEC standard | +/- 7.5 degrees C at 1000 degrees C |
|--------|------------|--------------|--|
| R type | 0.0025 [t] | IEC standard | +/- 3.3 degrees C at 1300 degrees C |

- Tolerance of the whole *K3* machine at the time of shipment from factory is larger, because the relay terminal block, compensating lead wire etc. are included.

7-5-2-4. HANDLING OF THERMOCOUPLE

- Store the thermocouple in a dry place. Insulation resistance may be decreased in a humid place. Furthermore, if it is heated rapidly to high temperature zone when it contains moisture, its ceramic tube may be broken.
- When you remove the thermocouple unit from the machine, always disconnect its cord by pulling on the plug. The thermocouple is made of very thin metal wire. So, if you yank the lead wire to disconnect the plug, the lead wire may be broken.
- Take deliberate care when you set the thermocouple in position so that its lead wire should not be strained.
- When you dispose the thermocouple, observe the regulations on industrial waste disposal.
- * Material wire of the R-type thermocouple is precious metal.

8. TROUBLE

8-1. ERROR NUMBER

8-1-1. ERROR NUMBER LIST

When an error number was displayed on the parameter display window, take necessary actions as below.



If you do not take an action and ignore the error number, the machine may be seriously damaged.

- In the case of an error number without R mark in the below list, the machine continues to operate its casting process displaying the error number. You need not suspend this casting process. After this casting process has been finished, check the machine for

solution. If you press (RESET) key during this casting process, this casting process is

suspended and the machine is turned back to its normal standby state.

- In the case of an error number with R mark in the below list, casting process is automatically suspended. After error number is indicated, the chamber is opened to air.

Press (RESET) key to reset the machine to initial state. Then, check for solution.

| | Display | Description |
|---|---------|---|
| R | E 0 1 | Oscillator alarm |
| | E 0 2 | Lid/mold chamber open (at starting casting operation) |
| R | E 0 3 | EMERGENCY STOP button ON |
| R | E 0 4 | Water supply abnormality |
| R | ЕОЬ | Communication errror of TEMP. CONTROLLER |
| R | רם | Measurement temperature error |
| R | E 0 9 | Panel open / High temperature of drain water |
| | E 10 | Parameter over limit |
| | E 12 | Process time over |
| | E 14 | Voltage alarm (out of 195 V - 245 V) |
| R | E 15 | Voltage abnormality (out of 180 V - 260 V) |
| | E 1P | Power failure record |
| | E20 | Operation panel contact abnormality |
| R | E 2 2 | Evacuation abnormality |

8-1-2. CAUSE & SOLUTION OF ERROR NUMBER

(1) E [] | Oscillator alarm

(2) E 0 2 Lid/mold chamber open

CAUSE: This number is displayed if lid-lock is activated when the lid is not slid in position just above the melting chamber or when the mold chamber is not slid in position securely or the sensor is not positioned correctly.

SOLUTION: Press RESET key once, so that the error number will be turned off.

Then, close the lid or mold chamber securely, and then activate locking of the lid. Try this a few times, and if the same error number appears, it becomes necessary to check the action of the sensor. If the same error number appears, contact with the distributor at your place.

(3) E [] 3 EMERGENCY STOP button

CAUSE: The EMERGENCY STOP button is pressed in.

SOLUTION: Turn the knob of the EMERGENCY STOP button clockwise, and then

press (RESET) key. If the same error number appears, turn the BREAKER switch

OFF once, and then turn it ON again.

(4) E [] 4 Water supply abnormality

CAUSE:

- 1) The valve of tap water supply is not opened.
- 2) Flowing water amount or water pressure is not enough.
- 3) The strainer is clogged.

SOLUTION:

- 1) Open the valve of tap water supply.
- 2) Amount of water supply should be more than 3 liters per minute. Water pressure should be over 1.5 kg/cm².
- 3) The strainer is clogged. Remove its nut and rinse the internal filter (metal mesh)

with water.

(5) E D 6 Communication error of TEMP. CONTROLLER

CAUSE: Communication was suspended momentarily between the control unit board and the TEMP. CONTROLLER.

SOLUTION: Press (RESET) key once, so that the error number will be turned off.

Then, operation can be continued. However, it may be possible that HEAT parameter can not be used. After casting is finished, it will be necessary to check wire connection of communication line. Contact with the distributor at your place.

(6) E [] 7 Measurement temperature error

CAUSE: During casting process by the AUTO MODE, temperature at the time of pouring is automatically checked by the machine. If the temperature exceeds the specified limit (K type 1250 degrees C, R type 1450 degrees C), this error number is indicated.

SOLUTION:

Automatic process after the POUR action continues normally, however;

- 1) In the case of FULL heating, stop FULL heating immediately.
- 2) Check that the cable of the thermocouple does not have breaks.
- 3) Check that selection of the type of the thermocouple (K or R) is correct.
- 4) Replace the thermocouple into a new one.
- 5) Check that the cable between the thermocouple and the TEMP. CONTROLLER is not disconnected.
- 6) Check the TEMP. CONTROLLER (P. 81 84).

(7) E [] Panel open / High temperature of drain water

CAUSE:

- 1) The side or rear panel of the machine body is open.
- 2) Water supplied to the machine is discharged outside after cooling inside of the machine, and when temperature of discharge water is abnormally high, this error number is displayed.

SOLUTION:

- 1) Close the panel of the machine body.
- 2) Check that water supply temperature is less than 30 degrees centigrade, water

supply amount is more than 3 liters/minute and water supply pressure is more than 1.5 kg/cm².

(8) E I Parameter over limit

CAUSE: Entered parameter was over limit.

SOLUTION: Check input range and enter parameter again.

(9) F 12 Process time over

CAUSE: When it took more than 2019 sec. from start to finish of casting, this error number is displayed. When speed of temperature rise is abnormally slow, this error number is displayed as well.

SOLUTION: Check entered parameter value. Also, remove any other causes.

(10) E 14 Voltage alarm

CAUSE: When power supply voltage exceeded the range of 195 V - 245 V, this error number is displayed.

SOLUTION: Press (RESET) key once, so that the error number will be turned off.

Then, operation can be continued. However, there is possibility of breakage of the internal electrical parts, so there may be a need of checking them before use.

(11) E 15 Voltage abnormality

CAUSE: When power supply voltage exceeded the range of 180 V - 260 V, this error number is displayed.

SOLUTION: The machine automatically stops heating at once. Press (RESET) key,

then turn the BREAKER switch off. After improving power supply voltage to standard value (215 V +/-10%), turn the BREAKER switch on again.

(12) E Ib Power failure record

CAUSE: When power was suspended during the AUTO MODE process, this error number is displayed at the time of power recovery.

SOLUTION: Press RESET key once, so that the error number will be turned off.

Then, operation can be continued.

(13) E 2 [] Operation panel contact abnormality

CAUSE: When power is turned ON, contact points are automatically inspected. If there is any short-circuited switch or button, this error number is displayed. SOLUTION: It is necessary to check whether wiring is normally connected, and the key panel board is normally working. Contact with the distributer at your place.

(14) Evacuation abnormality

CAUSE: During the AUTO MODE, when vacuum degree at 10 seconds after start of vacuum action is near to atmospheric pressure (smaller than - 20 kPa), this error number is displayed.

SOLUTION: Check the below 1) to 4).

- 1) Parameter of VAC is extremely short (0 to 2 seconds).
- 2) The vacuum pump is disconnected.
- 3) O-ring of the melting chamber or mold chamber is not set securely. If problem can not be solved after checking above, the knob of SET PRESS regulator may be malfunction. Contact with the distributer at your place.

8-2. ALARM LED ON OSCILLATOR UNIT

When the error number [[] is shown on the operation panel, open the right-side

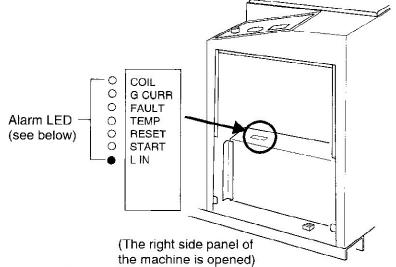
panel of the machine, and check the LEDs on the cover box of oscillator unit. Note that some of the below LEDs show alarm without display of the error number on the operation

panel.

LEDs of COIL,G CURR and FAULT are lighted, when

you turn HEAT key ON and

there is malfunction.



COIL (Color: yellow, Resonance circuit)

- The crucible is not set in position.
- The heating coil is short-circuited.

G CURR (Color: red, Ground-fault current)

- Short-circuit between the heating coil and chamber.
- Other internal element may be broken.

FAULT (Color: red, Output overcurrent)

- The heating coil is short-circuited.
- Other internal element such as the power transformer etc. may be broken.

TEMP (Color: yellow, Inside temperature)

Temperature inside the oscillator unit has become high, so the sensor is ON to light the LED. --- Check the water supply system.

RESET (Color: green, heating)

When reset signal was input from CPU, the LED is lit.

VL (Color: green, heating)

The LED is lit, when heating is applied.

IN (Color: green, Power supply)

This LED is lit when power is supplied to the power supply unit of the oscillator unit. When the LED is OFF, it means that the machine is in trouble. The fuse for internal control power supply may be broken. When power supply voltage is abnormally high, it is possible that the internal fuse has blown.

8-3. TROUBLES OF THERMOCOUPLE 8-3-1. CAUSES OF TROUBLE

Abnormality of the thermocouple is usually determined by display value on the temperature controller.

| Temperature display | Causes | |
|--|--|--|
| Off-scale to minus side or to plus side. (Temp.controller shows "0000") | Wire breakage inside thermocouple. Circuit breakage between thermocouple and temp. controller. | |
| Temperature display show room temperature value when heating is applied. | Short-circuit in the connecting part of temp. controller in the circuit of compensating lead wire. | |
| Temperature display value is abnormal. There is large difference between display and actual temperature. | Deterioration of thermocouple. Thermocouple is not set properly in position. Polarity of compensating lead wire is opposite. Polarity of plug is opposite. Insulation deterioration of compensating lead wire. | |
| Temperature display value is unstable. | Poor connection of thermocouple. Contact failure of contact part. Electrical noise. Contact failure of grounding wire of machine body. | |

8-3-2. IRREGULARITY OF DISPLAYED TEMPERATURE

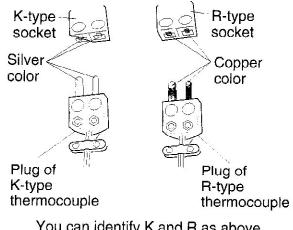
If the displayed temperature largely differs from the actual metal temperature you estimate from visual observation, type selection of thermocouple (K or R) may not be correct, or the thermocouple may be short-circuited, or the thermocouple is deteriorated, or parameters of the TEMP. CONTROLLER may be incorrectly set, or the lower end of the thermocouple may not reach the inside bottom of stopper. Check if two lead wires of the thermocouple are short-circuited or not (particularly check the upper part of the thermocouple), and replace it into a new one. If the error can not be solved after checking, contact with the distributor at your place.

^CAUTION

If heating is continued in spite of too much rise of actual metal temperature, carbon powders splashed around the crucible may be burned instantaneously when you open the lid. Also, the thermocouple, the protection crucible and other parts surrouding the crucible, the coil etc. may be damaged.



In the case of the K-type machine, if the "R-type thermocouple" is connected to the "K-type socket" by mistake, display temperature will be lower, and actual temperature of metal will become too high. Such mistake at type selection may cause hazardous results, so always check that the type of thermocouple is correct.



You can identify K and R as above

8-3-3. SETTING OF TEMP. CONTROLLER

Temperature is controlled by PID in the TEMP. CONTROLLER. Effectiveness of PID to stable temperature control varies depending upon conditions such as kind of gas, amount and kind of metal in the chamber at heating. However, PID is preset at the factory to the values such that the machine can widely correspond to those various conditions and can perform casting fast. So, usually it is not necessary to change the preset values. You can check that those values are correctly set by the procedure in P.81 to 83.

IMPORTANT: Do not operate (a) key unnecessarily. Protection will be released, and the TEMP. CONTROLLER is set into complicated modes.

8-4. OTHER TROUBLES

8-4-1. LID DOES NOT OPEN OR OPENS UNNECESSARILY

When the lid does not open after casting, or when the lid can not be opened at other timings, or when the lid is forcedly opened during the vacuumed state, the following causes are probable.

- Gas for action of the lid is not supplied sufficiently.
- Gas is still remaining in the chamber. --- Check the exhaust valve and check clogging of the exhaust port.
- Malfunction of the lid lock cylinder system.
- Malfunction of pressure sensor in the control board (Atmosphere can not be detected).

8-4-2. LID DOES NOT CLOSE OR DOES NOT OPEN FULLY

- The O-ring of the melting chamber or the O-ring of the mold chamber is not set properly. Set the O-ring securely.
- The cylinder head cover is not set.
- Malfunction of the lid lock cylinder.

The internal axis of the cylinder is not moving properly.

There is gas leakage in the cylinder.

- Malfunction of the lid-lock valve.

8-4-3. POWER FAILURE DURING ACTION

When power failure happened during operation, pressure in the chamber is released while suspending actions. When power is recovered, error number E-16 is displayed.



8-4-4. EMERGENCY STOP BUTTON

When the EMERGENCY STOP button is pressed, all actions are suspended. Do not use this button except in the case of emergency.

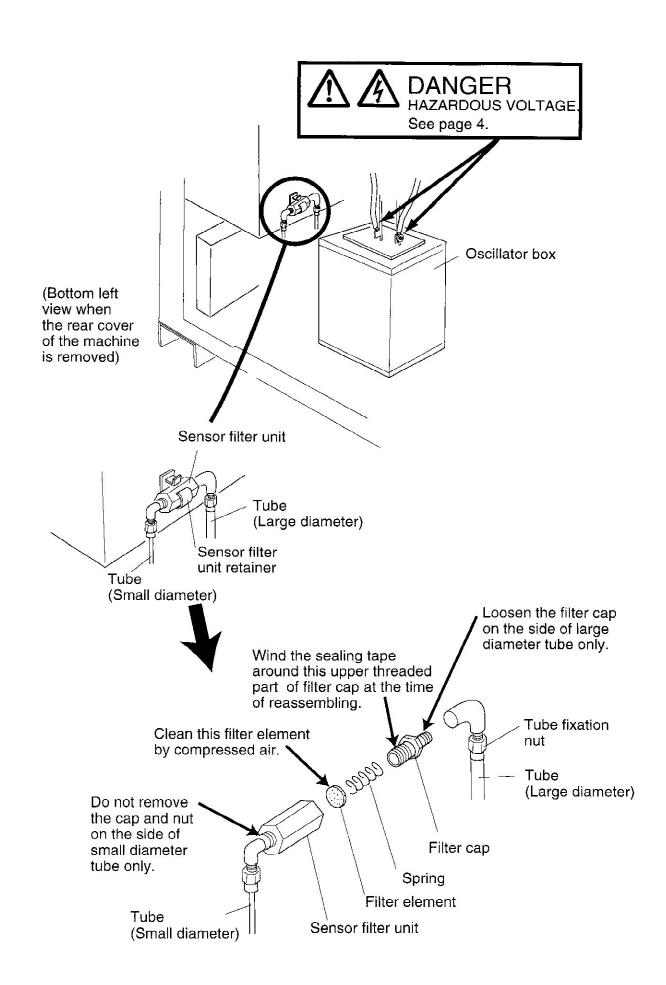
In the case of operation mistake, use RESET key.

8-4-5. DIGITAL READOUT DIFFERS FROM GAUGE

When digital readout shows difference from indication of melting chamber pressure compound gauge, it is possible that the filter for the sensor is clogged, although occurrence of clogging of the filter is only probable after several years of use.

Cleaning procedure is as follows.

- 1) Turn power off.
- 2) Turn off gas supply.
- 3) Open the rear panel.
- 4) Turn the cap for the sensor filter unit on the side of the larger diameter tube to remove.
- 5) You will find the spring and the filter element inside the sensor filter unit.
- 6) Clean the filter element with compressed air.
- 7) Reassemble the parts.



MORE DETAILED INSTRUCTIONS

Following pages are more detailed instructions about change of setting, checking etc.

9. OPERATION -2 (ADVANCED OPERATION)

9-1. MANUAL MODE

The action keys in the MANUAL MODE are used for checking of action.

Most of action keys work during the lid lock state only action for safety purposes.

- (1) START button (for lid lock)
 - When the START button is pressed, the lid moves downward and the lid is locked.
 - To release the lid lock (to open the lid), press (RESET) key
- (2) POUR key (for stopper elevation)
 - When LED of POUR key is turned off, the stopper is lowered.
 - When LED of POUR key is turned on, the stopper is lifted.
- (3) HEAT key (for heating)
 - When HEAT key is pressed to ON (LED of the key is turned on), heating action is

started.

- When the key is pressed once again to OFF (LED of the key is turned off), heating action is stopped.
- Heating can be operated even if the lid is lifted, as far as the lid is positioned just above the melting chamber. However, when the lid is slid outside and the limit sensor switch of the lid is off, heating is impossible.
- When the mold chamber is slid outside, heating is possible.
- Heating output is indicated by the HEAT POWER indicator.
- Temperature is raised by PID control to SV value of the TEMP. CONTROLLER.

- (4) VAC key (for vacuuming)
 - When VAC key is pressed to ON during the lid lock state, the melting chamber and

mold chamber are evacuated.

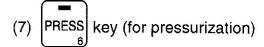
- While the key is pressed and held, action is ON. When the key is released, action is OFF (momentary switch action).
- When FNC key and VAC key are pressed simultaneously to ON, evacuation is carried out continuously.
- When FNC key or VAC key is pressed once again to OFF, evacuation is stopped.
- (5) M-GAS key (for charging inert gas)
 - When M-GAS key is pressed to ON during the lid lock state, GAS2 is charged in the

melting chamber and mold chamber (momentary switch). Maximum is 0.1 MPa. NOTE: If gas supplied to GAS2 is same to gas supplied to GAS1, same gas as supplied to GAS1 is charged into the chamber through GAS2.

- (6) OXY key (for air introduction)
 - When OXY key is pressed to ON, air is drawn into the chamber through the

EXHAUST port (momentary switch).

NOTE: If inside of the chamber is not vacuumed condition, air introduction is not carried out. In turn, if inside of the chamber is more than atmospheric pressure, gas in the chamber is released to outside.



- When PRESS key is pressed to ON during the lid lock state, gas connected to GAS1 is

introduced in the melting chamber.

- It is possible to operate pressurization action once only for safety.
- It is necessary to adjust pressure in the melting chamber (final pressure) with the knob of SET PRESS REGULATOR beforehand. It is possible to set pressure in the melting chamber to maximum 0.1 MPa.
- (8) EXH key (for exhaust, air introduction)
 - When EXH sylvanter and outside air are communicated.

At this time;

If gas remains in the chamber over atmospheric level ---> to be exhausted.

If inside of the chamber is vacuumed condition ---> air is to be introduced.

- When the key is pressed once again to OFF (LED of the key is turned off), the valve is closed.
- (9) SUC-U key (for chambers communication)
 - While SUC-U key is pressed and held, its LED is lit and the melting chamber and mold chamber are communicated.
- (10) SUC-L key (for suction of mold chamber)
 - While SUC-L key is pressed and held, its LED is lit and the mold chamber only is evacuated.

NOTE: When it is necessary to evacuate both the melting chamber and mold chamber simultaneously, use vacuate both the melting chamber and mold chamber

9-2. AUTO MODE

21 sets of casting parameters can be registered in Memory Nos.00 to 20. (In Memory No. of more than 50, the FUNCTION MODE (for maintenance etc.) is allocated.)

9-2-1. DIGITAL DISPLAY

- (1) MEMORY NO. display
- In MEMORY NO. display, Memory No. is displayed in two digits. Display range is from 00 to 99.
- (2) Parameter display
- On the parameter display, parameter set value of the selected action key is displayed.

When power is turned ON, four bars (- - - -) are displayed on the parameter display.

- Check and change of set value

Press an action key to be checked or changed. LED of the selected action key is lit. To change the set value, turn (TEN KEY) key. Then, LED of the selected action key flashes. At this time, the key is on standby for input of new value. Action keys now work as numerical value keys. Input new set value, and finally press (ENT key.

NOTE:

If a certain range of Memory Nos. are locked by Memory No. 99, data of those Memory Nos. can not be changed.

9-2-2. PARAMETERS OF EACH ACTION

Timing of each action is registered as parameter to each Memory No. Accordingly, maximum 21 sets of casting pattern can be registered and used by the AUTO MODE.

(1) VAC key (To set vacuum keep time)

Available range: 0 - 999 seconds

Time period of evacuation of the melting chamber and mold chamber after pressing the START button is set. When the timer of this key is in action, timer display in the parameter display is counted down.

(2) M-GAS key (To set inert gas charging time)

Available range: 0 - 19.9 seconds

Time period of charging GAS-2 into the melting and mold chambers after "VAC KEEP" time is set. When inside pressure of the chamber reached 100 kPa, M-GAS is stopped.

(3) OXY key (To set air introduction time)

Available range: 0 - 9.9 seconds

Time period of opening the exhaust valve to introduce air into the melting and mold chambers after finish of M-GAS action is set. See P.64 about how to set timing of starting air introduction by temperature.

(4) SUC-U key (To set time of communication between two chambers)

Available range: 0 - 9.9 seconds

Suction of the melting chamber is carried out during this time.

Time period of action of the communication valve between the suction line of melting chamber and the suction line of mold chamber is set.

When process temperature reaches the Set Value and CAST START (C) (P.52) is activated, action set by this key starts, and after elapse of setting time it is turned off.

(5) SUC-L key (To set time of suction of mold chamber)

Available range: 0 - 99.9 seconds

Time period of evacuation (suction) of the mold chamber is set.

When process temperature reaches Set Value and CAST START (C) (P.52) is activated, action set by this key starts, and after elapse of setting time it is turned OFF.

NOTE: The above (4) and (5) work together with VAC action. See the flow chart (P.52) for details.

(6) $\begin{bmatrix} POUR \\ 2 \end{bmatrix}$ key (To set waiting time for start of pouring by lifting of stopper)

Available range: 0 - 99.9 seconds

Time period from expiration of the time preset by "SUC-U" to lifting of the graphite

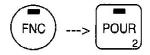
stopper is set.

- During waiting time in the AUTO MODE, LED of POUR key flashes. During POUR

time (stopper is lifted), LED of POUR key remains lit.

IMPORTANT:

Before start of casting, always check stopper action to be sure that the lower end of the stopper is correctly fitted with the inside bottom opening of the crucible. It is possible to carry out POUR action, whether the lid is opened or not.



(7) PRESS key (To set waiting time for starting pressurization)

Available range: 0 - 99.9 seconds

Waiting time from start of POUR to action start of PRESS is set.

During waiting time in the AUTO MODE, LED of PRESS key flashes. During

pressurization, LED of PRESS key remains lit.

(8) $\begin{bmatrix} - \\ EXH \\ 3 \end{bmatrix}$ key (To set time to exhaust finish)

Available range: 0 - 999 seconds

Time period from pouring start to finishing exhaust of gas in the chamber is set.

To avoid wearing of the crucible by oxidation, it is recommended to set a longer time.

During action, this setting time is displayed in the parameter display by countdown.

LED of EXH key flashes, but it remains lit when exhaust is activated.

After the lid is opened, LED of EXH key is turned off.

(9) HEAT key (To set heating temperature)

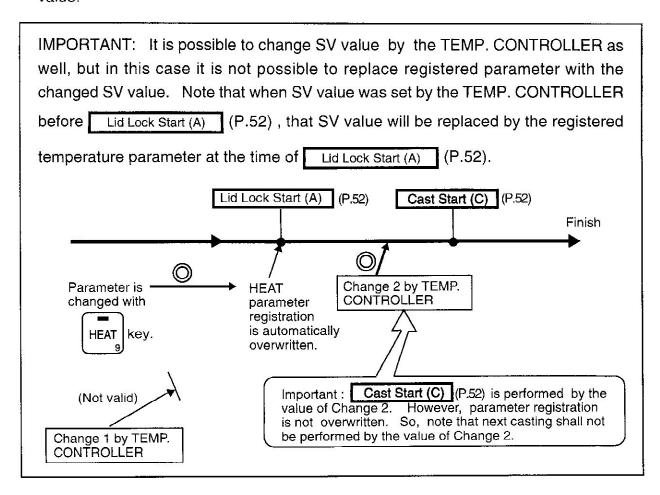
Available range:

K type 0 - 1200 degrees Celsius

R type 0 - 1450 degrees Celsius

Casting temperature is set.

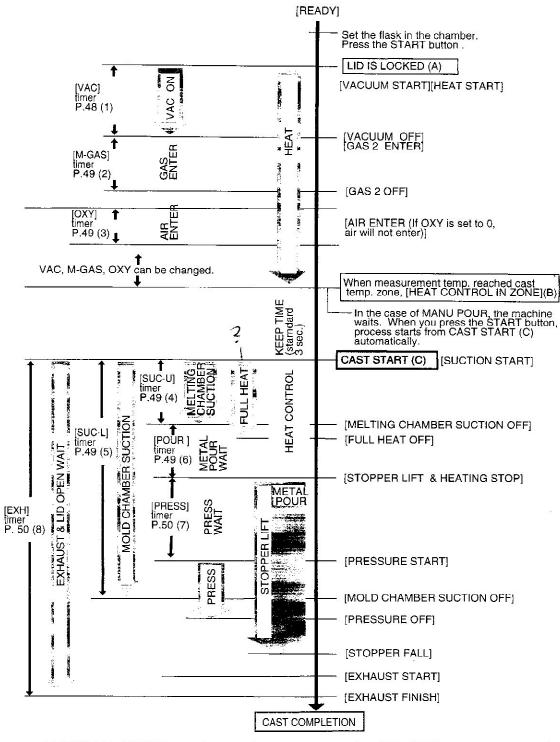
After inputting value with ten key, press ENT key, then set temperature is displayed on the parameter display. SV value of the TEMP. CONTROLLER is overwritten by this value.



9-2-3. FLOW CHART OF CASTING

If you press the START button in the AUTO MODE, casting is automatically started. Check safety and understand this manual before starting actual process.

<FLOW CHART FOR STANDARD AUTO MODE ("MOLD-IN BEFORE HEATING" MODE)>

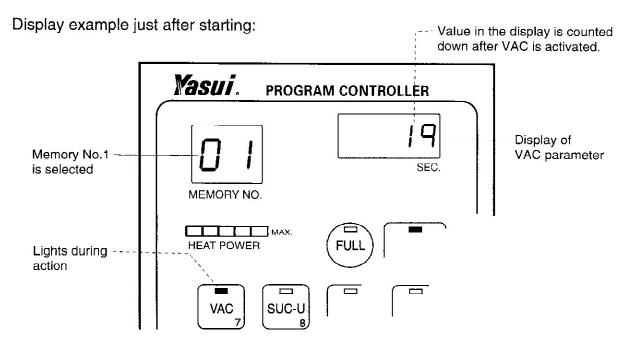


In the case of MANUAL POUR mode, you have to press the START button once again to activate CAST START (C).

9-2-4. ACTION AFTER STARTING AUTO MODE

9-2-4-1. PARAMETER DISPLAY

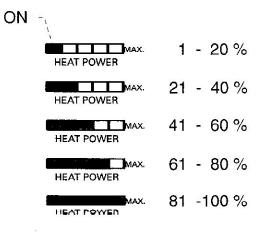
- As process starts, LEDs of action keys which are operating are lit. Further, parameter value of operating actions are indicated on the parameter display window.
- Set values of vacuum action and exhaust actions are displayed on the parameter display at the time of starting, but as their actions proceed their display parameters will be changed into count down display.
- If FNC is pressed during action, pressure value in the chamber is displayed.



9-2-4-2. HEAT POWER DISPLAY

-During heating, LED of HEAT key is lit. At the same time, output is indicated in the

HEAT POWER indicator as the below figures depending upon output amount.



9-2-4-3. FUNCTION OF ACTION KEYS

- After the AUTO MODE has started, the below action keys only can be manually operated for small adjustment. However, their operation time range is limited. See the flow chart in P.52 for operation range.



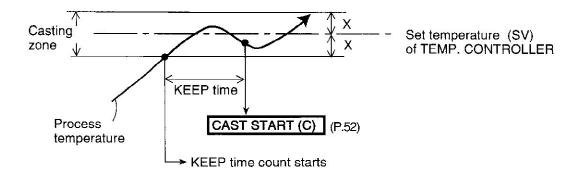
9-2-4-4. TEMPERATURE AND CAST START

When temperature enters into the Casting Zone by heating, casting is started on specified conditions.

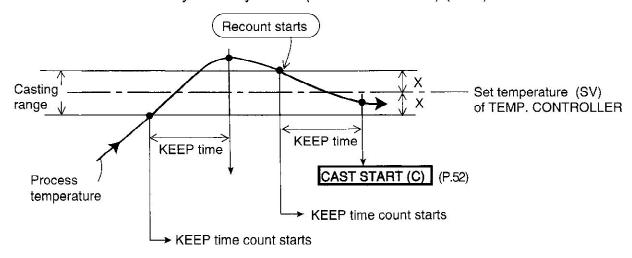
" Casting Zone =

Temperature SV of the TEMP. CONTROLLER +/- X degrees centigrade "
(Standard of X : 3 degrees centigrade)

It is possible to change the Casting Zone by the TEMP. CONTROLLER.



- KEEP time is set by Memory No.80 (Standard: 3 sec.) (P.62).



9-2-5. MANUAL POUR

To determine manually timing of CAST START (C) (P.52) during casting process by the AUTO MODE is called "MANUAL POUR" in this instructions manual. All actions except timing of CAST START (C) (P.52) are carried out in the same way as the standard process of AUTO MODE casting.

1) Starting MANUAL POUR

Press and hold MANU and AUTO keys simultaneously for about one second before pressing the START button, so that the MANUAL POUR mode is effective. (LEDs of both keys are lit at this time.)

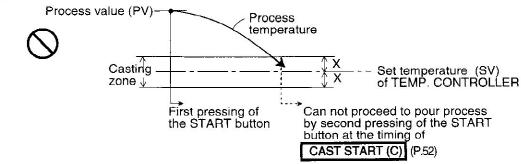
2) Timing of CAST START (C) (P.52)

When temperature reached to the casting zone of "Set Temperature Value - X degrees centigrade" (X is "3" in the case of standard setting as described in P.54), CAST START (C) (P.52) can be started any time by pressing the START button.

IMPORTANT: If process value (PV) was already higher than set value (SV) when the START button was first pressed, it is not possible to proceed to pouring process of MANU POUR by pressing the START button again at the timing of CAST START (C) (P.52) when process temperature vaue reached the casting zone of "Set Temperature Value +/- X degrees centigrade"(X is "3" in the case of standard setting as described in P.54).

Process value (PV)

Process
temperature



3) To return to the AUTO MODE, press AUTO key only. the LED of MANU key goes off,

and the LED of AUTO key only is kept ON, to show that the AUTO MODE is operating.

9-2-6. MOLD-IN AFTER PREHEATING

To melt the metal temporarily before setting the mold in the mold chamber for casting under the AUTO MODE is called "mold-in after preheating" in this instructions manual.

9-2-6-1. SETTINGS FOR MOLD-IN AFTER PREHEATING

By Memory No.53, set the parameter values of pre-process action (preheating) for "mold-in after preheating" casting (P.60-61). When "mold-in after preheating" mode is selected, process of Memory No.53 is added to pre-heating process of all memory Nos.

IMPORTANT: When the "mold-in after preheating" mode is selected, it is necessary to input parameter value other than "0" with VAC key in Memory No.53.

If parameter value of "0" is input with VAC key in Memory No.53, the "mold-in after preheating" mode becomes ineffective and the standard mode starts.

9-2-6-2. PROCEDURE OF MOLD-IN AFTER PREHEATING

- 1) Select Memory No.53.
- 2) Set parameter value (Recommended value: 30) other than "0" with VAC key in Memory No.53.

Set parameter value (Recommended value: factory preset value) with M-GAS key in Memory No.53.

Further, set parameter value (Recommended value: factory preset value) with HEAT

key in Memory No.53.

- 3) Select a Memory No. from Nos.00 to 20.
- 4) Press the START button. Primary process (preheating) of Memory No. 53 starts as follows.

Lid-lock ---> VAC ---> M-GAS ---> HEAT ---> When temperature has reached the specified level, the lid is opened automatically, and the machine is ready for setting the mold.

- 5) When the lid is opened, set the mold withdrawn from the furnace into the mold chamber.
- 6) Press the START button once again.
 Secondary process of the Memory No. selected by the above 3) starts.

NOTE:

[1] When the START button is pressed first time as the above 4),

shown on the parameter display to indicate the "mold-in after preheating" is started. [2] When the START button is pressed second time as the above 6), Memory No. of normal AUTO MODE casting, selected at the above 3), is shown on the parameter display.

9-3. FUNCTION MODE

9-3-1. MEMORY NOS. AND PRESET VALUES

By selecting Memory No. of more than 51 in the below table, special casting action or specific setting of parameter will be possible. (Other Nos. of more than 51 not listed in the below table are not used.)

FUNCTION MODE and FACTORY PRESET VALUES

| Memory No. | Function name | Key | Factory Preset | Description | |
|---------------|--|-------------------|-------------------|-------------------------------|--|
| 51 | Shot maker (Thermocouple used) | Parameter display | Pid | See following page. | |
| 52 | Shot maker (Thermocouple not used) | Parameter display | HEAT | See following page. | |
| 53 | Mold-in after | VAC | 0 | Evacuation time | |
| | preheating mode | MGAS | 10 | Gas injection time | |
| | | HEAT | 600 | Preheat finish temperature | |
| 80 | Basic parameter 1 | VAC | 10 | Stopper lift time | |
| | for casting | MGAS | 0.0 | Protection gas injection time | |
| | E | POUR | 3.0 | Temperature KEEP time | |
| | | PRESS | 1.0 | Pressure valve open time | |
| | | FULL | 0.0 | Full heat time | |
| | | OXY | 0 | OXY activating point | |
| | | HEAT | 100 | Setting second output | |
| 81 | Basic parameter 2 | HEAT POWER LED 1 | OFF | Select thermocouple | |
| | for casting | HEAT POWER LED 2 | OFF | Select auto mixing | |
| | | HEAT POWER LED 3 | ON | Select OXY timing | |
| × | | HEAT POWER LED 4 | OFF | Protection Gas | |
| | | HEAT POWER LED 5 | OFF | Printout | |
| 85 | Printout | SUC-U | 0 to 100 | Cast counter | |
| | | SUC-L | 0 | Printout range (memory) | |
| | | POUR | 1 | Printout range (parameter) | |
| ∗ 99 | Data lock | VAC | 54 | Locking data | |

^{*}Locked Memory Nos. can be checked only on display window.

9-3-2. DETAILS OF FUNCTION MODE

9-3-2-1. No.51, 52 --- for Shot Maker SM3 (option)

When the "Shot Maker SM3" (option) is installed in the machine, the Shot Maker can be used more safely, if the machine is operated by this Memory No.

Select either No.51 or 52 in the AUTO MODE, and then operate in the MANUAL MODE.

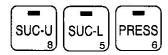


See the instructions manual provided with the Shot Maker *SM3* for how to use the Shot Maker *SM3*, and always observe the warnings described in the *SM3* instructions manual to avoid hazardous results, injury or machine damage.

(1) No.51 for Shot Maker (option) (thermocouple type)

In the case of Memory No.51, Pid (Pid) is displayed on the parameter

display. Heating is regulated by PID control of the TEMP. CONTROLLER. The below three action keys can not be used because of safety purpose.



Heat action by (HEAT 9) key can be activated if the lid sensor is ON, even when the lid is

opened. The keys except HEAT key are activated, when the lid is closed.

(2) No.52 for Shot Maker (option) (no-thermocouple type)

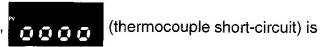
In the case of Memory No.52, HEAT) is displayed on the parameter

display. Heating is applied by manual operation of HEAT key.

In the case of Memory No.52, the TEMP. CONTROLLER and stopper are not used. Remove the stopper. However, plug the thermocouple into the socket of the machine and lay the thermocouple body down in the melting chamber. See instructions manual of Shot Maker *SM3*.



During heating by this No.52, temperature in the crucible (metal) can be checked by visual observation only. Always take care to avoid overheating.



displayed in the PV window of the TEMP. CONTROLLER. However, there is no problem for use because the TEMP. CONTROLLER is not used.

- The below four action keys can not be used.



- In the case of HEAT key, heating is carried out by preset output power value.

However, FULL key is 100% output only.

- Setting of output by HEAT key can be done by the below procedure.

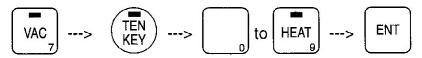


9-3-2-2. No.53 --- for "mold-in after preheating" mode

Parameters for "mold-in after preheating" can be changed by the below procedure. (The parameters are separated from VAC and M-GAS of the AUTO MODE.)

(1) Evacuation time (Factory preset value: 0)

Evacuation time is set with VAC key by the below procedure.



(Setting range: 0 to 999)

Recommended VAC value for the mold-in after preheating mode is "30".

IMPORTANT: If "0" is input by VAC key, the mode is changed into the normal

"mold-in before heating" mode.

(2) Gas injection time (Factory preset value: 10)
Inert gas injection time is set by the below procedure.

(Setting range: 0 to 99.9)

(3) Temperature of pre-heating process finish (Factory preset value: 600 "600" means 600 degrees centigrade)

When pre-heating process is finished, the lid is opened once. Timing of this pre-heating process finish is determined by temperature. When process value (PV) temperature reached set temperature value, pre-heating process is finished.

Setting is done by the below procedure.

During this process, P-53 is indicated on the parameter display.

9-3-2-3. No. 80---for casting action parameter 1

Parameters of the AUTO MODE can be changed by Memory No. 80.

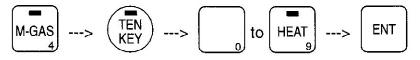
NOTE: Memory No. 80 is locked at the factory. In order to change its parameters, it is necessary to release data lock (P.67).

NOTE: AUTO must be selected.

Stopper lifting time (Factory preset value: 10)
 Time of the pouring valve ON (stopper is lifted and held) is set.
 Setting is carried out by the below procedure.

(Setting range: 3 to 99)

(2) Gas injection time (Factory preset value: 0.0) Inert gas injection time is set by the below procedure.

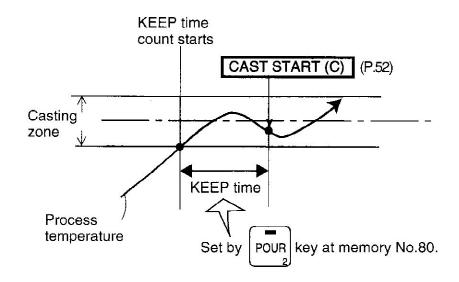


(Setting range: 0.0 to 99.9)

(3) KEEP TIME (Factory preset value: 3.0)

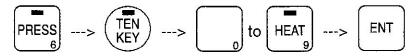
KEEP time from reaching the Casting Zone to CAST START (C) (P.52) is set.

(Setting range: 0.0 to 99.9)



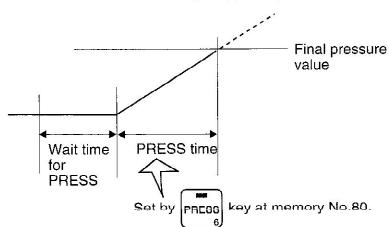
(4) Press time (Factory preset value: 1.0)

Time from starting of press to press valve OFF can be set. Setting is carried out by the below procedure.



(Setting range: 0.1 to 99.9)

Relation between press time and final press value varies depending upon outside piping or setting of the SET PRESS regulator. Therefore, timer setting should be determined by trial operation by the MANUAL MODE. For safety, final pressurization in the chamber is forcibly stopped by maximum 0.1 MPa.



(5) Full heating time (Factory preset value: 0.0)

Full heating (100% output) takes preference to PID control heating by the TEMP.

CONTROLLER. Timing of full heating is activating time of CAST START (C) (P.52).

Setting is carried out by the below procedure.

(Setting range: 0.0 to 9.9)

It is possible to activate full heating independently even during the AUTO MODE process. However, if full heating is done too long, control is disordered largely for a moment when normal PID control is recovered. Full heating should be done within short time (about 3 to 4 seconds).

Disordered

Proper example of short-time full heating

Manual use of full heating in the AUTO MODE is possible from finish of M-GAS and OXY actions to the time of reaching the Casting Zone.

(6) OXY action timing (Factory preset value: 0 ---when M-GAS is finished)

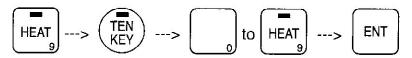
OXY action timing is selected.

0: OXY action is started when M-GAS is finished.

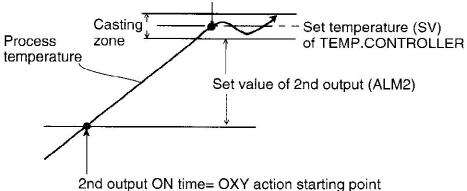
1 : OXY action is started when 2nd output (ALM2) of TEMP. CONTROLLER is ON.

(7) Setting 2nd output (ALM2) of temp. controller (Factory preset value: 100) In case OXY timing point is set to 2nd output (ALM2) ON time by item (6) in Page 63, 2nd output (ALM2) ON timing is determined by temperature value as follows.

Set temperature (SV) - Set value of 2nd output (ALM2) = OXY action starting temperature



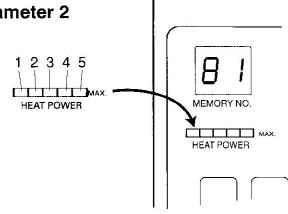
(It is not necessary to input minus sign (-).)



(in case "1: 2nd output ON time" is selected by P. 63 (6).)

9-3-2-4. No.81---for casting action parameter 2

Settings of basic actions of the machine can be checked by LED of the HEAT POWER indicator.



ON

| LED | Description | OFF | ON | |
|-----|----------------------------|------------------|----------------|---------------------|
| 1 | Thermocouple | K type | R type | Set by Memory No.81 |
| 2 | Auto mixing (full heating) | Not possible | Possible | Set by Memory No.80 |
| 3 | Timing of activating OXY | At the time of | At the time of | Set by Memory No.80 |
| | | second output ON | M-GAS finish | |
| 4 | Protection Gas | Not possible | Possible | Set by Memory No.80 |
| 5 | Printout | Possible | | |

Standard presetting at the factory of K-type machine is HEAT POWER

Thermocouple type is set by No. 81. Other modification work inside the machine is also necessary when thermocouple type is changed. Contact the distributor at your place.

9-3-2-5. No.85 --- Printout (when printer is installed)

(Printer, printer cable etc. are optional accessories)

NOTE: No.85 is preset at the factory to be data lock. In order to change parameters, it is necessary to release data lock (P.67).

Settings are carried out by using action keys and parameter display.

- (1) When SUC-U is pressed, current casting counter value is displayed.---maximum 999
 - This counter value is printed out as data at the time of printing.
 - This counter value is incremented each time casting process by the AUTO MODE is finished normally.

(If casting process was suspended by pressing (RESET) key, the counter is not incremented.)

- Counter value can be changed by the below procedure.

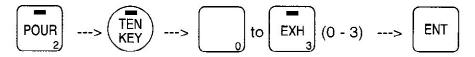
At next finish of casting, increment starts from this input value.

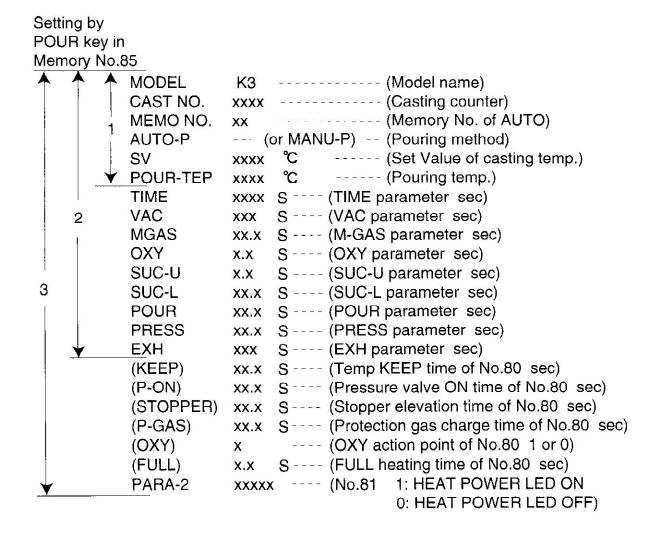
- (2) When SUC-L is pressed, content of Memory No. at the time of standby can be printed out.
 - Data of KEEP to PARA-2 (P.66) and parameters of selected Memory No. and of the following four Memory Nos. are printed out.

NOTE: If ENT key is pressed once only, printout is not started. If you want

printout, press ENT key twice.

- (3) Printout is carried out automatically each time the AUTO MODE casting action. Its printout range can be set by POUR key.
- If "0" is set, printout is not carried out.





Example of range 1

Example of range 2

Example of range 3

| MODEL | KЗ |
|----------------------|------------------|
| CAST No. | 3 |
| MEMO No. MANUPOUR | 1 |
| SV POUR TEP | 300 °C 446 °C |

| MODEL | кз |
|----------|--------|
| CAST No. | 4 |
| MEMO No. | 1 |
| MANUPOUR | |
| SV | 300 °C |
| POUR-TEP | 408 °C |
| TIME | 102 S |
| VAC | 10 S |
| MGAS | 2.0 S |
| OXY | 0.0 S |
| SUC-U | 2.0 S |
| SUC-I_ | 10.0 S |
| POUR | 1.0 S |
| PRESS | 1.0 S |
| EXH | 60 S |

| MODEL | K3 |
|----------------------|-----------------|
| CAST No. | 1 |
| MEMO No. | 1 |
| MANUPOUR SV | 300 °C |
| POUR-⊺EP | 386 °C |
| TIME | 236 S |
| VAC | 10 S |
| MGAS | 2.0 S |
| OXY | 0.0 S |
| SUC-U | 2.0 S |
| | 10.0 S 1.0 S |
| PRESS | 1.0 S |
| EXH | 100 S |
| (KEEP) | 3.0 S |
| (P-ON) | 1.0 S |
| (STOPPER) (P-GAS) | |
| (OXY) | 0 |
| (FULL) | 0.1 S |
| PARA-2 | 01100 |
| | |

9-3-2-6. No.99 --- for data lock

(Factory preset value: 54)

Set Memory No. to 99, then set the range of lock by $\binom{-}{VAC_7}$ key as follows.

By input of a Memory No., parameters of later Memory Nos. can not be changed.

$$VAC_{7}$$
 ---> TEN_{KEY} ---> TEN_{8} TEN_{1} TEN_{2} TEN_{3} ---> TEN_{3}

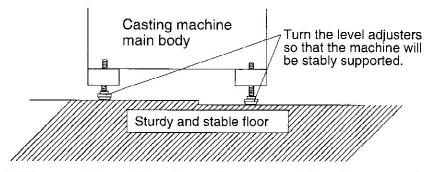
For example, if "2" is input, parameters of from No.02 to No.98 can not be changed.

To release the whole of lock, input "90".

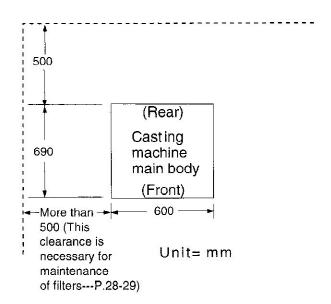
10. INSTALLATION

10-1. PLACE

- 1) Floor must be sturdy and stable. The machine must be free from vibrations.
- 2) The machine must be levelled. (When the floor is not flat, adjust the level adjuster, so that the machine should be levelled.)



- 3) Do not install the machine at the place where material such as gas, that may affect casting and operation of the machine, is produced.
- 4) The machine must be installed at a dustless place.
- 5) Electrical noise should not be produced nearby.
- 6) Proper power supply is necessary.
- 7) Save enough space around the machine for daily maintenance.



10-2. POWER SOURCE

10-2-1. PHASE AND LINE VOLTAGE

Use the power source of AC 215 V +/- 10%, single phase, 25 A, Approx.5 KVA, 50/60 Hz only for the machine.

MARNING

- [1] The machine must be earthed effectively.
- [2] Connection of the power supply cord should be made by a specialized electric technician only.
- [3] Do not connect the vacuum pump to the *K3* machine body. Use exclusive power supply line for the vacuum pump.

10-2-2. WHEN 3 PHASE POWER SUPPLY IS USED

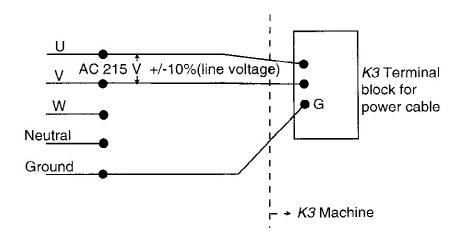
- In case 3 phase power supply is used, check line voltage before connecting power cable.



ELECTRIC SHOCK HAZARD: Never connect the "Neutral" line with the ground terminal of the *K3* machine. Serious injury or death could occur in the event of a fault condition.

10-2-2-1. IN CASE OF 3 PHASE AND LINE VOLTAGE 215 V

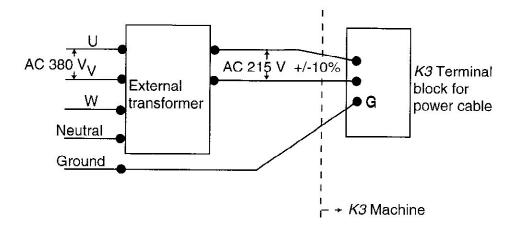
- When power supply is four-line (=3 phase + neutral) system, such power supply can be used only in case the line voltage is AC 215 V+/- 10%. Never use the "Neutral" line.



10-2-2-1. IN CASE OF 3 PHASE AND LINE VOLTAGE 380 V

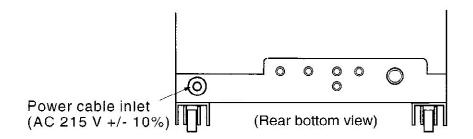
- When power supply is four-line (=3 phase + neutral) system, and the line voltage is AC 380 V, use an external transformer available in the market as the below figure so that

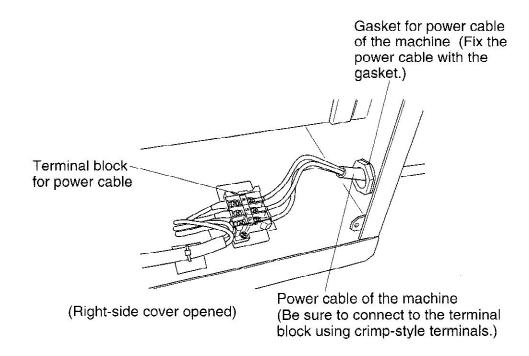
voltage shall be dropped to AC 215 V +/- 10% before K3 machine. Never use the "Neutral" line.



10-2-3. CONNECTING TO MACHINE

- 1) Open the right-side cover.
- 2) The terminal block for power source is located at the bottom. Connect the power cord for the machine to the terminal block.





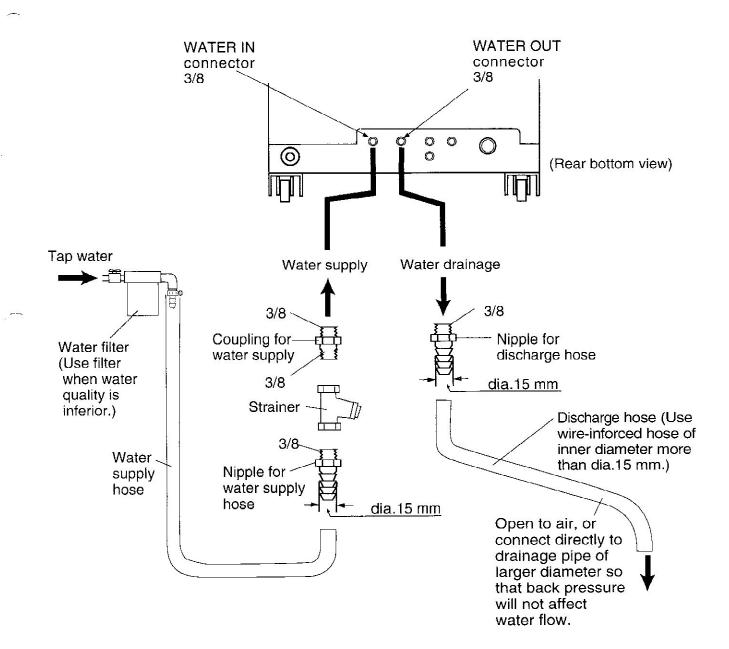
10-3. CONNECTING WATER HOSE

This machine needs internal circulation of tap water for cooling. Connect to water supply of sufficient water pressure (over 1.5 Kg/cm² in average).

MCAUTION

- [1] In case water from the tap is not clean, water should be filtered.
- [2] Be sure to complete water supply correctly before start heating.

Connect a water supply hose and an water discharge hose as below figure.



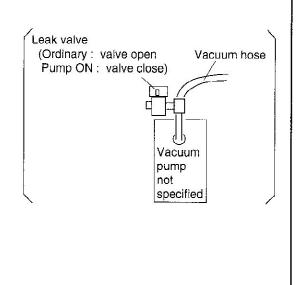
10-4. CONNECTING VACUUM PUMP

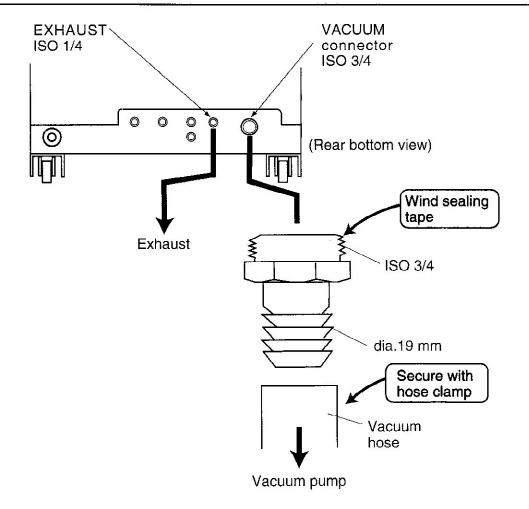
Connect the vacuum pump specified by the manufacturer to the machine as follows.

ACAUTION

[1] Use a pump of 300 liters per minute.

[2] Connect the power cable of the vacuum pump to the power outlet separately from the casting machine, so that the pump will operate alone independently. Be sure to set a 'leak valve' to the vacuum pump so that the inside of the hose will become exhaust condition at the moment when the pump is turned OFF. That leak valve should synchronize with power ON-OFF in such a manner that when the pump is ON, the leak valve should be OFF and when the pump is OFF, the leak valve should be ON.





10-5. INERT GAS

MARNING

- [1] Never use inflammable gas (such as hydrogen gas, etc.).
- [2] Never replace the gas cylinder while the machine is in operation.

10-5-1. FUNCTION OF GAS

Tubing method depends on the casting program to be used. Consult the distributor at your place.

GAS 1 (for driving the lid lock cylinder etc.)

Supply of gas for driving the lid lock cylinder (including pressurization gas) is necessary to the inlet of GAS 1.

GAS 2 (for gas substitution)

Supply of gas for substitution is necessary to the inlet of GAS 2.

10-5-2. GAS SUPPLY PRESSURE

When Ar gas is used for both GAS 1 and GAS 2:

GAS 1 Ar --- Supply pressure 0.7 MPa

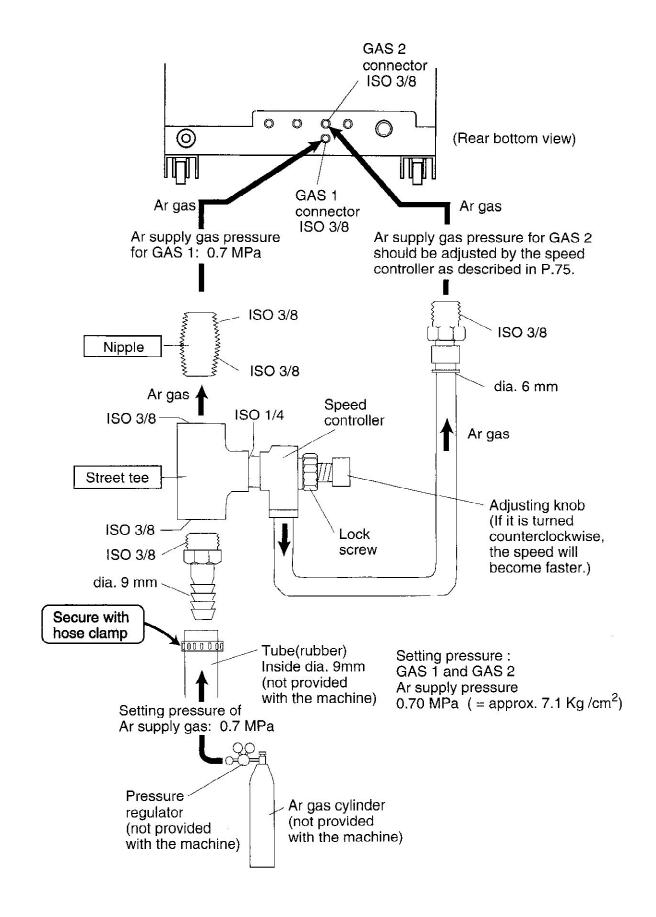
GAS 2 Ar --- Supply pressure 0.7 MPa

When Ar gas is used for GAS 1 and He gas is used for GAS 2:

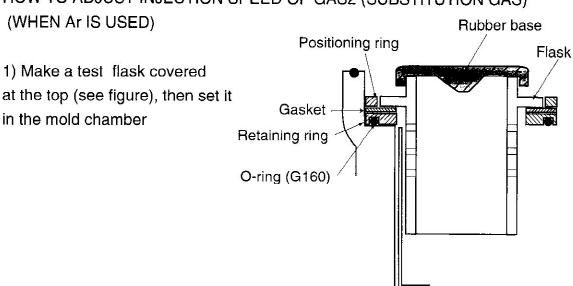
GAS 1 Ar --- Supply pressure 0.7 MPa

GAS 2 He --- Supply pressure 0.1 MPa to 0.3 MPa

10-5-3. WHEN Ar GAS IS USED FOR BOTH GAS 1 AND 2



HOW TO ADJUST INJECTION SPEED OF GAS2 (SUBSTITUTION GAS)



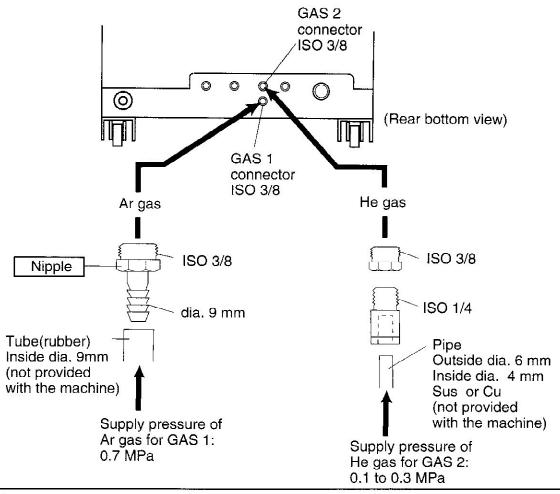
- 2) Turn power on the machine and set to the MANUAL mode. Before starting the below procedure, the machine should be ready for both the MANUAL mode and the AUTO mode, further the operator should be already familiar with operating method of the machine.
- 3) Press the START button, then the lid is locked. Evacuate for about 20 seconds.
- 4) Press M-GAS key.
- 5) At this time, watching the needle movement of melting chamber pressure compound gauge, measure time period from vacuum (about -0.1 Mpa) to atmospheric pressure (0).

Standard time should be about 10 seconds. If measured time is faster or slower than the standard time, turn the adjusting knob of the speed controller (P.74) set outside of the machine, so that the standard time will be achieved.

6) When standard speed of about 10 seconds is achieved, tighten the lock screw of the speed controller so that the adjusting knob will be locked.

10-5-4. TUBING FOR Ar TO GAS 1, AND He TO GAS 2

Apply sealing agent to threads, so that leakage should be prevented thoroughly.



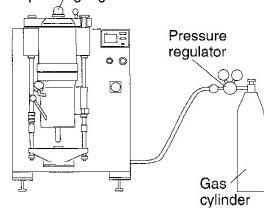
IMPORTANT: He gas pressure has an effect on gas substitution level. Therefore, set He gas pressure at same value every day. To make fine adjustments of He gas pressure, activate the machine and check actual gas injection speed as follows:

Procedure:

1) Set the machine to the MANUAL MODE.

- 2) Lock the lid of melting chamber.
- 3) Evacuate the inside of chamber.
- 4) Activate M-GAS injection.

Melting chamber pressure compound gauge

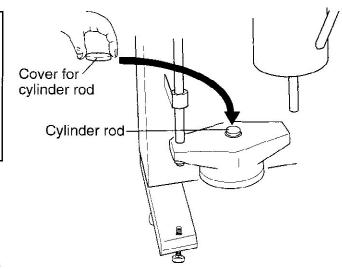


At this time, watching the needle movement of display value of melting chamber pressure compound gauge, adjust the pressure regulator of the gas cylinder, so that time period from vacuum (about -0.1 Mpa) to atmospheric pressure (0) should be within about 10 to 12 seconds.

10-6. CYLINDER ROD HEAD COVER

Place the cover for cylinder rod on the top of the cylinder rod for protection.

IMPORTANT: If the cylinder rod head cover is forgotten, the lid lock action can not be performed properly. At the time of installing the machine, be sure to check it is set in place.

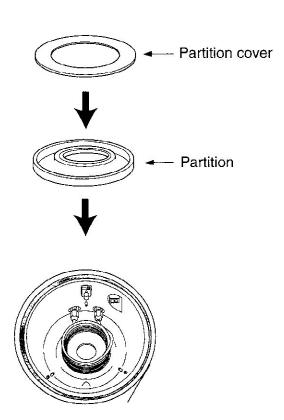


10-7. MELTING CHAMBER 10-7-1. HEATING COIL

Position of the heating coil is already adjusted at the factory, but it is possible that its position is offset especially in vertical direction due to vibration during transportation. Normal position of the coil is such that the protection crucible can be placed in position smoothly after the partition is set to its place.

10-7-2. PARTITION

Set the partition down in place.



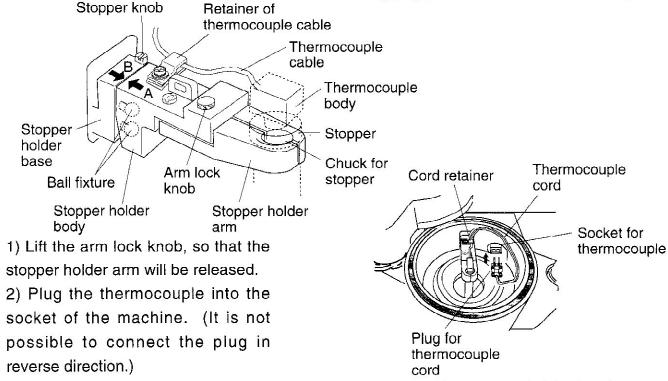
10-7-3. THERMOCOUPLE

ACAUTION

(See also P.40)

- [1] Always use the K-type thermocouple for the K-type machine, and use the R-type thermocouple for the R-type machine. Never use other type of thermocouple.
- [2] In the case of the K-type machine, if the "R-type thermocouple" is used by mistake, display temperature will be lower, and actual temperature of metal will become too high. Such mistake at type selection may cause hazardous results, so always check that the type of thermocouple is correct.
- [3] In the case of the R-type machine, if the "K-type thermocouple" is used by mistake, display temperature will be abnormally higher than actual metal temperature.

IMPORTANT: It is possible that a large amount of moisture is contained in protection tube of a new thermocouple. Carry out preheating up to around 200 degrees C before actual casting.

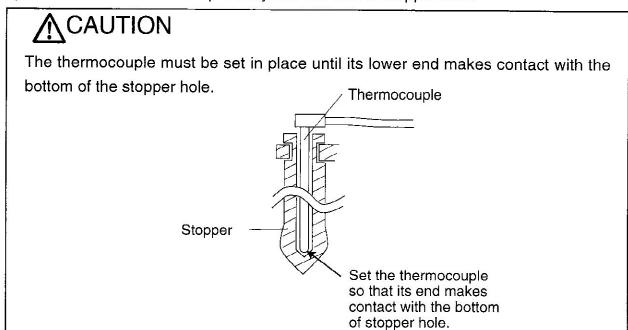


3) Secure the thermocouple cable with the cord retainer on the stopper holder bracket using a Phillips screwdriver.

MCAUTION

- [1] Carefully route the thermocouple cable so that the cord should not be caught by other parts.
- [2] Do not kink or strain the thermocouple cable.

4) Put the tube of thermocouple body into the hole of stopper hole.



- 5) Chuck the stopper with the stopper holder arm. Lower the arm lock knob.
- 6) Lift the stopper holder base.
- 7) Set the stopper holder in place, making alignment with the ball fixture.

IMPORTANT:

Check that the level of stopper holder (A) and that of stopper holder base (B) will be same as shown in the figure of P.78.

8) Turn the stopper knob for safety.

11. CHECKING ON OPERATION PANEL

The following checking is possible on the operation panel.

11-1. MONITORING POWER SUPPLY

Press MANU key to enter into the MANUAL MODE, and press as below.

Then, present value of power supply voltage is displayed on the parameter display.

Power supply voltage (Unit: V)

- Power supply voltage is displayed. Check whether power supply is within the permissible limits.
- Permissible limits: AC 215 V +/- 10%
 If power supply is over the limits, error number (P.36) is displayed.

11-2. MONITORING OUTPUT OF TEMP, CONTROLLER

Monitoring range: 0 to 100 %

Press MANU key to enter into the MANUAL MODE, and press as below.

- Even during standby time (HEAT) key OFF), output is carried out by the TEMP.

CONTROLLER while SV is larger than PV. However, heating is not carried out at this

- Output value is not constant because output is controlled by PID.

12. TEMP. CONTROLLER

IMPORTANT:

[1] Parameters etc. are preset at the factory. For usual casting, keys of the TEMP. CONTROLLER should not be operated. Protected parts at the factory presetting will be released and sequence action will not operate normally. If you need to change parameter values, do it with good understanding.

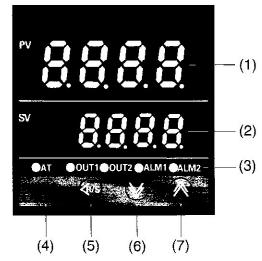
[2] Operation of the TEMP. CONTROLLER is limited to display of Process Value (PV).

Setting of Set Value (SV) is carried out by the HEAT key on the operation panel.

However, it is possible to modify Set Value (SV) of the TEMP. CONTROLLER after the AUTO MODE has started.

[3] PV display value dffers from actual temperature of the metal depending upon amount of the metal, tolerance of the thermocouple, tracking capability for inscreasing or decreasing speed of temperature, etc. So, handle the PV value as reference value.

12-1. NOMENCLATURE OF TEMP. CONTROLLER



- (1) PV (Process Value) display (green)--- Process value is displayed.
- (2) SV (Setting Value) display (orange)---Set value is displayed.
- (3) Display LED --- Signal output status is displayed.
- (4) Set key --- Used to register and recall parameters for the TEMP. CONTROLLER.
- (5) R/S key --- Used to select digit to be changed.

Further, used to select RUN/STOP function.

- (6) Down key --- Used to decrease value.
- (7) Up key --- Used to increase value.

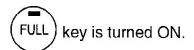
12-2. CHANGING SV VALUE

- 1) Press key once. Most bright digit indicates the selected value.
- 2) Select a digit to be changed by pressing less key.
- 3) Press ((UP) key or (DOWN) key to input the desire value.
- 4) Finally, press 📵 key.

NOTE: Be sure to press key finally, otherwise the SV will return to the old value automatically after one minute.

NOTE: This TEMP. CONTROLLER is working even during the standby state, so

"OUT1" LED (P.81) is lit, however heating is not carried out except that HEAT key or



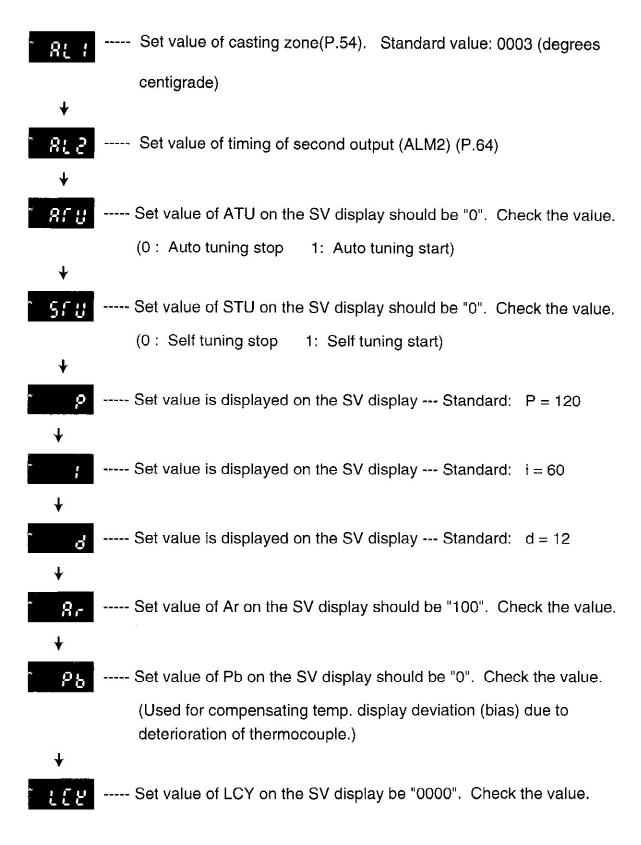
12-3. CHECKING PID VALUE

Standard settings at the factory of PID value are P = 120, i = 60, d = 12. You can check or change the set values by the below procedure.

↑ CAUTION

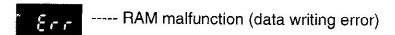
- [1] Do not change the parameters values of AL1, AL2 unnecessarily, because those values will greatly influence casting process and results.
- [2] <u>Do not change the P,i.d settings unnecessarily</u>. Unnecessary change of the P, i, d settings will greatly influence casting process and results.
- [3] <u>Always set ATU, STU to "0"</u>. If they are changed into "1" unnecessarily, P,i,d are overwritten and influence casting process and results.
- [4] Never change settings of Ar and LCY.
- [5] When change of thermocopule type is necessary, modification work is necessary for the machine. Contact the distributor at your place.
- 1) Press (a) key for more than two seconds.
- 2) Parameter display title is displayed on the PV display and the current parameter set value is displayed on the SV display. Every press of key changes display as follows.

Use (UP) key or (DOWN) key to modify the value when necessary.



3) Finally, press (a) key for more than two seconds to return to usual PV display.

12-4. ALARM BY TEMP. CONTROLLER



1138 ---- PV value flashes. PV value exceeded input range.

----- Short-circuit of the thermocouple, or PV value exceeded display range (upper limit).

----- PV value exceeded input range (lower limit).