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INSTRUCTION MANUAL

OF

AUTOMATIC TEMPERATURE CONTROL VALVE

(NS MODEL NO. TCV-7465/6)

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C O N T E N T S

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We have the pleasure to expressing our hearty thanks for your application of our Automatic temperature control valve, NS Model No. TCV-7465/6 (hereinafter referred as " temp.cont.valve").

The features of construction, directions of handling and maintenance herein, might please be read carefully in order that the functional efficiency of the temp.cont.valve should be display fully for a long duration.

1.Features

The construction of this model temp.cont.valve is so designed as combined flow-controlling mechanism through detecting temperature and NS Model No. 500 Pilot type steam reducing valve. That is to say, the maximum pressure of heating steam is to be restricted by means of steam reducing valve, and the heating steam flow is to be controlled successively in proportion to the temperature variation of the fluid to be controlled at the outlet of heater.

The temperature detecting end device as the thermo bulb is react sensitively for a slight temperature variation and operates the pilot valve, and the main valve is to be open and closed through piston movement and this have equal efficiency of the certain type instrumentation control. The reducing operation of heating steam pressure is to be performed thereby, so there is no critical condition that the case of exceeds the specified set pressure is occurred even in the case variation of the pressure of heating steam. Consequently, the following is not required at all, install the reducing valve in upstream of the temp.cont. valve. This temp.cont. valve is compact and installation and maintenance are simple. Gland packing is not especially used for it, so this temp.cont.valve have been employed on broadly scale for the temperature control of fluid in the marine vessels and all other industrial facilities.

2. Construction and operation

This model temp.cont.valve is detect the temperature of the fluid to be controlled at the outlet side of heater and regulates the supply of heating steam flow to the heater.

The basic construction is showing as the drawing at the end of this manual, and the component followings are contained in the valve body as the pressure regulating mechanism, the main valve which performs throttling action of heating steam, adjusting spring, diaphragm, pilot valve and piston.

Thermo bulb is employed for the temperature detecting end device in the fluid to be controlled, and the volatile agent is to be charged therein.

Temperature controlling mechanism is consist of the followings, bellows connected with flexible tube, temperature adjusting spring and lever.

When the temp.cont.valve has been installed in normal conditions and the pressure adjusting screw (17) released (to turn anticlockwise) and then the pressure adjusting spring (30) set in free, both the main valve (5) and pilot valve (9) will be at closed state by means of respective forces of springs (28) and (29).

Then firstly, open the stop valve on the upstream of the temp.cont.valve gradually and let the heating steam flow into the temp.cont.valve, the steam pressure will act for the back of the main valve and also act for the back of pilot valve through the steam leading hole which made in the inlet side of body (1), this steam pressure obviously giving stronger closing force to the main valve and pilot valve.

Secondly, turn the pressure adjusting screw (17) in clockwise direction to compress the pressure adjusting spring (30), then the diaphragm (12) will be warped slightly downwards and simultaneously the pilot valve will be opened and the steam introduced on the head surface of the piston, will overcomes the back pressure of the main valve to push it down to open and let the steam flow into the outlet side of body and is to be into the heater. Consequently, the water, oil and all other fluid in the heater will be heated.

The diaphragm (12) will have receive the steam pressure through the leading hole which penetrates the outlet side of body (please refer to drawing), so the pressure adjusting spring (17) is to be pushed away thereby.

Therefore, the balance of the forces of this steam pressure from the outlet side and the spring are kept, the pilot valve will have closed. So, the steam on the inlet side acted upon the head surface of the piston will be cut off, and the main valve will have closed by means of spring (28).

(In this instance, the steam pressure acted upon the head surface of piston will come out toward the outlet side of the body through the circumferential clearance between the piston (6) and cylinder (7).

A further compression of the pressure adjusting spring (closckwise turning) will have increase the steam pressure in the outlet side. So the specified pressure, that is to say, the maximum heating steam pressure required for the peak load of the heater will be obtained in such a way.

Following the steam has been consumed in the outlet side of temp.cont.valve, the pressure drop will be found therein. Consequently, the diaphragm (12) will be warped downwards by means of spring (30). The pilot valve is to be opened again, and the main valve is to be opened through the piston to feed the steam, so the specified pressure is to be kept successively.

As the temperature of the fluid to be heated rises through the supply steam flow into the heater, the liquid charged within the thermo bulb (at the outlet of heater) which immersed into the fluid to be heated begins to feel to expand and evaporate. The vapour pressure thus generated will be exerted upon the bellows (55) connected with flexible tube. The force thus exerted will overcome the compression of the temperature adjusting spring (31), and, through the rod (27) and lever (19), thrust back the pressure adjusting spring upwards. As the result, it is to be the same action as loosening of pressure adjusting spring, and the pressure of outlet side in the temp.cont. valve will successively to restrict the flowing of the steam into the heater.

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While the temperature decreases the fluid to be heated, the vapour of liquid agent contained in the thermo bulb will be condense and the pressure is to be decrease naturally, the bellows (55) thus will be thrust back by means of the temperature adjusting spring. Accordingly, the upward force acted upon the pressure adjusting spring will be lost through the lever, and the pilot valve will be again opened by action of the pressure adjusting spring. And this will open the main valve for increasing the pressure of the heating steam supplied to the heater, so the fluid to be heated will be kept under the specified temperature. It might be presumed in this case that even when the temperature of the fluid to be heated has been decreased, the main valve would not open if the outlet side pressure of temp.cont. valve to be specified pressure. However, such a phenomenon will seldom occure because the heating steam pressure in the heater should be lowered in case the temperature is decreased due to the heat exchanging action in the heater.

3. Temperature detecting device

The temperature detecting device consists of a thermo bulb immersed into the fluid to be controlled, and a bellows with the case which receive the expansion or vapour pressure of the liquid agent charged in the thermo bulb and of which regulates the heating steam flow, and flexible tube connected between these two elements.

As aforementioned, the adoption of the vapour pressure method for this temperature detecting device, it is possible to select in accordance with the setting temperature required, a suitable charged liquid agent from various volatile liquids are used it.

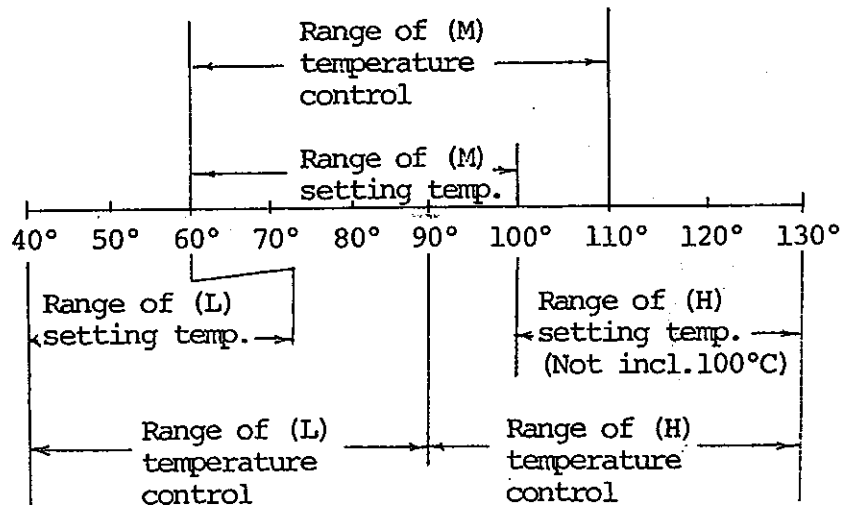
Symbol of temperature detecting device and range of temperature control :

- (a) Length and symbol of flexible tube

Symbol 3 5 7 are expressing the
Length 3 meter 5 meter 7 meter respectively.

- (b) Symbol of liquid agent and range of temperature control :

Kind of liquid agents;	(L)	(M)	(H)
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- (c) Symbol of temperature detecting device

3 - M
 ↳ (M) liquid agent (setting temp, 60° to 100°C
 range of temp.control 60° to 110°C)
 ↳ Length of flexible tube: 3 Meter.

- (d) Designation of symbol

The above mentioned symbol is marked on the upper surface of bellows cover.

4. Installation

The temp.cont.valve should naturally be installed correctly so as to meet the conditions of the process you have to controls.

It is a matter of high importance, from the standpoint of preventive maintenance and repair works, to find out a correct position where the valve is to be installed. Therefore, before installing the valve, take all surrounding conditions into consideration and install it in the optimum way in order to obtain the best results.

The principal items that must be observed when performing the installation of temp.cont. valve is as follows,

- (1) Take care so that the valve will not be subject to continuous vibration, stress or other conditions unfavourable corrosion from chemical points of view.
- (2) With respect to the temperature difference between the ambient air and required setting temperature, the following localities should be chosen, 15 °C or more. Pay the special care so that the bellows of temperature detecting device will not be subjected to the radiant heat of adjacent steam pipe etc.
- (3) Avoid such localities where a collision or access of any movable equipment are presumed.
- (4) Clean the interior of all pipings thoroughly before installing the temp. cont. valve as sand, gravel or scale contained within the pipe might injure the pilot valve and main valve. Sufficient flushing should be carried out prior to start commissioning after piping.
- (5) Install the temp.cont. valve in horizontal pipings under the upright position (sideways or inverted position are prohibited) in conformity with the arrow head (marked on the side of body) which shows the flow direction of heating steam.
- (6) RAISED FACE shall not apply to the piping flanges, of a cast iron or bronze temp.cont.valve, lest it should be damage or deformed.
Moreover, use no other packings than full surface packings.
- (7) Insulate thermally the pipes connected upstream or downstream the temp. cont. valve to make the amount of drain as less as possible.
- (8) Preserve the ample spaces over and under the temp.cont.valve for the convenience of overhaul and repair works.
- (9) When installing temp.cont.valve, connect a bypath valve around it and stop valves (up and downstream the temp.cont. valve) for the convenience of maintenance and repair. At the same time, install each of following accessories to protect the temp.cont.valve. ;

(a) Strainer

Provide the strainer on the upstream of the temp.cont.valve to prevent the scale or dust from entering into the valve.

(b) Drain valve

Provide a drain valve in the heating steam line for perfect drainage of condensed water; this is to prevent water hammering action and to assure and to expect the best performance of the temp.cont. valve.

(c) Pressure gauge and thermometer

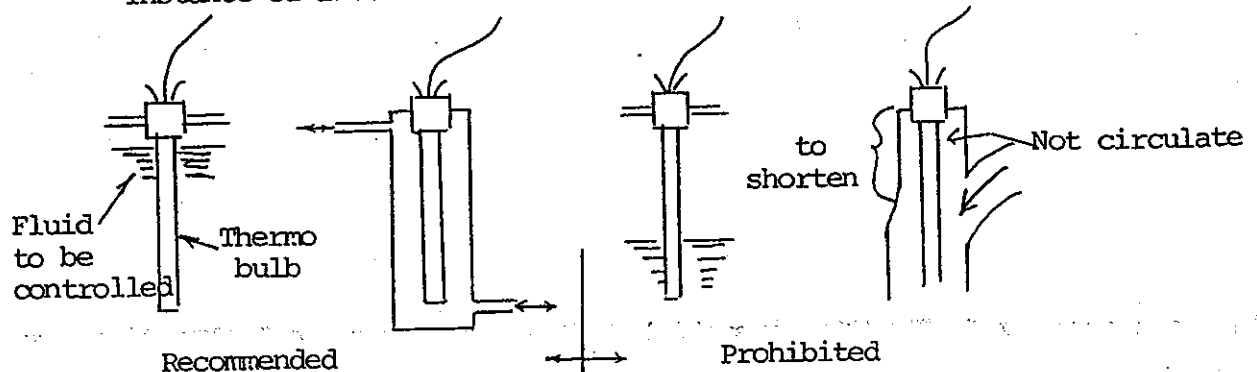
Provide the pressure gauge in up and downstream the temp.cont. valve while at the heater, install a thermometer for measuring the temperature of liquid to be controlled in the heater.

Thermometer is to be installed near and readily visible that thermo bulb of temp.cont. valve as close as possible.

- (10) The following items should especially be observed, because it will have important effect upon the performance of temp.cont.valve depending on the installation of the thermo bulb.

- (a) The fluid to be controlled is to be circulated and to contact along the overall length of thermo bulb.

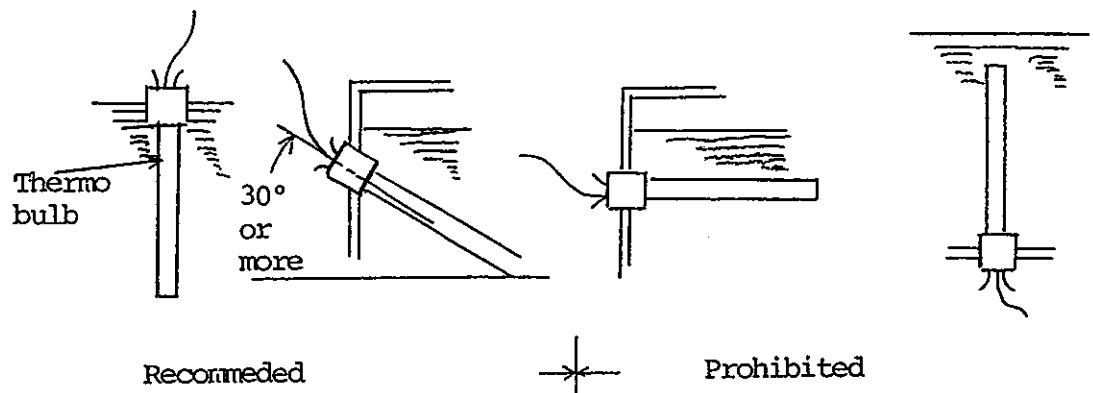
Instance of installation of thermo bulb is as follows,



- (b) In case the thermo bulb is installed directly to the heater, the installation should be performed in such a manner that its temperature distribution will become uniform or install the thermo bulb so that it will receive the mean temperature of heater. also, place both the thermometer and thermo bulb in the nearest possible position.

(c) Install the thermo bulb vertically and normally.

Even if there are no alternatives but to install it obliquely, take care that it will not be installed at an angle less than 30° from the horizontal position.



This is to be preventive of followings: the liquid agent vapour in the thermo bulb gets enter directly into the flexible tube, and thereby the irregular factor of condensation etc. will be added to the inside of the flexible tube to faulty operation of the temp.cont. valve.

(11) Flexible tube should not be bent abruptly. When lengthened, the support should be given in a proper position. In this instance, however, don not contact with the steam pipe,etc. having high temperature.

In case of carrying of the temp.cont. valve, care should be paid not to hang the flexible tube by hand.

Because it causes the leakage of the liquid agent out of the joint in the flexible tube.

5. Adjustment

When the temp.cont.valve has been installed on the piping correctly and the flushing is completed, make the adjustment in accordance with the following procedures.

In this case, it is important to operate the heater under maximum load and to know the steam pressure (flow quantity) which will yield necessary heat capacity to keep these conditions.

The method of adjustment shall be described in sequence:

- (1) First of all, close the stop valves on both up and downstream of the temp.cont.valve.
- (2) Loosen the pressure adjusting screw (17) to release the compression of spring (30).
- (3) Open the stop valve on the upstream gradually.
- (4) Dispose the drain, and open the drain valve of the strainer, and dust or other foreign matters are to be blow out.
- (5) Adjustment of pressure
 - (A) In case the steam pressure (flow quantity) under the maximum load condition of the heater is known:
 - (a) Tighten the temperature adjusting screw (25) until the lever (19) has been brought to relaxed state with the attached spanner.
 - (b) Keep closed the stop valve on the down stream of the temp.cont. valve.
 - (c) Screw down the pressure adjusting screw (17) to regulate the steam pressure (minimum flow quantity) under the maximum load condition of the heater. the lever is to be relaxed therein at this state.
 - (d) Open the stop valve on the downstream slowly.
 - (B) In case the steam pressure (flow quantity) under the maximum load condition of the heater is unknown:
 - (a) Tighten the temperature adjusting screw until the lever (19) has been brought to the relaxed state with the attached spanner.
 - (b) Open the stop valve on the downstream slowly.
(Keep the heater under maximum load condition.)
 - (c) Tighten the pressure adjusting screw (17) gradually.
In case the temperature of the fluid to be controlled on the outlet side of the heater keeps the specified temperature, this steam pressure shows the lowest value of heating steam pressure that is necessary for the operating under maximum load condition.

Following the completion of the above mentioned procedures for setting the steam pressure, tighten the lock nut (45) to keep this position firmly the adjusting screw (17), and care shall be paid it not to be loosen.

(6) Adjustment of temperature

Loosen the temperature adjusting screw (25) gradually, and the rod (27) will be lowered a little, and then the relaxed state of lever (19) will be turn to felt in tension. Furthermore, go on loosening the temperature adjusting screw (25) a little, and the steam pressure at the downstream of the temp.cont.valve will begin to reduce thereby.

The point in just before this state is the adjusting point in the temperature.

(7) In case of the change of setting temperature

(a) In case the setting temprature is to be lowered:

Loosen the temperature adjusting screw by means of the attached spanner, and the steam pressure of downstreams will begin to reduce successively, and then it will come to the "0". Therefore, you may find the balanced point of the steam flow quantity and the load of heater from the positions of temperature adjusting screw in between the previous point (higher temp,) and the "0" pressure point stated as above.

(b) In case the setting temperature is to be risen :

In case the temperature difference is little campared with the setting temperature, the temperature required to be risen will be obtained by only means of fastening of temperature adjusting screw. However, the pressure in the downstream of temp.cont.valve should generally be risen. Therefore, the adjustment of pressure and temperature should be carried out in accordance with the above mentioned procedures.

(8) Attention on adjustment

(a) Minimum 0.1MPa of the differential pressure is required for accross the valve disc of temp.cont. valve.

(b) The flow ratio in accross the valve disc of temp.cont.valve should be limited to 10 : 1 in minimum.

(c) The adjustable range of pressure in the downstream of temp.cont.valve is to be 0.1 ~ 0.7MPa

(d) The adjustable range of temperature, please refer to the item 3 of Temperature detecting device in Page 5 preceding.

(e) Temperature adjusting work should be performed taking ample time as much as possible. Owing to the remaining heat of heater, time lag will cause slightly for valve operation.

(f) Never touch to the screw (46) of lever (19).

(g) When the operating of heater is executed through a manual operation with bypath valve, the temperature rise should not done over the adjustable range of the temp.cont valve, because the temperature detecting device may be damaged thereby.

6. Maintenance

The periodic inspection should be carried out for the purpose of preventing sudden accidents besides protecting the temp.cont.valve to elongate its service durability.

The outlined procedures of maintenance are as follows,

(1) Disassembly

(a) Shut the stop valve in the up/downstream on the temp.cont.valve.

(b) Remove the thermo bulb from the heater. The handling of flexible tube is to be performed carefully and the abrupt bending should be avoided.

Care should be paid for preventing that the fluid to be heated is flowing out through the fitting hole of thermo bulb in the heater or intrusion of dust or foreign matters the outside.

(c) Loosen the temperature adjusting spring (25) until the free condition.

(d) Take the temp.cont.valve out from piping, if necessary.

(e) Loosen the bolts (43), nuts (44), and remove the temperature detecting device from the valve section.

(f) Loosen the bolts (51) and the pressure adjusting spring is to be taken out thereby, In this case, the pressure adjusting bolt (17) should not be loosen and kept its as it was.

(g) Loosen the bolts (40), and the cover (21) (to fixing the diaphragm) is to be taken out and the diaphragm (12) is to be found therein.

(h) The diaphragm is generally to be adhered to the corresponding seat, so, the scriber should be employed for the removal.

(i) Loosen the pilot seat, and then pilot valve and the spring can be removed, these are located in the interior of hole bottom, so employ the pincette or suitable tools and or reverse the valve body.

(j) Loosen the nuts (39) and remove the bonnet (3) (middle cover)

(k) Remove the piston (6), Pull it out utilizing of the screw (6 mm) into the tapped hole which prepared in the center of the piston.

(l) Avoid the unnecessary removal of the piston ring from the piston. Because there is possibility of deformation.

(m) Loosen the nuts (37) and take the cover (2) (for bottom of body) out, and then the main valve disc (5) and spring (28) are can be taken out from the body.

(n) Each packing is generally to be adhered to the corresponding seat surface, so care should be paid not to damage.

- (o) There are small parts therein, so special care should be taken not to lose them.
- (p) Do not give the damage to the sliding parts, the sealing surfaces of valve seat and valve disc.
- (q) Avoid the unnecessary removal as to the screw (46) of lever(19).

(2) Inspection and assembly

All disassembled parts should be rinsed with kerosene, and inspect the following items, then the assembly should be carried out.

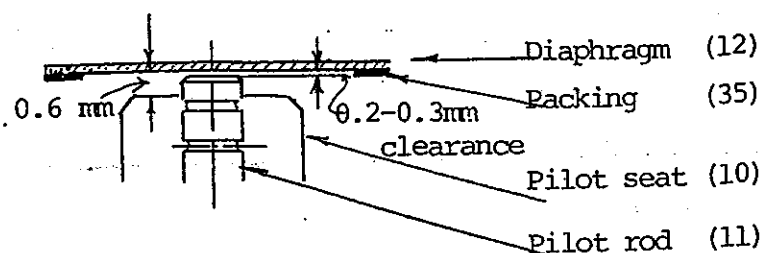
(A) Parts inspected before assembly

- (a) The scale attached, if any, the outside surface of the thermo bulb shall be removed thoroughly, but do not use the file for it.
- (b) Check whether the charged liquid agent in temperature detecting device is leak or not. In case the large quantity of leakage, it can be found through the inherent chemical smell of the charged liquid agent. However, immerse the thermo bulb into the hot water in general, and see how the bellows (55) moves. If there is the leakage, please return it for replace or repair to Nakakita.
- (c) Inspection of deformation or damage of each spring.
- (d) Check whether each packing is damage or not.
- (e) Check whether each sliding part is damage or not.
If the flaw is slight, it should be removed with sand papers.
- (f) Check that the piston ring moves freely in the grooves of the piston and the scales are to be removed surely. And also check whether it has the proper elasticity.
- (g) In case there are flaw or permanent strain in the sealing surface of main and pilot valves, the lapping should be carried out. Renew it in proportion with the degree of flaw.
- (h) Check whether there is distortion in the diaphragm (12) or not.
- (i) The parts which have the flaw, permanent distortion and damage should be repaired or renewed through the above mentioned inspection.

(B) Assembling points

The assembly is to be performed through the reverse procedures of aforementioned (1) Disassembly, however the following items should be checked in this process.

- (a) Apply the graphite or other suitable lubricant onto the threads surface of each bolt to prevent the seizure.
- (b) Check the parts of the valve inside once again regarding the existence of dust, sand or other harmful foreign matters.
- (c) Place both main valve and spring on the bottom cover, then mount them in the body and screw up the bolts.
- (d) Insert the piston into the cylinder and check that the piston moves smoothly when push it down lightly by fingers.
- (e) Fasten the pilot seat in the bonnet (3) (middle cover) firmly, at this time, the insertion of spring (29) and pilot valve (9) are not to forgotten , Because the heating steam leakage through this part due to the slackness of the pilot seat (10) requires much disturbance at the adjustment or during commissioning.
- (f) Push the pilot rod (11) a little and check its movement.
- (g) The connection among the pilot rod, diaphragm and their necessary clearance are to be made such that the sketch showing as below, In this case, the correction of the parts may be required.



- (h) After the completion of item (e) above, mount the diaphragm holder (14) in the cover (21) (to fixing the diaphragm), and tighten it with the bolts (40) evenly.
- (i) Put the lever (19) on the lever holder (18).
- (j) Set the spring (30) and spring supports (top & below) (15/16), and put them on the diaphragm holder, and place the spring case (22) upon them. then fasten the bolts (51) evenly, and the downstream steam pressure adjusted before disassembly can be restored without the adjustment.

7. Measures in the case of trouble

In case the trouble occur during the service of the temp.cont.valve, take measures as table below depending on the kind of trouble, and marked as[*] shows the item of trouble may being caused easily happened.

Phenomena of trouble	Point of trouble	Required measures
1. Set-temp is too risen.	Poor adjustment.	Readjustment.
A. Stability is found even beyond the Set-temp. B. Temp. rises extremely.	<p>* Main or pilot valves jamming the foreign matters and/or bounds the scale in guide of main valve. Incomplete shut-off of the valve because of flaw or other defects. Fixing of scale in the guide of diaphragm-holder. * Fixing; because of draining scale of piston. Permanent distortion/deformation of spring. Deformation of diaphragm. Poor adjustment of the pilot valve clearance. Slackness of pilot seat. Leaks of liquid agent in temp.detect-device. Leaks of bypass valve.</p>	<p>Disassembly, repair, cleaning, as the case may be lapping is required.</p> <p>Renewal of relative parts.</p> <p>Readjustment. Overhaul & retighten. Renewal (to return to Nakakita.)</p>
2. Set-temp is too dropped.	<p>A. Stability is found even lowered the set-temp. B. Temp. is not reach to set-temp point.</p>	<p>Readjustment. Reexamined is required.</p> <p>Disassembly & repair.</p> <p>Cleaning. Readjustment.</p> <p>Renewals part & cleaning. Reexamined is required As B. in Item 1 above.</p>
3. Up/lower limit of set-temp is too large.	<p>* Valve is not opened or not fully opened. (causing scale adhesion & sticking so forth.) Foreign matters are being collected in piping. Poor adjustment of pressure setting. Deformation of diaphragm, distortion of piston rings or scale adhesion in the piston. Excessive capacity of valve. As per B. in Item 1 above.</p>	<p>Disassembly & repair.</p> <p>Cleaning. Readjustment.</p> <p>Renewals part & cleaning. Reexamined is required As B. in Item 1 above.</p>
4. Rising the down-steam press.	Leaking of liquid agent.	Renewal (to return)
5. Motion is dull.	Deformation of diaphragm,	Renewal of part.
6. Downstream press. fluctuation & simultaneously abnormal Noise are generates.	Excessive capacity of valve or excess of lower limit in the range of flow rate control.	Reexamined is required
7. Smelled the liquid agent.	Leaking of liquid agent (damaged of thermo bulb)	Renewal to return to Nakakita.

