Robertshaw CONTROLS COMPANY
Uni-Line North America A SIEBE COMPANY

Control Tips

April 1996

Residential Gas Oven Systems
Operation - Troubleshooting - Recalibration

Gas Oven Components

The main components in most gas ovens are: 1. **Manual Shut-Off Valve**, 2. **Pressure Regulator**, 3. **Safety Valve**, 4. **Ignition Device**, 5. **Thermostatic Control**. (Figure 1).

Other components may be included in the operation of the oven, but they are in addition to the ones listed.

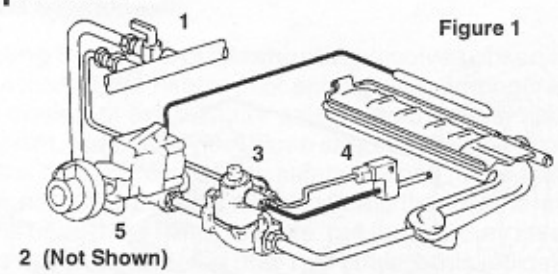


Figure 1

Gas Oven Operation Types

Gas Oven Operations are designated as either **Modulating** (Throttling) or **Cycling** (On-Off) Systems. Older systems were of the modulating type while newer systems are cycling types.

Modulating systems are characterized by a constant-on burner. Whenever a temperature is set on the thermostat the oven burner flame throttles between a minimum (bypass) and full flame based on temperature changes sensed by the oven thermostat. (Figure 2a).

Safety valves in modulating systems are usually of the protective type and are generally electromagnetic. Protective safeties are open so long as a standing pilot is present to energize the thermocouple and ignite the burner. In the event the standing pilot is extinguished, the safety valve will close and no gas can flow to the burner until the pilot is relit and the safety valve is reset.

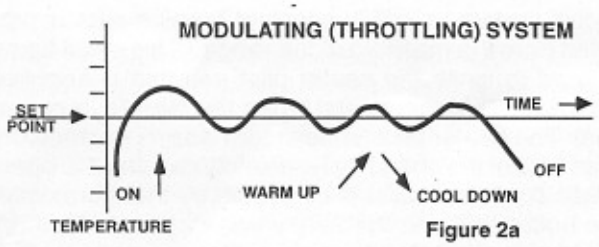


Figure 2a

Cycling systems function in an on-off manner either through the operation of a cycling pilot and operative safety valve, or the switching of an electrical circuit controlling a solenoid or an operative type safety. Operative type safety valves like the mercury bulb FM(4000), MSA(4060) and MSC(4060-7xx) models are opened and closed by the cycling of a heater pilot flame through the thermostat. Bimetal HV(4090) valves are opened and closed by electrical current flowing through a resistance wire within the valve which is activated by the thermostat. (Figure 2b).

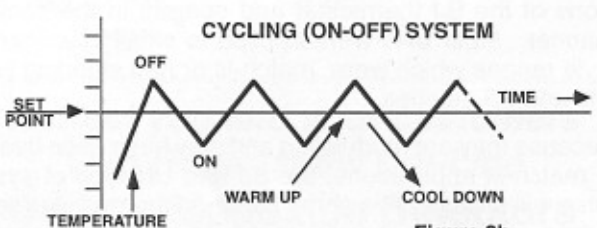


Figure 2b

Cycling systems normally have a wider operating differential than modulating systems and the set-point is an average temperature overtime.

Note: This issue of Controls Tips deals with Gas-Operated Gas Oven Systems. A future edition of Control Tips will address Spark Ignition and Electric-Operated Gas Oven Systems.

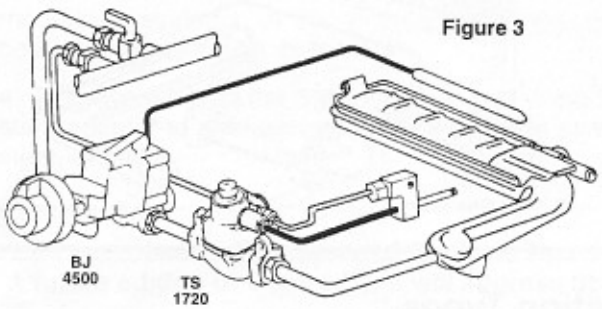
Modulating Systems

BJ(4500); BJC(4520); UN(4700) (Figure 3)

The first oven thermostats used, about 1916, were modulating, rod and tube type devices mounted on the side of range top ovens. Remote mount, bulb and capillary type thermostats were introduced in the mid-1930s and were dominant until the late 1950s. Gas ovens were match-lit until about 1940 when the TS(1720) electromagnetic safety and standing pilots were introduced and combined with the BJ(4500) thermostat to provide a safety factor in the event the pilot was extinguished.

There were over 50,000,000 domestic BJ thermostats produced over a twenty-plus year period. And many ranges with this type control are still in existence.

Figure 3



Commercial BJ(4350) thermostats are still produced and found on many new restaurant type ranges and griddles. Model FD(4200) thermostats are another series of commercial, modulating controls still widely used today.

The BJC(4520) thermostat, introduced in 1959, combined the BJ control with the TS safety into a single control. This thermostat is obsolete and ranges with it must be retrofit with a separate BJ thermostat and TS safety (4520-002 Uni-Kit®).

UN(4700) Thermostats are modern (mid-1960s) versions of the BJ thermostat and operate in the same manner. Most UNs were applied to small apartment style ranges which were match-lit or had standing pilots and TS safeties.

Because they are modulating and may have been used in match-lit applications, the BJ and UN type of systems will always have some flame on the oven burner during operation. They cannot hold steady temperatures much below 250°F.

When a modulating type thermostat is on and as the oven nears the set-point, the fluid in the sensing bulb expands, causing the diastat in the control to expand, moving the internal valve onto its seat. As the internal valve seats, minimum flame (approx. 1/8") on the burner is maintained by gas supplied through a bypass port within the control.

Two specific problems may be experienced with modulating type thermostats:

1. **Under-Temperature Condition** – may be caused by maintaining a prolonged broil setting, using the oven as a heater, or a flash grease fire in oven. Each of these situations may subject the sensing bulb to too high a temperature that may cause the diastat to over expand and take a set. If this occurs, the diastat may be unable to retract as far as it should during future operations, causing the oven to operate below the temperature setting. In some cases, this problem may be corrected by recalibration of the thermostat.
2. **Over-Temperature Condition** – may be caused by a leaky hydraulic system or complete loss of the sensing fluid. This is considered dangerous and a complete failure. The control must be replaced immediately.

Modulating System Troubleshooting is based on observing the operation of the main burner. As the oven temperature rises and nears the thermostat set-point, the burner flame will begin to modulate down until only a minimum bypass flame remains around the burner. If this flame is sputtering or erratic, or if it is larger than 1/8", it should be adjusted using the bypass adjusting screw on the thermostat.

Recalibration of thermostats is rarely needed and should not be resorted to unless cooking results prove that the control is not maintaining the temperature it is set for. In all modulating systems, recalibration should not be attempted until the bypass oven flame has been properly adjusted. Recalibration steps are reviewed at the end of this article.

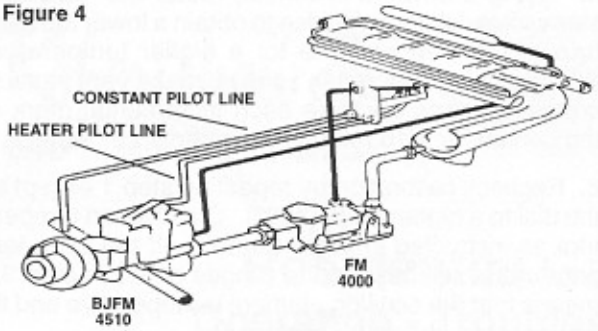
Modulating/Cycling System

BJFMA(4510) (Figure 4)

The BJFMA(4510)-FM(4000) system, introduced in 1959, incorporated both modulating and cycling features. This is the transition system between the two types of operations and at this time the mercury safety was introduced. Range thermostats were now able to provide for the control of oven temperatures as low as 140°F.

In this system, a small, constant-burning pilot is provided from the manifold of the range. This small flame is used to ignite the heater pilot gas that is supplied from the BJFM thermostat when the oven is in operation. The heater pilot flame in turn warms the mercury filled bulb of the operative type safety causing it to open. When the heater pilot is cycled off by the thermostat, the bulb cools and the safety valve closes. Mercury safeties are designed with a reverse-acting lever mechanism so that they close when the pilot is removed. They will not open in the event the bulb or capillary is damaged and fluid is lost.

Figure 4



The BJFM thermostat is a standard BJ thermostat which is internally modified by the addition of a porting in the gas cock. This porting is aligned to provide the heater pilot outlet with gas whenever the thermostat is set to temperatures above 325°F. This continuous heater pilot flow keeps the safety open all the time and the system modulates from minimum to full flame based on demand, just like the BJ type thermostat.

When the BJFMA thermostat is set below 325°F, the porting is no longer aligned, forcing the heater pilot gas to be cycled through the thermostatic valve. This cycling of the heater pilot causes the mercury safety in turn to be cycled on (open) and off (closed), which allows for lower holding temperatures in the oven.

Troubleshooting procedures for the BJFM type system are the same as those for modulating systems at temperatures above 325°F, and for cycling systems at temperatures below 325°F.

Gas-Operated Cycling Systems

MP(4400); U-Series(4700); ELO(4750); BH(4800) (Figure 5)

These systems are gas-operated cycling systems and all work based on the cycling of heater pilot gas in order to open and close an operative style mercury bulb safety valve.

The MP(4400)-MSA(4060) – 1961, was unique in that oven burner gas is piped directly to the MSA mercury safety instead of being routed through the thermostat. The gas for the constant burning pilot is supplied from the mercury safety, the manifold, or in some cases through the thermostat.

The MP thermostat's primary function is to cycle the heater pilot gas which in turn causes the mercury safety to open and close based on oven temperature needs.

U-Series(4700) – 1964, ELO(4750) – 1970s, and BH(4800) – 1990s controls all function in the same manner and all are used with the MSC(4060-7xx) mercury safety valve. With these thermostats, main gas was again rerouted through the control so as to provide a positive shut-off when the oven was not in use.

The UA, ELO and BH thermostats primarily control the flow of heater pilot gas in cycling the mercury safety.

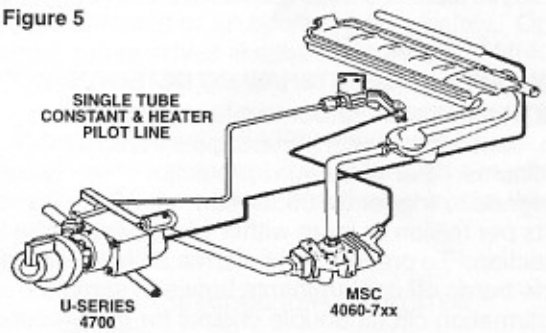
One significant change is that instead of a double-tube pilot like those used with BJFM and MP systems, a new single-tube pilot was used. Due to internal porting of the thermostat, and with the use of a "Select-A-Gas" adjustment both the constant burning flame and the heater flame are passed through the same line to the pilot.

In these thermostats, the constant pilot gas and the heater pilot gas both pass through the "Select-A-Gas" adjustment. This adjustment allows the thermostat to be set for either Natural or L.P. gas. It does not provide for additional adjustment of the heater pilot flame; which must be accomplished through orificing if necessary. Additionally, when changing from one gas to another, all of the orifices on the range must be changed or adjusted appropriately.

Cycling System Troubleshooting involves observing the action of the heater pilot and the reacting opening and closing of the mercury safety. As the oven nears set-point, the heater pilot flame should withdraw allowing the bulb of the mercury safety to cool. If the flame does not withdraw, this might indicate that the thermostat is bad. If the flame retracts, but the mercury safety does not close after the bulb has cooled, this indicates a bad safety valve. Caution should be taken to not try and troubleshoot cycling systems as modulating systems because that can often result in erroneously replacing a thermostat that is working properly.

Control Recalibration

Figure 5



If recalibration of any thermostat is needed, use a test instrument or reliable mercury thermometer to check the oven temperature. Place the probe of the test instrument or thermometer in the center of the oven. Do not use small bimetal oven thermometers for oven calibration as they are not completely accurate and stable.

1. Set dial to 400° and light the oven burner.

2. After the burner has been on about 15 minutes, and it cycles down to minimum (modulating), or the heater pilot retracts (cycling), check the test instrument and read the temperature. The oven door should be opened for as short a time as possible if reading a thermometer inside the oven.

3. Continue to check temperature at 5 minute intervals, until two successive readings are within 5 degrees of each other. If the reading is off more than 10° in modulating systems, or 25° in cycling systems, proceed with recalibration as follows:

4. Remove the dial, the dial assembly, and/or the "D" stem adaptor to gain access to the calibration screw, stem, or plate.

5. Using a small screwdriver, rotate the calibration stem/screw/plate clockwise to obtain a lower temperature or counterclockwise for a higher temperature. When rotating calibration screws, make very small incremental turns because each incremental mark on the control, or 1/16 rotation represents 25 degrees.

6. Recheck calibration by repeating step 1 except set the dial to a higher mark (450°). Check oven temperature as instructed in steps 2 and 3. If the oven temperature is still beyond the ranges noted in step 3, it means that the sensing element is inoperative and the oven control should be replaced.

Caution: Servicing of gas equipment should only be conducted by qualified service personnel with due regard for all code and safety procedures. The information contained in this edition of Control Tips is of a general nature and should not be construed as technically correct in all regards. For information regarding specific controls and applications, instructions sheets are packaged with every Uni-Line thermostat, or may be requested from Uni-Line North America at the location shown below.

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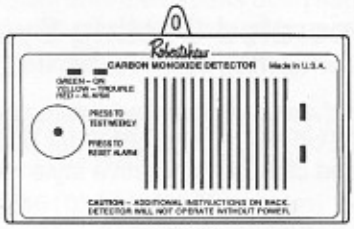
CARBON MONOXIDE DETECTORS

7605 SERIES

HOW DOES A ROBERTSHAW CO DETECTOR WORK?

The Robertshaw carbon monoxide detector uses a semiconductor sensor that samples the air for CO every 3 minutes. For maximum protection, the detector is designed to trigger an 85dB alarm at CO levels of 100 parts per million or more within 10 minutes of the initial detection. To prevent false alarms an electronic purge cycle burns off contaminants between samples, and a confirmation circuit double checks for the presence of CO before sounding the alarm. The reset button is sealed against dust and corrosion, and temporarily mutes the alarm for six minutes. If the CO level has not dropped below dangerous concentrations during that time the alarm will resound. Separate CO alarm and malfunction LEDs eliminate confusion as to type of alarm.



7605-521

ORDERING DATA

UNI-LINE ORDER NO.	SUPPLY VOLTAGE	DESCRIPTION
7605-511	115 VAC	LINE/POWER CORD 60"
7605-521		DIRECT OUTLET PLUG-IN
7605-531		HARD WIRE – SURFACE MOUNT
7605-541	12 VDC	SURFACE MOUNT
7605-542		FLUSH MOUNT
7605-551	24 VAC	SURFACE MOUNT
7605-552		FLUSH MOUNT

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