HEATING CONTROL HANDBOOK for the INSTALLER and SERVICE MAN OIL BURNER GAS BURNER AND STOKER CONTROLS
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Control circuits are classified broadly as either line voltage or low voltage, according to the voltage at which they operate.

Low voltage circuits usually operate at 25 volts, and if the supply is alternating current, a transformer is connected across the line to reduce the voltage to 25 volts. Thus low voltage controls and their wiring are designed to operate at 25 volts. It is usually more convenient and economical to use low voltage control circuits with suitable switches (relays) to handle the line voltage necessary for operating equipment such as blower motors, oil burner motors, circulators, unit heater fans, etc. For example, a Series 10 oil burner relay has switching contacts for line voltage loads and also has a built-in transformer to furnish low voltage for the control circuit. (Note that the "Series 10" designation refers to the thermostat side of the relay circuit, not to the load circuit of the relay.) Low voltage gas valves, however, are supplied with external transformers.

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Line voltage controls (thermostats, etc.) may be used on low voltage circuits (if the type of switching action is correct). Low voltage controls MUST NOT be used in line voltage circuits.

A control system normally consists of one or more controllers and a primary control. Controllers in the broad sense include operating controls, such as room thermostats, limit controls, which are used to maintain excessive temperatures or pressures in the heating plant; and low limits, which are used to maintain temperature or pressure in the heating plant above a selected minimum.

Primary controls are the final control units which directly regulate burner operation. They may be gas valves, oil burner relays, or other relays. Plain switching relays are often used to make and break circuits that the thermostat, for example, cannot handle directly—because of the heavy current or voltage load, or because two separate circuits must be closed simultaneously.
Every controller has a differential—the difference in temperature or pressure between "cut-in" and "cut-out."

Calibration of a controller is the adjustment of the mechanism to make the scale reading agree with the actual temperature (or pressure). Occasionally a room thermostat, for example, may need recalibration in order to maintain actual room temperature at the scale setting.

**CODE IDENTIFICATION**

Honeywell type numbers are based on a simple code for identifying controls as to purpose, circuit type, and voltage, enabling you to select the proper control for a given application.

A—Accessories, such as switch elements (AS—) or transformers (AT—).

C—Combination Controls (Pyrostats, Protectors, Stackswitches, Plugstats), and Lo-Water Controls.

H—Humidity Controls (incl. combination humidity-temperature controls.

K—Motorized Valve Assemblies: control flow of steam, water or air.

L (or LA) = Alloy Controls (Aquastats, Austats, Combination Fan and Limit, Plugstats, Vaporstats, Vacuumstat, high pressure Steamstat, and some remote bulb-temperature controls).

M=Motors (Electric motors, damper motors, circulators).

P=Pressurestats (low pressure only).

Q=Accessories (example: auxiliary switches).

R=Relays (intermediate or switching, Pressurestats, Stokerstats).

S=Switches (Time-O Switch, Stokerswitch, Dan-Nite Time Switch, manual switches).

T (or TA)=Thermastats (Applinnew, Chronotherm, Dan-Nite Aroma-therm, Timer-O-Rator, and the Voltage) and most remote bulb-temperature controls.

V=Valves (Solenoild, Motor, and Diaphragm) and valve bodies (tens operator).

W=Accessories (certain type; for example, definers).

Y=Packaged sets.

**NOTE:** The "A" following the type letter, as in LA or TA, indicates a redesign of a previous model having the same function.

The first numeral in the type number indicates the "series" classification of the control:

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<td>Low</td>
<td>Two contacts make in sequence to start, break in reverse sequence to stop.</td>
<td>1. 2-wire low voltage. 2. Both contacts on same side of moving blade.</td>
<td>Series 10 or Series 40</td>
<td>1. Protector relays (A.C. motors.) 2. Series 10 Relays. 3. Series 10 Gas Valves.</td>
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<td>Line</td>
<td>Makes circuit when switch is closed, breaks circuit when switch is open.</td>
<td>1. 2-wire line voltage (control connection). 2. Mercury tube or line switch makes contact in one position.</td>
<td>Series 40</td>
<td>1. Protector relays (D.C. motors.) 2. Series 40 Relays. 3. Direct Control.</td>
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<td>None</td>
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<td>Series 60</td>
<td>Line</td>
<td>Line voltage equivalent of low voltage Series 20.</td>
<td>1. 2-wire line voltage. 2. Contacts on opposite sides of moving blade.</td>
<td>Series 60</td>
<td>1. Series 60 Motors. 2. Series 60 Valves.</td>
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<td>Low</td>
<td>Low voltage equivalent of line voltage Series 40.</td>
<td>1. 2-wire low voltage. 2. Mercury tube or switch makes contact in one position.</td>
<td>Series 10 or Series 40</td>
<td>1. Series 80 Motors. 2. Series 80 Valves. 3. Series 80 Relays.</td>
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THE SPECIFICATIONS FOR EACH TYPE OF DEVICE SHOWN IN THE DURAVAC CATALOG LIST THE ELECTRICAL CONTROL CIRCUIT TO WHICH IT IS APPLICABLE.

THE CONTROL CIRCUITS IN COMMON USE ARE NAMED SERIES 50, SERIES 70, SERIES 40, SERIES 60, SERIES 80, AND SERIES 90 (SEE TABLE OPPOSITE).

WITH FEW EXCEPTIONS, THERMOSTATS DESIGNED FOR OPERATION WITH ONE CONTROL CIRCUIT WILL NOT FUNCTION WITH CONTROLS ARRANGED FOR ANOTHER CONTROL CIRCUIT. SERIES 10 THERMOSTATS SHOULD BE USED ONLY WITH SERIES 10 PRIMARY CONTROLS; SERIES 20 ONLY WITH SERIES 20, ETC. THE PRIMARY CONTROL USED IN EACH CASE DETERMINES THE CONTROL CIRCUIT. (PRIMARY CONTROLS ARE RELAYS, PROTECTORS, GAS VALVES, CONTROL MOTORS, ETC.)


SERIES 40 (LINE VOLTAGE) AND SERIES 80 (LOW VOLTAGE)

SERIES 40 AND SERIES 80 CONTROL CIRCUITS ARE THE SIMPLIEST TYPES—EACH WITH TWO-WIRE CIRCUITS. AS THE DIAGRAM INDICATES, EACH CONTAINS ESSENTIALLY A CONTROLLER WITH SINGLE-POLE SINGLE-THROWN POSITIVE-ACTION SWITCHING MEANS CONNECTED IN SERIES WITH A TWO-WIRE DEVICE (MOTOR, VALVE, OR RELAY). THE CONTROLLER INDUCES THE CIRCUIT IN THE "OFF" POSITION AND BREAKS IT IN THE "ON" POSITION.
The difference between Series 40 and Series 80 is that a Series 40 control circuit takes its power directly from the line, whereas the Series 80 circuit is supplied with low voltage (20-25 volts) from a transformer. The Series 40 controller therefore may operate a line-voltage device such as a blower motor directly (or through a relay where the load is too heavy for the controller or where multiple-circuit or sequence switching is required), but the Series 80 controller may be used only with low-voltage devices such as a gas valve, or a relay where a line-voltage device must be controlled. Therefore, a Series 80 control may be used only in a low-voltage control circuit, although a Series 40 controller (thermostat or limit control) may be used in a low-voltage circuit as well as on line voltage.

Series 40 circuits normally require wiring in conduit or armored cable; in Series 80 circuits, exposed low-voltage cable may usually be used (see your local electrical codes).

In a two-wire circuit (Series 40 or 80) with a gas valve, the high-limit control, if used, is normally connected in series between the thermostat and the valve. In a Series 40 (D-C) oil burner system, however, the high limit should be connected into the “hot” line to the Protector relay or Lockswitch, to ensure positive shutdown of the burner (without false safety shutdown). And on a D-C oil-pressure control system, the high-limit control normally is connected between the flickerswitch or relay and the starter motor.

Where a low-limit control is used, it should be wired in parallel with the thermostat so that either controller can energize the load or primary control. The high-limit control should always be able to shut off the valve or stop the motor regardless of the thermostat or low-limit control.

Typical examples of Series 40 control circuits are the following:

1. A gas-fired unit heater with line-voltage thermostat operating both gas valve and fan motor;
2. A furnace fan control directly operating the blower motor;
3. A line-voltage thermostat and Series 40 Protector relay or Lockswitch on an oil-burner system in a D-C power district.

A typical example of the Series 80 circuit is a two-wire thermostat operating a two-wire low-voltage gas valve, with an external transformer supplying the low-voltage power for the system.
Fig. 1 illustrates the basic Series 10 circuit as applied to a simple relay such as the R19A. The diagram includes a thermostat but no limit controls. A Series 10 relay normally includes a built-in transformer, and one or more line-voltage load contacts (No. 2) in addition to the low-voltage “holding” contact (No. 1). A Series 10 valve does not usually include a load contact, and is used with an external transformer, but otherwise the basic circuit is identical. The coil may be the magnetic coil that “pulls in” the armature in the relay, or a solenoid, motor, or relay-type coil in a gas valve. Every Series 10 primary control has a “holding” contact that closes when the coil is energized.

Fig. 1—Simple Series 10 Circuit.

Fig. 1 shows the thermostat “satisfied” (both contacts open). The thermostat is arranged so that on a drop in temperature the flexible blade first “makes” the White contact, and then the stiff blade, the Blue. On a temperature rise, the contacts break in reverse order.

In Fig. 1, heavy lines represent line-voltage circuits, and lighter lines represent low-voltage circuits. The broken lines indicate external wiring (between control units).

In tracing the operating cycle through the following diagrams, however, please remember that:
1. Line voltage circuits are omitted to save space, but current is taken as supplied to the transformer primary continuously.
2. Contact 1 (and No. 2 on a relay) is closed whenever the coil is energized. (In a valve, the valve seat is also opened.)
3. Solid lines indicate wires in which current is flowing.
4. Dotted lines represent inactive circuits.

Fig. 2—Thermostat Satisfied.
The following problems will help you to get the Series 10 circuit firmly in mind. Refer to the preceding diagrams to see "Why?" in each case.

Open circuits due to poor splicing, loose terminal screws, broken or defective wire.

1. Break in white wire. Thermocouple can't pull in the relay (open the valve), nor hold it in (open) after momentary shorting of W-B at the relay or valve.
2. In blue wire. Thermocouple can't pull in relay (valve) but can hold.
3. Broke red wire, or broken heater plug screw. Short cycling on blue contact—single-point operation.

Short circuits resulting from careless wiring at terminals or broken insulation.

1. Shorted white to white. Relay or valve stays "on" unless power supply is cut off by limit control, switch, or disconnecting wire at transformer.
2. Shorted red to white. Thermocouple can start but can't stop—burner.
3. Shorted red to blue. Short-cycling (double-pointing) on white contacts above.

Interruption of color coding through careless wiring at terminals or at splices.

1. White-blue (interchanged). Short-cycling on blue contact.
2. Blue-red (interchanged). Short-cycling on red contact.
3. Red and white (normal operation except heater is effective at once, resulting in shorter operation than normal).

UNCOLORED THERMOCAP CABLE

Suggested method for determining and labeling wires of thermocouple cable that is not color coded (Series 11).

1. With the two wires properly connected at the relay or valve, hold the three bar wires, at the other end, together.
2. Remove one wire—if the balance stops, this is the white wire. Attach it to the W terminal of the thermocouple.
3. If burner does not stop, hold all three bar ends together again and try another wire until the white wire is found.
4. After the white wire has been found, and secured to the W terminal, one of the remaining two wires will start the burner when shorted to the white. This is the blue wire. Connect it to the B terminal.
5. The remaining wire is the red and should be connected to the R terminal.

KEY TO SERIES 10 CIRCUIT

B to W—Pull-In Circuit
R to W—Hold-In Circuit
As shown in the diagram, the basic Series 20 circuit consists of a low-voltage controller with S.P.D.T. switching action, a transformer (external) and a low-voltage two-position motor. The motor is unidirectional: the shaft rotates 180 deg. to open the damper or valve, and completes the remaining 180 deg. rotation to close. A cam-operated maintaining switch in the motor (1) assures positive maintenance of the circuit through each half-turn, and (2) stops the motor at the end of the half-turn. (See operating sequence below.)

1. At A, the thermostat has just made Red to Blue on a drop in room temperature. The circuit is completed through R-B and maintaining switch MS1, energizing the motor.

2. Motor starts rotating with the arrow, and MS1 closes as always at B. Now, even if the closing contacts of the thermostat open, the motor will continue to run.

3. At C the motor is shown at the end of its 180-deg. travel. Maintaining switch MS2 has opened, stopping the motor.

4. On a rise in room temperature the thermostat first opens R-B, and then closes R-W. The motor then runs through its closing stroke of 180 deg., in the same manner already described—except that MS2 is the “maintaining” contact after initial movement, and MS1 opens to stop the motor at the end of the 180-deg. stroke.

Important: Series 20 devices should be used only with other Series 20 devices.

A high limit control in a Series 20 circuit may be connected between the thermostat and the primary control in such a manner that it can drive the motor to the “off” position. This is accomplished by breaking the Blue circuit (or the Red) from motor to thermostat and making positive contact between Red and White of the motor (reference to the diagram will show how this prevents the thermostat from operating the motor and positively drives the motor closed).
T11A or T81A
T44A or T45A
T42A
T42
T4B
T50A
T10A
T50A
T107, T247, T347
T44A "Plug-in" Chronotherm
Things to DO—
1. Pick at least two good locations before asking the customer to choose.
2. Use new thermostat cable.
3. Plug hole in plaster to prevent drafts from affecting thermostat.
4. Run wiring color-to-color: red wire to R terminal, blue to B terminal, white to W.
5. Chronotherm: wire clock transformer primary to un-interrupted line to avoid stoppages.
6. Use the clock transformer furnished with the Chrono-
therm.
7. Advise home owner not to place lamp or radio under 
thermostat.

Things NOT to DO—
1. Don’t wait for customer to choose a poor location and try to argue him out of it.
2. Don’t reverse wires or make careless errors in splicing.
3. Don’t connect doorbells, toy trains, or any other load except the clock to the Chronotherm clock transformer.

GOOD Thermostat Locations—
1. In the living room; sometimes, dining room.
2. About five feet from the door.
3. On an inside wall.
4. In good natural air circulation.

POOR Thermostat Locations—
1. Don’t mount it in kitchen, bath, or entry.
2. Don’t “freeze” it on an outside wall.
3. Don’t hide it in an alcove or behind an open door or behind furniture.
4. Don’t mount it where cold drafts can strike it.
5. Don’t mount it next to concealed pipes or ducts.
6. Don’t mount it in direct rays of sun.
7. Don’t mount it in the air stream from a warm air register.
8. Don’t mount it over lamp, radio or other source of radiant heat.

REMEMBER—that a neat and satisfactory thermostat inst- 
allation is good advertising for the entire heating plant.
**Things to DO—**
1. Install thermostat first, and let it reach room temperature before checking operation of the system.
2. Make sure the right heater plug is used (see p. 40, 49, or 62 for heater plug specifications).
3. On 1-pipe steam, increase differential to 3 or 4.
4. Check operation of the completed installation.

**Chrotherm—Things to DO—**
1. Use external hand wheel to set clock.
2. Make sure day-night indicator in clock face shows white by day (6 a.m.—8 p.m.), black by night (6 p.m.—6 a.m.).
3. Consult user for desired settings of "setback" and "pickup" time.
4. Instruct customer how to set temperature indicator, and how to postpone night "setback."

**Things NOT to DO—**
1. Don’t calibrate a thermostat at installation—give it time to "settle out" under operating conditions.
2. Don’t check calibration of a Chrotherm unless the clock has been running (with cover on) at least two hours.
3. Never bend blades or contacts.
4. Don’t recalibrate with blue contact screw (see "Recalibration:" on the last page).
5. Don’t set Chrotherm clock by moving clock hands.
6. NEVER file or scratch thermostat contacts.

Before checking calibration, remember—
1. Burner should be "off" for 10 minutes to allow heater plug to cool.
2. Thermostats are carefully adjusted at the factory.
3. They are so sensitive they are easily affected by warmth of breath or radiant heat from hands or body.
4. Chrotherms are factory adjusted to allow for heat from the clock.
Series 10

Series 10 thermostats are calibrated to make Blue (start the burner) when the temperature fails to scale setting, and to break (or makes) White at setting plus differential. Main scale calibration is done by adjusting a calibration screw. Differential setting is made by the White contact screw. The Blue screw should not be adjusted unless a non-linear differential does not agree with differential scale setting (refer to instructions packed with Q56A Tattelite).

The best way to calibrate a Series 10 thermostat (particularly if main scale error is not known) is with Q56A Tattelite to signal when White makes and when Blue makes.

T11A Acratherm—If Error is Known:

Main scale may be corrected by steps shown in diagram.

T11A Acratherm—Error Unknown:

Correct main scale with aid of Tattelite as shown.

1. Attach Tattelite clips as shown.
2. Set dial at room temperature.
3. Tighten lock screw.
4. Turn calibration screw \( \theta \) to open both contacts.
5. Wait 10 minutes for heater plug to cool.
6. Turn calibration screw SLOWLY \( \theta \) until Tattelite (1) lights up and (2) goes out. This is when burner starts.
7. Loosen lock screw, reset dial for desired temperature.
Calibrating 2147A Chronotherm

1. After removing cover, set lever at room temperature.
2. Tighten lock screw.
3. Turn calibration screw about ¼ turn to open contacts.
4. Slip cover on. Wait 10 minutes for temperature inside to level off.
5. Remove cover and attach Tantalus clips as shown. Be careful to avoid shorting B to W.
6. Turn calibration screw SLOWLY until Tantalus (1) lights up and (2) goes out. This is when burner starts.
7. Loosen lock screws, set lever for desired temperature, replace cover.

Calibrating 2160A Day/Nite Airtsuherm

1. After removing cover, replace winding knob and turn it all the way 
2. Attach Tantalus clips as shown.
3. Set dial at room temperature.
4. Turn calibration screw until both contacts open.
5. Wait 10 minutes for heater plate to cool.
6. Turn calibration screw SLOWLY until Tantalus (1) lights up and (2) goes out. This is when burner starts.
7. Turn winding knob ½ turn to put the thermostat in milk cycle.
8. Set dial 5°F above room temperature, blank, then AT room temperature. (For thin method room temperature must be below 75°F.)
9. Turn right calibration screw 
10. Wait 10 minutes for heater plate to cool.
11. Turn right calibration screw SLOWLY until Tantalus (1) lights up and (2) goes out. Now the thermostat should be in calibration.
TSHA Aerotherm

If the error is known, follow the first diagram for calibrating TSHA, p. 16.

If the error is not known, use the following procedure (order to
sequence of T11, but note that Tattletale must not be used—separate
action of the contacts makes it easy to tell when they close):

1. Set dial at room temperature, and tighten lock screws.
2. Turn calibration screw to the left to open the contacts if they
   have closed.
3. Wait 10 minutes for the heater plug to cool.
4. Turn the calibration screw to the right (SLOWLY) until the con-
   tacts just close. Then the thermostat should be calibrating.
5. Loosen lock screw and reset dial for desired temperature.

TSHA Time-O-Stat

1. After removing cover, collect winding leads and turn
   1/4 turn, or as if off.

2. Tune dial to normal temperature.

3. Turn dial calibration screw 1/4 turn clockwise.
4. Turn dial to slowly 1/4 turn until contacts just make. Slow
   dial is calibrated.

5. Step back and wait a few minutes for effect of body
   heat on the forward to disappear.

6. Turn winding leads 1/4 turn.

7. Turn dial to high end of scale (850).

8. With switch on, move the setting screw to indi-
   cate mark is one and between "5" and "55" mark.

9. Turn right calibration screw so that the day cali-
   bration screw (Sec. 11) can touch its case.

TSHA Chromotherm (for TSHA)

1. After removing cover, set both levers at room tem-
   perature.

2. Tighten lock screws.

3. Tune calibration screw 1/4 turn 1/4 turn to the con-
   tacts are open.

4. Slip cover back on and wait 5-10 minutes for tem-
   perature inside to level off again.

5. Remove cover and turn calibration screw SLOWLY
   until contacts just close. Now the Chromo-
   therm is in calibration.
WARM AIR LIMIT CONTROLS

INSTALLATION

Things to DO—
1. Follow appliance manufacturer’s recommendations.
2. Try to locate bimetal element where it can respond quickly to AIR temperature changes.
3. Locate control where it is handy to act.
4. Always use one of mercury switch type (LA119 or LA412).
5. Connect high limit switch in circuit according to recommendation for the primary control used (p. 28, 42 or 52).

Things NOT to DO—
1. Don’t let bimetal too close to hot surface.
2. Don’t locate where cold air return can affect elements.
3. Don’t mount LA101 or LA401 where temperature inside cover will exceed 150°F.

SETTING AND ADJUSTING

Things to REMEMBER—
1. High-limit switch breaks at indicator setting and makes at setting minus differential (fixed, in LA101, LA601).
2. Furnacestat (LA412) starts fan at indicator setting, stops it at setting minus differential (adjustable).
3. LA101 and LA401 have separate indicators for setting limit cutoff, fan “on” and fan “off.”

Things to DO—
1. Use lowest limit setting that will assure enough heat.
2. Use lowest fan settings possible without cool drafts from registers before fan stops.
3. Instruct customer in summer fan operation.

Things NOT to DO—
1. Never set Furnacestat “on” above Airstat setting. (Note that LA101-412 are designed to prevent overlap.)
2. Don’t forget to tell user about setting Furnacestat (LA412) for correct fan operation in the heating season.
INSTALLATION

Things to DO—
1. Surface Aquastat:
   a. Mount it on riser about 2 ft. above boiler.
   b. Scrape surface of pipe clean.
2. Immersion Aquastat:
   a. Locate the well in freely circulating water.
   b. Locate it where it is handy to set.
3. Be sure the case is mounted level.

Things NOT to DO—
1. Surface Aquastat:
   a. Don’t install on pipe smaller than 1½".
   b. Don’t replace pipe insulation around the Aquastat.
2. Immersion Aquastat:
   a. Don’t put the element too near the cold return inlet.
   b. AVOID packet, baffles or excessive bushings.
   c. Don’t jam a long-shank element into an old short well.
   d. Don’t twist the bimetal element.

WIRING
Things to DO—
1. Connect high-limit Aquastat in circuit as recommended for the operating control used (p. 28, 42 or 52).

Things NOT to DO—
1. Don’t use low-voltage model on line voltage.
2. Don’t use surface Aquastat as operating control.

SETTING
1. Use the scale setting recommended by burner or boiler manufacturer.
2. Generally, use lowest setting that will assure enough heat.
INSTALLATION

Things to DO—
1. Make sure that the Pressuretrol installation conforms to any local ordinances.
2. Mount the Pressuretrol on a siphon to prevent steam or foreign matter from reaching bellows. NOTE: Siphon coil must be at right angles to front of case as in sketches above, for correct operation.
3. Make sure the case is level.
4. Make sure no sludge or lime obstructs the piping.
5. Make sure the pressure rating of the Pressuretrol is high enough for operating pressures expected.

Things NOT to DO—
1. Do NOT put a shutoff valve between boiler and Pressuretrol.
2. Don’t use excessive amounts of pipe dope on threads.

WIRING
1. Connect high-limit Pressuretrol in circuit as recommended for the primary control used (p. 26, 52 or 52).
2. Don’t use a low-voltage model on line voltage.

SETTING
1. Use settings recommended by burner or boiler manufacturer.
2. REMEMBER: A high-limit Pressuretrol opens circuit at main-scale setting. Plus differential setting—makes circuit at main scale setting.
INSTALLATION

1. DO make sure the Cutoff opens the circuit at low water level (with boiler at operating pressure).

2. DON'T expose the Cutoff to pressures above its rating.

WIRING

Connect the Cutoff in the circuit as recommended for high limit switch with given primary control (see p. 26, 42 or 52).

REMEMBER

1. —to instruct the user to blow down the Cutoff once a month.

2. —to clean out the housing once a year.
RJ16 or RJ17
Protectorelay

R217A Electronic
Protocooielay

R314A
Protectorelay

R161
Protocooielay

C6A
Pyrostat

C5A
Protocooielay
OIL BURNER "DO'S AND DON'TS"

A = Location of Stack Element  B = A Protectivestat Installation

INSTALLATION

All Models—
1. DO follow equipment manufacturer’s recommendations.
2. DON’T change factory-set timings unless necessary—NOR without rechecking operating sequence.
3. ALWAYS check operating sequence, including safety shutdown, before leaving the job.
4. NEVER BEND ANY CONTACT BLADES
5. DO leave cover on as all times.
6. DON’T get oil or grease on contact mechanism.
7. DO see that Pre-wet or Protectivestat contacts are in starting position before starting burner.

Stack-Mounted Models—
1. DO install between furnace and draft regulator—and remove stack damper or fasten it wide open.
2. DON’T expose element to temperature over 1000 F.
3. DO put stack element in path of hot gases (cut A).
4. DON’T locate element rear of adjustable.
5. DON’T expose case to excessive radiant heat from stack.
6. DON’T open ventilating slots (RA116-117) on average jobs.

Wall-Mounted Models—
1. DO mount on solid vertical wall free from much vibration.
2. DON’T mount on raster or beam near ceiling.
3. FIND a location handy to burner and power supply.

WIRING
1. Wiring must conform to local electrical ordinances.
2. High limit switch should preferably be connected in the "hot" line to terminal No. 1.
3. NEVER put the high limit switch in the line from relay to oil burner motor (as limit shutdowns may wrap out safety switch).

REMEMBER—

to tell how to reset the safety switch.
**NORMAL START**

1. On thermostat's call for heat—
   a. RA116: relay "5" pulls in, starting motor and ignition.
   b. RA117: relay "1" pulls in, starting ignition and plunging in motor relay "5".
2. If stack temperature expands bimetal element "1" moving Pyrotstat contacts (pp. 28-29):
   a. "Hot" contact shunts safety switch heater.
   b. Then "Cold" contacts break starting circuit (and drop out ignition relay, on RA117).

**IF OIL DOESN'T IGNITE**

1. "Hot" contact doesn't close—safety switch heats.
2. "Cold" contacts don't open—ignition stays on (RA117).
3. Safety switch trips—must be reset manually for restart.

**IF FLAME GOES OUT**

1. "Hot" contact opens—burner stops.
2. Delay for "scavenging" any unburned vapors.
3. "Cold" contacts make, permitting attempted restart if thermostat still calls for heat.
Fig. A—Pyrostat contacts—cold or starting position.

Fig. B—Pyrostat contacts—hot or running position.
OPERATION:
1. Expanding bimetal (not shown) pushes drive shaft (3) to the left, and on contracting pulls it back.
2. Clutch fingers 3 and 7 are carried by friction with shaft until “unlocked” by hitting stops Stops 3 and 6 limit inner or “hot” clutch (1), 4 and 10 the “cold” clutch (2).
3. In cold position, hot contact is open (A—8) and cold contacts are closed (A—9).
4. As bimetal heats, hot clutch closes hot contacts (B—6).
5. Then cold clutch lets cold contacts open (B—9).
6. As bimetal cools, hot contact opens (A—8).
7. Then cold contacts are pulled together (A—9).

REMEMBER—FOR SATISFACTORY OPERATION:
1. Hot contact must be open, cold contacts closed at start.
2. Hot contact must close before cold contacts have opened.
3. Hot contact must open (on cooling) before cold contacts have closed.
4. Drive shaft must move out a little more after cold clutch hits the stop arm (A), to keep contacts in step.

TO MAKE SURE CONTACTS ARE "IN STEP":

1. Look to see that hot contact is open, cold contacts are closed.
2. As you slowly pull out shaft, see whether hot contact closes before cold contacts have opened.
3. As you slowly release shaft, see that hot contact opens before cold contacts have closed.
4. Checking burner operation, watch whether drive shaft moves a little more after cold clutch hits stop arm.
1. The control circuit is Series 10, and Series 10 operating controls are normally used.

2. The flame-sensing element is a photocell, which responds instantly to changes in light from the flame. In the presence of flame it passes a small current (rectified A.C.) which is amplified by the electronic circuit until it can actuate the flame-checking relay unit.

3. The electronic flame-checking system is so fast that normal practice is to use intermittent ignition and to return the unit on loss of flame.

4. Consequently, recycling is provided only after power interruption. On ignition failure and on continued loss of flame after a normal start, the RI77A locks out. It also locks out on a beyond-fairness, short-circuit, grounds, or open circuits in photocell circuit.

5. The RI77A is available only for factory applications. It is designed into the burner and at least partly installed at the factory.

6. The RI77A is NOT available for conversion applications. Underwriters' approval is predicated on tests of the system as applied to particular models of burner.

7. Installation must be completed in accordance with the instructions furnished with the burner.

8. No field adjustments on the RI77A are provided for (fitting, etc.) and none should be attempted.
With Electronic Flame-Checking

Typical Control System—Gravity or Steam

Things to DO—
1. Use only Series U thermostat (or "jumper" R.B at relay if 2-wire thermostat must be used).
2. Follow manufacturer’s instructions in mounting and wiring.
3. In mounting the relay on the base, start all tilt mounting screws before tightening them. If the base, start all tilt mounting screws before tightening them.
4. Make sure photocell faces fire (facing mark toward boiler).
5. If light (40) (flame) relay won’t pull in, or chatter:
   a. Check for spot on the cell (or filter if used).
   b. Measure current through cell with a 0.0 microammeter in series with F terminal and load at the cell mount. It should be at least 3 microamps (1 to 2 microamps) with flame present. If not, replace cell. If meter is not available, replace the photocell and check performance.
   c. If current is right, try replacing the vacuum tube.
   d. If good cell and tube don’t restore operation, mount a replacement relay on the base.
6. If photocell mount with filter is used, be sure filter is in place after checking. (Temperature of photocell must not exceed 65°F.)

Things NOT to DO—
1. NEVER bend relay contact blade.
2. Don’t try to adjust or repair EI77A—if it is defective, return it for factory repair or replacement.
3. Don’t return a relay before checking photocell and tube, and looking for dirty cell or filter and hose connections.

To Order Replacements—
Photocell: A1774L Tube: No. 38305
Relay: R177A use base (specify voltage and frequency).
R14 PROTECTORELAY

Accelerated Lockout

Points to REMEMBER:
1. The R14 is available for intermittent ignition (R114A) or for constant ignition (R114B), when oil valve delay is not needed and where accidental runs after flame failure are desirable.
2. With C4A Pyrostat or C5A Protectostat, R14 guards against ignition failure or loss of flame.
3. The R14 locks out if flame is not established in approximately 40 seconds.
4. On flame failure, as soon as the Pyrostat or Protectostat opens its contacts, the current of both delay coils flows through the safety switch heater, and lockout follows in about 30 seconds.
5. The R14 must be mounted on a vertical wall or column free from excessive vibration.

R10B PROTECTORELAY

OIL Delay—Nonrecycling—Fast Restart

FEATURES:
The R10B Protectorelay is designed primarily for commercial or industrial oil burners requiring delayed oil valve opening, timed ignition, lockout on flame failure (non-recycling), and a fast reset after normal shutdown. It guards against either ignition failure or loss of flame.

In case of flame failure, the Protectorelay receives a power interruption. In case of flame failure, it shuts down the burner as soon as the combined current of its two delay coils drops to a certain point after a time delay set by the engineer.

The R10B Protectorelay is used with the C4A Pyrostat or C5A Protectostat, or for the flame failure unit sensitive to flame conditions, with the R7060 Electronic Flame Detector Relay photoflood for photoflood and flame rod.

The R10B Protectorelay is for intermittent ignition burners. The R10LA is also available for intermittent ignition burners where recycling after a flame failure is desired. The R10LC is available for constant ignition burners, with the same features as the R10B (excepting timed ignition).

Things to DO:
1. Mount the Protectorelay on a vertical surface free from vibration.
2. Check out the system completely for satisfactory operation.
3. Make sure the connections are correct as shown in diagrams. (Refer also to instructions packed with the controls.)

NOTE: Diagrams on opposite page show standard connections for R10B used with R609A Flame Detector Relay: (a) on oil burner with tick ignition or with gas pilot with main flame supervision only; (b) on oil burner with intermittent gas pilot. In the latter, the oil valve cannot open until the pilot is proven; both pilot and main flame are supervised.
Connections for R161B and R709A—Spark Ignition Burner, or Burner with Gas Pilot Requiring Main Flame Supervision Only

Connections for Supervising Pilot (Start) and Main Flame (Ruff)
Important Points—
1. Mount between draft stabilizer (if used) and furnace or boiler.
2. Don’t mount where element will be exposed to more than 1100 F.
3. Make sure contacts are in starting position (open) before starting burner (see instructions packed with control).

Important Points—
1. Line of sight from diaphragm must strike flame at all times.
2. On brickwork mounting, space between insulated flange and brickwork must NOT be filled with cement.
3. On fire-door mounting, the flange must be at least one inch back from the mounting flange.
4. The Protectostat will not operate correctly if the diaphragm gets excessively hot.
When there is no apparent cause for erratic operation and occasional lockouts: (1) prove relay; (2) prove thermostat cable; (3) prove the thermostat.

**Relay**

1. Make sure that:
   (a) there is power at terminals 1 and 2;
   (b) safety switch is not locked out;
   (c) Pyrostat or Protectstat contacts are in starting position.
2. Remove thermostat wires from terminals R, W and B at relay.
3. Place jumper, or short, across these three terminals.
4. After burner has operated a few seconds, remove jumper from B terminal only. If burner continues to run several minutes, relay is operating correctly.
5. If relay does not pull in at all, or if burner doesn't continue to run as outlined in step 4, we suggest replacing relay.
6. If relay passes tests, reconnect thermostat wires as in relay.

**Thermostat Cable**

1. With thermostat wires connected to relay and thermostat, remove thermostat from its base plate.
2. Short or jumper the R and W terminals on base plate. If burner starts, there is a short between red and blue wires within the thermostat cable. Remove, replace thermostat cable.
3. If burner did not start in step 2, momentarily short B to R and W jumper—until burner starts—then remove B jumper. If burner continues to run, thermostat cable is free from open or short circuits. If burner stops with R and W shorted, the red wire is open. Try to locate the break or replace the entire cable.
4. If burner did not start in step 3, the white or blue wire is open. Check for loose connection, find break, or replace cable.

**Thermostat**

We have now checked both the relay and the thermostat cable. If the trouble has not been found it is now in order to check thermostat.
1. Check the heater plug screw for tightness. (A loose heater plug screw would cause a break in the red wire.)
2. Check the three mounting screws for tightness.
3. Make sure the blue contact is not making ahead of the white contact. If it is, recalibrate differential and main scale according to instructions packed with the QSTA Tattles.
4. Make sure contacts are clean. Polish only with a piece of hard-surface paper—NEVER use file, emery cloth or sandpaper.
STEAM OR GRAVITY

This is a control system for a domestic steam, gravity warm air or gravity hot water system. The Series 10 thermostat actuates the RA117 Proportional (or RA116 with constant ignition) to start and stop the burner. The high-limit Asstat, Aquastat or Pressurized (depending on the heating medium) stops the burner before excessive pressure or temperature is reached in the heating plant. On a steam system, the Lo-Water Cutoff (L-W-C.O.) guards against operation with a dry boiler. When the T109A or T147A is used, lowered temperature at night is provided with automatic return to day-time temperature.

In this control system for forced hot water heating, the thermostat actuates the switching relay (BR122A), which in turn starts the circulator and actuates the Proportional to start the burner. The high-limit Aquastat will stop the burner before excessive temperature is reached in the boiler, but the circulator will run as long as the thermostat calls for heat. The RA117 Proportional is used with intermittent ignition burners; the RA116 with constant ignition. When the V-09A or T47A is the thermostat, with lowered temperature is provided at night, with automatic return to day-time temperature in the morning.
NEW MODELS

INSTALLATION AND SERVICE TIPS

For your convenience we are including several new units in this section. These represent the latest developments in Minneapolis-Honeywell control devices.

T118B and T83C
Time Modulation Thermostats

V808A Diaphragm Gas Valve
Used with "Plug-In" Transformer

Powerpile Gas Control System
Electric Power Supplied by Thermopile
**TIME MODULATION THERMOSTATS**

Types T11B and T8IC

**Things to DO—**

1. Install according to standard good practice for conventional thermostats.
2. Make sure the heater element used is the correct one for the primary control (see table).
3. With the T11B, use ONLY the wall plate furnished, and wire color-to-color according to plate markings.
4. If the temperature maintained indicates that the main scale must be recalibrated—
   a) determine the change necessary;
   b) adjust by first method shown for T11A (p. 16) to avoid the difficulty of judging when the heater has cooled just to the "on" point.

**Things NOT to Do—**

1. Don't mount a T11B on a T11A wall plate—use the plate furnished with T11B.
2. Don't use T11B or T8IC with R817F Protector relay.
3. Don't widen the differential unless the burner operations are definitely too short (these thermostats are designed for shorter, more frequent cycles).

**NOTE:** On an average system, the "on" time will be approximately as follows:

- **T11B:** 3 min.
- **T8IC:** 2½ min.

<table>
<thead>
<tr>
<th>In mild weather (50-60°)</th>
<th>5 min.</th>
<th>4½ min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>In &quot;90%&quot; weather (equal on and off)</td>
<td>5 min.</td>
<td>4½ min.</td>
</tr>
</tbody>
</table>

**HEATERS THAT MUST BE USED IN T11B AND T8IC**

<table>
<thead>
<tr>
<th>PRIMARY CONTROL</th>
<th>BEATER COLOR CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T11B</strong></td>
<td><strong>T11B</strong></td>
</tr>
<tr>
<td>R10A</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>R10AA</td>
<td>60 Gray, Green &amp; Orange</td>
</tr>
<tr>
<td>R10B</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>R10BB</td>
<td>60 Gray, Yellow &amp; Blue</td>
</tr>
<tr>
<td>R10B B</td>
<td>60 Gray &amp; Brown</td>
</tr>
<tr>
<td>R10BB</td>
<td>60 Gray, Green &amp; Orange</td>
</tr>
<tr>
<td>R10BC</td>
<td>60 Gray, Green &amp; Orange</td>
</tr>
<tr>
<td>R10BB</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>V10A</td>
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</tr>
<tr>
<td>V10</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>V10A</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>V10B</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td>V10B</td>
<td>60 Gray &amp; Green</td>
</tr>
<tr>
<td><strong>T8IC</strong></td>
<td><strong>T8IC</strong></td>
</tr>
</tbody>
</table>

1. With standard transformer
Things to Do—
(Refer to general "Do's and Don'ts" p. 52, and Installation Instructions, Form 05-1488.)

1. Pipe the valve with flow in the direction of arrow. (Notice that bleed connection is over inlet of right-hand model, over outlet of left-hand model.)

2. Be sure to run bleed line into the combustion chamber where bleed gas will be ignited.

3. Be sure to use the specified transformer—the "plug-in" AT82A, or Type AT75A where conventional type is desired.

Things NOT to Do—
1. Don't attempt to convert right-hand to left-hand model or left-hand to right-hand. Remember that the valve is available in either model.

2. Don't forget to instruct the occupant in use of the manual opener—and in the necessity of closing the valve after manual operation. (It does not recycle.)

3. Don't use standard gas model on L.P.G. The valve is available in 8 oz. rating for L.P.G.; standard model is acceptable on all conventional gases including sulphur-bearing gases.

<table>
<thead>
<tr>
<th>THERMOSTAT HEATERS FOR USE WITH V898</th>
<th>T8IA, T847</th>
<th>T8IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Gray and White</td>
<td></td>
</tr>
</tbody>
</table>
Things to DO—
1. Follow standard good practice for installation of thermostat (pp. 14-15), valve (p. 12), and pilot (p. 61).
2. Be sure that T804 is level.
3. Install VS887 with flow in direction of arrow (remember bleed connection is over inlet of left-hand model, over outlet of left-hand model).
4. Be sure to run bleed line into combustion chamber.

Things NOT to Do—
1. Don't substitute another thermostat for T804.
2. Don't use ordinary Pilotstat thermocouple—use only the pilot generator supplied.
3. Don't attempt to convert right-hand valve to left-hand, or left-hand to right-hand. REMEMBER: two models only. REMEMBER: two models only.
4. Don't use standard-gas model on L.P.G.
5. Don't use wrong pilot orifice size for the gas used.

If Valve Fails to Operate Correctly—
1. Check wiring for loose connections.
2. Make sure that pilot flame burns blue.
3. Check thermocouple output with millivolt meter. The open circuit voltage should be 300 mv. minimum.

(Refer to the instructions supplied with the system.)
This is a control system for forced hot water heating with cistern hot water supplied by the boiler (through an indirect heater). In response to demands from the thermostat or to a drop in water temperature, the L147 activates the Protekthermostat to start the boiler.

The L147 also incorporates a switching relay which, on demand from the thermostat, starts the circulation. The circulator does not operate on "low-limit" action of the L147. The L4232 serves as high limit control, and also delays circulator operation if boiler temperature is too low to provide both heating and also domestic hot water.

**WARM AIR SYSTEM**

This control system for forced warm air features a Combination Furnace Control (L481A) which includes a high limit switch to prevent excessive furnace temperature and a fan switch to start and stop the circulating fan according to furnace temperature. The high limit cutoff point and the fan "on" and "off" points are separately set, but the fan "on" cannot be set higher than the limit setting. (L480A may be used as limit control and L481 as fan control, if preferred.) The series 10 thermostat starts and stops the boiler through the RA117 Protekthermostat (use RA116 for constant ignition). The T19A or T17A provides lowered night temperature with automatic "pickup" in the morning.
This control system for forced warm air includes a two-speed control of the blower. The thermostat controls the burner through the RAI17A Protectorstat (for RA17A for constant ignition burners); and the limit switch is the LLA45A combination control stops the burner before furnace temperature becomes excessive. On initial rise in furnace temperature the LLA45 starts the fan; whenever the furnace temperature rises to the speed-change setting of the LLA45S, the fan is shifted to high-speed operation. The T190A or T447 if used provides external setback with automatic morning pickup.

This control system for a steam plant includes provision for summer- winter hot water. Two Aquastats (L171) are shown; a low limit in the storage tank to operate the burner as required to maintain domestic hot water; and a high limit in the boiler (below water line) to prevent steam on low-limit operation. The Penta-stat prevents excessive pressure during thermostat operation, and the thermostat operates the burner (through the Protectorstat) to maintain steam temperature at the proper level.
TYPICAL CONTROL SYSTEMS

Wall-Plate Connections to Series 10 Thermostats Available
For Lowered Night Temperature

T-41A Ovens

To Line Not Interrupted
By Switch—To Avoid Stepping Clock

ATTEN (Do Not Substitute)

Series 10 Primary Control
R, W and E Terminals

TIPS A Di-Nail

See Note A

Series 10 Primary Control
R, W and E Terminals

TIPS A Terminals

NOTE A: R lead should be put in
line voltage wiring, switch must
break white wire.

Manual Switch or
Time Switch—
Closed for "DAF"
Operation
(B154 Max. 196
Watts Total)

Series 10 Primary Control
R, W and E Terminals
<table>
<thead>
<tr>
<th>RELAY</th>
<th>T11A, T77, T79, T93A, T949, T178, T111, T147, T81I</th>
</tr>
</thead>
<tbody>
<tr>
<td>LI47A</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>LI47A</td>
<td>(60 cy.) Black &amp; Green</td>
</tr>
<tr>
<td>R11A, B, C (65 cy.)</td>
<td>Black &amp; Green Blue</td>
</tr>
<tr>
<td>R14A, B, C, D (60 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R199A (50-65 cy.)</td>
<td>Red Black &amp; Red</td>
</tr>
<tr>
<td>R114A, B (45 cy.)</td>
<td>Blue Black &amp; Blue</td>
</tr>
<tr>
<td>R114A, B (50-60 cy.)</td>
<td>Yellow &amp; White Black &amp; White</td>
</tr>
<tr>
<td>R116-4 (50-60 cy.)</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>R116-4 (60-60 cy.)</td>
<td>Red Black &amp; Red</td>
</tr>
<tr>
<td>R116A, B (55 cy.)</td>
<td>Black &amp; Green Blue</td>
</tr>
<tr>
<td>R156A, B (40-60 cy.)</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>RA116A, B (25 cy.)</td>
<td>Black &amp; Green Blue</td>
</tr>
<tr>
<td>RA116A (40-60)</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>R117.3 (35-30)</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>R117.3 (40-60)</td>
<td>Red Black &amp; Red</td>
</tr>
<tr>
<td>R117A (35 cy.)</td>
<td>Black &amp; Green Blue</td>
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<tr>
<td>R117A (40-60)</td>
<td>Green Black &amp; Green</td>
</tr>
<tr>
<td>RA117A (25 cy.)</td>
<td>Black &amp; Green Blue</td>
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<tr>
<td>RA117A (40-60)</td>
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<tr>
<td>R132A (65 cy.)</td>
<td>Black &amp; Green Blue</td>
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<tr>
<td>R132A (60 cy.)</td>
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<td>R137A (35-30)</td>
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<td>R137A (50-60)</td>
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<td>R138A, B, C (25-60)</td>
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<tr>
<td>R177A (50-60)</td>
<td>White Brown</td>
</tr>
<tr>
<td>R182A, B, C (60 cy.)</td>
<td>Green Black &amp; Green</td>
</tr>
</tbody>
</table>

For other controls see Form 93-1340 & write for information.
STOKER CONTROLS

R163B Steamtime (Right)

FEATURES:
1. Fire-maintaining timer adjustable for 1 or 2 operations an hour. 1/2 to 7½ minutes.
2. Series 10 switching relay built-in to operate stoker.
3. Removing jumper permits control of motor starter.

R154C or D Day/Night Timemaster

1. Fire-maintaining timer, with same features as R163B plus "skip" after timer reset.
2. Tote switch for day/night change-over (with T9A).

S400A Stokertimer (Right)

1. Timer operation adjustable for 1 operation each hour or half-hour, ½ to 7½ minutes.
2. Line-voltage mercury switch.

GENERAL INFORMATION

1. The basic function of stoker primary control are:
   (a) to maintain a pilot or minimum fire when the thermostat is not calling for heat—usually accomplished by a timer that periodically operates the stoker for short intervals;
   (b) to provide line-voltage switching facilities to start and stop the stoker motor in response to a low-voltage room thermostat or the timer itself.
2. A Stoker timer (S400A) provides only the fire maintaining operation, and is normally used with a separate switching relay for control of the stoker by a low-voltage thermostat or other operating control.
3. On D-C applications, fire-maintaining action is normally provided by a stack-mounted Stoker switch, responding to furnace temperature. Room-temperature control is provided by a line-voltage thermostat and a D-C switching relay.
Things to DO—
1. Mount relay on a solid vertical wall.
2. Mount R16 where it is handy for future time adjustments by owner.
3. Level up S400A by the pendulum indicator so that mercury switch will operate correctly.
4. All wiring must comply with local electrical ordinances.
5. Connect light limit control in hot line from relay to stoker.
6. Use right size fuse in R15A for stoker motor to be controlled.

Things NOT to DO—
1. Don't use oil on any part of relay or timer.

Points to REMEMBER—
1. Timer can be used as fire-trying switch: manually rotate to the right until trip arm drops into recesses.
2. With R15A, high limit must be wired between terminal 3 and the stoker to avoid tripping the day-night time clock.
3. With R15A, day thermostat is out of control at night, but its contacts must be closed to permit night thermostat to operate.
4. In D-C objects where timers can't be used, Y2A thermostat and L405A stoker switch can be used, up to 1/4 hp; T44A, R16A D-C relay and L405A from 1/4 by to 1/2 hp.
**Adjustments—Timer and Clock**

**Timer (All Models)**

Branded timers leave the factory set for 5-minute operation every half hour. Settings must have to be changed to fit characteristics of the installation and the coil used. If so, see diagram.

**Dail Length of Conversation**

1. The black and white dial is in effect a 24-hour clock.
2. The tone index mark at left is in effect the hour hand.
3. The half-dial from a 12 to a 6 (filing the switch) that can be adjusted in width in position relative to the time dial.

**Day-Night Clock (H154 or 26-5)**

**REMEMBER**

1. The black and white dial is in effect a 24-hour clock.
2. The tone index mark at left is in effect the hour hand.
3. The half-dial from a 12 to a 6 (filing the switch) that can be adjusted in width in the position relative to the time dial.

**To Be Cool To Right**

1. Pull out and down to make sure it is not loose or stuck.
2. Release the handle so that dial heart is seen and main unit with the firing parts.

**Diagram Diagram**

- Take hold of the knob.
- Turn it in a clockwise direction.
- Release the knob to the right.
- Arrow points to the right.
- Arrow points to the left.
STEAM OF GRAVITY

This control system is frequently used for a domestic steam, gravity hot water, or gravity waste heat application. The R3535 operates the stoker periodically to maintain a minimum fire, and responds to the thermostat by operating the stoker when heat is required. The Pressure Switch, Safety, or Aquastat (depending on the heating medium) stops the stoker (without cutting off power from the motor) in the R3535 to prevent excessive pressure or temperature in the boiler or furnace. The low limit control shown is optional for a steam system maintenance boiler water temperature for supplying domestic hot water with an auxiliary heater. The T19 or T147 may be used where desired night temperature is desired.

STEAM OR GRAVITY

This control system for steam or gravity heating plants utilizes the T16A for automatic lowering of temperature at night. A time switch in the R154 makes the chainmotor, and a timer providing periodic stoker operation to maintain the fire between thermostat operations of the stoker. The high-limit control is a Pressure Switch, a Safety, or an Aquastat, depending on the heating medium. The low-limit Aquastat when used as a steam boiler with indirect heater maintains the domestic hot water supply. It should be an immersion type mounted below the waste line.
T415A Outside Control
On Manual Switch

LA48A Return
Low Aquastat

LA48A or L65A
Aquastat

P404A Presurator

P404A Presurator

C406A Lo-Water Cutout

Wires

RETURN-LINE
CONTROL SYSTEM

Lo-Voltage

Low Voltage

T614 4184 Tuesday

This control system is suitable for commercial steam heating installations where positive distribution of steam on each stoker operation must be assured. Night operation at a level to maintain a minimum boiler temperature (as for supplying domestic hot water from an indirect heater) is provided automatically.

Day-time operation is as follows: Whenever the switch contacts in the T415A outside control (or the manual switch if used instead) are closed to indicate a need for heating, the R114 Timerelay starts the stoker when the LA48A Aquastat signals a drop in temperature in the condensate return line. The timer continues to operate until the Presurator in the low-voltage circuit resets steam pressure high enough to insure saturation of the radiators.

The time switch in the R114 provides automatic shutdown and pickup at selected times, night and morning. During night shutdowns, or when the T415 (or manual switch) opens its circuit, the stoker operates under command of the low-limit immersion Aquastat to maintain minimum boiler water temperature. At all times the R114 will automatically operate the stoker between Aquastat or Presurator operation if necessary to maintain the fire; the "skip feature" prevents a timer operation immediately after an operation called for by the other control.

The high-limit Presurator prevents excessive boiler pressure and the Lo-Water Cutoff guards against dry-boiler operations.
TYPICAL CONTROL SYSTEMS

THREE-PHASE (OR HEAVY-DUTY) STOKER

This diagram of a gravity hot water, gravity steam, or steam system shows recommended connections for room thermostat control of larger (or three-phase) stoker motors. The R163B Stoker-dial operates the stoker in response to the thermostat, and also provides periodic flame-maintaining operations between thermostat operations. Note that the jumper between terminals 1 and 3 must be removed, and terminals 3 and 4 connected to the control terminals of the motor starter. (R19 relay and S460A-Shutoff timer) together may replace R163B: remove L3 jumper and connect 3 and 4, in parallel, to starter control terminals.)

Note that where the power supply is 115 volts, the white or ground side of the power supply to the relay is connected to terminal 2. The dotted line indicates the third wire in a three-phase system.

The high-limit control (Pressurecontrol, Airwater, or Aquastat, depending on the heating medium) should be connected as series with the relay and the motor starter coil. The optional low-limit control shown is an Aquastat for maintaining boiler water temperature in a steam system with domestic hot water supplied from the boiler.

NOTE: For arrangement of terminals on wall plates of various Series 10 thermostats, see p. 39.
This is one of the standard control systems for a forced hot water heating plant. The thermostat actuates the switching relay (R132A) which starts and stops the stoker (through the relay unit in the R183) and the circulating pump. The timer in the R183 operates the stoker between thermostat operations as necessary to maintain a minimum fire. The surface (L4409) or immersion Aquastat (L4410A) can shut down the stoker (but not the circulator or the timer motor) so as to prevent excessive boiler temperatures. A reverse-acting Aquastat (L4410B) may be used as shown, connected in series with the circulator, to prevent circulator operation until the boiler is up to temperature.

This is a control system for a forced hot water installation with domestic hot water supplied by the heating boiler. The room thermostat actuates the R125A relay which in turn operates the stoker and circulator. The 8402A Stoker timer provides periodic fire-maintaining operations. The L4410A Aquastat operates the stoker (but not the circulator) as necessary to maintain domestic hot water service. One switch in the L438A Aquastat shuts down the stoker if boiler temperature rises to the limit setting, and if the temperature rises a predetermined number of degrees above the limit setting, the second switch starts the circulator to dissipate the excess heat.
TYPICAL CONTROL SYSTEMS

WARM AIR SYSTEM
BOILERT CONTROL OF FAN

This simple control system for forced warm air provides thermostat control of the stoker and furnace temperature control of the circulating fan. Either the thermostat or the timer mechanism in the R16B can actuate the switching relay unit built into the R183, and this in turn operates the stoker. The LA401A Combination Furnace Control includes a high-limit switch to prevent excessive furnace temperature and a "on" switch that starts and stops the fan according to the temperature in the furnace. As indicated, an LA41p Access may be used as a limit control and an LA401A Furnaceact to control the fan.

THERMOSTAT CONTROL OF FAN

This control system provides thermostat control of the stoker and the fan. The thermostat actuates the R13a relay, and either the latter or the LA00A Stokeract can operate the stoker. The limit switch in the LA401B will shut off the stoker before an excessive furnace temperature is reached, and the right-hand fan switch permits the relay to start the fan when the furnace is up to minimum temperature. The additional switch is the "over run" switch; it will start the fan regardless of the thermostat, so as to dissipate excess heat, if the furnace temperature rises above the limit setting.
This control system for stoker-fired warm air is popular in some sections because of the two-stage operating sequence. On a drop in room temperature, the T82B pulls in the R19 relay. If the furnace temperature is above the "fan on" point of the L440B, the fan starts, and runs until the thermostat is satisfied or until the furnace cools to the "fan off" point. When heat is not available in the furnace, or when for some other reason the room temperature falls a little further, the "high stage" contacts of the T82B close, actuating the R143B to start the stoker and generate more heat. The R143B also provides periodic stoker operations to maintain a minimum fire. The L440B includes a high-limit switch; the fan switch whose function has already been mentioned; and an "over-run" switch that will start the fan independently of the other controls if the furnace temperature rises above the limit setting.

**THERMOSTAT HEATERS for Use With Series 10 Relays**

<table>
<thead>
<tr>
<th>THERMOSTAT</th>
<th>TIA, T17, T79, T108, TIA, T109, T111, T747, T78, T847</th>
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<tbody>
<tr>
<td>L147A (25 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>L147A (60 cy.)</td>
<td>Blue</td>
</tr>
<tr>
<td>R19A, B, C (25 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R19A, B, C, D (60 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R132A (25 cy.)</td>
<td>Green</td>
</tr>
<tr>
<td>R132A (60 cy.)</td>
<td>Green</td>
</tr>
<tr>
<td>R154C, D (25 or 60)</td>
<td>Green</td>
</tr>
<tr>
<td>R182A, B, C (60 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R182B (25 cy.)</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R182B (60 cy.)</td>
<td>Green</td>
</tr>
</tbody>
</table>

For other controls see Thermostat Heater Index, Form 95-L346, or write for information.
When there is no apparent cause for erratic operation: (1) prove the relay; (2) prove thermostat cable; (3) prove the thermostat.

Relay (Type RSP. R.154)

1. Make sure that:
   a. There is power at terminals 1 and 2.
   b. The “thermostat control” contacts of these are made.
   c. The limit control contacts are made.

2. Remove thermostat wires from terminals R, W, and B at relay.

3. Place jumper, or short, across these three terminals.

4. If stoker has operated a few seconds, remove jumper from B terminal only. If stoker continues to run several minutes, the relay is operating correctly.

5. If relay does not fall in after step 3, or if stoker doesn’t continue to run as outlined in step 4, we suggest replacing relay.

6. If relay passes tests, reconnect thermostat wires at relay.

Thermostat Cable

1. With thermostat wires connected to relay and thermostat, remove thermostat from its base plate.

2. Short or jumper the R and W terminals on base plate. If stoker starts, there is a short between red and blue wires within the thermostat cable. Remove; replace thermostat cable.

3. If stoker did not start in step 2, momentarily short B to R-W jumper until stoker starts—then remove B jumper. If stoker continues to run, thermostat cable is free from short or open circuits. If stoker stops with R-W shorted, the red wire is open. Try to locate the break or replace the entire cable.

4. If stoker did not start in step 3, the white or blue wire is open. Check for loose connection, for break, or replace cable.

Thermostat

We have now checked both relay and thermostat cable. If the trouble has not been found it is now in order to check the thermostat.

1. Check the heater plug screw for tightness (a loose heater plug screw would open a break in the red wire).

2. Check the three grounding screws for tightness.

3. Make sure the blue jacket is not making a seal of the white con- tact. If it is, it will cause differential and fan starting. Instructions packed with the QMS Transformer.

4. Make sure contacts are clean; Polish only with a piece of hard-surface paper—NEVER use file, emery cloth or sandpaper.
INSTALLATION

THINGS TO DO—
1. Install valve on horizontal pipe with power unit up—sod with flow in direction of arrow on valve body.
2. Use new pipe properly tinned and free from chaff.
3. Put dope on all but the first two threads of pipe only.
4. On diaphragm valves, run bleed line into combustion chamber where pilot will ignite bleed gas.
5. If local gas has high moisture content, installing a drip head of valve is recommended.
6. On high-heat bearing gas, use valves with special trim to prevent corrosion. (V161 and V188 standard models are acceptable.)

THINGS NOT TO DO—
1. Don't risk gumming up the valve by putting dope on first two pipe threads or threads of valve body.
2. Never use lead of valve as lever to swing valve on pipe—use proper-valve wrench on valve body hex next to pipe.
3. Never use valves on gas pressures in excess of ratings.
4. Never use standard (natural or manufactured gas) valves on liquefied petroleum gas (L.P.G.). Use L.P.G. values constructed, tested and marked for this service.
5. Never try to turn control valve without breaking union nut between power unit and valve body—serious damage to valve and gas leakage might result.

WIRING

THINGS TO DO—
1. Wiring must comply with local electrical ordinances.
2. Use only proper transformer for voltage and frequency of available source (refer to instructions with valves).
3. High limit if used is normally connected in thermostat circuit—on Serie 38, patch should break white wire.
4. Always select a constant source of power—one not interrupted by a light switch.
5. Check out the complete installation to see that thermostat and limit switch will operate valve—and that automatic pilot shuts off main burner if pilot goes out.
6. If splices are necessary, always follow color coding and make good, solid connections.

THINGS NOT TO DO—
1. Never connect low-voltage valve directly to line.
2. Never run control wiring too close to firing door of furnace or boiler.
3. Don't fasten cable to steam or hot water pipes.
4. If Safety Valve with manual opener is used, don't connect limit or pilot switch in transformer circuit.
VIBA Series 10—Manual opening and automatic recycling.
Refer to p. 52 for installation and wiring Do's and Don'ts.

If valve fails to operate properly:
1. Is valve installed in vertical position?
2. Is power available to valve and at proper voltage?
3. Is pilot in and are pilot contacts made?
4. Check wiring for loose connections.
5. Is holding contact making and breaking properly?
6. If valve stays open when power in applied with thermostat contacts open, check recycling contact.
7. If there are deposits from the gas, periodic cleaning of valve seat, plunger and plunger tube is necessary.
   a. Turn off gas supply and disconnect wiring.
   b. Remove rear knob.
   c. Remove the four screws holding power unit to valve body.
   d. Carefully lift power unit over reset stem.
   e. Remove screw holding reset lever assembly.
   f. Clean with pure naptha the plunger, plunger tube and reset assembly—including top of plunger and around centering pin.
   g. Carefully re-assemble valve stem and power unit. Be sure to use new gasket.
   h. Be sure to replace screw in end of valve body and tighten all screws.
   i. Test valve for operation.

To test manual reset and automatic recycling mechanism:
1. Turn off power supply and turn down thermostat.
2. Manually open valve by turning reset button.
3. Turn on power supply and valve should close automatically.

Note: Limit controls and automatic pilots are normally wired in thermostat circuit. Recycling mechanism requires power to operate.
Refer to page 32 for installation and wiring tips.

**IF VALVE FAILS TO OPERATE PROPERLY:**

1. Is valve installed in vertical position?
2. Is power available at valve and at proper voltage?
3. Is pilot lit and are pilot contacts made?
4. If manual opening device is used, is it in the proper position to allow valve to close normally? This type of valve does not recycle—must be closed manually after being manually opened.
5. Check wiring for loose connections.
6. If there are deposits from the gas, periodic cleaning of valve seat, plunger and plunger tube is necessary.
   a. Turn off the gas supply and disconnect wiring.
   b. Unscrew small nut on top of valve assembly and lift off top (cool) assembly (V44-V46).
   c. Use suitable wrench to unscrew clamp nut.
   d. The valve plunger, stem and valve disc can then be lifted out and cleaned with pure naphtha (Inflammable).
   e. Recover foreign matter from plunger and clamp tube thoroughly. Be sure to scrub top of plunger tube.
   f. Reassemble valve and check its operation.
Refer to p. 52 for general installation and wiring tips.

Things to DO—
1. BE SURE to run bleed line into combustion chamber.
2. Instruct customer how valve can be opened manually during power failure periods.

Things NOT to DO—
1. Don't restrict bleed line—sharp bends can retard gas flow and prevent normal opening of the valve.
2. Don't oil synthetic diaphragms.
3. Don't bend any levers on the relay unit!

IF VALVE FAILS TO OPERATE PROPERLY—
1. Is power available to valve at proper voltage?
2. Is pilot lit and are pilot contacts made? Check by placing jumper across the pilot terminals.
3. Is the holding contact on the relay making and breaking properly when the valve operates? (V148 and V149.)
4. Does the relay operate the lever on the diaphragm control valve?
5. Does the wiring to valve follow connections outlined above?
6. Does the recycling contact make and break properly?
7. For further checks refer to "Trouble-Shooting by Elimination," on p. 42.
8. If leaky diaphragm is stiff so that valve opens and closes slowly, oil the diaphragm through outlet (9, drawing above). Use about 50 drops of Neatsfoot oil, light acid-free mineral oil or meter oil. Replace plug.
9. If the foregoing checks don't correct faulty operation, replace the diaphragm control valve.
These diaphragm controllers are pilot valves to operate diaphragm gas valves. Refer to p. 12 for general "Do's and Don'ts."

**Installing on Diaphragm Valve or Adapter Plate**

1. Remove cellulose tape from bottom of controller and top of boss on diaphragm valve.
2. Make sure central opening is free from foreign matter.
3. Make sure gasket is in proper position on diaphragm boss.
4. Be sure to tighten controller mounting screw.
5. Be sure to run bleed line into combustion chamber.

**If Valve Fails to Operate Properly (Complete Assembly)**

1. Is power available to valve at proper voltage?
2. Is pilot lit, are pilot controls made? Check with jumper.
3. Is relay holding contact making and breaking properly?
4. Does recycling contact make and break properly?
5. If valve still fails to operate correctly, refer to "Trouble-Shooting By Elimination," p. 44.
6. If all checks fail, replace diaphragm controller.

**Things NOT to DO**

1. Don't bend ear at top of relay armature. When valve is manually opened, this ear huddles relay armature in proper position for recycling when power is restored.
DIAPHRAGM GAS VALVES

VI17—V417—V817—VI18—V418—V818—VI19—V419—V819

REFER to prental "Do's and Don'ts," p. 52. For wiring, see opposite page.

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<thead>
<tr>
<th>SERIES 10</th>
<th>SERIES 40</th>
<th>SERIES 80</th>
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<tbody>
<tr>
<td>Assembly</td>
<td>Sub-Units</td>
<td>Assembly</td>
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<tr>
<td>VI17</td>
<td>V117</td>
<td>V117</td>
</tr>
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<td>V118</td>
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<tr>
<td>VI19</td>
<td>V119</td>
<td>V119</td>
</tr>
</tbody>
</table>

V117 Diaphragm Gas Valves

1. Install diaphragm assembly as a unit if possible. If it must be disassembled, see instructions packed with it (Form 93-986A).
2. To locate damper arm, loosen clamp nut, rotate diaphragm housing, and tighten nut. See that arm can operate freely.

If Valve Fails to Operate Properly—
1. Check bleed piping for stoppage, and bleed adjusting valve if used.
2. Check channel openings in diaphragm casing.
3. Can the valve stem move freely in the guide?
4. Does the damper arm operate freely?
5. When damper arm is used to operate secondary-air door, see that arm is not overloaded and that air door operates freely.
6. Is normal gas pressure available to operate diaphragm?
7. If diaphragm leather is dried and stiff, treat with Neatsfoot oil, light acid-free mineral oil or motor oil.

V118-V119 Diaphragm Gas Valves

1. To remove diaphragm unit from valve body refer to instructions packed with the assembly (Form 93-1198).
2. To relocate damper arm, loosen the hold-down bolts in bottom of diaphragm housing and rotate entire top unit. Tighten hold-down bolts again.
3. Counterbalance damper arm for weight of secondary-air door.
4. If frame plate is used and larger or smaller pilot flame is needed refer to instructions (93-1198).

If Valve Fails to Operate Properly—
1. Check bleed line for stoppage, and bleed adjustment valve if used.
2. Check channel openings in the diaphragm casing.
3. Does the valve stem move freely in the guide?
4. Does the damper arm operate freely?
5. When arm operates secondary-air door, see that arm is not overloaded and that air door operates freely.
6. Is normal gas pressure available for diaphragm operation?
7. If diaphragm leather is dry and stiff, treat with Neatsfoot oil, light acid-free mineral oil or motor oil.
VI55 MOTORIZED GAS VALVE

Refer to p. 52 for general "Do's and Don'ts" and to instructions packed with valve for detailed instructions.

Things to DO—
1. Shut off power and gas before removing power unit.
2. Lock power unit in manual-open position before removing.
3. Before replacing power unit on body, be sure seat and valve disc are clean.
4. Before tightening clamp nut, locate damper arm properly and see that arm operates freely.
5. If leather diaphragm dries out, treat with Neatsfoot oil, light acid-free mineral oil, or miter oil.
6. Teach customer manual operation of valve during power failure.

Things NOT to DO—
1. Don't forget to put gasket in proper position.
2. Don't leave cover off after installing or servicing valve.
3. Don't forget to jumper W and Y terminals if valves or Pilotstat is used.
4. Don't use abrasives on any contacts on valve.
5. Don't oil holding contact assembly or cam that operates the contact points.
6. Don't use motorized valve for final shutoff service where it must remain open for long periods. Use diaphragm valves.

To use "knee-action" mechanism, remove changeover screw (9). Then valve will close fully even if secondary air door sticks partly open. This also prevents manually opening the valve by depressing the damper arm.

TO OPEN valve (with changeover screw removed), take off cover, turn lever arm "11/" and push in reset button "1." Valve recycles automatically when power returns.

IF VALVE FAILS TO OPEN OR CLOSE PROPERLY:
1. Is power available, and at proper voltage?
3. Does secondary air door operate freely?
4. Does motor open and close freely (by hand)? If not, and oiling doesn't free it, replace power unit. (Use only M.H. oil on motor bearings)
5. Does holding contact make and break properly when valve operates?
6. Does recycling contact open and close properly (on manual opening)?
7. If valve still fails to respond properly to thermostat see "Trouble-Shooting by Elimination," p. 62.
REMEMBER—

Don’t remove valve power unit without first shutting off gas supply and power.
IMPORTANT: Liquefied Petroleum Gases are considerably heavier than air and any leakage will accumulate at low levels.

Things to DO:
1. Ensure this equipment is installed in basement or confined area.
2. Provide adequate ventilation where L.P.G. appliances are installed in basements or confined areas.
3. Use equipment specially designed for L.P.G. service.
4. Use automatic pilot that will shut off both main burner gas and pilot gas if the pilot flame goes out. (See drawings below; vortex model pilotstat has gate supply tapping; switch model may be wired to shut pilot valve as well as main valve.)
5. Use pipe dope suitable for L.P.G. (immediate in petroleum product).
6. Check local ordinance for requirements on L.P.G. installations.
7. With balance-air mixtures up to 1000 Btu's cu ft and propane-air mixtures up to 1700 Btu's cu ft delivered at less than 7" w.c., standard valves may be used, but立足 a shut-off on pilot valve is required.

Things NOT to DO:
1. Don't use valves with seats, seals, baskets or diaphragms of leather (unless specially treated for L. P. G. service).
2. Don't use ordinary pipe dope on L.P.G. installations.

For general information, refer to other pages in this section.
INSTALLATION

Things to DO—
1. Follow carefully instructions packed with Pilotstat.
2. Check stamping on pilot burner box for correct size of orifice for the gas used. Normal sizes:
   Natural or Ricard: .025—.038
   Manufactured: .030—.033
   L. P. Gases: .011—.013

Things NOT to DO—
1. Avoid sharp bends in thermocouple leads at brazed joint below thermocouple and at connector end.
2. Don’t kink the thermocouple lead.

TROUBLE-SHOOTING

If Pilotstat fails to hold in when reset:
1. Check pilot for blue flame. If it burns yellow, clean primary air opening on pilot burner.
2. Check thermocouple position on pilot burner: only ½" to ¾" of tip should be in flame.
3. Check couple connection: it should be finger tight plus ½ turn.
4. Check thermocouple output with millivoltmeter test kit.

<table>
<thead>
<tr>
<th>C408.509, 809</th>
<th>C418</th>
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<tr>
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<td>18—23</td>
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</tbody>
</table>

5. If output is satisfactory with main burner off, does reading vary appreciably with burner on? If it drops appreciably, it may be necessary to install a baffle around the pilot burner to protect against drafts or turbulence.

If Pilotstat has been dropping out for no apparent reason but holds in if reset—
1. Pilot flame may be smothered by main flame on cold start after long shutdown. Eliminate cause of smothering.
2. Dows drafts or temporary low gas pressure could also be the cause.

Make sure both parts of connector are clean and making good contact.
GENERAL

If Valve Seat Leaks:
1. Be sure that disc closes against seat.
2. Examine seat and disc and clean off any foreign particles.
3. Replace disc or valve body if found to be nicked or scored.
4. Be sure that seat is not distorted.
If Valve Has Body Leak at Gasket:
1. Replace gasket or body of valve with new gasket on both sides of old gasket.
2. Be sure that screws are tight.
If Solenoid Valve Is Noisy:
1. Clean top of plunger and the centering pin in top of tube.
2. Check centering washer for tension.
   a. Remove top power unit and turn upside down.
   b. Press plunger against centering washer and release.
   c. Plunger should rise slightly.
   d. If not, increase tension evenly around ring.
3. Make sure voltage is not too low.

Things NOT to DO:
1. Never squeeze sides of valve body in a vise.
2. Don’t clamp hose in a vise if you can screw a pipe nipple in and clamp that in the vise.
3. Don’t strain the valve body (put wrench on the hex next to pipe).
4. Never use wrench on sides of valve body.

TROUBLE-SHOOTING BY ELIMINATION
Series 10 Gas Control System
When there is no apparent cause for erratic operation, check:
1. Power source.
2. Pilotstat.
3. Valve.
4. Cable to limit control.
5. Limit control.
6. Cable to thermostat.
7. Thermostat.

Power Source
1. Make sure power is available to transformer and from transformer to valve.

Pilotstat
1. If CHBA Pilotstat or switch model automatic pilot is used, make sure circuit is made with main burner off AND on.
2. If valve model such as CS19 is used, make sure pilot terminals are jumpered (on V14 or V155 valves).

Valve
1. Remove thermostat wires from terminals R, W, B at the valve.
2. Place jumper across R and W terminals—nothing should happen.
3. Momentarily short B to R-W jumper—valve should open and remain open after B short is removed—as long as R-W circuit is closed.
4. If valve operates correctly, reconnect cable to valve, color-for-color.
   If valve did not operate correctly, replace it.
Series 10 (Continued)

Cables—valve to limit control
1. Disconnect cable from valve side of limit control.
2. Short red and white wires—nothing should happen. If valve DOES open, there is a short between blue wire and red or white.
3. If valve did not open, touch all three wires together—valve should open. Remove blue wire and valve should stay open.
4. If valve operates correctly but cable is good. If not, replace.
5. Reconnect wires to limit control (cable-to-cable).

Limit Control (Series 10)
1. Disconnect wires from thermostat side of limit control.
2. Place a jumper across W and R terminals (thermostat side). Nothing should happen.
3. Momentarily short B terminal to W and R, and valve should open. Remove B jumper and valve should stay open.
4. With burner running (R-W still shorted) lower limit control scale setting below actual temperature or pressure in heating plant—valve should close. If not, replace the limit control.
5. If valve operates as described in 3 and 4, reconnect wires to limit control and reset indicator at proper point.
6. If Series 40 (two-wire) limit control is used instead of Series 10, make sure that the switch is connected into the white wire. Check for defective limit control as explained in step 4 below

Cable—Limit Control to Thermostat
1. With wires connected to thermostat, limit control, and valve, remove the thermostat from its wall plate.
2. Connect a jumper from R to W terminal—nothing should happen. If valve opens, there is a short from blue wire to red or white.
3. Momentarily short B terminal to R-W jumper and burner should start. Remove B short and burner should stay on. If not, replace cable.
4. TWO-WIRE LIMIT CONTROL: If burner did not start in step 3, check for defective limit switch by shorting terminals in limit control. If burner started in step 3 and continued to operate, lower limit control setting to make sure it will stop the burner.

Thermostat:
We have now checked the entire circuit up to the thermostat. If the trouble has not been found, it is in order to check the thermostat.
1. Mount the thermostat on the plate, and check the heater plug screw for tightness (a loose screw would mean an open red wire).
2. Make sure the blue contact is not making ahead of the white. If it is, realign differential and main scale according to the instructions packed with the QM-4A Tattletale.
3. Make sure contacts are clean. Polish only with a piece of hard-surface paper—NEVER use file, emery cloth or sandpaper.
TYPICAL CONTROL SYSTEMS

STEAM OR GRAVITY
SERIES 10

In this control system for a steam, gravity hot water or gravity warm air installation, the Series 10 thermostat actuates the gas valve as needed to maintain room temperature. The C418 Pilotstat prevents the main valve from opening if the pilot goes out, and the Pressurizer, Aquestat or Airstat (depending on the heating medium) guards against excessive pressure or temperature in the heating potiot. The gas valve shown is the V16, or the V166-A Diaphragm Controller included in the V117 or V138 diaphragm gas valve assembly. For terminals arrangements of other Series 10 gas valves see p. 68. For terminal arrangements of Series 10 thermostats see p. 49.

STEAM OR GRAVITY
SERIES 80

This control system for steam or gravity systems utilizes Series 80 (two-wire) controls, except for the Series 10 limit control. A Series 80 limit control may be used if a two-wire unit is preferred. The operating sequence is the same as that of the Series 10 system above. In either system, one or the optional thermostats will provide for lowered night temperature.

This Series 80 control system (with the limit control commonly omitted) is popular for floor furnaces and similar applications.

On all gas systems a valve Pilot-stat (C509) may be used in place of the C418A switch model.
This control system is suitable for an installation using a sectional burner and multiple pilots. Each pilot burner is provided with a Pilotstat, and all the Pilotstats are connected in series so that if any pilot goes out, the main gas valve cannot open and the gas supply to all the pilots is cut off by the pilot gas valve. With pilots burning normally, the thermostat opens and closes the main valve, and the high limit control (if used) guards against excessive pressures or temperatures in the heating plant. The arrangement shown, with single or multiple pilots and Pilotstats, is suited to L.P.G. installations where 100% shutdown on pilot failure is required.

The control system for forced hot water incorporates the V135 motorized gas valve (see p. 68 for optional valves). The room thermostat controls the gas valve and the circulator through the R132A relay. The L44A Aquastat (solid line) is the high limit control. An additional L44A may be used as shown to maintain minimum boiler water temperature on a Summer/Winter installation, and in this case an L44B Aquastat (reversal wiring) may be used to prevent circulator operation until the boiler temperature is high enough for adequate heating and maintenance of domestic hot water services. When the T102 or T147 is used as the thermostat, lowered temperature at night is provided, with automatic return to day time control.
This control system for forced warm air provides the same control sequence as the one above, but utilizes two-wire controls (excepting the limit-and-fan control). Thermostat, limit switch, solenoid valve and switch Pilotstat are normally connected in series in the low voltage circuit as shown. A two-wire Combination Furnace Control (with internal barrier) may be used if preferred; or standard Series 40 controls (L4401A, or L4419 and L4412) may be connected into the line-voltage circuit as shown in the insert.
This is a control system for a steam heating installation in which domestic hot water is supplied from the heating boiler through an indirect heater and storage tank. The room thermostat controls the gas valve as necessary to provide steam for heating; the Pressurstat prevents excessive pressure and the Lo-Water Cut-off guards against dry-boiler operation. The L170A Aqualog is in the tank operates the heater to maintain domestic hot water, and the L173 in the boiler prevents the low-limit control from operating the burner long enough to generate steam when heating of the rooms is not required.

The main diagram shows a typical live-voltage control system for a gas-fired unit heater. The T42, T424 or T44 thermostat starts the fan motor and opens the gas valve when heat is required. The P50stat shuts off the gas valve if the pilot goes out, and the high limit switch (if used) prevents overheating the unit. The inset shows how a sensitive Series 10 thermostats (with or without night setback operation) as preferred may be used with a switching relay to replace the live-voltage thermostat.
<table>
<thead>
<tr>
<th>VALVE OR RELAY</th>
<th>T11A, T17, T19</th>
<th>T125A, T160, T200B</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 Cycle</td>
<td>T8A, T811, T827</td>
<td>T9B12B</td>
</tr>
<tr>
<td>L147A</td>
<td>Green</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R19A, B, C, D</td>
<td>Green</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R131A</td>
<td>Green</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>R180A, B</td>
<td>White</td>
<td>Brown</td>
</tr>
<tr>
<td>R182A, B, C</td>
<td>Green</td>
<td>Black &amp; Green</td>
</tr>
<tr>
<td>V15A to G</td>
<td>Blue</td>
<td>Black &amp; Blue</td>
</tr>
<tr>
<td>V16A, B</td>
<td>Black &amp; Blue</td>
<td>Black &amp; Yellow</td>
</tr>
<tr>
<td>V16</td>
<td>Black &amp; Blue</td>
<td>Black &amp; Yellow</td>
</tr>
<tr>
<td>V111-112-119</td>
<td>Control valve determination</td>
<td>V116, V166</td>
</tr>
<tr>
<td>V149A, E, G, H, K</td>
<td>Green</td>
<td>Black &amp; Green</td>
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<tr>
<td>V156A, E, G, H</td>
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<td>Black &amp; Green</td>
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<tr>
<td>V155A, E, C, D</td>
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<td>Black &amp; Green</td>
</tr>
<tr>
<td>V155A, B</td>
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<tr>
<td>B2210</td>
<td>Green</td>
<td>Black &amp; Green</td>
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<tr>
<td>P1210</td>
<td>Yellow</td>
<td>White</td>
</tr>
</tbody>
</table>

**FOR USE WITH SERIES 10 VALVES AND RELAYS**

<table>
<thead>
<tr>
<th>VALVE</th>
<th>THERMOSTAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V84A, B, C, D</td>
<td>Yellow &amp; White, Blue &amp; White</td>
</tr>
<tr>
<td>V817-812-813</td>
<td>Yellow &amp; White, See V86</td>
</tr>
<tr>
<td>V33</td>
<td>Blue</td>
</tr>
<tr>
<td>V866</td>
<td>Green</td>
</tr>
<tr>
<td>V866B, D</td>
<td>Blue</td>
</tr>
</tbody>
</table>

*For other frequencies or other controls see Form 51-1346 or write for information.*
<table>
<thead>
<tr>
<th>TYPE NUMBER OF CONTROL</th>
<th>TRANSFORMER TO BE USED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POWER TYPE</td>
</tr>
<tr>
<td></td>
<td>50-60 cy.</td>
</tr>
<tr>
<td>V16</td>
<td>AT71A*</td>
</tr>
<tr>
<td>V174</td>
<td>AT73A*</td>
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<tr>
<td>V148</td>
<td>AT76A*</td>
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<td>V155</td>
<td>AT71A*</td>
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<tr>
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<tr>
<td>V167</td>
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<tr>
<td>V168</td>
<td>AT77A*</td>
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<tr>
<td>T475</td>
<td>AT75A*</td>
</tr>
<tr>
<td>T48A*</td>
<td>AT72B*</td>
</tr>
</tbody>
</table>

*Standard. **Optional. ▲Used with special 20 volt tubes.

[Used in certain special systems] [Chromosome clock—specified transformer must be used. **DO NOT CONNECT CLOCK** to valve transformer.]

Transformer "Do's and Don'ts"

1. Install in conformity to local electrical ordinances.
2. Always select a constant source of power—one not interrupted by a light switch.
3. **Never connect Chromotherm clock to any other transformer than the one furnished with the Chromotherm.**
4. Use Tattelite to check availability of power AT TRANSFORMER SECONDARY.