HEATING CONTROL HANDBOOK for the INSTALLER and SERVICE MAN

OIL BURNER GAS BURNER AND STOKER CONTROLS

MINNEAPOLIS Honeywell

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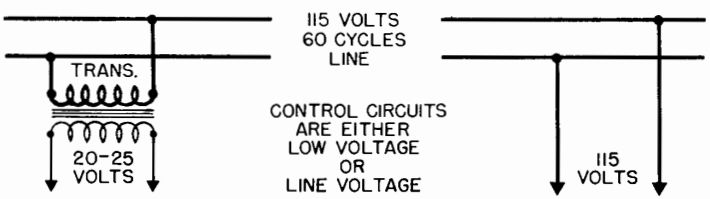
DEFINITIONS

Control circuits are classified broadly as either line voltage or low voltage, according to the voltage at which they operate.

Line voltage circuits are taken directly off the line and have the full voltage of the line from which they are taken. Thus, if we are discussing a line voltage control wired to a 115 volt (or 230 volt) circuit, all of the controls and the associated wiring must be suitable for the full line voltage, in this case 115 (or 230) volts.

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.



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 prevent 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 stoker 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.

DEFINITIONS; CODE IDENTIFICATION

Every controller has a *differential*—the difference in temperature or pressure between "cut-in" and "cutout."

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—Combustion Controls (Pyrostats, Protectostats, Stackswitches, Pilotstats); and Lo-Water Cutoffs.

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

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

L—(or LA)—Limit Controls (Aquastats, Airstats, Combination Fan and Limit, Furnacestats, Vaporstat, Vacuumstat, high pressure Pressuretrol, and some remote bulb temperature controls).

M—Motors (Electric Janitors, damper motors, circulators).

P—Pressuretrols (low pressure only).

Q—Accessories (example, auxiliary switches).

R—Relays (intermediate or switching, Protectorelays, Stokerelays).

S—Switches (Time-O-Switch, Stokerswitch, Da-Nite Time Switch, manual switches).

T (or TA)—Thermostats (Acratherm, Chronotherm, Da-Nite Acratherm, Time-O-Stat, and line voltage) and most remote bulb temperature controllers.

V—Valves (Solenoid, Motor, and Diaphragm) and valve bodies (less operator).

W—Accessories (certain types; for example, dampers).

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:

T11A (T*1*) = Series 10		T21A (T*2*) = Series 20
RA117A (RA*1*) = Series 10		LA419A (LA*4*) = Series 40
V155A = Series 10	V435A = Series 40	V835A = Series 80
T847A = Series 80	LA101A = Series 10	V575A = Series 50

SUMMARY OF CONTROL CIRCUIT SERIES

Control Circuit	Voltage	Operation	Thermostat Identification	Limit Control	Primary Controls
Series 10	Low	Two contacts make in sequence to start, break in reverse sequence to stop.	1. 3-wire low voltage. 2. Both contacts on same side of moving blade.	Series 10 or Series 40	1. Protectorelays (A. C. models.) 2. Series 10 Relays. 3. Series 10 Gas Valves.
Series 20	Low	Makes one circuit to start, makes a second separate circuit to stop.	1. 3-wire low voltage. 2. Contacts on opposite sides of moving blade.	Series 20	1. Series 20 Motors. 2. Series 20 Valves. 3. Series 20 Motor Switches.
Series 40	Line	Makes circuit when switch is closed, breaks circuit when switch is open.	1. 2-wire line voltage (conduit connection). 2. Mercury tube or line switch makes contact in one position.	Series 40	1. Protectorelays (D. C. models). 2. Series 40 Relays. 3. Direct Control.
Series 50	None	None-electrical (Mechanical). Self-contained unit, valve less operator, etc.			
Series 60	Line	Line voltage equivalent of low voltage Series 20.	1. 3-wire line voltage. 2. Contacts on opposite sides of moving blade.	Series 60	1. Series 60 Motors. 2. Series 60 Valves.
Series 80	Low	Low voltage equivalent of line voltage Series 40.	1. 2-wire low voltage. 2. Mercury tube or switch makes contact in one position.	Series 10 or Series 40	1. Series 80 Motors. 2. Series 80 Valves. 3. Series 80 Relays.
Series 90	Low	Modulating control action.	1. 3-wire low voltage. 2. Potentiometer and wiper.	Series 90 or Series 20	1. Series 90 Motors. 2. Series 90 Valves.

CONTROL CIRCUITS (SERIES)

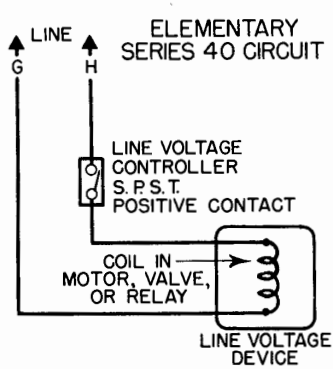
The specifications for each type of device shown in the Honeywell catalog list the electrical control circuit to which it is applicable. The control circuits in common use are named Series 10, Series 20, Series 40, Series 60, Series 80, and Series 90 (see table opposite).

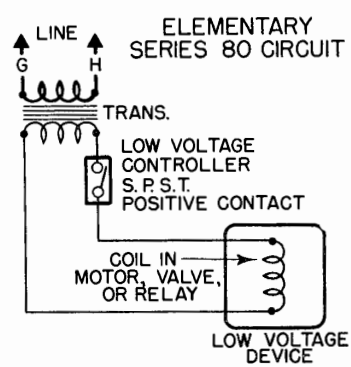
With few exceptions, thermostats designed for operation with one control circuit will not function with controls arranged for another control circuit. Series 10 thermostats should be used only with Series 10 primary controls; Series 20 only with Series 20, etc. The primary control used in each case determines the control circuit. (Primary controls are relays, Protectorelays, gas valves, control motors, etc.)

The high limit control should be wired into the circuit at the right place to insure absolute shutdown of the burner when necessary. For example, we specify Series 40 high limit controls with oil burner systems, so that the limit switch can be wired into the "hot" line to the Protectorelay (but not between the relay and the burner motor, for then the relay would "go out on safety" if the thermostat demanded heat during a limit shutdown). With a Series 10 gas valve, on the other hand, a limit control in the circuit between thermostat and valve can shut the valve but will not interfere with the automatic "recycling" feature on manual operation of the valve. With a Stokerelay, we normally put the limit switch between the relay and the stoker motor, to avoid stopping the timer motor.

SERIES 40 (Line Voltage) And SERIES 80 (Low Voltage)

Series 40 and Series 80 control circuits are the simplest types—both two-wire circuits. As the diagram indicates, each consists essentially of a controller with single-pole single-throw positive-action switching means connected in series with a two-wire device (motor, valve, or relay), The controller makes the circuit in the "on" position and breaks it in the "off" 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 Protectorelay or Lockswitch, to insure positive shutdown of the burner (without false safety shutdown). And on a D-C stoker control system, the high-limit control normally is connected between the Stokerswitch or relay and the stoker 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 Protectorelay 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.

SERIES 10 CIRCUIT

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.

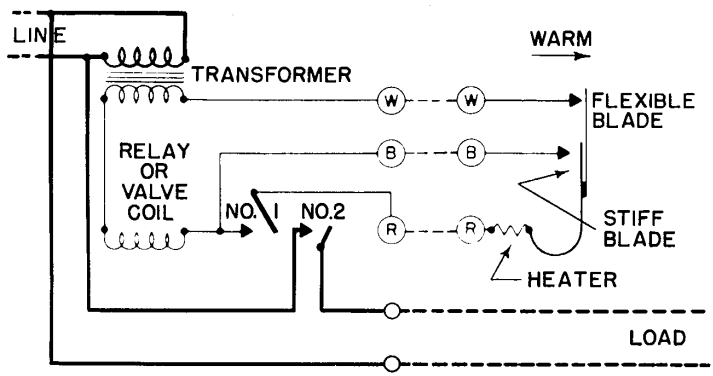


Fig. 1 shows the thermostat "satisfied" (both contacts open). The thermostat is arranged so that on a drop in temperature the flexible blade first "makes" the White contact, and then the stiff blade, the Blue. On a temperature rise, the contacts break in reverse order.

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

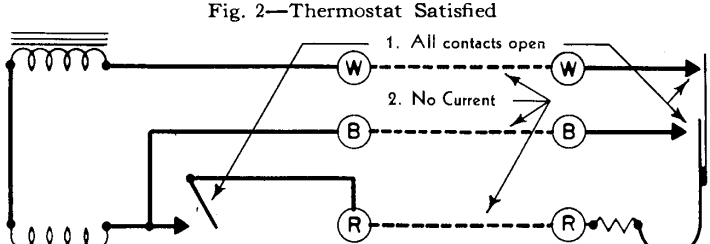


Fig. 3—Slight Temperature Drop

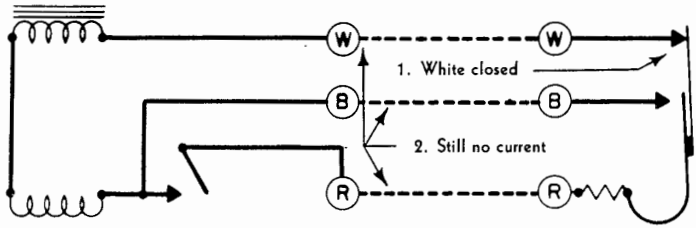


Fig. 4—Further Temperature Drop

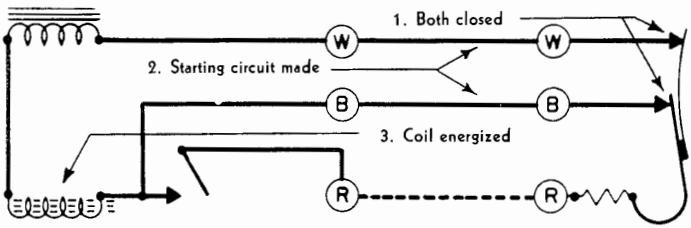


Fig. 5—An Instant Later

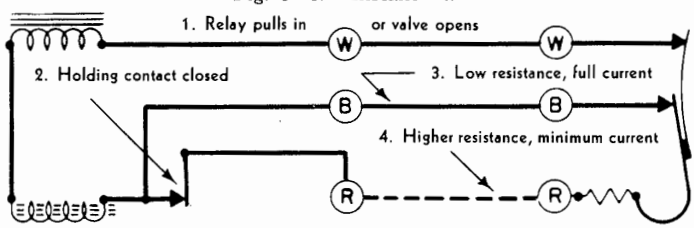


Fig. 6—Slight Temperature Rise

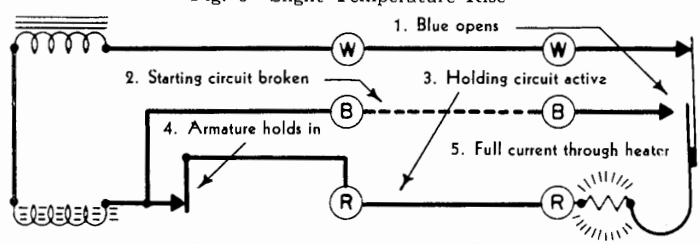
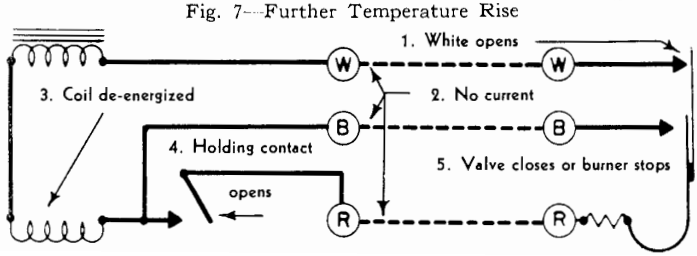


Fig. 7—Further Temperature Rise



REVIEW OF SERIES 10

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? Thermostat 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? Thermostat can't pull in relay (valve) but can hold.
3. Broken *red* wire, or loose *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 *blue?* 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?* Thermostat can start but can't stop burner.
3. Shorted *red* to *blue?* Short-cycling (single-pointing) on *white* contact alone.

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

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

UNCOLORED THERMOSTAT CABLE

Suggested method for determining and labeling wires of thermostat cable that is *not color coded* (Series 10).

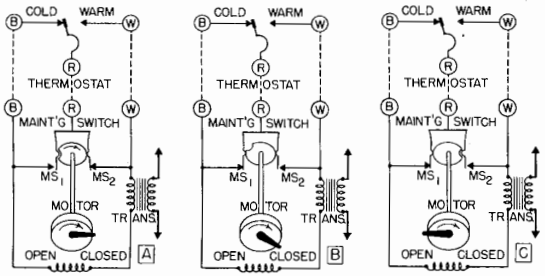
1. With the three wires properly connected at the relay or valve, hold the three bare wires, at the other end, together.
2. Remove one wire—if the burner stops, this is the white wire. Attach it to the W terminal of the thermostat.
3. If burner does not stop, hold all three bare ends together again and 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

SERIES 20 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) insures 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 MS2, energizing the motor.

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

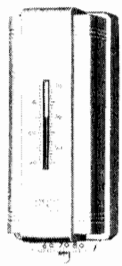
3. At C the motor is shown at the end of its 180-deg. travel. Maintaining switch MS2 has opened, stopping the motor.

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.

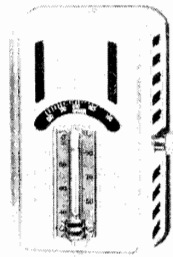
Important: Series 20 devices should be used only with other Series 20 devices.

A high limit control in a Series 20 circuit must 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).

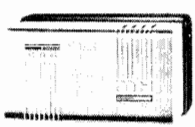
T11A or T81A



T44A or T45A



T42A



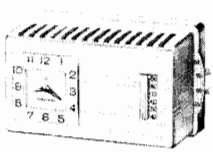
TA42

T491B

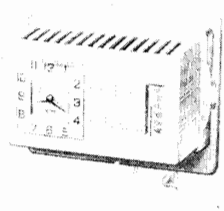
T109A

T19A

T801A



T147, T247, T847



T848A "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 uninterrupted line to avoid stoppages.
6. Use the clock transformer furnished with the Chronotherm.
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 floor.
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 installation 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 69 for heater plug specifications).
3. On 1-pipe steam, increase *differential* to 3 or 4.
4. Check operation of the completed installation.

Chronotherm: 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.—6 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 Chronotherm 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 next page).*
5. *Don't set Chronotherm 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. Chronotherms are factory adjusted to allow for heat from the clock.

THERMOSTAT CALIBRATION

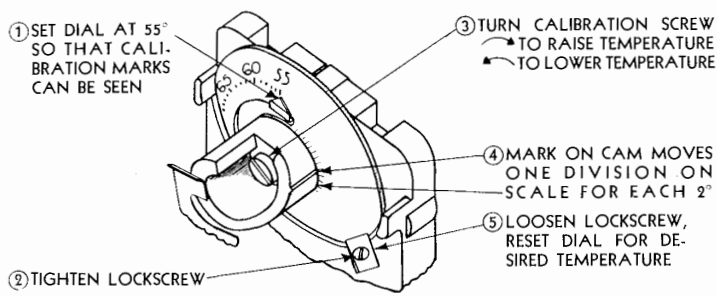
Series 10

Series 10 thermostats are calibrated to make Blue (start the burner) when the temperature falls to scale setting, and to break (or make) 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 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.

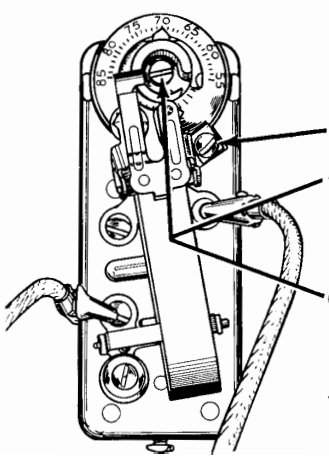
T11A Acratherm—If Error is Known:

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 lockscrew.

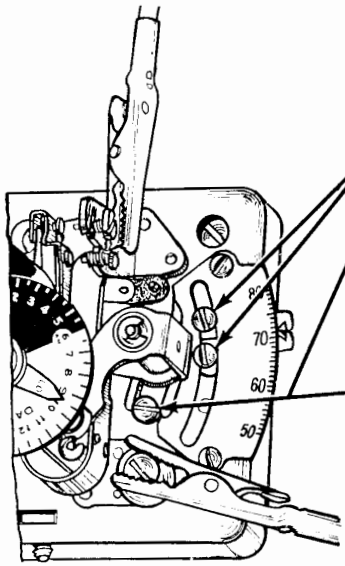
4 Turn calibration screw ↶ to open both contacts.

5 Wait 10 minutes for heater plug to cool.

6 Turn calibration screw SLOWLY ↷ until Tattelite (1) lights up and (2) goes out. This is when burner starts.

7 Loosen lockscrew, reset dial for desired temperature.

Calibrating T147A Chronotherm



1 After removing cover, set levers at room temperature.

2 Tighten lock screws.

3 Turn calibration screw about ⅛ turn ↖ to open contacts.

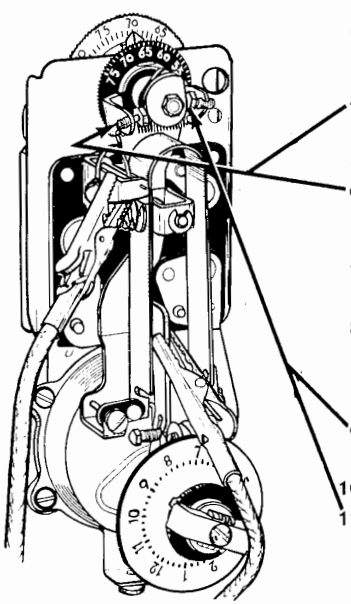
4 Slip cover on. Wait 10 minutes for temperatures inside to level off.

5 Remove cover and attach Tattelite clips as shown. Be careful to avoid shorting B to W.

6 Turn calibration screw SLOWLY ↗ until Tattelite (1) lights up and (2) goes out. This is when burner starts.

7 Loosen lockscrews, reset levers for desired temperature, replace cover.

Calibrating T109A Da-Nite Acratherm



1 After removing cover, replace winding knob and turn it all the way ↖.

2 Attach Tattelite clips as shown.

3 Set silver dial at room temperature.

4 Turn calibration screw ↖ until both contacts open.

5 Wait 10 minutes for heater plug to cool.

6 Turn calibration screw SLOWLY ↗ until Tattelite (1) lights up and (2) goes out. This is when burner starts.

7 Turn winding knob ¼ turn ↗ to put the thermostat on night cycle.

8 Set day dial 5° above room temperature, black dial AT room temperature. (For this method room temperature must be below 75 F.)

9 Turn night calibration screw ↗ to open both contacts.

10 Wait 10 minutes for heater plug to cool.

11 Turn night calibration screw SLOWLY ↖ until Tattelite (1) lights up and (2) goes out. Now the thermostat should be in calibration.

THERMOSTAT CALIBRATION

Series 80

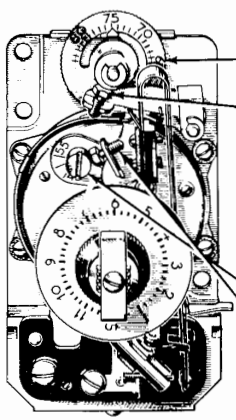
T81A Acratherm

If the error is known, follow the first diagram for calibrating T11A, p. 16.

If the error is not known, use the following procedure (refer to diagrams of T11, but note that Tattelite need not be used—snap action of the contacts makes it easy to tell when they close).

1. Set dial at room temperature, and tighten lockscrew.
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 contacts just close. Then the thermostat should be calibrated.
5. Loosen lockscrew and reset dial for desired temperature.

T801A Time-O-Stat



1 After removing cover, replace winding knob and turn it ↖ as far as it will go.

2 Turn day dial to room temperature.

3 Turn day calibration screw ↖ to open contacts.

4 Then turn it slowly ↗ until contacts just make. Now day dial is calibrated.

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

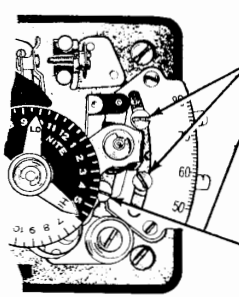
6 Turn winding knob ½ turn ↗

7 Turn day dial to low end of scale (60°).

8 With screwdriver turn night setting screw so indicating mark is centered between "5's" on 55 mark.

9 Turn night calibration screw so that the day calibration screw (Step 3) just touches its cam.

T847A Chronotherm (or T848)



1 After removing cover, set both levers at room temperature.

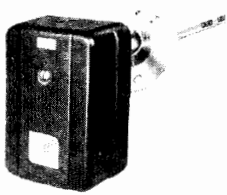
2 Tighten lockscrews.

3 Turn calibration screw ⅛ turn ↖ so the contacts are open.

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

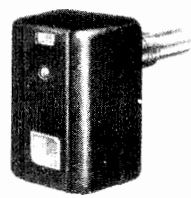
5 Remove cover and turn calibration screw SLOWLY ↗ until contacts just close. Now the Chronotherm is in calibration.

LIMIT CONTROLS

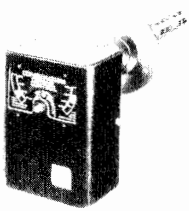


LA419 Airstat or
LA412 Furnacestat

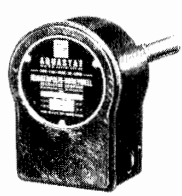
Surface
Aquastat



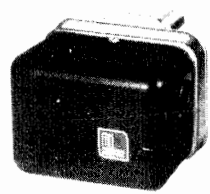
L144, L444, L170
Immersion Aquastat



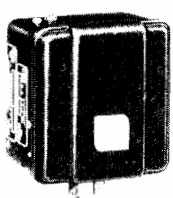
Combination
Furnace Control



L428
Immersion Aquastat



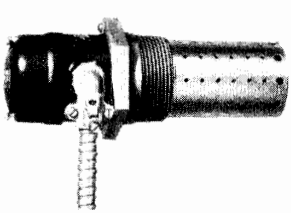
Summer-Winter
Controller



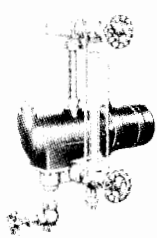
P104 or P404
Pressuretrol

Vaporstat

Vacuumstat

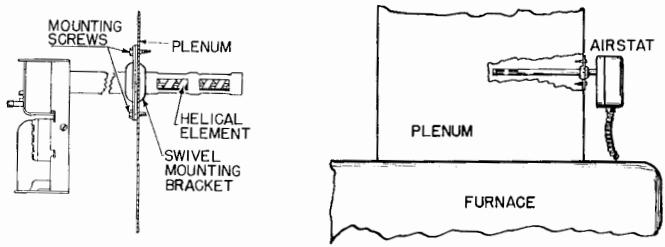


C401 or C601
Lo-Water Cutoff



C402
Lo-Water Cutoff

WARM AIR LIMIT CONTROLS



Typical Mounting of 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 set.
4. Always level case of mercury switch type (LA419 or LA412).
5. Connect high limit switch in circuit according to recommendation for the primary control used (p. 26, 42 or 52).

Things NOT to DO—

1. *Don't get bimetal too close to hot surface.*
2. *Don't locate it where cold air return can affect element.*
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, LA401).
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 cutout, fan "on" and fan "off."

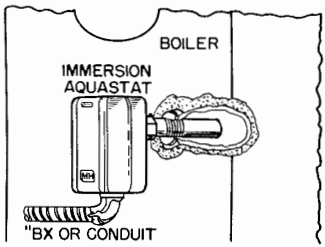
Things to DO—

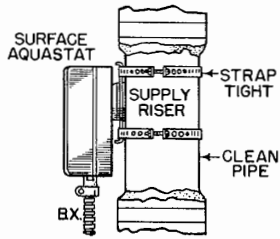
1. Use lowest limit setting that will assure enough heat.
2. Use lowest fan settings possible without cool drafts from registers before fan stops.
3. Instruct customer in summer fan operation.

Things NOT to DO—

1. *Never set Furnacestat "on" above Airstat setting. (Note that LA101-401 are designed to prevent overlap.)*
2. *Don't forget to tell user about resetting Furnacestat (LA412) for correct fan operation in the heating season.*

HOT WATER LIMIT CONTROLS





Typical Installation of Aquastats

INSTALLATION

Things to DO—

1. *Surface Aquastat:*
   a. Mount it on riser about 2 ft. above boiler.
   b. Scrape surface of pipe clean.
   c. Clamp Aquastat *securely* to the riser.
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 pockets, 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. 26, 42 or 52).

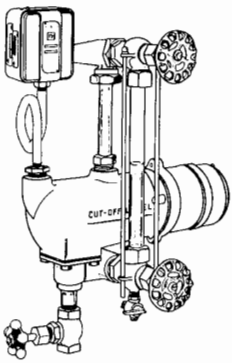
Things NOT to DO—

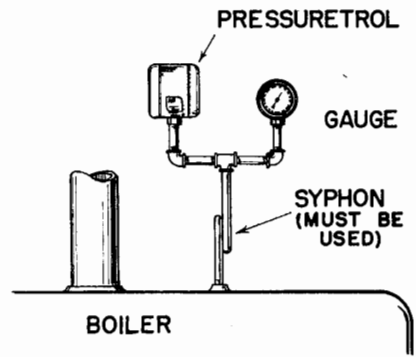
1. Don't use low-voltage model on line voltage.
2. Don't use surface Aquastat as operating control.

SETTING

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

Pressuretrols





Mounting: (A) On Lo-Water Cutoff; (B) By Pressure Gauge.

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—

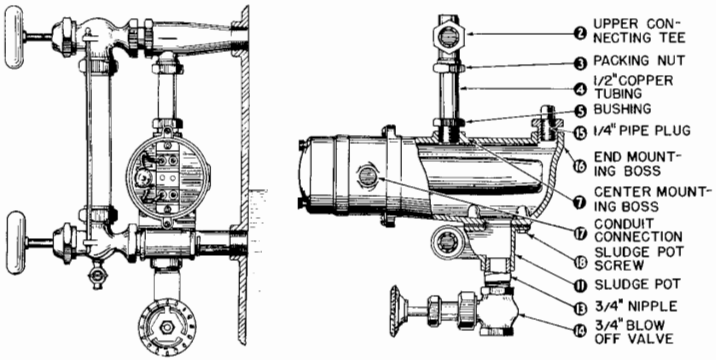
1. *Do NOT put a shutoff valve between boiler and Pressuretrol.*
2. *Don't use excessive amounts of pipe dope on threads.*

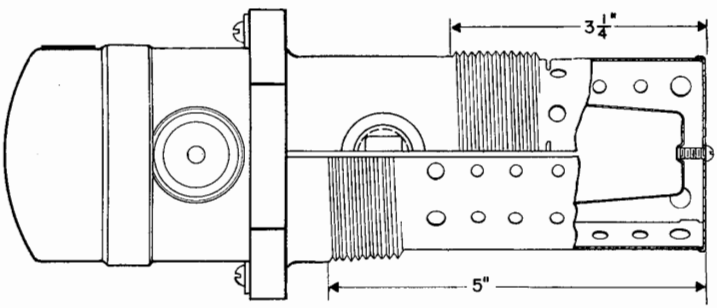
WIRING

1. Connect high-limit Pressuretrol in circuit as recommended for the primary control used (p. 26, 42 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

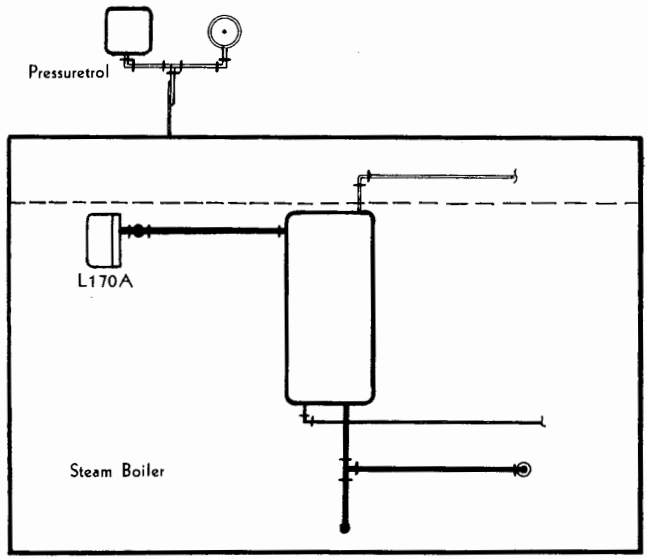
1. DO make sure the Cutoff opens the circuit at low water level (with boiler at operating pressure).
2. *DON'T expose the Cutoff to pressures above its rating.*

WIRING

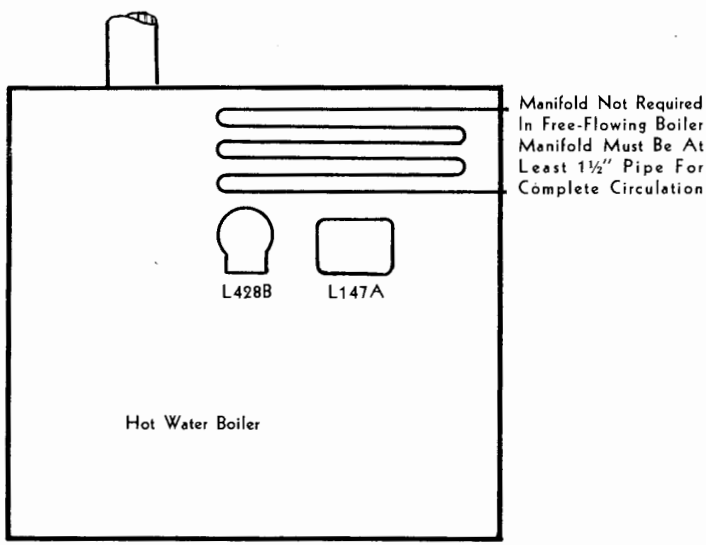
Connect the Cutoff in the circuit as recommended for high limit switch with given primary control (see p. 26, 42 or 52).

REMEMBER

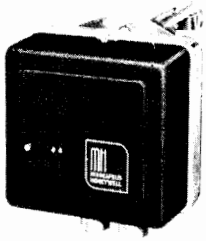
1. —to instruct the user to blow down the Cutoff once a month.
2. —to clean out the housing once a year.



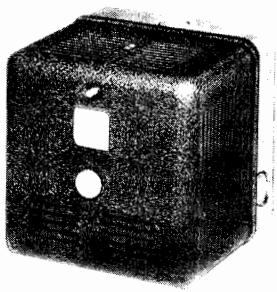
Typical Summer-Winter Installation—Steam



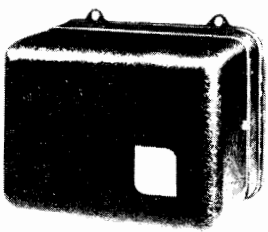
Typical Summer-Winter Installation—Forced Hot Water



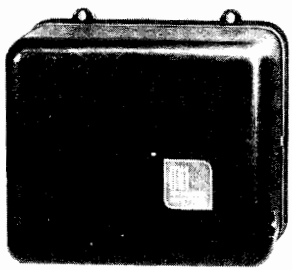
RA116 or RA117
Protectorelay



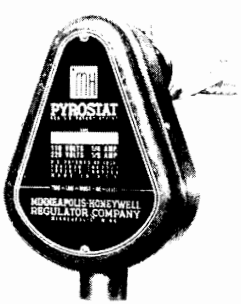
R177A Electronic
Protectorelay



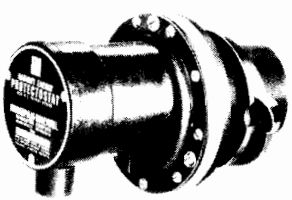
R114A
Protectorelay



R161
Protectorelay

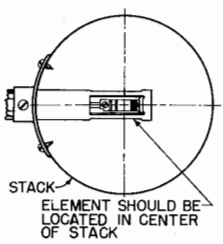


C40A
Pyrostat

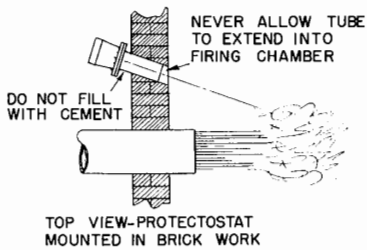


C57A
Protectostat

OIL BURNER "DO'S AND DON'TS"



A—Location of Stack Element



B—A Protectostat 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 at all times.
6. *DON'T get oil or grease on contact mechanism.*
7. DO see that Pyrostat or Protectostat 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 near inside of elbow.*
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—

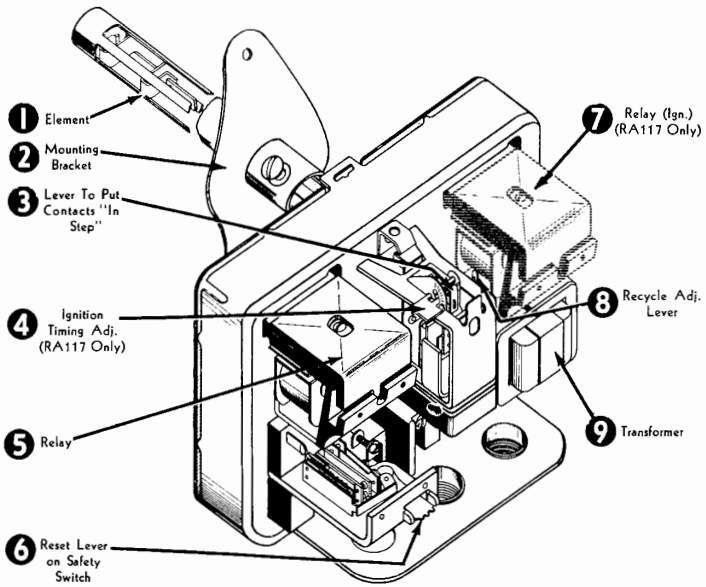
1. DO mount on solid vertical wall free from much vibration.
2. *DON'T mount on rafter or beam near ceiling.*
3. FIND a location handy to burner and power supply.

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 (or limit shutdown may warp out safety switch).*

REMEMBER—

to tell user 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 "7" pulls in, starting ignition and pulling in motor relay "5".
2. Rising stack temperature expands bimetal element "1" moving Pyrostat 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.

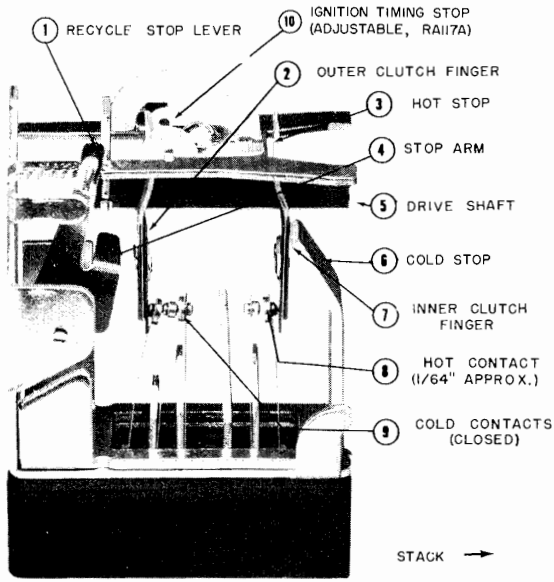


Fig. A—Pyrostat contacts—cold or starting position.

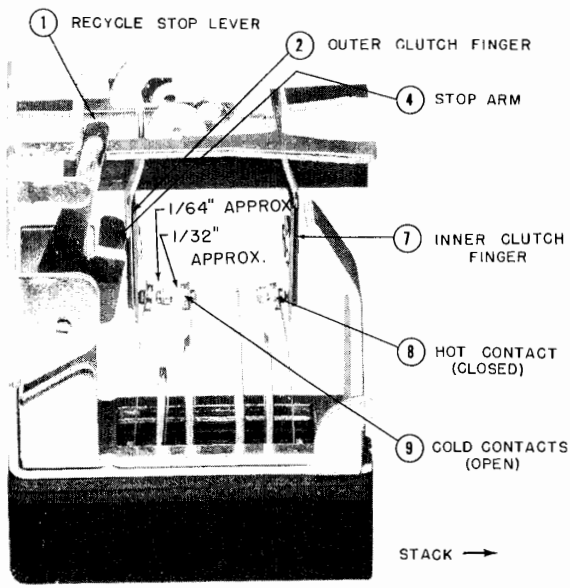


Fig. B—Pyrostat contacts—hot or running position.

PYROSTAT CONTACTS

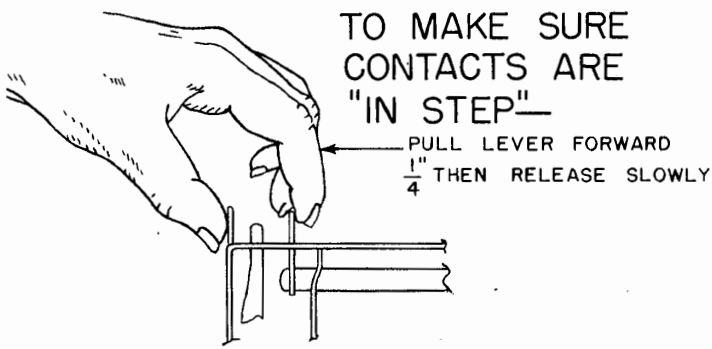
RA116A or RA117A

OPERATION:

1. Expanding bimetal (not shown) pushes drive shaft (5) to the left, and on contracting pulls it back.
2. Clutch fingers 2 and 7 are carried by friction with shaft until "unlocked" by hitting stops. Stops 3 and 6 limit inner or "hot" clutch (7); 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—8).
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).

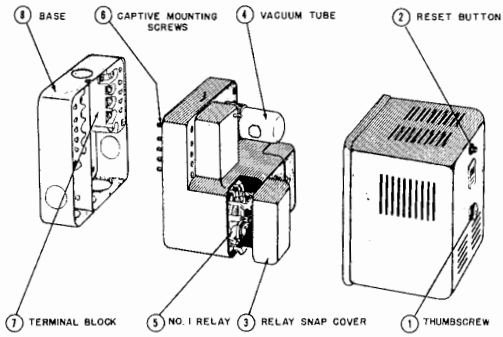
REMEMBER—FOR SATISFACTORY OPERATION:

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 (4), to keep contacts in step.*



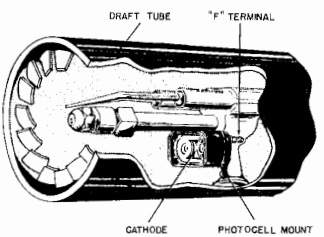
1. Look to see that hot contact is open, cold contacts are closed.
2. As you slowly pull out shaft, see whether hot contact closes before cold contacts have opened.
3. As you slowly release shaft, see that hot contact opens before cold contacts have closed.
4. Checking burner operation, watch whether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

With Electronic Flame-Checking



"Exploded" View of Type R177A

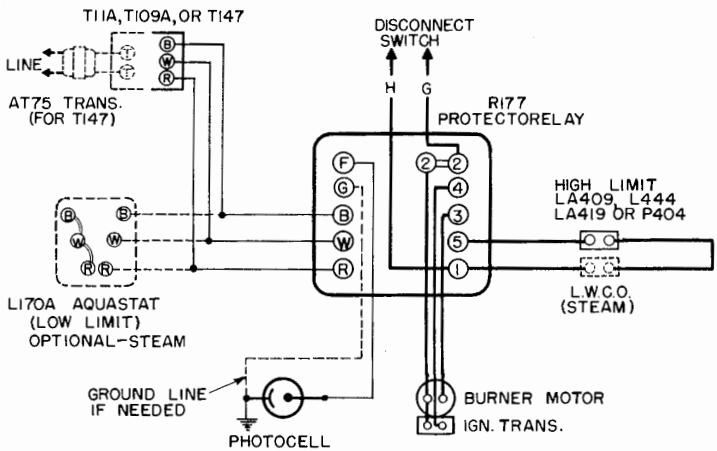
Typical Installation of Photocell



Things to KNOW about R177A—

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 ignition 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 R177A locks out. It also locks out on component failure, short-circuits, grounds, or open circuits in photocell circuit.
5. The R177A is available only for factory application. It is designed into the burner and at least partly installed at the factory.
6. The R177A 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 R177A are provided for (timing, etc.) and none should be attempted.

With Electronic Flame-Checking



Typical Control System—Gravity or Steam

Things to DO—

1. Use only Series 10 thermostat (or "jumper" R-B at relay if 2-wire thermostat must be used).
2. Follow burner manufacturer's instructions in mounting and wiring.
3. In mounting the relay on the base, start all ten mounting screws and then draw them up snug.
4. Make sure photocell faces fire (trade-mark toward holder).
5. If right-hand (flame) relay won't pull in, or chatters:
   a. Check for soot on the cell (or filter if used).
   b. Measure current through cell with a D-C microammeter in series with F terminal and lead at the cell mount. It should be at least 2 microamp (2 to 5 normal) 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 165 F.)

Things NOT to DO—

1. NEVER bend relay contact blades.
2. Don't try to adjust or repair R177A—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 loose connections.

To Order Replacements—

Photocell: A177A1 Tube: No. 38305

Relay: R177A less base (specify voltage and frequency).

R114 PROTECTORELAY

Accelerated Lockout

Points to REMEMBER:

1. The R114 is available for intermittent ignition (R114A) or for constant ignition (R114B), where oil valve delay is not needed and where manual reset after flame failure is desirable.
2. With C40A Pyrostat or C57A Protectostat, R114 guards against ignition failure or loss of flame.
3. The R114 locks out if flame is not established in approximately 60 seconds.
4. On flame failure, as soon as the Pyrostat or Protectostat opens its contacts, the current of both relay coils flows through the safety switch heater, and lockout follows in about 30 seconds.
5. The R114 must be mounted on a vertical wall or column free from excessive vibration.

R161B PROTECTORELAY

Oil Delay—Nonrecycling—Fast Restart

FEATURES:

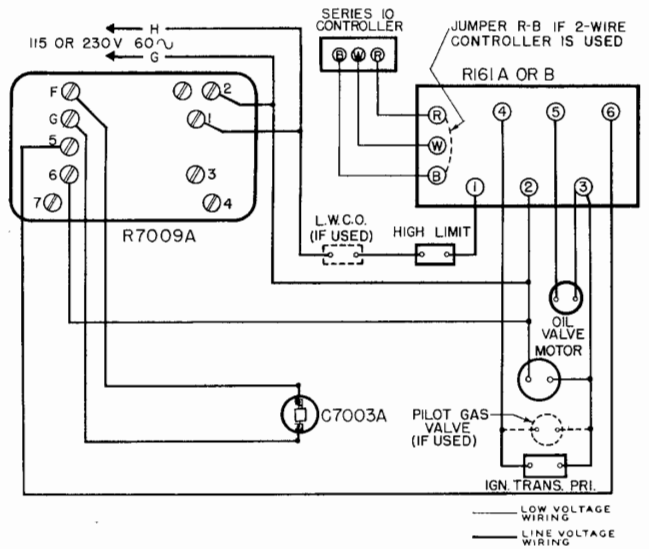
The R161B Protectorelay is designed primarily for commercial or industrial oil burners requiring delayed oil valve opening, timed ignition, lockout on flame failure (non-recyling), and a fast restart after normal shutdown. It guards against either ignition failure or loss of flame, and like other Protectorelays recycles after a power interruption. In case of flame failure, it shuts down the burner as soon as the combustion control opens its contacts, and thereupon goes into safety shutdown without recycling. This Protectorelay is used with the C40A Pyrostat or C57A Protectostat; or for the fastest and most sensitive response to flame conditions, with the R7009 Electronic Flame Detector Relay plus photocell (or photocell and flame rod).

The R161B Protectorelay is for intermittent ignition burners. The R161A is also available for intermittent ignition burners where recycling after a flame failure is desired. The R161C is available for constant ignition burners, with the same features as the R161B (excepting timed ignition).

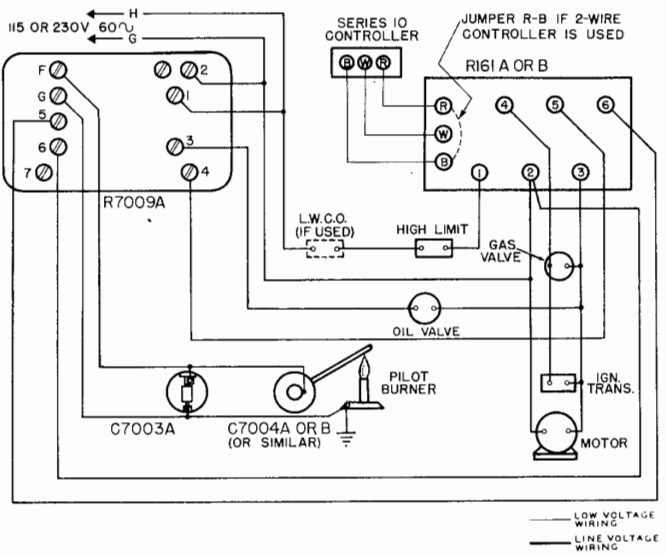
Things to DO—

1. Mount the Protectorelay on a vertical surface free from vibration.
2. Check out the system completely for satisfactory operation.
3. See that wiring conforms to local electrical ordinances.
4. Make sure that connections are correct as shown in diagrams. (Refer also to instructions packed with the controls.)

NOTE: Diagrams on opposite page show standard connections for R161B used with R7009A Flame Detector Relay: (a) on oil burner with spark 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 proved; both pilot and main flame are supervised.

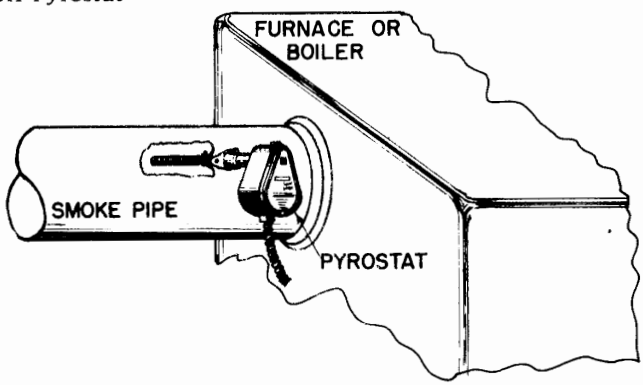


Connections for R161B and R7009A—Spark-Ignition Burner, or Burner with Gas Pilot Requiring Main Flame Supervision Only



Connections for Supervising Pilot (Start) and Main Flame (Run)

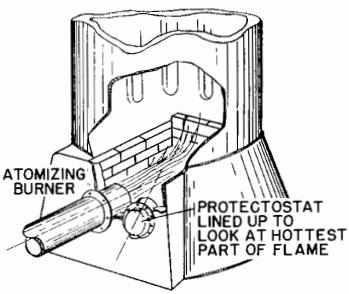
C40A Pyrostat—



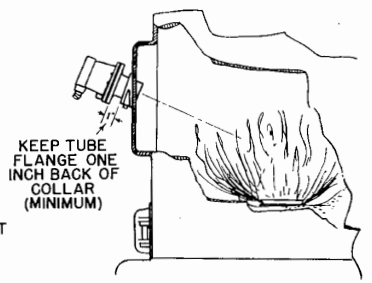
Important Points—

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).

C57A Protectostat—



PROTECTOSTAT WITH
ATOMIZING TYPE BURNER



PROTECTOSTAT MOUNTED ON FIRE DOOR
FOR ROTARY TYPE BURNER

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 collar.
4. The Protectostat will not operate correctly if the diaphragm gets excessively hot.

TROUBLE-SHOOTING BY ELIMINATION

Series 10 Oil Burner System

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 Protectostat 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 after step 3, 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 at relay.

Thermostat Cable—

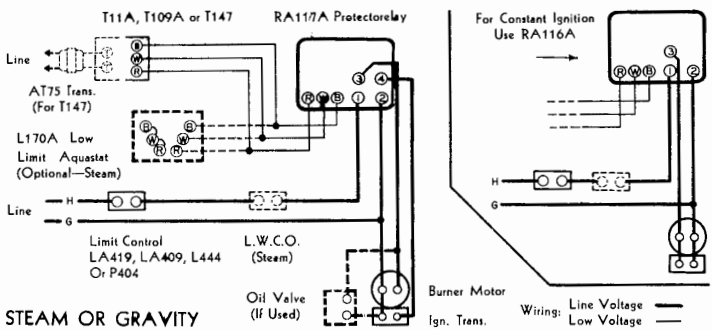
1. With thermostat wires connected to relay and thermostat, remove thermostat from its base plate.
2. Short or jumper the R and W terminals on base plate. If burner starts, there is a short between red and blue wires within the thermostat cable. Remedy: replace thermostat cable.
3. If burner did not 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—

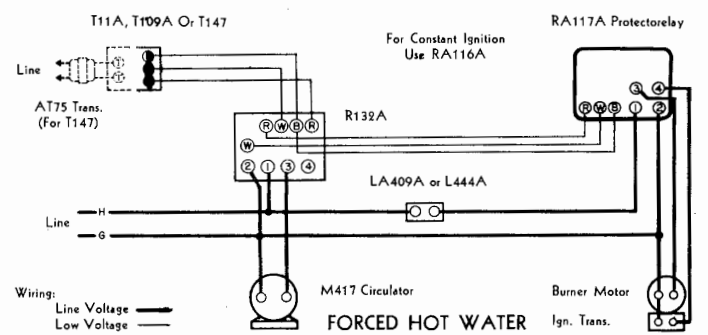
We have now checked both the relay and the thermostat cable. If the trouble has not been found it is now in order to check thermostat.

1. Check the heater plug screw for tightness. (A loose heater plug screw would mean 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 Q56A Tattelite.
4. Make sure contacts are clean. Polish only with a piece of hard-surface paper—NEVER use file, emery cloth or sandpaper.

TYPICAL CONTROL SYSTEMS



This is a control system for a domestic steam, gravity warm air or gravity hot water system. The Series 10 thermostat actuates the RA117 Protectorelay (or RA116 with constant ignition) to start and stop the burner. The high-limit Airstat, Aquastat or Pressuretrol (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.

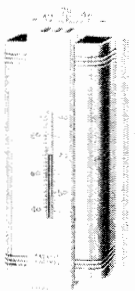


In this control system for forced hot water heating, the thermostat actuates the switching relay (R132A), which in turn starts the circulator and actuates the Protectorelay to start the burner. The high-limit Aquastat will stop the burner before excessive temperature is reached in the boiler, but the circulator will run as long as the thermostat calls for heat. The RA117 Protectorelay is used with intermittent ignition burners; the RA116 with constant ignition. When the T109A or T147A is the thermostat used, lowered temperature is provided at night, with automatic return to day temperature in the morning.

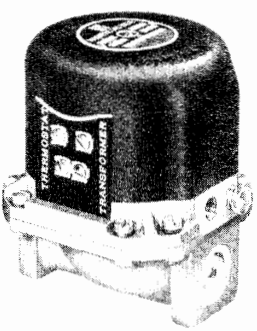
INSTALLATION AND SERVICE TIPS

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

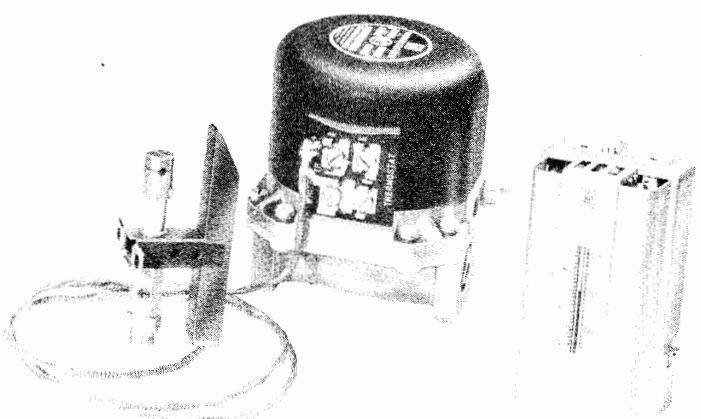
T11B and T81C
Time Modulation Thermostats



V898A Diaphragm Gas Valve
Used with "Plug-In" Transformer



Powerpile Gas Control System
Electric Power Supplied by Thermopile



TIME MODULATION THERMOSTATS

Types T11B and T81C

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 used (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 T81C with RA117 Protectorelay.*
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	T81C
In mild weather (50-60°)	3 min.	2½ min.
In "50%" weather (equal on and off time)	5 min.	4½ min.

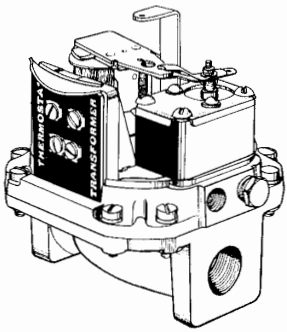
HEATERS THAT MUST BE USED IN T11B AND T81C

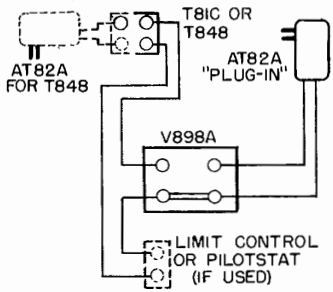
PRIMARY CONTROL		HEATER COLOR CODE	
TYPE NO.	CYCLES	T11B	T81C
R19A	60	Gray & Green	Gray & Green
RA116A	60	Gray, Green & Orange	.....
R132A	60	Gray & Green	.....
R177A	60	Gray, Yellow & Blue	.....
R180B	60	Gray, Yellow & Blue	.....
R182A, B	60	Gray & Brown	Gray & Brown
R182C	60	Gray, Green & Orange	Gray, Green & Orange
R183B	60	Gray & Green	.....
V16A*	60	Gray, Black & Blue	.....
V84*	60	.....	Gray, Yellow & White
V148*	60	Gray & Green	.....
V155A*	60	Gray & Green	.....
V166*	60	Gray & Green	.....
V835*	60	.....	Gray & Blue
V898*	60	.....	Gray & White

*With standard transformer

V898A DIAPHRAGM GAS VALVE

With "Plug-In" Transformer





Typical Connections for V898A

Things to DO—

(Refer to general "Do's and Don'ts" p. 52, and Installation Instructions, Form 95-1488.)

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—

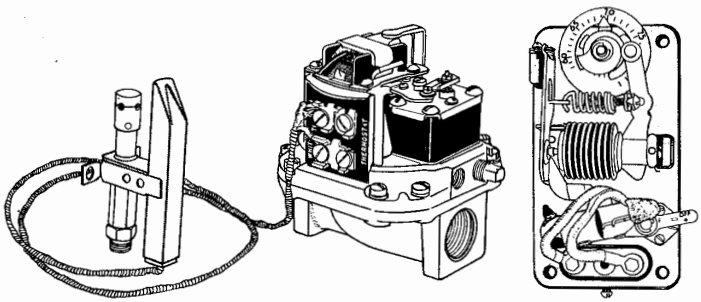
1. Don't attempt to convert right-hand to left-hand model or left-hand to right-hand. Remember that the valve is available in either model.
2. Don't forget to instruct the occupant in use of the manual opener—and in the necessity of closing the valve after manual operation. (It does not recycle.)
3. 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.

THERMOSTAT HEATERS FOR USE WITH V898

T81A, T847	T81C
White	Gray and White

POWERPILE GAS CONTROL SYSTEM

T804—VS887—Q182 Pilot Generator



Things to DO—

1. Follow standard good practice for installation of thermostat (pp. 14-15), valve (p. 52), 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 right-hand model, over outlet of left-hand model).
4. Be sure to run bleed line into combustion chamber.
5. Wiring: Make tight, low-resistance connections with good copper wire. Avoid splices.

Things NOT to Do—

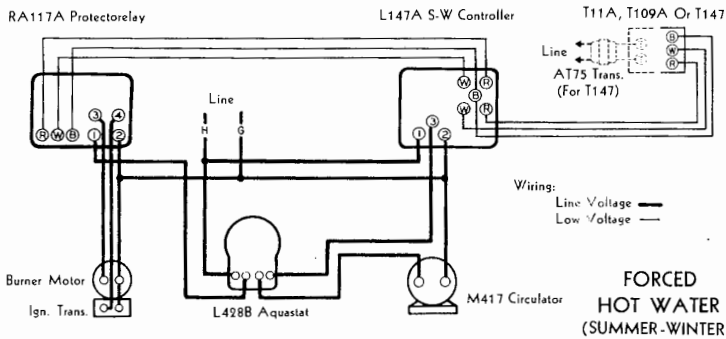
1. *Don't substitute another thermostat for T804.*
2. *Don't use ordinary Pilotstat thermocouple—use only the pilot generator supplied.*
3. *Don't attempt to convert right-hand valve to left-hand, or left-hand to right-hand. REMEMBER: two models are available.*
4. *Don't use standard-gas model on L.P.G.*
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.)

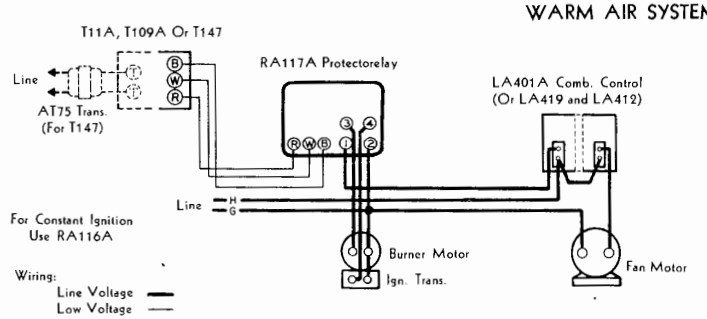
TYPICAL CONTROL SYSTEMS



FORCED HOT WATER (SUMMER-WINTER)

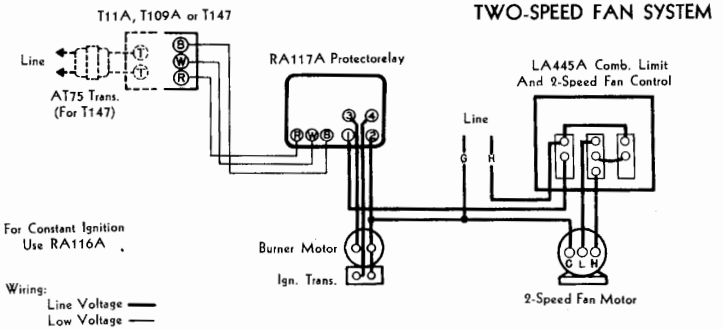
This is a control system for forced hot water heating with domestic hot water supplied by the heating boiler (through an indirect heater). In response to demands from the thermostat or to a drop in boiler temperature, the L147 actuates the Protectorelay to start the burner. The L147 also incorporates a switching relay which, on demand from the thermostat, starts the circulator; the circulator does not operate on "low-limit" action of the L147. The L428B 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

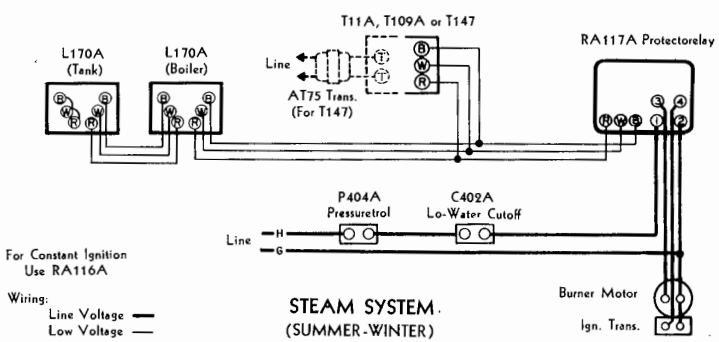


This control system for forced warm air features a Combination Furnace Control (LA401A) which includes a high limit switch to prevent excessive furnace temperatures and a fan switch to start and stop the circulating fan according to furnace temperature. The high-limit cutout point and the fan "on" and "off" points are separately set, but the fan "on" cannot be set higher than the limit setting. (LA419 may be used as limit control and LA412 as fan control, if preferred.) The Series 10 thermostat starts and stops the burner through the RA117 Protectorelay (use RA116 for constant ignition). The T109A or T147A provides lowered night temperature with automatic "pickup" in the morning.

TYPICAL CONTROL SYSTEMS



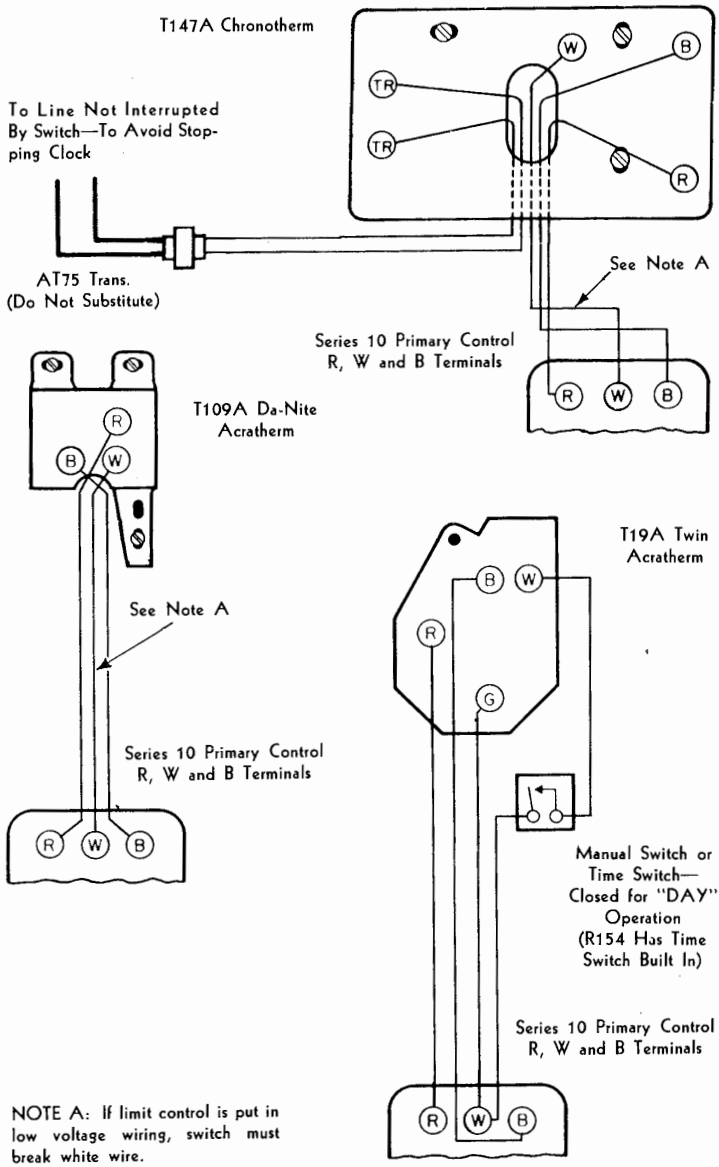
This control system for forced warm air includes two-speed control of the blower. The thermostat controls the burner through the RA117A Protectorelay (use RA116A for constant ignition burners); and the limit switch in the LA445A combination control stops the burner before furnace temperature becomes excessive. On initial rise in furnace temperature the LA445 starts the fan; whenever the furnace temperature rises to the speed-change setting of the LA445, the fan is shifted to high-speed operation. The T109A or T147 if used provides night setback with automatic morning pickup.



This control system for a steam plant includes provision for Summer-Winter hot water. Two Aquastats (L170) 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 steaming on low-limit operation. The Pressuretrol prevents excessive pressure during thermostat operation, and the thermostat operates the burner (through the Protectorelay) to maintain room temperatures at the proper level.

TYPICAL CONTROL SYSTEMS

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



NOTE A: If limit control is put in low voltage wiring, switch must break white wire.

THERMOSTAT HEATERS

FOR USE WITH SERIES 10 RELAYS

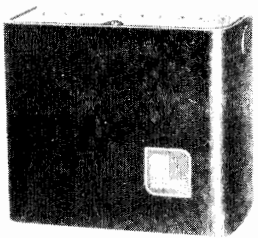
RELAY	THERMOSTAT	
	T11A, T17, T19, T81A, T109, T178, T111, T147, T811	T12HA, T105, T802B
L147A (60 cy.)	Green	Black & Green
L147A (25 cy.)	Black & Green	Blue
R19A, B, C (25 cy.)	Black & Green	Blue
R19A, B, C, D (60 cy.)	Green	Black & Green
R100A (25-60 cy.)	Red	Black & Red
R114A, B (25 cy.)	Blue	Black & Blue
R114A, B (40 cy.)	Black & Blue	Black & Yellow
R114A, B (50-60 cy.)	Yellow & White	Blue & White
R116-4 (25-30 cy.)	Green	Black & Green
R116-4 (40-60 cy.)	Red	Black & Red
R116A, B (25 cy.)	Black & Green	Blue
R116A, B (40-60 cy.)	Green	Black & Green
RA116A, B (25 cy.)	Black & Green	Blue
RA116A, B (40-60)	Green	Black & Green
R117-3 (25-30)	Green	Black & Green
R117-3 (40-60)	Red	Black & Red
R117A (25 cy.)	Black & Green	Blue
R117A (40-60)	Green	Black & Green
RA117A (25 cy.)	Black & Green	Blue
RA117A (40-60)	Green	Black & Green
R132A (25 cy.)	Black & Green	Blue
R132A (60 cy.)	Green	Black & Green
R157A (25-30)	Green	Black & Green
R157A (50-60)	Red	Black & Red
R161A, B, C (25-60)	Red	Black & Red
R177A (50-60)	White	Brown
R182A, B, C (60 cy.)	Green	Black & Green

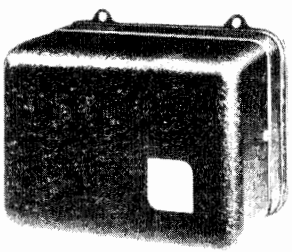
For other controls see Form 95-1346 or write for information.

R183B Stokerelay (Right)

FEATURES:

1. Fire-maintaining timer adjustable for 1 or 2 operations an hour, ½ to 7½ minutes.
2. Series 10 switching relay built in to operate stoker.
3. Removing jumper permits control of motor starter.



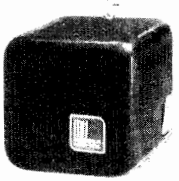


R154C or D Da-Nite Timerelay

1. Fire-maintaining timer, with same features as R183B plus "skip" after thermostat operation.
2. Time switch for day-night change-over (with T19A).
3. Built-in fused disconnect switch.

S400A Stokertimer (Right)

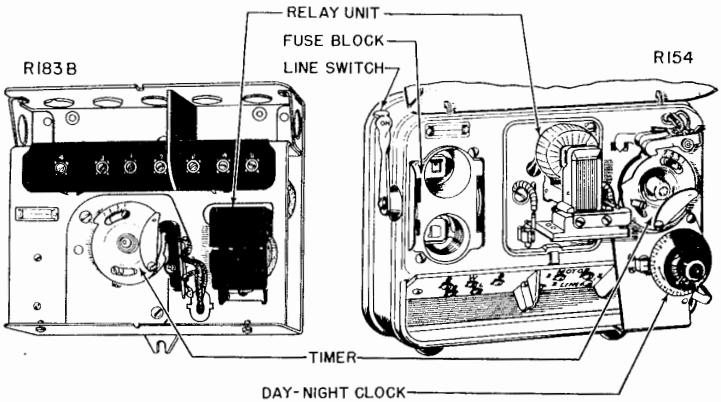
1. Timer operation adjustable for 1 operation each hour or half-hour, ½ to 7½ minutes.
2. Line-voltage mercury switch.
3. Jumper removable for control of motor starter.



GENERAL INFORMATION

1. The *basic functions* of stoker primary controls 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 Stokertimer (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 Stokerswitch, responding to flue-gas temperature. Room-temperature control is provided by a line-voltage thermostat and a D-C switching relay.

INSTALLATION "DO'S AND DON'TS"



Things to DO—

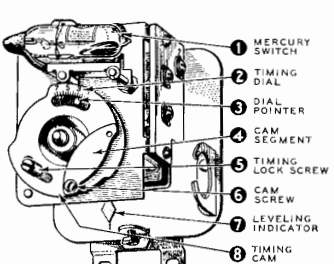
1. Mount relay on a solid vertical wall.
2. Mount it where it is handy for future timer adjustments by owner.
3. Level up S400A by the pendulum indicator so that mercury switch will operate correctly.
4. All wiring *must* comply with local electrical ordinances.
5. Connect high limit control in hot line from relay to stoker.
6. Use right size fuse in R154 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—

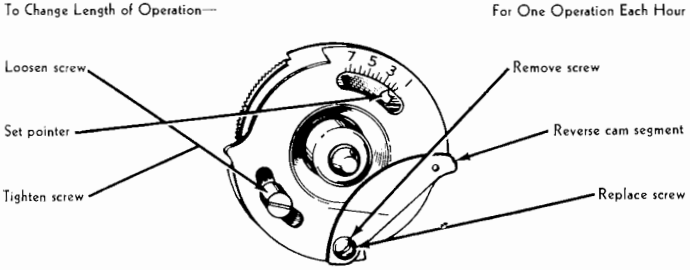
1. Timer can be used as fire-trying switch: manually rotate to the right until trip arms drop into recesses.
2. With R154, high limit *must* be wired between terminal 3 and the stoker to avoid stopping the day-night time clock.
3. With R154, day thermostat is out of control at night, but its contacts must be closed to permit night thermostat to operate.
4. In D-C districts where timers can't be used, T42A thermostat and L405A Stoker switch can be used, up to ¼ hp; T44A, R15A D-C relay and L405A from ¼ hp to ½ hp.



ADJUSTMENTS—TIMER AND CLOCK

Timer (All Models)—

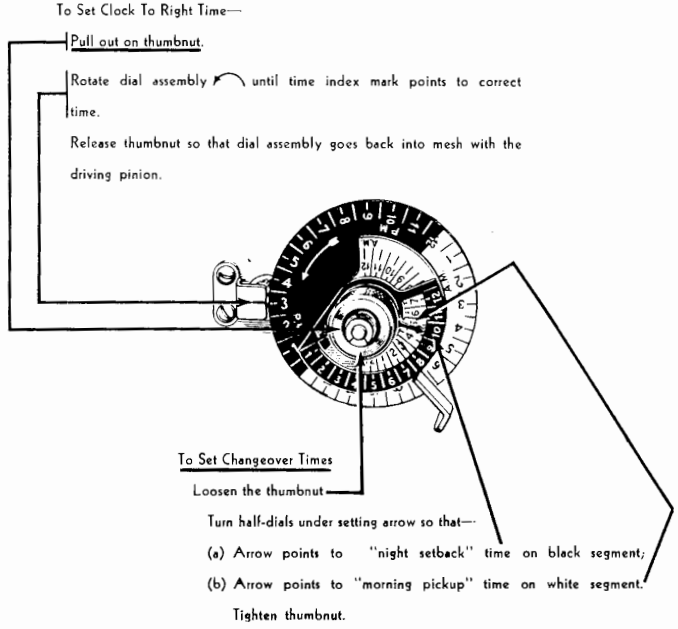
Standard timers leave the factory set for 2-minute operation every half hour. Settings may have to be changed to fit characteristics of the installation and the coal used. If so, see diagram.



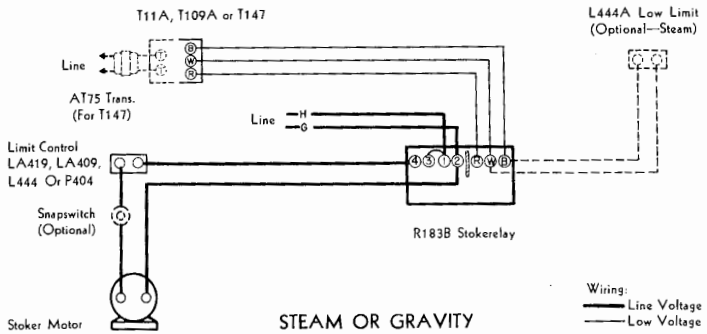
Day-Night Clock (R154 or S610)—

REMEMBER:

1. The larger black-and-white dial is in effect a 24-hour clock.
2. The time index mark at left is in effect the hour hand.
3. The half-dials form a cam (for tilting the switch) that can be adjusted in width and in position relative to the time dial.

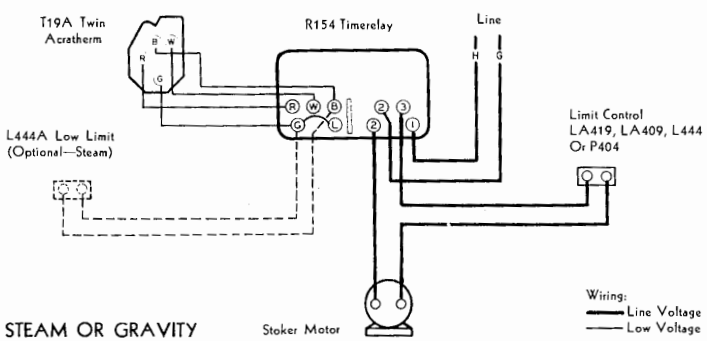


TYPICAL CONTROL SYSTEMS



STEAM OR GRAVITY

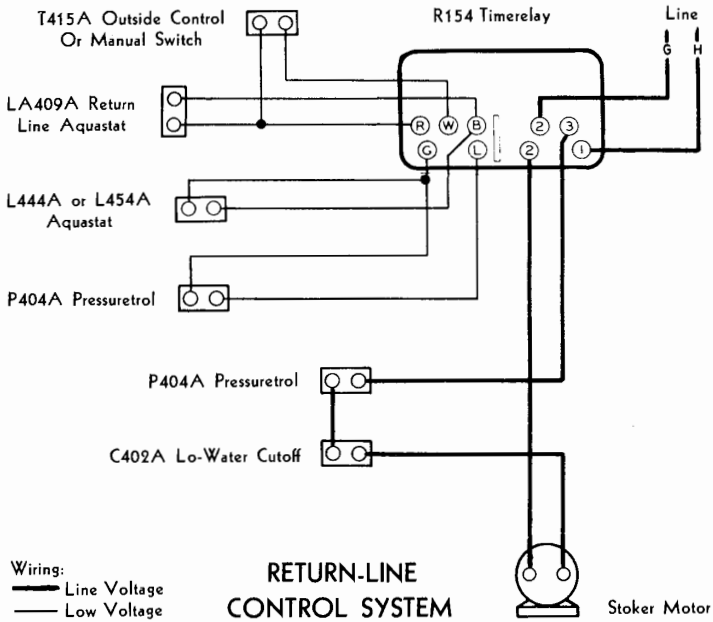
This control system is frequently used for a domestic steam, gravity hot water, or gravity warm air application. The R183B operates the stoker periodically to maintain a minimum fire, and responds to the thermostat by starting the stoker when heat is required. The Pressuretrol, Airstat or Aquastat (depending on the heating medium) can stop the stoker (without cutting off power from the timer motor in the R183B) to prevent excessive pressure or temperature in the boiler or furnace. The low limit control shown as optional for a steam system maintains boiler water temperature for supplying domestic hot water with an indirect heater. The T109 or T147 may be used where lowered night temperature is desired.



STEAM OR GRAVITY

This control system for steam or gravity heating plants utilizes the T19A for automatic lowering of temperature at night. A time switch in the R154 makes the changeover, and a timer provides periodic stoker operation to maintain the fire between thermostat operations of the stoker. The high-limit control is a Pressuretrol, an Airstat or an Aquastat, depending on the heating medium. The low-limit Aquastat when used on a steam boiler with indirect heater maintains the domestic hot water supply; it should be an immersion type mounted below the water line.

TYPICAL CONTROL SYSTEMS

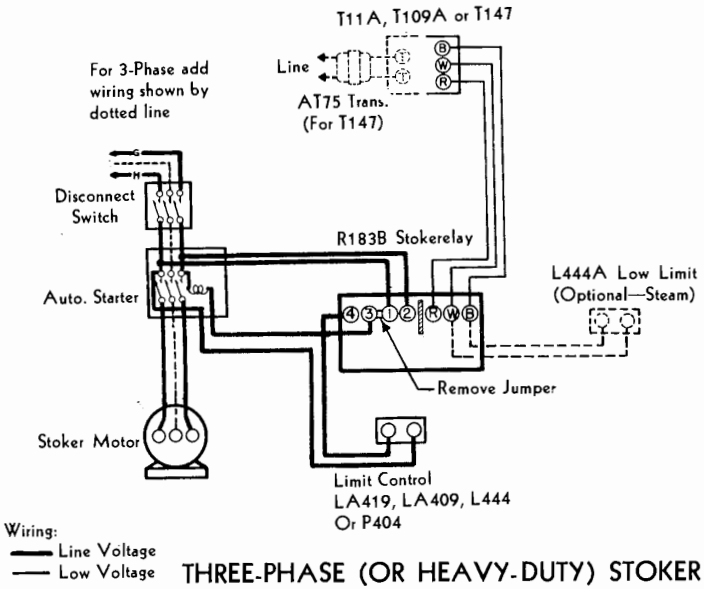


This control system is suitable for commercial steam heating installations where positive distribution of steam on each stoker operation must be assured. Night operation at a level to maintain a minimum boiler temperature (as for supplying domestic hot water from an indirect heater) is provided automatically.

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 R154 Timerelay starts the stoker when the LA409A Aquastat signals a drop in temperature in the condensate return line. The stoker continues to operate until the Pressuretrol in the low-voltage circuit senses steam pressure high enough to insure saturation of the radiators.

The time switch in the R154 provides automatic shutdown and pickup at selected times, night and morning. During night shutdown, 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 R154 will automatically operate the stoker between Aquastat or Pressuretrol operations if necessary to maintain the fire; the "skip feature" prevents a timer operation immediately after an operation called for by the other controls.

The high-limit Pressuretrol prevents excessive boiler pressure and the Lo-Water Cutoff guards against dry-boiler operation.



THREE-PHASE (OR HEAVY-DUTY) STOKER

This diagram of a gravity hot water, gravity warm air, or steam system shows recommended connections for room thermostat control of larger (or three-phase) stoker motors. The R183B Stokerelay operates the stoker in response to the thermostat, and also provides periodic fire-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 S400A Stokertimer together may replace R183B; remove 1-3 jumper and connect 3 and 4, in parallel, to starter control terminals.)

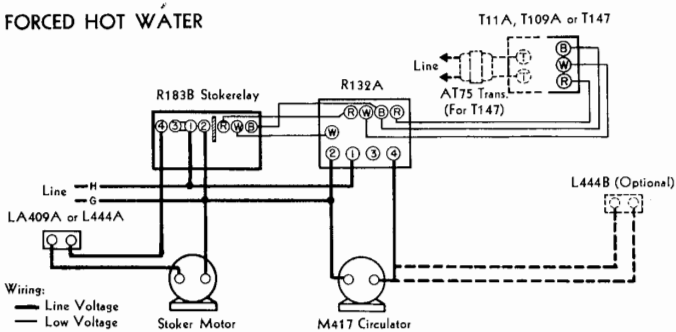
Note that where the power supply is 115 volts, the white or ground side of the power supply to the relay is connected to terminal 2. The dotted line indicates the third wire in a three-phase system.

The high-limit control (Pressuretrol, Airstat or Aquastat, depending on the heating medium) should be connected in 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.

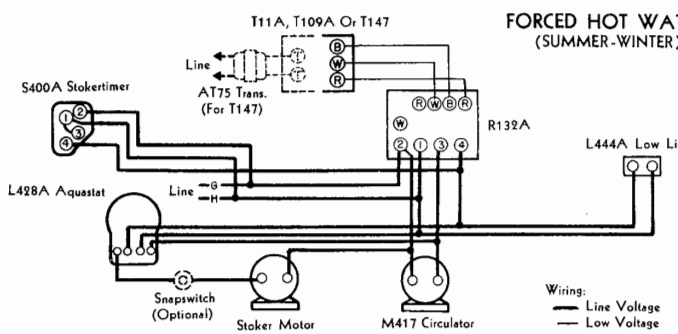
NOTE: For arrangement of terminals on wall plates of various Series 10 thermostats, see p. 39.

TYPICAL CONTROL SYSTEMS

FORCED HOT WATER

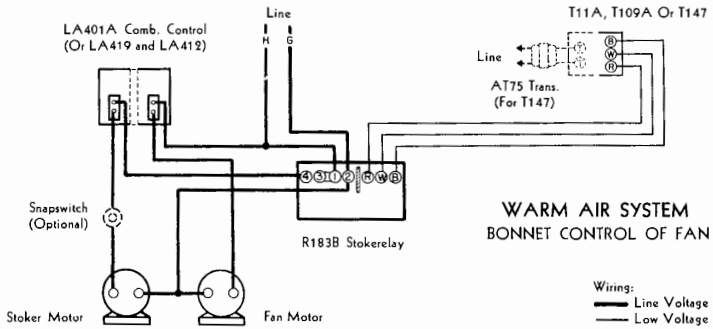


This is one of the standard control systems for a forced hot water heating plant. The thermostat actuates the switching relay (R132A) which starts and stops the stoker (through the relay unit in the R183) and the circulating pump. The timer in the R183 operates the stoker between thermostat operations as necessary to maintain a minimum fire. The surface (LA409) or immersion Aquastat (L444A) can shut down the stoker (but not the circulator nor the timer motor) so as to prevent excessive boiler temperatures. A reverse-acting Aquastat (L444B) may be used as shown, connected in series with the circulator, to prevent circulator operation until the boiler is up to temperature.

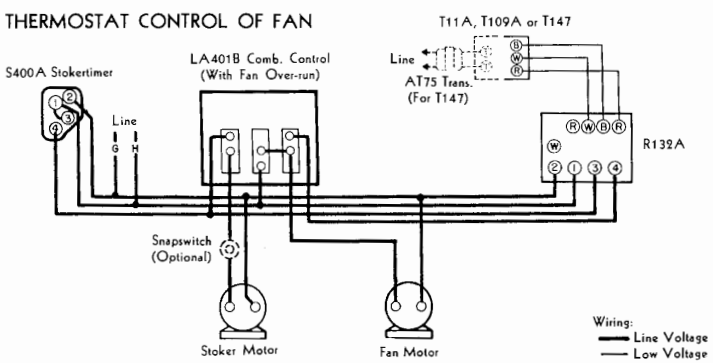


This is a control system for a forced hot water installation with domestic hot water supplied by the heating boiler. The room thermostat actuates the R132A relay which in turn operates the stoker and circulator. The S400A Stokertimer provides periodic fire-maintaining operations. The L444A Aquastat operates the stoker (but not the circulator) as necessary to maintain domestic hot water service. One switch in the L428A 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

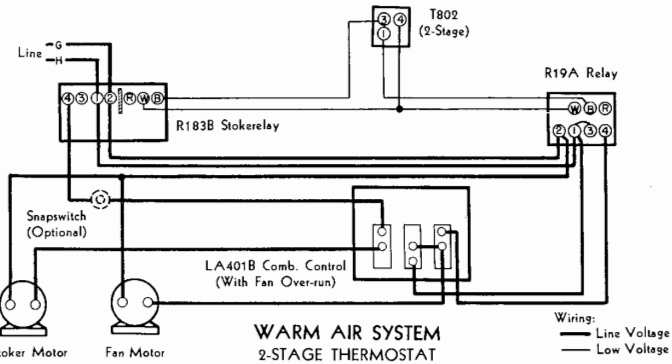


This simple control system for forced warm air provides thermostat control of the stoker and furnace-temperature control of the circulating fan. Either the thermostat or the timer mechanism in the **R183B** can actuate the switching relay unit built into the **R183**, and this in turn operates the stoker. The **LA401A** Combination Furnace Control includes a high-limit switch to prevent excessive furnace temperature and a fan switch that starts and stops the fan according to the temperature in the furnace. As indicated, an **LA419** Airstat may be used as limit control and an **LA412A** Furnacestat to control the fan.



This control system provides thermostat control of the stoker and the fan. The thermostat actuates the **R132** relay, and either the latter or the **S400A** Stokertimer 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.

TYPICAL CONTROL SYSTEMS



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 T802B pulls in the R19 relay. If the furnace temperature is above the "fan on" point of the LA401B, 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 T802 close, actuating the R183B to start the stoker and generate more heat. The R183B also provides periodic stoker operations to maintain a minimum fire. The LA401B 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

RELAY	THERMOSTAT	
	T11A, T17, T19, T81A, T109, T111, T147, T178, T847	T12HA, T105, T802B
L147A (25 cy.)	Black & Green	Blue
L147A (60 cy.)	Green	Black & Green
R19A, B, C (25 cy.)	Black & Green	Blue
R19A, B, C, D (60 cy.)	Green	Black & Green
R132A (25 cy.)	Black & Green	Blue
R132A (60 cy.)	Green	Black & Green
R154C, D (25 or 60)	Green	Black & Green
R182A, B, C (60 cy.)	Green	Black & Green
R183B (25 cy.)	Black & Green	Blue
R183B (60 cy.)	Green	Black & Green

For other controls see Thermostat Heater Index, Form 95-1346, or write for information.

TROUBLE-SHOOTING BY ELIMINATION

Series 10 Stoker System

When there is no apparent cause for erratic operation: (1) prove the relay; (2) prove thermostat cable; (3) prove the thermostat.

Relay (R183B, R154)

1. Make sure that
   (a) There is power at terminals 1 and 2;
   (b) the "thermostat control" contacts of timer 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. After 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 pull 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.

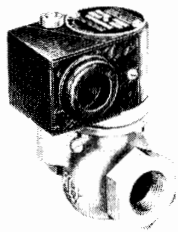
Thermostat Cable

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. Remedy: 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 open or short 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, find break, or replace cable.

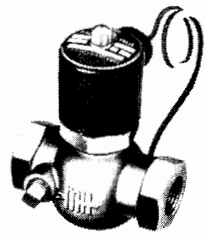
Thermostat

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 mean 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 Q56A Tattelite.
4. Make sure contacts are clean. Polish only with a piece of hard-surface paper—NEVER use file, emery cloth or sandpaper.

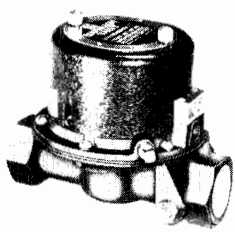


V16A

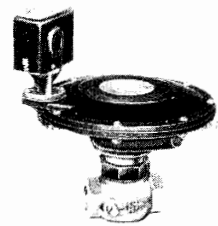


V435 or V835

V44 or V84

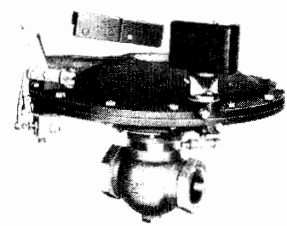


V148

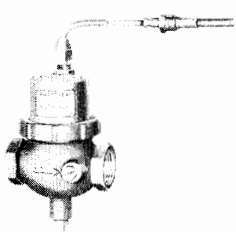


V117

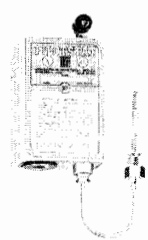
V155



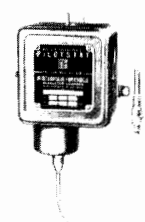
V118



C509



C418



C409

INSTALLATION "DO'S AND DON'TS"

INSTALLATION

Things to DO—

1. Install valve on horizontal pipe with power unit up—and with flow in direction of arrow on valve body.
2. Use new pipe properly reamed and free from chips.
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 ahead of valve is recommended.
6. On sulphur-bearing gas, use valves with special trim to prevent corrosion. (V155 and V898 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 head of valve as lever to swing valve on pipe—use proper-sized 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. valves constructed, tested and marked for this service.*
5. *Never try to turn conduit outlet without loosening union nut between power unit and valve body—serious damage to valve, and gas leakage, might result.*

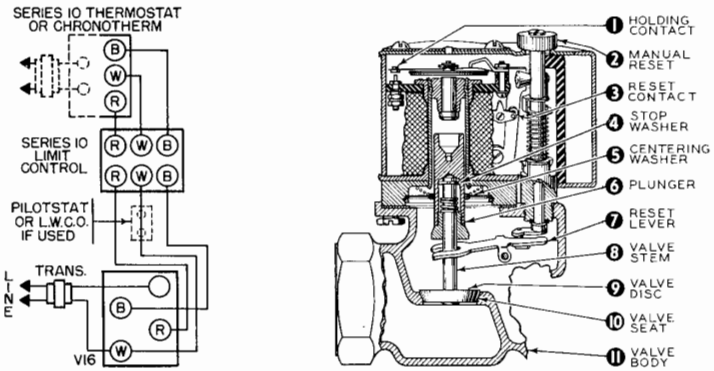
WIRING

Things to DO—

1. Wiring must comply with local electrical ordinances.
2. Use only proper transformer for voltage and frequency of available power (refer to instructions with valve).
3. High limit if used is normally connected in thermostat circuit—on Series 10, switch should break white wire.
4. Always select a constant source of power—one not interrupted by a light switch.
5. Check out the completed installation to see that thermostat and limit control 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 Series 10 valve with manual opener is used, don't connect limit or pilot switch in transformer circuit.*



V16A 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 lit 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 is 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 reset 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 side of valve body and tighten all screws.
   i. Test valve for operation.

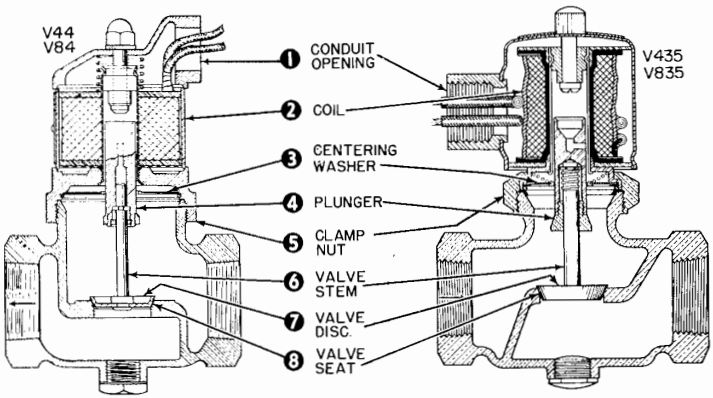
To test manual reset and automatic recycling mechanism:

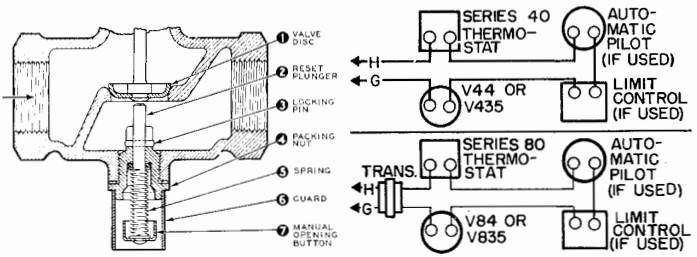
1. Turn off power supply and turn down thermostat.
2. Manually open valve by turning reset button.
3. Turn on power supply and valve should close automatically.

Note: Limit controls and automatic pilots are normally wired in thermostat circuit. Recycling mechanism requires power to operate.

SOLENOID VALVES—TWO-WIRE

V44—V84 V435—V835





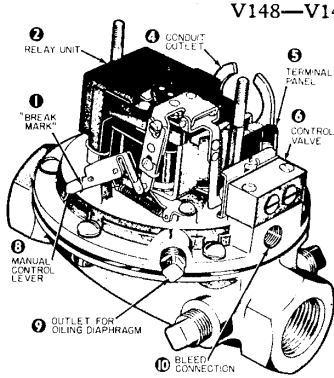
Refer to page 52 for installation and wiring tips.

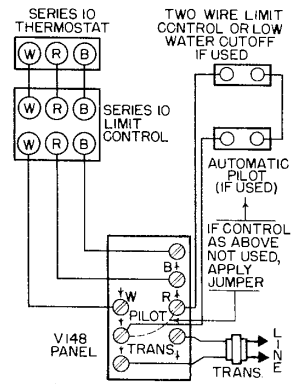
IF VALVE FAILS TO OPERATE PROPERLY—

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 (coil) assembly (V44-84).
   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. Remove foreign matter from plunger and clean tube thoroughly. Be sure to scrub top of plunger tube.
   f. Reassemble valve and check its operation.
7. High-sulphur-content gases require specially trimmed valves.

DIAPHRAGM GAS VALVES

V148—V149—V448





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—

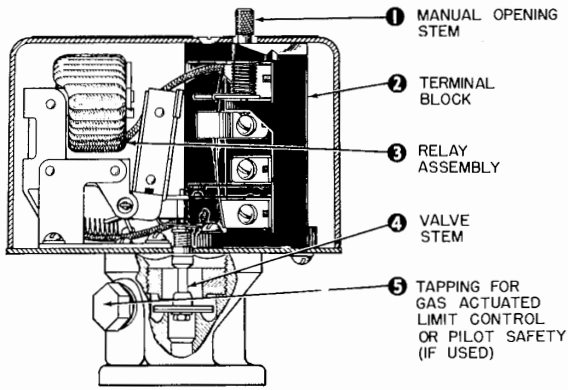
1. *Don't restrict bleed line—sharp bends can retard gas flow and prevent normal opening of the valve.*
2. *Don't oil synthetic diaphragms.*
3. *Don't bend any levers on the relay unit!*

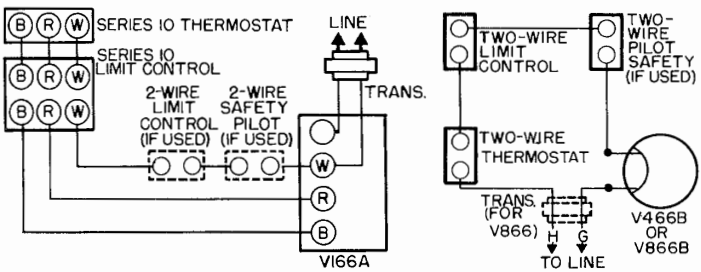
IF VALVE FAILS TO OPERATE PROPERLY—

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. 62.
8. If leather 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.

DIAPHRAGM VALVE CONTROLLERS

V166A—V466B—V866B





These *diaphragm controllers* are pilot valves to operate diaphragm gas valves. *Refer to p. 52* 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 channel openings are free from foreign matter.
3. Make sure gasket is in proper position on diaphragm boss.
4. Be sure to tighten controller mounting screws.
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 contacts 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. 62.
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 holds relay armature in proper position for recycling when power is restored.*

DIAPHRAGM GAS VALVES

V117—V417—V817—V118—V418—V818—V119—V419—V819

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

SERIES 10		SERIES 40		SERIES 80	
Assembly	Sub-Units	Assembly	Sub-Units	Assembly	Sub-Units
V117	V517 V166A	V417	V517 V466B	V817	V517 V866B
V118	V518 V166A	V418	V518 V466B	V818	V518 V866B
V119	V519 V166A	V419	V519 V466B	V819	V519 V866B

V517 Diaphragm Gas Valves

1. Install diaphragm assembly as a unit if possible. If it must be disassembled, see instructions packed with it (Form 95-980A).
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 casting.
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 meter oil.

V518-V519 Diaphragm Gas Valves

1. To remove diaphragm unit from valve body refer to instructions packed with the assembly (Form 95-1198).
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 flare pilot is used and larger or smaller pilot flame is needed refer to instructions (95-1198).

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 casting.
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 meter oil.

V155 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 meter oil.
6. Teach customer manual operation of valve during power failure.

Things NOT to DO—

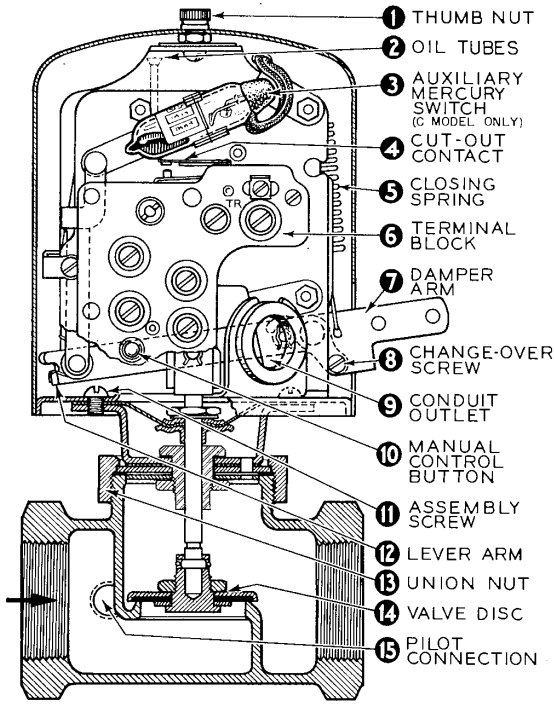
1. *Don't forget to put gasket in proper position.*
2. *Don't leave cover off after installing or servicing valve.*
3. *Don't forget to jumper W and Y terminals if valve-model Pilotstat is used.*
4. *Don't use abrasives on any contacts on valve.*
5. *Don't oil holding contact assembly or cam that operates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

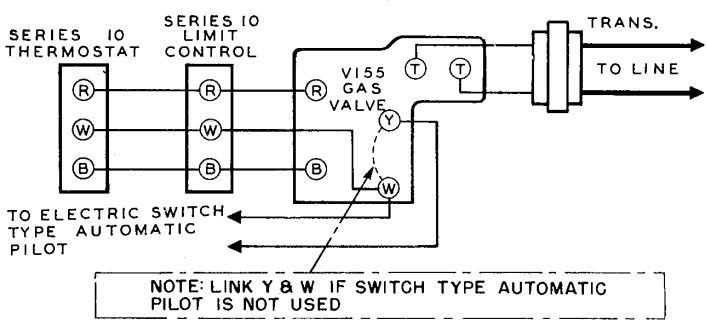
To use "knee-action" mechanism, remove changeover screw (8). Then valve will close fully even if secondary air door sticks partly open. This also prevents manually opening the valve by depressing the damper arm.

TO OPEN valve (with changeover screw removed), take off cover, raise lever arm "12" and push in reset button "10". Valve recycles automatically when power returns.

IF VALVE FAILS TO OPEN OR CLOSE PROPERLY:

1. Is power available, and at proper voltage?
2. Is pilot lit and Pilotstat contacts closed? Check by placing jumper across Pilotstat terminals.
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.





Typical Connections for V155 Gas Valve

REMEMBER—

Don't remove valve power unit without first shutting off gas supply and power.

LIQUEFIED PETROLEUM GASES

(L.P.G., or "Bottled Gases")

REMEMBER: Liquefied Petroleum Gases are considerably heavier than air and any leakage will accumulate at low levels.

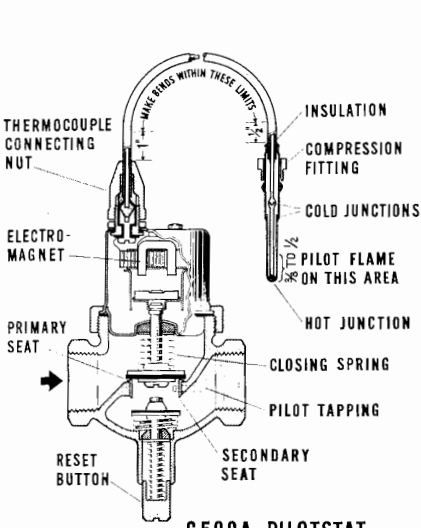
Things to DO—

1. BE SURE to guard against leakage or escape of unburned gas.
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 pilots that will shut off *both* main burner gas and pilot gas if the pilot flame goes out. (See drawings below: valve model pilotstat has pilot 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. (insoluble in petroleum product).
6. Check local ordinances for requirements on L.P.G. installations.
7. With butane-air mixtures up to 1000 Btu/cu ft and propane-air mixtures up to 1500 Btu/cu ft, delivered at less than 7″ w.c., standard valves may be used, but 100% shutoff on pilot failure is still required.

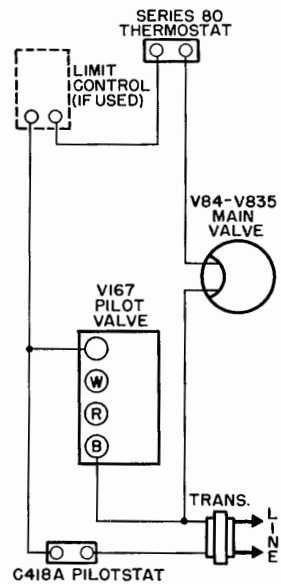
Things NOT to DO—

1. *Don't use valves with seats, seals, gaskets 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.



C509A PILOTSTAT



C409—C418—C509 Pilotstats

INSTALLATION

Things to **DO**—

1. Follow carefully instructions packed with Pilotstat.
2. Check stamping on pilot burner hex for correct sizing of orifice for the gas used. Normal sizes:

   Natural or mixed: .025—.028 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 $\frac{3}{8}$" to $\frac{1}{2}$" of tip should be in flame.
3. Check couple connection: it should be finger tight plus $\frac{1}{4}$ turn.
4. Check thermocouple output with millivoltmeter test kit.

	C409, 509, 809	C418
With normal flame meter should read	13—17	18—23
Pilot should ignite main burner down to reading of	4 mv	6 mv

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. Down drafts or temporary low gas pressure could also be the cause.

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

SERVICE TIPS

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 apply Gaskalac to both sides of old gasket.
2. Be sure that screws are tight.

If Solenoid Gas 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 hex 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 C418A Pilotstat or switch model automatic pilot is used, make sure the circuit is made with main burner off AND on.
2. If valve model such as C509 is used, make sure pilot terminals are jumpered (on V148 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-to-color. If valve did not operate correctly, replace it.

Series 10 (Continued)

Cable—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 the cable is good. If not, replace.
5. Reconnect wires to limit control (color-to-color).

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 R and W, 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

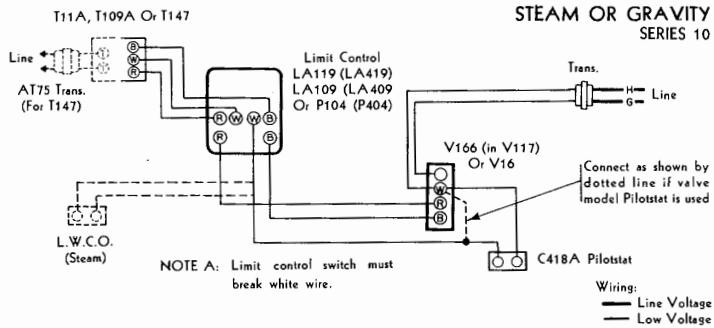
1. With wires connected to thermostat, limit control, and valve, remove the thermostat from its wall plate.
2. Connect a jumper from R to W terminal—nothing should happen. If valve opens, there is a short from blue wire to red or white.
3. Momentarily short B terminal to R-W jumper and burner should 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:

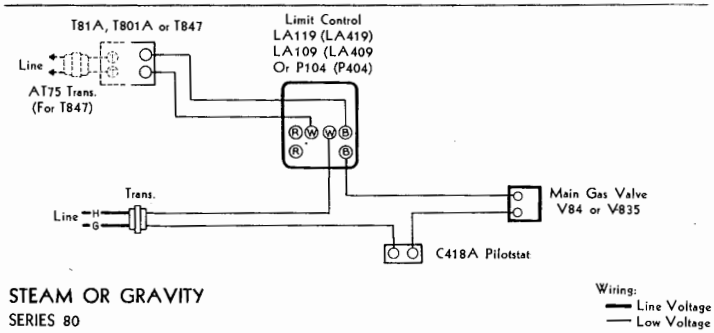
We have now checked the entire circuit up to the thermostat. If the trouble has not been found, it is in order to check the thermostat.

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, recalibrate differential and main scale according to the instructions packed with the Q56A Tattelite.
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



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 Pressuretrol, Aquastat or Airstat (depending on the heating medium) guards against excessive pressure or temperature in the heating plant. The gas valve shown is the V16, or the V166A Diaphragm Controller included in the V117 or V118 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. 39.

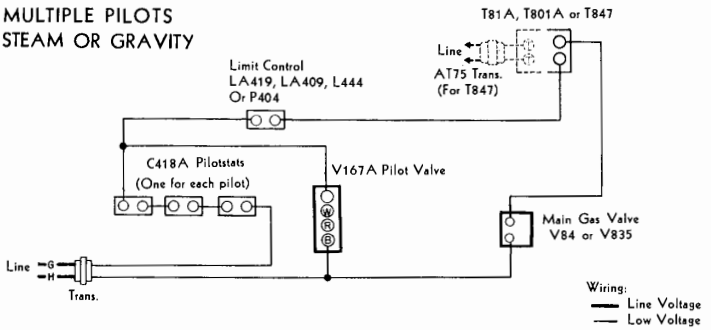


STEAM OR GRAVITY
SERIES 80

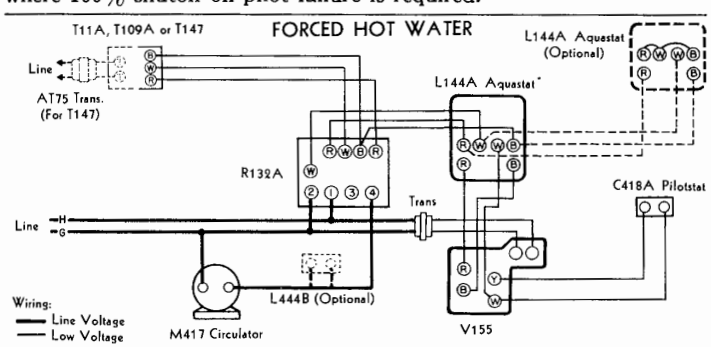
This control system for steam or gravity systems utilizes Series 80 (two-wire) controls, except for the Series 10 limit control. A Series 40 limit control may be used if a two-wire unit is preferred. The operating sequence is the same as that of the Series 10 system above. In either system, one of the 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 appliances.

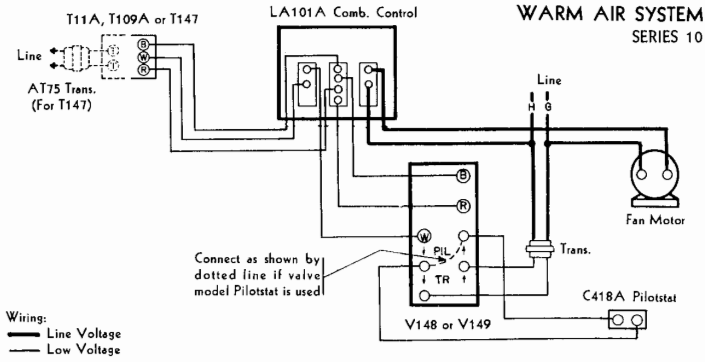
On all gas systems a valve Pilotstat (C509) may be used in place of the C418A switch model.



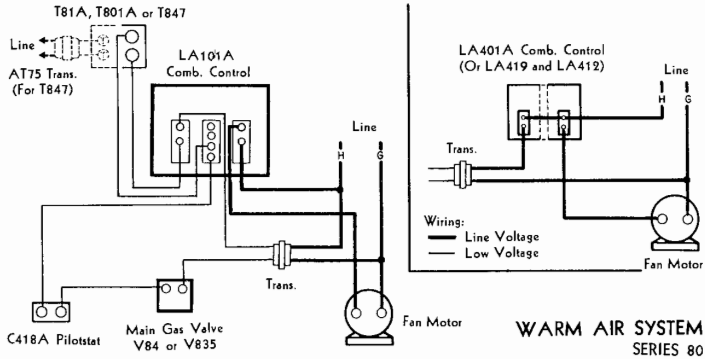
This control system is suitable for an installation using a sectional burner and multiple pilots. Each pilot burner is provided with a Pilotstat, and all the Pilotstats are connected in series so that if any pilot goes out, the main gas valve cannot open and the gas supply to all the pilots is cut off 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% shutoff on pilot failure is required.



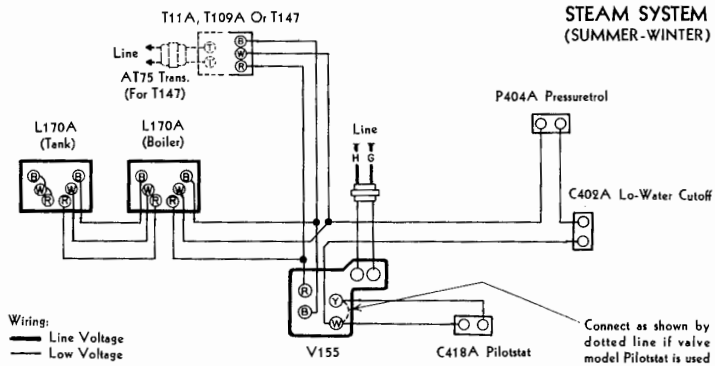
This control system for forced hot water incorporates the V155 motorized gas valve (see p. 68 for optional valves). The room thermostat controls the gas valve and the circulator through the R132A relay. The L144A Aquastat (solid lines) is the high limit control. An additional L144A may be used as shown to maintain minimum boiler water temperature on a Summer-Winter installation, and in this case an L444B Aquastat (reverse acting) may be used to prevent circulator operation until the boiler temperature is high enough for adequate heating and maintenance of domestic hot water service. When the T109 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 room-temperature control of the burner and furnace-temperature control of the fan. The T109 or T147 may be used to provide semi-automatic or fully automatic night setback. A two-wire Combination Furnace Control (use LA401AX5, with internal barrier) may be substituted for the LA101A, or an Airstat (LA419) as limit control and LA412A Furnacestat as fan control. In either case, the limit switch must break the White wire. The V148 (as shown) has separate terminals for connecting the C418 Pilotstat; these terminals must be "shorted" if a valve model safety pilot is used instead of the C418.

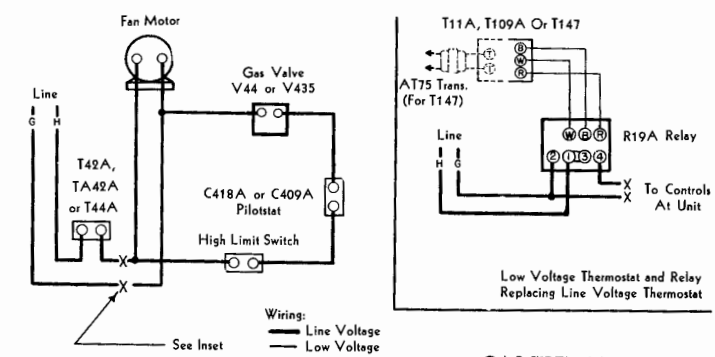


This control system for forced warm air provides the same control sequence as the one above, but utilizes two-wire controls (excepting the limit-and-fan control). Thermostat, limit switch, solenoid valve and switch Pilotstat are normally connected in series in the low voltage circuit as shown. A two-wire Combination Furnace Control (with internal barrier) may be used if preferred; or standard Series 40 controls (LA401A, or LA419 and LA412) may be connected into the line-voltage circuit as shown in the inset.



STEAM SYSTEM
(SUMMER-WINTER)

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 Pressuretrol prevents excessive pressure and the Lo-Water Cutoff guards against dry-boiler operation. The L170A Aquastat in the tank operates the burner to maintain domestic hot water, and the L170 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.

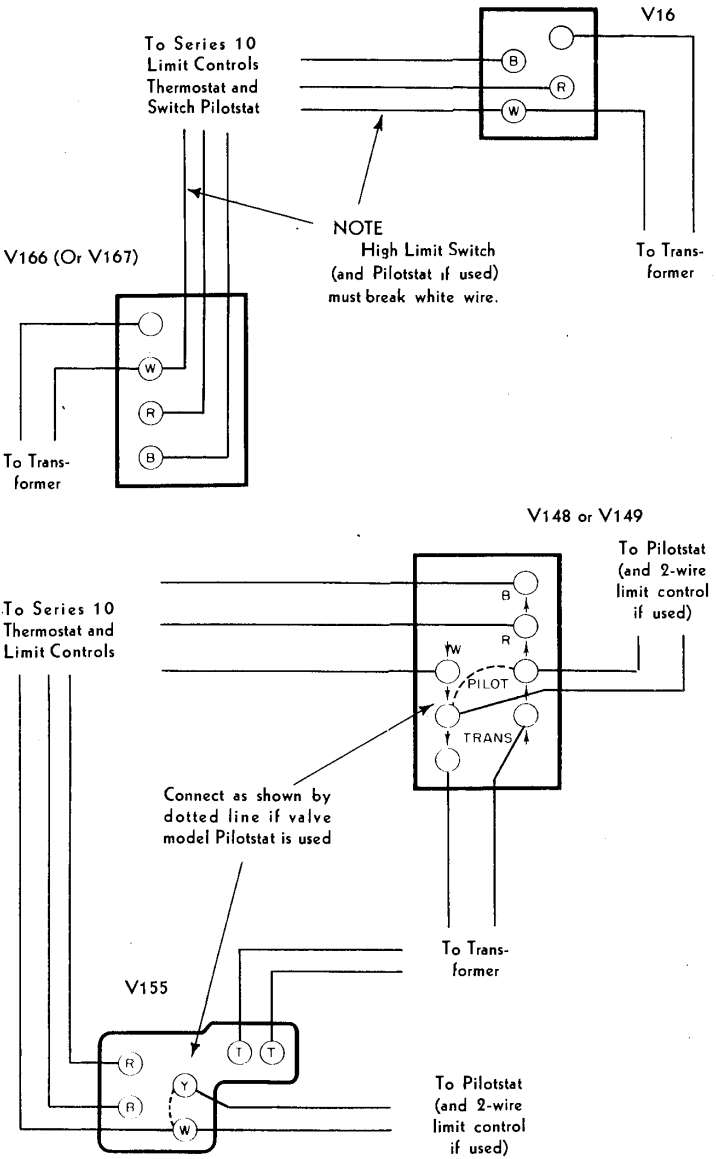


GAS-FIRED UNIT HEATER

The main diagram shows a typical line-voltage control system for a gas-fired unit heater. The T42, TA42 or T44 thermostat starts the fan motor and opens the gas valve when heat is required. The Pilotstat 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 thermostat (with or without night setback operation as preferred) may be used with a switching relay to replace the line voltage thermostat.

SERIES 10 GAS VALVES

Terminal Connections



THERMOSTAT HEATERS

FOR USE WITH SERIES 10 VALVES AND RELAYS

VALVE OR RELAY 60 Cycle*	THERMOSTAT T11A, T17, T19 T81A, T109, T111, T147, T178, T811	T12HA, T105, T802B
L147A	Green	Black & Green
R19A, B, C, D	Green	Black & Green
R132A	Green	Black & Green
R180A, B	White	Brown
R182A, B, C	Green	Black & Green
V15A to G	Blue	Black & Blue
V16A, B	Black & Blue	Black & Yellow
V116	Black & Blue	Black & Yellow
V117-118-119	Control valve determines: V116 ,V166	
V148A, E, G, H, K	Green	Black & Green
V149A, E, G, H	Green	Black & Green
V155A, B, C, D	Green	Black & Green
V166A, B	Green	Black & Green
V167A	Green	Black & Green
B2210	Green	Black & Green
F2210	Yellow	White

FOR USE WITH SERIES 80 VALVES

VALVE 60 Cycle*	THERMOSTAT T81A, T811, T847	T802B
V84A, B, C, D	Yellow & White	Blue & White
V817-818-819	See V866.	
V835	Blue	Black & Blue
V866	Green	Black & Green
V868B, D	Blue	Black & Blue

*For other frequencies or other controls, see Form 95-1346 or write for information.

TRANSFORMER SPECIFICATIONS

TYPE NUMBER OF CONTROL	TRANSFORMER TO BE USED				
	POWER TYPE		LEAKAGE TYPE	FUSED SEC'Y	
	50-60 cy.	25 cy.		50-60 cy.	25 cy.
V16	AT71A*		AT77A†		
V84	AT72A*	AT73A*		AT72B†	AT73B†
V148 V149	AT70A*	AT71A*			
V155	AT71A§ AT80‡		AT77A*		
V166 V167	AT70A*	AT71A*	AT77A†		
V835	AT72A*	AT73A*	AT77A‡	AT72B†	AT73B†
V866	AT70A*	AT71A*	AT77A†		
V868	AT72A*	AT73A*		AT72B†	AT73B†
T147# T847#			AT75A*		
T848A#			AT82A*		

*Standard. †Optional. §Used with special 20 volt valves.

‡Used in certain special systems. #Chronotherm 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 Chronotherm clock to any other transformer than the one furnished with the Chronotherm.*
4. Use Tattelite to check availabliity of power AT TRANSFORMER SECONDARY.