VIII. ALL CONTROLS

A. Radio Interference — Noise in radio.
   a. Contacts not closing with proper snap action.
      1. Weak relay coil on stack switch. Relay chatters as it tries to pull in. Replace control.
      3. Contact blades bent by rough handling. Install new control.
      4. Dirt in relay mechanism between relay armature and magnet core. Clean. DO NOT OIL ANY PARTS.
   b. Overload causing excessive arcing when breaking contacts. Determine cause of overload. If not remedied, this condition will result in either burned out motor or some other “No Heat” call besides burning up the contacts.
   c. Low voltage condition causing relays to chatter. Check with voltmeter.

B. Noise and Vibration.
   a. Not rigidly mounted.
   b. Loose screws, bolts, or covers.
   c. Dirt or other foreign matter between relay armature and magnet core causing chattering action.
   d. Low voltage condition causing hum.

CHAPTER 29.

Electrical Hook-ups

In this chapter is given a multiplicity of wiring diagrams covering practically all systems of automatic controls and their wiring as applied to burner installations of different types of heating systems.

Both constant and intermittent ignition systems are covered.

Among the many diagrams presented in this chapter are numerous Minneapolis Honeywell hook ups, followed by a number of Mercoid diagrams with explanations under each.

| OHM'S LAW |
|---|---|---|
| SYMBOLS | MEANING OF SYMBOLS |
| I= E/R | CURRENT = PRESSURE | RESISTANCE THAT IS AMPERES = VOLTS OHMS |
| R=E/I | RESISTANCE = PRESSURE CURRENT | THAT IS OHMS = VOLTS AMPERES |
| E-IR | PRESSURE = CURRENT \ TIMES \ RESISTANCE | THAT IS VOLTS = AMPERES OHMS |
PLATE 1—Domestic control system for gravity warm air, hot water or steam installations.

These diagrams and the following suggestions cover the common household installations using low pressure steam boilers, furnaces without circulating fans, hot water boilers without circulating pumps or summer-winter domestic hot water heaters. The controls used are the same in each case except for the limit control which must be selected according to the type of heating plant.

FEATURES OF THIS SYSTEM:
1. Burner operation by the thermostat in response to room temperature requirements.
2. Flame failure and ignition failure protection.
3. High limit protection to guard against over-heating and excessive furnace or boiler temperatures.

SPECIFY THESE CONTROLS:
1. A room thermostat (T11 Acratherm shown) See diagram TH-1 for optional thermostats.
2. A Protectorelay (RA116 or RA117)
3. A high limit control (select from the following):
   a. For Warm Air—LA410 Airstat
   b. For Hot Water—LA409 Aquastat

For Steam—P404 Pressurestat
For Vapor—LA408 Vaporstat (Specify 0-16 or 0-4 lbs).

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm, the Protectorelay is actuated to start the burner.
2. The burner continues in operation until the Acratherm is satisfied which then actuates the Protectorelay to stop the burner.
3. In the event that excessively high temperatures are reached in the furnace or boiler, the high limit control acts to stop the burner.
4. No operation of the burner is possible until the furnace or boiler has cooled to the "on" point of the high limit control.

YEAR ROUND HOT WATER:
Any low pressure steam boiler can be used to automatically supply year-round domestic hot water through the use of an indirect water heater. The only additional control needed is an L444A Immersion Aquastat installed below the water line in the boiler and wired as shown by the dotted lines above.

OPTIONAL THERMOSTATS:
For completely automatic operation to give lowered night temperature and returns to daytime temperature use the T110 or T120 Chromatherm. For manual lowered night temperature and automatic return to daytime temperature use the T109 Da-Nite Acratherm. (See Diagram TH-1 for wiring diagram).

PLATE 2—Single zone summer-winter gravity hot water heating system with tank type domestic hot water heater.

These diagrams and following suggestions cover a single zone, gravity hot water heating system with provision for year-round domestic hot water. During the winter, when the thermostat calls for heat, the boiler water temperature will rise to whatever level is necessary to maintain satisfactory room temperatures. When the burner is not operating under command of the thermostat, the low limit control operates the burner to maintain proper domestic hot water temperature. Thus year-round domestic hot water is assured. This system can be used on a multiple zone installation simply by adding as many thermostats and motorized valves as may be needed and wiring them for parallel operation.

FEATURES OF THIS SYSTEM:
1. Burner operation together with operation of the motorized valve in response to room temperature requirements.
2. Safety operation of the burner to guard against ignition and flame failures.
3. High limit protection to guard against room overheating and excessive boiler water temperature.
4. Low limit operation to assure year-round domestic hot water.

SPECIFY THESE CONTROLS:
1. A room thermostat (T11A)
2. A Protectorelay (RA117A)
3. A Motorized Valve (K208A equipped with W52B Auxiliary Switch)
4. A High Limit Control (L444A or LA409A)
5. A Low Limit Control (L444A)

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the K208A Valve is opened, which on opening closes the circuit through the W52B switch to activate the Protectorelay and start the burner.
2. The Motorized Valve remains open and the burner continues in operation until the Acratherm is satisfied, when the Valve is closed and the burner is stopped.
3. Should the boiler water temperature become excessive, the High Limit Control will stop the burner, but the Motorized Valve will remain open until the Acratherm is satisfied.
4. The Low Limit Control will operate the burner between periods of Acratherm operation to maintain a minimum boiler water temperature and thus assure year-round domestic hot water.

ADDITIONAL ZONES:
Additional zones can be controlled through the addition of a T21A Acratherm and a K208A Motorized Valve and W52B Auxiliary Switch, one of each for each additional zone. The controls should be wired so that any one of the Acratherms can operate its associated Motorized Valve and start the burner.

This control system is simple and when installed with a correctly designed boiler and correctly sized indirect heater will maintain a very even house temperature and also supply large quantities of domestic hot water.
PLATE 3—Domestic forced warm air system with bonnet control of fan—using a combination furnace control.

These diagrams and the following suggestions cover a forced warm air installation where fan operation is governed by the temperature of the air in the furnace bonnet. Burner operation is under control of the thermostat. A manual switch built into the Combination Furnace Control provides for continuous fan operation when desired. Another desirable feature of this system is the high limit protection afforded by the Combination Control which eliminates the need for an extra control.

FEATURES OF THIS SYSTEM:
1. Burner operation by the Acratherm in response to room temperature requirements.
2. Furnace temperature control of the circulating fan.
3. Safety operation of the burner to guard against ignition and flame failures.
4. High limit protection to guard against over-heating of the living quarters and to prevent excessive furnace temperature.

SPECIFY THESE CONTROLS:
1. A room thermostat (T11A Acratherm)
2. A Protectorelay (RAII7A)
3. A Combination Furnace Control (LA401A)

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the Protectorelay is actuated to start the burner.
2. As soon as the air in the furnace bonnet reaches the setting of the Combination Control, the circulating fan is started.
3. The burner continues to operate until the Acratherm is satisfied or until the room is up to temperature.
4. The fan continues to run after the burner is shut down only so long as the furnace temperature is above the "fan off" point. Both "fan on" and "fan off" points are separately adjustable.
5. Should the temperature of the air in the furnace bonnet reach the setting of the high limit switch while the Acratherm is calling for heat the burner, but not the fan, will be shut down. The burner cannot start again until the bonnet temperature has dropped sufficiently to permit the limit switch to remake the circuit.

MANUAL OPERATION OF FAN:
When desirable, or in the summer months, continuous operation of the fan for purposes of ventilation can be had by turning the Fan Switch knob on the face of the LA401 Combination Control to the "manually" position.

OPTIONAL THERMOSTATS:
For completely automatic lowered night temperature with return to daytime setting, specify the TIIA Chronotherm. For manually lowered night temperature with automatic return to daytime setting specify the TIIA Da-Nite Acratherm (See THI).

PLATE 4—Domestic forced warm air system with thermostat control of fan—using a combination furnace control.

These diagrams and the following suggestions cover a forced warm air installation where both burner and fan operation are controlled by the thermostat. A manual switch built into the Combination Furnace Control provides for continuous fan operation when desired. Another desirable feature of this system is the high limit protection afforded by the Combination Control which eliminates the need for an extra control.

FEATURES OF THIS SYSTEM:
1. Burner operation by the Acratherm in response to room temperature requirements.
2. Thermostat control of the circulating fan.
3. Switching relay (RI32A)
4. A Combination Furnace Control (LA401A)

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the Protectorelay is actuated through the RI32A switching relay to start the burner.
2. At the same time the power circuit to the fan is established so that the fan can start as soon as the air in the furnace bonnet reaches the "fan on" point. Both "fan on" and "fan off" points are separately adjustable.
3. Burner and fan continue to operate until the Acratherm is satisfied or until the room is up to temperature.
4. Should the temperature of the air in the furnace bonnet reach the setting of the high limit switch while the Acratherm is calling for heat the burner, but not the fan, will be shut down. Under this condition the fan will run until the bonnet temperature has dropped to the "fan off" point on the Furnace Control.
5. The burner cannot start again until the bonnet temperature has dropped sufficiently to permit the limit switch to remake the circuit.

MANUAL OPERATION OF FAN:
When desirable, or in the summer months, continuous operation of the fan for purposes of ventilation can be had by turning the Fan Switch knob on the face of the LA401 Combination Control to the "manually" position.

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PLATE 3—Domestic forced warm air system with year round thermostat control of fan — using summer-winter relay and combination furnace control.

FEATURES OF THIS SYSTEM:
1. Burner operation by the Acratherm in response to room temperature requirements.
2. Summer and Winter operation of the circulating fan under control of the Acratherm.
3. Safety of the burner to guard against ignition and flame failures.
4. Limit protection to guard against overheating of the living quarters and to prevent excessive furnace temperature.

SPECIFY THESE CONTROLS:
1. A room thermostat (T11A Acratherm).
2. A Protectorelay (RA117A).
3. A Program Relay (RIS5A).
4. A Combination Furnace Control (LA401A).

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the Protectorelay and Program Relay are actuated to start the burner and circulating fan.
2. The fan starts when the air in the bonnet of the furnace is up to the "fan on" point of the Combination Control.
3. The burner and fan operate until the thermostat is satisfied or until the room is up to temperature.
4. Should the temperature in the furnace bonnet reach the limit switch setting while the Acratherm is calling for heat the burner, but not the fan, will be shut down. Under this condition the fan will operate until the bonnet temperature has dropped to the "fan off" point. Both "fan on" and "fan off" points are separately adjustable. The burner cannot start until the bonnet temperature has dropped sufficiently to allow the limit switch to remake the switch.
5. In the summer, or in mild weather, the Program Relay can be switched over to circulate air for ventilation under control of the Acratherm.

FAN OPERATION:
A feature of this system is the dual method of obtaining fan operation for air circulation in the summer. Use of the switch on the RISSA Relay will give fan operation under command of the Acratherm. Use of the manual switch on the LA401A Control will give continuous fan operation regardless of the Acratherm.

PLATE 6—Steam heating system with summer-winter domestic hot water, using tank type heater.

FEATURES OF THIS SYSTEM:
1. Burner operation by the thermostat in response to room temperature requirements.
2. Safety of the burner to guard against ignition and flame failures.
3. Low limit operation to maintain minimum domestic hot water temperature coupled with high limit operation to prevent steaming.
4. Limit protection to guard against excessive boiler pressure and prevent overheating of living quarters.
5. Low water protection to safeguard the boiler.

SPECIFY THESE CONTROLS:
1. A room thermostat (T11A Acratherm).
2. A Protectorelay (RA117A).
3. A low limit Aquastat (L170A).
4. A high limit Aquastat (L170A).
5. A Pressuretrol (P404A).

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the Protectorelay is actuated to start the burner.
2. The burner continues in operation until the room is up to temperature or until the thermostat is satisfied.
3. Should the pressure in the boiler reach the setting of the Pressuretrol while the thermostat is calling for heat the burner will be shut down. The burner cannot be started until the pressure has dropped sufficiently to allow the Pressuretrol to remake the circuit.
4. Should the water level in the boiler drop below the operating level established by the Lo-Water Cutoff, the burner will be shut down and prevented from starting until the proper water level is restored.
5. Between periods of thermostat operation, the low limit Aquastat in the tank will start the burner to maintain domestic hot water of proper temperature.
6. When heat for radiation is not required the high limit Aquastat in the boiler will operate to prevent boiler water steaming when the burner is under command of the low limit Aquastat.
FEATURES OF THIS SYSTEM:
1. Burner operation by the thermostat in response to room temperature requirements.
2. Safety operation of the burner to guard against ignition and flame failure.
3. Low limit operation to maintain minimum domestic hot water temperature.
4. High limit protection to guard against excessive boiler pressure and to prevent overheating of living quarters.
5. Low water protection to safeguard the boiler.

SPECIFY THESE CONTROLS:
1. A room thermostat (111A Acratlierm)
2. A Protectorelay (RA117A)
3. A low limit Aquastat (L170A)
4. A Pressuretrol (P404A)
5. A Lo-Water Cutoff (C402A)

HOW THIS SYSTEM OPERATES:
1. On a call for heat by the Acratherm the Protectorelay is actuated to start the burner.
2. The burner continues in operation until the room is up to temperature, or until the thermostat is satisfied.
3. Should the pressure in the boiler reach the setting of the Pressuretrol while the thermostat is still calling for heat the burner will be shut down. The burner cannot be started until the pressure has dropped sufficiently to allow the Pressuretrol to remake the circuit.
4. Should the water level in the boiler drop below the operating level established by the Lo-Water Cutoff, the burner will be shut down and prevented from starting until the proper water level is restored.
5. Between periods of thermostat operation, the low limit Aquastat in the tankless heater will start the burner to maintain domestic hot water of proper temperature.

These diagrams and the following suggestions cover a single zone steam system with provision for Summer-Winter domestic hot water. The low limit Aquastat may be mounted in the boiler itself below the water line, whenever necessary between periods of thermostat operation, the low limit Aquastat in the tankless heater will start the burner to maintain domestic hot water of proper temperature.
PLATE 1. A room thermostat (T1A Acratherm) 4. Should the temperature of the boiler water lines as an optional control to be added when the thermostat is calling for heat, the heater. It will prevent circulator operation unless enough installation, year ‘round domestic hot water can be assured.

3. High limit protection to guard against excessive boiler water temperature and to prevent overheating of the living quarters.

4. Circulator control to prevent overheating of the living quarters.

FEATUES OF THIS SYSTEM:

1. Burner and circulator operation by the thermostat in response to room temperature requirements.

2. Maintenance of a minimum boiler water temperature.

3. High limit protection to guard against excessive boiler water temperature and to prevent overheating of the living quarters.

4. Circulator control to prevent circulator operation unless boiler water temperature is high enough to insure domestic hot water of proper temperature.

SPECIFY THESE CONTROLS:

1. A room thermostat (T1A Acratherm)

2. A Protectorelay (RA117A)

3. A switching relay (R132A)

4. A high limit control (LA409A or L444A)

5. A combination low limit and circulator control (L628A)

6. A water circulator (M403B)

7. A flow valve (V960A or V963A)

HOW THIS SYSTEM OPERATES:

1. On a call for heat by the Acratherm, the switching relay is actuated to start the circulator.

2. At the same time a parallel circuit to the Protectorelay is established which starts the oil burner.

3. The circulator and burner continue in operation until the room is up to temperature, or until the thermostat is satisfied.

4. Should the temperature of the boiler water reach the setting of the high limit control while the thermostat is calling for heat, the burner, but not the circulator, will be shut down. The burner cannot be started until the boiler water has cooled to the “on” point of the limit control. The circulator will remain in operation as long as the thermostat calls for heat.

5. The L628A Aquastat will start the burner whenever necessary between periods of thermostat operation to maintain a minimum boiler water temperature.

L444 B AQUASTAT OPTIONAL:

The L444B Aquastat is shown by the dotted lines how the L444B should be wired into the circuit.

PLATE 10—Forced circulation summer-winter hot water system with tankless type domestic water heater.

These diagrams and the following suggestions cover a domestic installation using a circulator to circulate hot water, at the same time providing for plenty hot water the year round when a tankless heater of sufficient capacity is used. The use of the L628 Combination Aquastat insures the maintenance of a minimum boiler water temperature at all times and prevents operation of the circulator unless the boiler water is hot enough to provide radiation without interfering with the domestic hot water supply.

Thus, with reasonable attention to the scale setting of the L628A, both adequate radiation and domestic hot water can be assured.

1. A room thermostat (T1A Acratherm)

2. A Protectorelay (RA117A)

3. A switching relay (R132A)

4. A high limit control (LA409A or L444A)

5. A combination low limit and circulator control (L628A)

6. A water circulator (M403B)

7. A flow valve (V960A or V963A)

HOW THIS SYSTEM OPERATES:

1. On a call for heat by the Acratherm, the switching relay is actuated to start the circulator.

2. At the same time a parallel circuit is established to the Protectorelay which starts the oil burner.

3. The circulator and burner continue in operation until the room is up to temperature, or until the thermostat is satisfied.

4. Should the temperature of the boiler water reach the setting of the high limit control while the thermostat is calling for heat, the burner, but the circulator, will be shut down. The burner cannot be started until the boiler water has cooled to the “on” point of the limit control. The circulator will remain in operation as long as the thermostat calls for heat.

5. The L628A Aquastat will start the burner whenever necessary between periods of thermostat operation to maintain a minimum boiler water temperature.

6. The circulator control switch in the L628A Aquastat will prevent circulator operation unless the boiler water temperature is up to the “on” point of the control. Thus, even without a tank year ‘round domestic hot water can be assured.
Plate 11—Optional thermostats for series 10 circuits to give lowered night temperature and humidity control.

The hookup shown above are:
1. T105A Du-Nite Acratherm used with any Series 10 primary control.
2. T105A Chronotherm used with any series 10 primary control.
3. T11A Chronotherm used with any Series 10 primary control.
4. T117A Combination Humidity and Temperature Control used with any Series 10 primary control.

Except the 854 relay—use T105A Thermostat with this relay.

Be sure that the Accelerator or heater plug in the thermostat is correct for the primary control being used. The T105A Chronotherm and T11A Twin Acratherm use the same heater plug as the T105A Acratherm. The heater plugs for the T105A Chronotherm and the T117A Temperature-Humidity control are different. When ordering be sure to specify the type of control equipment to be used with the thermostat.
Plate 13—Control hook-up for oil burner fired steam heating system with fully automatic day-night thermostatic control. This control hook-up quite generally employed in the field, covers an oil burner fired system where steam is generated for heating purposes only, and where the room temperature is automatically lowered at night in order to conserve fuel.

Plate 14—Control hook-up for oil burner fired low pressure steam heating system with low water protection. It is highly recommended that all oil burner fired steam boilers be equipped with low water controls to prevent burning up the boiler in the event the water line becomes low. This simplified control hook-up, in general use in the field, provides fully automatic regulation as well as low water protection to low pressure systems where steam is generated for heating purposes only.
PLATE 15—Control hook-up for oil burner-fired steam heating system, providing year-round domestic hot water through indirect heater. This hook-up covers a system in general use where the steam heating boiler is equipped with an indirect Taco heater (Taco heater not shown) for supplying year-round domestic hot water. During the normal heating season steam must be furnished to the radiators, and in addition domestic hot water must be generated. During mild or summer weather, when no heat is required in the building, domestic hot water alone must be generated without raising steam.

PLATE 16—Control hook-up for oil burner-fired hot water heating system—gravity circulation. This simplified control hook-up, in general use in the field, covers an oil burner-fired hot water heating system wherein the water circulates by gravity (no circulating pump employed).
PLATE 17—Control hook-up for oil burner fired gravity circulation hot water heating system — with fully automatic day-night thermostatic control. This control hook-up, quite frequently employed in the field, covers an oil burner fired hot water heating system, wherein the water circulates by gravity (no circulating pump employed) and where the room temperature is automatically lowered at night in order to conserve fuel.

PLATE 18—Control hook-up for oil burner fired, gravity circulation hot water heating system — two-stage thermostat minimizes cold air stratification. This hook-up is highly recommended in connection with gravity circulation hot water heating systems as cold air stratification is reduced to a minimum resulting in greater heating comfort.
PLATE 19—Control hook-up for oil burner fired hot water heating system with forced circulation pump controlled by line voltage thermostat—provides year around domestic hot water through indirect or tankless heater. This hook-up is quite generally employed in the field in connection with oil burner fired, forced circulation hot water heating systems which are equipped with indirect or tankless heaters (heaters not shown) for supplying year around domestic hot water.

PLATE 20—Control hook-up for oil burner fired hot water heating system with forced circulation pump controlled by low voltage thermostat—provides year around domestic hot water through indirect or tankless heater.
PLATE 21—Control hook-up for oil burner fired, forced circulation hot water heating system — providing year around domestic hot water through indirect or tankless heaters. Very satisfactory results are obtained when this hook-up is employed in connection with oil burner fired, forced circulation hot water systems which are equipped with indirect or tankless heaters (heaters not shown) for year around domestic hot water.

PLATE 22—Control hook-up for oil burner fired hot water heating system with forced circulation pump controlled by low voltage thermostat and reverse action temperature control — provides year around domestic hot water through indirect or tankless heater. Oil burner fired hot water heating systems with forced circulation are quite generally controlled as shown in this hook-up and very satisfactory results as well as economical operation, are obtained.
PLATE 23—Control hook-up for oil burner fired, forced circulation hot water system, with two stage thermostatic control, also providing year around domestic hot water through indirect or tankless heaters. Distinct advantages are realized when this hook-up is employed in connection with oil burner fired, forced circulation hot water systems which are equipped with indirect or tankless heaters (heaters not shown) for year around domestic hot water.

PLATE 24—Control hook-up for oil burner fired warm air heating system—gravity circulation. This simplified control hook-up, in general use in the field, covers an oil burner fired warm air system wherein the air circulates by gravity (no blower employed).
PLATE 25—Control hook-up for oil burner fired gravity circulation warm air heating system, with fully automatic day-night thermostatic control. This control hook-up, quite frequently employed in the field, covers an oil burner fired warm air system wherein the air circulates by gravity (no blower employed) and where the room temperature is automatically lowered at night in order to conserve fuel.

PLATE 26—Control hook-up for oil burner-fired warm air heating system equipped with forced circulation fan. Warm air heating systems equipped with oil burners and forced air circulating fans are most generally controlled as shown in this simplified hook-up.
CHAPTER 30

Trouble Shooting

As previously stated, there is a great multiplicity of types of so called oil burners. The author after making a study of the bulletins of practically all the manufacturers of high pressure domestic oil burners arrives at the conclusion that there are basic features common to all, differing in minor details. It may be said that they are now pretty well standardized.

To illustrate trouble shooting the Delco burner is taken as an example, but the instructions may be applied in general to practically all high pressure oil burners.

Procedure.—When an oil burner fails to operate, a systematic search is necessary in order to find the trouble with a minimum expenditure of time and effort.

The following steps are arranged to provide a logical order of testing the burner and controls in order to locate the trouble quickly. It has been found through a study of the reasons for service calls that approximately 60% of the troubles may be identified and easily cured by following the instructions here given for Trouble Shooting.