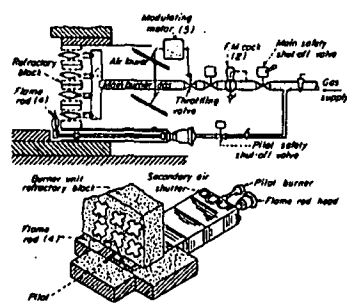




By selecting recommended automatic-lighting devices and sequences you feel sure you're getting

MAIN GAS SAFETY SHUTOFF VALVE

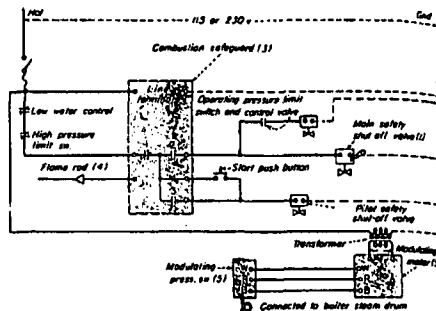
Avoid using an automatic-opening, automatic-closing safety shutoff valve with the replaceable flame rod and pilot unit shown above. Reason is that lighter-torch flame-contacting rod within the housing would automatically admit unburned gas.

SAMPLING COCK

Approved sampling cock (No. 2, above) for leakage test of main safety shutoff valve located downstream of safety shutoff. Connected with 1/4-in. OD copper tubing.

COMBUSTION SAFEGUARD

Contact 1 is safe-start relay contact, and must be closed if safety shutoff valves are to open. After start pushbutton is pushed and a torch is inserted to light the pilot, pilot flame contacts the flame rod causing flame relay contacts 2 and 3 to close, and completing circuit to pilot safety shutoff valve and main safety shutoff valve. After start pushbutton is released and as long as pilot flame contacts flame rod, pilot safety shutoff valve remains open. Main safety shutoff valve must be opened manually. Flame relay contacts 2 and 3 open on flame failure. See No. 3, drawing, right.



FLAME ROD

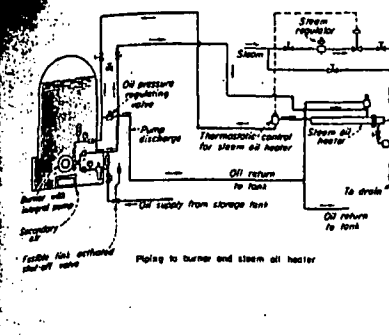
Located so pilot flame contacts it only where pilot will reliably ignite the main burner. No. 4, in the drawing, left, above.

MODULATING MOTOR

This motor, No. 5, above, controlled by a modulating pressure switch, adjusts the firing rate in response to steam demand by means of linkage operating gas throttling valve and burner shutters. In closing, the throttling valve travel is stopped at the least opening that produces a stable flame at the main burner unit. If steam demand is still too small at this firing rate to halt the rise in boiler steam pressure, the operating-pressure-limit switch opens, closing the operating-pressure-limit control valve, which turns off the main burner unit. First drop in boiler steam pressure automatically opens the operating-pressure-limit control valve, and a further drop causes the throttling valve to begin opening. Drawing, right, above, shows wiring.

OIL SAFETY SHUTOFF VALVE

Automatic-opening, automatic-closing approved for use with heavy oil. See drawings facing page. Remember, heavier oil



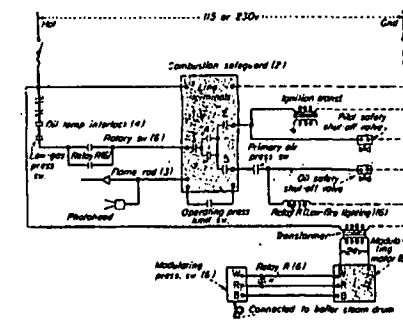
adequate protection, reliable operation for today's highly popular unattended packaged boilers

need definite flame stabilization before you're sure they're safe. Combustion safeguard, No. 2, above. Contacts 1 and 2 close through action of motor-driven cams or thermal warp switches upon a call for heat by the operating-pressure-limit switch, start the burner motor (not shown), and ignite the gas pilot. Contact 3, the safe-start relay contact, must close if you are to get ignition and open safety shutoff valves. When gas-pilot flame contacts the flame rod, the flame-relay contacts 4 and 5 close, completing the circuit to the oil safety shutoff valve provided there is proper primary air pressure. After the trial-for-ignition period, contacts 1 and 2 open to shut off the gas pilot and require the photohead to sight the oil flame or shut off the oil and burner motor by opening contacts 4 and 5. Flame-relay contacts 4 and 5 open on flame failure. See wiring diagram, right, above.

Flame rod, No. 3, is located so pilot flame contacts it only where pilot reliably ignites oil.

Oil-temperature interlock No. 4 is set so burner cannot operate unless oil is at temperature recommended by burner manufacturer.

Electric oil heater No. 5 should be located in the piping so



close to oil-burner spinner cup as possible. Thus heated oil is available at the spinner cup promptly after safety shutoff valve opens, thereby avoiding possible ignition troubles.

Modulating motor No. 6 adjusts firing rate to steam demand by linkages operating the oil throttling valve and primary and secondary air dampers. In closing the throttling valve, travel is stopped at the least opening that produces a stable oil flame. If steam demand is still too small at this firing rate to halt the rise in boiler steam pressure, the operating-pressure-limit switch opens its contacts. This causes the oil safety shutoff valve to close and the burner motor to stop. The first drop in boiler steam pressure closes the operating-pressure-limit switch and starts the lighting-off cycle.

Modulating motor also gives low-fire lighting. Such a motor either has a spring return to the low-fire position upon power interruption or requires electrical power to move from high- to low-fire position. Where a motor is of the power-return type a rotary switch mounted on the motor shaft and wired in the safety circuit should be provided to insure that motor is in low-fire position before ignition of pilot or main burner can be attempted.

Tried and Tested Automatic Combustion

► DESPITE state and local government's insistence on safeguards for automatic-fired boilers, these units accounted for 13% of the 1936-1948 losses from boiler-furnace explosions with all fuels. As a class these boilers run smaller than manual-lighted boilers (averaging below 10,000 lb per hr for units surveyed) and are not constantly attended. They usually have, though, automatic combustion control of a sort that varies the firing rate in response to steam demand. They can be further generalized as having one burner, combustion air or forced-draft fans, and occasionally induced-draft fans.

But protection of these units has become unduly complicated. It has suffered from an accelerated development of many different pilots, automatic lighting sequences and nonapproved methods of application to boilers. What should be a straightforward job becomes confused and proves the most dangerous element in operating these boilers. Because of this confusion and a trend toward larger automatic-lighted boilers, the Factory Mutual Engineering Div. has put together recommended methods

¹Preventing Fuel Explosions in Gas- and Oil-Fired Boilers, Factory Mutual Engng Div., 184 High St., Boston 13, Mass.

(see summary above) for protecting these units against important fuel-explosion hazards.

There are actually only two danger periods where boiler explosions may occur: (1) during lighting-off (2) while burners are firing.

First period occurs with ignition of dangerous accumulations of unburned fuel or flammable products of incomplete combustion left in the furnace chamber from previous operation. It has been responsible for about 60% of the total explosions.

Second danger period—while burners are firing—touches off explosions by

Controls Reduce Packaged Boiler Ills

setting afire unburned fuel accumulated after a flame failure or igniting of flammable products left behind from incomplete combustion.

Lighting-Off Period. An approved combustion safeguard assures safe lighting-off. It does it this way. The safeguard detects flame failure and, teamed with program relays, limits amount of unburned fuel discharged to the furnace. This action sequence is known as the trial-for-ignition period. Stack switches and other unapproved safeguards prove too slow. They permit too long a trial-for-ignition time and hence too heavy a build-up of explosive materials. They

may be likened to a careless fireman who turns on the main fuel, then waits a minute or two before bothering to check if the main flame has lighted.

In fact, approved combustion safeguards are even more alert than the most diligent fireman. They can sense the main flame promptly and, what's more, prove² that a pilot flame is present before ever permitting the main fuel valve to open. With such absolute assurance that an ignition source is present you can design for a longer trial-for-ignition period. This ability extends the automatic lighting feature to ²See "Definitions" on page 94.

heavy oil burners that require definite flame stabilization before you're sure they'll stay lit.

Firing Period. Once the burner is firing, your explosion danger drops off. Only a third of the total explosions reported occurred during the period. And then two out of three happened because of dangerous accumulations of unburned fuel following a previous flame failure. Flammable products of incomplete combustion accounted for the remainder.

Here again, approved combustion safeguards minimize the risks. Where unburned fuel, for example, accumu-