lates, safeguards can quickly shut the fuel supply safety valve after a flame failure. In build-up of flammable products, you should solve the immediate problem with adequate combustion-air supply to the boiler room for purging and proper adjustment of burner air-fuel ratio.

Proper Safeguards. At beginning of this article a set of numbered recommendations pinpoint essential safeguards for both gas and oil firing. Certain basic requirements must be met. For gas they are: (1) Provide a combustion safeguard and safety shutoff valves in both main- and pilot-burner gas lines. (Each should be approved and the combustion safeguard further approved for type of pilot used. Be certain the safeguard causes the safety shutoff valves to close in a failure.)

(2) Prove the existence of a pilot flame at a point where it will reliably ignite the main burner, before permitting the main safety shutoff valve to open. (This is a function of

(*Continued on page 200*)

Definitions and Specifications

1. Automatic-lighted boilers. Unit where pressure- or temperature-controlled devices turn on fuel to main burner automatically. Control arrangement automatically provides (a) electric ignition source or electric-ignited pilot flame, or (b) continuous-burning manually-lighted pilot for main burner.

2. Automatic combustion controls. Devices to vary firing rate with load changes and maintain a constant fuel-air ratio.

3. Combustion safeguard. Control that senses flame presence and causes a fuel-safety shutoff valve to close in flame failure. Any currently approved combustion safeguard shuts off fuel to: (a) main burner by calling for closure of a safety shutoff valve 2-4 sec after receiving a flame-failure signal (b) pilot burner by calling for closure of pilot-safety shutoff valve within 2-4 sec after flame-failure signal, unless control provides a reliable ignition source for relighting pilot. An approved safety shutoff valve closes in not more than 5 sec after call for closure.

4. Supervised flame. A flame whose presence or absence is detected by a combustion safeguard. **Proved pilot.** A pilot flame supervised by a combustion safeguard that senses presence of pilot flame before opening the main burner's fuel-safety shutoff.

5. Flame-sensing element. A flame rod, photoelectric cell or photoconductive cell of a combustion safeguard. A flame rod, generally not suitable for oil, is an electrode extending into the gas flame that, *because of the conductive property of ionized gases* in the flame, draws a current through it to the safeguard.

Photoelectric cell emits electrons. Emission rate increases on exposure to luminous flames and permits current flow to the combustion safeguard control circuit. Mounted outside the boiler-furnace, cell sights when flame is supervised.

Photoconductive cell's internal resistance lowers on exposure to both luminous and nonluminous flames, thus permitting current flow to the combustion safeguard control circuit, suitable for both gas and oil. Mounted outside the boiler-furnace.

6. Programing combustion safeguard. On lighting off, it turns on ignition system, determines its running time, and when pilot and main fuel valves open. On failing to sense the flame, it shuts off all fuel and locks out.

An approved recycling programing combustion safeguard automatically proves the pilot and repeats the lighting cycle once, following an accidental flame failure. An approved interrupted pilot repeats the lighting cycle only after the trial-for-ignition period is completed and before end of the call for heat. With the non-recycling type, both pilot and main-burner-safety shutoff valves close and lock out, and there is no ignition attempt after flame failure.

Approved programing combustion safeguards work this way:

a. *Gas main burner.* Pilot flame is proved by the combustion safeguard before letting the main gas valve open, and an interrupted pilot is used to limit trial-for-ignition to 15 sec.

b. *Oil main burner.* Pilot flame is proved by the combustion safeguard before letting the oil valve open, trial-for-ignition is limited to 60 sec. With an unproved pilot, 15 sec, with no recycle.

7. Trial-for-ignition period. Period of time the programing combustion safeguard permits the main-burner fuel valve to be open before the main flame-sensing device is required to detect the main flame. If this flame is not detected, all fuel is shut off and locked out at once, and there is no further ignition attempt.

8. Pilot-flame-establishing period. Length of time the combustion safeguard permits the pilot fuel valve to be open before the flame-sensing device is required to detect pilot or main flame.

9a. Continuous pilot. Only the fireman can light it. Burns without turndown entire time the boiler is in service, whether main burner is firing or not. Upon pilot-flame failure without the presence of a supervised main flame, the combustion safeguard should call for shutoff of both pilot and main burner fuel.

9b. Interrupted pilot. Device electric-ignited automatically each time there is a call for heat. Programing combustion safeguard usually cuts off pilot fuel automatically at end of main burner's trial-for-ignition period, so main flame supervision must begin. But with a photoelectric, supervised, main oil flame with ground interrupted gas pilot, the pilot flame need not cut off automatically until some predetermined time after trial-for-ignition period. This is true provided the programing combustion safeguard interrupts the pilot flame detection (flame rod) circuit at end of trial-for-ignition period so main flame supervision must begin. In either case, should the pilot fail to ignite upon a call for heat, the programing combustion safeguard closes and locks out the pilot safety shutoff valve after it has remained open not longer than a pilot-flame-establishing period of 60 sec.

9c. Intermittent pilot. It is electric-ignited automatically each time there is a call for heat. It burns during the entire time the main burner fires, and shuts off with the main burner at end of *call for heat. Should the pilot fail to ignite upon a call for heat,* the programing combustion safeguard closes and locks out the pilot safety shutoff valve after permitting a pilot-flame-establishing period of not more than 60 sec.

Acceptable intermittent pilot works as follows:

Main Burner—Gas. Proved intermittent gas pilot: With a gas-fired main burner or burner unit and flame rod or photoconductive supervision, the flame rod or photoconductive cell cannot distinguish main from pilot flame. So there can be no trial-for-ignition period nor supervision of the main flame exclusively. For these reasons the interrupted pilot is preferred.

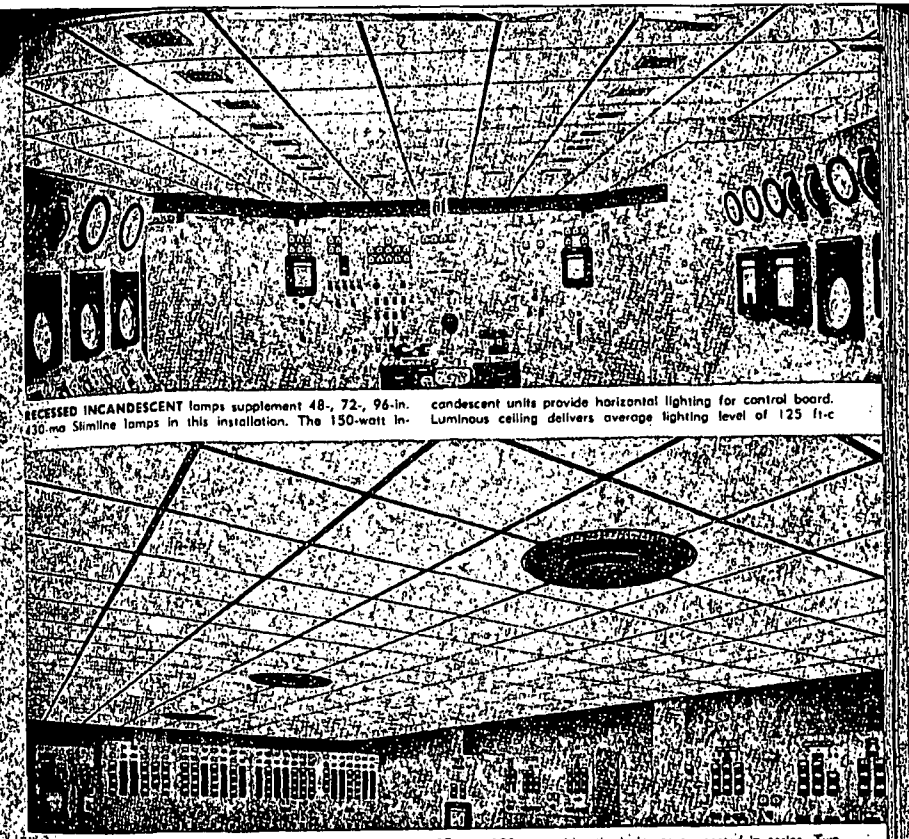
Main Burner—Oil. Proved intermittent gas pilot: With a photoelectric supervised oil flame, locate the flame rod as nearly as possible to a point where pilot flame insures oil ignition from the pilot before the programing combustion safeguard permits turning on the oil. The only programing combustion safeguard approved for this arrangement interrupts the pilot-flame-detection (flame rod) circuit at end of trial-for-ignition period.

Unproved intermittent gas pilot: The trial-for-ignition period of the photoelectric or photoconductive supervised oil flame is limited to 15 sec. If the main flame is extinguished at end of trial-for-ignition period, the programing combustion safeguard closes and locks out the pilot and main-burner-safety shutoff valves.

An expanding pilot, lighted by the fireman, normally burns at a low turndown throughout the time boiler is in service, whether the main burner is firing or not. Upon a call for heat the pilot automatically expands to reliably ignite the main burner, and turns down at end of this burner's trial-for-ignition period so main flame supervision must begin. In the expanded condition, pilot operates and is safeguarded the same as an interrupted pilot.

10. Safe-start component check. A checking circuit, usually built into the combustion safeguard. It prevents lighting off if the flame relay contacts are in an unsafe position.

11. Power burner. Either gas or air, or both, are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure; this added pressure is applied at the burner.



RECESSED INCANDESCENT lamps supplement 48-, 72-, 96-in. 430-ma Slimline lamps in this installation. The 150-watt incandescent units provide horizontal lighting for control board. Luminous ceiling delivers average lighting level of 125 ft-c

COLD-CATHODE lamps supply 52 ft-c lighting level. Room is 71x40 ft, ceiling is 11 ft high. Light source is 3500-k, white, 25-mm, 100-ma, cold-cathode lamps connected in series. Two lamps are 17½ in. above each panel, spaced 14 in. apart

Modern Control-Room Lighting With...

...Luminous Ceilings

Consider a luminous ceiling as a lighting fixture large as the room. Ceiling consists of lighting source, straight runs of lamps with diffusing panels hung below wall to wall

► PLASTIC used as light-diffusing medium is finding many applications in the power field. On these three pages are shown typical applications for control-room lighting. The same basic lighting plan is being used for offices, banks, hospitals, laboratories, etc. In essence, the lighting scheme consists of a plastic light-diffusing bed below banks of fluorescent lamps producing an even, over-all shadow-free luminous ceiling.

Every square inch of a luminous ceiling is a source of low-brightness light. This is in marked contrast to the "pinpoint" lighting methods of yesteryear. The diffusing panels eliminate glare from the light source. Lighting values of 100 foot-candles and higher can be had at the working level without glare. The glare angle is important in control-room lighting. With individual lighting fixtures the glossy surface of tables, glass-top desks, instrument and meter faces often pick up images of concentrated light and reflect them, to the annoyance of the operating men.

Diffusing Panels. In a luminous ceiling the panels take light from a concentrated source and diffuse it with high