pot; (2) a secondary combustion chamber, or heat exchanger, in which combustion is completed. The flue connection is made to this chamber or through a second heat exchanger which may be of the diving-flue type installed to increase efficiency. The burner may be designed for operation both with and without mechanical draft.

Blue-flame oil burners differ from the pot-type variety in that removable perforated sleeves are provided above an oil pan instead of a metal pot, and lighting rings or kindlers are used for easy lighting.

Both types of oil burners operate by the burning of the oil vapor rather than the oil itself, the oil being first fed to a chamber in which the oil is entirely varporized, then mixed with air introduced through suitably located ports and burning at the top of the pot or perforated sleeves. Such heaters are designed to burn No. 1 oil (See Table 4, Chapter 14) or kerosene (coal oil). At no time should oil heavier than that for which the burner is designed be used, as heavier oils may cause excessive carbonization in the burner or fuel feed line.

### Materials and Construction

Formed sheet steel and welded assemblies are used primarily in oil heater construction. Standards governing construction which have been generally accepted are:

1. Commercial Standard for Flue-Connected Oil-Burning Space Heaters equipped with Vaporizing Pot-Type Burners, CS101-43 (*National Bureau of Standards*).
2. Standard for Oil-burning Stoves, Subject 896 (*Underwriters' Laboratories, Inc.*).
3. Standard for Construction and Performance of Oil Burners for Installation in Stoves and Ranges, Subject 865 (*Underwriters' Laboratories, Inc.*).

Some States or municipalities have codes which apply locally, but these usually apply primarily to installation, and the *Underwriters' Laboratories* label of approval is sufficient to cover acceptance of the unit.

### Testing and Rating

Commercial Standard CS101-43 is intended to provide a uniform standard method for ascertaining the maximum practical heat output in Btu per hour of flue-connected oil-burning space heaters under approximately normal service conditions. This method is based upon the following equations:

$$H_r = A - B \tag{8}$$

and

$$E = H_r/A \tag{9}$$

*where*

$A$ = total heat of fuel used.
$B$ = heat lost in flue gases.
$H_r$ = net heat delivered to the room.
$E$ = unit efficiency.

The following minimum performance requirements are stipulated:

1. Adequate provision for ease of lighting and insurance against loss of ignition prior to heating of burner.
2. Ease of operation of controls.



3. Proper operation of burner without excessive carbonization with grades of oil recommended by the manufacturer.
4. The heater shall be capable of passing the 6 percent *ICHAM* smoke test.
5. The heater shall be capable of operating with an overall efficiency of not less than 70 percent under conditions of test, or at a lower stack draft recommended by the manufacturer.

### Design Considerations

Some factors important in the design of oil-burning heaters are:

1. Proper pitch of oil lines from the sump to the burner, thus preventing vapor and air lock.
2. Proper positioning of the oil sump or constant-level valve to maintain the proper oil level in the burners, if factory assembled.
3. Tight construction, not only of oil lines, but of oil tank, sump, and burner to prevent a hazardous condition due to oil leakage.
4. Provision for leveling and aligning the entire heater for maintenance of proper operation. If a separate fuel tank is used, the heater should have provision for secure fastening to the floor to prevent excessive strain on oil supply line, and the consequent danger of leakage of oil.
5. Provision of a draft regulator to prevent abnormal draft fluctuations.
6. Proper shielding of an attached fuel oil supply tank to prevent excessive oil temperatures.
7. All metal parts subjected to the corrosive action of the oil shall be made of noncorrodible metal, or of metal suitably coated to resist corrosion.
8. The heater should have suitable baffling or insulation to prevent overheating of floors and walls.
9. Strength in assembly to prevent transportation and use damage.

## GAS HEATERS

Vented gas heaters are defined as those capable of removing 90 percent of the flue gases through a single flue outlet. All heaters having a gas input rating in excess of 50,000 Btu per hour must be of the vented type in order to meet *ASA* Approval Requirements for Gas-Fired Room Heaters.[12]

Space heaters may be classified by burner type as follows:

1. *Injection Burner* type which employs the energy of a jet of gas to inject air for combustion into the burner and mix it with the gas.
2. *Yellow Flame Burner* type in which secondary air only is depended on for the combustion of the gas.

### Materials and Construction

Standards covering materials and accessories used in the construction of gas heaters are described in ASA Approval Requirements for Gas-Fired Room Heaters[12] and in applicable Listing Requirements.[13]

### Efficiency Requirement

Vented space heaters having input ratings in excess of 20,000 Btu per hour are required to have a heating efficiency of not less than 70 percent,[12] based on the total heating value of the gas. Vented space heaters having input ratings of 20,000 Btu per hour or less are required to have a heating efficiency of not less than 65 percent.[12] These efficiencies are based upon the following equation:

$$e_t = 100 - \frac{H_t}{q} \times 100 \tag{10}$$

*where*

$q$ = hourly gas heat input, Btu per hour.
$H_t$ = heat above room temperature carried away by the flue products, Btu per hour.
$e_t$ = heating efficiency, percent.