for example, connection to an effective flue is mandatory. Furthermore, all such heating equipment must incorporate an automatic ignition pilot that will shut off gas supply to the main burner or burners in the event of pilot outage. If liquefied petroleum gas is used, the automatic pilot must cut off all gas supply to the appliance, including the pilot burner, in case the pilot flame becomes extinguished.

Rating and Sizing Gas Appliances

Input rating for a gas appliance is established by demonstrating that the appliance can meet the Approval Requirements of the ASA. The tests are conducted at the A.G.A. Testing Laboratories. Output rating is determined from the approved input and a minimum required efficiency stated in the Approval Requirements, and is the heat available at the outlet.

Although gas-burning equipment usually is completely automatic, maintaining the temperature of rooms at a predetermined figure, there are some manually controlled installations. In order to overcome effectively the starting load and losses in piping, a manually-controlled gas boiler should have an output as much as 100 percent greater than the equivalent standard radiation which it is expected to serve.

Boilers under thermostatic control, however, are not subject to such severe pick-up loads and consequently, it is possible to use a lower selection factor. For a gas-fired boiler or furnace under thermostatic control, a factor of 20 to 25 percent is usually sufficient for pick-up allowance.

In those installations, in mild climates where 100 percent outdoor air is used, furnaces should be of larger size in order to provide adequate capacity and quick pickup under intermittent heating conditions.

The factor to be allowed for loss of heat from piping will vary somewhat, the proportionate amount of piping installed being greater for small installations than for large ones. For selection factors to be added to installed radiation under thermostatic control, see Chapter 35.

Appliances used for heating with gas should bear the approval seal of the A.G.A. Testing Laboratories on the manufacturer's nameplate; together with the official input and output ratings. It is not permissible to operate a gas heating unit above its stated rating. It may be necessary to operate below this rating at elevations above 2000 ft. Installations should be made in accordance with recommendations of the American Gas Association, as shown in current *American Standard for Installation of Gas Piping and Appliances in Buildings*, ASA Z21.30, and in accordance with local regulations.

Sizing of Gas Piping

Piping for gas appliances should be of adequate size, and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of supply (the meter) and the burner. The size of gas pipe required depends upon the following:

1. Maximum gas consumption to be provided.
2. Length of pipe and number of fittings.
3. Allowable loss in pressure from the outlet of the meter to the burner.
4. Specific gravity of the gas.

To obtain the cubic feet per hour of gas required by the burner, divide the Btu input rate at which the burner will be adjusted, by the average Btu heating value per cubic foot of the gas.

Capacities of different sizes and lengths of pipe, in cubic feet per hour, with a pressure drop of 0.3 in. of water column for a gas of 0.60 specific gravity, are shown in Table 3. In adopting a 0.3 in. pressure drop, due allowance for an ordinary number of fittings was made.

To convert the values given in Table 3 to capacities for another gas of different specific gravity, multiply the tabular values by the multipliers shown in Table 4.

Pipe capacities for gas flow up to 100,000 cfh for various lengths of pipe are given in Fig. 16 which is based on a specific gravity of 0.60. The capacity at a given pressure loss for a different specific gravity may be obtained by multiplying Fig. 6 capacities by a multiplier obtained from Table 4.

Table 3 .... Capacity of Gas Piping—Cu Ft Per Hr.
(At pressure drop of 0.3 in. water. Specific gravity = 0.60)

Length of Pipe Ft	Iron Pipe Size (IPS) Inches										Length of Pipe Ft
	½	¾	1	1¼	1½	2	3	4	6	8	
15	76	172	345	750	1220	2480	6500	13880	38700	79000	15
30	52	120	241	535	850	1780	4700	9700	27370	55850	30
45	43	99	199	435	700	1475	3900	7900	23350	45600	45
60	38	86	173	380	610	1290	3450	6800	19330	39500	60
75		77	155	345	545	1120	3000	6000	17310	35300	75
90		70	141	310	490	1000	2700	5500	15800	32250	90
105		65	131	285	450	920	2450	5100	14620	29850	105
120			120	270	420	860	2300	4800	13680	27920	120
150			109	242	380	780	2090	4350	12240	25000	150
180			100	225	350	720	1950	4000	11160	22800	180
210			92	205	320	660	1780	3700	10330	21100	210
240				190	300	620	1680	3490	9600	19740	240
270				178	285	580	1580	3250	9000	18610	270
300				170	270	545	1490	3000	8500	17660	300
450				140	226	450	1230	2500	7000	14420	450
600				119	192	390	1030	2130	6000	12480	600

From American Standard Installation of Gas Piping and Gas Appliances in Buildings, ASA Z21.30-1954.

Table 4 .... Multipliers for Various Specific Gravities
(For Use With Table 3 and Fig. 16)

Specific Gravity	Multiplier	Specific Gravity	Multiplier
0.35	1.31	1.00	0.775
0.40	1.23	1.10	0.740
0.45	1.16	1.20	0.707
0.50	1.10	1.30	0.680
0.55	1.04	1.40	0.655
0.60	1.00	1.50	0.633
0.65	0.962	1.60	0.612
0.70	0.926	1.70	0.594
0.75	0.895	1.80	0.577
0.80	0.867	1.90	0.565
0.85	0.841	2.00	0.547
0.90	0.817	2.10	0.535

COMMERCIAL AND INDUSTRIAL GAS EQUIPMENT

No attempt can be made, due to space limitation, to describe or classify the varied types of equipment used for commercial and industrial applications. Much of the equipment utilized is custom built to suit a particular process. Certain standard parts such as venturi and burner head sets, ring burners, proportional mixers, or compressors, are purchased for assembly in existing equipment, usually by the installer. Furnaces to provide particular atmospheres or for annealing, soaking pits, metal melting, etc. are usually engineered by industrial gas-equipment manufacturers.

Burners utilized in industrial equipment often operate at gas pressures higher than encountered in domestic usage. High-pressure gas provides flexibility of control required in the production of constant temperatures. In addition, air-gas ratios can be closely maintained under throttling conditions, and heat liberation per cubic foot of combustion space is considerably greater than can be achieved with lower pressures.

A few of the many basic types of burners used are as follows: single-pipe high-pressure, proportional mixing, premix, two-pipe high-pressure, and atmospheric.

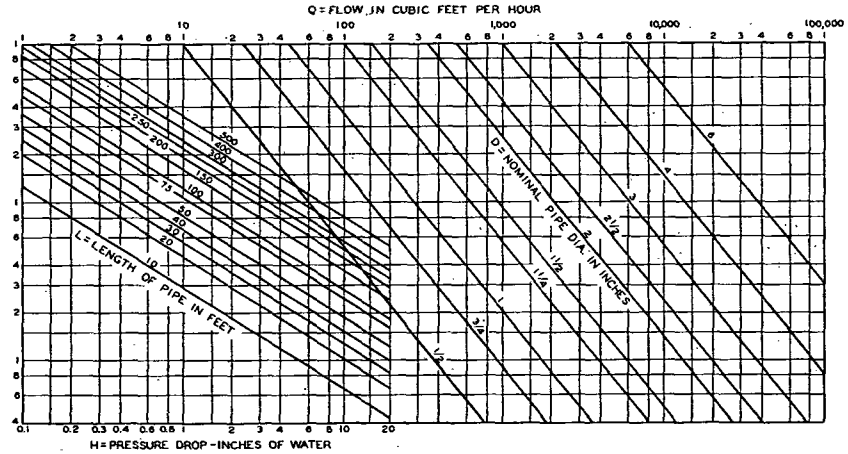
The *single-pipe high-pressure burner* system utilizes gas delivered to the orifice of a venturi at pressures from 10 to 50 psig. A constant pressure compressor, sometimes remotely placed, is occasionally used to increase the gas pressure. The velocity of the gas issuing from the orifice entrains primary air which is controlled by an air shutter on the venturi tube. An advantage of this system is that when the gas pressure is reduced (lowering the input) the air-gas ratio will remain constant over a fairly wide range.

In the *proportional mixing burner*, an enclosed type venturi is used and high-pressure air is delivered through an orifice. The resulting partial vacuum entrains the gas which is supplied through a zero pressure governor. When the air pressure is reduced, the amount of gas entrained is similarly reduced, thus maintaining a constant air-gas ratio over a wide fuel capacity range.

The *pre-mix burner* system embodies a compressor which mixes air and gas intimately and discharges the mixture through pipes to the burners where it is discharged through orifices and burned. The pre-mix compressor can be remotely installed and the mixture can be closely controlled.

The *two-pipe high-pressure burner* system utilizes both air and gas under pressure, both being delivered through orifices and mixed prior to delivery to the burner.

The *atmospheric burner* system is not commonly used. It consists of a burner supplied with gas at a pressure of 2



Based on Spitzglass Friction Factor and 0.60 Specific Gravity. To convert for other specific gravity see Table 4.

Fig. 16 .... Flow vs. Pressure Drop for Low Pressure Natural Gas