greatest importance in such boilers are *grate area* sufficient to burn the particular fuel contemplated at a moderate rate when carrying the rated load, a depth of fire-pot sufficient to receive a liberal charge of fuel, an advantageous disposal of direct heating surface in the furnace for absorption of the radiant heat of the fire, sufficient indirect heating surface to extract the heat from the gases by convection, yet without interposing an undesirable resistance of flow to the chimney, and simple yet effective means for control of the draft and rate of combustion.

For the larger installations, such as large apartment buildings, hotels, office buildings, and other large public buildings, the fire-tube steel, the cast-iron vertical section and the water-tube steel boilers are commonly used, but with such a selection as the local conditions governing the installation may dictate. Some designs of the two former types are more compact than others and in such cases their size may influence their selection. Often low water line and low height may be a limiting consideration. In many cases also if steel tubular boilers are selected, the provision of sufficient room to permit of removing and replacing tubes may need to be considered. In this repect, the latter type is at a disadvantage compared with the sectional cast-iron and sectional steel types of boilers. The latter, due to their ease of access into crowded boiler rooms, are often given preference. Water-tube steel boilers are used mostly in the large installations where it is expected that there may sometime be a desire to turn to high pressure operation.

*Fire tube boilers* are usually constructed of steel, which shows the greatest resistance to splitting, cracking or similar stress due to the expansion and contractional strains of temperature differences of too excessive pressures, or temperature. They are well adapted to oil burning on account of this resistance to the wide temperature ranges encountered with this type of fuel. They have large water and steam spaces so that while they may heat up and steam slowly they retain heat and supply steam for comparatively long periods with a receding fire, thus tending to compensate for fluctuations in firing by the fly wheel effect of their water and steam capacities. Their large steam capacity also tends to prevent priming and fluctuation of the water line. They are comparatively steady under sudden and wide variations in load conditions and require little attention on this account. Steel boilers may be built for high or low pressure and are therefore flexible in converting from one pressure to another.

Fire tube boilers may be of the direct tube, return tube or a combination of direct and return tube type and have any desired ratio between grate and heating surface, are generally efficient in operation, and with adequate draft producing means may be operated up to 150 per cent of rating without difficulty.

Water tube boilers are usually constructed with steel or iron tubes, steel drums and either steel, cast steel or cast iron headers. On account of the smaller diameter of drums and the fact that the tubes are the only parts to come into direct contact with the hot furnace gases it is generally felt that this type of boiler is safer to operate, especially on high pressure. They heat up and steam rapidly but also lose their heat and steam pressure quickly. The water and steam spaces are moderate and their performance on rapid and wide variations of load is accordingly fair.





The principal heating surface consisting of tubes with the water inside and the heated gases outside, is easy to clean from the inside with hydraulic or pneumatic tube cleaners and from the outside with steam or air jet soot blowers although with highly scaling waters the scale formation on the inside of a small tube may be comparatively rapid.

The water line is generally high and considerable space and head room is required. On account of being constructed with drums and banks of tubes they may be shipped knocked down and be assembled on the job, thus passing through small openings at any stage of the construction. The sectional construction facilitates repairs or increase and decrease in capacity. This type of boiler is efficient in operation, comparatively high in first cost, but may be operated to 200 per cent of the usual normal rating without undue loss in efficiency.

## BOILER RATING

The three words, size, rating and capacity, when applied to a heating boiler are sometimes used indiscriminately to designate any one of the three things for which they should be used. The size of a boiler should indicate its physical dimensions, *i.e.* the size of a sectional boiler may be the inches in width of a rectangular fire box or the inches in the diameter of a round fire pot, combined with the number of sections; the size of a return tubular boiler is usually the inches in the diameter by the feet in the length of its shell combined with the number and size of tubes. The sizes of fire box boilers are usually arbitrary figures based on heating surface and grate surface. The size of a water tube boiler is generally stated in horse power, or the number of tubes wide by the number of tubes high with the size and length of tubes.

The rating of a boiler is the measure of what it will do under certain conditions. The manufacturers' rating is the measure which the manufacturers place upon the performance of their own boilers; this may be given for one or more well defined sorts of conditions or for what the manufacturers may choose to consider average working conditions without definition but in any case the conditions under which ratings have been established should be stated.

The ratings of low pressure boilers are usually stated in terms of the number of square feet of standard cast iron direct radiation the boiler will supply with steam or hot water, referred to conditions when the plant is heated up and operated under stable conditions with the radiation in still air at 70 deg. fahr. and all proper allowances made for the added load of piping and connections. These ratings are usually for an 8 hour or other stated firing period and for hard coal or other stated fuel with allowance factors for other lengths of firing periods and for other kinds of fuel when the smaller sized boilers are being considered. In connection with most rating the chimney or draft requirements corresponding to the ratings are given.

Unfortunately there are wide differences in the ratings of boilers by the various manufacturers due largely to the fact that there has never been a full and complete cooperation in the establishment of a standard code on which to rate. For the larger sizes of boilers and with other fuels,