

- (1) Steam pressure gauge.
- (2) Thermometer, to measure the temperature of the feed water.
- (3) Thermometer, to measure the flue gas temperature.
- (4) CO_2 recorder or flue gas analysis apparatus.
- (5) Draft gauges to measure the difference in draft above and below the fire bars, and the difference in draft between the combustion chamber and exit flue.

SUMMARY OF LOSSES, AND PRECAUTIONS TO BE TAKEN.

i. Excess Air.—This is determined by flue gas analysis. Take occasional samples from the furnace as well as the flue, and if they differ, air is leaking through the setting. The remedy is to look for cracks and stop them up, or if it be due to porous brickwork, coat the brick with sizing or other non-porous substance. The air leakage into the furnace and through the setting always increases with an increase in the "pull" of the fan or chimney. It is advisable, therefore, to always reduce this by closing the damper in the smokestack at the lower rates of steaming, instead of closing the ash-pit door.

Holes in the fire bed will also cause excess air, hence care should be taken to avoid them. When draft gauges measuring to 1/100 inch of water are used, they will show a marked reduction in the draft, when there are holes in the fire.

ii. Incomplete combustion of gases.—An analysis of the flue gases will indicate, by the percentage of carbon monoxide (CO) present, whether combustion is complete. Carbon monoxide is not the sole combustible gas which leaves the fire, other gases—principally hydrogen (H_2), and methane (CH_4), both formed by the distillation of the coal, accompany it. But it is more easily detected by analysis than the other gases. To burn these gases, it is necessary to mix them at a temperature above their ignition point, with a secondary supply of air, and to provide a furnace large enough to give them time to burn. By firing small quantities of coal frequently, the quantity of combustible gases passing through the furnace will not vary so much between the times of firing as when larger charges of coal are fired at longer intervals. It is necessary to remember that it is not economical to burn these gases by admitting a very large supply of air over the grate, since this would render the increase in loss due to excess air greater than the gain due to the use of the heat generated by the additional gas burnt. The exact quantity to be admitted, must be carefully adjusted by careful experimenting with each particular fuel and boiler.

iii. Incomplete combustion of the solid combustibles.—Some solid combustibles which consist principally of carbon, pass through the air spaces in the grate bars, and are removed from above the grate bars in cleaning the fire. This loss is greater when coals are used which contain a large amount of ash, and when the ash melts at a low temperature permitting the formation of clinkers. To reduce this loss, grate bars must be used which are the most suitable for the size of coal and fusing properties of the ash. In order to decrease the tendency to form clinkers, thin fires should be carried. Steam passed in with the air supply below