as the speed, the pressure increases as the square of the speed and the power consumed increases as the cube of the speed. It is evident therefore that if more air is required but at an increased pressure it would be better to install a larger or additional fan rather than increase the speed of the present fan.

FORCED DRAFT

In forced draft work the air enters directly to the ash-pit so that the fuel bed is under pressure. Pressure maintained is sufficient to force the air through the duct system, stoker setting and fuel bed otherwise there would be an objectionable leakage of gasses whenever the fire doors were opened. Losses through the boilers, breechings, etc. are cared for by the stack.

Forced draft equipment requires a higher stack than when the induced draft system is used. As the fan handles comparatively cool air the

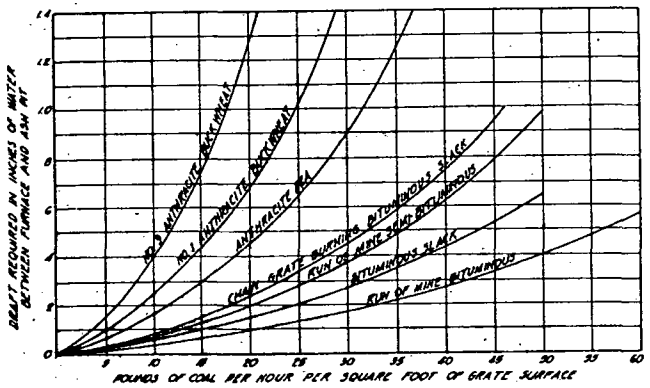

FIG. 86. DRAFT REQUIRED TO BURN VARIOUS KINDS OF COAL

equipment required is smaller and uses less power than an induced draft system of similar capacity.

Forced draft is used in under feed stokers and with chain grate stokers when high peak loads, beyond the capacity available with the natural draft, are required.

INDUCED DRAFT

Fans for induced draft are placed near the base of the stack and handle the smoke and hot gasses leaving the furnace. It is desirable to use this system when an even draft is required and the chimney available is of limited height.

With the practice of providing economizers, air heaters, etc. in the modern boiler plant and operating up to 400 per cent rating an excessive load is placed upon the chimney and induced draft equipment is necessary.

A good idea of the draft needed to burn various kinds of coal at the rate indicated under normal conditions is shown in Fig. 86. Draft for

various loads varies with the combustion rate and with the kind of fuel used. The principal losses which the draft will have to overcome will be through the boiler, fuel bed, the stokers, brick work, breechings and economizers.

The amount of air required with the forced draft system will depend upon the size of the plant and will necessitate the assumption of the combustion rate and the evaporation. There are theoretically 12 lb. of air required for the combustion of 1 lb. of coal, actually the requirements are from 20 to 25 lb. per pound of fuel.

It is customary in mechanical draft work to allow for 100 per cent excess air for hand-fired installations and 50 per cent excess where a stoker is used. This, however, is affected by the kind of stoker used, the size of the installation and the rating it carries. As there is a definite relation between the analysis of flue gases leaving the boiler and the quantity of air supplied, the results of an analysis will give the amount of air or gases being handled by a forced or induced fan. The method used is usually the Orsat apparatus. The amount of air being used may be determined by taking CO_2 readings in the breeching or forced draft connections, or by weighing the coal and ash and taking a flue gas analysis.

MECHANICAL STOKERS

Three types of stokers are commonly used, namely chain-grate, under feed and over feed type. Their use permits a uniform fuel supply, efficient combustion, boiler operation at higher rating and the effectual meeting of peak loads. Either forced or induced draft is successful with chain grate stokers which are designed primarily for the use of bituminous coal particularly the free burning and clinkering types. Where forced draft is used, air is delivered at different pressures under the grate, the control being accomplished by dampers, to suit the grade of fuel and the firing rate. At the front the pressure will not exceed 2 in. water gauge and will decrease toward the rear as the fuel bed gets thinner.

Over feed stokers are adapted for all kinds of fuel and the angle of the grate bars will indicate whether bituminous, semi-bituminous coking coal or the non-coking types are to be used.

Under feed stokers are made in single or multiple units and will burn coking or non-coking varieties of coal equally well. In both cases either forced or induced draft may be used.

The important points to be observed in recommending and using stoker installations are:

1. Stokers in large plants used in conjunction with modern methods of coal storage and handling at their disposal show a considerable labor saving.
2. In small plants stokers are only advisable where the saving in fuel will be large or where the smoke question is a factor.
3. The upkeep cost of stokers generally exceeds that for hand fired furnaces.
4. The use of different fuels and a better efficiency is obtainable with mechanical stokers.