## DESIGNING BRICK AND STEEL CHIMNEYS.

In designing chimneys the height is generally decided upon first. This involves consideration of the height of surrounding buildings or hills, the length of all horizontal flues necessary, the character of fuel to be used, etc., as well as any local laws or ordinances that may apply. The chimney diameter may then be calculated, based upon the selected height and the boiler horsepower or the amount of fuel to be consumed. In the October 8th issue of Power, Mr. Everard Brown discusses the designing of chimneys and we herewith reproduce the article.

The minimum height necessary, however, will be governed to a great extent by the fuel—wood usually requiring the least and fine anthracite coal the greatest—the character of the installation and the number of furnaces served. Obviously the smaller and more round-about the flues, the higher must be the stack; likewise, a single furnace will require less height than several discharging into a common flue. On account of these variables, it is practically impossible to evolve a general formula applicable to all cases. Except in rare instances, extremely tall chimneys are not necessary and any increased efficiency gained by them hardly ever justifies their greater cost. The tendency is to build two or more smaller ones rather than one high one, which can very often be done at less cost.

A chimney should be proportioned to give sufficient draft for the boiler to develop much more than its commercially rated power, or, according to Kent, to bring about the combustion of 5 lb. of fuel per rated boiler horsepower per hour. By assuming such a liberal rate of combustion, the stack will certainly be large enough. Based on this assumption Kent gives the following equation:

$$E = \frac{0.3 \text{ Hp.}}{\sqrt{H}} = A - 0.6\sqrt{A}$$

where:

$E$ = Effective sectional flue area of stack in square feet;
Hp. = Horsepower of boilers;
$H$ = Height of chimney;
$A$ = Actual sectional flue area of stack in square feet.

The actual is not the effective sectional area because friction retards the ascending gases. The annular stratum of gas retarded by the wall in reality diminishes the flue area.

Molesworth gives:

$$A = \frac{\text{Hp.}}{1.28\sqrt{H}} = \frac{C}{12\sqrt{H}}$$

where

$C$ = Pounds of coal consumed per hour.

From this equation, H may be found if the sectional area is known or assumed, or by the same process the horsepower may be found for which an existing stack is sufficient. Sometimes wind-caps are used to increase the stack capacity, but this is only rarely advisable because of their dangerous position.

Stability and wind resistence are next to be considered. Wind pressure is usually assumed to be horizontal and uniformly intense at all levels. Where a chimney is shielded by buildings, only the part actually exposed need be considered. Generally a maximum pressure is assumed of 50 lb. per square foot, although this would require a wind velocity seldom reached. A simple rule for calculating wind pressure is:

The square of the velocity in miles per hour divided by 200 equals the pressure in pounds per square foot.

The total pressure against a round chimney is about one-half that against the diametral plane of that chimney. It is therefore the product of the pressure per square foot by one-half the total projected area of the exposed part. Similarly the total pressure may be calculated for chimneys of almost any form.

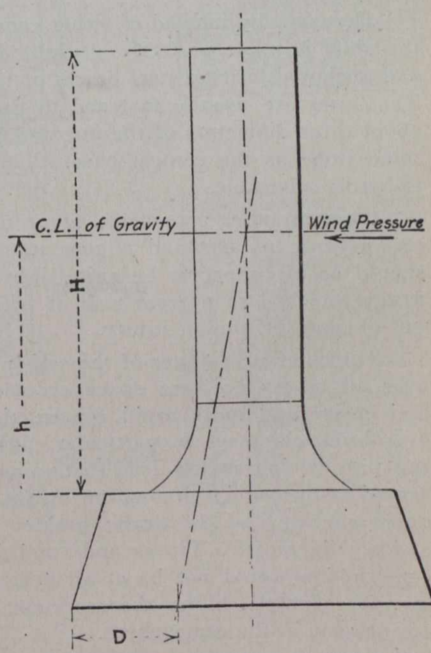
The resultant of this pressure may be assumed to act horizontally through the centre of gravity of the exposed part. The stability of a wholly exposed chimney, therefore, is determined by finding the moment of this pressure acting through the centre of gravity. From the accompanying illustration this moment is

$$h \times P_1 = H \times P \times \frac{A}{2}$$

where

$h$ = Height of the centre of gravity above the top of the foundation;
$P_1$ = Total pressure exerted;
$H$ = Total height of the stack;
$P$ = Pressure in pounds per square foot;
$A$ = Total vertical sectional area.

For chimneys with vertical axes, the moment of stability is the same in every direction, but few chimneys have exactly vertical axes; therefore, the least moment of stability must be considered as that which opposes the lateral pressure in the direction in which it leans. The stability at any height of a chimney, for example at a certain bed-joint of a brick structure, may be established in the same way by simply considering that part of the chimney above the point at which the stability is to be determined. Opinions differ regarding the strength of brickwork, which, together with the varying qualities of materials and workmanship, makes it exceedingly difficult to accurately calculate the power of resistance. Consequently a large factor of safety is always advisable.




**Determining Stability of Chimney.**

Fundamentally, a chimney's stability depends upon the weight of its outer shell and the diameter or width of its base, and, while the cohesion of the mortar in a brick stack may add something to its strength it is too uncertain to be relied upon. The effect of the two forces—the weight of the chimney and the pressure of the wind—is to shift the centre of pressure at the base from the axis toward one side, extent depending upon the relative magnitude of the two forces. A comparatively safe rule to follow is to make the base diameter not less than one-tenth of the height. This rule has been approved by many years of actual practice.

**Steel Chimneys.**—Probably the cheapest chimney is a straight steel shell guyed with rods or wires. These are secured to the shell, usually by an encircling band, and should be anchored to incline at an angle of not more than 45 deg. with the ground. Where other structures are convenient the guys may be fastened to them. This type of stack is rapidly being supplanted by the so-called self-sustaining stack. It can be lined or not. Ordinarily when working to full capacity, the high velocity of the ascending gases allows little heat to be lost by radiation even through