than the first which may be done as T is very small as compared with d, the resisting moment,

$$M = \frac{\pi \times 8 \times d^3 T s}{32 d} = 0.7854\ d^2 T s \qquad (2)$$

Solving equations (1) and (2),

$$s = \frac{P d H^2}{2 \times 0.7854\ d^2 T} = \frac{0.053\ P H^2}{D T} \qquad (3)$$

or the stress per lineal inch along the circumference is

$$S' = \frac{0.053\ P H^2}{D} \qquad (4)$$

If E be taken as the efficiency of a riveted joint, equation (2) becomes,

$$M = 0.7854\ d^2 T s E \qquad (5)$$

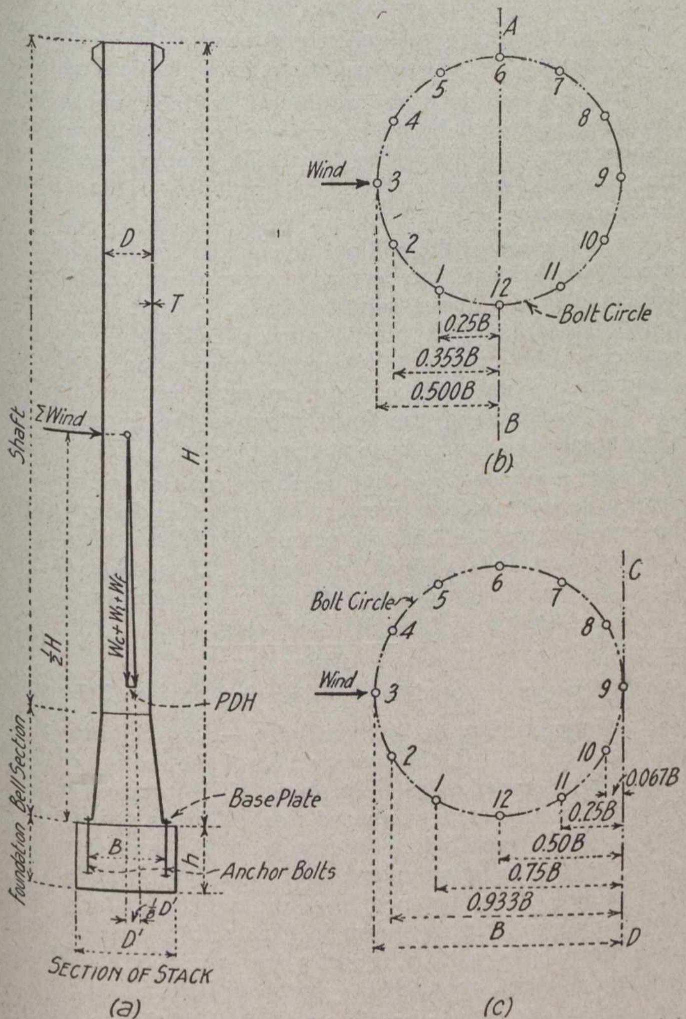

Fig. 1.

Solving equations (1) and (5) for T, we have

$$T = \frac{P d H^2}{2 \times 0.7854\ d^2 s E} = \frac{0.053\ P H^2}{D f E} \qquad (6)$$

which gives the thickness of plate necessary at any section to resist the moment due to wind pressure, for any fiber stress, f, and any efficiency.

The unit stress at any section due to the weight of the stack above the section is,

$$s' = \frac{W}{24 \pi D T} = \frac{490 \pi D H T}{144 \pi D T} = 3.4\ H \qquad (7)$$

Therefore the total unit stress in the plate at any section is given by

$$S = 3.4\ H \pm \frac{0.053\ P H^2}{D T} \qquad (8)$$

It is evident from equation (8) that the stress due to weight of stack above the section may be neglected up to a height of over 400 feet with an error of less than one per cent.

The weight of the lining has been neglected as it is usually carried by the foundation. In special cases it may be carried on angles riveted to the shell. In such cases the weight should of course be included.

Taking P as 20 lb. per sq. ft., f as 16,000 lb. per sq. in., and E for double-riveted joints as 0.70, equation (6) gives the safe minimum thickness of plate for double-riveted horizontal joints as,

$$T = 0.0000947\ H^2/D \qquad (9)$$

Taking E as 0.50, we have for the safe minimum thickness of plate for single-riveted horizontal joints,

$$T = 0.0001326\ H^2/D \qquad (10)$$

Equations (9) and (10) have been plotted as shown in Figs. 2 and 3. These diagrams give the safe minimum thickness of plate to resist the moment due to wind pressure for any given height and diameter.

Example: Determine the thickness of plate for a stack 16 feet in diameter with double-riveted horizontal joints, with a height of 240 feet above the section.

Enter Fig. 2 with the diameter at the top, and follow down the vertical line through 16 till the height, 240 feet, is reached, and read 3/8-in. plate as the thickness required.

For permanent structures 1/4-in. is recommended as the minimum thickness of plate to be used at any time, though 3/16-in. plate has been used for the upper 30 feet of some comparatively temporary stacks.

Thus starting with 1/4-in. plates at the top, the diagram gives the distance down from the top at which a change of thickness is required. The diagrams are arranged to read from the top downward to correspond with the method of designing. The design is carried in this way from the top down to the top of the bell section. It is customary to use plates for the bell section 1/16-in. thicker than the plates immediately above the bell. These plates are placed vertical with butt joints and single outside straps, though in small stacks the bell section is often built up of circumferential plates.

In stacks of large diameter, the thin plates of the upper sections may require stiffening to guard against lateral collapse. This is usually done by riveting rings made up of angles on the inside of the stack.

It is interesting to note that some engineers recommend that the bell section be made 1/7 the total height above the foundation and that the diameter of the bell at the foundation be 1½ to 2 times the diameter of the stack. These proportions are pleasing to the eye. The development of modern æsthetic taste cannot be ignored entirely by the designer. His stack should be structurally secure and also well proportioned. A neat cornice at the top of the stack is also desirable because of these considerations.

Minimum Size of Foundation.—First Solution: As the kern for a circular section is $D'/4$, the resultant of the weight of the stack, stack lining, foundation, and wind pressure must cut the base at a point not greater than $D'/8$, as shown in Fig. 1 (a). Therefore, equating the resisting and overturning moments,

$$(W_o + W_l + W_f)\ D'/8 = \tfrac{1}{2} \cdot 20 \cdot DH\ (H + h) \qquad (11)$$

or

$$D' = \frac{80\ DH\ (H+h)}{W_o + W_l + W_f} \qquad (12)$$

which gives the minimum diameter of foundation that will insure compression over all portions of the base.

If h be neglected as being very small in comparison with H, and in like manner W_o and W_l be neglected as being small as compared with W_f, an approximation