WIDTH OF VALVE SEATINGS.

This note deals more essentially with valves subjected to continual "hammering" action and through which water or steam is passing at a high speed, *e.g.*, Boiler Feed check valves, Suction and Delivery valves of pumps (not Kinghorn valves), Needle valves of Mumford automatic feed regulators, &c., in which the lift of the valve is small. Wear on a valve of this sort is due to two causes :—

(1) The "hammering" action of the valve on its seat due to the sudden release of pressure on the under side when the pump comes to the end of its stroke.

(2) The erosive action of water or steam passing at high velocity between the valve and its seat.

Experience shows that a valve of this type with a broad seating wears considerably more rapidly than one with a narrow seating. From the point of view of the "hammering" action a lower stress on the surfaces in contact will result in the case of the broad seating than in the case of the narrow seating as the areas in contact are larger though the load is the same in either case. A "knife-edge" seating would produce an infinite stress.

It appears, therefore, that the wearing of the metal is due to the erosive action of the steam or water passing. The metal being "fatigued" by the continual "hammering" is more easily eroded by the water or steam passing especially if its velocity be high. The seating is also subject to erosion but not to nearly the same extent owing to the direction of motion of the water or steam.

The erosion will be a minimum in the case of the valve with the "knife-edge" seat owing to the greater facility with which water can pass the valve.

Consequently minimum wear should attend maximum stress and *vice versâ*. On the premises that the wear is due entirely to the erosion, it follows that the narrowest seating possible should be given, the limiting factor being the compressive strength of the metal under the load caused by the "hammering" action.

Unwin gives the following figures for the allowable stress under these conditions.

Greatest pressure on surface of valve seat :—

Cast Iron - - -	1,000	lbs. per	sq. in.
Gun Metal - -	2,000	,,	,,
Phosphor Bronze -	3,000	,,	,,

Let P = Total load on valve in pounds.
,, p = Load on valve in lbs. per sq. in.
,, D = Diameter of valve in inches.
,, W = Width of seating in inches.
,, R = Load on seating at right angles to its face in lbs.
,, A = Area of valve in sq. inches.
,, f = Allowable stress in lbs. per sq. in.

Load perpendicular to valve seat $= R = \frac{P}{\sqrt{2}} = \frac{p\,A}{\sqrt{2}}$
(assuming that the seating is inclined 45° to valve axis).

Area of seating $= \pi\,D\,W$ - - - approximately.

Area of valve $= A = \frac{\pi\,D^2}{4}$

Then $\frac{p\,A}{\sqrt{2}} \times \frac{1}{\pi\,D\,W} = f$

$$\therefore\ w = \frac{p\,\pi\,D^2}{4\sqrt{2}\,\pi\,Df} = \frac{p\,D}{5\cdot 65f} =$$

$$= \frac{p\,D}{5{,}650} \text{ for cast iron.}$$

$$= \frac{p\,D}{11{,}300} \text{ for gun metal.}$$

$$= \frac{p\,D}{16{,}950} \text{ for phosphor bronze.}$$

The metal most commonly in use for the purposes under consideration is gun metal.

The narrowest seating that can be allowed is given then by the formula :—

$$w = \frac{p\,D}{11{,}300} \text{ for gun metal.}$$

For ease of calculation and because the difference is negligible when the human error in machining is considered and also owing to the uncertainty of the correct figure for the stress allowable, assume

$$w = \frac{p\,D}{10{,}000}$$

Similarly for cast iron the formula $\frac{p\,D}{5{,}000}$ can be used and for phosphor bronze $p\,D/15{,}000$.

The formula for gun metal has been found to give very satisfactory results in practice.

In using this formula it is necessary to remember that p does not represent the pressure on top of the valve but the difference in pressure between the top and bottom on the valve at the time of closing, and that the effect of the inertia of the valve is not taken into account.