

upper ends of the vertical girders. Fig. 3 shows the conditions of loading for this type of gate. The load on the top horizontal member, per unit of length, is equal to  $62.5 \frac{h^2}{6h} (h_1^3 - h_2^3)$ . When the upper pool is at the top of the gate and there is no lower pool acting, this expression becomes  $62.5 \frac{h^2}{6}$ , which is one-third of the total water pressure on the gate. The other two-thirds of the pressure is carried to the sill.

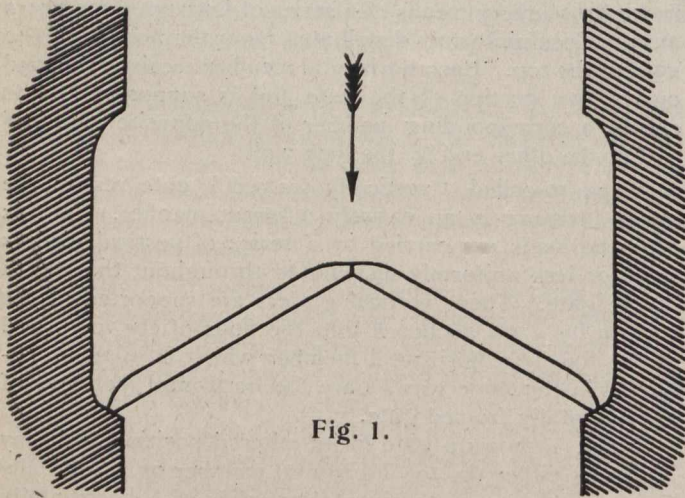


Fig. 1.

The most important points to be considered in the choice of type for any particular gate are cost and efficiency, and of these it may be said, the cost of a gate is a relatively small part of the cost of the whole lock, whereas its efficiency is a very important factor in the lock's successful operation; and, therefore, no saving in cost on the gates is justified if it impairs their efficiency. On the other hand, it is just as true that if a saving can be made on the cost of the lock gates without impairing

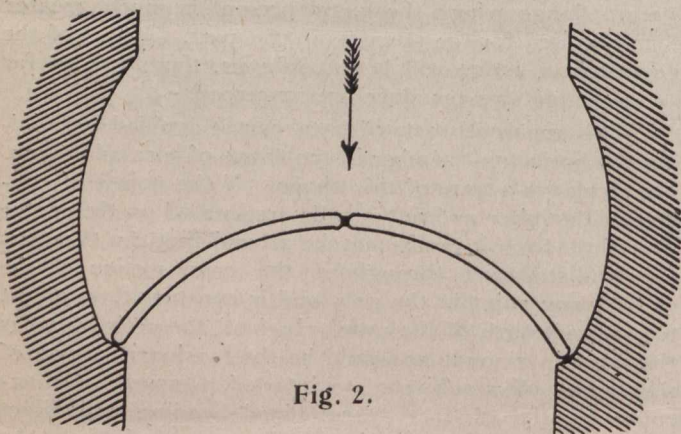


Fig. 2.

the efficiency of the structure, the saving is justified even though it should amount to only a small percentage of the cost of the lock.

In comparing the relative costs of two types of lock gates the following elements should be considered: (1) the weight of the gate, (2) simplicity of design and ease of erection, and (3) the cost of that part of the walls and sills which is influenced by the design of the gate.

The advantage in weight for the two types for any particular lock can best be determined by making rough

designs and comparing them. An inspection of the two types leads to the conclusion that for gates which are long in proportion to their height, vertical framing will weigh less, and that as the height is relatively increased the difference becomes less, until the two types will weigh alike and a further increase in height will result in an advantage in favor of horizontal framing. General H. F. Hodges states that the weights will be equal when the height is two-thirds of the length. The writer has made comparisons between the two types for various dimensions and is of the opinion that a vertically framed gate will weigh the same as a horizontally framed gate, in which arches are used, when the height is about 75 per cent. of the length and that when girders are used for the horizontal members the weights of the two types will be equal when the height is equal to the length.

Turning now to facility of construction—there can be no doubt that a vertically framed gate is much to be preferred. The conditions of loading and support are such that no extraordinary accuracy of workmanship is required. So far as water pressure is concerned, the gate is supported along the sill and at two points on the upper girder, while a horizontally framed gate is supported along three edges of the rectangular surface exposed to the water. It is clear that in order to obtain the support, in the latter case, extraordinary care in fabrication and erection is necessary. A vertically framed gate is well adapted to the use of adjustable diagonal bracing by means of which any sag or warp in the gate can be corrected. With large horizontally framed gates, it has not so far been practicable to use adjustable diagonals, and therefore the gate must be built so as to remain comparatively free from warp and sag, and this extra precision in workmanship and erection can not be obtained without extra cost.

Another cost-involving element in horizontally framed gates is the large amount of curved work usually found in this type. Even in those gates which have horizontal girders instead of arches, the ends are usually curved so as to reduce weight where the bending moment is small. The result is that the rivet holes in the sheathing plates are a little farther apart than those in the flange angles and the holes in the sheathing splices are still farther apart and will not agree with standard rivet spacing. This necessitates extra care in locating the rivet holes so that they will match up after assembling.

It is stated that for the Panama lock gates it was necessary to drill many holes from the solid after assembling the plates, in order to avoid excessive reaming which would have resulted in oval holes. The labor of bending the angles and plates and cutting the web plates on curves adds to the cost. None of this is necessary with vertical frames: first, because there is little curved work in the gate and, second, because, by being able to adjust the gate with diagonals, no extraordinary precision is required. The conclusion from the above is that where weight is the same the vertically framed gate is the cheaper on account of the facility of construction.

The type of gate selected affects the design of lock walls and sill. It is proper, therefore, to consider this effect in deciding upon type of gate for any given conditions. It relates principally to the amount of masonry and metal work required.

As to the volume of masonry in the walls, it has been stated, as a disadvantage of the vertically framed gates, that this type brings a heavy strain high up in the wall due to one-third of the total thrust being concentrated at the top girder. While it is true that there is a heavy load on the upper part of the wall, there is, nevertheless, no