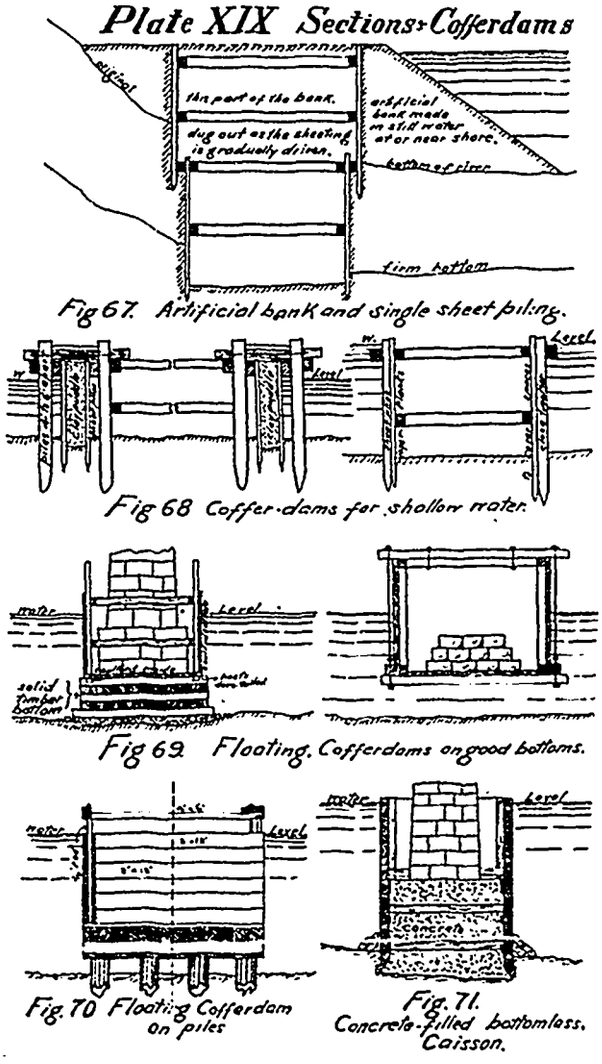
thirty cents per foot for the same in great lengths of fifty or sixty feet; driving will vary from two cents or three cents per foot in situations where great quantities are driven by steam hammer, to four cents or five cents per foot where driven by a track pile driver on cars; but for ordinary railway construction work, scattered and in small quantities, eight cents to twelve cents per foot is not out of the way. An ordinary price on railway construction is about thirty cents per foot for good piles, 12 inches in diameter at the small end, in place in the work, and fifteen cents per foot for all cut-off ends, this includes all labor of driving and cutting off to the exact height if on land, but cutting off under water is extra, and sometimes a matter of considerable expense.

Deep Foundations on Land. — Where foundations require to be carried down for any considerable depth, it is more economical to timber and sink vertically than to put earth slopes on the foundation pit, such timber will, in general, consist of vertical hand-driven sheet piles and horizontal rings of timbers and braces to sustain them at five or six foot intervals, as shown Fig. 67, Plate XIX.,



and in planning such work it is well to remember: (1) To allow for extra room more than is apparently required, in order to give freedom of movement, extra timbers, etc.; (2) To be sure to find out how deep it is to good bottom before digging is begun, in order to see whether piling might not be less expensive, and chiefly so as to be able to say definitely how many rings of timber there will be, and how much extra room will, therefore, be needed to step in all around about 15 inches every 10 or 12 feet in depth; this is a very important consideration. See Fig 67.

FOUNDATIONS IN WATER.

When masonry work is to be built in water, the considerations which determine the method to be adopted are: (1) The depth of water and its fluctuation in level. (2) The depth of soft material underlying the water which must be penetrated to secure good foundation. (3) The velocity of the current. (4) The money and materials available.

Of these considerations Nos. 1 and 2 are most important, and the total depth from water surface to bottom of structure will determine whether the foundation should be obtained by:

(*A*) Fixed cofferdams; (*B*), floating cofferdams, with solid timber bottoms; (*C*), bottomless cofferdams or caissons; (*D*), compressed air; (*E*), open dredging.

Fixed Cofferdams.—These are used where there is shallow water, at most only a moderate current, and where the bottom is of such a nature as to admit of sheet piles being driven in and the foundation suitably excavated to a firm foundation bed. This may be accomplished in various ways. Where the structure is near shore and waste excavation is available, it will pay to make an embankment above water level, and carry down hand-driven sheet piles kept in position by rings of timber, the excavation being always kept about level with the bottom of the sheet piles. This method is illustrated in Fig. 67. If, however, the structure is not thus situated, the sheet piles are either driven in a double layer, as in Fig. 68, or a single row of Wakefield sheet piling is used (this is an artificially made sheet pile composed of three planks spiked together to form a tongue and groove). If any of these methods are employed, a centrifugal pump will be kept busy keeping down the water while the foundation courses are being laid, but in case such pumping power is not advisable or available a more expensive form of cofferdam can be used, as in Fig. 68. Rows of guide piles are driven at considerable distances apart, then walings are bolted on, and a double row of sheet piles is driven around the area to be unwatered, between which is rammed clay puddle, making a very watertight, but expensive, cofferdam. This is generally employed in extensive works where the area is to be unwatered for some length of time.

Floating Cofferdams with Solid Timber Bottoms — It is moderately certain that as long as timber is covered with running fresh water it will never decay, and it is even contended that in any fresh water it is practically safe also; this has led to the adoption of methods of foundation building which do not involve the unwatering of the bottom. If the bottom is bare and moderately level, or can be dredged to a good bottom and levelled up with broken stone, it is manifestly easy to build a watertight box with either a solid timber (Fig. 69) or stone-filled crib, or only a plank layer, as a bottom (Fig. 69), and, after floating it into position, sink it, by building in it or by external loading, and after the structure has been built up above water level tear off the sides of the watertight box, leaving the bottom as a permanent part of the structure. If, on the other hand, the foundation is soft and good bottom can be reached by piling, the piles are driven to a firm bearing, sawed off under water close to the bed of the river, and the same operation as just described is gone through, the structure being landed on top of the piles as a foundation, as in Fig. 70. These methods are cheap and satisfactory in situations where the current is not excessive, but in very swift currents such constructions are not as manageable as the bottomless cofferdams to be described, and even where used, it is