well is limited, and only certain types of pumps are adaptable for this work. For all-round results we have found the Nye and Pulsometer types most effective, because they are small, compact, easily handled and are economical in operation. If one unit is not sufficient, additional units can readily be dropped down and operated in conjunction with the first.

CEMENT JOINTS FOR CAST IRON MAINS.*

By Clark H. Shaw, Assoc.M.Am.Soc.C.E.

THIS paper presents the method of making successful cement joints in cast-iron water mains. A brief history of the use of this joint establishes the fact that this method of construction has long since passed the stage of experiment, and has been proved to be an economic factor in laying such mains.

The process of making the joints is described and illustrated, some experiments in jointing are described, cases showing the strength of cement joints under trying conditions are cited, and data relating to cost, etc., are presented.

About 1886 a cast-iron pipe line for water distribution was laid with cement joints at Redlands, Cal., and in 1891 joints of that kind were used at Los Angeles, Cal., but evidently with questionable results, as the method was not adopted. In January, 1907, Mr. Charles Thornburg,

Fig. 1.

Fig. 2.

then superintendent of one of the water companies operating in Long Beach, Cal., decided to try cement joints for a 16-in. cast-iron pumping main, and instructed his foreman of construction, Mr. F. M. Shrode, to conduct some experiments.

No definite process was outlined to the foreman, but his experiments and practice in repairing steel riveted water mains under pressure, by using a dry mixture of neat cement in caulking the bands around these pipes, gave him an idea that a moist cement could be caulked into the bell solidly, and would produce the results desired. It was probably Mr. Shrode, who, by this experiment, finally perfected the joint and used it in construction of the entire line. When this line was completed and put into service, working under a static head of about 190 ft., several places showed some seepage, particularly at the lower end of the line, where the work was started, and it was decided to re-caulk these joints at the first opportunity; it was noticed, however, that the moisture was gradually drying up, and the seepage finally ceased.

Cast-iron construction was then abandoned by this company until 1911. During that year the works came into the possession of the municipality, and the writer was appointed engineer of the water department. After looking into the merits of the cement joint, as used on this 16-in. pumping main, it was adopted as the proper method of construction, and since that time it has been used throughout the entire system.

Long Beach now has 60 miles of cast-iron water mains, ranging from 4 to 24 ins. in diameter, laid with

Fig. 3.

joints of this type. All these pipes are under pressures ranging from 40 to 80 lbs. per square inch, and are giving perfect satisfaction.

Method of Making the Joint.—In making the cement joint the pipe is placed and spaced in the usual manner. A thin backing of the best dry jute is used instead of oakum, as the jute is free from oils and grease (which should be avoided). A Portland cement, conforming to the specifications advocated by the American Society for Testing Materials, is used. The dry cement is placed on a piece of canvas (usually a cement sack ripped open), and moistened just so that when thoroughly mixed by hand it will be of such a consistency that when gripped tight it will hold the form of the hand (Fig. 1), and when dropped 12 ins. it will crumble (Fig. 2). The canvas containing the cement is placed under the bell, and the cement is tamped into place by hand with a caulking iron until the bell is about half full (Fig. 6). It is then caulked with heavy blows until the cement is thoroughly packed in the back of the socket. This process is continued until the bell is packed solid out to the face (Fig. 7). A small bead of neat cement in a plastic condition is then put on, using the caulking iron as a trowel (Fig. 8). As soon as the initial set of the cement in the bead has taken place, the joint is covered with earth to protect it from the air and sun. In back-filling, the excavated material is always settled with water, which helps to cure the exposed portion of the joint.

The bead is essential, in the writer's opinion, as the cement packed in the bell is so dry that without protection

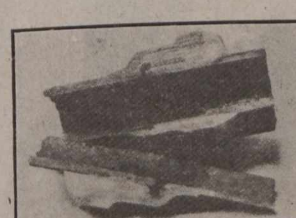

Fig. 4.

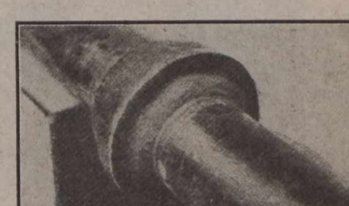

Fig. 5.

it would absorb moisture from the water used in settling the trench, and it is believed that, should the joint develop seepage when the pressure is put on in the main, the cement, being dry, would expand and aid materially in keeping the joint tight.

Experiments on cement joints constructed without the bead showed that, 24 hours after completion, they absorbed water readily. In cases where seepage has developed and has subsequently closed, it is assumed that the dry cement absorbed the moisture from the inside, expanded, and filled the seepage pores.

About 20% of the cement is wasted by falling off the canvas or being thrown out by the caulker. If any dust

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