to be as well adapted for the joints of cast-iron pipe under pressure. Lead joints may be driven or re-caulked, and all leakage stopped, while the pressure is on, which is quite an advantage over cement, as it would be impossible, practically, to secure any bond with the cement after it had thoroughly set. In case of an important leak it would be necessary to shut off all pressure on the main, and possibly the water would have to be drawn off; then, after removing all the original cement, an entire new joint would have to be made.

In a grade-line pipe, there is no doubt that cement joints would be safe and economical; but in a high-pressure cast-iron main, it would appear to the writer to be difficult to find a substitute for lead joints; under the present prevailing high prices of materials, and especially metals, the cost and the special requirements relative to the safety of the structure, should be well considered before work begins.

It is possible that this paper may bring out some discussion relative to the likelihood of electrolysis along a cast-iron main with cement joints paralleling electric car lines; it would seem that, as cement is a non-conductor, such a line of pipe would be unfavorable to electrolytic action, as the current being so frequently broken would leave the main in minor quantities without causing deterioration; however, experiments would demonstrate this matter more satisfactorily.

The author states that the cement joint for cast-iron pipe has passed the experimental stage, especially in work with which he has been connected, and that such joints are safe and satisfactory. The work seems novel to the writer, and he is indebted to the author for attracting his attention to new construction methods.

H. G. Moulton, M.Am.Soc.C.E.—With respect to the use of Portland cement instead of lead in forming joints for cast-iron water mains, it may be said that this is the method against which there is every theoretical objection, but in favor of which there is the practical argument that it has become a demonstrated success in actual practice. For a number of years past the use of cement for this purpose has been standard practice in Los Angeles, a thriving municipality of some 350,000 population, and the speaker is indebted to William Mulholland, M.Am.Soc.C.E., chief engineer of the Bureau of Water-works and Supply of that city, for much interesting information in regard to this method of making joints. The following statements in regard to costs and conditions in Los Angeles are in a large measure based on figures furnished by Mr. Mulholland.

The advantage in favor of this method lies in its great economy. In 1912 about 9,000 ft. of 30-in. high-pressure water main were laid in Los Angeles. Cement at that time was quoted at $2 per bbl. there and lead cost 5 cents per lb. The total saving on the job by using cement instead of lead was approximately $3,500. At present comparative prices of lead, cement, and labor, the saving would be very much greater, and, of course, on 36 or 48-in. mains a very large saving is possible.

An additional advantage in the use of cement lies in its insulating effect, in that it appears to act as a perfect seal between the separate sections of pipe and thus to reduce materially the effect of electrolysis. As damage to cast-iron pipe from stray electric currents has resulted in deterioration of water mains in many places, any type of joint which tends to reduce such damage, by stopping the flow of stray current along the pipe, is worthy of serious consideration.

The arguments against the use of the cement joint are based on a fear that temperature changes, resulting in uneven expansion and contraction, would tend to break up the joint, and also on doubt as to the action of pipe caulked by this method in the event of settlement, in filled ground or otherwise. In Los Angeles, the usual practice is to refrain from the use of cement joints where pipe must be laid on fills, probably on the assumption that, in case of settlement opening up joints, they can be re-caulked more easily if lead is used. In Long Beach, however, as mentioned in the paper, the cement joint has been used in filled ground, and also under conditions where trenches adjacent to the pipe have allowed sections of it to sag over a length of 40 ft. in one instance; and another instance is mentioned in the paper where some 98 ft. of pipe broke away and dropped into a trench with all the joints remaining in perfect condition, except those at the actual point of rupture.

In regard to the question of the ability of pipe to span extensive distances when the supporting ground is washed away, it may be said that, in designing connections for water pipe lines, good practice does not call for laying them out as suspension bridge connections, under the assumption that the pipe should be able to hang suspended over extensive spaces without failure. Under all normal conditions, a water pipe joint need only be considered in regard to its ability to prevent the leakage of water with reasonably continuous support and with a proper depth of cover above. Its behavior under abnormal conditions, where it has to hang suspended over wash-outs or cave-ins, is a matter of interest only from a standpoint of curiosity, and one is certainly not justified in designing all pipe on the assumption that it must meet conditions such as this, and providing special connections for this purpose.

In regard to the question of temperature changes, it may be said that there is seldom a variation of more than 50° between the winter and summer temperatures in city water mains. In winter, temperatures lower than 32° Fahr. cannot exist, on account of the fact that, at this point, the water changes to ice; and above a temperature of 85°, it is certainly too hot for use as drinking water. In Los Angeles the maximum variation in temperature is from 45° Fahr. in winter to 82° in summer, or a total range of 37° Fahr. Under this range, no trouble has been experienced with cement joints from leakage introduced by temperature stresses.

This paper brings up an interesting method which was first devised in California, and the success of which has been proved there on an extensive scale. It is no longer in an experimental stage, and is worthy of serious consideration on the part of eastern municipalities. The saving in expense made possible by the substitution of cement for lead in the joints of cast-iron pipe is so great that all the larger eastern cities would be justified in commencing immediately the use of cement joints in an experimental way in outlying districts, working gradually in to more important parts of the water system as the advantages and limitations of the method are developed in each municipality.

The author is entitled to a large measure of credit for having brought thus forcibly before the society the advantages of a pioneer engineering method having great possibilities, which the engineering profession as a whole has been slow to recognize and adopt.

Three hundred and eighty-four electric hoists with 25 h.p. motors are used to handle the hinged spouts of the new ore dock (No. 5) of the Duluth, Missabe and Northern Railway at Duluth, Minn.