REPAIRING THE CONCRETE PIER OF A BRIDGE BY INJECTION OF LIQUID CEMENT MORTAR.

During the night of the 26th and 27th of August, 1906, a Dutch steamer of 8,000 tons, the "Graenyesberg," loaded with ore, steaming through the Kiel canal from west to east, collided with the north pier sustaining the fixed truss of the swinging bridge over this canal at Osterrönfeld. The impact was so violent that the entire upper part of the pier, measuring 29½ feet in length by 19¾ feet in width, was moved in an easterly direction, and those horizontal joints about 10 feet below the water gave way, and opened to the extent of 5 to 6 inches. The most important crack was that of the lower joint, and extended first horizontally for a depth of 42 2/3 feet into the pier, then turned sharply downward for about 5 feet. This crack was about 5 inches wide. The upper two cracks were of similar dimensions, reaching only for about 18 feet into the pier, and were 4 inches to 6 inches in width. In the interior of the cracks the materials were as if crushed. The bridge rested upon this pier on a fixed anchor sill with a pan, and the violence of the collision threw the bridge 15¾ inches to the east, displacing the pan. To repair this damage, it was resolved to leave the upper part of the pier entombed, and to simply consolidate the whole of the structure by forcing in the open joints liquid mortar under air pressure. This operation had to be done entirely under water. In order to do this, the bridge was first put again in its place upon the pier, and underpinned to its proper level, so as not to disturb the railway traffic. Then the supports of the bridge upon the pier were taken away, and the work of filling in the cracked joints started. First divers were sent down to examine and properly locate the fissures, and to clear away as much as possible, without danger to themselves and to the bridges, the stones covering these fissures. Then they drove in tightly hardwood wedges in the open cracks in their entire length, and calked them with oakum. Eighteen of these wedges had lengthwise semi-cylindrical notches, and were driven in in pairs, so as to form a hole for the reception of nine pieces of iron pipe with threads on the projecting end, on which an elbow could be screwed on. Through these pipes the liquid cement mortar was to be forced into the cracks. On these elbows were screwed on vertically pieces of gas pipe 19¾ feet long and 1 3/5 inches in diameter, fastened to the pier by means of clamps. The upper ends of these pipes were connected to rubber tubes, conveying the liquid mortar under pressure from the injection tanks.

In order to tighten the work still more, a canvas 5 feet wide was fastened upon the damaged part of the pier, securely rolled on top and at the bottom over two steel cables wrapped up in oakum and twisted straw and solidly anchored to two piles driven alongside of the pier on both sides, and these piles again were fastened to one another by chains drawn tight. Upon this canvas were vertically fastened, from 8 inches to 10 inches strips of wood 1 3/5 inches to 2¾ inches thick, the whole tightly secured by two iron bands, anchored to the piles and tightly wedged against the pier. This preliminary work was completed in fifteen days. The gas pipes were now put in place, and the operation of filling in the cracks begun. Two scows were anchored against the pier. One carried the engine driving the air compressor, and the air tank for the compressor; the other three tanks to contain the liquid mortar and the necessary material for filling the tanks. These three tanks were connected with the compressed-air tank and with one of the gas pipes. The air tank had a gage and a valve, and was connected by means of a cock with three openings with the mortar tanks. This cock was so constructed that only one tank at a time was connected with the air tank. Each of the three tanks had a funnel for the purpose of filling them; an agitator with a handle, for the mixing of the mortar in the tank to avoid settlement; a discharge cock opening and closing the flow of the mortar into the tube connected with the gas pipe.

The mortar used was composed of one part Portland cement and one part fine sand, with the addition of a volume of water equal to the volume of the mixture. The mortar was poured into the tanks, each of 74 quarts capacity, and forced into the cracks by means of the gas pipes. The maximum pressure was 141 cubic feet, and the work, started at 7 A. M., was finished by 9 P. M., by which time the mortar ascended to the mouth of the gas pipes, so indicating that the cracks were tightly filled. This was also confirmed by the divers, who reported that the mortar had bulged the canvas and made excrescences all around the joints.

The total quantity of forced-in mortar was 494 cubic feet, representing two hundred fillings of the tanks.

For the purpose of ascertaining how the mortar would behave under water, a wooden box lined with canvas was sunk alongside the pier at a depth of 10 feet and filled in in the same manner as the cracks. The contents of the box were examined after two weeks', and again after four weeks' immersion. At the same time the mortar in the cracks was examined by boring holes 3/5 inch in diameter in the same. At the end of five weeks the setting was considered sufficient, and on the 25th of October, 1906, the resistance tests of the pier were made. These tests were a complete success, and the circulation of the trains was immediately restored. Since then the filled-in joints have not shown any tendency to slide or to settle. The cost of the repairing was about $2,171, and the entire putting in order of the bridge for travel about $3,136. This expenditure is considered very low, and certainly much lower than if the pier had to be demolished and reconstructed.—Translated from Génie Civil.

A FEW SUGGESTIONS FOR INVENTORS OF SAFETY DEVICES.

BY EDWIN PHILLIPS.

When our forefathers first went down to the sea in ships, little was known or even thought of safeguards or "prevention." They put off to sea almost wholly at the mercy of the waves and when storms arose were in grave jeopardy. To begin with, there were no rudders to steer by, keels to prevent rolling, anchors to "let go," mariner's compasses to direct a course, life-saving apparatus for emergencies, storm warnings to put them on their guard, nor lighthouses to spread welcome beams across the broad expanse of waters. But to-day, thanks to invention, the hardy mariner possesses all these. Also many more. But more still are wanted, for hardly a month elapses but losses of life occur upon our coasts, many of which losses could be averted. Science has made efforts innumerable to anticipate storms and thereby prevent their dangers. For the sake of man's humanity to man such efforts need direct encouragement.

"How true," wrote Carlyle, "is that old fable of the Sphinx who sat by the wayside proposing her riddles to the passers, which, if they could not answer, she destroyed them." The riddle of the hour is, How can we encourage "prevention"? Why should not dray and other road vehicle wheels have a guard depending in front of them—a combination footstep, handrail and body pusher, for example? Have not fly and other wheels in factories a guard? It cannot be denied that about moving wheels there is an element of danger. "Dad, I won't carry stones any more," were the dying words of a sixteen-year-old youth in Melbourne not long since. At the inquest on his remains at the morgue it appeared that he was leading a horse drawing two tons of spawls, when, said an evening paper describing the event, he slipped, and the wheel passed over his body. Foot passengers crossing streets are liable to the same accident, and it is by no means an infrequent occurrence. The dangers attending such a fall are considerably reduced if there is a guard to push the prostrate one aside. Very true, very true indeed are Zimmerman's words, and they call for serious thought: "Laws act after crimes (accidents) have been permitted; prevention goes before them both."

"There's no education like adversity," said Disraeli, which being modified might read: "There's no education like accidents." In the past, accidents, because they have been accidents, have generally been regarded as unavoidable. But investigation teaches that in the future they may be perceived through different spectacles. Experience shows that accidents may be divided into two classes—(1) preventable, (2) unpreventable. It further shows that a hard-and-fast line can be drawn between those that can be avoided and those that cannot. Likewise that the list of accidents in variety and number is increasing every year with the increased invasion of new types of machinery. By thought and reform, accidents which were formerly consigned to the second or unavoidable class are now elevated to the first or preventable class.

The heroes of science, chemistry, and physics have in the past held doctrines that they dared not promulgate publicly. If they did it was with the fear of death to themselves and delay to the cause. That the sun and planets revolved round the earth was once a common belief. Giordano Bruno knew otherwise and for saying so was (about 1600) burned at the stake and his ashes cast to the winds. To-day his theory is an accepted fact. When Boyer in France, more than a century ago, preached inoculation as a preventive of smallpox, when Edward Jenner about 1790 announced his doctrine of vaccination, both the pulpit and the press strove to talk and write them down. A desperate battle against overwhelming opposition had to be fought before people could accept the new theory. But the great truth conquered; and another great truth is that nearly all the ailments to which flesh is heir may sooner or later succumb to preventive measures. If, with the limited knowledge of those days, Dr. Jenner could discover a preventive for smallpox, with the scientific progress made since there should be no difficulty in discovering means for preventing pneumonia, diphtheria, bubonic plague, influenza, etc. The day may, and should, soon come when instead of the human arm having one mark on it as an indicator that smallpox has been warded off, it will have many marks for each of the diseases enumerated, in fact a mark for each disease as man one by one conquers them. It is a vulgar error to assume that prevention will win no more victories, but is dead.

SCIENCE NOTES.

According to a recent census the total population of the Canal Zone is 50,000. Of this number 24,963 persons are employed either by the Isthmian Canal Commission or the Panama Railroad Company. Of the total population 14,635 are white, 34,785 are negroes, and 583 are Chinese. Of the whites 6,863 are from the United States, and of these 5,213 are males and 1,650 females; 2,030 married men and 1,048 married women; 2,713 single men and 172 single women; 451 children, 232 boys and 219 girls between the ages of 6 and 16 years. There are also from the United States 73 colored persons, 57 males and 16 females. The total cost of taking the census is given at $3,936.36.

In sinking an artesian well at Newlyn an interesting discovery has been made in tapping springs of highly mineralized water. The sinking of the well was undertaken for Mr. R. R. Bath, and the Newlyn Ice Company, in connection with the factory which has been erected for the manufacture of ice, to procure water to use in ice-making. A depth of about 180 feet has been reached, two tin lodes having meanwhile been passed through, and water from the springs reached was submitted for analysis to Mr. J. H. Bosanko, of the Penzance Mining and Science Schools. He was surprised to find that the water was highly mineralized. The simple test revealed an abnormal quantity of iron in the water, showing that it must be running through rich mineral veins. No water of this description has ever been found in West Cornwall, and it is thought that perhaps it may possess medicinal properties of some value.

From experiments conducted at Ottawa, in Canada, it appears that there are some slight grounds for the widely-accepted opinion among agriculturists that snow is a direct fertilizer, says the Pharmaceutical Journal. It is found to contain total nitrogen equivalent in round numbers to about a pound per acre of land covered by an average winter snowfall in that district. The amount of nitrogen as free ammonia was high, but fluctuated greatly, from 0.082 to 0.589 parts per million; the nitrogen as albuminoid ammonia ranged from 0.033 to 0.078 parts per million, and the nitrogen as nitrites and nitrates ranged from 0.027 to 0.390 parts per million. The average of twelve determinations from February 21, 1907, to May 4, was, nitrogen, as free ammonia 0.256, as albuminoid ammonia 0.052, and as nitrates and nitrites 0.163 part per million. The value of snow as a direct fertilizer would appear, so far as the nitrogen content is concerned, to be greatly overestimated. It is intended to continue the experiments both in summer and winter to determine definitely the manurial value of both snow and rain.

THE CURRENT SUPPLEMENT.

The extent to which electricity is used in the manufacture of street gas is hardly realized even by technical men. How much can be done by electrical means to simplify the handling of material in gas-works is set forth by Dr. Alfred Gradenwitz in the opening article of the current SUPPLEMENT, No. 1708. In an Austrian oil-field there was recently installed the first machine for the extraction of oil from bore-holes by the Leinweber system. The installation is described by the English correspondent of the SCIENTIFIC AMERICAN. E. S. Lincoln contributes an article on "Testing Direct-current Dynamos." The Hon. Robert J. Strutt, well known as an authority on radioactivity, explains in a characteristic, clear style the radioactive changes in the earth. Charles L. Hubbard gives a brief review of liquid fuel for the benefit of those who desire a general knowledge for purposes of comparison without going too much into details. "Training the Man Behind the Gun" is the title of a stirring article that reveals the secret of the marvelous success achieved by the skilled naval gunner in firing at targets. The daily press has commented at length on the highly dramatic paper read by Francis Darwin before the British Association for the Advancement of Science, in which he explained his theories of the memories of plants, and his view that the development of any living creature from an egg seems to presuppose something akin to biological memory. The first installment of the paper appears in the current SUPPLEMENT. The improved Parseval airship, which has aroused almost as much interest as Von Zeppelin's gigantic, ill-fated craft, is described and illustrated. Eugène Lemaire explains how parchments injured by fire may be restored. Does the planet Venus revolve on its axis, or does it always present the same side to the sun? The question is one that has long puzzled astronomers. Otto Hoffmann considers the question from both sides, and produces all the available evidence for and against rotation.