to the harbor, were lost sight of in the sympathy extended to all in the face of this terrible storm visitation.

IMPROVEMENT OF THE RIVER FRONT OF NEW YORK CITY.

The Department of Docks of the City of New York has, for a number of years, been engaged in improving the river front of this city. The work was begun under the administration of General George B. McClellan as Chief Engineer, in 1871. In July, 1875, it passed into the charge of Mr. G. S. Greene, Jr., Chief Engineer of the New York Department of Docks. The work has been principally done on the Hudson River front, where granite bulkheads have been built. Different constructions have been used for different localities. This article is specially devoted to the subject of the new bulkheads that are now being constructed. Two typical forms are illustrated. The wall will be seen to consist of a foundation of concrete or piling or both sustaining a granite wall backed up by concrete. The concrete blocks, which act as a foundation for the granite wall, are backed up by cobble stone and riprap, braced by straight and sloping piling where the nature of the ground requires it. The general method of constructing a wall supported on piling where rock bottom cannot be reached is as follows:

The vertical piling is first driven. It is usually white, yellow, or Norway pine, cypress, or spruce, varying in diameter from 16 to 28 inches, and of a maximum length of about 90 feet. In many instances short piles, however, only can be used, on account of the presence of rock. Where loose stone is to be penetrated, an iron shoe is placed over the foot of the pile. The vertical piles are first driven and the three front rows are cut off 15·3 feet below low water. They are cut by a circular saw worked from a floating pile driver. The saw is journaled to a large timber which is lowered to the proper distance, and the feed is accomplished by moving the pile driver up to its work. The six rear rows of piles terminate 2 inches above mean low water, and are notched at the top to receive transverse caps.

After the vertical piles are driven, cobble stones, gravel, and riprap are put in place around them. As these are put in in layers, the riprap on the outside and cobble stone filling on the inside, each tends to take its own slope, so that a sort of interlacing of the two classes of stone filling occurs. Before the entire cobble stone and riprap filling is in place, binding frames are put in to hold the piles in place. These consist of two pieces of 5 inch by 10 inch spruce placed one above the other. Through the ends 8 inch by 8 inch oak beams pass, and are wedged back against the piling. On the three front rows of piles which were cut off by the circular saw, concrete blocks are placed. Each of these blocks is 7 feet wide on the bottom, 5 feet on the top, and 6 feet in length; their vertical height in front is 13 feet, in the rear 14 feet, affording a step for the granite wall. Each block weighs about 70 tons. Before they are lowered, a mattress, composed of burlaps filled with about two inches of mortar, is placed on top of the piling, which mattress is carried on a network of marlin attached to a wooden frame. When it has sunk to its place divers descend and cut the marlin so that the frame floats upward, leaving the mattress and marlin netting lying on top of the piles. This mortar is made with slow-setting cement, and as quickly as possible the 70 ton concrete base block is lowered on top of it, thus obtaining a firm bedding on the piling, members of which may vary one or two inches in height. More cobble stones are added, and the inclined bracing piles are driven, an inclined pile driver being used for the purpose. These go down between the vertical ones, and are placed at a distance of three feet from center to center; their slope is represented by an inclination of two vertical upon one horizontal. All the piles are adjusted and stay-lathed as soon as they are driven. The bracing piles are now cut off at the top and capped with 12 inch by 12 inch timbers lying horizontally, and more cobble stones and riprap are filled in. The granite wall is completed and backed by concrete, and a general light filling is placed above the riprap. All of these features can be clearly understood by inspection of the drawing. The concrete backing is further protected by a four-inch oak planking. Oak treenails are used for all fastenings, so that the whole represents a structure built without metal, which is, from an engineering point of view, quite a curiosity in the present age of steel. From this peculiarity it has excited much comment abroad.

The moulding and moving of the concrete blocks, which is illustrated in some detail, is a matter of special interest, as they are, probably, the largest moulded blocks ever handled in this manner. They are made in moulding boxes, and consist of two volumes of sand and one volume of Portland cement, mixed dry and moistened down with a sufficiency of water. To this mortar small sized stone, broken so as to pass through a 3 inch ring, is added in such proportions that there will be enough mortar to fill all interstices when rammed. This proportion is determined by hydraulic or water test, as well as by the practical mixing of samples. The concrete will average in its proportions 1 cement, 2 sand, and 5 broken stone; but is found to vary with the stone used. The same is to be said with regard to the water used for mixing the mortar. This is added to the mixture in such quantity as may be required by the particular sand and cement used.

The concrete blocks as moulded have vertical grooves passing down each side, and a groove across the bottom or a hole through their mass near the bottom. This groove, and hole, if present, are for receiving the hoisting chain by which they are lifted, as shown in the large illustration. The floating derrick which raises them has a capacity of 100 tons, and as each block weighs 70 tons, there is quite a surplus of power for handling them. When lowered into position the clevis of the chain is detached and a rope is fastened to the loose end. The derrick then draws the chain out and clears it from the block. By means of the rope the end is allowed to descend just as fast as the other end is hoisted, in order to prevent the chain from being caught in the aperture or on the corners. The hole passing through the block at a distance from the base is found to be objectionable, as tending to cause a fracture of the base, and the method shown in the cut is usually employed.

All this work applies to the formation of a bulkhead or river wall. It is done in sections, much delay being experienced from the opposition made by private owners. By means of this bulkhead a depth of 12 feet at mean low water against the face of the wall is secured, which is considered a sufficient depth for any vessel 200 feet long, that being the maximum length between piers. Where rock bottom exists the piling is dispensed with and concrete in bags is used for the base blocks to rest upon. An example of this construction is shown in one of the cuts. Different shaped concrete blocks are employed for different situations also. The general type is given here.

Through the concrete blocks weep holes are carried from rear to front, which are left open in order that water accumulating in the filling may have a chance to escape. When the blocks are put in place, it will be seen that the vertical grooves must come together. They are filled with concrete in bags rammed down, so that a species of tongue is formed, anchoring the blocks together and preventing transverse displacement. The granite headers of the wall are dovetailed at their rear end, so as to be anchored back into the concrete, while a firm longitudinal bond is given by the breaking of joints in the stretcher courses. One feature of the work is the thorough ramming to which the concrete is subjected, the object being to have stone touch stone in the mixture, to have no space between them, and to have sufficient water to insure setting. The quality of the cement is of the best, and it is subjected to elaborate tests for strength, time of setting, color, etc. In one section, where the piling failed to reach hard bottom, the whole structure is practically floating on a soft mud. Yet this section appears to be as secure as any.

The Outer Ring of Saturn.

BY JAMES E. KEELER, ASTRONOMER OF THE LICK OBSERVATORY.

In the *Sidereal Messenger* for February, 1888, and more recently in *Ciel et Terre*, I described the appearance of a very fine division on the outer ring of Saturn, which was seen on several occasions with the 36 inch equatorial immediately after its erection at the observatory, and particularly well on the night of January 7, 1888. In the year which has elapsed since the time of its discovery, the division has been repeatedly looked for by different members of the observatory staff, but without success; and I had come to the conclusion that it was either invisible by reason of the greater obliquity of the ring, or that it was of temporary character, and no longer existed. More recent observations show that our failure was due simply to the lack of sufficiently good definition.

On the night of March 2, which was one of the finest that we have had at the observatory, the division was seen by Professor Holden, Mr. Schaeberle, Mr. Barnard, and myself, and was independently estimated by all four observers to be situated at one-sixth of the width of the outer ring from its outer edge.

Mr. Barnard and I continued to observe the planet, with different magnifying powers, until after it had passed the meridian. The brilliancy of the whole system, particularly of the gauze ring, was remarkable, and the outlines appeared with a sharpness more characteristic of the lines of a steel engraving than of the usual telescopic image. With a power of 400, a faint shading could be seen on the outer ring, A, at about one-third of its width from the outer edge. If no higher power had been available, we should have said that we had had an excellent view of the Encke division (or shading).

With a power of 1,500 the appearance was different. The division near the outer edge of the ring then became visible, not as a shade, but as a distinct black line of exceeding fineness, and from this a dark shading extended inward nearly to the inner edge of the ring. Mr. Barnard placed the maximum depth of shade at one-third the distance from the outer edge, or where the Encke shading appeared with the lower power. To me it seemed farther out, nearly at the division which separated the shading from the brighter margin of the ring. The narrow strip lying between the division and the outermost edge of the system appeared to both of us to be the brightest part of ring A.

The outline of the planet's shadow on the ring was seen with the greatest distinctness, and was a perfectly smooth curve, agreeing, as nearly as we could judge, with that required by geometrical principles. A very minute irregularity could easily have been detected.

In my opinion, the division described above is a permanent feature of the outer ring, but it is so minute that it may fairly be classed among the most difficult and delicate of planetary details, requiring the most powerful instruments and exceptional atmospheric conditions for its observation.—*The Astronomical Journal.*

A Suggestion for Fuel at Apia, Samoa.

The question of cheap fuel is important to us all, and none the less so in the oil regions, where to burn up our surplus stocks means better prices for our commodity.

To obtain perfect combustion in burning crude oil as a fuel under boilers, stoves, etc., is and has been a desideratum.

The best device brought to my notice is a cast iron burner, which is placed in the fire box of a boiler and connected to an oil retort by pipes having the necessary shut-off cocks, with a slight fall toward the burner.

This burner is also connected by pipes, etc., to the boiler itself for steam.

In order to start the fire, you have only to turn on a small amount of oil and ignite it. Then open the steam connections to burner, and as the oil passes through the burner it becomes superheated into gas, and as the gas and steam blend and rush into the firebox, you have a gas fire at once of most intense heat, and as effective as natural gas, and when the steam and oil supply are adjusted, nearly perfect combustion is obtained.

In case you do not have steam up when the burner is started, and have water pressure at hand, the burner is adjusted to make its own steam.

What suggested this letter were the numerous articles in the papers of late indicative of anxiety at our naval headquarters as to our fuel supply for war ships centered at Samoa; also the need of a fuel for the navy that would steam quickly.

For the war ships plying the Pacific Ocean at Samoa, I would suggest the government erect, at Pago-Pago, several iron tanks of two thousand barrels capacity each, near the coaling docks; to connect these tanks with the docks, by pipe lines and proper shut-off cocks; to buy crude oil from the California or Ohio oil fields and have it delivered at the nearest seaport harbor, and thence transported in bulk in ships to Pago-Pago and stored in these iron tanks to be used when wanted.

About 3 to 3½ barrels of oil (weight about 350 pounds to 42 gallons) equals in heating units a ton of coal.

Crude oil can be purchased at Hueneme, California, on the coast, for about two dollars per barrel, or in Ohio on cars for 35 cents per barrel.

Have made for each ship a certain number of iron air-tight storage cylinders, the number to be regulated by the rules that govern the coal supply.

Put an oil burner in each boiler, to be connected with and supplied by these storage cylinders, which in turn are fed from the tanks on shore before the ship leaves the harbor.

Keep steam in one boiler continually, and this will call for very little oil if the steam supply is not drawn upon, and the amount of oil can be regulated so as to keep a certain amount of steam with no waste of fuel.

Now, then, an order is given to steam ready for action.

The boats using oil fuel will be ready and off long before the coal burners will have steam up.

Steam can be raised this way as quick as if generated by natural gas. This system of burning oil can be used to steam up with only, and then use coal, or if desired, coal and oil can be burned simultaneously.

The greatest danger to be overcome would be to store these oil cylinders where they could not be reached by the enemy's shot.

The cost of firing with oil wholly would reduce the firemen's pay roll three quarters. C. L. GIBBS.

Titusville, Pa.

A Valve for Electricity.

A device which may be of considerable value is described by M. Neyreneuf in the *Journal de Physique* as an electric valve, by means of which the current can be sent in one direction, but not in the other. With a voltameter constructed of two aluminum electrodes, dilute acid as electrolyte, and an alternating current, he found that pure hydrogen was evolved at both electrodes, but on making up an arrangement with one electrode of aluminum and one of mercury, using distilled water as electrolyte, the current was found to pass in one direction only.

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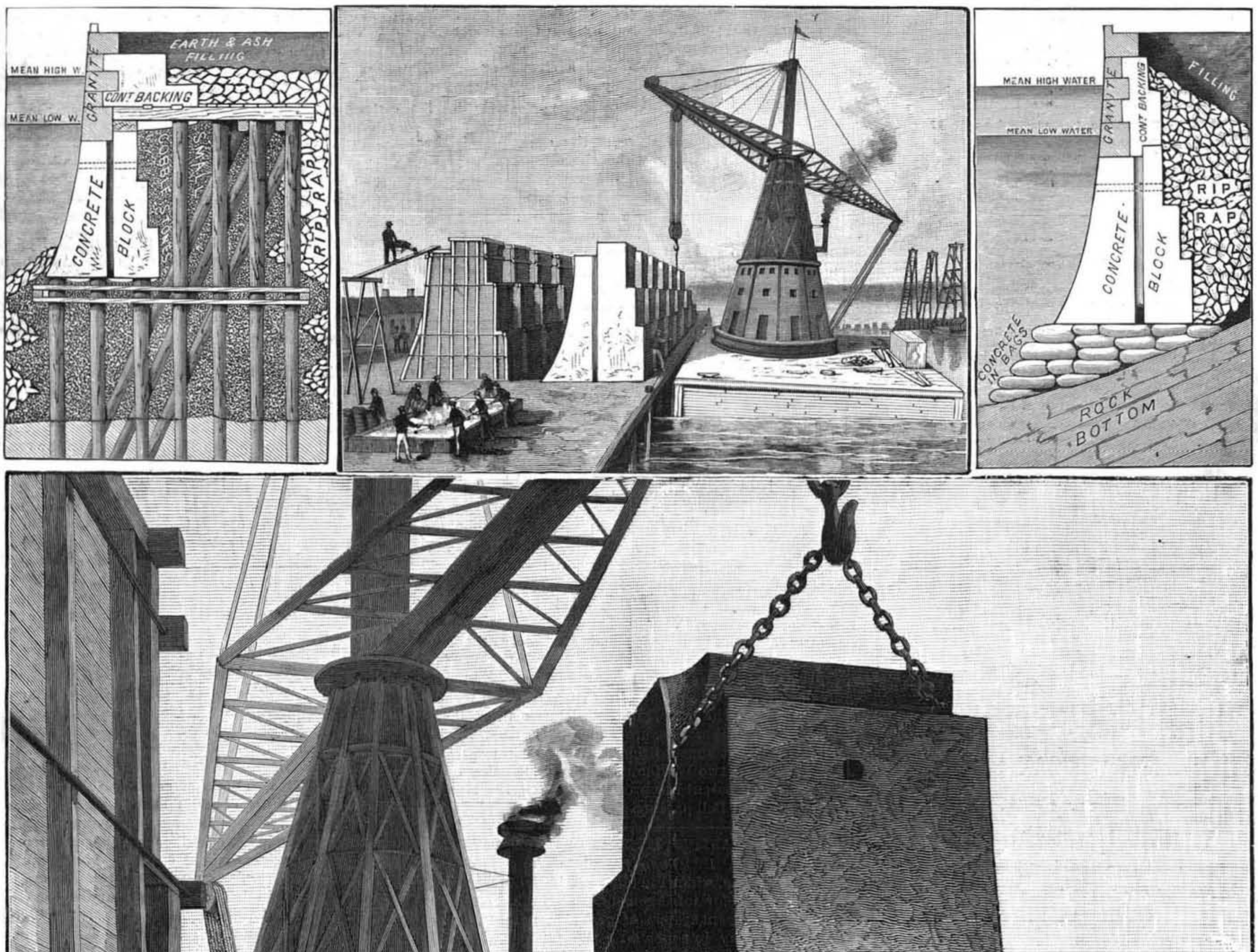

IMPROVEMENT OF THE RIVER FRONT OF NEW YORK CITY.—[See page 261.]

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