shell is composed of these plates it is wonderful bow the creature increases in size, as it cannot, like the crab, cast its old shell when too small and take to itself a larger one. But in order to overcome this the delicate lining membrane with which the entire surface of the body is covered insinuates itself between the edges of these plates and deposits round the margin of each particles of calcareous matter, so that each plate simultaneously increases round its edges, and the original form of the shell is preserved.

The surface of a sea-urchin after a certain age becomes thickly studded with spines (in young specimens the spines are much less in number), which are employed as a means of locomotion, and therefore are freely movable. If a single spine be removed, and note taken of the part it previously occupied, it will be seen that on the shell is placed a rounded tubercle, and that the base of the spine is furnished with a hollow socket into which the tubercle fits, so that the spine has perfect facility of movement. The spine is bound to the tubercle by a tendinous ligament, connecting the center of each much as is the case with the larger joints of vertebrate animals. The power of motion is communicated by the membranous covering that envelops the body during the life of the animal.

Besides the animals I have described as being members of the marine community, were also very small clump-clawed crabs, numerous *Neris* worms, a small variety of the *Cardum*, and minute acorn barnacles. In fact this single mass contained enough animal organisms to stock an aquarium for many months' study. The young sea-horses were introduced into the aquarium occasionally that they might enjoy an extra feed of small annelids.

THE KING PENGUIN.

Most interesting, by far, among all rookeries of penguins which I have seen was one of king penguins (*Aptenodytes longirostris*) which I met with at Marion Island.

The rookery was on a space of perfectly flat ground of about an acre in extent. It was divided into two irregular portions, a larger and smaller, by some grassy mounds. The flat space itself had a filthy black slimy surface; but the soil was trodden hard and flat.

About two-thirds of the space of one of the portions of the rookery, the larger one, was occupied by king penguins, standing bolt upright, with their beaks upturned, side by side, as thick as they could pack, and jostling one another as one disturbed them.

The king penguins stand as high as a man's middle. They are distinguished at once not only by their size, but by two narrow streaks of bright orange yellow, one on each side of the glistening white throat.

Penguins were to be seen coming from and going to the sea from the rookery, but singly, and not in companies like the crested penguins.

The king penguins when disturbed made a loud sound, like "*urr-urr-urr.*" They run with their bodies held perfectly upright, getting over the ground pretty fast, and do not hop at all.

A good many were in bad plumage, moulting; but there were plenty also in the finest plumage.

On the small area of the rookery, which consisted of a flat space sheltered all round by grass slopes, and which formed a sort of bay among these, communicating with the larger area by two comparatively narrow passages, was the breeding establishment. These penguins are said by some observers to set apart regular separate spaces in their rookeries for moulting, for birds in clean plumage not breeding, and again for breeding birds. Here the breeding ground was quite separate, and the young and breeding pairs were confined to this smaller sheltered area. This was the only king penguin rookery which I saw in full action.

At Kerguelen's Land the king penguins were only met with in scattered groups of a dozen and twenty or so, and they were then not breeding, but only moulting. On this breeding ground, at its lower portion, numbers of penguins were reclining on their bellies, and I thought at first they might be covering eggs; but on driving them up I saw they were only resting. There was a drove of about a hundred penguins with young birds among them.

The young were most absurd objects. They were as tall as their parents, and moved about bolt upright, with their beaks in the air in the same manner; but they were covered with a thick coating of a light chocolate down, looking like very fine broom-fur. The down is at least two inches deep on the birds' bodies, and gives them a curious inflated appearance. They have a most comical look as they run off to jostle their way in among the old ones. They seemed to run rather better than the adults, but perhaps that was fancy.

Absurd in appearance as these young are, those that are just dropping the down and assuming the white plumage of the adults, are far more so. Some are to be seen with the brown down in large irregular patches and the white feathers showing out between these. In others the down remains only about neck and head, and in the last stage a sort of ruff or collar of brown remains sticking out round the bird's neck, and then when it cocks up its head it looks like a swell boy in stick-up collar.

The manner in which these young ones cock up their heads gives them a peculiar expression of vanity, and as they ran off on their short stumpy legs I could not resist laughing outright.

At the farthest corner of the breeding space, in the most sheltered spot, was a clump of birds of a hundred or more. The birds were, most of them, in a slightly stooping posture, and with the lower part of their bodies bulged out in a fold in front.

As I came up and bullied these birds with my stick a little they shifted their ground a bit with an awkward sort of hopping motion, with the feet held close together. It immediately struck me that they were carrying eggs with them, as I had read that king penguins do Their gait was quite peculiar and different from the ordinary one, and evidently labored and difficult.

I struck one of them with my stick, and after some little provocation she let drop her egg from her pouch and then at once assumed the running motion.

These birds carry their eggs in a complete pouch between their legs, and hold it in by keeping their broad web feet tucked close together under it. They make absolutely no nest, nor even mark from habitually sitting in one place, but simply stand on the rookery floor in the described stooping position, and shift ground a bit from time to time as occasion requires. I suppose the egg is not dropped till the young one begins to break the shell.

Charles Goodridge says that the period of incubation is seven weeks, and that the birds commenced laying in the croyets in November, and continued to lay, if deprived of their eggs, till March. The birds with eggs were sitting close together. When, on my frightening them, some were driven against others, savage fights ensued and blood was drawn freely, the birds whose ground was invaded striking out furiously with their beaks.

Round about the brooding birds were others, I think males, in considerable numbers. The males probably feed the females with which they are paired. There were also some young downy birds.

If one of these latter was driven in among the brooders it was at once pecked almost to death. The young ones utter a curious whistling cry, of a high pitch and running through several notes, quite different from the simple bass note of the adults.

The egg of the king penguin is more than ordinarily pointed at the small end. It is greenish-white, like other penguin eggs.—*H. N. Moseley, Challenger Notes.*

The Menominee Iron Mines.

A correspondent of the *Iron Age*, accompanying the American Institute of Mining Engineers on its excursion among the mining districts of Lake Superior, anticipates a revolution in iron making to result from the inexhaustible stores of cheap ore in that region. He says:

We have questioned the propriety of calling some of the great openings of the Marquette and Negaunee districts "mines," as they might with more propriety be called "ore quarries;" but what shall we call these Menominee openings? They are not even quarries. You strip off the surface, and beneath lie deposits of ore such as the eye of man hath not seen. We are amazed, astounded, confused. Some of us who are interested in Eastern mines even turn away disgusted; and what wonder, when we see miners working these vast deposits of steel ore with pick and shovel as easily as they would dig a cellar on a sand hill; when we see ore of unapproachable richness and purity loosened, loaded, and put in cars for 25 cents a ton, including everything except the royalty of 50 cents. We have been impressed from the first; now we are appalled. I do not exaggerate in any respect the feelings of those who saw these mines for the first time on Tuesday, and who had enough acquaintance with the iron trade to understand the meaning of what they saw. "There is nothing like it in the world," says every one, and no one can intelligently question the statement that in this Menominee range, with its incalculable wealth of ore in sight and its unlimited possibilities of development, has been found the solution of the ore question for a longer time into the future than any one now in the iron business has any occasion to look. . . . Description cannot do justice to the subject, any more than it could to the Falls of Niagara. Even when we see the falls we wonder how this mighty cataract is fed, and when the supply of water which pours over the precipice in never diminishing volume will be exhausted. But our question is answered when we cross the great inland seas which are its unfailing fountains. So it is with Lake Superior iron ores. We see them steadily flowing into the port of Cleveland in increasing volume, and have allowed ourselves to be deluded by the mistaken predictions of such authorities as Mr. Bell, that they are drawn from pockets of known extent, and that the end of the supply can be predicted. When we go and look for ourselves we see that the supply is not a matter of years, but of centuries; that as yet we have but scratched the surface of a mineral wealth for which the world has no parallel, and that within two or three years at most, the abundance and cheapness of these ores will so reduce the cost of iron as to materially change the condition of national industrial development and international competition. If any one doubts this let him go and look, and his eyes will be opened. For the first time your correspondent appreciates the value of the Lake Superior ores as a factor in the problem of our iron development.

The Menominee range is the latest and grandest development of this wonderful country. In 1877, 10,405 tons of ore were shipped; in 1878, 94,245 tons; in 1879, 269,089 tons. This year there have already been shipped 375,000 tons, and before the close of navigation between 500,000 and 600,000 tons will have gone forward. Every pound of this ore will make Bessemer iron. The average cost at all the mines will not exceed $2 per ton on cars. In the furnace they will melt like snow. In one instance the ore costs 20 cents a ton at the surface, and with a total force of 60 men at work the mine yields 400 tons per day. Nothing is shipped which does not contain 55 per cent of metallic iron or over. The 50 per cent ore is piled near the workings in the expectation that in the event of a sudden demand it may be wanted. This production can be increased as rapidly as it may be needed, and there will soon be no room for foreign Bessemer ores in a market so abundantly supplied from Michigan and Wisconsin. The time is not far distant when this ore will be delivered at Cleveland at $4 per ton, leaving the mining companies $1 per ton profit. At this point the purest ores will meet the Connellsville coke, the finest metallurgical fuel in the world, and the pure magnesian limestones of the lake shores, than which there are no better. The rest may be guessed.

Original Inventions and Supplementary Improvements.

The *Telephonic Exchange Reporter*, in its allusion to the large number of patents issued on the telephone since Professor Bell introduced his instrument, adds the following remarks concerning the importance of patenting supplementary improvements.

When an inventor, says the writer, files a proper application for a patent, the government will grant to him a patent for whatever he can justly claim as his invention. Such invention properly belongs to the inventor, not by reason of a government privilege, but by reason of his having been the creator of the property. The government grants no privilege; it simply recognizes a legal right. The Patent Office makes an examination into the novelty of the invention in order that official recognition may be given only to that which appears to be new. If the official inquiry be not subsequently proven at fault, the invention or improvement patented is solely for the use or let of the patentee. He may let it drop, and thus make nothing from it. He may put a prohibitory value on it, and thus get nothing from it. He may put a just value on it and reap a rich reward, if his invention has merit. The justness of the inventor's charges will be evidenced entirely by public acceptation. If he charges too much the public decline his invention.

Another man may add an improvement to the original inventor's device. The improvement may consist of an added element, or in a useful change in form of old elements. The improver can patent his improvement.

The fundamental invention thus belongs to the first man, and the improvement belongs to the second man. The first man is not at liberty to make, sell, or use the improvement without the consent of the party who owns the patented improvement.

The second party is not at liberty to make, sell, or use the fundamental invention without the consent of the owner of the patent on the fundamental invention. In the absence of an arrangement, the first party must do without the improvement, and the second party must do without the fundamental invention. The first party can operate his invention without the improvement, but the second party can do nothing with his, because he has no fundamental invention to which he can apply his invention. He invented and patented his improvement with the hope that the owner of the fundamental patent would appreciate its merits and arrange for the use of the improvement. Without the allowance of the fundamental inventor, the improver is rock bound. He may have fine quarters on an upper floor; quarters which the party down stairs might envy him the possession of, but if the down stairs party has a sole title to stairs and exit, the up stairs party must leave his quarters vacant, or come to terms with the base.

In the case of patented inventions there may be hundreds of improvers on a fundamental invention; there may be improvements on the improvements; and many of the improvements may not be improvements at all, but may be fallacies based on wrong observation or incorrect experiment.

The status of patents is generally well understood by inventors, and they also well understand that the reward of the improver is likely to be handsome if his improvement will create a marked advance in the merit of the invention improved upon. The wise inventor does not cease his labors because his invention is a tributary one. Howe patented the essential fundamentals of sewing machines, but Singer was not thereby deterred from patenting an improved Howe sewing machine which he could never make without Howe's consent.

Bee Keepers' Convention.

The eleventh annual convention of the North American Bee Keepers' Society met in Cincinnati, Ohio, September 29. About one hundred and fifty delegates, from nearly all the States of the Union and from Canada, were present at the first session. In the annual address by President W. T. G. Newman, of Chicago, the honey crop of this year was said to be but half the usual amount, owing to bad weather. Papers were read on honey-producing plants and trees, new discoveries in the cure of foul brood, the yellow race of bees, Cyprian bees, etc.

The Cologne Cathedral.

Since 1821 the public and private contributions to the building fund of Cologne Cathedral have amounted to $4,500,000. Adding the contributions of past centuries, notably the money expended on the colossal foundations, a German paper finds that as it now stands the cathedral represents about $10,000,000.

Treatment of Nickel with Phosphorus.

M. J. Garnier, of the French Academy of Sciences, recently presented the following interesting paper to that body, giving the results of his experiments with nickel:

Pure nickel after melting generally contains more or less oxygen, and the metal is brittle. To prevent this injurious action of the oxygen, it is necessary to incorporate with the molten nickel a substance which has a great affinity for oxygen, but which shall also have a great affinity for the nickel itself; furthermore, this substance must not make the nickel brittle. The injurious action of the oxygen is proven by the fact that pure nickel melted in an atmosphere free from oxygen is extremely malleable. Such is the case with that which is accidentally deposited on the nozzles of the furnace blowers surrounded by combustible material. This same nickel, remelted or simply brought into contact with the air while at red heat, may then be pulverized under the hammer. Satisfied of this fact since 1876, I thought of adding metallic manganese to the metal, as is done in making steel. I chose manganese as the proper combining substance on account of its low price in the state of ferromanganese; but other easily oxidizable metals, it is needless to say, would have given the same results.

The manganese, it is true, did improve the quality of the nickel; but, like all metals having a great affinity for oxygen, it disappeared after successive remeltings, leaving the nickel again brittle. Thus I found that the oxidizable metals would not serve my purpose in practice, and I then employed phosphorus with success.

Besides the advantage of not perceptibly diminishing in remelting, when used in the small quantity necessary, phosphorus absorbs a much greater quantity of oxygen than any metal that can be used for the same purpose, using equal weights; thus while one unit of phosphorus absorbs 1·25 of oxygen in passing into phosphoric acid and 1·50 in passing into simple phosphate, one unit of manganese will absorb only 0·30 of oxygen in becoming protoxide of manganese; one unit of zinc will take only 0·25 of oxygen, and one unit of magnesium only 0·66 of oxygen. Furthermore, the phosphorus acts on the metal in such a way as to give it the various qualities necessary for its use in the arts, and its effect upon nickel may be compared with that of carbon upon iron. Thus up to three thousandths of phosphorus the nickel is soft and very malleable; beyond this amount its hardness increases at the expense of its malleability.

One of the means which I use to incorporate the phosphorus with the nickel is to add to the molten metal, in the desired proportion, a phosphide of nickel containing about six per cent of phosphorus. I obtain this phosphide by melting a mixture of phosphate of lime, silica, carbon, and nickel. This phosphide is white, hard, and brittle.

I have easily beaten out both cold and hot nickel containing 0·0025 of phosphorus, obtaining without difficulty sheets of two thousandths of an inch in thickness, that is to say, as thin as they could be made without beating out *en paquets*, and there is every reason to expect even better results. I have noticed that the first blow of the laminator brings out all the defects of an ingot, but that hardly any others show themselves during the remainder of the work, the reverse of what happens with *maillechort* (a kind of alloy resembling German silver); it is, therefore, very important to have ingots very free from defects.

Phosphorized nickel, united with brass, zinc, and iron, has given me results very greatly superior to those obtained with non-phosphorized nickel; the ingots were more perfect, since the phosphorus in absorbing the oxygen in the mass of the metal produced a solid and not gaseous compound. Thanks to phosphorus I have been able to unite nickel and iron in all proportions, always obtaining a soft and malleable alloy. This explains why some distinguished chemists have contradicted each other as to the malleability of nickel and iron united, some alleging that that alloy was brittle, and others that it was malleable; these latter used phosphorous iron.

Lake Superior Copper Mines.

The recent Lake Superior meeting of the American Institute of Mining Engineers brought out a considerable amount of interesting information touching the mineral resources of that wonderfully productive region.

The copper region of Lake Superior is divided into three districts, to wit: 1. Ontonagon; 2. Portage Lake; 3. Keweenaw Point. The Ontonagon district commences at a point in the neighborhood of twelve miles southwest of the shores of Portage Lake, while the Keweenaw Point district begins about four miles northeast of the Calumet and Hecla mine The only productive fissure veins developed on Lake Superior so far are those that have been wrought in the Keweenaw Point district, at the Cliff, Phœnix, Central, and Copper Falls mines.

The industries mining on conglomerates are the Calumet and Hecla, Osceola, Allouez, and Ahmeek. Those on the amygdaloid deposits are the Quincy, Pewabic, Franklin, Hancock, Atlantic, Huron, Tecumseh, Osceola, Schoolcraft, and Concord.

The members of the Institute visited but one of these three copper districts—the second. Mining is being carried on at the following points north of the lake:

Hancock Mine.—Started in 1859. Working on amygdaloid deposit. Has produced up to December 31, 1879, about 1,400 tons of ingot copper. Local superintendent, John C. Ryan.

Quincy Mine.—In active operation about twenty years. Working on an amygdaloidal deposit. Deepest shaft, 2,000 feet. Dressing mill fitted up with the "cam" style of stamp heads, and Scheuermann's mineral dressers and Evan's slime table. Total production of ingot copper to December 31, 1879, about 25,000 tons. A. J. Corey, local superintendent.

Pewabic Mine.—Commenced regular work in 1858. Adjoins Quincy on the north and is mining on the same deposit. Deepest shaft, about 1,800 feet. Ball's stamps, and Collom's washers and Evan's slime tables in dressing mill. Has produced in the neighborhood of 11,000 tons of ingot copper up to December 31, 1879. Johnson Vivian, local superintendent.

Franklin Mine.—Started to produce regularly in 1859. Is adjacent to Pewabic, and is under the same local and Eastern management. Deepest shaft, 1,600 feet. The outfit in dressing works the same as the Pewabic. Yield from commencement to December 31, 1879, about 14,000 tons of ingot copper.

Concord Mine.—Started in 1866. At work on an amygdaloid on the northern prolongation of the Isle Royale series. So far has produced about 400 tons of ingot copper. Under same management as Franklin and Pewabic.

Osceola Mine.—Lies in line about eight miles northeast of the Franklin. Was started in 1873, mining on conglomerate and amygdaloid deposits. From commencement to December 31, 1879, has produced about 6,500 tons of ingot copper. Deepest shaft, 800 feet. Ball's stamps and Collom's washers and Evan's slime tables in dressing works, which are located on the shore of Portage Lake. The stamp rock is transported from the mine to the mill over the Mineral Range Railroad. John Daniell, local superintendent.

Calumet and Hecla Mine.—Borders on the Osceola. Active work commenced in 1866. Mining on a conglomerate belt. Deepest shaft, about 2,000 feet. Produced from commencement to December 31, 1879, in the neighborhood of 111,000 tons of ingot copper. Two stamp mills, each containing Ball's heads and Collom's washers. J. N. Wright, local superintendent.

The only mines on the south side of Portage Lake are the following:

Huron Mine.—Operated extensively first in 1863. Mining on an amygdaloidal lode in the Isle Royale, or eastern mineral series of this district. Deepest shaft, about 700 feet. The mine has afforded, since its commencement, over 4,000 tons of ingot copper. Johnson Vivian, local superintendent.

Grand Portage Mine.—Commenced in 1862. Mining on an amygdaloidal lode in the Isle Royale formation. Production to December 31, 1879, about 850 tons of ingot copper. C. F. Eschweiler, local superintendent.

Atlantic Mine.—(Formerly South Pewabic.) First worked in 1865. Lies over a mile to the southwest of Huron, in the course of the west formation of the district. Deepest shaft, over 800 feet. Dressing mill has in it Ball's heads, Collom's washers, and Evan's slime table. Total production of mine from commencement to December 31, 1879, about 8,000 tons of ingot copper. Wm. Tonkin, local superintendent.

The geology of this district, as described in the circular of the local committee, is as follows:

The trap range at Portage Lake has a width of over three miles, and is made up of a series of compact, granular, and amygdaloidal traps, with intercalations of sandstone and conglomerate, the whole having a strike of north 32° east and south 32° west, with a dip from 38° to 56°, the highest angle of dip being near the southeastern boundary of the range, while toward the northwestern limit the rocks become more and more horizontal. Occurring both in course and in dip, with the rocks of the range are the copper lodes of the district, which present no features of mineral bearing fissures, being beds of amygdaloid trap and belts of conglomerate, the former carrying small masses and grains of native copper, while the copper in the latter is in small particles. Both deposits carry a little pure silver.

Supplementing this statement, Prof. W. H. Pettee, of Ann Arbor, Mich., described the modes of occurrence of the copper in the different districts. A northwest and southeast cross section of the peninsula at Portage Lake shows upon the southeast a considerable body of sandstone lying nearly horizontal, and not rising much above the general level of the lake. Next to the sandstone there is a series of beds having a northeasterly strike and a northwesterly dip. These beds, the number of which is very great, are partly conglomerates and partly amygdaloids, or traps, the latter being of volcanic origin. They are all conformable in stratification. Further to the northwest there is another series of sandstone beds similar to those on the southeast. The copper-bearing beds are confined to the amygdaloids and conglomerates. Whether the copper-bearing beds are older than the sandstones, or are of the same age, is a question which is still open for discussion. The key to the solution of the question is to be looked for along the line of junction between the sandstones and the traps. In Prof. Pumpelly's report it is stated that the rocks belong to two distinct periods, though some more recent examinations of the district point to the opposite conclusion. There is also a difference of opinion as to where the whole series belongs in the geological column, it having been assigned at different times to the Azoic, the Silurian, and even to the Triassic. At present the accepted view is that they are either Huronian or Lower Silurian, or form a series by themselves between the two just mentioned. Not all the beds of the copper-bearing series carry copper; neither is any one bed equally rich in all its parts.

Prof. R. C. Irving, of the State Geological Survey of Wisconsin, expressed the opinion that the copper-bearing rocks are older than the Potsdam sandstone. From evidences of non-conformity obtained in Wisconsin he was inclined to the opinion that the rocks of the copper region come between the Huronian and the Potsdam, the base of the Lower Silurian.

An Average Summer Rainfall

While the rainfall throughout the United States generally, from all reports, has been lighter during the summer months of this year than in years past, the fall in this vicinity, though very moderate, was heavier than in 1879. This is contrary to the general impression, which is that the fall here was exceedingly light. Data taken from the reports of the Signal Service officers with respect to the rainfalls during the months of June, July, and August for the last ten years, reveal some curious variations. The aggregate fall for these months in 1873 was very fair, yet in June only 1 29·100 of an inch fell. This is supposed to be the lightest monthly fall recorded anywhere in the United States in the past twenty years. The next lightest fall was in June, 1875, when 1 66·100 of an inch fell. As in 1873, however, the aggregate fall for the summer was good. The third lightest fall recorded was last August, when 1 69·100 of an inch fell.

The heaviest fall in the last ten years was in August, 1875, when 10 42·100 of an inch fell. The next heaviest fall was in July, 1872, the fall in that month having been 9 45·100 of an inch. The following table gives the exact amount of the falls in the summer months since 1871:

1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
7·14	2·94	1·29	2 87	1·66	2 87	3·31	2·91	3·42	4·40
3 60	9 45	4·15	3·22	5·23	5·72	3 86	5.26	3·39	6·67
5·48	6 13	7·68	2·53	10·42	2 97	2·54	7·30	5 17	1·69
16·22	18·52	13·12	8·62	17·31	11·56	9·71	15·47	11·98	12·76

—*New York Daily Graphic.*

New York's Summer Excursions.

The *Herald* devotes several columns to a review of the summer's work and receipts at the more popular resorts about this city. The summing up is as follows:

Resort.	Visitors.	Expenditures.
Coney Island	4,500,000	$8,775,000
Long Branch	400,000	1.800.000
Highlands, etc.	250,000	1,000,000
Rockaway	1,000,000	1,500,000
Long Beach	300,000	750,000
Glen Island	750,000	562.000
Fort Lee	750,000	375.000
Totals	7,950,000	$14,752,000

Nearly a million people paid for baths at the four bathing stations on Coney Island. Mr. John H. Starin, whose barges and steamers carry most of the excursionists to less prominent points, estimates that one and a half millions of dollars were spent on excursions alone to such places as Glen Alpine and points up the Hudson, and all of the chosen resorts of New York's people about Staten Island and beyond Hell Gate. If one were to go further, and add what has been spent at the races, in visits to picnic grounds, by rail and sailing craft, and the money spent in a hundred ways of pleasure seeking, of which no account can ever be had, it might be found that the 3,000,000 people who live in and around New York expended this year over $18,000,000 in keeping cool and enjoying themselves.

The Excavation of Flood Rock, Hell Gate.

The mining of Flood Rock, Hell Gate, in the East River at the northerly part of New York city, preparatory to blowing it up after the manner of the Hallett's Point work, is being pushed forward rapidly. The expenditure last year amounted to $140,000, and a large part of the $200,000 appropriated this year for the improvement of East River will go to this work. Employment is now given to 135 men, divided into three shifts of eight hours each. The central shaft is fifty feet deep.

Running across the river are twenty headings; at right angles to these are eleven cross headings, none of which have yet been extended their entire length. They average seven feet high and ten feet wide, and are situated about twenty feet apart. Near the main shaft, however, where more light and space are required for working, they are larger. Three acres have thus been undermined, or one-third of the whole. It is not intended to enlarge the headings until each one has been carried out to its full length. Then the chambers will be widened and made higher, so that the whole excavation will resemble an immense cave, the roof being supported by the rocky pillars which now form the sides of the headings. The thickness of the rock forming the roof will then be about ten feet, varying according to the character of the rock, whereas it is now from fifteen to thirty feet in thickness.

The work of tunneling proceeds very slowly, owing to the hardness of the rock of which the reef is composed. The rate at which it is now going on is from 500 to 600 feet a month, representing an excavation of about 1,500 cubic yards It is impossible to tell when the whole will be accomplished even at this rate. Frequently a seam is struck in blasting which stops the work in that heading altogether, on account of the leakage. In such a case it is customary to work around the leak. According to the last report, the work done during the past year was much greater than in any previous year; 24,000 cubic yards of rock were removed, 43,000 blasts made, and 57,066 drills sharpened. The number of blasts made each night now averages 150. The rock thus broken up is loaded on scows and dumped in the deep water to the south of the reef. Part of it was also used to fill up the space between Big and Little Mill Rocks, which lie to the north.