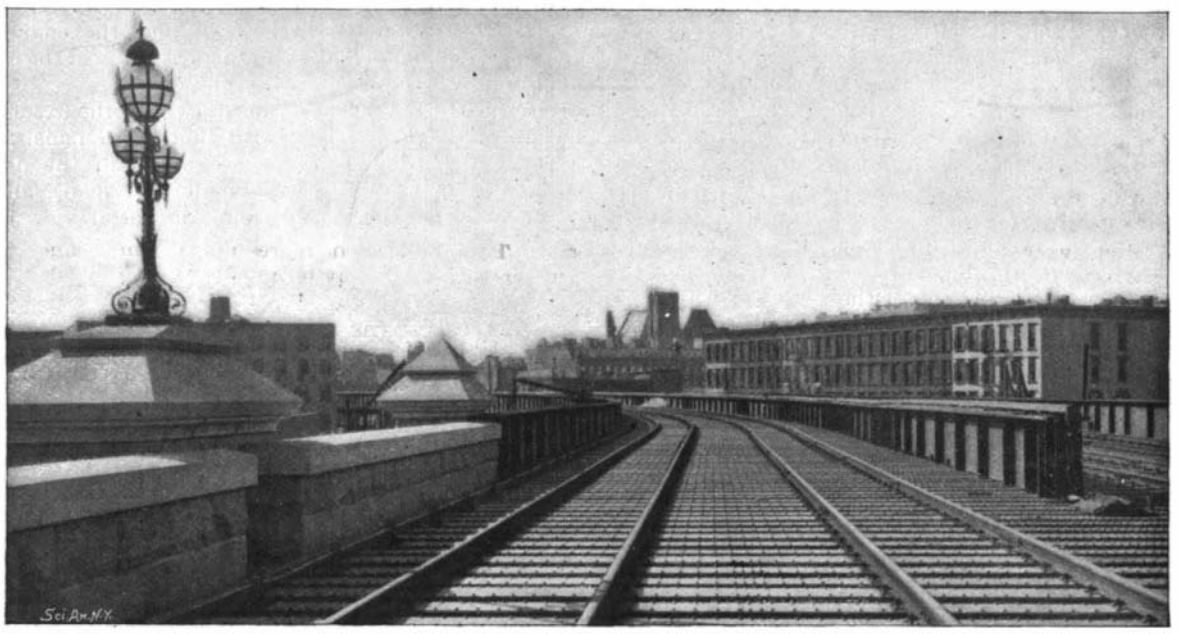
OPENING OF THE NEW YORK CENTRAL FOUR TRACK DRAWBRIDGE AND VIADUCT IN NEW YORK CITY.

In the early hours of Monday, February 15, connection was made at each end of the magnificent viaduct which will henceforth carry the heavy traffic that enters New York by way of the New York Central and Hudson River Railroad. Our readers are doubtless aware that the New York Central is the only railroad company that possesses a terminus on Manhattan Island. In addition to carrying the heavy through passenger traffic which the vast Vanderbilt system brings to the metropolis, the lines of the company accommodate the large express and suburban traffic of the New York, New Haven & Hartford Railroad, as well as the heavy suburban travel on what is known as the Harlem road. The New Haven and the Harlem trains converge near Mount Vernon, and at Mott Haven their number is swelled by the traffic of the main line, which, turning in from the Hudson River at Spuyten Duyvil, joins the Harlem branch at Mott Haven to the north of the Harlem River. To accommodate all these trains there was formerly a low level two-track bridge across the river, which contained a center pivot drawspan, supplemented by a hinged lifting bridge. For several blocks north and for a shorter distance south of the Harlem River the tracks ran at street grade, and this necessitated low level crossings, which seriously interfered with traffic on important thoroughfares in Mott Haven. The Harlem River, moreover, is a legal waterway, and the small head room



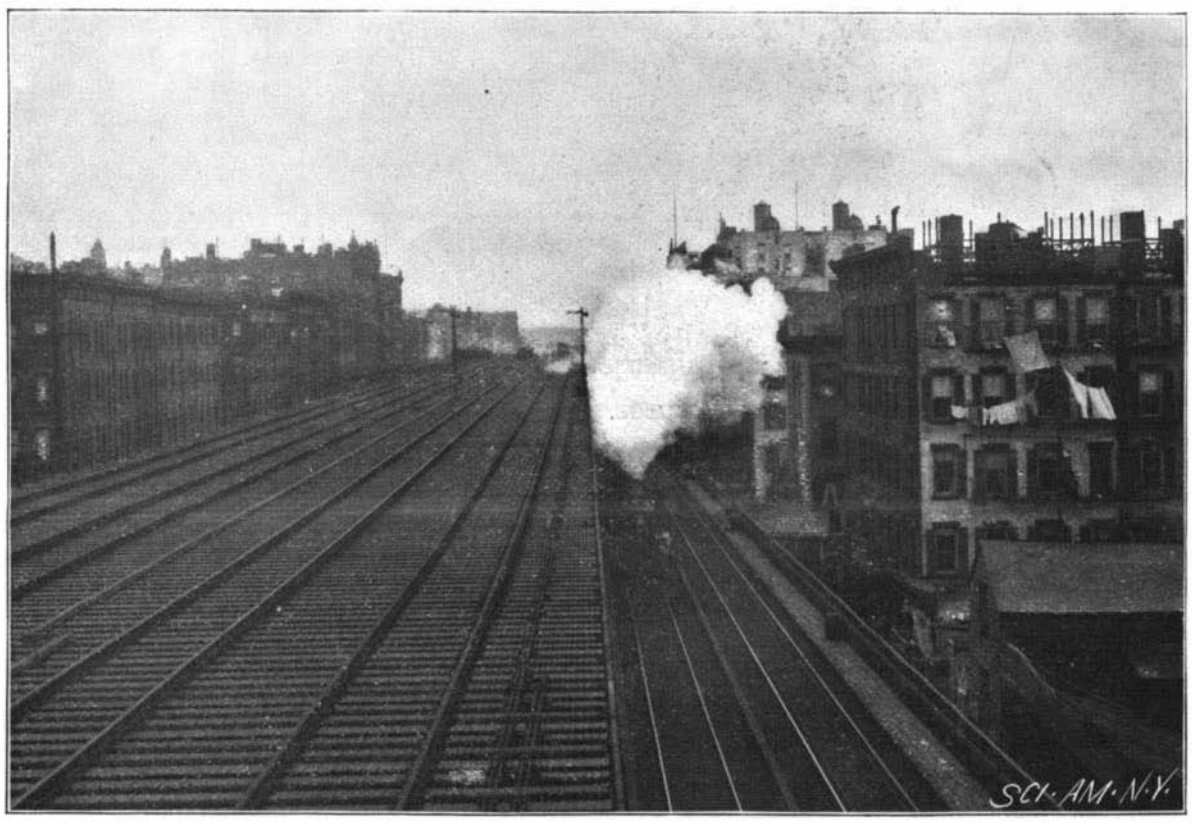
THE CURVE FROM HARLEM RIVER TO PARK AVENUE.

beneath the drawspans necessitated frequent openings, which were a constant interruption to traffic both on rail and river. Nor was this all. On the south side of the river the tracks ran through the center of Park Avenue in a cut of varying depth, which necessitated blocking off the through vehicular traffic on streets which in common with this section of Park Avenue had developed a considerable amount of traffic in the later years of the city's growth. From this it will be seen that the old arrangement was a constant source of delay and annoyance to traffic, whether on the rail, the river, or the streets.

The remedy adopted was worthy of the traditions of the New York Central Railroad. It was decided to build a high level, four track steel viaduct over two miles in length through the district in question, and span the Harlem with a massive four track drawbridge, which should give two clear openings of 100 feet each for the passage of the larger vessels and provide when closed a sufficient headway for smaller craft to pass under. This would abolish the street grade crossings and leave the whole width of Park Avenue, for the distance affected, free of all obstructions except the three lines of columns which carried the viaduct.

Now this work as projected involved the construction of the heaviest drawbridge in the world and over a mile of massive viaduct, at a total outlay of $3,000.000—a large and costly undertaking; but the difficulty of the work was greatly increased by the fact that it was necessary to carry out the whole of it without interfering with the traffic of a great four track railroad or the waterborne traffic of an important waterway. No greater tribute could be paid to the skill of Col. Katté, the chief engineer of the railroad, and his corps of assistants than is given by the fact that this was done without a single interruption that could be charged to the plans of reconstruction.

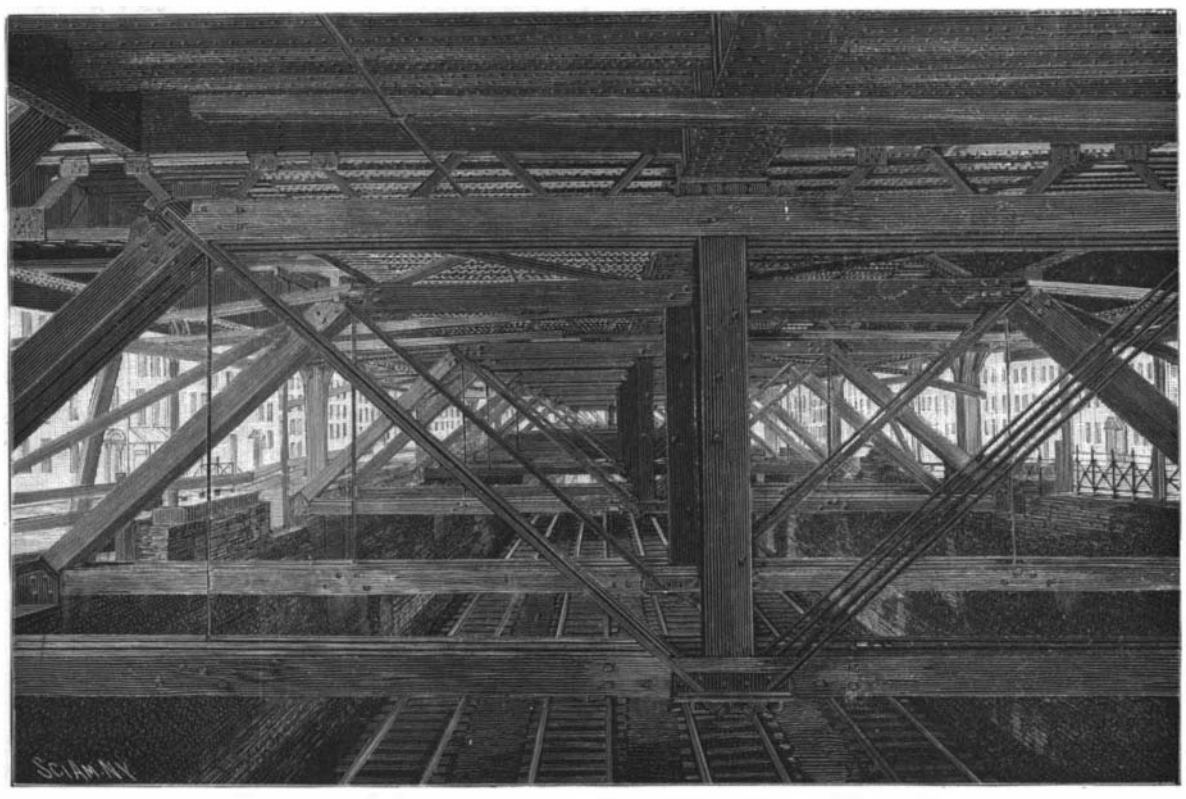
The temporary work consisted in building two two-track trestles, one on each of the old tracks, for the purpose of carrying the trains from the high level at which the tracks leave the Park Avenue tunnel at Ninety-eighth Street down to the grade of the old tracks at about One Hundred and Fifteenth Street, and it was also necessary to build a temporary crossing over the Harlem River to the west of the existing bridge for use during the erection of the new drawspan and the two fixed spans which were to constitute the new crossing. It was also necessary to erect a large number of temporary trusses above the depressed tracks to assist in carrying the floor of the viaduct during construction.



THE VIADUCT AND TEMPORARY TRACKS NORTH FROM ONE HUNDRED AND TENTH STREET STATION.

The viaduct is carried upon three rows of latticed columns, the outer row being built on the line of the old retaining walls of the cut and the center row standing on the center line of the old roadbed. The flooring, which is of the well known open box girder type, commonly known as trough flooring, used by the company on its bridges, is carried by three rows of longitudinal plate girders, which are generally 7 feet 2 inches deep, with a ⅜ inch web for the outside girders and a $\frac{9}{16}$ web for the center row. The trussed flooring is riveted to the plate girders, the "troughs" or channels running, of course, across the bridge, and the rails are fastened with clips directly to the flooring, insulating material being interposed between the rail base and the metal to deaden the sound. The columns are spaced 65 feet between centers longitudinally and 28 feet between centers measured across the viaduct, the total width of the floor being 56 feet. Lateral stiffness is provided by a transverse lattice girder at each set of columns, and the whole structure is further stiffened by the method of attaching the flooring to the girders and by deep knee braces at the tops of the columns.

The erection of the viaduct as far north as One Hundred and Fifteenth Street presented no special difficulties, the foundations being built and the columns set up on the site of the abandoned tracks; but north from One Hundred and Fifteenth Street the trains had to run over the old tracks, and while the outer row of columns could be built on the site of the side walls, there was no room for the erection of the center row of columns. In order to carry the center girders, temporary wooden trusses were thrown across the tracks, the ends of the trusses being carried by the side walls of the cut, or, where the tracks were at street grade, by wooden piers. The arrangement is clearly shown in the accompanying woodcut. These trusses alone



TEMPORARY TRUSSES UNDER THE VIADUCT—OLD TRACKS BELOW.

THE NEW YORK CENTRAL FOUR TRACK STEEL VIADUCT, NEW YORK.

were a large source of expense, as they were placed beneath the viaduct for a distance of several thousand feet and had to be made strong enough to carry one-half the weight of the floor and the traffic. Now that the depressed tracks are abandoned, the steel columns will be put in place between each pair of trusses and the trusses removed.

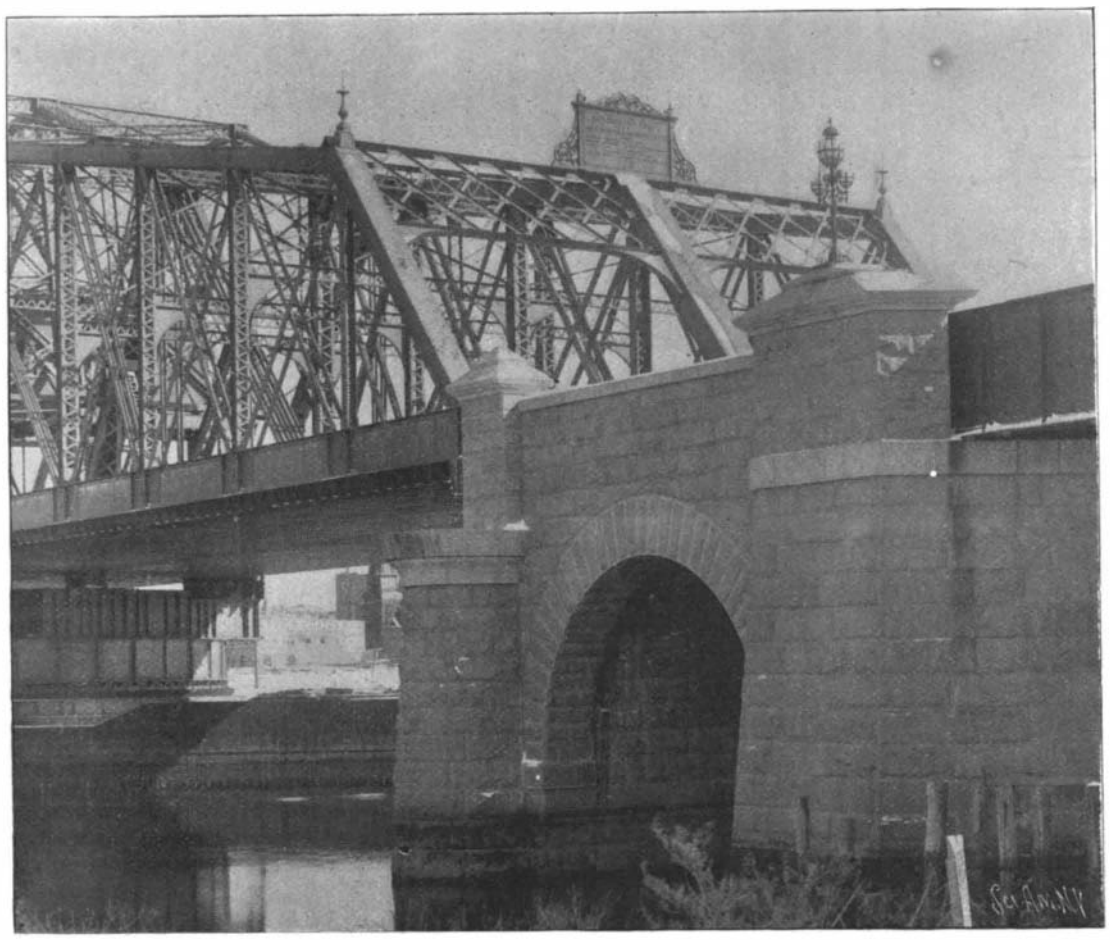
The great 400 foot four track drawspan over the Harlem River is the most striking feature of the whole work, and taken with the two fixed spans to the north of the draw, it forms one of the handsomest specimens of bridge design in New York City. It can well be understood that to provide a stable and perfectly level platform upon which this great mass of 2,500 tons should rotate called for specially heavy foundations. The center pier rests upon 700 piles, which were driven to a depth of 54 feet below high water, the distance between centers being 2½ feet. The piles were cut off to one level and 1,200 yards of concrete were filled in between them and finished off flush with their heads. Upon this was placed 6½ feet of timber grillage, the surface of the latter being below high water and forming the foundation for the masonry work of the pier. This is built in an annular form and consists of a central portion beneath the central pivot and an outer circular wall beneath the rollers, the two portions being tied together with six radial walls.

The weight of the draw is carried upon two concentric drums which are strongly braced together and are respectively 46 and 54 feet in diameter, the inner drum being 5 feet 11¾ inches deep and the outer 5 feet 10 inches deep. If the great weight of the draw had been transferred directly to the drums by the bottom chords, it would have brought too great a concentration of weight on the rollers at certain points, and in order to give an even distribution of weight, eight massive distributing girders, nearly 6 feet deep, were placed across the drums at right angles to the center line of the bridge and the load was transferred to them by four raising girders, two extending longitudinally under the middle truss and one under each of the side trusses. There are 72 cast steel rollers beneath each drum, the outer set being 24 inches and the inner set $20\frac{7}{16}$ inches in diameter, the faces being 10½ inches wide in both cases. There is a cast steel center pivot provided, which carries a massive collar to which the radial struts which keep the drums and rollers in their true path are attached. No weight is carried by the center pin. The cast steel rack with which the mechanism for turning the drum engages is of $4\frac{9}{16}$ inch pitch and has a 10 inch face. For turning the draw a duplicate set of engines and boilers is provided, one set only being ordinarily in use. The engines, which have cylinders 10 inches in diameter by 7 inches stroke, were made by Edwards & Company, of New York.

In order to prevent hammering by the free or unloaded end when a train enters the drawspan, provision is made for transferring about 200 tons of the weight to the end piers. This is done by means of a powerful system of levers acting on the principle of a toggle joint, which are carried at the ends of the draw and operated by shafting from the turning engines. By reference to the illustration it will be seen that the engines are housed upon a platform which is built in the central tower over the pivot pier.

The trusses, both of the draw and the fixed spans, are of the Pratt type, with subdivided panels. The trough flooring of which we spoke in the description of the viaduct is used on all three spans, and the effect, as may be judged from the portal view of the drawspan, is to give the bridge an appearance of great strength and solidity. The use of the trough flooring necessitated the substitution of a deep plate bottom chord on all three spans in place of the eye-bars or shallow box chords which are usual in this form of truss. The plate flooring brings a bending strain upon the bottom chord between the panel points, to resist which the bottom chord was given that noticeable depth which is a striking feature of this handsome structure.

Of the two fixed spans, the shore span is 131 ft. 4¼ in. long and the river span 185 ft. 4½ in. long, their depths being respectively 26 ft. 3¼ in. and 30 ft. 10¾ in. The drawspan is 400 ft. long over all and 389 ft. between end pins. Its breadth from center to center of outside trusses is 58 ft. 6 in. Between these trusses are two clear ways, each 26 ft. wide, and each carrying two tracks. At the center of the drawbridge the trusses are 64 ft. deep center to center and at the ends 25 ft. deep. Limitations of space forbid any detailed reference to the size of the members in the drawspan, but it may be mentioned that the steel pin in the center truss at the pivot pier is 12 inches diameter, and that the eight tension members extending from the top of the tower to the hips of this truss represent a mass of metal whose cross section is nearly a square foot of steel.



WEST ABUTMENT OF THE HARLEM RIVER BRIDGE.

In addition to the massive bridge work, which of course forms by far the heaviest and most costly portion of the work, it has been necessary to make extensive changes in the platforms and general accommodation of the three stations which are affected by the alterations. These occur at One Hundred and Tenth Street, One Hundred and Twenty-fifth Street and at Mott Haven. It has been necessary in every case to raise the platforms to the level of the new tracks, and we present illustrations of the viaduct at One Hundred and Twenty-fifth Street showing how the problem has been worked out at this point. It will be seen that the waiting rooms, ticket offices, etc., have been built at street grade and beneath the floor of the main viaduct. The two interior express tracks are located, as usual, on each side of the central longitudinal girder. The spaces between these tracks and the outside girders are taken up by two platforms 15½ feet wide, which do duty for all four tracks. To carry the local tracks it has been necessary to widen the viaduct to 82 feet, build an outer line of girders 12 feet from the main viaduct, and support it by transverse plate girders, whose outer ends are carried by columns located on the curb of the sidewalks.

AUXILIARY GIRDERS FOR CARRYING LOCAL TRACKS AT ONE HUNDRED AND TWENTY-FIFTH STREET STATION.

THE NEW YORK CENTRAL FOUR TRACK STEEL VIADUCT NEW YORK.

The steel viaducts were built by the Elmira Bridge Company and the New Jersey Iron and Steel Company, at a contract price of $1,500,000. The Harlem River crossing, of which the drawspan and two fixed spans were built by the King Bridge Company, of Cleveland, O., cost, with its foundations, $1,000,000. The work at Mott Haven cost $500,000, the masonry work of the viaduct piers $100,000, the temporary tracks $100,000, making a total cost for the whole undertaking of over $3,000,000.

We are indebted for our information to the courtesy of Mr. Walter Katté, chief engineer of the New York Central, and to Mr. George E. Gifford, C.E., the Eastern representative of the King Bridge Company.

A MACHINERY exhibition will be held in Munich, Bavaria, from June 1 to October 10, 1898, to which manufacturers of motors and machine tools of all countries are invited. The General Industrial Association of Munich celebrates by this exposition its fiftieth jubilee, and will have the co-operation of the Polytechnic Association and also the patronage of Prince Luitpold, Regent of Bavaria.

Science Notes.

Dr. Nansen, the Arctic explorer, delivered a lecture in Christiania on January 27, in the course of which he said that the best course to take to get to the North Pole was from Behring Sea toward the north-northeast, afterward drifting with the ice current, which would be certain to lead to Greenland.

It has recently been discovered that iodine exists in combination in the human body. It occurs in the thyroid gland, and may be concerned as the essential chemical substance in the internal secretion of that gland. The proof of the occurrence of iodine in the living structure of animals is of great scientific interest and importance, says Knowledge, and is the most remarkable discovery made by chemical physiology for some time.

The technical library of the late Eckley B. Coxe has been given by his widow to Lehigh University, and will constitute an important addition to the equipment of that institution, says the Electrical Review. The library numbers about 8,000 volumes, and comprises also the complete library of Julius Weisbach, whose pupil Mr. Coxe was in Freiberg, and whose work on mechanics Mr. Coxe translated into English. A fine oil painting of Weisbach accompanies the library.

Dr. E. Oddone has recently examined the seismic record of Liguria during the last century (1796–1895), in order to determine whether the frequency of earthquakes in that district is subject to any periodic laws, says Nature. The record is a non-instrumental one, and the results derived from it have not therefore the same value as those obtained from a seismometric catalogue. Dr. Oddone shows that the supposed nocturnal prevalence of earthquakes is here insensible, but there is a daily period with its maximum between 6 and 7 A. M. The two halves of the century do not exhibit the same distribution of earthquakes throughout the year, and in the latter half (during which the record is most complete) earthquakes are equally numerous in the summer and winter months. They are less frequent during years of maximum solar activity, and vice versa, so that there appears to be a period of eleven years, and possibly also one of about twice this length.

It is not generally known that in chemical analyses different results, in many cases, are obtained by different chemists from the same substance. Thus, according to a paper read by F. P. Dewey, of Washington, D. C., before the American Institute of Mining Engineers, this fact was illustrated, notably in a case of examination of gold and silver in copper materials—a case in which there were twenty-six results by twenty chemists, working by two main methods, each by a single chemist, varying from 135·38 to 122·88, and averaging 127·94 ounces per ton, the extreme variation being 12·5 ounces per ton, or 9·77 per cent of the average determination. In the silver assay of the copper borings, nine chemists' reports by the scorification method averaged results varying from 164·35 to 154·40, the rate per ton running some 159·36 ounces, thus showing an extreme variation of 9·95 ounces per ton, or 6·24 per cent of the average. Further, fifteen chemists' reports of sixteen results by combined wet and scorification methods varied from 161·40 to 148·50, averaging 156·48 ounces per ton, the extreme variation being 13·9 ounces per ton, or 8·88 per cent of the average. Summing up, there are thus shown twenty-six determinations by twenty chemists, working by three methods, ranging from 164·35 to 148·5, and averaging 157·67 ounces per ton, the extreme variation being 15·85 ounces per ton, or 10·05 per cent of the average determination.

Some experiments with Roentgen radiation have recently been carried out by Prof. Threlfall and Mr. Pollock. Some particulars of these were given at a recent meeting of the Physical Society, says the Engineer. The authors describe a form of Crookes tube which, while it can be made by anyone capable of the most elementary glass blowing, gives a plentiful supply of Roentgen rays. The results of their experiments are summed up as follows: 1. The Roentgen radiation does not consist in the projection of gaseous matter; or, if it does, the amount of such matter involved is extraordinarily small. 2. The Roentgen radiation does not consist in the projection of ether streams having a velocity above a couple of hundred meters per second; this is true, whether the radiation takes place in air or in benzine. 3. The properties of the ether regarded as determining the velocity of electromagnetic waves are not greatly changed—i. e., not at all within our experimental limits—by the Roentgen radiation; and this applies alike to the ether in air and in benzine. 4. A selenium cell composed of platinum electrodes and highly purified selenium is affected by Roentgen radiation to an extent which is comparable with the effect produced by diffused daylight. 5. No permanent or temporary electromotive force is set up in a selenium cell by the Roentgen radiation. The authors have come to the first conclusion by exposing an exhausted tube placed in parallel with a spark gap, so adjusted that the spark just passes over the gap rather than through the tube, to the Roentgen radiation. They find that a vacuum tube in parallel with a spark gap is very sensitive to changes in pressure within the tube.

The Stevens Institute Celebration.

The twenty-fifth anniversary of the founding of Stevens Institute was inaugurated on the evening of February 18 by a dinner at the Hotel Waldorf. There were present a large number of invited guests. Ex-Mayor Hewitt was introduced as the first speaker.

"I suppose I am the only one in this room, if not in the country," he said, "who has seen all the members of the Stevens family, from the head of the family of revolutionary fame down to his grandchildren and great-grandchildren of the present day. This may seem a strange statement, but when I was five years old I was standing at the foot of Jay Street with my father when I saw a steamboat going up the Hudson River. I asked my father whose it was, and he took me across the river to Hoboken and introduced me to John Stevens, the owner, then 83 years old. Mr. Stevens was in possession of all his faculties and interested in all my father had to say to him. John Stevens saw the first engine ever set up in this country. It was brought here from England, but Mr. Stevens built the first engine in this country, and it was placed in a steamboat which traversed a route from Belleville to New York nine years before Fulton launched the Clermont and started it on the Hudson. I traveled on this ferry, and John Stevens was on the boat.

"My next recollection of the Stevens family was when I was a student at Columbia College, then away down town. We played baseball then. It was the only game we had, and not such a detriment to a college as it is to-day. We lost most of our baseballs by knocking them over into the yard of a house in Barclay Street. One day, when we were short and could not get any baseballs, I was appointed a committee of one to visit the house and ask for some. A gentleman appeared in answer to my question, and, producing a basket containing twenty-five or thirty baseballs, asked me if they were ours. I said I supposed they were. 'Well,' he said, 'every one of those balls has broken a window in my house. You may take them, and when you have all the windows in my music room broken come over to Hoboken and there you shall have a fair field.' That man was the greatest mechanical engineer, the greatest naval engineer, the greatest railroad engineer which the nineteenth century has produced—Robert L. Stevens. [Cheers.]

"In 1846 Edwin Stevens came to me and asked me to make him 2,000 tons of steel rails. Material was so enormously high priced in those days that it was impossible to import the rails from abroad. My friend, Mr. Carnegie, will lick his chops when I tell him what the price was. [Laughter.] Mr. Stevens told me he would pay the lowest price quoted in the foreign market, with the duty included, which amounted to $90 a ton, and at the latest quotations whispered to me by my friend Carnegie, 10,000 tons can be bought for this amount to-day. John, Robert, and Edwin Stevens worked as one man, and attended personally and minutely to everything they did, and there was—I say this for the benefit of you young men—never a quarrel of any sort between them.

"One has to go back as I do, when there were no steamboats, no steamships, no railways, no telephones, no telegraph, when this State beyond the Mohawk Valley was not traversed, and when this great empire was a wilderness, to appreciate what the Stevens family has done for this country. You gentlemen are reaping the fruits of what they have sown. You will attend to your business, try to make money and succeed in life, but try and do so as the Stevenses did, by throwing sunshine into the lives of everybody they came in contact with. I know the Stevens family for sixty years, and there never was a strike in any of the industries controlled by the Stevenses. The heads of the family knew personally every one of their workmen, from the highest to the lowest, and could call every one by his first name."

After the conclusion of Mr. Hewitt's speech, which was received with applause, President Morton, of Stevens Institute, read a poem and Mr. Carnegie then made a speech. He was followed by Commodore Melville and President Morton, who also made addresses.

The Scientific American.

The SCIENTIFIC AMERICAN, says the Collegian, fills the requirements and demands of those who desire information concerning inventive and applied science. The discussions on problems of electrical transmission and of carriages without horses have economic as well as scientific aspects. The descriptions of inventions are graphic and lucid, and in keeping with the genius of the age. The table of the thoughtful and inquiring and inquiring reader must contain this periodical.

The Williamette Collegian reflects the opinion of a large number of educational institutions who are regular subscribers of this paper and other of our publications. "Experimental Science" is in general use in colleges as a work of reference.

SAEKKINGEN, in Baden, will erect a monument to Scheffel, the student poet whose "Tompeter von Säkkingen" made the town famous.

Archæological News.

After ten years of antagonism, Flinders Petrie has become reconciled with the Egypt Exploration Fund Society, accepted a place on its committee, and is going to work under its auspices. He declined, at a recent meeting, to disclose the scene of his next excavations, but it will be in a hitherto untouched region and connected with the period of the Libyan invasion that took place three thousand years before the Christian era.

In the Architectural Record for the quarter ending March 31, 1897, is a very interesting article by Prof. W. H. Goodyear on "Constructive Asymmetry in Mediæval Italian Churches." This article is possibly even of more interest than those which have preceded it. It is accompanied by a number of careful ground plans and sections of Italian churches and cathedrals. These plans and sections are the result of the Brooklyn Institute Survey, led by Mr. Goodyear, and show an enormous amount of labor, and archæological knowledge of a high order. It is gratifying to note that Mr. Goodyear's researches are being widely known and recognized.

At a special meeting of the Archæological Institute of America, held in New York City, on Saturday, January 30, says Architecture and Building, Prof. John Williams White, of Harvard University, was chosen president in place of President Seth Low, resigned. The scheme for a joint publication presented by the managing committees of the schools of classical studies at Athens and in Rome was approved in general. The new publication will be issued as a continuation of the present series of the American Journal of Archæology, which has been edited and published for eleven years by Profs. Frothingham and Marquand, of Princeton. The editor-in-chief is to be Prof. John H. Wright, of Harvard. The initial number of the new publication will be the first report of the School of Classical Studies in Rome, by Prof. Hale, of Chicago University.

In the Prussian budget a sum of 500,000 marks is provided as an installment toward the cost of erecting a new museum in Berlin, which is estimated at 5,850,000 marks. The site selected is the northern part of the island on which the royal palace, the National Gallery, the old museum and various other buildings now stand. The need of an additional museum is manifest to every stranger who visits Berlin. The accumulation of works of art has long outgrown the accommodation provided in the two museums which were completed in 1840. In consequence of the limited space the sculpture from Pergamus cannot be properly exhibited. Many other examples of ancient art may also be said to be entombed, for they are deposited in places which are only dimly lighted. The quantity of Renaissance sculpture is likewise an embarrassment to the curators. As in no other city are so many earnest students of art to be found, it is time some facilities should be allowed to them in their pursuit of knowledge.

At a recent meeting of the Royal Botanic Society, the secretary, Mr. J. B. Sowerby, showed stems of the Egyptian papyrus, from the plant growing in the Victoria water lily tank at the gardens, which has this year attained extraordinary dimensions, forming a clump 7 feet in diameter, with stems 14 feet long and 2¼ inches at the base. From the white pith of which the stems are composed the ancient Egyptians made a paper remarkable for its durability—simply slicing the pith up into flat strips and laying them side by side until a sufficient length was obtained. Under pressure the pieces adhered together, forming a perfectly smooth, even sheet, which could be written upon and rolled up without further preparation. He compared paper made in this way, from plants grown in the gardens, with a fragment taken from an Egyptian tomb, and, according to Dr. Birch, at least three thousand years old. The only difference between the two was the darker color of the older specimen. Major Cotton said the plant, though once abundant, was now extinct in lower Egypt.

In a recent issue of the London Times some interesting matters are stated regarding the work in Philæ. The island is being cleared of debris to permit a more careful examination of the ancient monuments, and it has been discovered that the foundations of the main Temple of Isis are laid upon the granite rock, being in some places over 21 feet in depth, and the temple has nearly as much masonry below ground as above. The southeastern colonnade has also its foundations upon the granite, and so far as excavated they are curious if not unique in design. They consist of parallel cross walls some meters high, but varying according to the slope of the rock surface, with large stone slabs placed horizontally upon their tops, and the pillars forming the colonnade are erected upon the slabs. The nilometer is marked in three characters—Demotic, Coptic, and another much older, probably Hieratic, of which a copy has been sent to Berlin for decipherment. A stela was found bearing a trilingual inscription in hieroglyph. No traces have been discovered of any buildings anterior to the Ptolemaic periods. M. De Morgan, director-general of the antiquities department, is engaged upon repairing the great Hall of Columns at Karnak.