Scientific American.

ESTABLISHED 1845.

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

TERMS FOR THE SCIENTIFIC AMERICAN.

(Established 1845.)

One copy, one year, for the U.S., Canada or Mexico.................. $3.00
One copy, six months, for the U.S., Canada or Mexico............... 1.50
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

Remit by postal or express money order, or by bank draft or check.

MUNN & CO., 361 Broadway, corner Franklin Street, New York.

The Scientific American Supplement

(Established 1876)

is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, for the U. S., Canada or Mexico. $6.00 a year, or £1 4s. 8d., to foreign countries belonging to the Postal Union. Single copies 10 cents. Sold by all newsdealers throughout the country. See prospectus, last page.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT will be sent for one year, to one address in U. S., Canada or Mexico, on receipt of *seven dollars*. To foreign countries, *eight dollars and fifty cents a year*, or £1 14s. 11d., postage prepaid.

Building Edition of Scientific American.

(Established 1885.)

THE BUILDING EDITION OF THE SCIENTIFIC AMERICAN is a large and splendidly illustrated periodical, issued monthly, containing floor plans and perspective views pertaining to modern architecture. Each number is illustrated with beautiful plates, showing desirable dwellings, public buildings, and architectural work in great variety. To architects, builders, and all who contemplate building this work is invaluable.

Single copies 25 cents. By mail, to any part of the United States, Canada or Mexico, $2.50 a year. To foreign countries, $3.00 a year, or £0 12s. 4d. Combined rate for BUILDING EDITION with SCIENTIFIC AMERICAN, to one address, $5.00 a year. To foreign countries, $6.50 a year, or £1 6s. 9d. Combined rate for BUILDING EDITION, SCIENTIFIC AMERICAN, and SUPPLEMENT, $9.00 a year. To foreign countries, $11.00 a year, or £2 5s. 2d., postage prepaid.

Export Edition of the Scientific American

(Established 1878)

with which is incorporated "LA AMERICA CIENTIFICA E INDUSTRIAL," or Spanish edition of the SCIENTIFIC AMERICAN, published monthly, uniform in size and typography with the SCIENTIFIC AMERICAN. Every number contains about 100 pages, profusely illustrated. It is the finest scientific industrial export paper published. It circulates throughout Cuba, the West Indies, Mexico, Central and South America, Spain and Spanish possessions—wherever the Spanish language is spoken. THE SCIENTIFIC AMERICAN EXPORT EDITION has a large guaranteed circulation in all commercial places throughout the world. $3.00 a year, or £0 12s. 4d., postpaid to any part of the world. Single copies, 25 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

☞ The safest way to remit is by postal order, express money order, draft or bank check. Make all remittances payable to order of MUNN & CO.

☞ Readers are specially requested to notify the publishers in case of any failure, delay, or irregularity in receipt of papers.

NEW YORK, SATURDAY, JANUARY 16, 1897.

Contents.

(Illustrated articles are marked with an as erisk.)

TABLE OF CONTENTS OF

Scientific American Supplement

No. 1098.

For the Week Ending January 16, 1897.

Price 10 cents. For sale by all newsdealers.

COMPETITIVE SYSTEMS OF TRACTION IN NEW YORK CITY.

There is probably no city in the world where so good an opportunity is presented for a comparative test of the merits of the various systems of street traction as that which is offered on the lines of the Metropolitan Traction Company, New York. In addition to its world renowned Broadway cable line, which carries by far the heaviest traffic of any cable road in existence, the company operates some miles of electric underground trolley road on Lenox Avenue, upon which also it is running experimentally some compressed air motors built on the Hoadley patents. The fierce competition between the surface and elevated roads of the city is favorable to an unbiased judgment of results; for it is safe to say that after complying with the restrictions of the law, that system which proves to be the most economical and effective will be finally adopted.

In a recent interview with President Vreeland, of the Metropolitan Company, we were given certain facts regarding the situation which are timely and significant. The policy of the company in building the cable road on Broadway, and its later extension on Lexington Avenue, and also the proposed underground trolley lines on Eighth and Sixth Avenues, has been determined by the exigencies of an ever increasing and overburdened traffic. So rapid has been the growth of travel in New York City that there has never been a time when it has not exceeded the capacity of the company's roads. Extensions and improvements have been made under the spur of pressing necessity, and the company has never been able to afford the time necessary for any lengthy experimental work of its own to determine the best form of traction. In all contemplated improvements it has had to choose the best system in sight at the time. This was the case when the cable was chosen for Broadway, and it is the same pressing necessity that causes the company to put in the costly underground trolley on forty-three miles of its lines on Eighth and Madison Avenues, before its experimental work with the compressed air motors is completed.

With regard to the cable road, the company is satisfied that in spite of the high state of efficiency to which electric traction has been brought and its superior economy under average conditions the cable is the best form of traction for the exceptionally heavy traffic on Broadway. The fact that electricity is replacing the cable in San Francisco and elsewhere, and showing a higher comparative economy, proves the case only for such conditions as obtain on these lines, where the volume of travel is moderate and the headway between cars is measured by minutes. The Broadway cable road, however, is operated under conditions that find no parallel in any city of the world. The average headway between cars is twenty seconds, and during the "rush" hours it is as small as ten seconds. Add to this that the bulk of the travel on the busiest portions of the line is local, necessitating frequent stops, and one has some idea of the enormous demand that is put upon the power house, and the value of having at command the great reservoir of momentum which is provided by the cable and its miles of moving cars. The problem of transportation on a line where the headway is measured by seconds instead of by minutes resolves itself largely into one of celerity in starting and stopping, and the management and engineers of the Broadway line are satisfied that this is more efficiently solved by the existing cable than it could be by any form of electric traction.

That the company considers this efficiency to hold good only where the burden of traffic is abnormally heavy is proved by its intention to equip the parallel lines on Eighth and Madison Avenues electrically. These lines are at present operated by horse cars, and the change is being made chiefly with a view of relieving the congestion on Broadway, and incidentally to provide a better service on these lines. The change will affect forty-three miles of road. The Eighth Avenue line will extend from One Hundred and Fifty-third Street to Fifty-ninth and thence by way of Sixth Avenue to a terminus at the lower end of the city. The Madison Avenue line will extend from One Hundred and Thirty-eighth Street to the Post Office by way of Fourth Avenue, the Bowery and Center Street. The construction and equipment will be similar to that which is used on the Lenox Avenue line, an illustrated description which was given in the SCIENTIFIC AMERICAN of February 22, 1896. Power for the Madison Avenue line will be furnished from the Twenty-fifth Street power house, in which will be erected four 850 kilowatt generators, driven by direct connected engines of 1,300 horse power. At the One Hundred and Forty-sixth Street station three 850 kilowatt generators will be added to the two 400 kilowatt generators which are already in place.

With reference to the experiments in compressed air traction which the company is carrying out on Lenox Avenue, we are informed that electricity was not chosen for the new lines because of any unfavorable results which had attended these trials, but simply because the experiments had not extended over a sufficient period to allow any reliable data to be tabulated. The results have so far been satisfactory, and two more motors will soon be added to the equipment. The company still has over one hundred miles of horse car lines which have yet to be changed to some form of mechanical traction, and if the compressed air motors fulfill their present promise after a sufficiently lengthy trial, they will probably in time be placed on a portion of these lines.

WELDED RAIL JOINTS.

There is certainly no part of the roadbed of steam railroads that has received more careful attention of late years than the rail joints. Time was when these were the most neglected portion of the track, and two small strips of iron, loosely bolted to the web of the rail, were considered to be a sufficient reinforcement. So long as the ends of the rail were held fairly well in line, the roadmaster was satisfied. The idea of attempting to restore the whole strength of the rail does not seem to have been seriously entertained, and as a consequence the rail ends soon became permanently bent under the incessant pounding of the traffic, and every joint became a hollow spot, lying more or less below the track level. To-day, however, the engineer has changed all that. By designing the joints on scientific principles, giving them a section adapted to the strains which they have to endure, it has been possible to produce a length of track whose vertical stiffness and strength are continuous, the joints displaying these qualities as fully as the body of the rail itself.

Such, at least, is the condition of first-class modern track when it is first laid. Laboratory tests have shown that some of the modern joints possess even greater rigidity than the rail itself, at least under the conditions of test where the load is applied as a static pressure, and has no dynamic effect. Conditions of service, however, are so entirely different that it can easily be understood that the results fall far below those which are obtained in the testing machine. The loads, represented by the weight of the train concentrated on the wheels, come upon the joints with the dynamic effect of a blow, the bending effect of which is far greater than would be due to the quiet load. The tendency of this pounding is to loosen the fastenings and allow movement and wear of the parts, with the ultimate result that no amount of screwing up will take out the "sag," and keep the joint up to level. Although it is true that by increasing the weight of rails and fastenings these difficulties are reduced, yet in the best of track the joints still remain the chief source of care and expense.

In view of this fact, it is natural that engineers should be directing their energies to the design of a continuous joint, in which there shall be no break in the metal. Such a joint would at once get rid of the defects of all "fished" or spliced joints—always provided, of course, that the welded joint shall be perfectly sound.

Of late years the production of better rail joints has been greatly stimulated by the rapid development of electric traction, and this for two reasons: First, the destruction of joints was increased by the heavy pounding of rigidly supported motors (a difficulty which the partial supporting of the motors on springs has merely reduced, but has not removed); and secondly, the desire to secure the greatest possible electrical conductivity has directed attention to welded joints.

The first efforts to secure a continuous metallic joint were made by electrical welding, and this was followed by what is known as cast welding. In the first case a powerful electric current is passed through the ends of the rails and pieces of iron, known as chucks, which take the place of the fishplates. When the metal has been raised to a welding heat, heavy pressure is brought against the side plates and they are welded to the rails, the flow of metal filling in the space between the rail ends and forming a butt weld. It is claimed, and justly so, that a perfectly welded joint is stronger than the body of the rail. In cast welding, molten cast iron is run into a mould which incloses the abutting rail ends, which are thereby heated (or are supposed to be) to the welding point, so that the resulting joint is solid and continuous.

Mr. W. K. Bowen, superintendent of the Chicago City Road, has recently given some data in a paper before the convention of the American Street Railway Association, at St. Louis, which promise well for this style of joint. He stated that, of the 17,000 cast welded joints made on his road in 1895, only 154 were lost, and these breakages were due to flaws in the metal. Comparative tests have shown the joint to be "far stronger than the rail itself." The joints are made as follows: After the rail ends have been scraped or filed off so as to present a bright surface, a cast iron mould is placed around the joint, the fit being made so snug as to prevent the escape of any metal from the mould.

The metal is then poured in, and the outer part of the casting, being chilled by the mould, sets first, forming a crust which retains the molten metal. As this crust contracts faster than the interior, the latter is forced up against the rails and a more perfect contact is insured.

Although the first object of electrical engineers in making welded joints, electrical or cast, was to secure better electrical conductivity, as a matter of fact the mechanical advantages of this style of joint are of scarcely less importance. The strength of a bolted joint is entirely dependent on its fastenings being tightly held in place; and the construction of city tracks is such that these fastenings are often beyond the reach of the trackman's wrench. However well they may be secured when the track is laid, they soon slack up under the pounding of the traffic. This fact will account for the noisiness of street as compared with main line track. The welded joint requires no attention and may be covered up by the street paving with impunity.

As to the question of expansion and contraction of the rails due to change of temperature, it was proved in an experimental test at Johnstown, a few years ago, and in subsequent tests, that the elasticity of the steel is capable of accommodating such changes of length as take place. It should be noted in conclusion, however, that a continuously welded track, to be safe from distortion, must be exceptionally well spiked to the ties, and the ties and ballast must be of first class quality.

The Latest Plan of Rapid Transit for New York City.

The plan of rapid transit adopted by the Commission at its last meeting shows important modifications of the proposals recently made by the chief engineer. The reason for the changes, as stated by the president of the Commission, Alexander E. Orr, is that the main object of any proposed railway must be to secure really rapid transportation between the northerly and southerly portions of the city, and to obtain this requires the running of express trains and the consequent construction of a four-track railroad. While a three-track road permits the running of express trains at certain hours of the day, a two-track road in a city must be run solely as a local road. It follows that, if two two-track railroads were constructed north of Forty-second Street, the one east and the other west of Central Park, as originally proposed, the scheme would entirely fail in furnishing rapid transit to the district to the north.

The amended route is as follows: A two-track road starting from a loop at South Ferry and running beneath Broadway as far as Chambers Street. From Chambers Street and City Hall Park, where another loop would be constructed, a four-track underground road would be run beneath Elm Street and Fourth Avenue to Forty-second Street; thence westerly, under Forty-second Street, to Broadway; thence northerly under Broadway and the Boulevard to One Hundred and Fourth Street. At One Hundred and Fourth Street the road will divide into two two-track branches, the westerly branch continuing to the north under the Boulevard, Eleventh Avenue, Elmwood Street and Broadway, to a point in Kingsbridge immediately north of the Harlem River, where connection could be made with existing surface roads running north. The easterly branch from One Hundred and Fourth Street and the Boulevard would run in a northeasterly direction beneath private property, One Hundred and Sixth Street and Central Park, to Lenox Avenue; thence northerly beneath Lenox Avenue to the Harlem River, beneath which it would be carried by a tunnel. From the Harlem River the line would be carried to Bronx Park.

The west side line would be underground from the Battery to One Hundred and Ninetieth Street, except across Manhattan valley. The easterly branch would also be underground from One Hundred and Fourth Street, beneath the Harlem River, to a point east of Third Avenue, beyond which an elevated road would be built.

The estimated cost is somewhat less than $35,000,000, and the Commissioners are of the opinion that, while such a system would not be complete, it would soon demonstrate its success, and would ultimately be supplemented by say a branch from Forty-second Street to Fourteenth Street, and another branch on the east side of Central Park, from Forty-second Street to One Hundred and Tenth Street, to connect with the present proposed route.

Taken altogether, the revision of the original plans shows good judgment and is warranted by the city's experience with the existing roads.

The substitution of a four-track for two two-track roads from Forty-second Street to One Hundred and Fourth Street, with a view to securing unobstructed tracks for express service, is well made, for the new scheme must give an accelerated service if it is to secure popular approval. The Commissioners have also supplied an important missing link in the original plans, by including a two-track underground from South Ferry to City Hall Park.

THE wave length of Roentgen rays has been ascertained by Dr. Fromm, of Munich, at fourteen millionths of a millimeter, that is about seventy-five times smaller than the smallest wave length for light. This determination was based upon interference phenomena observed by Dr. Fromm, says Prometheus.

The Rheinfelden Hydraulic Power Plant.

Most American tourists who cross the ocean every year to pay a visit to the Continent know that part of the Rhine which forms the frontier between Switzerland and the Black Forest, that is, the part between the picturesque Falls of Schaffhausen and the ancient city of Basle. Many of the visitors may also remember the rapids over which the Rhine rolls its foaming waters near the little town of Rheinfelden, near Basle. This quiet and pretty little town has now got quite a lively aspect, since a work has been commenced in its immediate neighborhood which is destined to change the whole surrounding country. Some enterprising men, among whom are some of the leading engineers and financiers of Germany and Switzerland, had, a couple of years ago, formed a company for the utilization of the water power of the Rhine, and as there was no difficulty in obtaining the concession from the two adjoining countries, a well known engineer, Prof. Zschokke, of the Zurich Polytechnic School, was intrusted with the execution of a work which, on completion, will be the largest of its kind in Europe. In short, once more nature is to be made serviceable to man, and the considerable quantity of water (on an average 12,400 cubic feet a second) which the Rhine carries over the rapids of Rheinfelden will be brought to yield some 30,000 horse power, to be transmitted as electrical energy to industrial establishments within a radius of twenty miles.

The first part of the work is nearly finished, and it is expected that before next autumn 16,800 horse power will be available. To obtain this force a canal had to be constructed five-eighths of a mile in length and 165 feet wide, which is partly built in the bed of the river, and is separated from the river proper by a wall from 33 to 39 feet in height, with a width of 15 feet at the foundation. This wall alone absorbed some 23,550 cubic meters of solid rock, mostly excavated from the bed of the river, which, with innumerable mines, had to be deepened considerably at the lower end of the canal, so as to allow the water to flow away easily after having passed the turbines

At the lower end of the canal, standing diagonally across it, we find the building which contains the twenty turbines, all manufactured by the well known firm of Escher, Wyss & Company, of Zurich, and each of which has a capacity of 840 horse power. The same building contains the electrical machinery which produces the current. These engines are constructed partly by the famous "General Electric Company," of Berlin, and partly by the "Manufactory of Oerlikon," near Zurich.

By means of an iron bridge the works, which are situated on the German side of the river, are connected with the Swiss side. This bridge also carries the numerous cables which are to transfer the electric energy to the various industrial centers in Switzerland. The whole of the network is to cover some 315 miles. More than half of the available energy is already disposed of to industrial enterprises, which have come to establish themselves at Rheinfelden in order to take advantage of the exceptionally cheap motive power, the prices for which rank considerably below those of steam. Some large electro-chemical factories are now in course of construction, which will be manufacturing aluminum, chlorine, soda and calcium carbide. Several railway lines are also being built now in order to connect the large territories belonging to the company with two of the principal railways of Germany and Switzerland. In fact, to look at the activity displayed round the electric works of Rheinfelden, where hundreds of workmen are busy building and constructing, the casual visitor would hardly recognize the quiet old town on the Rhine.

Death of General Francis A. Walker.

General Francis A. Walker, President of the Massachusetts Institute of Technology, died suddenly at his residence in Boston, on January 5. General Walker was born in 1840. He graduated from Amherst College in 1860 and then studied law. When the war broke out he enlisted as sergeant major in the Fifteenth Massachusetts regiment and was rapidly promoted. He was captured at Reams Station and kept for some time in Libby prison. At the close of the war General Walker taught classics and tried journalism. In 1869 he was appointed chief of the Bureau of Statistics at Washington, and a year later organized and conducted the Ninth Census. His executive ability was seen and recognized and some of the best features in the Bureau of Statistics date from General Walker's incumbency as chief. In 1871 he became United States Commissioner of Indian Affairs, and in 1873 Professor of Political Economy at the Sheffield Scientific School at New Haven. In 1876 he was chief of the Bureau of Awards at the Centennial Exhibition. In 1879 he organized the Tenth Census, and in 1881 he became president of the Massachusetts Institute of Technology.

General Walker attained by his many writings and lectures a great reputation as a political economist. Notwithstanding these various interests General Walker devoted the bulk of his time to the Institute of Technology since he became its president, and his wonderful faculty for organization resulted in a continuous expansion of the work of the institution, until it is now in the front ranks of American scientific schools. As an educator, General Walker will be sorely missed.

A Suggestion for Laying Gas Pipes.

Those of our readers who have undergone the vexation of having their lawns cut up and more or less disfigured by the process of pipe laying will find the method adopted by Mr. Charles Lurcott, an employe of long standing in the office of the SCIENTIFIC AMERICAN, of practical interest. Mr. Lurcott was desirous of putting in the gas in his amateur workshop, which is 24 feet distant from the house. To avoid digging the customary trench across the lawn, and the permanent disfigurement which follows, he determined to bore a hole through the soil from the cellar to a point below the floor of the shop. The boring apparatus was extemporized out of a piece of $\frac{3}{16}$ inch flat iron, a ¾ inch bar, some 6 foot lengths of piping and a carpenter's brace. The flat iron, $\frac{3}{16}$ by 1 inch and 2 feet long, was bent cold with a twist of half a turn in 6 inches at one end, the other end being scarfed and riveted to a 6 foot length of ¾ inch round iron. The opposite end of the ¾ inch iron was threaded into a ⅜ inch pipe coupling, and with the addition of three 6 foot lengths of ⅜ inch pipe and couplings, the apparatus was complete. To connect the carpenter's brace with each piece of pipe as the boring proceeded, a short length of ¼ inch pipe was screwed into a ⅜ inch cap, its other end being filed square so as to enter the brace. With this simple and cheap boring machine completed, all that was necessary was to remove a stone in the cellar wall and commence boring. The auger cut its way readily through the soil, and in just 15 minutes a hole large enough for a ½ inch gas pipe was made for the required distance of 24 feet. The auger cut its way without any tendency to swerve out of line, and had any rocks been encountered, it would have been easy to dig down and remove them.

It should be added that the ground at the time was frozen and covered with several inches of snow, and anyone who has had to dig a trench under such circumstances will appreciate the saving of labor attending the methods of pipe laying employed by Mr. Lurcott.

A Large Waterfall.

A special dispatch from St. Paul, Minn., says that the following letter has been received from S. A. Thompson, at Santa Catalina, Venezuela:

"During the exploration of the concession of the Orinoco Company, headed by Donald Grant and other Minnesota men, a trail was cut to the Imataca Mountains, starting from this point, a village of 150 inhabitants. The duties assigned to some members of the party kept them upon or close to the Orinoco until a few weeks ago, when two of us, Leslie O. Dart, of Litchfield, Minn., and myself, of Duluth, found time to make an excursion to the mountains.

"Pushing on beyond the point reached by the other party, we heard from the top of a mountain a sound which at first we thought to be thunder, but afterward decided that it must come from a waterfall of considerable magnitude. Working in the general direction of the sound over a difficult trail, we came, at noon on Thursday, October 15, to a large river, and discovered what must rank as one of the greatest waterfalls in the world.

"The river bursts diagonally through an almost perpendicular cliff, which I estimate to be 1,600 feet in height, breaks into half a dozen separate streams, which divide and subdivide, spread out into broad, fanlike expansions, and twist about in such a curious, corkscrew fashion, that the water at the bottom of the falls flows in exactly the opposite direction from the course it holds where it first comes into view.

"By clinging to bushes and going up the giant creepers hand over hand, we climbed up the cliff until the aneroid indicated an elevation of more than 500 feet, but it was impossible to reach the top and learn how much higher the falls are."

Rich Lands in the Far North.

Mr. Tyrell, of the Geological Survey Department, has arrived at Winnipeg, bound for Ottawa, and reports having discovered rich tracts of agricultural and stock raising country hitherto unknown. He left Selkirk on January 24. From Norway House he descended the Nelson River in a canoe to the Pine River, ascending it to Wolf River. Again the Nelson was descended for seventy-five miles, until the Brentwood River was reached, thence down the Grassy River to the Sturgeon, which brought them to the Saskatchewan at Cumberland House. Recently they reached Prince Albert. Mr. Tyrell says that there are large areas of rich, cultivable lands west of the Nelson River, and though wheat is not grown, simply because it would be of no value, all varieties of vegetables are produced in the gardens of the Hudson Bay Company posts, and prove hardy. Except for the climate, he declares that that country is as richly blessed as the famed Red River valley.