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(Illustrated articles are marked with an asterisk.)



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**THE SCIENTIFIC AMERICAN SUPPLEMENT**

**No. 200,**

**For the Week ending November 1, 1879.**

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## PROTECTION FROM LIGHTNING.

We learn that a lightning rod company in Cincinnati has patented a system of lightning protection which consists of an iron rod running along the ridge of the building, with points at each end projecting upward. It is supported upon large glass insulators, and has no electrical connection with the building and no rod running to the ground. It is said that there are many public buildings in Iowa which have been provided with this system of lightning rods. We also perceive in the September number of the College Quarterly, a journal issued by the Iowa Agricultural College, in the interest of industrial progress, an inquiry addressed to Professor Macomber of that college in regard to the possibility of protecting a building from lightning by insulating it with a glass foundation. Professor Macomber in his reply admits that it would be possible that a house thus built could be struck by lightning; but adds, "By insulating a building the tendency to be struck by lightning would be very much lessened and the severity of the shock much decreased. Practical illustrations of this can easily be obtained by means of an electrical machine. A spark can be made to pass from the machine to an insulated body, although the force of the shock will be much less than when not insulated." After further illustration, Professor Macomber concludes thus: "Practically it would be almost impossible to insulate a building because after rain commenced to fall it would wet it so that communication with the earth would be established." The belief is quite common that by providing a chair or a bed with glass blocks upon which it rests, safety from lightning is secured, and the lightning company of Cincinnati and the inquirer in the College Quarterly both have the belief in mind. Professor Macomber is evidently not a believer; but we are nevertheless tempted to criticise the tender manner with which he treats this belief, and his use of the word "practical." In his illustration he causes a spark to pass from an electrical machine to an insulated body, and says that the shock of this spark will be much less than when the body is not insulated. We cannot regard this as a practical illustration of what would take place even if a house could be perfectly insulated by a glass foundation. In a laboratory one is dealing with feeble sparks. Moreover the relation between the size of the spark, the size of the insulated body, and the height of its insulation from the earth or neighboring conducting masses is entirely different from the relation which exists between the size of thunderbolts, the size of buildings, and the height of any glass foundation with which any building could be provided. We cannot regard his illustration in any sense a practical one. A thunderbolt which can leap to a house or other building would not be prevented from working its effect upon the building by any insulation which human means could provide its foundation with. The spark would strike the house and then pass by another leap the comparatively insensible interval which separates the house, provided with a glass foundation, from the ground. It is true that the spark would be divided into a spark to the house and another to the ground, through or around the glass foundation; but for the practical purpose of demolishing the house, its energy would be but little impaired. Suppose that a metallic ball a foot in diameter should be hung up by a rubber cord just an eighth of an inch from the ground, and we should cause a spark twenty feet or more in length to leap to the ball, what would take place? The ball would receive almost the entire force of the shock, and the discharge would find its way, so to speak, to the ground through the space of one eighth of an inch which separates the ball from the ground. It does not matter whether this space is filled with air or glass or any insulating medium now known.

This relative magnitude between the discharge and the object struck is apparently not considered by the "Chambers National Lightning Protection Company" of Cincinnati. It is needless to say that their system is impracticable and entirely untrustworthy, for the reasons that we have given above.

For the same reasons the glass insulators with which most lighting rods are provided are useless. If there is a path of least resistance from the lightning rod to the ground through the house the discharge will take this path without regard to the glass insulators. The ordinary lightning arrester in telegraph offices is an illustration of this. The discharge leaps across the short air interval provided between the telegraph wire and an earth connection, this air interval could be replaced by a plate of glass and the spark would still leap through it. All lightning rods should be connected with the system of gas pipes and steam heating apparatus, furnaces, or large masses of metal about a house, and then carefully grounded in moist earth. The best ground can be obtained by connecting the lightning rod with the water pipes if there are such about the house.

## FREEZING IN FIRE.

A few days since, while observing the action of his new absorption refrigerating machine at Ruppert's brewery, 92d street and 3d avenue, Mr. T. L. Rankine casually placed a lighted candle against the expansion pipe leading from the liquid receiver. His intention was to melt the frost from the pipe; but to his surprise the effect was quite the opposite, frost forming within the flame much more rapidly than on other portions of the pipe. He afterward observed in the cellar he was refrigerating that directly over the burning gas jets the frost on the pipes along the ceiling was whiter and more abundant than elsewhere.

To those unfamiliar with the fact that the vapor of water is always a necessary product of combustion, the production of frost in an atmosphere of fire seems to be not merely wonderful but magical. And we confess that perfect familiarity with the chemistry of combustion did not greatly mitigate our surprise on witnessing the phenomenon. Of course the principle is the same as in the familiar experiment of freezing water by the rapid vaporizing of sulphuric ether or other volatile liquid in the presence of high heat; but in this case refrigeration is from within, and one sees only the flame surrounding an iron pipe, on which the nascent water vapor is immediately transformed into white frost. It is worthy of remark that the frost is whitest where the flame is hottest, for there the vapor is formed and the combustion is freest from smoke. Incidentally the phenomenon gives evidence of the intense cold generated by the machine, which is as compact and simple as it is powerful. It will be remembered that Mr. Rankine is the gentleman who constructed the large skating rink at Gilmore's Garden last winter, maintaining for some weeks the largest sheet of artificial ice ever known.

## EFFECTS OF HEAT IN THE COMSTOCK MINES.

In an interesting paper read at the Pittsburg meeting of the American Institute of Mining Engineers, Mr. John A. Church reviewed at considerable length the accidents in the Comstock mines and their relation to deep mining. During the twenty-two months preceding May, 1879, there were 101 accidents, killing outright 53 persons and wounding 70 others. The accidents were classifiable under the eight following heads: 1. Falls of rock, timber, etc.; 2. Tramming; 3. Effects of heat; 4. Falls of men; 5. Explosions, 6. Hoisting apparatus; 7. Overwinding; 8. Miscellaneous. Most of these causes of danger and loss of life are common to all mining operations; the third class includes accidents peculiar to the Comstock mines.

In several instances miners have been fatally scalded by falling into the hot mine waters, which exhibit temperatures rising to 158° Fah. The most remarkable casualties, however, are due to the killing effect of labor in the hot and steaming atmosphere. The proportion of fatal casualties is larger in this class than in any other, being 73 per cent; and from the peculiar mental effects of the heat it is highly probable that it may be the real cause of many mishaps, which under other circumstances would be ascribed to culpable blundering.

On the 1,900 level of the Gould & Curry mine a drift was run along and quite near to the black dike, one of the hot spots of the mine. At a spot where the thermometer marked at times 128° Fah., Thomas Brown fainted while at work. When taken to the surface and revived he was found to have completely lost his memory. He could not tell his name or where he lived, and had to be dressed and taken home by his friends. The newspaper which recorded the occurrence said that such sudden loss of memory from overheating was quite common in the mines; and suggested that the fact might furnish an explanation of the walking off into fatal winzes and chutes by experienced miners, seemingly with deliberate intention.

A frequent accident in these mines is fainting in the shaft while the cage is rising to the surface. The faintness is always felt immediately upon reaching the cooler air, a hundred or a hundred and fifty feet from the surface, where there is usually a side draught through some adit. This happens so often that a man who has been working in a hot drift is never allowed to go up alone. Long habitude to the heat is no safeguard against this danger, and serious accidents have occurred in this way.

Among minor casualties, Mr. Church mentions one which happened to Mr. Sutro, in the Sutro Tunnel, before it made a connection with the Savage mine. After spending some time in an air temperature of 110° Fah., Mr. Sutro went to the air pipe to cool off. He stayed so long that the miners told him to get way from the pipe and let them have air. He did not move, and when they tried to stir him up with the handles of their shovels they found him unable to move. He had lost all volition, and had to be taken out on a car.

The graver results of overheating include insanity and death. The death of a carman on the 1,400 level of the Caledonia mine, Gold Hill, March 11, 1878, is a case in point. He had been idle for six months, and that morning he was working his first shift. At an early hour he rushed into the station of the 1,400 level and reported that the wheels of his car were smashed. The station master returned with him to his car and found it all right. There was evidently something wrong with the man, and he was taken to a cooling place. Here decided mental aberration was discovered, and the man, firmly lashed to the cage, was hoisted to the surface, where he fainted at once and died in a few minutes. In this case the heat was only about 90° Fah.

In another case a miner died from cramps, attributed to heat, but which may have been due to drinking ice water; and another death is charged to a cold taken while cooling off after being partially overcome with heat. Though contrary to the rules of outside hygiene, the miners resort to copious draughts of ice water or to exposure to strong cold air currents for recovery from overheating, and usually with impunity. The cold air cooling is considered the safer method; but to gain time Mr. Church commonly chose the ice water, and never felt any ill effects from it. With several thousand cases a day of rapid cooling off by one or the other of these methods it is surprising that fatal consequences have been so infrequent.

The next case illustrates the violent effects which excessive heat may have upon a person not accustomed to it: "On Friday, October 11th, 1878, John McCauley went to work for the first time in the Imperial Mine. He was cautioned against over-exerting himself in the extreme heat of the lower levels. He replied that he thought he was strong enough to stand anything and paid no attention to the advice. At half past two in the afternoon he was brought to the surface in an unconscious state, and died the next morning at half past ten o'clock."

Two other cases very similar to this have occurred in the Imperial within a few years. This mine is excavated in one of the hot spots of the Comstock.

The hot drift on the 1,900 level of the Gould and Curry is the scene of the most serious of these casualties due to heat. Five men were sent there in June, 1878, to load a donkey pump on a car. The work was so exhausting that when the pump caught on a plank they were not able to move it. They seem to have been in a state of mental confusion, but felt that they could not remain longer. Starting up a winze which connects with the 1,700 level one man fell on the way, and the others were afraid to stop to help him, but pressed on, reaching the 1,700 level in half an hour from the time they left it. They were very confused and nearly speechless, and hardly realized what had occurred. Three men went down to the rescue and found the fallen man still alive. Clearing the pump they got into the car and signaled to hoist, but on the way up the winze the man they had gone to rescue reeled and fell off. The car was stopped at once, but he was jammed between it and the brattice so fast that the others left him and went for help. They all gave out, two half way up, and the other just as he reached the 1,700 level, where a friendly hand pulled him up. A new rescue party went down and found two men dead, and the third died soon after. The shift boss reports that "the accident was due solely to the heat, as the air is good enough and pure enough, barring the heat." The winze was not an abandoned one, but in daily use. A heavy volume of steam is reported to rise through it from the 1,900 level, the temperature of which, at the time of this accident, is given at 128° Fah. Mr. Church gathers from the detailed account that the death of the men is possibly attributable to the fact that when the miner fell off the car the latter was stopped in a place that was hotter than the rest of the winze.

It is to be regretted that no adequate studies have been made upon the precise physiological phenomena presented by death under these circumstances. The legal requirements are satisfied when it is proved that the casualties are due to heat.

## PUSHING AN IRON BRIDGE ACROSS A RIVER.

A notable feat in engineering was brought to successful issue in the latter part of September, at Dinard, in the department of Ille and Vilaine, France. In carrying a railway across the river Rance, the novel plan was adopted of building the bridge on shore and boldly pushing it bodily across the stream. The bridge weighed 2,600,000 pounds; its height above the river was 100 feet, and the length of the main span 314 feet. Twelve windlasses were used in rolling the bridge into position. It was calculated that four or five days would suffice for the work of putting the bridge in place, but owing to the breakage of chains, it took two weeks.

Our correspondent, Mr. Geo. Quincy Thorndike, who furnishes these details, also favors us with a photograph of the bridge, taken just before the end touched the west bank. For two hundred and fifty feet or so, the western end of the bridge is comparatively light in structure, so that only about fifty feet of the main span projected over the river before connection was made with the further side.

We do not recall any previous instance of the pushing of a long and heavy bridge into position in this manner. The nearest approach to it—and quite as notable as a specimen of engineering skill—is the splendid bridge of the Cincinnati Southern Railway across the Kentucky river, a full description of which, with several illustrations of the structure at different stages of construction, appeared in the SCIENTIFIC AMERICAN SUPPLEMENT for October 27, 1877. In the latter case the chasm to be crossed was 1,138 feet wide, with almost vertical walls of limestone from 280 feet high. The bridge was made of three spans of 375 feet each, resting on the bluffs and on two iron piers supported by stone piers. During erection the truss was a continuous girder, 1,125 feet long, of the Whipple type, but after erection it was converted into one continuous girder, 525 feet long, projecting at each end 75 feet over its points of support, and carrying from each of these cantilevers a 300 foot span, bridging the distance from the cantilever to the bluff.

Taking advantage of two towers and two sets of anchorage, which had been constructed at the point of crossing for a wire suspension bridge, and abandoned, the engineer in charge, Mr C. Shaler Smith, bolted to the towers the first panel of the bridge on each side, and then pushed forward the construction of the bridge by corbeling out panel by panel. The towers were calculated to be strong enough to carry 196 feet of projecting spans, and at that distance temporary towers of wood were built to furnish an intermediate support. The corbeling process was then continued until the shore spans each reached the main iron piers, which were built up simultaneously, so that the projecting bridge and piers met in mid-air. Each half of the center span was then corbeled out as before until they met in the center, where they were joined.

This is regarded as not only one of the boldest and most original pieces of bridge engineering in America, but one of the best in the world when judged by the crucial test of accomplishing a great work at the least possible cost. How the French bridge will compare in the latter respect cannot be told without more detailed information.

## THE ELEVATED RAILWAY EXTENSION.—DETAILS OF CONSTRUCTION.

The constructors of the iron work of the Second Avenue Metropolitan Elevated Road and the extension of the west side line to Harlem, Messrs. Clarke, Reeves & Co., furnish the following figures, supplementing those given in our description of that work last week. It is proper to add that we are indebted to the same gentlemen for the photograph from which the large engraving of the 110th street curve was made.

The new structure on the east side has a length of seven and thirty-six hundredths miles, and required 28,000 tons of iron. The west side extension, from 83d street to Harlem river, four miles in length, required 16,200 tons of iron. In the 44,200 tons of iron used in building the two sections of the road, there are 971 miles of angles, 314 miles of flat bars, 20 miles of Phœnix columns, 2 acres of plates, 5¼ million rivets, and 21 million punched holes. The preparatory work was done at the Phœnixville rolling mills and shops, the average day's work being 3 miles of angles and 1¼ miles of flat bars, at the mills; and 66,600 holes punched and 17,430 rivets driven, at the shops.

The high viaduct shown in our engravings is 4,000 feet long, with an average height of 45 feet. At 8th avenue and 110th street the road is 59 feet above the pavement, and the foundation extends 36 feet below the pavement, making the total height of the structure 95 feet. The foundations are from 30 to 40 feet deep, and cost $200,000 a mile. Each pair of high piers contains as many bricks as a house 20 by 50 feet and three stories high.

If the grades had followed the streets a maximum grade of 170 feet to the mile would have been required. Now the maximum grade is 75 feet. The foundations and general design and arrangement of the iron work were planned by John Baird, General Manager, and W. F. Shunk, Chief Engineer of the Metropolitan Elevated Railway Company. The special design and construction of the iron work was by Clarke, Reeves & Co., of Phœnixville, Pa.

## AMERICAN INDUSTRIES.—No. 21.

### THE BROWN & SHARPE MANUFACTURING COMPANY.

For accuracy of workmanship, order, cleanliness, and completeness, no establishment is more justly noted than that represented in our leading illustration this week, and the work turned out at this shop is recognized everywhere as being as near perfection as it is possible to make it. Only accurate tools, skilled workmen, and good materials, supplemented, of course, by capital and experience, can produce these results, and these are found in the works of the Brown & Sharpe Manufacturing Company, of Providence, R. I.

The business of the company was begun in 1833 by David Brown and his son, Joseph R., and has been conducted under the style of David Brown & Son, Joseph R. Brown, J. R. Brown & Sharpe, and is now managed under the style of the Brown & Sharpe Manufacturing Company. From the first its aim has been to develop mechanical perfection by producing machinery of superior design and finish, and to furnish tools of such quality to the users as would enable them also to carry a just system practically into their work.

In 1866 the rule and gauge making branch of J. R. Brown & Sharpe's business combined with Samuel Darling, adding the business formerly known as Darling & Schwartz, of Bangor, Maine. The new firm adopted the style of Darling, Brown & Sharpe, and have since carried on the manufacture of U. S. standard rules, Ames' universal squares, patent hardened cast steel try squares, the American standard wire gauge, bevel protractors, hardened T squares and bevels, and a great variety of steel and boxwood rules and scales, and other small tools for machinists, draughtsmen, and wood-workmen's use. Darling, Brown & Sharpe occupy premises in the new factory of the Brown & Sharpe Manufacturing Company, and partake of the same high character in respect to the superiority of their productions.

The building occupied by this company in Providence, R. I., is architecturally handsome, and its plan admirably provides for light, ventilation, and security. It is not only adapted in its particular appointments and on account of its size, the area of floors equaling 60,000 feet, to their purpose as manufacturers, but it is fireproof and every way calculated to preserve the patterns and machines, the drawings and plans that years of study and labor have perfected.

The machines made by this company are so well known that they need no special description. We have represented two of the more important ones in our engraving, the one on the right being the universal milling machine, the producer of tools, a machine that is indispensable in any well equipped shop; that on the left is the universal grinding machine, designed for doing a large variety of work by the use of solid emery and corundum wheels. It is especially adapted for grinding soft or hardened spindles, arbors, cutters, either straight or angular, reamers, and standards, also for grinding out straight and tapered holes, standard rings, hardened boxes, jewelers' rolls, and other work.

Besides these machines this company make surface grinding machines, small milling machines, screw machinery, gear cutting attachments for milling machines, index plates for gear cutting machines. In addition to this they make a lathe which is not designed to compete with other lathes in the matter of price, but to supply a want felt by those who require a lathe that is as near absolute perfection as the most skilled workmen can make it. Besides this they are the makers of the Willcox & Gibbs sewing machines, and have filled the orders of that company for nearly 300,000, complete for market. This sewing machine among experts bears the reputation of being among the finest pieces of well executed mechanical work. They are the inventors of machinery as well as the users of it, by which the most mathematically correct instruments that are furnished to draughtsmen and others are manufactured.

Their weighing scales turn upon the accession of the thousandth part of a pound. Their sheet metal gauge determines thickness to the thousandth part of an inch. From tiny and light instruments to the universal milling machine with gear cutting attachment, their great factory produces in mathematical correctness of detail the tools that are in constant use in the different manufacturing establishments throughout the country.

Our engraving shows in the central figure the exterior of the buildings of the Brown & Sharpe Manufacturing Company, and the two upper figures show the lathe and planer room, and the gear cutting and milling room. The lower and larger view represents the department devoted to the manufacture of the Willcox & Gibbs sewing machine. These views serve to give an idea of a part of the works only; it would require a volume to illustrate and describe in detail the various departments of this establishment. There is of course a similarity between machine shops the world over; but in the matter of system and cleanliness we do not know of an establishment that excels this.

From storerooms situated upon the respective floors small tools are furnished for especial use to workmen, who deposit checks therefor, to be redeemed upon the return of the article taken. There is a library of interesting and valuable books free to all employes, and it is prized by them, as is made evident by their constant use of it. Every man employed, in an apartment for the purpose, finds accommodation for clothing and even dinner pail, if he brings one, under a registered number. Each man of all the large force has his appointed place for washing after work, even the soap that he uses not being interfered with by any one else. A little river of clear rinsing water flows through the center of the best devised washing accommodation for hundreds of men we have ever seen inside a building. One may judge what class of mechanics are at work in an establishment so ordered, and what may be expected from their hands.

### The Egyptian Obelisk for New York.

Lieutenant Commander Gorringe, U.S.N., and his assistant, Lieutenant Schroeder, have sailed for Liverpool, on their way to Egypt, to superintend the removal and shipment of the Cleopatra Needle presented by the late Khedive to this city. The machinery to be used in handling the monolith has been prepared at the Roebling Works, Trenton, under the direction of Mr. Gorringe. The *World* says that this machinery will aggregate about eighty tons in weight. It consists of two towers, each 26 feet in height (which are to be shipped in sections and put together after their arrival in Alexandria), two steel castings, each weighing over six tons, and a cradle 60 feet in length. The towers correspond to the sides of a gun carriage, and the castings to the trunnions on a gun. Like the machinery for handling the monster gun of the colossal Italian ironclad Duilio, this machinery for moving the Alexandrian obelisk will command the critical attention of machinists and engineers; and it is satisfactory to know that the work of transferring to the New World this great Egyptian monument will be carried out entirely under American auspices.

The method of embarking the obelisk is described as follows: A steam collier having a water ballast compartment will be secured alongside of the pier, and the necessary preparations made for heaving her down to careening lighters placed alongside on the side opposite to the pier. The water ballast compartment will be filled. A port having been opened to admit the obelisk into the fore-hold, it will be launched in. The listing of the steamer from taking its weight will be overcome by heaving down on the careening lighters, and the sinking due to both operations will be counteracted by pumping out the water ballast compartment, thus removing a weight of water corresponding to that of the obelisk. Tidal and wind-drift differences of level will be overcome by means of a float secured at the shore end after the fashion of a ferry slip.

### An Extensive Beard.

The Detroit *Post and Tribune* has been interviewing the possessor of the longest beard on record, Mr. Edwin Smith, of Fairfield, near Adrian, Mich. The beard measures 7 feet 6½ inches. Mr. Smith is a farmer, forty-seven years old, 6 feet high, and weighs only 145 pounds; hair and beard sandy and tinged with gray. His twin brother, less bearded, is stouter and enjoys much better health. No unusual growth of hair is noticeable in any other member of the family. Mr. Smith had a fuzzy face in childhood, began to shave at the age of thirteen, but stopped shaving eighteen years ago. His hair is thick and strong, and has to be cut fortnightly.