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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE SCIENTIFIC AMERICAN AND THE ST. LOUIS FAIR.

In spite of some rather serious but inevitable defects the St. Louis Exposition is unquestionably the most comprehensive and instructive of any that have been held in this country. Its chief drawback, as we have already stated in these columns, is its huge area size; but this was scarcely avoidable when once the sponsors of the fair had planned it on the vast scale upon which it has been built. The late President McKinley once spoke of expositions as being the timekeepers of progress, and in the intervening eleven years since the last great international fair was held in this country, such has been the feverish activity of industrial life, not merely in America but in every part of the civilized world, so vast have been the strides that have been taken in many of the industrial arts and sciences, that it seems to require an exposition of the magnitude of the present one at St. Louis adequately to record, in concrete form, the world's advancement during these eleven years.

If it be a difficult task merely to walk through the exhibits and see them with one's own eyes, it becomes a still more formidable task to serve as the eyes of the great multitude of readers of the SCIENTIFIC AMERICAN, and adequately set before them by pen and by picture a comprehensive review of the Exposition. Of the two alternative methods of doing this which presented themselves, that of publishing a special World's Fair number devoted exclusively to the Exposition was rejected, for the reason that it was altogether impossible to do justice to the fair in any single compact edition that would not be too cumbersome to serve its purpose. Consequently we have decided to distribute our World's Fair articles through the successive issues of the SCIENTIFIC AMERICAN and the SUPPLEMENT—a policy which will enable us to place the subject more exhaustively before our readers than would be possible in a single issue. Our editor has just returned from a two months' residence on the grounds, and the material that he gathered will be used in the form of illustrated and descriptive articles that will appear in our various publications during the next few months.

RAILWAY SPEEDS HERE AND IN EUROPE.

There are some controversies that will not down, and one of the most persistent of these is that relating to the relative speed of railroad travel here and in Europe. We have been in receipt lately of several letters asking us for an expression of opinion on the subject, and we therefore think it well to state, for the benefit of those who are interested in the question, that in respect of the number and speed of fast express trains, our railway service in this country simply cannot compare with that of France and England. We say this with the full knowledge that there are a few fast expresses that maintain a high average speed for long distances in this country—trains which, if the element of total distance be taken into account, as in the case of the Twentieth Century Limited, on the New York Central and Lake Shore lines, have no competitor in Europe. There is also a service of very fast trains running between Philadelphia and Atlantic City, during the summer months, which are scheduled to run at a higher speed than the fastest of what might be called short-distance expresses in other countries. But when it comes to a broad comparison of fast express service in France and England with that of the United States, we may as well confess to the uncomfortable fact that our service, taken as a whole and judged merely with regard to its speed, can scarcely be entitled to be called first-class. After we have eliminated the Empire State Express, with its average speed of about 54.5 miles an hour between New York and Buffalo; the Twentieth Century Limited, with its average speed of about 50 miles an hour from New York to Chicago, and the service of a few fast trains from Philadelphia to Atlantic City, maintained during the summer months, we have mentioned all of the trains that can be presented in comparison with the remarkable service that is being run on regular schedule this year on the other side of the Atlantic.

It was only a few years ago that the French railroads took the lead from England by putting into service several trains that ran at average speeds of from 55 to 60 miles an hour. At the present time there are in France thirty-five trains that are booked to run at speeds from start to stop of 55 miles an hour and upward. The fastest of these runs from Paris to Longeau, 79 miles, at 60.8 miles an hour; another is timed to do the distance from Paris to Busigny, 112½ miles, at 60.3 miles an hour; the next fastest run is the 109 miles from Paris to Abbeville, at 60.2 miles an hour, and the fourth fastest train runs from Paris to St. Quentin, 95¼ miles, at 60.1 miles per hour. Then follow seven trains, with a timed speed of from 58 to 58.6 miles per hour; eleven trains at from 57.1 to 57.8 miles per hour; and ten that run at an average speed of from 55.0 to 56.5 miles an hour. These runs are made without a stop over distances that will average about 85 miles.

During the past two years the English railroads have been building more powerful engines, and the result is seen in a greatly-accelerated train schedule. They have regained the lead in fast express service by putting in regular service a total of fifty-three daily trains scheduled to make a speed of 55 miles an hour and over from start to stop. The fastest run of these is over the 44¼ miles from Darlington to York at 61.7 miles an hour; but the most meritorious are the runs from London to Bath, 106⅛ miles, at 59.4 miles; from London to Bristol, 118½ miles, at 59.2 miles; two trains between London and Exeter, 193¾ miles, at 56.7 miles, and three at 55.3 miles an hour. These last-named trains are run on the Great Western Railway, on which a train carrying the American mails was recently run from Plymouth dock to London, a distance of 246¾ miles, at an average speed of 65.49 miles for the whole journey, the last 36 miles being covered at the rate of 79.17 miles an hour. The fifty-three daily expresses that run in the British Isles include twenty-four trains with a schedule speed of 55.1 to 55.8 miles an hour; thirteen trains with a speed of from 56.2 to 56.9 miles an hour; seven trains of from 57.0 to 57.8 miles an hour speed; five trains of from 58.1 to 58.9 miles an hour speed; three of from 59.1 to 59.4 miles, and one of 61.7 miles per hour schedule speed. The average distance of these runs, start to stop, is 101 miles.

It must be understood that this comparison is made merely on the basis of the actual number of high-speed trains available to the traveling public. No account is taken of train weights. Compared with American train weights these European trains are light; but so are the engines. Moreover, though the trains are lighter, their carrying capacity, owing to the lighter construction, is equal to that of our larger and heavier trains, so that the passenger is still the gainer. It would not pay to run so many trains at such high speeds in the United States, for the reason that our latest Pullmans weigh over 60 tons, or over 2 tons to the passenger, which, from an engineering point of view, is an absurd proportion. The only argument in their favor is that such heavy cars are safer in a collision; but would it not be a saner policy to build our cars lighter, abolish collisions, and operate our railroads with the same care that enabled the English roads, in spite of their many fast trains, to operate their railroads, as they did the year before last, without killing a single passenger?

Surely this is a problem worth consideration.

A GREAT RAILWAY SCHEME.

The government of Canada has entered into partnership with a newly-incorporated company for the construction of a transcontinental railway from the Atlantic to the Pacific, to be wholly within Canadian territory. This road will be about 3,600 miles in length; and the total cost is estimated at $150,000,000. This does not include the branch lines, aggregating about 2,000 miles.

The western division, extending from Winnipeg to the Pacific, is to be constructed by the Grand Trunk Pacific Railway Company, a chartered corporation, not yet organized, to be controlled by the Grand Trunk Company, which will be the majority stockholder. The line from Winnipeg to the Atlantic terminal, at or near Moncton in the province of New Brunswick, will be built by the government, and leased to the Grand Trunk Pacific Company at a 3 per cent rental for fifty years.

From Winnipeg to Edmonton, about 800 miles, the line will run through a prairie country, paralleling or intersecting branches of the Canadian Pacific and Canadian Northern railways. Northwest from Edmonton, for 300 miles to the foothills of the Rocky Mountains, there are no engineering difficulties until the route enters the valley of the Upper Peace River. Following this valley through the Rockies, the surveyed line reaches a point where a southerly turn brings it to the canyon of the Skeena. By a tortuous and difficult route through the Coast Range, the line finds its western terminal at or near Port Simpson, within a dozen miles of the recently defined southernmost point of the Alaskan boundary. An official statement presented to the Senate gives the length by the surveyed route, through the mountains, as 766 miles. This makes 1,886 miles for the total length of the division, Winnipeg to the Pacific, to be built by the company.

The surveys of the eastern division have not yet made sufficient progress to permit a definite location of the route. The most favorable line will probably be found north of the height of land, crossing a succession of valleys which have their outlet in Hudson's Bay. The St. Lawrence River will be traversed by the great bridge now under construction a few miles west of Quebec city. Between Quebec and Moncton, the line will come very near to the boundary of the State of Maine, until the valley of the St. John River is reached, thence a choice of routes is presented to the seaboard.

The government provides the cost of the eastern division. For the western division, bonds issuable by the Grand Trunk Pacific Company are to bear government guaranty of 3 per cent in respect of three-fourths of the total amount; the interest on the remaining fourth part is to be guaranteed by the Grand Trunk Company. The government guaranty, however, becomes operative only on the completion of the railway from Winnipeg to the Coast. Interest upon outlay in construction is to be capitalized. The western division must be completed by December 1, 1911.

THE ROMANCE OF LIGHT.

There are few objects in daily use about which we stop to ask how they came to us, and through what stages of development they passed before arriving at that perfection which we now enjoy. Should we turn a retrospective eye toward "those good old times," we should be amazed at the slow steps of progress, and the almost infinite struggles through which inventions came into acceptance.

The connection between a burning fagot and an electrolier may seem remote, but every link in the chain is perfect. From the smoky rays of the first flaring brand of the cave-dweller, to the electric light, filling the most spacious halls with its glory and making the streets of our cities luminous as the day, the way has been paved with human effort and illumined by human genius.

The pine torch was no doubt coeval with fire in the hands of men. The resinous knot was the first step in artificial illumination. Its use is found in every savage tribe and nation, while it is a necessity in the lives of all first settlers in new countries. When the nineteenth century dawned, the children of America were learning to read by the light of pine knots and the crackling of logs of an open fire-place; so closely are we related to what may seem the remote past.

It is hard to believe that the world groped on to the thirteenth century without discovering even the tallow candle; yet so it is. The expression that "mankind was plunged in darkness during the early ages" is true in every sense. It was perhaps the accidental burning of a bit of fat of some slain animal that suggested its use as a luminant, while the hollow shell from the sea, a concave rock, or a mold of sun-baked clay held the fat, which was burned by placing a rush in the fat, with the lighted end projecting over the edge of the rude dish. Step by step the lamp was fashioned into a thing of beauty, though barely a joy forever. Thus came the first improvement in the art of domestic illumination.

Admirable specimens of lamps in terra cotta, in stone, in brass, and in bronze have been found on sites of Hebrew cities and in the temples of Hindustan. From the tombs of Egypt; from the tumuli of Assyria and ancient lettered Babylon; from the opened graves of Chaldean sages, come examples of household lamps, revealing a general use many centuries before the Christian era. Herodotus speaks of a procession of lamps, as a scene of imposing magnificence, and Homer sings of a torch borne upon a staff, its flame no doubt feeding upon the wax from the wild honey, and the resinous gums of the forest trees, nearly a thousand years before the Christ.

So, from the fat of slain animals, the resinous products of the forest trees, and the wax of the wild bee came those lights which gleamed upon fair women and brave men at Belshazzar's feasts, the revels of Dives and the grand balls given by the first Napoleon in the Palace of the Tuilleries.

When men discovered the art of extracting oil from the olive and other vegetable sources the use of the lamp became very general among the wealthy and noble. Only they could enjoy the less offensive methods. Lamps wrought in cunning form of marble, silver, and gold were ornamented with precious stones, inlaid with curious handicraft and artistic workmanship indicate a high position for this method of illumination. Even the terra-cotta specimens, used in

cottages, are graceful in shape with an elegance of finish which no art of modern times can surpass.

Beautiful as indeed they were, of how little practical use! An eighteen-penny lantern of the eighteenth century, with its tin reflector and its bullseye of third-rate glass, diffused a better light than any lamp of Rome or Greece in the days of their greatest glory.

As they knew no method for refining oil, they made it a luxury by mixing with it the perfumes of the rose and of sandal wood. Although detracting from its burning properties, the fragrance was supposed to compensate for diminished light. The flame emitted an enormous amount of smoke, and fluttering in the slightest breeze spluttered out altogether in a gust of wind. At the end of an evening conference a party of noble Romans would resemble a congregation of chimney sweeps.

From Rome the oil lamp passed successively into Germany, Gaul, and Britain. In these countries, torches, rushes dipped in grease and a very odorous fish oil were the methods of artificial lighting until the Roman conquest. The rush-light of that day consisted in a notched wooden stick set in a wooden base. Stalks of the rush were peeled to the pith save for one strand of husk, and passed through hot grease. Sometimes three or more were twisted together and when cold were placed in a notch of the standard, to be pushed up when the fire neared the wood. It emitted a strong flame and a similar odor. You may make one of these, and enjoy for an hour the ancient light of Britain and that which to this day dispels the gloom of night in remote Irish cabins. The candle of the common people was the rush-light of our ancestors. It burned where candles made from wax were too dear and before Chevreul and others found a way to refine a cheap candle grease from the fat of animals.

The Picts and Scots, the Danes and the tribes of Scandinavia had not advanced to the use of the rush-light at the time of the conquest. When torches were necessary they stuck a bit of wood into the body of some fat bird, and supporting the stench as best they could allowed this dismal sort of a candle to burn until the bird became a cinder.

The lamp as brought from Rome continued in use without being greatly modified until well into the thirteenth century, when the invention of candles made an artificial light of comfort to those who could afford it.

The curfew bell which tolled at eight o'clock was no hardship to our ancestors, considering the badness of the lamps which lighted their houses or hovels as the case might be. Through all the mediæval ages, men were supposed to rise at daylight and retire soon after the sun had set.

The first step toward the use of the modern candle was the invention of a tallow torch which came into use about the last of the twelfth century. This remained in use for about a hundred years when the tallow candle either dipped or molded made its appearance, much as it now exists. The haughty barons who forced King John to sign the Magna Charta at Runnymede would have considered a bundle of tallow dips of almost as great value as the rights which they wrung from the unwilling hand of their sovereign. To have stolen one from the kitchen table would have incurred the noose without hope of pardon. Not until the fifteenth century were the burgesses and trades people able to purchase a tallow candle. At the opening of the nineteenth century they were sold singly for about twelve cents each.

Flax being the wick, they burned rapidly. Cotton was more expensive than silk and to use it for wicks was extravagant folly. Three pounds sterling was the price of a pair of cotton stockings one hundred years ago. Tapers made of wax had been in use in churches since the ninth century, but no one ever dreamed of using so expensive and sacred an article for domestic purposes. Toward the close of the fourteenth century they were timidly introduced in a few palaces, and the homes of great noblemen. To offer a wax taper at a shrine was a princely gift, and absolution followed the presentation of a taper weighing one pound. To vow a taper to the Virgin Mary was like vowing a hundred doves to Venus or a heifer to Juno. At a cost of four hundred crowns in gold, King Henry sent two wax tapers weighing twenty pounds each to Thomas à Becket, hoping thereby to appease the great primate of Canterbury.

In the Cathedral of Pisa a ton of bronze slowly swings from the lofty dome. A keen-eyed student watches its regular oscillations as its hundred wax tapers flash upon a thousand worshippers engaged in evening prayer. The great candelabrum, almost a world's wonder at the time, was weaving a message of light in Galileo's brain, and from the cathedral he went away to startle the world with the story of its motion and to reveal the secrets of the pendulum as a means for measuring time. Still swings the chandelier under the cathedral's dome, with the same potent motion as when its flashing lights taught the old astronomer the deeper story of the world's life.

In the year of 1509 a few enterprising chandlers conceived the idea of mixing animal fat with the wax, but the deceit being discovered the king by royal edict debarred every chandler of the realm from making and offering for sale any mixed substance or composite article in the place of wax.

It was no doubt after seeing on his grocery bill that he was paying 36 shillings a dozen for candles that Oliver Cromwell in the year 1654 blew out one of the two candles on his wife's work-table, on the ground of unnecessary extravagance. Louis XV. complained that he could keep a regiment, music and all, with what was spent in lighting the palace at Versailles. It is related of Voltaire, that, when dissatisfied with the salary afforded by Frederick the Great, he used to put in his pocket the wax candle ends of his royal master, and from them turned quite a pretty penny. The cost of lighting the Tuilleries under the first Napoleon with wax candles was about what it would be were the electric lamps of the present day employed —namely, $4,000 per annum. When the Emperor was giving magnificent fêtes at Dresden he often spent six hundred dollars for the wax candles of a single night's carousal.

When, however, wax and tallow had been sufficiently cheapened to allow their use in drawing rooms and boudoirs, the oil lamp and the rush light were relegated to the parlors and kitchens. No room in which costly paintings and gilded furnishings began to exhibit elegance and refinement could tolerate the smoky and greasy contrivances which remained without improvement through the centuries.

Toward the middle of the eighteenth century the number of lamps increased among the poorer classes, owing to the invention of Colza oil. The new liquid was far cheaper than the olive oil used in France and Italy or the whale oil of England and America. Not till then began the processes of lamp regeneration. It was in 1783 that an enthusiastic and radical reformer, one Argand, discovered a lamp which consumed its own smoke and most of the odor. By admitting oxygen to both sides of a flat flame he increased the light so that a shade became necessary. The new lamp was at once popular in France and England. When improved by a convex reflector placed behind the flame, the light was rendered too dazzling for an ordinary room.

Fred and Phillipe Girard improved this lamp, placed the reservoir for oil below the wick; softened the glare by the use of whitened glass, giving the first effect of beauty to artificial light. It is an interesting fact that the first appearance of the new lamp devised by the brothers Girard took place in London at a party given by the Duchess du Barry, then in exile. Josephine, hearing that it was enthusiastically admired, and jealous that it was not first seen at her soirees, ordered the brothers to bring a lamp at once to the palace. The significance of this circumstance is little beyond the fact that the lamp presented by the brothers to the Empress was decorated by a young and obscure artist, struggling for bread, to be later known throughout the world as Jean Auguste Ingres.

On the arrival of the Pilgrims at Plymouth in 1621 they adopted the Indian's method for light and used the pine knots, furnished in abundance by the virgin forests. No doubt the pitchy drippings of these knots were a source of discomfort to the cleanly housewife, and the candle when it came was greatly prized. Cattle were not introduced into the colony until about eleven years after the arrival of the "Mayflower," up to which time candles were unknown except when imported at rare intervals. Elliot translated the Bible by a spluttering, smoky torch. New England literature was spattered by the dripping flame and clouded, perhaps, by the odorous smoke.

There is a long step between the torch of the fathers, still in use at the opening of the nineteenth century, and the electric searchlight, of which it was the humble progenitor.

The forerunner of the street light was the basket torch, fastened to a building at a street corner, or later swung by a chain across the street. This basket filled with pitch pine knots made the place quite light. Such a basket, but of enormous proportions, was swung from a crane at the top of a high place in Boston and gave the name to Beacon Hill.

In the year 1660 candle making became quite common with the pilgrim housewife. Tallow was not plenty, so the fat of the bear and deer was added to the tallow, increasing the light but softening the candle, making is less durable. The method usually employed was dipping, with a few molded candles for "company." To dip, a number of wicks were placed upon the sticks a sufficient distance apart, the wick suspended vertically. These wicks were dipped or carefully lowered into a pot of hot tallow on a cold day. Tallow would adhere and quickly cool. This repeated until the proper size was reached secured the "taller dip" of the "mothers."

Not alone was the oil from the sperm whale used as an illuminant, but the fatty substance which gives the name to the fish was discovered to be most excellent for candles, being more costly, but of greater power. Inclosed in little square lanterns "spermaceti" candles lighted the streets of Boston, were suspended over the front doors of the wealthy, and adorned the front halls of elegant mansions. That which gave happiness to the young eyes of "Dorothy Q.," the grandmother of the genial "Autocrat of the Breakfast Table," is still in existence.

Not until about 1830 did our fathers have a match to carry in their pocket. Up to that time they must light their pipe with an ember or by the tinder box. Should the fire of the hearth go out he must revive it by steel and flint or make a hurried trip to the neighbor's to secure his fire. At an early hour on a cold morning this was no pastime.

In the early days of the last century, Sir Walter Scott, writing from London, to a friend in Edinburgh, said: "There is a fool here who is trying to light the city with smoke."

Sir Walter's "smoke" was not a human invention. It was a product of nature's laboratory. Accumulations of gas from coal beds found their way to the surface, and being highly inflammable attracted the attention of men who erected altars over them, and their perpetual fires were dedicated to the gods. After the defeat of the Persian armies at Platea, two victorious generals, Pausanius and Aristides, were directed by the Oracle to build an altar to Jupiter, and to offer no sacrifice thereon until they had extinguished every altar fire in the country, polluted by the Persians, and had relighted them with the sacred fire from Delphi. It would be natural to expect men of science to imitate a process of nature which held such promise. For thousands of years the Chinese have speculated upon the meaning of the natural gas which has escaped abundantly from the earth in several provinces.

In 1726 Dr. Hales informed chemists that by distilling a few grains of coal, he had obtained an equal number of cubic inches of "inflammable air," and that, if attempted on a large scale millions upon millions of cubic feet of that valuable substance could be made, and conveyed unseen along the highways of the land, and become the means for obtaining perpetual day. In 1813 Sir Walter's "smoke" was burned on Westminster Bridge in London, and one year later the streets of St. Margarets, Westminster, enjoyed illumination from gas, it being the first parish contracting for such a luxury.

The common kerosene lamp, with its chimney of glass, its varied forms of beauty, its shades modified to every grade of vision and of taste, suggests the relation of man to light. The oil, natural, cheap, brilliant and volatile, was long known to civilized humanity as a crude outflow from the earth. It was not until about 1845 that the iridescent scum seen floating on the surface of a stream near Pittsburg suggested to thoughtful men to dig for a greater supply. Indians came from a distance and soaked it from the water with their blankets which they wrung out into vessels in order to secure a quantity for some secret purpose. When the American found it he was rich beyond computation, at the same time providing at a small cost the best fuel and the cheapest light for the common people. It was not until 1860 that it passed into common use. Since that time it has driven every form of wax, grease, fluid, camphene, and whale-oil lamps from the common use of mankind.

From the clouds overhead, lowering along the horizon as the sun goes down, Franklin and Edison have drawn the electric fire and in our chambers darkness is unknown. All the way from the pine knot to a nightless day has been won from the darkness in the lifetime of one man and he but just reaching the century point.

This is the Age of Light. FRED. HOVEY ALLEN.

On the Lake Erie & Western Railroad, which belongs to the Vanderbilt group, an experiment is to be tried in electrification. It has been determined, according to report, to install electric motors upon portions of the Peoria division where the competition of electric surface lines is keenest, with a view of trying to recover some of the passenger traffic which the road has lost. If the experiment on this division proves successful, it is likely that before another year is ended the Lake Erie & Western will have an electric passenger service all the way between Lafayette and Indianapolis, and will later extend such service to cover every mile of road which comes in competition with surface lines.

The transporter bridge that is being erected across the river Mersey between Widnes and Runcorn, and which was described in a recent number of the SCIENTIFIC AMERICAN, is rapidly approaching completion. The most difficult part of the undertaking has now been successfully accomplished. This was the suspension of the two aerial cables, of a span of 1,000 feet, which are to carry the suspended traveling deck.