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THE SCIENTIFIC AMERICAN SUPPLEMENT

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THE ST. GOTHARD RAILWAY TUNNEL.

The junction of the northern and the southern sections of the St. Gothard tunnel was accomplished on the morning of February 29, thus bringing to successful issue the boldest and most difficult engineering work of the kind hitherto attempted.

The St. Gothard group of mountains comprise that part of the Alpine range in South Central Switzerland, directly north of the valley of Lake Maggiore, and separating the railway system of Switzerland from that of Northern Italy.

The project of tunneling Mount St. Gothard was a necessary consequence of the tunnel through Mont Cenis. Until that time most of the traffic and travel between Italy and Switzerland—in other words, a large part of the overland commerce between England, Belgium, Northeastern France, Western and Central Germany, and Northern Europe generally, on the one hand, and Italy on the other, and the Levant, as reached through the Italian ports—was carried on through Switzerland. The three great roads over the Swiss Alpine passes, the Simplon, the Splügen, and the St. Gothard, monopolized by far the larger part of this important trade. This monopoly was broken up when the Mont Cenis tunnel was completed in 1870, the bulk of the traffic and travel being thereby diverted through Western Italy, by way of France, to the inconvenience and loss of Northern and Central Europe.

Switzerland and Germany especially felt the need of restoring a more direct line of transit. The Simplon route was rejected because, like the Mont Cenis route, it would be directly tributary to France. The Splügen pass was less difficult than the St. Gothard, but the road leading to it must pass along the upper Rhine, in dangerous proximity to the Austrian frontier. The favorable geographical situation of the St. Gothard route, in the heart of Switzerland, more than offset, it was thought, its engineering difficulties, and it was therefore adopted. The entire length of the costly railway line, of which the St. Gothard tunnel forms a part, is 151 miles, 17 per cent of it being tunnels, and 1 per cent bridges and viaducts. The main tunnel is about 9⅓ miles long. There are twelve other long tunnels, ranging between 1,106 and 2,027 yards, and aggregating nearly ten miles in length; five tunnels between 220 and 550 yards in length; and twenty-five tunnels between 110 and 220 yards long. In all, there are fifty-two of these subsidiary tunnels, having a total length of 16 miles. The line is also carried over sixty-four bridges and viaducts, the longest, at Cadenazzo, in Tessin, consisting of five spans of 55 yards each.

The main tunnel traverses Mt. St. Gothard between Goeschenen on the north side and Airolo on the south. The contract for its construction was awarded to M. Louis Favre, of Geneva, August 7, 1872. The work was begun at Airolo the following month, and at the other end in November. The time set for the completion of the great task was eight years—six months more than the time actually employed.

Airolo station is 3,757 feet above the level of the sea, and Goeschenen 3,639 feet. The tunnel runs straight between these two points, except for 158 yards at the Airolo end, where a curve connects the tunnel with the station. The tunnel has been constructed for two lines of way, 4 feet 8½ inches gauge, the contract calling for a cutting of horseshoe form, 19·68 feet high by 24·93 feet wide at the level of the sleepers, and 26·24 feet at the springing of the arch, 6½ feet above the sleepers. The arch is a complete semicircle of 4 meters radius. The sides are curved to a radius of 33·13 feet. Where the rock was solid the tunnel was cut to the exact section without masonry.

The line of the tunnel rises from both ends to a summit level 197 yards in length; the northern gradient, for 8,128 yards, rising at the rate of 1 in 172; the southern gradient, 1 in 1,000, for 7,970 yards.

Before the work was begun, Professor Fritsch made a careful study of the strata to be pierced, and expressed the opinion that the principal mass to be traversed consisted of gneiss rich in mica; mica schist, gneiss, and hornblende-schist. These, he believed, extended through the mountain in the form of a fan, and he figured the amount of each as follows:

	Meters.
Granite gneiss, more or less homogeneous	2,200
Gneiss, more or less schistous	450
Crystalline limestone and gray marble	350
Micaceous schist passing into gneiss	1,300
Gneiss rich in mica passing into mica schist	6,600
Mica schist with hornblende	1,600
Gneiss more or less schistous	270
Mica schist, with veins of quartz	800
Hornblende schist	1,250
Dolomite, gypsum, etc	100

The nature of the rock met throughout went, in the main, to justify the Professor's prophecies. The material taken from the opposite ends differed widely. At the north end a layer of very hard rock was first met; hardly any water came from the roof, and but little timber was needed. At the southern extremity, on the contrary, the dominant rock was mica-schist, with numerous fissures, through which water leaked into the tunnel in great quantities. At one time it rushed in at the rate of 420 gallons per minute, and brought with it masses of *débris*. Later on, when beds of clay were struck, it rushed in at the rate of 2,640 gallons per minute. One hundred and eighty yards in a spring was met, which delivered 1,000 gallons a minute, and stopped the work for several days. The leakage kept varying from time to time, and at that side always giving much trouble to the workmen.

The headings were about eight feet square, giving frontal areas of sixty-seven and a quarter square feet. For the first half year they were driven by hand; after that, mechanical perforators, operated by compressed air, were employed. Full descriptions of the various devices of this sort, adopted during the progress of the work, with much detailed information touching the methods of working, rates of speed, cost of excavation, and so on, will be found in the several volumes of the SCIENTIFIC AMERICAN SUPPLEMENT, with many illustrations of the machinery employed and of the general engineering features of the work.

For the most part the air for the rock drills and for ventilating the tunnels was compressed by water power. At the north end of the tunnel the river Reuss furnished an abundance of water with a fall of 385 feet. This was utilized by means of turbines. On the south side water was scanty, so that it became necessary to work under a fall of nearly 600 feet. The turbines operated 16 air compressors at each end of the tunnel, supplying air enough under a pressure of 8 atmospheres to work from 18 to 20 drills, and to thoroughly ventilate the tunnel. About 600 pounds of dynamite were used daily, and, latterly, as many as 4,000 men were employed.

Many changes were made in the apparatus employed during the progress of the work, and great improvements were introduced. The temperature of the air in the tunnel was found to be always higher than that without. It steadily increased as the excavation proceeded. On the first day it rose from 35° Fahr. to 58°, while the air outside remained at 34°. The average temperature further in was found to be over 70°, while the rock was also much warmer than the surrounding atmosphere. Large bell exhausters were erected at each end of the tunnel for the removal of atmospheric impurities, although artificial ventilation was not needed until the boring was 1,000 meters deep. About 5,000,000 cubic feet of compressed air were forced into the excavation each day from either end, and an exhauster, capable of extracting 16,500 cubic feet per minute, was provided at each.

The contract price for the work was $196.40 a foot, tunnel complete; the work to be done October 1, 1880. For every day beyond that time the contractor was to forfeit $1,000 for the first six months, and $2,000 for each day of the second half year; a year's delay forfeiting the contract and the $1,600,000 deposited by the contractor's friends as security. On the other hand, a premium of $1,000 a day was allowed for each day gained upon the contract time. Accordingly there is due the contractor's successors the snug little premium of $215,000 for the early completion of the work.

Unfortunately the original contractor, M. Favre, did not live to see the accomplishment of his heroic task. While showing the levels to a French engineer, Saturday morning, July 19, he suddenly complained of a cramp, called for a glass of water, and fell down dead from an affection of the heart.

The prospect of losing by the St. Gothard route a large part of the traffic which now passes through the Mt. Cenis tunnel, has driven the French to urge the subsidizing of a project for piercing a still greater tunnel on the Simplon route.

The proposed tunnel strikes the mountain at a lower level than was thought of when the St. Gothard tunnel was projected; and, although its length will be greater, the conditions are so favorable that no doubt is felt in regard to its possible execution. Competent geologists pronounce the rocks of the Simplon less hard than those of St. Gothard, and predict that the work will suffer less from the infiltration of water. There is, besides, abundance of water power at both ends of the tunnel; and from their lower altitude the works will be less liable to interruption by the severity of the winter cold.

The railway extending from Lausanne up the lower part of the Rhone Valley is without curves, while the gradient nowhere exceeds 1 in 100. At its exit on the southern side of the mountain, in the Diviera Valley, the gradient is somewhat stronger—13 in 1000. In fact, when the tunnel is completed, the highest point of the line between Paris and Milan will not be in the Simplon, but between Dijon and Lausanne.

The tunnel will be over 12 miles in length, as compared with the 9 1-3 miles of the St. Gothard, and the 7½ miles of the Mt. Cenis tunnels; and as it is estimated that a daily advance will be made of 9 to 10 meters in the boring, so that the completion of the work is promised in 6 or 7 years after it is fairly begun.

The superior rate of progress in the St. Gothard tunnel over that in the tunnel of Mt. Cenis (9 1-3 miles in 7½ years, against 7½ miles in 13 1-3 years) was due mainly to the great improvements made from time to time in the machinery and explosives employed. The projectors of the Simplon tunnel count on a continuance of such inventive progress.

THE PATENT BILL NOW BEFORE THE SENATE.

We have heretofore pointed out the disingenuousness of the proposed new law, "To regulate practice in suits brought to recover damages for infringement of patents," the injustice it would certainly work to all who have property in patents, its practical confiscation of vested rights in what are assumed to be matters of only small concern to the owners, and the fairly doubtful question of its constitutionality, if tried on a broad issue in the tribunal of last resort. There is little satisfaction, however, to be derived by the owners of patents from the latter consideration, although it ought, indeed, to furnish a leading argument for the defeat of the bill; but, should it once become law, there is little doubt that its provisions would be generally sustained by the lesser courts throughout the country, and it would be many years, and only after it had done about all the injury possible, before a final reversion might be obtained.

It has also been shown that the passage of the bill through the House was effected by a sort of *coup d'état* " in the interest of the Western farmers! "—and that no consideration of its provisions was had in that body; it did not come from the Committee on Patents, which has from time immemorial had charge of such matters, and was passed with a very light vote, under the assumption that it covered nothing of essential consequence. It did not matter that Congress had heretofore, for two or three years, given a great deal of attention to the question of the revision of the patent laws, and that the Senate had ably canvassed the whole ground before passing a bill which the House summarily rejected; all of this goes for nothing, and the House, taking not more than five minutes' time therefor, passes a bill whose practical effect would be even greater than that of the previous Senate bill, and which cannot fail, if it become law, to work an almost complete confiscation of the property of thousands of patentees.

The proposed law is undoubtedly in the interest, and is the immediate, though skillfully concealed work, of a powerful combination of monopolists. The influence of great moneyed interests in shaping legislation, national as well as state and municipal, has undoubtedly been on the increase of late years. The great corporations and combinations of capitalists which now exist have only lately attained their present gigantic proportions, and, though the manner in which they work to compass their ends is partially understood, the far reaching scope of their schemes is almost beyond ordinary comprehension. There are so many "wheels within wheels" in the complex machinery they employ, that it is always difficult, and often impossible, to decide whence the power is derived, and precisely what object is to be attained. The effort to put through the proposed new patent law, the dexterity with which it was managed in the House, and the plausible and "taking" reasons at once given to the public for the urgent necessity of such a measure, show the way in which this department of their work is attended to. To suppose that the real reason for the passage of the bill was the one given—that it was simply a measure for the " protection of farmers"—would be ridiculous. But to find out exactly who are the parties working so strenuously for the passage of this law, how they have attained their present measure of success, and how much a complete victory would be worth to them in dollars and cents, would be to discover a portion of their work which it is their main object to cover up. A large proportion of the users of patented devices would prefer to pay an equitable price for the value they in this way receive, and in this fact lies the primal strength of our patent system. Any persistent and determined effort, therefore, to confiscate the rights of patentees, cannot have a popular indorsement, and the intimation that " the farmers," whose benefits under our patent system have been so great, are the sponsors of this movement, is absurd on its face. This excuse, and this particular way of changing our patent laws, were not thought of until lately, although there has been, for a long time, a powerful interest working for such amendments as will make it more easy and safe to infringe upon the rights of patentees.

Among those who have most earnestly sought such changes, and who would be the greatest beneficiaries thereby, are the great railway corporations; the sop thrown to the " farmers " would be but a bagatelle to what they would gain, for the passage of such a bill as that now before the Senate would give them advantages whereby they might virtually confiscate thousands of patents involving details of construction and operation, in road-bed, bridges, cars, locomotives, supplies, etc. Certain large manufacturers of the Eastern States have also been very zealous in this work, from the success of which they would reap substantial benefits in escaping payment of fees on many minor patents.

The danger will not be over until the bill is taken up in the Senate and *defeated*, or so amended as to make another vote upon it necessary in the House. In the latter case, we may be assured, it will not again go through on a stolen passage. Meantime, and until some permanent disposition is made of the matter, it behooves all patentees, and all who are interested in the maintenance of any rights heretofore supposed to have been "secured" to them by our patent laws, to see that the members of the Senate are individually furnished with as many personal protests as the threatened enactment of so unjust a law ought to bring out.

Imitation Stained Glass—A New Idea.

A few years ago stained glass windows were rare in this country, even in churches, except among the ambitious and costly of those of two or three denominations. Now ornamental windows are comparatively plenty, not only in churches, but in other public and private buildings, and would be more common in ordinary dwellings were the cost within the scope of ordinary purses.

The growing taste for this sort of color decoration cannot fail to be materially advanced by the cheap and very successful imitation of stained glass effects now coming into use. Thin sheets of silk paper are printed with brilliant oil colors, in varied artistic patterns; and when pasted upon common glass windows they produce all the brilliant effects of costly colored glass. The color sheets can be applied without skilled labor, and show a great advance in decorative effects over ordinary curtain shades or blinds. The invention has been patented, and we predict for the product a large demand. The address of the manufacturer may be found in our advertising columns.

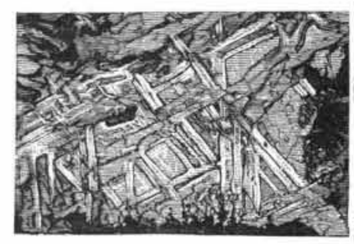
THE NEW METEORITE.

In our issue of March 6, we gave a brief account of a new meteorite, discovered near Chulafinne, Ala., by Mr. John F. Watson, and now in the possession of Mr. Edison's expert mineralogist, Mr. W. E. Hidden, of Newark, N. J.

Meteorite from Chulafinne, Ala.

We now present our readers with a side view of this interesting object, and give a representation of the Widmannstaettian figures which it exhibits. Upon analysis of the meteorite, its constituents are found to be approximately as follows: Iron, 92 per cent; nickel, 7 per cent; phosphorus, about the same as ordinary steel; and of copper and carbon only a trace. It is about as hard as copper, and exhibits about the same tenacity under the cutting tool.

This in common with other metallic aerolites is very heterogeneous, as indicated by the marked figures developed on the polished facet by the action of nitric acid. Mr. Edison suggests that " These lines are without doubt a map of the streets of the New Jerusalem."



Widmannstaettian Figures on the Chulafinne, Ala., Meteorite.

Meteorites of this size (31 lb.) are not extremely rare, and they have been found of all sizes, weighing from a few ounces to 25 tons. It is now generally conceded that these strange bodies fill the spaces between the orbits of the planets and swing around the sun like so many miniature worlds, until by unexplained causes they are brought within the attractive influence of the larger planets, when they gravitate toward the superior body.

Kepler's idea that there were more small bodies flying about in space than there are fishes in the ocean, seems to find support in modern discoveries.

The Great Iowa Meteorite.

This great meteorite, which fell in Iowa the early part of last year, is thus described by Professor Thompson, of the Minnesota State University, in a recent astronomical essay: May 10, 1879, was a bright, clear, cloudless day. At 5 o'clock in the afternoon, in full sunshine, this meteorite passed through the air, exploded, and fell in the town of Erterville, Emmet County, Iowa, about ten or twelve miles below the southern boundary of Jackson County, Minn., in latitude 43° 30′ north, longitude 94° 50′ west from Greenwich. The path it followed marked a course from northwest to southwest, and was seen for a distance of several hundred miles. Its appearance in the heavens was that of a huge globe of fire, attended by a fiery cloud. The people who saw it were greatly alarmed; not more at the flying ball of fire which seemed so near to them, than at the terrific explosions immediately above them; those who did not see it thought an earthquake had occurred, and were in great terror. The noise accompanying its flight is described as rumbling, cracking, crashing, similar to that produced by a train of cars crossing a long bridge; then came a very loud report, followed immediately by two distinct reports in quick succession, though not so explosive or loud as the first. It struck the ground in separate masses, together with smaller fragments scattered over an area of three or four miles. There were two large pieces which fell about two miles apart.

The largest mass, weighing 470 pounds, now at Keokuk, Iowa, penetrated a hard blue clay soil, to the depth of twelve feet. Another mass, weighing 170 pounds, now at the State University, fell on a dry grassy knoll, and was buried to the depth of 5½ feet. A few rods from the largest mass was found a fragment weighing 30 pounds, and a schoolboy picked up a specimen weighing three pounds. The form of all the pieces is like that of rudely detached masses from a quarry, or ejected from the mouth of a volcano. The mass in the museum of the university has an irregular rhomboidal outline, about 15 by 18 inches, of an average thickness of 6 inches, and when first obtained was covered, as most meteorites are, with a black shining coat or crust. The largest mass is not so regular in its formation. It is more ragged and bristles with points of nickeliferous iron. Professor Heinrich, of the Iowa State University, pronounced it the more valuable of the two large masses; but a full analysis will probably determine them to be one and the same. While the nickeliferous iron seemed more abundant in the largest, the crystalline formations are far more numerous in the smaller.

THE FIRST STEP IN INVENTION.

A correspondent, who has had some experience as an inventor, suggests that the SCIENTIFIC AMERICAN should regularly set apart a portion of its space for the outlining of inventions needed. This for the purpose of setting inventors "on the right track," and so laying out their work, that they may "go immediately at the thing wanted."

To a considerable extent the SCIENTIFIC AMERICAN has always made a practice of suggesting, whenever it could, opportunities for invention; and not unfrequently such suggestions have been successfully worked out and patented by wide-awake readers. Further opportunities of the sort will be gladly taken advantage of; and pleasure will also be taken in presenting the suggestions of any who clearly perceive the need of and opportunity for specific improvements in any art or manufacture, but are unable, for lack of time, means, or inventive capacity, to undertake to work out the needed invention.

Such suggestions, however, our correspondent will readily understand, are not likely to be numerous. Our countrymen are by habit as well as by nature, inventors; and when one sees a chance to better any process or product he is very sure to keep his knowledge to himself for future developments. It is mainly in connection with inventions requiring a large outlay of time, labor, or money, or all three, that men voluntarily give away ideas of value. However original and valuable, such ideas are not apt to be salable; while only the more courageous and forehanded among inventors dare attempt to develop them materially.

Opportunities for working out such costly and complicated inventions are obviously of little use to the class of inventors which our correspondent has in mind. What he wants is specific information touching this, that, or the other clearly felt deficiency in the means or methods of one or other of the arts, deficiencies which the would-be inventor could supply if he only knew what was wanted.

Such deficiencies are doubtless infinite in variety and number; but, for the most part, it is the business of the inventor to discover them, as well as to invent the remedy; and, in most cases, his acuteness is chiefly manifested in detecting the opportunity for a useful invention. The arts are full of improvable means and methods, and of openings for entirely novel processes. As a rule, it is the inventor of the future who will first detect where the needed improvements and substitutions should fall; and in this his genius will be chiefly displayed. The development of the inventions will be a secondary and comparatively simple work.

Accordingly, the faculty which the young inventor should cultivate most sedulously is the faculty of critical observation. He must learn to look upon everything in two aspects —first, to see exactly how it appears, how it was produced, and how it works; second, to see how its appearance, its working, or the manner of its production can be improved, simplified, and cheapened, or its uses extended; or whether something entirely different would not answer the purpose better. With the cultivation of this faculty the inventor's difficulties arise not from the lack of opportunities to invent, but from their multiplicity, and the need of restricting his thoughts and constructive labors to such novelties as are likely to be profitable.

In short, the young would-be inventor must begin further back even than Mrs. Glasse advised in her famous receipt for cooking the hare. He must not merely " catch the hare," but he first must learn how to catch hares and where they are likely to hide. After that the catching and cooking are easy.

THE telephone has been found by Herr Niemöller (*Wied. Ann.*) capable of determining very quickly and accurately the resistance of liquids. It is substituted for the galvanometer in a galvanic bridge, and an induction current is used; then, if the resistances compared are a large liquid resistance on the one hand, and a Siemens resistance box on the other, so that the electro-dynamic constants of the branches are very small; if, further, a German silver or platinum wire be used as measuring wire, it is found that in the position where the galvanometer shows no deflection, the tone in the telephone has a well-marked minimum of intensity. Supposing the liquid resistance has 2,000 units, a variation of it, even 4 units, reveals itself in a displacement of the minimum position.

AT the present time there is annually manufactured on the Mississippi River and its tributaries about 1,500,000,000 feet of white pine lumber, with its proportionate accompaniment of shingles, laths, and pickets. This is mostly consumed west of the river, and finds its way to Texas, Kansas, and Nebraska, and even to Colorado. St. Louis receives more lumber annually than any other point on the river, but after deducting the amount required for home consumption, Hannibal distributes more for foreign consumption than St. Louis.