WORK ON THE SIMPLON TUNNEL.

The road from Paris to Milan by way of the Mont Cenis tunnel is 1,058 kilometers, and by way of the St. Gothard tunnel 1,068 kilometers in length. To reduce this distance to 979 kilometers is the primary purpose of the Simplon tunnel.

The new tunnel through the Simplon Pass, when completed, will undoubtedly be the most stupendous engineering feat of its kind ever performed—a feat which many engineers thought it impossible to accomplish by reason of the great depth which was to be attained.

It is evident even to a layman that it is far easier to carry a load up a hill for a distance of 500 yards than for 1,000 yards. It is this lightening of the task to be performed by the railroad locomotive which will be one of the ends attained by the new tunnel in comparison with the routes of St. Gothard and Mont Cenis. The highest point of the Simplon tunnel is 705 meters; of the St. Gothard, 1,154 meters, and of the Mont Cenis as much as 1,294 meters. The greater the height, the more formidable the difficulties. In winter time especially the operation of Alpine roads is a herculean task and involves appalling additional expenses. With the completion of the new road these difficulties will vanish. Indeed, there is probably no part of the Alps more admirably situated for railway purposes than the Simplon Pass. The construction of the St. Gothard route necessitated the building of approaches of magnificent proportions, the cost of which rivaled that of the tunnel itself. The builders of the Simplon will be confronted by no such necessity. On the northern side the new tunnel starts at the level of the valley, and on the southern side terminates after a few miles at the very border of the great plain of Lombardy.

So rapid and so fast have been the strides made by the modern engineer that this latest engineering work will be completed in a far shorter time than any of its predecessors, despite the character of the country. The building of the Mont Cenis road required thirteen years; the St. Gothard tunnel was completed only after seven and a half years; but the engineers of the Simplon have pledged themselves to finish the tunnel through the pass in five and a half years; which, in comparison with the St. Gothard, represents a reduction in cost of 25 per cent. Despite the greater rapidity with which the work can be pushed forward, and the consequent saving in expense, the tunnel will cost $55,500,000.

Keenly appreciating the difficulties which confronted the engineers of the St. Gothard and Mont Cenis routes, so far as the provision of proper ventilation was concerned, the Simplon engineers have hit upon a simple and ingenious method of improving the sanitary conditions within the tunnel. Instead of constructing a single two-track tunnel, it was decided to build two single-track tunnels, one of which was to serve, when completed, as a huge ventilating tube for the other, still incompleted tunnel. How enormously this simple expedient has improved the ventilation is shown by a comparison with the conditions that prevailed in the St. Gothard tunnel. The quantity of fresh air which could be supplied to the workmen of the St. Gothard tunnel was 1½ to 2 cubic meters per second; in the Simplon tunnel the laborers are supplied with 25 cubic meters. Moreover, by the use of sprayers the temperature has been so far reduced that the thermometers in the cuts have never registered more than 32 deg. C.—the maximum temperature attained at the St. Gothard. This result is all the more gratifying when it is considered that many skeptical engineers had declared that a minimum temperature of 40 deg. C. would be met. Disastrous epidemics occurred only too frequently among the laborers of the St. Gothard. In carrying on the work of the Simplon comparatively few men have reported themselves ill. The astonishingly small sick list may also be partially attributed to the admirable provisions made by the company in charge of the work, by securing the very best sanitary conditions. The tunnel exits consist of covered passageways through which the laborers pass into large bathrooms where they wash themselves and change their clothes.

After long diplomatic negotiations between Italy and Switzerland, work was at last begun in the autumn of 1898. Before the final permission to break ground had been received, elaborate preparations had been made for pushing on the work as fast as possible. Above all it was necessary to provide sufficient power. On each side of the mountain about 2,000 horse power was available, and this was to be used primarily to drive the ventilating apparatus and hydraulic compressors as well as workshop tools and dynamos. In the north, water power is obtained from the river Rhone: in the south from the Diveria. Through huge flumes, over 1½ meters in diameter, the water is led many miles from its source to the power house. Great repair shops were built, in which many hundred artisans were to be employed whose duty it was merely to make and repair the tools and rock drills. That so huge an undertaking should necessitate the installation of many small plants is easily understood.

From the latest reports which have been received, it would seem that about a half of the work has been completed; and if unforeseen hindrances are not encountered, the tunnel will be open for traffic before the contracted time of five and a half years. If such be the case, the engineers will receive a bounty of 5,000 francs for each day between the actual day of completion and the contracted day; for each day required in excess of the contracted time, a fine of 5,000 francs is imposed.

On the south side, the rock up to the 3,820th kilometer had been found perfectly dry; but when the 3,825th kilometer had been reached, springs yielding four to five liters of water per second were found. The schist forming the walls of the galleries was moist without, however, causing any inconvenience. But when the 3,900th kilometer was reached, more formidable springs yielding as much as 160 liters per second were discovered, the temperature of which, strange to say, varied from 25 to 30 deg. C.

During the early stages, work progressed but slowly, particularly on the south side, where the rock was exceptionally hard. How difficult was the removal of the rock on the south side may be inferred from the fact that daily progress on the north side is about 6 meters and on the south side 5 meters. This daily progress is the result of three attacks—drilling, blasting and removing the rock. The three attacks require from 6½ to 7½ hours. On the north side 7 to 8 drill holes, on the south side 11 to 12 are necessary. On the north side drills are sunk to the depth of 1.8 to 2 meters; on the south side the depth attained is only 1.2 to 1.4 meters. To blast one cubic meter of rock on the north side, 4 kilogrammes of dynamite are required. On the south side 5 kilogrammes are necessary. It is, therefore, not to be wondered at that the consumption of dynamite for a month amounts to from 13,000 to 15,000 kilogrammes (28,600 to 33,000 pounds).

The geological formations proceeding from south to north along the line of the tunnel are as follows: Calcareous mica schist and Antigoria gneiss, 6,330 meters; Teggialo lime, calcareous mica schist, mica schist and gneiss, Valle limestone, 9,700 meters; mica and gypsum on the Rhone banks, 3,700 meters. The entire tunnel length will be 19,730 meters. The rock drills used were invented by Mr. Brandt, one of the engineers. Depending upon the hardness of the rock, the water pressure on the north side at the drills varies from 60 to 70 atmospheres, on the south side from 90 to 100 atmospheres. The rapid daily progress is to be entirely attributed to the efficiency of these drills.

The laborers are almost without exception Italians, recruited from all parts of the Apennine Peninsula, from Lombardy to Sicily. The northern Italian, more industrious and more accustomed to hard work, is preferred; for the southern men, when winter comes, throw down their tools and return to their homes in the South. But despite this winter desertion, ten men are always ready to fill a place which has become vacant. Many of the laborers bring with them their wives and children. Thus it happens that on each mountainside whole villages have sprung up almost in a single night. At the present time about 2,000 laborers are employed. They have all the virtues and all the vices of the southern European. Industrious enough on the whole, sober and frugal, they are, however, easily excited. Every laborer is considered something of a disguised revolutionist, although he may have no clear idea of the meaning of socialism and anarchy. It cannot be denied that these Italian workmen are exceedingly susceptible to the fiery speeches of their countrymen. They will blindly follow their leaders without knowing whither. Strikes occur apparently for no cause. The men are ordered to lay down their tools. They obey. But it always happens that after a few days of idleness the men all return to their work under the old conditions.

An English bridge builder with experience of life in India, gives an interesting account of the wages of coolie and other caste men who have to be drawn upon for a working force in riveting, skilled workmen being very scarce. It appears that all sorts and conditions of men are impressed into the work, without consideration of their previous occupations. Whereas a blacksmith is always a blacksmith in India, and the man born to a carpenter-father follows the trade of his parent, in riveting any caste may be drawn upon. Accordingly there are sometimes milkmen, butlers, gardeners, and even outcasts impressed into closing the rivets in the several members of bridges, but the English bridge builder aforementioned says that very drastic methods are practised to make capable workmen out of the material at hand. The pay for the head riveter is about 30 cents a day; for the holder-on, 16 cents. They drive 100 1-inch rivets a day, seven days in the week, with no extra pay for Sunday, and often they are on scaffolds 200 feet from the ground, in a temperature of 115 in the shade; in the sun it is so hot that a man cannot hold his hand on the iron.

Engineering Notes.

Another new line is to unite the cities of Poltava and Yekaterinoslav, Russia. This road will be 106 kilometers (66 miles) long. The concession is for eighty-one years, but after twenty years the government is to have the right to buy the road for a stipulated price. The necessity for this line is fully appreciated by the Russian railroad building commission.

In order to combat the smoke nuisance, the Prussian government called together a committee for the trial of all smoke-consuming apparatus, says The Engineer. This committee has finished its work, and common measures are about to be taken to remove the evil. It was proposed to institute schools where stokers could be specially trained for the handling of steam boiler plants. The Steam Boiler Revision Association consulted most of the branch associations, and the result was that most of them were against the idea of the schools; but it was proposed to send properly qualified men to instruct the stokers employed in the various steam plants.

An artesian well in Grenelle, France, took ten years of continuous work before water was struck, at a depth of 1,780 feet. At 1,259 feet over 200 feet of the boring rod broke and fell into the well, and it was fifteen months before it was recovered. A flow of 900,000 gallons per day is obtained from it, the bore being 8 inches. At Passy, France, there is another artesian well 1,913 feet in depth, and 27½ inches diameter, which discharges an uninterrupted supply of 5,500,000 gallons per day; it cost $200,000. An artesian well at Butte-aux-Cailles, France, is 2,900 feet in depth, and 47 inches diameter. These are all surpassed by an artesian well in Australia, which is 5,000 feet in depth.

An elephant-catcher rather than a cow-catcher seems to be needed in India. On the railroad between Bengal and Assam, according to the Railroad Gazette, as the superintendent of the line was making an inspection trip, while passing through the great Nambar forest, the train came to a stop with a jolt that threw the travelers out of their berths. The train had run into a herd of wild elephants which were trotting down the track, the last of which had both hind legs broken and was thrown into the ditch, while the engineer counted seven others which got away. This is not the first time that wild elephants have got on the track, and ordinary fences and cattle-guards are no protection.

A locomotive boiler explosion in England is attracting much attention among engineers, by reason of the circumstances attending it. The use of copper for fire-boxes is universal there, and recently an alloy of copper and another metal has been used for stays and stay-bolts. The exploded boiler was nearly new, and had been just overhauled, nevertheless the fire-box collapsed on one side near the bottom by the failure of the stay-bolts, and threw the boiler 174 feet into an adjoining field. An examination into the probable cause of the disaster revealed that the over-heating of the composition stay-bolts by an assumed shortness of water reduced the factor of safety to about 1.38, which did not take into consideration the transverse strains to which the bolts were exposed. It is asserted that at a black-hot temperature such alloys are reduced 50 per cent in strength, and are manifestly unfit for such duty. It is said that the railway company has forty boilers fitted with these stays, but none of them have given any trouble before.

Reports of English railways for the first half of the current year are very discouraging to the stockholders, and they are hunting around, trying to find some one to make the directors of the railways do something to improve the status. The losses were chiefly in carrying freight, for the passenger traffic showed a good margin of profit, and the directors have a scapegoat in the increased cost of coal which they work for all it is worth, and a little more. In this emergency—the loss of profits—the directors are scanning the foreign horizon with the expectation of discovering better methods of handling freight, so as to decrease the cost of that detail, for it is one of the principal sources of loss. It appears that British railways are really express companies, in so far as freight is concerned, for it is asserted that merchants insist upon the delivery of goods the next day after they are ordered, whether large or small lots, and regardless of the amount of traffic there may be to any given locality. As a consequence the railways are put to great expense, which could be avoided if the time for delivery was not so short, for a few hundred pounds of freight have to be carried in a car and delivered at some country town, possibly a long distance off. Sometimes, indeed, it has to be reshipped at certain points, all of which is an added tax to the railway. In brief, the railway freight of Britain consists to some extent of small packages carried short distances, and is necessarily more costly to conduct than in this country, where the reverse is the case, so comparisons of relative cost here and abroad are out of order.

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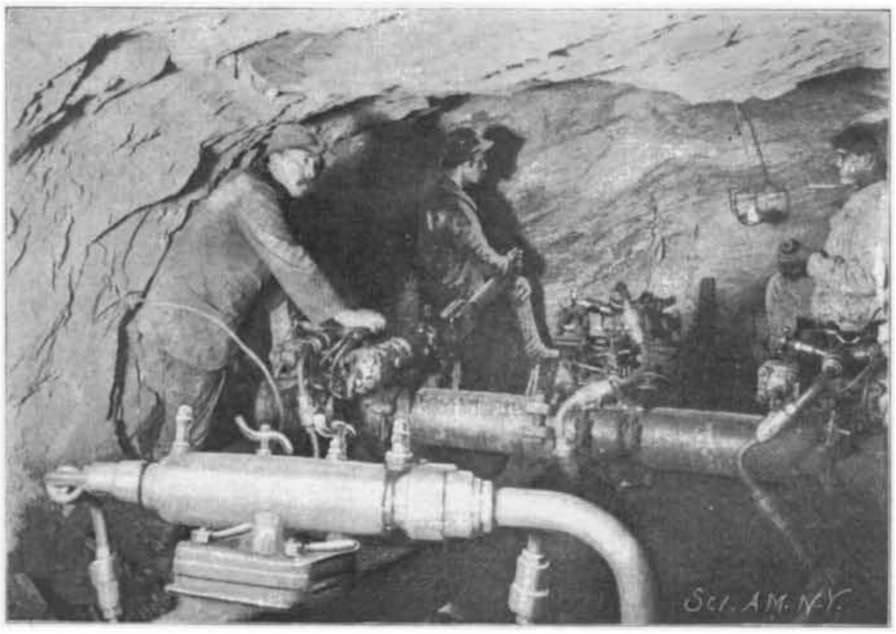
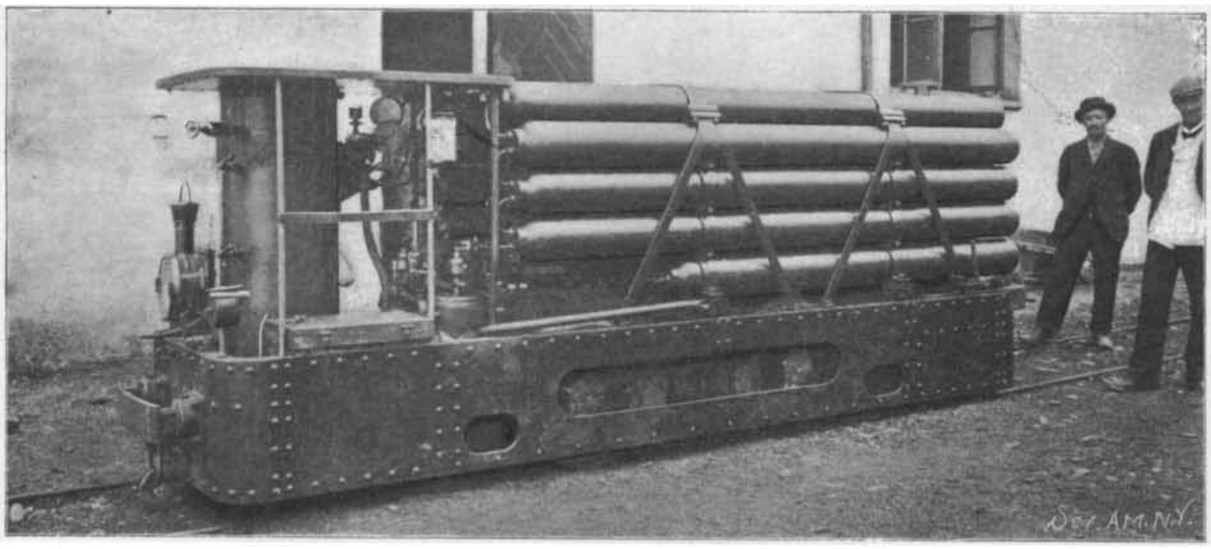
Upper Power House. Iron Bridge Across the Diveria for the Flume. To the Left, a Small Tunnel Leading to the Main Tunnel.

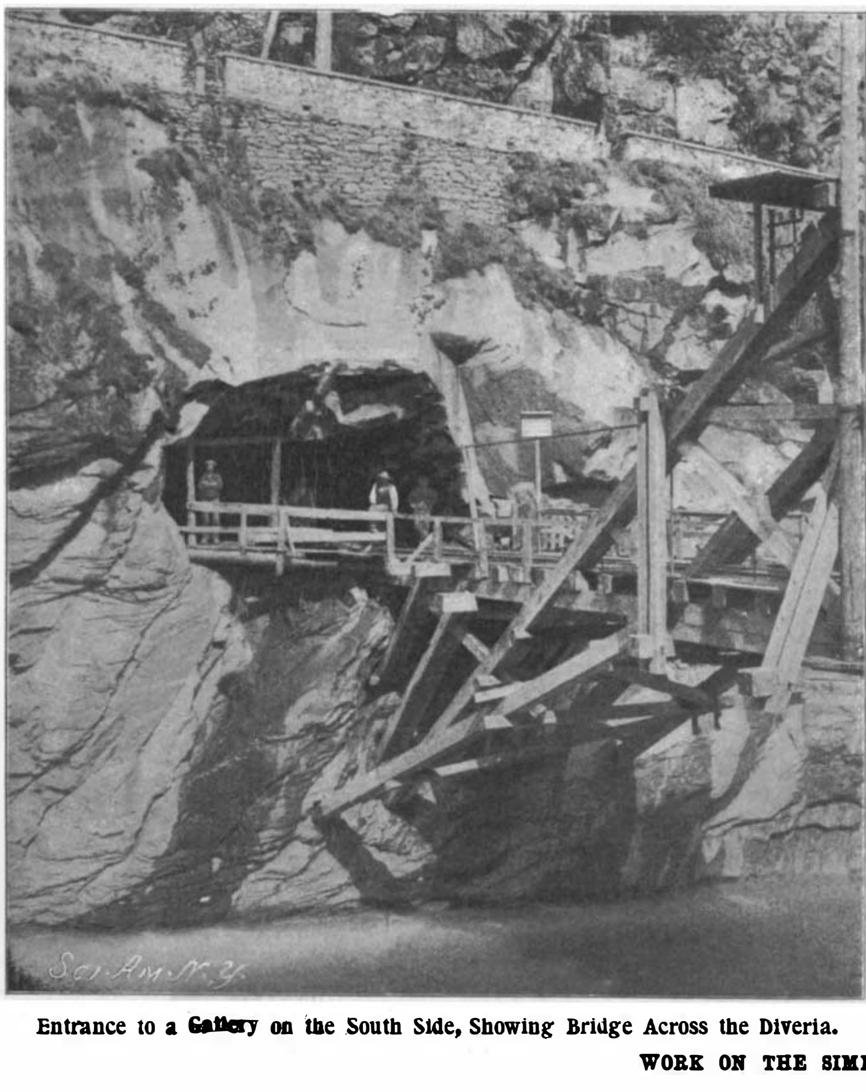


Three Brandt Hydraulic Rock Drills.

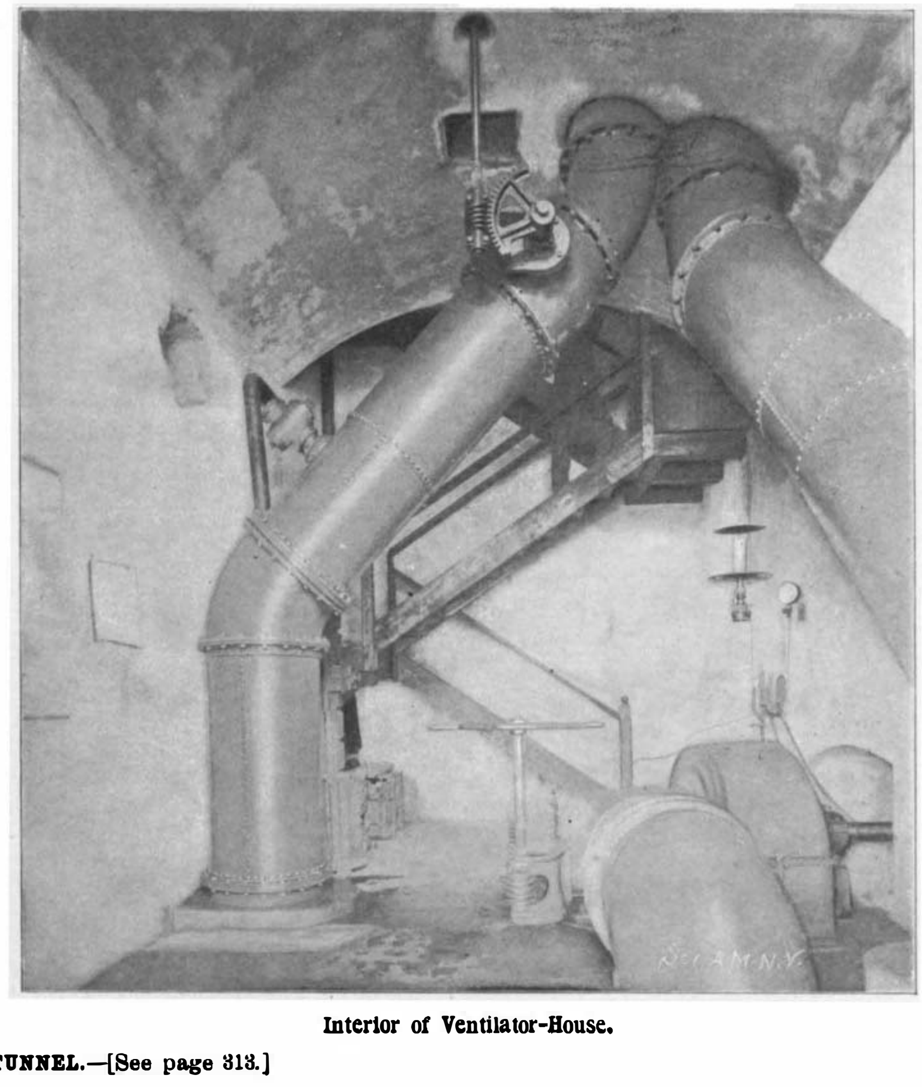


Compressed-Air Tunnel Locomotive.

Interior of the First Tunnel.



Entrance to a Gallery on the South Side, Showing Bridge Across the Diveria.



Interior of Ventilator-House.

WORK ON THE SIMPLON TUNNEL.—[See page 313.]