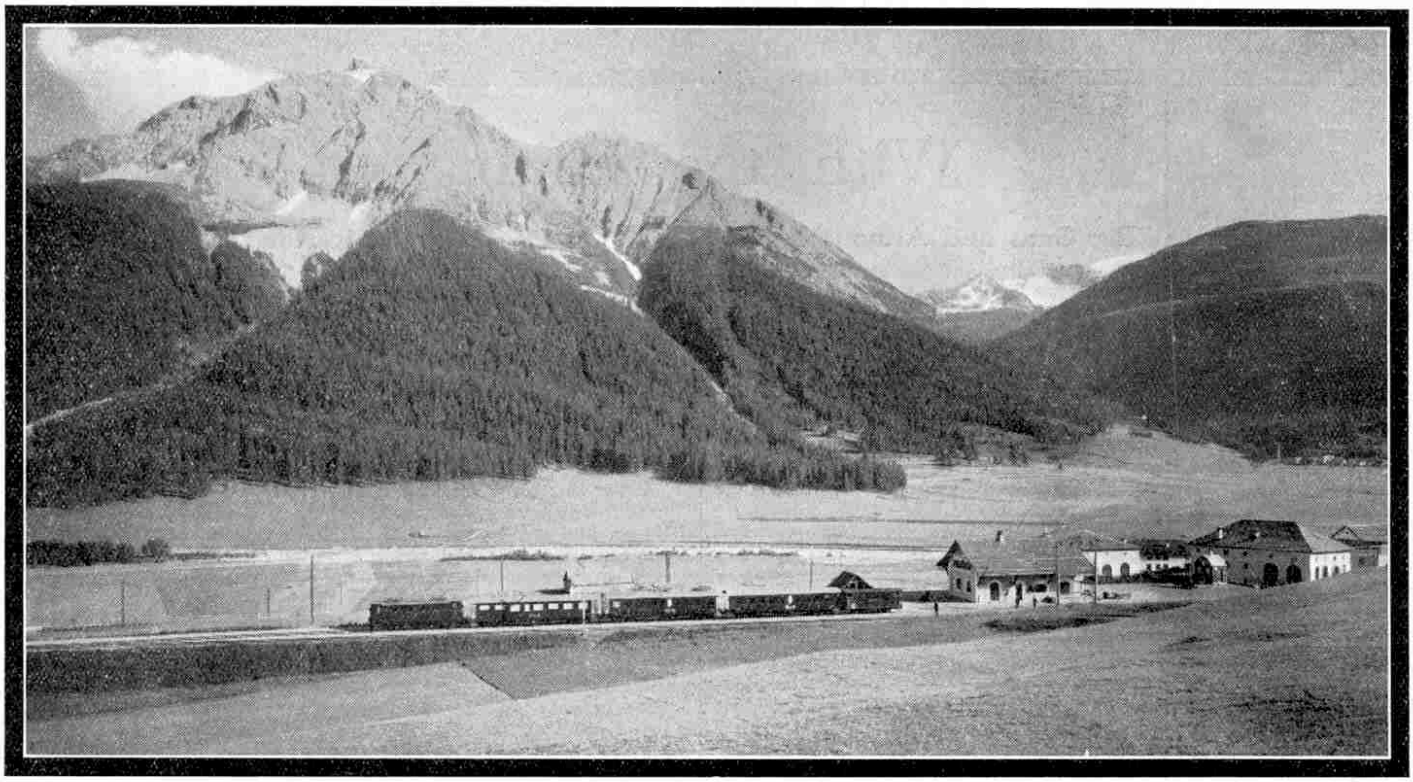
The Rhaetian Railway

An Electric Mountain Railway with 81 Tunnels and 407 Bridges



A Typical View on the Rhaetian Railway. The station at Madulein

OUR cover this month depicts a scene on the Rhaetian Railway in Switzerland, and shows an electric train on one of the many fine bridges over which this railway runs. The line is laid through some of the most beautiful scenery in the world, and the construction of the track may be claimed as a triumph of engineering skill, so that the railway is extremely interesting from more than one point of view.

Owing to the mountainous character of the country, the railway crosses a great number of steep valleys and wild gorges. This necessitated the construction of innumerable bridges, which had often to be built in the most difficult engineering circumstances. Often, too, huge masses of rock had to be cut away to form steps or ledges in mountain sides, on which the track could be laid. Altogether the planning and actual work of construction called for great technical ability and considerable perseverance and determination.

A Railway with a World-wide Reputation

The Rhaetian Railway is well known to most travellers in Switzerland, and as large numbers of people visit this charming country every year from all parts of the world, the railway probably enjoys a world-wide reputation, and, is perhaps, known even further afield than many of its "big brothers."

Although Switzerland is one of the smallest countries in Europe and has a total number of inhabitants less than the population of London, the traffic on the Rhaetian Railway and on the Swiss railways in general is very considerable on account of the large numbers of visitors. The railway runs through what is perhaps the most interesting part of Switzerland, the south-east region known as the Canton of the Grisons. This is decidedly an alpine canton for even its lowest valleys, where chestnuts ripen and where the vine and maize thrive excellently, are protected by high mountains.

The little alpine republic enjoys a particular all-the-year-round popularity, chiefly owing to its famous natural attractions. In the heat of summer it offers the cool mountain air of the Alps, and during the winter when fogs are prevalent in our large cities it offers the visitor the clear warm sunshine of its valleys. It is no matter for wonder, therefore, that with these attractions, and with a delightfully pure atmosphere, the Grisons is a favourite resort for sportsmen and invalids alike.

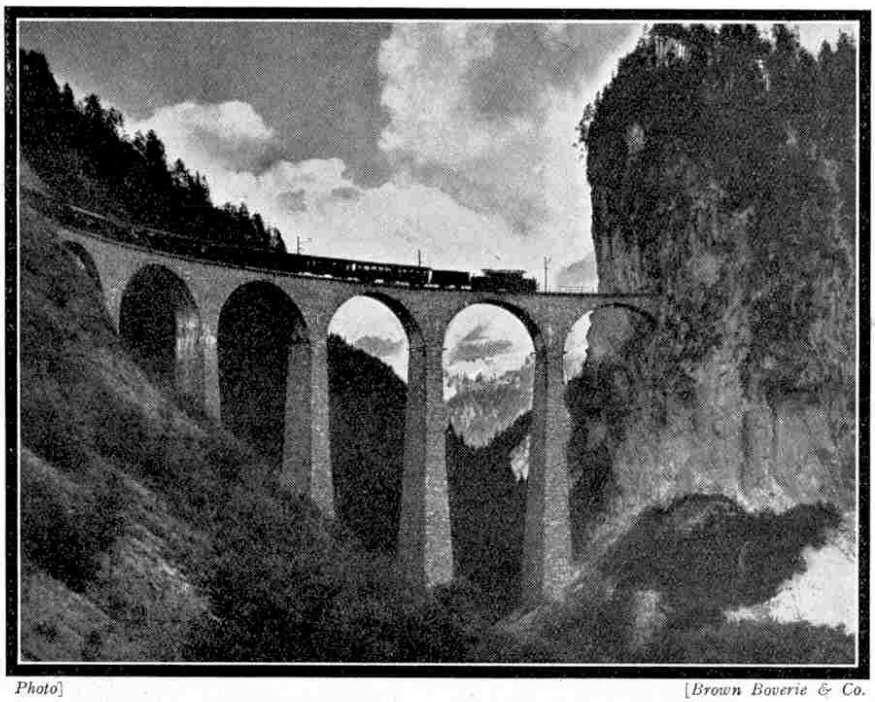
The Maze of Valleys

Nearly half the total area of the Grisons (2,775 square miles) consists of mountains, glaciers, and alpine lakes. There is also a complicated system of mountain rivers and torrents and, in fact, almost every natural feature that makes railway construction particularly difficult.

There is a regular maze of over 150 valleys, and a tourist on foot could easily become lost in the mountains without a guide. Consequently, travelling by road is

very difficult and even dangerous, especially during the winter when it is almost impossible for a guide to find his bearings when all the notable landmarks are covered with snow. The difficulty of winter travel was entirely overcome by the introduction of the mountain railways, however, which have linked up the valleys, and made the Alps more easily accessible to visitors at all seasons. To keep the line clear in winter is a strenuous task, as the snow is often piled on both sides of the line as high as the top of the carriage windows.

Conrad Mayer, a famous Swiss poet, has written (in "*Jurg Jenatsch*") of the bewildering multitude of these valleys. A minister who, when explaining the mountainous character of the country to the French Duke Rohan, gives the Duke, with a few bold strokes, a sketch of the geographical features. He reduces the confusion of the valleys to an ordered scheme by arranging them according to the rivers to which they belong, all of which rise in the country and flow into three different seas. He then speaks of the numerous mountain passes and dwells with evident interest and surprising knowledge of detail upon their military importance.



Photo] [*Brown Boverie & Co.*

The Landwasser Viaduct on the Albula Branch of the Rhaetian Railway, near Filisur

The Coming of the Romans

The canton of the Grisons has many historic associations, dating back to prehistoric times. In those days, it was inhabited by the Rhaetians, an uncultivated and warlike people of Celtic origin, who lived in the almost inaccessible mountains. Later, it was one of the regions that the Romans decided to possess, more particularly because of the important alpine passes that formed the shortest routes from the Lake of Como to Lake Constance.

Thus it came about that the country was conquered during the reign of Augustus and in the year 15 B.C. became a Roman province. Here the Romans, famous for their engineering accomplishments, built roads across the Alps, and established fortified camps, some of which are to-day traceable in ruins.

It is interesting to find that among the inhabitants of the Grisons many Roman customs still survive, and that even to-day the native language used in this canton was originally based on the Latin speech of the Roman soldiers and colonists, who settled in these districts.

Unfortunately we have not space to dwell at greater length on the interesting historical aspect of the country through which the Rhaetian railway runs. Indeed, the matter has only been mentioned to show that centuries ago the inhabitants of this canton were associated with a certain amount of engineering achievement.

Importance of Road and Railways

The growth and maintenance of any country naturally depends upon the system and efficiency of its communications. The first thing the Romans did on landing in Britain was to construct a system of roads, for they knew the importance, especially in a hostile country, of having good communications.

The same is true, even to a greater extent in the case of the Swiss Cantons, which until the railways were constructed, depended for their communication entirely on the alpine passes. Until the commencement of last century there were no good roads in the Grisons and traffic had to cross the Alps by means of mere tracks. During the last century, however, a system of roads approximately 750 miles in total length was constructed, and some of the roads became as well known as the more famous alpine passes.

But even good roads are not the best means of maintaining communication and this is well illustrated by the fact that 25 years ago the south-east corner of Switzerland was comparatively unknown to the average tourist owing to its inaccessibility. The nearest railway station was at Coire, from which the traveller had to travel by diligence over by the Albula Pass—a journey requiring about 13 hours, and a very tiresome and uncomfortable journey it was! Now, as a result of the construction of the railway, the journey is accomplished in comfort in about 3½ hours.

It is interesting to note that up to 1923 the only motor traffic in the Grisons consisted of official postal cars. Laws in this canton are made by popular vote and in June 1923, by 11.420 votes against 9,066, it was decided to admit private cars on certain routes.

Map of Rhaetian Railway

(To be continued)

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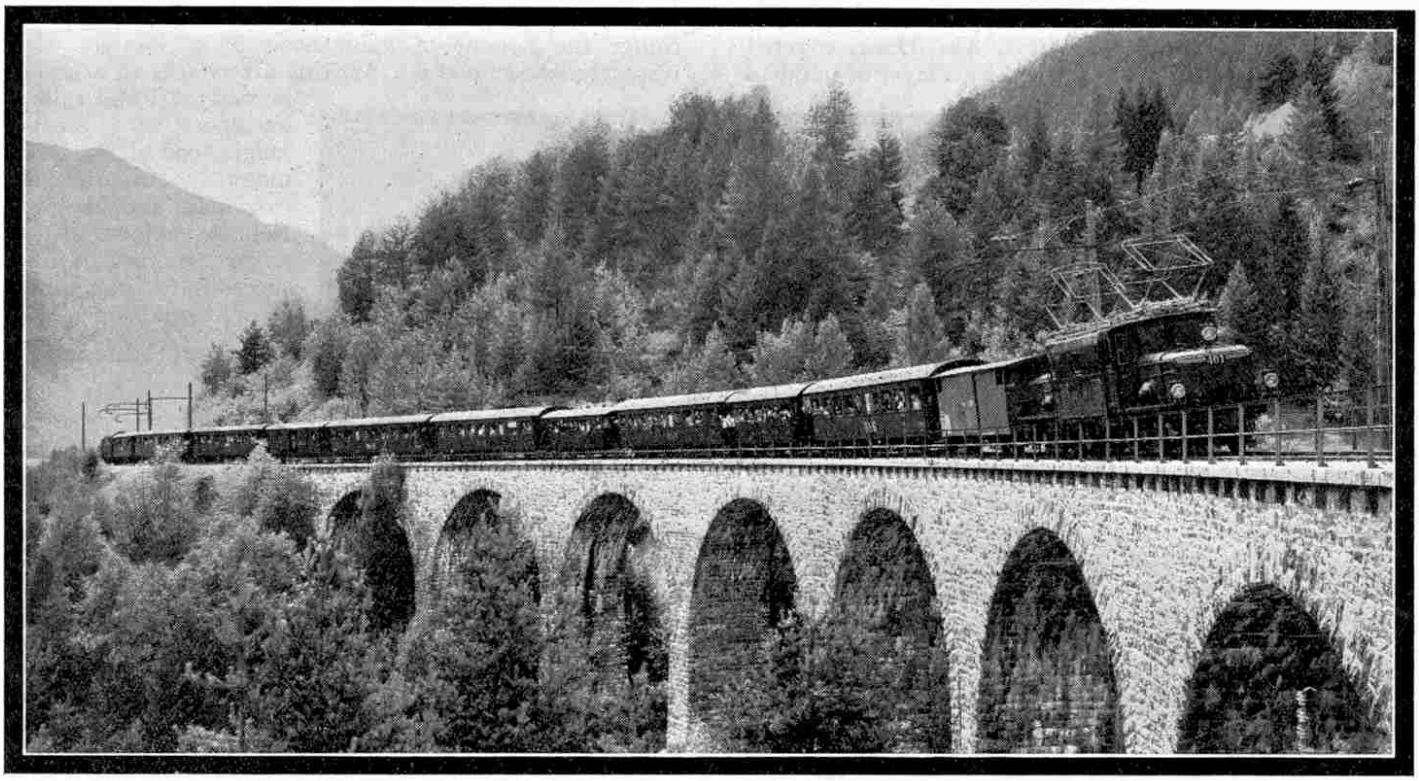


1000 h.p. Electric Loco hauling 200 ton train over the mountain stretch between Tiefencastel and Filisur

(*Continued*)

In the Grisons there are several railways, a total of about 250 miles of narrow gauge railways having been built since 1889. All the railways are now run by electricity—a fact particularly appreciated by visitors, for the wonderful scenery is thus unpolluted by smoke from steam locomotives. Had steam-power been retained, travelling by rail would have been very expensive, because of the exceedingly high cost of coal and the difficulty in transporting it.

Of the several railways in the Grisons, the Rhaetian Railway is the most important. It consists of 173 miles of permanent way, and is a marvel of engineering skill from many points of view. The first portion to be built, the Prätigau line from Landquart to Klosters, is slightly over 20 miles in length and was opened on the 9th October 1889. In July of the following year a further 10½ miles were added—from Klosters to Davos—and in 1896 the line was extended from Landquart to Thusis, and a further 25 miles added.

In that year the original private undertaking, which had built the line from Landquart to Davos, became known as the Rhaetian Railway Company and the canton of Grisons and the Swiss Confederation became the principal share-holders.

On the 1st June 1903, a further 12 miles of track, from Reichenau to Ilanz was opened, and on the following 1st July the Engadine celebrated, by a triumphal procession and general rejoicing, the completion of the Albula railway, from Thusis to Celerina, a distance of 37 miles.

A Wonderful Achievement

The line from Celerina to St. Moritz (2 miles), was finished in 1904, and four years later that from Samaden to Pontresina (3 miles), and Davos to Filisur (12½ miles). In July 1913 the scheme was completed by the opening of 31 miles of line between Bevers and Schuls.

The approximate cost of this completed electrified railway system was 120,000,000 frs. (£4,600,000) or 1,000 frs. (about £38 10s. 0d.) per head of the population.

Although a mountain railway, the Rhaetian Railway is exclusively an adhesion railway, rack and pinion not being used anywhere. Because of the mountainous country traversed and its extremely difficult alignment, the construction of such a railway has always been considered a wonderful achievement. Its maximum gradient does not exceed 237.6 ft. per mile, however, whilst even the rack railway at Mount Pilatus does not climb at more than 306.25 ft. per mile.

The maximum gradient on any of the permanent lines of the Rhaetian Railway is 1 in 28.5, and the maximum on the section between Landquart and Davos is 1 in 22.2.

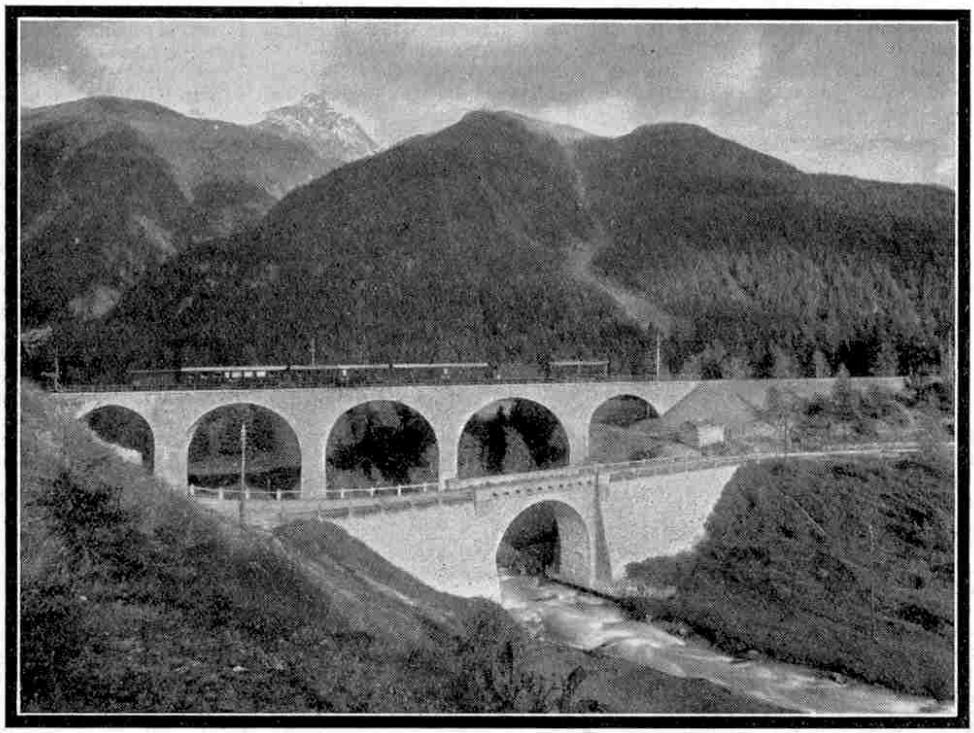
The normal minimum curve radius is 393.7 ft., but in a few difficult places this has been reduced to 328 ft. The average speed attained is 21.6 miles per hour

and the maximum speed 28 miles per hour.

Tunnels and Bridges Galore

The track consists of 57½ lb. vignole rails. Of the total of 173 miles of permanent-way about 104 miles are straight, the remainder being on curves. Over 18¾ miles of track is laid through 81 tunnels and over 5¾ miles is laid over 407 bridges.

The termini at Landquart and Coire are respectively 1,729 ft. and 1,929 ft. above sea-level. The highest points are at Wolfgang, near Davos, which is 5,330 ft. above sea-level, and in the Albula Tunnel, 5,981 ft. above sea-level. This tunnel, situated at the highest section of the line, is nearly 11 miles in length, and is the highest tunnel in Europe.



The Sulsanna Viaduct, and the Road Bridge

The high altitude naturally necessitated many loop developments in the track, the most notable of which is between Bergun and Preda, where there are seven loop tunnels 2¼ miles in length. On emerging from the last tunnel, there is a wonderful view of the Albula Valley, and immediately below are visible the many loops of the line, a sight unique and impressive.

Although the cutting of these tunnels was a great engineering achievement, the most outstanding feature of the railway is undoubtedly the large number of bridges and the wonderful way in which the difficulties of their construction have been overcome.

Some Splendid Bridges

We have already mentioned that on the railway there are over 407 bridges with a total running length of over 5¾ miles. These bridges, built throughout of stone, cross the many valleys fed by the mountain streams.

Perhaps the finest example of a notable group is that near Wiesen station, on the Davos-Filisur line. This bridge, with a total length of 687 ft., has a middle arch of 180 ft. span, at a height of 292 ft. above the Landwasser river.

Another fine example of bridge-building is the Solis Bridge, 543 ft. in length, with a middle span 138 ft. in width and 291 ft. above the Albula river. Incidentally, it may be mentioned that the narrow gorge of the Albula is also bridged by the highest road bridge in the Grisons.

The Landwasser viaduct between Alvaneu and Filisur has six spans of 66 ft., at a height of 213 ft. above the valley, and a minimum radius of 390 ft.

The Rusein Bridge close to Disentis, with four spans of 66 ft. each, is 183 ft. above the gorge, which is also bridged nearer to the mountain by the highest wooden structure in the country, still in good preservation and 183 ft. in length.

Two other interesting bridges are the Inn Bridge near Cinuskel, 153 ft. in length, and the Püzza Bridge near Fetan, 438 ft. in length with four spans of 87 ft. each.

Economy Effected by Electrification

Owing to the very high cost of the working, particularly in bad weather, and the mountainous nature of the country traversed, the rates on the Rhaetian Railway had to be fixed considerably higher than in flat country running.

In the days of the steam trains, coal had to be imported and its high cost caused the subject of electrification to receive serious consideration, so therefore in 1910, when the section from Bevers to Schuls was being built, the management decided to introduce electric traction. It was also decided to electrify the existing Engadine tracks by way of a first experiment. A single phase alternating current of 16⅔ periods was used, giving a trolley-line potential of 11,000 volts and the experiment proved highly successful. Since 1913 all the tracks in the Engadine have been electrically operated, although the success of the innovation was a foregone conclusion.

The many advantages of electrification on the whole of the railway had long been under review, and it was the scarcity and excessively high price of coal during the war that finally decided the management to electrify the remaining tracks.

A commencement was made with the steeper gradients, which were linked up with the large transformer station at Bevers, and by 1919 the line from Bevers to Filisur was ready for electrification. The tracks from Filisur to Thusis and Landquart, and from Filisur to Davos, Klosters and Landquart, were next equipped in rapid stages. The work went on simultaneously, so that by the summer of 1922 the whole of the Rhaetian Railway had been converted for electric working.

The Powerful Electric Locos

Power is drawn from the Grisons Electric Co., in Coire, and from the Rhaetian Electric Company in Thusis. The former company has a power station delivering a single phase alternating current of 11,000

volts by means of a hydro-electric plant, using rotary single-phase transformers each of which has an output of 2,400 k.w. The Rhaetian Electric Co., in Thusis, supplies current by two sets of hydro-electric single-phase rotary generators, each producing 2,000 k.w. This company has also taken from the Brusio Co., the transformer station at Bevers, which operates the railway system running parallel with the Thusis works.

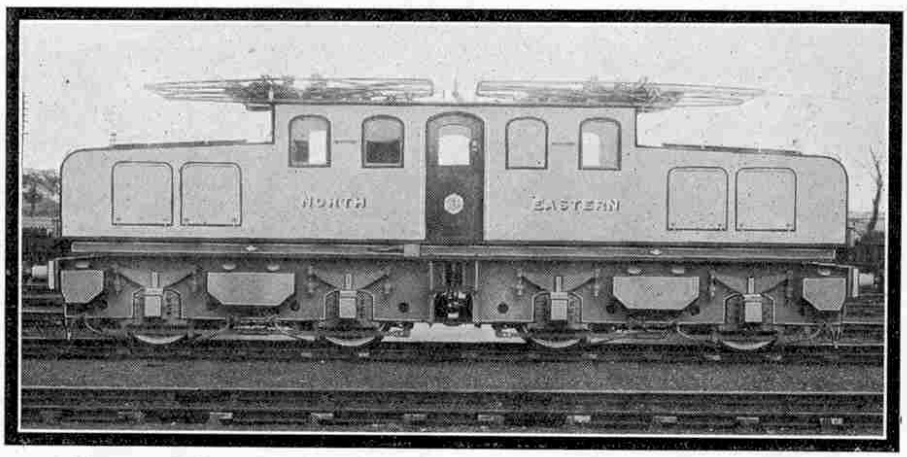
At present the Rhaetian Railway owns 25 electric locomotives, seven of which develop 300 h.p., eight 600 to 800 h.p. and ten 1,000 h.p. The latter high power locos are of special technical interest, and are the most powerful narrow-gauge electric locomotives yet built. They weigh 66 tons and can haul a freight train of 200 tons on a gradient of 1 in 28.5 or 150 tons on a gradient of 1 in 22, and are able to attain a speed of 21.8 miles per hour

Electric Railways in Switzerland

The extent to which electricity is applied to railway working in Switzerland is well illustrated by some recently published figures regarding the Swiss Federal Railways. At the beginning of last year the electrified portions of these railways included 75 km. of lines working with three-phase current at 3,000 volts and 536 km. working with single-phase current at 15,000 volts. During the period between the beginning of 1925 and February this year an electrification programme prepared in 1918 and revised in 1923 was completed on 313 km. bringing the total length of electrified line up to 924 km. (about 574 miles) which represents 31 per cent. of the Federal Railway system. It is expected that by the end of the present year electric traction will have been introduced on lines totalling 85 km.

With the completion of their electrification programme in 1928-29 the Federal Railways will have approximately 1,620 km. (1,006 miles) of lines operated by electricity, or 56 per cent. of their system. Electric traction will apply to 75 per cent. of their total traffic. A pause in electrification work will probably occur after that date, although a number of requests for the transformation of other lines not included in the 1918-23 programme have already been submitted to the Federal Railways. The price of coal is expected to be the determining factor when fixing a date for the resumption of work.

Recent calculations of the Federal Railway Board, based on the experience gained in 1924 and 1925, show that with the completion of the electrification programme in 1928-29 electric traction ought to be decidedly cheaper than steam traction. Recent extensions have demonstrated that the profitableness of electricity as a prime mover increases with the length of the electrified system.



A Pioneer of Electric Freight Locos in England. The L.N.E.R. Shildon-Newport Electric Loco

Standard Types of Locos

The Federal Railways are endeavouring to adopt standard types of locomotives namely (i.) express for mixed traffic on the plains; (ii.) express for mixed traffic on mountain routes; (iii.) goods; and (iv.) motor-coaches. The average ratings and maximum speeds of these types are respectively 1,900 h.p. and 90 km. (56 miles) per hour, 2,000 h.p. and 75 km. (46 miles) per hour, 2,200 h.p. and 65 km. (40 miles) per hour, and 900 h.p. and 75-90 km. (46-56 miles) per hour. Individual axle drive is favoured for fast locomotives, while coupling rods are in use on mountain express and goods engines. A larger type of express engine for the plains is under construction; it will be of the 4–8–2 wheel arrangement, with a rating of 2,800 h.p. and a maximum speed of 100 km. (62 miles) per hour. Two electric shunting locomotives of 700 h.p., which were put into service in 1924, have proved entirely satisfactory, and 10 more have been ordered. A fresh order for 54 locomotives and 16 motor-coaches was placed with three Swiss firms in January 1926. At the end of 1927 the Federal Railways will have 370 electric locomotives and motor-coaches in service, and these are expected to do the same work as 490 steam engines.

Reconstruction of Bridges

One of the principal items in electrification is the reconstruction of numerous bridges, which is necessitated by the greater weight per axle (maximum 20 tons) of electric locomotives. The biggest undertaking in this connection is the reconstruction of the Grandfey Viaduct, near Fribourg, which was built in 1869 and has a length of 383 metres (1,276 ft.) and a height of 78 metres (260 ft.) It will be completed in the spring of 1927, at a total cost of four and a half million francs (£160,000). There is only a single track at that point, and the work has to be carried out without any interruption of traffic.

What's in a Nom-de-Plume

Jack was turning over the pages of back numbers of the "*M.M.*," and when he came to anything that he could not understand, he would ask his elder brother, Tom, to explain. Tom was trying hard to solve a problem for himself with his Meccano Outfit, so that, I'm afraid, his answers were not always as clear and convincing as they might have been otherwise. But nevertheless he did his best to maintain his reputation, so that, on coming to the cycling articles on the "Open Road" page, Tom felt it was "up to him" to give Jack something to think about :—

"Who is this 'Rover' Tom?"
Jack ask'd his brother.
"Oh! don't bother Jack, he's—
Someone or other."
"Please don't put me off Tom,
I've *got* to know—true!"
"Then, if that's the case John,
Just look up 'Who's Who!'"
"But, surely you've heard Tom,
So come—be a sport!
And tell me what truth there
Is in the report,—
That his 'family' boasts
Great men by the score!
And has ancestors quite
A mill-ion or more!"

"If you really *must* know
Jack, let me own up—
The 'Rovers' that I know
Did *not* 'lift the Cup,'
But, *other* things mostly—
Now I come to think,
Right back through the ages
As far as the Link!"

"The Peter Pan pirates
And the bold Tom Jones,
Honest (!) John Silver—and
Er—well, dead men's bones!
Dick Turpin of course, and
Old Ad-m'ral Benbow,
Are *these* the Rovers, Jack,
That you *want* to know?"

"But, don't be alarm'd, Jack,
As far as that goes,
There were heaps of others
Who made decent 'shows.'
Just take for example
The brave Robin Hood.
His exploits—remember
Were really quite good!"

"It matters *now*, little,
Whether your 'Rover'
With Will-iam the Conq'rer
Really 'came over.'
You may rest quite assur'd
That he 'plays the game,'
And, as for the rest, Jack,
Well—just do the same!"

R. C. Manning ("Rover")

Better Shoes Coming

The American Chemical Society announces that after considerable research processes have been evolved by which the life of leather may be prolonged and hundreds of thousands of pounds saved to industry. One process involves using Glauber salts instead of the common salt in tanning hides. The presence of calcium chloride in the salt is said to be destructive, whereas the substitute is reported to have a definite preservative action.

An apparatus has been invented for determining what kinds of leather allow the greatest amount of moisture to pass from the foot and thus increase the wearer's comfort. It was found that patent varieties permit the least evaporation and ordinary calf leather the greatest. Science's warfare against bacteria of all kinds is also being used to the improvement of leather in showing how to kill various organisms that cause spots, stains and other imperfections, and in combating the effects of mould, which does its greatest damage after tanning.