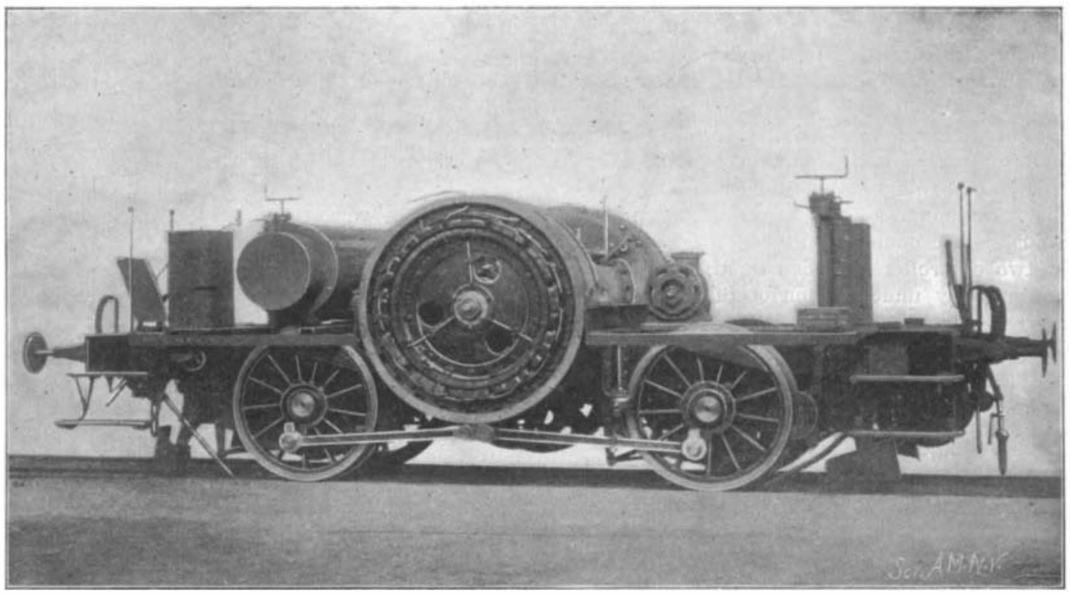
THE ELECTRIC ROAD OF BERTHOUD-THOUNE, SWITZERLAND.

During the course of the year 1899, a road was opened in Switzerland, between Berthoud and Thoune, which, like the mountain lines of Gournegrath and Jungfrau, uses as a motive power the three-phase low-tension electric current. The road, which was built by Brown, Boveri & Co., is essentially one of standard dimensions, and operated practically under the same conditions as a steam line. For that reason the results which have been obtained during the two years of service should prove of no little interest.

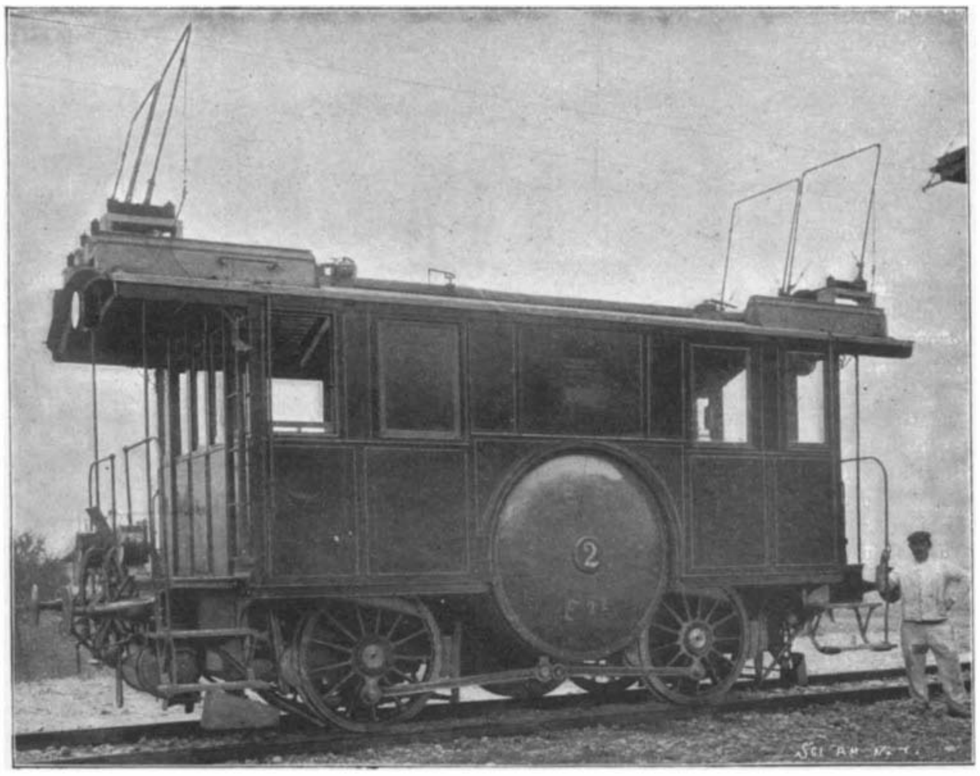
The total length of the line, which is a single-track road, is 40 kilometers (24.8 miles). Starting at Berthoud (Burgdorf), a station on the Berne-Olten line, the road follows the Emmenthal Railway for a distance of 7 kilometers (4.3 miles) to the station of Hasle-Ruegsau. At Konolfingen it crosses the Berne-Lucerne line, and finally connects at Thoune with the road running from Berne to Interlaken.

The maximum grades have been fixed at 25 millimeters per meter (0.98 inch per 3.26 feet). The minimum radius of the curves is 250 meters (815 feet).



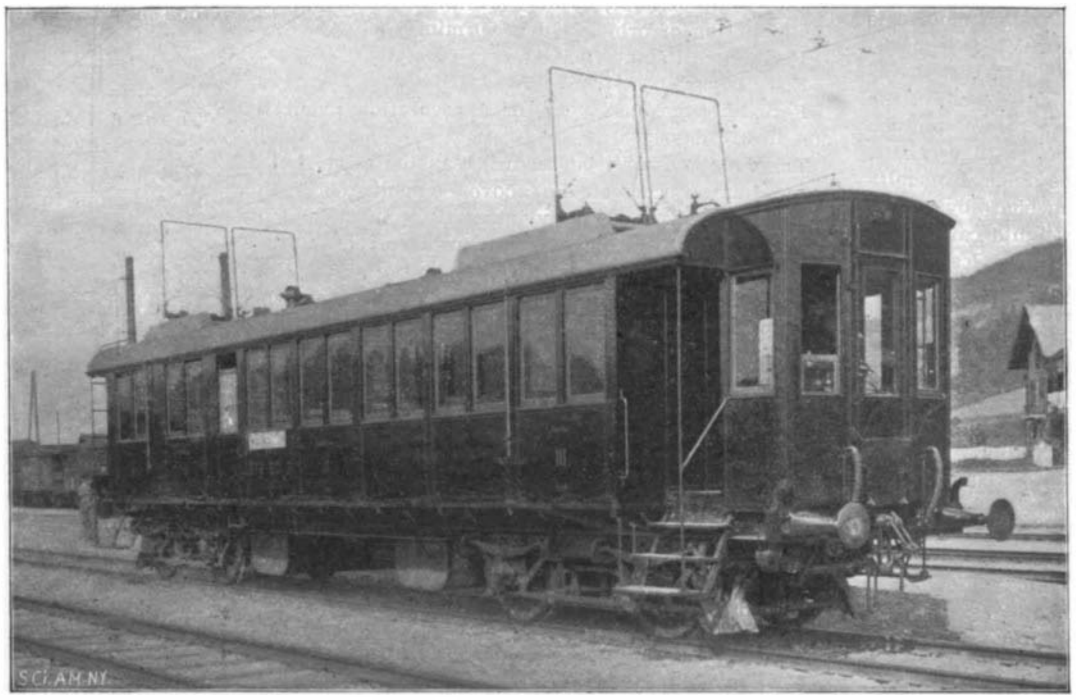
LOCOMOTIVE WITH BODY AND MOTOR-CASINGS REMOVED.

The current is generated at Spiez by a hydro-electric plant connected with sub-stations, distributed along the line at intervals of 3 kilometers (1.8 miles). Three-phase current is fed to these stations under a tension of 16,000 volts, and is stepped down to 750 volts to the line conductors. The passenger rolling stock is composed of six auto-motor coaches each weighing 32 tons empty, and of ten ordinary passenger cars. Freight is transported by means of sixty cars of the ordinary type and two electric locomotives.



A LOCOMOTIVE OF THE BERTHOUD-THOUNE ELECTRIC ROAD.

The Spiez central station, which is situated on the shores of Lake Thoune, derives its water power from the falls of the Kander flowing into the lake. Part of the Kander River is diverted by means of a canal running along the falls for a distance of 680 meters (2,217 feet). The canal communicates with a tunnel 860 meters long (2,721 feet), at the entrance of which is a gate. The total head of water is 63 meters (206 feet), from which it follows that about 5,500 horse power is generated. Horizontal, Escher-Wyss turbines to the number of six, each of about 900 horse power, are directly coupled to three-phase alternators of the Brown-Boveri type. The speed of these alternators is 300 revolutions per minute. The tension of the current which they generate is 4,000 volts, which is afterward raised to 16,000 volts by means of static transformers. The high-tension conductors extending from the central station to Thoune are secured to metallic supports embedded in blocks of concrete spaced 50 meters (163 feet) apart. These high-tension conductors are composed of three copper wires having a constant diameter of 5 millimeters (0.2 of an inch) for their entire length. The same supports likewise serve as a fastening means for various feeders for power and lighting purposes.



AN AUTOMOTOR COACH OF THE BERTHOUD-THOUNE ELECTRIC ROAD.

Throughout the entire length of the line the feeders for the cars are supported simply by pine posts injected with zinc chloride. The posts are about 8 meters (25 feet) high and are spaced 45 meters (146.7 feet) apart.

The height of the posts for the high-tension conductors has been so chosen that the lowermost wire is never less than 6 meters (19.5 feet) above the ground. The posts are placed 45 meters apart. Wherever a highway or a railway is crossed, this distance has been reduced as far as possible in order to avoid the use of guard nets. Wherever a railway is crossed, netting is used.

The wires are secured to the necks of the insulators so that they face the post. Hence, in case of a rupture, the wires will fall upon the framework of the posts. Posts which are situated at curves are provided with frames of iron, which serve to prevent the wires from falling to the ground. The insulators are of the double-bell type. At intervals of five posts horn lightning arresters are employed.

It has been said that the wire of which the high-tension line is composed has a constant diameter of 5 millimeters. The lines which supply the transformers are composed of wires 4 millimeters in diameter. The longest of these lines measures not less than 750 meters (2,450 feet).

The transformer sub-stations, which number fourteen, have been located, so far as possible, in the vicinity of stations, in order that they can be more readily inspected from time to time. The average distance between such stations is 3 kilometers (1.8 miles). The first and last sub-station are each situated about 500 meters (1,630 feet) from the terminals of the line.

The transformers of the sub-stations have been proportioned on the assumption that there would never be more than one train on the same section of road. The calculations made, which allowed for grades, gave different results for different sub-stations. It was, therefore, decided to adopt one type of transformer for the purpose of avoiding too great a complication.

Each sub-station contains a 450-kilowatt transformer, which is of sufficient power to drive a double train.

One of the terminals of the secondary winding of the transformer is directly connected with the rails of the line by means of a wire 8 millimeters (0.3 inch) in diameter. The two other terminals are directly connected with a small switchboard inclosed in a sheet metal casing, secured to two wooden posts planted on the other side of the road. By means of this little switchboard, which is provided with the usual circuit-breaking and measuring devices, the wires conveying the current to the motors of the cars can be placed in connection with the secondary winding of the transformer. Adjacent to the station containing the transformer which furnishes power to the line are two posts, which support the transforming device, which is connected with the lighting circuits and which is directly supplied by a high-tension feeder. Some of the lighting transformers are, however, fed by the line. The two posts upon which the lighting transformers are carried are provided with a high-tension switch, by means of which circuits leading to the transformer stations can be broken.

The high-tension line is protected by horn lightning arresters.

The trolley wire by which the cars are driven is composed of two copper wires 8 millimeters in diameter. These trolley wires are suspended from insulators which have resisted a tension of 6,000 volts, and also from ball insulators. The transverse wires, by which the different parts of the line are supported, are composed of steel wire 6 millimeters (0.23 inch) in diameter. The transverse wires are suspended from the post by means of hangers, of such construction as to permit a play of 30 centimeters (15.7 inches).

As we have already seen, the trolley wire is divided into five sections, separated from each other by sectional insulation, whereby it is possible to cut out one section whenever it is necessary to make repairs.

As a general rule, the transverse wires are spaced about 35 meters (104.8 feet) apart. This distance is reduced at highway crossings, in order to attain great safety. On curves the distance has also been decreased, in order to prevent the trolley loop from leaving the wire.

For the return of the current a method of connection has been devised by the engineers of the Brown-Boveri Company, which consists in making use of fish-plates to conduct the current to the rails. As a matter of fact, this system of return has been long used in

England and in the United States in a somewhat different form.

The rolling stock of the road consists of motor cars, electric locomotives, ordinary passenger coaches and freight cars. The motor cars have a seating capacity of 66, and are divided into first and second-class compartments. Each motor car has a hauling capacity of 20 tons at a speed of 36 kilometers (22.4 miles) per hour, on a 25-millimeter grade. The weight of each motor car is 32 tons. The body, which has a length of 16.3 meters (53½ feet) between the buffers, is carried on two bogie trucks separated by a distance of 9½ meters (30.1 feet). Each axle carries a motor of 60 horse power, with a speed of 600 revolutions per minute. The total weight of electrical equipment of the motor car is about 10 tons. Each motor alone weighs 1,500 kilogrammes (33,000 pounds). The electrical equipment of these cars, besides four asynchronous motors of 16 horse power, comprises two controllers; four variable resistances disposed transversely under the bodies between the bogie trucks; one controlling device for these resistances; four trolley loops; two sheet-metal boxes inclosing each four lead fuses, conveying current to the motors; one 18-kilowatt transformer to step down the current from 750 to 100 volts, for heating and lighting the car; one box containing fuses for the transformer; one compressor driven by a four horse power motor supplied with current at a hundred volts; one automatic circuit breaker for the motor of the compressor; six electric lamps for regular outside lighting; ten lamps for interior illumination; fourteen electric radiators for heating; six heat regulators; and one small switchboard carrying the switches controlling the radiators and the lamps, as well as the lead fuses of the motor of the compressor.

The three-phase motors employed have eight poles, with a fixed field magnet and movable armature. The winding of the field magnet comprises fifty-one turns for each phase. The resistance of the winding of a phase is 0.71 ohms. The winding of the armature comprises eight turns per phase, and the resistance of the winding for each phase is 0.0153 ohms. When the armature turns with a speed equal to that of the generating dynamo, the number of revolutions is 60 per minute. The four field magnets of a car are mounted in parallel in the circuit conveying the current. The four armatures are connected with four independent rheostats located beneath the car and regulated simultaneously by the controllers. These rheostats are used at the moment of starting. In order to cut out a motor the two corresponding circuit breakers are operated.

The trolley loops are of rather novel form. They consist of two frames placed side by side and carefully insulated from each other. That portion of the loop which is subjected to sliding friction is made of a highly polished brass tube triangular in cross section. By a single rotation of 120 degrees the surface of contact can be changed.

Each motor car is equipped with a Westinghouse air-brake as well as the usual shoe-brakes, which latter serve not only to check the speed on down grades, but to bring the car to a stop. In order to check the car on down grades, the motors themselves are used; for when the number of revolutions exceeds that required for perfect synchronism a braking action is obtained.

The locomotives employed for the haulage of freight trains are carried on two axles. Their weight is about 30 tons each.

The locomotives are provided with sills similar to those of steam engines. By reason of the comparatively large amount of space taken up by the two motors, which are each of 150 horse power, it was found impossible to mount them in the usual way. They were, therefore, disposed outside of the two sills. The method employed to transmit to the axle the movement of the common shaft of the two motors is original. Beneath the motor shaft, which is equidistant from both axles, is an auxiliary shaft, which carries two gears meshing with two pinions keyed on the motor shaft. These two groups of gears and pinions constitute a variable speed gear. The auxiliary shaft, which turns at the same speed as the axles, transmits to them the movement of the driving shaft by means of four connecting rods. Counter weights carried on the auxiliary shaft balance the rods and lessen the perturbations due to the inertia of the parts.

This arrangement of the motors may, at first sight, seem open to criticism. It must, however, not be forgotten that the locomotive is intended to be used for the haulage of heavy freight trains at fairly high rates of speed.

The speed of the motors is 300 revolutions per minute. Two changes of speed are obtained by cutting out one of the trains of gears.

With the motors developing a speed of 300 revolutions per minute, the normal speed attained is 33.6 kilometers per hour (21.6 miles) with a high-speed gear. By throwing in the other train of gears, the speed is reduced one-half. In this latter case double the load can be hauled. The throwing in of the gears cannot be accomplished while the train is in motion.

Each locomotive is equipped with two controllers similar to those to be found on the auto-motor passenger cars. Starting is effected by the interposition of resistances, which are cut out when the speed has risen to a certain point. The electrical equipment of these locomotives is almost exactly similar to that of the auto-motor passenger coaches.

The length of a locomotive from buffer to buffer is 7.8 meters (25.58 feet); the diameter of the wheels is 1.23 meters (4 feet); the total weight is about 30 tons, about 10 tons of which fall upon the electrical equipment.

Like the coaches, the locomotives are equipped with Westinghouse brakes. The air is compressed by a small pump driven by a four horse power motor. The starting resistances of the motors are inclosed in a cylindrical casing.

From all accounts the road has been very successfully operated at a comparatively low expense. The road is still another instance of the successful adaptation of the polyphase current to electrical traction.

THE BROOKS COMET OF 1902.

BY DR. WILLIAM R. BROOKS, F.R.A.S.

Announcement of the discovery of this comet on April 14 was duly made in the Scientific American. The writer was engaged in sweeping the eastern morning heavens with the ten-inch equatorial telescope of this observatory, when the comet was discovered near the northwest corner of the great Square of Pegasus.

It is a curious fact that this comet was found in the same telescopic field in which my comet of February 23, 1883, was discovered, that, however, being in the evening sky. This is, of course, simply a coincidence, and does not indicate that the two comets are identical, or indeed, have any relation to each other.

The appearance of this latest comet is well shown in the accompanying picture—a highly magnified telescopic view. The body of the comet was slender, tapering gradually to the coma, which had a minute stellar nucleus. The tail was narrow and slightly branching. The comet was fairly bright in telescopes of moderate power and an interesting object.

THE BROOKS COMET OF 1902.
Discovered by Dr. Brooks April 14.

Its path was diagonally across the Square of Pegasus, and at the time of discovery was moving toward the sun at the rate of three degrees daily.

The following elements of the comet's orbit have been furnished by Prof. Leuschner:

Time of passing perihelion, May 28.
Perihelion minus node, 274 deg. 30 min.
Longitude of node, 35 deg. 3 min.
Inclination of orbit, 71 deg. 50 min.
Perihelion distance, 0.5542.
Eccentricity, 0.3947.
Periodic time, 0.88 year, or a revolution about the sun in 320 days.

These data are to be regarded as tentative, but if approximately correct the above elements show this comet to be an exceedingly interesting one, having by far the shortest period of any known comet.

Encke's comet has a period of three and one-third years—the shortest heretofore discovered—and other short-period comets have periods ranging from five and a half to thirteen years; while this latest cometary addition to our solar system, should the above elements prove fairly accurate, performs its revolution in less than a single year.

The comet is at this writing lost to view in the sun's overpowering rays. It will emerge therefrom south of the sun, after which the comet should be well observed from the southern hemisphere.

According to statistics prepared by W. E. Nichols & Co., of New York, there are eighty-three banks in New York city, having an aggregate capital of $98,872,700, and thirty-seven trust companies of New York and Brooklyn, with an aggregate capital of $43,000,000.

Correspondence.

Volcanic Eruptions.

To the Editor of the Scientific American:

Volcanic eruptions are the absorbing topic since the terrible calamity on the island of Martinique. Their cause and prevention furnish interesting problems for discussion. It seems to be the consensus of opinion that "water" is the "spark" which explodes these awful mines. The question which presents itself is: Is not this explosive agent automatic in origin; being in fact the lake of water which is generally found filling up the crater of the so-called extinct volcano? Following an eruption as a rule the volcano continues more or less active for years. Then an interval of inaction succeeds; during which the bottom of the now inactive crater fills up and becomes impacted and waterproofed with the accumulating detritus of years. The rains of many years following this period gradually collect and form the crater lake. This lake during another lapse of years slowly percolates and weakens some spot in its bed until sufficiently enlarged to suddenly precipitate its contents in the subterranean depths below. This event may be accelerated by an unusual atmospheric pressure.

If the above hypothesis furnishes the true cause, the prevention naturally suggests itself to be the emptying and future draining of the crater through a tunnel which would prevent any large collection of water. B. S. P.

Savannah, Ga., May 19, 1902.

Lightning Effects.

To the Editor of the Scientific American:

Please give me an opinion through your paper on the following: On Friday night, May 2, a storm passed over our town, the lightning striking two trees, one with very peculiar results. A large red oak tree stood about 30 feet from a vacant house. The tree had a large slab torn from one side, the slab being about 25 feet long. The slab was broken into six large pieces and hundreds of small ones, some thrown a distance of 40 yards. One piece, 12 feet long, went entirely over the house; one struck a large tree near by; and the heaviest, 10 feet long and weighing about 70 pounds, struck against the closed shutters of a window, broke through shutters, sash, and glass, carrying all away clean; tore a large hole in the ceiling, then crashed into a window frame on the opposite side of the room. Now to the point. The timber doing the damage was a "stump piece," and had part of a root to it, the ground end having struck the house first. To do this it was thrown upward at an angle of about 35 deg., as the hole in the ceiling shows. My questions are these:

What force threw the timber? Was it steam caused by the heat of the lightning?

What caused the timber to fly upward?

Did the current run up the tree?

The force surely acted from below.

The tree has no marks above where the slab was torn off—is not shattered.

The lightning did not strike the house.

Gaithersburg, Md. S. A. Lehman.

[We must say we do not know to what the lightning owes its power to rend and split stones, trees, houses, etc.; not to steam in the case of dry articles, surely. That the electric current went from the ground to the cloud in this case seems certain. It does in many cases. Our professor in college said he always saw the lightning go up and never down. This is a mere result of habit of mind, since the flash is so sudden that no one can see it go in either direction, and any one may train himself to see it go in either direction. —Ed.]

Standard Time-Signals by Electric Light.

To the Editor of the Scientific American:

For many years the time-ball has been generally accepted as the standard form of apparatus for giving time-signals to the public. In most of the principal seaports of the United States are time-balls which are dropped exactly at noon by telegraph from an astronomical observatory. The signals thus given are of great public benefit, and are especially valuable to shipmasters whose vessels lie within sight of the ball. A time-ball, as usually constructed, is about three feet in diameter, and can be seen with the unaided eye at a distance of about two miles. The care and expense involved in its maintenance are such that it is usually impracticable to operate it oftener than once a day.

In a letter published in the Boston papers in April, 1901, the writer suggested the use of incandescent electric lights for giving time-signals, and proposed that the lamps used to illuminate the dome of the Massachusetts State House be utilized for the purpose. It was pointed out that such lights can be readily seen at a distance of ten miles or more, and that if operated automatically by telegraph from an observatory, they could be made to give standard time-signals which