Electric Traction.

A 10,000-VOLT ALTERNATING CURRENT LOCOMOTIVE FOR THE BERLIN-ZOSSEN EXPERIMENTS.

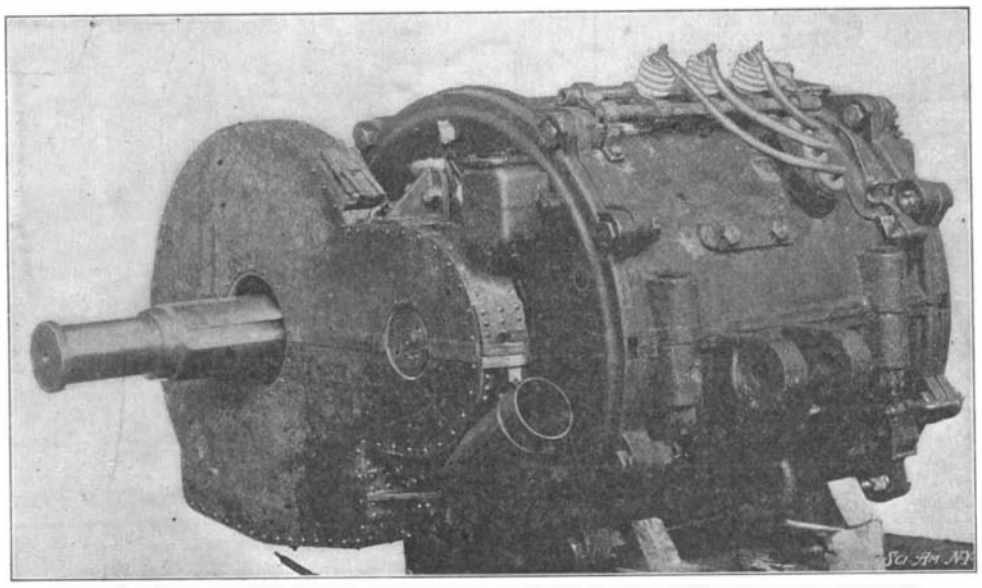
The Berlin-Zossen experiments are about to be resumed with an alternating current locomotive designed by Herr Walter Reichel. It will be remembered that it was the Reichel car, described in the columns of the SCIENTIFIC AMERICAN and SUPPLEMENT, which attained a speed of 155 kilometers and even 160.2 kilometers an hour during the tests, speeds equivalent to 96 miles and 99.5 miles. It will, furthermore, be remembered that the tests were abandoned, because the track construction was defective, the rails being too weak and the substructure not solid enough.

Reichel's locomotive is intended to reduce weight. With this end in view, he has abandoned transformers on the vehicle and supplied the line voltage of 10,000 volts directly to the motors. The old car weighed 96 tons; the new locomotive 20 tons less, including passengers. The total horse power has been diminished from 1,000 to 920. These reductions will result in a saving of power, will diminish wear and tear and lighten the cost of maintenance. Moreover, the current flowing in the line will be diminished so that a considerable saving of power to be transmitted will be effected when running at full speed and when starting at the terminal points.

The locomotive's underframe has four axles, similar to those of the old experimental car. The gage is the standard German; the wheels have a diameter of 49 inches and meet with the requirements of the Prussian State Railways. Each bogie has a wheel base of 10 feet 8 inches. There is room on each bogie for two motors; but only one has been mounted. The bearings are placed within the motor windings, for the reason that it is necessary to make the utmost use of the space between the wheels. In order to equalize pressure on the two bearings, the motor shaft is geared at each end to the car and axle.

It was necessary to carry on experiments for the purpose of determining what system of lubricating would be most effective. When it is considered that the velocity of the gear teeth is about 59 feet per second, and that there are 147 teeth in the larger wheel, and 69 in the smaller wheel, the reason for these experiments is apparent. It was finally found that a system of forced lubrication with compressed air would answer the purpose best. The oil is driven out of the reservoir at a distributing cock which is turned to the right or left, depending upon the direction of the locomotive's travel. The oil flows through pipes to nozzles above or below the toothed wheel. After lubrication, the oil is pumped back to the oil reservoir. It is only with the higher velocities, obtained with a gear ratio of 2 to 1, that such a system of lubrication is necessary. For smaller velocities the ordinary methods are quite adequate.

The cast-steel motor case is composed of two parts. The bearings are made in one part, bronze-lined with white metal. The active iron upon which the primary winding is mounted, is screwed into the motor case, while the rotor of the motor is fastened to the motor shaft by means of a sleeve. From this it follows that the motor can subsequently be arranged on the car axle for direct driving.



ONE OF THE MOTORS OF THE 10,000-VOLT HIGH-SPEED ELECTRIC LOCOMOTIVE.

The secondary winding is carried on the active iron of the rotor. A second sleeve holds two collector rings on the rotor, from which rings carbon brushes collect the current. The motor itself is lubricated by means of oil and wicks, a special arrangement having been here devised for the purpose of saving space.

The primary winding on the experimental car was on the rotor, a construction possible only with bar winding. In the present case it was not necessary to construct the motor for a very high turning moment, since for the small starting torque required the rotor could be made smaller, and the primary winding placed on the stator.

For the purpose of obtaining as much cooling space as possible, the cores of both rotor and stator were designed in a peculiar way. The slots are quite deep, and the coils within are wide. The laminations for the rotor are in one piece; those of the stator are made in segments. For the winding 72 open slots are used; with 77 wires per slot of the primary. The wires are run through mica tubes. In order to prevent the passage of sparks from one phase to another and to save space, the coils are placed alternately in longer and shorter tubes so that the longer ends lap over the shorter ones.

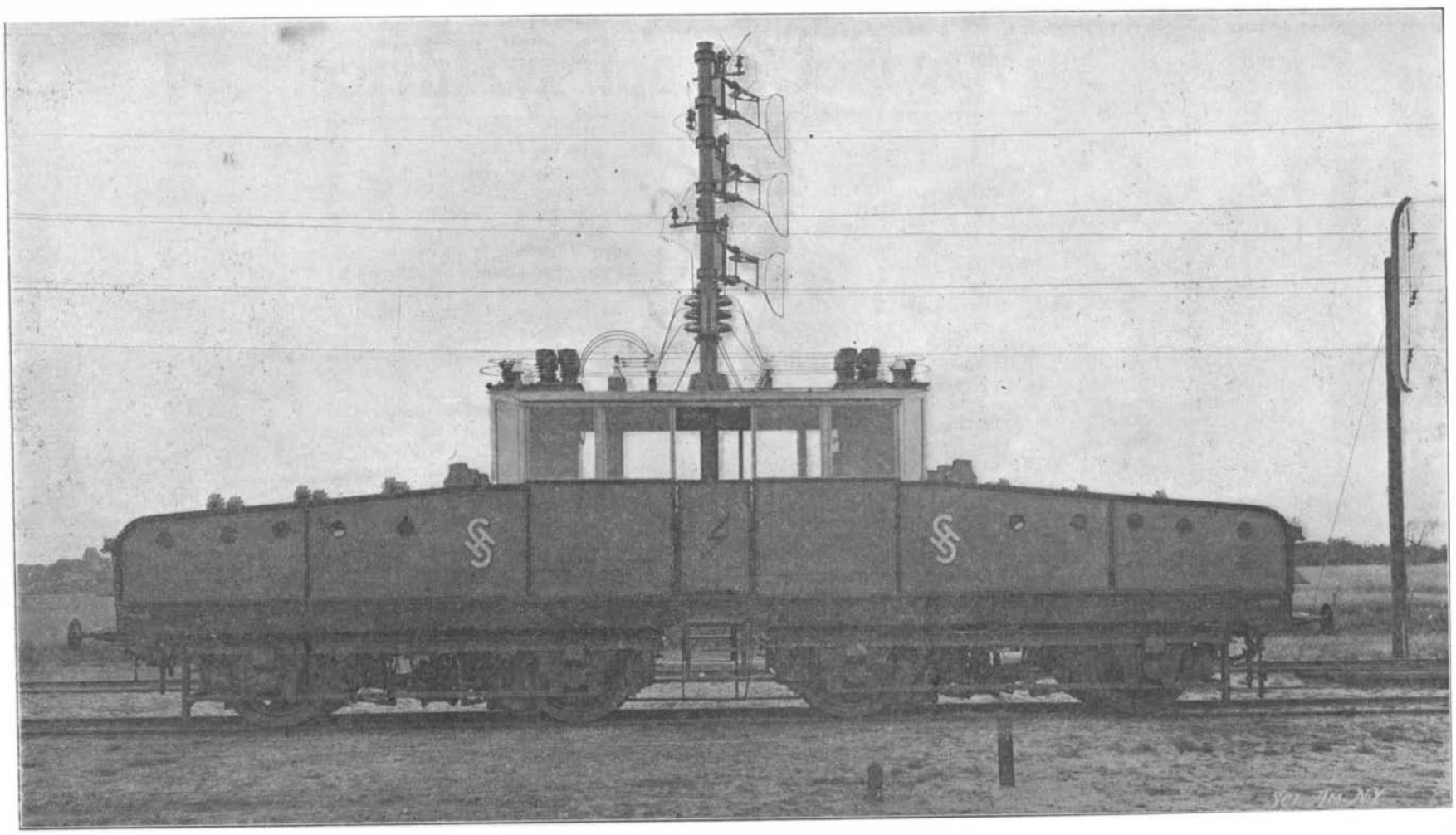
Experiments were carried out for the purpose of determining what insulation would be most effective. As a result of these experiments an insulation was adopted which has withstood a voltage of 22,000. The winding of the motor is a wave winding connected in star and placed in 90 half-closed slots. It consists of a number of single, flat copper wires arranged in series, four to the slot. Two of the free ends go to the collector rings, while the third is fixed to the core of the rotor. The pressure in these rotor windings is 700 volts at starting. The use of bars for this winding facilitates the application of bronze rings to hold the winding against centrifugal force. Air enters near the shaft and is directed out through openings in the rotor casing by vanes. This current likewise cools the stator coils. Air pressure thus obtained is equivalent to several millimeters of water.

Naturally the leading-in of the three high-pressure cables has been done with care. Cables insulated to stand 15,000 volts pass through three soft rubber brushes placed inside hard-rubber brushes. Ending in the three terminals, these cables are mounted on corrugated porcelain insulators attached to saddles which are supported on mica-insulated iron tubes fixed to the casing of the motor.

The weight of the motor and gear is 9,000 pounds. The connections of the motor and controller are substantially those previously described in the SCIENTIFIC AMERICAN SUPPLEMENT. The speed at starting is regulated by varying resistances in the rotor or secondary circuit which is insulated from the earth. The rotor resistance has twenty-four stops. The resistance coils are spirals of Kruppin wire held by porcelain insulators. This resistance is controlled by a hand wheel on a vertical spindle. The switches for the primary high-pressure circuit are worked by air pressure.

On the completion of the locomotive, tests were made at a gradually increasing pressure, starting at 6,000 volts and about 50 alternations. The final test was made at 11,000 volts and 95 alternations. With a 31-ton trailer 65 miles an hour was the speed obtained. About 260 kilowatts were developed which corresponds to a load of about 280 horse power on the driving wheels. This agrees substantially with previous experiments at 62 miles per hour.

It now remains to be seen whether the high speeds for which this road was built can be attained with a lighter locomotive. Probably not before the coming spring may definite results be expected.



THE BERLIN-ZOSSEN 10,000-VOLT HIGH-SPEED ELECTRIC LOCOMOTIVE.