out danger. Switches are only provided on the 50,000-volt side; for the transmission line these switches are doubled.

All switches have electromagnetic remote control operated from the switchboard in the engine-room; they are fitted with automatic overload releases which can be adjusted for a time limit and are also arranged for hand operation. Lightning arresters, excess pressure discharges and choking coils for checking short-circuits are provided.

The energy generated at the power station is carried by a 50,000-volt line to two transformer stations where it is stepped down to the contact line pressure of 15,000 volts.

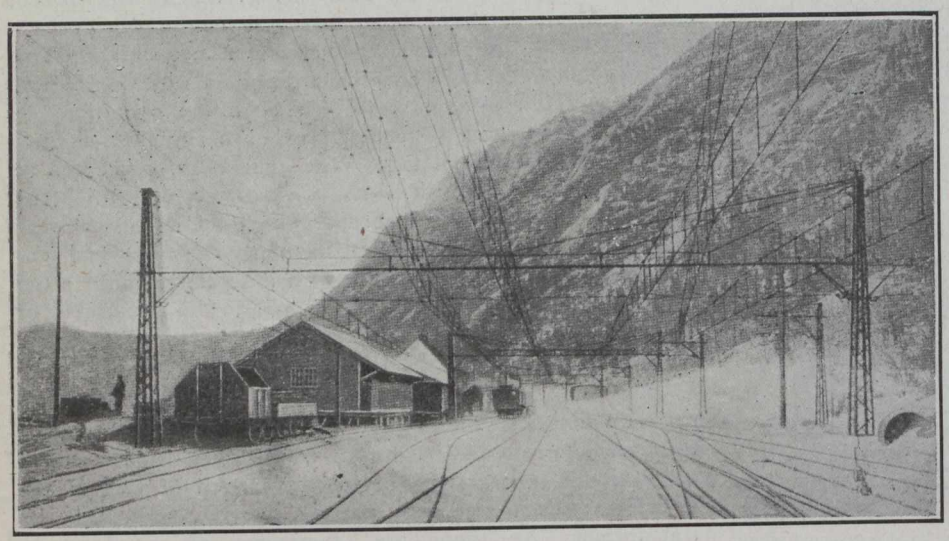

Fig. 3.—Arrangement Contact Line; Rjukan Railway.

The transformer stations, which will also supply current to the Bavarian line pending the completion of the Walschensee Works, are situated at Reith, 19 km. from the Eastern, and at Schanz, 3.3 km. from the Western boundary of Austria.

The transmission line, which is carried mainly on the poles for the overhead contact line, consists of two wires, each having a section of 35 sq. mm. Only the connection between the power station and the railway track (about 6 km. in length) is carried on a separate line of poles.

The first important section of the 50,000-volt line is situated in a desolate district, which is difficult of access in winter; increased care was, therefore, required in its design and construction. On this account, the line in this part consists of three wires, two of which are usually in service, the third serving as reserve to replace a defective wire.

As a protection against atmospheric discharges, a copper earthing wire is mounted above the h.t. line on the tops of the poles, and is carefully earthed to the depth of ground water at each pole. Lattice poles are employed exclusively for carrying the line, and are erected at distances of 80 metres apart; every fourth or six pole will stand firm, even when the line breaks on one side, the intermediate poles being flexible. The 50,000-volt line, for the section from 8.8 km. to 16.3 km. on the Innsbruck-Scharnitz line, has also been erected on a special row of poles, the number and length of tunnels in this section being too considerable for the line to be laid out on the contact line supports.

On account of the transmission pressure of 50,000 volts, which is rather high for Continental practice, special care had to be taken in choosing a suitable type of insulator, as far at least as its mechanical strength was concerned. The overhead line follows a series of sharp curves, and the poles have to stand the jerks produced by the swift motion of the current collectors. Investigation showed that only chain-ling (disk) insulators would stand this heavy stress, no part of these insulators being exposed to traction or inflection strains. The type of insulator ultimately developed by the A.E.G.-Union Co. possesses a breaking strength of 7,800 to 8,000 kg. with a weight of only 2.8 kg. Moreover, it also possesses excellent insulating qualities.

An essential difference between this insulator and those used by American engineers is that the channels are not of circular cross-section and instead of a wire rope exposed to rusting, steel bands applied throughout their width on the porcelain (so as not to injure the enamel) are used to fix it. After fitting the insulators in position, the channels are filled in, thus preventing any water from entering and freezing within the insulator. Another distinctive feature is the flexible armature of the insulator which absorbs all shocks, thus preventing any damage to the enamel.

Chain suspensions, without any automatic tightening devices, are used for the contact wire, which is exclusively carried by lattice poles.

The rolling stock of the Mittenwald railway at present comprises nine locomotives, each of a normal output of 800 h.p. As previously mentioned, the maximum gradient of 36.4 per mile is found extensively on this railway; each locomotive will haul over this gradient a gross train weight of 124 tons at about 30 km. per hour, which corresponds to a tractive effort of about 7,500 kg. What this performance really means will be gathered from the fact that the locomotives during several months' experimental work on the Dessau-Bitterfeld Railway hauled goods trains of 1,100 tons in schedule time over the level track.

Each locomotive, inclusive of the driver and the oil and sanding tanks has a weight of 53 tons in working order.

The current is taken off the overhead wire by two bow collectors each having two sliding sections, and is conducted by a bare high-tension wire arranged above the roof, to a lightning arrester choking coil, and thence into a transformer room where the line is connected up to the h.t. oil switch. The latter has a quadruple break, and includes an extra resistance for reducing any strain produced in switching in the transformer. From the front driver's platform the oil switch is operated directly by the switch lever; from the rear platform it is switched out by a button fed through a series resistance from the controller coil, while a lever system is used for switching in. Between the lightning arrester coil and the oil switch there is inserted a grounding switch operated automatically as soon as the protective cap of the oil switch is removed.

The driving motor is a 12-pole single-phase commutator machine of 800 h.p. normal output, at a speed of 30 km. per hour. It is designed on the A.E.G. system, in accordance with which (contrary to the directly-fed pure series motors), the current in the armature is induced by transformer effects. The rotor winding is, in fact, closed by short-circuiting brushes, thus obtaining the secondary winding of a transformer, the primary winding of which is the field winding of the stator.

Excitation is effected from the rotor, current being supplied to the armature through another pair of brushes from a special exciter transformer connected up in series with