

# Westinghouse Electric Company Ships Equipment for French Railroad Electrification

Within a few weeks of the departure of the record-breaking shipment of apparatus for the Chilean Railroad Electrification, another enormous train-load of electric railroad apparatus left the East Pittsburgh plant of the Westinghouse Electric & Manufacturing Company this month for France.

The shipment consisting of transformers and lightning arresters was part of an order from the French Midi Railways which totaled well over a million dollars. The amount of the apparatus in the shipment, which weighed approximately eight hundred tons, can be estimated by the fact that 32 railroad cars were required to transport it. The material went by the Pennsylvania Railroad to New York, and shipped from there to Bordeaux.

The order was of more than ordinary interest, because it covered material for the first system outside of the United States to adopt 150,000 volts for its main transmission.

The lines of the Midi Railways are mostly located in the South of France north of the Pyrenees. As far back as 1906 the management of the Railways commenced an exhaustive study of the electrification of this part of their system, having in mind the utilization of the water power available on the northern slopes of the Pyrenees. By 1914 four sections had been electrified with single phase current at 12,000 volts and 16.67 cycles, but all work was stopped at the outbreak of the war.

The French early in the war lost practically all their coal fields to the Germans. This more than anything emphasized the necessity of developing the water power resources of the country and electrifying the railroads wherever it could be economically done. Thus on the cessation of hostilities one of the first acts of the government was to send a technical commission abroad to study existing railway systems.

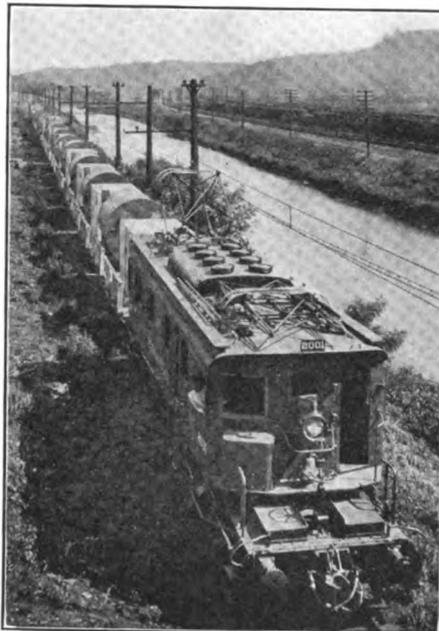
The commission, after visiting Switzerland, Italy and America, recommended that 1,500 volts, direct current, be adopted as the standard for the electrification of all French railroads, and the Midi Railways Company, in conformity with this decision, immediately resumed the work interrupted by the war on this new basis. The sections already electrified at 12,000 volts will be changed to 1,500 volts, direct current, so as to have a uniform system throughout.

The power will be generated in six stations or groups of stations capable of developing a total of 362,000 horsepower, the stations being put up progressively as the different sections are electrified. The head of water varies from 350 feet in the sta-

tion with the lowest head to a maximum of 2,500 ft. Power is generated at 8,000 volts and 50 cycles, and is distributed to the railway sub-stations over a 60,000 volt three-phase distribution system, distant points of the distribution system being connected by 150,000 volt transmission lines.

The railway sub-stations, which are located along the railroad at intervals of 12 to 18 miles, are connected directly to the 60,000 volt distribution system. They all contain rotary converters with the exception of a few in which mercury arc rectifiers will be used.

The equipment for the generator stations, the distribution system, the railway sub-stations and the locomotives will be



ELECTRIC LOCOMOTIVE HAULING A TRAIN LOAD OF AMERICAN-MADE ELECTRICAL EQUIPMENT FOR FRENCH MIDI RAILWAYS

built in France. The work entrusted to the Westinghouse Company comprises a large part of the 150,000 volt transmission system, including the transformers, synchronous phase-modifiers for the voltage control, and the relay protective gear.

For the initial development three generating stations will be utilized. The 150,000 volt lines will connect these with the distant cities of Pau, Dax and Bordeaux to the west and Toulouse to the east. At the generating stations 20,000 kv-a. banks made up of Westinghouse single phase two-winding transformers will raise the voltage from 60,000 to 150,000 volts. At the sub-stations near these cities the transmission system connects again with the distribution system through step-down

transformer banks of 20,000 kv-a. made up of Westinghouse single phase three-winding transformers, lowering the voltage from 150,000 to 60,000 volts. These transformers have a third winding of 6,600 volts for feeding Westinghouse synchronous phase modifiers.

These machines are intended to automatically keep constant the voltage at the sub-station irrespective of the load. Owing to the length of the lines and the high voltage of the transmission they are designed to cover a wide range of reactive kv-a. At Bordeaux, there will be two-phase modifiers each of 15,000 kv-a. capacity and 7,500 kv-a. lagging capacity. At Dax and Toulouse there will be in each two machines of 8,000 kv-a. leading and 4,000 kv-a. lagging capacity. All these phase-modifiers are equipped with the Westinghouse patent automatic voltage regulator designed to cause the machine to give the right amount of reactive kv-a. leading or lagging required to keep the line voltage constant.

The Westinghouse Company in conjunction with the engineers of the Midi Railways worked out a complete scheme of relay protection embracing the generator, distribution and transmission. The generators and transformers are individually protected differentially, that is, they are automatically taken off the line in case of internal trouble.

The transmission and distribution are so laid out that the supply to the railway sub-station is assured. The lines are therefore for the most part in duplicate, except where sections are fed from both sides. Where the transmission lines are in duplicate they are equipped with balanced line protection by means of the recently developed Westinghouse directional relay which does not require potential transformers. The whole relay scheme is so laid out that in case of trouble in any section of line or piece of apparatus the part in trouble is isolated without interrupting the supply to the rest of the system.

The whole order, of which this shipment forms a part, covered twenty-five single-phase transformers of 6,667 kv-a., two synchronous phase-modifiers of 15,000 kv-a., four of 8,000 kv-a., thirteen 150,000 volt lightning arresters and a large number of relays and current transformers.

## Railway Mileage

There are 740,000 miles of railways in the world, of which 266,000 are in the United States, 220,000 in Europe, 70,000 in Asia, 60,000 in South America, 30,000 in Africa and 26,000 in Australia.