The early New Haven passenger locomotives were of this type and have been quite successful, although some trouble was experienced with them after a few months of operation, on account of nosing. This was overcome by the addition of pony wheels at each end of the locomotive and the use of a toothed cam centering device.

This type of locomotive is very successful as long as the track is kept in good surface, for, in spite of the low centre of gravity, the motors are entirely spring borne, so that a direct shock is very seldom given to the track.

3rd. The third type of locomotive exhibited had the motors geared to the quill surrounding the axle, which is connected to the driving wheels through long flexible springs which permit the motor and quill to move a total distance of three inches in a vertical direction with respect to the axle. It is, therefore, possible to mount the motors directly on the truck frame. This form of locomotive is made for the New York, New Haven & Hartford, with but one motor per axle and with twin motors. Where one large motor is used, it is necessary to have double gears which require very accurate alignment. Where twin motors are used only one gear is required and both of the motors drive through the same gear. The small motors are found to be less expensive for single phase work and are lighter and easier to handle. On the New Haven Railroad, the same motors are used for both locomotives and multiple unit cars, excepting, of course, the motor frames which have to be adapted for a different type of mounting. This type of locomotive gives high centre of gravity and is an exceptionally easy riding machine. All of the weight above the wheels and axles is spring borne, and there being absolutely no tendency for nosing, the machine

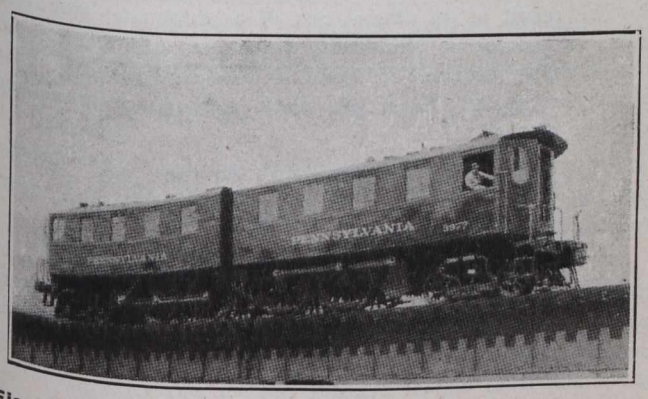

Fig. 2.—A Pennsylvania Railroad 160-ton D.C. Locomotive (600 Volts) for New York City Pennsylvania Terminal Operation.

is very easy on the track and is very comfortable to ride in.

Locomotives for both heavy freight and passenger work and for switching service with this type of drive were shown. It has been adopted as a standard by the New York, New Haven & Hartford, which has purchased over sixty locomotives of this type.

4th. Locomotives with motors mounted high in the cab and connected to the driving wheels through parallel rods from the motor to a jack shaft on the same level as the driving axles and thence to the drive-wheels by other parallel rods. The principal locomotive of this type which has been built is that of the Pennsylvania for use in the New York terminal. This is probably the most powerful electric locomotive ever built. It is used to haul trains of more than 800 tons weight up a 2 per cent. grade into the station. The locomotive weighs about 160 tons and has exerted a drawbar pull on level track of nearly 80,000 pounds. It is also able to handle the heavy passenger trains at 60 miles per hour on level track. This type of locomotive has the highest centre of gravity of any that have been built, and its operation on the track is similar to that of the best steam locomotives. A few years ago this would not have been considered very good by electrical engineers, but sad experience with machines having low centre of gravity has modified their opinions to a great extent and they are now glad to claim that such locomotives are as good as the best steam locomotives. This locomotive has established a wonderful record for reliability, there being only thirteen train minutes delay charged against the locomotives in the first year's operation. Such a record with 33 locomotives is little short of marvelous.

Another type of locomotive exhibited was that of the Italian States Railways, which connects the motors to the driving axles through a Scotch yoke. This is a form of side rod which is quite satisfactory for slow and moderate speed service. It has never been used for high speeds.

Another type is a combination of gears and side rods. This form is used for the locomotive built by the Oerlikon Company, in Switzerland, for the Loetchberg tunnel. The motors are geared to a jack shaft, instead of connecting to the latter by means of parallel rods as in the case of the Pennsylvania locomotives. This permits the use of a much higher speed motor and a considerable reduction in the weight and cost of the locomotive. It also enables the use of a single design of motor for various speeds of locomotives which may be secured by simply changing the gear reduction.

Some of the principal advantages of electric locomotives were discussed briefly and Mr. Storer expressed himself as being opposed to the extremely high wheel loads which are being used with the latest types of steam locomotives, and advocated the use of electric locomotives with wheel loads about equal to the maximum wheel loads on freight or passenger cars. It is claimed by many engineers that the destruction to the track is due almost entirely to the locomotives. These heavy wheel loads are probably necessary for the tremendous units that are now demanded, but the use of electric locomotives will permit the weight to be distributed so that no locomotive wheel need carry more weight than a car wheel in the same train. This will give the best possible results on the roadbed and will give more flexibility in locomotive units.

The matter of the arrangement of the commission appointed by the Department of Marine and Fisheries to investigate the water levels on the St. Lawrence River at and below Montreal, was brought up by Mr. Frank Carvell, at a recent session of the Commons, who stated that dredging had reduced the level in the harbor of Montreal very considerably from what it was eight or ten years ago. He suggested that the channel had something to do with the lowering of the water level in the harbor. The Honorable Mr. Hazen stated that the efforts of his department were now being directed to getting a thirty-five-foot channel. He had discussed the matter of the water level with officials of the department and had come to the conclusion that it was most desirable to obtain the best information on the point. On the recommendation of Messrs. Stewart and Forneret, of the department, he had invited Professor Haskell, dean of the Engineering School at Cornell University, to join them. Prof. Haskell had been engaged upon many river undertakings. The commission would confine its attention to the water levels between Montreal and Quebec, because the matter of navigation was urgent. A report was required without delay, whereas a commission with wider instructions would necessarily occupy a much longer period.