satisfactorily they should as far as possible be spring supported, either by mounting them on the main locomotive frames or on a separate system of springs. The relation, however, between the motor shaft and the axle must be definitely maintained and at the same time it is important to provide flexibility and cushioning of the motor weight.

There are four distinct types of connections between motor and driving wheels, namely:

(1) Motors mounted directly on the axles and connected either rigidly or by means of spring or quill connections to the driving wheels: Where the complete motors are mounted rigidly on the axles it is obviously impossible to carry the motors on springs. The New York Central locomotive motors are bi-polar and gearless, and the armatures only are mounted on the axles, the remainder of the motor being attached to and carried by the locomotive frames. The earlier New Haven locomotives had the motors mounted on quills with a relatively small amount of movement provided for in the spring drive.

(2) Motors geared to the axles either directly or through quills and driving springs: Until comparatively recently the usual practice has been to gear the motors directly to the axles and there are numerous examples such as the Baltimore and Ohio, Grand Trunk, Michigan Central, and others. The later New Haven locomotives are examples of the use of motors geared to quills and provided with flexible spring drive between quills and wheels. Where the motors are geared directly to the axles the motors are usually suspended at the same level as the axles and geared horizontally to them, part of the weight of the motor being carried on the locomotive frame which in turn is flexibly supported by the main locomotive springs. There is practically no flexibility transversely with this method of mounting. Where the motors are geared to quills around the driving axles the entire weight of the motors and gears is carried on springs but the amount of flexibility both vertically and horizontally is restricted by the relatively small clearances that are permissible with this arrangement.

(3) Motors geared to jackshafts which are in turn connected to the driving wheels by means of side rods: In this case the motors with gears and jackshafts are all mounted on the main frames and hence are spring supported and the connection between the jackshafts and drivers is effected by means of side rods with the maximum amount of flexibility and this arrangement provides the same freedom of movement as is permissible and customarily provided in steam locomotives. The Norfolk and Western locomotives are an example of this type of drive.

(4) Motors connected to jackshafts by means of main rods and drivers connected to jackshafts by means of side rods: This arrangement has the same advantages as to flexibility of mounting and spring cushioning of motor weights as in the case of (3) above. It has been used in the United States only for the Pennsylvania Terminal locomotives which are of the high-speed passenger type and, therefore, rod connections were used between motors and jackshafts in preference to gears.

It is claimed by the users of motors mounted above the axles and connected either by gears or rods that improved riding qualities are obtained due to the high centre of gravity of the locomotive as a whole, the tendency being for the heavier parts to roll on the springs and to reduce side pressure on the track rails. On the other hand, it is the opinion of those who use motors located on or near the axles, that the high centre of gravity is not necessary to give good riding qualities, provided the running gear is so designed as to avoid the setting up of an oscillatory tendency.

Axle Weight.—Another interesting feature of electric locomotive practice is the maximum weight per axle. On the domestic locomotives the weight per driving axle ranges from 30,000 lb. in the case of the New York Central to 55,000 lb. in the case of the Norfolk and Western, the majority of locomotives having a weight of between 40,000 and 50,000 lb. on driving axles. It is noted that this is considerably less than the axle weights used in steam locomotive practice where they range from 40,000 to 62,000 lb. and in some cases even as high as 68,000 lb. as in the case of the heaviest Pennsylvania engines.

Rigid Wheel Base.—Another feature of the mechanical design of electric locomotives is the length of rigid wheel base, which for domestic locomotives ranges from 6 ft. 6 in. to 13 ft. (excepting a few B. & O. engines). In the majority of recent electric locomotives the rigid wheel base does not exceed 8 ft. with the exception of the Norfolk and Western where the rigid wheel base is 11 ft. This compares with a maximum of 14 ft. for steam passenger engines and 17 ft. 6 in. for steam freight engines.

Locomotive Capacity.—Inasmuch as the source of power for the operation of electric locomotives is not on the locomotive itself but in the power house and lines connecting the power house with the locomotives, it is feasible to construct electric locomotives of almost unlimited power or capacity by providing a sufficient number of driving axles and motors. There is naturally a limit to the capacity which can be secured per axle on account of the limitations of track gauge and width and height of engines and on account of limitations in mechanical strength of materials used in the construction of the parts and restriction as to permissible weight per axle carried on the track. As an example of capacity may be cited the Norfolk and Western locomotive which consists of two units; two of these complete engines or four units will handle the same tonnage as three of the largest Mallet type of steam engines but at twice the speed.

It may be said that electric locomotives have been built and operated to perform every kind of railroad service, that is, high-speed and suburban passenger and road and yard freight up to and in excess of the maximum capacity for which steam locomotives have been built for similar service. It is, however, too early to attempt to standardize electric locomotives either electrically or mechanically.

Canadian manufacturers look upon the Russian market as one of great value. Comparatively few of our exports have gone to Russia in past years. The filling of war orders for that country by several important Canadian firms has awakened a remarkable interest in the Russian market. The directors of many of these firms have visited Russia and are of the opinion, with others, that after the war, Russia will probably undergo an active development such as has been the case in Canada during the past ten years. This development will call for considerable railroad construction, with the consequent demand for steel, locomotives, cars and general equipment. And that is only a typical example of general construction work.