ELECTRIC RAILWAYS.

(PART 5.)

MOTOR CARS AND THEIR EQUIPMENT.

1. General Description of Equipment.—As a rule, the term **rolling stock** as applied to an electric railway is taken to mean the car bodies and trucks, including sweepers and snow plows. Under this head we will also consider the motors, controllers, and other devices necessary for the operation of the cars.

Besides the car body and truck, with its brake equipment, an ordinary trolley car is provided with *motors* (usually two or four per car), two *controllers*, two *canopy* or *hood switches*, one *lightning arrester*, one *fuse block*, one *trolley base*, and one *pole*, with its *harp* and *trolley wheel.* These various devices will be described in detail later. It is now becoming common practice to equip cars with *circuit-breakers* instead of canopy switches and fuse blocks. The equipment also includes one or more *lighting circuits*, and in many cases a *heating circuit* also.

CAR BODIES.

2. The **car body** constitutes the main part of the car and is mounted either on a single truck or on two trucks, depending on its length. Car bodies are made in a large variety of styles. Some are open for summer use, others are closed, and others are a combination of the two. They are made in lengths from 18 or 20 feet up to 40 or 50 feet. The larger cars usually have the seats arranged crosswise, like an ordinary railway coach.

3. Selection of Car Body.—The selection of the cars for any given road is a matter that requires careful attention. No fixed rules can be laid down to govern the selection of the car body in all cases, because conditions vary. A body that is adapted to one place and condition of service might fail entirely to meet the requirements elsewhere. In some places, open cars can be used the year round, while in other sections there are only a few days in the year when closed cars are uncomfortable. The average conditions call for both open and closed cars, and much attention has of late been paid to the question of devising a car that can be made an open car in warm weather and a closed one in cold weather. The result of much study, experiment, and expense has been the so-called *convertible* or *combination* car, a type which all car manufacturers now make. The nearest approach to a solution of the problem of producing a combination car that is as good in hot as in cold weather is found in the car that is partly open and partly closed. This car has the advantage that it is not only adapted to hot and cold weather, but to rainy weather as well. It has the disadvantage that in no kind of weather does it, as a rule, carry a full load, except during the rush hours, so the power house must carry just so much dead weight over the road. The convertible cars, with removable or sliding panels, can be hardly said to have had a fair trial yet, but there is no doubt that it would be a great saving for a road to have a set of cars that could be run with perfect comfort to the passengers all the year around. It means that little more than half the number of cars need be bought and maintained; also, that every car on the road would at all times be equipped and ready to run.

Cars are constructed according to many different designs, depending on the particular uses to which they are to be put. The single-truck four-wheel car is fast giving way to double-truck eight-wheelers, because a single truck, on account of the limited wheel base, cannot well accommodate a car body over 20 or 22 feet long, and it has been found that in most cases it pays better to run long cars at long but certain intervals than to run short cars at shorter intervals. The most economical practice of all, from the energy point of view, is to run **trailers.** A trailer is a car similar to a motor car, but it is lighter and is not equipped for running itself. On account of the trailer being so light, the ratio of live weight to total weight carried is very much increased, and also the trailers can be left off when they are not needed. But unfortunately the use of trailers increases the number of accidents and consequent damage suits, and these more than offset the value of the power saved.

The point must often be decided as to whether single-truck or double-truck cars should be purchased for a road. It can be safely said that if there is the least doubt as to which to buy, give the preference to the double-truck car. There is nothing so attractive as a well-built and well-appointed double-truck car. This type of car is easier on the car body, easier on the line work, easier on the track, and last, but not least, it is easier on the passengers. Actual statistics have shown that the introduction of the double-truck car will create travel. Being higher from the rail and longer than the single-truck car, it takes longer to load and unload passengers, and for this reason is not adapted to local runs, where the travel is heavy and the stops frequent. This, of course, does not apply to open cars, where ingress and egress are just as free as on a single-truck car.

TRUCKS.

4. The main requirements of a good truck are that it be easy riding, durable, have few parts, wearing parts easily replaced, and wheels easily changed. The trucks must be entirely self-contained; that is, the one framework must include the wheels and axles, the brakes, motors, and driving gear. This in reality constitutes the car, for the car body above is merely a framework to hold and shelter passengers, having none of the vital parts necessary to operation. The fact must not be overlooked, however, that the car body has to stand severe strains on account of the rapid acceleration at starting and an equally heavy strain when the brakes are suddenly applied in stopping; so that this portion of the car must be carefully designed or it will not last long.

5. Classes of Trucks.—Trucks are of two kinds: **single trucks** and **double trucks.** Double trucks are of two kinds: *ordinary double trucks* and *maximum-traction trucks.* A single truck has four wheels, takes a single motor on each axle, and there is one truck to a car. An ordinary double truck has four wheels, all the same size, can take a motor on each axle, and there are two trucks to a car. A maximum-traction truck has two large wheels and two small ones, the idea being to throw most of the weight on the large wheels, to whose axle the motor is hung and geared. The weight on the small wheels is regulated by means of a compression bolt and spring, just enough compression being put on to keep the small wheels on the rail when rounding curves. As a rule, the large wheels take about 70 per cent. and the small ones 30 per cent. of the total weight. Experiment has proved that for a given weight of car, the maximum-traction trucks do not require as large an expenditure of energy as a single truck with a 7-foot wheel base. The single truck, being more rigid, binds more in curves and does not equalize as readily as the maximum-traction truck, with its shorter wheel base. The ordinary double truck equipped with a single motor has the disadvantage that the driving power is all on one axle, while the weight is divided between two. The result is a tendency for the driving wheels to spin when called on to do heavy duty, because the traction, that is, the friction between the wheel and the rail, is not great enough. By putting a motor on each axle, making four motors to the car, conditions are much improved.

Neither maximum-traction nor ordinary double trucks are as well adapted for use on an icy rail as the single truck. A single truck will go up an icy grade that neither of the other trucks can ascend.

The car body is rigidly bolted to a single truck by body bolts passing through the car sills and the top rail of the truck's side frame. Double trucks are attached to the car body by means of center bearings and pins, around which the truck turns as a center. Part of the weight is sustained and the car body kept balanced by the **rub plates,** which are circular pieces of brass that engage mates attached to the car body. These rub plates should be kept well greased. Cars mounted on double trucks sit higher from the rail than single-truck cars, because the body of the car has to clear the wheels and motors. In open cars the truck wheels have to clear the side steps, so that in some cases two steps must be used.

6. Types of Trucks.—Fig. 1 is a type of single truck; Fig. 2, an ordinary double truck; Fig. 3, a maximum-traction truck. In Fig. 1 the motors are supported by the suspension bars *b*, *b*, and these bars are in turn supported by the springs *s*, *s* resting on the side frame of the truck. The method of mounting the motors will be explained more in detail when the subject of motors is taken up. Since it is advisable to support the motor on springs, it is, of course, equally necessary to provide a flexible support for the truck frame and car body. For short cars, springs placed close to the wheels would be sufficient, although such a construction would have little merit. The reason for providing a longer spring base is to prevent oscillation, which is unpleasant for the passengers and hard on the car body. The oscillation when excessive diminishes the traction on the rising end of the car and causes the wheels to slip. For these reasons, the spring base is extended by adding extra springs at S_1, S_1. The car wheels generally used with such trucks are 30 or 33 inches in diameter, and the trend of present practice is towards the larger size, because it is heavier, raises the

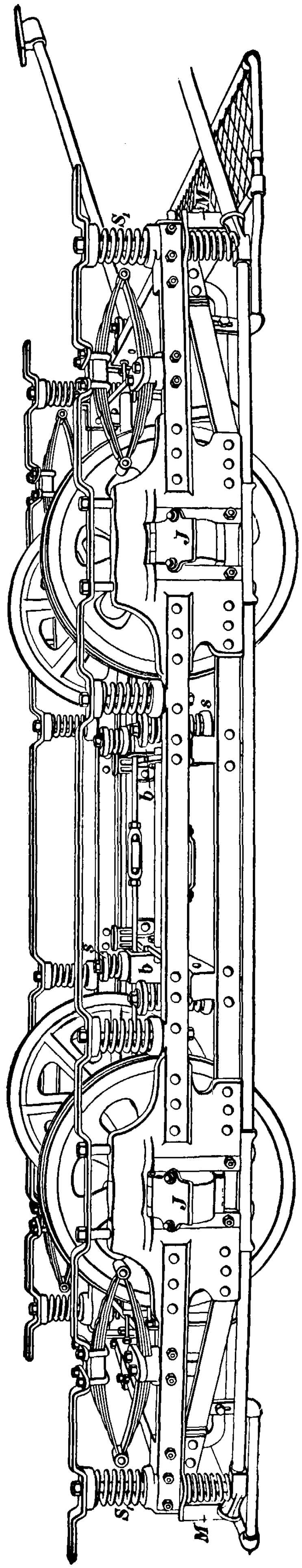

FIG. 1.

bottoms of the motors farther from the paving, allows higher speed, and gives less trouble from breaks and flats. The axle bearings are outside of the wheels, to give stability to the car body, the journal-boxes *J* being free to move vertically through a short distance controlled by a heavy coil

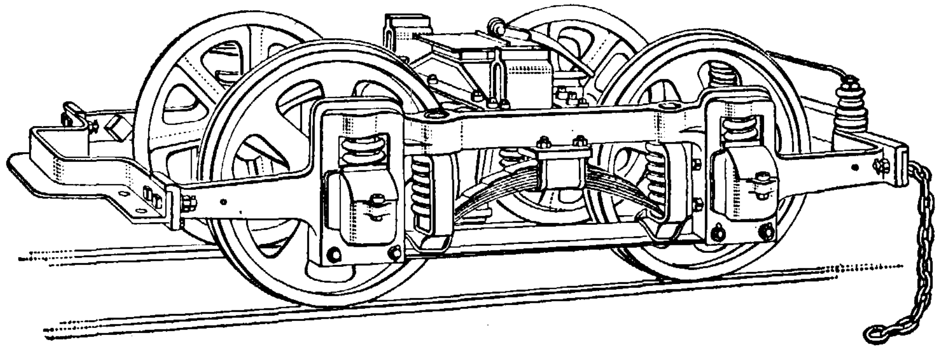

FIG. 2.

spring or rubber washer. Rubber does not amount to much as a cushion after it is old, because it becomes very hard.

Fig. 4 shows a larger view of the bearings used on a single-truck car; *a* is the journal and *b* the bearing brass, which is on the upper half only, because the thrust is all in

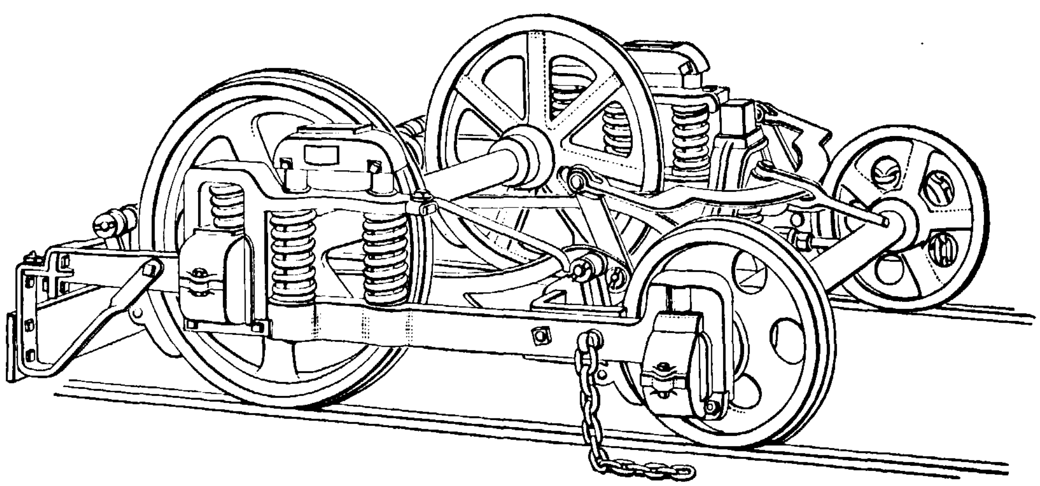

FIG. 3.

one direction. This brass presses against the box casting *c*, which in turn bears up against the spiral springs *s*, that are held in a socket in the frame *f*, as indicated in Fig. 4. By removing the piece *d*, the frame can be lifted clear of the axles. The journal is lubricated by means of waste *g* in the lower part of the casing. This waste is kept soaked with oil and effects the lubrication in the same manner as on

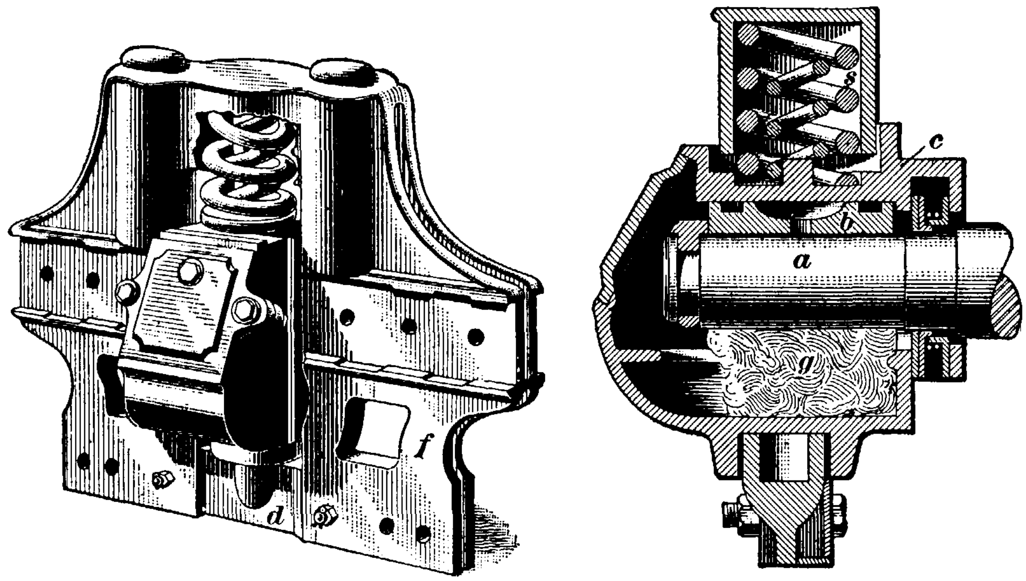

FIG. 4.

ordinary railway cars. To guard the wheels against obstructions, the **pilots** *M*, *M*, Fig. 1, are bolted securely to the frame at a sufficient height from the track to avoid touching the rails.

7. The **wheel base,** that is, the distance between wheel centers as measured along the rail, should be long enough to support the car body without excessive oscillation, but not so long as to bind on curves. Any car body that calls for a wheel base of over 7 feet should be provided with double trucks. Excessive length of wheel base not only wears out the rails and wheels, but increases the power required to pull the car around a curve. If it takes a pulling force of 500 pounds to pull an 8-ton car with a 7-foot wheel base around a curve whose radius is 50 feet, it will take a pulling force of only 350 pounds to pull the same car around the same curve on a 4-foot base. To pull the same car around a curve of 100 feet radius on a 7-foot wheel base would take a pull of 255 pounds, and on a 4-foot base a pull of 185 pounds. The difference in the pull required on the two bases on the 100-foot curve is much less than it is on the 50-foot curve, which goes to show that the greater the radius of the curve, the less difference does it make what the wheel base is. It is evident, then, that in laying out a road, all the curves should be made of as great a radius as possible; and in buying trucks for a road already installed, the radii of existing curves should be consulted. To enable cars to round curves with the least effort and to save the rails and flanges, curves should be kept clean and well greased. Other points to be considered are in regard to the treads and flanges of the wheels; on them depends very much the ease with which a car will take a curve. The treads should not be so wide that they run on the paving outside of the track, and the shape, depth, and width of the wheel flange should be governed by the shape, depth, and width of the rail groove.

ELECTRICAL EQUIPMENT.

8. The electrical equipment of a trolley car includes several different devices. Some of these, such as the motors, controllers, etc., are concerned directly with the operation of the car. Others—for example, the lightning arrester, fuse box, and hood switches—are more in the line of protective devices. Before considering these various parts in detail, we will glance briefly at the general equipment of a car by referring to Fig. 5. This shows an ordinary 18- or 20-foot car with the details of the truck omitted, in order to show the location of the motors m, m_1. Practically all trolley cars are equipped with at least two motors, and many of the larger cars using double trucks are equipped with four motors. The method of speed control now in use requires at least two motors, as will be shown later. The two motors m, m_1 are hung on the inside of the two axles and geared to them as shown at a, a_1. The speed of the motors, and hence that of the car, is controlled by means of the two **controllers** c, c_1 mounted against the dash irons i, i and operated by the handles n, n_1. When