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The Electrical Equipment of an Ordinary Street Car.

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(Continued from last issue)

The question of brakes does not properly enter into the electrical equipment of a car, except those which are electrically operated, though it is interesting to note the various styles and classes which have become more or less standard. There are in use to-day three main types, the manual, mechanical, and electrical. The greater part of the equipments in ordinary city work belong to the first division, being equipped with spring or gravity release, and occasionally being reinforced with the safety device of a plunger arranged to act as a block behind the rear wheels, used only on systems running over numerous heavy grades on which stops have to be made. In the mechanical class are grouped those types whose braking mechanisms are actuated by the motion or momentum of the car through the medium of a clutch mounted on one of the axles. The air system would also come under this head ; there are two distinct methods, one in which the car reservoirs, comparatively small, are charged from a motor and pump carried on the car itself, and the storage system, in which the cars are replenished from a common pump situated at some convenient point on the line, in which event the car storage tank is relatively larger. The electric types operate either by friction discs, one revolving with the axle and the other mounted on the motor, or by a solenoid pulling a plunger on to the rail head and at the same time, through a suitable system of cams and levers, setting the shoes on the wheels in the ordinary manner. In both types the current, which is obtained by operating the motors as generators, is controlled by the main cylinder, which is then provided with additional steps and turns backward from the off position. There is also the emergency electric brake, which, while not commercial, may occasionally be of great service ; it will be discussed later.

The lighting of practically all our modern cars is by means of incandescent lamps, and presents no special features ; they should in all cases be equipped with reflectors, whether mounted in groups or singly. Cars built lately are usually equipped with either bullseyes or illuminated signs to indicate the route to which they belong ; these are furnished with light by either a series of lamps of their own, or else by some of those which also light the car.

It is now usual in the case of double-ended cars to arrange the headlight so that when one is in use the vestibule light on that platform is extinguished, and vice versa ; this is accomplished either by means of a removable headlight, in which case the action is automatic, the transferring of the lamp itself accomplishing the switching ; or else if the headlights are stationary, one on each end, switches are used to light either them or the vestibule lamp as desired.

The headlight most frequently consists of an incandescent lamp, mounted inside a weatherproof case, which also contains a reflector, more or less efficient according to the money put into it, though very frequently, especially for interurban work, where cars are run at a fairly high speed and therefore require a somewhat greater length of road in which to stop, arc lamps are used for this purpose. Being on a 500 volt circuit, they require a rheostat in series; sometimes the incandescents in the inside of the car are used for this purpose, though it is more usual to employ a dead resistance. In the more temperate climates this is occasionally used as part of the car-heating system, being mounted under the seats and arranged with radiating facilities, so that the hot air coming from them assists in warming the car. Occasionally the cars are equipped with arc lamps for inside lighting as well as for the headlight, in which case they are all run in series.

On those systems which require artificial heating of the cars, the method by which it is to be accomplished is a very moot point, coal, hot water and electric all being available, the advantages, from the passenger's point of view, being all with the latter ; there is also much to be said in its favor from the operator's standpoint. In the first place, it is absolutely clean as compared with any form of stove, there being no ash to cause dust, nor fuel of any sort to carry along with the car ; if properly built they present no source of fire risk ; they give off no noxious fumes, ready for instant service, they do not occupy the conductor's attention which might profitably be employed elsewhere, and if properly arranged they distribute the heat all along the car in the place where it is most needed, namely, near the floor. On the other hand, any form of coal stove placed in the car body is notoriously deficient on all of the above points, scratching the frame when being taken in and out, a source of dust and dirt it is unanimously voted a nuisance by everybody ; the only thing to be said in favor of any of the various forms of heating, opposed to electric, is that they are cheaper. Roughly speaking, it costs something like seven times as much to heat a car electrically as it does by coal, or, to put the matter in another way, seeing that the average horse power consumption of an ordinary city car will be somewhere in the neighborhood of 20 h.p. per hour, and that of the heaters from 5 to 10, it will at once be recognized that if the cars are to be heated electrically that the generating equipment, with the engines and boilers or water-wheels to operate it, must be materially increased over that necessary for the work of propelling alone. It is usual in electric heating to provide means for varying the temperature and correspondingly the current consumed, by dividing the heaters into sections and connecting these in various combinations of series or parallel.

The rheostats of modern equipments are usually built of some form of iron resistance, coiled iron wire, iron ribbon, or cast iron girds, the latter being the latest form. They are required to dissipate considerable energy in the form of heat, and therefore have to be kept more or less away from the car body, usually being mounted on insulated supports to the under side of the framework where they can be got at for inspection, and still not be in the way of water and dirt from the wheels and street.

The usual equipment is not designed to remain in circuit for any appreciable period longer than that necessary to start the car, which is the reason for marking only certain of the controller steps as running positions ; if the cylinder be left too long on those which have the whole or part of the rheostats in circuit, they are likely to be damaged. Commercial requirements, which are the limiting features of all apparatus, seldom call for continuous running on any of the rheostatic steps ; if desired it is only a matter of money to put in sufficient capacity to be able to do so. In locomotive work, where shunting at slow speeds is a necessity, the rheostats are made much larger, the equipment for a pair of motors used for this class of work being in some cases as much as four to five times as large as that necessary to control it for ordinary traction duties.

We next come to the consideration of the motors themselves; they constitute that part of the equipment in which the electrical energy, conveyed from the stationary trolley wire to the moving car by means of the trolley pole, is converted into mechanical power, the machine which forms the actual source of motion of the car. The electric motor, as we have so often been told, was more or less accidentally brought to light ; it being discovered that an ordinary dynamo if supplied with current would rotate and deliver mechanical power from its shaft ; similarly the first street railway motors were dynamos, arc machines it is generally reported, coupled to the axle by means of belting or chains ; these were soon followed by machines designed for this particular work, the first types being bi-polar, with high speed armatures and double reduction gearing (two pinions and two gears), the electrical parts being absolutely unprotected from the weather. The motors of to-day, irrespective of their makers, all have the same general features ; four poles, two sets of brushes, single reduction enclosed gears running in grease, and a practically water-tight cast steel motor case, usually parted horizontally. Between the first more or less experimental forms and the machines now standard there were a tremendous variety of ideas and forms brought out ; it is impossible to go into details here, though it will be of interest to touch on the main features.

The first gears, as above, were double reduction, that is, there were two pinions driving two gears, made of rawhide, brass and steel ; cast iron also was used ; to-day cast steel for gears and hammered iron or steel for pinions is the usual standard. It was soon found that the open gears wore very rapidly on account of the dust and dirt which they encountered, and therefore with the introduction of the single reduction type came the gear case ; this at first was of sheet copper with a cast brass frame riveted and soldered together, passing in turn through a number of stages to cast iron, malleable iron and pressed sheet steel ; experiments are now being made on a type composed of a canvas cover on a brass frame with a spring sheet steel lining on the lower half.

Both ring and drum windings have been used for the armature, made sometimes with round wires and again with those of oblong section, the coils wound on to the body by hand, or again being machine formed before winding. For the commutator cast brass and cast and wrought copper have all been tried ; to-day standard construction uses machine wound coils, drum windings and wrought copper bars equipped with carbon brushes.

The first machines were bi-polar, and when it was found desirable to cut out one set of gearing there came the consequent struggle to reduce the armature speeds ; the most obvious method was to increase the number of fields from two to four, and a number of forms were brought out for that purpose. The first types had two consequent and two salient poles ; if arranged with the former horizontal, they made the depth of the motor too great, seeing that the standard 33-inch wheel allows but little room to keep clear of the roadbed ; if placed vertically the machine could not be parted along the horizontal plane, which latter was an extremely desirable feature. Finally there came the four pole salient type arranged with the poles set 45 degrees from the vertical, which allows convenient horizontal parting and is the form which has been adopted by practically all manufacturers.

Practically nothing but cast steel, or some one of its nearly allied compositions, has been used for the motor frame proper. The original machines were entirely open, and the first attempt at protection from water and dust was a pan placed underneath and partially up the sides of the machine ; then canvas was hung down from the car body ; next the frame itself