Electric Railway Department

Recent Developments in Electric Railway Car Equipment.

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The Railways and Canals Department's statistics show that the electric railway systems of Canada for the year ended June 30, 1914, totalled 98,917,808 car miles, with a total operating expenditure of $19,107,807, of which $513,016 was for the maintenance of the electric equipment of cars. Putting this on a car mile basis, we find a total operating cost of 19.3c. per car mile, of which amount 0.52c. represents the cost of maintenance of the electric equipment of cars, or 2.7% of the total operating cost. A comparison with the figures for the previous year, ended June 30, 1913, is of decided interest. In that year there were 89,005,216 car miles run, with a total operating cost of $17,765,372, of which $614,167 was for the maintenance of the electric equipment of cars. On a car mile basis we find a total operating cost of 20c. a car mile, of which amount 0.69c. represents the cost of maintenance of the electrical equipment of cars, or 3.45% of the total operating cost. For the year ended June 30, 1912, the cost of maintenance of the electric equipment of cars was 0.768c. a car mile, or 4.4% of the total operating cost. It will thus be seen that the cost of maintenance of the electrical equipment of cars has been steadily coming down and forming a smaller percentage of the total operating cost. It appears obvious that this reduction has been effected as a result of the greater consideration that the electric railway companies are giving this subject. It must also be borne in mind that in the effort to keep down maintenance costs the railway companies have the earnest co-operation of the electrical manufacturers, who are keeping this phase constantly in mind in the design of new equipment and in the re-design of existing equipment. In this connection we may consider recent advances made in the design of the various items of electric equipment for cars, operating under city, suburban and interurban conditions.

Motors.—The ventilation which the modern motor receives has enabled the designers to secure 15% to 25% higher current carrying capacity for the same total weight of motor, with the fully ventilated type, over that possessed, for the same heating values, by the non ventilated type of motor. The method of ventilation further insures all parts of the motor being equally cooled, and eliminates the "hot spots" which exist in the closed motor. Our method of ventilation is by means of a fan which is an integral part of the armature core head, in conjunction with longitudinal ducts through the interior of the commutator and armature. The pinion end frame head with this type of ventilation is provided with a ring which diverts the air from the fan through openings in the head, the incoming air being drawn through a screened intake at the pinion end. Another method is to draw in cool air at the commutator end. This air travels in parallel paths to the pinion end, one path being under the commutator and through ducts in the armature punchings, the other through spaces between the field coils and over the surface of the armature. A fan at the pinion end forces the air out of the frame. In the first case, the air drawn in at the pinion end first travels over the armature and between the field coils, and then through the armature and out at the pinion end; whereas, in the second case, these two paths are in parallel. If special conditions require that the motor be operated entirely closed, the first method of ventilation is used, the ring being left out. This permits of the air being circulated internally; and, even under these conditions, the motors are capable of increased service capacity over the non ventilated type. The ability of the ventilated motor to dissipate heat depends in a great measure on the amount of cooling air drawn in by the fan as influenced by the armature speed. The advantages gained by ventilation depend, therefore, on the character of service. In city service, with frequent stops and a consequent low average ampere speed, the advantages of the ventilated motor are less than any used for interurban service, having infrequent stops and a high average armature speed. Generally speaking, in city service having frequent stops and schedule speeds of from 8 to 10 miles an hour, the ventilated motor can handle from 10 to 15% heavier loads than the closed motor of the same horse power rating. For interurban service having infrequent stops and schedule speeds of 18 miles an hour or more, the ventilated motor will handle from 25 to 30% heavier loads than the closed motor with the same horse power rating.

Any saving in weight effected in the motors for any given service means a saving in the weight of the total car equipment; and the reduced power consumption is in direct ratio to this saving; it also means a saving in maintenance costs on account of reduced wear on trucks and track. Five cents a pound is the figure generally used in estimating the yearly saving for weight reduction, the limits being from 3 to 8c.

The use of commutating poles, and cutting down the mica between commutator segments, has largely decreased the maintenance costs on commutators, brushes, and brush holders, through greatly reducing brush and commutator wear; and, through improved commutation, eliminating flash overs. With commutating poles there are lower magnetic densities, and commutator and core losses are reduced, resulting in an increase in capacity and efficiency. The use of commutating poles has also made field control practicable for special cases where conditions warrant its use. The use of the shunted field necessarily means some additional complication of the control. With the tapped field it is sometimes possible to use a rather lower speed gearing than would otherwise be the case, thereby reducing accelerating current and resistance losses and giving a lower power consumption. The reduction of the heating effect on the motors and the use of a lower gear speed may possibly permit the use in some cases of smaller motors. Many equipments operating in cities on schedules having a large number of stops per mile are used for interurban running on schedules where the number of stops is very much less. Under these conditions field control affords a saving of from approximately 5 to 8%. For strictly interurban work, however, it is generally considered that saving in energy effected by the tapped field is not sufficient to warrant the increase expenditure and complications.

A very large percentage of the railway motors in use throughout Canada are of the split frame type. The box frame type has numerous advantages over the former and we can safely predict a steady increase in the number of box frame motors used, especially in the larger sizes for the heavier classes of service, although one of our roads has already adopted this type in 40/50 h.p. rating. Eighty to ninety per cent. of the railway motors building at present by one of the large electrical manufacturing firms in the United States are of the box frame type, and of the percentage of split frame motors, 19 out of 20 are under 40 h.p. rating. Many of our railway companies doubtless prefer the split frame type of motor, as their shop facilities are unsuited to readily lifting car bodies and motors from the trucks; however, the matter is worthy of serious consideration in view of the advantages possessed by the box frame type over the split frame type. These principal points of superiority are: For any given capacity the box frame motor can be made lighter in weight, smaller in overall dimensions, and of more rugged and durable construction. The box frame overcomes trouble occasioned in the magnetic circuit by dirt and oil getting between the halves of the split frame, trouble with field coil jumpers, and with oil working into the frame from the axle caps. The box frame also has the advantage over the split frame in a number of mechanical points.

The gear and pinion being integral parts of the motor, it is interesting to note that maintenance on these, as well as the labor in breaking down and assembling when changing, has been very considerably reduced by the use of tool steel, oil tempered forged, heat treated, and armorized gears and pinions. With regard to the gear ratio to be selected for a given service, the possibilities of securing a saving in power consumption by exercising care in the proper selection of ratio are much greater than is ordinarily appreciated.

With many of the older types of motors, before grooving of the commutator segments was adopted, the commutators had to be frequently sandpapered or turned. The wear was so rapid that it was considered good practice to make the segments very deep, a wearing depth of 1¼ in. not being considered excessive. With the modern commutating pole motor the wear on the commutators is usually so slight that after a year's run it can hardly be detected. Ten mils wear in a year is not an exceptionally low figure, at which rate a ½ in. wearing depth of copper will last for 50 years.

Reduction in brush wear has kept pace with reduction in commutator wear. I have inspected some equipments that averaged over 250,000 miles a car. The original motor brushes were still in use and showed about one quarter of an inch wear. The original compressor brushes were also running. These cars had not