Storage Battery Cars on the Canadian National

Cars Maintain Schedules Which Would Be Difficult for Steam Trains—Operating Costs Are Low

By E. B. Walker
Electrical Engineer, Canadian National Railways

The first storage battery car operation on Canadian railways commenced on May 16, 1921, when car No. 15801 started an hourly service between Trenton, Ontario and Belleville more as a mechanical test than with any regard to traffic needs. The population of Belleville is 12,240 and of Trenton 5,500 and the distance between the towns is 11.4 miles.

When the service was started there were seven trains a day in each direction on the steam railways and a number of buses on the highway. Ten normal trips a day were made by the battery car with an additional round trip on Saturday.

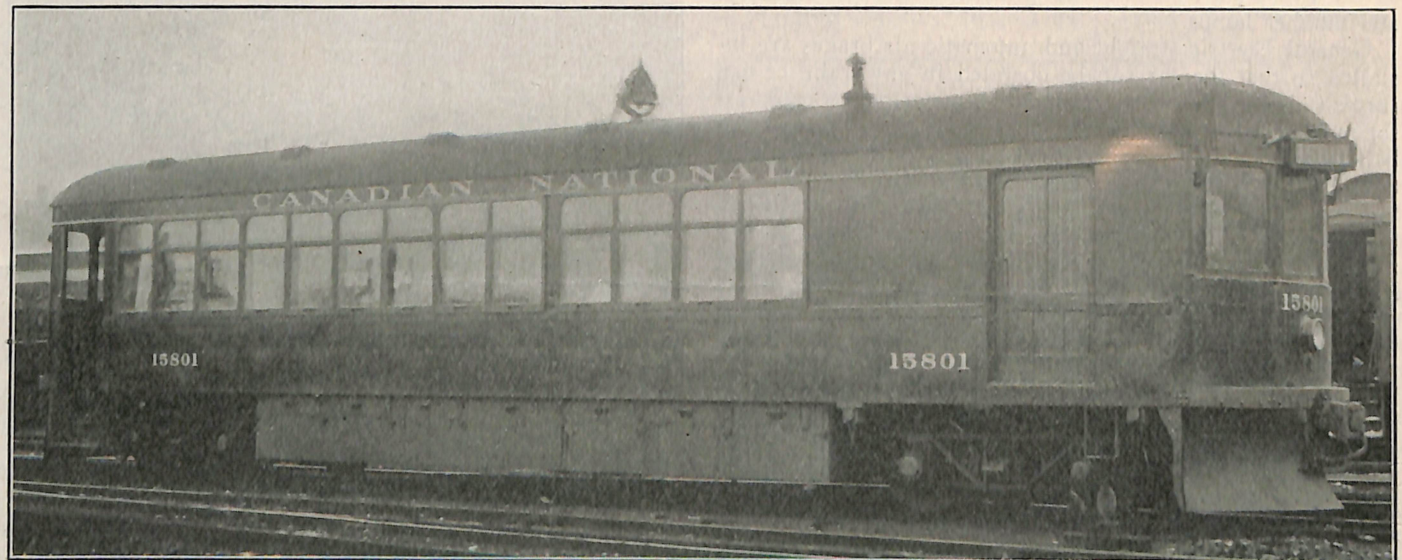
The novelty of the service first attracted attention and brought sufficient traffic from the outset to pay expenses, but instead of decreasing as the novelty wore off it steadily increased until a month later, there were often more than 500 revenue passengers a day. The schedule speed of this operation was 20 minutes for a single trip including three to four intermediate stops, but we were able to make the trip in a minimum of 17 minutes. The Trenton-Belleville run was continued for a month with a reliability of performance that established the battery car as an entirely satisfactory operating unit.

On June 27, 1921 the car was started on a schedule run between Bathurst, New Brunswick and Campbellton, replacing a steam train. The distance between the towns is 63 miles and one round trip a day was made with about 18 intermediate stops. An interesting point to note here is that there were nine schedule stops and two flag stops when the service was started, but the ease in starting and stopping the car soon led to a gradual addition in the number of flag stops until a total of 18 was reached. The schedule allowed 2 hrs. and 50 min. for the trip although it was found that this could easily be reduced to 2½ hours if necessary.

This operation was continued with remarkable reliability through winter and summer until September, 1922, when the car was removed to a new service between Toronto and Beaverton carrying passengers and milk. This run is 64 miles between terminals or 128 miles a day, and the schedule of 3 hrs. and 5 min. allows time for handling the milk which amounts to 120 cans on Monday morning.

Construction of the Car

The car body, built by Brill, is of simple construction as shown in the illustration. The underframe consists of two I-beams as centre sills and two channels as side sills with trussed cross members to carry the battery weight. The side posts are T-irons, on which 3/32 in. steel plates are riveted. The most important feature of the design is to obtain sufficient strength with a minimum of weight and the car designer must continually bear in mind that every extra ton means 3½ kw. hr. in battery capacity for a hundred mile run.



Car No. 15801 is Equipped with Four 25 hp. General Electric Motors, 2 Type K-36 Controllers, G. E. Straight and Automatic Air Brakes and Complete with Double Flooring, Storm Windows and Extra Battery Box Lining, Weighs 33 Tons

The trucks are Brill 69-E-2. They are of arch bar construction and are arranged for inside hung motors. The journal boxes are supplied with two Gurney ball bearings each. The Davis Steel wheels are 33 in. M.C.B. and are mounted on 4½ in. axles and have a wheel base of 5 ft. 6 in.

These trucks appear of light construction when compared with the type usually designed for interurban electric cars of similar size, but it must be remembered that the service is much easier than the usual rural trolley line with heavy grades and frequent stops.

In all cases the trucks gave entirely satisfactory service until we loaded 120 milk cans all at one end, which made it necessary to add another leaf to the elliptic springs and substitute heavier coil springs. The ball bearings have given no trouble whatever.

There are four General Electric 261-A-25 hp. 250/300-volt ball bearing motors mounted in the usual manner with gear ratio 16 to 91. This motor is developed from the G. E. 258 600-volt safety car motor. A standard series parallel controller and circuit breaker is installed at each end, and in the baggage compartment there are an ammeter, voltmeter, ampere-hour meter, underload circuit breaker and switches for the control of the battery compressor and lighting.

The storage battery consists of 250 cells of type A-12-H Edison assembled in trays of 5 cells each and arranged in the battery boxes under the floor, as shown in the illustration. The capacity of the battery is 450 ampere hours at an average of 300 volts or 135 kw. hr.

We have found it possible, however, to obtain 580 amp. hr. from these cells on emergency with a minimum of about 150 volts. This additional capacity has proved useful in winter when heavy snow drifts are encountered.

The lighting is furnished by ten of the main battery cells, which can be cut off from the power circuit by a double throw switch and consequently prevent the fluctuations in the power voltage from affecting the lights. The ten cells supply 12 volts for the 15-watt lamps inside the car as well as the two Golden Glow headlights, markers, classification, and number lamps.

General Electric straight and automatic air brakes are installed so that the car can be operated in any train, or can furnish air for one or two trailers. A motor driven compressor is installed in a compartment in the centre of one row of battery boxes and the usual air whistles, air operated locomotive bell, air sanders and hand brakes are also provided.

A Peter Smith forced draught hot air heater is installed in the baggage compartment and the fan motor is provided with a double throw switch giving full or half speed by means of a centre tap in the battery circuit.

Battery Charging

Direct current at 250 or 500 volts can be used for charging and the car is equipped with switches for arranging the battery cells in either series or parallel depending on the available voltage.

For the Trenton-Belleville run a 75-kilowatt 250 volt motor generator set, which was on hand was temporarily installed near the station. This allowed charging at the normal rate of 90 amps. at night and gave sufficient capacity for three "boost" charges during the day of 150 amps. These figures are of course doubled with the battery connected in two groups in parallel.

For the Bathurst-Campbellton run the car was first charged at night at Bathurst only from a 75 kw. 250-volt motor generator set. We found, however, that when snow came there was insufficient battery capacity to make the round trip of 126 miles on a charge so the Trenton set was moved to Campbellton and the car recharged there during the lay-over.

For the Toronto-Beaverton run the car is charged at night from a motor generator set made from a 70-hp. 900 r.p.m. 60 cycle induction motor, coupled to a 50-hp. 500-volt direct current motor used as a generator. During the day it receives a boost charge from the 600 volt street railway circuit through a grid resistance.

For normal charging about 75 kw. should be available and 250 volts is preferable to 500 especially with a grounded circuit like a street railway. Mention is made of these different charging equipments to show that a variety of apparatus can be used for the purpose.

The time required for a normal full charge is 5 to 7 hours but higher rates can be used as long as the temperature of the battery does not exceed 115 deg. F. We have charged an empty battery in 2¼ hours with a maximum temperature of 106 deg. F.

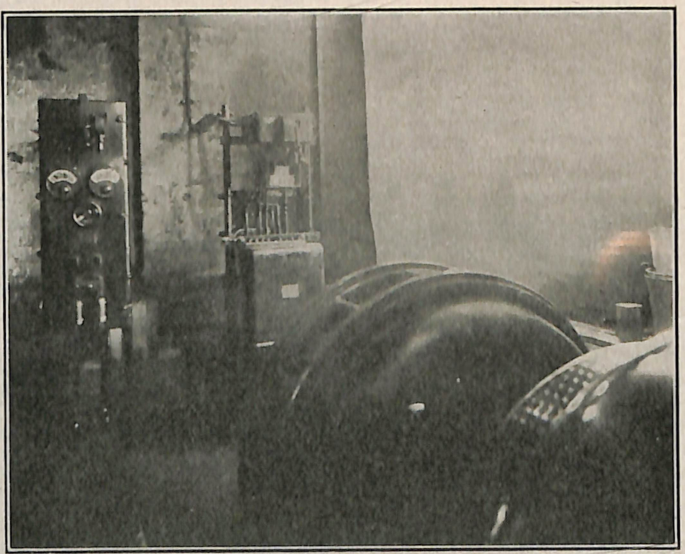
Normal Operation

The car will usually travel about 140 miles on a full charge with normal grades but it is wise to limit this to about 100 miles if possible or to arrange for a boost charge.

The consumption of power is about 35 watt hours per ton-mile under normal circumstances but head winds and snow may increase this considerably. Intelligent use of the coasting powers of the car will help materially in reducing power consumption. As an example of coasting, in the Toronto-Beaverton run there is a climb of 25 miles out of Toronto with an average grade of 0.577 per cent with long stretches of 0.75 per cent. The car climbs this at about 26 miles an hour but on the return journey the entire 25 miles are made without any power consumption except for starting.

The acceleration is about ½ mile per hour per second and the speed on the level is about 40 miles an hour, but 48 miles an hour has been obtained with shunted fields. We have discontinued the use of shunted fields as the high speed is not necessary and the increase in current consumption is considerable.

As the car weighs about 30 tons unloaded the figure of 35 watt hours per ton-mile gives a consumption of 1.05 kw. hr.



Very Simple Equipment is Required for Charging the Car Batteries

per car mile, which, of course, varies with the load, grades, windage, track conditions, etc.

In estimating the cost of charging current, 2½ to 3 kw. hr. per car mile should be allowed at the alternating current side of the charging set to allow for the above variation and for the battery and motor generator set inefficiencies.

Winter Operation

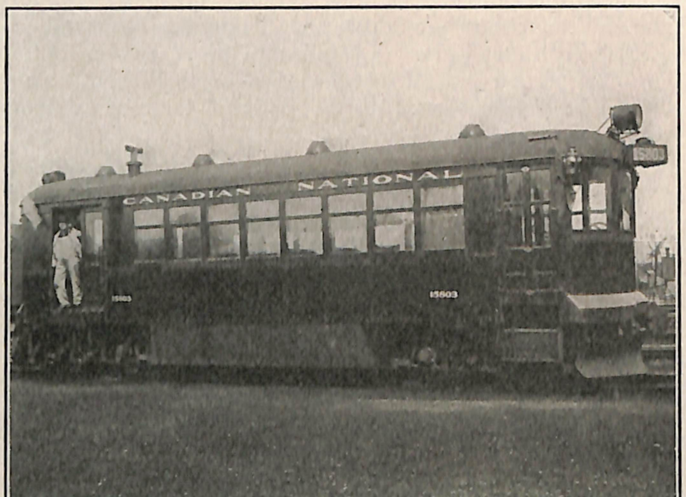
Fear was expressed that low winter temperatures would so reduce the capacity of the battery that operation would be unsatisfactory. We found, however, that the heat inertia of the large battery in well lagged compartments was quite sufficient to maintain reasonable temperatures when standing even in the coldest weather and during operations the temperature increased due to internal resistance losses.

As an example of our winter operating conditions I cannot do better than quote from a report made by the electrician in charge of the car:

"On Monday, January 23, we struck a very severe wind storm on trip west. The temperature was between 20 and 30 below zero. The snow drifted badly and some places the drifts were 3 feet high. Although the drifts were frozen hard we managed to get through them all successfully and caused great surprise at Campbellton, as it was not thought that the car would be able to get through. We arrived at Campbellton 30 minutes late but as the local delayed us 14 minutes we were therefore only 16 minutes later than our running time; also we were 470 amp. hr. discharged. I notice the hard drifts bent the pilot slightly.

"At night we were badly blocked by limited and local, more especially the latter. The local I understand was finally pushed in by a freight as the water pipe between tender and engine got frozen. We arrived at Bathurst one hour and 35 minutes late but actually we made up time.

"The temperature is still remaining around 20 below, but we are making our running time O. K. Last night we were



Car No. 15803 is Equipped with Four 21 hp. Westinghouse Motors, 2 Type K-35 Controllers, Westinghouse Air Brakes with Emergency Feature and Weighs 25 Tons

blocked 27 minutes by limited at Eel River but we arrived at Bathurst on time."

Throughout this winter the car has operated without a failure between Toronto and Beaverton, although the snow has been unusually heavy.

Trailer Operation

The car has a tractive effort of about 2400 lb. at the one hour rate. As an experiment it easily pulled a trailing load of 208,000 lb., although it is not intended for such service.

On one occasion we pulled a 25-ton trailer with ordinary bearings from Bathurst to Campbellton, making all stops; there was no difficulty in maintaining schedule and we were able to make up 10 minutes lost waiting for a meet.

At the end of the run the battery was 450 amp. hr. discharged and the temperature of the commutators was only 85 deg. F. with an outside temperature of 60 deg. F. This shows that the motors are of ample capacity for a trailer, although it would be advisable to equip the trailer with ball bearings and make it as light as possible, as the miles per charge are almost proportional to the weight.

A better type of two-car train consists of two battery cars with multiple unit control.

Battery Maintenance

The Edison battery is easy to look after if the cells are kept clean and dry and flushed regularly with distilled water. They lose capacity if not in service but a cycle or two of charge and discharge will soon bring them back to normal. Overcharges at high rates every week or two seem to keep the battery voltage at a higher average than can be obtained by the normal charge only.

The maximum life of the cells is difficult to ascertain. The battery on car No. 15801 is five years old and is over the rated capacity; we also have cells which have been 10 years in this class of service and which give full catalogue rating. It seems safe to estimate a useful life of at least eight to 10 years with normal care and conditions.

Cost of Operation

The cost of operation varies so greatly with local conditions, cost of electric power, wages, etc., that no general figure can be given but it is easy to estimate the cost for any particular operation from the following:

(1) Electric power should be estimated at 2½ to 3 kw. hr. per car mile (30-ton car) at the alternating current side of the charging set.

(2) Wages of crew will have to be added according to local conditions.

(3) The partial services of an electrician for flushing the batteries, and inspection will be required.

(4) Car maintenance and supplies, this should be from 2 to 3 cents per car mile.

(5) Depreciation should be included at 10 per cent for the battery and 5 per cent for the car body and motors.

(6) Interest.

Failures

Since the car was put in operation there have been two interruptions due to electrical defects and three or four due to insufficient charging.

The first electrical trouble was caused by a trailing lead

End View of Car No. 15801

rubbing on the armature of one of the motors which caused a burn-out. The car operated in an entirely satisfactory manner for two or three weeks with one motor cut out while the armature was being repaired.

The second electrical trouble was caused by a grounded cell while charging from the 600 volt street railway system. We do not know what started the ground but suspect that it was due to careless flushing. The result was that the grounded cell punctured and spilled the electrolyte which caused other cells to ground. Three cells in all were injured in two different trays. Seeing smoke from the battery compartment the yardmaster cancelled the run and sent out a steam train, although, had the electrician been advised in time, it would have been a simple matter to cut out the injured cells and operate the car as usual, which was actually done for the next day's run.

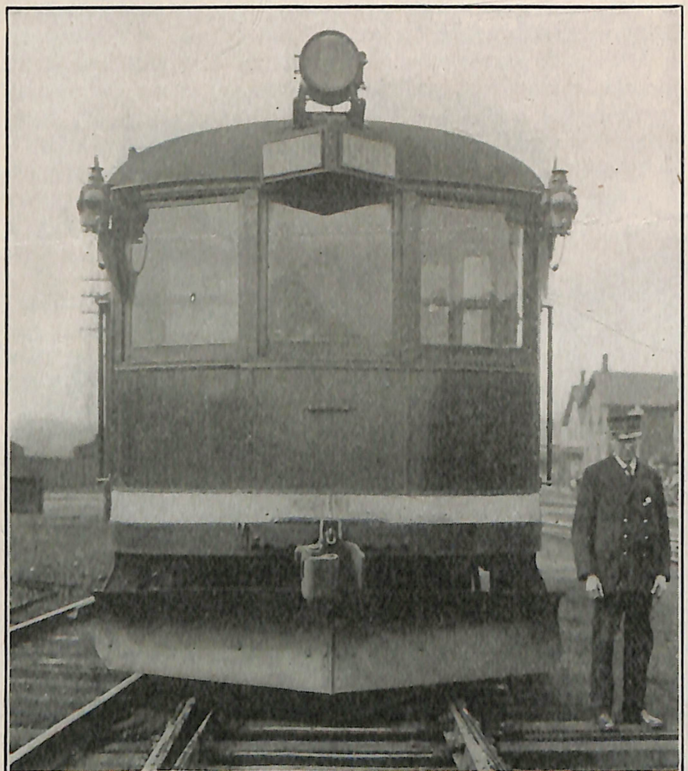
The charging failures were mostly due to an old steam driven generator at Campbellton which broke down more than once, which resulted in the installation of the motor generator set referred to elsewhere.

The only other charging failure was due to somebody who turned the ampere hour meter back to zero by hand, with the result that the charge was shut off before completion.

Battery Cars Now in Service

Car No. 15800 is an old gas electric car which is being remodeled. The body is of steel of similar construction to that already described but it is 60 ft. long by 10 ft. wide and the seats will hold three abreast. The baggage and engine compartments are being cleared out and fitted with seats as a smoking compartment, giving a total seating capacity of about one hundred. The car will be put in service between Winnipeg and Transcona, a distance of about seven miles, making seven round trips per day.

Ball bearing trucks with 33-in. rolled steel wheels will be applied and the electric equipment will be identical with that described above. The battery will consist of 260 cells of A-12-H Edison and will be charged in parallel from the 250-volt d.c. shop circuit at Transcona.



End View of Car No. 15803

Car No. 15801 is our first car, supplied by the Railway Storage Battery Car Company, and described above. The seats in the smoking compartment shown in the illustration have been removed to give sufficient room for the milk cans, service between Toronto and Beaverton will be continued.

Car No. 15802 is a Brill car similar to No. 15801 but slightly shorter. It seats 30 in the main compartment and 20 in the smoker and has a 10-ft. baggage compartment. It is equipped with four Westinghouse V-65-A3-250-volt ball bearing motors, gear ratio 15 to 91, mounted on Brill 69-E trucks with S.K.F. bearings, and 30-in. chilled iron wheels. This is a similar truck to the 69-E-2 but the wheel base is 4 ft. 6 in. instead of 5 ft. 6 in. and the motors are outside hung. Westinghouse air brakes and compressor are installed, Peter Smith heater and other details similar to car No. 15801. The battery consists of 270 cells of A-12-H Edison. This car will be put in service on the Bathurst-Campbellton run formerly furnished by car No. 15801.

Car No. 15803 is of identical construction to No. 15802 but it is only 36 ft. 6 in. long, over end sills and seats 30 passengers in the main compartment and with a few folding seats for smokers in the baggage compartment. The motors and trucks are identical with car No. 15802 but the gear ratio is 22 to 84 to allow the use of a lower voltage battery. The battery consists of 110 cells of M V X-33 Iron Clad Exide battery. Half of the cells are under the seats and the remainder are in the usual battery compartments under the floor. This battery has a capacity of 544 amp. hr. at an average of 215 volts or 117 kw. hr.

It is in service between Brockville and Westport and runs 107 miles per day on one charge. The grades on this section are heavy and reach a maximum of 1.77 per cent.

The car is charged at night from a motor generator set in the Brockville roundhouse. The set has a capacity of 57 kilowatts at 275 volts and the battery is charged with all cells in series. By charging at night only, advantage is taken of the off peak power rate, which is 35 per cent less than the day rate.

Car No. 15804 is under construction at our St. Catharines shops and will be 60 ft. long to seat 60 with a 10-ft. baggage compartment. The electrical equipment will be identical with car No. 15800. No run has yet been assigned to this car.

Comparison of Batteries

Comparison of the relative merits of the nickle-iron and lead batteries have been made very fully by various authorities and it is not necessary to go over this again.

In brief, we have found that the nickle-iron battery will stand rough usage and give long life in battery car service and we are waiting with interest to compare results with the lead battery on car No. 15803.

The longer life of the nickle-iron battery is partially offset by the lower price and high efficiency of the lead battery, which however, has its drawbacks of greater weight; only by experience and careful records can we obtain an accurate comparison.

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