THE EDISON-BEACH STORAGE BATTERY CAR *

R. H. Beach.

Probably it is not clear to many electric railway men how a storage battery can perform the very difficult task of supplying the large amount of electrical energy necessary to propel a heavy car, to accelerate it at frequent intervals and cause it to climb grades. Experience with batteries composed of lead compounds immersed in acid-electrolyte has been such as to lead many to think that all secondary batteries are delicate and have a short life, and therefore are to be avoided for use on vehicles. The Edison secondary battery, which is the source of energy in the Edison-Beach storage battery car, is neither delicate nor short-lived. The principle of the Edison storage batterv is that metallic iron tends to combine with oxygen. When oxygen is combined with iron energy is developed either in the form of heat or electric energy. Conversely the oxygen may be removed from iron oxide, but to do this requires the expenditure of energy. The Edison battery consists essentially of plates of iron oxide and plates of nickel oxide immersed in water, to which potash is added. If an electric current is caused to pass through the electrolyte from the iron plate to the nickel plate the oxygen present in the iron oxide passes to and remains with the nickel oxide. When all of the oxygen has been removed from the iron oxide and is taken up by the nickel oxide then the battery is fully charged. In this condition the negative plate is composed of metallic iron, while the positive or nickel plate is composed of oxide of nickel and also a super-oxide of nickel. The finely divided metallic iron has an affinity for the oxygen in the positive plate and it will receive this oxygen if permitted to do so. It cannot receive the oxygen, however, without giving off energy in some form. If an electrical circuit be completed between the two plates an electro-chemical action takes place and the oxygen in the positive plate is transferred to the metallic iron in the negative plate. This process is accompanied by the generation of electricity.

The Edison battery is analogous to but quite different from the older forms of lead batteries. Combinations of iron and nickel oxides and water are not self-destructive. Neither are they destroyed by the transfer of the oxygen back and forth. In a word, the distinctive feature of the Edison secondary battery is its stability. The battery is not liable to injury from use, and it suffers nothing from neglect. It may be charged at a rate as high as ten times the ordinary rate, or it may be discharged on short circuit. The electrolyte may be boiled or frozen without damage to the cell. With ordinary treatment the battery can be relied upon to do its best work, providing it is kept reasonably clean. From experience extending over several years, it is known that the battery will not fall off in capacity during the first six years of its life. It is guaranteed for three years and it is believed that it will last for a much longer time, especially if distilled water is used.

With the older types of storage batteries it has been necessary to allow almost as long for charging the battery as for discharging it under service conditions. The older types of batteries require about eleven hours for a complete charge and in car operation this would mean that the car would be out of service at least half of the time. Because of the fact that the Edison battery is not injured by high rates of charging, a car equipped with this type of battery need be out of service practically none of the time. In Washington, D. C., a car is operated over a line 4 miles long. The running time is sixteen minutes and the layover time at the terminal is three minutes. The battery is charged at five times its normal rate during the three-minute layover and the car then runs to the other terminal, where the operation of charging is repeated. The battery is not charged at any other time and the car runs 204 miles each day. The three-minute layover at each terminal is required for changing the fender and giving the conductor an opportunity to reset the fare register. Advantage is merely taken of this time to charge the battery. Another car, operated in Concord, N. C., makes 99 miles a day and is charged twenty times for ten minutes at each terminal. The total charging time is three hours and twenty minutes during the day.

Mr. Edison has said of this battery that it is the most useful of all of the devices that he has invented. As the field of its application becomes better known it will be the means of supplementing and, to a large extent, supplanting many of the present means of electrical transmission. It makes not only possible but almost certain the removal from the street of all overhead trolley wires, and makes unnecessary and uneconomical the third rail and the conduit.

In designing the cars on which these batteries are used the writer has aimed to reduce the dead weight and to eliminate, as far as possible, friction losses. The average Pullman car weighs 3,000 lb. per seated passenger. The ordinary wooden day coach used by steam railroads weighs about 1,500 lb. per seated passenger. A steel suburban coach weighs 1,100 lb. per seated passenger. An ordinary single-truck trolley car weighs about 800 lb. per seated passenger and an ordinary double-truck car about 1,000 lb. per seated passenger. The average current consumption of a trolley car is approximately 125 watt-hours per ton mile. The Edison-Beach double-truck storage battery car weighs only 600 lb. per seated passenger, while the small single-truck car weighs 380 lb. per passenger. The latest type of long wheel-base, single-truck car weighs 360 lb. per seated passenger. The weight of the battery required on each of these cars is about 60 lb. per seat.

This reduction in weight has been accomplished by making a number of departures from the usual practice in body and truck construction. All of the joints in the truck frame are welded instead of being riveted or bolted. No difficulty has been experienced from broken welds. In longitudinal seat cars an electrically welded latticed steel girder forms a rest for the seat and extends the length of the car body. It is bolted to the side and cross sills and side posts. In an 18-ft car these girders weigh about 300 lb. and they so stiffen the body that a reduction of nearly 3,000 lb. can be made in the weight of the other parts. A very light roof is used because it is not necessary to support a trolley base. The body of an 18-ft. car with 5-ft. platforms and folding doors, but no bulkheads or interior doors, weighs about 3,700 lb. A standard monitor-deck car body of the same length weighs about 6,700 lb. and the light bodies with the steel girders are much stronger than the heavy bodies.

After extensive experiments had been made it was found that there was a considerable saving in friction losses if the wheels were permitted to rotate on the axles instead of having the axles fixed in the wheels and rotate in the journal bearings. Exactly how much saving in current consumption has been effected by this change is not known. A silent chain drive is used between the motors and the wheels. There is some gain in efficiency with this type of drive over the gear drive, but it is difficult to say exactly the amount. When new the gear drive is probably very nearly as efficient as the chain, but as it wears it loses its efficiency, whereas

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