THE WADDELL-ENTZ STORAGE BATTERY CAR TRACTION PLANT OF THE SECOND AVENUE RAILROAD COMPANY, NEW YORK.

Very extensive trials have been made in the past in the utilization of storage batteries for street car propulsion. Generally, these batteries have been of the lead plate-sulphuric acid type. In practice it was found that various objections attached to their use—the jarring of the car, and the occasional heavy draughts made upon them for current, both told in the deterioration of the plates; but worse than all was their great weight, the complete battery for a street car weighing so much as, in itself, to be an almost prohibitive feature.

In our present issue we illustrate the works of the Waddell-Entz storage battery traction system, as now in daily use on the Second Avenue line in this city. It is characterized by the adoption of a zinc-copper accumulator as a source of current utilized by a special Gramme ring slow-speed motor. The power station is a most interesting part of the installation, as it represents a systematic set of appliances and a routine method for running the cars subject to its operations.

Of course, the battery is the main feature, and of a cell of this battery we give an illustration, showing its interior construction. The cell proper is of steel $4\frac{3}{8}$ inches by $7\frac{1}{2}$ inches area and $11\frac{3}{4}$ inches high. The joints are soldered with a special solder. The surface of the cell forms a portion of the negative element, the rest being formed by a series of steel plates dropped into it. Between the steel plates and between the outer steel plates and the case is the positive element. This is built up, in general terms, as follows:

Around a wire of copper, copper oxide is compressed ; over this is woven a covering of very fine copper wire, and over this a cotton braid. The structure thus produced is similar in appearance to a heavily insulated wire conductor wound in a species of flat spiral, round and round itself, so as to produce what is virtually an oblong plate. To "form" the plate the copper oxide is reduced to the metallic state. One of these plates goes between each of the intervals between the steel surfaces. To preserve the distance uniform a distance braid is attached to both sides of the copper outside element. These features and the general connection of the steel plates in parallel with each other and of the positive or "wire" plates, also in parallel with each other, are shown distinctly in the cut.

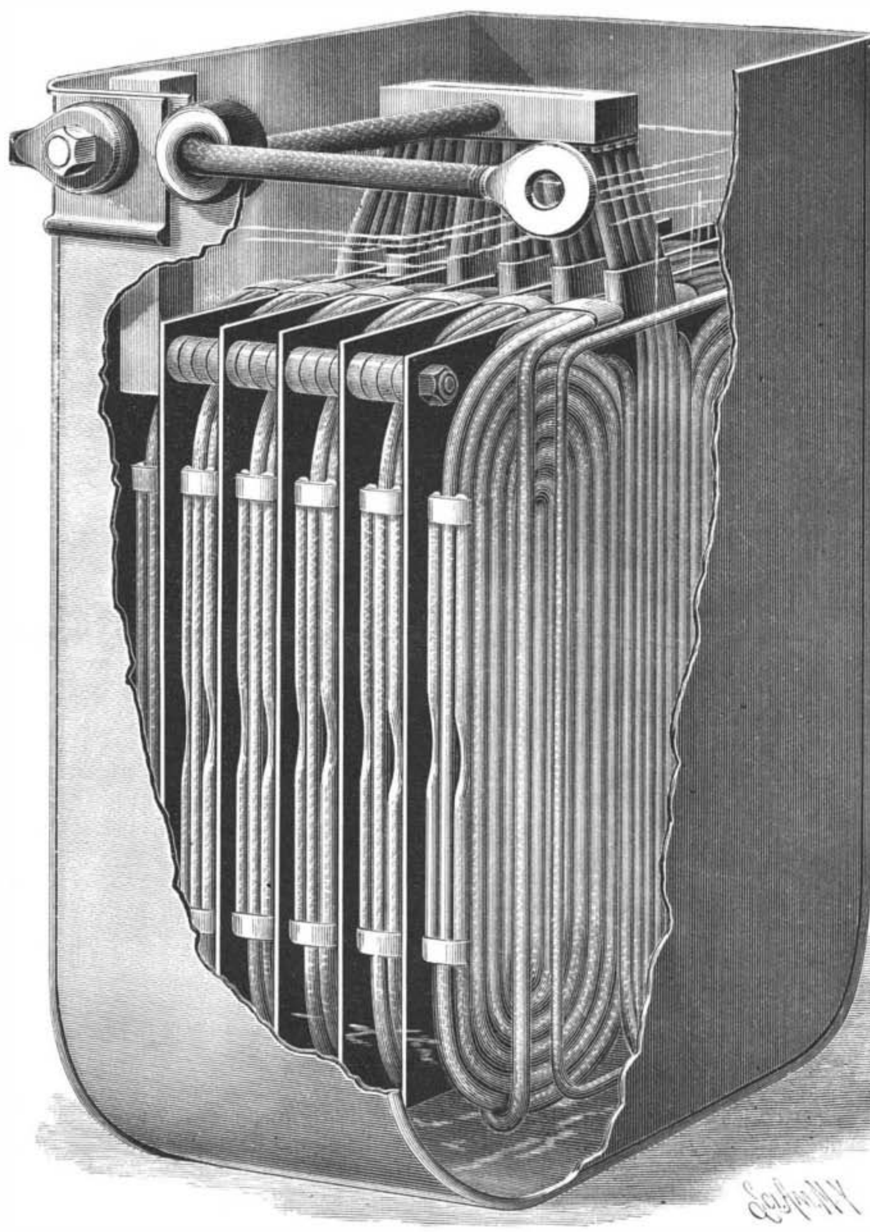
The solution for these batteries is made by dissolving zinc oxide in caustic potash, to a specific gravity of 1·45. In the charging operation, when the batteries are attached to the electrodes of the charging dynamo, the solution is decomposed, metallic zinc is deposited on the steel surfaces, and red oxide of copper is produced in the porous mass surrounding the central wire of the positive plate. In the discharge a reverse operation takes place. When current is taken from the battery, the alkaline solution dissolves the metallic zinc, while the hydrogen, going to the other pole, produces the oxide of copper which has been formed there in the charging operation. It will be seen that in its discharge the battery is virtually a Lalande-Chaperon couple of the type so favorably known here in the Edison modification.

For the cell thus produced most remarkable results are claimed. On short circuits almost any current can be yielded by it without deterioration. The alternate oxidation and reduction of the positive plate is of such a nature that the plate is absolutely free from any danger of buckling. While its working current averages 40 amperes, 1,000 or more can be taken from it. On the low discharge its resistance is about 1-1000 of an ohm, which resistance, very curiously, becomes reduced on the high discharge to about one-half of this amount. Its electromotive force on discharge is 0·89 volt, and for charging only 0·94 volt is required, a much smaller excess than in the case of the lead storage battery. The capacity of the cell is 240 ampere hours. Its weight is 28 pounds.

In the charging some interesting points are to be noticed. The oxide of copper to be produced is the red or cuprous oxide ; not tne black oxide. When the latter begins to form, an instant change in the voltage occurs, which indicates when the charging is completed. Again, as the zinc is deposited on the steel plates, if the distance between them and the positive plates is uneven, there is danger of a building up of zinc on the negative at this point, something which has to be guarded against. To preserve the alkaline liquid a layer of heavy oil is poured upon its surface, which prevents the carbonic acid gas of the air from combining with the alkaline solution.

On each car there are 144 cells, weighing altogether 4,032 pounds. They are carried on special trays provided with rollers and are introduced beneath the seats of the cars through openings in the dashboard and end of the car body, being rolled in and out by power.

In this appears what is really one of the distinctive details of the system. By a traversing table the car can be shifted laterally a few feet. Thus, as the car reaches the place, the new batteries may be lowered and rest in front of the car a little to one side of the car openings. The old ones are withdrawn, the car is traversed, bringing its end openings in line with the fresh batteries. These are then drawn in by power, the car is traversed back and is ready to proceed. Meanwhile the exhausted batteries are raised to the next story. The great advantage of this system is obvious. No large opening is made in the car body, and the battery is introduced in two complete sections, one for each side. Our illustration shows very clearly the methods and appliances. One set of batteries is seen in mid-air suspended from the electric crane while being taken away for charging. The other set is going into the car.



THE WADDELL-ENTZ STORAGE BATTERY.

The charging of the batteries is done on the upper floor of the building. The charging room is traversed by a 30-ton Sellers electric crane, all of whose motions are effected by electric motors. This crane is worked from an elevated stand by one man, so that the batteries are rapidly raised or lowered to the upper floor and deposited in any desired place. In charging, the batteries rest on steam coils, as the charging is best effected at a higher temperature than that of the air.

The car motor, which is shown in one of the cuts connected to the driving wheels, is a Gramme ring dynamo of the same inventors. It is of 15 kilowatt capacity and its rotation is reduced by single gear to proper axle speed. There are two on each car, thus giving a total maximum rate of about 50 horse power. On the dashboard is mounted the controller, a seven point switch, also shown in detail in one of the cuts. With this the motor man governs the car. At the first mark the current is shut off entirely. On the next point the connection is made so that the motor shall be converted into a dynamo and operate in the direction of charging the batteries. This causes it to act as a brake to some extent and also effects a certain economy on down grades and in stopping. On the other points the cells are connected in different ways so as to regulate the speed, the final and maximum speed being given by weakening the field so as to lower the counter electromotive force.

It has been found best to adopt a systematic course of operation with the batteries. Each one is introduced into its car, the proper mileage is run, and it is removed and charged for a definite period. In a sense all goes by clockwork. The batteries are not charged until they will take no more, and are not discharged to complete exhaustion. They are worked a specified period and charged for a specified period. An elaborate switchboard enables all these operations to be carried out.

The power and generating plant includes two 100 horse power Worthington boilers, two automatic Ideal 75 horse power engines directly connected to two 75 horse power Waddell-Entz 8 pole Gramme ring dynamos. In one of the cuts we show the power-generation room, with these two engines and dynamos. The plant has now been in operation for a number of months on the exhausting service of the Second Avenue line of street cars in this city, a line including several very heavy grades and well adapted for testing the manageability of the cars. Conservative figures supplied by the Waddell-Entz Company give an expense of operating of between 9 and 10 cents per car mile.

The present plant has a full capacity for 18 cars, each making 80 miles a day, a total daily mileage of 1,440 miles.

Of the cells on the car, some are used for lighting, so that car traction could really be executed with a somewhat smaller battery. Each set of cells runs a car for about two hours. By the use of the electric power mechanism, when introducing and withdrawing the batteries, and for raising and lowering them and depositing them in their proper places in the charging floor, the labor item of the charging station is very light.

Exercise.

All authorities that have treated on longevity place exercise, moderate and regularly taken, as one of the main factors of a long life. That there are many exceptions does not alter the fact that physical exercise is as useful in keeping one healthy as it is to prolong life. Good walkers are seldom sick, and the same may be said of persons who daily take a certain prescribed amount of exercise. Exercise is both a preventive and a remedial measure. In my own practice I have seen a case of persistent transpiration that followed the least bodily effort, and which annoyed and debilitated the person at night—this being a condition left after a severe illness—disappear as if by magic after a day or two of exercise on a bicycle. Pliny relates that a Greek physician who took up his residence in Rome was wont publicly to declare that he was willing to be considered a charlatan if at any time he should ever fall ill, or if he failed to die of any other disease but old age. Celsus, in speaking of the same physician, observes that his faith in the benefit to be derived from exercise was so great that he had in a great measure abandoned the administration of internal remedies, depending mostly on hygienic measures and exercises. As an evidence of the correctness of his views, Pliny tells us that this physician lived to be a centenarian, and then only died from an accident.—*Nat. Pop. Review.*

THE penny-in-the slot electric lamps have come into use on the London underground railways. It is two years since the first experimental lamps were put on a few trains. Since then arrangements have been made to fit the lamps to all the trains and the work is now complete. There are four lamps in each compartment. The ordinary light is usually insufficient. A penny put in the slot obtains electric light which lasts half an hour. If more light is wanted another penny must be inserted. The lamps are placed at the back of the seat so as to throw the light on the book or paper.

THE city of Caracas in Venezuela has lately been the scene of much rejoicing over the opening of a new railway between that place and Valencia, in the interior, a distance of about 111 miles. Many difficulties in the construction had to be overcome, owing to the mountainous nature of the route. Several important bridges, tunnels, and viaducts were constructed. The road opens up a very rich and important agricultural region. The road was built under the auspices of a German corporation.

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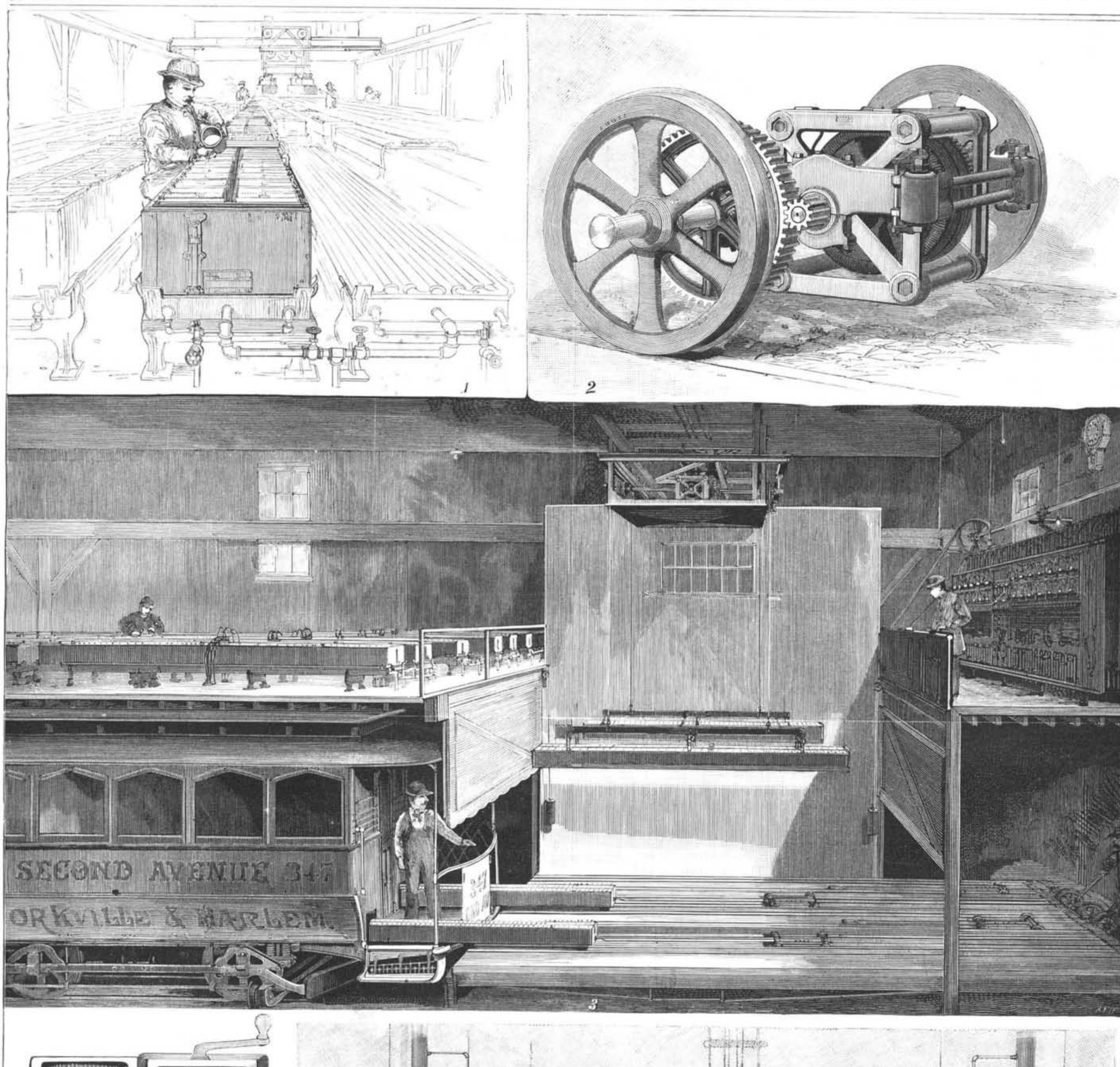

1. The battery charging room. 2. The Waddell-Entz car motor. 3. Putting car batteries in place and removing batteries to the charging room. 4. The controller. 5. The power generating plant.

THE STORAGE BATTERY SYSTEM ON THE SECOND AVENUE RAILROAD, NEW YORK CITY.—[See page 184.]