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SCIENTIFIC AMERICAN SUPPLEMENT

No. 598.

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ELECTRIC ACCUMULATORS.

At the present time, much interest is excited in the electrical world by storage batteries. When first introduced as a practical apparatus, some years ago, they were hailed as providing for the storage of electricity, which was considered a great desideratum. For a while interest in them weakened, but it has revived again. Their acknowledged failure in returning the full quantity of electricity with which they are charged is offset by the consideration that they can be charged from the cheapest possible source of that form of energy, the dynamo. This loss of electricity is due to several causes, some, doubtless, unknown as yet. In charging accumulators, the current has to be maintained at a tension slightly greater than that producible by the discharge. Otherwise the battery would discharge itself through the dynamo. Hence, there is an inevitable loss in voltage. This does not only apply to the natural voltage of the cell. There is a "spurious" voltage, as Prof. Forbes has recently termed it, to contend against. The regular electro-motive force being 2 volts, the initial tension of the cell is sometimes as high as 2¼ volts, and the charging has to be done against this, indicating in such a case a waste of about eleven per cent of the electro-motive force of the charging current. This is not the only loss, for the tension is not alone reduced, but there is also a fall in quantity or intensity. The ampere hours suffer in somewhat the same proportion.

Thus, tests of Faure accumulators have given the following results in electricity returned: Return in quantity (ampere hours), 84·34 per cent; return in electrical work (watts hours), 62·44 per cent; return in mechanical work (foot pounds), 46·50 per cent. The figures in the three cases are the results obtained by Messrs. Monnier & Guitton with Faure-Sellon-Volckmar batteries in October, 1883. They are still considered authoritative. For working figures, 90 per cent, 60 per cent, and 40 per cent are sometimes taken.

The cause of these different losses is not yet satisfactorily ascertained. The spurious electro-motive force has been attributed to hydrogen bubbles sticking to the positive plates. The loss in quantity may be due to local action between the metallic grids and the peroxide. The perfect contact of plates and peroxide is advocated by some as the panacea for the latter. More than one inventor has endeavored to do away with the lead supports in the negative plate, and to substitute therefor a solid mass of lead peroxide. One of the batteries now claiming the public's attention in England, the "Union battery," is thus constructed.* Its negative element consists of a slab of peroxide, mixed with lead sulphate. Strips of platinum are used to form a connection for the binding posts. For positive, a plate of spongy lead is adopted. With such a combination, it is asserted by Prof. Forbes that the spurious voltage is extremely low.

Yet the return question seems not fully solved by any battery, and it seems doubtful if it will be. Investigators are now most interested in obtaining a more favorable ratio of total weight of battery to electrical energy yielded. It is here that one of the many anomalies of the storage battery manifests itself. In a primary battery the zinc can be dissolved to the last grain and be rigorously accounted for. In the usual forms of storage battery only a small portion of the active substances, spongy or formed lead and peroxide of lead, is utilized in the discharge.

Thus, a determination was made of the amount of peroxide reduced during the discharge of a lithanode battery. Two and one-half ounces out of eleven of peroxide were reduced. This gives a basis for a very disadvantageous ratio of weight to power. The other forms of battery in which a metallic frame or grid is used to support the peroxide present a similar, together with an additional, reason for the discrepancy. The metal frame is all idle material, if, as already suggested, it is not worse, in forming the positive element in a destructive local circuit.

The advertised weights of cells of two leading accumulator companies, with their quantity of discharge, illustrate this well. One cell, weighing 125 pounds, is stated to deliver 350 ampere hours with a discharge period of 10 hours. Another cell, weighing thirty-four pounds, is credited with 150 ampere hours in 4¼ hours. The electro-motive force being two volts, the above reduced to electrical horse power represent 133 pounds and 84 pounds of dead weight respectively per hour horse power. Taking the rate of delivery into consideration, in each case about $\frac{1}{10}$ horse power per hour is maintained. Practically speaking, it must be remembered that the weight of a storage battery does not represent the weight of an engine only, but of an engine and its fuel. Thus, to develop one electrical horse power hour, we may say that about one hundred pounds would suffice. This compares favorably with a steam engine and boiler with an hour's fuel and water, but ten times the above weight would be required to advantageously maintain this rate. Again, suppose ten hours horse power were wanted. The same weight of steam engine and boiler would be required, with about forty-five pounds of coal additional. But of the storage battery, ten times the weight would be required, or about nine hundred pounds additional. Not only have the volt-amperes to be considered, but the period of discharge, a practical factor settled by experience only, has to be allowed for. The extremely low resistance cannot be taken full advantage of. The rapid discharge is wasteful and destructive of the plates.

To the reduction of this dead weight, electrical engineers are now devoting themselves. One way of lessening the trouble in house service may be mentioned. To introduce private installations in cities, it is proposed to renew the plates as fast as exhausted. This method does away with the weight of the cells. Only the plates are transported, the cells remaining in the house. A central station would be fitted up to recharge and distribute. In the lighter of the batteries just cited, the plates for an electrical horse power hour would weigh 67 pounds, according to the figures of the company supplying it. One gross ton of such plates would represent nearly 34 electrical horse power hours. The lithanode plates, it is claimed, give still lower weights. For them 56 horse power hours per ton is claimed. This reads very much as if a one horse engine burned forty pounds of fuel an hour, or rather as if the coal contained so little combustible matter that forty pounds were required to keep a one horse engine going for an hour.

The above trouble due to dead weight affects transportation, and use in vehicles and boats, but does not enter to the same extent into installations where a dynamo is included in the plant. Here the weight is of less moment, yet any move to reduce it would be welcomed. Another peculiarity of the storage battery, and one already alluded to, stands in the way of what might seem an obvious method of reduction. A small battery frequently charged and discharged at a high intensity would solve the problem in at least some cases. But the storage battery cannot be so discharged with economy. For the ends of efficiency and durability the rates already instanced in the case of two particular forms of accumulators cannot be exceeded. In practice the lighter one of the two is used at a far less intensity of current than that given, or about one ampere per hour to two pounds of battery. No more startling spectacle in electricity than the work of a storage battery on a circuit of infinitesimal resistance can be witnessed. To see a heavy copper wire a foot or more in length heated to full redness by a secondary battery no larger than a pocket book gives an exalted idea of the power of the accumulator. But wonderful as it is, it is a mere *tour de force*. It is done at the expense and utter sacrifice of durability and efficiency.

It is clear that a vast field is open for improvements in this class of batteries. The electrodes need to possess a larger percentage of active material. Polarization and the spurious voltage need reduction. Finally, a battery that can be quickly discharged without injury to its durability, even at the sacrifice of efficiency, would certainly have a definite field of work, where its services would be highly valued.

* For description of this battery see SUPPLEMENT, No. 598.

HEADWAY OF GREAT SHIPS.

To the Editor of the Scientific American:

In vol. liii., No. 10, page 144, I saw an article under the heading, "Speed on the Ocean," in which it says: "A great ship while at full speed will run several miles before she can be brought to a full stop or turned a few degrees to the port or starboard."

Some time ago I related this statement to a friend of mine who is in the New York Custom House, and he declared it untrue, and has since made inquiries of several officers and captains, and they tell him such a statement is absurd—that they can stop their vessels when at full speed in going three or four times their length.

I write this, asking you, for the satisfaction of others as well as myself, to ascertain the facts if possible.

WILL. P. SESSIONS.

Brandon, Vt., April 26, 1887.

[The question as to how far a fast steamer would run with engines stopped was referred to Mr. Nash, the secretary of the Board of Pilots. Mr. Nash has been connected with the Board for fifteen years, and been present at many of the trials which pilots are subjected to for running ships ashore and like mishaps. He calculated that if the engines of a ship running 19 knots an hour in dead water were stopped and reversed, she would not begin to gather sternway until she had covered a distance of at least two miles, and perhaps even as much as three miles. Two of the best pilots of the port being called into the office, each made separate estimates, and the result agreed with the calculations of the secretary. One of them said that long experience aboard these fast ships had proved to him that if two such vessels were approaching each other, each making 19 knots an hour, and the danger signal was heard when they were four miles apart, it could not avail to avert the impending danger, if the weather was thick, because they could not be stopped until the point of meeting had been reached, and all their masters could do would be to "trust to luck" to slip safely by.

Another pilot gave the following instance of the diffi-