SCIENCE

FRIDAY, DECEMBER 14, 1888.

ELECTRIC PROPULSION.

Nov. 26 and Dec. 5 of the current year will be memorable dates in the history of electric propulsion; for on those days the largest and most powerful electric railway-motor yet constructed gave proof, on the Ninth Avenue line of the New York elevated railways, of its capability to do all that the steam-locomotives there in use are called upon to perform in their regular service. This motor was the Daft motor 'Benjamin Franklin,' whose plan and side-elevation illustrate this article.

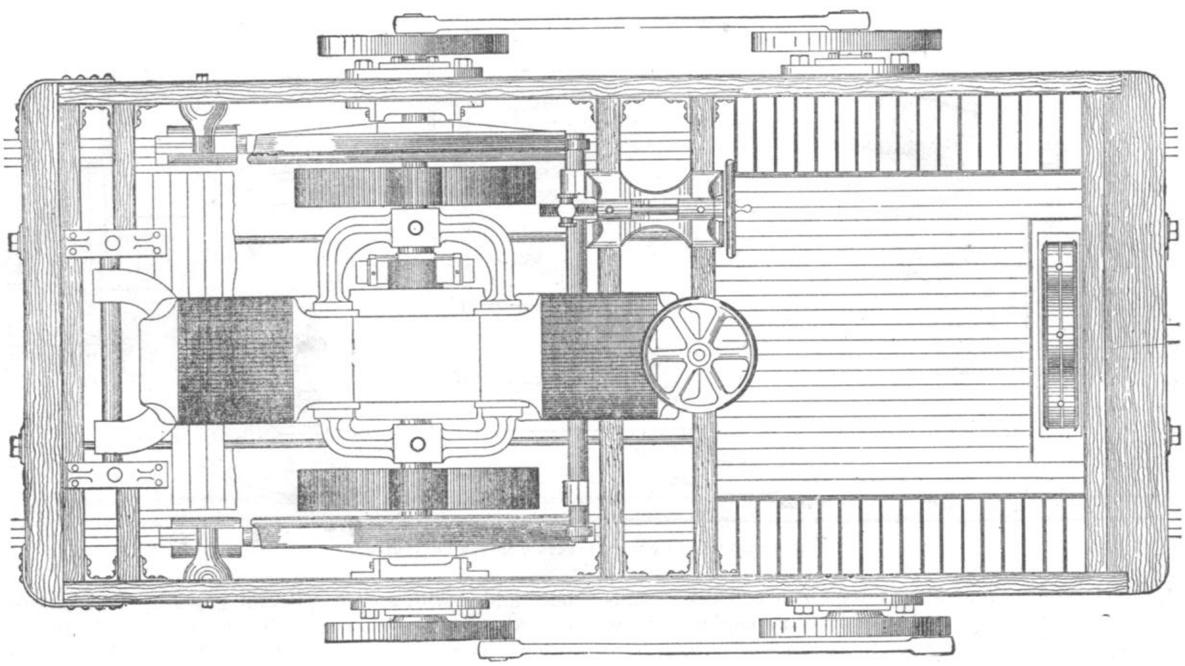
Electrical traction on a minor scale is no new thing: Siemens, at Berlin and Port Rush, had accomplished it as early as 1881, and Daft himself had achieved the first commercial success in this line — that is to say, the first electric railway ever built under a business contract, completed and paid for in accordance therewith, and continued in operation without modification thenceforward — at Baltimore in 1885; but nothing excepting the Pittsburgh motors of 35 horse-power, also of Daft's design, had passed the limit of 10 or 15 horse-power until the 'Franklin' appeared on the scene.

A general description of this motor follows; and the cuts will give a clear idea of its mechanical arrangement and details. The total weight is ten tons, — very little over half the weight of the steam-locomotives in regular use, — and the wheel-base and length over all are respectively 5′ 6″ and 14′ 6″. The total horse-power is probably 150, although there has as yet been no opportunity of making an ultimate test in this respect.

The 'Franklin' was designed to pull four cars and their seated load — a total weight of 75 tons — over any gradient of the Ninth Avenue Elevated Railway at the schedule speed of ordinary trains. In the trials a train of eight empty cars — a load of 122 tons, 47 in excess of that agreed upon — was taken up the maximum gradient (nearly two per cent) at a speed of 7½ miles per hour, and a loaded four-car train exceeded the schedule speed by almost 3 miles per hour.

The question will naturally suggest itself, 'What future has this motor, and what are its claims to preference over the system now in use on the New York elevated railways?'

The answer is, radical economy, which lies in the recognized wastefulness of small — especially locomotive — engines, and the high efficiency of large stationary engines of improved type. Multiplication of power-generators implies loss in efficiency, and increased cost of attendance. Derivation of power from one origin, with ready capability of subdivision, is economy. The average consumption of coal per horse-power, as between light rapid express and slow heavy freight-trains, is about nine pounds per hour for steam-locomotives. A modern compound condensing engine will yield a horse-power for two pounds per hour, or even less. Admitting that the conversions from power to current, and *vice versa*, consume one-third of this, it still remains that the locomotive-engine needs more than three times as much coal as the stationary for every horse-power exerted upon the track. It is demonstrable that the New York elevated railroads can be run at less than half the present cost for motive power, including a charge for interest on the cost of the new equipment, and ignoring the proceeds derivable from the sale of the old.



PLAN OF DAFT ELECTRIC MOTOR 'FRANKLIN.'

Other economical features of the system are, —

1. Reduction of attendance.

2. Conservation of permanent way from the diminution in weight of motor permitted by its superior adhesion. This is always available where the rails constitute part of the circuit, and makes plain why the 'Franklin,' of half the weight of a steam-locomotive, can haul as great a load. One of the most invaluable features of the system is the high degree of adhesion between the motor-wheels and the rails, which permits the employment of much lighter tractors than would be practicable if steam-locomotives were used, to the manifest advantage of the vehicles themselves and of the permanent way. This adhesion is not magnetic, and probably results from molecular change produced by the current in contiguous surfaces of wheel and rail. It sometimes amounts to forty per cent of the weight as opposed to twenty per cent usually observable in steam-

locomotives as the average of all conditions of track as affected by weather and use.

3. The possibility of dispensing with the complicated methods of insulation that are necessary and most expensive features of high-potential systems.

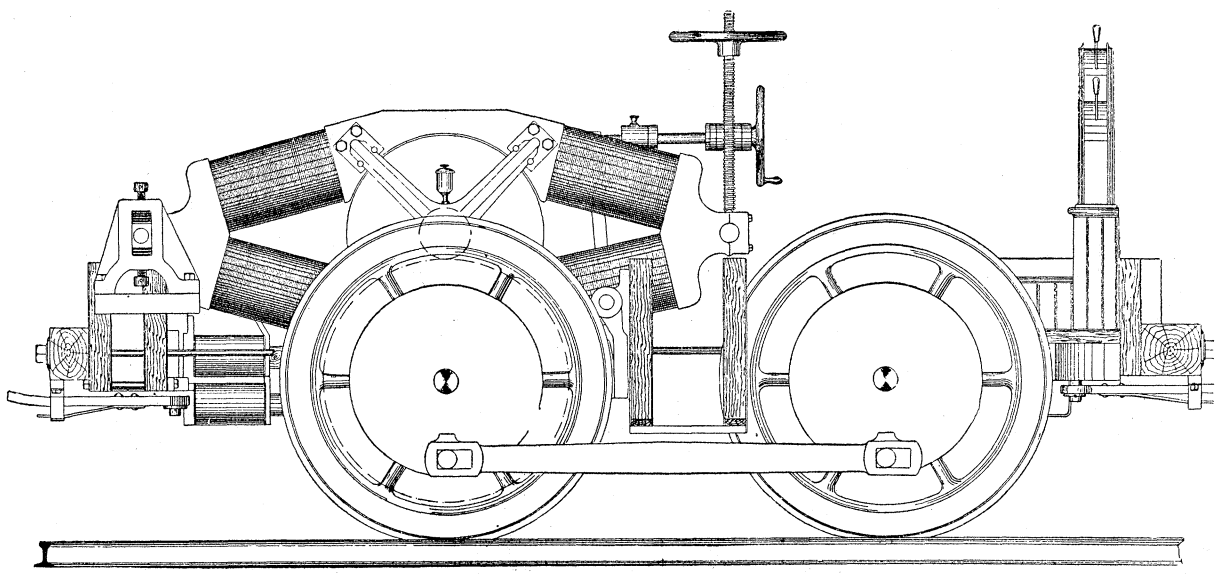
4. A potent cause of the economical working of electric railways is found in the capacity for instantaneous adjustment of the current to demands made upon it. This is so marked in the case of a double-track road with the same number of trains moving in both directions, and all deriving their power from a common generating-station, as to prompt Dr. C. A. Siemens to draw this striking analogy. He declares that two trains on the same track, one descending and the other ascending a gradient, are in as absolute connection by the current in the rails as if tied together by an actual rope. The counter-current generated by the free revolution of the dynamo of the descending train re-enforces the main current, and thus helps the ascending. The result of this is that the maximum capacity of the generating-station need only equal the average work of one motor multiplied by their total number. This will always prove sufficient. Every steam-locomotive must be ready at all times to exert its full power; and the waste of this, in the aggregate, is enormous.

familiar steam-engine, which has profited by eighty years of use, experiment, and analysis by the best human ingenuity.

To resort to generalization, the steam-engine's characteristic function is to transform heat into mechanical work; and the labor and thought of three generations have only succeeded in recovering, in the shape of work, from ten to twenty per cent of the total heat applied to it. The peculiar office of the dynamo-electric machine is the conversion of mechanical work into current electricity; and in the first decade of its useful existence it returns, in the form of electrical current, ninety per cent of the mechanical work applied to it. The adept steam-engine attains one-tenth of its possible efficiency; the tyro dynamo-electric machine, nine-tenths. "If they do these things in a green tree, what shall be done in the dry?"

ELECTRICAL POWER-DISTRIBUTION.

ONE of M. Victor Popp's friends was recently describing with post-prandial eloquence the wonderful system of compressed-air distribution now so extensively operated in Paris. As if it were not marvellous enough to picture to his hearers' minds pneumatic clocks throughout Paris, and all sorts of machinery deriving power from a central station for compressing air, the interesting 'diner-out' added with a most graceful gesture, "Why, messieurs, with the Popp system you freeze the dead bodies in the morgue, and you cremate them in Pere la Chaise." And thus the idea is continually forced upon one's mind that this is an age of centralization in the supply of heat, water, light, and power, and, in fine, every thing that makes life more comfortable, and business more practicable. The application of electricity to the distribution of power has been developed with comparatively more marked progress than the electric-lighting industry met with in the early stages of its existence; and this is not strange, when we consider the advantages of electric motors, and the fact that their use makes a material difference with small manufacturers in the item of cost of power, besides constituting an important feature of safety. The fact that the noisy, dusty, and dangerous steam-engines which are being used in so many printing-offices, book-binderies, and various other shops where power is needed, may be displaced by quiet-running electric motors, which are not dangerous and do not take up much room, added to the actual saving in money which is accomplished by such a change, are points which are so easy of demonstration, and commend themselves so readily to the popular mind, that the introduction of electric motors has not met with any serious obstacles. Although the first experimenters built motors before they built dynamos, it is only within the last two or three years that practical machines of a high efficiency have been offered to the public. Some of the machines now give an efficiency of over ninety per cent in the conversion of electrical into mechanical



SIDE-ELEVATION OF DAFT ELECTRIC MOTOR 'FRANKLIN.'

The following facts are significant as regards electrical propulsion: 1. The production, by modern stationary engines of the highest efficiency, of a horse-power for two pounds of coal, or less, per hour; 2. A recovery, in kind, from an electric circuit of reasonable length, of at least sixty-five per cent of the mechanical power applied to it; 3. The consumption by small stationary and locomotive engines of from seven to nine pounds of coal per horse-power per hour; 4. The consequent development in the circuit of a horse-power for three pounds of coal as opposed to seven or nine; 5. A marked reduction in original and current cost of motive power, due to lessened weight, simplicity, and diminished attendance; 6. A notably lower rate of deterioration than other machinery, due to the use of low-potential currents, absence of reciprocatory motion, etc.; 7. Conservation of permanent way, arising from the lessened weight of motor due to superior natural adhesion and the power of increasing the same magnetically to any necessary degree; 8. A unique economy arising from the fact that there is no necessity of having superfluous power in reserve, — a consequence of the capacity for instantaneous adjustment of a current throughout an entire circuit to the demands made upon it.

If one may judge by comparison with other mechanisms, the future of the dynamo-electric motor is pregnant with possibilities. The measure of perfection of any machine is the degree of efficiency with which it performs its specific work. Referred to such a criterion, dynamo-electric machinery stands, at the very starting-post of its career, infinitely nearer to its theoretical ultimate than the