SCIENCE

FRIDAY, FEBRUARY 22, 1889.

PRACTICAL ELECTRIC-RAILWAY PROPULSION.

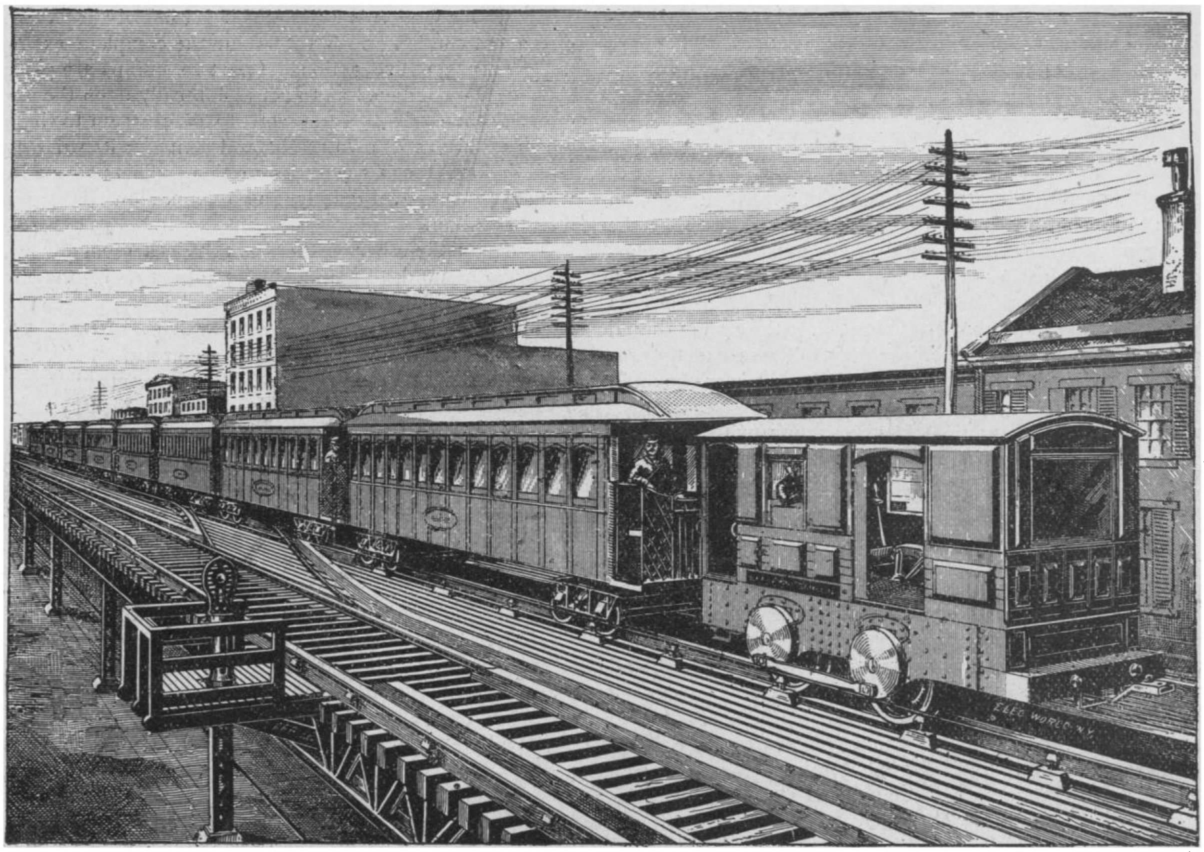
IT is a striking indication of the overcrowded surcharged state of modern life that events of extreme significance and momentous importance take place without exciting more than a ripple on the surface of its current, so rapid, deep, and vast it is.

Such an instance is depicted in the accompanying illustration, which is of the electric locomotor "Benjamin Franklin," with its eight-car train, now running upon the Ninth Avenue Elevated Railway in New York City.

With these perfectly intelligible and merely fortuitous differences, the service of the steam and electric train is identical.

What the "Franklin" has achieved in its experimental work may be briefly stated as follows: It has drawn eight empty cars — making, with the locomotor, 122 tons in train — up a gradient of nearly two per cent at 7½ miles per hour, developing, in so doing, over 120 horse-power; it has taken four cars up the same gradient, with the average load of passengers, or 70 tons in train, at 15½ miles per hour, more than two miles faster than the schedule speed of the steam-locomotives; it has maintained speed of 30 and 25 miles per hour with trains of two and three unloaded cars.

All this has been done without the slightest accident or delay of any kind, and with every indication of the locomotor still being well within its ultimate capacity. For facility, certainty, and promptness of manipulation, nothing more could be asked for.



DAFT ELECTRIC MOTOR AND TRAIN OF EIGHT CARS ON THE NEW YORK ELEVATED RAILWAY.

To be literally accurate, it should be said that the service is confined to certain hours of the day, that only three or four cars are used in it, and that passengers are only taken on at the termini; viz., Fourteenth and Fiftieth Street stations.

The reasons for these limitations are as follows: Since the locomotor has to be switched from one end of the train to the other at each terminus, only that portion of the day is available in which the headway of the steam-trains, among which it runs, affords sufficient time for the operation. In the many hundred miles that the "Franklin" has made, it has never delayed a steam-train or deranged their succession. The cause of not stopping at intermediate stations is, that, as the locomotor has at present no means of utilizing the air-brakes, — though this lack is being provided for, — the necessary reduction of speed near every station, to permit of the trains being brought to rest by hand-brakes, would so trench upon the time needed for switching, at each terminus, as to endanger delaying steam-trains, or sacrificing trips to avoid so doing.

Such a chapter of success as this, quite apart from its technical and commercial significance, ought surely to have been fittingly recognized. The first grand scale electric locomotor in the world's history, and the first ever brought into direct competition with steam-locomotives, after doing all that they do, and triumphantly complying with every imposed condition, elicits little more from the technical press than a few perfunctory allusions alike distinguished for incompleteness and inaccuracy.

The gist of one notice was dissatisfaction that the "Franklin," in spite of its complete success, was not something else than what it is, and an inane caution, that, notwithstanding its ready disposal of every suggested test, and easy rivalling of the steam-locomotives in all respects, it would be advisable to lay this practical, actual entity on the shelf, and wait for the possibility of something better turning up, in shape of the inchoate *eidolon-fori* of some nameless dreamy inventor.

Technical journalism, in the field of electrical power at least, would seem to be at a low ebb in New York.

As for the current-generating plant and conductive system, they, as well as the "Franklin," are entirely of the Daft design. The former is on Fifteenth Street, about midway between Sixth and Seventh Avenues, and wires of suitable size convey the current to and fro between the stationary plant and the track-conductors. A steam-engine of 250 horse-power drives four dynamo-generators of 50 horse-power each.

The conductor is a copper rod, five-eighths of an inch in diameter, sustained by insulators attached to the guard-timbers alongside the track. Elastic copper "brushes" pressing against and sliding along this rod convey the current to the electro-motive mechanism, which it traverses, causing revolution by its passage, and completes its circuit through the wheels and track-rails.

Time and space will not admit of an analysis of the inherent and incidental economy of electric propulsion; but "he who runs may read," whether or no the preference lies with the light, comparatively noiseless, cleanly electro-locomotor, devoid of steam, smoke, cinder, and hot *jets d'eau*, or the ponderous, clamorous, steam-locomotive, wasteful of fuel, destructive of road-bed, and inherently hampered by nuisances from which its electric rival is absolutely free.

X.

THE WORTHINGTON INDEPENDENT CONDENSER.

THAT the practical results attained by condensing-engines should approximate to those that theory indicates, it is important that the condensing-apparatus employed should be the most efficient possible; that it should maintain the highest vacuum, with the least cost of production; that it should be regular and reliable in action, and simple in construction; and that its application to the engine should be unaccompanied by any risk of accident. These exacting requirements, it is claimed, are fully met by the condenser shown in the accompanying illustrations.

Exhaust-steam from an engine enters a vacuum with a velocity of about 1,900 feet per second; and water, under atmospheric pressure, with a velocity of 47 feet a second. Excepting the machine herein described, it may be said that in all forms of jet-condensers operated by air-pumps, the injection-water and the water from the steam fall to the bottom of the condensing-chamber, come to a standstill before entering the pump, and consequently lose the valuable momentum acquired when entering the vacuous space. In this condenser, however, the construction and arrangement are such that the momentum of the steam and water is conserved, and this force is utilized to assist the pump in its work.

By a careful adaptation of the injector principle, it is possible, in an experimental way, to produce a vacuum, of low degree however, without the use of a pump at all, — simply by the momentum given to a flow of water by the impact of the exhaust-steam at the point of condensation. A condenser dependent upon this alone is not practical, because of its small range of action, the inferior vacuum it obtains, and the low temperature of the discharge-water. A change of the amount of steam to be condensed disturbs the theoretical conditions, and renders this kind of apparatus too unreliable in practice. It is plain that the addition of a duplex pump to the discharge of such an ejector condenser perfects and governs its action. As the momentum of the water is not impaired, the highest economy of operation is reached.

In this condenser, the air set free by the condensation of the steam is intermingled with the water. The pump has the same regularity of motion that is characteristic of Worthington pumping machinery; in fact, it acts as a water-pump, although the water is aerated. There is here a great distinction between this condenser pumping aerated water, and an air-pump pumping air and water unmixed. In the latter case, the air-pump has a varying and irregular duty to perform, and the inevitable result is an irregular and slamming movement.

The lower of the accompanying illustrations is a longitudinal section of one side of the condenser-pump, and also a section of the condenser-cone, spray-pipe, exhaust-elbow, and injection-elbow. *A* is the vapor-opening, to which is connected the pipe that conducts to the apparatus the steam or vapor that is to be condensed, and in which a vacuum is to be made and maintained. The injection-water used to produce the condensation of the steam or vapor is conveyed by a proper pipe attached to the injection-opening at *B*. *C* is the spray-pipe, and has at its lower extremity a number of vertical slits, through which the water of injection passes, and becomes spread out into thin sheets. The spray-cone *D*, by means of its serrated surface, breaks the water passing over it into fine spray, and thus insures a rapid and thorough intermixture with the steam. This spray-cone is adjustable by means of the handle *E*. The piston-pump *G* is of the well-known Worthington type; built, however, with especial attention to the requirements of the service which is now being considered. *H H* shows the position of the induction, and *I I* of the eduction valves. *J* is the discharge-opening. At *K* may be seen the steam or engine end of the machine, the standard form used on all Worthington steam-pumps. The steam-valve is an ordinary slide-valve, working upon a flat surface over ports or openings. The motion of this valve is produced by a vibrating arm, *L*, which swings through the whole length of the stroke with long and easy leverage.

This valve motion is a prominent feature of the Worthington independent condenser. To it is due the complete exemption from noise or concussive action. The two pumps are placed side by side, and so combined as to act reciprocally upon the steam-valves of each other. One piston acts to give steam to the other, after which it finishes its own stroke and waits for its valve to be acted upon before it can renew its motion. This pause allows all the water-valves to seat quietly, and removes every thing like harshness of motion.

As one or the other of the steam-valves must always be open, there can be no dead point. The pump is therefore always ready to start when steam is admitted, and is managed by the simple opening and shutting of the throttle-valve.

The operation of the condensing-apparatus is as follows: Steam being admitted to the cylinders *K*, so as to set the pump in motion, a vacuum is formed in the condenser, the engine-cylinder, the connecting exhaust-pipe, and the injection-pipe. This causes the injection-water to enter through the injection-pipe attached at *B*, and spray-pipe *C*, into the condenser-cone *F*. The main engine being then started, the exhaust-steam enters through the exhaust-pipe at *A*, and, coming into contact with the cold water, is rapidly condensed. The velocity of the steam is communicated to the water, and the whole passes through the cone *F* into the pump *G* at a high velocity, carrying with it, in a thoroughly commingled condition, all the air or uncondensable vapor which enters the condenser with the steam. The mingled air and water are discharged by the pump through the valves and pipe at *J*, before sufficient time or space has been allowed for separation to occur.

It will be seen that the zone in which the condensation takes place is small, and the rapid effect is due only to the immense surface exposed by the spraying water. In case the water accumulates in the condenser-cone *F*, either by reason of an increased supply or by a sluggishness or even stoppage of the pump, as soon as the level of the water reaches the spray-pipe and the spray becomes submerged, the vast surface is reduced to a minimum, only a small annular ring being exposed to the steam from the main engine. The vacuum is immediately broken, and the exhaust-steam escapes by blowing through the injection-pipe and through the valves of the pump, and out the discharge-pipe at *J*, forcing the water ahead of it: consequently flooding does not occur.

These condensers have been constructed from those of a very small size up to those of enormous power. Two, which are probably the largest independent condensers in the world, are now applied to an engine of 8,000 horse-power, the injection-water of which amounts to 15,000 gallons a minute, or what is equivalent to about 20,000,000 gallons a day. Many of them are in use in connection with stationary steam-engines, and with marine engines on boats running in fresh water. The Worthington condenser is also used in connection with surface condensers on sea-going steamers, where it has a field of usefulness that is at once apparent to those who will but consider its functions. It performs the duty of two distinct pumps, — the air-pump and the circulating pump. It