LARGE SHIPMENT OF AMERICAN LOCOMOTIVES TO AUSTRALIA.

Sending locomotives to Australia is nothing new in the history of American industrial development. Many have gone there as well as to other British colonies. But strenuous attempts have been made of late to direct this trade to English shops; a plant with English machinery and models has been established on the ground, with the avowed purpose of remodeling the English type of locomotive to suit the conditions of Australian service, and comparative trials have been made between American and English construction. In the face of this, that a large order should be sent hither is an interesting fact. The locomotives shipped by the Baldwin Locomotive Works on the steamer Henley to the government of New South Wales are 27 in number, while the total order received by the Baldwin Works amounts to 47 locomotives in all. Of the first lot, fifteen are light tramway locomotives intended for passenger service on the Sydney tramways. The other twelve are heavy passenger locomotives of what are known as the ten-wheel type, with three pairs of driving wheels and a four-wheeled leading truck. They have separate eight-wheeled tenders. The general dimensions of these locomotives are as follows: Total weight in working order, exclusive of tender, about 125,000 pounds; weight on forward truck, 28,000 pounds; weight on driving wheels, 97,000 pounds; approximate weight of tender with full supply of coal and water, about 80,000 pounds; cylinders, 21 in. diameter by 24 in. stroke; driving wheels, 61 in. diameter; gauge of track, 4 ft. 8½ in.; water capacity of tender, 3,600 gallons. The boilers are of steel, 62 in. diameter, with copper fire-boxes, copper stay-bolts and brass tubes. They are covered with magnesia sectional lagging similar to United States dynamite cruiser Vesuvius and other United States war vessels of recent construction. The driving-wheel centers are of wrought iron forged by a novel process developed at these works. The truck and tender wheels are steel-tired. The engine and tender are fitted with Westinghouse equalized pressure driver brake fixtures, which are actuated by brake equipment supplied by the Westinghouse Air Brake Company, limited, of London. As most of the locomotives on the New South Wales railways are equipped with the English apparatus, it is preferred to that made at Pittsburg. The driver and tender brakes can also be operated by powerful screw apparatus. The reversing gear is operated by a screw, in accordance with the English practice. The locomotives are also equipped with United States metallic packing, Nathan sight-feed lubricators, special lubricators for oiling the driving boxes for high-speed service, and other latest improvements.

The service for which these engines are intended is described by the following extract from a letter from the Secretary for Railways: "The sharpest curve on our road is 528 feet radius (nearly 11 deg). The steepest grade is 176 feet per mile. It is proposed to haul with this engine trains weighing 152 gross tons (340,500 lb.) up long grades of 130 feet per mile. This would be the usual train, and we expect it to be hauled up this grade at about 22 miles per hour. Occasionally the train would have an additional car, making the load without engine and tender 176 tons, or 394,240 lb. These loads include a full complement of passengers, mail and baggage. The cars are all on trucks or bogies.

"The regular load up the 176 feet grades would be 120 gross tons (269,000 lb.) without engine or tender. These grades are free from very sharp curves, and therefore in practice a greater proportionate load can be hauled than on the 130 feet grades. It is therefore expected that occasionally an extra car could be handled, making the total weight of the train 144 gross tons (322,500 lb.) without engine or tender."

An engineer, William Rhodes, of the Baldwin Company will supervise the erection and trials of the locomotives in New South Wales.

John H. Converse, of Burnham, Williams & Co. (Baldwin Locomotive Works) in a recent conversation with a representative of the SCIENTIFIC AMERICAN said:

"There is not anything particularly novel in the dimensions or construction of the locomotives which we are shipping to the government of New South Wales. As far back as 1877 we exported locomotives to Australia. The American type of locomotive is undoubtedly the best type for Australia, and no one knows this better than the Australians.

"This is proved by the fact that usually when they want a locomotive they either order it from American builders, or else have an English-built locomotive modified by American designs. The American locomotive is peculiarly adapted for use in Australia on account of the general topography of the country. The English locomotive has a plentiful lack of flexibility in its make-up. It is a good engine in insular England, but not in continental Australia. The English locomotive is made to run on short, straight, and level roads, and is inferior to the American locomotive wherever the topography of the country requires a twisting and bending of the road, sinuous paths and sharp corners. The Australian likes the superbly balanced American locomotive, the ease with which it accommodates itself to tortuous roadbeds. They like the accessible position of our cylinders, the good 'kite' which the sand boxes afford the driving wheels. And they know that on a good road the American locomotive is the equal of the English locomotive, while on a poor road the English locomotives are like the man who drove the hearse—they are not in it. As to relative cost, from all the data that I can obtain, I am of the opinion that at present an American locomotive can be delivered in Australian ports at about the same cost as an English locomotive."

It may be said, however, that the relative cost of the two types, American and English, is not as important a factor in this discussion as adaptability. A locomotive that will fulfill the conditions of service easily fetches a fair price, while a locomotive which will not do this is costly at any price. It is only fair to add, lest a wrong inference should be given, that the English type of locomotive, though wholly unsuited to long, uneven and tortuous roads, such as obtain in newly settled countries, is yet an admirable design for the short and smooth and highly perfected roads of Britain. It would be manifestly unfair to compare the work of English locomotives on American roads or American locomotives on English roads, but on neutral ground like South America, Japan and Australia, where both are asked to fulfill the same conditions, the same being quite unlike what they have been used to, there is an excellent opportunity to test the relative skill of the two designers. Notwithstanding our tariff restrictions, American locomotives have found a ready market in those regions, while in Canada they long since drove the English type out of the market.

It has been asserted, and without contradiction, that the English locomotive burns less coal than the American. But the American locomotive does more work than the English. It could not reasonably be expected that locomotives pulling heavy loads on uneven roads with high grades should be as saving of fuel as engines pulling less, for their weight, along smooth, short, and perfectly constructed road-beds. The freight locomotive in England works under unusually favorable conditions. Once it starts on its journey it has the right of way, and there is rarely any reason for stopping it. The American type has much more to contend with. It draws a much heavier train, often 50 cars, or 4,500,000 lb. Nor is that even a maximum load. On the Pennsylvania it is sometimes 80 and 85 cars. To start such a train and obtain a headway of 40 miles an hour, it has been computed to require a net pull (friction excluded) of 243,000,000 foot-pounds, a force that would serve to have hauled the train quite three miles on the level. Having frequently to stop, often to move off upon a siding to let passenger trains go by, and running upon roads which, because of their enormous length, it is almost impossible to keep in good repair, American locomotives are called upon to withstand frequent and severe strains. English locomotives, when put to such tests, have failed signally; nor do the English designers, even when forewarned that they must fulfill such conditions, prove equal to the emergency, the trials between American and English freight engines in South America and Australia proving conclusively that those brought up in the American school of designing most fully appreciate the serious nature of the obstacles to be encountered.

A good illustration of the inadequacy of English locomotive designing to fulfill conditions of service on other than English roads was recently had on the Pennsylvania road, where an English locomotive of the compound type, built at large cost especially to compete with American passenger service locomotives, was found unable to draw the regular trains, nor was the boiler capable of evaporating as much water per pound of coal as the American-built engines performing the same work.

In the British colonies, as in America, it has been found advisable, indeed most economical, to run heavy trains, the present tendency being to increase both load and speed. Whether this system is the best it is not the purpose of this article to inquire; it is sufficient to state the fact that that is the character of the service demanded of the American locomotives now being sent to New South Wales, and it is that kind of service that has reduced the average rate of freight service in America to less than half of that of English, French and Italian roads, and about 65 per cent of the rate charged on German roads. In a recent discussion of the relative heating surface of American and English locomotives, per ton of adhesion weight, the heating surface of certain standard engines was given as follows:

Pennsylvania, class A	1,052	sq. ft.
" " A, anthracite	1,205	"
" " P	1,330	"
Chicago, Burlington and Quincy, class H	1,506	"
Michigan Central, 10-wheel express	1,670	"

The mission of these engines is to draw express trains of between 300 and 500 tons weight. With English types the heating surfaces are as follows:

London, Brighton and South Coast	1,500	sq. ft.
Webb Compound	1,457	"
Worsdell	1,139	"

But it must be remembered that English train loads scarcely average 200 tons.

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A New Discovery Wanted.

"It does not appear at all probable that electric lighting, carried out on the present lines on a large scale, will ever be cheaper than gas lighting. Its superiority in so many other respects to gas lighting may ultimately lead to its very general adoption, but it must be obvious to everybody that complete success cannot be hoped for until some entirely new system, by which a greater proportion of the available energy is converted into light, has been discovered. In a gas flame not more than one per cent of the energy consumed appears in the useful form of light; and in the electric arc (our most efficient form of artificial light), the proportion of useful effect is only raised to 2 or 3 per cent. The remaining 98 or 97 per cent being below the limit of the visible spectrum, is wasted in the form of invisible heat. Light waves produced by combustion or incandescence are invariably accompanied by an enormously larger proportion of waves of a lower pitch, which merely produce heat; or as Dr. Lodge puts it, 'it is as though, in order to sound some little shrill octave of pipes in an organ, we were obliged to depress every key and every pedal, and to blow a young hurricane.' The writer just quoted also predicts that a boy turning handle could, with his energy properly directed, produce as much light as is now produced by the consumption in massive mechanism of large quantities of fuel."

Certain recent investigations by Langley and Very with spectroscopic and thermal estimations were made, and the result was to show that the whole of the radiant energy of the firefly lies within the visible spectrum. No radiant heat, below the red end of the spectrum, could be detected by the bolometer, an instrument which has proved sufficiently delicate to measure the thermal radiation from the moon. It was concluded that insect light is associated with about $\frac{1}{400}$ part of the heat which is ordinarily associated with the radiation of flames. "Nature thus produces light at about $\frac{1}{400}$ part of the cost of the energy which is produced in the candle flame, and at but an insignificant fraction of the cost of the electric light."

These investigations of Langley and Very are of the greatest interest as showing that the attainment of an enormously higher efficiency in the production of artificial light is contrary to no law of nature, and may suggest a system of electric lighting destined to supersede the enormously wasteful methods at present in use.—*Electrical Review.*

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Electrical Properties of Semi-permeable Walls.

A semi-permeable material, according to Ostwald, is a material which permits the solvent to pass through it, but not the dissolved salt. The permeability of a given material, however, depends not on the nature of the given salt as a whole, but upon the character of each of its ions. Copper ferrocyanide, for example, is permeable by potassium chloride, because it allows both the potassium and the chlorine ions to pass through it. But it is not permeable by barium chloride because it does not permit the barium to pass, nor by potassium sulphate because it does not allow the passage of the SO_4 ions. If a solution, the ions of which cannot pass through a semi-permeable material, be electrolyzed, the electrodes being separated by a semi-permeable wall, the latter will itself act as a metallic electrode. In the author's experiments, a U-tube filled with a solution of potassium ferrocyanide and having parchment paper tied over its ends was used to connect two glasses containing solution of copper sulphate, so that a layer of copper ferrocyanide formed on the paper. After passing a current through the apparatus for a time, metallic copper was found to be deposited on the paper in the glass containing the positive electrode.

The fact seems to be that the positively charged copper ions, coming in contact with the film of ferrocyanide, through which they cannot pass, give up their charges and are deposited in the metallic state; the negative $FeCy_6$ ions, accumulating on the other side of the film and there giving up an equivalent of negative electricity, are converted into triad ferrocyanide ions. At the other film the potassium ions, permeating the copper ferrocyanide film, pass through it and establish electrical equilibrium by uniting with the SO_4 ions of the copper sulphate. The author thus explains Becquerel's observation that when a tube containing copper nitrate solution is placed in a solution of sodium sulphide, a deposit of copper takes place in the interior of the tube. He also shows that many electrophysiological phenomena may be explained in this way, by the action of semi-permeable materials; such, for example, as the secondary resistance of albumen noticed some years ago by Dubois Reymond.—*Zeitschr. physikal. Chem.*, vi., 71; *J. Chem. Soc.*, lviii., 1354, Dec., 1890.

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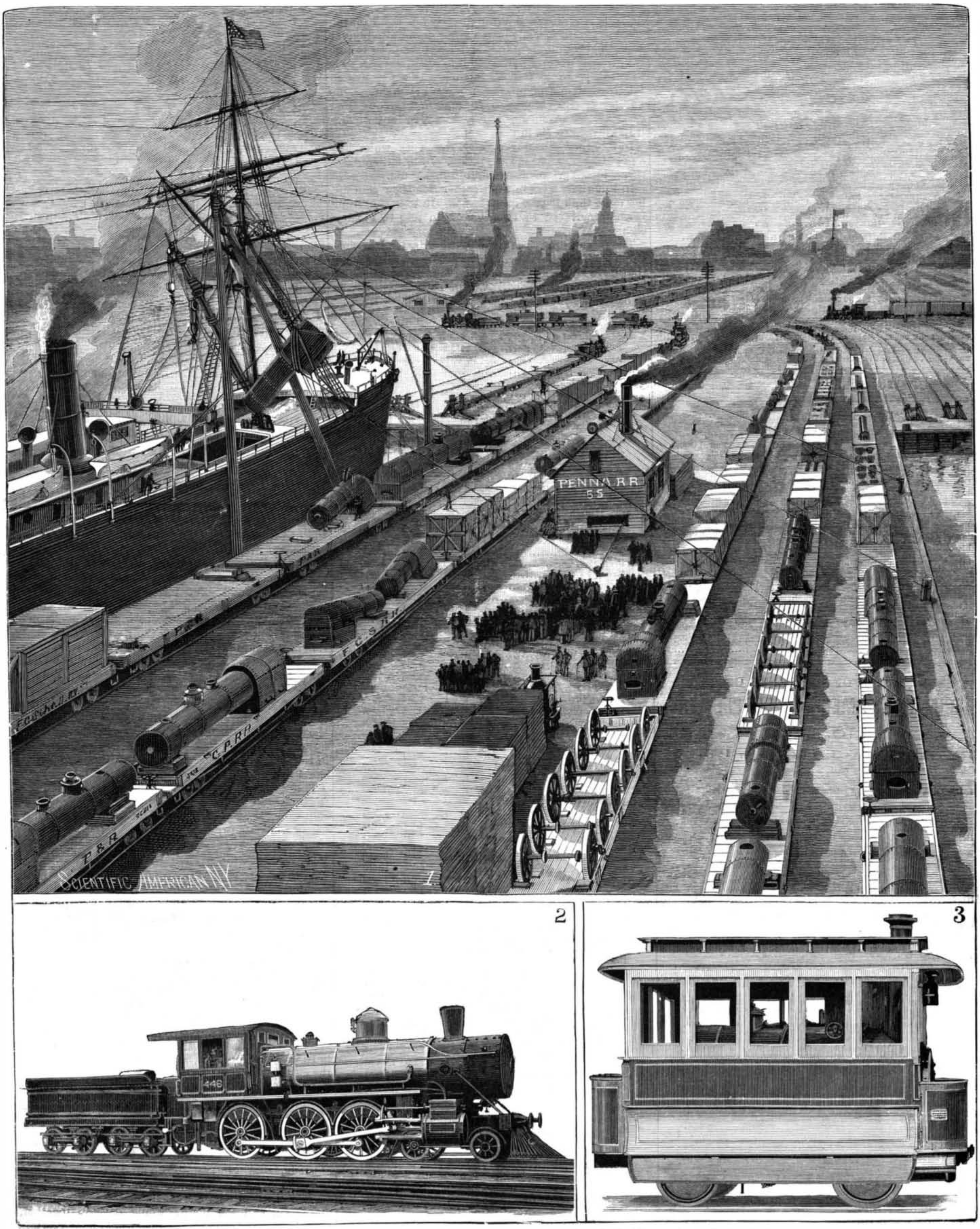

1. Loading the locomotives on the steamer Henley. 2. Type of ten-wheel passenger locomotive. 3. Light tramway locomotive for street service.

SHIPMENT OF AMERICAN LOCOMOTIVES TO AUSTRALIA.—[See page 293.]