

level lines, or where the gradients are easy; Class D, known as the "Mogul," for goods and for heavy gradients; Class E, known as the "Consolidation," for roads having exceptionally heavy gradients, or a very large traffic to be hauled. The passenger engine has a four-wheeled truck, which not only swivels, but can move laterally under the front end of the engine by means of a swinging bolster; it can adapt itself to the shortest curves in use on railways, and to the greatest inequalities in the road. The four driving-wheels are equalized together, as also are the four truck wheels. In the goods engine the same arrangement for swinging trucks is found. The truck is composed of only one pair of wheels. On the Lehigh Valley Road, where there is a heavy coal traffic, gauge 4 ft. 8½ in., Class E works over maximum grades of 126 feet per mile, with a maximum load of 329 gross tons of wagons and loading, and the usual load is 235 gross tons. On a gradient of 76 feet per mile, one of these engines draws a maximum load of 140 empty four-wheeled wagons (476 gross tons) at a speed of eight miles per hour. The usual train is 100 wagons (340 gross tons) on an incline three miles in length, with a gradient of 96 feet per mile, combined with frequent curves of 8 and 10 degrees radius, and with only two tangents, each less than a mile long. Engines of this class (E) take forty loaded four-wheeled wagons, which are hauled at a speed of twelve miles per hour. The wagons weigh each 3 gross tons 8 cwt., and carry each six gross tons of coal; so that these engines haul up the above incline a train weighing from 329 to 376 gross tons. They consume 3¼ tons of coal daily.

On the Denver and Rio Grande Railroad 3-ft. gauge, where the maximum gradients are 4 per cent. or 211 feet per mile, and the sharpest curves 30 degrees or 193 feet radius, and where the rise in 14·7 miles is 2,370 feet, and in 10·8 miles 1,136 feet, this class (E) of engines hauls one luggage-van and seven passenger carriages, containing 160 passengers, weighing 100 tons, stretched over a length of 360 feet.

On another narrow-gauge road where the maximum gradient is 140 feet per mile, 3 miles in length, combined with several curves of 574 and 478 feet radius, one of 338 feet, and several reverse curves of longer radius, the regular load of these engines (Class 10/24 E), at a speed of 12 miles an hour, is fifteen coal wagons, weighing 9,500 lb. each, with passenger carriages weighing 18,000 lb., making total load, exclusive of tender, of 81½ tons. On gradients of 52·8 feet per mile, the usual load is 27½ tons of 2,000 lb. As regards train-mileage, the following comparative statement, showing working results on English, American, and Indian railroads for the year 1876-77, will prove interesting and instructive:—

ENGLISH.		No. of Engines.	Miles operated.	Train-miles per engine.
Great Western	...	1,478	2,274	17,397
Great Eastern	...	505	907	20,600
Midland	...	1,326	1,588	18,219
London and North-Western	...	2,058	2,158	15,800
		5,367	6,927	4)72,016
			Average of all	... 18,004
AMERICAN.		No. of Engines.	Miles operated.	Train-miles per engine.
Pennsylvania	...	515	*1,071	32,627
New York Central	...	602	†1,000	30,870
Michigan Central	...	219	804	30,812
Erie...	...	468	956	26,900
		1,804	3,831	4)121,209
			Average of all	... 30,302
INDIAN.		No. of Engines.	Miles operated.	Train-miles per engine.
East Indian	...	450	1,504	14,737
Great Indian Peninsular	...	331	1,288	17,000
Madras	...	100	858	23,334
Bombay and Baroda	...	64	417	19,149
		945	4,067	4)74,220
			Average of all	... 18,555

The above shows 12,298 more train-miles per engine for American roads than for English, and 11,747 than for Indian roads. The following statement shows the average cost of locomotives on four of the English roads, and the average cost of American engines:—

ENGLISH.		AMERICAN.	
Midland	... £2,648	1st Class Passenger Engine (C)	... £1,720
Great Eastern	... 2,271	1st Class Goods Engine (D)	... 1,800
Great Western	... 1,767	1st Class Goods Engine, extra power (E)	2,300
London and North-Western	... 1,617		
	4)8,303		3)5,820
Per Engine	... £2,076	Per Engine	... £1,940

Mr. Danvers's report does not show the cost of the English engines erected ready for service in

\* On the Pennsylvania Railroad, including the double and third lines, the aggregate number of miles operated by the 515 engines was 2,881.

† On the New York Central the same was 2,433 by 602 engines.