For line A the two type B engines would not work up to their capacity with trains of only 408 gross tons. On this grade of 1 in 37 they could take up trains of a total weight of 504 tons. Therefore the fuel for these engines on line A is reduced in the ratio of 408 to 504.

TABLE III.—COST PER ENGINE MILE IN PENCE.

Railway.	Type.	Tractive Power.	Fuel.	Repairs.	Stores	Wages.	General.	Total Cost per Engine Mile.	—
New Zealand ...	B	15,790	7·30	2·20	0·25	4·18	1 60	19·65	Returns.
Denver and Rio Grande	400	37,000	9·40	8·50	0·40	...	...	...	
Southern Pacific	...	24,900	13·86	3·69	0·14	5·35	1·94	24·98	
New Zealand ...	B	10,000	4·62	1·39	0·16	...			Returns per 10m. adhesion.
Denver and Rio Grande	400	10,000	2·54	2·30	0·11	...			
Southern Pacific	...	10,000	5·57	1·48	0·06	...			
New Zealand ...	B	10,000	4·62	1·39	0·16	...			Ditto, with fuel equated to 13s. per long ton.
Denver and Rio Grande	400	10,000	4·72	2·30	0·11	...			
Southern Pacific	...	10,000	3·76	1·48	0·06	...			
New Zealand Line, A only	B	15,790	6·03	3·60	0·25	4·20	1·60	15·68	Cost for Arthur's Pass lines per engine mile.
New Zealand ...	B	15,790	7·45	3·60	0·25	4·20	1·60	17·10	
	85-ton	22,500	10·61	5·20	0·36	4·20	1·60	21·97	
	90-ton	23,600	11·13	5·45	0·38	4·20	1·60	22·76	

For a check on the fuel-cost of Table III. I have made some calculations based on the indicated horse-power. Not having complete data for New Zealand type B engine, I have used the Denver and Rio Grande, 400 type, the performances of which are shown in Table III.

Data, Denver and Rio Grande 400 type locomotive.

Drivers	51 in. diameter.
Cylinders	22 in. by 28 in.
Working boiler-pressure	180 lb.
Weight on drivers	164,425 lb.
Adhesion, nine-fortieths	37,000 lb.
Average speed in miles per hour uphill on Soldier Summit grades	9½.
Revolutions per minute	62·6.
Piston-speed, feet per minute	290·6.

The mean effective pressure at nine miles and a half per hour, from page 27 of Baldwin's "Pocket-book of Locomotive Data," is 87 per cent. of the boiler-pressure, which gives 156·6 lb. By the formula for horse-power, on page 28 of the same book, there results—

$$\text{I.H.P.} = \frac{156{\cdot}6 \text{ by } 2{\cdot}33 \text{ by } 380 \text{ by } 125{\cdot}2}{33000} = 1041.$$

At nine miles and a half per hour the distance travelled in one minute is 836 ft., which, multiplied by the tractive power of adhesion, 37,000 lb., gives 30,900,000 foot-pounds per minute, equivalent to 937 effective horse-power, which is just 90 per cent. of the indicated horse-power found above, and shows an efficiency of 90 per cent., which is very fair for this type of engine.

With coal at 4½ lb. per horse-power hour (see Wellington), this engine will burn 1,041 by 4½, equals 4,680 lb. per hour, and at nine miles and a half per hour the coal per mile will be 492 lb., equals 0·22 long tons, and the cost of coal per engine mile will be 7s. by 0·22, equals 1s. 6½d.

But, as the coal consumed running downhill with steam shut off is about 10 per cent. of this (see Wellington), or 1·8d. per mile, the average cost of fuel per average engine mile run would be about 10·15d., to which should be added an amount—say, 5 per cent.—for coal used in getting up steam and that left unburned in the fire-box at the end of the run. This gives a total average of 10·65d. per engine mile, while the actual results for all of these engines on the Soldier Summit grades of the Denver and Rio Grande show about 9·40d., and engine No. 401 shows 10·505d.

In the calculations the engines have been assumed to be doing their maximum duty all the time while going uphill, while this condition is not maintained for the entire length of the grades between Thistle Junction and Helper, on the Denver and Rio Grande Railroad. Between Thistle Junction and Tucker the maximum grade is 2 per cent., and between Helper and Kyune it is 2·4 per cent., and these maximum grades determine the weight of the trains behind the tender. When on the maximum grade full power and full coal-consumption are used, but on the stretches of grade less than the maximum less coal is consumed. Therefore the actual coal-consumption for these engines shows a little less, about 10 per cent., than the calculation from full horse-power, as it should. It is probable that engine No. 401, which checks with the calculations to within 1½ per cent., was used as a helper on the 3·8-per-cent. grade between Tucker and Soldier Summit, where the grade is practically uniform and maximum all the way, and most nearly fulfils the conditions assumed for the calculations. This agreement is remarkably close, and proves the accuracy of these calculations.