EXPANSION OF ELECTRIC RAILWAYS IN MASSACHUSETTS.

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Expansion of electric railways as to length of tracks, investment, gross and net earnings during 1901, in this State, was greater than that of any other year. For the twelve months ending September 30, 1901, $14,896,088 were added to street railway investments, and 264 miles of main track were laid within the State. During this same period the gross earnings increased $1,766,700 and the net earnings $361,506 over the corresponding sum for the previous year. These results were reached by additions of 11,254,457 to the number of car miles of operation, and of 38,499,737 to the number of passengers carried during the year of 1900. The general characteristics of street railway development since 1889, when electric traction began to displace horses, have been an increasing yearly addition to investments, equipments, service rendered, and net earnings. These characteristics are all present in the returns of 1901. Another accompaniment of the physical changes in street railways has been the decline in the ratio of operating expenses, and the rise in the ratio of net earnings, to gross income.

During the year under consideration interurban lines were the most marked feature of street railway development, the 264 miles of main track added amounting to 13 per cent of the total length in 1900.

EQUIPMENTS AND OPERATION OF STREET RAILWAYS IN 1900 AND IN 1901.

	Year of 1900.	Year of 1901.	Difference.
Miles main track	1,913	2,177	264
Number of cars	6,531	6,997	466
Number of motors	9,545	11,284	1,639
Investment	$84,715,097	$99,611,185	$14,896,088
Car miles	81,750,768	93,005,225	11,254,457
Employes	12,766	14,749	1,983
Passengers	395,027,198	433,526,935	38,499,737
Gross earnings	$19,999,640	$21,766,340	$1,766,700
Net earnings	6,839,693	7,201,199	361,506
Operating expenses	13,159,947	14,565,141	1,405,194

This increase in length of tracks accounts in large part for the rise of investments by 17 per cent, and also for the fact that operating expenses went up 10 per cent, while gross earnings gained only 8 per cent.

PER CENT OF INCREASE FOR EQUIPMENTS AND OPERATION DURING 1901 OVER 1900.

	Per cent Increase.		Per cent Increase.
Miles main track	13	Employes	15
Number of cars	7	Passengers	9
Number of motors	17	Gross earnings	8
Investment	17	Net earnings	5
Car miles	13	Operating expenses	10

As might be expected, the 9 per cent of increase in the number of passengers was less than the addition of 13 per cent to car miles, or of 15 per cent to employes, occasioned largely by the new lines. The car miles increased at the same rate as the length of main track, showing that the rate of track operation was just maintained. It is interesting to note the continued movement toward double motor equipments, as illustrated by the addition of 17 per cent to the number of motors, and only 7 per cent to the number of cars. The replacement of single by double-motor equipments is made evident by the fact that the increase in the number of motors was 1,639, while the like number for cars was only 466.

In order to bring out the great changes that have taken place in the physical and financial operations of street railways, since the introduction of electric traction on a commercial basis, in 1889, the figures for investments, equipments, and operation, in the years of 1888 and 1901, are here compared. In each case the figures for the fiscal year of 1901 are divided by the like figures for the fiscal year of 1888.

EQUIPMENTS AND OPERATION OF STREET RAILWAYS IN 1888 AND IN 1901.

	Year of 1888	Year of 1901.	Ratio.
Miles main track	533.59	2,176.98	4.07
Number of cars	2,588	6,997	2.70
Investment	$17,237,100	$99,611,185	5.77
Car miles	23,244,767	93,005,225	4.00
Employes	5,531	14,749	2 66
Passengers	134,478,319	433,526,935	3.22
Gross earnings	$6,824,317	$21,766,340	3.18
Net earnings	1,291,520	7,201,199	5 57
Operating expenses	5,532,797	14,565,141	2.63

By these divisions the ratios of the several quantities in the years named are determined. This comparison brings out strongly the main differences between the conditions and results with horse and electric traction, because 1888 was the last year in which horses held the entire field.

The most striking figures indicative of the change from horse to electric traction are those for investments, which were multiplied 5.77 times during the period under consideration. Next to investments in relative increase came the net earnings, which were 5.57 times as great in 1901 as they were in 1888. The miles of main track owned by the street railway companies were 4.07 times as great in the later as in the earlier year, while the car miles of operation were just quadrupled. Passengers show the next greatest relative increase, having been 3.22 times as numerous in the later year. Gross earnings have followed closely the increase of passengers, with a ratio between the sums for the two years of 3.18, showing that the income per passenger has remained nearly constant.

The multiplication of cars, employes, and operating expenses has gone on more slowly than that of the other factors in street railway development. Cars were increased to 2.7, employes to 2.66, and operating expenses to 2.63 times their former figures, in 1901. This brings out the reasons that have made the superior service of electric traction possible without an increase of fares, namely, that while larger investments have become necessary to perform a given amount of transportation work, these investments have brought with them lower operative costs.

Further light is thrown on the changes in connection with street railways since 1888, by comparisons of the relative as well as the absolute items of equipment and operation. Starting with the investment per mile of main track, which stood at $32,304 for the horse lines of 1888, the figure of $45,757 in 1901 shows an increase of 41 per cent with electric traction. The length of yearly travel per car with the increase of cars has just about kept pace with track extensions, as may be seen from the fact that the car miles per track mile in 1901 were 99 per cent of what they were in 1888. Density of traffic has necessarily fallen off with the great extension of interurban lines, and this has brought the number of passengers per mile of main track in 1901 down to 79 per cent of the like number in 1888. In the earlier year, the net earnings per mile of main track were $2,420, but in the later the corresponding amount was $3,308, an increase of 36 per cent.

MILES OF MAIN TRACK, CARS, CAR MILES, AND PASSENGERS IN RELATION TO OPERATION.

	Year of 1888.	Year of 1901.	Ratio.
Investment per mile of main track	$32,304	$45,757	1.41
Car miles per track mile	43,562	42,722	0.99
Passengers per mile main track	252,023	199,141	0.79
Net earnings per mile main track	$2,420	$3,308	1.36
Car miles per car	8,981	13,292	1.48
Net earnings per car	$499.04	$1,029.18	2.06
Passengers per car	51,960	61,958	1.19
Electric motors or horses per car	4.40	1.61	0.36
Net earnings per car mile	$0.0556	$0.0774	1.39
Passengers per car mile	5.7	4.6	0.80
Gross earnings per car mile	$29.36	$23.40	0.79
Expenses per car mile	23.80	15.66	0.65
Gross earnings per passenger	0.0507	0.0502	0.99
Expenses per passenger	0.0411	0.0336	0.81
Net earnings per passenger	0.0096	0.0166	1.72
Investment per passenger	0.12	0.22	1.83
Passengers per employe	24,313	29,393	1.20
Expenses divided by earnings	.8107	.6692	0.82

The average miles of travel for each electric car in 1901 were 48 per cent greater than the travel of each horse car in 1888. Net earnings showed an even greater rise per car, standing for the later at 2.06 times this amount in the earlier year. Passengers per car show only a moderate increase of 19 per cent during the period. Each car required 4.4 horses when they furnished the energy for traction, but the average motors per car in 1901 was 1.61, or 36 per cent of the number of horses per car, previously in use. The results of greater economy in operation are seen in the increase of net earnings per car mile by 39 per cent during the period under consideration, in spite of the fact that the number of passengers declined 20 per cent, and the gross earnings per car mile 21 per cent during the same years. To bring about these results, the reduction of operating expenses per car mile in 1901, to 65 per cent of what they were in 1888, was necessary. Though the average length of travel for each passenger has materially increased, the rate of fare has remained nearly constant, as shown by the fact that gross earnings per passenger ended the period at more than 99 per cent of the figure at the beginning. Operating expenses per passenger show a decline of 19 per cent, and this explains the increase of net earnings from 0.96 to 1.66 cents per passenger, a rise of 72 per cent. In the year 1888 the street car systems had an investment of 12 cents for each passenger carried, but during the year of 1901 the like investment was 22 cents, or 183 per cent of the sum in the earlier year.

The electric system of street car traction has cut down the ratio of employes to passengers, so that instead of one employe to every 24,313 passengers, as in 1888, the number of passengers per employe was 29,393, in 1901. This reduction in the relative number of employes is one of the ways in which the electric system has cut down operating expenses.

In 1888, 81 per cent of the gross earnings were consumed by the operating expenses, but for 1901, with electric traction, the operating expenses fell to 66.9 per cent of the earnings. In other words, the ratio of operating expenses to gross earnings was only 82 per cent as great with electric as with horse traction.

SCIENCE NOTES.

A small specimen of radium was recently put on exhibition at the American Museum of Natural History, and has attracted wide attention. The specimen weighs about two grains, and was shown in the gem room on the fourth floor of the building. The two grains cost about $300.

From investigations carried out by J. Elster and H. Geitel, it would seem that cave and cellar air acts as if it were itself radio-active or had become so. Air aspirated from rock-masses is specially active. Masses of air absorbed under the earth's surface must therefore be exercising an influence upon our atmosphere, ionizing it and the like.

It is gratifying to note that Lieut. Peary has received a leave of absence which will allow him to carry out his cherished hope of another trip in search of the pole. Instead of relying upon sails as the chief part of motive power, the explorer will depend almost entirely upon steam, sails only being used as an auxiliary. Peary's plan is to make his base on Grant Land, and winter at Cape Columbia, or some part further west. Some of the Eskimos will transport his party across the hummocky ice that exists between the 83d and 86th degrees of latitude. The men who are to make the dash for the pole are not to engage in any of this toilsome work, but are to preserve their energies for the last stage, which will be 300 miles long. The expedition will be small. In all probability it will not number more than twenty-five men.

The manatee which has lately been added to the Zoological Society's living collection is an animal of much interest, as it does not belong to the ordinary species of the American coasts, but is a representative of the smaller form (*Manatus inunguis*) which is confined to the fresh waters of the Amazon. Here it was first discovered by the Austrian explorer, Natterer, in the Rio Madeira, in 1830, and designated *inunguis* from the complete absence of nails on the hand, which are always present in *M. americanus*. A single living specimen of the same form was previously received by the Zoological Society in 1896, and its anatomy was described by Mr. Beddard in the Proceedings of the Zoological Society for 1897. The present manatee, which is a young animal about three feet long, has been placed in one of the tanks in the reptile house, and is fed principally upon lettuce. An excellent colored figure of the marine manatee, based upon life-sketches made by the late Joseph Wolf, will be found in the mammal volume of Salvin and Godman's "Biologia Centrali-Americana."—Nature.

Morse and Frazer have conducted experiments on the measurement of high osmotic pressures, the specially constructed porous cells employed being made of fine materials, very uniformly mixed and hard burned, and semi-permeable membranes being produced in them by electrolysis. The electrical resistance of the membranes so obtained varied very considerably, the lowest resistance being about 3,000 ohms and the highest more than 200,000 ohms. The observations made show that high-resistance membranes are requisite for successful osmotic-pressure measurements, but no certain method of obtaining such membranes has been discovered. Experiments were carried out with half-normal and normal cane-sugar solutions. For the former the osmotic pressure was found to be about 13.5 atmospheres, and for the latter a lower limit of 31.4 atmospheres was determined. This osmotic pressure of more than thirty atmospheres was developed within two hours of commencing the experiment, and the membrane within the cell had a resistance of more than 200,000 ohms.—Amer. Chem. Jour.

Messrs. E. Rutherford and A. G. Grier, in a recent paper on the subject of deviable rays of radio-active substances, state that uranium, thorium, and radium emit both deviable and non-deviable rays, the proportion of deviable rays being largest in the case of uranium. Polonium, on the other hand, gives out no deviable rays. The active products separated from uranium and thorium contain all the substance responsible for the deviable rays, while the original radio-active material still retains the power of emitting in the case of uranium a large proportion, and in the case of thorium 30 per cent, of the non-deviable rays. The authors think that most of the deviable rays from uranium and thorium may be given out by a secondary product, derived by disintegration from the uranium or thorium molecule; the difference in properties between these secondary products (uranium X and thorium X) and the original substances renders their separation possible. The non-deviable rays may be due to the other secondary product, or to an inductive action of UrX or ThX on the mass of the radio-active material.