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CHAPTER 5

Utilization of Equipment in Passenger Service

WHAT COMPONENTS CAN BE STUDIED?

In passenger as in freight service, monthly traffic performance per unit of equipment depends partly on the number of traffic units (here passenger-miles) per car- or locomotive-mile, partly on the speed at which vehicles travel, and partly on the number of hours they are in use. Unfortunately, passenger train-hours were *not* reported before January 1935. Without such figures neither the average speed nor the hours in use per vehicle per month (or year) can be computed. We cannot examine cyclical variations in the second and third components separately. But their product is miles traveled per month (or year) per vehicle.[1] This we can calculate. In effect, therefore, we regard the utilization of cars or locomotives as having two components: passenger-miles per vehicle-mile and vehicle-miles per vehicle. We can go a little further, for indirect evidence tells us something about the variations in speed, from which we can draw inferences as to hours in use.[2]

MORE PEOPLE IN A CAR OR TRAIN WHEN AGGREGATE TRAVEL WAS LARGE

Passengers in a car

Anyone riding on a railroad during prosperity is likely to have more companions in his car than he would during a depression. Cars become more crowded during a cyclical growth in total passenger business, and emptier during a cyclical decline. From 1920 through 1938, every expansion in passenger-miles was accompanied by a rise in passenger-miles per car-mile and every

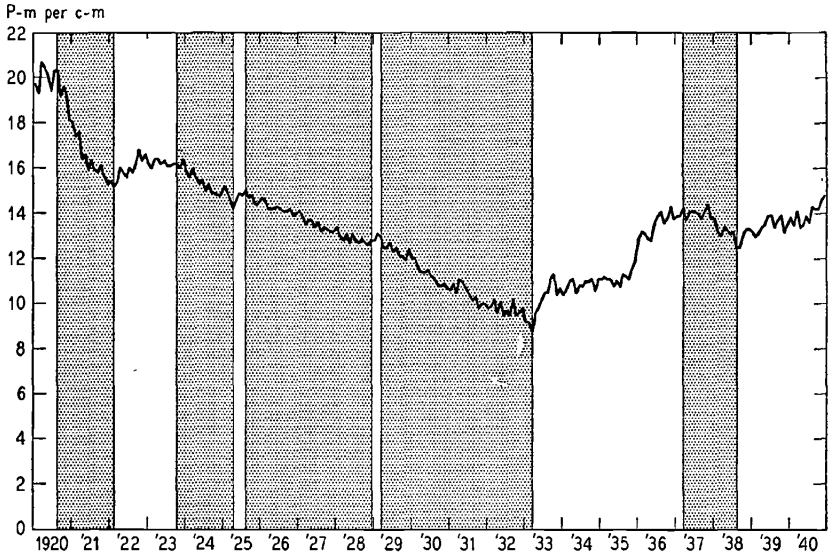
$$\frac{\text{Car-miles}}{\text{Car-hours (in trains)}} \times \frac{\text{Car-hours (in trains)}}{\text{Cars}} = \frac{\text{Car-miles}}{\text{Cars}}$$

[2] In general, passenger service and equipment statistics are less detailed than those for freight, and consequently various features of Chapter 4 can have no analogues in this chapter.

contraction by a fall (Chart 54).[3] Even the very brief and mild expansions of 1925 and 1928–29 were reflected in temporary rises in the average carload.

CHART 54

Passenger-miles per Passenger-carrying Car-mile, January 1920—December 1940



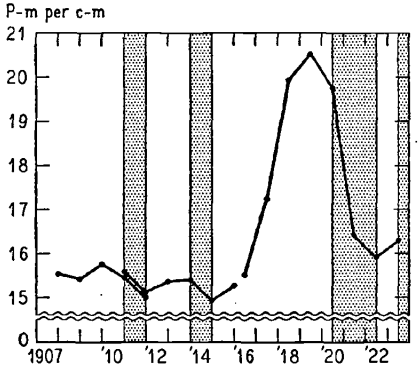
Shaded periods are contractions in passenger-miles.

[3] Transportation of travelers is not the only commercial purpose to which the operation of passenger trains contributes. They carry mail and express, sometimes milk or even freight. Not all the cars in passenger trains are there for the accommodation of travelers. Those the ICC calls 'passenger-carrying cars'—coaches, parlor cars, and sleepers—clearly serve passengers. So do such vehicles as club and observation cars, diners, and baggage cars. On the other hand, mail and express cars or company business cars do not. It would seem appropriate to relate passenger traffic to the movement of equipment used to carry it. Logically, perhaps, we should compare passenger-miles with the mileage of 'passenger-carrying' cars, plus that of the other cars that contribute to the convenience of travelers. Actually totals for all such cars are not readily available. Indeed a complete segregation would be arbitrary; since one car often carries baggage, mail, and express. We therefore confine discussion to the movement of 'passenger-carrying' cars. Prior to 1935 the Commission included therein the mileage of 'observation' cars and of combination passenger cars, i.e., cars containing some space for passengers and some for baggage, mail, express, etc. Since then it has excluded observation car mileage and one-half of the mileage of combination passenger cars. Figures are available on both bases for 1935. In that year, the change made a difference of only 1 or 2 percent. We have used the new basis from January 1935 onward, but have treated it as comparable with the old one.

Annual data pertaining to four specific phases of passenger-miles, beginning with a contraction from 1911 to 1912, indicate that car occupancy varied in much the same way as after 1920 (Chart 55).[4] Passenger-miles per passenger car-mile rose in both expansions, fell in both contractions.

CHART 55

Passenger-miles per Passenger-carrying Car-mile, 1908–1923



Shaded periods are contractions in passenger-miles.

Passenger-carrying cars in a train

Although passenger operating officials do not add or drop cars in proportion to the changes in travel, they do tend to vary the number in a train slightly (Table 32). Passenger-carrying car-miles per train-mile increased in all expansions after 1919, declined in 3 of 5 contractions. In the others, 1923–25 and 1925–28,

[4] Some readers may be surprised that we show no information for still earlier cycles, since we have annual data for passenger-miles much further back. But the latter indicate a continuous expansion from 1897 to 1910 (monthly data would no doubt reveal more phases). The car-mile data begin in 1908. Hence the first complete phase for which we can compute the carload is 1910–11.

The annual figures on passenger-miles rise continuously from 1915 to 1920. Since we have no monthly data for car-miles, we are obliged to treat this period as a single phase of expansion, although there is reason, previously noted, to believe that it includes a contraction from late 1918 to early 1919.

In computing the data for Chart 55 we added 'passenger' and 'sleeping, parlor and observation' car-miles as reported in *Statistics of Railways* to obtain passenger-carrying car-miles.

The 1908–12 segment in the chart refers to all line-haul roads, while the 1911–23 segments relate to Class I line-haul roads alone.

Table 32

Passenger-miles per Passenger-carrying Car-mile, and Passenger-carrying Car-miles per Train-mile
Change between Peaks and Troughs in Passenger-miles, 1920–38, 1911–20

Turn in passenger-miles		Months or years from prec. date	Passenger-miles per car-mile[a]	Car-miles per train-mile[a]	Change from preceding date				
					Absolute, car-miles per train-mile			Percentage	
						Per month or year			
Date	Level				Total	To peak from trough	To trough from peak	Passenger-miles per car-mile	Car-miles per train-mile
		Months					Per month		
Aug. 1920	Peak	...	19.9	4.30	...	...	...	...	...
Feb. 1922	Trough	18	15.3	4.14	−.16	...	−.0089	−23.2	−3.7
Oct. 1923	Peak	20	16.1	4.25	.11	.0055	...	5.2	2.7
April 1925	Trough	18	14.5	4.36	.11	...	.0061	−9.9	2.6
Aug. 1925	Peak	4	14.8	4.44	.08	.0200	...	2.1	1.8
Dec. 1928	Trough	40	12.7	4.71	.27	...	.0068	−14.2	6.1
Mar. 1929	Peak	3	12.9	4.82[b]	.11	.0367	...	1.6	2.3
Mar. 1929	Peak	...	12.9	4.39[b]	...	...	...	...	...
Mar. 1933	Trough	48	9.2	4.00	−.39	...	−.0081	−28.7	−8.9
Mar. 1937	Peak	48	13.9	4.21	.21	.0044	...	51.1	5.2
Aug. 1938	Trough	17	12.7	4.14	−.07	...	−.0041	−8.6	−1.7
		Years					Per year		
1911	Peak	...	15.6	3.78	...	...	...	...	...
1912	Trough	1	15.1	3.81	.03	...	.0300	−3.2	0.8
1914	Peak	2	15.4	3.86	.05	.0250	...	2.0	1.3
1915	Trough	1	15.3	3.73	−.13	...	−.1300	−0.6	−3.4
1920	Peak	5.5	20.1	4.14	.41	.0745	...	31.4	11.0

Class I line-haul railways.

[a] Three-month average, 1920–38; date of turn is middle month. Annual data, 1911–20. For kinds of car-miles included in computation, see text, note 3.

[b] Train-miles without locomotives excluded from divisor, 1911–20, 1920–29, included, 1929–38.

the ratio did not rise as fast as in the adjoining expansions, except that in 1923–25 the increase was somewhat more rapid than in 1922–23.

During the four pre-1920 phases, passenger-carrying car-miles per train-mile rose in both expansions, fell in one contraction. In the other (1911–12), it must be admitted, the ('passenger-carrying') length of trains not only increased but did so a trifle more rapidly than in 1912–14. The contraction, however, was very mild, almost negligible; aggregate passenger-miles fell only 0.21 percent.

Passengers in a train

Since both the number of passengers in a car and the number of cars in a train tend to rise and fall with traffic, it must be expected that the number of passengers in a train will do likewise. And in fact passenger-miles per train-mile—equivalent to the product of passenger-miles per car-mile and car-miles per train-mile—increased in every expansion after 1919–20, even the two very short and mild ones, and diminished in every contraction (Chart 56). Annual figures show that the same thing was true in earlier times. Beginning with the 1894–95 contraction in travel, passenger-miles per train-mile conformed to cycles in passenger-miles without exception (Chart 57). There was an actual net rise in every expansion, and an actual net fall in every contraction.[5]

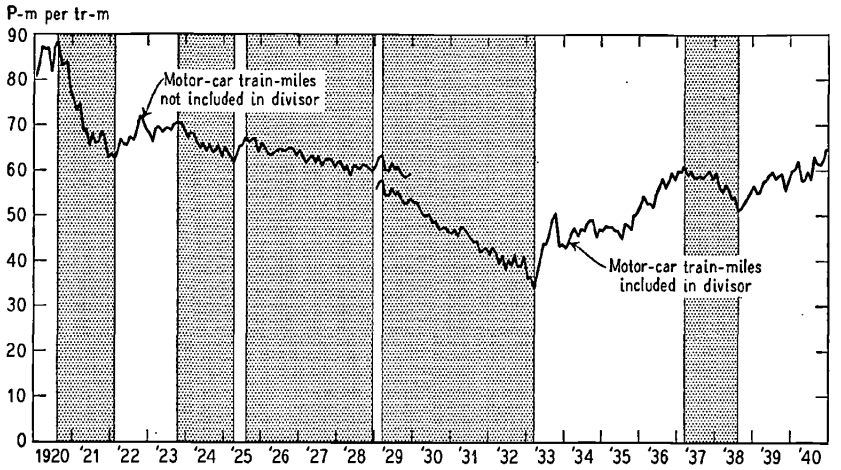
Of the two components, the carload is more important than the number of cars as a factor in cyclical variations in the train-load. In each of the four expansions since 1920, passenger-miles per car-mile increased by a greater percentage than car-miles per train-mile. In three of the five contractions, the carload declined by a larger percentage than the number of cars, while in the other two, cars per train actually rose although the number of

[5] Although the average train load can be computed back to 1882, with the help of Poor's figures, it would serve no purpose to present the results here, for the data indicate a continuous rise in aggregate passenger-miles from 1882 to 1894, and we do not know how much earlier it began; consequently we cannot mark off a specific cycle in which to study the train load.

In both the annual and the monthly figures, passenger train-miles include the movement of some trains that carried only mail, express, empty cars, etc.—no passengers. Nothing can be done to remove this train-mileage from the computations, but we believe it to be negligible.

CHART 56

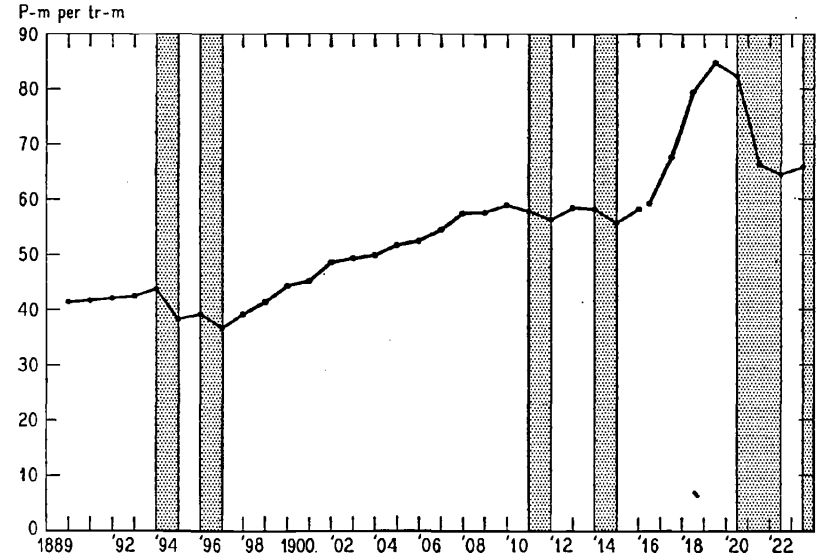
Passenger-miles per Train-mile, January 1920—December 1940



Shaded periods are contractions in passenger-miles.

CHART 57

Passenger-miles per Train-mile, 1890–1923



Shaded periods are contractions in passenger-miles.

passengers per car declined (Table 32). In the earlier phases (for which we have only annual data) the carload increased more than the number of cars in both expansions, and a fall in the carload, 1911–12, was accompanied by a rise in the length of trains. The 1914–15 contraction was exceptional: trains were shortened more than passengers per car declined.

Obstacles to readjustment of service

A railroad company cannot reduce the number of train-miles very much without inconvenience to travelers, even when traffic is declining. The number of trains, and hence train-miles, between any two points can be cut in only two ways: by eliminating extra sections of scheduled trains or by reducing the number of trains scheduled.

Very few trains run in extra sections even at the peak of prosperity; consequently not much reduction can be accomplished in this manner. Moreover, the number of patrons for any one train probably usually declines gradually, but the elimination of a section is a radical change: if the schedule has been running in two sections the number of trains on that schedule must be reduced by one-half; even if it has been running in three the minimum reduction possible is one-third. In the latter case, if the cut is made when travel has fallen 10 percent, the number of passengers per section would become 35 percent larger than it was before the decline began. The remaining sections might be rather crowded.

To reduce the number of schedules (i.e., to delete one departure or more and the corresponding arrival or arrivals from the timetable) would be even more disturbing. Where there are numerous schedules, each is usually especially adapted to the needs of some travelers, who would suffer from its removal. A train leaving after business hours will enable some travelers to arrive at their destination just before business hours the next day. On the other hand, travelers to a more remote point on the same route who face a journey of 18 hours or so in any case and who likewise wish to arrive before business hours need an earlier departure. One train will give travelers who want to make a connection the shortest wait between trains; for other connections some other schedule

will give the minimum delay. An early evening departure will get some customers home early; a later schedule will give others time to transact late business or spend an evening in recreation before leaving. If separate trains are run for local and through traffic, passengers for the larger towns will not be delayed while others get off at way stations.

Such are the difficulties where schedules are plentiful; even more serious ones are encountered where they are infrequent. On some lines, even in prosperity, there is but one train a day; here the only alternatives are to make no change at all or to eliminate service altogether on one or more days of the week; in the latter case many travelers, in former times, would have been obliged to leave a day sooner or wait a day longer than they wished; nowadays, they would often turn to some competing means of transport. If a railroad eliminates a schedule it may lose patrons to a competitor, discourage them from traveling at all, or find itself involved in a complaint before a public service commission. Even if all schedules between any two places were equally convenient to travelers, the number of scheduled trains, like that of sections, often cannot be reduced in small doses. Dividing the train-miles in 1937, for example, by the miles of road on which passenger service was provided yields a quotient of only 6.5. This figure means that on a line of somewhat less than average frequency of service, with the number of trains going one way the same as the number returning, there were only 3 per day in each direction. If only 3 trains are operated, the minimum curtailment is $33\frac{1}{3}$ percent; if this is attempted when travel has fallen only 15 percent the remaining trains may become appreciably more crowded. Probably the prospect of inconvenience to the public and of resulting lost patronage and impaired public relations is the principal circumstance that keeps train-miles from falling in proportion to traffic. On the other hand, when a cyclical rise of traffic begins, the railroads are already providing a fairly diversified service, carried over in large part from a previous era of prosperity, and there are few occasions to add more trains.

The number of cars in a train, like the number of trains between any two places, cannot be changed in small increments. An average train contains about four passenger-carrying cars. On branch lines many carry only one or two, perhaps only a combination

car in which part of the space is reserved for mail, express, and baggage. Trains of more than average length often carry different classes of equipment. If a train has eight passenger-carrying cars, half may be coaches, half Pullmans. The least possible cut in either class of service is then one-fourth, the next smallest one-half of the original number. Some of the vehicles, moreover, are through cars, one of which may be scheduled for transfer to one connecting train, a second to another. If the company discontinues such a car, it may force people to dress in the dead of night and cross a cold station platform. As with the number of trains, so with the number of cars: reduction is likely to inconvenience travelers. Railroad managements are apparently reluctant to subject the public to such trouble even when declining traffic makes a reduction in costs especially urgent. Conversely, when traffic revives, facilities are already fairly adequate and additional traffic does not bring occasion for a proportionate increase in car service.

Performance per motive-power mile

Cyclical variations in the average amount of travel to which the operation of a locomotive for one mile contributes must be similar to those in passenger-miles per train-mile. Formation of a judgment on this point is complicated by the fact that not all trains are pulled by engines; some are propelled by motors installed in the cars. Travel in the two kinds has never been reported separately for each, and we cannot directly compute either passenger-miles per locomotive-mile in one kind of service or passenger-miles per motor-car-mile in the other. A very high percentage of all travel, however, must have depended on engines. Train-miles without locomotives (i.e., motor-propelled) never in any year exceeded 15.00 percent of all train-miles. That peak, in 1933, was the climax of a gradual increase from 3.16 percent in 1923, the first year in which the two kinds of train-miles are segregated in the statistics. Later the percentage declined somewhat. The ratio of passenger-miles in trains with locomotives to miles run by such trains must have fluctuated with the corresponding ratio for all passenger-miles in all trains. And locomotive-miles (including helper mileage) were closely proportional to train-miles with locomotives. Between 1923 and 1940 the annual excess of the

former over the latter ranged from a minimum of 1.2 percent in 1932 to a maximum of 3.7 percent in 1936. Passenger-miles (in trains propelled by locomotives) per locomotive-mile undoubtedly rose and fell in much the same way as passenger-miles per train-mile in all trains. The ratio of motor-car miles to motor-propelled train-miles was apparently more flexible than that of locomotive-miles to train-miles with locomotives; it fell from 3.34 to 2.65, or about 21 percent, from 1923 to 1932. Such flexibility might counteract any fluctuations in motor-propelled train-loads. But operations of this kind, as noted, were not very important.

MILES PER CAR OR ENGINE INCREASED IN EXPANSION

Cars

During the course of a year a passenger car makes a number of trips. The length of each depends on the distance between the beginning and ending points of the run. The sum of the distances on all trips is the total mileage the car travels during the period. From 1910 to 1938 the average mileage per car for all 'passenger-carrying' cars was almost always higher at a peak of passenger traffic than at a trough (Chart 58).[6] Indeed the only exception came in the expansion of 1912–14, when there was a slight net decrease. Even in that instance, the fall in mileage per vehicle was apparently less rapid than in the preceding and much less rapid than in the following contraction.

Changes in the average length of individual runs probably do not account for the cyclical variation in movement per car. The

[6] Car-miles reported under the following headings are included in the numerator: 1910–35, 'Passenger', 'Sleeping, parlor and observation'. 1936–39, 'Passenger coaches', 'Sleeping and parlor', 'Combination passenger'. Movement in mixed trains is included, and also that in special trains except 1936–39.

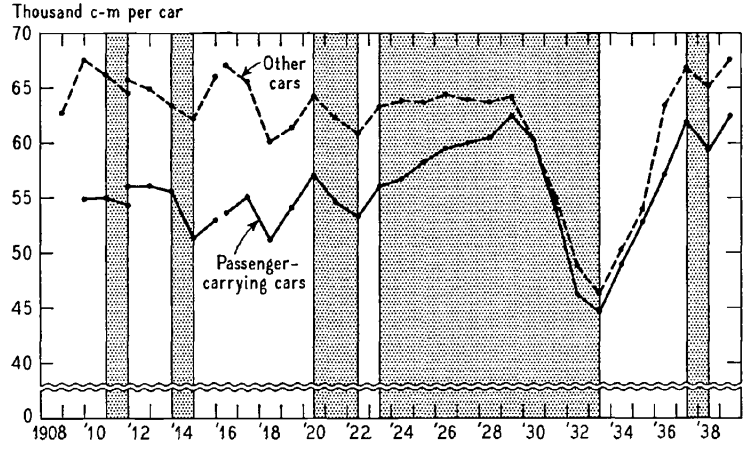
Cars owned by railways and reported under the following headings are included in the denominator: 1910–14, 'First class', 'Second class', 'Combination', 'Parlor', 'Sleeping'. 1915–36, 'Coaches', 'Combination passenger', 'Parlor' and 'Sleeping'. 1937–39, the same, as subdivisions under 'Standard passenger train cars', 'Passenger rail motor cars', 'Multiple-unit train cars'. Pullman cars reported as 'Standard sleeping', 'Tourist sleeping', 'Parlor' and 'Composite' are included in all years. Pullman estimated for June 30, 1909 and 1910. Ratio of Pullman Company cars of these four types on June 30, 1911, as reported by the ICC, to all cars July 31, 1911, as reported in Pullman's Palace Car Co. *Annual Statement*, is 0.985. This ratio was applied to *Statement* figures for July 31, 1909 and 1910.

Roads included: all line-haul, 1910–12; Class I line-haul, 1912–39.

pairs of terminal points between which they are made cannot change in such a way as to affect the average length very much during a single phase. It does not seem likely, either, that the distribution of trips among runs of different lengths can alter very much. The principal factor, in the larger fluctuations at least, must be the average number of trips a car is called on to make. When traffic grows, more vehicles are pressed into service; aggregate mileage divided by the total number, active and idle, increases. When traffic diminishes, fewer cars are run; mileage per car for all vehicles, including those operated infrequently or not at all, decreases.

CHART 58

Car-miles per Car per Year, Passenger Train Service, 1909–1939



Shaded periods are contractions in passenger-miles.

In two phases the change was highly irregular. After rising from 1915 to 1917, mileage per car fell abruptly to a point somewhat below the original level, then rose again, finishing at a new high in 1920. The efforts of the Railroad Administration to reduce congestion by curtailing service below the ordinary standard probably explain the interruption (see Ch. 2). In the long 1923–33 contraction, movement per car increased through 1929, then decreased to a figure much below the initial one. The shrinkage of traffic during the first period was much less severe than during the second. From 1923 to 1929 the annual average loss was 1,147 million passenger-miles, from 1929 to 1933 it was 3,683 million.

In addition to the mileage of cars classified as 'passenger-carrying' there is a substantial movement of other passenger-train cars. Because we have no physical measures of the service performed in this equipment—meals served, ton-miles of baggage, mail, express, etc.—we did not attempt to compute performance per car-mile and are unable to calculate performance per car. But we can compute the average movement of these vehicles, and it may be worth noting that it conforms to cycles in travel in somewhat the same way as the movement of 'passenger-carrying' cars (Chart 58).[7] The difference between 1912–14 and its neighboring phases, to be sure, is not as evident from the chart; computation nevertheless indicates that movement per car diminished only 1,150 miles per year in 1912–14; in 1911–12 the loss was 1,700 and in 1914–15 it was 1,200. After the curtailment in 1918 average mileage rose to a level, in 1920, somewhat higher than at the beginning of the phase but below the 1916 peak. The contrast between the two portions of 1923–33 is not as sharp; instead of rising noticeably to 1929, the curve remains flat. Despite these differences, however, movement per vehicle conformed positively without exception.

The movement of diners and baggage cars is influenced by the amount of travel, but that of other non-passenger-carrying cars is influenced by the volume of mail and express traffic. The conformity to passenger-miles, therefore, may result in large part from conformity both of travel and of mail and express to business conditions.

[7] Car-miles are those reported under the following headings: 1908–14, 'Other passenger'. 1915–35, 'Dining', 'Other passenger'. 1936–42, 'Club, lounge, dining, and observation', 'Business cars', 'Mail, express, and baggage, and combination other than passenger'.

Railroad-owned cars are those reported as: 1908–14, 'Emigrant', 'Dining', 'Baggage, express and postal', 'Other'. 1915–36, 'Other combination', 'Emigrant', 'Dining', 'Baggage and express', 'Postal', 'Other'. 1937–42, 'Dining', 'Club, lounge and observation', 'Postal', 'Baggage, express, and other nonpassenger', 'Other passenger', all under 'Standard passenger-train'; also 'Other passenger-train' under 'Rail motorcars (nonarticulated)' and under 'Articulated passenger-train'. Cars of Pullman Company described as 'Dining', 'Private' and 'Miscellaneous' included in all years. For June 30, 1909 and 1910 these are assumed to equal the residual 1.5 percent left by the operation described in the preceding note.

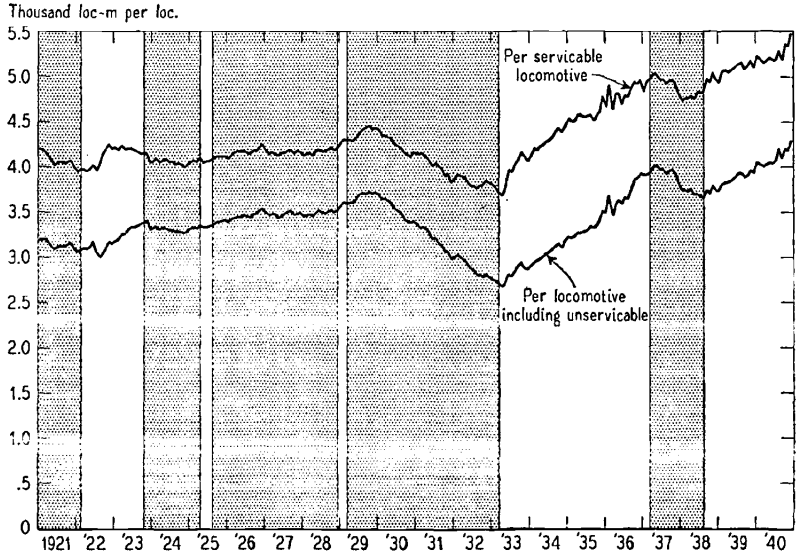
For the railroads included, see that note.

Locomotives

The average distance an engine traveled during a month lengthened in every expansion from 1922 onward, became shorter in every contraction except 1925–28 (Chart 59). In that phase it increased at a slightly lower rate (computed between end-averages in the usual manner) than in the preceding and a perceptibly lower rate than in the following expansion. There are no data on locomotive-miles in early times, but rail motor cars cannot have been important, and we should obtain a fair approximation to the average movement if we divide train-miles by the number of locomotives. This we can do from 1894 to 1914 (Chart 60). The resulting ratio increased in the three expansions, although the change in 1912–14 was minute. It fell in the 1894–95 contraction, rose in 1896–97 but less rapidly than in the bordering phases, did not change in 1911–12. It therefore conformed positively to traffic both after the period of missing information, 1914–22, and before, although the difference between 1911–12 and 1912–14 was negligible.

CHART 59

Locomotive-miles per Passenger Locomotive per Month, January 1921—December 1940



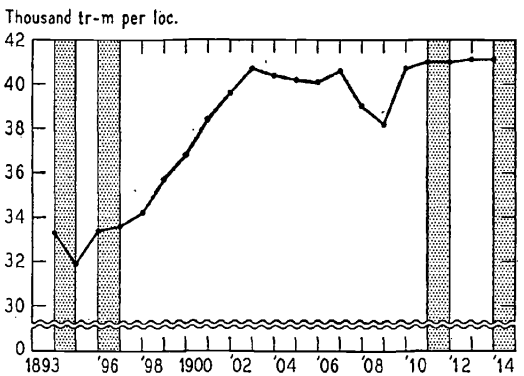
Shaded periods are contractions in passenger-miles.

Speed vs. hours in trains

During a cycle speeds in passenger service probably vary less than do those in the handling of freight. Lengthening schedules would evoke protests from the traveling public. In Chapter 7 we shall present data on overtime and man-hours paid for but not used which suggest that from the middle of 1921–23 onward there were no appreciable wave-like variations in miles per hour. It seems unlikely that alterations of speed can account for the cyclical variations in miles per vehicle, at least during cycles in which the latter were pronounced. The average number of hours in use per car or locomotive, therefore, must have conformed positively to traffic. Certainly this was true in 1937–38, for in that contraction we have data and know that average speed increased slightly; yet miles per vehicle were reduced.

CHART 60

Train-miles per Passenger Locomotive per Year, 1894–1914



Shaded periods are contractions in passenger-miles.

INTENSITY OF USE VARIED WITH TRAVEL

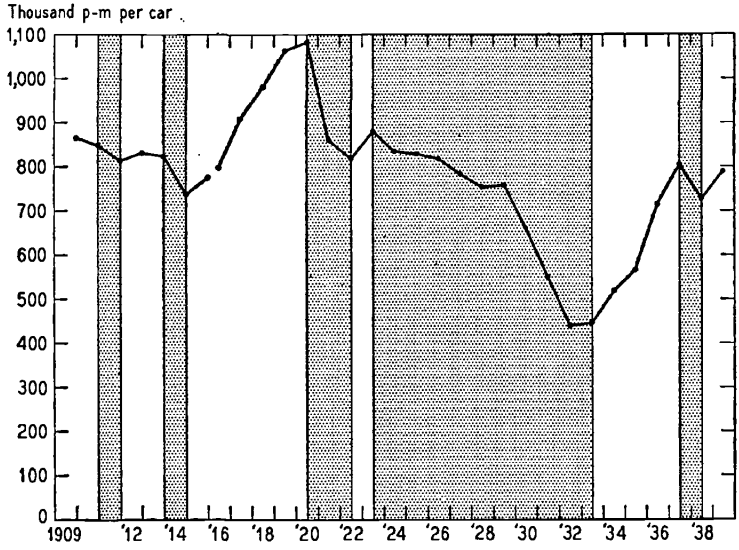
The average amount of passenger service to which the operation of a car contributes is the product of average load and average mileage. Somewhat more precisely:

$$\frac{\text{Passenger-miles}}{\text{Car-miles}} \times \frac{\text{Car-miles}}{\text{Cars}} = \frac{\text{Passenger-miles}}{\text{Cars}}$$

The preceding discussion has shown that both component ratios rose in expansion, fell in contraction. Their product must vary

CHART 61

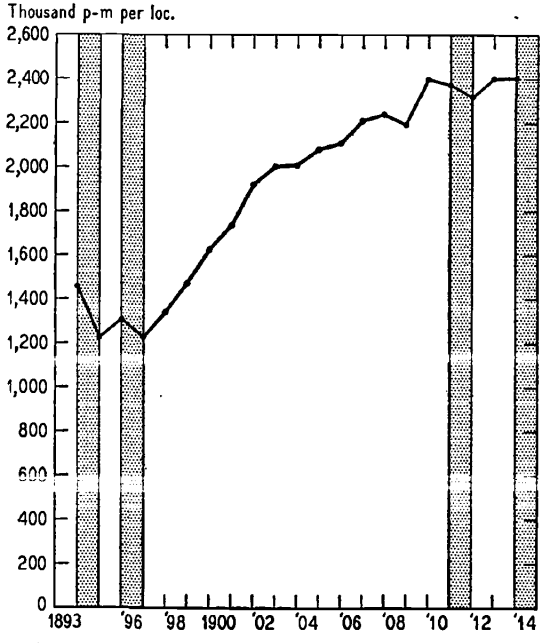
Passenger-miles per Passenger-carrying Car per Year, 1910–1939



Shaded periods are contractions in passenger-miles.

CHART 62

Passenger-miles per Passenger Locomotive per Year, 1894–1914



Shaded periods are contractions in passenger-miles.

similarly. Indeed if both increase, it must rise, and if both diminish, it must fall, by a greater percentage than either. More and more travel occurred in the average car in every expansion of passenger-miles, less and less in every contraction (Chart 61).

Likewise the average amount of travel to which a locomotive contributes is the product of passenger-miles per locomotive-mile and locomotive-miles per locomotive. We have reasoned from fairly direct evidence that the first ratio must have risen in expansion, fallen in contraction. And we have shown that the second tended to do so, although it increased slightly in two contractions and was constant in a third. We cannot compute the product ratio directly for recent times, because we cannot segregate the appropriate traffic; but it seems fairly certain that the average locomotive 'produced' a growing number of passenger-miles in expansions, and a diminishing number in contractions, of aggregate travel. In the cycles from 1894 to 1914, when motor-car trains were unimportant, we may venture a direct comparison of passenger-miles with locomotives (Chart 62). In every phase, performance per vehicle rose and fell with traffic.