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3. Use and Stocks of Equipment

More intensive use in prosperity

It has often been supposed that when the quantity of goods or services sold by a business enterprise increases, the managers of the enterprise ordinarily must increase their stock of equipment to cope with the growth of sales. In the railway industry, it might be supposed, an expansion of ton-miles requires an increase in the aggregate capacity of goods wagons (railway freight cars), an expansion of travel requires an increase in the capacity of carriages (railway passenger cars), and an expansion of total traffic cannot be handled without an increase in motive power. The supply of rolling stock, it is implied, will be adjusted to the level of traffic.

There are, of course, grounds for questioning whether these consequences must always or even usually occur. The supply of equipment at the beginning of a traffic expansion might be large enough to take care of the growth of traffic. It might be possible to use the initial equipment more efficiently. Even if railway managers feel that additional rolling stock is needed they may not be able to get it, for it takes time to build cars and locomotives, and they may not arrive from the construction shops until the boom is over. On the downswing, railway managers will certainly not reduce the stock of equipment in proportion to the fall in traffic. Perhaps they will junk some archaic or badly worn vehicles, but they will keep the rest, anticipating a return of prosperity, unless they think the decline in traffic is quasi-permanent and not merely cyclical.

In fact the changes in the supply of rolling stock have usually been much smaller than those in traffic, and have often been in the opposite direction. The size of the freight car stock ("wagon park") shows little positive relation to cycles in ton-miles. We have continuous figures on railroad-owned wagons only, although privately-owned rail wagons (mostly for coal) played an important part in freight movement; they were almost as numerous as those belonging to the railroads (Table 18).

TABLE 18

Privately-Owned and Railway-Owned Goods Wagons (Freight Cars)

PRIVATE[a]		RAILWAY[b]	
Aug. 1, 1918	628,344	Dec. 31, 1919	730,416
Aug. 1, 1928	638,215	Dec. 31, 1928	706,081
July 28, 1937	637,670	Dec. 31, 1937	656,834

[a] Dates are those of special censuses.

[b] Dates are most nearly comparable ones available. Figures include brake vans.

It does not seem likely, however, that the percentage changes in either stock during any phase of traffic was much greater than that in the other. At any rate, the railroad stock, although it grew in each expansion before World War I, never increased by as large a percentage as traffic; after the war it actually shrank (Table 19). Ton-miles per wagon in stock must have increased in every expansion. The number of wagons diminished in only two contractions, and then by a lesser percentage than traffic. The amount of traffic handled in a typical wagon during the course of a month must have diminished in every contraction.

TABLE 19

Freight Traffic and Number of Railway-Owned Wagons
Per Cent Change between Peak and Trough Years in Freight Traffic
1873-1908, 1921-1938

EXPANSIONS			CONTRACTIONS		
	Per cent change			*Per cent change*	
Dates	*Traffic*[a]	*Wagons*[b]	*Dates*	*Traffic*[a]	*Wagons*[b]
			1873-74	−1.3	6.1
1874-77	12.5	8.6	1877-78	−2.5	1.6
1878-83	28.9	15.0	1883-86	−4.4	10.9
1886-91	21.9	15.7	1891-93	−5.5	7.5
1893-1900	44.9	18.3	1900-01	−2.1	1.9
1901-07	24.0	5.5	1907-08	−4.7	1.0
1921-24	43.4	−5.1	1924-26	−26.3	0.6
1926-27	34.2	−0.2	1927-28	−5.9	−1.0
1928-29	6.3	−1.2	1929-32	−20.8	−4.0
1932-37	23.1	−2.6	1937-38	−9.3	2.1

[a] Tons conveyed, 1873-1908: net ton-miles 1921-38.

[b] Number of wagons for each year was computed by averaging numbers at beginning and end of that year. Percentage change was computed from these averages.

Railway coaches were more intensively used in years of large than in years of small travel. During expansions in travel for which we have data, the number of cars and their seating capacity either diminished, or increased by a smaller percentage than the number of passengers; in contractions, the fall in the number of travelers was always greater than the decline, if any, in the number of cars and seats; indeed the railroads actually increased the seating capacity a little in three such phases (Table 20).

TABLE 20

Passenger Journeys, Number of Passenger Vehicles, and Number of Seats[a] Per Cent Change between Peak and Trough Years in Journeys, 1920-1938

EXPANSIONS				CONTRACTIONS			
	Per cent change				*Per cent change*		
Dates	*Journeys*[b]	*Vehicles*[c]	*Seats*[c]	*Dates*	*Journeys*[b]	*Vehicles*[c]	*Seats*[c]
				1920-22	−20.0	−1.0	1.3
1922-23	1.3	−1.2	−0.1	1923-26	−13.0	−0.5	3.7
1926-29[d]	10.6	1.1	2.5	1929-32	−8.7	−4.2	−1.4
				1929-32	−10.0	−5.0	−1.9
1932-37	13.5	−6.4	−3.7	1937-40	−25.3	−1.2	0.3

[a] Includes London underground railways, 1920-32; excludes them, 1929-38.

[b] Includes journeys of season ticket holders.

[c] Number for each year computed by averaging number at beginning and end of that year. Percentage change computed from these averages.

[d] Journeys, including London underground, did not contract in 1927-28.

We can't make direct comparisons between traffic and the number of locomotives; on the one hand, lacking data on passenger miles, we can't set up a composite measure of freight and passenger movement, and on the other, statistics on the stock of engines are not subdivided in accordance with the service to which engines were assigned. But the total number of steam locomotives declined almost continuously from 1920 to 1938 (Chart 18). Performance per locomotive must have increased when aggregate traffic was growing. The fall, if any, in the stock of engines during a contraction of travel or of ton-miles was always gradual. Between November 1929, a peak, and the second quarter of 1933, a trough in ton-miles, the number in stock declined from 23,497 (average for October, November, and December) to 21,454 (average for the quarter), a fall of 9 per cent. A similar computation for the somewhat different dates of the passenger contraction likewise yields a fall of 9 per cent. In all other contractions of freight or passenger traffic the number of locomotives declined 1 per cent or less.

Whenever traffic expanded, then, the railroads were able to handle more and more of it per car or locomotive on hand. Whenever it contracted, they got less and less remunerative work out of a typical unit of equipment. Rising traffic was accompanied by more intensive, and falling traffic by less intensive use. This can happen in either, or both, of two ways. The amount of work performed by an average car or locomotive during each hour of use may be higher in prosperity, because of heavier loading or faster movement; or vehicles may be kept in use during a greater percentage of the time, and spend fewer hours standing idle.

Heavier carloads and trainloads; but slower movement in freight service

In the movement of goods, the average weight loaded into a car increased and diminished with aggregate ton-miles (Chart 12).[1] These variations may reflect changes in the average weights to which the various kinds of traffic are loaded, or changes in the relative importance of heavily and lightly loaded species, or both. Data on loads are available for the three major subdivisions of ton-miles. They suggest that, in at least two instances, changes in composition must account for the fluctuation in the overall figure. In 1923-26, except at the very end, the average load of each component rose (general merchandise not conspicuously, but it did not decline either), yet the all-commodity average fell. In 1927-28, one component fell, then rose, one increased throughout, the third was steady, yet the average for all three declined continuously. In all other phases, however, changes in at least one of the components contributed to the characteristic change in the overall figure. Except at the coal strike troughs, the amplitude of the changes was rather small.[2]

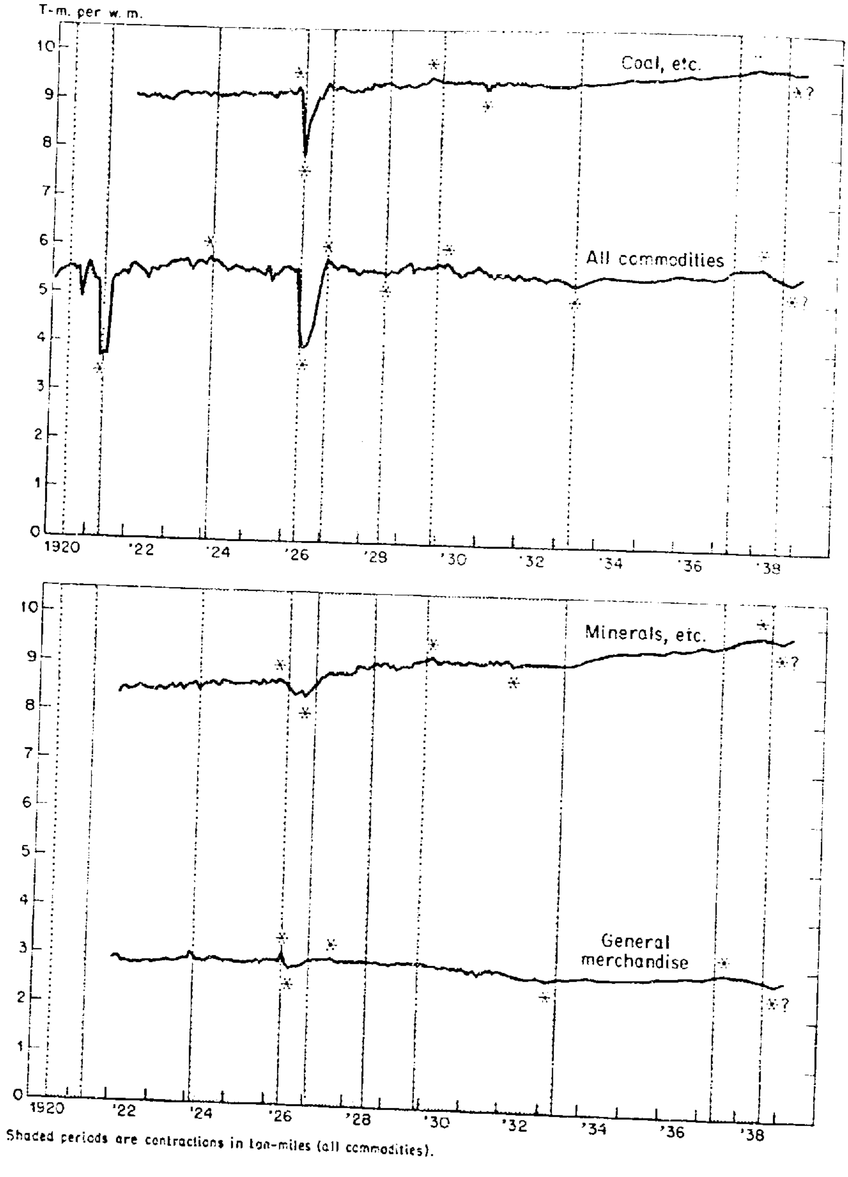
From 1927 onward, marshalling yard staffs and others responsible for the make-up of trains were able to switch more and more loaded

[1] In discussing average loads and other operating statistics we rely on quarterly rather than monthly data after 1931, for reasons explained in the note on sources at the end of this paper.

[2] The sharp exceptional declines in the all-commodity averages resulted primarily from the virtual disappearance of the heavily-loaded coal traffic.

CHART 12

Average Wagon Load (Net Ton-miles per Loaded Wagon Mile)
January 1920-First Quarter 1939



Shaded periods are contractions in ton-miles (all commodities).

cars into an average train as aggregate traffic swelled; when the latter diminished the average loaded length became shorter (Chart 13). In earlier phases the sequence of change was less regular. At the coal strike troughs, trains were lengthened enormously. Perhaps railway managers, confronted with a shortage of locomotive fuel, made unusual efforts, by lengthening trains, to get a maximum of work out of each engine.[3] Except near the trough, the change in 1920-21 and 1921-24 was normal by the standard of later cycles. The mild rise in the last half of 1921-24 did not persist; during most of the 1924-26 contraction the curve is flat, although it does not fall. The 1926-27 period violated the rule throughout; but coal production did not recover its normal level until near the end of this brief expansion (Chart 2).

Partly because of the changes in the average wagon-load and partly because of those in wagons per train, the average trainload became heavier in expansions and lighter in contractions of traffic (Chart 14). We can pair a cycle in ton-miles per train mile with each cycle in aggregate ton-miles. (At the 1921 and 1926 troughs the change in loaded length tended to counteract the effect on the average trainload of the change in tons per car, but the latter was more powerful.)

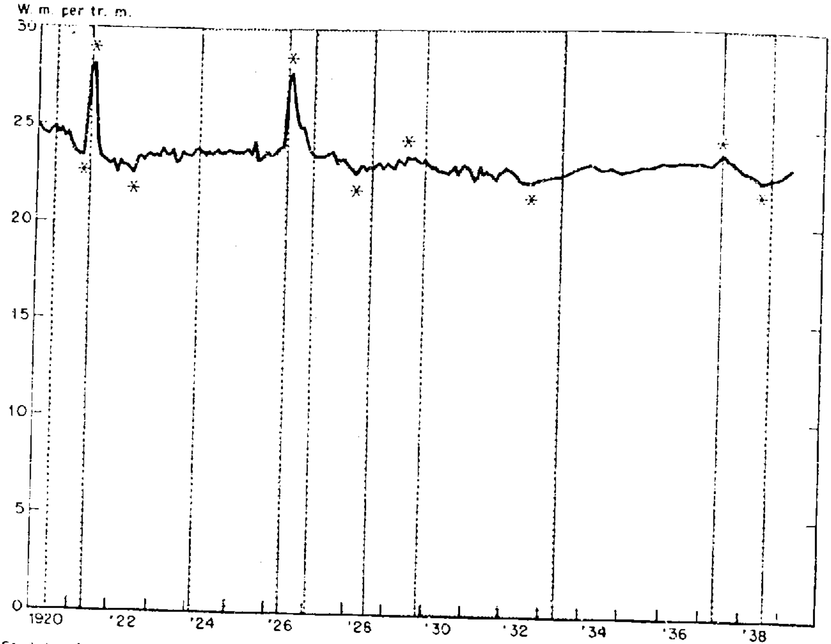
If the average speed of trains were constant, the cyclical variation in the trainload would mean that ton-miles per hour of train movement would increase in expansion and decrease in contraction. The labor of train crews would become more productive in the former and less productive in the latter. But in fact the movement of trains was, on the whole, accelerated in contraction and retarded in expansion, although the change was very irregular in 1924-26 and 1928-29 (Chart 15). Apparently greater density of traffic resulted in increased congestion and delay, and shrinkage of traffic permitted more freedom of movement. The changes in speed tended to counteract the effect of the changes in trainload on the work that could be accomplished in an hour. Indeed, there was no consistent relation between ton-miles per train-hour and aggregate volume (Chart 16).

Since there are no data on passenger-miles or passenger car-miles, we cannot compute passenger-miles per car-mile, car-miles per train-mile, or passenger-miles per train-mile. We can infer a good deal, however, about what happened to the last-mentioned ratio. Its numerator,

[3] Another possible surmise is that trains composed primarily of coal traffic are normally shorter than other trains and that the especially sharp cessation of this traffic therefore increased the average length.

CHART 13

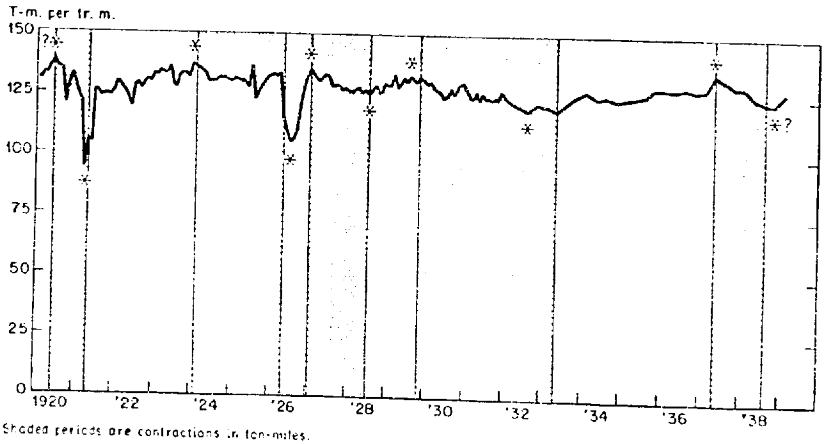
Loaded Wagon Miles per Freight Train Mile, January 1920-First Quarter 1939



Shaded periods are contractions in ton-miles.

CHART 14

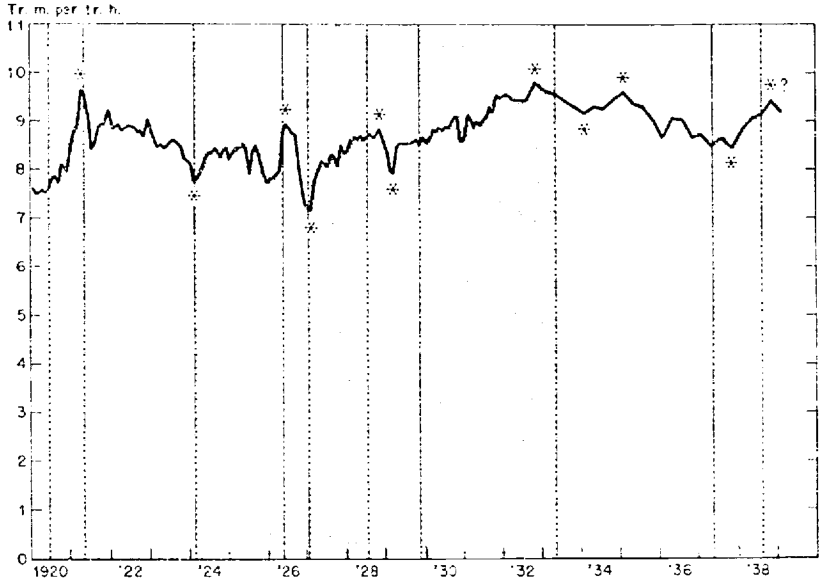
Average Train Load (Net Ton-miles per Freight Train Mile) January 1920-First Quarter 1939



Shaded periods are contractions in ton-miles.

CHART 15

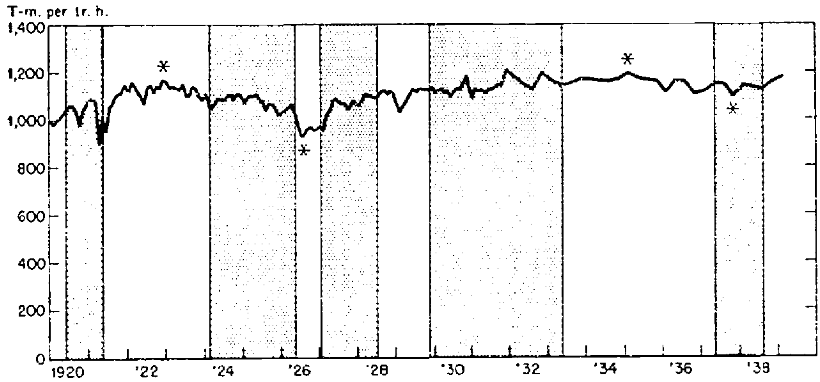
Freight Train Miles per Freight Train Hour
January 1920-First Quarter 1939



Shaded periods are contractions in ton-miles.

CHART 16

Net Ton-miles per Freight Train Hour
January 1920-First Quarter 1939



Shaded periods are contractions in ton-miles.

aggregate passenger-miles, is the arithmetical product of the average miles per journey and the number of journeys. It is not likely that the average length of journey increased in contractions of travel, which roughly coincided with contractions in business. On the contrary, as prosperity waned it is likely that people economized and took shorter journeys. Passenger-miles probably diminished by a greater percentage than the number of trips. Train-miles, on the other hand, diminished very little or actually increased (Chart 17). With passenger-miles falling and train-miles virtually constant or rising, passenger-miles per train-mile must have decreased — in other words, the average train-load fell.

In the first two expansions we must distinguish between the brief initial period of recovery from the strikes and the rest of the expansion. If we take the first three months after the strike effects had apparently subsided as a quasi-trough, we find, in 1921-24, that train-miles increased by a *greater* percentage than the number of passengers (Table 21, line 10). But this was not much of an expansion. Underground rides contracted during most of the time that rail journeys were expanding (Chart 9). In the combined totals that we are here obliged to examine (since train-miles cannot be segregated) there was no rise from one group of months to the next, except at the very end (Table 21, lines 6 to 10). From the 1927 quasi-trough to the 1930 peak, and likewise from 1933 to 1937, the number of journeys rose by a greater percentage than train-miles (lines 16 and 18). Since the average length of journey probably increased with prosperity, passenger-miles probably increased more than the number of trips and hence more than train-miles. We conclude that passenger train loads normally increase in expansions and decrease in contractions of travel. Patrons of the railroads would indeed be considerably inconvenienced if train service in contractions was reduced in proportion to traffic.

Matters went otherwise at the time of the strikes. In 1921, shortages of locomotive fuel eventually forced the railroads to curtail train service out of proportion to travel (lines 1 to 5). In 1926, when railroad workers participated in the earlier stages of the general strike, train service immediately fell off by a greater percentage than travel (lines 11 to 14).

The speed of passenger trains was not affected very much by cycles in travel (Chart 17). Again conditions were abnormal at the strike troughs. Probably, in an effort to serve both local and through traffic with a limited number of trains, the railroads greatly curtailed non-stop express service. Whatever the reasons, trains were slower than usual, and the miles-per-hour ratio shows a net rise in the expansions, a net fall in the contractions. But the change occurred principally in the immediate vicinity of the strikes, and the ratio would hardly have fluctuated in this way had there been no shortage of fuel for engines.

Passenger-miles per train-hour, a measure of the revenue-producing work performed by a train and its crew during a unit of time, is the arithmetical product of passenger-miles per train-mile and train-miles per train-hour — of the load and the speed. Since the load diminished in contractions, and the speed rose but little, we must conclude that passenger-miles per train-hour fell. Since the load increased and the speed also increased a little in expansions, hourly train performance increased. The productivity of passenger train crews, unlike that of freight train crews, goes up in expansions and down in contractions of traffic.[4]

Equipment used more of the time

Except at the coal strikes, the average load of freight cars did not change very much. The speed at which the cars travelled diminished in expansion and increased in contraction. Average hourly traffic performance, the product of the load and the speed, must have fallen in expansions and risen in contractions. The increase in performance per car in stock during expansions (Table 19) must have been achieved entirely by keeping cars loaded and in trains a greater percentage of the time. Likewise the fall in traffic performance per car in stock during contractions must be attributed entirely to a decline in the ratio of useful to total time.

The average number of passengers in a car no doubt increased and diminished with aggregate travel, and since there was little change in speed the average number of passenger-miles per hour of car movement must have increased and diminished similarly. But the larger number of train-miles at the peaks of travel suggests that a rise in the

[4] The equipment of British railways includes horses, road wagons, and motor trucks used in carting certain kinds of freight from consignors' business premises to railway stations and from stations to consignees' premises. Data on the average load per road wagon, the average load per truck, and the tonnage handled per working horse or truck per day, have been published, for two months of each year, usually February and September, 1922 to 1931, for one four-week period in 1932, and for another in 1933. They do not show any appreciable cyclical change.

TABLE 21

Rail Journeys and Coaching (i.e. Passenger) Train-Miles
Selected Periods, 1921-1937

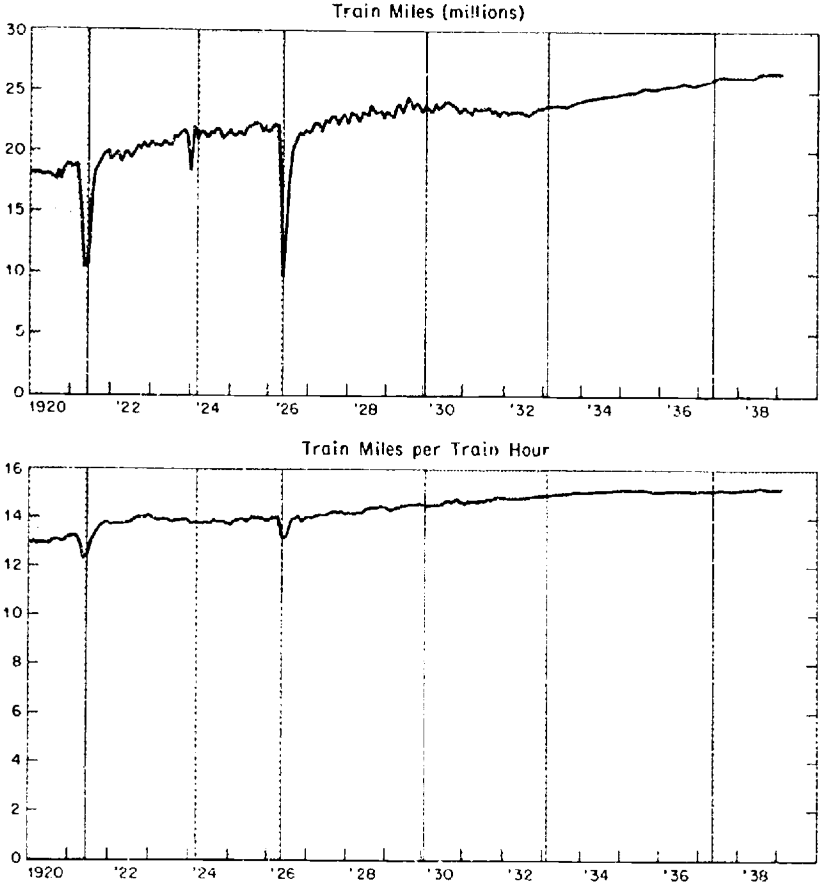
LINE	FIRST MONTH	LAST MONTH	NO. OF MONTHS	LEVEL OF NO. OF RAIL JOURNEYS	MONTHLY AVERAGE (millions): No. of rail journeys[a]	MONTHLY AVERAGE (millions): Train-miles[a]	% CHANGE FROM PRECEDING QUASI-TROUGH: No. of rail journeys	% CHANGE FROM PRECEDING QUASI-TROUGH: Train-miles
1	Jan. 1921	Mar. 1921	3	Quasi-trough	118.3	18.77		
2	April 1921		1	Strike-depressed	94.2	15.48	......	......
3	May 1921		1	Strike-depressed	81.9	10.40	−20	−18
4	June 1921		1	Trough	77.7	10.54	−31	−45
5	July 1921		1	Strike-depressed	92.2	15.96	−34	−44
							−22	−15
6	Aug. 1921	Oct. 1921	3	Quasi-trough	101.1	18.81		
7	Nov. 1921	July 1922	9	Expansion	100.2	19.61	......	......
8	Aug. 1922	Apr. 1923	9	Expansion	100.2	20.42	......	......
9	May 1923	Jan. 1924	9	Expansion	100.4	20.76	......	......
10	Feb. 1924	Apr. 1924	3	Peak	105.0	21.55	......	......
							4	15
11	Feb. 1926	Apr. 1926	3	Quasi-trough	103.4	22.03		
12	May 1926		1	Trough	52.3	9.84	......	......
13	June 1926		1	Strike-depressed	71.3	13.56	−49	−55
14	July 1926		1	Strike-depressed	84.0	17.41	−31	−38
							−19	−21
15	Jan. 1927	Mar. 1927	3	Quasi-trough	96.0	21.86		
16	Dec. 1929	Feb. 1930	3	Peak	104.3	23.49	......	......
17	First quarter 1933		3	Trough	91.7	23.85	9	7
18	Second quarter 1937		3	Peak	122.5	25.99	......	......
							34[b]	9[b]

[a] Rides on and train-miles of London underground railways are included.

[b] Per cent change from preceding actual trough.

CHART 17

Passenger Train Miles and Train Speed
January 1920-First Quarter 1939



Shaded periods are contractions in number of rail journeys.
London underground railways included in all data.

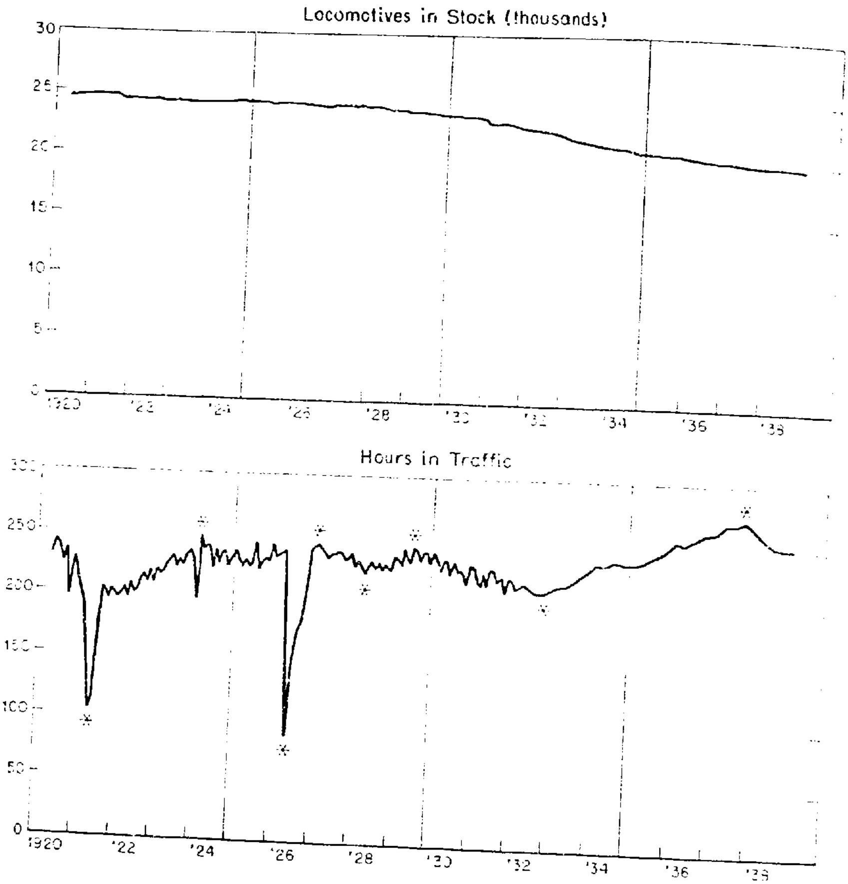
percentage of time that cars were in operation contributed to the higher level of travel per car in stock.

As to motive power, we have direct figures on the average number of hours a locomotive spent in traffic per month (Chart 18). Although we cannot date the cycles in composite traffic exactly, the number of hours per month clearly rose in expansions and fell in contractions.

For the major kinds of equipment, then, the problem posed by expanding traffic was met in large part by running an existing stock of

CHART 18

Steam Locomotives in Stock and
Hours in Traffic per Steam Locomotive per Month
May 1920-First Quarter 1939



equipment for longer hours. At least this was the case in 1920-38, when a wave of traffic seldom overtopped its predecessor.