SCIENTIFIC AMERICAN

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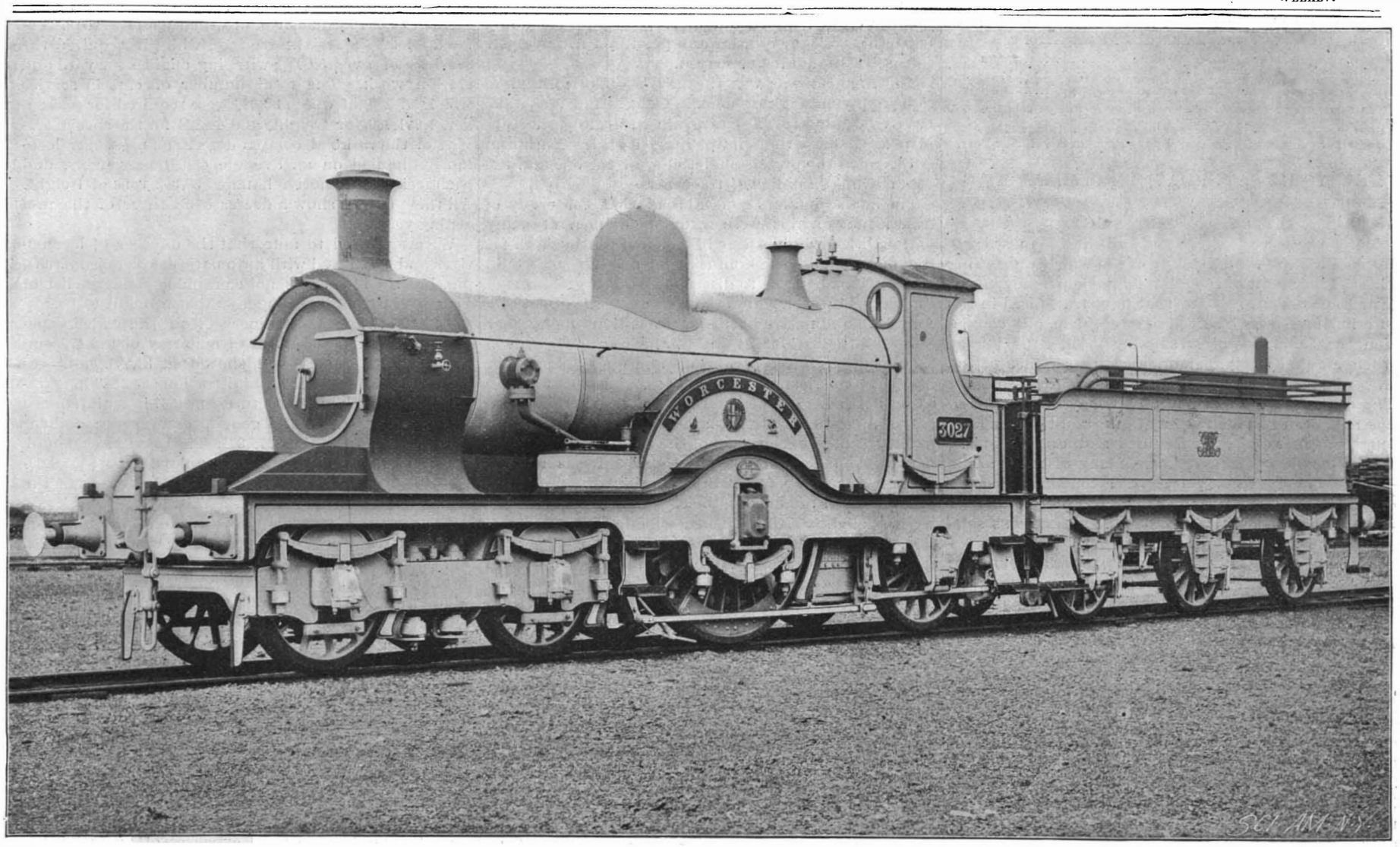
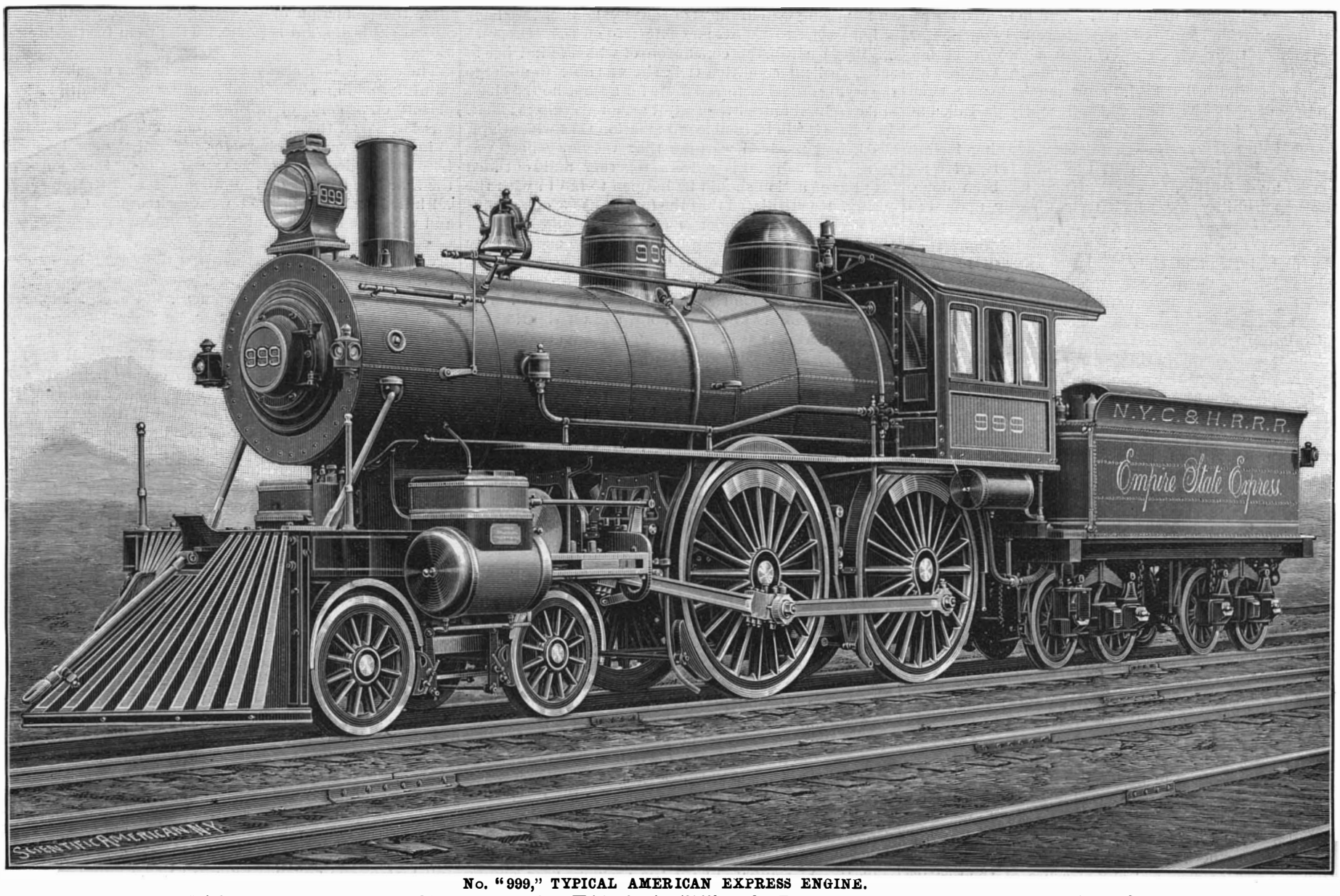


THE "WORCESTER," TYPICAL ENGLISH EXPRESS ENGINE.

Cylinders, 19 × 24 inches. Diameter of drivers, 7 feet 8 inches. Weight of engine, 107,520 pounds. Heating surface, 1,467 square feet. Boiler pressure, 160 pounds.



No. "999," TYPICAL AMERICAN EXPRESS ENGINE.

Cylinders, 19 × 24 inches. Diameter of drivers, 7 feet 2⅛ inches. Weight of engine, 124,000 pounds. Heating surface, 1,930 square feet. Boiler pressure, 190 pounds.

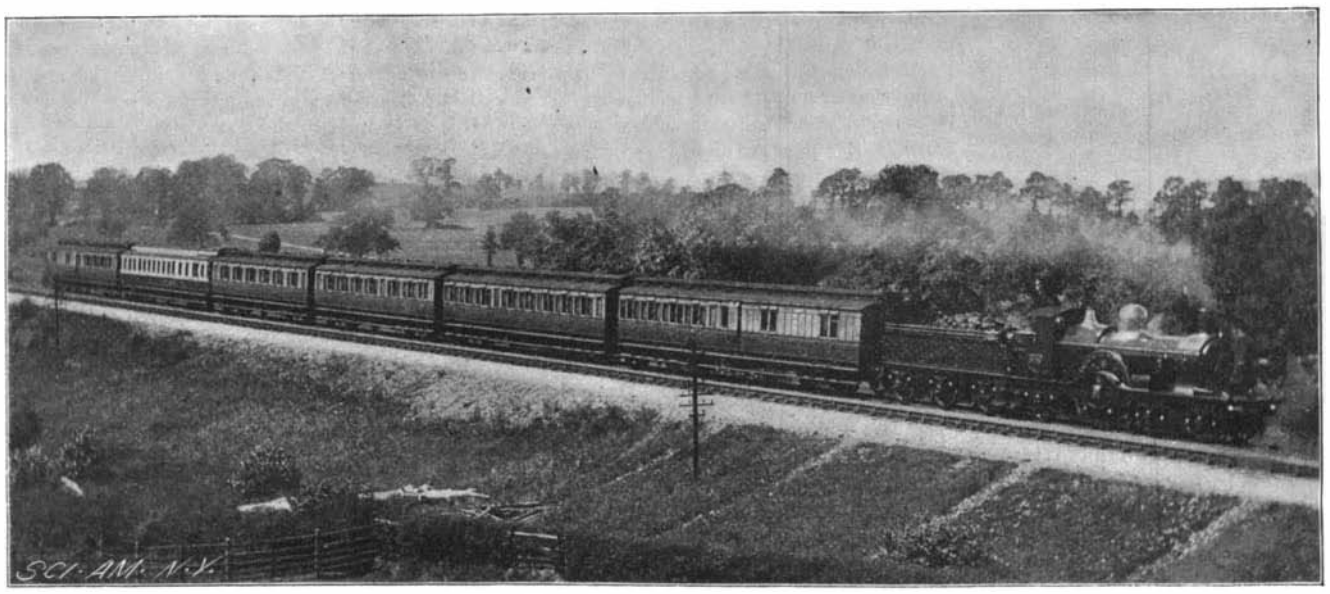
THE TWO FASTEST LONG DISTANCE RUNS WITHOUT STOP.—[See page 152.]

THE TWO FASTEST LONG DISTANCE RUNS WITHOUT STOP.

It was during the ever memorable year of the Chicago Exhibition that the New York Central and Hudson River Railroad opened the present remarkable era of fast, long distance express trains. Locomotive No. 999 and the Empire State Express are an old story by this time, and its remarkable punctuality day in, day out, is accepted as a matter of course by the public; but the famous train, whatever higher speeds the future may have in store, will always figure conspicuously in the annals of the world's railroads as being the first to maintain a regular schedule speed of over 52 miles an hour for an unprecedented distance and for runs of unprecedented length between stops.

We say this with all due deference to the splendid work which had been done for several decades on the crack English roads, where regular express trains, with a booked speed of about 50 miles an hour, had been running with great regularity; and where, during the annually recurring summer competition, some scheduled speeds of about 60 miles an hour had been maintained for trips of over 400 miles. The regular trains, previous to the year of which we speak, however, rarely ran further than about 70 miles between stops, and the trains that were scheduled for 60 miles an hour were literally "racing outfits," run for a few weeks in the summer season, in the endeavor to secure or hold the much coveted record from London to Aberdeen.

What gave the Empire State Express its world-wide celebrity was its high average speed, the great distances (nearly 1,000 miles) over which this speed was maintained, and the great distances covered by the train between stops—the first stage of the journey, New York to Albany, 142·88 miles, at the rate of 53·58 miles per hour, being by far the longest scheduled run without stop ever attempted. It was natural that the remarkable work done by the New York Central should stimulate engineers in the home of the "fast express," and of late years there has been a gradual raising of the speed of a few crack trains on leading English roads. The fastest long distance run without a stop in Great Britain is now made on the Great Western Railway, the first section of the Cornish Express covering the distance from London to Exeter, 193·92 miles, at the rate of 53·36 miles per hour.



CORNISH EXPRESS AT FULL SPEED.

Speed, 53·36 miles an hour; distance run without stop, 193·9 miles; greatest weight of train, 200 tons.

There is a popular impression that these crack expresses are extremely light trains, hauled by powerful locomotives, and that their running cannot therefore be taken as representative performances. With a view to enabling the public to judge for itself, we have gathered together in a more complete way than has ever been attempted the engineering data of the two most famous long distance runs without stop in the world.

THE EMPIRE STATE EXPRESS.—In estimating the merit of a locomotive performance there are numerous conditions which must be known before we can determine its value. The mere statement that a train ran at such a speed for such a distance is of little value until the weight of the train, nature of the road, and other qualifying conditions are known.

The weight and power of the locomotive also are considerations that greatly modify the merit of a fast run, and there are minor considerations, such as the quality of the coal and, in a lesser degree, of the water, that may have a telling effect one way or the other upon the value of these phenomenal long distance speeds. For the data regarding the Empire State Express we are indebted to Col. Katte, chief engineer, and William Buchanan, the master mechanic, of the New York Central Railroad, and the facts regarding the English train have been communicated by J. C. Inglis, chief engineer, and William Dean, locomotive superintendent, of the Great Western Railway.

The Track.—The New York Central road, from New York to Albany, is a tide-level line, running along the banks of the Hudson River at an average elevation of 5 feet above mean high water. Immediately after leaving the New York terminus, the road climbs a slight summit of 53·7 feet; but at about 5 miles from the starting point it reaches tide water and continues to run at a practically dead level to Albany. The slight elevations just before reaching Peekskill and at Poughkeepsie, where the road is carried over elevations of about 35 and 30 feet, are the only exceptions, the slight intermediate changes of grade being due to bridges or a raising of the grade at the time the road was built, to reduce the amount of excavation in rock cuttings. Although the road is an easy one in respect of grades, it is full of curvature, some of the curves being decidedly heavy for a fast express service. The following table gives the degree and approximate length of the curves from Spuyten Duyvil (where the road first strikes the Hudson River and is well clear of New York city) to Albany. The curvature in the city limits is even heavier than that given in the table.

There is a total of 29 miles of curvature of over 1° and about 39 miles of total curvature. The roadbed is probably as fine as, and in some respects superior to, any in the world. The first fifty miles are laid with steel weighing 100 pounds to the yard. This is a very stiff rail, measuring 6 inches in height, and the joints are fished with two long and heavy six-bolt angle bars 40 inches in length. Ties are 6 inches deep by 8 inches wide and 9 feet long, spaced 16 to the 30-foot rails, three ties being bunched beneath each joint, one at each end of the angle bars, and one under the center. Beyond Garrison's for the last 93 miles the rails weigh 80 pounds to the yard and the angle bars are 36 inches long. Twelve inches of broken stone ballast is used throughout the whole line.

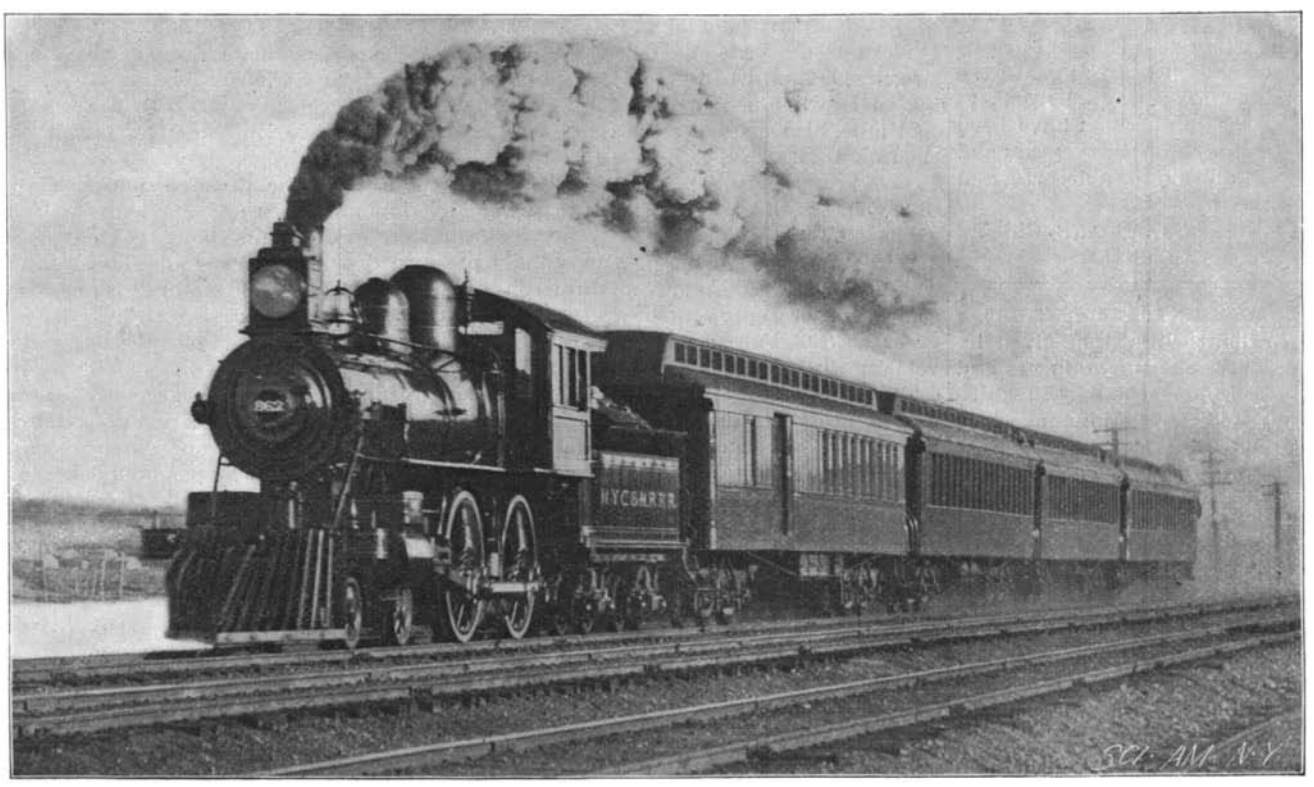
Curves of	Total length.
7° 32′	1,000 feet.
7° 15′	790 "
5° 00′	2,035 "
4° to 3°	2,084 "
3° to 2°	4·25 miles.
2° to 1°	23·00 "
1° and under	10·00 "

The obstructions to fast running include road crossings at grade, slow-ups for water, and reduced speed at bridge crossings. The first 15 miles out of New York are run at considerably below the average speed. From the Grand Central Station to Mott Haven, 5·3 miles, the speed is 31·8 miles per hour; the next 5·8 miles to Spuyten Duyvil are run at 43·87 miles per hour; and the next 4 miles to Yonkers at 48·84 miles an hour. There are three slow-ups to a speed of 25 miles for water, one at Montrose, 38·8 miles, another at Hyde Park, 79·2 miles, and the third at Linlithgo, 108·3 miles from New York. The speed is also reduced in crossing the Harlem River at New York and the long bridge at Albany, where three minutes are consumed in crossing the Hudson River. Speed is also slackened for curvature or crossings at Mott Haven, Yonkers, and Hudson. With these detentions in mind, it can easily be understood that many of the miles are run at from 60 to 70 miles an hour.

The Train.—The regular train consists of four cars weighing 376,000 pounds; but it frequently happens that the heavy special car of the vice-president, weighing 110,000 pounds, is coupled on, and as the schedule time is kept with this load, we feel justified in including it in this discussion of maximum performances. The train is thus made up as follows:

	Pounds.
Buffet car	94,000
Day coach	82,000
"	97,000
Drawing room car	103,000
Special car	110,000
Total	486,000

The cars are 70 feet in length over all. They are carried on six-wheeled trucks, and have the vestibule connection, additional steadiness being secured by a system of hydraulic buffers which hold the cars closely together and greatly reduce the sway on curves at high speed. The riding of the cars, we can state from experience, leaves nothing to be desired, even on the sharpest curves and at the maximum speeds.



EMPIRE STATE EXPRESS AT FULL SPEED.

Speed, 53·58 miles an hour; distance run without stop, 142·8 miles; greatest weight of train, 243 tons.

The Locomotive.—The trains are hauled by a class of 4-coupled 8-wheeled locomotives of which No. 999, illustrated on our front page, is the best known example. The later locomotives of this class differ chiefly from 999 in having drivers 6½ instead of 7 feet in diameter, and slightly less heating surface. The dimen-

sions of No. 999 are as follows: Cylinders, 19 by 24 inches; diameter of drivers, 86½ inches; weight on drivers, 84,000 pounds; total weight, 124,000 pounds; heating surface, 1,930 square feet; steam pressure, 190 pounds. Our wood engraving of this engine speaks for itself, and shows it to be of extremely handsome and impressive appearance. There are no features in which it departs materially from the lines of a typical American 8-wheeler, and it would be difficult to find a class of engines that better represents the standard express locomotive practice of the present day in this country. The engines are good steamers and economical coal burners. Our English friends will be surprised to learn that careful tests by Mr. Buchanan, the master mechanic, show that the coal consumption when hauling the Empire State Express is 38·3 pounds per mile for No. 999 and 33·47 pounds for the 871 class with smaller drivers.

THE CORNISH EXPRESS.—The Great Western Railway, over which the first section of the Cornish Express makes its phenomenal run, is one of the oldest and best administered lines in England. It is also, unfortunately, one of the least known to American tourists, although the excellent service of the Hamburg-American lines, in connection with which a system of superb ocean express trains is being run on the arrival of the boats, is doing much to introduce Americans to the lovely southern and western counties of England, through which the lines of the Great Western Railway are laid.

The line was located and built by I. K. Brunel, who is better known as the constructor of that leviathan steamship the "Great Eastern." Brunel was an engineer of large ideas, as he showed in the Great Western Railway. The road was built literally regardless of expense. Hills were tunneled, valleys crossed by massive embankments or costly viaducts of masonry, and nothing was spared to make the line as nearly as possible both level and straight, for American engineers had not then taught the world that locomotives can climb hills and travel at speed around curves of comparatively small radius. Brunel also adopted a gage of 7 feet, and it was only a few years ago that this was abandoned for the standard gage of 4 feet 8½ inches.

The Track.—In spite of the effort of the first builders to avoid heavy grades, it will be seen from the diagram showing the profile of the line that the road is by no means an easy one. In the first 77 miles from London to Swindon the road climbs on a fairly even grade of about 4 feet to the mile to an elevation of 339 feet above the sea. It then falls on gradients of from 4 feet to 50 feet to the mile to Bristol. From Bristol there is a climb for 5 miles at the rate of 12 feet to the mile, and after running down on the other side of the summit, there follow 35 miles of level grade to Taunton, at the foot of what is known as the Whiteball incline. Here the train commences the hardest 10 miles of the whole 194, climbing to an elevation of 392 feet above sea level over grades of 30, 58⅔, and 66 feet to the mile. From the summit to Exeter, a distance of 18 miles, the road falls about 300 feet over undulating grades.

The curvature of the road, especially when compared with that of the New York Central, is light. Although there are some curves of from 8° to 9°, they are few and of short length, as will be seen from the following table:

Curve of	Total length.
8° to 9°	1,716 feet.
6°	528 "
4° to 5°	340 "
3° to 4°	379 "
2° to 3°	5,417 "
1° to 2°	6,237 "

There are curves of less than 1°, the total length of which we are unable to give.

At the time when the runs of which the Great Western engineers have furnished us with the data were made, the line was being relaid with heavier rail. A part of it consisted of 68 and 71 pound rail of the inverted U or "bridge" pattern, laid on 7 × 14 inch longitudinal timbers, but most of the road had been relaid with 95-pound double-headed rail of the standard English pattern. These rails are 32 feet long, and with 13 ties to the length, a heavy cast iron chair being interposed between the rail and the tie.

Considerable merit is derived from the fact that time was made by this train in spite of the frequent slow-ups which had to be made on account of this relaying. Chief Engineer Inglis writes us: "Taking an average week in the month referred to (July, 1897), when actual time was kept, the following were the slow-ups:

At mile	36	slow to 15 miles per hour.
"	53	" 25 "
"	54	" 15 "
"	86¾	" 10 "
"	93	" 30 "
"	106	" 25 "
"	118	" 10 "
"	154	" 15 "
"	156	" 15 "
"	172	" 15 "

The detentions, of course, necessitate some very fast running to maintain the average of 53·36 miles per hour for the whole 194 miles.

An analysis of the booked time of the train shows that unlike the Empire State Express, the fastest running was made in the first stages of the journey. The first 36 miles to Reading were run at a speed of 61·71 miles an hour, and the rest of the climb to the summit at Swindon, a distance of 41·27 miles, at the speed of 59·61 miles an hour. From Swindon to Bristol, 42 miles, strange to say, the speed falls to 46·38 miles an hour. The next 44 miles, between Bristol and Taunton, were booked for 54·07 miles an hour; and the run of 30 miles over the Whiteball summit, where the single-driver engine had to haul a 200-ton train over a total elevation of about 350 feet, was made at an average speed of 50 miles an hour. This last performance after a continuous run of 164 miles is exceedingly meretorious, and shows what a remarkably efficient machine the modern locomotive has grown to be.

The Train.—The Cornish Relief, as the first section of the Cornish Express is called, is run just ahead of the regular train, and its length and weight vary according to the demands of the traffic. During July of last year the train frequently consisted of seven or eight cars. The heaviest train ever hauled by a single engine consisted of eight cars of the 2-truck 8-wheeled type, whose weight was as follows:

Composite car, weight		46,116 pounds.
"	" "	55,216 "
"	" "	55,496 "
"	" "	52,360 "
"	" "	54,768 "
Third class car,	"	45,892 "
"	" " "	44,800 "
"	" " "	45,696 "
Total		400,344 "

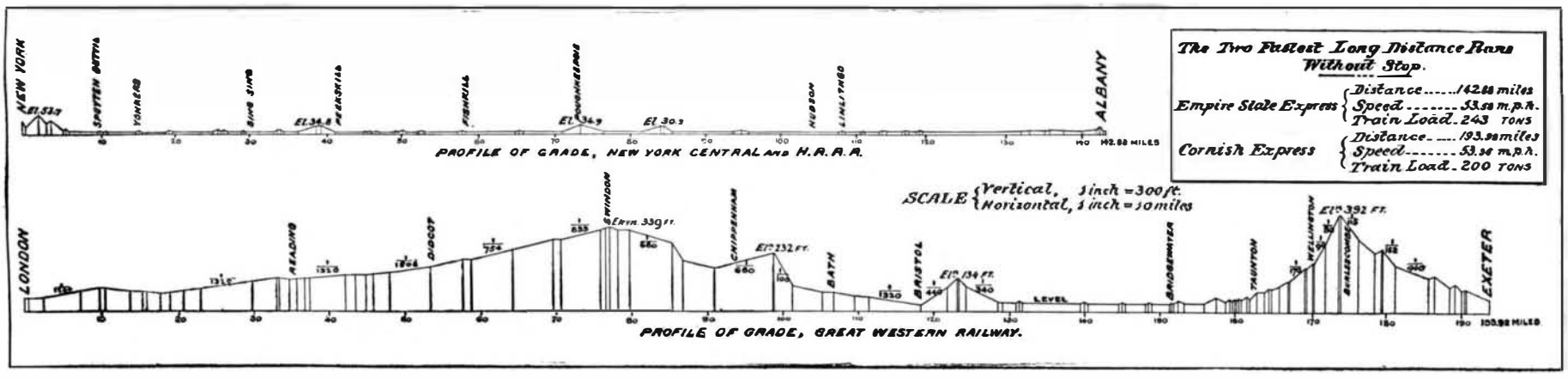
The cars are narrower, shorter (50 to 55 feet), and not so lofty as those of the American type. In their general arrangements they might be called modified American cars, and they embody several characteristic features of each type. Many of them contain a corridor leading from one end of the car to the other down one side of the car, the compartments opening onto the corridor in the same way as do the drawing rooms on a Pullman car. They are provided with lavatories and many of the best features of our own system. As illustrating the growth of American ideas among the English roads, we illustrate the interior of a dining or buffet car on the Great Western Railway. Except for its lower roof and narrower width, it might be mistaken for a buffet car on one of our own roads.

The Locomotive.—Like No. 999 of the New York Central, the English engine "Worcester" is an excellent representative of up-to-date practice in that country. It embodies the distinctive features of inside connected cylinders (the latter being located side by side within the frames and beneath the smoke box) and a single pair of driving wheels. The cylinders are 19 inches diameter by 24 inches stroke and the drivers are 7 feet 8 inches in diameter. The weight on the trucks is 39,872 pounds, on the drivers 39,984 pounds and on the trailing wheels 27,664 pounds, the total weight of the engine being 107,520 pounds. The boiler carries the copper fire box which is usual in English practice; the total heating surface is 1,467 square feet and the working pressure is 160 pounds to the square inch. The coal consumption worked out at 29 pounds per mile for the whole trip.

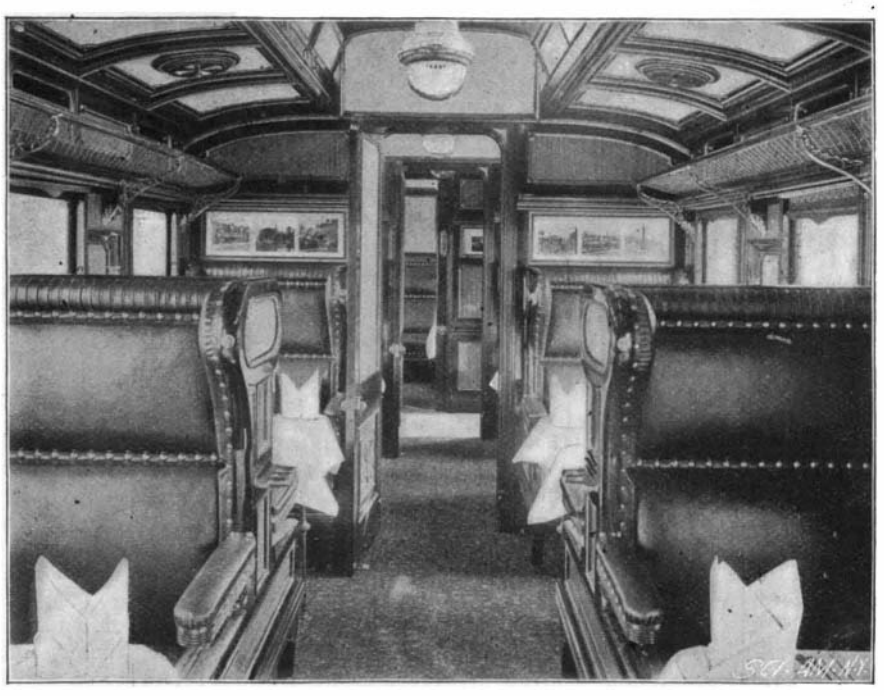
The acceleration which has lately taken place in the speed of the Great Western trains is largely due to the competition between the transatlantic steamship lines which ply to Plymouth and Southampton.

Plymouth is the westernmost port in England which affords access and accommodation at all times and tides to the largest ocean liners. By calling at Plymouth the Hamburg-American line is able to save five or six hours over the route via Southampton, and the ocean mail trains which were put on by the Great Western Railway to rush the mails and passengers through to London form one feature of a new schedule of exceptionally fast trains of which the Cornish Express is the most notable.

In conclusion the reader will naturally institute comparisons between these two fine locomotive performances, and place the palm where in his own mind it belongs. The New York Central train is considerably heavier, the road is more full of curvature and the train is handicapped at the outset by having to run at greatly reduced speed for the first 10 miles. On the other hand the Great Western run is one-third longer, and the hills which have to be climbed add greatly to the difficulty of maintaining a high average speed. In speed the Empire State Express is a shade the faster.



GRADES OF THE NEW YORK CENTRAL AND THE GREAT WESTERN RAILWAYS.



INTERIOR OF DINING CAR ON THE GREAT WESTERN RAILWAY, ENGLAND.

THE German government has recently opened a new observatory at Heidelberg, situated on the Königstuhl, a high hill overlooking the town. The new observatory belongs to the state, and has no connection with the university, although opportunities will be afforded to students and investigators to carry on special studies and researches.