

The early express trains usually comprised only about four coaches and were hauled by light-weight 4-4-0 locomotives designed by the Great Central's chief locomotive engineer Harry Pollitt (not to be confused with his much later communist namesake). In 1900 John G. Robinson succeeded him in that post, and from the Company's works at Gorton Manchester he produced a stream of capable and handsome locomotives. In 1903 the first of his 'Atlantic' 4-4-2 express engines appeared. Their curvaceous elegance led to their nickname of 'Jersey Lilies' after the daughter of Dean Langtry of Jersey, a celebrated, perhaps notorious, actress of the day who was currently enjoying much of the attention and expenditure of the monarch. On occasion these locomotives would work through to Banbury over the Woodford – Banbury link and even beyond.

The line never saw heavy passenger traffic, mainly because as a latecomer to the capital with a main line serving mainly quiet towns and remote countryside, it struggled to compete with the established services of the L.N.W.R from Euston and the Midland Railway from St Pancras.

The G.C.R. did however operate fast, long and frequent coal trains from the Nottingham fields to London. These trains were nicknamed 'Annesley Runners' and in their last few years, when British Railways put their heavy 2-10-0 freight locomotives to work them, as 'Windcutters'. They would run at up to 50 mph and, being unbraked, had an immense stopping distance. For this reason two sections of track ahead (the distance between signal boxes) had to be kept clear for them. instead of the usual one. The noise they made when racing south through the Birdcage at Rugby had to be heard to be believed.

The G.C.R.'s principal express trains ran initially through to Manchester, but in later years only as far as Sheffield or Bradford. Two of these were graced in British Railways days (post 1948) by titles – 'The South Yorkshireman' and 'The Master Cutler'. On occasion they were hauled by the well-known A3 Pacific locomotives of Sir Nigel Gresley, including 'Flying Scotsman' herself (or himself), happily preserved and still mobile in 2008 at the age of 84.

Towards the end, in the late 1950s and 1960s, the trains ran through only to Nottingham, but even they were occasionally hauled by locomotives of the 'Royal Scot' class of the old L.M.S.

The line also saw for about fifteen years slip carriage workings, whereby the rearmost carriage (or carriages) were detached from express trains at speed to serve intermediate stations, to obviate the need to stop the complete train. Just before the First World War the G.C.R. detached