often laminar. Dr. Devonshire pointed out that this need not contradict his postulate that for the most favourable conditions of potential energy domains should be elongated. The large domains found optically may be subdivided into smaller domains of equal c direction but different direction of polarization. Dr. Kay then showed that the structural changes in barium titanate and solid solutions of barium and strontium titanate can be explained with surprising accuracy if one assumes the barium and oxygen ions to be rigid spheres with the conventionally accepted ionic radii. This assumption even gives the right value for the spontaneous polarization. However, as Dr. Kay pointed out, the physical meaning of the changes could scarcely be so simple.

Mr. M. G. Harwood (Philips Electrical, Ltd.) reported experimental results regarding the lattice parameters of the tetragonal, ferro-electric form of barium titanate over a wide range of temperature, directing particular attention to changes which occur at points below room temperature, where other workers had previously found anomalies in the dielectric properties. The axial ratio c/a, although on the whole increasing steadily with decreasing temperature, shows discontinuities at approximately $+5°$ and $-70°$ C., a sudden drop in the ratio being recorded at each of these temperatures. This was analysed in terms of anomalous changes of the lengths of the tetrad and diad axes, which at all other temperatures vary in a continuous and regular manner. X-ray and optical examination shows that at these two particular temperatures, where two structures co-exist over about 10° C., the domains change their direction of polarization in the absence of an applied electric field. The reason for this still awaits an explanation; but it may account for the peaks in permittivity at these points.

[1] Mason, W. P., *Phys. Rev.*, **72**, 854 (1947).
[2] For example, Rushman and Strivens, *Trans. Farad. Soc.*, A, **42**, 231 (1946).
[3] Megaw, *Proc. Roy. Soc.*, A, **189**, 261 (1947).
[4] Kay and Rhodes, *Nature*, **160**, 126 (1947). Hulm, *Nature*, **160**, 127 (1947).
[5] Harwood, Popper and Rushman, *Nature*, **160**, 58 (1947).

GEORGE STEPHENSON, 1781-1848

ON August 12, 1848, a century ago, George Stephenson died at his home, Tapton House, Chesterfield, at the age of sixty-seven, and was buried in Trinity Church in that town. For some years he had been more concerned with his properties than with railways, taking special delight in horticulture and his Derbyshire collieries. His father had been a fireman at a Northumberland coal mine, and Stephenson himself had passed his boyhood amidst coal pits, pumping and winding engines. He had become an assistant fireman when fifteen, was the mechanical engineer at Killingworth Colliery at thirty-one, built his first colliery locomotive at thirty-three; his first railway was that laid down at Hetton mines a little later, and the famous Stockton and Darlington Railway, of which he was the engineer, was designed primarily for mineral traffic. His interest in collieries was therefore life-long.

The story of Stephenson's rise from obscurity to fame is a familiar one in industrial history. Born in the lowliest circumstances, he enjoyed none of the early advantages of Watt or Smeaton or Rennie, and it was only when eighteen, through his own perseverance and industry, he learnt to use a pen and entered the magical world of books. His mechanical ingenuity, however, was evident from the first; and it was only a year after he constructed his first locomotive, *Blucher*, that he devised the 'Geordie' miners' safety lamp, for which he was given £1,000 by his fellows. The reputation thus gained was increased by his success at Hetton, and at a time when the mechanical world was divided over the respective merits of horses, stationary engines and 'travelling engines' for industrial railways he was able to prevail upon the Darlington manufacturer, Edward Pease (1767–1858), to use locomotives, except for steep inclines, on the Stockton and Darlington line.

Moreover, through the confidence Stephenson inspired, he was enabled to secure the co-operation of Pease and others in founding the first locomotive-building works in the world. Set up at Newcastle in 1823, under the title R. Stephenson and Co., the firm supplied many of the most famous of all early locomotives. George Stephenson was then in his 'forties, his son Robert in his 'twenties, and it is impossible to dissociate the work of one from the other. Generally it may be stated that the period 1820–25 saw the construction and opening of the Stockton and Darlington Railway and the period 1825–30 the construction and opening of the much more important Liverpool and Manchester Railway, on which in 1829 took place the epoch-making Rainhill locomotive trials, which decisively placed the steam locomotive in the position of supremacy.

Needless to say, the steam railway would have come if George Stephenson had never lived; but it was his good fortune to be in the current of affairs at a critical time, and to be endowed with both the mental and physical characteristics necessary for the task which lay ahead. The locomotives of Trevithick, Hedley and Blenkinsop had preceded Stephenson's, while railroads or tramways had been in use a very long time. Then, too, many men, without any claims as inventors or engineers, saw what was possible, and their views were shared by men of high commercial standing. Before the Stockton and Darlington Railway was started and before Stephenson's factory at Newcastle was opened, in 1820 Thomas Gray, who died in poverty two months after Stephenson passed away, published his little book entitled "Observations on a General Iron Railway", which ran through five editions in five years, and contained plans for trunk lines from London to Falmouth, Dover, Edinburgh, Holyhead, etc. Still other promoters were William James, Nicolas Wood, the mining engineer, and Charles Maclaren, the editor of *The Scotsman*.

By this time the advancement of civil engineering and mechanical engineering in the eighteenth century had given Britain great constructional works and engine shops, the supply of iron for rails, boilers and engines was ample and many men were ready to follow in the footsteps of Stephenson. His lines and his shops, too, provided the training grounds for the future railway engineers, and so it was that with the completion of the Liverpool and Manchester Railway the great era of railway construction began. In Great Britain alone, by 1840 there were more than 800 miles of lines open, by 1860 more than 10,000 and by 1880 some 18,000 miles. Not a single engineer of those days would have denied that the world was entitled to regard George Stephenson as the 'father of railways'.