the map was drawn, and so the omission of the name of St. Gilles can be accounted for. Vesconte knew that there was no longer a port of St. Gilles, if he knew that there ever had been, and, being of no interest to those for whom the map was made, it was omitted, but the topography he took, directly or indirectly, from the older map. If this map is compared with a restoration of the twelfth century topography, as deduced from modern maps of the region, the agreement, as regards the eastern end of the inlet, is so close, that his representation of the western portion, where direct restoration is more uncertain, may be taken as corroboration of the western approach to the port of St. Gilles.

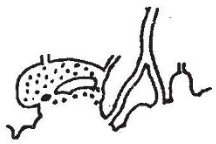

FIG. 3.—Coast between Cette and Cap Couronne, from the map by Petrus Vesconte, dated 1318.

The later history of these maps, so far as it affects this region, may be briefly summed up. The Vesconte map is the last which gives an air of reality to the western channel, and it is probable that in contemporary maps, by other makers, the representation had already assumed the conventional form, seen in the Dulcert map of 1339, and repeated throughout the series of later maps. At the same time, there is a great advance in the representation of the sea-face, which maintained a remarkable correctness until about the middle of the fifteenth century; after that, a change of conditions, by deterioration of the channels of access to Arles and Aiguesmortes, and by the increase in size of the merchant ships, led to this coast being avoided by the mariners who used these charts, and a steady deterioration set in, due to errors introduced by repeated copying, uncontrolled by any check.

From the evidence outlined above we may reconstruct the history of St. Gilles as a seaport. In Roman times it was an inland town, of no great importance, past which one of the branches of the Rhone flowed, as at the present day, but, instead of turning southwards, the river flowed on to the west, in a valley cut out of the upraised alluvium, to where the étang de Mauguio now stands. Then came the subsidence in the Dark Ages, the lower part of this valley became submerged, and an inlet of the sea was formed, with sufficient depth of water to enable ships to reach St. Gilles, which, by 1080, had become so well established that it was selected as the most appropriate landing-place for a princess of Sicily, on her way to the Court of France. The importance and prosperity of the port increased during the succeeding half-century or more, but, once further subsidence of the land had ceased, the alluvial deposits of the river began to advance into the flooded lands until St. Gilles, instead of being a port on an inlet of the sea, became a town on the banks of a small river, and at the same time the rivers Vistre and Vidourle, entering the inlet near its western end, built up a barrier across it. These two causes, combined, made access from the sea to St. Gilles increasingly difficult until, by the end of the twelfth century, its life as a seaport had come to an end. Since then, the remains of this old inlet were gradually filled up by silt deposited from the flood-waters of the rivers, and the process would still be going on, if these rivers had not at last been completely hemmed in by flood-proof embankments.

(*To be continued.*)

The Centenary of the Railway.

By Engr.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE celebration of the centenary of the opening of the Stockton and Darlington Railway is an occasion of world-wide interest, for from that pioneer line has sprung the vast network of railways which stretches to the uttermost parts of the earth. It was the first of British public steam railways, and just as the Romans were the great builders of roads, so our race became the great builders of railways. Even as British ships navigate every sea, so railways designed by British engineers traverse every continent. The modern textile industry and the steel industry both had their birth in our isles, but it is probable our three greatest contributions to material progress were the steam-engine, the steam-ship, and the locomotive. Watt and Stephenson, like Shakespeare, Newton, and Faraday, have been eulogised beyond measure, but we are perhaps even now too near the revolutions they set in motion to realise their full significance in the history of mankind.

The Stockton and Darlington Railway was opened on September 27, 1825, when George Stephenson drove his famous engine *Locomotion* from Darlington to Stockton with a train of miscellaneous vehicles and trucks filled with goods and passengers. That great experiment must always be associated with the name of Stephenson, who, however, was but the outstanding representative of the pioneers of the steam railway to whom tribute should be paid. Tracks of wood and wheels of iron had been in use for many years. In 1801 William Jessop had built the first authorised public line, the Surrey Railway. It was probably Jessop who gave us our gauge of 4 ft. 8½ in. By 1820 railways were becoming common, and no fewer than twenty were sanctioned in that year alone. These were worked by horses. In the eighteenth century, Cugnot, Murdock, and Trevithick had all built steam-carriages; and in 1804 Trevithick set a locomotive to work on an iron track in Wales. In this engine he used the exhaust steam as a blast. Two or three years later Trevithick had one of his engines running round a track where Euston Square now stands. Blenkinsop's engines with cogged wheels date from 1812, and about the same time Foster and Hackworth assisted Hedley to construct *Puffing Billy* and *Wylam Dilly*, the two oldest locomotives now extant. Stephenson's first Killingworth engine *Blucher* was built in 1814, his second in 1815, and eight years later, with assistance from Pease, Richardson, and Longridge, he opened his engine factory at Newcastle, where *Locomotion* was built.

Originally projected by Edward Pease as a mineral line for bringing coals from near Bishop Auckland to the sea, the plans for the Stockton and Darlington Railway were passed in 1821, and two years later, largely through Stephenson, powers were obtained for carrying passengers and for using locomotives, the general idea being to use locomotives on the level and stationary winding engines for the inclines. At first *Locomotion* was the only locomotive, but it was soon followed by other engines afterwards named *Hope, Black Diamond, Diligence,* and *Royal George,* for it was found that "an intercourse and trade seemed to grow out of nothing." Stephenson by now was also engineer to the vastly more important railway, the Liverpool and Manchester, and just as he had prevailed upon Edward Pease to use the locomotive for the Durham line, so he converted the proprietors of the Lancashire line to his ideas. When the line was nearing completion a prize of 500*l.* was offered for a locomotive fulfilling certain conditions, and the remarkable success of the *Rocket* at the historic Rainhill trials held in October 1829 sounded the knell of both horse railway and stationary-engine railway. A year later the Liverpool and Manchester Railway was formally opened by a procession of eight locomotives, headed by the *Northumbrian,* driven by Stephenson, and with that event the era of the steam railway set in.

Railway progress since those early days has been due to two great schools of engineers: the mechanical engineers devoted to the design and construction of rolling stock, and the constructional engineers responsible for the track. To the former belong both George and Robert Stephenson, Hackworth, Bury, Crampton, Gooch, Fairlie, Ramsbottom, Baldwin, Webb, Belpaire, Borsig, de Glehn, Mallet, Pitkin, and Vauclain, whose names have been household words. Between the *Rocket,* weighing with her tender 7½ tons, and the giant *Virginia,* built by the American Locomotive Co., weighing 450 tons, lies the work of a great army. With her fire-box surrounded with water spaces, her copper tubes and her direct drive, the *Rocket,* compared with anything which had gone before, was as a racehorse to a dray horse. It was in the *Planet,* however, that the cylinders were placed under the smoke-box with the driving wheels aft as we have them to-day.

In the history of the locomotive it is impossible to say too much for Howe's invention of the link gear, which gave the driver a simple means of reversing, and also of regulating the cut-off in the cylinder. The link gears of Walschaerts, Gooch, Allan, and Joy were all later than Howe's invention, which was made in 1842. Other landmarks in the history of the locomotive are the brilliant invention of the injector by Giffard, the introduction of his ingenious water trough by Ramsbottom, the use of compounding by Mallet and Webb, and the introduction of superheating, notably by Schmidt. But in truth every part of the engine and boiler, tubes, valves, gauges, cylinders, pistons, springs, bearings, axles, and cranks, have been the subjects of close investigation and continual improvement. In the development of rolling stock, special mention should be made of the invention in 1869 of the Westinghouse brake, while we are also indebted to the United States for the Pullman carriage and the Swift refrigerator car. Scientific research has long been the handmaid of locomotive engineers, and it is worth recalling that August Wöhler's epoch-making work on materials began with the study of axles.

Just as Stephenson was the first to build an iron railway bridge, so he was the first to lay a line across a bog and to drive one through a hill. There can be no denying him the title of "the father of the railway." After the Liverpool and Manchester line came the London to Birmingham, then the Grand Junction continuing this line to Liverpool, and the South Western, South Eastern, and Eastern Counties Railways. With these and other railways at home and abroad are associated the names of Robert Stephenson, Locke, Brunel, Berkley, Errington, Vignoles, Bell, Hawkshaw, and Brassey. On some of the lines were works of great magnitude. Of the early bridges the most remarkable was the Britannia Bridge over the Menai Straits. Its originality, its great length, its height, and the audacity and skill displayed in raising the immense spans to the top of the towers created as much interest in the public mind as the building of the *Great Eastern* in the next decade. Robert Stephenson and Fairbairn were the engineers of the bridge, and for Fairbairn, Hodgkinson carried out his important inquiries on the strength of iron structures. The Britannia Bridge was opened in 1850. Five years later a railway bridge was thrown across Niagara by Roebling, and the year 1859 saw the opening of the Victoria Bridge over the St. Lawrence, of Lohse's bridge across the Rhine at Cologne, and of Brunel's bridge over the Tamar. These bridges, of course, were all built of iron, but with the steel age came even more remarkable structures, such as the Forth Bridge, containing sufficient steel to build two battleships, and the Victoria Bridge over the Zambezi River, high enough to overleap St. Paul's.

Less spectacular than bridge-building, but of equal importance in the development of railways, has been the art of tunnelling. The first railway tunnel was that on the Canterbury and Whitstable line. The elder Brunel's Thames tunnel, begun in 1824, was not a railway tunnel, but it led to the invention of the shield, which, improved by Greathead, has been used for all our tube railways. But the romance of tunnelling centres around the Alps. First came the Mont Cenis Tunnel, then the St. Gothard, then the Arlberg, the Simplon, and the Lötschberg. These have a combined length of 46 miles. It was in the Mont Cenis Tunnel, begun in 1857 and finished in 1871, that Graddoni and Sommeiller, through Colladon the physicist, first used compressed air, and it was reading of their work which gave Westinghouse the inspiration for his brake. To the lay mind there is nothing more marvellous than the boring of long tunnels from the opposite sides of a massive mountain range, and making them meet within a few inches. The total discrepancy in the alignment of the Simplon Tunnel, 12 miles long, was only 3⅝ inches. Tunnelling, like all railway work, may be said, in the words of Emerson, to be "girt about with a zodiac of sciences, the contributions of men who have perished to add their point of light to our sky." If men had not followed the motion of the stars, pored over the mystery of light, or studied fossil forms, the Alps would still have remained as great a barrier to the traveller as they were to the armies of Hannibal, and in commemorating the centenary of the railway we do homage alike to those who have enlarged the boundaries of knowledge and to those who have applied that knowledge to useful ends.