case for the Cleator and Workington Junction Railway Bill, the competing scheme. The Bill proposes to incorporate a company with a share and loan capital of £200,000 for making a railway of about 20 miles in length from the Cleator Moor Station of the other railway, passing through Distington to Lord Lonsdale's railway north of Workington, with branches to Whitehaven, with a junction at Harrington, and also to a point south of Workington. At the close of the learned counsel's address the Committee rose.

Yesterday (Thursday) the Ramsgate Local Board, Leicester Improvement, Sittingbourne and Maidstone Railway, Whitehaven, Cleator, and Egremont Railway, and the Cleator and Workington Junction Railway Bills, all opposed, were proceeded with and adjourned until to-day. The North East Worcestershire Water Bill, also opposed, was postponed until Monday. The Lynn and Fakenham Railway Bill passed Committee.

The Examiners have reported compliance with Standing Orders in the case of the Banbury and Cheltenham Direct Railway Bill, and in the case of the petition for additional provision in the Firth Bridge Railway Bill; but the petition for similar provisions in the case of the London and North-Western (New Lines) Bill has been referred to the Committee on Standing Orders.

The Standing Orders Committee have allowed the Standing Orders to be dispensed with in the case of the petition of the Earl of Dunraven against the Merthyr and Rhondda Valley Junction Railway Bill; but have refused to do so in the case of the petition of the Harwich Conservancy Board against the Felixstowe Railway and Pier Bill. The Committee has also decided that the Standing Order 131 of that House, which limits the period within which petitions are to be deposited against Private Bills, ought not to be dispensed with in the case of the petition of proprietors in the Wilts and Berks Canal Navigation Company against the Wilts and Berks Canal (Sale) Bill, and also in that of the petition of Edward Henry John Craufurd against the Glasgow and South-Western Railway Bill, which therefore remains an unopposed Bill. In the case of the Brighton Borough Extension Bill, petition for additional provisions, before the Examiners of Petitions for Private Bills, the Standing Orders were found not complied with. The Court of Referees have allowed a general *locus standi* to the following petitioners:—The Justices of the Peace for the County of Chester against the Upper Mersey Navigation Bill, the Rural Sanitary Authority for the District of Uppingham in the County of Rutland against the Uppingham Water Bill, and the London and North-Western Railway Company against the Walsall Gas Purchase and Borough Extension Bill. The *locus* was disallowed of Mr. Edward Whalley to be heard against the Stafford Borough Extension Bill, of the Staffordshire Waterworks Company against the Walsall Gas Purchase and Borough Extension Bill, and of the Severn Commissioners against the Coombe-hill Canal Navigation Bill. The *locus standi* of the Burntisland Owners in the case of the Burntisland Mineral Railway Bill, of the Glasgow and Coatbridge Railway Company, and the Glasgow Union Railway Company (except as to Railways Nos. 2, 3 and 4), in the case of the Caledonian Railway (Additional Powers) Bill, of Baird and Company in the case of the Caledonian Railway (Grangemouth Harbour) Bill, of certain Traders and Freighters against the Cleator and Workington Junction Railway Bill, and of the West Somerset Railway Company against the Great Western and Bristol and Exeter Railway Companies' Bill, have also been disallowed.

Petitions have been deposited against the following bills in the Commons:—Felixstowe Railway and Pier (1); Halifax Water and Gas (1); West Kent Main Sewerage (1); London and North-Western Railway (New Lines) (1); Humber Conservancy (1); and the North Wales Narrow Gauge Railway (1) Bills; and petitions in favour of the Tyne Improvement (2); Ramsgate Local Board (2); Sittingbourne and Maidstone Railway (5); Golden Valley Railway (1); and the Lynn and Fakenham Railway (4) Bills have been deposited; while the following petitions have been withdrawn:—That of Hutchinson's Hospital against the Glasgow and Kilmarnock Joint Line and Caledonian Railway Bill; that of Messrs. Ind, Coope and Co. against the Great Eastern Railway Bill; of Mr. Treherne against the Great Western Railway Bill; of the Redcar Board against the Redcar and Coatham Gas Bill; of Messrs. Rogers and others against the Banbury and Cheltenham Direct Railway Bill; of the Edinburgh Council against the Caledonian Railway (Additional Powers) Bill; of the Midland Railway Company against the Chesterfield Water and Gas Bill; of the Dewsbury Corporation against the Great Northern Railway Bill; of the Devon and Somerset Railway against the Great Western and Bristol and Exeter Railways Bills; of the Redditch Board against the North-East Worcestershire Water Bill; of the Sandwich Corporation against the Pegwell Bay Reclamation Bill; of the Rochester Corporation and the London, Chatham, and Dover Railway against the Queenborough Harbour Bill; of the South-Eastern Railway Company against the West Kent Main Sewerage Bill; of the Great Western Railway Company against the Bristol United Gas Bill; of the Midland Railway Company against the Leicester Improvement Bill; of the Didcot, Newbury, and Southampton Railway Company against the London and South-Western, Midland, and Somerset and Dorset Railway Companies' Bill; of the East London Waterworks Company against the Great Eastern Railway Bill; of the London and North-Western Railway Company against the Oldbury Local Board Bill; of the Crystal Palace District Gas Company against the South Metropolitan Gaslight and Coke Bill.

The Chichester and Midhurst Railway Bill has been withdrawn, and permission has been given to Mr. Laing and Mr. Lopes to bring in a new bill. The North and South (Gravesend Tunnel) Junction Railway Bill will also be withdrawn if leave be given.

The consideration of the Glasgow (City) Union Railway Bill, unopposed, has been adjourned till Tuesday, 21st March.

The following Bills have been read in the House of Commons for the second time:—The Kilsyth and Falkirk Railway; London and South-Western, Midland, and Somerset and Dorset Railway Companies; Monmouthshire Railway and Canal; Newcastle and Gateshead Water; Spennymoor and Tudhoe Gas; Walsall Commissioners Gas Purchase; Bristol United Gas; Lancashire and Yorkshire Railway; North Wales Narrow Gauge Railway; and the Albert Hall Bills; and for the third time, the Dublin (City) Steam Packet Company, and the South Alloa Dock Bills. The Derby Gas, Ely, Haddenham, and Sutton Railway, Manchester and Milford Railway, Scotswood and Wylam Railway and Dock, and the Shepton Mallet Water Bills stood for third reading yesterday, the Prince of Wales' consent on behalf of the Duchy of Cornwall having to be signified in the latter case. The South-Eastern Railway Bill similarly stood for second reading, subject to a notice of motion to read it this day six months.

In the House of Lords, the Dublin South City Markets Bill has been read a second time, the Standing Orders not complied with having been dispensed with. The Southwark and Vauxhall Water Bill is withdrawn. The Standing Orders Committee of that House have decided that the Standing Orders not complied with in the case of the Sidmouth Railway Bill ought to be dispensed with upon conditions.

THE CHANNEL RAILWAY.*

(*Concluded from page* 173.)

THE CHANNEL TUNNEL.

THE author has already referred to the fact that the tunnel project of M. Thomé de Gamond became in time absorbed in another, that of which Sir John Hawkshaw is the engineer in England, and with whom Mr. Brunlees is now associated. In 1872 a company was formed to carry out the project for establishing uninterrupted railway communication between Great Britain and Europe. Committees have been appointed in England and France. It may be as well here to observe that Mr. William Low was at one time—prior to 1872—connected with the same gentlemen, but has since become dissociated from them, and is now, it is believed, projecting a tunnel having a slightly different route. As stated in the author's paper of 1869, Sir John Hawkshaw had previously given considerable attention to the subject, having begun his practical researches in 1865. He examined into the nature of the strata beneath the Channel, and put the question of a submarine tunnel in a position to be seriously discussed and considered by the public. In addition to careful geological surveys and investigations, Sir John, in conjunction with the late Mr. Brassey and Mr. George Wythes, had borings sunk on each coast, and examined the bottom of the Channel in a number of places. The point of departure on the English coast ultimately selected by Sir John Hawkshaw was St. Margaret's Bay, about four miles to the east of Dover, the position of the tunnel on the French coast being midway between Calais and Sangatte. By adopting this route the line of the tunnel would be wholly through the lower chalk, which is assumed to be homogeneous. No ventilating shafts or other above-Channel constructions are to be adopted, the work consisting simply of a tunnel from shore to shore. The bed of chalk through which the proposed tunnel will be made has been found to be upwards of 500ft. deep on each shore from high-water level, and Sir John Hawkshaw's investigations so far lead to the conclusion that this bed of chalk is continuous, and stretches beneath the sea uninterruptedly across the Straits. The tunnel is to be made at such a level as that in no place will there be less than 200ft. thickness of strata between it and the bed of the Channel.

The question as to whether, if the lower chalk, while resisting infiltration from above, would be so saturated with water as to overcome ordinary pumping power, has been well considered by Sir John. From personal experience gained in tunnelling for five miles through the chalk on the sea shore at Brighton, and from the experience of others in sinking deep wells at Dover and Calais, he arrives at the conclusion that no obstacle of that nature would be insurmountable. Sir John, however, reserves one point, and that is the occurrence of any open unfilled fissure reaching from the sea to the great depth it is proposed to carry the tunnel. He believes, however, that such fissures, if at any time existing, have been filled by the lapse of ages. For the execution of the work, as far as mechanical aid is concerned, there need be no apprehension, there now being ample means in the way of tunnelling machinery, and ample experience in its extensive use. During the construction, according to Sir John's present views, the impure air would probably be drawn from the advanced end of the working through tubes by a fan, fresh air following in from the shore ends of the tunnel. For bringing out the *débris* and carrying in the materials for lining the tunnel, pneumatic tubes would be used. When completed the artificial ventilation of the tunnel would be effected by pumping air.

The tunnel will be a single one of circular or of the ordinary tunnel section, the chalk boring being 36ft. in diameter at the arch springing, and when lined with brickwork in cement it will have an interior diameter of 30ft. The works will commence by a junction with the London, Chatham and Dover and the South-Eastern Railways at Dover, and will be carried in tunnel eastward through the chalk along the coast for four miles to St. Margaret's Bay. The gradient between these two points will be a descending one of 1 in 80. At St. Margaret's the tunnel will turn southward under the sea with a descending gradient of 1 in 2640 to a point under mid-Channel, where the gradient will rise towards the coast of France at the same rate of inclination, terminating in a rise of 1 in 80 for a length of about six miles between the coast and the junction with the French system of railways. The total length of the tunnel will be thirty-one miles, and Sir John Hawkshaw estimates the cost at £10,000,000, and the time of completion ten years from the commencement of the works.

Before the permanent works are commenced it is proposed to sink an experimental shaft on either side of the Channel. In each case a shaft will be sunk to the depth of about 450ft., and from the bottom of the shaft a driftway will be driven for about half a mile under the sea. If these preliminary operations prove successful, the permanent works will then be proceeded with, provided of course that the required capital is forthcoming. For the preliminary operations about £100,000 will be required, and towards this amount the London, Chatham and Dover and the South-Eastern Railways are empowered by an Act of Parliament obtained last year to contribute to the extent of £40,000 between them. It is expected that the preliminary operations will shortly be commenced.

BISHOP'S CHANNEL TUBE.

The uncertainties and probable difficulties attendant upon the tunnel scheme, no less than those motives which have animated other earnest workers in the same direction, namely, a desire to afford a more easy, agreeable, and rapid system of communication between England and France than at present exists, these incentives led to Mr. Paul J. Bishop advancing a scheme for a railway carried through tubes laid on the bed of the Channel. In 1870 Mr. Bishop consulted the author upon the subject, and communicated to him the general features of his project. The author thereon worked out the engineering details of a tubular railway, which are shown in the drawings. Mr. Bishop's method of connecting the railway systems of England and France consists in having two distinct tubes of cast iron which are to be laid in a parallel course on the bed of the Channel, each tube being laid with a single line of rails. The route selected is from Dover to Cape Grisnez, between which points the deepest sounding is 30 fathoms, and the steepest gradient 1 in 100. The whole length of the line is 21¾ miles, and the estimated cost is about one million sterling per mile for two distinct tubes. The tubes are shown in transverse section at Figs. 1 and 2. They will be elliptical in section, 4in. in thickness, and cast in lengths of 5ft., which will be bolted together internally through flanges 12in. deep, cast on the end of each length. The tube will be lined with brickwork in cement, 12in. thick, and over this will be laid a lining of ⅝in. boiler-plate iron, which will render the interior surface flush and even throughout, so that either the locomotive or pneumatic system can be employed. The outer dimensions of the tube will be 17ft. 8in. on the major and 14ft. 8in. on the minor axes of the ellipse, and the inner 15ft. and 12ft. respectively.

The weight of each section of the tube will be somewhat in excess of the weight of the water it will displace, so that it will remain quiescent upon the bed of the Channel. Before lowering, five sections of the tube will be bolted together into lengths of 25ft. on board a pontoon or floating workshop, from which they will be lowered into position. Fig. 3 shows a section of the completed joint. Each end of the 25ft. lengths will be fitted with a movable watertight wrought iron bulkhead, part of which is shown in section at Fig. 4 and the whole at Fig. 5. Assuming a length to have been lowered and fixed in position in connection with the shore works, a 25ft. length will be lowered directly in advance of it by means of slings and chains, as seen at Figs. 1 and 6, the latter of which shows a length of tube being lowered, the general operation being seen from Figs. 7 and 8, which show respectively a side and end view of the pontoon. The slings will be bolted to the tube from the inside, and after the tube has been connected with the preceding length the bolts are partially withdrawn and the slings hauled up. The bolts are then screwed up again, the ends being left to project beyond the outside of the tube. The slings on the seaward end of the length of the tube assumed to have been laid, are provided with pulleys, under which are passed a set of hauling chains, the ends of which are attached to the slings on the shoreward end of the tube being lowered. As soon as the latter reaches the level of the tube which has been laid, it is drawn towards it by the hauling chains, which are operated from the pontoon.

Upon the bulkhead of the fixed length of tube is a cast iron projection seen in Figs. 5 and 6. This is for the purpose of guiding the last lowered length of tube up to the face of the work, the guide fitting into a sheath or socket formed in the bulkhead of the unfixed tube. As soon as the tubes have been drawn close together, the screwing up is commenced from the interior of the laid tube, the screws having previously been placed in the flange of the forward end of the tube, and is continued until the flanges meet, a packing of india-rubber being interposed to make a temporary watertight joint. The joint is afterwards caulked from the inside with iron cement, and is thus made permanently water-tight. The flanges having been bolted together, the first bulkhead is removed, and the second bulkhead is then in view. The first bulkhead, owing to its elliptical form, can be placed on a special trolley and run back through the tube to shore for use for the next length. The guide of the second bulkhead is removed by unbolting from the outside, and thus a manhole is formed, by which the workmen can enter the length of tube just laid, and remove the body of the bulkhead by unbolting it from the interior. Fig. 9 shows a section of the tube with the wrought iron bulkhead bolted to it by 4in. bolts, the 3in. bolts alternating with them being those by which the lengths of tube are fastened together. The bulkhead is composed of four ⅝in. plates with three extra plates as a ring around the manhole where the guide is attached, as seen at Fig. 10, which shows the connection of the bulkheads to the flanges of the tubes. By the time that the bulkheads have been removed and the joint made good another 25ft. length will have been lowered in front of the last laid length, and the process of connecting it with the seaward work is carried out as just described. As each length of tube is laid it will be secured in position by six screw piles screwed from the inside and passing through stuffing boxes, three at each end of every 25ft. length.

During the process of laying the tube, communication will be maintained with the shore and the advanced end of the tube by electricity, and the transport of men and materials will be effected by means of rails, which will be laid down as the work proceeds, and which may be the permanent rails of the system. The workmen will also be placed in electrical communication with those on the pontoon above, which will enable them to give directions respecting the lowering of the next section of the tube, the exact position of which they can ascertain by means of three glass sight-holes fixed in the bulkhead. The floating pontoon will be 400ft. long, 100ft. wide, and will have an opening in the centre 100ft. long, by 25ft. wide, through which the lengths of the tube will be lowered. It will be attended by steam launches and tenders for conveying materials, &c., to and from the shore, and for shifting the anchors as the process of laying proceeds.

The ventilation of the tube when completed will be effected by means of engines of 1000-horse power, placed one at each end of the tubes. This power will be necessary for the proper ventilation of the tubes, but at the same time it may be used for the propulsion of the trains upon the pneumatic principle if desired. The work of laying the tubes may be expected to occupy five years, but if the seasons be moderate it might be done in three.

A favourite argument with some objectors to the iron tubular projects is that the sea water would have an injurious effect upon the metal. The author would meet this objection by the following extract from Maury's "Physical Geography of the Ocean:"—"Count Marsigh divides sea water into surface and deep sea water; because when he makes salt from surface water (not more than 6in. below the upper strata) this salt will give a red colour to blue paper; whereas the salt from deep sea water will not alter the colour at all. The blue paper can only change its colour by the action of an acid. The reason why this acid is found in surface and not in deep sea water is that it is derived from the air." Before the tubes were laid, however, all the ironwork will be well coated with Calley's Torbay oxide paint, of the protective qualities of which for ironwork the author has had favourable experience. But even assuming that there is a chance of the iron of the tube being attacked by oxidation, it would be some years before that could take place if properly protected in the first instance, and doubtless by that time the tube would be silted up into a solid mass, which would insure the permanency of the Channel railway.

The following statement shows the weight of a 25ft. length of the tube:—

Weights.		Tons.
Tube, 25ft. length, cast iron		140
Wrought iron plate lining		12
Brick lining in cement		65
Screw pile boxes		5
Seaward bulkhead	16½	
Shoreward ditto	14½	
Slings (2 pairs)	20	51
Weight of each 25ft. length of tube ready for lowering		273

The following is the author's approximate estimate for the double line of tubes:—

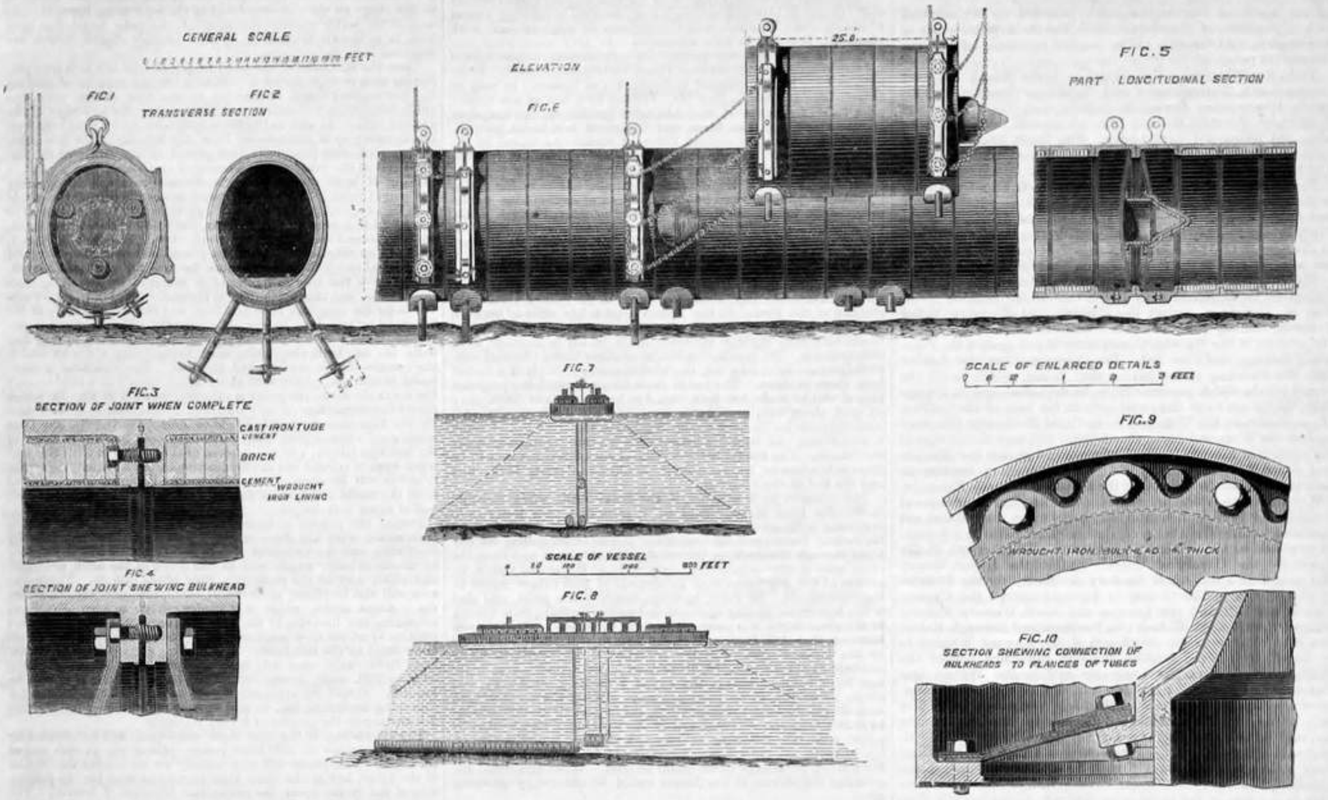
Tons.		
1,503,600	Cast iron tubes, tapped and fitted ready for fixing in place delivered f.o.b. in the Thames, at £7	£10,525,200
125,240	Wrought iron linings, bent, punched, and fitted ready for fixing, bolts and screws for fixing same, and screws for fixing together the lengths of tube, delivered f.o.b. in the Thames, at £15	1,878,600
1,628,840	Of iron work in the above items, including india rubber and iron cement for joints, painting and all incidental items, including pontoons and tenders, and all machinery required, screw piles for anchoring tubes, bulkheads, slings, chains, permanent way, &c., at £5	8,144,200
	Brickwork lining	300,000
	Contingencies, 2 per cent.	400,000
	Engineering, surveys, &c. &c., 2½ per cent. on £20,000,000	500,000
		£21,748,000

GENERAL CONSIDERATIONS.

With regard to the position of the two schemes, tunnel and tube, it would be affectation to pretend otherwise than that the projectors of the tunnel had got a very fair start. They have the countenance of the Governments of both countries, and the support of the two English railways which would be most directly affected by the scheme. At the same time, it may be assumed that both that countenance and that support would be readily transferred to any scheme palpably possessing superior merits. Now at the best, the tunnel scheme involves an immersion in a closed route 31 miles in length, and the contingency—which is not denied by its most strenuous advocates—of sudden and irretrievable ruin in construction by the occurrence of a fault in the lower chalk formation. In support of this latter position it may be observed—and it is a well-known fact—that the examination made by the French Government did not prove entirely satisfactory with regard to the state of the ground for tunnelling operations, and that indications were discovered near the French coast of the strata of the bottom of the Channel being in a disturbed state; that pockets and crevices filled with loose sand were discovered, which, if they extended to any great depth, would render tunnelling, if not impossible, at least too uncertain an operation to warrant a great expenditure. In further support of this, Professor E. Hébert, in August last year, read a paper at a meeting of the British Association at Bristol,

* Paper read before the Society of Engineers, by Mr. Perry F. Nursey.

BISHOP'S CHANNEL TUBE.



describing certain undulations of the chalk formations in the North of France. From these he argued the extreme probability that similar undulations or flexures would be found under the Channel, and if so, the tunnel would have to be constructed in a circuitous instead of a direct line. He added that it was already known that a fault, many feet wide, which began in the neighbourhood of Fécamp, intersected the tunnel line. Again, Mr. James Chalmers, in his pamphlet on the Channel railway, states that at the deepest point at which the tunnel could be driven, the head of water would give a pressure of 110 lb. to the square inch, and if at this point a pick or drill should penetrate a crevice connecting with the water above, the result might be the ruin of the entire undertaking. He states that an accident of this nature a few years ago, in the Lake district, not only flooded a valuable mine, but the jet of water passed through the body of an unfortunate miner as if it had been a rod of iron.

A distinguished member of the Geological Society, and a late president, Mr. Joseph Prestwich, who appears to doubt the feasibility of constructing a tunnel between Dover and Calais on account of the risk of meeting with fissures in the chalk, in the year 1873 read a paper before the Institution of Civil Engineers on "The Geological Conditions affecting a Submarine Tunnel between England and France." He is satisfied that a tunnel could be safely driven through the palæozoic rocks which underlie the Channel at more than 1000ft. below the surface, the attempt to pierce which would involve the construction of a tunnel to connect it with the existing railways on either side of the Channel of at least five times the length of the distance between Dover and Calais, thereby increasing the cost, the difficulties of construction, and of ventilation to such an extent as to deprive the work of any practical value, and remove it out of the category of works of useful or profitable enterprise.

In the discussion upon a paper read by Mr. W. Hawes before the Society of Arts upon the Channel tunnel, Mr. Bateman—to whose Channel tube scheme the author has previously referred—observed that he was anxious to see the project carried out, but it presented so many uncertainties and so many difficulties, that he could not recommend the attempt to be made. No human being could say that there was not some dislocation or fissure in the submarine line between Dover and Calais; and if such were the case, no human power could contend with the pressure of some 400ft. of water from an ocean channel. He thought the project was hazardous, and would prove a failure. Independently of these considerations, and as regards the question of cost, the author feels perfectly certain that Sir John Hawkshaw's estimate of £10,000,000 for 31 miles of tunnelling, with the lining of brickwork, the laying a double line of rails, the connections with other lines, and other accessories, would prove wholly inadequate. There would, unquestionably, have to be added to this a very large sum for contingencies and extras which would go far towards doubling the original estimate. On the other hand, and although the advocates of a tunnel may have their reasons to advance against a tube, the author contends that the latter, according to Mr. Bishop's plan, is a practicable scheme; and that although the estimate of £22,000,000 is a large sum, yet it will be sufficient to cover all expenses, and that the method proposed involves no emergencies that ordinary care and precaution, combined with engineering skill, cannot foresee and consequently provide against. Then, as to time; it is obvious that a long period will not be required for experiments in the case of the tube as in that of the tunnel, but after a final survey of the bed of the Channel—an undertaking of comparative ease—the works can be proceeded with forthwith. The fitting and preparation of the work ready for laying can be carried on upon the shore, and if required, can be proceeded with night and day. The author is fully alive to the fact that in either case the undertaking must be classed among the gigantic enterprises of the age, but he is fully prepared, after a careful study of the question, to accept the responsibility of carrying out such a work as he has described, provided that the necessary means be forthcoming. And he believes that no engineer, however much he may be interested in another direction, would pronounce such a tube to be an engineering impossibility.

Financial Considerations.

These latter observations bring the author back to the second and third of the three positions which he advanced at the commencement of his paper: namely, can the necessary capital be raised? and, will the undertaking pay? Twenty-two millions of money certainly appears to be a large sum to be raised. The amount, however, is only one-third of the annual return of the revenue of Great Britain, and one-eighth of the indemnity that France paid in two years, in addition to her other expenditure, and immediately after the war. Moreover, from the nature of the undertaking, the capital would only be required by instalments, as the works proceed, and would be contributed by England and France together, though not wholly by those two countries, for every other commercial people in the world must feel interested in the work, and it is anticipated that they will, doubtless, be ready to avail themselves of an investment that will not only accommodate, but also conduce to the enrichment of every nation. They will, however, have first to be shown that their investment will yield an adequate return, for they will put the author's question, "Will the undertaking pay?" In answer to this, the author would point out that as far back as 1866, Mr. James Chalmers, and also M. de Gamond, estimated the annual revenue of a railway connecting England and France at £1,300,000. Since that estimate was made there has been a great increase in the export and import trade. In the year 1866 the returns amounted to the sum of £590,121,706, and in the year 1873 they had advanced to the sum of £744,790,653, being an increase of £154,668,947 in eight years. In addition to the imports and exports, a large source of revenue is anticipated from the mail service; the sum paid for packet services by the British Government alone in 1872 being £1,028,501. There will also be a considerable sum to be realised annually from the telegraph companies in the shape of rental for the right of laying their wires through the tube. From calculations which have been carefully prepared, it is estimated that the annual revenue, when the traffic is fully developed, will be £2,500,000, a sum sufficient to pay 10 per cent. per annum on an extended capital of £25,000,000.

Conclusion.

The author believes he has now answered the three main questions with which he started as far as they possibly can be answered at the present time. He has demonstrated that a Channel railway carried in a tube is well within the limits of practicability. He has shown that there is a reasonable expectation of the capital being raised when required, and he has proved—so far as figures can prove—that the undertaking would be a commercial success. He has, moreover, he believes, advanced sufficient reasons for the preference of a tube as proposed by Mr. Bishop to a tunnel, whether carried through the lower chalk, or through the underlying Wealden formation. But should the time arrive for the execution of the project, whatever be the principle adopted, it can but have the best wishes and the hearty support and co-operation of all nations, for all nations will directly or indirectly be benefited in some degree by the establishment of a direct and unbroken means of transit between Great Britain and the Continent of Europe. The missing link in the chain of perfect communication with the Far East will thus have been established.

The Use of Pulverised Coal in Cupolas.—At the Edgar Thomson Steelworks, U.S., pulverised coal (or, rather, fine slack) is used in their cupola. There had been some difficulty with the cupola scaffolding, that is, the metal and coke solidified, and retarded the work. Mr. Jones, the manager, conceived the idea of forcing fresh fuel into the cupola through the tuyere holes, and thus melting down the salamander; and having taken out the tuyere pipe he rammed in a lot of small coal and again put on the blast. The effect was that in a few moments the entire scaffold was removed and the work proceeded as usual. To prevent any further delay from scaffolding, Mr. Jones has perforated the blast pipe, and now infuses a portion of small coal into the blast, which is carried by the blast through the tuyeres into the cupola, the effect of which is that the cupola has not scaffolded since, and indeed works so much better and so much more rapidly that only one cupola is now used where two was necessary before the blast was introduced. But this is not the only or most important advantage claimed for this discovery. It was well known to metallurgists that the great waste of iron in melting in a cupola occurs at the zone of the tuyeres, on account of the immense amount of air blown in and the absence of carbonic oxide at that point. What little carbon the air comes in contact with at this point forms carbonic acid, which is almost as destructive to the iron as free oxygen. The principal waste of the metal occurs after its fusion and in its passage through this carbonic acid and atmosphere. By the injection of the fine coal with the blast its combustion is secured at the zone of the tuyeres, producing carbonic oxide, and thus preventing the oxidation of the descending metal. The descending column of coke and metal retards the upward flight of the coal, consequently it is projected downward and forms a projecting covering on the face of the liquid metal and prevents its oxidation. The tuyeres are as bright as those of a blast furnace at a temperature of 1000 deg. Fah., and the wall of the cupola are glazed. This improvement not only saves the waste of the iron but it also transmits to the converter a much larger percentage of the carbon which the pig contains, a very important consideration. In conclusion, this improvement, it is claimed, is not limited to the Bessemer process, but would be of great value in all cupolas for melting iron for castings, as the great difficulty in that line is that the carbon is burned out of the metal. It is stated that the plan is especially suitable for stove plate manufacturers, as it will not only save the loss of metal but will make the metal run more fluid and produce finer and tougher castings.

A Long Tunnel.—The transactions of the Institution of Civil Engineers contain a very interesting paper by Herr L. Markus on the use of boring machines at Schemnitz. The deep adit level known as Joseph II.'s adit at Schemnitz, which was commenced in 1782, is intended to be of a total length of 17,827 yards, or about 1420 yards longer than the St. Gothard tunnel. Of this length 15,320 yards have been driven by hand labour during the course of 92 years, leaving two sections unfinished, one of which is 1504 yards and the other 1000 yards long. In the latter section the use of machinery was commenced experimentally in the year 1873, and was continued at intervals during the following year. In the first series of experiments one machine of Sachs' construction was used, the average depth of the bore-holes being 1·3ft., which were charged with dynamite, and fired by means of fuse. The average daily advance of the level, which was 8·5ft. high and 6·9ft. broad, was 2·1ft. In the second series two machines were used, and the charges were fired by electricity; the result was a daily advance of 3·28ft., the rock being, as in the first series, a moderately hard trachyte (rhyolite). In the third series two machines on an improved frame were used, the holes being 2·3ft. deep; the advance was 9·8in. per day in greenstone. In the fourth series, when the men were becoming better acquainted with the use of the machines, the average length driven per day was 4·8ft. Great difficulty was at times experienced in the use of the electrical apparatus from miss-fires, especially when the air in the level was highly charged with moisture. It was found most convenient to have two machines, which were used alternately, and only taken into the mine when the holes were loaded and ready for firing. It was also considered desirable not to fire more than twelve holes at one time. In order to obtain a basis for comparison with hand labour, a fifth series of experiments was made by twelve selected miners, working four at a time, eight-hour shifts, under continuous supervision; when it was found that twelve men in four days advanced the level 11·5ft., equal to 2·9ft. per day, thus producing somewhat less effect than a single machine. Although the latter works at a disadvantage as compared with hand boring, on account of the time taken up in adjusting the stand and the accessory operation of laying railways and bringing up air and water pipes, and also because of the necessity of clearing away the whole of the rock blasted in one operation before beginning upon a new face, the author considers that there is an undoubted saving in time to be effected by the use of the machine. The most advantageous method of arranging the bore-holes is considered to be in four vertical lines about equal distances apart, but having the holes in the centre rows somewhat closer together than those at the side, there being six in each of the former series, and only four in the latter. By this arrangement, a uniform depth of 2·3ft. being adopted as a standard, the stand only requires to be fixed twice for each set of twenty holes. The two central rows are loaded to a third of their depth with dynamite and fired first, making a deep notch in the face. This increases the effect of the side holes, which are fired subsequently with a somewhat smaller charge. Deep holes are not considered economical, as their effect is not found to be in proportion to the increased consumption of dynamite, besides being more uncertain than shallower ones. In conclusion, the author compares the results obtained with those of the St. Gothard Tunnel in 1873, when the drift at the Göschenen end was advanced, by six of Francois and Dubois' machines, 6·2ft. per day, or 20·4in. per machine; while at Schemnitz at the end of 1874 two of Sachs' machines drove at the rate of 3·4ft. per day, or 20·5in. per machine. In the former case 62·6 per cent. of the total depth of holes bored proved effective, while in the latter the proportion was 75·2 per cent., a result which the author attributes to the electric ignition, and the method of firing adopted. The cross sections at Schemnitz is 58 square feet.