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A
COMPLETE ACCOUNT
OF THE
CLIFTON BRIDGE

BY W. W. WEBB.

Issued under the sanction of the Directors

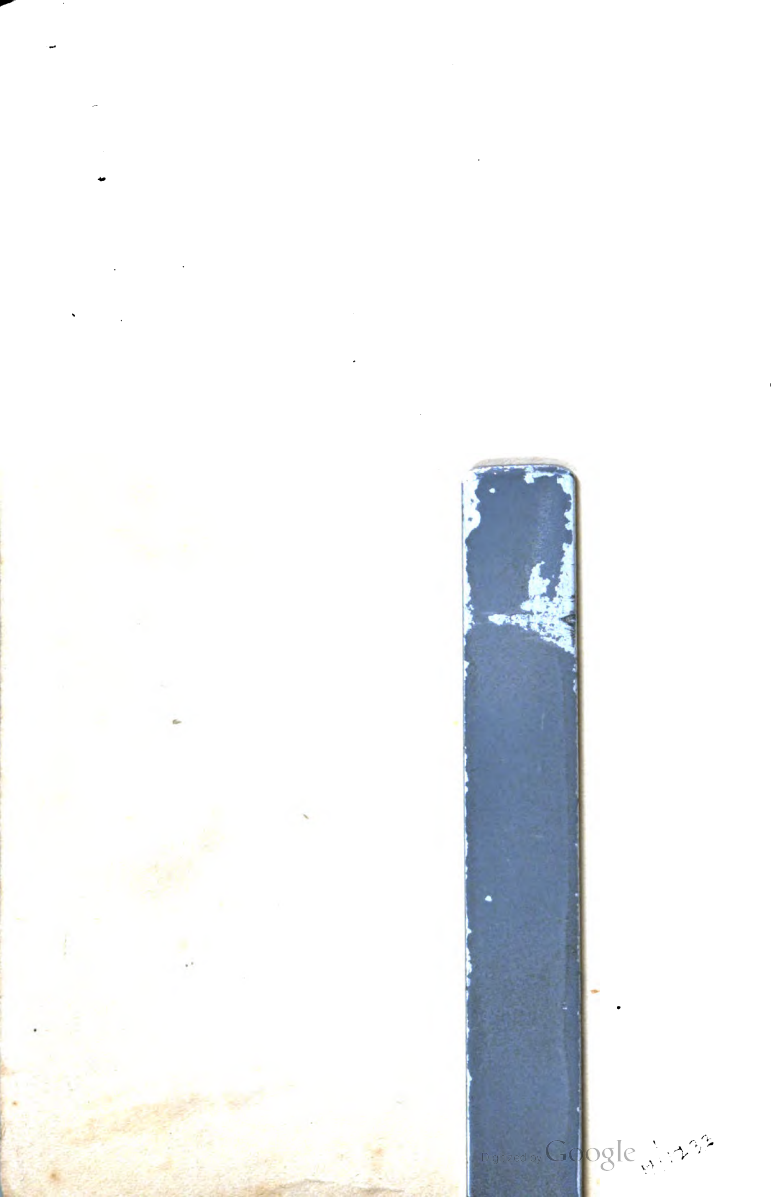


BRISTOL

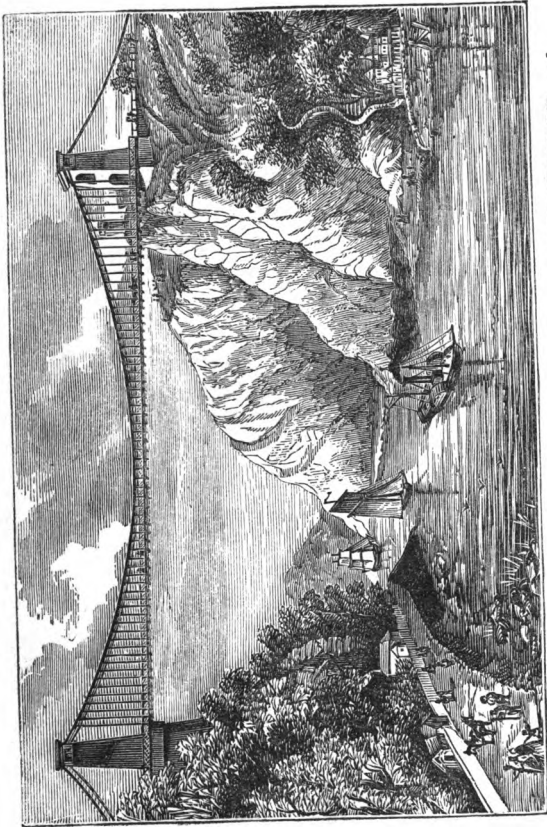
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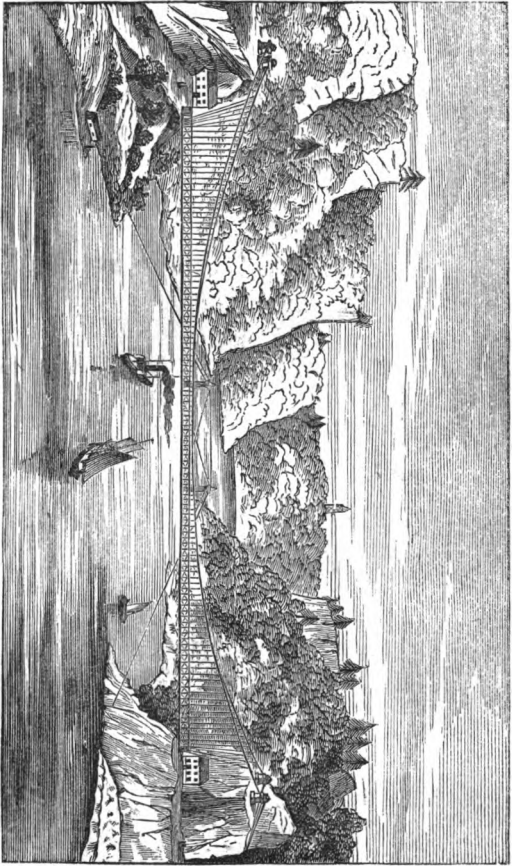
**SECOND
EDITION**



BOL



**The CLIFTON SUSPENSION BRIDGE, erected by Messrs. J. HAWKSHAW, C.E., and
W. H. BARLOW, C.E. Span 703 feet.**



**THE WIRE BRIDGE, erected by Lieut. Col. E. W. SERRELL, C.E., over the NIAGARA.
Span 1040 feet.**



A
COMPLETE ACCOUNT
OF THE
ORIGIN AND PROGRESS OF THE
CLIFTON
SUSPENSION BRIDGE,
OVER THE RIVER AVON.

BY
W. W. WEBB.

SECOND EDITION.

(ISSUED UNDER THE SANCTION OF THE DIRECTORS.)

Entered at Stationers' Hall.

“ This Bridge will ever exist to repeat to the most remote generations : Here stood a rich, industrious, and powerful city. The Traveller at this sight will imagine that some great Prince sought to signalize the end of his reign by many years of labour, and to immortalize the glory of his actions by this imposing structure.”

BRISTOL :
PUBLISHED BY THE AUTHOR,
SOLD ON THE BRIDGE, AND BY ALL BOOKSELLERS.

1865.

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ARROWSMITH, PRINTER, QUAY STREET.



THE
CLIFTON SUSPENSION BRIDGE.

ON the 1st December, in the year 1753, Mr. William Vick, Wine Merchant, and Alderman of the City of Bristol, gave all his residuary estate in manner following, viz. :—Two-thirds to his sister Rebecca Vick, her executors, administrators, and assigns, to her and their own use, charged with the payment to the Society of Merchant Adventurers in Bristol, of the sum of £666 13s. 4d. within two years after her decease, for the uses thereinafter mentioned; and the other third of his residuary estate he gave to his good friend and partner, Roger Watts, his executors, administrators, and assigns, to his and their own use, charged with the payment of the sum of £333 6s. 8d. to the said Society of Merchants within two years after his decease;

and for securing the payment of such sums, he directed that his sister and the said Roger Watts should, within one year after his decease, severally enter into bond to the then Master of the said Society, or to such person or persons as the said Society should direct, in a sufficient penalty, and with a sufficient surety, for the payment of the said sums respectively ; and in case either of them should neglect to give such bond, that then the devise to him or her so neglecting of the said proportion of his residuary estate should cease, and he gave such proportion to the said Society of Merchants, upon the trusts thereafter mentioned ; that was to say, whereas he was of opinion that the erecting a stone bridge over the River Avon, from Clifton Down, in the County of Gloucester, to the opposite side on Leigh Down, in the County of Somerset, for carriages as well as horse and foot passengers, toll free, would be of great public utility ; and he had heard and believed that the building of such bridge was practicable, and might be completed for less than £10,000 ; for the advancing and effecting of so useful a work, and for the encouragement of contributions thereto, he directed that the two

sums above mentioned should, when received, be placed and continued out at interest by the said Society of Merchants, either on their own, or on the Chamber of Bristol, or on Government security, until the same should, with the interest or proceeds thereof, accumulate and increase to the sum of £10,000. And in order thereto he directed that when and as soon as £100 or less than £100 (if the same could be invested) should arise and be in hand for interest, such £100 or less sum should be placed out at interest, and made principal until such accumulation or increase was effected; whereupon he requested and directed the said Society of Merchants to lay out the said sum of £10,000 or as much thereof as should be necessary in erecting such stone bridge and in defraying any needful expenses thereabouts, either for obtaining an Act of Parliament to be enabled to carry on and complete such work, or for making satisfaction to the proprietors of Rownham Ferry, or for purchasing of such ferry, if either should be necessary or otherwise; and the surplus, if any, after the building and completing of such bridge, he directed to be applied by the said Society of Merchants to such charitable

use as they should think proper: and his will further was that the said Society of Merchants should be at liberty to lay out or contribute the said trust money for the use aforesaid, at any time before the accumulation or increase thereof, in case other moneys should be given or contributed, which together with the then amount of the trust estate should be deemed sufficient for such undertaking; and his will expressly declared that in case the said Society of Merchants should decline or refuse to lay out the said trust money for the uses aforesaid when such accumulation or increase was effected, or that the erecting of such bridge should be then deemed impracticable, unuseful, or improper, then he gave such trust moneys to the Mayor, Burgesses, and Commonalty of the City of Bristol; and directed the said Society of Merchants to pay over the same to them, or to the then Chamberlain of the said City for their use, in trust, as for and concerning the sum of £4000, part of the said sum of £10,000, to be by the said Chamberlain of Bristol lent out, interest free, on bond, with sufficient sureties, to such young honest and industrious clothworkers, residents of the parish of Minchinhampton, in the County

of Gloucester, as should apply therefor, in sums not exceeding £100 to one person, and for such term of years not exceeding ten years, as the said Chamber of Bristol should think proper; and in case no application from such clothworkers, or the number applying should be insufficient to exhaust such sum of £4000, then he directed that the said sum of £4000, or what should be left thereof, should be applied by the said Chamber of Bristol in increase of, or addition to, the fund of loan moneys, interest free, to young burgesses of Bristol, in the manner such loan moneys were then lent, or in any other manner as the said Chamber should think proper. And as to the sum of £6000, being the remainder of the said £10,000, he directed that the same should be applied by the said Chamber of Bristol towards the founding, erecting, and maintaining an hospital for illegitimate children, and to be added to any subscription or contribution for that useful and much wanted charity, under and subject to such trusts, directions, limitations, and restraints, as the Chamber of Bristol should think proper; and until the said sum of £6000 should be so employed, he directed that it should be added to the said loan money fund

and lent, interest free, to young, honest, and industrious burgesses of Bristol, in manner above mentioned.

He appointed his sister Rebecca Vick and Roger Watts joint executors, who proved his will in the Prerogative Court of Canterbury, on the 25th February, 1754.

The legacy was duly paid to the Society of Merchants, who invested the money, and the interest continued to accumulate until the year 1830, when the fund amounted to about £8000.

In consequence of the great anxiety which the citizens then manifested for the accomplishment of the work, the Society of Merchants were induced to take into consideration the best course to be adopted for the purpose of commencement.

The inadequacy of the fund at disposal to defray the cost of the work, and the consequent necessity of levying tolls for raising the additional sum required, and the desirability also of the substitution of an iron for a stone bridge (the estimate for the latter being £90,000) were considerations which rendered an Act of Parliament unavoidable.

A committee consisting of several members of the Society of Merchants, the Mayor of Bristol, the Governor of St. Peter's Hospital, and the President of the Chamber of Commerce was appointed to take steps to ensure an early completion of the work.

They therefore advertised for plans, and these having been submitted to them, they proceeded with the assistance of Mr. Telford to take them into consideration; but having due regard to picturesque effect, it was on examination ascertained that none of the plans delivered were suitable to the site selected, and Mr. Telford was therefore requested to prepare a design adopted to the boldness of the cliffs, and the beauty of the surrounding scenery.

Two styles of architecture were considered; single columns like the Monument at London, or Gothic towers. The last was preferred for the following reasons:—That it would best harmonise with the elegance of the suspension principle. That it would preserve the effect of the bridge from being overpowered by the surrounding scenery. That columns would have no historical claim to the spot, whilst the fact of St. Vincent's Chapel and Hermitage having

been founded on the rock, gave a consecrated locality to the scene.

Keeping these considerations in view, Mr. Telford prepared and submitted to the trustees a singularly beautiful plan, which we will describe in his own words.

“The magnitude and magnificence of the situation determined upon required much thought in forming a suitable design.

“With a view to stability and general effect, I have disposed of the space to be passed over into four parts, two of which are given to the middle and one to each side. The contracting the middle opening between the points of suspension and making the sides each equal to one-half of it lessens the stress upon the main chains, equalises the angles on each side of the piers, and guards against the effects of violent gusts of winds which must be expected in that deep and narrow valley, while by increasing the apparent height the magnificence is also improved.

“Suspension Bridges have a singularly light appearance; in order to harmonise with this mode of construction, the Gothic style of architecture has been adopted for the supporting

piers, in which although each is a considerable mass, yet being composed of slender parts the whole corresponds with the portions of the structure, which consists of iron work.

“Here, as in other instances of very lofty piers built under my direction, they are intended to be hollow with interior longitudinal and cross walls ; this lessens the quantity of material to be employed, ensures correct workmanship, and in very high and large buildings causes the mass sooner to dry and indurate : in the present case it affords a useful space for stairs to pass up to a gallery at about half the height of each pier.”

The estimate made by Mr. Telford for the construction of a bridge from this design was £52,000.

Before adopting any plan the trustees determined to apply for an Act of Parliament ; meanwhile an engraving of Mr. Telford's elegant design was prepared, and thousands of copies were disposed of.

The first Act of Parliament was not obtained without some opposition. Improvements are, unfortunately, often opposed by prejudice ; and vested interests will sometimes clash with public accommodation.

The opposition, however, on this occasion was of no serious character, as will be seen hereafter.

In the will of Mr. Vick satisfaction is directed to be made to the proprietors of Rownham Ferry, or for purchasing such ferry if either should be necessary.

This ancient horse and foot ferry passed to the Dean and Chapter of the Cathedral Church of the Holy and Undivided Trinity of Bristol by Royal Grant, and by the Dean and Chapter it was, in 1862, transferred to the Ecclesiastical Commissioners for England, by whom it has since been sold to the Corporation of Bristol.

There is no other passage between Pill and Cumberland Basin, and although the accommodation at Rownham is as good as it can possibly be, it is insufficient for the convenience of the immense number of persons crossing the river in our time. Sir Eardley Wilmot, in alluding to this subject, said, "I cannot help feeling, on looking at this ferry and the magnitude of the city, that it is a signal instance of how far a useful institution, in providing for the convenience of the inhabitants, has outlived the demand for it. Other institutions have gone ahead in every part of the city; but they

found the old ferry remaining there as in the time of Queen Elizabeth, who was such a benefactor to the city of Bristol; and if a person living in those days could again come alive, the only place that would be familiar to him would be the banks of the Avon; and he would exclaim, 'Here am I, and here is the ferry as it was three hundred years ago.' "

Notwithstanding Sir Eardley's condemnation of this ancient institution, the ferry is a very valuable one, and the title to it can be carried back to a date long before the time of Queen Elizabeth, as will be seen from the following extract:—"When Robert Fitzhardinge, grandchild to the King of Denmark, who came into England with William the Conqueror, whose mother Godive was sister to Robert Duke of Normandy, father of the said William, in the fifth of King Stephen, in 1140, began the foundation of the Abbey of St. Augustine by Bristol, which he finished in the thirteenth year of King Stephen, 1148, and on Easterday, then on the 11th April, 1148, the said Church and Monastery was consecrated and dedicated by the Bishops of Worcester, Exeter, Llandaff, and St. Asaph to the honour of God and St.

Augustine, the English Apostle; and they inducted the Abbot and the Black Canons of the Order of St. Victor. At the same time the said Robert, by his deed laid down upon the altar, endowed the said monastery with the manors of Almondsbury, Horfield, Ashelworth, Cromhall, Cerney, Blacksworth (of which Rownham Ferry forms part), and divers lands in Erlingham in the county of Gloucester, and the manor of Leigh, near Bedminster, and the manor of Bilswick juxta Bristol, wherein the monastery is seated, all which, upon his blessing, he enjoined should be for ever observed. He after became a Canon in the said monastery, and died in the seventeenth year of King Henry the 2nd, in 1171, and lyeth buried in the entrance into the choir."

This monastery was dissolved in 1539, and was one of the great abbeys that went to the Crown. It was afterwards erected into a bishoprick by Henry VIII., in 1542, who endowed it with part of the manors and lands of the old monastery, amongst which was the Manor of Leigh, near Bedminster. We find that the reversion of this manor was, by deed dated 25th May, 1550, granted by Bishop Bush

to King Edward VI., who subsequently granted it to Sir George Norton and his heirs for ever.

Charles II., by his royal grant, conferred upon the Dean and Chapter (amongst other manors) the Manor of Blacksworth, in which, as before-mentioned, is "the passage of Rownham." The merry monarch doubtless knew more about the locality in question than did good Queen Bess; and if the King could come alive again he would probably exclaim, "Here are the banks of the Avon *unaltered*, and here is the ferry which, after the battle of Worcester (Sept. 3rd, 1651), I passed to safe shelter in the old manor house of Abbot's Leigh."

The ferry was formerly fordable, and, "if we have writ our annals true," we find that in the year 1610 the son of Baron Sir George Snigge, Recorder of this city, was drowned in attempting to ford "the passage of Rownham."

The River Avon rises near the northern boundary of Wiltshire, "marching in stately path" westward of Brandon Forest to near Malmesbury, thence to Chippenham, and on "to wondrous Bath and Bristol fair." It is seventy-eight miles long, and drains an area of nine hundred square miles. It enters the

Bristol Channel just below the mouth of the Severn.

The channel of the Avon is almost dry at low water, but on the flow the tide rises to a height of forty-five feet, and it has been calculated "that upwards of ten millions of tons of water are every twelve hours poured into and out of the Avon," the tide running up and down with a velocity varying from two to four knots per hour.

But to resume. The Dean and Chapter, in 1830, very properly insisted on having "the satisfaction" referred to in Mr. Vick's will. The Chapter Clerk of that day (Mr. Geo. Rogers, who held the office over fifty years), estimated the compensation to be paid to the capitular body for the supposed injury to the ferry at £200 per annum. He wished to have that amount secured by the Act, and to be paid to the Dean and Chapter half yearly; but Lord Shaftesbury was of opinion that the protective clause proposed by the bridge trustees was amply sufficient to guard the interest of the owners of the ferry, and he would not grant more. This clause forms part of the existing Act of 1861 hereafter referred to. It

states that "persons having a right of ferry across the River Avon, called Rownham Ferry, may in some respect be injured by the building and using of the bridge; and it is fit, in case such ferry should be injured or deteriorated thereby, that a fair compensation should be made; and it directs the Company to make compensation for any injury in value, or deterioration which may be done."

Although the proposed bill for 1830 was a deviation from Mr. Vick's will, no person appeared in opposition in that respect but a Mr. James Acland, who at that time had gained some notoriety by the publication of a small paper called "The Bristolian." Mr. Acland petitioned the House of Commons against the measure, the ground of his opposition being that the bill was a deviation from Mr. Vick's directions, and an injury to the reversionary objects of the trust; but at this time there were few, if any, cloth workers at Minchinhampton, and the Common Council of Bristol, at a meeting held on the 2nd February, 1830, resolved to support the application to Parliament, and to render their assistance and co-operation in the prosecution of the measure.

B

The opposition was unsuccessful, and the first Act received the Royal Assent on the 29th May, 1830.

Under this Act the Bridge Fund was vested in the Master for the time being of the Society of Merchant Venturers of Bristol, the senior Sheriff for the time being, and Thomas Daniel, Esq., and their successors, with power to appoint additional Trustees.

In pursuance of this power the undermentioned persons were appointed :—Messrs. John Savage, James Adam Gordon, John Haythorne, George Daubeny, John Cave, Joseph Haythorne, Thomas Stock, Philip Protheroe, John Scandrett Harford, George Hilhouse, Abraham Hilhouse, John Evans Lunell, John Hare, Thomas Kington, William Fripp, James George, Edward Sampson, Joseph Cookson, Isaac Cooke, William Wright, Henry Bush, Daniel Wade Acraman, George Thomas, Thomas Richard Guppy, Charles Payne, John Winwood, Rev. James Lewis, John Acraman, John Hare, Junr., Nicholas Roch, Thomas Carlisle, Henry Andrews Palmer, George James, Edward Bowles Fripp, and William Singer Jacques.

Messrs. Jere Osborne, and Richard Brickdale Ward, were appointed Solicitors of the Trustees; and Robert Fletcher, Esq., was appointed Accountant.

As many persons had promised donations, and others had agreed to advance moneys by way of loan, the Act was accordingly framed upon that liberal principle. The tolls of the bridge were made applicable to the payment of interest on the loans; but the subscribers were not constituted a Joint Stock Company.

The Trustees, immediately after the passing of the Act, obtained from a select number of the most eminent engineers designs for the bridge; and as the plans submitted by Mr. Telford, Mr. Brunel, and three others, appeared to possess superior merit, they were reserved for special consideration.

On investigation it appeared to the Trustees that the undertaking could not be effected at a cost much below £50,000 upon any plan, having regard to main objects, strength of materials, and grandeur of design.

Being unwilling to depend on their own judgment, the Trustees had recourse to the

assistance of Davies Gilbert, Esq., formerly President of the Royal Society; and in March, 1831, he visited Clifton for the purpose of inspecting the locality.

After a very laborious examination of the several plans, and much consideration and consultation, the result was the rejection of Mr. Telford's plan, and the unanimous adoption by the Trustees of the design submitted by Mr. I. K. Brunel.

This design took for the base of the supporting tower on Clifton Down the boldest of the whole range of St. Vincent's Cliffs.

From a lofty perpendicular rock, rising to an altitude of 230 feet above high water mark, projecting towards the bank of the river, and affording a natural pier, it proposed to carry the bridge across the immense chasm to an abutment to be built in Leigh Woods on the opposite side.

In selecting this design the Trustees stated,—
“That a chain bridge suspended amongst such stupendous rocks would in itself appear little more than a fairy web thrown across the gulf; but this effect would be relieved and a high degree of architectural beauty as well as

grandeur imparted to the work by giving to the towers erected for the support of the chains the form and proportions of Egyptian gateways, taken from the beautiful examples found in the ruins of Tentyra. Of the various forms there presented, the most elegant have been chosen as the model; and that this style of architecture, from its grandeur and simplicity, is peculiarly suited to rocky situations, is proved by the Temple of Philæ, which is a barren rock of the most broken and romantic outline."

Mr. Brunel estimated the cost of constructing the bridge on his design at £57,000.

The Trustees then issued a Prospectus, in which they set forth the advantages of the proposed work; and they stated "that from Clifton and the western side of Bristol, in which direction the population had of late years, owing to various causes, been gradually moving, a direct communication would be opened with a very populous district of the country on the Somersetshire side of the river, bordering on the Bristol Channel, whereby the value of land would be greatly increased, an additional impulse given to its improvement, and im-

portant advantages afforded in the supply of agricultural produce to the inhabitants of Bristol and Clifton.

“That those were some of the immediate benefits which would result from the undertaking ; but there were others in prospect upon which the city might calculate, and the accomplishment of which this undertaking would have a natural tendency to accelerate. That the bridge would open a direct road between Clifton and the watering places of Clevedon (remarkable for the beauty of its surrounding scenery and the mildness of its climate) and the sheltered retreat of Portishead, shortening the distance upwards of four miles, and avoiding the other inconveniences of the old road ; and, in addition to these considerations, a very important source of benefit to the neighbourhood, and to the undertaking, would be derived from the continual influx of visitors which a structure of such unrivalled grandeur and magnificence would attract.”

A very excellent lithograph copy of Mr. Brunel's design (from a drawing by Brooke Smith, Esq.), was issued to the public. The landscape in this view was very beautifully

shown, and the bridge was a true copy of the original design, with all its elaborate ornamentation.

In 1831 the Trustees determined to commence the work, and, after breakfasting at the Clifton Hotel, and being accompanied by Sir Abraham Elton, Bart., and his lady, and by a considerable concourse of ladies and gentlemen, they proceeded to the projecting rock. The first stone was then excavated under the direction of Mr. Brunel, and delivered by him to Lady Elton in token of the commencement of the work, who thereupon expressed the warm interest she felt in so great and important an undertaking, and her hope that the labours of the Trustees might be prosecuted prosperously, and brought to a happy termination. The event was announced by the discharge of artillery, and by the band of the Dragoon Guards playing the National Anthem, after which Sir Abraham Elton addressed the meeting. He said "he considered the object for which they had met as one promising the most important consequences, and interesting not only to the City of Bristol but also to the world at large.

Anxiously desiring the welfare of the city, he thought it became him to declare his sentiments; and he believed that the accomplishment of their object would make Bristol, already distinguished amongst the cities of the empire, yet more renowned."

The following sonnet, by the Poet Bowles, was written on the occasion :—

ON THE SUSPENSION BRIDGE AT CLIFTON.

(*The first stone laid June 20, 1831.*)

O'er the red rocks and woods, and streams below,
 Ev'n from this loftiest peak that frowns sublime,
 As if to mock vain man, and baffle time,
 Artist, thy fairy-web of network throw,
 Bridging the fearful chasm! The sea-beat trow
 And the tall-masted ship, diminished, seem
 Like small canoes, as toiling up the stream
 They work their difficult way, laden and slow.
 But look beyond: there the proud Severn rides,
 On—on—in sunshine, to Atlantic tides!
 Speak not these works of nature and of art—
 Oh! speak they not to every human heart?
 Yes; *one* proclaims the emmet of an hour—
 The *other*, God's eternity and power!

The land required for the bridge, and the roads and approaches on the Clifton side, was liberally presented by the Society of Merchants,

the lords of the manor, who have since munificently given up 230 acres of Clifton Down as a place of resort and recreation for the citizens and inhabitants of Bristol.

The Trustees afterwards took the necessary measures for procuring further subscriptions and donations, and for purchasing the land for the abutment and approaches on the Somersetshire side; but owing to various unforeseen causes, and particularly to those calamitous events which happened in this city in 1831, the Trustees were unsuccessful, and from that time to the end of the following year very little was done in obtaining subscriptions.

In the early part of 1833 the Trustees resumed their efforts, in the hope that the period was arrived in which a further public appeal would prove effective. They devoted much time to the object, and no inconsiderable sum was the result; but the amount was not sufficient to justify them in proceeding with the work without either resorting to the power of borrowing money or sacrificing the ornamental portion of Mr. Brunel's design.

Subsequent events combined to destroy for a long time all hope of obtaining further sub-

scriptions, and therefore the Trustees took into consideration how far it was practicable to proceed by means of the funds at their disposal.

They thereupon consulted Mr. Brunel upon the subject, who informed them that the construction of a bridge of equal strength as that originally designed, omitting certain portions of the work, but capable of afterwards being completed according to his design, could be accomplished considerably under his original estimate.

The passing of the Great Western Railway Bill in 1835 created for a time a new spirit of enterprise in the city, which induced the Trustees to believe that if they again set about the work with renewed vigour the public would come forward and aid them to accomplish the undertaking. They therefore determined to proceed with earnestness as far as their funds would permit, and to sacrifice, if necessary, the architectural ornamentation.

This determination to depart from the original design created some dissatisfaction, and at a subsequent meeting of the Trustees the former resolution for proceeding with the bridge on the principle of dispensing with the ornamental

part of its construction, was unanimously revoked, and as additional subscriptions had been obtained, it was resolved to proceed with the work on the basis of the original design.

At a subsequent meeting Mr. Brunel was instructed to prepare working plans of the pier or abutment in Leigh Woods, and advertisements were issued for tenders for raising the stone required from the quarry granted by Mr. Miles.

In 1836, for the purpose of facilitating the works, an iron bar was hung across from Clifton Rocks to Leigh Woods, at points lower than the present piers. To this bar was attached a basket, in which the workmen were carried to and fro. As many persons applied for permission to cross the immense chasm by means of this suspended rod, the Trustees resolved to charge each person the sum of 5s. for car, or rather basket hire. This amount was subsequently reduced to 2s. 6d. The charge afterwards fell to 1s., and in 1853 the bar was removed, the total sum received from passengers by this somewhat dangerous contrivance being £125.

The preliminary arrangements for com-

mencing the construction of the Leigh Wood abutment having been completed and contracts having been entered into for the work, the foundation stone was laid on the 27th of August, 1836, by the Most Noble the Marquis of Northampton, on the occasion of the meeting in this city of the British Association for the Advancement of Science, at which meeting Lord Northampton presided.

On the morning of the memorable 27th August, at an early hour, thousands upon thousands of people came into Bristol, some rushing to the banks of the river and others to the Downs, the rocks, to Leigh Woods, and to every spot from which it was possible to view the ceremony.

The great point of attraction was the Clifton side, and every inch of that portion of the Down leading to the Observatory Hill was covered. Every place affording safe standing room on the cliffs was occupied. The whole line from the Observatory to the Sea Wall on Durdham Down was taken up. Looking across the river to the opposite woods the concourse appeared immense, and on the river (it was high water) were steam packets, wherries,

and boats, all crowded with the people in holiday attire.

The Trustees, and several other gentlemen who took part in the ceremony, met at Cumberland Basin, where the procession formed under the direction of Captain Claxton, R.N., the late indefatigable secretary of the company, in the following order :—

Men carrying Flags of all Nations.

Ships' Flags and Banners.

Band of Music.

THE MARQUIS OF NORTHAMPTON,

In his carriage, drawn by six noble greys. Postillions, wearing jackets of crimson satin, black velvet caps with gold tassels.

THE ARCHITECT, I. K. BRUNEL, Esq.,

Bearing the Inscribed Plate; the Trowel; the Mallet.

TRUSTEES of the Undertaking.

Four Hundred Subscribers and Friends.

LORD SANDON. SIR T. D. ACLAND.

The Magistrates.

MR. BRUNEL, SENR.

The General Steam Packet Company placed two of their splendid steam ships at the disposal of the members of the British Association. There were bands of music on board, and the ships were beautifully decorated for the occasion.

When the procession arrived at the opening in Leigh Woods it descended by a gangway formed for the purpose to the site fixed upon to receive the foundation stone. Commodious galleries or grand stands had been erected above for the special accommodation of those who had fortunately secured tickets.

The signal of "all ready" having been given, the Marquis of Northampton was handed a number of coins, together with the inscribed plate. His lordship deposited the coins in the proper spot, and then placed the plate, on which was engraved the following inscription :—

"The foundation stone of the south pier of this bridge, erected under the provisions of an Act of Parliament, of the eleventh year of the reign of his Majesty King George the Fourth, by means of subscriptions raised in aid of a fund created by Mr. William Vick, formerly a citizen of Bristol, was laid on the 27th day of August, 1836, in the seventh year of the reign of his Majesty King William the Fourth, by the Right Honourable the Marquis of Northampton, President of the sixth annual

meeting of the British Association for the Advancement of Science, held in Bristol, amidst the acclamations of a large concourse of the citizens, and of their illustrious visitors, Members of the Association.

PRINCIPAL DIMENSIONS OF THE BRIDGE.

“Distance between the two points of suspension, 700 feet; length of suspended roadway, 630 feet; height of roadway above high water mark, 230 feet; total width of floor, 34 feet.

“I. K. BRUNEL, Esq., F.R.S., Engineer.”

His Lordship after covering the plate then addressed the people, and said “It was with great pride and pleasure he had assisted in laying the foundation stone of this magnificent edifice. He trusted that the prosperity of Bristol would be as permanent as that erection, the foundation of which the many distinguished persons before them had countenanced by their presence. Science was the great connecting link of nation with nation, as this magnificent bridge would connect one point of that delightful valley with the other. In the bridge they would have an example of what science and art when combined with genius could effect; in it they would have an everlasting ornament for Bristol, and

an imperishable monument of the genius of Mr. Brunel ; a memorial of the munificence of the founder, William Vick ; and lastly, he trusted it would also serve as a remembrance of the visit of the British Association."

This concluded the ceremony. The procession then returned in the same order.

There were several displays of fireworks in the evening ; one piece, a model of the bridge, being very beautiful, was much admired.

A sketch of the bridge was afterwards engraved upon the silver trowel, together with a suitable inscription, written by J. S. Harford, Esq., who presented the trowel in the name of the Trustees to the Right Honourable the Marquis of Northampton, who in acknowledging its receipt, and expressing his acknowledgments to the Trustees for the complimentary inscription, conveyed his best wishes for the success of the undertaking, and also for the prosperity of the city of Bristol, to whose vicinity he trusted that the bridge would be a noble and enduring ornament.

The best thanks of the Trustees were also presented to Capt. Claxton, for his very useful exertions on the interesting occasion.

For some time after the commencement of the Leigh abutment the contractors proceeded with the work satisfactorily, but in the Spring of 1837, the progress was so trifling that the Trustees were obliged to take the works into their own hands, and shortly afterwards the contractors became bankrupt. These circumstances occasioned a delay of many months, but ultimately other contractors were found who entered into an agreement to complete the work.

The process of lifting the immense blocks of stone to the site of the abutment by ordinary machinery having proved tedious, a steam engine was erected for the purpose ; the work afterwards proceeded at a rapid rate, and was completed in 1840.

The tunnels and chambers in the rock for fastening the main chains and the excavations for the roads of approach were then commenced, and the whole of the iron work was contracted for.

The works progressed until the year 1843, when it appeared that the funds contributed up to that time, including Mr. Vick's gift, amounted to about £45,000, the whole of which had been

required for the prosecution of the works before mentioned, and the construction of one-half of the chains, suspending rods, and flooring of the bridge. There now only remained to be executed the ornamental additions to the piers (the cost of which was estimated at about £4000) the other half of the iron work, the suspension of the chains and rods, the construction of the flooring, the erection of the toll houses, and the completion of the roads, the estimate for the execution of the whole of which was £30,000.

Under these circumstances the Trustees again appealed to the citizens for support, and in so appealing they were reluctantly obliged to admit that failure in obtaining the sum required would lead to the abandonment of the work. They however believed that the possibility of such a result would be sufficient to induce the citizens to support them in the crisis, feeling that to abandon the undertaking would be a cause of lasting reproach to the city.

The Trustees, however, found it impossible to counteract the feeling of apathy which now took place—vexatious delays and unforeseen circumstances had unfortunately occurred, tend-

ing to lessen the public interest in the work, but over these circumstances the Trustees had no control; their efforts were frustrated, and in 1853 the works were stopped for want of funds—the total sum expended having been £45,000.

The time limited by the old Acts for the completion of the bridge expired on the 29th May, 1853. On the 11th July, 1853, arches were turned over the openings on both sides of the river, and the undertaking closed.

The Society of Merchants subsequently took possession of the land on the Clifton side, and railed off the abutment, thus affording the citizens access to the pier, commanding views, which, for extent and beauty, are perhaps unrivalled in any part of England.

The works were unfortunately abandoned on the very eve of completion. The portions of the chains, suspending rods, and flooring of the bridge, which were delivered at Clifton, were obliged to be sold by the Trustees for the purpose of satisfying the demands upon them. Many tons of iron work were disposed of, but one Trustee, "who had taken an interest in the bridge from the first, having been an

original shareholder," thought it due to himself to put on record that he objected to the sale. Many years have passed over the head of that much-respected citizen since he first took an interest in the work, but, "hoping to see the bridge constructed upon the same principle as designed by Mr. Brunel," he without delay joined the present company, and again gave his warm support to the undertaking. This induced others to "go and do likewise," and we are pleased to say that the gentleman referred to, has had the great satisfaction to witness the completion of this magnificent work.

In the year 1857 Lieutenant-Colonel E. W. Serrell, C.E. (of the United States, the Consulting Engineer of the American Government), who designed and constructed the Queenston and Lewiston Wire Suspension Bridge over the Niagara, of 1040 feet span, of which we give an engraving, proposed to complete the Clifton Bridge with supports of iron wire. We will describe to our readers the manner in which Colonel Serrell proposed to construct the bridge.

The span of the stretcher was to be 703 feet. The principal supports were to be iron wire cables. These cables were to be made of several thousand strands of wire, about the size of an ordinary lead pencil. They were to be done up in bundles, and wrapped round with soft wire, for the purpose of keeping them in place. From the cables the roadway was to be suspended in the ordinary way. On either side of the roadway a parapet of timber was to be built five feet high, so as to render the passage secure.

For the purpose of protecting the cables from rust, each strand was to be covered with an unoxidizable paint, and when the strands were formed in bundles, the interstices between them were to be filled in with boiled linseed oil and the oxide of Franklinite, for the purpose of cementing them and rendering them waterproof.

The roadway was to be $19\frac{1}{2}$ feet wide, similar to the deck of a ship, the planks being laid lengthwise. The estimated cost of the work was £17,000.

The proposal created much interest, but it ultimately fell through for want of sufficient support.

Many bridges of this kind have been constructed of great strength and durability.

There is a wire bridge 1010 feet span over the Ohio River, built in 1848 by the Hon. C. Elliot.

Another over the Niagara; called the Clifton Bridge, built in 1855, for the following account of which we are indebted to a gentleman who has recently visited the bridge :—

“The transatlantic Clifton Bridge is thrown across the river Niagara, just two miles below the celebrated falls of that name, which are visible from the bridge. It therefore unites Canada with the State of New York.

“The river itself is essentially different from the tidal waters of the Avon, being a wild and turbulent stream of very deep water (which to the eye is of an indigo blue colour), of apparently greater width than the Avon at its highest tide, almost constant in its volume and intensity, and full of eddies, one of which, just below the bridge, is, from its extreme violence, known as “the whirlpool,” and in which no boat can live. But the banks of the river are in their character and height very similar to those of the Avon at Clifton. From its shore the rocks rise at a steep inclination, clothed

with verdure and bristling with foliage, and with an occasional contrast of bare rock, while, notwithstanding that the falls are caught in the vista, the river winds and twists, especially below the bridge, with only less violence of curvature than with us.

“The bridge is constructed with a double roadway, one under the other—the upper one being a railway, that below a carriage-road; but instead of being macadamised, the roadway is boarded with planks, a by no means unusual way of finishing roads in the towns of Canada. Carriages can only pass in one direction at the same time, and they are restricted to a walking pace, and even thus the vibration caused by the heaviest railway trains above, is said to be less than that of the ordinary carriages below, although the latter is very trifling. The Americans do not appear to have profited by our experience of the evils of a diversity of gauge, for the bridge carries three different railways of three different gauges, viz., the Erie and Ontario Railway, 6 feet; the New York Central, 4 ft. 8½ in.; and the Great Western of Canada, 5 ft. 6 in.

“Instead of a large pier at each end of the

bridge, extending its full width, there are two corner towers—of no very great apparent massiveness—to carry the chains, or rather cables, for it is a wire bridge. There are but two of these wire ropes on each side, of $10\frac{1}{4}$ in. in diameter. One of these cables supports especially, or ostensibly, the railroad floor, the other drops to a deeper curve, to sustain the carriage road floor. No doubt, in fact, that by means of the suspension rods and other mechanical appliances, both floors are mutually supported by both cables, still the difference in the curve of the two, corresponds to the difference in the level of the railway and carriage way respectively; and this diversity of curve is less displeasing to the eye than might have been expected.

“There is a great deal of timber used in the construction of this bridge, and there is a perfect reticulation of iron and woodwork connecting the upper and lower roadways. There are also a great number of rods stretching diagonally to the rocks on either side. It is stated that the roadway underneath (which may be considered the subsidiary structure), instead of diminishing the stability of the

railroad above, materially increases it, and that the whole is unaffected by the winds, which frequently blow through the channel with great violence.

“This magnificent structure has stood the test of use for some years. It is 822 feet from pier to pier, and 258 feet above the water level to that of the rails on the upper floor. The height of the towers on the American side is 88 feet above the rock, and on the Canadian side 78. The width of the railway floor is 24 feet, outside measurement, or two feet less inside. The carriage road below is somewhat narrower.

“It is calculated that the aggregate strength of the cables is 12,400 tons; the weight of the super-structure only 800 tons; and of that with its maximum load 1250; while the bridge is calculated to sustain, if required, 7309 tons, giving a surplus strength of upwards of 6000 tons.

“The bridge was commenced in 1852, and has been in operation since 1855. Its architect or engineer was Mr. J. A. Roebling, of New Jersey, in the United States.”

The speed of the trains in crossing the bridge is about four miles an hour.

The St. John's Bridge, New Brunswick (also constructed by Colonel Serrell), has a span of 630 feet; distance between the anchorages 1,279 feet. This bridge, with the exception of the towers, is somewhat similar to the Clifton Bridge, and connects two parishes. The Clifton Bridge also connects two parishes, one of which is rapidly progressing to the proportions of a large town, (its ancient name was "The City of the Chasm,") and it also opens a communication with the counties of Gloucester and Somerset.

There is also the Fribourgh Bridge, in Switzerland, over the Sarine, 876 feet span, and 160 feet above the river, built in 1834 by Mons. Challey. The contractor received £12,000 for its construction, and the toils for forty years were assigned to him. In 1834 the official trial of the strength of this bridge was made, when fifty pieces of very heavy artillery and about 300 persons passed over the bridge, and charged successively every part of the platform. At this trial scarcely any oscillation was visible, but the platform sometimes sunk considerably at the point where the greatest weight was. On the opening of the bridge on the 19th October,

1834, 2000 persons passed over it in procession twice, when a horizontal oscillation of sixteen inches was observed.

It was not the first time that the attention of the Trustees had been drawn to wire bridges.

In January 1835, Mr. William West, under whose direction, the old Windmill on Clifton Down (erected in 1766), was converted into the building now known as the Clifton Observatory, submitted to the Trustees an interesting account of a visit he had made to Switzerland and France to view the suspension bridges constructed in those countries. His opinions and arguments made a strong impression on the Trustees, and they invited Mr. Brunel to a conference upon the subject, but after due consideration the Trustees were perfectly convinced that the adoption of wire could not be recommended either as regarded saving of expense or for any other reasons. Mr. Brunel stated "that there was a great difference between circumstances in England and the South of Europe. In the latter, wire as a manufactured article was cheaper for strength than iron, and £1 worth of wire would give greater strength than £1 worth of manufactured iron. In England it

was exactly the reverse, iron was cheaper here, and a ton of iron would be stronger than £10 worth of wire. That with regard to the Fribourgh Bridge, notwithstanding all the parade of artillery and men, heavy travelling carriages were not allowed to trot over it; and that was a bridge we should not like to have in this country. The Fribourgh Bridge was not a cheap bridge, it had cost £12,000 and the tolls for 40 years; and he had an account of eight foreign bridges which had fallen, and he was quite sure that flimsy bridges, like those to be met with abroad, would not suit this country."

Wire bridges of immense strength have however been since erected in England. We may instance the Lambeth Suspension Bridge, length 1040 feet, constructed by Mr. Barlow. This bridge is suspended by iron wire cables, carried over four pairs of towers, and forms three equal spans of 280 feet each. The strength of the cable is equal to 4000 tons.

Colonel Serrell's Lewiston and Niagara Bridge is the longest wire bridge in the world, and is the admiration of all beholders.

We must, however, remember that the celebrated engineer, William Tierney Clark, Esq.

(who was educated and apprenticed in this city), after building the Hammersmith Suspension Bridge, the Marlow Suspension Bridge, and the Norfolk Suspension Bridge, constructed the Pesth Suspension Bridge, over the Danube, 1227 feet in length, and 39 feet wide. This is a chain bridge, and connects the cities of Pesth and Buda. It was commenced in 1839 and finished in 1849 for £622,000. The Emperor of Austria greatly admired this magnificent structure, and testified his admiration by presenting to Mr. Clark a very valuable present on the opening of the bridge.

In 1860, a favourable opportunity presented itself for resuming the Clifton Bridge works, under the circumstances mentioned in the following extract from the speech of the chairman of the company (Mark Huish, Esq.), to the first general meeting of the shareholders, held at the Merchants' Hall, Bristol, on the 2nd. August, 1861.

The chairman, said "When he reflected on the time that had elapsed since the first conception of that bridge; when he remembered the disappointment that had occurred, and the

large amount of money that had been expended, the heartburnings that had arisen ; when he remembered all these things, he did feel some astonishment at finding himself in his present position, a stranger to them all, from a distant part of the country. He had associated himself with a number of gentlemen in London and elsewhere, practically to carry into effect an object which had been so dear to the hearts of so many gentlemen in Bristol, for a period of upwards of 100 years ; and he confessed that he felt somewhat to realise the imaginative anecdote of Lord Macaulay, he felt as though he was a New Zealander come among them, not to sketch the broken arch, but with other New Zealanders, to complete, repair, and renovate the Suspension Bridge. For thirty years past, the skeleton of the great work which Brunel designed and was instructed to carry out, had remained in an incomplete condition. It may be considered intrusive on the part of strangers to have interested themselves on the subject ; but it so happened that by fortuitous circumstances, an opportunity was afforded of applying one of the modern works of Brunel, which in the progress of improvements on the Thames

was about to be removed, to the completion of his older and more gigantic work across the Avon. The Hungerford Bridge was about to be taken down to make way for a larger and more imposing structure to carry the railway across the Thames, and it so happened that not only were the chains peculiarly adapted for completing the Clifton Suspension Bridge, but the span was pretty nearly the same. Altogether the opportunity was so favourable, that the principal members of the Civil Engineers Institute, who had an interest in the work as completing a monument to their late friend Brunel, and at the same time removing a slur from the engineering talent of the country, thought that so magnificent a work should not remain in an incomplete state. They associated themselves together, and purchased the chains and materials of the Hungerford Bridge (at a cost exclusive of the piers of £5000, subject to the purchasers being at the expense of taking them down and removing them), and entered into negotiation for the transfer of the works at Clifton to a new company. The chains were purchased, the piers were negotiated for, and after some time had elapsed a satisfactory settlement was effected with the late Trustees ; satis-

factory to us, satisfactory to them; for the property was worthless, and we gave it a value. These steps justified them in going to the people of Bristol, London, Liverpool, and Manchester, and soliciting their aid in the completion of the bridge. That application was responded to, to a very considerable amount of capital subscribed, and they then proceeded to Parliament for a Bill, which had passed into an Act without the slightest opposition."

The Act incorporating The Clifton Suspension Bridge Company received the royal assent on the 28th June, 1861. Messrs. George Parker Bidder, Isaac Allen Cooke, James Ford, Douglas Galton, John Robert Hall, Mark Huish, John William Miles, and William Smith Nicholson, were appointed the first Directors of the Company, who appointed John Hawkshaw, Esq., F.R.S., and W. H. Barlow, Esq., F.R.S., Engineers; Messrs. Osborne, Ward, and Co., Solicitors; Captain Claxton, R.N., Secretary; and John Curtis, Esq., Accountant to the company.*

* Capt. Claxton resigned in 1865, when John Curtis, Esq., was appointed Finance Secretary; and Robert Coles *Esq.* Managing Secretary.

Under the provisions of this Act, the piers and land on both sides of the river were transferred to the Company, in exchange for paid up shares to the extent of £2000.

A sum amounting to £50 a year is to be annually paid over by the Company to the former Trustees of the bridge, who are maintained as Trustees for the purpose of securing the object of Alderman Vick's bequest, namely, a bridge toll-free. Meanwhile tolls are payable in respect of foot passengers, horses, and carriages; but the Act contains the usual exemption clause in respect to soldiers, including our National Guard, the volunteers.

The dividends of the Company are limited to $7\frac{1}{2}$ per cent. per annum, but the deficiency of any one year is to be made good out of any surplus profits beyond $7\frac{1}{2}$ per cent. in any subsequent year.

Any surplus profits, after satisfying dividend and arrears of dividend, are to be paid over to the former Trustees of the bridge, who are to apply such moneys in the purchase of any moneys borrowed under the borrowing powers of the Company, or of any portion of share capital, but not at a less rate, if compulsorily, than £1

for every shilling dividend in the preceding year.

And the Trustees may receive from any person or Corporation any moneys or shares for the purpose of aiding in rendering the bridge free from toll.

Many of the Trustees named in the first Act of Parliament, and of the others subsequently appointed, are no more.

The surviving Trustees are John Savage, John Scandrett Harford, Abraham Hilhouse, John Evans Lunell, Joseph Cookson, George Thomas, Thomas Rd. Guppy, Edward Bowles, Fripp, Henry Andrews Palmer, Thomas Lane Coulson, Nicholas Roch, and Robert Bruce, Esquires, who have had the gratification of witnessing the completion of the great work.

It was proposed (before the passing of the Act) to construct the bridge 24 feet wide, giving a roadway of 16 feet, with two footways of 4 feet each, but an arrangement (the terms of which are incorporated in the Act) was made between the Directors and Sir John Henry Greville Smyth, Bart., whereby in consideration of the enriching influence the bridge will have on the land on the Somersetshire side, the

wealthy baronet agreed to take shares in the Company to the amount of £2500, and to give a donation of £2500, in aid of the expenditure of the Company. In consideration of this donation, no toll or payment whatsoever during the first 30 years after the opening of the bridge, is payable by the owner for the time being of Ashton Court estate, personally, or in respect of horses and carriages passing over the bridge; and in consequence of the aid thus afforded the bridge is 30 feet wide; being 5 feet less width than was intended by Brunel.

A very handsome model of the bridge, constructed by Mr. James Lane, the Grove, Battersea Rise, at a cost of £100, was placed in the Great Exhibition of 1862, and attracted much attention; it was afterwards liberally presented by the Directors of the Company to the Mayor and Corporation of Bristol, by whose directions it has since been placed in the vestibule of the Bristol Athenæum, where it remains for inspection, free of charge.

No unnecessary delay took place in the removal of the Hungerford chains; meanwhile

the preliminary work at Clifton commenced, under the very able direction of Thomas Airey, Esq., the superintending engineer of the work.

Mr. Airey commenced by carrying over iron wire coils, 1100 feet long, and weighing two tons each. There were nine coils, three of which were placed on the site of the south chain, and three on the site of the north chain. Upon these a wooden gangway, or platform, was fixed. Two other coils were then raised about four feet above the platform, and formed handrails. The remaining coil was fixed high above all, and was used for the purpose of carrying the iron and other work to place. This coil was therefore called the "traverser."

There was another contrivance in the shape of the cradle or box suspended to the handrails, and worked by pulleys.

These preliminary operations were difficult, and occupied a considerable time, but they were all completed without accident.

The process of fixing the main chains was next commenced. The chains had to be conveyed per "traverser," and afterwards put together link by link, at the rate of about forty a day.

The first main chain on the south side having been securely fixed, a second was safely carried over it, and then a third—the three completing the south main chain.

The difficult and laborious process of removing the coils and platform to the north side then had to be achieved, and this having been accomplished, the second or north main chain was securely carried, the course of proceeding being precisely similar to that with respect to the south chain. During the fixing of the north chain, the weather was not so favourable as before, but the work was happily accomplished without accident.

The next step was the longitudinal girders. These are fixed in lengths, each length measuring about sixteen feet, and weighing about a ton. The two girders enclosing the carriage way are formed of forty lengths; these are connected with the main chains by the suspending rods mentioned hereafter.

There are eighty cross girders, eighteen inches deep and thirty-three feet long, weighing about a ton each. These are bolted underneath, and project six feet from the sides of the longitudinal girders; and on these

projections are formed the two footways of five feet wide each.

The chains and other iron work taken down from Hungerford, and removed to Clifton, consisted of 1040 tons. These were insufficient to complete the bridge, and the Company had therefore to prepare 200 tons of additional chains and 300 tons of girder and iron work.

Great praise is due to the directorate, the engineers in chief, to Mr. Airey, and to the contractors, Messrs. Cochrane and Co., for the rapid and satisfactory manner in which the undertaking progressed; but in the language of the Chairman "their efforts would have been in vain if they had not such firm foundations to proceed upon; and we must not forget that these foundations were laid by Brunel."

We will now in imagination visit this engineering work, which is of its kind unparalleled in this country.

Proceeding from the magnificent Clifton Hotel, we in a few seconds arrive at the bridge, and our attention is first drawn to the main chains. These chains are embedded in the tunnels and chambers formed in the rocks, and

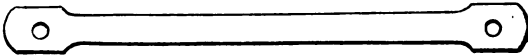
are fastened to an anchorage 70 feet below the level of the road. From this anchorage they are carried up to the saddle of the supporting pillar on the Clifton abutment, a distance of 220 feet; from the pillar they are carried across the chasm, 703 feet wide, to the saddle of the supporting pillar on the abutment in Leigh Woods, from thence they are continued on to an anchorage similar to that on the Clifton side.

The span from saddle to saddle is 702 feet 3 inches; the clear span between the abutments is 627 feet; the height of each pillar, exclusive of the iron cap, is 73 feet, and including cap 86 feet; the width of the carriage way is 20 feet; the footpaths are each $5\frac{1}{2}$ feet wide; the rise of the roadway in the middle of the bridge is two feet four inches.

The whole of the ironwork of the bridge is about 1500 tons. Of these 1100 tons consist of plates and pins, constituting the main chains, and there are about 20 tons of suspension rods.

The links of the chains consist of plain bars with swelled ends, each about seven inches wide, one inch thick, and twenty-four feet long, with pin holes or eyes $4\frac{3}{8}$ inches in diameter.

There are 4200 of these links, shaped thus :—



The main pins are $4\frac{5}{8}$ inches in diameter, and about 25 inches long, with a screw at each end. The number of pins used in connecting the links is 400.

The suspension rods are $1\frac{5}{8}$ inches in diameter, 8 feet apart, and vary in length from 65 feet to 3 feet. They number 162, and are of wrought iron. Every one is calculated to bear a weight of 80 tons. The handrail is of the best American heart oak.

In nearly all the suspension bridges we have before alluded to, the roadway is formed of wood. The floor of the Hammersmith Bridge is, however, macadamized. A somewhat similar floor was suggested for the Clifton Bridge. It was proposed to lay about 3 inches of hard gravel on a roadway formed of wrought iron. Mr. Brunel considered timber beams preferable to iron, and he was of opinion that the platform should be of a solid and substantial character, but that it should be covered, if found expedient, with a coating of gravel. He however subsequently proposed to dispense with

the gravelling, and to cover the planking with a preparation similar to that used at Scottiswood Bridge. Colonel Serrell proposed a roadway similar to the flush deck of a ship. The beams were to be of hard pine, and the flooring of spruce. Messrs. Hawkshaw and Barlow have formed the carriage road of sleepers of Baltic timber braced together, over which flooring planks are laid transversely.

We now cross the bridge, at an altitude of 245 feet above the winding Avon, and we have before us the great abutment in Leigh Woods. The apparent size of this work is dwarfed by the grandeur and extensiveness of the scenery surrounding it. There are but few persons who are aware of the large dimensions of the mass of masonry presented to the view. The foundation stone is nearly 130 feet above the river, and the total height of the abutment itself, up to the floor of the bridge, is about 110 feet. The whole mass consumed upwards of 500,000 cubic feet of masonry, and the total cost of the work, including the pillar, was £13,971.

While walking upon this splendid bridge,

suspended at the enormous height of 245 feet, and uniting rocks which at some remote period were doubtless rent asunder, we are struck with the beauty of the scene before us, "apparelled in all the glory and freshness of a dream." Where in all England is a finer panoramic view? On the one hand we gaze upon sea, river, rock, and wood, and on the other, on a diversified landscape, stretching as far as the eye can reach, and having in the distance, which rises an immense height, the well-known Tower of Dundry, over which four centuries have rolled.

Considering everything in connection with this bridge, it may well be said that the work is without a parallel in this kingdom, and it reflects great honour upon those who have been instrumental in its creation.

"God's blessing on the architects who build
The bridges o'er swift rivers and abysses.
Before impassable to human feet."

The Act of Parliament limits the weight to be carried over the bridge by wagons, &c., to six tons, and limits the weight of persons and carriages to be on the bridge at the same time to 28 tons. It is the general opinion that the

greatest load to which a bridge can be subject is a body of soldiers marching in close columns; but according to the calculations made by the late Mr. Brunel, "the greatest weight per square foot which can be produced on a road is that arising from a dense crowd of persons. This does not exceed 110 lbs. per foot even when full sized men are crowded together as close as possible, and it rarely amounts to 60 lbs. per square foot. We may therefore take 120 lbs. per foot over the whole floor as a greater weight than a bridge can ever have to support." And he adds, "A regiment of infantry marching has been thought to be a more severe trial of strength of a bridge than a mere crowd of people, but I believe this idea to be entirely erroneous. In the first place, infantry in marching order cover a very considerable space, even in close column; 1600 men would cover the whole carriage way of the bridge, and would not weigh above 145 tons; and in open columns, which is the usual order of marching, 800 men would cover the same space, and weigh only 73 tons, while the weight of the chains and floor would be upwards of 1000 tons; so that even if all the

men stepped together the effect of their impulse upon such a mass, elastic as it must necessarily be, would be very trifling. But this case does not occur in practice, for if the best disciplined troops marching in the best order and to music—take for instance the Foot Guards going to parade—be carefully watched, it will be seen that, instead of rising and falling all in one body, there is a wave formed which does not extend to the fortieth man, or in other words, the fortieth man crosses step with the first; and when marching on ordinary occasions, this wave does not extend beyond the fifteenth or twentieth man, so that this weight, although in motion, ought not to affect the bridge more than an equally heavy dead weight. And in practice it does not; for I have seen infantry march over a very light suspension bridge—‘Pont de la Place de Gréve,’ in Paris—without producing any peculiar effect, although in this case the men weighed nearly as much as the bridge.”

The test load applied to the Clifton Bridge, in November, 1864, was 500 tons of stone distributed over the surface of the carriage roadway. Under this load the deflection in the

middle was seven inches. The saddles approached each other one inch, and on the load being removed, the bridge very nearly assumed its original position.

It has been erroneously stated that suspension bridges are not liable to oscillation, even in the most exposed situations; but we frequently passed the Hungerford Bridge, and found that when many persons were upon it, or the wind was blowing briskly, a swinging was produced which was inconvenient. The wind has a similar effect upon the Menai Bridge; and Mr. Provis, who was the resident engineer of that bridge, states, in his description of the work, that he found by experience that the undulations during a storm were produced in the first instance by the lateral swinging of the chains.

We find recorded some interesting facts in respect to expansion and contraction of the chains, consequent upon the changes in the temperature. There is another effect to be provided against, which is that of the expansion of the outward plate when exposed to the direct rays of the sun. An elevation of temperature causes an expansion sufficient to

relieve the plate from a portion of the strain, and it appears that with the action of the sun on the one side and a cold wind on the other, the cold part of the chain has to bear the greatest part of the weight.

Proper precaution has of course been taken against expansion and contraction, and allowance made accordingly; we are assured that the bridge is stronger than was intended by Brunel, and is, in fact, the strongest suspension bridge in the world.

It will be remembered that the Hungerford Suspension Bridge was taken down for the purpose of making way for the Charing Cross Railway Bridge. It is a remarkable fact that almost as soon as the chains were delivered at Clifton, they again encountered the rail.

The Port and Pier Railway, which was opened in March, 1865, and made for the purpose of furnishing to merchants, and others engaged in the commerce of Bristol, rapid means of communication between the city and docks and the mouth of the river, runs from Avon Mouth along the margin of the river to the Clifton pier of the bridge, and from that point it is to be extended so as to connect it

with the railway termini, at Temple Meads. To accomplish this work, it is proposed to bore through St. Vincent's Rocks, and to tunnel for a distance of 536 yards from the Clifton Station. The bridge works, however, are protected from injury, and the railway company are not, without the consent of the bridge company, to excavate or disturb any of the rock lying under or adjacent to the Clifton pier.

The Portishead Railway is formed (in part) on the opposite bank of the river, and passes the Leigh abutment of the bridge; but in this case also there is a clause in the Act of Parliament for protection of the bridge company.

The tunnel of 536 yards before mentioned, will form no great obstacle to the extension of the Port and Pier Railway. Tunnels in former years were considered great difficulties, and were avoided as much as possible; but after the formation of the Box Tunnel on the Great Western Railway small tunnels were deemed but trifling works. The Box Tunnel, it will be remembered, is one of Brunel's stupendous undertakings. It is one mile and three quarters in length, forty feet in height and thirty feet wide. It is 400 feet below the summit

of Box Hill, and millions of travellers have passed through it without the slightest inconvenience.

But all this is digression. Let us return to the bridge.

The question of the advantage of the Clifton Suspension Bridge has long since been determined. Upwards of 100 years ago it was deemed a work of great public utility, and in 1830, as we have before observed, the Trustees pointed out the advantages then to be derived from the work. We may now be allowed to enlarge upon these advantages.

The opening of the bridge has already led to the formation of a Company, who have purchased Leigh Woods (about 168 acres) at a cost of £40,000. The object of the Company "is to preserve from destruction that portion of this far-famed locality which comprises the Hanging Woods, Nightingale Valley, and the other picturesque and romantic spots which, from their beauty and close neighbourhood, add so essentially to the unrivalled scenery of Clifton. The remainder of the land is to be

applied to the erection of first-class buildings, so as to establish upon a site so admirably suitable, a suburb worthy of its contiguity to Clifton."

The united population of the adjacent villages of Ashton, Clevedon, Clapton, Tickenham, Wraxall, Flaxbourton, Abbot's Leigh, Nailsea, Portbury, St. George's, and Portishead, is over 30,000. To these agricultural districts the bridge is of great advantage, enabling the agriculturists to supply the markets of Clifton, from which they were formerly excluded.

In addition to this, it cannot be doubted that the Somersetshire side of the Avon will be much resorted to by visitors, and by the wealthy inhabitants of Clifton using carriages for the purposes of recreation. The scenery on that side is very celebrated, and the shaded walks and drives are numerous and delightful.

We have stated that the united population of the eleven parishes and villages above mentioned is over 30,000. On the Gloucestershire side of the bridge we have two parishes, Clifton and Redland, whose united population is about the same; and the nine adjacent parishes are also thickly populated.

They contain the mansions, villas, and dwelling houses of our bankers, merchants, and traders.

As regards Clifton, the Downs, Sneyd Park, Westbury, and Henbury, the sites commanding beautiful views of the Avon and the Bristol Channel have been selected, regardless of cost. Many first-class mansions are already erected, and others are in course of erection.

As respects Redland, Cotham, and Horfield—less favoured but yet very delightful localities—detached villas are being built by hundreds, and Churches and other places of worship spring up in every direction.

We now turn to the Somersetshire side of the river, and we find a comparatively small population, chiefly of an agricultural class. There are but few mansions, no detached villas, no large dwelling houses—few houses, in fact, of any class.

The reason of this is, that the inhabitants of Bristol and Clifton have been hitherto shut out from the Somersetshire side. The bridge now opens to them a new country, and presents advantages which will be quickly embraced.

The building land at Clifton is nearly all appropriated, and the few remaining acres will

doubtless command a very high price. The city is not only largely increasing in its working, but also in its wealthy population. The former is driven out by the conversion of dwelling-house property into warehouses; the wealthy inhabitants of course seek sites for the erection of mansions suited to their respective wants and tastes, and the first-class shopkeeper and trader select suburban villas. The bridge opens building sites probably not to be surpassed, commanding extensive views of the Bristol Channel. The plans proposed by the Leigh Woods Land Company, will doubtless be followed by other plans yet more extensive, and it is not going too far to assert that Abbot's Leigh will, in no great space of time, become as thickly populated as Clifton.

Leigh possesses great advantages over Clifton, beautiful as the latter really is. Leigh has its woods and downs, sheltered walks, and extensive views, and it will doubtless become the retreat of those wealthy individuals who seek quiet and repose.

But it is not the rich and wealthy who alone will enjoy the advantages of the communication; the sylvan woods of Leigh, have ever

been the favourite resort of the people, and when we assure our readers that upwards of 380,000 persons formerly crossed the river annually by means of boats, it will be seen that the bridge is a great convenience to the masses.

THE OPENING DAY.

The ceremony in connection with the opening of the bridge took place on Thursday, December 8th, 1864. There were three processions.

THE MILITARY PROCESSION

was under the command of Colonel Bruncker, and formed in the following order :—

The Naval Reserve
(under Commander Field, R.N.).

The Queen Charlton Troop of North Somerset Yeomanry
Cavalry

(under the command of Capt. Haviland).

The Stapleton Troop of Royal Gloucestershire Hussars
(under the command of Capt. Cruger Miles).

The Troops of Yeomanry
(under the command of Major A. B. Savile Royal G. H.).

The Bristol Volunteer Artillery, with 6 guns
(under the command of Lieut.-Col. Savile).

The Bristol Volunteer Engineers
(under the Command of Major Pearson).

The Bristol Volunteer Rifles
(under the command of Lieut.-Col. Bush).

The troops assembled in Princes' Street and Queen Square, and at ten o'clock they moved off the ground, the route taken being *vid* Thunderbolt Street, Broad Quay, the Drawbridge, College Green, Park Street, Queen's Road, Clifton Church, Royal York Crescent, Princes' Buildings, Caledonia Place, the Mall, Portland Place, and Gloucester Row. On the arrival at the bridge the Naval Reserve and the dismounted Artillery passed over to the Leigh Woods side.

THE BRIDGE PROCESSION

formed on the road leading from the Clifton Hotel, and was arranged in the following order :—

Contractors—Messrs. Cochrane and Grove.

Superintendent of Works—Mr. T. Airey, and the Bridge Workmen.

The Naval Reserve.

The North Somerset Yeomanry Cavalry.

The Royal Gloucestershire Hussars.

The Bristol Volunteer Artillery, with six Field Guns and Band.

A Detachment of Bristol Volunteer Engineers and Band.

A detachment of Bristol Volunteer Rifles and Band.

Col. Brunker and Staff Officers.

Officers of Army, Navy, Militia, & Volunteers in Uniform

Field Officers of Volunteer Corps.

Consuls of various Nations.

The Rt. Rev. the Lord Bishop of Gloucester and Bristol.

Bishop's Chaplain. Bishop's Secretary.

The Very Rev. the Dean of Bristol.

The Residentiary Canons.

The Incumbent of Clifton.

The Incumbent of Christ Church.

The High Sheriffs of the counties of Gloucester and Somerset.

The Right Honourable the Earl of Ducie
(Lord Lieutenant of the County of Gloucester and of the
City and County of Bristol).

The Right Honourable the Earl of Cork
(Lord Lieutenant of the County of Somerset).

The Members in Parliament for the Counties of
Gloucester and Somerset.

Noblemen and other Invited Guests.

Chairman of the Bridge Company—Mark Huish, Esq.

Deputy Chairman—Capt. Douglas Galton.

Directors :

G. P. Bidder, Esq.

I. A. Cooke, Esq.

J. Ford, Esq.

J. W. Miles, Esq.

Capt. W. S. Nicholson.

A. J. Knapp, Esq.

Engineers—J. Hawkshaw, Esq., W. H. Barlow, Esq.

Solicitors—Mr. C. E. Ward, Mr. C. G. H. St. Patrick.

Secretary—Capt. Claxton, R.N.

Accountants—Mr. J. Curtis, Mr. W. W. Webb.

Auditors—Mr. J. Bush, Mr. T. T. Pike.

The Shareholders in the Company.

The Rt. Worshipful the Mayor of Bristol, attended by
the Officials of the Corporation in State.

The Recorder. The High Sheriff.

The Magistrates.

The Aldermen and Town Councillors.

The Master, Wardens, and Commonalty of Merchant
Venturers of Bristol.

The Governor, Deputy Governor, Assistants, and Guardians of the Poor.
 Presidents and Office Bearers of Oddfellows, Foresters, Druids, Shepherds, Friendly Societies and Trades.

THE CIVIC PROCESSION.

The trades and friendly societies assembled in the Old Market Street, and proceeded to the Council House, from thence in the following order :—

Body of Police.

The Right Worshipful the Mayor of Bristol (W. Naish, Esq.), accompanied by the Treasurer, Sword Bearer, Mace Bearers, and Civic Officers, in State.

The Governor (Dr. Robertson), Deputy-Governor (J. Linter, Esq.), and Members of the Corporation of the Poor.

Messrs. Derham Brothers Military Band, in uniform.

John Mills Kempster, Esq., Mr. H. E. Allen, Mr. John Parsons, and Mr. Grace, the chairman and honorary secretaries of the Procession Committee.

The Iron Bedstead Manufacturers, carrying various models of their trade.

Printers, with Printing Press at work.

Band.

The Sawyers, with banners and emblems.

The Gold Beaters, with banners and emblems.

The United Carvers, Gilders, and Picture Frame Makers, with banners and emblems.

The Cork Cutters, with banner, models, and emblems.

Band.

The Bristol Branch of Stone Masons, with banners and emblems.

Band of North Somersetshire Yeomanry.

The Plasterers and Painters, with banners, models,
and emblems.

Band.

The Workmen of Derham Brothers, Shoe Manufacturers,
with banners and emblems.

Aerated Water Manufacturers (Messrs. Withy and Co.),
with machinery in motion.

Band.

The Boiler Makers and Iron Shipbuilders, with banner,
various models, machinery in motion, emblems, &c.

Band.

The Coach Makers, with banner, show carriages,
models, &c.

Band.

The Brass Founders, Finishers, and Copper Manu-
facturers, with banners, models, emblems, &c.

Band.

The various Fire Brigades.

Lithographic Press in motion—Mr. J. Lavars.

Band.

Cabinet Makers, &c. (U. Alsop's), with banners, models,
and emblems.

Band.

The Hatters, with banner, models, and emblems.

Band.

The Agricultural Implements Makers, Wheelwrights, &c.
(Messrs. A. and T. Fry's), with models, emblems, &c.

Band.

The Shipwrights, with banners, models, and implements
Cabinet Makers (Mr. A. Brown's).

Mr. Hodder's car.

Boys of Bristol and Clifton Union Schools, with bands.

The United Ancient Order of Druids Benefit Society,
with banner and regalia.

Band.

The Ancient Order of Foresters and Shepherds. Bristol United District, with banners, badges of office, scrips, crooks, &c.

Band.

The Ashton Unity of Shepherds, with banners, regalia, and emblems.

The Provincial Grand Conclave, Past Arches, Provincial Arch Chapter, and Brethren of the Ancient Order of Druids.

Band.

The Independent Order of Odd Fellows, Manchester Unity, with banners, silver regalia, and scarves.

The District Grand Master, Officers, and Brethren of the Ancient Order of Free Gardeners, accompanied by Practical Gardeners.

Band.

The Bristol Hibernian Benefit Society, with banners, &c. Car drawn by eight horses (Mr. Ginnett).

The procession proceeded by way of Corn Street, Clare Street, St. Augustine's Parade, College Green, Park Street, Queen's Road, Richmond Terrace, Clifton Church, Royal Crescent, Prince's Buildings, Caledonia Place, the Mall, and Portland Place, to the right, by Manilla Hall, to Litfield Place, Clifton Turnpike, and down the Bridge Valley Road, on which and the adjacent towing path it halted during the ceremonial of opening the bridge.

The approach to the bridge, on the Clifton side, was lined by detachments of the Bristol

Volunteer Engineers and Rifle Corps ; and the ground in the immediate vicinity was kept by Superintendent Handcock and a body of Bristol Police.

The approach on the Leigh Woods side was lined by the Naval Reserve, the Somersetshire Volunteer Artillery Corps (under Captain Sir A. H. Elton, Bart.), and by the Bristol Volunteer Artillery Corps, Chief-Constable Valentine Goold, and a body of Somerset County Police kept the ground.

THE GRAND STAND.

A commodious stand, with chairs for the accommodation of ladies and gentlemen was erected in the roadway of the Clifton approach.

THE BRIDGE.

The boys of Queen Elizabeth's Hospital, and also of Mr. Colston's Hospital, and Mr. Colston's Temple School, marched with their bands to the bridge, and were ranged on the footpaths.

THE OPENING CEREMONY.

The bridge procession passed over the bridge from Clifton at 12 o'clock, and on its arrival on the Leigh Woods side, a salute was fired by the guns of the Volunteer Artillery, stationed

in the woods ; and the procession, with the exception of the Naval Reserve, Cavalry, and Artillery right about faced, and recrossed the bridge.

On the return of the Lords Lieutenants in front of the grand stand, the ceremony of opening the bridge took place. The chairman read an address, at the close of which he said "that the new body of proprietors, have been enabled in less than four years to finish this grand work of art—a work highly creditable to their distinguished engineers, and calculated to be of the greatest local utility. In drawing their labours to a close, and on the occasion of dedicating the bridge to the service of the public, the Directors congratulate themselves on the presence of her Majesty's representatives for the counties of Gloucester and Somerset. They confidently believe that the result of their exertions will be conducive to the public weal, and that the structure which they now deliver over to your lordships officially to open (a structure as grand in its proportions and beautiful in its details as it is unrivalled in its position), will form a bond of social union between the counties as enduring

as the chains which now, for all time, indissolubly link them together." He then requested the Lords Lieutenants to declare the bridge open as from the following morning, and thereupon the Earl of Ducie for the county of Gloucester and city and county of Bristol, and the Earl of Cork for the county of Somerset, accordingly declared the bridge open for public traffic.

Hearty cheers were then given for the Directors, the Engineers, Captain Claxton, and others, amidst a salute from the Artillery—the bands playing the National Anthem—and the interesting ceremony terminated.

Thus was "the stamp of public approbation given to the Company, who have carried out a great scheme with zeal, energy, and fidelity; and the Clifton Suspension Bridge now stands a monument of refined science among the wild beauties of one of the most glorious landscapes that ever adorned the vicinity of a city."

A P P E N D I X .

LIST OF SUSPENSION BRIDGES.

TELFORD'S MENAI BRIDGE OVER THE CONWAY.

Span between pillars	579 feet.
Span of the Catenary	570 "
Versed sine	43 "
Height from high water to roadway	100 "
Height of pillars above roadway	50 "
Span of each of the arches	52½ "
Breadth of roadway	28 "

divided into a footway of 4 feet wide in the centre, and two carriage ways of 12 feet wide each.

Number of suspension chains 16, each composed of 5 bars, and each bar having a section of 3½ inches.

SERREL'S QUEENSTON AND LEWISTON BRIDGE. (see plate)

Total length of cable	1245 feet
Distance between towers	1040 "
Length of roadway.....	849 "
Clear width of roadway	20 "
Number of cables	10 "
Strength of Bridge.....	835 tons

BARLOW'S LAMBETH SUSPENSION BRIDGE.

Total length of cable 1040 feet

Width of roadway 32 "

Clear width of roadway 20 feet, and two footways 5 feet each.

The cables are carried over 4 pairs of towers. There are 3 spans of 280 feet each.

ELLET'S BRIDGE, over the Ohio, at the city of Wheeling, has a span of 1010 feet, and his wire bridge over the Niagara, at Belle Vue, has a span of 798 feet.

SERREL'S ST. JOHN'S BRIDGE, New Brunswick, has a span of 630 feet, and the length of cable from one anchor pit to the other, is 1279 feet.

CHALLEY'S FRIBOURGH BRIDGE, over the Sarine, has a span of 876 feet, and is 167 feet above the river. The other bridge at Fribourgh, is in length 941 feet, height 180 feet, breadth 22 feet 11 inches. It was completed in 3 years, and cost £25,000

There is also the **NASHVILLE BRIDGE**, 538 feet span, and there are about thirty other bridges, smaller than those above referred to, in other places.

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AND

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ROYAL INSURANCE BUILDINGS, CORN STREET,
BRISTOL.

Total
Annual Revenue.
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Funds in Hand.
£1,000,000.

CAPITAL,—TWO MILLIONS.

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H. C. W. MILES, Esq.	CHAS. E. WARD, Esq.
H. J. EVANS, Esq., Cardiff	E. J. PHILLIPS, Esq., Newport.

Physician :—Dr. SYMONDS.

Surgeon :—S. H. SWAYNE, Esq.

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on application at the District Office or of any of the Local
Agents.

PERCY M. DOVE, Esq., <i>Actuary.</i>	HENRY B. O. SAVILE, Esq., <i>District Manager.</i>
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