

Teverone. This bridge was blown up during the panic caused by the approach of Garibaldi to Rome in 1867.

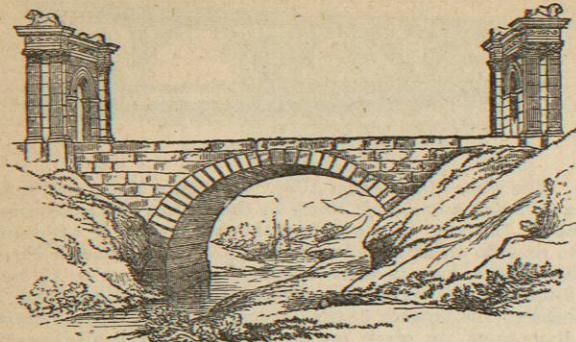


FIG. 106.—Bridge at St Chamas.

We see here, perhaps, one of the earliest examples of the castle built to protect the bridge against an enemy or to enforce payment of a toll,—the bridge and castle of mediæval romance.

§ 74. 1000 to 1300 A.D.—A very bold arch over the Serchio near Lucca is shown in plate 58 of Hann and Hosking's treatise, with the approximate date of 1000 A.D., but the authority for this date is not given. The span of the arch is 120 feet, and the roadway, which stands at a height of more than 60 feet above the water level, is only 9 feet wide; in fact the arch is little more than a broad

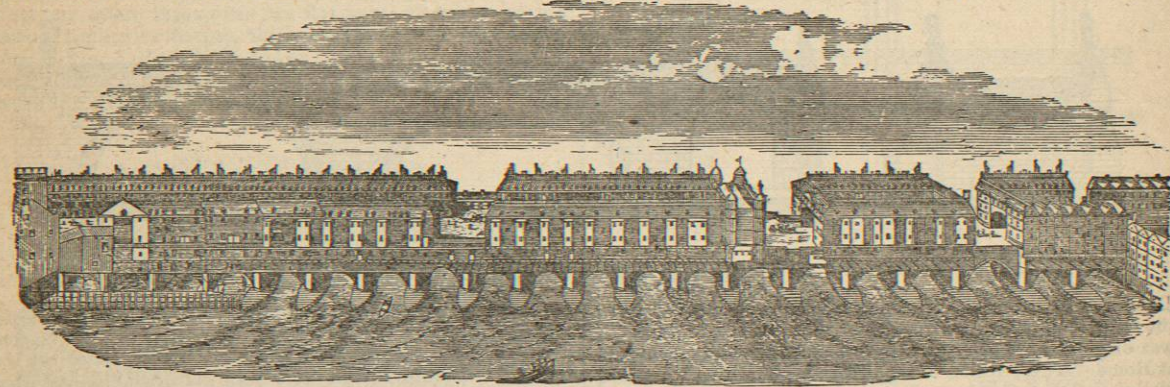


FIG. 108.—Old London Bridge, A.D. 1700.

present London Bridge, but it seems quite uncertain when the first bridge over the Thames was built. There is little doubt, however, that it was of timber, and had frequently to be reconstructed. Stow, in his *Survey of the Cities of London and Westminster*, gives a description of the building of the first stone structure, commonly called Old London Bridge, Plate XVIII. fig. 1.<sup>1</sup>

Heavy repairs were frequently necessary, and the timber houses built on the bridge were often burnt down; yet the main structure appears to have remained unaltered until

<sup>1</sup> "About the year 1176 the stone bridge over the river Thames at London was begun to be founded by the foresaid Peter of Colechurch (called priest and chaplain before), "near unto the bridge of timber, but more towards the west, for I read that Botolph's wharf was in the Conqueror's time at the head of London Bridge. The king assisted this work, a cardinal then being legate here; and Richard, archbishop of Canterbury, gave one thousand marks towards the foundation. The course of the river for the time was turned another way about by a trench cast for that purpose, beginning, as is sup-

wall. Owing chiefly to the excellence of the mortar employed, this arch withstood a flood which rose nearly 30 feet above the springing of the arch. This structure is one of the many "Devil's Bridges."

In the year 1178 a famous bridge was begun over the

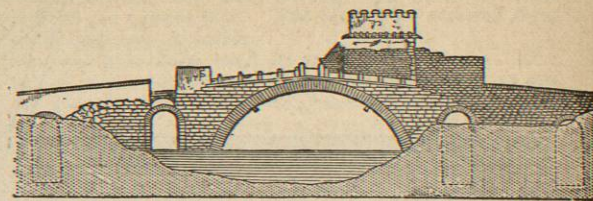


FIG. 107.—Ponté Salaro.

Rhone at Avignon by Saint Benezet, the head of one of certain religious confraternities, which undertook the building or repair of bridges during the Middle Ages, and were called *Fratres Pontis* or *Hospitalarii Pontifices*. The bridge was finished in 1188. Four arches still remain, and are remarkable in having an elliptical outline with the radius of curvature smaller at the crown than at the haunch, a form which accords more truly with the linear equilibrated arch than the modern flat ellipse with the largest radius at the crown. A description and drawing of this remarkable bridge will be found in the *Dictionnaire raisonné d'Architecture* of M. Viollet-le-Duc.

A religious confraternity, founded in the first instance by a certain Mary, the maiden daughter of a ferryman, is said to have built a timber bridge near the site of the

beginning of this century. It does not seem improbable that Peter of Colechurch and Saint Benezet may have been in communication with one another, both being heads of religious bodies engaged in similar works at the same time. Their letters to one another would interest engineers. A French brother Isembert, from Saintes, succeeded Peter as engineer for London Bridge.

Stow describes the partial rebuilding of the timber houses in 1645:—

"The building was of timber, very substantial and beautiful, for

posed, east about Rotherhithe, and ending in the west about Patricksey, now termed Battersea. This work, to wit the arches, chapel, and stone bridge over the Thames at London, having been thirty-three years in building, was, in the year 1209, finished by the worthy merchants of London—Serle Mercer, William Almaine, and Benedick Botewrite, principal masters of work; for Peter of Colechurch deceased four years before the work was finished, and was buried in the chapel builded on the same bridge in the year 1205."

the houses were three stories high, besides the cellars, which were within and between the piers, and over the houses were stately platforms leaded with rails and ballasters about them, very commodious and pleasant for walking and enjoying so fine a prospect up and down the river, and some had pretty little gardens with arbours."

The passage between the houses was made 20 feet; previously it had been but 14 feet, and in some parts 12 feet. These beautiful houses were burned in 1666, when they were replaced by a still finer pile of buildings, with a uniform roadway of 20 feet in width. Fig. 108 shows the bridge as it appeared in 1700.

The piers varied in thickness from 25 to 34 feet, and were raised on strong elm piles, covered with thick planks bolted together. The openings in the arches varied from 10 feet to 32 feet 9 inches. The whole waterway was 336 feet 9 inches, two thirds of the stream being occupied by piers.

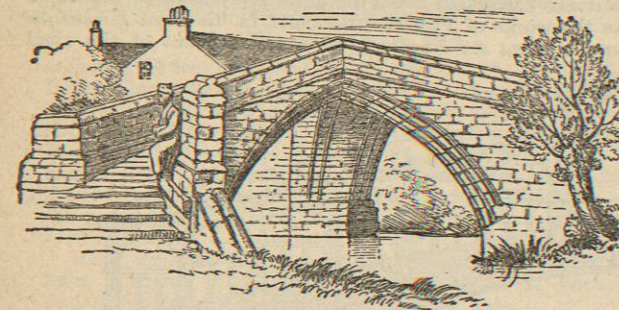


FIG. 109.—Croyland Bridge.

§ 75. 1300 to 1700 A.D.—The strange triangular bridge at Croyland (fig. 109) is another example of a bridge probably built for or by a religious body. This structure stands at the confluence of the Welland, the Nyne, and the Catwater drain; three pointed arches, having their abutments at the angles of an equilateral triangle, meet in the middle, giving three watercourses and three roadways. Each arch has three stone ribs, and the nine meet in the centre. Croyland "triangular bridge" is alluded to in a charter of the year 943; from the character of the masonry the present structure is supposed to have been built in the beginning of the 14th century. A bridge over the Trent at Boston, 1534 feet in length, and consisting of 34 arches, was also built by a religious community under Abbot Bernard.

Fig. 110 shows the old bridge at Saintes as M. Viollet-le-Duc considers that it appeared towards the end of the 14th century. The following description is abridged from his *Dictionnaire raisonné d'Architecture*:—

"The first gate appeared on the right shore of the river, on the side of the Faubourg des Dames; next came the Roman arch, the upper part of which was crenelated during the Middle Ages; next on the side of the town stood a tower of oval plan, through which the road lay; the town gates with flanking towers closed the end of the bridge. From the first gate to the Roman arch the bridge was of wood, as was also the case between the great tower and the town gates, so that by the removal of this part of the roadway all communication could be cut off between the town and the tower as well as between the bridge and the Faubourg; moreover, the parapets were crenelated, so that the garrison of the town could at will stop all navigation."

Clearly it was quite as important in those days to be able to arrest as to facilitate communication between the two sides of the river.

The architects of the Renaissance showed great boldness and originality in their designs. The largest arch known to have been built spanned the Adda at Trezzo, constructed by order of Bernabò Visconti, duke of Milan (latter half of

14th century. This bridge is described in Hann and Hosking's *Bridges*, as having consisted of "a single arch of

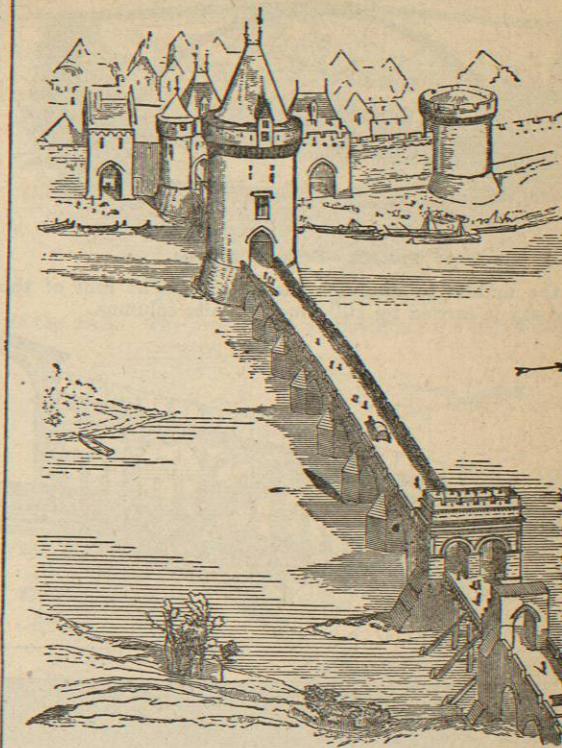


FIG. 110.—Saintes Bridge.

granite, very well constructed of stones in two courses, the innermost  $3\frac{1}{2}$  feet thick in the direction of the radius, the outermost 9 inches, the span at low water 251 feet; the river rises sometimes 13 feet." The radius of the arch was 133 feet. This noble bridge was destroyed by Carmagnola.

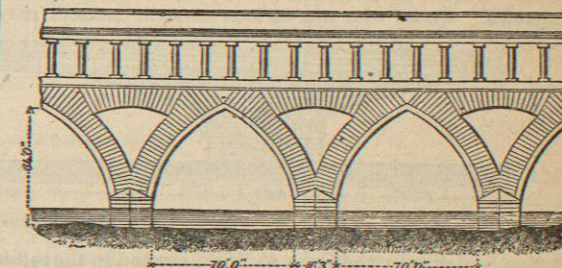


FIG. 111.—Bridge over the Ticino at Pavia.

The covered bridge over the Ticino at Pavia (fig. 111) was erected, under Gian Galeazzo Visconti, about the end of the 14th century. This bridge, which still exists, has seven pointed brick arches, each 70 feet in span and 64 feet in height; the depth of the arch ring at the crown is 5 feet 6 inches. The tympanum is pierced; the bricks used in

the arches are formed to suit their position, and are hollow



FIG. 112.—Bridge of Brioude.

in the middle to diminish the weight. The roof of the roadway is carried by 100 rough granite columns.

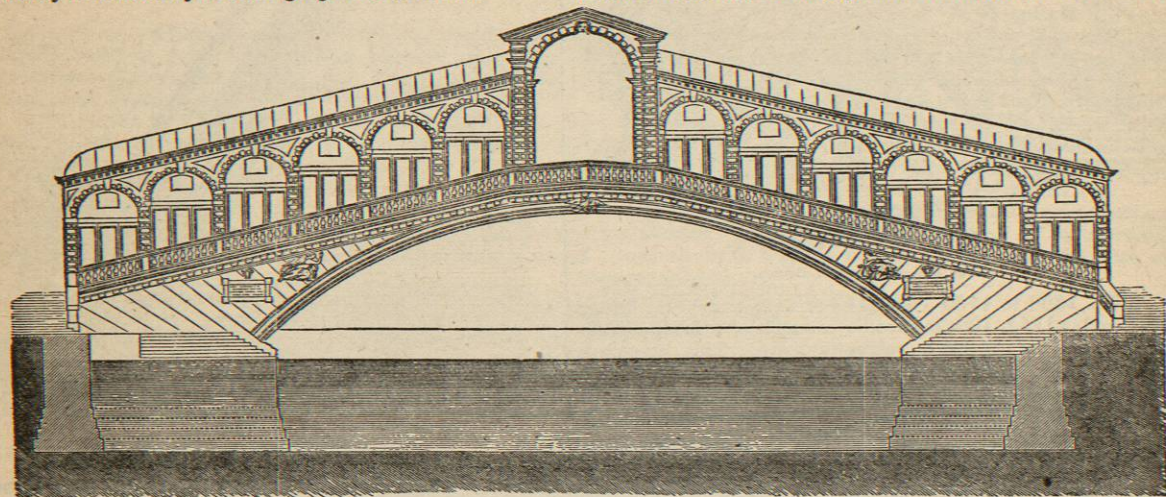


FIG. 113.—Bridge of the Rialto, Venice.

designs submitted to the senate by Antonio da Ponte and Palladio.

Florence.  
Ponte della  
Trinità.

Fig. 114 shows the singularly beautiful "Ponte della Trinità," erected at Florence (1566) from the designs of Ammanati. Those who are curious in such matters may

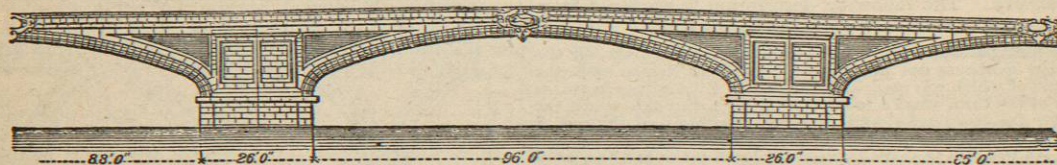


FIG. 114.—Ponte della Trinità, Florence.

A fine bridge over the Ouse at York, erected in the reign of Queen Elizabeth, was taken down some years ago; it is shown in fig. 115. The span of the largest arch was 81 feet (Allen), and the rise 26 feet 3 inches.

The well-known Pont Neuf at Paris was built in 1604. The design has no feature calling for special remark. Fig. 116 shows the bridge over the Conway at Llanrwst in Wales, the design for which was furnished by Inigo Jones in 1634. The middle arch has a span of 58 feet. The structure is easily set in vibration, and is known as the

Fig. 112 taken from Montfaucon's *Antiquités expliquées*, shows the old bridge of Brioude across the Allier in France. Montfaucon and Séguin speak of this as a Roman work, but Gauthey gives the date 1454 for its construction, and names Grenier and Estone as builders without giving his authority. The design of the bridge appears to favour the date given by Gauthey. The span was 183.73 English feet (Rennie, *Proc. I.C.E.*), the arch was a segment of a circle and the height 60 feet, while the width of the bridge was only 16 feet. This bridge fell in 1822.

The bridge of the Rialto at Venice (fig. 113) was begun in 1588, Antonio da Ponte being the architect. The span of the arch is 91 feet, the height above the water level 24 feet 6 inches, and the width of the footway 72 feet. Erroneous statements are often met with that this bridge was built from a design by Michel Angelo; the mistake has arisen from the misinterpretation of a passage in the works of Vasari. Rondelet, in his *Essai Historique sur le Pont du Rialto*, gives a full account of the rival

observe with interest the amended design for this bridge, given in Hosking's *Architectural Treatise on Bridge Building*, p. 241, which serves to show how easily a noble design may be spoiled by an alteration in the proportions of its parts.

"shaking bridge." Further particulars concerning this and many other old English bridges will be found in Smiles's *Lives of the Engineers*, chap. iii. vol. ii., edition 1874.

A bridge over the Senderud at Ispahan is described as follows in Heck's *Iconographic Encyclopædia*, with illustrations:—"It (the bridge) is 2250 feet long, 120 feet high, and 156 feet broad; the middle way is 60 feet broad, and the sideways are paved with marble, and the latter lead through arcades, to which the ascent is by stairs

in the four towers of the bridge. The bridge has 29



FIG. 115.—Old Bridge at York.

arches of 50 feet span, and the pillars are 25 feet thick. In the illustration the arches are Moorish, and the covered sideways lofty, with 3 arches of small span over each main arch of the bridge. The design is remarkably fine. Heck calls it the bridge of Barbaruh, and states that it is named from its builder, but it is of unknown antiquity. All the bridges of Ispahan are said, in the 7th edition of the present work, to have been built under Shah Abbas I. (1585 to 1628).

Heck mentions a bridge at Loyang in China, said to have a length of 26,800 feet, and another at Focheu 22,000 feet long, both from 60 to 70 feet wide.

Old Westminster and Blackfriars Bridges.

§ 76. 1700 to 1817.—Old Westminster Bridge (Labelye) and Old Blackfriars Bridge (Mylne), both of which have now been removed, were built in the middle of the 18th century. Their failure after so short a period was due to a defective system of foundation and to the increased scour caused by the removal of old London Bridge.

Pont-y-tu-Prydd.

The Pont-y-tu-Prydd over the River Taff near Newbridge is shown in fig. 117. The arch measures 140 feet between the abutments, and has a rise or versed sine of 35 feet. The width of the soffit is 15 feet 10 inches at the springing, diminishing to 14 feet 5 inches at the crown by six offsets

on each face. The roadway is 11 feet wide over the centre

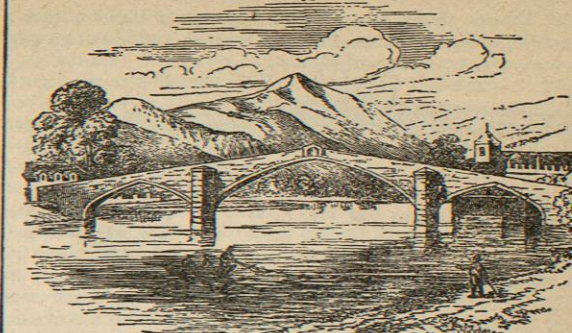


FIG. 116.—Llanrwst Bridge, Wales.

of the arch. The arch stones on the face are 2 feet 6 inches

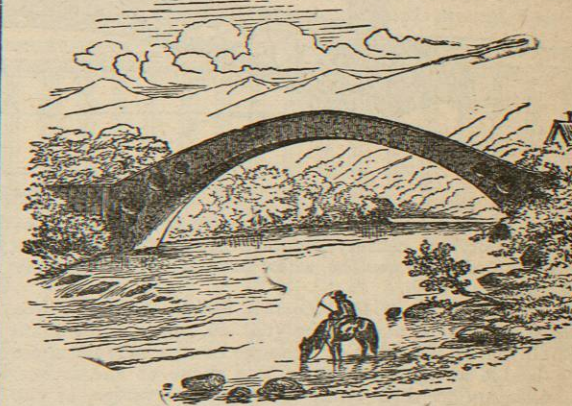


FIG. 117.—Pont-y-tu-Prydd.

deep, the rest of the ring being rubble masonry. This

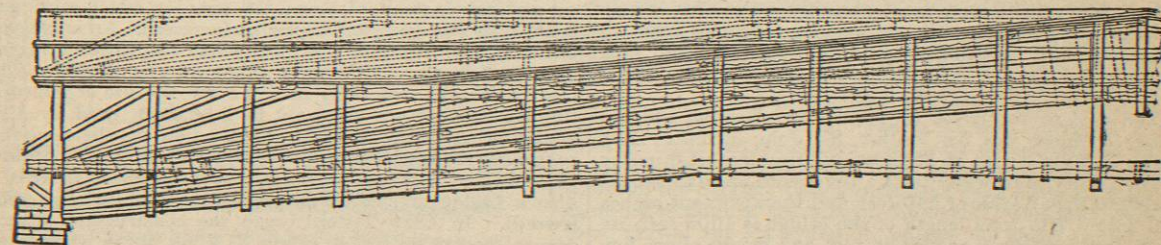


FIG. 118.—Half Truss of Wittingen Bridge.

bridge was built by William Edwards, a self-educated country mason. It was completed in 1750 after the failure

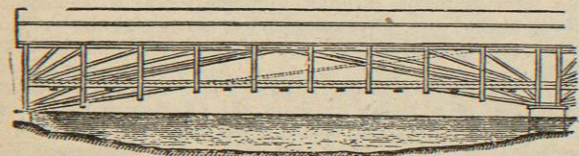


FIG. 119.—First Arch of Schaffhausen Bridge.

of a similar structure, in which the weight of the haunches

was excessive and forced up the crown, the depth of which was very small. This failure led to the adoption of the pierced spandrels.

Fig. 118 shows half of the truss for the bridge of Wittingen, built in 1758 by the brothers Grubenmann, probably the finest specimen of a wooden bridge that has ever been constructed; the design might be analyzed as consisting of a series of superposed trusses, as in fig. 87, which represents the bridge at Schaffhausen built by the same engineers or village carpenters. The Schaffhausen bridge (fig. 119), destroyed by French troops in 1799, had two openings, one of 172 feet and the other 193 feet. The Wittingen bridge, burnt shortly afterwards, had a span