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RAILWAY PRACTICE.

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A COLLECTION

OF

WORKING PLANS AND PRACTICAL DETAILS OF CONSTRUCTION

IN THE

PUBLIC WORKS

OF THE MOST

CELEBRATED ENGINEERS,

COMPRISING

TUNNELS AND TUNNEL FRONTS—TURNPIKE ROAD BRIDGES—OCCUPATION BRIDGES IN EMBANKMENTS AND IN CUTTINGS —ORNAMENTAL BRIDGES, WITH VARIOUS DESIGNS FOR IRON RAILS AND FRAMING—VIADUCTS OF SEVERAL DESCRIPTIONS —RETAINING WALLS—CULVERTS—SIDINGS—CUTTINGS AND EMBANKMENTS—PERMANENT WAYS—CHAIRS, BLOCKS, &c.— CUTTINGS IN ROCK, AND UNDERSETTING—AQUEDUCTS—TURN-TABLES—CRANES, AND RAILWAY DEPOTS, WITH SHEDS, &c.

ON THE SEVERAL

RAILWAYS, CANALS, AND OTHER PUBLIC WORKS

THROUGHOUT THE KINGDOM;

AS THE LONDON AND BIRMINGHAM—GREAT WESTERN—GREENWICH—MIDLAND COUNTIES— NORTH UNION—LEEDS AND SELBY—GRAND JUNCTION—SLAMANNAN, AND WISHAW AND COLTNESS RAILWAYS;

AND

THE ELEGANT AQUEDUCT OF THE LANCASTER CANAL,

OVER THE RIVER LUNE.

THE ARRANGEMENT IS CLEAR, AND THE STYLE FAMILIAR; THE ILLUSTRATIONS ARE UPON A LARGE SCALE, AND IN EXPRESS IMITATION OF THE ORIGINAL DRAWINGS MADE FOR THE PURPOSE; THE SUBJECTS ARE REPRESENTED UNDER EVERY VARIETY OF LOCAL CIRCUMSTANCE, AND IN CONTRASTED MODES OF CONSTRUCTION, ACCOMPANIED THROUGHOUT BY FULL DETAILED SPECIFICATIONS, ACCURATE DESCRIPTIONS, AND APPROPRIATE REMARKS.

*** The whole of the information necessary for this Treatise is derived from the only legitimate source—the direct communications of the Engineers to the several Works, who have kindly sanctioned and promoted the Undertaking.

A SERIES OF ORIGINAL DESIGNS

FOR EVERY DESCRIPTION OF RAILWAY WORKS, IN VARIOUS STYLES OF ARCHITECTURE,

COMPLETES THE VOLUME.

Second Edition, corrected and improved.

By S. C. BREES, C.E. &c.

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PREFACE.

In presenting to the public the first volume of Railway Practice, the author begs leave respectfully to explain the general intention and purpose of the publication.

It has long been his conviction that a work of this nature was required by practical and professional men, and that it would at all times prove acceptable to the public generally, yet more especially at the present moment, while rail-roads are the all engrossing topic of conversation and discussion, and the subject of investigation the most acute and searching.

This early impression on the author's mind was confirmed by the opinion of gentlemen the best qualified to decide on such a question, and it became conviction when he was assured by his intelligent publisher, "that enquiries after such works were frequent, and the demand for information connected with them urgent." Satisfied, therefore, as to the paucity of such information, and the consequent value of any particulars descriptive of the *minutiæ* of this most important branch of engineering, he could not hesitate as to the propriety of producing his *Railway Practice*, to which he now solicits the favourable notice of the reader.

The present volume has few pretensions as a work of art; the endeavour of the writer having been to render the whole plain and easy of comprehension, it became his duty to avoid the expense of fine engravings, as unnecessary to the purpose in view; and it is in this plain and practical light, that he would have his work considered and reviewed. The working plans are effectively pourtrayed,

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and the details and descriptions fully illustrated. A clear arrangement and appropriate distribution of subjects, strict adherence to correct drawing, and simple explanatory effect, are all that he has attempted as author, or artist, beyond a due regard to contrast in the selection of the works here represented and illustrated.

The whole of the plates are made to resemble actual drawings, from which, indeed, when tinted, they will hardly be distinguishable; and it is presumed, that this easy and familiar effect will supply a *desideratum* to the profession, by whom the smaller engravings on engineering subjects are objected to for their severe dryness, extreme intricacy, and generally uninteresting appearance.

The series of designs for railway works are respectfully submitted to the attention of the profession, not that they are by any means considered as models of perfection. They are a collection of rough sketches, and of original ideas, of as much diversity of style and variety in plan as is perhaps practicable. Full latitude has been allowed to the pencil in these views; a hasty sketch frequently maintaining more of the original spirit in the form of composition, than when the idea is conveyed by a more elaborate process; seeing, that in the former case, something is left for the imagination to complete.

The author hopes to escape the charge of presumption, if venturing to assert that in this respect a much wider field is open than is generally recognised. Notwithstanding the temptation, however, he has devoted but a few sheets to this portion of the work, being aware that examples from the extensive railways now progressing will prove more useful. Should the present volume, after a careful perusal, supply a few hints and suggestions, it will have equalled the anticipations and fulfilled the intentions of the writer.

The author of *Railway Practice* cannot conclude this brief Preface, without earnestly expressing his warm acknowledgements to the several gentlemen, engineers to the works here represented; who having sanctioned and patronized the work in its original project, kindly contributed to its progress, not only by offering

every facility to his own researches, but by direct communications upon the subject to Mr. Williams, the publisher, and to himself.* His especial thanks are due to the gentlemen whose names follow, and whose assistance and encouragement it is his pride to acknowledge and record.

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&c. &c. &c. &c. &c. &c.

S. C. BREES, C.E., &c.

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* The author of the present volume is arranging materials for a sequel, which will speedily appear, and for which communications, addressed to S. C. Brees, 40, *Ely Place*, are earnestly requested, and will be gratefully acknowledged.

ERRATA.

Page 15, *for* (vide Plate No. 25) *read* (vide Plate No. 24.)
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DESCRIPTION OF THE PLATES.

LONDON AND BIRMINGHAM RAILWAY.

ROBERT STEPHENSON, Esq. M.I.C.E. Engineer.

(Vide Specification of the Extension of the Line, Page No. 7.)

PLATE 1. Permanent Rails, as laid down upon part of the line.

The Plan shews the Rails, Sleepers, &c., together with the mode of Drainage, which is particularly efficacious.

PLATE 2. Bridge for Wriothesly Street, as executed. (Vide Page 8.)

The effect of this Bridge is remarkably good: presenting an appearance of stability, without the least degree of heaviness; indeed, to our taste, the design is very little short of perfection, such is the repose, and balance of parts, throughout the whole composition.

PLATE 3. Bridge for an intended street on the Duke of Bedford's estate. (Vide Page 9.)

This Plate shews the design as originally projected. (The alterations made in execution, are shewn in Plate 19.)

PLATE 4. Bridge over the Hampstead Road (as originally intended, vide Page 9.)

The back of the outer main Rib, and section through ditto, and details of face plates, are similar to those of Park Street Bridge, and are shewn on Plates 5 and 6.

(The alterations made in execution, are shewn on Plate 19.)

PLATE 5. Bridge for Park Street (as originally intended, vide page 11.)

This Bridge is very similar to Hampstead Road Bridge; both, it is needless to observe, are specimens of good work, as regards effect and practical detail. (The iron work was executed rather slighter, as appears by Plate 19.)

PLATE 6. Ditto, Details of same.

The middle Ribs are similar to those of Hampstead Road Bridge. (For alterations in execution, see Plate 19.)

PLATE 7. Bridge for Stanhope Street (as originally intended, vide Page 10. The alterations made in execution are very trifling, they are shewn in Plate 19.)

In a notice of this Bridge, however slight, we cannot avoid calling the attention of the reader to the extraordinary flatness of the segment forming the Arch, a flatness, which to the casual observer, appears the more extraordinary on account of the Abutments being concealed; admirably exemplifying an axiom of ordinary acceptance:—"That we may make Arches as flat as we please, provided we have sufficient Abutments." We admire the skill shewn in this Bridge; too much praise, indeed, cannot be bestowed, considering the care with which it must have been executed; for a very small settlement would have produced fatal consequences, and the fact of its having good abutments, is, with us, an additional claim to attention and approval.

PLATE 8. Retaining Wall, from Park Street to the Regent's Canal. (Vide Page 7.)

This Plate likewise shews the abutment Pier of the Iron Bridge over the Regent's Canal. The height of this wall varies, and is of the several thicknesses shewn on Section.

The whole of the Retaining Walls, upon the extension, are of this description; at least, in giving this, we certainly give the whole of them; they are, however, reduced and modified to the nature of their situation.

PLATE 9. Bridge over the Regent's Canal, near Chalk Farm (as originally intended; vide Page 11, 12, and 13.)

PLATE 10. Details of Main Ribs

PLATE 11. Ditto.

PLATE 12. Ditto.

PLATE 13. Details of Girders.

PLATE 14. Ditto.

PLATE 15. Ditto.

PLATE 16. Ditto.

PLATE 17. Details of Iron Piling.

(The Iron Piling, &c. was not used—the several Alterations made in execution, will be found in Plate 18.)

This Bridge is one of the boldest specimens of construction on the whole line; the railway being entirely suspended by attached Rods, as shewn upon the several plates. We believe this is the first application of the Suspension principle to carry Locomotive Engines and Trains, as used upon a railway.

Without entering on an argument, whether there might or might not have been a saving of metal, we are bound to admit that much judgment and discrimination are shewn in the union and connection of the several parts; they are uncommonly well secured together: and as we have heard doubts expressed of the utility of the wrought iron Tension Rods, on account of the main ribs being very strong, we take this opportunity of declaring our conviction that these rods have their office to perform, particularly in the event of any unusual bound, or jerk; in such a case they tend to stiffen and bind the whole together: the Supports are shewn on Plates 13 and 14, performing an office similar to Stirrups in a queen-post-framed Principal.

Plate 18. Bridge over the Regent's Canal, near Chalk Farm. (Alterations, &c. made in execution of same.)

By this plate it will be perceived that a Retaining Wall was substituted for the Iron sheet Piling, the Retaining Walls between abutment piers are likewise strengthened, the wrought iron Ties in wall (shewn in Plate 9) are omitted, the Girders are reduced in substance, the point of Attachment of suspending rods in centre Bracing Frame is strengthened, and a portion of the extremity of Bracing Frames, resting on walls, is taken off diagonally, &c. We have given the bridge as intended, and as executed, that the curious may be enabled to judge of and contrast the several variations; and it is our intention to continue the same system with the whole of the designs, when the works are completed.

Plate 19. Alterations from the Designs made in execution of Bridges on the Extension of the London and Birmingham Railway.

Fig. 1.—Bridge for intended Street on the Duke of Bedford's estate, shewing the method of backing the arch, &c.

Fig. 2.—Park Street Bridge. The inner Girders supporting roadway, &c. are reduced in width, and are of the dimensions shewn on the plan; their span, or bearing, clear of walls, is 26 feet 8 inches; the versed line of ditto being 2 feet 10 inches; and the filling in and bearing walls upon the arches, between girders, are carried up 9 inches thick, instead of 14 inches, as projected. (Alterations exactly similar were made to the Hampstead Road bridge.) Fig. 3.—Bridge for Stanhope Street. The only deviation from the contract drawings was in the face walls of the Bridge, which were carried to the extent of the backing upon the arch, and finished in a triangular shape, as shewn in this plate.

Plate 20. Method of working the Primrose Hill Tunnel. (Vide Description of same in specification, page 38.)

Plate 21. Ditto ditto

These drawings will be found of considerable utility, and will be readily understood by a careful inspection.

Plate 22. Tunnel. Details of Iron Plates for Tunnel Fronts.

An Iron Plate is used to keep in the retaining or front wall at the mouth of a Tunnel. In the Primrose Hill Tunnel, (which is of a similar shape to the one shewn, but three bricks thick on account of the nature of the excavation) it is placed in the centre of the wall, with connecting Rods 100 feet in length, to another plate fixed in tunnel; but the method of securing the rods shewn on plate is considered superior.

Plate 23. Bridge for the Bourne End Road. (Vide Specification of same, page 32.)

A specimen of a good embankment Bridge, without ostentation, yet sufficiently effective.

Plate 24. Bridge for Haxter's End Lane. (Vide Specification of same, page 32.) We consider this one of the best Bridges of its description on the line; the method by which the wing walls are gradually strengthened as the embankment leaves them is very good.

Plate 25. Bridge for road from Berkhampstead to Gread Gaddesden. (Vide Spe ification of same, page 33.)

This design follows in the same style as the two preceding plates, and forms a very suitable companion.

PLATE 26. Front of Northchurch Tunnel.* (Vide Specifications of same, commencing at page 36.) The radiating stones at entrance remind us of the Tunnel upon the Leeds and Selby Railway, not that it can be called in the least a copy.

PLATE 27. Ditto, Plans, Sections, &c.

PLATE 28. Details of Shafts, &c.

PLATE 29. Ditto, Details of Iron Curbs to Shafts.

These Curbs we believe to be the last and best contrived.

PLATE 30. Plan of Culverts. (Vide Specification of same, page 46.)

These again are not the same upon all parts of the line; but they have been considered as good, to say the least, as any culverts that have been used.

PLATE 31. Plan of Siding, or passing Place, as drawn in the Contracts. (Vide Specification of same, page 47.)

It is doubtful whether this method will be invariably adopted; but, the plan being very perfect, and the subject of Sidings interesting, we have thought proper to give it.

PLATE 32. Undersetting of Rock in Blisworth Cutting. (Vide Specification of same, page 57.)

The plan and elevation shews the mouth or entrance of west end of cutting This is one of the heaviest parts of the line. The method of undersetting the rock is described and figured on the drawing, and will be found sufficiently explanatory.

PLATE 33. Bridge from Towcester to Cotton end. (Vide Specification of same, page 76.)

The style of this Bridge is quite Italian. It recalls to our recollection the arches discovered in the back grounds of paintings by the old masters, and is a very great favourite with us.

PLATE 34. Stone Bridge from Roade to Plane Woods. (Vide Specification of same, page 75.)

A good contrast to the preceding Bridges. The several sections will be found sufficiently explanatory.

* In the first Edition of this work, this Tunnel was entitled the "Linslade," whereas it should have been the "Northchurch;" a similar Design having been prepared for the former Tunnel, which eventually was not made use of.—EDITOR.

PLATE 35. Bridge for Road from Biisworth to Courtenhall. (Vide Specification of same, page 76.)

Another stone Bridge of good character.

PLATE 36. Stone Bridge from Stivichall to Hearsall Common.

A good specimen of what can be built at a very trifling expense. We rarely see a Bridge with less work upon it; yet a neat and pleasing appearance is obtained, neither is its strength in the least sacrificed.

PLATE 37. Front of Kilsby Tunnel, and Details.

The formation of this Tunnel has been found more difficult than was anticipated, and it is the most formidable undertaking on the line. It has two ventilating Shafts, each 60 feet diameter, dividing it into three parts. The section is similar to that of Northchurch Tunnel.

PLATE 38. Weedon Viaduct.

We believe this design is not exactly as it will be executed, for the sake of shewing the method of Drainage, which being considered good, it may not be unacceptable. (We intend hereafter giving the alterations.) The arrangement of the Parapet Cornices and projections are bold, and in good taste; and there is no superabundance of brickwork, in the shape of backing, upon the spandrils, &c., which we not unfrequently observe.

This Viaduct is upon a slight curve.

PLATE 39. Ditto. Details of same.

PLATE 40. Bridge at Road in Yardley Parish.

There are many Bridges of this description upon the line, and they have a very light appearance.

PLATE 41. Bridge over the River Sow.

A Bridge of uncommonly good effect: the design is in the same style as Plate 33, being in the Italian taste; the opportunity here offered of producing a work calculated to become an ornament to the country, and in just keeping with the intended purpose, has not been thrown away.

PLATE 42. Details of a 12 ft. Turn-rail, as originally intended. (Vide Specification of same, page 83.)

The Turn-rails are not supported by stone Blocks in the centre, as drawn; but a circular bearing Wall is built, to receive a cast iron curb, or Frame, (the frame is executed of

different patterns at different parts of the line,) similar to the turn-rails used upon the Leeds and Selby Railway, upon which the centre pedestal is fixed : the turn-rails executed are similar in principle to the above mentioned, except that there are wrought iron Arms to the rollers, and inclined planes for the wheels of the carriages to stop against. No very great alteration or improvement having been made in turn-rails since their first introduction, this plan, although not executed, may be considered useful.

PLATE 43. Ditto. Details of same Plans, enlarged parts, &c.

GREAT WESTERN RAILWAY,

I. K. BRUNEL, Esq. F.R.S., M.I.C.E., Engineer.

These Designs form very good companions to the preceding: Their plans of construction and appearance are quite different to those upon the Birmingham line, and the fact of their being as it were of another school is self-evident, from inspection and comparison.

PLATE 44. Bridges in Cuttings and Embankments.

The dimensions, &c. being shewn and figured, it is presumed these designs will be readily understood.

PLATE 45. Bridge crossing the Float at Bristol.

A good Bridge, in which the Gothic style is very well preserved.

PLATE 46. Bridge for Uxbridge Road.

An iron Bridge, and considerably askew: The plan of throwing in iron Beams, or Girders, as shewn in this bridge, being of a novel character, deserves attention.

LONDON AND GREENWICH RAILWAY,

GEO. LANDMANN, Esq., M.I.C.E., &c., Engineer.

The Blocks upon this line are of Granite, 2 feet square, and 1 foot thick, buried in Concrete, with a layer of Sand below, and the spaces between the blocks filled up with concrete. The Rails are of wrought iron, weighing 50 lbs. per lineal yard, and the Chairs are of cast iron, each weighing about 18 lbs.

The Drain on the superstructure is of brickwork, in cement.

PLATE 47. Bridge over the Spa Road, Bermondsey. Plan and Elevation.
PLATE 48. Ditto, Sections and Details, &c.
PLATE 49. Ditto, ditto.

Description of the Design, and Remarks.

Angle of Skew.. 52°.. 30′.

	ft.	in.
Perpendicular span of Centre Arch	27	9
Span on the face of	35	4
Rise of	9	0
Radius of	22	0
Thickness of rim of Arch	1	6

Perpendicular span of Side Arches	8	0
Span on the face of	10	2
Rise of	2	7
Radius of	6	3
Thickness of rims of Arches on the face ..	1	2
Ditto in the interior of the work	0	9

The Plinth for the columns, also Piers in roadway, and the Springers to arches, are of Bramley fall stone. The Abutments, arches, spandrils, internal spandril walls, parapets, &c. being carried up in brickwork; The Bricks throughout are good, sound, hard-burnt stocks. The three Oblique Arches, and

solid spandrils over the same, are set in Roman cement, composed of Halling Lime and river Sand.

The Grecian Doric columns, supporting the arch, &c., are of cast Iron, and filled with Concrete; each having a wrought iron Bar carried vertically through the centre, let into the plinth and stone springers, which are connected by Chain Bars, and having mortices, through which these vertical bars are passed, and secured to a horizontal bar made to receive them, at a level of 4 feet 9 inches above the springing line of arches.

The Spaces between the internal spandril walls are filled up to the level of the crowns of the arches with Concrete, composed of seven parts of river gravel and one of ground Halling lime.

The Cornice, Parapet and coping are in Roman cement. The Caps of the recesses on the superstructure are of Bramley fall stone.

MIDLAND COUNTIES RAILWAY,

Charles Vignoles, Esq., F.R.A.S., M.I.C.E., Engineer.
Thomas J. Woodhouse, Esq., M.I.C.E., Resident Engineer.

The Midland Counties Railway, after several surveys having been made, was finally laid out by Chas. Vignoles, Esq., and the Act of Parliament for making it was obtained in the session of 1836.

Thos. J. Woodhouse, Esq. is the Resident Engineer appointed to superintend the execution of the works—to whom we are indebted for the following valuable communication.

This line of Railway commences at the London and Birmingham, near the town of Rugby, and after passing the large manufacturing towns of Leicester and Loughborough, crosses the river Trent nearly midway between the towns of Nottingham and Derby. Immediately after crossing the river, the line separates, and diverges to the eastward and westward; the one Branch running to and terminating at the town of Nottingham, the other going to the town of Derby, and

there connecting with the North Midland Railway, and also with the Derby and Birmingham.

The Acclivities in the Midland Counties Railway are very favourable for cheap and expeditious transit, generally not exceeding 1 in 500, and the greatest ascent on the line (which is fifty-seven miles long) is only 1 in 330. This Line, when completed, will be by far the most direct route from the metropolis to the extensive manufacturing districts of Yorkshire, including the large towns of Sheffield, Leeds, &c.

The Contracts are let for the part of the line between Nottingham and Derby, and the works are in active operation.

PLATE 50. Viaduct for carrying the Railway over the River Avon, near its junction with the London and Birmingham Railway. (Vide Specification of same, page 85.)

PLATE 51. Bridge over the River Trent. (Vide Specification of same, page 87.)

Mr. Woodhouse concludes by observing, "that stability combined with simplicity and economy, has been principally aimed at in designing the above works;" and we think the attempt has been very successful, since there is an elegance, united with strength, throughout both compositions.

NORTH UNION RAILWAY,

CHARLES VIGNOLES, Esq., F.R.A.S., M.I.C.E., Engineer.

PLATE 52. Viaduct over the River Ribble.

A noble work, consisting of six Arches, each of 120 feet span.

LEEDS AND SELBY RAILWAY,

JAMES WALKER, Esq. P.I.C.E., F.R.S., &c., Engineer.
GEO. SMITH, Esq., Resident Engineer.

PLATE 53. Details of Tunnel Front.

The appearance of this front in the design is bold, simple and unassuming; and as executed, these characteristics are still more strongly marked.

PLATE 54. Details of Shed at the Selby Depôt.

The construction it is presumed will be readily understood from the plate.

PLATE 55. Details of Shed at the Leeds Depôt.

The Sheds upon this Railway deserve especial notice and consideration, being well arranged, and of good construction; moreover a considerable degree of elegance has been preserved without any corresponding outlay.

PLATE 56. Do. Details of Do.

Details of Iron Columns, Brackets, &c.

PLATE 57. Details of Turn Tables.

These Turn tables are of good construction, and work particularly easy; perhaps the addition of connecting Rods from the centre pedestal to the rollers, instead of the latter being fixed, would form an improvement.

PLATE 58. Cranes in the Shed of the Leeds Depôt.

These Cranes are of very light construction, and are attached to the columns supporting the roof of Shed. We have shewn in the plate the most approved Break.

PLATE 59. Plan of Chairs with vertical keys, to secure railway bars.

This description of Chair and Keys were laid down upon part of the line by Mr. George Smith, the Resident Engineer, to obviate the frequent jarring of the rails at a joint chair, when of the usual description; this jarring arises from there being *but one key;* now, as the two meeting rails are not always of the same dimensions, the key consequently secures but one of them, leaving the other partially loose, thereby increasing the wear and tear of the rails. The plan of having *two keys* is the principle of the improvement, although they are likewise of a peculiar form, and applied in a different manner.

GRAND JUNCTION RAILWAY,

JOSEPH LOCKE, Esq. M.I.C.E. Engineer.

PLATE 60. Aqueduct for the Duke of Bridgewater's Canal at Preston Brook.

This Work is built entirely of stone. In order to prevent

the water from penetrating through the arches, at the points marked A A A A, the backing is covered with Milled Lead, 7 lb. to the foot superficial, and the plan has answered admirably; for, as I am informed by Mr. Locke, no sign of a canal being upon them can be traced from beneath.

PLATE 61. Details of Iron Bridges.

There are several Bridges of this description on the line, of one two, three, and more, similar Arches; some of which are upon the skew.

PLATE 62. Bridge at Slade Heath, near Wolverhampton.

The character of this Bridge will be readily understood from the plate: It is good in its construction, and produces great breadth of effect.

PLATE 63. Bridge over the River Mersey and Canal.

This is a novel and excellent design, decidedly one of the best works on this or any other railway.

PLATE 64. Details of proposed Foot Bridges.

These Bridges present a very light appearance, and are of a very economical principle, considering their permanency.

SLAMANNAN RAILWAY,

JOHN MACNEILL, Esq. F.R.S. F.R.A.S. Engineer.

PLATE 65. Details of Cuttings, Embankments, &c.

For description Fig. 1—vide Specification of the Slamannan Railway, page 94. Figs. 2 and 3, page 96. Fig. 4, page 97. Figs. 5 and 6, page 98, and Figs. 7 and 8, page 100.

PLATE 66. Occupation Bridge on Farm Road, over the lands of Hill. (No. 1.)

The application of trussed Girders, instead of an Arch, is rather unusual, but very economical. In the Specification of this railway, a bridge of similar character is described at pages 102 and 103.

LANCASTER CANAL,

JOHN RENNIE, Esq. Engineer.

PLATE 67. Aqueduct over the River Lune.

A very elegant Work: We cannot do better than avail ourselves of Mr. Peter Nicholson's description, as given in his Architectural Dictionary:—

"Mr. Rennie also constructed the Aqueduct Bridge over the River Lune, at Lancaster, which is considered as one of the most magnificent works of the kind extant. At the place where it is built, the water is deep and the bottom bad,—the foundation is therefore laid 20 feet below the surface of the water, on a flooring of timber resting on piles; the Arches are five in number, each of 70 feet span, and rise about 39 feet above the surface of the water. It has a handsome Cornice, and every part is finished in the best manner. The total height, from the surface of the river to that of the canal, is 57 feet, and the canal admits barges of 60 tons burden to navigate upon it. The foundation alone of this building cost £15,000. and the superstructure more than double that sum, although the stone was obtained from a quarry less than a mile and a half from the spot."

PLATE 68. Ditto Ditto

Elevation, shewing the works in state of execution, as they appeared in September, 1795.

DESCRIPTION OF THE DESIGNS.

PLATE 69. Designs for Viaducts.

Six Designs, principally in Grecian Architecture. No. 1. has the stones forming face of Arch continued through the spandrils, the interstices being filled in with broken stone, properly bedded in mortar, which will be found a saving, at the same time producing a pleasing effect. No. 2 has a double tier of Arches, by which means the walls need not be executed so thick, and advantage may be taken of the ground tier to form a roadway or platform thereon, as occasion may suggest. The parapet walls are likewise pierced with small arches, the additional expence of which is trifling. The remaining designs are fully explained by the engraving.

PLATE 70. Design for a Viaduct.

This Design is intended to be constructed entirely of bricks, coping excepted; the buttresses will be found a considerable support, considering the piers are not solid but arched over within.

PLATE 71. Ditto. Plan and Section of same.

The composition will be clearly understood from this plate.

PLATE 72. Design for an Oblique Iron Bridge over a Canal.

This may, at first sight, appear rather too florid, but upon a careful inspection, we trust such impression will be removed. If a design is required in Gothic architecture, something more is necessary than merely drawing a pointed Arch or embattled Parapet; the details should be carefully attended to, and, provided we can accomplish the same without increasing the expence, properly avoiding all useless ornament, and making every feature subservient to its end, where can be the objection?

We are led by the subject to hazard the following remarks upon design: Fitness for the purpose is of the first consideration, and admits of very great argument and difference of opinion; however, one illustration will be sufficient:—The wing walls of a Bridge in embankment are intended for the retaining or supporting such embankment, and are so placed to avoid the necessity of sloping it gradually down, which method is generally attended with greater expense; therefore, a form best calculated to resist the pressure or weight of embankment is required; perhaps the circular form, after the principle of an arch—the earth bearing against the extrados—may be the most fit form for such wing wall, as the weight of embankment assists the bond, and tends to keep the whole well together: a wall, the reverse of this, would be completely thrust out by a force similarly applied; therefore, in the wall described, there is a *fitness* for the purpose intended. Having determined the plan or principle to commence upon, the next thing is, to clothe such wal. in a manner most consistent with the project intended; it may be costly, or plain, yet either must have an air of propriety; the art lies in working out every part to the same scale of grandeur, or of simple relief, as the case may be; and to have nothing extraneous, or set out without an intention or meaning; every member should have its portion of effect to produce, and in proportion to its utility should its importance appear. To apply these rules to the plate we were describing, is what we did not anticipate when we began to lay them down; however, the considerate reader will make some allowance for us, since we did not prepare for such ordeal. We will now endeavour to apply the character of fitness to our subject;—A Bridge in the Gothic style was desired: 1st. Because it harmonizes well with the surrounding country and objects, being a style peculiarly English, consolidating and improving in appearance by age. 2dly. It requires but very small mouldings and little work, compared with Greek or Roman architecture, when executed to a corresponding stage of excellence, consequently it is more economical; and, lastly, it is well adapted to engineering purposes; indeed, many fortifications, although planned without any reference to appearances, present a system purely Gothic,

abounding with counterforts or buttresses, battlements, loop holes, &c.

In reference to the Details and finishings of design, we will suppose the following questions:

Query.—For what purpose are the two square and octagonal Piers upon each side of the canal?

Answer.—To give strength and marked support to the Bridge, where it may be generally expected; to form a bay or enclosure upon the foot-path of the bridge, where railway officers or guides may be stationed, for the reception of tools, and inasmuch as they are attended with no great expense, yet give a character to the design, carrying off the sudden effect of the set-off between the two stages or faces of the wall.

Query.—For what purpose are the several smaller Piers against wing walls?

Answer.—These Walls are formed thicker at the bottom than at the top, and the diminution is apparent from an external view, as the front line of parapet sets back from face of wall at level of ground, and they are connected together by a set off; the piers or buttresses are introduced at regular intervals, and fill the same office as counterforts; and by reason of these several piers being so placed, the walls may be executed of less substance than were it otherwise.

Query.—For what purpose do you reject the usual mode of finishing iron Ribs, viz. that of throwing in abundance of diagonal pieces, merely chamfering all edges, and the like, and substituting in their place an ornamental Rib?

Answer.—To keep up the necessary character of the style attempted, and what attracted our attention more particularly to this point was, a conviction that a correct pattern or mould might be contrived, equally strong and serviceable, the difference in the expense forming a very insignificant item, compared with the cost of casting, conveying, and fixing the same.

The above remarks will suffice for our present purpose, but should circumstances permit, we intend, at a future, period, again taking up the subject, and pursuing it to a greater length.

We have been induced to proceed thus far at present, from a knowledge that some Engineers affect a contempt of architectural appearance; but as such enormous sums are being expended upon Railway Works, the opportunity should not be lost of erecting edifices which should command the attention, and excite the admiration of the refined and contemplative, as well as the scientific, of future ages. The prodigious and wonderful works of Greece and Rome, are instances of the most consummate skill and exquisite taste united; indeed, with them, these qualities appear inseparable.

PLATE 73. Design for a Bridge (over Railway) in the Gothic style.

This Bridge requires no particular description,—it is supposed to be erected in a country where free-stone can be procured.

PLATE 74. Designs for Ornamental Bridges, in various styles of Gothic architecture.

This Plate comprehends six designs for Bridges. Nos. 2 and 3 will be perceived to be in the Norman style. There are portions of a railway where something striking and characteristic may be desired, and we maintain that Railway Works, instead of spoiling pleasure grounds, and becoming prejudicial to property, may be converted into picturesque objects, thereby improving an estate.

PLATE 75. Designs for Tunnel Fronts.

Seven designs, principally of the Egyptian character. In this style we perceive a cavernous character, very appropriate for the entrance of a Tunnel.

No. 3 is a Tunnel Front and Lodge, surmounted by a watch Tower, upon which a signal might be hoisted, if occasion required.

PLATE 76. Design for a Tunnel Front in the Egyptian style.

The idea of the funnel-shaped entrance was suggested to us by Geo. Bidder, Esq. C.E., and which we take this opportunity of acknowledging: This entrance would have a very bold effect, and the expence be very moderate.

PLATE 77. Ditto. Section of same.

PLATE 78. Designs for Ornamental Bridges.

They are seven in number, and in the Grecian style of architecture.

PLATE 79. Designs for Ornamental Bridges, with Cast Iron Girders and Fronts, to support railway, in various styles of Gothic architecture, comprehending six designs. No. 3 is of the Elizabethan era, and No. 4, Norman.

PLATE 80. Designs for Ornamental Bridges.

Six designs in the Italian style of architecture.

LONDON AND BIRMINGHAM RAILWAY.

EXTENSION CONTRACT, No. I.

SPECIFICATION of the several Works to be performed in making and completing a part of the said Railway, commencing at a point marked A in a line with the faces of the Houses on the North side of a street called Drummond Street, in the Parish of Saint Pancras, in the County of Middlesex, and terminating at a point marked C, about ten yards Northward of the Towing Path of the Regent's Canal, in the same Parish.

EXTENT OF CONTRACT.

This Contract includes the formation and completion of so much of the Railway as shall be included between a point marked B at the termination of the intended Depôt, and about 275 yards from the hereinbefore named point marked A to the hereinbefore mentioned point marked C, being a distance of about 74 statute Chains.

It comprehends the following Works, viz.

The making and erecting of the Hoards or temporary fence herein specified to be erected before the commencement of any of the other works.

The formation of the whole of the Excavation Embankments and Spoil Banks represented upon the Plan.

The erection, backing and completing of the several Retaining Walls shewn on the Drawings, with that of the Parapet Walls of the embankment, and the piers and arches which support them, and the pillars and iron pallisading on the top of these walls.

Should the Hoard decay, or become damaged during the time that the ground enclosed by them remains in the possession of the Contractor, he shall replace it, or any part of it so damaged, with work equal to the first erection, to the satisfaction of the Engineer.

All Drains, or Alterations in or deviations from existing Drains or water courses, which may be necessary for the exclusion of Water from the excavations, for the prevention of Damage to the adjoining property, or for any other purpose whatever, during the progress of the works, shall be made by the Contractor, at his own expense.

EXCAVATIONS AND EMBANKMENTS.

The part colored Red on the Field Plan, shews the direction of the Railway, and the Area of the Land which will be purchased by the Railway Company.

The part colored Yellow will be rented by the Railway Company, and the Contractor will have liberty to enter thereon, and erect any Temporary Houses, Offices, &c. necessary during the progress of the works, or any Machinery for excavating and embanking, which shall not be specially prohibited by Act of Parliament, for making the extension of the Railway.

The Embankments are colored Green, and the Excavations Red, upon the Section of the Line.

EXCAVATIONS.

The Red line on the Section describes the tops of the Embankments and bottoms of the Excavations, previous to laying the permanent way.

The Black undulating line describes the present Natural Surface of the Ground along the centre line of the Railway, and shews the heights of the Embankments and depths of the Excavations, from which data their contents have been calculated, upon the supposition " that the Area of any Cross Section in sidelong ground does not differ from the Area of a similar Section in Level ground".

Plans and Sections of an Excavation, Embankment and Spoil bank, are shewn in Drawing No. 24.

The Excavations are shewn in the drawings, and include the excavation necessary for the Retaining Walls, and their foundations.

The Excavations shall be carried on in such lengths as the Engineer shall direct, and their sides and faces shall be supported by such timber or other mode as shall be to his satisfaction, at the expense of the Contractor, during their progress, and until the completion of the Retaining Walls.

The face of the Excavation shall in no case be carried on more than 40 feet in advance of the completed Retaining Wall, without the written permission of the Engineer.

Whenever or wherever Springs, Streams, or Soaks of Water may appear and issue from the sides of the Excavations, or any other portion of the work, the Contractor shall, at his own expense, take all such precautionary measures of Draining, damming, stopping, lading, or pumping such water, or otherwise getting rid of it, as the Engineer shall direct, in order to prevent any injurious effect, either during the progress or after the completion of the work.

EMBANKMENTS.

The Embankments to be made of such height and at such Slopes as are shewn in the Section and drawings, and the Slopes must be carefully trimmed to their proper inclinations as the work proceeds.

Each Embankment must be carried forward as nearly at the finished height and width as the allowance for shrinkage will admit of. (This must be strictly attended to in all cases, for obvious reasons,) and covered with soil 1 foot in thickness. The Contractor will also be required to cover with soil, not less than 2 feet in thickness, the whole (excepting slopes and roadway) of the Embankment or Spoil bank which is intended to form a crescent Garden on the Duke of Bedford's estate; the soil to be taken from the surface of any adjoining excavation.

The Contractor to provide himself with Tools, labour, &c. (a similar clause will be found in the specification of 5 B, vide page 22,) for working the excavations and embankments. He must take every precautionary measure while working the Hampstead Road and Park Street Tunnels, for the safety of the metropolitan Roads.

GENERAL STIPULATIONS.

The General Stipulations are similar to 5 B, except where otherwise described, (vide Pages 22, 23, 24, &c. ;) also the description of the Brickwork, mortar, roman cement, concrete, backings to arches, wings and spandrils, stone imposts, (except in cases of skew arches, the skew backs of which must be worked to suit the oblique direction of the springing of the courses,) the stones (with the exception of the backs,) to be fairtooled, string courses (except to be not less than 3 feet instead of 2 feet 6 inches in length), coping stones (except to be in 3 feet lengths instead of 2 feet, and the caps of pillars to consist of one stone); also excavating Foundations, (the Con-

tractor to do it at his own expense, unless the Engineer considers the foundations of any part of the works ought to be Piled, the Contractor shall do it, and be allowed for it as an Extra Work). The descriptions of the above works are similar to those given in Contract 5 B, (commencing at Page 22,) with the exceptions specified.

IRON WORK IN GENERAL.

The whole of the Cast Iron, except that otherwise specified, to be of good Grey iron of No. 1 pig. No open Sand Castings shall be allowed. All the Wrought Iron to be of best Merchant's iron. All the Iron to be subject to such Tests the Engineer may think proper, provided such test does not exceed a strain of 8 Tons per inch sectional area of Wrought iron, and 5 tons per inch sectional area in Cast iron. The castings to be clean, smooth and even, free from air holes and all other defects, entirely corresponding with the drawings; in the Skew Girders, the proper winde must be strictly preserved.

TIMBER.

All the Timber to be approved of by the Engineer.

ARCHES.

The method of turning the brick Arches similar to those described in 5 B, (vide Page 25,) and the counterforts, abutments and spandrils shall be so worked and bonded into the arch as the Engineer shall direct. When the Arches are askew, the bricks must be laid in proper Spiral lines.

FILLING IN OVER ARCHES.

A similar clause will be found in 5 B, (vide Page 23); but the 18 inches below the surface of the roadway may be filled with broken granite, as described under the head of "metalling of roads" hereinafter described.

RETAINING WALLS IN GENERAL.

The various Retaining Walls are respectively shewn on the several Drawings, where the several lengths, heights, inclinations and curvatures (where such occur) are shewn (vide Plates 2, 3, 4, 5, 6, 7 and 8). The first of these Walls is that which divides Wriothesley Street from the intended Depôt, and is represented on Drawing No. 3. The next wall extends from Wriothesley Street bridge to the Hampstead Road bridge, (vide

Drawing No. 5). From this last mentioned bridge, the walls extend to Crescent Place bridge, vide Drawing No. 11. From Crescent Place bridge they continue to the bridge under Park Street, as shewn on Drawing No. 14. From Park Street bridge to the Regent's Canal, they are represented on Drawing No. 18.

RETAINING WALLS.

Sections and Elevations of the Retaining Walls are shewn on the various drawings.

The faces of these walls will be a Curved Batter; the radius of this batter will be 50 feet, giving an average batter of $2\frac{1}{2}$ inches per foot on 20 feet in every case, excepting in the walls from Crescent Place to Park Street, which have a radius of 61 feet 8 inches, being an average batter of 2 inches to a foot on 20 feet. The whole of the brickwork of the walls will be laid in courses radiating from the supposed centre of the curve of the batter. The walls will increase in thickness the nearer they are to the foundations, by half-brick offsets, and the footings will consist of steppings of two courses of brick, projecting one-quarter of a brick.

One foot thickness of Concrete will be placed under the footings of the walls, it will project 6 inches from the footings in the front, and be flush with the neat work behind.

The space at the back of the walls shall be well Punned in with clay. The faces of the walls will be broken at intervals of 16 feet, or thereabouts, as near thereto as consistent with dividing a given length of wall into an equal number of parts, by Pilasters 4 feet by 4 inches wide, projecting half brick, built and bonded with the rest of the wall. Counterforts will be built at the back of the wall, equi-distant between the pilasters, and bonded into the wall. A stone plinth 6 inches thick must be built in at the required height, and the wall above it will recede $\frac{1}{4}$ of a brick from the face of the plinth.

In excavating for and erecting these walls, the Contractor will be required to provide at his own expence all such Centering, leading frames, plumb rules, and other implements and materials as the Engineer may deem requisite for the expedition or soundness of the works; and also such other Timbering, iron work, props, bars and pollings as the Engineer shall think necessary for protecting the face or sides of the excavation or any other part of the work.

As soon after the erection of the walls as the Engineer shall permit or

require, the Contractor shall proceed to cope them with stone. The Coping shall then be surmounted with pillars 4 feet high and 4 feet wide, capped with a weathered Cap stone 9 inches thick projecting in one stone over the several pilasters in front of the wall. The Palisade must then be fixed between the pillars, and holes cut in the stone for their fastenings.

At the termination of the excavation beyond Park Street, the Walls change their construction and become Parapets supported on Arches, the piers of which descend through the foundations excavated in the natural ground. These piers and arches will be erected before the formation of the embankment; and the walls will be coped, and pallisades and pillars fixed thereon, in the same manner as the retaining walls.

PALLISADING.

The Pallisading for the retaining wall is shewn on Drawing No. 23, (vide Plate No. 4): it is all of the same pattern, consisting of a Wrought iron Handrail rivetted to lengths of cast iron open work, the handrail will be in lengths of 16 feet 6 inches or more, if required. The Castings to be 3 feet 6 inches long and about 4 feet high; they will have solid projecting feet, which must be let into the stone, and run in with lead. The whole must be constructed and fixed in a proper and workmanlike manner The hand rail shall be of the best merchant's iron, and the castings of No. 2 pig.

WRIOTHESLEY STREET BRIDGE.

(Vide Plate No. 2.)

This Bridge is to be built on a part of the Railway marked on the Plan Drawing No. 2, where the balance line will be about a foot excavation. It will cross the railway at an angle of 76 degrees, and will consist of iron, stone, and brickwork.

The foundations will be Concrete, as shewn in the drawings, and hereinafter described in the specification for Stanhope Place bridge. The piers and abutments will be constructed in the same manner as those for the bridge under the Hampstead Road hereinafter described. The girders will be cast askew, and the cross arches built in the same manner as those in the bridge under Park Street hereinafter described. The coping, parapet, string-course, and dentils will be stone.

For particulars of Materials and workmanship, see general directions

hereinbefore given. The granite paving for a moiety of the road to and over this bridge to be provided and laid by the Contractor, according to the drawing; no stone must be less than 12 inches by 6 inches by 8 inches, good sound granite. The flagging must be the best Yorkshire, and the fixing of the whole, and otherwise completing the street, must be duly attended to.

BRIDGE ON THE DUKE OF BEDFORD'S ESTATE.

(Vide Plates, Nos. 3 and 19.)

This Bridge will be built at a part of the Railway marked on plan, Drawing No. 2, where the excavation is about 9 feet deep. It is Askew, crossing the railway at an angle of 76 degrees. The faces will be stone. The soffits at the arches will be laid in Spiral lines, as hereinbefore described in the general stipulations. The pier and abutment will resemble those hereinafter described for the bridge under the Hampstead Road. In other respects this bridge resembles that under Stanhope Place hereinafter described.

For particulars of materials, see general directions herein beforegiven.

BRIDGE ON THE DUKE OF BEDFORD'S ESTATE.

(Vide Plates, Nos. 3 and 19.)

The Bridge will be built at a part of the Railway marked on plan, Drawing No. 2, where the railway is about 13 feet in excavation. It is 5 feet wider than the last mentioned bridge between the parapets, but in other respects exactly resembles it. The Contractor is referred to drawing No. 7, and to the hereinbefore contained specification for bridge No. 1 on the Duke of Bedford's estate.

BRIDGE OR COVERED WAY UNDER HAMPSTEAD ROAD.

(Vide Plates, Nos. 4 and 19.)

This Bridge crosses the Railway at a part marked upon the plan, where it is about 20 feet excavation. Its total length is 339 feet. It will be built on an inclination of 1 in 60. The foundation will be concrete as the other bridges. The face of the piers and abutments, the impost, plinth of the parapet, and pillars of the same, are to be stone, also the facing of the plinth of the pillars in the pier. The pier will be a series of pillars with inverts sprung between them, and the impost stone laying on the top from

pillar to pillar above the opening. Each of these stones must be 6 feet long. In the abutments, the pilasters project only half a brick from the face of the wall, which increases in thickness as it gets lower. On the stone impost, and immediately over those pillars, the iron girders rest, whose ends are made flat to lie upon the stone. The Girders are Curved, and have a versed sine of about 2 feet 6 inches. Each girder must be of the best No. 1 iron, and they must be proved with a weight of not less than 40 tons; Groined cross Arches are sprung from one girder to the other the whole length of the bridge, and they must be well set in Roman cement. Two round wrought iron Bolts of not less than 2 inches in diameter must pass from the front girder through three cross arches, and be firmly keyed in.

The four Girders for the Faces of the bridge will be different from the others in their construction, and will be flat on the top to receive the stones which form the projecting string-course. An ornamental cast iron front will be bolted to each of these girders.

For particulars of materials, &c. see general directions hereinbefore given.

The Contractor will see by Drawing No. 10, the houses which are intended to be taken down for the erection of this bridge, and he will be held responsible for any damage that may accrue to any other house except those specified. The lines A-B, B-C, C-D, and E-F, (on the drawing), shew the length of railing the Contractor has to erect in Granby Street.

BRIDGE UNDER STANHOPE PLACE.

(Vide Plates, Nos. 7 and 19.)

This Bridge will be built at a part of the Railway marked 65 on the plan, where the excavation will be about 18 feet in depth. The faces will consist of stone, and the internal structure of brickwork. The foundations will be concrete 1 foot thick, projecting 6 inches from the footings, but flush with the neat work behind, see Drawing No. 12.

The pier and faces of the Abutments will consist of a series of brick pillars and pilasters, with arches and inverts strung between them, as drawing. The Actual Abutments shall be recessed, as shewn on the drawing, and set upon concrete. In case at any time the Contractor shall excavate too much earth, he must fill in the extra excavation with concrete, at his own expence. The stone imposts will be continued throughout the whole length of the bridge. Each arch will be a segment of a circle, with

a cord 25 feet long, and with a reverse sine of 2 feet 6 inches. The torus moulding must run the whole width of the bridge, and no stone can be used in it less than 4 feet in length; the parapet will be of stone, with stone pillars of the dimensions shewn in the drawings, and the whole coped with stone.

The Drains must be laid in Roman cement. For particulars of materials, &c. see general directions.

BRIDGE FOR CRESCENT PLACE.

This Bridge will be built at a part of the Railway marked on the plan, where the excavation will be about 21 feet deep. The voussiers, faces of the pier and abutments, facing of the plinth, the string course, dentels and coping, will be of stone. The spandrils, parapets, and other parts of the face of the work of malm bricks, tuck pointed, and the internal structure of good sound brickwork. The actual abutments are solid. This bridge resembles in other respects that of Stanhope Place, to which the Contractor is referred.

BRIDGE OR COVERED WAY UNDER PARK STREET.

(Vide Plates, Nos. 5, 6, and 19.)

This Bridge crosses the Railway at a part marked 15 on plan, where the excavation is about 22 feet. It will be built on an inclination of 1 in 135, but the soffits shall not be parallel with the rails, being 3 feet higher above the rails at the South end than at the North. The cross arches will not be groined, but the spandrils must be carried up from the girders as drawing, and the arches will then spring level for their whole width. In every other respect, the specification for the Hampstead Road bridge will apply to this.

BRIDGE OVER THE REGENT'S CANAL.

(Vide Plates, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18.)

This Bridge will consist of three Main Ribs of cast iron, properly secured. Each main rib will consist of two ribs, properly connected, and each of these will be cast in one piece. The Cross Girders will be secured to these ribs, and the thrust of the arch sustained by tie bolts. The open Ornamental work of the face will be bolted to the main ribs, (see Plates, Nos. 10 and 13.) The Roadway Plates to be fixed as drawing (vide Plate, No. 15), and they will be perforated for drainage. No ballasting will be laid on the bridge. The Chairs will be fixed on oak blocks, firmly secured to the girders.

Coffer Dams will have to be sunk by the Contractor at his own expense, and included in the amount of his tender, in order to get in the foundations of the abutments. Concrete will be employed in these foundations, as shewn on the drawings. The Abutments will principally consist of brickwork, set in mortar, (except so much as is included between the foundations and the level of 1 foot above top water level, for 18 inches from the face of the work, which must be set in Roman cement.) The abutments will be faced with stone, and stones will have to be built and bonded in various parts, as shewn on the drawings.

PILING, AND COFFER DAMS.

The Contractor shall provide and drive Cast Iron Piling,* to protect the sides or banks of the canal, in the parts directed by the Engineer. This piling must be set down in the schedule of prices, and to be provided and driven at so much per foot; and the Contractor will be paid at this rate for such quantity of piling as the Engineer shall see fit to give him written orders to drive; (vide Plate, No. 17.)

Upon commencing this Bridge, the Contractor must, in the first instance, proceed to place a coffer dam around the intended site of the South Abutment, sufficient to contain the whole of the foundations described in the drawings, and well and conveniently to erect the same; he will be at liberty to withdraw the same, after the completion of the abutment, unless the Engineer should see fit to order it to be driven lower than the top of the concrete shewn in the drawings, in which case the Contractor is required to cut off such piles level with the bottom of the canal. In case the Engineer should think fit to increase the length of the piles, the Contractor shall be bound to provide and drive them of such length as the said Engineer may order, and is to be paid for the same at the rate contained in his schedule of prices. When the south abutment shall be raised so high as the Engineer may direct, the Contractor shall drive the iron Piling for the new towing path, which must be all driven, and the new towing path made good, before they shall proceed to excavate the foundation of the North abutment.

The Girders are suspended to the bracing frames by $2\frac{1}{4}$ in. wrought iron suspension bolts; they consequently extend from rib to rib; and the oak blocks which carry the chairs are to be firmly bolted on the tops of them, as shewn on the drawing.

* The iron sheet piling was omitted, and a brick retaining wall built instead, (vide Plate No. 18.)—Ed.

The Roadway Plates consist of a lattice 1 inch thick, composed of 1 inch square bars, 3 inches from centre to centre. They are fixed as shewn upon drawing.

Three thicknesses of patent Felt are to be interposed between the bracing frames and girders, one thickness between the bracing frame and main rib, where the chipping pieces are shewn in the drawing, and one thickness between the girder and oak block, fastened on the top thereof. No bolt holes are to be cast in the ribs or girders, but they are to be carefully drilled out afterwards, to fit the bolts. The mortices in the tie bolts must not be cut until the bolts have been fitted in their places and accurately marked.

ABUTMENTS.

Piles, 8 feet long and 1 foot square, are to be driven at the points noted on the plan of foundations, and iron bolts are to be keyed to them, connecting the said piles with the iron piling, in order to hold the latter in the proper place.

The Bolts are all of them the same length, and the points where the piles are to be driven are situated so that the bolts form portions of radii of the curve in which the piling is fixed. The chairs which carry the rails are fixed on the oak blocks on the top of the girders throughout the whole space between the abutments. Over the abutments they are fixed on oak beams, which rest on the abutment wall, and extend 20 feet from the face of the work, so as to ease the rails in case of the settlement of the embankment. The Rails over the bridge are wrought iron bars, 6 inches by $2\frac{1}{4}$ inches. They are fixed on chairs of the construction shewn on Drawing No. 22 over the bridge, and on those generally used on the line afterwards. The Contractor must observe strictly, and not deviate in the least from the drawings and dimensions shewn, unless in compliance with the written order of the Engineer. The Contractor is to do it all in a thorough workmanlike manner, and no work shall be allowed to pass without the approval of the Engineer; his order must be strictly attended to in every case. The Contractor to provide himself with all Machinery, implements, labor, &c. deemed necessary by the Engineer for the furtherance of the work. Each Girder must be tested to 40 tons, and each Tie Bolt to 65 tons. For particulars not contained in this part of the specification, the Contractor is referred to the general directions.

BALLASTING AND LAYING THE PERMANENT WAY.

A similar clause will be found in 5 B, except that there will be a four-fold way of single Lines of Rails, and they will fall from the point A marked on the Section of the Line to the point B, at the uniform rate of 1 in 156, or 0.423 feet per chain; from the point B to the point C at the rate of 1 in 286, or 0.237 feet in a chain. From this point to the point D it will rise at the uniform rate of 1 in 60, or 1.1 feet in a chain; from the point D to E it will rise at the rate of 1 in 135, or 0.4888 feet in a chain; it will then rise 1 in 75, or 0.88 feet per chain, and continue at this level to the end of the contract. The two outside lines of the way are to be 6 feet apart, and as drawing. There shall be cross drains 30 feet apart, and a sink trap with iron grating to each alternate cross drain.

DISPOSAL OF MATERIAL.

The Contractor must calculate the quantity of earth contained in each of these several embankments from the heights given on the plan, the slopes being 1 to 1. The embankment between Park Street and the Canal will have to be formed from part of the remaining contents of the excavations, and the surplus material must be then carried over the canal, and will form the embankment adjoining the Chalk Farm depôt.

Notwithstanding these arrangements, the Company reserve to themselves the power to order the Contractor to lay out part of the material excavated on the site of the intended depôt at Euston Grove.

TIME OF COMPLETION.

The whole of the above described works are to be completed on or before the 1st of January, 1837.

CONTRACT No. 5, B.

SPECIFICATION of the several Works to be performed in making and completing a part of the said Railway, commencing at a point marked A on the Section, and corresponding with a pole on Boxmoor, 16 chains south of the Grand Junction Canal, in the parish of Hemel Hempstead, in the county of Hertford, and extending to a point marked B on the section, 25 chains north of the road leading from Northchurch to Little Gaddesden and Ashridge, in the parish of Berkhampstead in the said County.

EXTENT OF CONTRACT, AND GENERAL STIPULATIONS.

This Contract is to include the formation and completion of so much of the Railway as shall be included in the limits mentioned above, being a distance of about 350 chains.

It comprehends the following Works.

The making of the Temporary Fences necessary during the progress of the works.

The making of the Permanent Fences.

The formation of the whole of the Excavations and Embankments represented on the Section of the Line Drawing No. 2.

The erection of the following Bridges:

The bridge at the crossing of the Grand Junction Canal.

Ditto at the crossing of the road from Bourne End to Pouching End, (vide Plate No. 23).

Ditto at the crossing of the road from Haxter's End, (vide Plate No. 25).

Ditto at the crossing of the road from Great Gaddesden to Berkhampstead, (vide Plate No. 26).

Ditto at the crossing of another road from Great Gaddesden to Berkhampstead.

Ditto at the crossing of the road from Berkhampstead to Berkhampstead Place.

The making, metalling, and completing the Approaches to each of the foregoing bridges.

The making a Paved Crossing for the road from Berkhampstead Common, and completing the approaches to the same.

The Diversion of such Roads as may be required, and are shewn on drawings, with the metalling and completing the same.

The building a Retaining Wall opposite Berkhampstead Castle.

The making and completing the Tunnel called Northchurch Tunnel.

The formation of side drains in the excavations on each side of the railway.

The laying, ballasting, and drainage of the Permanent Way, including the providing of all Timber, bricks, lime, stone, or other materials necessary for the completion of the works. The iron rails, chairs, keys, pins, trenails, blocks, and sleepers for the purpose, being provided by the Company, under conditions hereinafter described.

The doing of all other works mentioned or described in the accompanying drawings or specifications.

Also, the execution of the following

EXTRA WORKS.

The erection of Gates.

The excavation and embanking of approaches to occupation bridges, permanent sidings, stations, and tool recesses.

The metalling of occupation roads.

The paving of occupation roads crossing railway on a level.

The building of Occupation Roads and Culverts.

The laying and ballasting Permanent Sidings, and the formation of Tool recesses.

The above Works must be executed at the places where they may be required, and the Contractor will be paid for them according to the schedule of prices for extra works set out in the tender.

The preceding enumerated works and mode of execution are described at length in the specification of each particular work, and their forms and dimensions are represented in the accompanying drawings, which are referred to in each specification. But should any discrepancies exist between the schedule attached, and the written dimensions, or between the drawings and specification, or any ambiguity in them, the same shall be

referred to the Engineer, whose decision shall be decisive; also any thing contained in either the drawings, or the specification, shall be equally binding to the Contractor as if it were contained in both. The written dimensions upon the drawings are to be taken in all cases in preference to the scale attached.

FENCING AND DITCHING.

The Fencing described in the following Specification is of two kinds. The first Temporary, and for the prevention of trespass upon the lands adjoining the railway, during the progress of, and until the completion of the works; the second, Permanent, for the enclosure of the railway when finished.

TEMPORARY FENCING.

Immediately after the delivery of any portion of the site of the intended Railway into possession of the Contractor, and previous to the commencement of the works, the Temporary Fencing shall be completed, and shall include the whole area of the land to be occupied by any of the works contained in or connected with this contract.

The Temporary Fencing shall consist of split oak Posts, placed 9 feet asunder, and 3 feet 6 inches high above the surface of the ground, morticed to receive three horizontal oak or larch Rails, which are also to be supported by an intermediate Stay, or prick post, firmly nailed to each of the rails.

The whole of this fencing must be firmly and substantially fixed, so as to exclude sheep and all cattle from the excavations and other works, and effectually protect the adjoining lands from trespass, at all times during the progress of the works. All Drains, or alterations or deviations in existing drains or watercourses, which may be necessary for the exclusion of water from the excavations, or for the prevention of damage to the adjoining property, or any other whatever, shall be made by the Contractor, at his own expence.

PERMANENT FENCING.

The Permanent Fencing is of one description only, and as follows:— Quick fencing and Ditching extending throughout the whole length of

this Contract on each side of the railway, excepting the space occupied by the various bridges and crossing of roads. This Fencing is to be placed within the limits of 15 feet from the terminating slopes of the excavations and embankments. A Ditch of 6 feet wide at top, 2 feet wide at bottom, and 2 feet deep, shall be made on the higher side of the ground to be occupied by the railway. And a Ditch of 3 feet wide at top, 1 foot wide at the bottom, and 1 foot deep on the lower side of the ground. The outside of the Ditch must be 5 feet distant from the Boundary of the Land occupied by the Railway; and if the last mentioned ditch shall be deemed insufficient in any particular case, the larger sized ditch shall be made instead. The Material excavated from the ditch shall be used to form a mound on the space between the edge of the ditch and the Railway slope, both sides of which must be neatly faced with Turf. When the Material excavated from the ditch shall be more in quantity than sufficient to form the mound, the surplus must be conveyed to the nearest embankment. The best portion of the Vegetable Soil excavated from the ditch shall be placed in the middle of the mound, on which a double row of good 3 years old Quicks, 2 years transplanted, shall be planted, and not less than twelve Quicksets shall be contained in one lineal Yard.

On the inner edge of the ditch, oak Posts and Rails must be fixed to protect the quicks. The Posts are to be of split Oak, 7 feet in length, and equal in a sectional area to a scantling of 5 inches by $3\frac{1}{2}$ inches at least. They are to be placed at a distance of 9 feet from centre to centre, and to stand 3 feet 6 inches above the top of the quick mound; each post is to have three mortices completely through it, for the reception of the ends of the rails, and to be as nearly of uniform size as possible. The horizontal Rails, two in number between each pair of posts, are to be of split Oak or Larch, equal in a sectional area to a scantling of $3\frac{1}{2}$ inches by $1\frac{1}{2}$ inches. They are to be 10 feet in length, and the ends to be scarfed so as to fill the mortices of the posts. Midway between the Posts, an oak or larch Stay, 5 feet long, 2 inches wide, and 2 inches thick, is to be firmly nailed to each of the three horizontal rails with good ten-penny nails. The Posts must be firmly fixed in the ground, and the ends of the Rails firmly driven into the mortices in the posts, a piece of new iron hoop, $1\frac{1}{4}$ inch wide and $\frac{1}{16}$ of an inch thick, shall be nailed round the top of every post, to prevent its splitting.

The Fencing shall be made with as few bendings as the nature of the ground will admit of, and the Ditch along the side of the mound shall descend as uniformly as possible to the nearest main Drain or water-course, by which the drainage of the adjoining lands may be effected. Such parts of the

Temporary Fencing as can be made available shall be permitted to be used in the construction of the Permanent Fencing, provided the material be of the requisite strength and quality, and uninjured by previous use.

The erection of the Permanent Fencing shall proceed as rapidly as the progress of the other works and the nature of the season will admit of. At the bottom of the Embankment, small Draining Tiles must be laid through the quick mound, at intervals of not more than twenty yards, for the purpose of bringing all the water draining from the slopes of the Embankment into the fence Ditches.

Such parts of the Permanent Fencing as may be erected before the completion of the other works, shall be kept in complete order by the Contractor. The Quicksets shall be cleaned and weeded at least twice a year, and all broken Posts, rails, or stays, replaced by new ones, equal in quality to those originally used. All the Quicksets which may not grow or take root, must be pulled, and three years old living quicksets, similar to those described, planted in their places.

EXCAVATIONS AND EMBANKMENTS.

The part coloured Red on the Plan, Drawing No. 2, shews the direction of the Railway, and the area of the land which will be purchased by the Railway Company, and upon which the Contractor shall have full permission to erect any Temporary houses, offices, &c. necessary during the execution of the works, or any Machinery for excavating or embanking, provided that such erection shall not be specially prohibited by the Act of Parliament for making the Railway.

The Embankments are coloured Green, and the Excavations Red, on the Section, Drawing, No. 1. The black line on the section describes the top of the embankments, and the bottom of the excavations, previous to the laying of the permanent way. The black undulating line describes the present Natural Surface of the ground along the centre line of the Railway, and shews the heights of the embankments and depths of the excavations, from which data their contents have been calculated, on the supposition "that the Area of any cross section in side long ground does not differ from the Area of a Section on level ground." The level and other admeasurements from which the section is made, are believed to be accurate, but the Contractor must verify the results, as he will be held liable to the consequences of any errors. Plans and Sections of an excavation and an embankment, with drains and fence, are shewn on Drawing No. 19.

EMBANKMENTS.

The whole of the Embankments in the contract are to be made at a Slope of two to one, that is to say, when the base of the slope is 2 feet, its height shall be 1 foot, and the widths of the Embankment at the level of the Red line upon the Section is to be 33 feet when turfed or soiled, neither more nor less. Each Embankment shall be carried forward uniformly as nearly at the finished height and width as the due allowance for shrinking of material will admit of, and this allowance shall not exceed or fall short of the quantity deemed necessary from time to time by the Engineer. In all cases this must be carefully and strictly attended to, in order to avoid the necessity of making any subsequent addition either to the heights or widths of the embankments, to bring them to their proper level and dimensions.

The surface of the Embankment shall be kept in such form, or shall be intersected by such Drains or channels, as will always effectually prevent the formation of pools of water on them, and ensure the embankments being kept as dry as possible during the progress of their formation. Whenever the Material turned over the end of the embankment shall not form the proper slope, it shall be carefully trimmed to its required form, and this operation shall be proceeded with at the same rate as the formation of the embankment.

As the Embankments advance and become consolidated, their sides shall be carefully trimmed into planes, or faces having the proper slope specified on the section, and the face of the slopes are then to be neatly covered with Turfs of grass, not less than 8 inches in thickness, laid with the green sward outwards. The turf must be taken from the ground to be occupied by the base of the embankments, and where the land is arable, the soil must be carefully removed from the base of the embankment, and afterwards uniformly distributed over the slopes not less than 6 inches in thickness. The Slopes which are to be thus covered with Soil or vegetable mould, are to be sown with rye grass and clover-seed, mixed in equal quantities, and not less than 3 lbs. of the mixed Seed per acre is to be sown and equally distributed on them as soon as the season will admit of its being properly done. When, amongst the material which is brought to and shot over the ends of the embankments, there shall be large lumps, they must, if more than 6 inches in diameter, be broken to pieces.

EXCAVATIONS.

The whole of the Excavations in this contract must be 33 feet wide at the level of the Red line upon the Section when turfed or soiled, neither more nor less. The Slopes will be one and a half to one, that is to say, 1 foot 6 inches horizontal base to every foot of vertical height, excepting in the excavation marked No. 36 on the Section, and for a distance of 20 chains southward of Northchurch tunnel in excavations marked No. 35, where the Slopes will be three quarters to one, that is, 9 inches horizontal base to every foot vertical height.

The Slopes of the Excavations shall be finished as the cutting advances, and they shall be neatly and uniformly trimmed or dressed to the specified inclination, as near to the face of the cutting as possible ; and immediately after any part of the Slopes shall have been dressed to the proper inclination, they shall be covered with Turfs which have been previously taken from the land so excavated, in the same manner hereinbefore specified for the embankments; and where the excavations occur in such parts as are not grass land, the slopes are to be covered with Soil or vegetable mould previously procured from the site of the said excavation, and sown with rye grass and clover Seed, as hereinbefore specified for the embankment.

In the formations of the Excavations and Embankments in this contract, the Contractor shall not remove the turf or soil from the ground for a greater distance than one statute Chain in advance of the face of the excavations or embankments, and that which has been cut must be removed back to a point where the slope is ready for receiving it, and laid down as previously directed, with as little delay as possible. Whenever and wherever springs, soaks, or streams of water may appear and issue from the face of the slopes, the Contractor shall be bound to make and maintain during the progress and until the completion of the works, such Drains or water-courses as shall completely and effectually prevent the said springs, soaks, or streams of water from injuring the Slopes, and shall convey the whole of such water into proper drains, so that none shall be permitted to lodge in the excavations; and when beds of sand and other loose material occur, the face of the slopes must be protected from the injurious effects of such springs or streams of water by such other means as may be deemed advisable or necessary by the Engineer. At the bottom of each Slope, a Drain of uniform depth below the rails, as shewn on Drawing No 19, shall be made; and these Drains must be continued on both sides under the Bridges which cross

the Railway; and a Drain shall be made at the top of each slope so as to exclude from the excavations any water draining off or flowing from the adjoining lands; and all covered or open Drains which may be intersected by the Excavations, must be made to discharge their water into the Ditch outside at the top of the slope, for which purpose the said Ditch shall be made as deep at least as the bottom of the lowest intersected Drains, and the Space between the ditch and the top of the slope of excavation shall be well puddled at the place of intersection. The Contractor shall be compelled to open or make any new Drain which the Engineer may deem necessary for the exclusion of any water from the Railway excavation or in the formation of any of the excavations or embankments. The Contractor must provide at his own expense, all the Rails, chairs, keys and pins, blocks and sleepers, as well as Waggons, barrows, planks, and all other machinery, materials and utensils, which may be necessary for executing this contract. When any Material occurs in the excavations suitable for making Bricks, the Contractor shall be at liberty to make use of that material for that purpose, but if in so doing, he shall cause any deficiency for the formation of the embankment, he shall make up the deficiency by a Side Cutting, at his own expense, in such of the excavations as the Engineer may direct; and if such side cutting require an additional quantity of Ground, the Contractor shall indemnify the Company for the purchase of the same. Trial Shafts have been sunk in several places on the Line, for the purpose of procuring information as to the nature of the material; and their situations are marked on the Section.

GENERAL STIPULATIONS.

Which are to apply to the whole of the Bridges, Culverts, and other Works wherein the workmanship and materials described may be used.

BRICKWORK.

The Bricks made use of shall be sound, well shaped, thoroughly burnt, and of uniform colour on the face of the work.

No broken Bricks shall be used, except in the case hereinafter mentioned, and no joint of mortar shall exceed one-quarter of an inch in thickness. No difference of workmanship shall be allowed in the inside and outside work, except so far as hereinafter specified; and the whole of the joints shall be flushed up solid with mortar, and the outside joints neatly drawn. The Bond shall be either English or Flemish, as the Engineer shall direct.

MORTAR.

The Mortar shall consist of the best fresh burnt Dorking or other Lime, approved by the Engineer, and sharp Sand, mixed in the proportion of 3 measures of sand to 1 of lime. They must be mixed in a dry state, and well tempered, by passing through a pug mill, with a proper quantity of water.

ROMAN CEMENT.

The Roman Cement shall be of the best quality, and shall be mixed with an equal quantity of sharp sand. None shall be used which has set or become hard.

ARCHES.

Arches when of brick shall be built either in concentric half-brick Rings, or in such other manner as the Engineer may direct.

BACKING TO ARCHES.

The Backing shall consist of Brickwork laid in mortar as before described, and shall be built in every respect equal to the outside work. Bats may be used in this part of the work, but no course shall contain a greater quantity of bats than whole bricks.

WINGS AND SPANDRILS.

The Wing Walls shall be of that description of brickwork before described ; they shall be built battering, as shewn upon the drawings. The Spandrils will be of precisely the same description of workmanship as the wings. The bricks must be cut so as to fit the arch accurately all round.

FILLING IN OVER ARCHES.

The space between the wing walls, arch and backing of bridges shall be filled in with hard dry material, when it can be got, well rammed down, but when it is necessary to use clay for the purpose, it shall be firmly punned down in layers of not more than 9 inches thick, until it is within 18 inches of the level of the surface of the roadway, which depth must be filled with gravel, and the roadway formed as described under "Approaches to Bridges" hereinafter described.

STONE IMPOSTS.

Where Stone Imposts or springing courses are used, the stones shall always be equal to the full thickness of the arch, and no stone shall be less than 2 feet 6 inches long, and, when required, they shall be dowelled together.

SPRING-COURSES.

These must be of the form and dimensions shewn on the drawings. No stone must be less than 2 feet 6 inches in length, and the whole to be throated underneath. All the surfaces, excepting the back, shall be fair-tooled.

COPING.

To be of the form and dimensions shewn on the drawings. No stone to be less than 2 feet in length, and each stone must be dowelled and leaded to the adjoining one. The coping shall be fair tooled all over, and a throating, half an inch wide, cut on its under side.

STONE.

All Stone used for Bridges and parts of bridges throughout this contract, shall be Derbyshire Bramley Fall, or stone fully equal to it in quality and approved by the Engineer. The String-course, Parapet Wall and Coping shall not be put on until after the centres are struck, which shall not be done without the permission of the Engineer. All the centering must be done to the satisfaction of the Engineer. Great care must be taken that the bridges are so placed, that the outside rails when laid shall be equidistant and parallel with faces of the abutments or parapet walls.

EXCAVATING FOUNDATIONS.

The Contractor is to Excavate for the foundations of all Bridges, Culverts and other works, to keep out all water, place Dams, and provide all Centering planks and tools of every description necessary for the perfect execution of his work, at his own expense, and to be included in the amount of his tender; and in case of the foundations of any of the works requiring, in the opinion of the Engineer, to be carried lower than is shewn upon the draw-

ings, the Contractor is to make such Extra excavations and do all Extra pumping, or other contingent works incident thereto, at the rate specified in the Schedule of prices. The increase to the masonry or brickwork, or other matter constituting the foundations caused by such additional depth, will be allowed as an Extra to the Contractor, according to the rate specified in his Schedule of prices.

DRAINS UNDER BRIDGES.

Drains must be constructed under all the Bridges, on each side of the Railway, 15 inches wide at the top, and 12 inches wide at the bottom; to be sunk as low as the drain at the outside of the ballasting. They will each consist of a brick wall, 14 inches thick, 3 feet deep, and equal in length to the width of the bridge, and as much more as shall be necessary to connect with the side Drains. At the outside of the ballasting, there will be two courses of bricks to form the bottom. The whole will be laid in mortar as described for the bridges.

CONCRETE.

All Concrete must be composed of Gravel, perfectly clean and mixed with fresh well burnt Lime in the proportions of 6 parts of Gravel to 1 of Lime. The lime and gravel to be mixed in a dry state, and a sufficient quantity of water afterwards added.

BRIDGE AT THE CROSSING OF THE GRAND JUNCTION CANAL.

The Railway intersects the Canal at an angle of 40°, and at a point where the height of the Rails above the level of the water is 29 feet 8 inches, and the depth of the Embankment 25 feet. The Railway rises in the direction of Birmingham at the rate of 1 in 330.

The Bridge will consist of 6 Main Ribs of cast iron, forming an arch of 66 feet span on the skew, and 11 feet 9 inches rise, and leaving a clear width of 33 feet 6 inches between the abutments, measured at right angles, to the centre line of the canal. Each of the Ribs will consist of three pieces, upon which the open work of the spandrils will be fixed. Beams of Oak will

run along the top of the four middle ribs, and be bolted to them; to these beams will be attached the Railway Chairs. The spaces between the ribs will be covered with cast iron Plates, upon which the ballasting of the railway will be laid. The Abutments and wing walls will consist of brickwork laid in mortar, excepting such parts of them as stand on the planked platform hereinafter described, which must be built in Roman Cement for the distance of 18 inches from the face up to the level of the Towing Path of the canal. The bottoms of the excavations for the foundations of the abutments must be made perfectly smooth and level; and a Platform, consisting of a double thickness of Planking, and extending under every part of the base of the abutments, must be laid down. On this platform the Abutments will be raised. At the springing of the Arch, a course of Bramley Fall stone, forming the skew backs or imposts, will be built into the brickwork, and upon this will be built the brick walls. At the backs of the Main Ribs, the backing of the arch, consisting entirely of brickwork, will be carried out between the wing walls to the extent shewn on the drawings. It will be supported on five small Arches, springing from walls which run parallel with the wing walls. The Wing Walls and pilasters in front of the abutments will be wholly of brick, and will be built battering. The whole of the outside of abutments and pilasters to be faced with White bricks from Cowley, or such other white bricks as may be approved of by the Engineer. A string-course of stone, as shewn in the drawings, will run along the wing walls and pilasters as far as the face of the abutments, and the same form will be continued in cast iron over the arch. The Pilasters, both in front of the abutments and at the ends of the wing walls, will have plinths, facias and caps of stone. The Towing path of the canal will be retained by a row of cast iron piles and plates running along its face and joining on the present towing path with an easy curve, as shewn in drawings. The Piles will be tied back by land Ties fixed into the abutments of the bridge, or to wooden piles driven in for the purpose; the space between this row of piling and abutments, will be filled with gravel and lime Concrete.

D^{o} ..... D^{o} PLANKING OF PLATFORM.

The Planking shall consist of two courses of good Memel Timber, each 4 inches in thickness. The upper course must cross the lower at right angles, and be firmly spiked to it with wrought iron Spikes 7 inches long and $\frac{1}{2}$ inch square.

D^o ..... D^o ABUTMENTS.

The bottom of the brickwork of the Abutments shall be laid 6 feet below the water level of the Canal, and 8 feet below that of the Towing Path; they will consist of brickwork laid in mortar, as hereinbefore described, excepting for the depth of 18 inches from each of the faces, and up to the level of the Towing Path, which will be laid in Roman cement. The Walls which carry the small arches supporting the backing shall be founded at the depth of 3 feet below the water level of the canal; they shall be 2 feet in thickness, and uniformly carried up to the springing of the cross arches; these Arches are of different spans, and spring at different heights, so as to keep the level at the crown the same in each; they are to be 9 inches in thickness; and the backing is to be 4 feet in thickness above the estrados of the cross arches last mentioned. The Walls at the back of the cast iron ribs shall be 3 feet in thickness, and carried up to the level of the top of the ribs; they shall consist entirely of brickwork. The Skew backs or Imposts shall be of Bramley Fall stone, of the shape and dimensions shewn on the drawing, and each Stone shall be cramped to the adjoining one with wrought iron cramps run in with lead, 12 inches long, 2 inches wide, and $\frac{3}{4}$ of an inch thick. The fronts and the beds of the stones are to be fairly dressed, and the backs only to be left rough.

D^o ..... D^o WING WALLS.

The Wing Walls shall consist of brickwork laid in mortar, and must be built up to the string-course with a batter of 1 inch to a foot. Counterforts, 3 feet wide, 3 feet in thickness, and about 11 feet apart, must be built at the back of the wing walls, and well bonded into the substance of the walls.

D^o ..... D^o STONE STRING COURSE.

A String-course of Bramley Fall stone, dressed into a torus moulding, must be set on the wing walls and abutments, at the height shewn in the drawings. The average length of the stones must be 4 feet, and whenever any stone falls short of this dimension, the next shall exceed it as much as the former is below it, and no stone shall be less than 3 feet in length; the whole must be neatly dressed, and the beds and cross joints made perfectly true and close.

Dº ..... Dº STONE PLINTHS, FACIAS AND CAPS TO THE PILASTERS.

The stone Plinths and Facias must project 2 inches from the face of the brickwork, and shall be bedded in the work not less than 6 inches. The Caps to the pilasters must be 9 inches thick on the face and 1 foot in the middle, and must in no case consist of more than one stone. The whole of the outer surfaces are to be fair-tooled.

Dº ..... Dº CAST IRON RIBS.

Each cast iron Rib will be a segment of a circle of 66 feet span and 11 feet 9 inches rise; 2 feet deep at the crown, and 2 feet 9 inches at the springing. The thickness of the metal of the middle part must be 2 inches, and that of moulding at top and bottom 6 inches. Each Rib is to be cast in three pieces, and they will be bolted together through the flanges cast on them for that purpose, with bolts 2 inches in diameter. The Open work in the spandrils must be cast separate, (excepting so far on each side of the arch as is pointed out by the letters A, A, Drawing No. 5, Fig. 1, which will be cast on the centre piece of the main rib), and keyed into sockets cast on the ribs for that purpose, as shewn on the drawings. Sockets must be cast on the ribs to receive the ends of the longitudinal and diagonal Braces, and to admit of their being firmly keyed to them, (see Drawing) and holes must also be formed at the proper places to allow a wrought iron Tie to extend from one side to the other of the bridge. All the bolt Holes which go through the outside ribs must be counter sunk. The Top Tables of each of the Ribs on which the oak timbers hereinbefore mentioned rest, must have bolt holes 1 inch in diameter cast in them, at a distance of 3 feet, centre and centre, alternately, on opposite sides of the beam, in order to secure the said timbers. They must also have bolt holes cast $\frac{3}{4}$ of an inch in diameter, suitable for bolting the roadway plates.

Dº ..... Dº SKEW BACK PLATES.

The Ribs will spring from cast iron plates 2 inches in thickness, cast in two pieces and bolted together with four 2 inch iron bolts. The parts where the main ribs spring must be so recessed as to present faces at right angles to the direction of the ribs, which must be also keyed into their places with wrought iron wedges. The stone Skew backs must be worked

to fit exactly the various bendings of the plates, and where they join they must be let into the stone work. The whole must be firmly and solidly bedded, and run with Roman cement.

Dº ..... Dº CROSS BRACES AND TIES.

Between the main ribs, and diagonally across the arch, are cast iron Braces, as shewn on Drawing No. 4. They are cast with palms to admit of their being wedged into the sockets cast on the ribs. Wrought iron Tie bolts run across the arch at a direction parallel with the abutments. They are contained in cast iron pipes, the sides of which are feathered, and the ends furnished with palms, in order that they may be wedged into sockets cast on the ribs. The greatest care will be required in the fitting of these braces and ties, in order that they may not be subject to unequal or twisting strains.

Dº ..... Dº TORUS MOULDING AND PLINTH OVER ARCH.

This moulding and plinth must be of cast iron. It must be cast in several pieces, which are to be bolted together with four 1 inch bolts; and sockets must also be cast in it for the reception of the standards of the iron railing, which are to be fastened with keys, as shewn on the drawing. The Back plates, or that part next the railway, must be cast separate, in order to give access to the bolts which form the fastenings to the main front rib. They must be afterwards screwed on, and the joints so arranged as to come intermediately between the joint moulding and plinth.

Dº ..... Dº IRON RAILING.

The whole of the distance between the pilasters and the abutments, and between them and the piers at the end of the wing walls, is to be occupied by Iron Railing, as shewn in the drawings. It is to be cast in lengths corresponding with those of the moulding and plinth, into the sockets of which, as before mentioned, it must be firmly fixed with wrought iron keys. Each length of railing must join to the next with a neat half-lap joint, and its middle standard must be steadied by having a cast iron knee or bracket screwed to it, as shewn on the drawings.

That portion of railing between the pilasters and piers, at the end of the wing walls, must be secured to the stone plinth, by being run in with lead, the knees or brackets being attached as before described. The ends

of the railing must run into the pilasters for the length of 3 inches, and either be secured there or left loose as the Engineer may direct. All the Castings must be of No. 1 iron, excepting the roadway Plates, which may be of No. 3; and no open sand casts will be allowed, excepting for roadway plates. All the malleable iron used in this work must be of the best scrap iron; a thickness of patent felt covered with white lead, to be placed between all the joints of the iron work. All the iron work must be painted with two coats of paint.

Dº ..... Dº OAK BEAMS.

An English oak Beam of the dimensions shewn in the drawings must be bolted on each of the four middle Ribs with bolts 1 inch square, 3 feet distant, centre to centre, so arranged as to be on opposite sides of the centre beams. The length of each oak Beam must be equal to that of the Rib, together with the thickness of the wall at the back of the ribs; they must be cut away to fit the road Plates, and their bolt heads, and so as to secure a firm and solid fitting upon the tops of the ribs. The Chairs must be secured to the beams, each with two wrought iron Bolts $\frac{3}{4}$ of an inch in diameter, screwed into nuts let into the substance of the beams. None of the beams shall be made in less than two pieces, and these shall be of equal length, and joined with a Scarf 2 feet long.

Dº ..... Dº FILLING IN BETWEEN WING WALLS.

The ends of the embankments shall not be brought by means of waggons nearer than 20 yards to the extremity of the wing walls, and the remainder of the earth necessary to complete the embankment shall be wheeled in barrows. The filling in between and around the wing walls shall be well punned in layers of not more than 9 inches thick, as the brickwork is brought up, so as to be firm and solid.

Dº ..... Dº BALLASTING ROADWAY.

The whole surface of the Bridge shall be covered with a stratum of clean Gravel, perfectly free from earthy matter. That part of the Bridge over the arch up to a level of 2 inches beneath the surface of the Rails, and the remainder of the bridge to be covered to the depth of 2 feet 4 inches beneath the same level, as hereinafter directed in the description of laying the permanent way.

D^{o} ..... D^{o} INCLINATION OF RAILWAY

The Railway over the Bridge will have an inclination of 1 foot in 330 feet, and the whole work must be erected as much out of the level as that quantity.

D^{o} ..... D^{o} CAST IRON PILING FOR TOWING PATH.

The Towing Path of the Canal is retained by a row of cast iron piling to the extent shewn on the drawings. The piling is to consist of Main Piles and Plates, the form and dimensions of which are represented on the drawing. The Main Piles are to be driven to the distance of 6 feet 5 from centre to centre, perfectly upright, and exactly equi-distant from each other at top and bottom; they are then to be tied back by wrought iron Ties, $1\frac{1}{2}$ inch in diameter, in the manner shewn in the drawings.

The ground having been cleared away between these piles, the cast iron Plates are to be dropped into the grooves in the main piles, and the whole being secured at top by the capping being firmly bolted on. The Tie bolts mentioned above are to be secured to stones built into the abutments, or to needle Piles, consisting of whole timbers, 12 inches square, and driven to the depth of 8 feet below the surface of the ground. At the ends of the Piling, and to the extent shewn on the drawing, brick walls are to be built; and they are to be 3 feet thick at the bottom and 2 feet 3 inches at the top, and must return for a depth of 18 inches at the points where they join the piling and the present towing path.

D^{o} ..... D^{o} COFFER DAMS.

In removing the Coffer Dams which may be necessary in putting in the foundations of the bridge, the sheet piles must be cut off level with the bottom of the canal.

In explanation of the restrictions to which the Contractor will be liable in regard to any interference with the navigation of the Canal which he may disturb in laying the foundations of this bridge, by driving coffer dams or otherwise, the following quotations from the Act of Parliament are subjoined:—

"And the said Railway Company shall and they are thereby
"required, during the progress of constructing each such bridge over
"the said Grand Junction Canal, and of the necessary repairs or

" renewal thereof from time to time, and at all times, to leave an open
" and uninterrupted Navigable water way in such Canal, of not less than
" 16 feet, during the time of constructing and putting the foundation
" walls of the abutments of each of the said bridges, and of the new
" towing path of the same up to 1 foot above the top water level of the
" said canal, and which time of contracting the water way shall not
" exceed thirty days; nor shall less than 22 feet for the said water way
" and 8 feet for the said towing path be left during the construction or
" repairing or renewing each such bridge; and the present Towing Path
" shall remain undisturbed until the new towing path wall shall be
" erected and the ground made good and properly gravelled, and open
" for the free passage for horses under each such bridge."

The Contractor shall be required to fix the whole of the Iron work of the bridge upon his own premises, for the inspection of the Engineer, and no part to be removed until he receives a written order to that effect. In this case, as in any other case. (in accordance to the general clause to that effect, hereinbefore mentioned,) the Engineer shall have the power to make any alterations, deductions or additions he may see fit.

BRIDGE AT THE CROSSING OF THE ROAD FROM BOURNE END TO POUCHING END.

(Vide Plate, No. 23.)

This Bridge passes under the Railway at a point where the depth of the embankment is 24 feet 9 inches and the level of the rails is 27 feet 1 inch above the present surface of the road. The Arch is a semicircle of 7 feet 6 inches radius and 1 foot 6 inches thickness; and the height of the springing from the level of the road is 15 feet 6 inches. The clear width between the parapets is 28 feet. This Bridge is to be built of brick, with the exception of the string-courses, copings and caps to the pilasters, which are to be of stone. Counterforts are to be built behind the Abutments, and Arches turned between them in the manner shewn in the drawings. For Materials and Workmanship, see General Stipulations hereinbefore given.

BRIDGE AT THE CROSSING OF THE HAXTER'S END ROAD.

(Vide Plate, No. 25.)

This Bridge passes over the Railway at a point where it is level with the present road. The bridge is to be of brick, except the string-course,

coping and imposts, which are to be of stone. The Arch is a semi-ellipse, 30 feet span, and 9 feet rise; the height from the rails to the crown of the arch is 17 feet, and the clear width between the parapets is 15 feet. The Inclination of the roadway must be at the uniform rate of 1 in 13. The Slopes of the approaches are 2 to 1 at right angles to the road, but they must be reduced to $1\frac{1}{2}$ to 1 along the face of the wing walls. The Approaches to the bridge are shewn on the drawings. For particulars of Materials and Workmanship, see general directions hereinbefore given.

BRIDGE AT THE CROSSING OF THE ROAD FROM BERKHAMPSTEAD TO GREAT GADDESDEN.

(Vide Plate, No. 26.)

This Bridge passes over the Railway at a point where the Embankment is 4 feet 4 inches deep, or where the level of the rails is 6 feet 8 inches above the present surface of the ground. It is to be built of brick, excepting the string-courses, imposts, coping, and caps to the pilasters, which are to be of stone. The Arch is a semi-ellipse of 30 feet span, and 10 feet rise, and 1 foot $10\frac{1}{2}$ inches thick. The height from the level of the rails to the crown of the arch is 17 feet, and the clear width between the Parapets is 15 feet. The Wing Walls run nearly parallel with the Railway, and are returned with a short wall at the ends, as shewn in the drawings. The Approaches to the bridge are shewn in the drawings. For particulars respecting Materials and Workmanship, see General Stipulations hereinbefore given.

BRIDGE AT THE CROSSING OF THE ROAD FROM BERKHAMPSTEAD TO GREAT GADDESDEN

This Road crosses the Railway at a point where the depth of the cutting is 24 feet, measured at the centre line. The Bridge is to be of brick, excepting the imposts, string-courses, and coping, which are to be of stone. The string-course is to be 9 inches deep on the face, to project 3 inches, and to be built into the brickwork $4\frac{1}{2}$ inches. The coping must be 6 inches deep in the middle, the top and upper corners must be neatly rounded off, and it must project 3 inches from the face on each side. A throating 2 inches deep must be cut on both string-course and copings on the underside, throughout their length. The Arch is a semi-ellipse of 30

feet span, and 8 feet rise, and the thickness is 1 foot $10\frac{1}{2}$ inches. The height, from the level of the Rails to the crown of the arch, is 17 feet 8 inches, and the clear width between the parapets is 15 feet. The surface of the Road is inclined at the rate of 1 foot in 8 feet. This inclination must be kept as it is, and the parapet of the bridge built parallel to it. The form and dimensions are shewn in the drawing. For particulars of Workmanship and Materials, see General Stipulations hereinbefore given.

BRIDGE AT THE CROSSING OF THE ROAD FROM BERKHAMPSTEAD TO BERKHAMPSTEAD PLACE.

This road passes the Railway at an angle of 45 degrees, and at a point where the depth of the embankment is 13 feet 6 inches, or where the surface of the rails is 13 feet 10 inches above the surface of the present road. The Bridge consists of six cast iron Girders, or Ribs, resting on a course of stone built into the abutment walls; those on the outside, and supporting the parapet walls, are 2 feet 6 inches deep, and those inside, carrying the Railway, are 2 feet 3 inches in depth, with top and bottom Tables, the former 10 inches, and the latter 1 foot 6 inches broad, the thickness of the iron throughout is 2 inches. Three pairs of wrought iron Ties, $1\frac{1}{4}$ inches in diameter, must pass through each of the outside ribs, and attach it firmly to the adjoining inside rib, in the manner shewn on the drawing. The holes in the face must be countersunk, and bosses must be cast on the inside, so as not to decrease the material at those particular points. A 2 in. plank of Oak extends along the top of the four inside ribs, and on this rest the railway Chairs, which must be bolted through the wood to the table of the Rib. Brick Arches, 9 inches thick, are to be turned between the ribs, in the manner shewn on the drawing, and the Spandril Walls must be built across the Bridge at right angles with the face, and carried up to a height level with the top of the ribs. A stone string-course, dressed into a torus moulding, runs along the bridge as far as the outside of the pilasters, in the front of the abutments: it must be attached to the ribs by iron plugs, leaded into the stone, and keyed under the table of the rib. The width on the square, between the Abutments, is 15 feet, and the clear headway under the ribs must be 15 feet also; but in order to obtain this height, the road must be lowered to the extent of 1 foot 9 inches under the bridge, and it must rise at the gradual inclination of 1 in 20 to the present

surface on each side. The Ribs must be of No. 1 iron, and the wrought iron bolts, &c. must be of the best scrap iron.

The Contractor must be at the expense of subjecting the whole of the iron work to any test which the Engineer may think proper to apply, in order to ascertain its strength and soundness; and if any defect shall appear, the contractor shall replace the defective casting, or iron work, for others free from such objection. For particulars of Workmanship, and material, diverting, lowering, and metalling the road, see approaches to bridges and General Stipulations.

RETAINING WALL AT BERKHAMPSTEAD CASTLE.

This Wall is for the purpose of retaining the Railway Embankments along the part of the road from Berkhampstead to Berkhampstead Place, immediately in front of the Castle. Pilasters are to break forward half a brick from the face of the wall, at a distance of 20 feet, as near as may be, centre to centre, and they are to run flush into the plinth at the bottom which must project half a brick. The top course of the Plinth must consist entirely of headers, neatly bevelled off, and laid in cement. A piece of stone, of the dimensions and form shewn, is to stand out as a string-course from the pilasters, and in the manner shewn in the drawings; and along the wall, at the same level, a half brick projection of equal depth is to be continued, the bricks of which must be rubbed on the outer surface. Where the road passes under the Railway, this arrangement is altered, as will be seen from the drawings. A torus moulding extending as far as the outside of the pilasters in front of the abutments. Immediately behind the pilaster, the wall must be broken by counterforts, of the form and dimensions shewn in the drawings, and they must be well bonded into its substance. The Footings are to be carried down 1 foot 6 inches below the present surface, and whatever is the section of the ground, they must in no part be formed at a less depth. The wall is finished at each end by a curved return, and along the top of the whole extends a stone Coping, 6 inches in depth. No Stone must be less than 3 feet in length, and each stone must be secured to the adjoining one with a wrought iron cramp, 8 inches long, turned down at the ends 2 inches, and run with lead. The length of the walls, between the commencement of the return walls at each end, is 555 feet 6 inches, and the length of the return walls is 42 feet 6 inches, making the

total length of the Wall 640 feet 6 inches. In bringing up the Embankment, the earth must be well rammed in layers of not more than 1 foot thick, for a distance of at least 6 feet from the back of the wall. The whole of this Wall must be neatly finished, and the joints drawn, and if they are acted upon by the frost before the mortar has become hard, they must be repointed in the ensuing Spring. Care must be also taken to give the wall a proper and even curvature, so that it shall be in every part parallel with the centre line of the Railway.

DIVERSION OF ROAD INTO BOURNE END ROAD.

This Road is to be diverted between the letters A and B, a distance of about 19½ chains. The diversion must follow the direction of the railway embankment at the outside of the ditch. The gravelling of the road must in no part be of less width than 15 feet, and a Fence and Ditch, similar to those specified for the Railway, must be formed along the further side of the road, joining neatly at the ends with the present fences. See Specification of Approaches to Bridges.

NORTHCHURCH TUNNEL.

(Vide Plates, Nos. 27, 28, 29, and 30.)

This Tunnel commences in the field marked 34 on the plan, and terminates in that marked 38, being about 16 chains in length. The Contractor is to confine his operations to the width of 1 statute Chain, upon the surface of the ground over the intended tunnel; and previous to commencing any part of the said tunnel, the above width is to be fenced in with Temporary Fencing, similar to that hereinbefore described, which must be made to unite with the fencing along the line of Railway. This Fencing is to be removed after the completion of the tunnel, and no other fencing erected, excepting over the ends, where Permanent Fencing (similar to that hereinbefore described) must be erected for the sides of the Railway. This Tunnel is to consist of a brick Arch, of the form shewn in the drawings, (vide plate No. 29) supported by carved Side Walls, standing upon stone skew backs, which are to be bedded upon the counter or Inverted Arch, forming the base of the tunnel: this part is to be one and a half brick in thickness, excepting the shaft, as shewn on next drawing, and the arch and side walls are to be two bricks thick throughout the whole length of the tunnel,

excepting for a length of 7 feet 3 inches at the front, and at a distance of 12 feet on each side of the shaft, together with the shaft length, where they will be three bricks thick, or in such other places as the Engineer may think it requisite to make them thicker; in which latter case the Contractor shall be paid for the increase according to the rate mentioned in his Schedule of Prices. The Arch, if of the thickness of one and a half brick, shall consist of three half brick rings; if it be two bricks thick, it shall consist of four and a half brick rings, and so on, and each ring shall contain five courses of bricks more than the ring immediately beneath it.

The Bricks to be made use of in that part of the arch between the points C and D, Drawing No. 17, Fig. 2, are to be moulded tapers, so that the sides may radiate agreeably to the curvature for that distance. All the rest of the bricks may be of the ordinary shape. The whole of the Brickwork is to be set in mortar, excepting that part on each side of the shaft which is marked on the Drawing No 17 to be set in Roman cement; but if the Engineer should think it necessary to have any other portion of it set in cement, the Contractor shall be paid for the difference of cost according to the rate set forth in his Schedule of Prices. The longitudinal courses of brickwork must be laid perfectly straight in the direction of the tunnel, and must be parallel in every direction with the surface of the rails; and if at any time the regular continuity of the brickwork of the tunnel shall be destroyed, either in consequence of irregular shrinking, or settlement of the arch, or imperfection of the centres, the Contractor shall amend or remove such irregularity in a satisfactory manner. The stone Skew backs of the side walls, (next the invert) shall consist of stone of the quality hereinbefore described. No stone must be used less than 3 feet in length. There must be a bed of brickwork under the stone skew back, extending to the inverted arch, in which the stone work shall be soundly bedded.

Dº ..... Dº Shafts.

(Vide Plates, Nos. 29 and 30.)

The Contractor may sink two working Shafts on the centre line of the tunnel, at such places as the Engineer shall direct. They shall be 9 feet diameter inside the brickwork, and the brickwork shall be of the thickness of one brick's length. The Shafts shall be the same diameter from top to bottom, perfectly cylindrical, free from bulges and all other imperfections. The brickwork shall rest upon a cast iron Curb, fitting into the crown of

the arch of the tunnel, forming a level base for the shaft to rest upon; the Bond shall be of whatever description the Engineer may require. The shafts shall be carried up to a level of 10 feet above the level of the surface, and finished with a coping of Bramley fall stone, 9 inches thick, and 15 inches long; and the stones shall be dowelled together, and run in with lead, and the dowels shall not be less than 4 inches long. Whenever any Water may occur in sinking the shafts, it must be excluded from it by a lining of Puddle behind the brickwork, or by setting the brickwork in Roman cement, or both, if necessary. The Contractor must also sink two other shafts on the centre line of the tunnel, one at each end of it, and drive a Heading, 4 feet wide and 5 feet high, the whole length of the tunnel. This Heading must be carried through, before any part of the main tunnel is commenced, and must be supported and kept open during the execution of the whole work, by timbering or such other means as may be deemed necessary by the Engineer. The Contractor will be at liberty to sink whatever Air shafts he may think proper, provided they in no case come within 50 yards of the working shaft. They are to be 3 feet diameter within the brickwork, and supported at their intersection with the arch of the tunnel on cast iron curbs. The specification for the working Shaft, in regard both to these curbs and other workmanship and materials, must be equally applicable to these shafts. A brick Drain, as shewn upon drawing, must be constructed throughout the whole length of the tunnel. The brickwork is to be laid in mortar, as hereinbefore described.

Dº ..... Dº EXCAVATING.

In excavating the Tunnel, the Contractor shall not in any length advance beyond the completed brickwork more than 6 feet, without the special permission of the Engineer; and should the nature of the ground render it unsafe or inexpedient at any time to advance so much as 6 feet with the excavation beyond the brickwork, the Contractor shall limit such advances, as may be directed by the Engineer. The Space excavated in advance of the brickwork shall be carefully and substantially supported by the usual modes of timbering, namely—sill props, or shores, bars, and polling boards.* The dimensions and arrangement of such timbering to be approved of by the Engineer. The invert sides, and the roof, must be cut out as nearly as possible of the finished size of the exterior of the brick-

* The Tunnel was worked similar to the Primrose Hill Tunnel, (vide Plates, Nos. 20 and 21.)

work ; and in any case where the bottom may have been taken out beyond the stipulated dimensions, the excess must be made perfectly sound and good, before the brickwork of the invert is commenced, by being well filled up with suitable material. Wherever any Space exists between the exterior of the brickwork and the excavation, whether on the sides of the roof, arising either from the required size of the excavation being exceeded, or whether from the withdrawal of the Bars, the greatest care shall be taken to form the same perfectly solid, with suitable materials, as the brickwork advances in height, and in no case shall the brickwork rise more than two courses without this operation being effectually performed.

When the bricklayers are getting in the Side Walls, and turning in the arch, one Labourer at each face must always be employed by the Contractor to do nothing else but to pack the brickwork, by ramming in small Chalk behind the walls with an iron Rammer; and in case the Contractor should neglect or refuse to employ a man at each face for that purpose only, the Engineer shall have power to do so, and to charge the Contractor with the expence. In the upper portion of the arch, where the Bars cannot be drawn, or the operation of packing performed, until the brickwork is completed, the operation shall be proceeded with as soon as the succeeding length of excavation shall have advanced so far as to admit of its being soundly and effectually performed from the end, by beaters of a suitable construction; and should the nature of the material through which the Tunnel may at any time be advancing, be so unsound as to render the drawing of the bars and planking likely to affect or disturb the brickwork, either in its form or stability, such portions of the said Bars and Planking shall be left as deemed necessary by the Engineer. None of the Sills made use of, excepting those in the first length in the shaft, shall be allowed to penetrate into or rest upon the brickwork in the Side Walls, but shall be supported by means of Tressels resting upon the invert, and quite independent of the side walls.

The holes formed by the Sills in the said first lengths shall be made good with brickwork laid in Roman cement, immediately on the sills being withdrawn. In the executing of this, and in every other part of the Contract, the Contractor must find all the Materials and Machinery for executing the works ; make all the necessary Shafts, bore holes, and perform every operation necessary for completing the work in the manner intended by the Specification. All the machinery, centering, &c. must be constructed to the satisfaction of the Engineer. The material excavated from this tunnel must be conveyed to form the embankments in this Contract. Marks or signals will be given to the Contractor by the Company's Engineers, for the

purpose of regulating and directing the level of the tunnel; and the Contractor shall be at the expense of erecting any temporary or permanent Marks or signals which may be considered necessary for giving the direction and levels with the requisite accuracy.

Dº ..... Dº IRON CURBS TO SHAFTS.

(Vide Plates, Nos. 29 and 30.)

The cast iron of the Curbs must be of the best No. 2 iron, the casting free from air bubbles and perfectly sound, and the bolts and nuts must be of the best scrap iron.

Dº ..... Dº TUNNEL FRONTS.

The two fronts of this Tunnel are not of similar design, as shewn upon the Drawings.

North Front.—The Arch of the Tunnel ends in stone quoins 2 feet deep on the face, and toothing into brickwork alternately 2 feet and 4 feet 6 inches; they project from the face to the extent of 3 inches. The Arises or corners thus formed must be neatly chamfered, and great care must be taken to make the joints close and accurate without flushing or flaw of any kind. Pilasters of solid brickwork faced with stone, break forward from the general front on each side of the arch. They are crowned with caps of stone, and the same form of moulding is carried on between the pilasters, and also on the tops of the side walls. The arch and pilasters are surmounted by a frieze cornice and blocking course. On the pilasters, the Frieze will be of brick, faced with stone to the depth of 1 foot 6 inches and 2 foot 3 inches alternately, whilst that over the arch will be entirely of brick. The Cornice will be of solid stone throughout, and all the mouldings cut sharp and clean. The blocking Course over the arch will consist of stone, whilst that over the pilasters will be of brick, faced as before mentioned with stone. It must also be closed in at the top, the joints of which must be laid in Roman cement, so as to completely exclude water. The whole of the stone work must be fairtooled, and the joints made true and accurate. A brick Drain runs along the back of the tunnel front, and connects with other drains down the slopes of the cutting, as shewn in drawing. This Drain is to consist of 9 inch brickwork, laid in Roman cement, and it must be bedded in a mass of concrete, of the extent shewn on the drawing.

South Front (vide Plates, Nos. 27 and 28). The Specification for the tunnel Front just described, must be considered equally applicable to this

in every thing which is common to both. The Arch of the tunnel ends into stone quoins, which tooth into brickwork, alternately 2 feet 6 and 3 feet 6 inches. The whole front is faced with stone, excepting the side walls, and a part of the parapet or frieze over arch, which are of brick. The Pilasters batter on the face, as shewn on the drawing, and the side walls batter at the same rate, being set back 9 inches. A Drain, as previously described, laid in cement, and bedded in concrete, runs along the foot of the slope, behind the tunnel front, and connects with other drains down the slopes of the excavation. In these fronts, wherever the brickwork appears, it must be faced with white Cowley bricks.

APPROACHES TO BRIDGES.

The Embankments forming the Approaches to the bridges, are to be made of the surplus material from the excavations on the line, should such exist. Should there be no surplus material, then the requisite quantity for any approach must be obtained by altering the slopes of one or more of the excavations on the line of Railway. The Approaches must be made of such height and inclinations as shewn in the section of approaches to each bridge. The width of the top of the approach shall be 6 feet more than the width of each bridge within the parapets. The embankments must be formed in the same manner as directed in the specification of the embankments on the line of Railway. The surface of the Embankments when formed, shall be made regular and even, and be well beaten with heavy beaters, and covered with a casing of good Gravel, 10 inches in thickness in the middle part of the road, and 6 inches on each side; the best portion of the gravel must be placed in 9 feet of the middle part of the road: The ruts must be filled up from time to time, and the surface kept smooth and even. The whole of the embankments, from either termination up to the parapet walls of the bridges, must be protected on both sides by wood posts and rails, as shewn on drawings. The wood Posts must be made of good oak, free from sap, and straight grained. The Rails, and so much of the posts as is seen above the ground, shall be sawn out square, neatly planed, and painted with two coats of stone coloured paint; all the joints must be made with white lead, and all the wood beneath the surface of the ground to be neatly charred. A Ditch, with railing and quick fence, similar to that hereinbefore described, for the tops of the excavations and bottoms of the embankments upon the line of Railway, must be made on each side of the line of embankments of each approach, and they must be made to join the

fence of the Railway. Previous to any of the works connected with any of the bridges, approaches to bridges, approaches to paved crossing, or diversions of roads, which may in any way affect existing roads, being begun, a good and well made Temporary Road shall be provided and maintained, for the free and uninterrupted passage of carriages of every description. Every precaution must be taken by the Contractor during the alteration of any of the roads to erect proper fencing, and fix lights, as the Company will not be held liable for any injury which may ensue from neglect of these precautions. The Contractor must make any alterations necessary in the direction of the roads, for the convenient approach to all bridges specified in this contract.

BALLASTING AND LAYING THE PERMANENT WAY.

(Vide Plate No. 1.)

The Railway is intended to form a double way, composed of four single lines of Rails, and will ascend in the direction of Birmingham at the uniform rate of 1 in 330, throughout the whole length of this contract. The greatest care will be required that the portions shewn on the Plan, Drawing No. 2, as straight, shall be perfectly so, and that the Curves are all uniform and properly brought into the straight lines. The laying and ballasting the Permanent Way is intended to be completed in such portions, and at such times, as will meet the convenience of the Contractor in executing the other works. Previous to the delivery of the materials of the permanent way to the Contractor, the surfaces of the embankments, and the bottoms of the excavations, shall be made the proper heights and depth, and uniform in width, level, or inclination; and they shall be completely drained, and certified by the Engineer as being in a fit state to receive the permanent ballasting. The Materials to be delivered to the Contractor, shall consist of Rails, chairs, keys, pins, blocks, sleepers, and oak trenails; and he will be held responsible for the re-placement, in case of loss or injury, of the materials thus delivered to him, from the time of their delivery to the expiration of his contract. The Rails, chairs, keys, pins, blocks, sleepers, and trenails, will be delivered on any wharf, or landing place, upon the line of the Grand Junction Canal which may be made choice of by the Contractor; but the Contractor is to pay the warfage, and other incidental charges, and also the expence of conveyance from the wharf, or landing place, to the line of Railway.

The Rails will be in lengths of from 12 to 18 feet, and weigh 50 lbs. per lineal yard. They will be supported every yard by a cast iron Chair,

or pedestal, which will weigh about 20 lbs., and be accompanied by two wrought iron keys for fixing the rail into the chair, and two pins for fixing the chair upon the block or sleeper. The Sleepers will be of wood, the dimensions of each part, and the construction of the whole is shewn upon the drawing. The Company will reserve to themselves the right of directing whether stone blocks or wood sleepers shall be used, or both, and if both, in what proportion and situation. The material for Ballasting shall be composed of broken stone, or clean gravel, entirely free from any admixture of clay, capable of setting hard, and not retentive of moisture. If broken stone be used, none shall be larger than cubes of 2 inches. The Ballasting shall be spread over the whole surface of the top of the embankment, and bottoms of excavations, between the drains, and an uniform thickness of 10 inches where stone blocks are employed, and 18 inches where wood sleepers are used. This stratum of Ballast shall be beaten into a firm and solid mass, by heavy beaters, worked by at least two men, and the thickness before mentioned shall be considered to apply only after this operation has been effectually performed. Upon this surface the blocks and sleepers are to be laid in their proper situations for receiving the rails.

When Stone Blocks are employed, each block shall be bedded in its proper situation, by frequently lifting it by a spring lever to the height of 1 foot above the surface, and letting it fall forcibly on the ballasting; this operation shall be continued until no sensible difference of level is perceived after each fall: should the block then be found too low, it shall be removed out, and more material placed in its intended bed, and the same operation continued until the block has reached its proper level, and has obtained as firm and uniform a bed as can be obtained throughout the whole area of the under side of the block. When wooden Sleepers are employed, the ballasting for the intended bed shall be beaten by heavy beaters, and each sleeper also forcibly beaten when it has been placed in its position, until it has been firmly and uniformly bedded throughout its whole length, and reached its proper level. If it be found lower than required, it shall be removed, and additional materials placed under its bed: the same process as before must then be renewed until it has reached its proper level. The Rails must be laid at their proper level, each of them parallel to each other, and at the same height at any point. The joinings must be made perfectly even, whether square, half-lapped, or scarfed, and be firmly secured in the chairs. The two lines of way to be 6 feet apart, and the width between the inside of the rails 4 feet $8\frac{1}{2}$ inches.

The Stone Blocks will be delivered to the Contractor in a rough state, and he will be required to drill two cylindrical holes in each block, 6 inches deep, and $2\frac{1}{4}$ inches in diameter; to make the upper surface of each block perfectly level; to drive the oak trenails, and cut off their tops flush with the surface of the block; and to fix the chair firmly in its proper position, by means of the iron pins furnished to him for that purpose. The wood Sleepers will be delivered to the Contractor as sawn out, and he will be required to make their upper surfaces perfectly level for the reception of the chair, which must be firmly fixed into the exact guage. The pins shall not be driven into the sleepers without the holes having been previously bored with a proper sized auger. The Rails must be securely fixed into the chairs, by means of two keys. The Chairs shall be firmly fixed on the sleepers, or blocks. The whole of the upper surfaces of the stone blocks must be worked to a plain surface, and a space in the centre, of sufficient size for the whole bed of the chair, must be fair tooled perfectly level, so that the chair will rest perfectly steady upon the block. Any of the Rails which may be twisted or bent in the least degree, to be made perfectly stright with proper hammers and anvils, previous to their being laid down. Should any Gravel, or any other suitable material, occur in any of the excavations included in this contract, the Contractor shall be at liberty to use the same; but if in so doing he shall cause any deficiency in the material for the formation of the embankments, he shall make up the deficiency by a side Cutting, in such of the excavations as the Engineer may point out, and at his own expense. If such side Cutting shall require an additional quantity of land, the Contractor shall indemnify the Company for the expense of purchasing the same.

The Contractor shall in no case remove any material from the intended sites of any of the embankments, unless permitted by the Engineer. The Contractor shall also be at the whole expense of purchasing and obtaining gravel, or stones, for the purpose of Ballasting, whether brought from the adjoining lands, or otherwise. Brick Drains, throughout the excavations, are to be laid in the ballasting, as shewn on the drawing. One Drain shall be laid in the centre of the ballasting, throughout the whole length of the excavations, and shall have Cross Drains, at intervals of every 5 yards, communicating with the Open drains outside the ballasting, on either side alternately. They must be properly and securely laid with good bricks, without mortar, but 18 inches in length at the open ends, and shall be laid in Roman cement.

The Contractor shall give the Assistant Engineer a receipt, stating the

number of rails, or other materials, in each parcel delivered to him, and after they are placed in his possession, he shall be accountable for the loss of any part of them. He shall also replace any rails, chairs, keys, pins, trenails, blocks, and sleepers, which may have been broken, or otherwise rendered unfit for use, while in his possession. The Contractor shall be permitted to make Sidings or crossings from one line of the permanent way to the other, for his own convenience, during the progress of the works, provided he does not injure the rails in so doing, and removes them when the works are completed. No Waggons, carriages, or engines, employed by the Contractor on the permanent road, shall have a greater weight placed on any one axle than 3 tons, unless the carriages, or engines, are placed on good and sufficient springs, and when they are so mounted, the weight on any one axle shall not exceed 4 tons.

EXTRA OR CONTINGENT WORKS.

FENCE GATES.

The Fence Gates are to be made of the form and dimensions shewn in the drawing. The heels and ends are to be of good oak, sawn out the proper dimensions, and morticed for the reception of the horizontal bars. The horizontal Bars are to be five in number, of cleft oak, and smoothed over. The ends must fit the mortices of the heels and heads, and be secured by oak pins. The diagonal Braces will be similar to the bars, and firmly nailed to them. The nails to pass through both, and their points are to be clenched. The Posts are to be of oak, the top sawn to the requisite dimensions and form, and a small cap fixed upon each. The bottoms of the post must be charred. The gate irons shall be of the form and dimensions shewn on the drawings. The Gates must be firmly fixed in the line of the quicksets, and the wood railing neatly joined to the gate posts. The gate posts must be painted in two coats of white or stone colour paint.

EXCAVATIONS AND EMBANKMENTS OF SLOPED OCCUPATION ROADS.

These Excavations and Embankments are to be made in the same manner as those upon the line of Railway, and slopes, as may be directed by the Engineer. The contents of the excavations shall be conveyed to the nearest embankment upon the line of Railway, or to the nearest spoil

bank. The embankments are to be formed with the surplus material in the excavations upon the line of Railway, should such exist; but if not, they must be made with material obtained from one or more of the excavations upon the line of Railway, as may be fixed by the Engineer, by altering the Slopes, so as to afford a sufficient supply; and the Contractor shall be paid for the same at the rate specified in the Schedule of Prices. But whenever there is a surplus of material, the Contractor shall employ the same in forming the Approaches to occupation bridges, or sloped roads, should such be required; and the cost of so employing it shall be considered a part of his contract, to which the stipulations and prices of extra works do not apply.

METALLING OF APPROACHES TO OCCUPATION BRIDGES.

To be done in the same manner described in the Specification of approaches to bridges.

PAVED CROSSINGS.

All the Roads crossing the Railway without bridges, are to be paved in the manner shewn in the drawing, with good 6 or 7 inch Aberdeen granite, or other granite equally good. The Paving must be laid on a bed of fine clean gravel, of 12 inches in thickness, in a solid and substantial manner. The paving stones must be cubes, as nearly as possible. Each rail must be protected by two iron Bars, as shewn in the drawing; they will be considered as part of the rails, and will be provided by the Company.

OCCUPATION BRIDGES.

The general form of Bridges which will be used as Occupation bridges is shewn on the drawings. For particulars of Materials and Workmanship, see General Stipulations hereinbefore given.

CULVERTS.

(Vide Plate, No. 31.)

The form and dimensions of the Culverts are shewn on the drawing, the sizes being selected to suit the particular situation. For particulars of Materials and Workmanship, see General Stipulations hereinbefore given.

LAYING AND BALLASTING PERMANENT SIDINGS.

(Vide Plate, No. 32.)

The Sidings are to be laid in such positions, and of such lengths, as may be directed by the Engineer. They must be laid in the manner and form shewn on the drawing. The Contractor will be required to take up any part of the rails already laid down which may be found necessary, to cut them into their proper lengths for the reception of the other iron work, to relax them, and to fix all the necessary crossing plates, check rails, moveable points, or sliding rails, with the requisite machinery for moving them. The whole must be made equally firm and substantial as the other parts of the permanent way. The Specification of the permanent Ballasting, already described, must be considered applicable in all respects to the construction and ballasting the sidings.

TOOL RECESS.

Tool Recesses, similar to that represented in the drawing, shall be built in such situations and intervals on the side of the Railway as may be directed by the Engineer. They shall be constructed of brickwork, with stone coping. For particulars of Materials and Workmanship, see General Stipulations attached to bridges.

DISPOSAL OF MATERIAL.

Throughout the whole of this Contract, the material from the excavations is to form the next adjoining embankment, as well as the approaches to the bridges, and crossings, of every description; and whenever, or wherever, any excavations shall not be sufficient in quantity to complete the next adjoining embankment, and approaches to bridges, and sloped roads, the quantity so deficient must be brought from the nearest excavation which shall have a redundancy. After excavation, No. 31, shall have been carried into embankment, No. 23, the deficiency of material to complete this embankment must be obtained from the redundancy in the other parts of the contract, including the material out of Northchurch Tunnel. If there should be a redundancy of material in the excavations, such redundancy may be laid in spoil bank if not required, to be otherwise disposed of by the Engineer. If there should be a deficiency of material in the excavations to form the embankments, the quantity required to

complete them must be obtained by altering the slopes of such of the excavations as the Engineer may think proper to order, and at the cost of the Contractor.

The entire surface of the Spoil Banks must be finished off with a regular, even, horizontal plane, excepting the outer edges, or boundaries thereof, which must be finished off with slopes of not less than 6 to 1. The area to be occupied by the spoil banks is to be stripped of all turf, or soil, previously to depositing the spoil thereon; all of which turf, or soil, shall be afterwards equally distributed over the surface of the spoil banks. The whole surface of the Spoil Banks, including their slopes, must then be sown with grass and clover Seeds, as hereinbefore described for the slopes of the excavations. All damage done to the lands by the occupation of, and during the execution of the above works included in this contract, and in the formation of spoil banks, to be defrayed by the Contractor. The Company binding themselves only to exercise the power of their Act of Parliament, in aiding the Contractor to purchase or to settle compensation for such Lands as he may select for the formation of spoil banks, or for other lands injured, or occupied, temporary or permanently, by any works or erections, or for any Side Cuttings which the said Contractor may employ, or require, beyond the width purchased by the Company, and described in the field plan.

TIME OF COMPLETION.

The whole of the Works in this Contract are to be completed on or before the 1st day of May, 1837, and the Contractor will be bound to keep in good order and uphold the whole of the works, for the space of one year after the works shall have been completed.

RATE OF PROGRESS.

Embankments Nos. 24, 25, 26, and 27, shall all be made on or before the 1st day of August, 1836, and at the same period, 100,000 cubic yards of the embankment, No. 23, must be formed.

150 yards in length of the Northchurch Tunnel to be completed in the same period.

In the same period, the foundations of the Bridge over the Grand Junction Canal, the site of which is represented between the fifteenth and twentieth chain on the section, must be laid, and the walls built up to the level of the springing of the arch.

On or before the 1st day of March, 1837, the whole of the excavations, and embankments, and the whole of the Northchurch Tunnel, to be completed.

It is understood, that only the neat Measurement of the masonry, brickwork, or timber, will be allowed, notwithstanding any custom to the contrary.

CONTRACT No. 1, F.

SPECIFICATION of the various Works to be executed in making and completing a portion of the said Railway, extending from, at or near the boundary between the Counties of Buckingham and Northampton, near Hartwell, to a part near the Grand Junction Canal, in the Parish of Blisworth.

EXTENT OF CONTRACT, AND GENERAL STIPULATIONS.

This Contract commences at or near the boundary between the Counties of Buckingham and Northampton, at a point marked with the letter A, in a field in the Parish of Hartwell, belonging to the Trustees of Stony Stratford Poor, numbered 2 on the Field plan, marked Drawing No. 2, and on the Section marked Drawing No. 2, hereto respectively annexed, and thirty-nine statute chains, or thereabouts, on the South East side of the road leading from Bozenham Mill to Hartwell, and terminates at a point marked with the letter Z, in a field in the Parish of Blisworth, in the County of Northampton, belonging to His Grace the Duke of Grafton numbered 35 on the said general plan and section, the point about twenty-seven statute chains on the North West side of the road leading from Towcester to Cotton End, being a distance of five miles or thereabouts.

It comprehends the following Works.

The making of Temporary fences necessary during the progress of the other works.

The formation of the whole of the Excavations and Embankments represented on the section.

The making of the Permanent fencing.

The erection of Bridges *under* the Railway, viz.

At the crossing of the road leading from Bozenham Mill at Hartwell.

At the crossing of the road leading from Stoke Bruern to Hartwell.

At the crossing of the road leading from Ashton to Hartwell.

At the crossing of the turnpike road leading from Towcester to Cotton End.

The erection of Bridges *over* the Railway. viz.

At the crossing of the road leading from Ashton to Roade.

At the crossing of the turnpike road leading from Hardingstone to Old Stratford.

At the crossing of the road leading from Roade Hyde to Roade.

At the crossing of the road leading from Roade to Plane Woods.

At the crossing of the road No. 2 leading from Roade to Plane Woods.

At the crossing of the road leading from Blisworth to Roade.

At the crossing of the road leading from Blisworth to Courteenhall.

The formation of Roads over or under the above bridges, and Metalling the same; and also for diversions.

The making of the following Culverts, viz.—

Two double, 6 feet in diameter.

One single, 6 feet ditto.

Three ditto, 4 feet ditto.

Three ditto, 2 feet ditto.

The formation of the side Drains in the excavations on each side of the Railway.

The laying, ballasting and draining of the Permanent Way, including the providing of all Timber, bricks, lime, stone or other materials necessary for the completion of the works.

The iron Rails, chairs, keys, pins, trenails, blocks and sleepers for the purpose, being provided by the Company, under conditions hereinafter described.

And all other Works mentioned or described in the accompanying drawings or plans; together with the following

EXTRA WORKS.

The erection of Gates.

The excavation and embanking of Approaches to occupation bridges.

The Metalling of occupation roads.

The Paving of occupation roads crossing the Railway on a level.

The building of Occupation Bridges and Culverts.

Laying and ballasting permanent Sidings, and the formation of Tool recesses, are considered as Extra works, and will be paid for as such according to the schedule prices for extra works set out in the tender.

The preceding enumerated Works, and the mode of execution are

described at length in the Specification of each particular work, and their forms and dimensions are described in the accompanying drawings, which are referred to in each specification, but should any discrepancies exist between the measurement by the scale attached to the drawings and the written dimensions, or between the drawings and the specification, or any ambiguity in them, the same is to be referred to the Engineer, whose decision shall be conclusive. Anything contained either in the drawings or specifications, shall be considered as being contained in both. The written dimensions are those by which it is intended the Contractor shall make his estimate. The clause relative to the "Fencing and Ditching, and the temporary and permanent Fencing," is similar to that specified in Contract 5 B hereinbefore given (vide page No. 17).

EXCAVATIONS AND EMBANKMENTS.

The part coloured Red on the Field Plan Drawing No. 2 shews the direction of the Railway, and the area of the land which will be purchased by the Railway Company, and upon which the Contractor shall have full permission to erect any Temporary houses, offices, &c. necessary during the execution of the works, or any machinery for excavating or embanking, provided that such proposed erection shall not be especially prohibited by the Act of Parliament for making the Railway.

The Blue line on the Section Drawing No. 1 describes the top of the embankments and the bottoms of the excavations previous to the laying and ballasting of the permanent way.

The uncoloured space on the Section below the blue line represents the embankments, and the space between the blue line and the surface shews the excavations.

The Black undulating line describes the present natural surface of the ground along the centre of the line of the Railway, shewing the respective heights of the embankments and depths of the excavations, from which data their contents have been calculated, on the supposition "that the area of any cross section in sidelong ground does not differ from the area of a similar section in level ground."

The levels and other admeaurements from which the section is made, are believed to be accurate, but the Contractor must verify the results, as he will be held liable for the consequences of any error.

Cross Sections of a Cutting and Embankments, with drains, fences, &c. are shewn in Drawing No. 19.

EMBANKMENTS.

The whole of the Embankments in this Contract shall have Slopes of 2 to 1, that is to say, when the Base of the slope is 2 feet, its perpendicular height shall be 1 foot only, and they shall be 33 feet wide at the level of the blue line on the Section, neither more nor less, which width shall extend equally on either side of the outside rails after they shall have been laid and completed, as hereinafter described. Each of the Embankments shall be uniformly carried forward as nearly at the finished heights and widths as the due allowance for the shrinking of the materials will admit of, and this allowance shall not exceed or fall short of the quantity deemed necessary by the Engineer. In all cases this must be carefully and strictly attended to, in order to avoid the necessity of making any subsequent addition either to the heights or widths of the embankments, to bring them to their proper level and dimensions.

The surface of the Embankments shall be kept in such form, or be intersected by such drains, as will always prevent the formation of pools of water upon them, and ensure the embankments being kept dry as possible.

Whenever the material teemed over the end of the embankments shall not form the proper Slope, it shall be carefully trimmed to its required form, and this operation must proceed at the same time with the end of the embankment, so as to obviate the necessity of any further addition of material to the sides of the embankment.

As the Embankments advance and become consolidated, the Slopes shall be carefully trimmed into planes having the proper slope, and be neatly faced or ramped with an uniform covering of turf of not less than 8 inches in thickness, and laid with the greensward outwards. The Turf must be taken from the ground to be occupied by the base of the embankments, and where the land is arable, the slopes of the embankments shall be covered with the Soil, which must be uniformly laid on, of the thickness of 6 inches, and sown with rye grass and clover Seeds, as soon as the proper season will admit of its being done, not less than one pound and a half of clover seed and one pound and a half of rye grass seed to be sown on each acre.

When the materials brought to the embankments consist of large lumps, they shall be broken into pieces of not less than 6 inches in diameter, unless they consist of rock.

EXCAVATIONS.

The Excavations throughout the Contract shall, when turfed or soiled, be 33 feet wide at the level of the blue line on the Section, neither more nor less, and shall extend to an equal distance on each side of the outside rails, except in certain parts of the excavation No. 5 where Retaining Walls are inserted, in which case the widths are variable; and the Contractor is referred to the drawing and specification of that part of the line.

The Excavations in this Contract are five in number, and are designated in the Section as Nos. 1, 2, 3, 4 and 5.

Trial Shafts have been put down in all the excavations, to ascertain the nature of the materials to be excavated, and the nature, thickness and relative positions of the various beds of Clay, marl, shale, limestone, &c. are shewn in the Section, which it is believed correctly represents the extent and quality of the materials to be cut through, but it remains with the Contractor to verify the correctness of the section, as he will be held liable to the consequences of any alteration in the continuity of the strata between the shafts.

The Shafts have been left open for examination; the materials obtained in sinking them may be seen at the top of each shaft, and samples of the various strata sunk through may be seen on application at the Railway office at Weedon.

As soon as any part of the Slopes, not having less base than $1\frac{1}{2}$ foot to every foot in height, are dressed to the proper inclination, they shall be covered with Turf taken from the land to be occupied by the excavations in the same manner as before directed in the embankments; and where turf cannot be obtained, the slopes must be covered with Soil and sown with rye grass and clover Seed, as before directed in the specification of the embankments.

In the formation of the excavations and embankments in this Contract, the Contractor shall not remove the turf or soil from the ground for a greater distance than half a statute chain in advance of the face of the excavation or embankment, and that which has been cut must be removed back to a point where the slope is ready for receiving it, and laid down as directed, with as little delay as possible.

Whenever and wherever springs, soaks or streams of water may appear and issue from the face of the slopes, the Contractor shall be bound to make

and maintain during the progress and until the completion of the works, such Drains or water-courses as shall completely and effectually prevent such Springs, soaks or streams of water from injuring the slopes, and shall convey the whole of such water into proper Drains, so that none shall be permitted to lodge in the excavation; and where beds of Sand, gravel, or other loose mould occur, the face of the slope must be protected from the injurious effects of such springs or streams of water by any other means that may be deemed advisable or necessary by the Engineer.

At the bottom of each slope, a Drain of an uniform depth below the rails, as shewn in the drawings, shall be made, and these drains must be continued on both sides under all the bridges which cross the Railway. A Drain shall also be made at the top of each slope, so as to exclude from the excavations any water draining off or flowing from the lands adjoining, and all covered or open drains which may be intersected by the excavations, must be made to discharge their water into the ditch at the outside of the top of the slope, for which purpose the said ditch shall be made as deep at least as the bottom of the intersecting drain, and the space between the outside drain, and the slope shall be well puddled at the point of intersection.

The Contractor shall also open or make any new Drain, which the Engineer may deem necessary for the exclusion of any water from the Railway excavation.

In the formation of the Excavation and Embankments, the Contractor must provide, at his own expense, all the necessary Rails, chairs, keys, pins, blocks and sleepers, as well as Waggons, barrows, planks, or other machinery, materials or utensils, which stipulation is however modified to a certain extent by the following conditions :—

It is not intended to deliver to the Contractor any of the Permanent Rails, chairs, keys, pins, blocks or sleepers, until at least one continuous mile of roadway, together with 300 yards in continuation at each extremity of such mile, shall have been completed; also certified by the Engineer as being ready for the reception of the permanent ballasting, as in the Contract hereinbefore mentioned, on which certificate a sufficient number of Rails, chairs, keys, pins, blocks and sleepers shall be delivered to the Contractor by the Company, and he shall be permitted to use them in such manner only as is hereinafter described in the specification of the ballasting and laying of the permanent way, provided however, that such permanent rails shall in no case whatever be laid down and employed within 300 yards of the face of any excavation, or the end of any embankment then in progress.

From the Shafts that have been sunk in the cutting No. 5, it is expected that a considerable quantity of Stone will be found sufficiently hard for the purpose of Blocks such as described in the drawings and specification of the ballasting and laying the permanent road.

In all and every case either in the above-named excavations, or any other within the limits of this Contract where Rock exist (which, in the opinion of the Engineer is proper for making blocks), the Contractor shall proceed in such manner as may be best calculated for obtaining blocks of the size and quality specified under the head of ballasting and laying already alluded to, and shall obey the directions of the Engineer in working such rock. For each Block so procured and delivered at the situation within this contract where it will be used, the Contractor shall be paid by the Railway Company one shilling over and above the amount of his tender; and should the Contractor in any case where stones exist suitable for blocks, neglect to work it in the manner best calculated for obtaining them both sound and in the greatest quantity, he shall be liable to a deduction from the amount of his tender, equal to the estimated value of the blocks which might have been obtained. The estimate of value shall be made by the Engineer.

Whenever Material occurs in any of the Excavations of a quality suitable for making Bricks, the Contractor shall be at liberty to make use of such material for that purpose; but if in so doing he shall cause any deficiency in the material for the formation of the embankment, he shall make up such deficiency in the material by a Side Cutting at his own expense, in such of the excavations as the Engineer may point out, and if such side cutting require an additional quantity of ground, the Contractor shall indemnify the Company for the purchase of the same.

The excavation No. 1 consists of Clay and Shale, and the sides are to be formed at a Slope having a base of 2 feet for 1 foot in perpendicular height.

The excavation of No. 2 consists of rubbly Sandstone, Limestone and Shale (as shewn in Section No. 1.), and the sides must be formed at a Slope having a base of 1 foot and a half for each foot in perpendicular height.

The excavation of No. 3 is nearly similar as regards material to No. 2, and the sides must have a like Slope of 1 foot and a half to each foot in perpendicular height.

The excavation No 4, is principally Soil and Clay, and must have the same Slope in the sides as Nos. 1, 2, and 3.

In the excavation No. 5, the strata are of various kinds, consisting

principally of a bed of Limestone extending nearly throughout the excavation, which bed of limestone is overlaid by beds of Clay and Marle in the deepest parts of the cutting, and underlaid by a thick bed of Shale throughout its whole length. The sides of the excavations must have Slopes of various inclinations (hereinafter particularly described) according to the nature of the materials to be cut through from the end of the cutting A to the point B; the sides shall be taken out to an uniform Slope of 2 feet base to 1 foot in perpendicular height.

Throughout the whole of the remaining part of the excavation, all Soil, Clay, Sand, Marle, or other materials above the aforesaid limestone rock, shall be taken out at a Slope of 2 feet base to 1 foot in perpendicular height, between the foot of which slopes, and the top of the cutting in the rock a Bench of 9 feet in width shall in all cases be left. The Slopes of the cutting in the limestone Rock to have 3 inches base to 1 foot in perpendicular height.

Whenever the Shale or other soft strata lying under the limestone is found to rise above the level of the bottom of the cutting, a portion of such shale or soft strata shall be excavated from under the limestone on each side of the cutting, and replaced by Walls, buttresses, arches, and inverts, as hereinafter described.

Whenever the depth or thickness of such Shale or soft strata falls short of 14 feet, the side walls shall be of the dimensions shewn in Drawings, Nos. 3, and 4, and described in the specifications relative thereto.

To prevent any injury to the Slopes by the springs of water issuing from the rock and other strata in this excavation, the strictest attention will be required on the part of the Contractor, and the modes of drainage adapted to the varying thickness of the shale and other strata, are particularly described in the Drawings, Nos. 3, and 4, and the specifications relative thereto.

Drawing, No. 4.*

Fig 1. Represents a cross section of such excavation where shale rises to the height of 22 feet above the bottom of the cutting.

AB. Fig. 1. Is a cross section of a buttress.

CD. Is a longitudinal section of one half of an invert.

EF. Is a cross section of the recess wall.

GH. Is a cross section of a drain in the centre of the cutting.

* Vide Plate No. 32, which shews the undersetting of the Rock in this Cutting (the Blisworth).

IK. Represents the method of carrying off the water from behind the wall.

LM. Section of pitching between buttresses.

Fig. 2. Is a plan of the retaining walls and buttresses.

AB. Plan of buttress.

CD. Plan of invert.

EF. Plan of recess wall.

GH. Plan of central drain.

A. Side drains, communicating with central drain by means of cross drains bb.

IK. Sunk drains in face of wall, communicating with side drains AA, by sunk drains CC.

LM. Plan of pitching between buttresses.

The Inverts to be of an invariable width of 27 feet, and to have a rise of 3 feet 3 inches; the radius being 29 feet 8 inches. The junction of which inverts with the face of the buttresses to be always at the level of the surface of the rails.

The face of the Buttresses in the cross section to be described by a radius of 106 feet; the radius to be square with the face of the rock, at its junction with the top of the buttresses; therefore, rising 3 inches vertical to 1 foot horizontal, corresponding to the slope of the rock.

The back of the Buttresses to batter outwards, from the centre of the cutting, at the rate of $\frac{3}{4}$ of an inch horizontal for 1 foot in height, as shewn in the section; and the side of the buttresses to batter, at the rate of 1 in 20, on each side, as shewn in the plan and elevation.

The Recess Walls to have the same batter at the back, corresponding with the buttresses, and the face of such walls to have a straight batter, of 2 inches horizontal to 1 foot vertical. These walls shall have three courses of 1 foot each in depth; each course to step 6 inches. The bottom of the walls to be level with the bottoms of the inverts and buttresses.

The central Drain to be made according to the dimensions in plan. Where it crosses the inverts, they will form its bottom; and between the inverts, the bottom to be laid to an uniform inclination.

At a depth, never falling short of 1 foot below any wet stratum that may occur, two courses of the recess wall and buttresses to be projected beyond the back of the wall; the lower course to project beyond the upper, so as to receive a stone, to rise 1 foot above the upper course, forming a Drain 12 inches deep and 6 inches wide; to be surrounded at the bottom and back with a casing of sound Puddle, and filled in at the top

with Rubble stone, to allow the top water to have access to the drain, as shewn in the Drawings at IK. This drain to have a regular fall from the centre of each buttress, as shewn by the dotted lines No. 1 and 2, in elevation Drawing No. 4.

The water, when thus collected, shall be carried through the recess wall, and down the sunk channel in its face, as shewn in section and elevation of Drawing No. 4.

The pitching between the buttresses to extend from the foot of recess walls to the side drains A A.

The Inverts being preserved of a constant width, at the level of the surface of the rails, and the face of the buttresses being an uniform curve, proceeding from the slope of the rock, at its junction with the top of the buttress, the width between the tops of any two Buttresses on section " will depend upon the depth of the shale above the bottom of the cutting." The width of the said Buttresses viewed in elevation being invariably 4 feet at top, the same circumstance will affect the width of their junction with the inverts: the same circumstance will also affect the thickness of the recess wall and buttresses. Thus, in Fig 3, Drawing No. 4, where the shale is 22 feet deep, the width between the top of the buttresses is 41 feet 6 inches; while in Figs. 4, 6, and 7, Drawing No. 3, where the depth of the shale is 14 feet, the width is 34 feet 2 inches. This will also in like manner determine the width of Excavation at the bottom of the rock, which being flush with the face of the buttresses at their top, overhangs the recess wall 1 foot 6 inches.

When the depth of the Shale, from the bottom of the rock to the bottom of the cutting, shall be less than 14 feet, then the Inverts between the buttresses shall be discontinued, and in lieu of the inverts, the buttresses shall have 4 courses of Footings, when the depth of Shale above the bottom of the cuttings exceed 10 feet; and 3 courses for all lesser depths. Further, when as aforesaid, the Shale, or clay, or other soft material, rises to the height of 10 feet above the bottom of the cutting, then the level of the bottom Footings of the buttresses shall be 3 feet 3 inches below the said cutting, which depth shall decrease proportionally as the above height diminishes, until the rock meets the level of the bottom of the said cutting.

Where there are no Inverts, (which is invariably the case where the depth is less than 14 feet) the distance between the tops of the buttresses, and consequently the width of the excavation between the tops of the buttresses, shall be uniformly 34 feet 2 inches.

The face of the Buttresses, and recess walls, being determined in this case by the same rules as where the inverts exist, and the width at the top buttresses being constant, the width of the cross section at the level of the rails will depend upon the depth of the shale, as will be seen by referring to Figs. from 4 to 13 inclusive, Drawing No. 3; where it will be seen that by this means the Cross Section at the top of the undersetting gradually approximates in width and form to the ordinary shape of the cutting in rock.

The North-west end (C) of the Retaining Wall terminates by a buttress, and at 38 feet North-west of the buttress, (extending to B) the excavation, as before stated, will have an uniform slope of 2 feet base to 1 foot in height.

Between the points C and B, the form of the Excavations will be determined by straight lines, drawn parallel to the surface of the Railway from corresponding points in the face of the cross section at C and B. Throughout this extent (from C to B) the Shale beneath the rock will have a facing of masonry, (commencing at C and terminating at B) as shewn in Figs. 1, 2, and 3, Drawing No. 3.

The back of this Retaining Wall to be determined in a similar manner to the front, by straight lines being drawn from corresponding points at the back of the buttress at C, to the same at the back of the lining at B, thus lessening regularly in thickness from C to B.

To render this description more easily understood, a Model of the North-west, and of the Cutting, accompanies the plans.

MATERIALS AND WORKMANSHIP FOR WALLING.

The whole of the Walls and Buttresses to be of masonry; the stones to be procured from the excavations. The courses to run as thick as the material obtained from the excavation will afford when properly quarried. The facing stones to be at least 18 inches; the beds to be square with the face of the buttress, or wall.

The stones to be hammer dressed, and brought to a rough bed, but perfectly true; special care being taken to prevent too full a bearing in the centre of them.

Their faces will not be required to be smooth dressed, but rough nobbled, similar to pitching, with rustic joints. If it should so happen, that after the quantity of sufficiently large stones shall have been procured to form the faces of the walls and buttresses, the excavation will not afford any of a similar description for the backing, then the said backing may be formed of Rubble, set in mortar, as hereinafter described; the stones com-

posing which to be brought to a bed, top and bottom, laid in courses. It being understood, that the Engineer or Engineers for the time being shall have the sole option of determining the necessity of adopting and the manner of performing the Rubble work. The bottom of the Rock to be taken out, to receive the walls and buttresses, as shewn in the plans and sections; and stones, corresponding as near as possible with those shewn in the said section, to constitute the top of the said walls and buttresses. The stones to be accurately fitted to rock, and soundly fixed, so that for the whole depth of the said walls and buttresses, the rock shall rest upon them.

The object of this arrangement being to secure a sound support to the rock, and to effect by the dove-tailed Stones a connection with the rock, to prevent the top of the wall being pushed out.

The Spandrils of the inverts and base of the buttresses to be filled with masonry in courses, and the angle made good, as shewn in the Fig. 1, Drawing No. 4.

The bottom course in all cases to be composed of stone as large as can be obtained, and the bottom be worked true.

The bottom of the Buttresses and walls, when there are no inverts, to be laid on a level bottom, the courses to be brought gradually to radiate with the wall at the top of the footings, by the varying thickness of the courses, as shewn in the Figs. 5 and 8, Drawing No. 3.

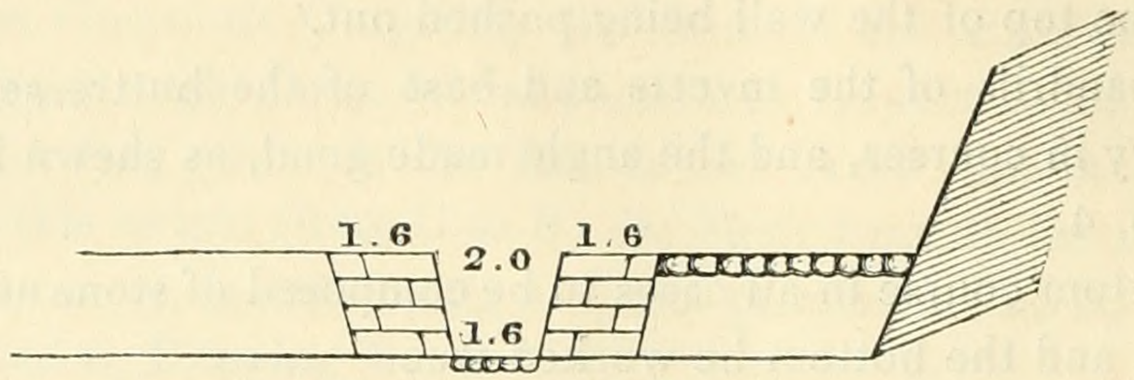
The courses of the Masonry in the walls between the points C and B, at the North West end of the walling, to correspond with those of the buttress at C, and to have the same inclination or rake. The increasing batter to be obtained by enlarging the width of the benches between the upper and lower courses in the face of the wall. The working, setting and mortar for this walling, will be similar to that specified for the buttresses and recess walls.

The Invert to consist of stones laid in regular courses, and each stone 2 feet in depth; the stones to be brought to a smooth bed, and radiated to the centre of the courses.

The Skew back at the end of the invert to be formed so as to suit the radiating course of the invert and the buttress, and to be not less than 9 inches deep on the face. The sides of the centre Drains to consist of masonry according to dimensions on plan, the interior face being fair and regular. The top to consist of an arch of brickwork set in mortar, or covered with stones, if they can be procured large enough to stretch across the drain, and to bed 4 inches on each side between the inverts; the bottom of the drain to be pitched with stones or brick brought to a fair face.

The Side and cross Drains to be formed either of brick or stone, neatly faced at the sides and bottom, and set in concrete mortar of the description hereinafter described.

The centre Drain will not be required between the points H and I, at the South East end of the cutting, and instead the side drains A A will be made 2 feet wide at top and 1 foot 6 inches at bottom, and deepened so as to be level with the bottom of the excavations; their bottom to be pitched and finished similar to the centre drains, and the drains for the cutting between D and H to be diverted by similar drains into the above. The side walls of the above to be of stone, or brickwork set in mortar, and to be 1 foot 6 inches thick: thus—



The Mortar to be used in *the beds and faces of buttresses, walls, sides of drains and invert arch,* to consist of one part Lime to three parts of clean river or other unexceptionable Sand. The sand to pass through $\frac{1}{4}$ inch skreens; the lime to be fresh, and well intermixed with the sand through beating.

The Mortar for running into *the upright joints of the courses, and for filling in the work sound,* to consist of one part Lime to four parts of small unskreened Gravel, to be well mixed and beat to a tough consistency and liquefied in tubs or other vessels, to be properly adapted to run into and fill up all vacuities. The mortar to be used as hot as is consistent with the safety of the work, and the sand and gravel to be perfectly free from any loamy or other particles of a muddy nature.

The Limestone rock found in the excavation may be used for the mortar specified to be used in the retaining walls in this Contract.

The Pitching between the buttresses to consist of 4 inch pitchers, procured from the excavation, and neatly squared; their base to be four-fifths their top face, and to be laid to an uniform surface, falling from the recess walls to the longitudinal drains, and filled in with grout made of mortar similar to the face mortar previously described, only with one part lime to five parts sand.

All spaces behind the walls and buttresses, and in front of the footings

beneath the ordinary bottom of the cutting, shall be filled with Clay or other suitable material thoroughly punned in; and if through mistake, or otherwise, any excavation for walls, buttresses, or inverts, shall be made below the proper level, the space shall be filled up to the proper level with Masonry or Concrete, at the option of the Engineer.

The Puddle behind the wall, for preventing the water from the wet clay intermingling with the dry strata beneath, to be at least 18 inches thick, and to consist of clay proper for the purpose, to be thoroughly worked in with the original strata of dry clay or shale.

The broken stones above not to be less than what will pass through a $1\frac{1}{2}$ inch ring, and to be laid indiscriminately, without any gravel, sand, or other loose material being intermixed in their interstices. This provision to be made whenever any wet strata shall be encountered.

Throughout that portion of the Excavation where the retaining walls are required to be built, the face of the cuttings shall in no case be advanced beyond the completed portion of the wall more than a length equal to the distance between two buttresses, so as to avoid the weight of the Rock breaking or injuring the natural solidity of the Clay or Shale; and should it be found necessary in effecting this object, to follow the face of the excavation with the retaining wall at a less distance than that already stated, the Contractor shall do so, or otherwise support the exposed portion of the shale by efficient Shoring, at his own proper cost and charge.

It will be understood, that the whole object of these precautions are to prevent the natural beds of the Shale being disturbed by the pressure of the Rock or dripping of water, previous to the retaining walls being completed, as already specified.

All moulds, templets and materials that may be requisite for the due execution of the above works, are to be furnished at the charge of the Contractor.

If the Engineer or Engineers for the time being, during the execution of the works, shall see fit to extend or diminish the length of the Walling, number of buttresses and inverts, or to alter the quantity of any excavation or other work scheduled, then a proportional deduction or addition shall be made according to the Schedule of Prices, or if any strata or fissure of Clay shall occur in the limestone Rock itself, then the clay or shale in such fissures shall be faced with masonry, according to the direction of the Engineer or Engineers for the time being, and paid for according to the Schedule of prices.

Throughout the whole of this Cutting, the slopes of the Clay and Shale above the rock, and the Fencing and ditching, will be executed as for the rest of this Contract.

The face of the Rock will not be required to be taken out to a smooth slope, but no projections or indentions on its face shall exceed 3 inches beyond the blue line of slope ; and if any loose lump or mass of rock shall occur in the slope, so as to be deemed insecure by the Engineer, then the said mass or lump of rock shall be removed at the charge of the Contractor.

EXTENT OF WALLING AND EXCAVATION.

The undersetting of the Rock in excavation No. 5 (the Blisworth Cutting) extends from the point marked D to the point marked B in the Section No. 1, a distance of 660 yards, and also between the points marked H and I, a distance of 440 yards. Of the length between B and D, the space B to E, extending 396 yards, will require inverts in addition to the walls and buttresses. The remaining space from E to D, 264 yards in length, and also the part included between H and I, extending 440 yards, as aforesaid, will only have the walls and buttresses, the inverts being omitted.

However, as the shafts merely indicate at different points the depth and thickness of the various strata, such Strata in the intermediate distances may not be shewn precisely correct upon the section; and any increase or diminution over or under the quantity of work calculated from the section, will be added to or deducted from the amount of this contract, according to Schedule of prices accompanying the tender.

The central Drain will be carried beyond the point C to the end (A) of cutting No. 5, at the same level below the bottom of the cutting as where the walling exists, and at A to be diverted into one of the side drains at the foot of the embankment.

DISPOSAL OF MATERIAL OF EXCAVATION.

The material yielded by Cuttings, marked on the Section Nos. 1, 2, 3, and 4, to be deposited in embankments, marked Nos. 1, 2, 3, and 4. The remainder of the material requisite for the completion of the said embankments, 1, 2, 3, and 4, to be obtained from the cutting No. 5.

The Embankments No. 5 to be formed entirely from the remainder of the material yielded by cutting No. 5.

In this Contract the aggregate contents of the Cuttings being rather

greater than the Embankments, the Contractor, after having supplied the quantity requisite to form the approaches to raised occupation roads, shall be at liberty to employ any remaining redundancy for ballasting the surface of the road, provided such redundancy consist of Rock or other material suitable for the purpose, and in conformity with that part of this specification wherein the Ballasting and laying of the rail is particularly described.

Throughout this Contract the Cuttings consist of variable proportions of Rock, Shale and Marle, the Contractor will therefore be required, throughout the progress of the different excavations, to make such arrangements as will ensure the Rock, Shale and Marle being yielded from time to time by each cutting, in such proportions, and disposed of at each embankment in such manner, as will effectually secure the embankments being composed of shale and marle in the centre, with a covering of rock on the tops and slopes.

It is not intended, however, that the Rock shall in any way be set by hand, but merely trimmed into an uniform slope, and covered with Soil and sown with Seeds, as already stipulated under the head of embankments.

GENERAL STIPULATIONS.

Which are to apply to the whole of the Bridges, Culverts, and other Works wherein the workmanship or materials described may be used.

BRICKWORK.

The Brick made use of shall be hard, sound, square, well burnt, and of good colour. No broken bricks will be allowed, and no joint of mortar shall exceed $\frac{1}{4}$ of an inch in thickness; no difference in workmanship will be allowed in inside and outside work, and the whole of the joints shall be flushed up solid with mortar, and the outside joints neatly drawn. The bond may be either English or Flemish, as the Engineer may direct.

MORTAR.

The Mortar shall consist of fresh burnt Lime, equal in quality to that from Dudley, and sharp Sand, mixed in the proportion of three measures of sand to one of lime; they must be mixed in a dry state, and well tempered by passing through a pug mill, with a proper quantity of water. Should the Limestone obtained from the excavations in this Contract, or in any adjoining quarries, be deemed suitable for building purposes by the Engineer, the Contractor shall be at liberty to employ it.

ROMAN CEMENT.

The Roman Cement shall be of the best quality, recently made, and shall be mixed with an equal portion of sand. None shall be made use of which has set or become dead.

STONE WORK.

Throughout this Contract, it is intended that all Stone required for bridges, walls, drains or other works of the like description, shall be obtained from the excavation. Should however the stone found in the excavation be deemed insufficient, either in soundness or other quality, for the above purposes, the Contractor shall substitute brickwork or other stone work equal in quality to the best Derbyshire Bramley Fall, in such places as the Engineer may direct, allowance being made for the same according to the prices stated in the Schedule.

VOUSSOIRES.

The stones of Voussoires of Bridges must be neatly hammer dressed, (except when directed otherwise); the joints chamfered; the beds dressed true and smooth; each Voussoire to consist of one stone not less than the full thickness of the arch, and to break joint into the body of the arch not less than as shewn in the drawings.

STRING COURSES AND FACIAS.

String courses and facias must be fair-tooled throughout, except at the back. No stone to be less than 2 foot 6 inches in length. The depths and widths, together with the forms, are fully described by the drawings.

PARAPETS.

The Parapet, when of stone, must not be in more than three courses in depth; the stone must be neatly hammer dressed, and the beds and cross joints made perfectly smooth. The average of the stones must be 2 feet in length.

COPING.

Coping when upon bridges which pass over the railway, must be neatly fair-tooled. The stones dowelled, and to be leaded together. No

stone shall be less than 2 feet in length. The cross joints and beds shall be made perfectly true. The form and dimensions of the Coping is fully explained by the drawings.

ARCHES.

When Arches are of *Stone*, to consist of stones not less than 24 in. on the soffit. All the surfaces must be hammer dressed perfectly true when they are in sight. The beds and joints to be chisel dressed, and accurately fitted. When the arches are of the Skew principle, especial care to be taken in working the skew backs with planes, truly square with the spiral direction taken by the arch stones. Where counterforts are added, the arch stones must be made longer, so as to abut in the manner of an arch against them, and form a rib on the back of the arch, and continued as near to the crown as shewn on the drawings.

When Arches are *of brick*, they shall be laid either in concentric half brick rings, or in such other manner as the Engineer may direct. In this case, the counterforts shall be bonded into the arch, as just described for stone arches. The courses of brick in the counterfort radiating, so as to correspond and bond into the arch.

IMPOSTS.

Imposts to arches shall be made of stone, of sufficient width in the beds to receive the whole thickness of the arch; and no stone shall be less than 2 feet 6 inches long, and where required, they shall be dowelled together. In cases of Skew arches, the skew backs must be cut or worked, so as to suit the direction of the springing of the courses. The stones to be dressed in the same manner as described under the head arches.

STONE FACING TO THE ROCK UNDER BRIDGES, &c.

The Stone shall be in courses of from 8 inches to 12 inches in depth, worked in regular header and stretcher. The headers to be the full thickness of the wall, and the stretchers on an average 2 feet 6 inches long. The beds must be worked true. The bed and cross joints chamfered. The middle part of the stones, on their outside, to be left rough.

COUNTERFORTS AND RIBS OVER ARCHES.

Whenever *Stone Counterforts or Ribs* are placed upon the arches, they must be of good Ashlar work, and bonded into the thickness of the arch.

The beds of the stone, as well as the cross joints, must all be dressed true. When they are *of brick*, they must be built either in the radiating direction of the joints of the arch, or in horizontal courses, as the Engineer may direct, but in all cases they must be of the same description of workmanship as the outside work.

RUBBLE BACKING.

The Rubble backing to arches shewn upon the drawings, must be built of rubble stone, carefully levelled up every twelve or fourteen inches, and thoroughly grouted with mortar of the kind hereinbefore described.

SPANDRIL WALLS.

Spandril walls, when *of stone*, shall be of good sound Ashlar, set in regular courses of headers and stretchers, from 8 to 12 inches in depth, but in no cases less than 8 inches. The headers shall be the whole thickness of the walls, and not less upon the point than 1 foot wide. The stretchers shall not be less than 2 feet upon the point, and one-half of the thickness of the wall.

The whole of their joints shall be neatly hammer dressed, excepting when described to be worked otherwise, and all the beds and cross joints shall be made perfectly true.

The whole to be set in mortar, as hereinbefore described.

When the walls are *of brick*, they must be of the description hereinbefore described under the head of brickwork.

WING WALLS.

Wing Walls, when of stone, shall be of the same description as that described under spandril walls.

EXCAVATING FOUNDATIONS.

The Contractor is to excavate for the foundations of all Bridges, culverts, and other works; to keep out the water, place dams, and provide all Centering, planks, and tools of every description, necessary to the perfect execution of his work, at his own expense, and to be included in the amount of his tender. And in case of the foundations of any of the works requiring, in the opinion of the Engineer, to be carred lower than is shewn upon the drawings, the Contractor is to make such Extra excava-

tion, and to do all Extra Pumping, or other contingent works incident thereto, at his own expense.

The increase to the Masonry, or brickwork, or other matter constituting the foundations, caused by such additional depth, will be allowed as an Extra to the Contractor, according to the rate contained in his Schedule of prices.

FILLING-IN OVER ARCHES.

The Space between the wing walls, arch, backing, and side of the excavation of bridges, to within 18 inches of the surface of the roadway, shall be filled in with broken Stone, where it can be got; to be punned hard down, and if required by the Engineer, to be mixed with a certain proportion of Lime. The metalling of the roadway, occupying the remaining 18 inches, is to be done as hereinafter described under the head of "Metalling of roadway to Bridges." If, in the opinion of the Engineer, it shall be advisable to substitute brick where stone is shewn in the drawings, or vice versa, it shall be found by the Contractor; the difference in expense being added or deducted, as the case may be, according to the rate given in his Schedule of prices.

All the Centering shall be constructed to the satisfaction of the Engineer, and all string courses, parapet walls, and coping shall not be put on until after the centres are struck, which in no case shall be without the permission of the Engineer. Great care must be taken that the bridge be so placed, that the outside rails, when laid in their proper line, shall be equi-distant and parallel with the faces of the abutments.

DRAINS UNDER THE BRIDGES.

Drains must be constructed under one of the bridges on each side of the Railway, 15 inches wide at the top, 12 inches wide at the bottom, to be sunk as low as the drain at the outside of the ballasting, and will consist of a brick wall 14 inches thick, 3 feet deep, and equal in length to the width of the bridge, and as much more as shall be necessary to connect with the side drain at the outside of the ballasting. There will be two courses of brick to form the bottom. The whole will be laid in mortar in the same manner as described for the bridges.

BRIDGE FOR ROAD FROM BOZENHAM MILL TO HARTWELL.

This Bridge is to be built at a point where the Railway is about 37 feet embankment, and the direction of the arch will make an angle of about 51 degrees with the line of the Railway. The Arch will be semi-circular, and must be built upon the skew principle for a distance of 10 feet from each end. Its span will be 15 feet, height from road to soffit 16 feet, length 141 feet, and thickness 1 foot $10\frac{1}{2}$ inches. The material will be brick, excepting at the faces of the arch and the imposts, which will be of stone. The Wing Walls will be of brick, finished by square pillars of brick, and the whole coped with stone, as shewn in the drawings. The abutments will be strengthened at the back by means of counterforts.

For description of materials and workmanship, see General Stipulations.

PARTICULAR DESCRIPTION WITH REFERENCE TO DRAWINGS, Nos. 5 and 6.

A. Abutments of 4 feet 6 inches thick carried up as high as the springing of the arch.

B. Counterforts 3 feet square carried up 2 feet above the springing of the arch.

C. Backing to the arch carried up 5 feet 4 inches above its springing.

D. The brick Arch, 1 foot $10\frac{1}{2}$ inches thick, and worked 10 feet in from each end, on the skew principle, the courses being made to tooth into the straight courses, as shewn in the drawing.

E. Stone voussoires at the ends of the arch. They must be each equal to four courses of bricks on the soffit, and tooth into the brickwork. Their whole length (under the arch) being alternately 1 foot 5 inches and 2 feet 6 inches, their height must be 2 feet, and they must project $1\frac{1}{2}$ inches from the face of the brickwork, being the depth of the chamfered rustic joints.

F. Stone imposts to be 9 inches deep, and not less than 2 feet long upon the bed. They must be cut to suit the direction of the skew back, and particularly in that part where the arch is worked upon the skew principle.

G. Spandril walls of brickwork.

H. Wing walls of brickwork, built with a batter of 1 inch to 1 foot of height.

I. Stone coping to wings to be 6 inches thick, and 1 foot 6 inches upon the bed.

K. Caps of pilasters to be of the dimensions shewn upon the drawings.

BRIDGE FOR ROAD FROM STOKE BRUERN TO HARTWELL.

This Bridge is situate in a part of the Railway where it is an embankment about 36 feet high, and the road will pass under at right angles to the Railway. The Arch will be of brick, 18 feet span and 16 feet high from the surface of the road to its soffit. The coping and caps to the pilasters will be the same as that described for the bridge for road from Bozenham Mill to Hartwell, Drawings Nos. 5 and 6. The forms of the different parts will be sufficiently seen by reference to Drawing No. 7.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ASHTON TO HARTWELL.

This Road at present crosses the Railway where the latter is in embankment of 7 feet 6 inches, but it will be diverted, as shewn upon the Field Plan No. 2 and Drawing No. 20, so as to allow height for the road to pass under. The Arch will be of brick, of 15 feet span and 16 feet from the ground to soffit; thickness of the arch, 1 foot 6 inches. The Wing Walls will be built at right angles to the Railway, and will terminate against pilasters in front of the arch. The stone coping and caps will be of the dimensions shewn on the drawing, and worked as described in general stipulations hereto attached. The form and dimensions of the different parts will be seen in the drawing.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD AT ONE MILE TWENTY-TWO CHAINS ON SECTION.

The Railway at the crossing of this Road will be in about 33 feet 6 inches cutting, and the Bridge will cross at right angle to the Railway. The Arch will be a segment of stone of 32 feet 6 inches span, 18 inches thick, and 10 feet 3 inches rise, 23 feet 8 inches from the rail to the soffit of the arch, and 15 feet in the clear between parapets. The rock forming the abutments at A must be faced with good Ashlar to support the imposts and protect the rock from weathering. The facing of the rock abutment will

return round its sides 3 feet wider on each side than the outside of the bridge, until it intersects the slopes of the cutting. The dimensions and forms of the various parts of the bridge will be seen upon the drawing.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ASHTON TO ROADE.

The Railway, at the crossing of this road, will be in about 24 feet 9 inches cutting. The Bridge will be built at an angle of 45 degrees with the direction of the Railway. The span of the Arch will be 30 feet, upon a section taken at right angles to the Railway. The height from the rail to its soffit will be 18 feet 8 inches, and the width, the clear between the parapets, 15 feet. The body of the arch will be of brickwork, $3\frac{1}{2}$ inches thick, and its quoins will be of stone, which will run in under the arch alternately 2 feet and 2 feet 6 inches. Each stone must be made equal to four courses of bricks on the soffit. The courses must run in a spiral direction, as shewn upon the drawing; and the imposts, as shewn on Fig. 5, must be cut or worked to suit the proper direction of the springing of the skew courses. The stones of the imposts must be dowelled together, and run in with lead.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM HARDINGSTONE TO OLD STRATFORD.

This Bridge is for the crossing the Railway where it is 33 feet 3 inches cutting, and must be built at an angle of $53\frac{1}{2}$ degrees to its direction. The span of the Arch will be 53 feet 6 inches upon the skew face, and its rise 8 feet 10 inches. The height from the rail to the soffit will be 26 feet 2 inches; the thickness of the arch (which will be entirely of stone) at the key will be 3 feet, and the springing 4 feet. The width, in the clear, between the parapets, 20 feet.

The Shale and Marle, marked A, upon which the rock from which the bridge springs, will require to be faced with Ashlar work, extending 10 feet on each side of the bridge, and of the thickness shewn upon the drawings.

An Invert (B) of rough stone must be made across the Railway, between the facing walls, and extend a certain distance on each side of the bridge as shewn in the drawing. The courses of stone composing the invert will be built square with the line of Railway; but the courses of

stone composing the arch of the bridge will be laid in a spiral direction, as usual in skew bridges, and as is shewn in Drawing No. 10, Fig. 2. The bridge for road from Ashton to Roade, and where they intersect the springing of the rock, must be cut or toothed, as shewn in Fig. 5, Drawing No. 10, to receive them. The whole of the remainder of the bridge will be built of stone.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ROADE HYDE TO ROADE.

This Bridge will be at a part of the Railway where it is about 35 feet 9 inches cutting, and will be square to the direction of the Railway. The span of the Arch will be 45 feet, and its rise 10 feet: thickness of the arch at the key, 2 feet 6 inches; thickness at the springing, 3 feet; the width between the parapets will be 15 feet clear. The whole of the bridge will be of stone: the dimensions are shewn upon the drawing.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ROADE TO PLANE WOODS. A.

This Bridge is upon a part of the Railway where it is about 46 feet 4 inches cutting, and will be built square to the direction of the Railway. The span of the Arch will be 45 feet 2 inches, rise 18 feet, thickness at the key 2 feet 6 inches, and at the springing 2 feet 9 inches; width between the parapets, 15 feet in the clear. It is intended to be built entirely of stone. The dimensions and forms of the various forms are shewn upon the drawing.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ROADE TO PLANE WOOD. B.

(Vide Plate No. 34.)

This Bridge is in a part of the Railway where it is about 52 feet 4 inches cutting. The Arch will be a semi-circle of 46 feet span, thickness at the key 2 feet 6 inches, thickness at the springing 3 feet, width in the clear between the parapets 15 feet. The bridge is intended to be entirely of stone.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM ROADE TO BLISWORTH.

This Bridge will be built in a part of the Railway where it is about 53 feet 6 inches cutting, and it will cross at right angles. The span of the

Arch will be 48 feet $4\frac{1}{2}$ inches, rise 18 feet 9 inches, thickness at the key 2 feet 6 inches, thickness at the right course, above the springing, 2 feet 6 inches: width in the clear between the parapets 15 feet. The bridge is intended to be built entirely of stone. The dimensions and forms of the various parts are shewn upon the drawing.

For description of materials and workmanship, see General Stipulations.

BRIDGE FOR ROAD FROM BLISWORTH TO COURTEENHALL.

(Vide Plate No. 35.)

This Bridge is on a part of the Railway where it is in about 55 feet 3 inches cutting, and will be built at an angle of 56 degrees with the direction of the Railway. The Arch is to be of stone, and to be strengthened, as shewn, by 4 counterforts of Ashlar work.

Span of Arch on the skew face 63 feet, rise of arch 13 feet, thickness at the key 2 feet 6 inches, thickness at the springing 3 feet 6 inches, width in the clear between the parapets 18 feet. The dimensions of the various parts are shewn upon the drawings.

For description of materials and workmanship, see General Stipulations.

BRIDGE AT THE ROAD FROM TOWCESTER TO COTTON END.

(Vide Plate No. 33.)

This Bridge is on a part of the Railway where it is in about 38 feet 9 inches embankments, and will be built square to the direction of the Railway. The Wings will be built parallel to the Railway, and will be pierced with arched openings. The span of the Main Arch, 30 feet, to be composed of brick, faced with stone, which will be worked with archivolt mouldings. No stone forming the front of the arch must be less than 2 feet long, measured on the circumference of the soffit of the arch, and they must tooth into the brickwork, so that the stones may be 1 foot 6 inches and 1 foot 1 inch in length, under the arch alternately, and also on the return of the groins of the abutments, which will also be faced with stone. The arch will also be faced with stone, and have archivolt mouldings. The fronts of the pilasters must be faced with stone, in courses of not less than 12 inches in height, consisting of regular headers and stretchers. The headers must be not less than 18 inches long, and 14 inches wide. The stretchers not less than 3 feet long, and 9 inches wide.

The fronts of the Pilasters, stone facing to main and side arches, key stones, facia cornice, dentils, plinth to parapet and coping, must be smooth chisel dressed, and the beds must be made true and level. The Wing Walls

will be pierced by openings, and they again will be intersected by other openings, at right angles to the former, so that the Transverse Arches will be resting upon piers only.

The whole of the details of form and dimensions will be seen upon the drawings.

For description of materials and workmanship, see General Stipulations.

FORMATION OF ROADS OVER AND UNDER BRIDGES, AND METALLING THE SAME.

Where the necessary backing to the bridges shall have been filled in, and duly completed, to within 1 foot 6 inches of the surface of the existing or intended road, then a coating (6 inches thick) of Stones, broken to a guage ring of 3 inches diameter, shall be properly spread and levelled; and on this another coating (also 6 inches thick) of Stones, broken to a 2 inch gauge ring, shall be laid and properly levelled. This being duly performed, the traffic of the road shall be allowed to pass over the new road. And when the new material has been sufficiently consolidated, in the opinion of the Engineer or Engineers for the time being, but previous to a surface crust being formed, then a further coating of Stone or Gravel, of a size and quality corresponding with that constituting the surface of the existing roads, shall be laid, of sufficient thickness and form so as to render it in every way agreeable to the form of such existing road: due allowance being made for sinking and compressing of the loose material.

Previous to the last coating of Stone or Gravel being applied, and also afterwards, until all the works included in this contract are completed, the surface of such roads shall be kept in proper form. The ruts being filled in, and all settling from sinking and compressing made good. And if there are on the existing roads any Footpaths, then similar ones shall be made, of the same form and dimensions, and of similar materials to those of the existing roads, at the charge of the Contractor.

It being further understood, that this Metalling shall extend for the whole width between the abutments or parapets of all the Bridges, and shall be continued beyond such abutments and parapets of the width and form of the existing roads, until its junction with the line of such roads. Through the extent of all or any of the diversions, the top soil shall be removed, and the level of the surface formed, so as to rise or fall from each commencement of such diversion to the lowest or highest parts of such diversions uniformly.

The metalling and footpaths for such diversion being excavated, as hereinbefore described for the roads over or under bridges. The gravel or Stones composing the existing line of road, when it is requisite, shall be Excavated and removed, and also the fences grubbed up, and left for the use of the owners or occupiers of such land. The vacuities and irregularities on the surface occasioned thereby, shall be levelled and made good by the soil from the new line of road, and if that is not sufficient, from the soil on the line of Railway.

The Fencing to make good to the ends of the parapets or abutments of the bridge; and for the extent of diversions, shall be executed in accordance with that hereinbefore described for the permanent fencing of the Railway; and where a ditch is not to be made, then an additional line of posts and rails shall be used in lieu thereof.

It is expressly stipulated, that in all cases wherein, (in the execution of the works herein specified,) any part of any carriage or horse or other Road, either public or private, shall be found necessary to be cut through, raised, or sunk, taken, or so much injured or interfered with that the same shall be rendered impassable or inconvenient for passengers or carriages, or the persons entitled to the use of such road, the Contractor shall, at his own expense, before any such road shall be so cut through, raised, sunk, taken, injured, or interfered with, as aforesaid, cause "another good and sufficient Road," as the case may require, to be set out and made in place of same; and maintain and keep the same in repair during the continuance of this Contract, or until the principal road shall be restored, and rendered as convenenient for passengers and carriages as the said road to be cut through, sunk, taken, injured, or interfered with, as aforesaid, or as near thereto as may be.

And whatever Agreement the Railway Company, by their Act of Parliament, shall be liable to perform with the Trustees of any road or roads, regarding the construction of such temporary roads during the continuance of the works, or the regulating of any of these works in connexion with these roads:

It is further stipulated, "that the Contractor shall become liable for the due observance of the same;" and if he fail in this, then the amount of any fines or penalties which the Company shall become answerable for, shall be deducted from the amount of his Contract.

CULVERTS.

The Culverts must be built in the situations at the angle, and of the size shewn upon the general Section, the form and particular dimensions to be as shewn upon the Drawing No. 21.

Each Culvert must be placed so as to afford a free and uninterrupted passage for the water.

The foundations must be cut out as nearly the size of the brickwork as possible, and the vacant spaces must be punned up to the surface of the ground.

The brickwork of the Side Walls and Wing Walls must be laid on English bond, and the Arch and Invert in separate half brick rings.

The materials and workmanship, and general instructions, must be similar to that described under the head of materials and workmanship, see General Stipulations.

All Culverts exceeding 4 feet in diameter, shall be covered with Clay 2 feet above the top, and 4 feet on each side, well punned in layers of 1 foot in thickness, and at least 500 cubic yards of earth shall be placed uniformly on each culvert, before the embankments shall be allowed to come upon it.

Wherever the direction or position of the Culvert does not correspond with that of the stream, the course of the latter shall be altered, so that the water may be conducted to and from each end of the culvert, in the manner best suited for facilitating the drainage.

The clause describing "the Ballasting and laying the Permanent Way" is similar to that specified in Contract 5 B, hereinbefore given (vide page No. 42.)

EXTRA OR CONTINGENT WORKS.

FENCE GATES.

The Fence Gates are to be made of the form and dimensions shewn in the Drawing No. 26.

The heels and the heads are to be of good English Oak, sawn out to the proper dimensions and morticed for the reception of the horizontal bars.

The horizontal Bars are to be five in number, of cleft oak, and smoothed over. The ends must fit the mortices of the heels and heads, and be secured by oak pins.

The diagonal Braces are to be similar to the bars, to which they must be firmly nailed. The nails to pass through both, and have their points clinched.

The Posts to be of oak, the top sawn to the dimensions and form, with a small cap on each. That portion of the post to be placed under the surface of the ground to be charred.

The gate irons shall be of the form shewn in the drawing.

The gates must be firmly fixed in the line of the quicksets, and the wood railing neatly joined to the gate posts.

The gates and posts must be painted with two coats of white or stone coloured paint.

EXCAVATIONS AND EMBANKMENTS OF SLOPED OCCUPATION ROADS.

These Excavations and Embankments are to be made in the same manner as those upon the line of Railway, and with Slopes, as may be directed by the Engineer. The contents of the excavations shall be conveyed to the nearest embankment upon the line of Railway, or to the nearest spoil bank.

The Embankments are to be formed with the surplus materials in the excavations upon the line of Railway, should such exist, but if not, they must be made with material obtained from one or more of the excavations upon the line of railway (as may be fixed by the Engineer) by altering the slopes so as to afford a sufficient supply; and the Contractor shall be paid for the same at the rate specified in the Schedule of prices.

But whenever there is a surplus of materials, the Contractor shall employ the same in forming the Approaches to occupation bridges or sloped roads, should such be required, and the cost of so employing it shall be considered a part of his Contract, to which the stipulations and prices for extra works do not apply.

METALLING OCCUPATION BRIDGES.

This is to be done in the manner as described in the specification of formation of roads over and under bridges, and for diversions.

PAVING CROSSINGS.

All the roads crossing the Railway without bridges are to be paved in the manner shewn in the Drawing No 25, with good 6 or 7 inch paving of

Leicester granite, or other granite equally good. The paving must be laid on a bed of fine clear gravel of 12 inches in thickness, in a solid and substantial manner.

The paving Stones must be cubes as nearly as possible.

Each rail must be protected by two iron Bars, as shewn in the Drawing No. 25; they will be considered as part of the rails, and will be provided by the Company.

OCCUPATION BRIDGES.

Those under embankments are to be similar to that at the road from Bosenham Mill to Hartwell, Drawing No. 5.

Those over cuttings to be similar to that for road at one mile 22 chains, Drawing No. 9. It being understood that the specification for the above bridges referred to are to apply to the occupation bridges.

CULVERTS.

The Culverts are to be built in the same manner as those previously described in the former part of the specification. They are to be built of the forms and dimensions shewn in Drawing No. 21, the sizes being selected to suit the particular situation.

LAYING AND BALLASTING PERMANENT SIDINGS.

The Sidings are to be laid in such positions, and of such lengths, as may be directed by the Engineer. They must be laid in form and manner shewn in Drawing No. 22.

The Contractor will be required to take up any part of the rails previously laid that may be found necessary, to cut them into their proper lengths for the reception of the other iron work; to relay them, and to fix all the necessary crossing plates, check rails, moveable points, or sliding rails, with the requisite machinery for moving them.

The whole must be made equally as firm and substantial as the other parts of the permanent way.

The specification of the Permanent Ballasting already described must be considered as equally applicable to the construction of the sidings.

TIME OF COMPLETION.

The whole of the Works in this Contract are to be completed within the space of two years from the date of signing this Contract, and the

Contractor shall be bound to uphold and keep in good order the whole of the works for the space of one Year after the works shall have been so completed.

RATE OF PROGRESS.

At or before the 22nd day of October, 1835, the Excavations, Nos. 1, 2, 3 and 4, referred to in the aforesaid Specifications, plans, section and drawings, shall be performed and completed. On or before the 22nd day of October, 1835, not less than 70,000 cubic yards shall be excavated at the situation marked with the letter A in the Cutting No. 5, and referred to in the said specification, and removed to the embankment or embankments as is directed in the aforesaid specification. On or before the 22nd day of April, 1836, not less also than 70,000 cubic yards shall be excavated at the situation marked the letter I, in Excavation No. 5, referred to and described in said specification hereunto annexed, and removed as aforesaid; and after the 22nd day of April, 1836, at the situation marked with the letter I, in Excavation No. 5; and after 22nd day of October, 1835, at the situation marked with the letter A, in Excavation No. 5, each described and referred to as aforesaid, the said (Contractor) shall excavate and convey to the several embankments not less than 25,000 cubic yards per Month, at each and every of the aforesaid places in each and every of the following months of April, May, June, July, August and September; and also 20,000 cubic yards at each and every of the above places as aforesaid, for each and every of the following months of October, November, December, January, February and March, until the completion of the said excavation, it being proposed, that under this arrangement, the whole of the excavations and embankments contracted to be executed by the said (Contractor) under this Contract, shall be completed and finished within two Years and a half from the date of the same Contract, all which said places and works are mentioned in the said specification hereunto annexed.

SPECIFICATION OF 12 FEET TURN-RAILS.

(Vide Plates, Nos. 42, and 43.)

The Turn-rails are to be 12 feet in diameter, and all of cast iron, except where otherwise described.

The Table is to be hung to and turn upon a centre Pivot, marked A, upon the drawing, and 8 cast iron Rollers, B B, which work upon wrought iron Arms, C C, radiating from a wrought iron Hoop, D, the whole working round the centre Pivot.

The whole table is to be enclosed by a cast iron Ring, E E, 12 feet 7 inches in diameter on the outside, and 1 foot $8\frac{1}{2}$ inches deep. Upon this Ring the circular Rail, F F, is to be cast for the rollers to work upon; the centre diameter of this Rail to be 11 feet 3 inches, and its width $1\frac{1}{2}$ inches.

The outside Ring is to be cast in 2 parts, and bolted together by means of flanches and screw bolts, 3 in number, each 1 inch diameter, on each side, as shewn in the drawings at G G. The section of Ring is shewn in the drawings, with the respective thicknesses marked thereon.

The top, or Table, consist of four principal Arms, marked I I, traversing the tables at right angles, 9 inches deep at their centres, and $6\frac{3}{4}$ inches at their ends. Also four Arms radiating from the centre piece to the corners formed by the others; these Arms are marked K K in the drawings, and are $8\frac{1}{4}$ inches deep at the centre piece. Holes $\frac{3}{4}$ of an inch diameter are to be cast in the first named arms, for fastening the Railway bars or Rails to the table. At the extremity of these arms is the circular Rail M M, for working or bearing upon the rollers; its centre diameter being 10 feet $3\frac{1}{2}$ inches, and its width 2 inches; the Section of which, with the respective thicknesses marked thereon, is shewn in the drawings.

In the centre piece 4 Holes are to be cast for receiving $1\frac{1}{4}$ inch screw bolts, for hanging the table to the centre pivot. The space between the principal arms are to be left open, and the Grating to be of the shape shewn in the drawings, and to be put on afterwards.

The table to work upon 8 cast iron Rollers, B B, of the shape shewn in the drawings, and 10 inches diameter; to have a hole bored out in their centres for a $\frac{3}{4}$ of an inch rod to work in freely. The periphery of each roller to be turned. These rollers to work between 2 wrought iron Hoops, P P, $\frac{5}{8}$ of an inch thick and 2 inches deep, and made in 2 parts; and upon 8 wrought iron Arms, C C, $\frac{3}{4}$ of an inch diameter; each of these arms to be screwed into the hoops, and a nut Q Q, screwed up tight against them.

The other extremities of these arms are to be screwed into another wrought iron Hoop, D D, 2 inches deep, and 1 inch thick; the inside diameter of this hoop to be 5 inches, and to be turned, so as to work round the collar on the centre pedestal R. The Collar for the hoop D to work upon must be turned.

The centre Pedestal is to be of cast iron, having a Hole, 3 inches diameter, and 5 inches deep, bored out of its centre. A brass Step, S, 2 inches thick, is to be put into the bottom of this hole, for the pivot to work upon; 4 Holes, 1 inch diameter, to be cast in the feet of the pedestal, for fastening it to the stone block. The centre pivot A, is to be of cast iron, 13 inches long, including the head, which is to be 1 inch thick, and 10 inches diameter, with 4 holes, each $1\frac{1}{4}$ inches diameter; that part of the Pivot working in the pedestal to be 3 inches diameter, with a rounded end, as shewn in the drawings, the working part of the Pivot is to be turned: the remaining part of same to the underside of the head, is to be 4 inches diameter. A Hole, V, is to be cast in a slanting direction, down to the Pivot, for the supplying of oil to its working parts, so that it shall run into the pedestal at the side of the pivot.

The Table is to be hung to this pivot by 4 screw bolts, each $1\frac{1}{4}$ inch diameter, in such a manner that the table may be eased off or lowered on to the rollers at pleasure. The heads of these Bolts to be counter-sunk into the centre piece, as shewn in the drawings. On the surface of the table two Lines of Railway must be fixed, at right angles to each other; the distance between the rails inside to be 4 feet $8\frac{1}{2}$ inches. The bars or Rails, W W, are to be of wrought iron, 3 inches broad, and 2 inches thick, and of the shape shewn in the drawings; bolted to the principal Arms with $\frac{3}{4}$ of an inch screw Bolts, the heads being counter-sunk into the rails. 4 sets of wrough iron Inclined Planes are to be fixed at the intersection of the rails, for the flanches of the wheels to run upon when passing the openings. A Latch, X, is to be fixed to the table, and 2 Catches, Y Y, are to be cast on the outside rim at right angles to each other, for holding the table in the required position.

The whole of the materials and workmanship to be of the best possible description, and the Contractor is to uphold all the several parts for the space of six Months, replacing any unsound castings, or imperfect workmanship.

The Company's Engineer, or any person whom he may appoint, may reject any Turn-rail, or part of one, which he may think is not sufficiently sound.

N.B. The top, or table, may be cast in two parts.

MIDLAND COUNTIES RAILWAY.

Specification of the Works necessary in constructing the Viaduct over the Valley of the River Avon.

(Vide Plate No. 50.)

This Viaduct consists of eleven Arches, each of 50 feet span, which are to be built agreeably to the plan. The foundations to be sunk to an average depth of 6 feet below the surface of the ground, or to 44 feet below the level of the rails, as shewn on the longitudinal section. Should an increased depth appear necessary to the Engineer, or an artificial foundation be required, it will be paid for according to the Schedule of prices.

The structure to be Brickwork, with the exceptions hereafter specified. Every part of the work, where the thickness of the walls will admit of it, to be set flush in grout, and the whole to be put together in the most substantial and compact manner.

The ends of the piers to be faced with the best Staffordshire blue Bricks, properly bonded, and returned 9 inches and 14 inches into the flanks of the piers.

The rings or quoins of the Arches to be similar bricks, and similarly bonded into the soffit; also the Coping of the parapets to be formed of Staffordshire bricks, moulded 14 inches on the bed, and 8 inches thick, rounded on the top, and set 2 inches from the face in Roman cement. The Spandrils and Parapets to be faced with square hard burnt common bricks selected for the purpose, and the clay for the whole of the bricks for this structure to be ground; none other will be allowed to be used. Openings are to be left in the piers of the dimensions shewn, with Arches at the top and bottom of the same. Spandril arches to be built over the piers, and quarters of the main arches, as shewn in the sections.

In the centre of each pier, a cast irom Pipe of 2 inches diameter is to be built, to carry off any water which may percolate through the ballast and spandril arches, and openings to be left in the piers of the spandril arches, and channels formed, so as to draw any water to the pipe.

The whole of the Arches, when built, to be covered with a clay pun, or Puddle, 9 inches in thickness.

ASHLAR.

Imposts or Caps to the piers to be placed, of the dimensions shewn on the enlarged Section, and returned 2 feet 6 inches into the piers. The lower member to be 2 feet on the bed, with 2 inches projection, the upper member to have 12 inches projection, and 2 feet insertion into the wall. A Springer, 10 inches thick at the face, and 2 feet on the bed, to run entirely through the whole of the arches, and upon the face of same; and to run across the whole width of piers.

The Cornice to be stone, of the dimensions shewn on the plan. The upper member to be 15 inches thick, with 15 inches projection; the lower member to be 9 inches high, with 3 inches projection, and both to have at least 1 foot 9 inches bearing on the wall.

The Caps of the piers, at the ends of the parapets, to be of Ashlar, and the whole to be very neatly tooled. The cornice to be in lengths of not less than 3 feet, and the ends closely jointed, and pointed with Roman cement.

The Mortar is to be made by passing the lime and sand through a mill, in the proportion of 1 measure of Lime, newly burnt, to 2 measures of clean sharp Sand, and thoroughly incorporating them together with the least possible quantity of water; and no more is to be mixed or ground than will be used in the work by the expiration of the following day.

All Centering and other materials to be found by the Contractor.

The Earth at the back of the Abutments, and about the wings, to be carried up in courses, and regularly pounded, or rammed to the full height.

The whole of the Works to be executed in a workmanlike and substantial manner, to the entire satisfaction of the Engineer.

Specification of Works required in constructing a Bridge over the River Trent.

(Vide Plate, No. 51.)

EXCAVATION AND MASONRY.

The respective parts of the Works are to be built and made of the dimensions shewn in the drawings, and agreeably to this specification.

The excavations for the Foundations are to be sunk to the depths shewn on the drawing. A Coffer Dam is to be constructed for laying the foundations of the south pier; the dimensions of which, as also the mode of construction, to be approved of by the Engineer.

The dimensions required for the base of the said Pier, is to be enclosed by driving Sheeting Piles, 6 feet in length and 4 inches in thickness, each having a wrought iron shoe of $1\frac{1}{2}$ lbs. on its lower end, the piles to be driven until their tops are nearly level with the river bed. The space so enclosed is then to be excavated from 3 feet 6 to 4 feet below the bed of the river, and layers of Concrete, forming a depth of 2 feet, to be laid completely over and upon the space within the sheeting piles, the upper layer of concrete having been truly levelled up and down stream, a Grating of Timber to receive the masonry is to be laid upon it.

The component parts of the concrete, and the proportions of each, will be hereinafter specified; and the foundations will be required to be kept free from water, until the concrete has become properly set.

The Grating to be of Memel Beech, or Elm timber, of the following dimensions: the outer Sills lying transversely to the bridge, to be 12 inches square; the intermediate ones, 3 in number, to be 12 by 9 inches: the Cross Sills to be 9 inches square, and to be sunk into the transverse ones at the points of intersection, then to be properly trenailed and secured: the Spaces between the timbers to be filled with Concrete.

A similar grating, &c. to be used for the other pier and abutments, if thought necessary: in that case they will be paid for according to the Schedule prices.

The whole of the Abutments and Piers are to be built of Ashlar stone,

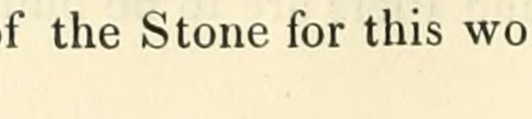
the largest blocks being selected for the bottom courses, and no course to be less than 18 inches high ; the beds of the stretchers to average 21 inches, the headers to form a third of the whole face, and to be 3 feet 6 inches deep on the bed, the beds and end joints to be truly wrought. The face from the foundations to 2 feet below water level, to be pick dressed. The remaining part to have a tooled or drafted margin, the remainder of the face to be neatly punched.

The filling of the Piers and backing of the Abutments to be of Ashlar stone, having one good bed. Two stones may be used to make the height of a course, each of which must be evenly levelled off: sound well burnt Bricks may be substituted for the stone backing of the abutments, if the Engineer should approve of the quality.

The Impost or moulded course under the springing of the Arches to be neatly tooled, and wrought in lengths not less than 3 feet, to be 2 feet on the pier, and filled with solid Ashlar masonry between.

The salient Angles of the piers to be formed with stone blocks of large dimensions, and no joint to be within two feet of the angular point.

The Caps of the Piers are to be formed in two blocks neatly tooled, close jointed and connected with iron dowels.

The stone blocks forming the Springing Courses to be the whole depth of the cast iron abutting or Springing Plates which is laid upon them, the bottom beds to be 3 feet deep, and not less than 3 feet long ; the back joints to be wrought square, and filled in with square wrought Ashlar masonry, so as to make the top of the piers a close bed of Ashlar work. The backs of the Springing Courses and the filling course are to be jointed and joggled thus  into which the springing plates, junction frames, or pier standards, are to be sunk.

The Wings are to be faced with Ashlar stone, neatly tooled ; and the backing is to consist of flat bedded Rubble masonry, properly bonded, and closed in each course, the Ashlar work to average 1 foot 9 inches in the bed, and to have headers in the proportion before described for the piers and abutments.

The Base Cornice (the members of the latter are to correspond with the cast iron cornice over the arches) and coping to be of Ashlar stone, of the figure and dimensions shewn on the drawing, closely tooled. The Parapet is to be of solid blocks, each the height of the parapet, margin drafted and punched, as before described, and to be coped with a moulded coping of 12 inches thick, having 4 inches projection on the outer face.

The whole of the Stone for this work to be of the best quality, from

the Cromford quarries, or some other which produces equally good stone; as to colour and quality, to be approved of by the Engineer.

The exterior face of all the Masonry in the Bridge, to the level of the tops of the piers from the foundations, for 9 inches in depth, from the outside, to be set in the best Roman Cement, with a proper proportion of clean sand, or in mortar, made in the following manner:—"Two measures of barrow Lime, one measure of Pozzuolana, and three measures of clean Sand;" the whole to be well ground and tempered until it forms a tough paste. No more water is to be used in mixing than is absolutely necessary to thoroughly incorporate the mixture. The Backing Mortar to be composed of one measure of Lime, half a measure of Pozzuolana, and two measures and a half of clean sharp Sand, ground, tempered and mixed as before stated.

The Concrete is to be made of fresh barrow Lime, ground as described for the mortar, and mixed with clean sandy Gravel, in the proportion of 1 of lime to 4 of gravel, mixed with the least possible quantity of water; the whole to be well beaten, and turned twice at least with a shovel, and used while in a hot state.

The Contractor is to cut away and open the banks of the River, to suit the new constructions, as may be directed. He must also cut a temporary Channel for the water on the north side, to enable him the better to get in the foundations; and also construct all Dams necessary for the construction of the work. He must find all Materials necessary for the construction of the work, according to the plan and this specification, and complete the same to the entire satisfaction of the Engineer, who shall have power to reject any improper materials, or order any insufficient work to be taken down and rebuilt; and his decision as to the intent and meaning of any and every part of this specification is to be binding on all parties concerned.

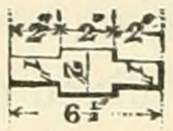
IRON WORK.

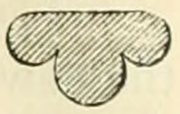
The Bridge is to have 3 Arches, each of 100 feet span, having a versed sine or rise of 10 feet; the inner curve being a segment of a circle of 260 feet diameter.

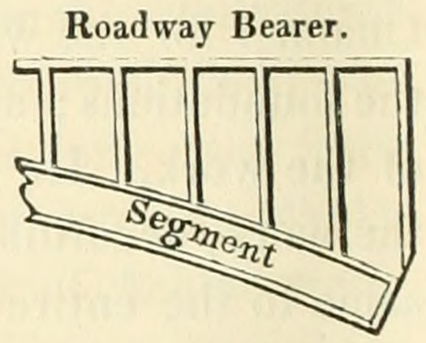
Each Arch is to consist of six Ribs of cast iron, and each Rib to be composed of 3 pieces; each piece being a solid casting, forming the segment spandrils and roadway bearer. The Segment Pieces are to be 3 feet deep at the springing, and to diminish to 2 feet 6 inches at the crown; the plate of the segments, excepting the outer ones, to be $2\frac{1}{2}$ inches thick, strengthened



with a top and bottom web or Flange, $2\frac{1}{2}$ inches square, thus the plate of the two outer segments to be 2 inches in thickness. The joints of the segments are to be connected by Tie Plates of a similar depth and thickness, and reaching the entire width or breadth of the bridge. The webs or Flanches to be returned on the ends of the joints of the segments, by which they are to be secured to the Tie plates with $1\frac{1}{2}$ inch screw bolts.

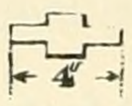
And further, to be braced laterally with feathered Diagonal Braces between each tie plate, secured to the segments by inch screw bolts, passing through flanches to be cast upon them; the Braces to be 6 inches broad in section, thus  The ends of the Segments are to rest upon and be fitted to cast iron Springing Plates, bedded and sunk into the abutments and piers, 3 inches thick, with raised grooves to receive the same. The plate of the Roadway Bearers is to be $1\frac{1}{2}$ inch thick and 9 inches deep, with a flanche on each side, on the top, of 3 inches by $1\frac{1}{2}$.

The Spandril fillings, next the pier standards, are to be 6 by 4 inches, and reduced gradually to 4 inches square, as they approach the crown of the arch; those on the outer ribs to be formed in Section, thus  with Gothic heads, as shewn in elevation.



The inner four to have plain vertical pieces of the above dimensions, and the Gothic heads to be omitted, thus. The several spaces of same being the same width as the outer ones.

The pier Standards are to be of the dimensions shewn on the elevation, and 2 inches thick; those on the outside to have a sunk panel, the inner ones plain; and they are to be secured at their junction with the ribs by flanches, with proper screws, bolts, and nuts.

The Roadway Bearers are to be braced by one set of diagonal Braces, between the crown of the arch and pier standards, to act on points at least 12 feet apart in the length of the bearer; to be feathered castings, 4 by 2 inches—thus  attached to the bearers by flanches, bolts, &c. as before stated.

A Cornice of cast iron, $\frac{3}{4}$ths of an inch thick, and of the figure shewn on the elevation, is to be secured to the outer bearers by inch screw bolts.

The parapet Railing is to be of wrought iron, $\frac{7}{8}$ths of an inch square; but the Gothic heads may be of cast iron. The handrails to be $2\frac{1}{2}$ inches broad, and $\frac{7}{8}$ thick, rounded on the top, and rivetted to the Gothic tops of the railing. The number of them is shewn on the drawing, and they must be keyed into the base or plinth of the parapet.

The Roadway is to be formed of half balks of Memel timber, Kyanized. To be not less than 12 inches broad, and 6 inches thick, and placed so as to leave spaces of 2 inches between them.

Each Timber to reach the entire width of the bridge—namely, 27 feet; and to be secured to the roadway bearer in two points of its length, by screw bolts $\frac{3}{4}$ths of an inch square—the bolts to be dipped into white lead before being driven; or, if the Engineer shall direct, the screw bolts shall be dispensed with, and the timber secured to the bearers by battens spiked to them from below; in which case, the upper flanche of the bearer will require to be cast beveled, so as to form a dovetail between the battens.

All the Joints of the Castings shall be truly fitted solid, by chipping or filing, and no packing of sheet iron, wedges, or cement, shall be used, but the workmanship shall be of the very best kind possible. The Castings shall be of the best grey metal, No. 2, without flaw or defect, and shall be put together and erected at the foundry where they are cast, and be subject to the inspection of the Company's Engineer, who shall reject all such as he may deem insufficient.

The Contractor to find all Models, fitting materials, centres, timber, tackle, and labour; to make, erect and complete the iron work as aforesaid upon the masonry provided to receive it, according to the true intent and meaning of the Plans, sections, and specification, and to the entire satisfaction of the Engineer.

The iron work to be painted when temporarily erected, and two coats when permanently fixed, of the best white lead and linseed oil.

SLAMANNAN RAILWAY.

JOHN MACNEILL, ESQ. ENGINEER.

Specification of the Work to be executed by the Contractor for the First and Second Lot of this Railway.

This portion of the Railway commences at a point on the Ballochney Railway, in the lands of Stanrigg, marked by a pin driven into the ground, and numbered 1.

This point corresponds with the points marked A on the Plan and Section of the first division of the proposed Railway hereto annnexed.

The Line runs in nearly a N. E. direction through the lands of Longrigend, Longrig, Lodge, Binnyhill, Balquharson, and Peatrigend, and terminates at the fence at the east side of the road leading to Pirney Lodge, after crossing the Burn.

The Red line on the plan represents the centre midway between the two lines of Railway, and is now marked out by stakes driven in the ground at every 100 feet apart, which are numbered on the top, commencing with the figure 1, at the Ballochney Railway. These numbers are continued in regular series up to No. , which terminates the first Lot.

The stakes are represented on the section by the same figures. The height of embankments, and depth of cuttings, are shewn by the figures in red on the Section at each of these stakes, which are 100 feet apart along the whole line.

Two large stakes will be driven firmly into the ground; one near the middle of the lot, the other near the termination, in the lands of Peatrigend, but out of the line of Railway, so as not to be dirturbed by the operation of the works; and which are to serve as standard Bench marks, to which the level of the stakes are to be referred in the first instance, and during the progress of the works.

These Bench marks and stakes will be levelled by the Superintendent, and the Contractor is to satisfy himself of their accuracy before he commences the work; and he is to sign a paper to that effect, to prevent all

disputes as to levels, as no extra sum whatever will be allowed the Contractor for cutting or embanking, beyond the depths or heights marked on the section hereunto annexed, in order to acquire the rates of Acclivity marked on the said Section; that is to say,

1 in 112 from A to B, being a distance of 1733⅓ yards;
1 in 349 from B to C, being a distance of 1233⅓ yards;
1 in 300 from C to D, being a distance of 400 yards;
1 in 100 from D to E, being a distance of 6649⅔ yards;

the whole measured along the surface of the Rails, when laid in the chairs, and fixed to the blocks or sleepers.

CUTTINGS AND EMBANKMENTS.

(Vide Plate, No. 65.)

The roadway through the Cuttings, at the surface of the rails, is to be 25 feet wide, except through the Moss, where it is to be 35 feet wide. The sides of the Cuttings are to be formed with slopes, 1 to 1, where the cutting does not exceed 4 feet in perpendicular height; 1½ horizontal to 1 perpendicular, where the height does not exceed 10 feet; and at all heights above that, the slopes are to be 2 horizontal to 1 perpendicular.

The Embankments are to be 30 feet wide, when raised to the proper height, and formed ready to receive the ballasting, except in Moss, where it is to be 35 feet. The slopes of all Embankments are to be 2 horizontal to 1 perpendicular.

All the Materials arising from the cuttings are to be employed in raising the embankments; and should it produce more than is necessary for this purpose, the residue is to be applied to giving a greater width to the embankments, by widening out the slopes, or otherwise disposed of in places equally convenient for the Contractor, as may be pointed out by the Engineer or Superintendent to the Company for the time being. But if the materials procured from the cuttings be not sufficient to make up the embankments to the specified heights and widths, a sufficient quantity must be procured by making the cuttings wider than specified, or by flattening the slopes, as may be pointed out by the Superintendent or Engineer, without any additional expense to the Company.

Before any Embankment is commenced on any part of the line, except through the moss, the Soil is to be raised for a depth of 6 inches over the whole space to be occupied by the embankment, and for the depth of 1 foot over the space to be excavated, and removed to some convenient site, pointed out by the Inspector or Superintendent; to be hereafter

employed in soiling down the slopes of the Cuttings to a depth of not less than 6 inches, and the slopes of the Embankments to a depth of not less than 12 inches. This part of the work is not to be done until after all the slopes are carefully levelled, trimmed, and dressed, and reported by the Superintendent to be sufficiently consolidated and firm.

The Embankments are to be raised by Lifts not more than 4 feet thick, and the Contractor is to satisfy himself that each layer is perfectly consolidated before he commences a new one over it.

In the cuttings through the Moss, Drains are to be formed at the bottoms of the slopes, as shewn in the drawings hereunto annexed, (vide Fig. 1, Plate No. 65). These drains are to be 9 feet wide at top, 3 feet deep; to slope on the outside as the cuttings—that is, 2 horizontal to 1 perpendicular, and on the inside 1 to 1. Two Drains are also to be cut, one on each side of the road, at the top of the cutting, and 6 feet from the edge of the slopes; these Drains are to be 8 feet wide at top, 3 feet at bottom, and 3 feet deep: the moss taken from them to be deposited on the outside of the drains, not less than 3 feet from the edge thereof.

In the moss the embankments are to be formed with slopes of 2 horizontal to 1 perpendicular, and to be 30 feet wide at the surface level of the rails.

Before the Sleepers are laid on the surface of the embankment, a space of 15 feet in width is to be covered with heather and green sward, or divits under the ballasting.

Should Rock be found in the cuttings, the slopes may be $\frac{1}{2}$ horizontal to 1 perpendicular; and the Contractor is to allow the Company, or the Contractors for the other portions of the line, to quarry and take away whatever quantity they may require for Blocks, masonry, ballasting, or any other work the stone may be fit for, without any charge whatever, provided there is a superabundance above what he will require for his own portion of the work. The Company, or Contractors, giving him, in place of the stone thus taken away, as much earth or other material as will make up the same quantity of embankment, should he so require it.

DWARF WALLS.

(Vide Fig. 2, Plate No. 65.)

The Contractor is to cast out the foundations, and build Dwarf Walls throughout the cuttings, except in moss, to the extent of 2,700 yards, on each side of the road; these Walls to be 21 inches thick at bottom, 15 inches at top, and $2\frac{1}{2}$ feet high, and coped with two courses of 3 inch

divits; these dwarf dykes to be of substantial dry stone work, with thorough bonds not more than 1 yard apart.

FENCES.

Post and Rail Fences are to be erected along each side of the Railway, at the top of the cuttings, and at the bottom of the embankments, except through moss;—these Fences are to consist of the best description of post and rails, and quick plants, or of earthen mounds, and stub fence. These mounds to be $2\frac{1}{2}$ feet high, 5 feet broad at the bottom, and 3 feet broad at the top; the sides, to the thickness of 1 foot, to be laid with divits on their flat bed, and the centre to be made up with fine soil, taken from the Railway sides of the Fences. The Plants are to be provided by the Company, but they are to be planted by the Contractor in a careful and workmanlike manner, at such times and seasons as may be pointed out by the Engineer to the Company. The Contractor to have the liberty of putting up either the *post and rail* fence, or *mound and stub* fence, as he may think proper, but it is to be uniform throughout the whole length.

DRAINAGE.

Besides the preparatory Drains already described along the moss, Cross Drains are to be formed where there is any run of water, or means of carrying off surface water. These Drains are to be open cut, 4 feet wide, and 3 deep, and made to communicate with the nearest stream or outlet for the discharge of the water.

Two Main Drains are to be cut, in such places as may be pointed out by the Engineer; these drains to be 10 feet wide at top, 3 feet wide at bottom, and of sufficient depth to communicate with the side drains already described in the cuttings through the moss. These drains are intended to carry off the water that would otherwise accumulate in the side drains, and overflow the road. They must be made in the best manner for discharging the water, and carried to a sufficient length to communicate with the stream that now runs to the South of the moss, or to some low situation where the drainage may be affected.

The Contractor shall also open the Foundations and build Drains along the Railway, (except in moss) and embankments to the extent of 2700 yards; the bottom of the drain to be 1 foot below the bottom of the level prepared for ballasting. The bottom of these drains are to have the same

declivities as the Railway when finished. These drains are to have Inlets in such places as may be pointed out by the Engineer. The Contractor is also to open foundations and build Cross Drains to the extent of 350 yards, on such parts of this portion of the Railway as may be fixed on by the Engineer, or his Inspector.

All these Drains shall be 1 foot square in the clear; the Side Walls shall be substantial Rubble masonry, not less than 1 foot thick, and laid in well prepared mortar; the Covers not less than 4 inches thick, no stone of which shall be less than 12 inches broad, and neatly hammer dressed in the joints, and to have a bearing on each side of not less than 6 inches; the Bottom to be laid with stone, set on edge, not less than 5 inches deep, and laid in well wrought clay puddle. 440 yards of Open Drain is to be made along the outside of the Railway, in Mr. Waddell's lands of Peatrigend. Besides the 350 yards of cross drains already described, five Cross Drains are to be built in the lands of Balquharson, the property of Mr. Waddell.

Three wooden Trunks, 18 inches square, are to be provided, and of sufficient length to cross the Railway in the moss, (vide Fig. 4, Plate No. 65), and are to be laid sufficiently low to carry the water from the main drains on the upper side of the moss to the main cross drains before described. These Trunks to be of Elm, or Fir, 3 inches thick, spiked, and bound with oak ties, or bonds, 4 inches square, tenanted and keyed; these bonds to be placed 4 feet apart along the trunks, and one 6 inches from each end. Should more of these trunks be necessary than those mentioned, the Contractor to be allowed for them Extra, at a fair price, to be settled previous to the work being done.

BALLASTING.

The whole extent of this division of the Railway is to be ballasted to the depth of not less than 9 inches on the Embankments, and 10 inches through the Cuttings, the width to be $12\frac{1}{2}$ feet. The remaining portion of the width of Railway to remain at present without ballast, for a space of 200 yards in length. The ballasting is to be the full width of 25 feet, for the Sidings in such places as may be hereafter agreed on by the Engineer.

The Ballasting is to be of hard durable free Stone, from the quarry at Arden, or any other quarry that may be approved of by the Inspector, broken so that every stone may pass in any direction through a ring 3 inches diameter. This ballasting is to be procured, carried, and spread on the Railway by the Contractor; but not until the Engineer is satisfied that the

embankments are consolidated, and the surface prepared and levelled, and brought to the rates of Acclivity that will be necessary to produce the rates already specified, and marked on the section, when the rails are laid.

Before the Ballasting is laid through the Moss, the surface is to be first covered with a layer of goss, whin, or fern, over which a layer of green vegetable sod or turf is to be laid, 4 inches thick, evenly laid, and jointed : If Gravel can be had, it may be used over the moss, instead of broken free stone; but it must be put on double the thickness above specified—that is, 20 inches thick. The ballasting may be got at Callough Burn quarry, or such other quarry as may be approved of by the Resident Engineer.

BLOCKS AND SLEEPERS.

The Blocks to be provided for this work, are to be taken from Craig Mochan, or Avon Bridge, or such quarries as may be approved of by the Inspector. To be not less than 9 inches thick, 18 inches square on the top, and 20 inches on the sole; those at the joinings to be 12 inches thick, 20 inches square on the top, and 24 inches on the sole. To be free from cracks or fissures, and otherwise neatly hammer dressed to the shape of the drawing, with the top, and bottom quite parallel, and so that every block shall rest on the natural bed of the stone. Two holes are to be bored in each block, 5 inches deep, and $1\frac{1}{2}$ inch in diameter. These Blocks to be placed as hereafter described, through the cuttings and embankments on the solid ground.

Through the Moss, Sleepers are to be used; they are to be of fir, or elm, that would square to 8 inches, and to be 9 feet long. Longitudinal Beams are to be laid along the sleepers, at least 9 feet 9 long, and 4 inches deep, and 10 inches broad, scarf jointed, to receive the chairs for the rails; the spikes to pass through these longitudinal pieces, and enter at least 3 inches into the sleepers.

The Blocks and Sleepers to be placed 3 feet apart, for receiving the chairs.

In the very soft and deep portions of the moss, and such places as the Resident Engineer shall direct, there must be a Platform of Timber, about 100 yards in length, (vide Fig. 6, Plate No. 65): this platform is to consist of common Fir poles, 5 or 6 inches diameter, and 10 feet long, placed side by side, so as to fill up the space between the sleepers; two Beams of timber, 8 × 10 inches, are to be laid along the sleepers in the line of the rails; these beams are to be laid so as to break joint with the one on the opposite side, and to be firmly fixed to the main sleepers by brackets and bolts, the joining of these beams to be at a main sleeper, the openings

between the sleepers, and the cross pieces to be filled with moss, or heather, and the whole covered with Gravel, or quarry chips, 4 inches thick. As the length of Platform that will be required is uncertain, the Contractor is to give in his tender a price per running yards. Should it be required, upright fir Piles are to be driven into the moss, for the sleepers to rest upon; these piles to be 8 inches diameter, and 8 or 10 feet long; the sleepers to be firmly spiked to the piles, and their ends secured by diagonal braces. This work is to be estimated for by the yard, so that it may or may not be used, as occasion requires.

RAILS.

The Rails required for the work will be provided by the Company; but the Contractor is to load, and lay them through the whole extent of this division of the Railway, in a single road, and that in the centre of the formation, with one set of offset plates, blocks, and other materials, and works necessary for the connections. All the Blocks, sleepers, offset plates, and rails, are to be accurately laid, both as to the line of direction, curve, and level. The joint Chairs to be neatly keyed, and the intermediate bearing Chairs carefully wedged.

The iron of which these keys and wedges are to be made, will also be provided by the Company, but the Contractor for the work must execute the workmanship thereof, and carry them to the line.

The Chairs are to be fixed to the blocks by two pegs, made of Scotch oak, with an iron pin, $\frac{3}{4}$ of an inch diameter, and 6 inches long, in the centre of each. The Company to provide these pins, but the Contractor is to provide the pegs.

Before laying the Blocks and Sleepers, the ballasting under them, and immediately adjoining them, is to be reduced to a solid and compact mass, by ramming them with a paviour's jumper, except where the sleepers are laid on moss.

The Rails will be delivered to the Contractor at the nearest point of the Ballochney Railway, and the Chairs, and other castings, from the foundry, in , at such times, and in such quantities, as the Resident Engineer may think desirable or necessary.

The Contractor is to be allowed the use of part of the Rails and Chairs, for carrying out the stuff, or loading building and other materials along the line; but he must provide Sleepers, offset plates, switches, keys, and pegs, necessary for laying the Temporary roads.

The Contractor shall furnish and provide all the necessary Tools and apparatus for laying the Blocks, sleepers, chairs, and rails, and adjusting them to the proper curve and level.

The Contractor not to be allowed the use of more than three-quarters of the quantity of Rails necessary for the permanent road; and should he injure, break, lose, or destroy, any of the rails or chairs, in using them for the Company's road, he must replace the same with others in every respect similar to those he may have injured, broken, lost, or destroyed.

In order to provide for the safety of the rails, the Temporary Road is to be laid, and maintained in good condition; and the waggon wheels and axles employed thereon, shall also be properly constructed, and kept in good working order, to the entire satisfaction of the Engineer to the Company for the time being; and no Waggon weighing more than $2\frac{1}{2}$ tons gross, shall upon any account, be allowed to pass along any of the temporary roads.

BOXING, &c.

When the Rails are laid, and permanently fixed, to the satisfaction of the Engineer, the ballasting is to be covered with good Boxing material, 10 inches thick in the middle between the rails, and diminishing gradually to 5 inches at the sides, as represented in the cross section, (vide Figs. 7 and 8, Plate, No. 65.) The Boxing to consist of hard, durable free stone, broken so that no stone will weigh more than 4 ounces. That part between the rails, for a width of $3\frac{1}{2}$ feet, and depth of 6 inches, is to be laid with the hardest of the stone produced from the dressing of the blocks, or scaling of free stone; these to be broken, so that no stone will weigh more than 4 ounces. The surface to be blinded, or dressed with 2 inches of fine gravel, or quarry chips, free from clay, to within an inch of the surface of the rails. If required, one side of the road through the cuttings, to the extent of 2700 yards, is to be edged or bordered with a neatly hammer dressed free stone Curb, no stone of which is to be less than 14 inches deep, nor less than 15 inches long; to be 5 inches thick at top, and 8 inches at the bottom, and to be neatly dressed in the joints to the depth of not less than 6 inches. The water channels, to the breadth of 6 inches, and to the same extent as the curb stone above described, is to be laid with hard stones set on edge, not less than 4 inches deep, and all laid and neatly packed, pinned, and pointed. The boxing to be taken from Avon Bridge or Craig Mochan quarry, or such other quarry as the Resident Engineer may approve.

When the boxing and roadway is completed, the surface is to be neatly trimmed and dressed, exactly to the curve represented on the cross section.

MASONRY.

There are to be three Occupation Bridges, two Parish road Bridges, and four Arches, or culverts, in this division of the work; the particulars of which are as follows:

No. 1. Parish Road and Bridge.

The Parish Road, leading from Avonhead to Slamannan, is to be crossed by the Railway at the point D, as shewn in the plan, in a 9 feet cutting. By lowering the parish road, a crossing may be made on the level, and in this case a bridge need not be built; but should the Company not be able to effect such an arrangement, then the Contractor is to build a Bridge as shewn in Plan No. 1, and according to the following specification:

The foundations are to be excavated sufficiently deep to secure a solid and uniform bearing. The walls of the bridge to be founded, and carried up to 1 foot above the surface of the ground, with stones measuring not less than 6 inches thick, nor less than 6 superficial feet on the bed; the joints to be made to fit each other, and laid in even courses of uniform height.

The face of the Abutments, arch, wings, parapet, and outside spandril walls, to be coursed work, with close square joints. No course in the abutments shall be less than 8 inches thick, and to be of the same thickness throughout; no stone in the abutments to be less than 1 foot 4 inches on the bed; no stretcher less than 18 inches long, and no header less than $2\frac{1}{2}$ feet long, laid one header for every two stretchers. None of the arch stones to be less than 21 inches long, nor less than 11 inches deep, and their beds neatly dressed, to radiate to that part of the arch where laid.

The face of the Abutments, arch, corners of wing walls, and spandril walls, likewise to have chisel draft round each joint, and bratched in the centre, not less than twenty-four stripes to the foot.

The quoins of the Abutments, ring pins, string course, and coping of parapet, and pillars at the ends of parapet, to be droved work; the quoins and ring pins to project $\frac{3}{4}$ of an inch, and each joint to be chamfered to that depth, and the ring pin to be made to vary in depth, so as to square with the joints of the outside spandril walls. No course in the wing walls to be less than 8 inches thick; no stone less than 12 inches broad on the bed; no stretcher less than 8 inches long; no header less than 24 inches long, laid one header for every two stretchers.

The face of the Wing Walls is to be neatly hammer dressed, with a chisel draft round each joint. The string course to be 12 inches thick, and no stone to be less than 18 inches long, and to project $2\frac{1}{2}$ inches. The parapet wall to be 1 foot thick, and one stone in breadth, wrought in the same manner as the abutments, and spandril walls. The cope of the parapet walls to be 16 inches broad, and 9 inches thick at the centre, and weathered off $2\frac{1}{2}$ inches on each side; no stone to be less than 18 inches, and to be connected to each other by cast iron dowels, 6 inches long, and $1\frac{1}{2}$ inches square, run with cement.

The cope of the pillars, at the extremity of the parapet walls, to be 1 foot thick, dressed, and weathered off, as described for the cope of the parapets, and firmly bolted to the masonry below.

The other parts of the building, not here described, to consist of substantial Rubble masonry; and all the stones to be laid on their natural bed, and all well packed, primed, and pointed.

The back of the Abutments, and space behind the wing walls, to be made up with hard dry materials, in courses not more than $1\frac{1}{2}$ feet thick, and beat up hard, and firmly placed behind the walls.

When the Masonry is completed, and finally approved of by the Engineer, then the approaches and roadway are to be made up by the Contractor, and the roadway is to be covered with broken stones to the breadth of 12 feet, and 1 foot thick.

The Contractor must be particular as to making up the Mortar fresh before it is used; it is to be composed of good lime, and mixed with sharp river sand, in the proportion of 1 of Lime to 2 of Sand. The lime to be well burned and slacked, and the whole well wrought, and thoroughly mixed with the sand, and used whilst fresh.

The Contractor is to make and maintain a Temporary, Road, for the accommodation of the public, while the bridge is erecting; he is to fence off the same, and do every thing else that the Inspector may deem necessary for the safety of the public.

As it is uncertain whether this Bridge will be required or not, or the parish road changed, the Contractor is to specify the sum for which he will build it separately.

No. 2. Occupation Bridge.

(Vide Plate No. 66.)

The Contractor is also to excavate the foundations, and build an Occuption Bridge over the Railway, in the lands of Longrigend, at the point marked E in the plan and section. The Bridge is for the accommodation of the occupier of the land, and is to be built according to the Plan

No. 2, the Abutments and Wing Walls according to the specification for the Bridge, No. 1.

Timber Beams are to be thrown across the piers, instead of a stone arch, as shewn in the plan and sections. These Beams are to be of Memel timber, 1 foot square, and trussed with 2 inch round iron, resting in three Saddles, as shewn in the plan. The Beams are to rest on a sleeper of Memel, 6 inches by 12, and are to be bound and connected by an iron Rod, and the upper surface sheeted with planking of the best description, 3 inches thick, firmly spiked to the main beams, and the roadway protected by two iron hand rails, as shewn in the plan.

No. 3.—An Arch is to be built under the embankment, at the point marked F in the plan and section, for farm occupation. This Arch is to be built according to the Plan No. 3, which accompanies this specification. The ground is to be Excavated to a sufficient depth to secure a good and solid base for the masonry. The whole of the walls are to be founded with stones, not less than 2 feet broad, 4 feet long, nor less than 10 inches thick, and dressed to a parallel upper and under bed; hammer dressed in the joints, and carried up in this manner to 1 foot above the level surface of the ground.

The Abutments, arch, and wing walls, shall be of coursed work, and of the same thickness throughout. No course in the abutments, or wing walls, to be less than 10 inches thick, and no stone to be less than 15 inches broad on the bed; no stretcher to be less than 2 feet long, and no header less than 3 feet long, and laid header and stretcher alternately. No arch stone to be less than 1 foot 9 inches long, nor 2 feet deep at the spring, but may be diminished gradually to 1 foot 9 inches at the crown, and no course to be less than 9 inches thick. The soffit of the arch is to be neatly dressed to the curve, with a chisel draft round each joint, and neatly picked between, and all the joints to be dressed full and fair. The quoins of abutments to be returned with stones, not less than 18 inches broad, and 3 feet long, alternately, and those with the ring pin to be droved work.

The Wing Walls are to be coped with stones, set on edge, 1 foot deep, and 1 foot 9 inches broad, with a 3 inch projection; to have a chisel draft on each joint, and left rough in the centre.

All the work in this Bridge, or Arch, not particularly specified, is to consist of the best and most substantial rubble masonry, and the large flat bedded stones laid so as to require little packing. The mortar used to be similar to that already described, and the whole to be executed in a substantial and workmanlike manner. The whole of the arch is to be covered with a layer of well wrought clay Puddle, not less than 18 inches thick.

In putting in the embankment near the arches, and other masonry, care must be taken to lay the stuff in regular courses, not exceeding 2 feet thick; which is to be pounded well up to the masonry, and beat into a solid, firm mass, for a distance of 15 feet at least from the face of the work.

No. 4.—An Occupation Bridge is to be built in the lands of Binney Hill, at the point marked G in the plan and section, in 30 feet cutting, according to the plan marked No. 4, and the specification for the bridge, No. 2, of the same description—that is, Stone abutments, and wing walls, and Timber roadway.

No. 5.—A Bridge for the parish road to Slamannan, by Binney Hill, at the point marked H, in 21 feet embanking, according to the Plan No 5, and agreeable to the specification for the bridge, No. 1, already described.

A 9 feet Arch is to be built over Collagh Burn, at the point marked I on the section, according to the Plan No. 6, on the occupation road to Binney Hill, the property of Mr. Waddell, and conformable to the specification of the arch over the said burn, in 35 feet embankment, as hereafter described.

The accommodation Road to Binney Hill is to be raised, as shewn in the ground section at I, so as to pass over the arch. It is to be 12 feet wide, and to be covered with 6 inches thick of stone from Collagh Burn quarry, properly broken, and laid on at such times, and in such quantities, as may be pointed out by the Inspectors.

A Fence is to erected on each side; it is to be of dry stone, or post and rails, as may be most agreeable to Mr. Waddell. A Retaining Wall may be found necessary on the East side of this road; if so, the dimensions and price is to be fixed by the Inspector, and the amount allowed in addition to the Contractor.

In case the Company should deem it advisable to deviate or alter any of these plans of Bridges, and build others of a different description, or omit them altogether, then the Contractor is to be furnished with another plan and specification, to enable him to make a tender for such work: or the Company may have the power of letting these bridges to other Contractors, should they think proper to do so; in which case, the estimated sum for these Bridges is to be deducted from the amount of the general estimate, a detail of which is to be annexed to the Contract.

ARCHES, OR CULVERTS.

Besides the bridges above specified, a Culvert, 4 feet wide, is to be built in the lands of Lodge, under a 17 feet embankment, according to the figures 4, 5, and 6, on the Plan No. 7.

The masonry in the Abutments and Wings to be of sound Rubble, the stones to be laid on their natural beds, and all well packed, primed, and pointed; the masonry of the Arch to be of dressed stone, neatly jointed and dressed, and finished in a workmanlike and substantial manner. The back of the abutments, and space behind the wing walls, to be made up with hard dry materials, in courses not more than 18 inches thick, beat up hard, and firmly placed behind the walls. The bottom of the Culverts to be paved with hard stone, firmly laid, and packed with stone chips, and the ends secured by a row of large stones.

A Second Culvert of the same width is to be built in the same lands, according to the figures 1, 2, and 3, in Plate No. 7, and of the same description of masonry as already described for the first culvert.

An Arch, 9 feet span, is to be built over the Callagh Burn, under a 35 feet embankment, according to the figures 1, 2, and 3, on Plan No. 8. The ground is to be opened for the Foundation in the direction of the stream; it is to be sunk 6 feet below the ground line, or as much more as may be necessary to secure a sure and firm bottom. The foundations of the Abutments and Wings to be of sound rubble masonry; feet thick at the base, to have an off of at height, and 9 feet thick within feet of the ground line. The Abutments to be of sound rubble, hammer dressed on the face, and no course to be less than 8 inches thick, and to be of the same thickness throughout. None of the arch stones to be less than 18 inches long, nor less than 12 inches deep, and their beds neatly dressed to radiate to the arch. The Arch to be 9 feet span, to rise 3 feet, and to spring feet above the ground line. The to be hard sound stone, 9 inches deep, laid dry, and firmly packed. The Wing Walls to be feet long, to be founded as low as the abutments, if found necessary, and to be built of sound stone masonry, feet thick, and at the ground line. The Spandril and Wing Walls, from the level of the ground line, to be thick, the counterforts to rise to the level of the springing. The parapet and wing walls to be coped with stone, similar to the bridges already described.

BREAST WALL.

A breast or Retaining Wall is to be built along the bottom of the slope, in front of Binney Hill Lodge, to prevent the slopes from being injured by a run of water in Collagh Burn in the times of flood. It is to be 2 feet 6 at bottom, 14 inches at top, 4 feet high, and 300 feet long, or more if required; the running yard should therefore be stated.

An Arch is to be built over the Cross Burn, in a 14 feet embankment, extending under the road to Slamannan by Pirney Lodge. It is to be 7 feet span, to be built according to the 4, 5, 6, in Plan No. 8, and agreeable to the specification of the 9 feet arch, already described, for the Collagh Burn; and a new water course is to be built, as shewn on the plan of the Railway at X Y.

CROSSING OF PARISH AND OCCUPATION ROADS,

Not already described as requiring Bridges.

The parish Road by Lodge to Slamannan is to be raised 1 foot, by earth and rubble pitching, laid by hand; the surface of which, to the depth of 4 inches, is to be covered with broken whinstone, 18 feet wide, neatly and evenly spread. The length to be 20 yards on each side of the Railway.

The parish Road to Slamannan at Blaquharson is to be raised 1 foot 2 inches, by a rubble pavement, placed on 6 inches of earth filling; and the pavement is to be covered with broken whinstone, 4 inches thick, neatly spread and formed. The width to be 18 feet and the length 20 feet on each side of the rail.

Where the Railway crosses the road to Slamannan by Pinney Lodge, this road is to be raised 9 feet 9 inches, as shewn on the general section at G, and carried on the level over the Railway. When the filling is completed, the surface of the road is to be carried up with 6 inches of properly broken whinstone, formed to a proper curve, and cross section, 18 feet wide.

A post and rail Fence is to be constructed on each side of the roadway, similar to that described for the Railway; only that there is to be a double row of posts and rails, to protect the quicks from cattle.

GENERAL OBSERVATIONS.

All the Stones required for the blocks, stone dykes, and bridges, shall be provided by the Contractor; which stones shall be taken from Craig Mochan quarry, Arden quarry, Avon Bridge quarry, upon payment of per fall, or from any other quarry that may be approved of by the Engineer or Inspector.

As it is of the greatest consequence that the Blocks should be provided and dressed in the quarry as early as possible, so as to be examined by the Resident Engineer from time to time, previous to their being carried to the

work, by which means he has time to examine and reject those that are defective in size or quality, the Contractor is to bind himself to furnish every month, or forfeit a sum of £10. for any such omission.

The Stones required for the Ballasting, boxing, drains, and dwarf walls, may be got from Arden, or any more convenient quarry, that may be discovered near the work, upon payment of per cube yard.

The contractor is to furnish and provide all Materials, Centering for the bridges, arches, and culverts, with Waggons, tools, barrows, and implements of every kind and description necessary for the proper execution of the work, with the exception of the rails and chairs as above mentioned.

The work shall be proceeded with so soon as the Contract (to follow hereupon) is subscribed to by the parties. The whole work herein specified shall be completed and perfectly finished before the 1st of

Until the Work be finally approved of by the Engineer, and taken off the hands of the Contractor, he shall maintain all the works, stone, masonry, and iron, and shall keep all the fields properly fenced through which the road passes, so far as his operations extend, and if by neglect of the Contractor, his workmen, or others, damage shall arise by cattle straying, or otherwise, the amount thereof shall be withheld by the Company from the amount of the Contract price for the work.

The Company is to pay all Temporary Damage on the line of road, in so far as the ground to be permanently occupied extends; but the Contractor shall be liable for damage done by himself or workmen by quarries, roads, or any other operation beyond the line of road.

The Company reserve power to make such alterations, or deductions from, or additions to the work, as they may think proper, without violating the Contract to follow hereupon: Provided such deviations or alterations be made in writing, signed by the Engineer and Clerk of the Company; allowance being made in either case for the same, as shall be fixed and determined between the parties by the Company's Engineer.

The whole work herein specified shall be done in a substantial, neat, and workmanlike manner, to the satisfaction of the Engineers to the Company.

In order to secure the proper laying and fittings of the Blocks and Sleepers, rails and chairs, for the Permanent Road, the Contractor shall be bound to appoint an experienced Foreman to conduct that part of the work, and one that shall be approved of by the Company's Resident Engineer.

Security will be required for the proper performance of the work, and the price will be paid by monthly instalments, as the work advances, and

as the Superintendent shall certify, deducting one-tenth from the amount of such certificate of the work actually executed, and measured in detail by the Superintendent. The Balance arising from these deductions to be paid the Contractor, on the certificate of the Engineer, every three months, or as often as he inspects the works.

The Contractor shall also be bound to maintain the Bridges, drains and other masonry executed by him, for the space of one year after the completion of the work.

Persons desirous to contract for the work are to state a lump sum for executing the whole work herein specified. The Engineer for the Company may however call for the detailed estimate of the Contractor approved of by the Company.

Should Stone be found in the cuttings, or along the line, fit for blocks or bridges, a corresponding deduction is to be made from the lump price mentioned for the same, as the Company's Engineer shall consider fair and reasonable between the parties.

The Company will not pledge themselves to accept the lowest offer for the work, unless the person so offering be otherwise approved of.

Sealed Proposals for the work, addressed to the Committee of Management, will be received at the office of Messrs. Mitchell, Graham, and Mitchell, 36 Miller Street, Glasgow.

(Signed)

JOHN MACNEILL.

London 3*d August*, 1836.

[All clauses referring to the Stone blocks and Stone bridges, centering, &c. were omitted, and the Contractor was not required to include the same in his estimate; also, the clauses relating to Security required, &c. were omitted.—*Editor*.]

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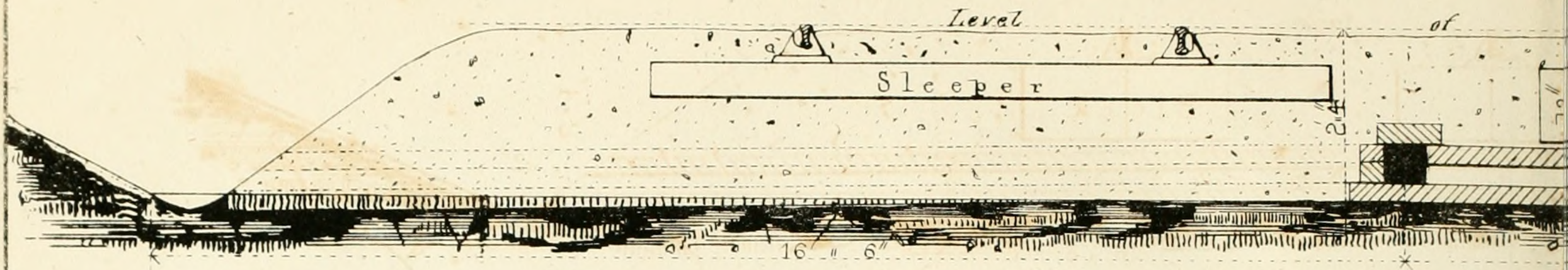
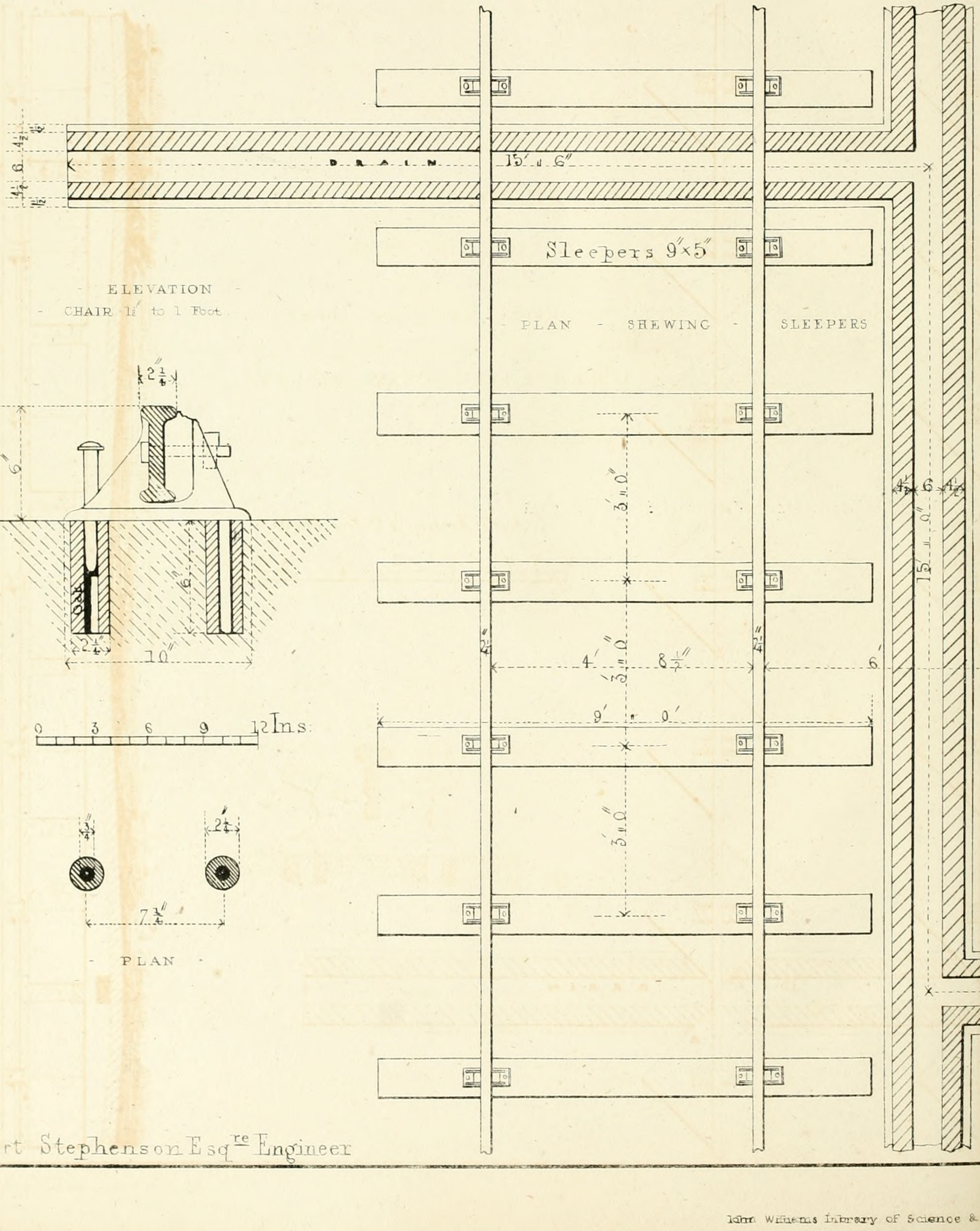
TRANSVERSE - SECTION





- ELEVATION -

- CHAIR 1½" to 1 Foot -

0 3 6 9 12 Ins.

- PLAN -

- PLAN - SHEWING - SLEEPERS & BLO

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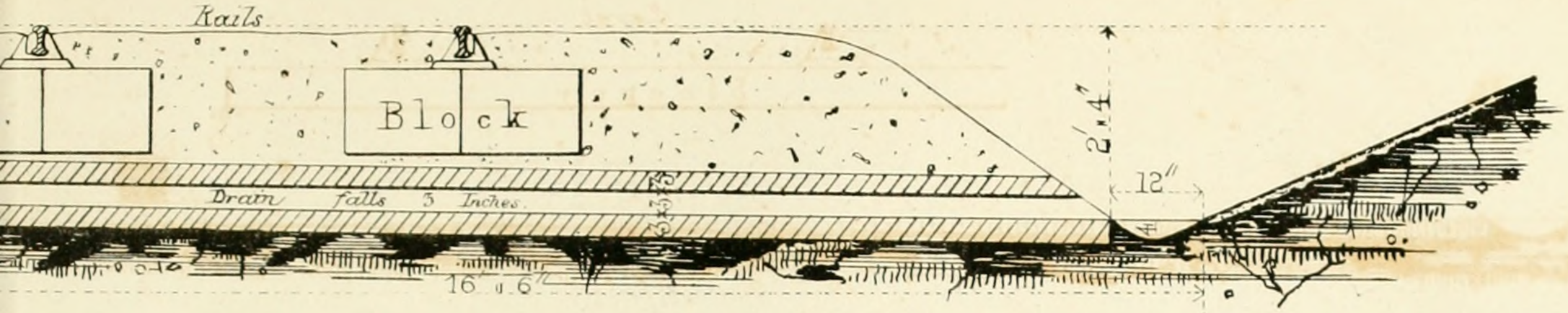
Plate 1

EXCAVATION

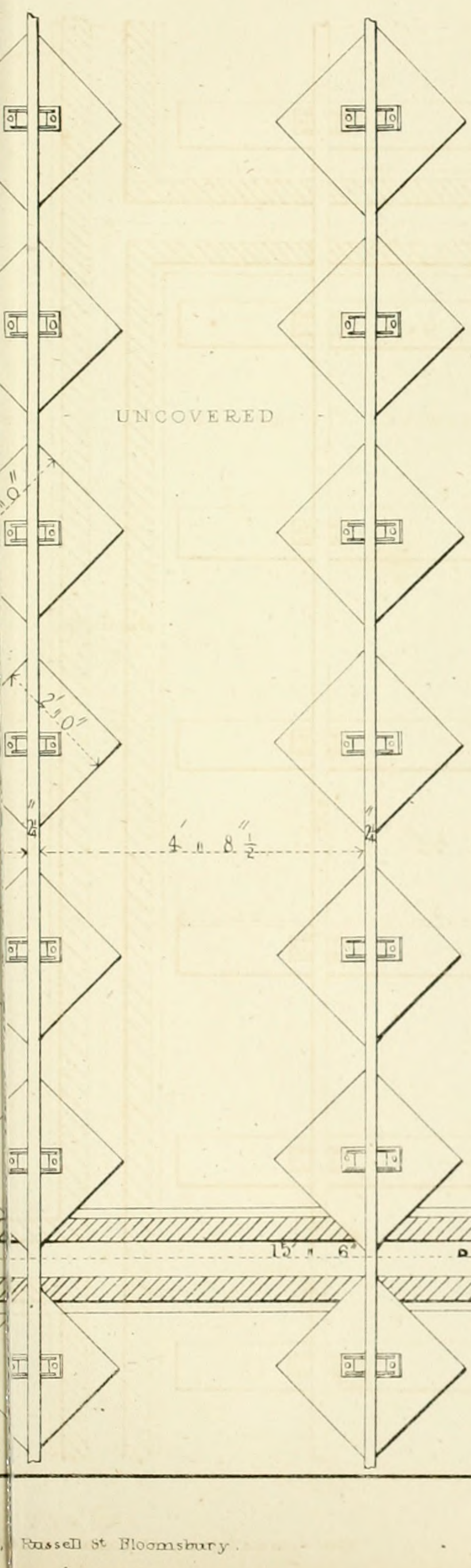


PERMANENT RAILS

AS LAID DOWN

UPON PART OF THE

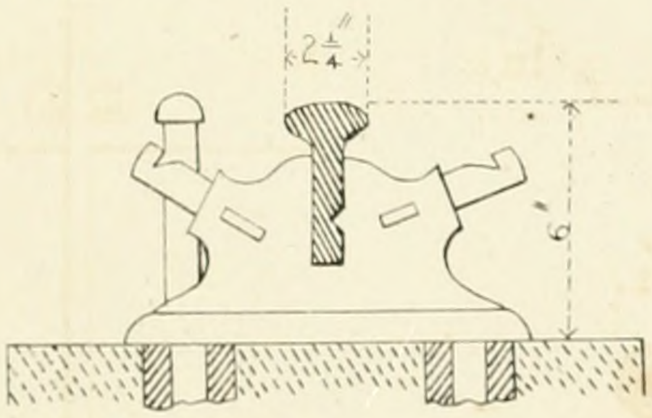
LONDON & BIRMINGHAM RAILWAY

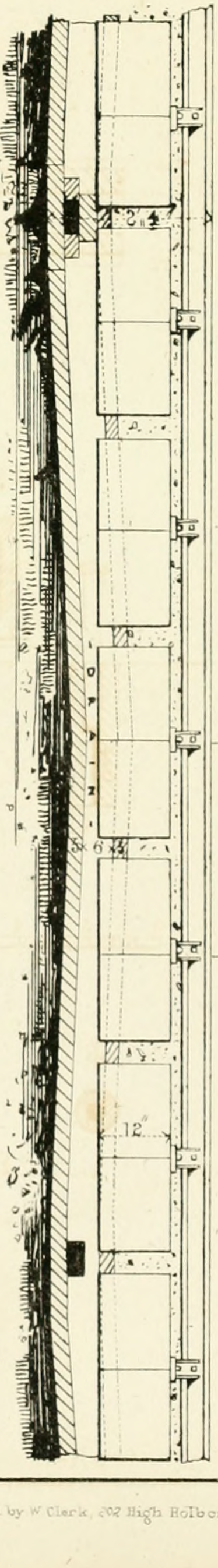


Scale being 3/8 in. to 1 Foot

12 6 0 1 2 3 4 5 Feet

ANOTHER CHAIR





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Russell St Bloomsbury.

- BRIDGE - FOR - WRIOTHESLEY - STREET - AS - EXECUTED - UP

Stone

Stone

Stone

N - THE - EXTENSION - L - & - B - RAILWAY -

Plate 11

Front

Iron Girder

Brickwork

25′ . . 0″

Level of Rails

ON -

Line of Bridge

- HALF - PLAN - SHEWING - FINISHED - SURFACE -

Granite Curb

York

From Roadway

Parapet Wall

Esq.- Engineer -

20 25 30 35 40 Feet

106 Gt Russell St Bloomsbury

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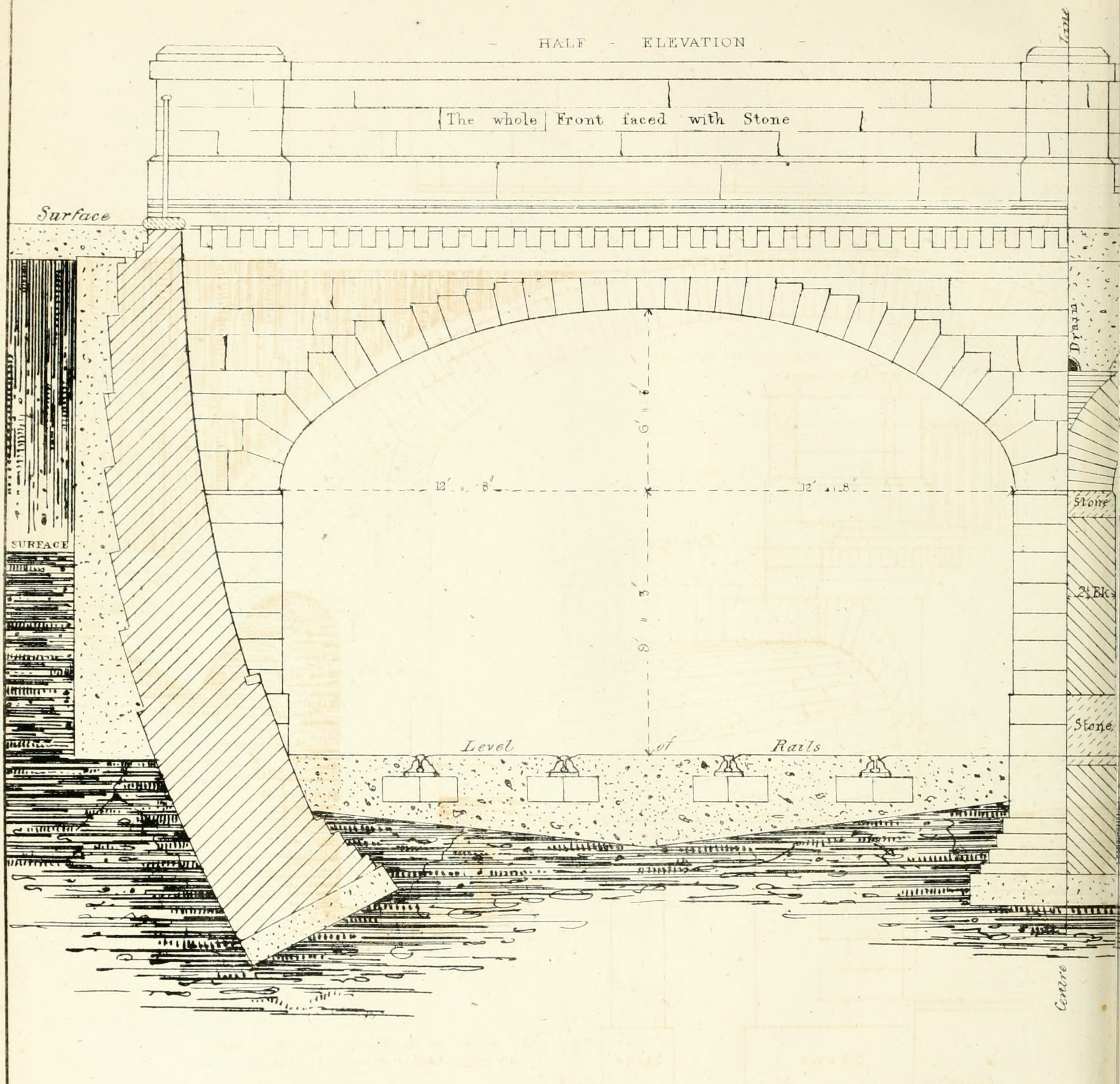
BRIDGE - FOR - INTENDED - STREET - ON - THE - DUKE - OF BEDFO

- HALF - ELEVATION -



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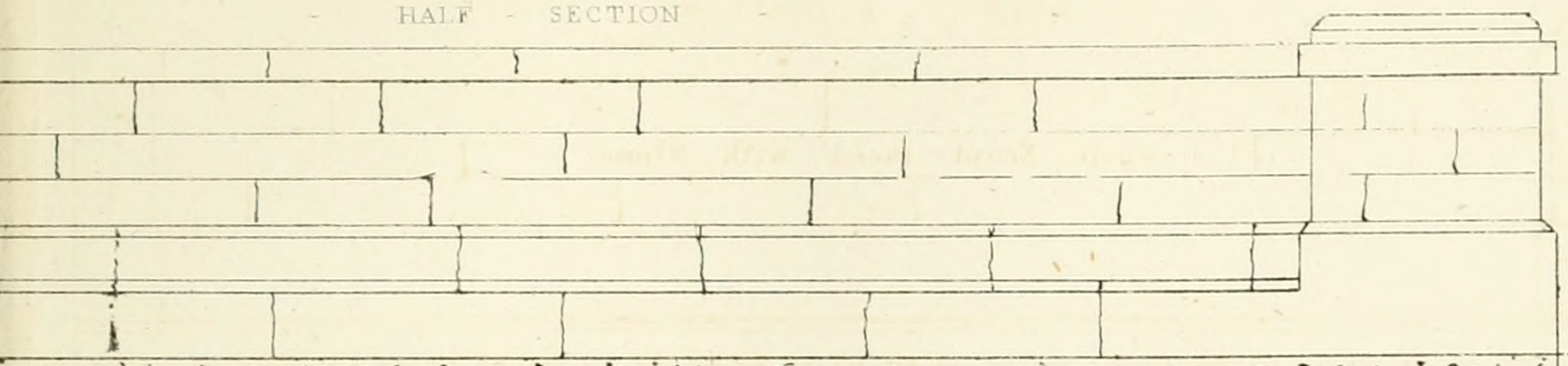
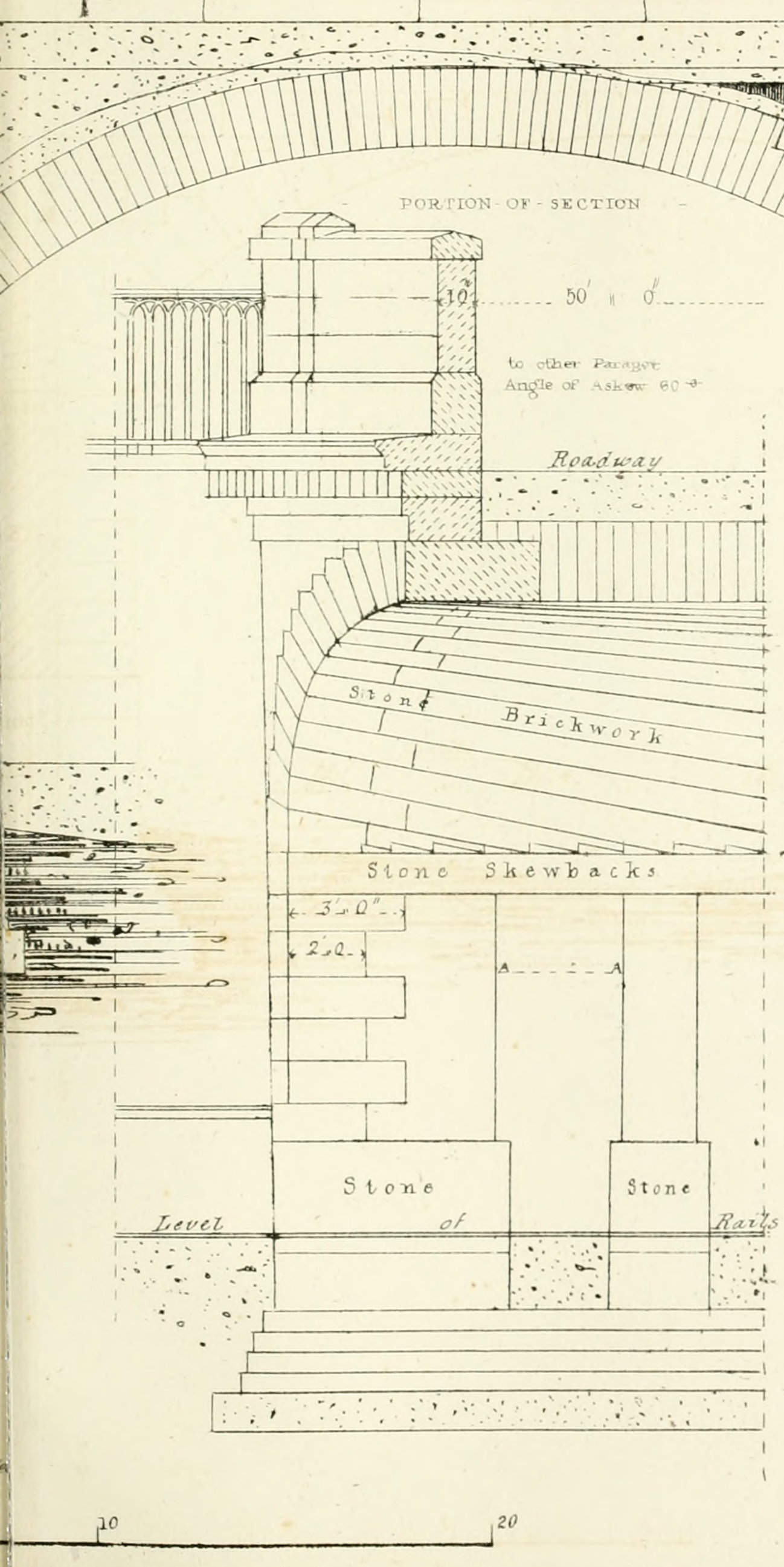
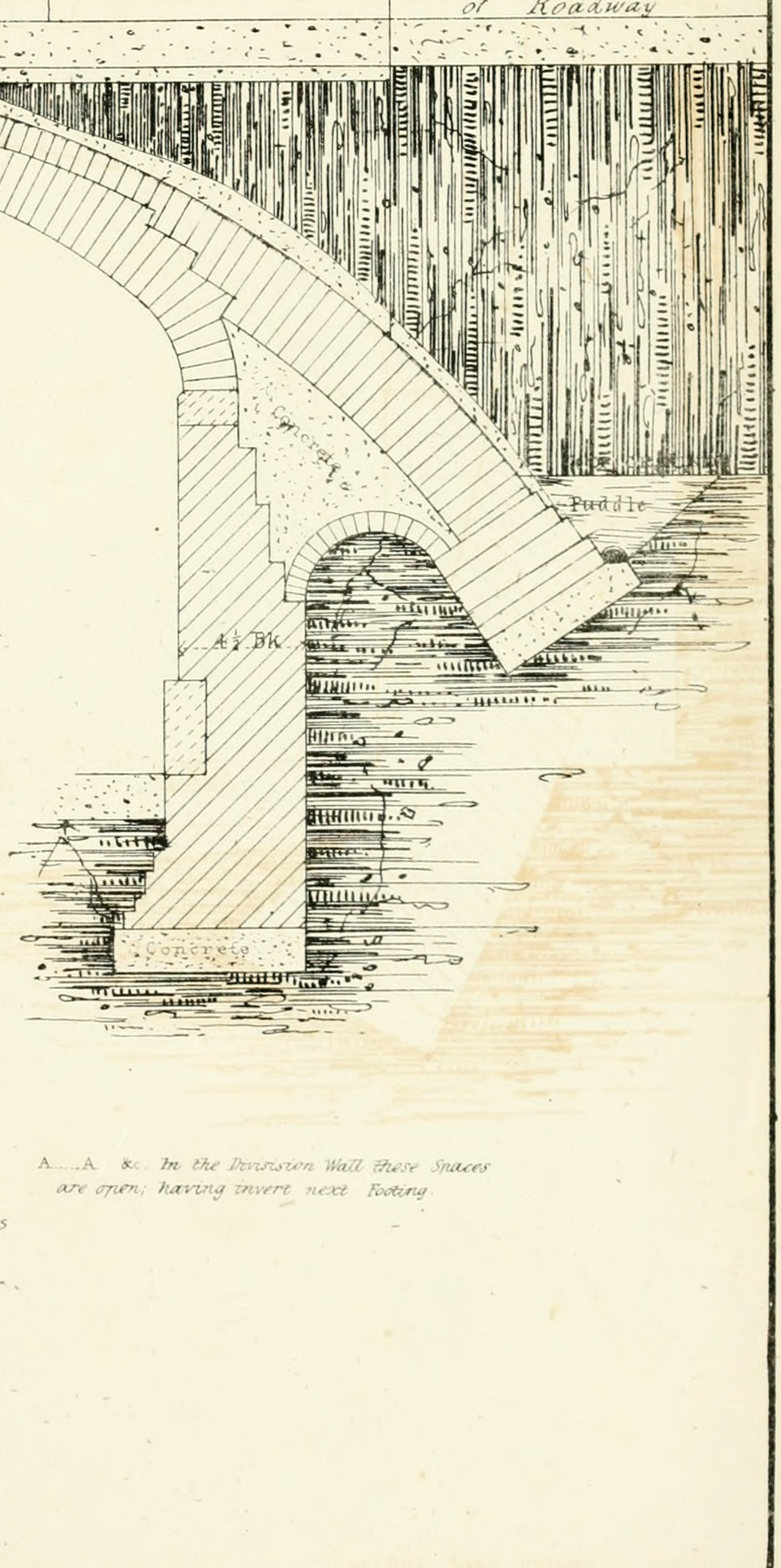
OS - ESTATE - UPON - THE - EXN - L - & - B - RAILWAY -

- HALF - SECTION -



- PORTION - OF - SECTION -





A.....A &c. In the Division Wall these Spaces are open; having invert next Footing.

Bloomsbury.

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BRIDGE - OVER - THE - HAMPSTEAD

S t

ELEVN - C

ELEVN - OF

- PLAN - OF - END -

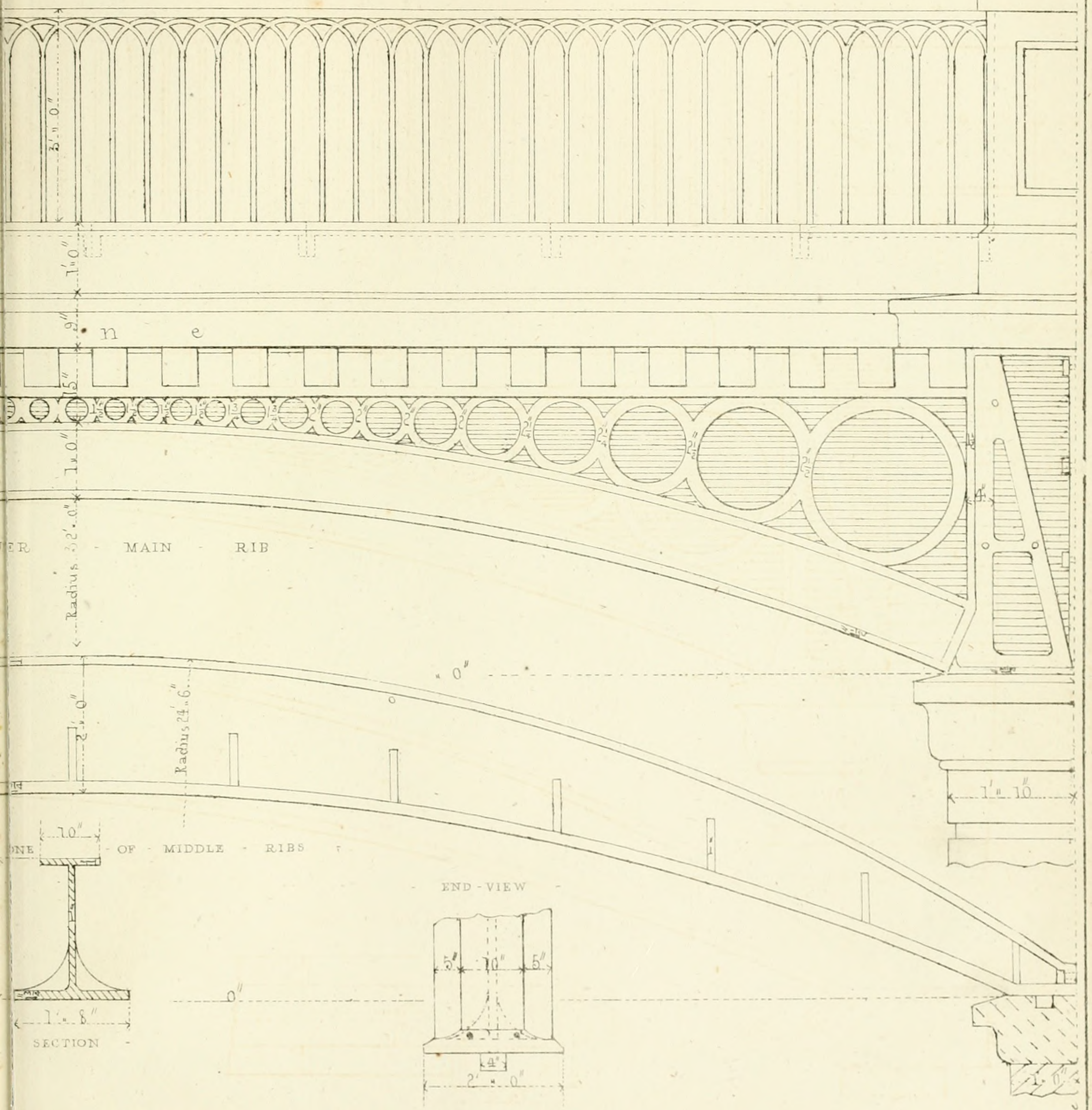
Robert Stephenson Esqre Engineer.

Scale

John Williams Library of Science & Art, N^ts

Plate IV

ROAD - EXTENSION - L - & - B - RAILWAY -



of Feet

0 5 10 15

06 Great Russell St Bloomsbury.

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BRIDGE FOR PARK STREET EXTENSIO

TRANSVERSE SECTION

THROH ABUTMENT

THROH CROWN OF ARCH

HALF

Surface of Roadway

Centre Line

Concrete

Stone

Line of Railway

Line

Centre Line

Scale of Feet

10 5 0 10 20

PLAN OF PARAPET

Rails

Rails

Stone Parapet

14" 14" 14" 14" 9"

Part of Iron Girder

Level of Rails

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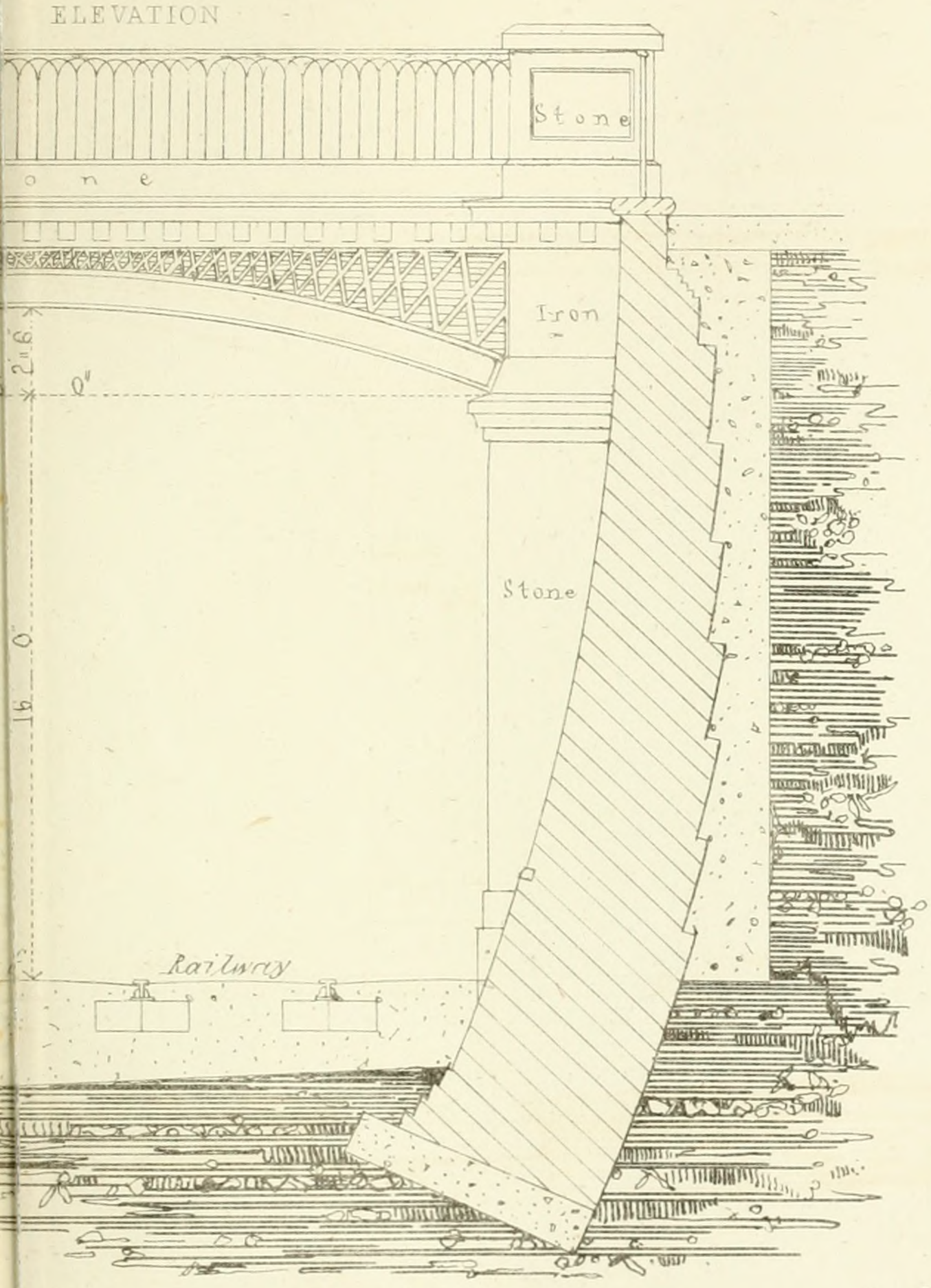
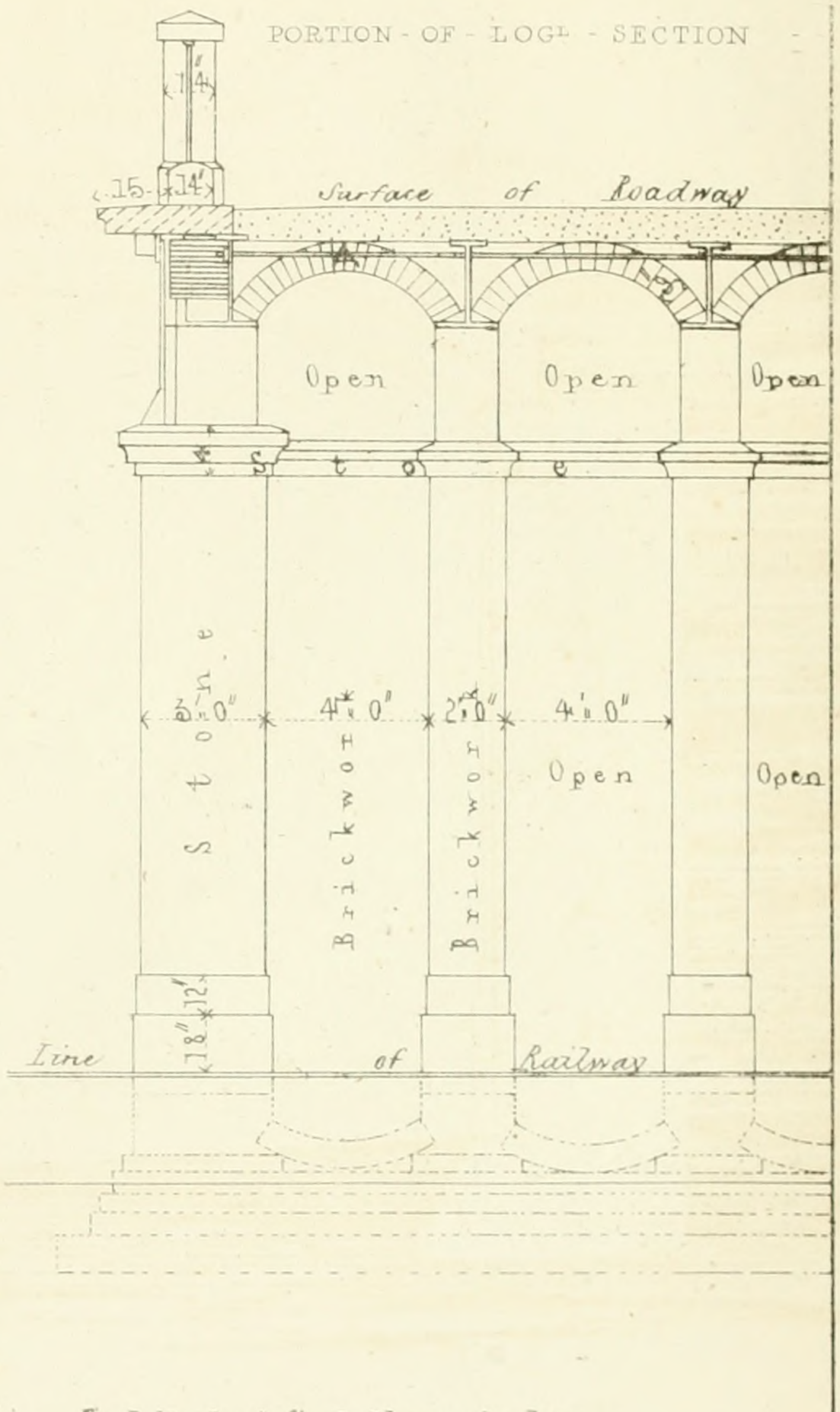
L & B RAILWAY

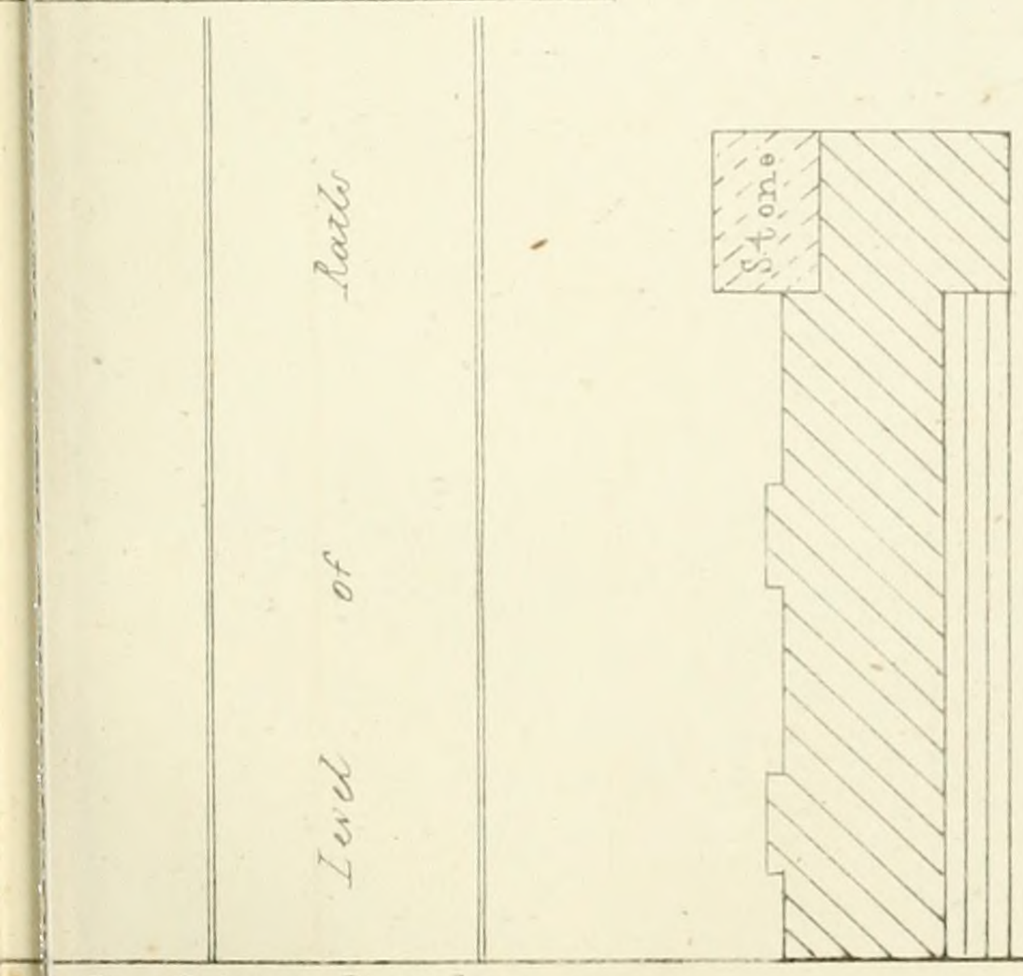
ELEVATION



PORTION OF LOG^L SECTION



A. Wrot" iron Tie Bolt thro" first three Arches



PLAN OF FOUNDATIONS

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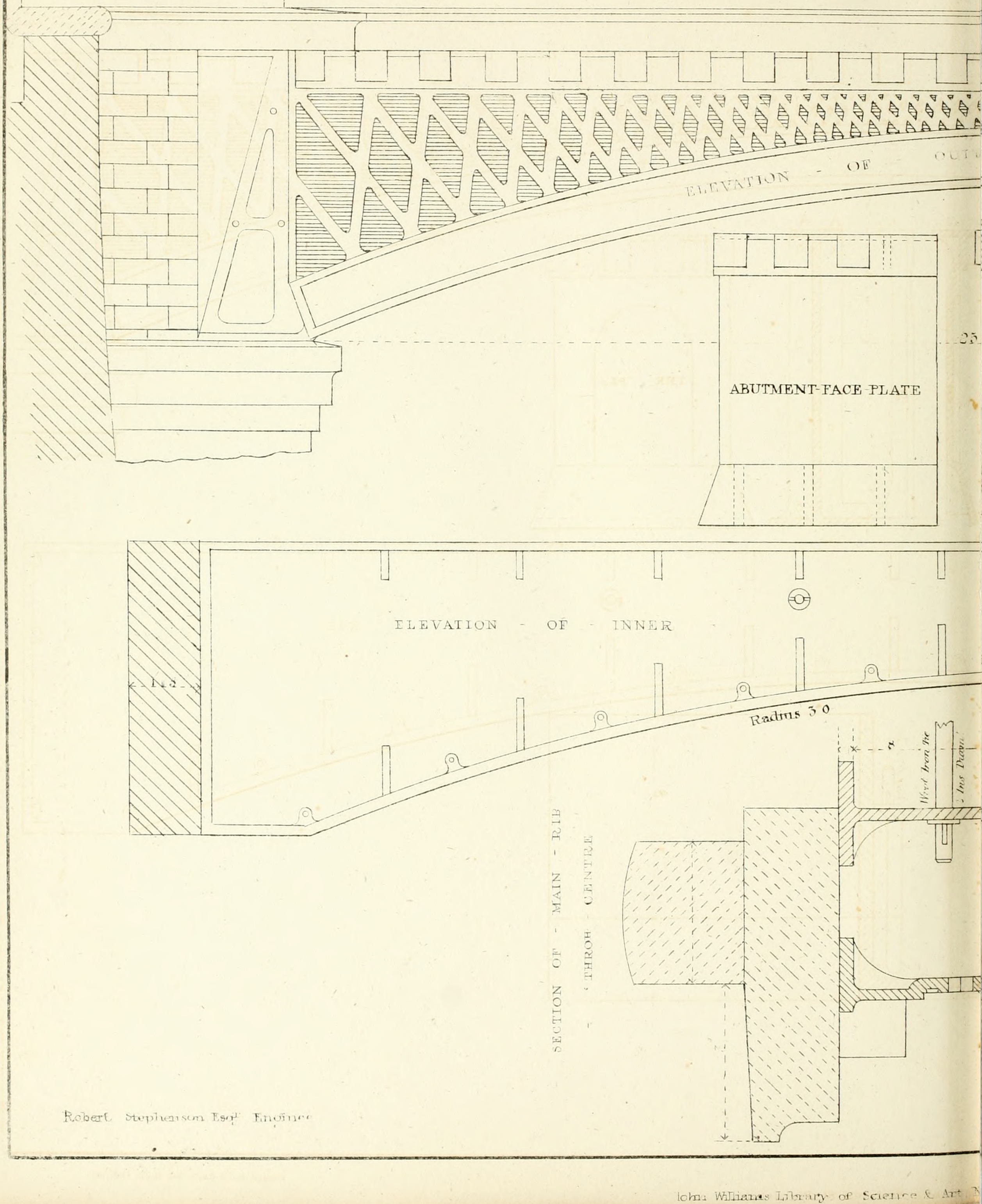
PARK - STREET - BRIDGE - UPON T



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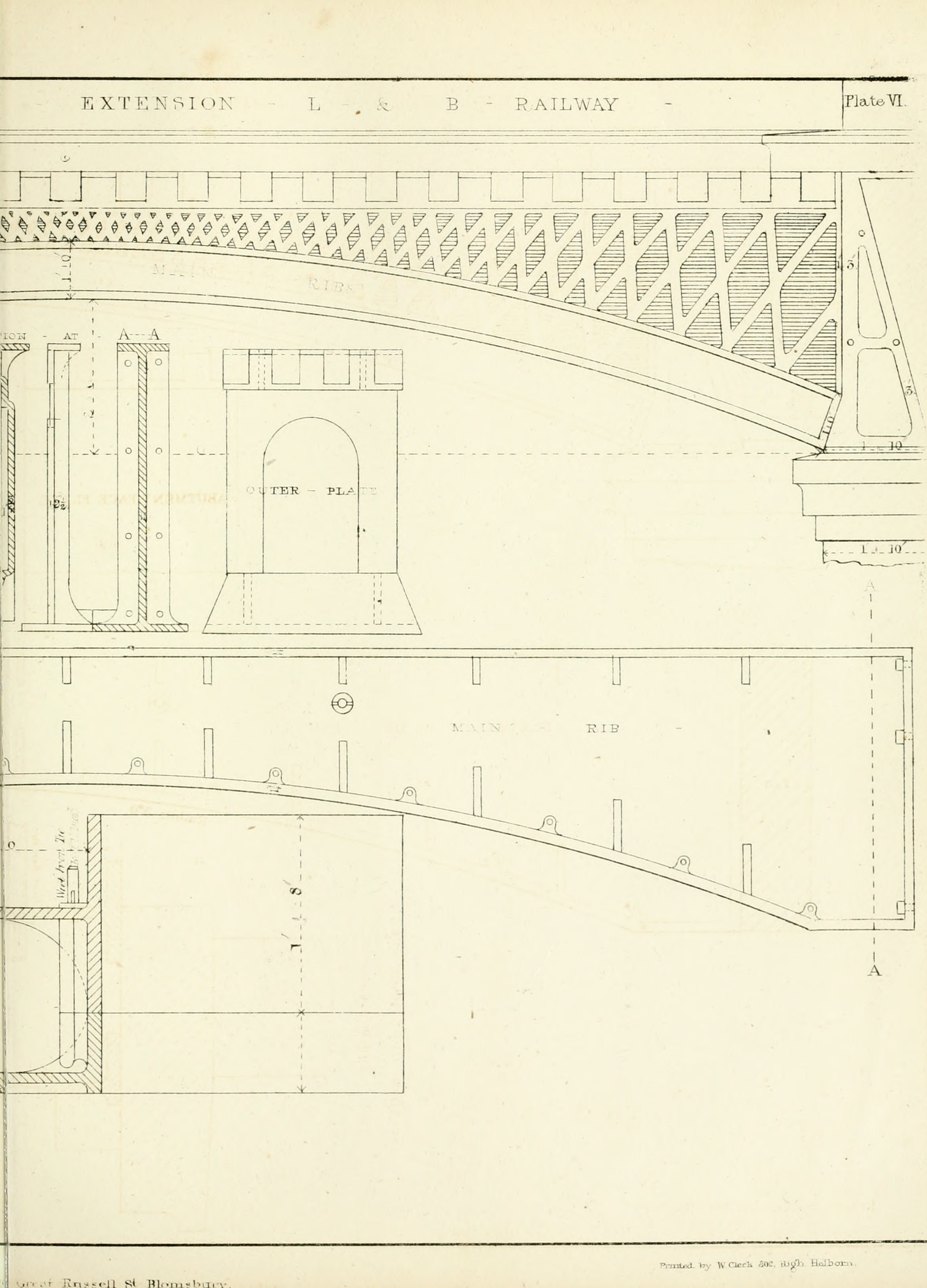
EXTENSION - L - & B - RAILWAY -

Plate VI.



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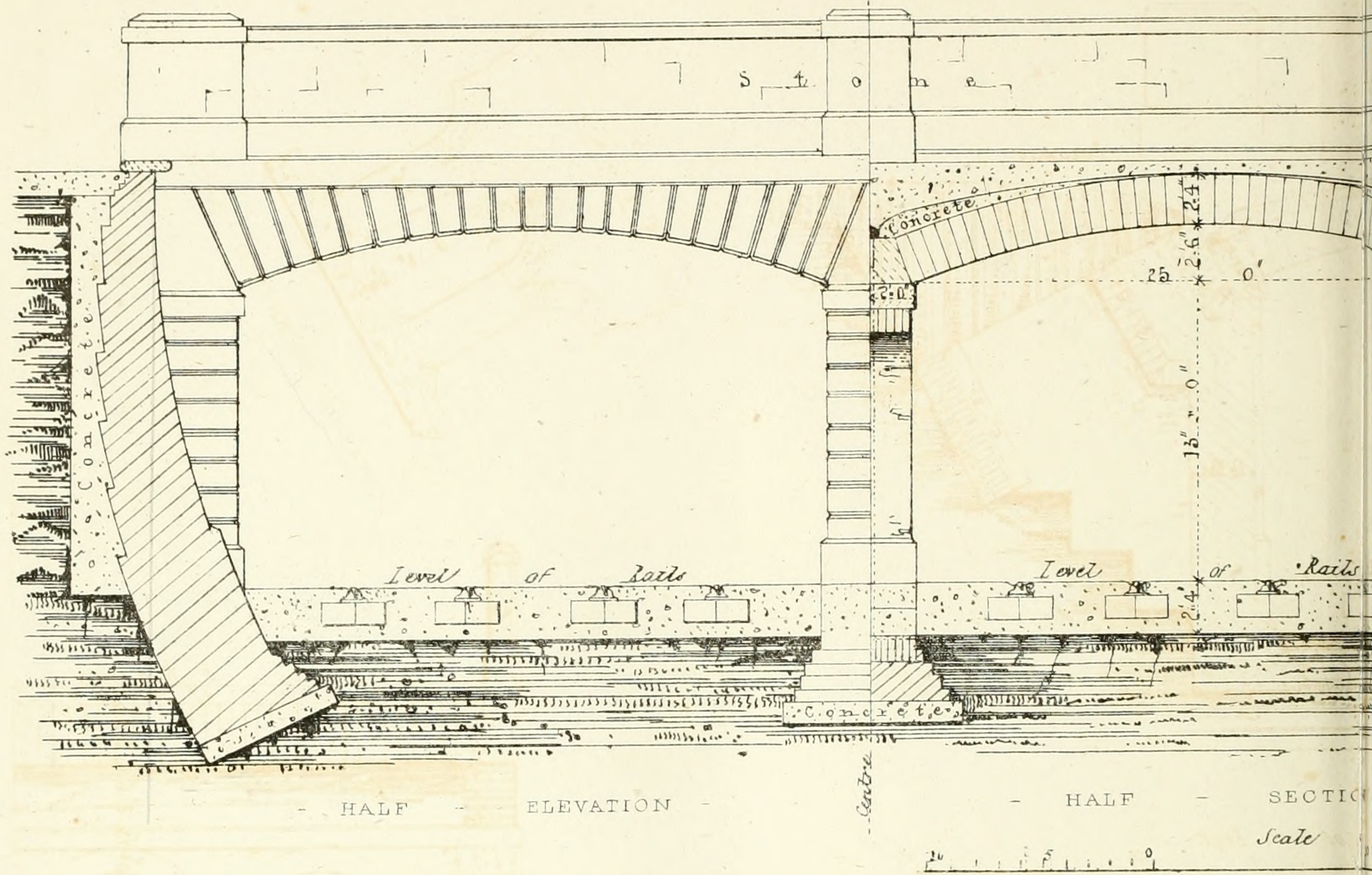
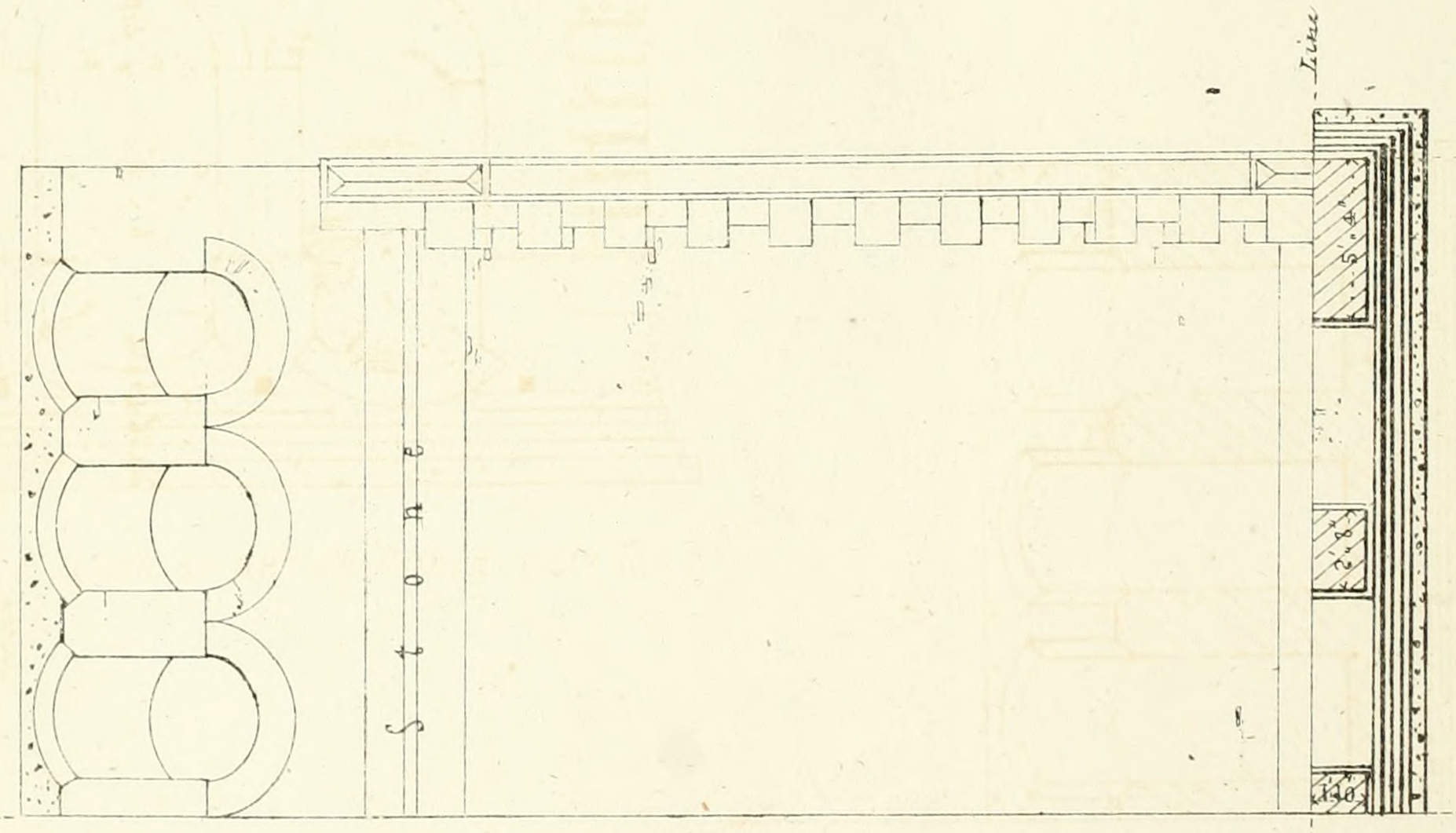
Great Russell St Bloomsbury.

- BRIDGE - FOR - STANHOPE STREET - - UPON - TH



- HALF - - ELEVATION - - HALF - SECTIO



QUARTER - PLAN - ABOVE - COPING - - QUARTER - PLAN - A

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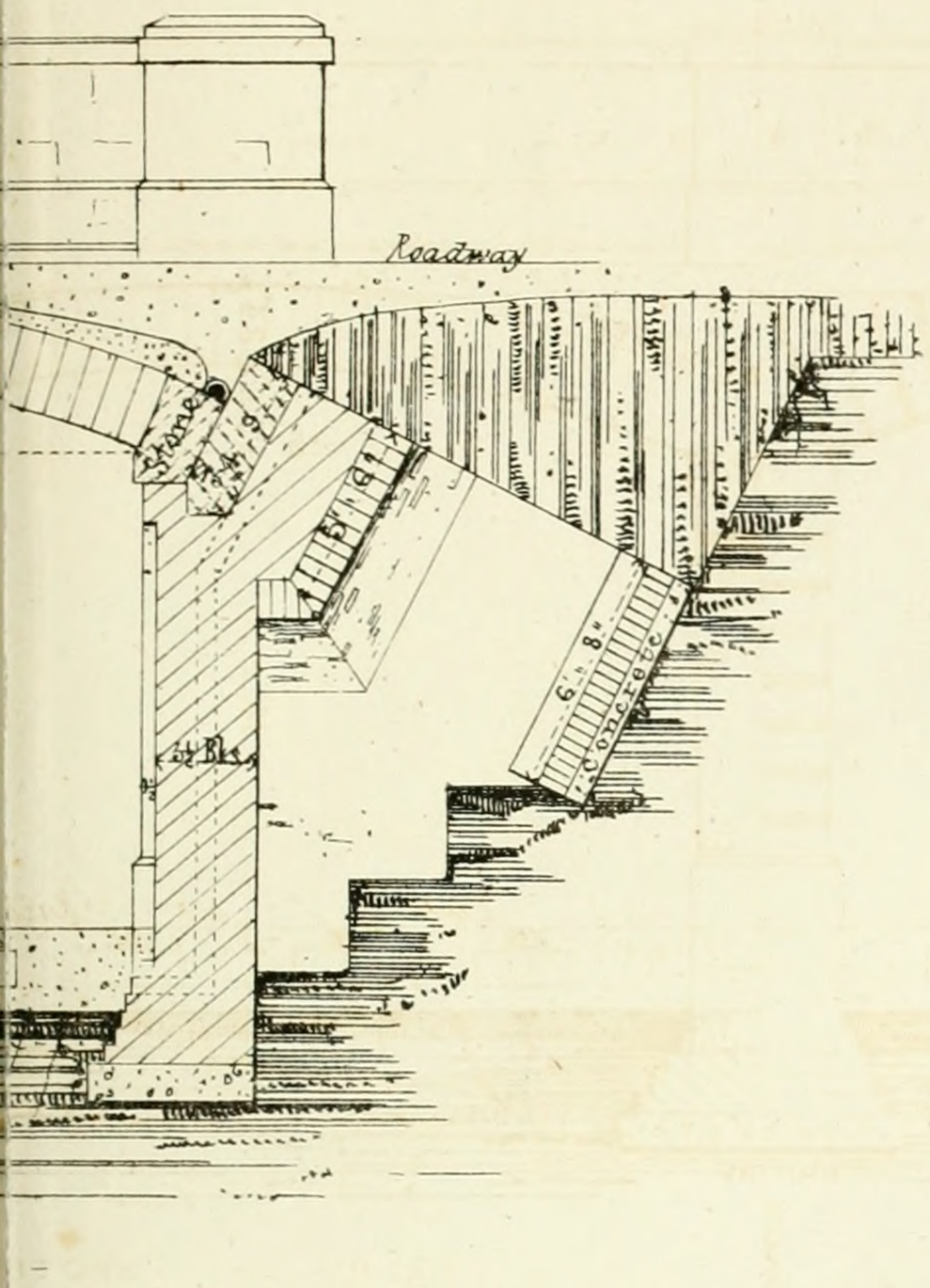
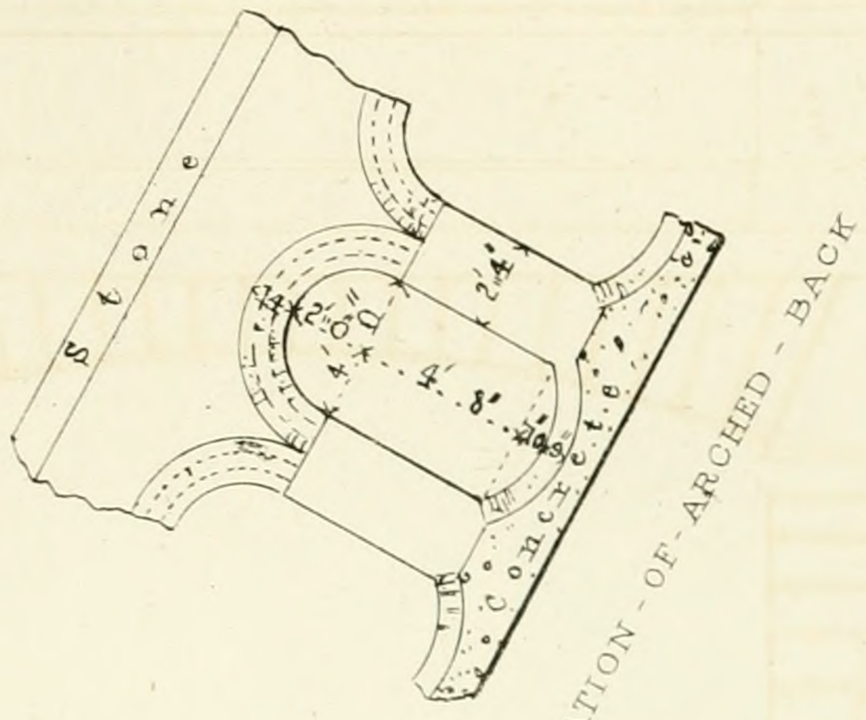
- EXTENSION - OF - THE - L - & - B - RAILWAY -

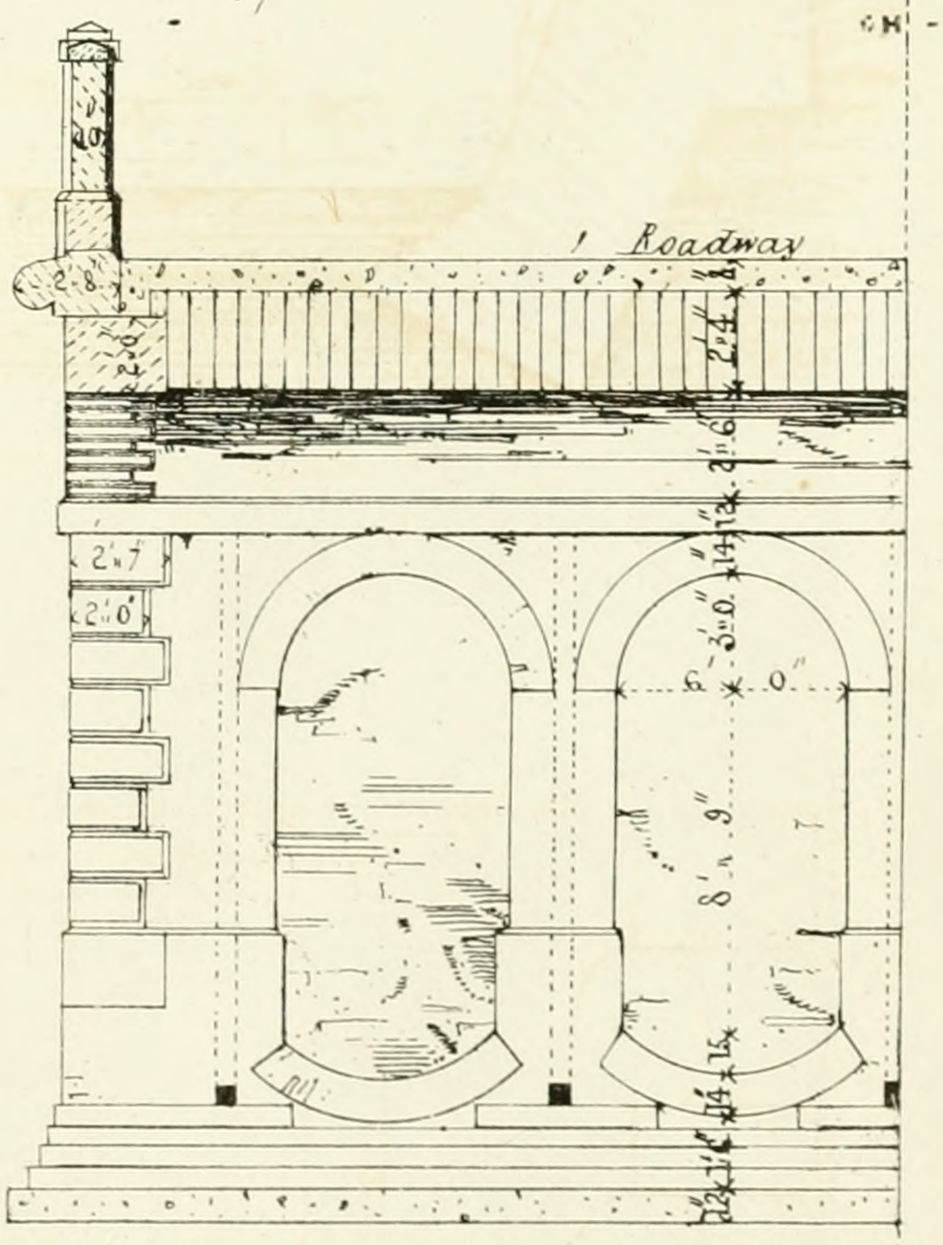


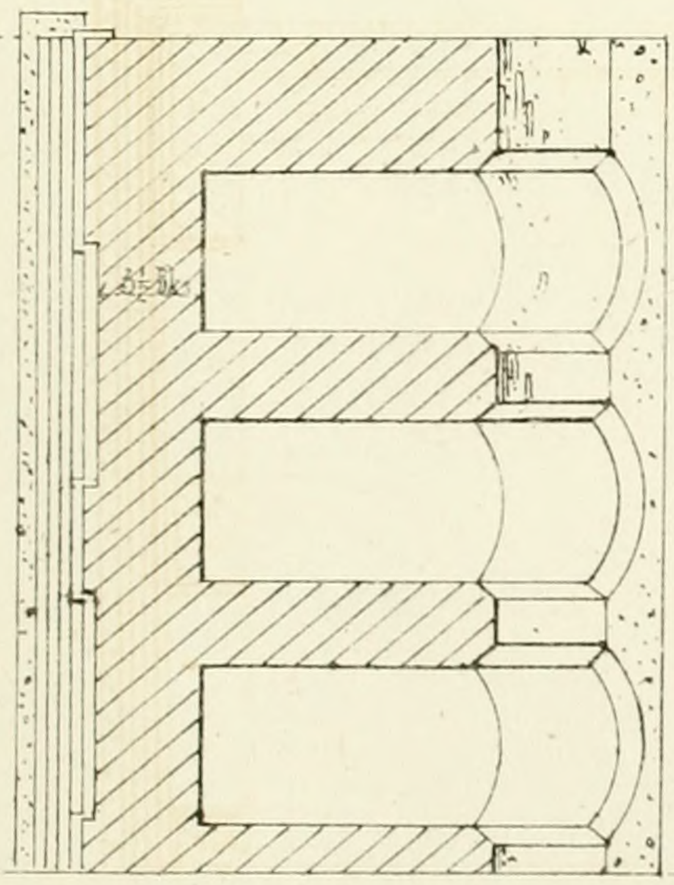


- ELEVATION - OF - ARCHED - BACK

of Feet.

20 30





- SECTION - THRO^H CENTRE - OF - ARCH -

- FOUNDATIONS -

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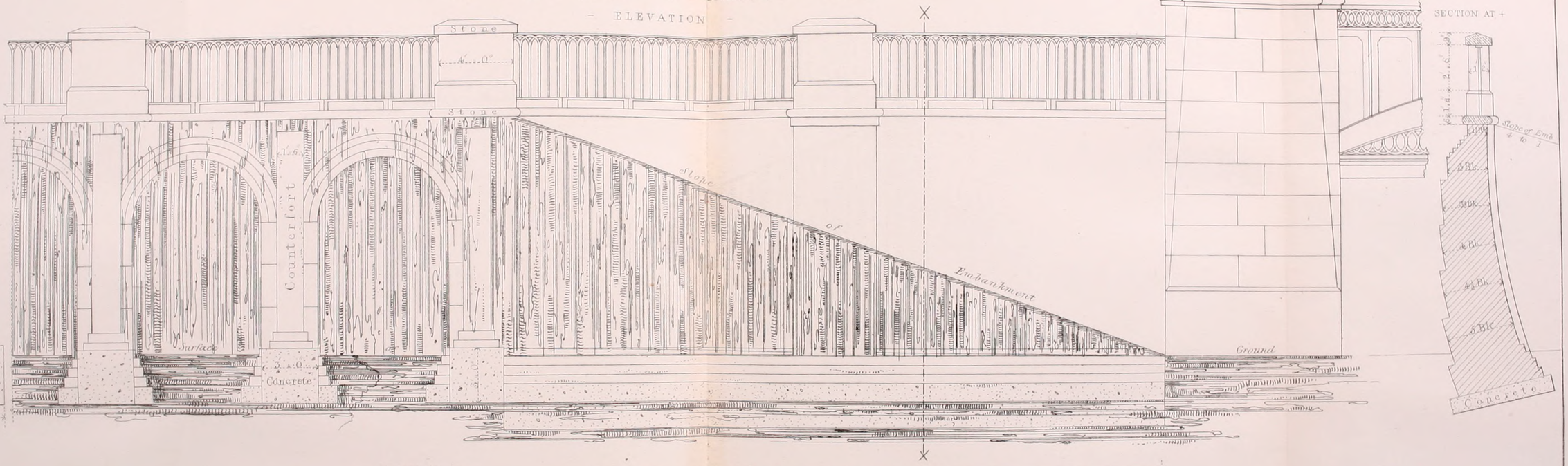
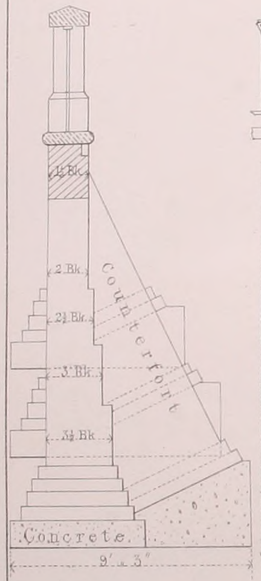
RETAINING WALL FROM PARK STREET TO THE REGENTS CANAL

UPON THE LONDON & BIRMINGHAM RAILWAY

ELEVATION

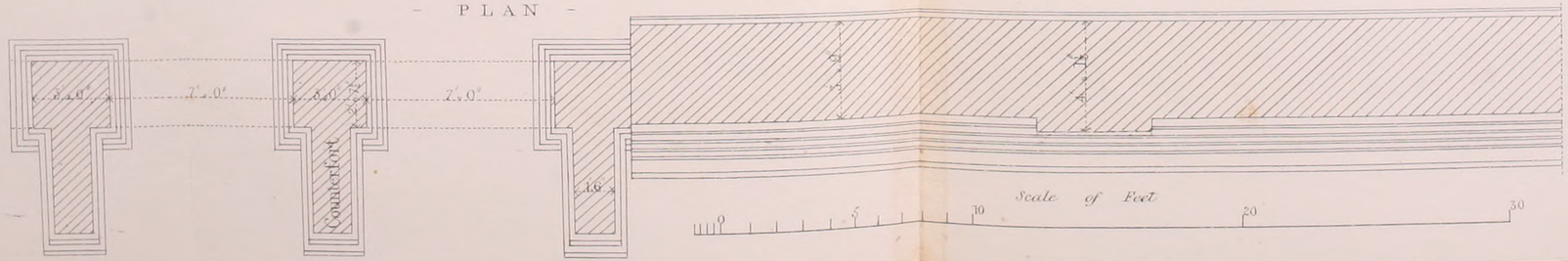


SECTION



SECTION AT +

PLAN



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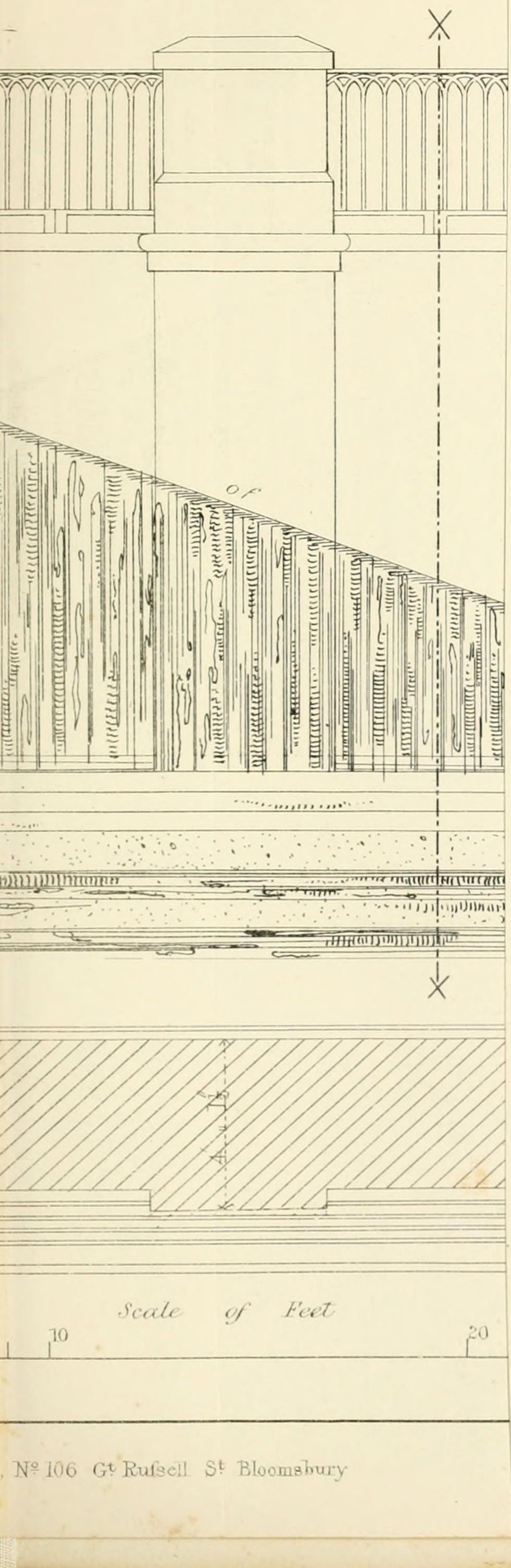
- TO - THE - REGENTS

MINGHAM - RAILWAY -



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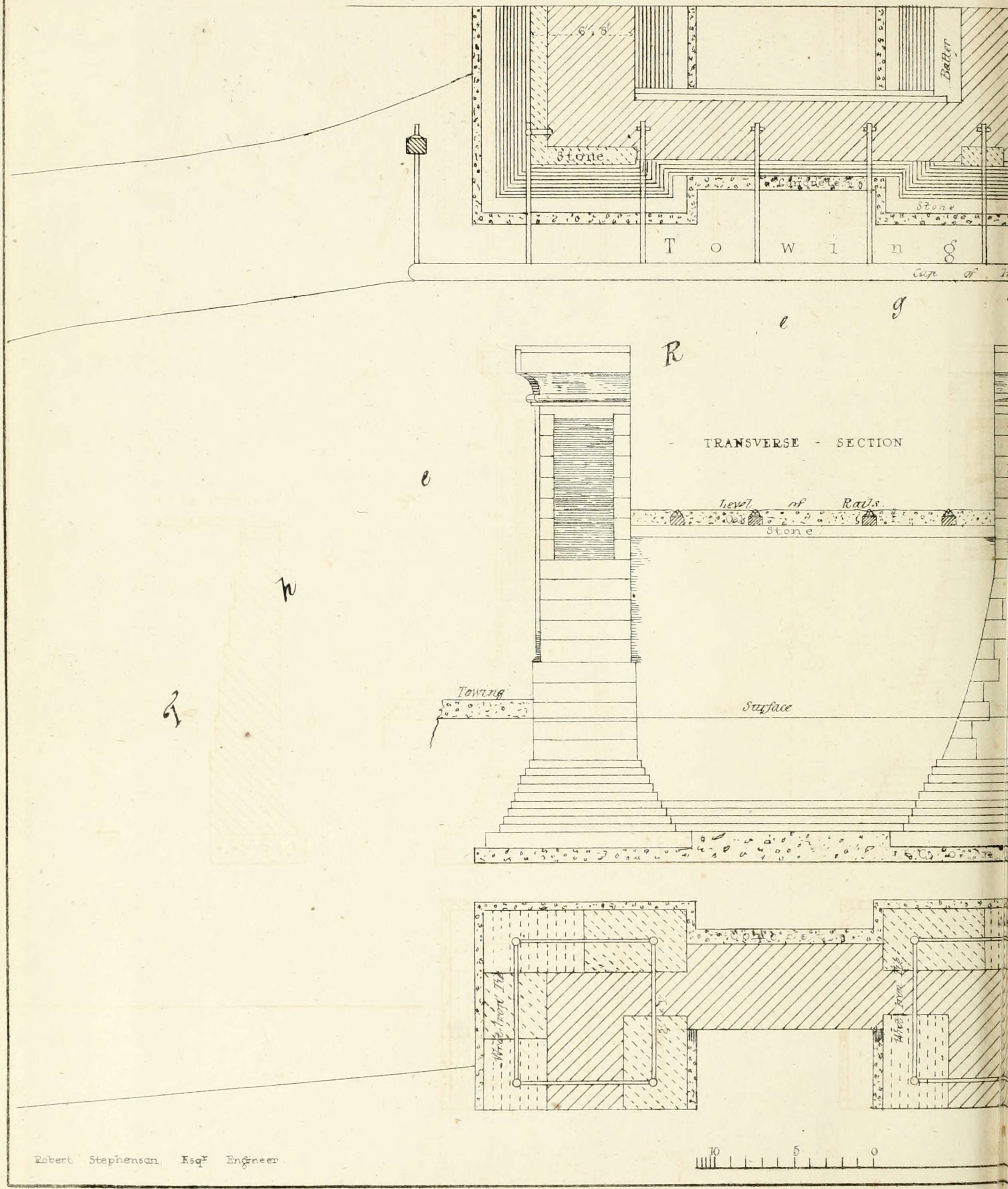
BRIDGE - OVER - THE - REGENTS - CANAL - NEAR



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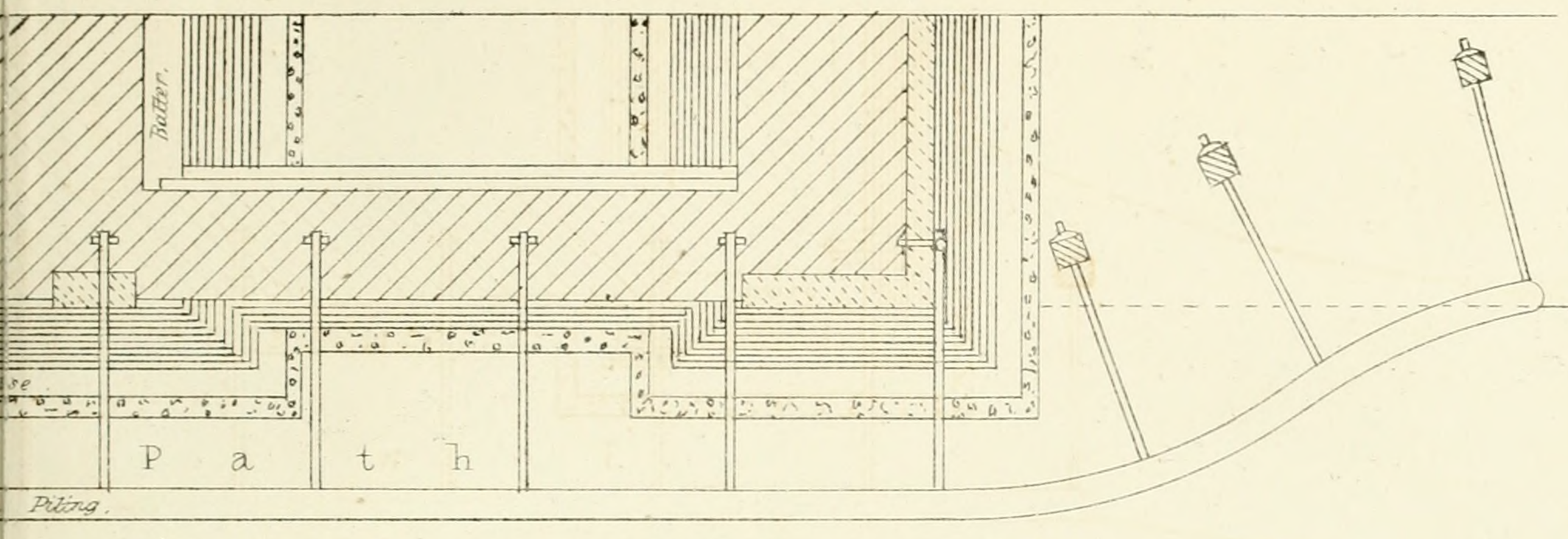
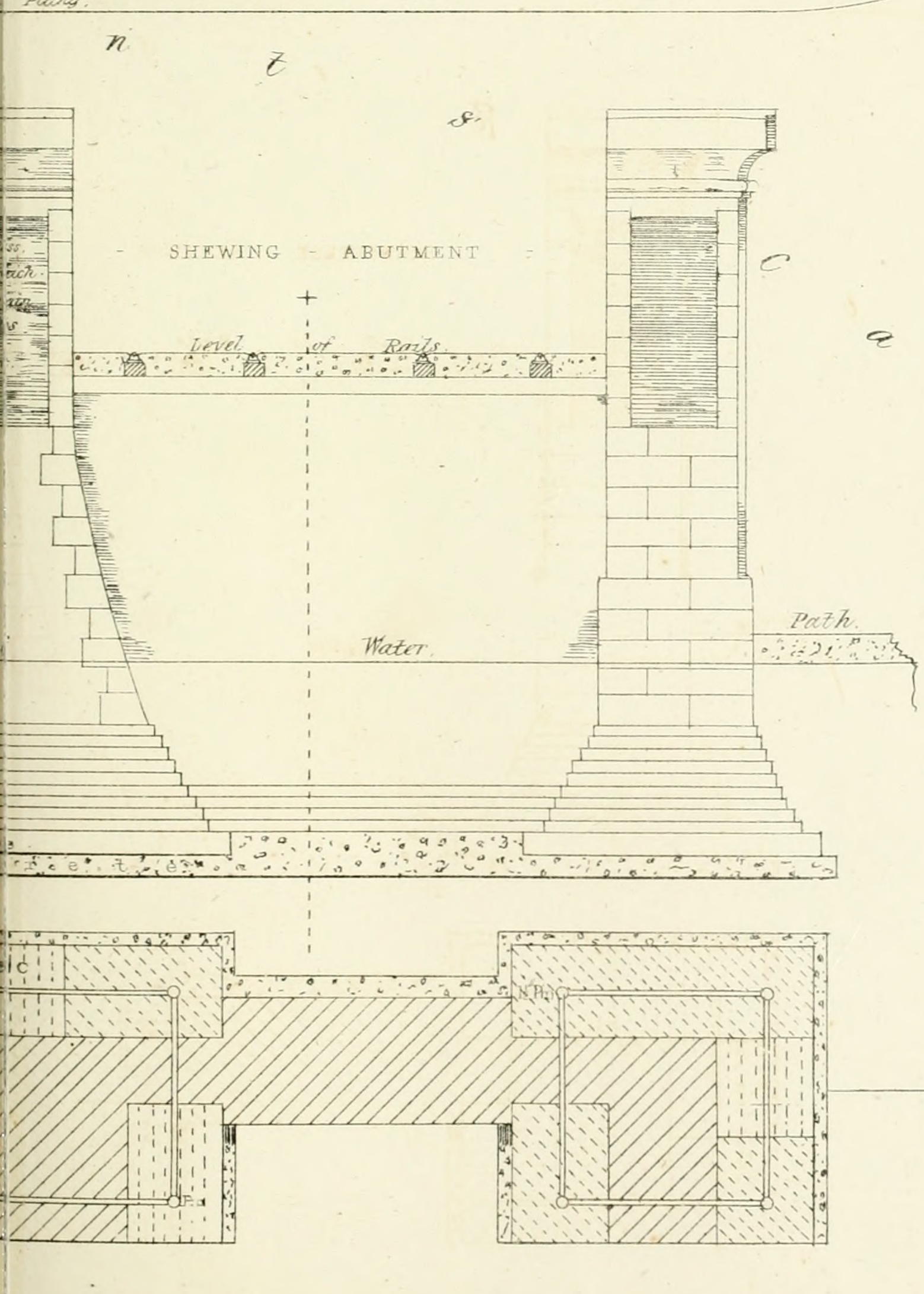
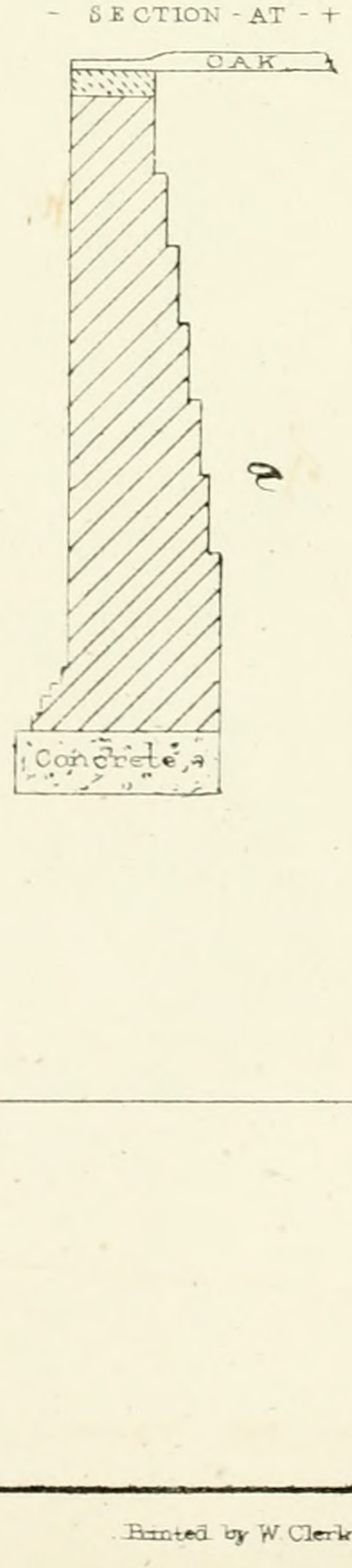
Plate, IX.

CHALK - FARM - L - & - B - RAILWAY -







106, Gt Russell Street, Bloomsbury.

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- BRIDGE - - OVER - THE -

- DETAILS -

- HA

6′ ″ 0″

1′ 3″

1′ ″ 3″

Pier

℄

Line

Centre

0 1 2 3 4 5

Coverings

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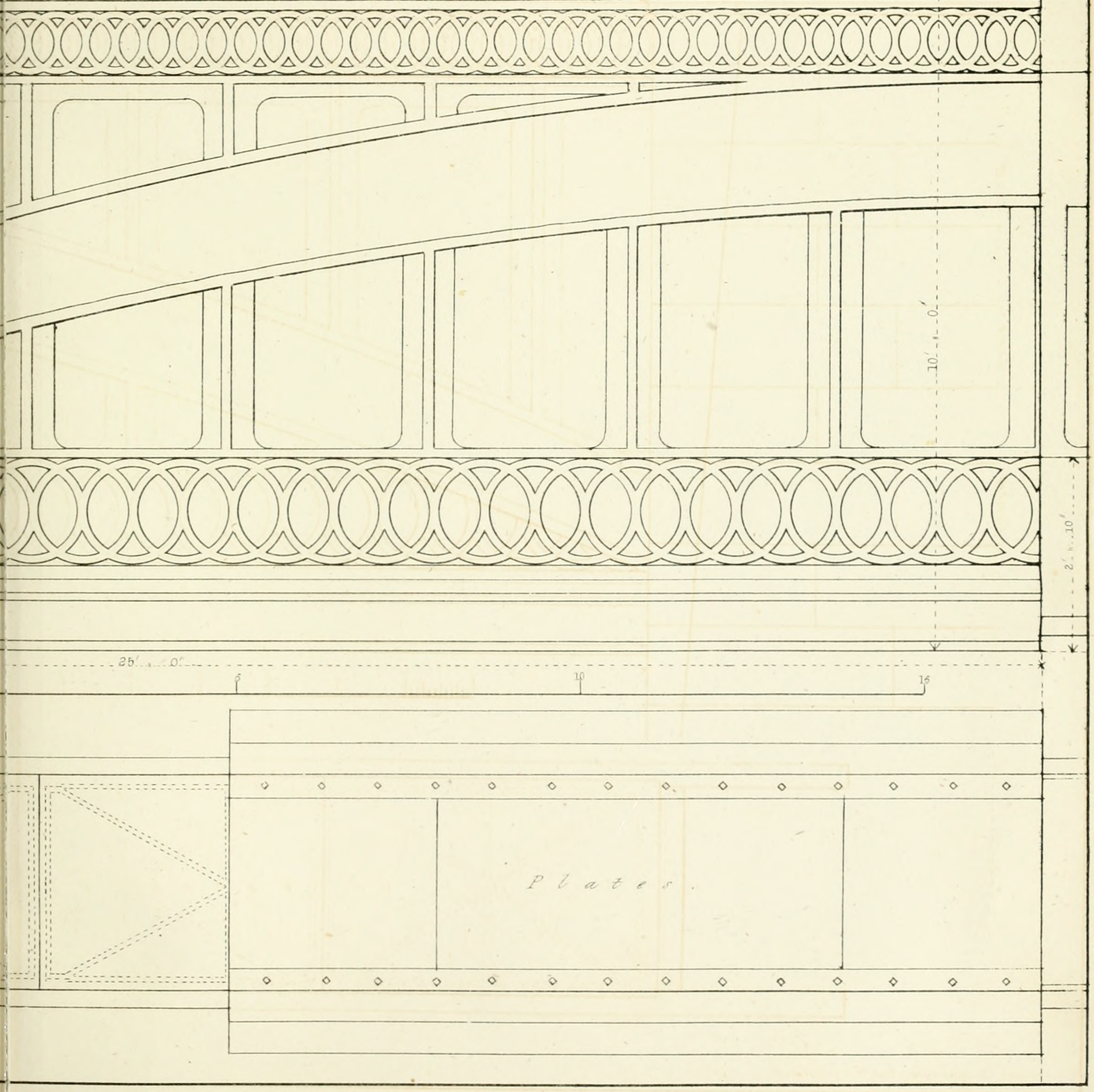
EGENTS - CANAL - NEAR - CHALK - FARM -

- OUTSIDE - MAIN - RIBS -

- ELEVATION -



Plates.

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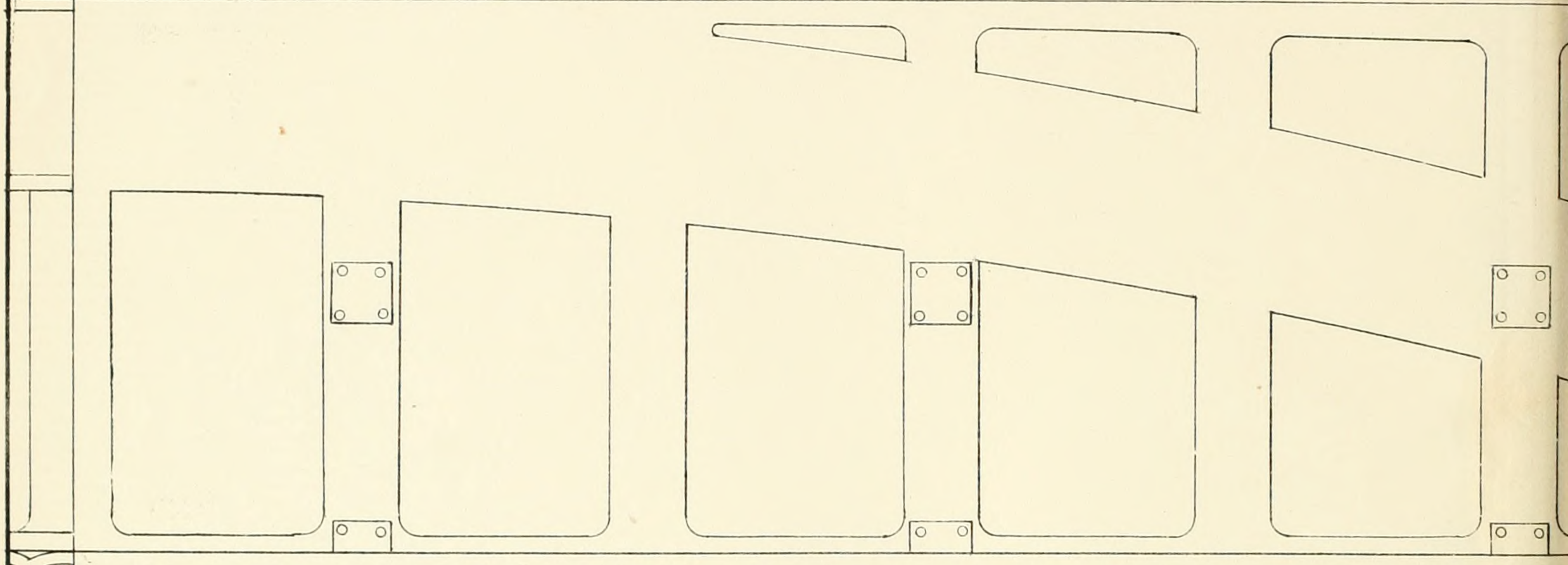
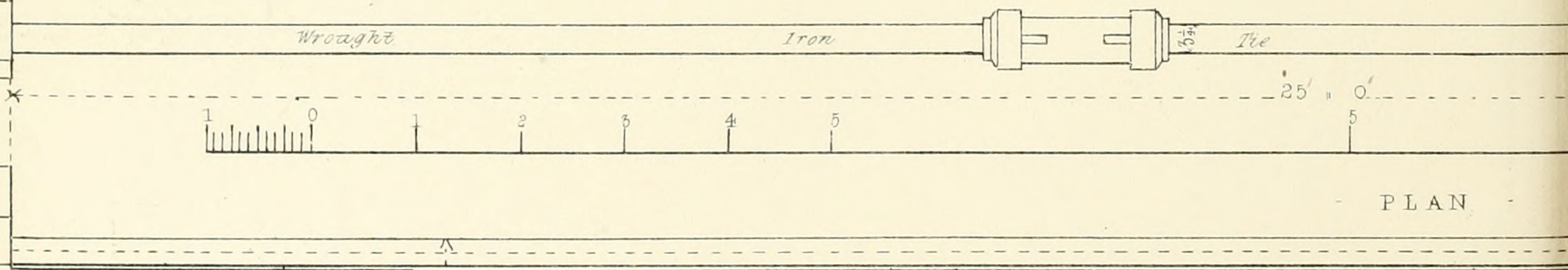
- BRIDGE - OVER - THE - REGENTS - CANAL - NEAR

- DETAILS - OF - OUTSIDE - MAIN

- HALF - SECTION -





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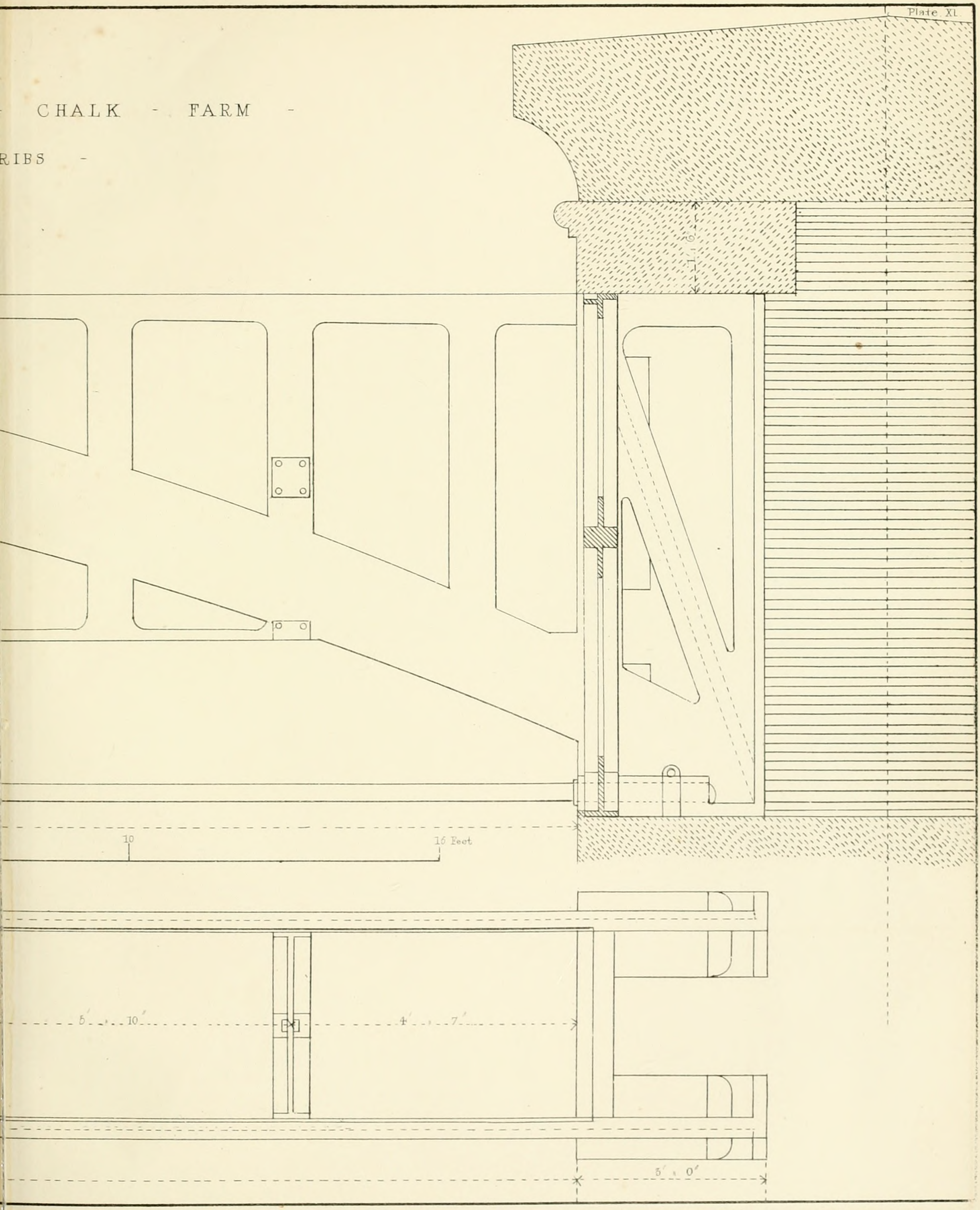
- CHALK - FARM -

RIBS -



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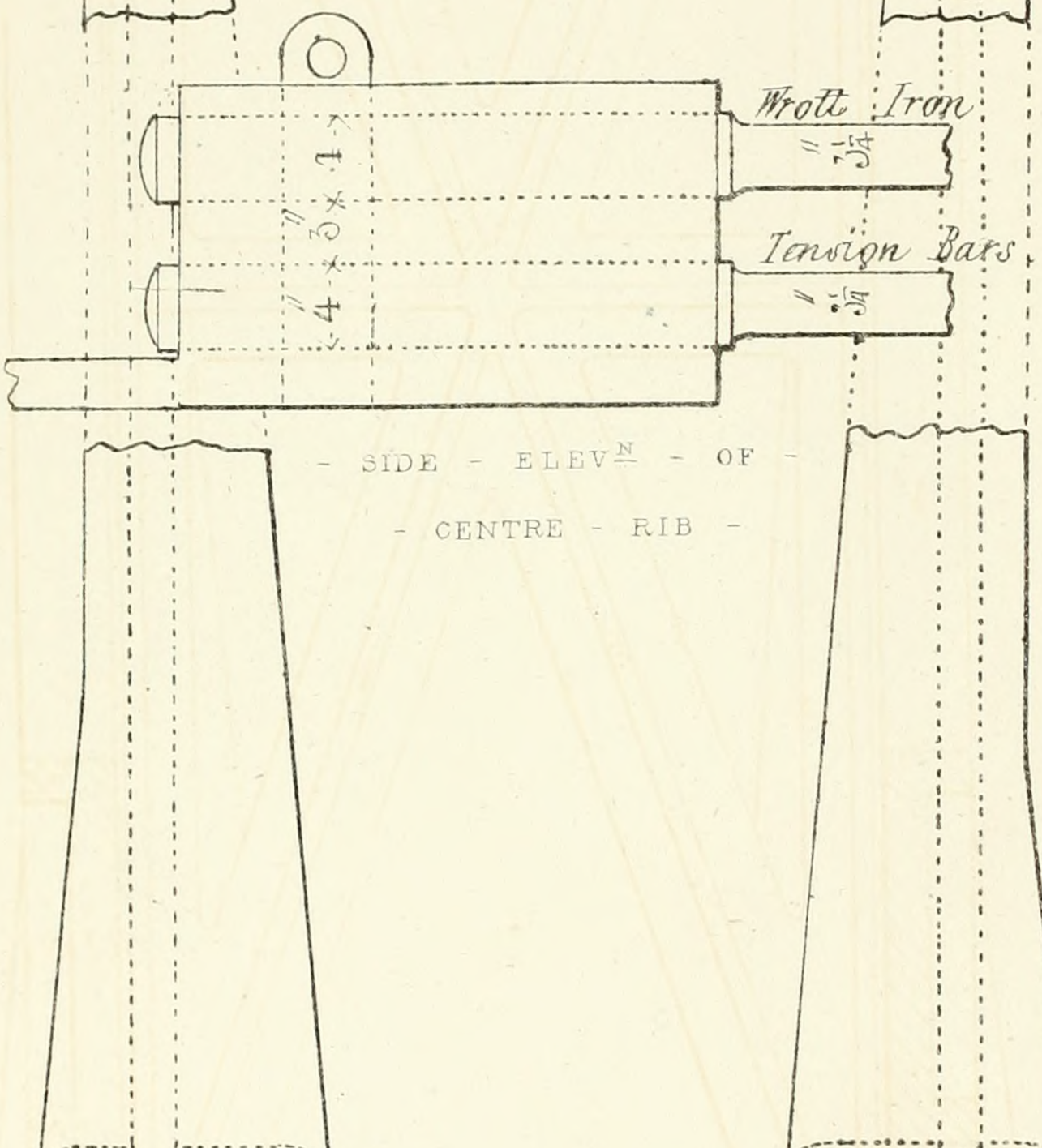
BRIDGE OVER THE REGENTS CANAL

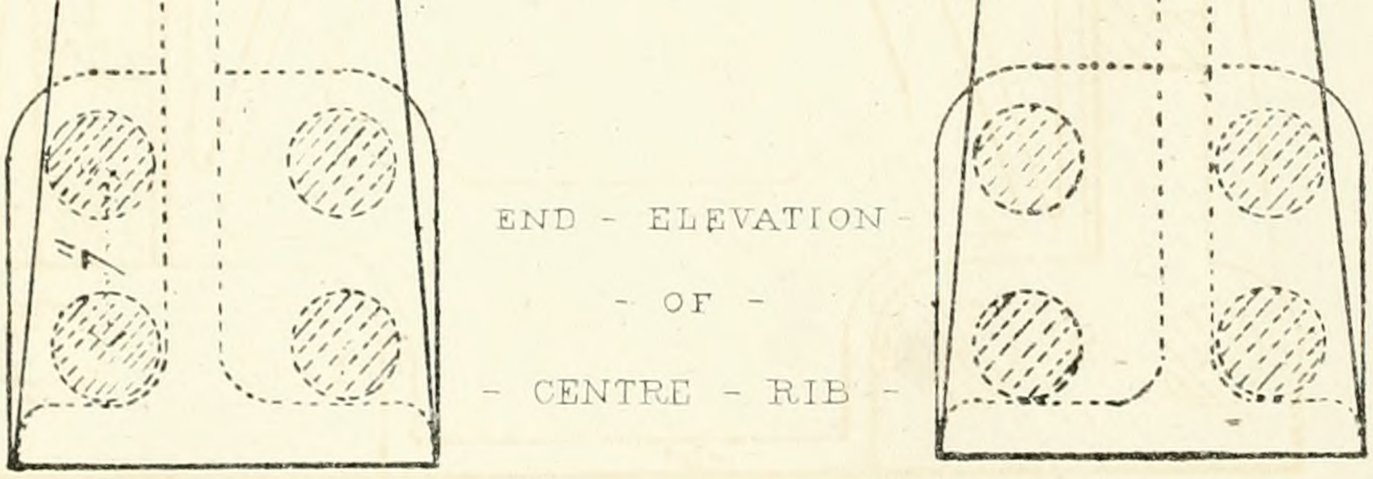
NEAR CHALK FARM

DETAILS OF MAIN RIBS



SIDE ELEVN OF

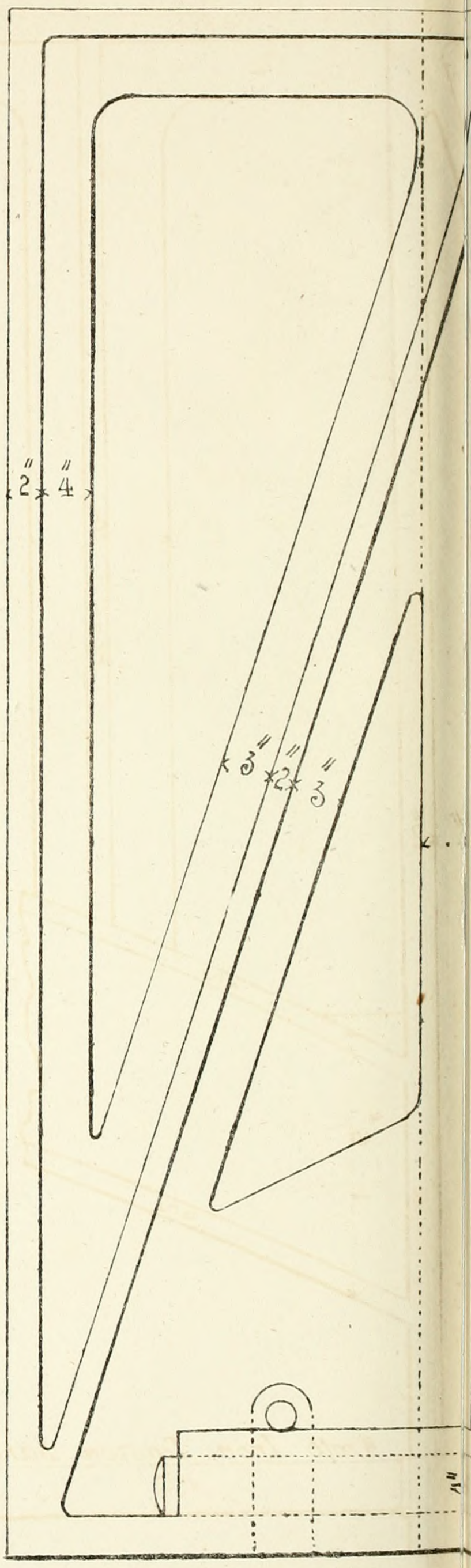
CENTRE RIB



END ELEVATION

OF

CENTRE RIB



Scale

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SIDE - ELEV^N

- OUTSIDE - RIB -

- BRACING -

- FRAME -

Wrott Iron Tension Bars

Feet

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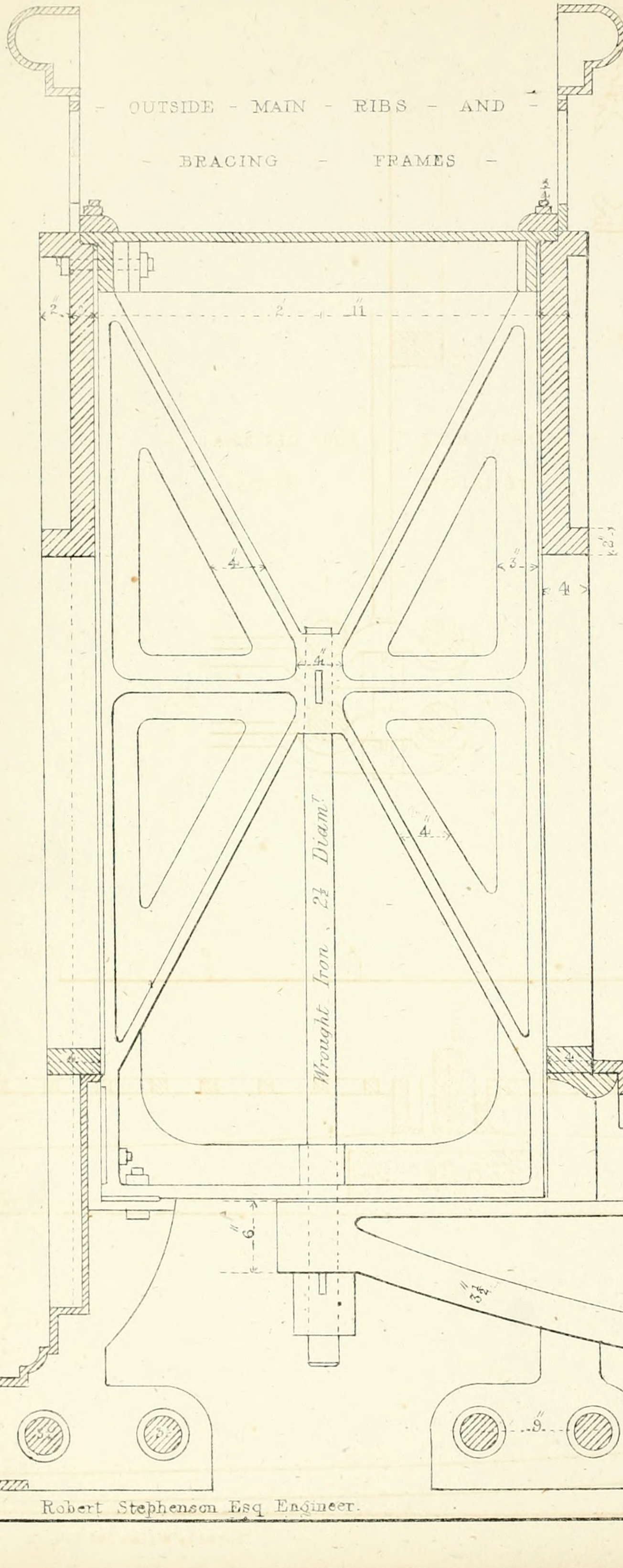
- OUTSIDE - MAIN - RIBS - AND -

- BRACING - FRAMES -



- BRIDGE - OVER - T

- NEAR - CHALK - FARM -



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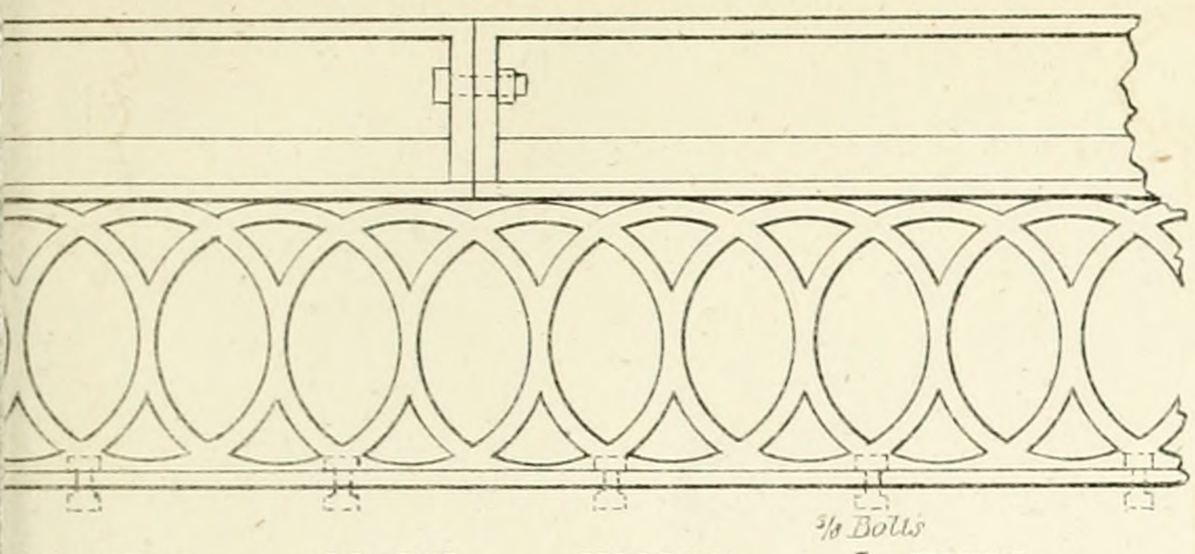
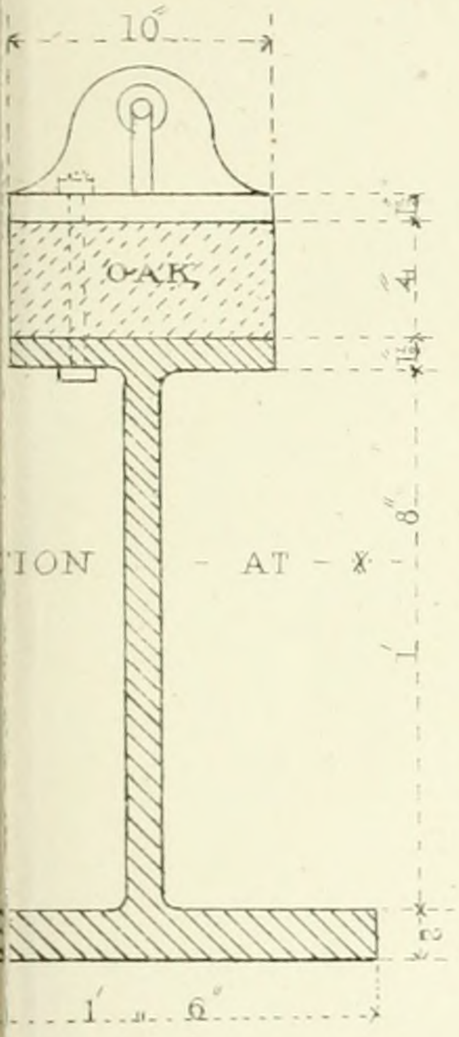


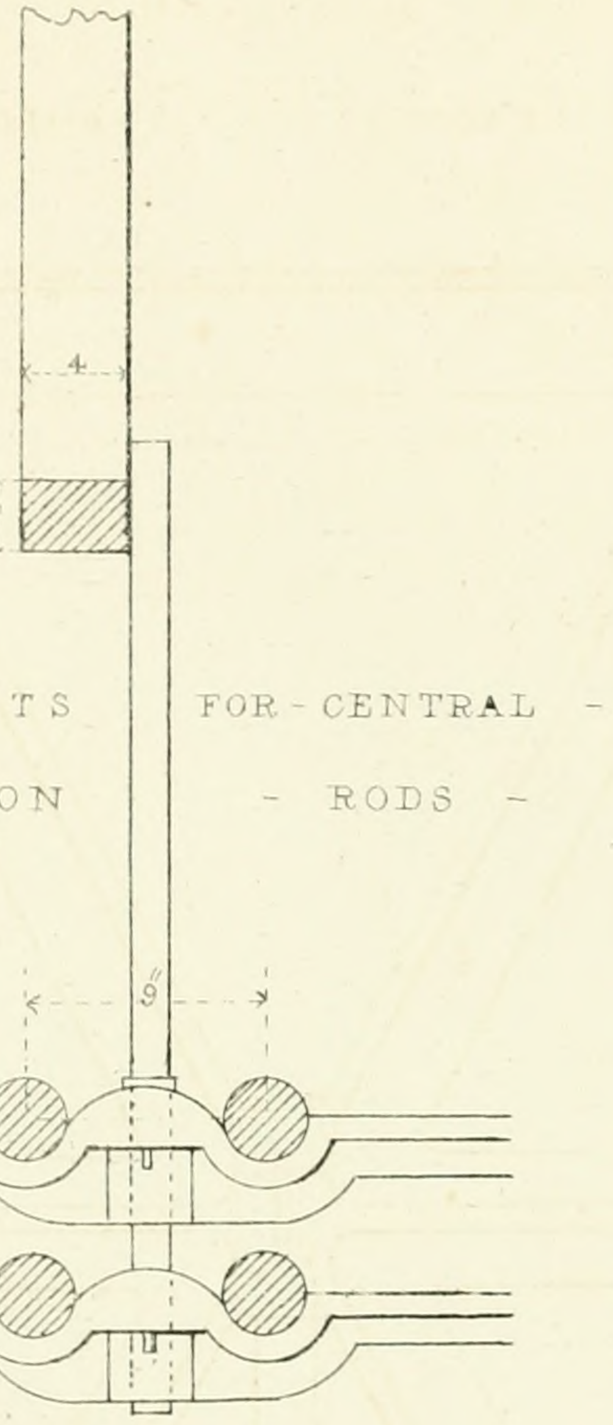
- MENTAL - WORK - INSIDE - VIEW -

- REGENTS - CANAL -

- EXN - L - & - B -

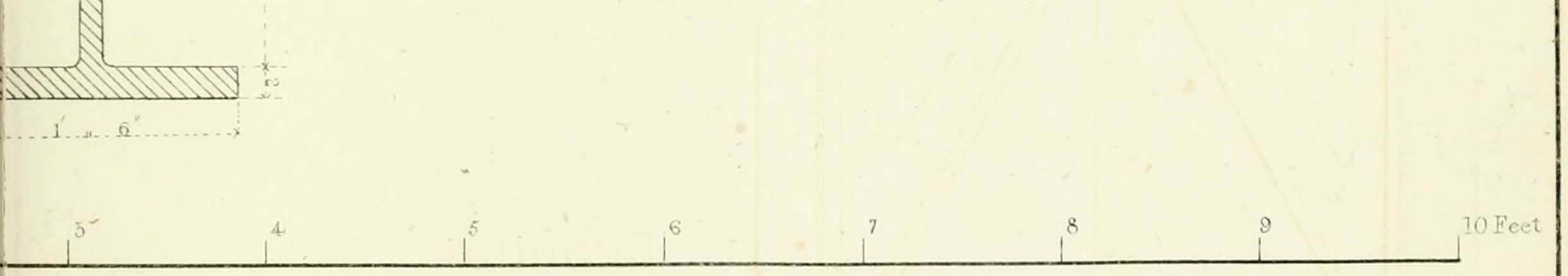


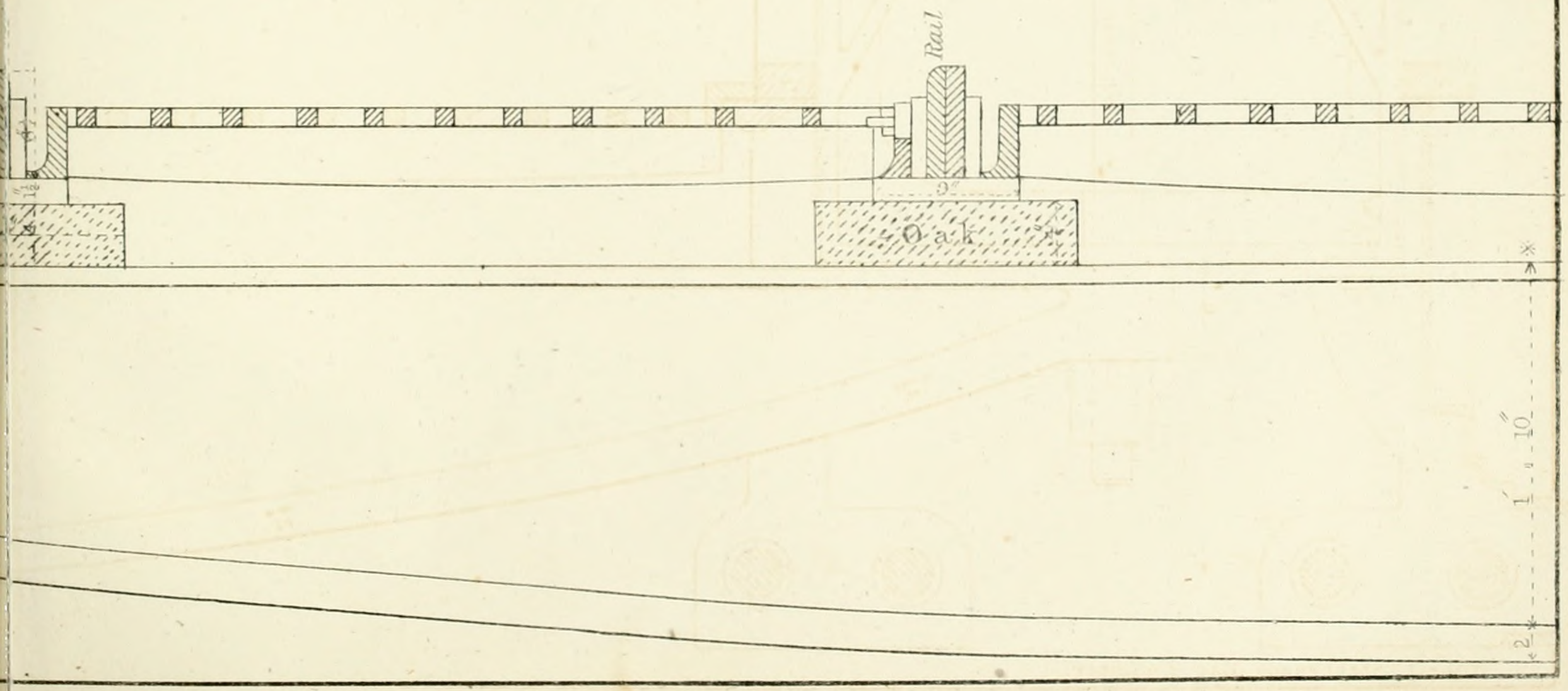
ION - AT - X -



- SUPPORTS FOR - CENTRAL -

- TENSION - RODS -





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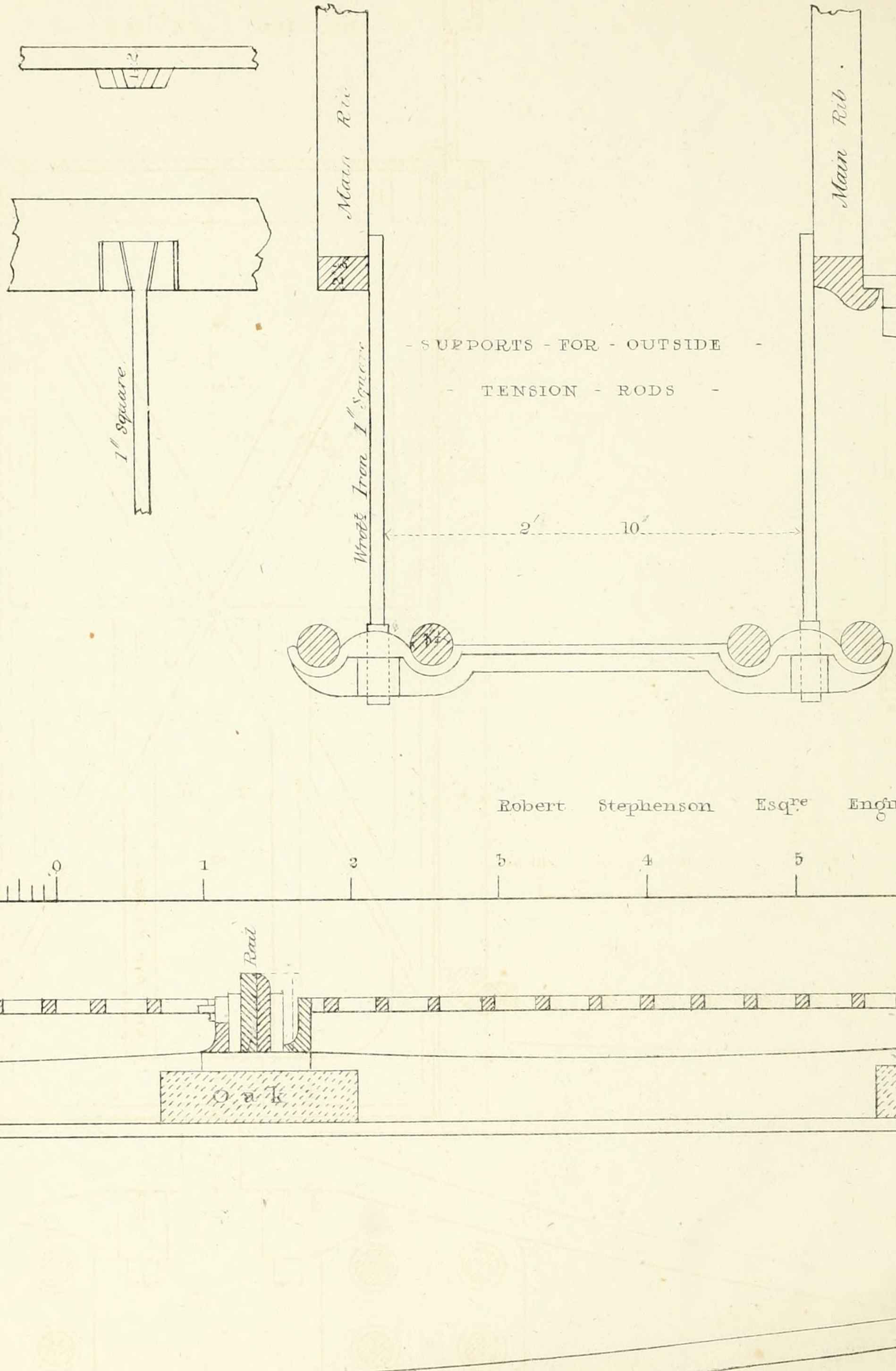
BRIDGE - OVER - THE - REGENTS CANAL - NEAR - CHAL



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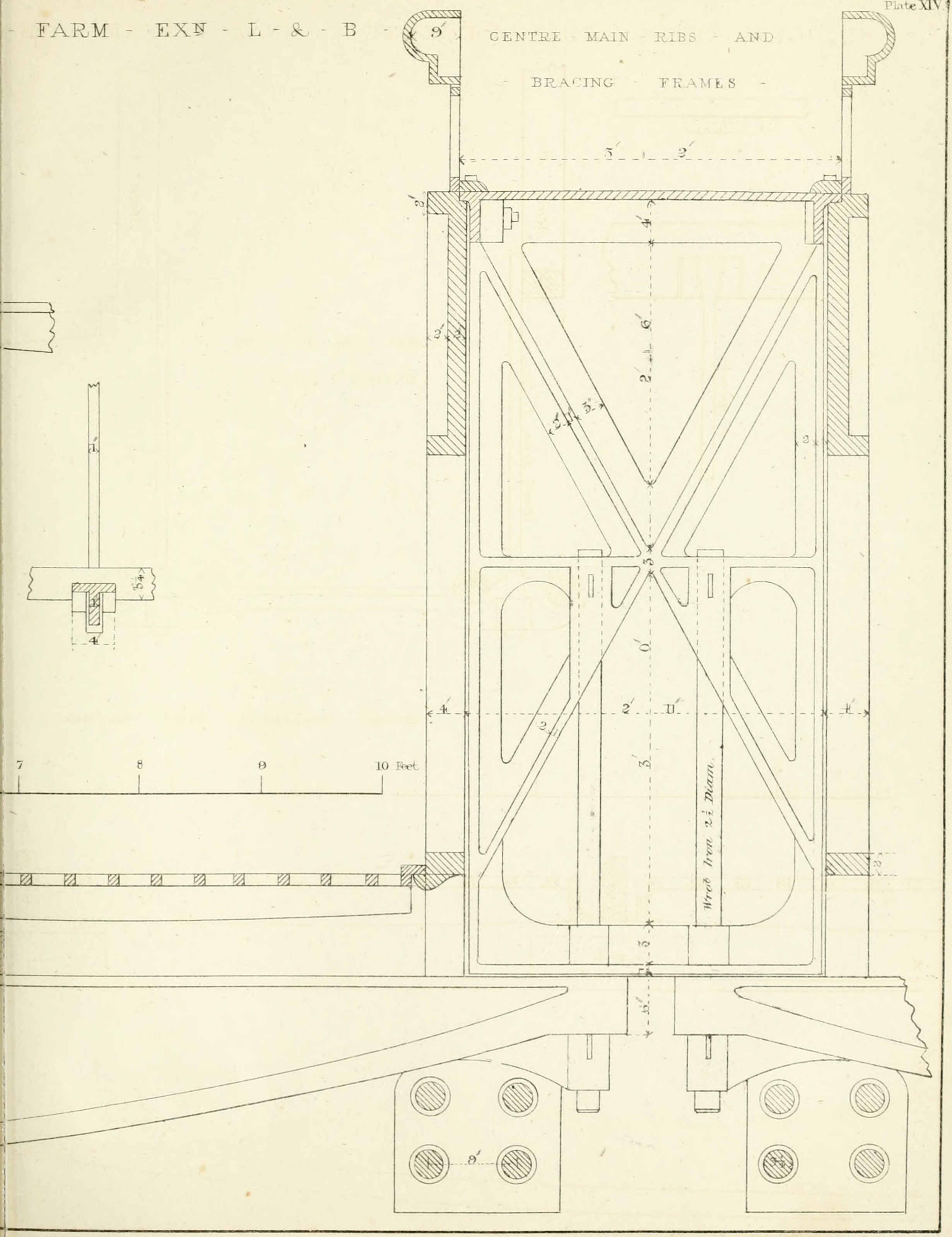
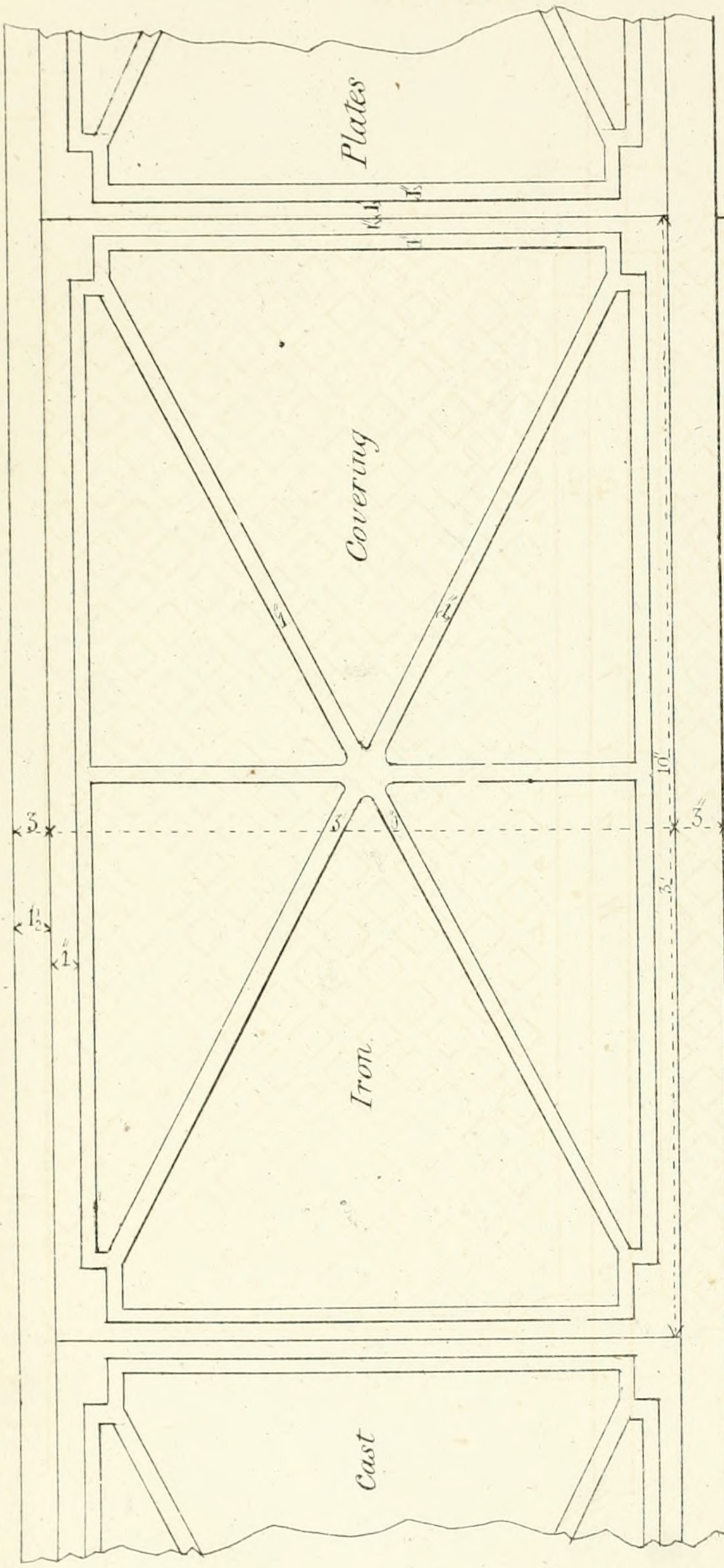
FARM - EXN - L - & - B -

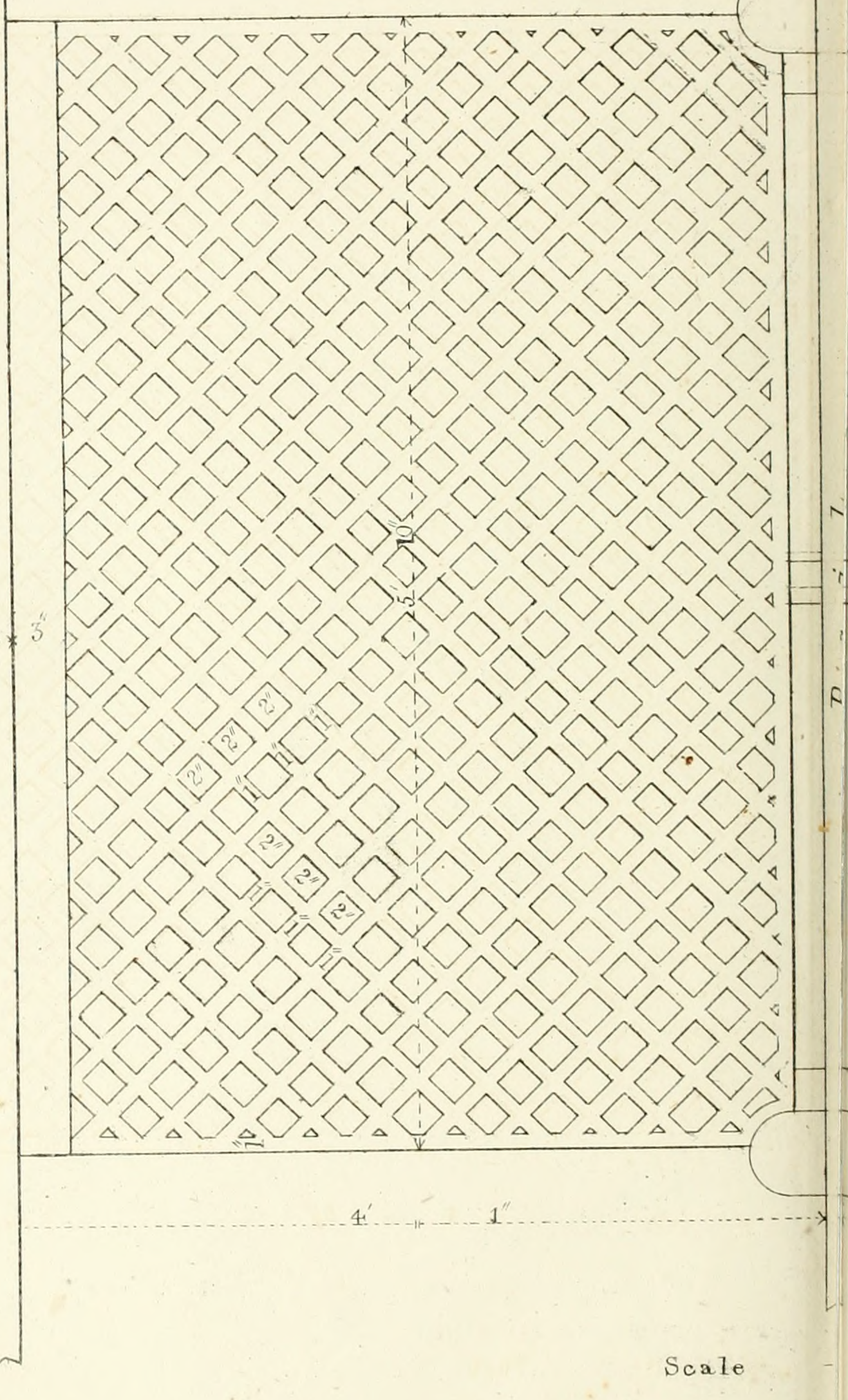
CENTRE - MAIN - RIBS - AND - BRACING - FRAMES -


9'
5'
2'
2'
4'
2'
6'
3'
3'
3'
2'
4'
2'
4'
3'
3'
3

BRIDGE - OVER - THE - REGENTS - CANAL - NEAR -

- PLAN -





Scale

12 6 0 1 2 3

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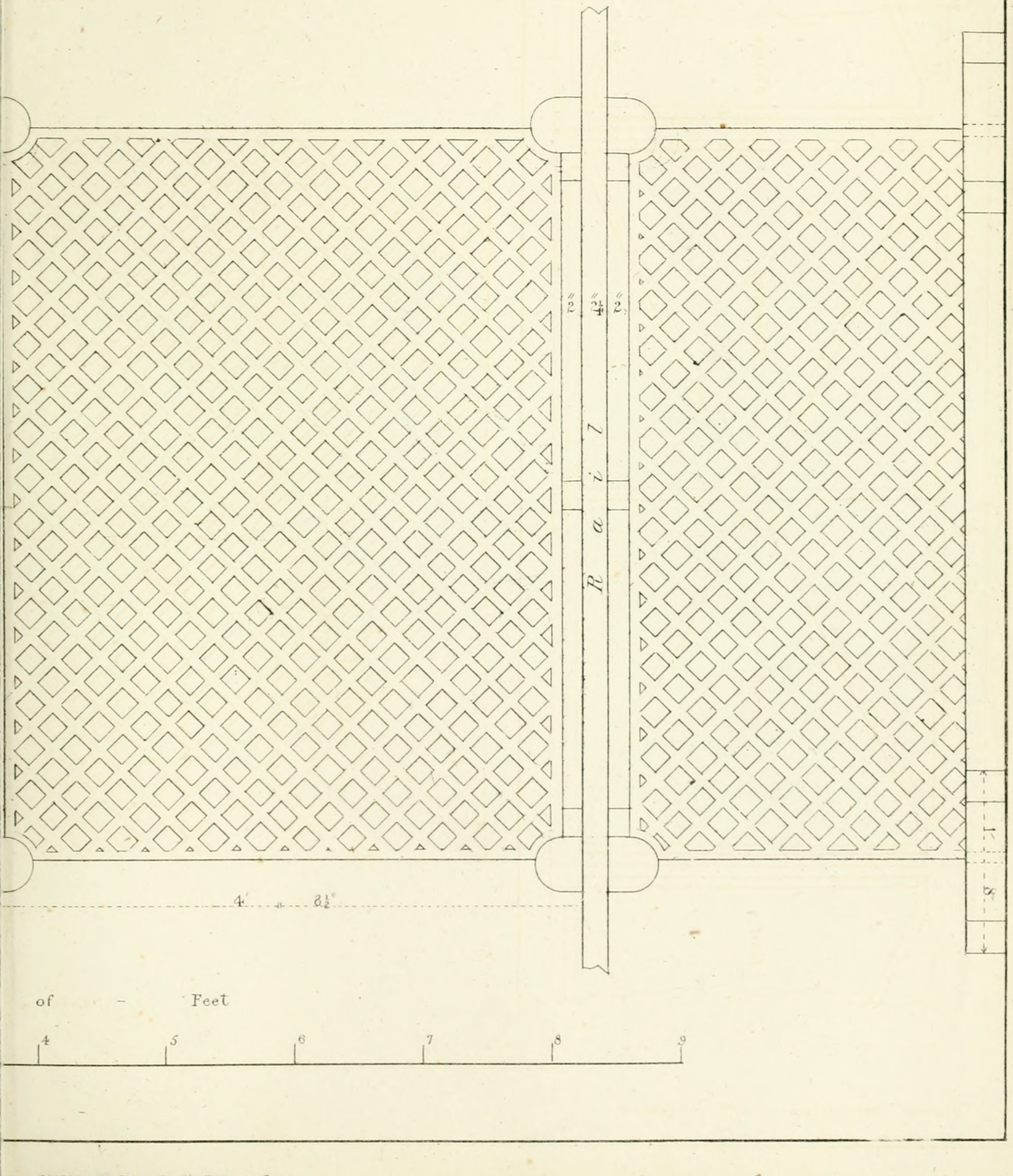
John Williams Library of Scien

HALK - FARM EX^N - L - & - B - RAILWAY -

HEWING - CAST - IRON - GRATING -



of - Feet

4 5 6 7 8 9

Art N° 104 62 Russell St Bloomsbury

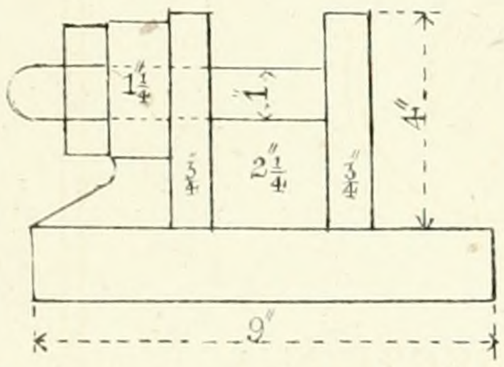
- BRIDGE - OVER - THE - REGENTS - CANAL - NEAR

PLAN - SHEWING - - MODE - OF

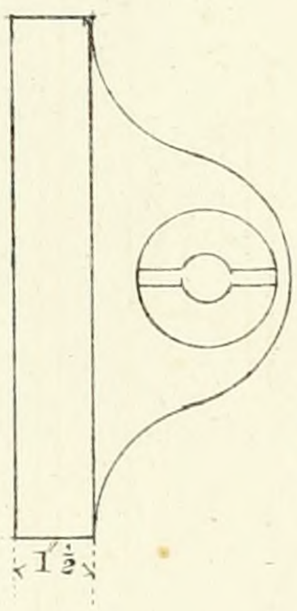
- CHAIR - FOR - SUPPORTING - RAILS -

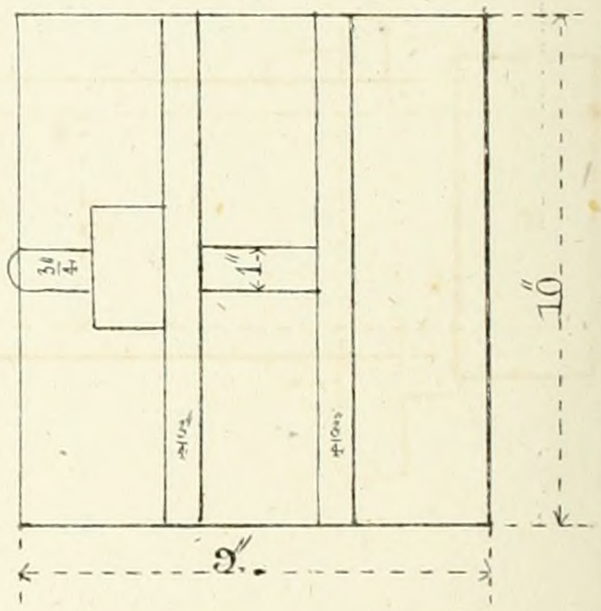
- PLAN -

END - VIEW -



- SIDE - VIEW -





Ins. 12 9 6 3 0

Rail

Rail

8"
10"
1'

3' 0"

4' 8"

Scale

12 6 0 1 2 3

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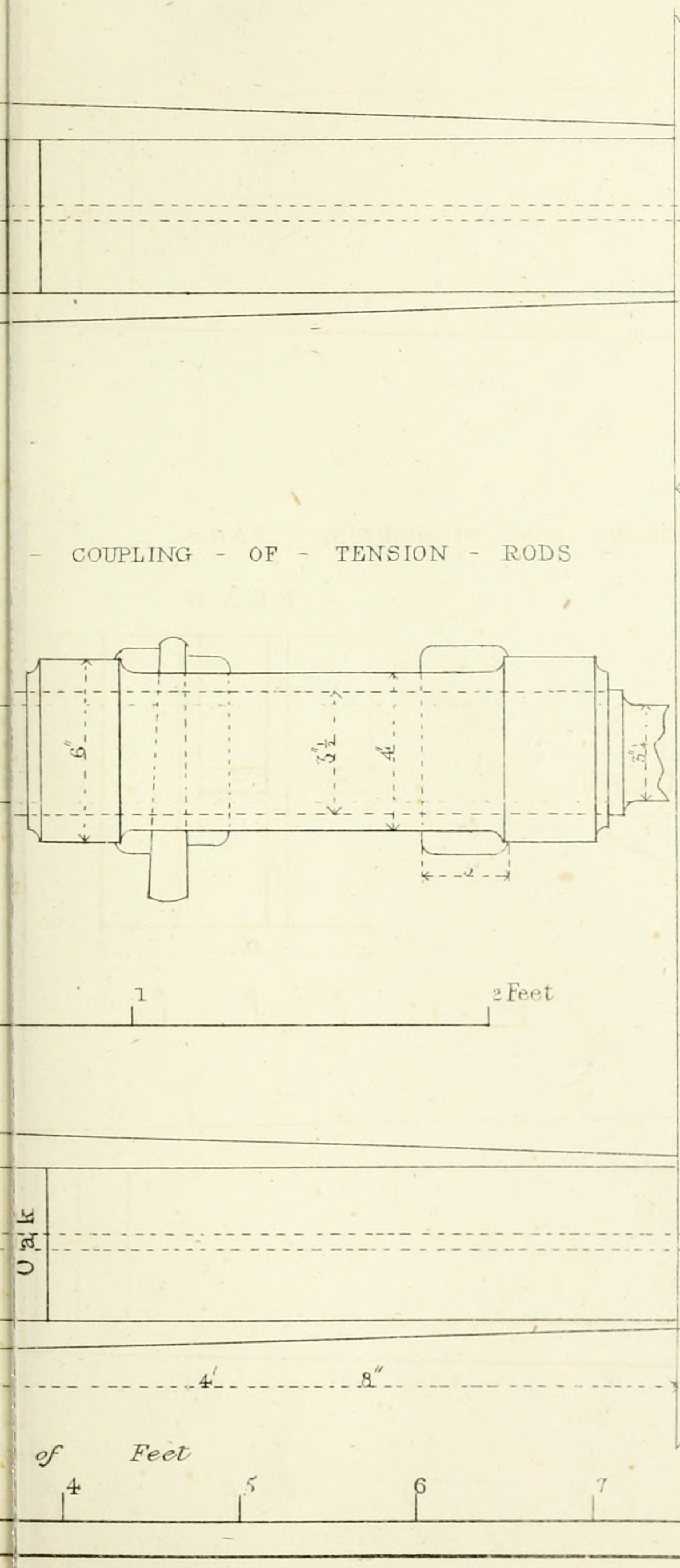
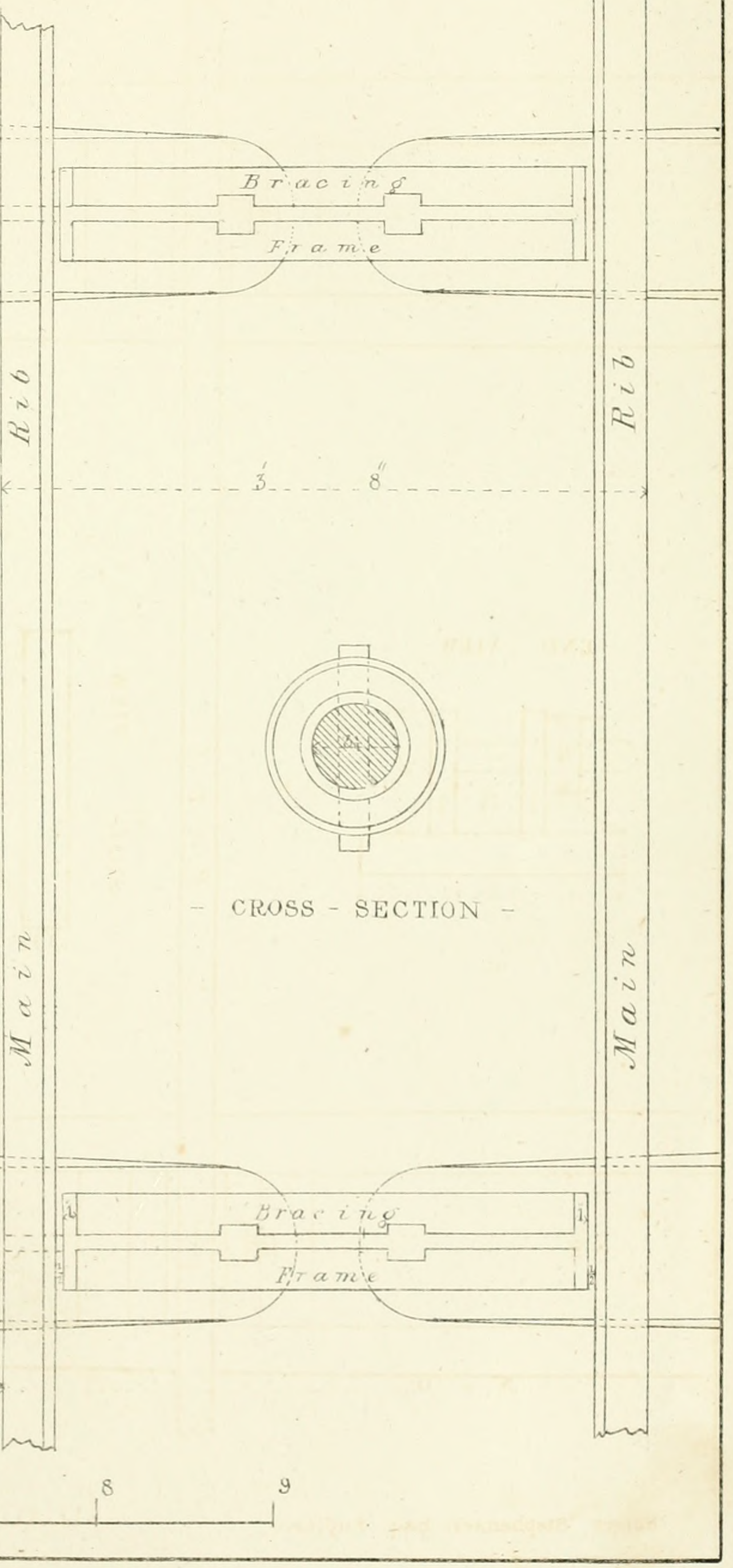
Plate XVI

CHALK - FARM - EX^N - L - & - B - RAILWAY -

FIXING - CHAIRS - RAILS - &c -





- COUPLING - OF - TENSION - RODS

- CROSS - SECTION -

4' 8"

of Feet

4 5 6 7 8 9

& Art, N° 106 Gt Russell St Bloomsbury.

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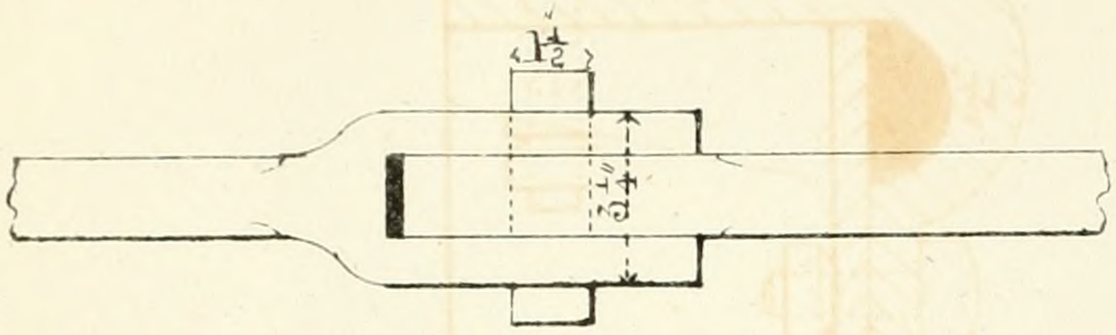
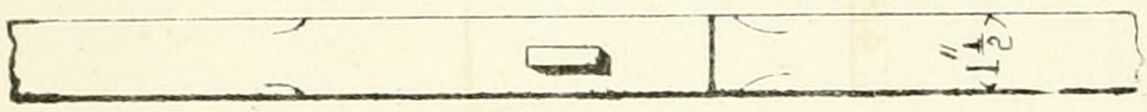
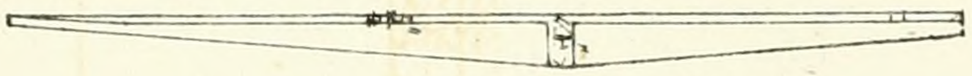
- DETAILS - OF - IRON - PILING -

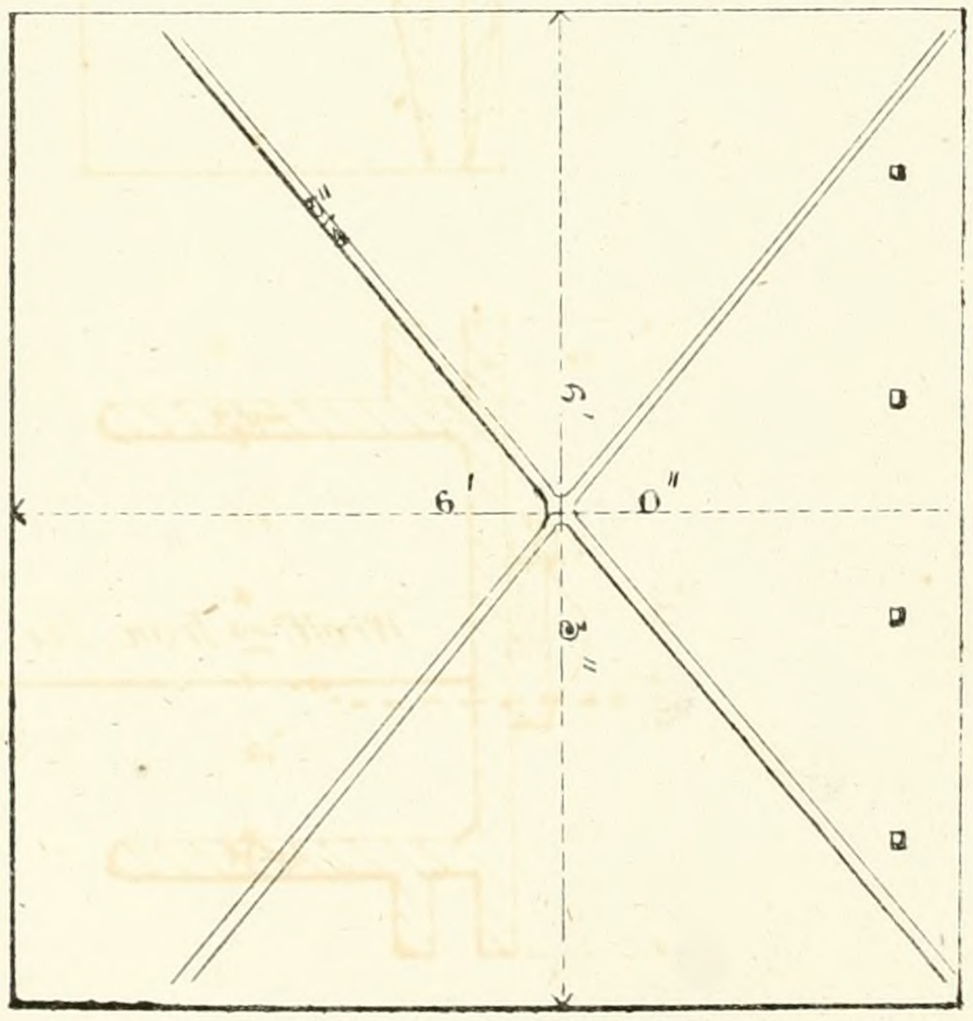




- COUPLING-THE - BOLTS -

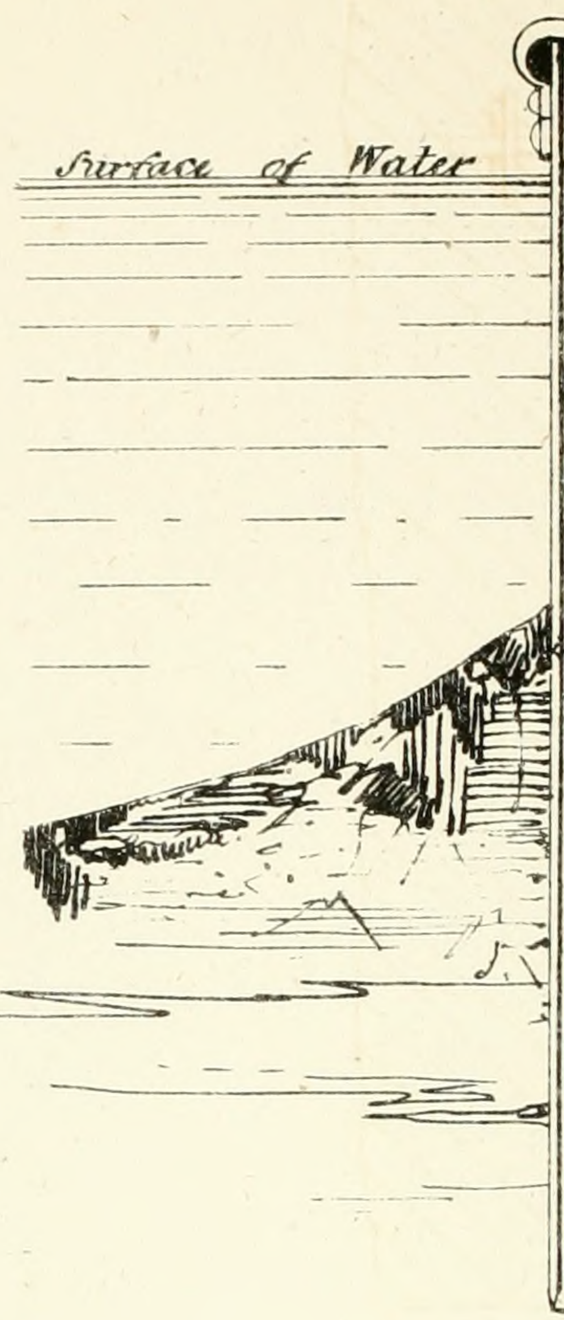
- BRIDGE - OVER - THE - REGENTS - CANAL -
- NEAR - CHALK - FARM -

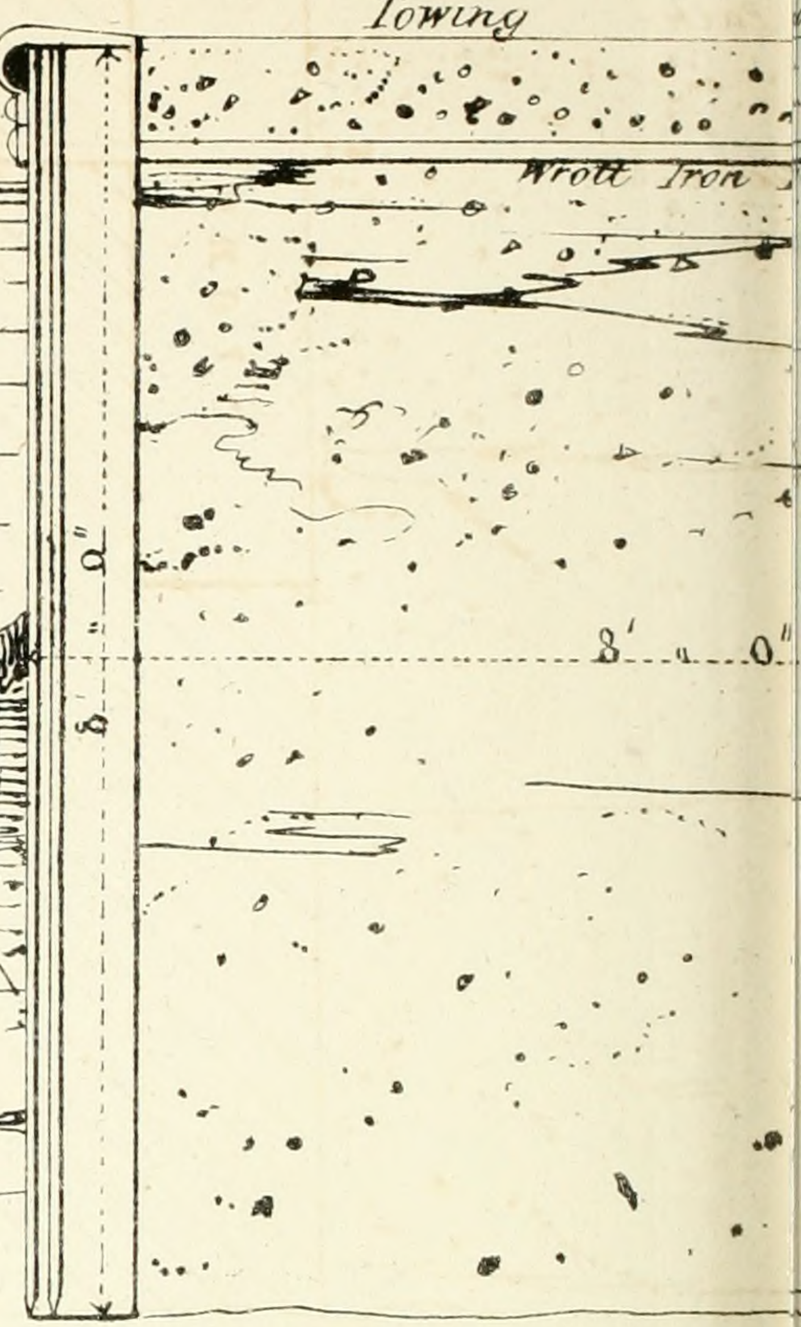


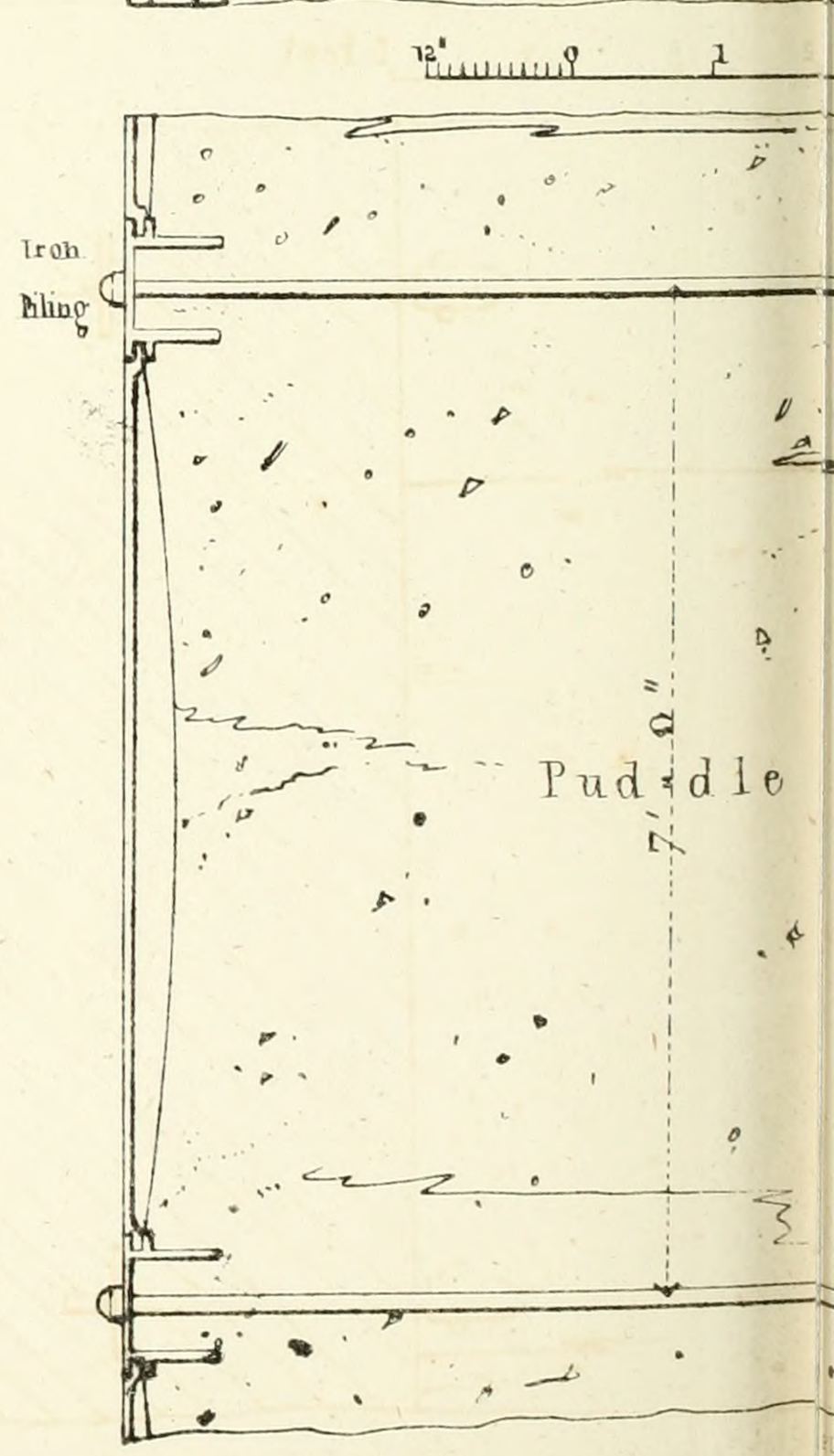


- CAST - IRON - WHARF - PLATE -

SECTION







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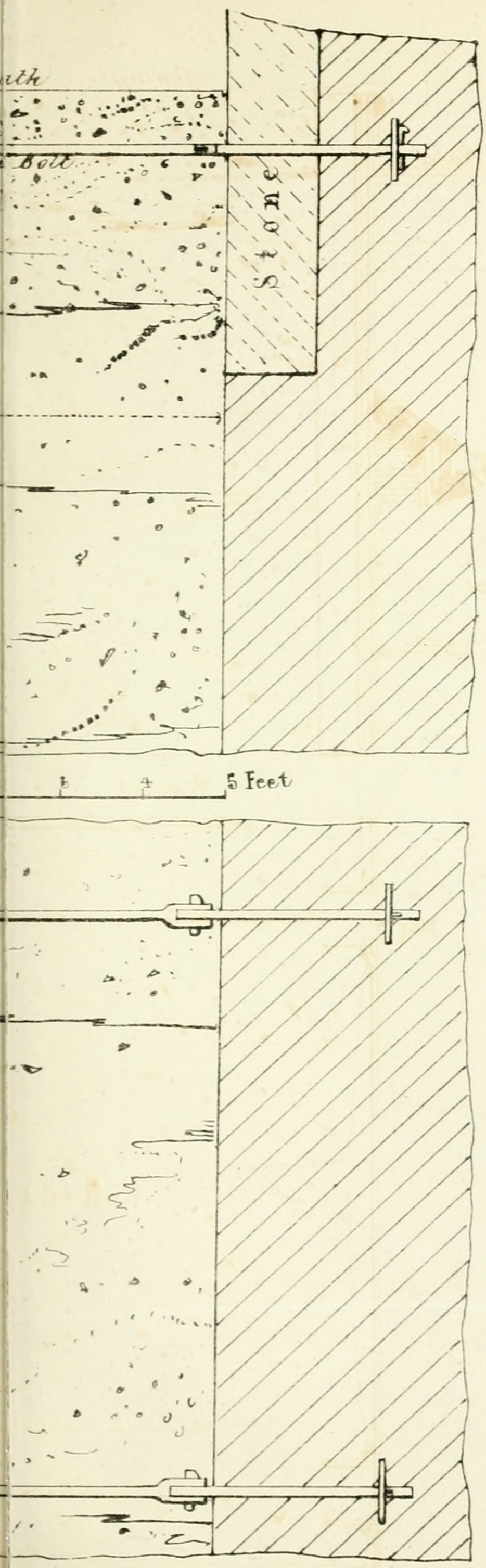

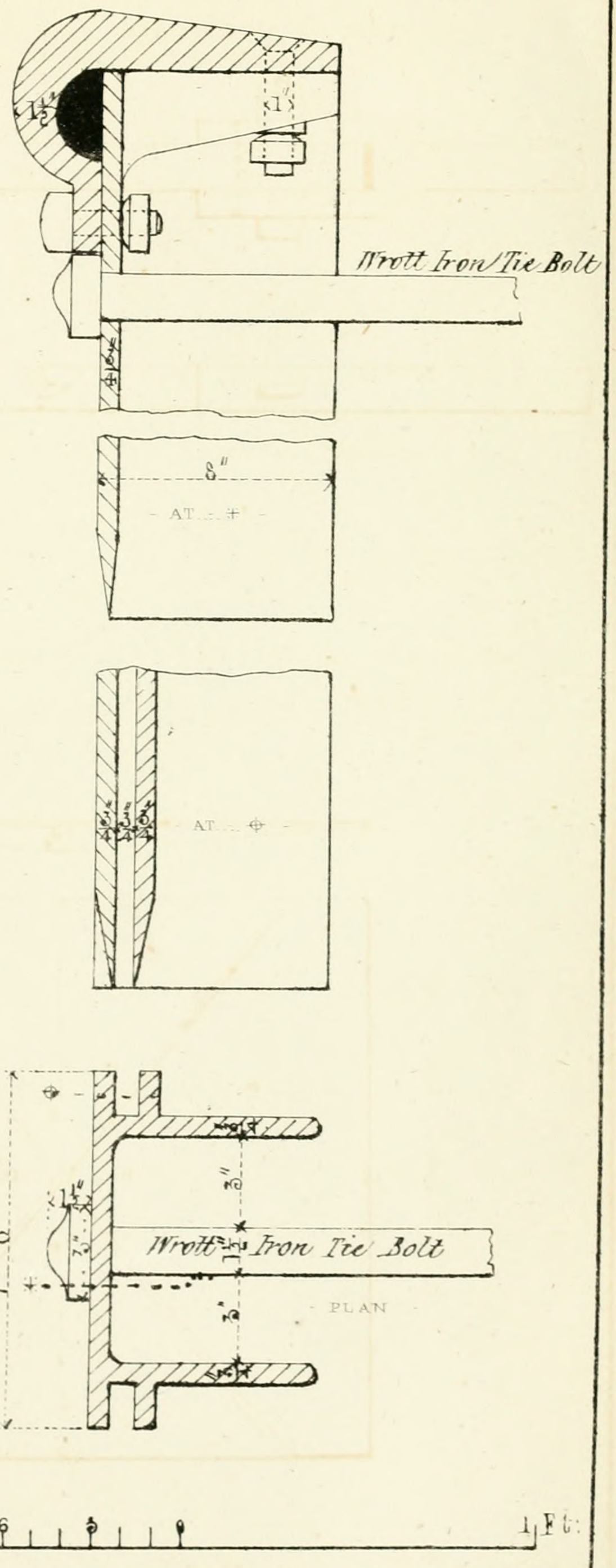

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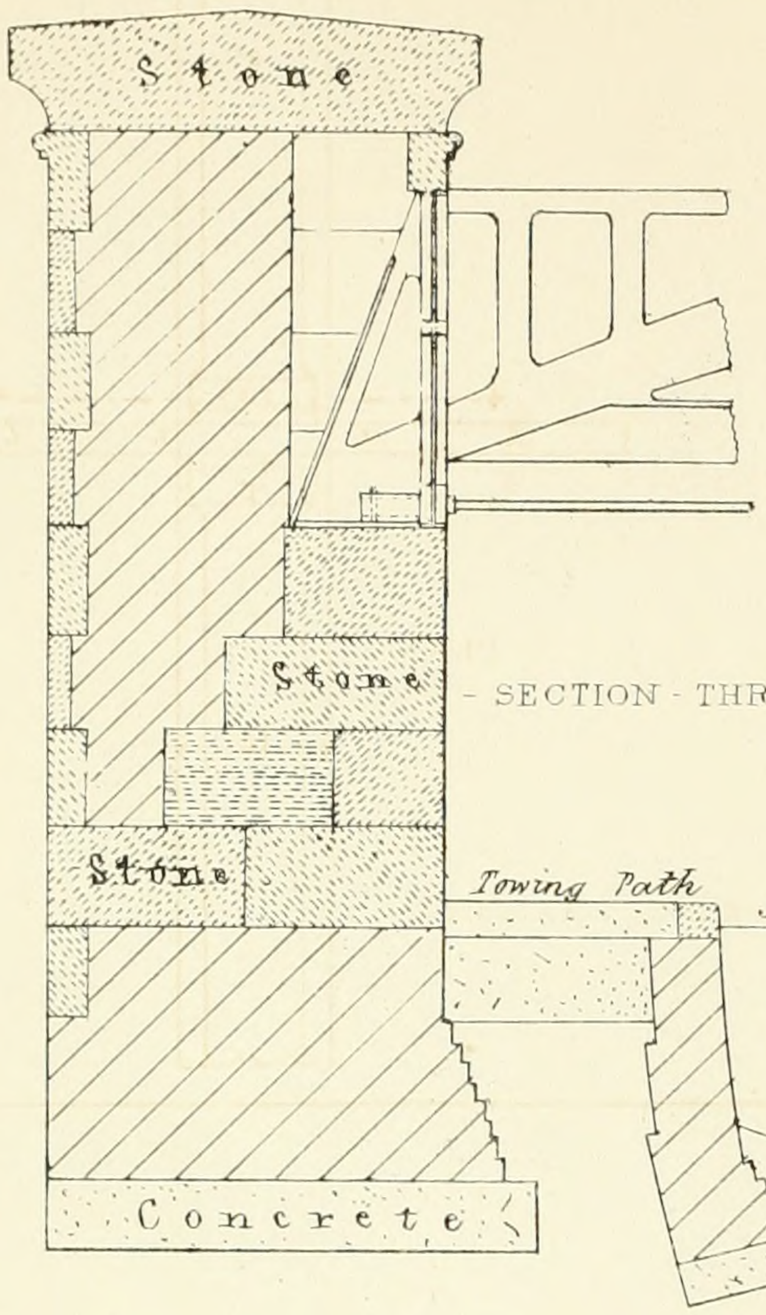
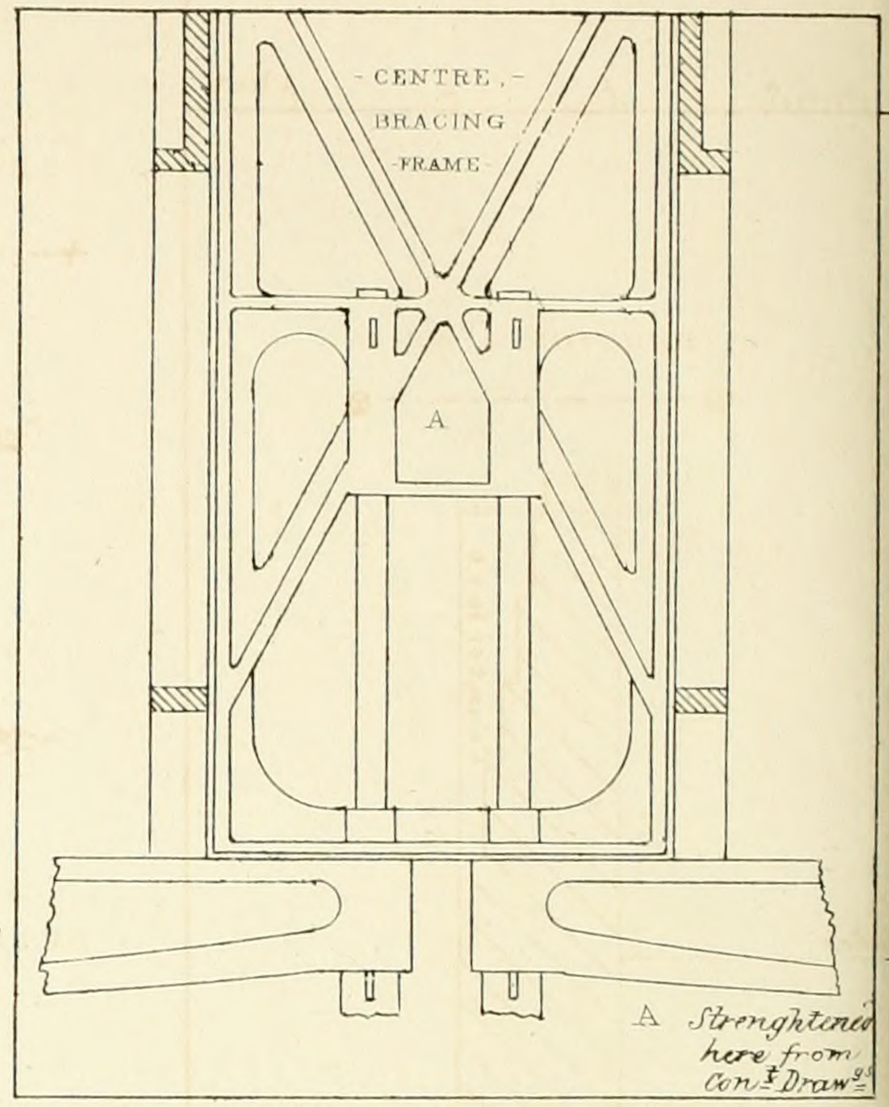
- BRIDGE - OVER - THE - REGENTS - CANAL - NEAR -

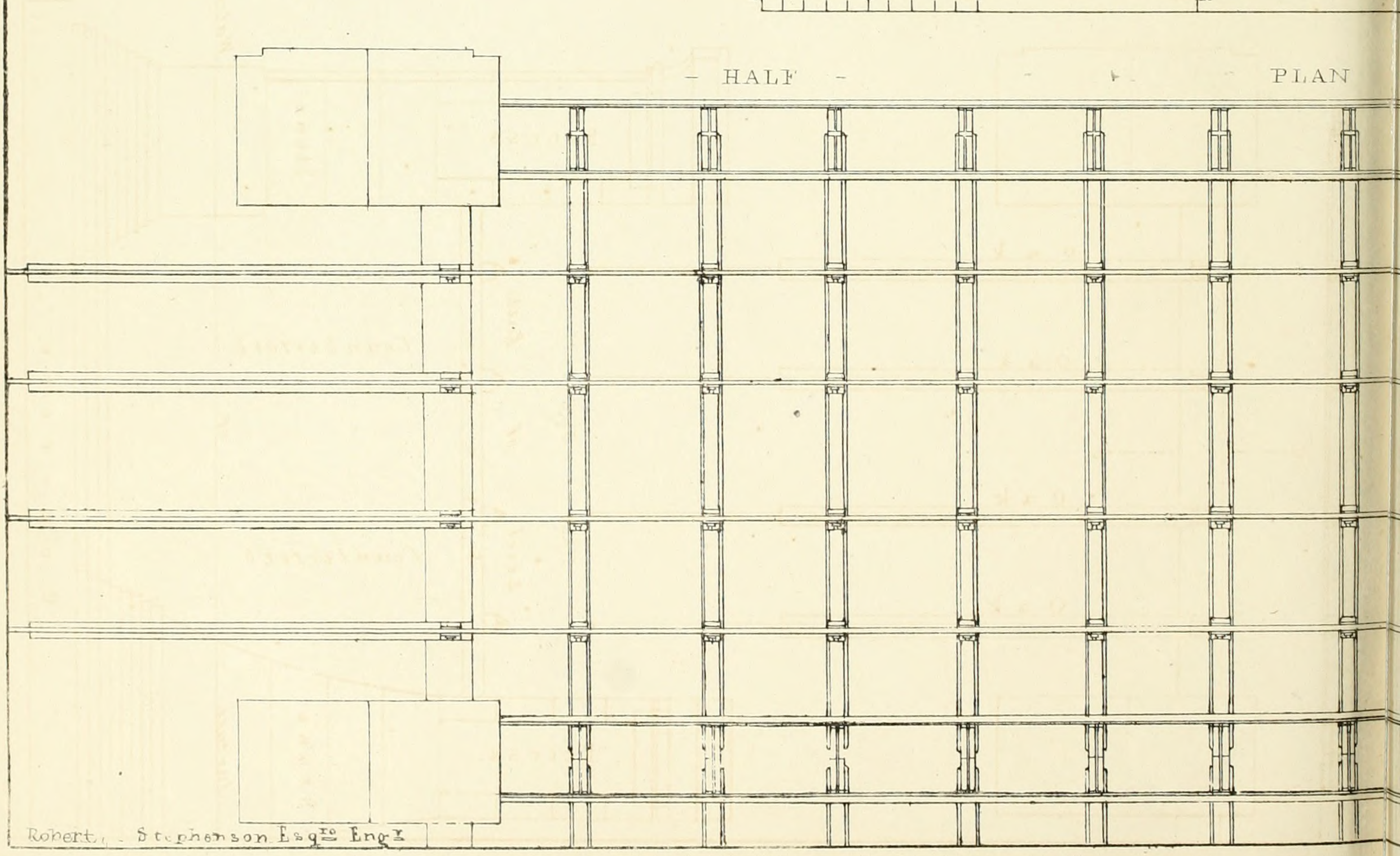


- SECTION - THRO^H - PIER -



Scale 0 5 0 10

- HALF - PLAN



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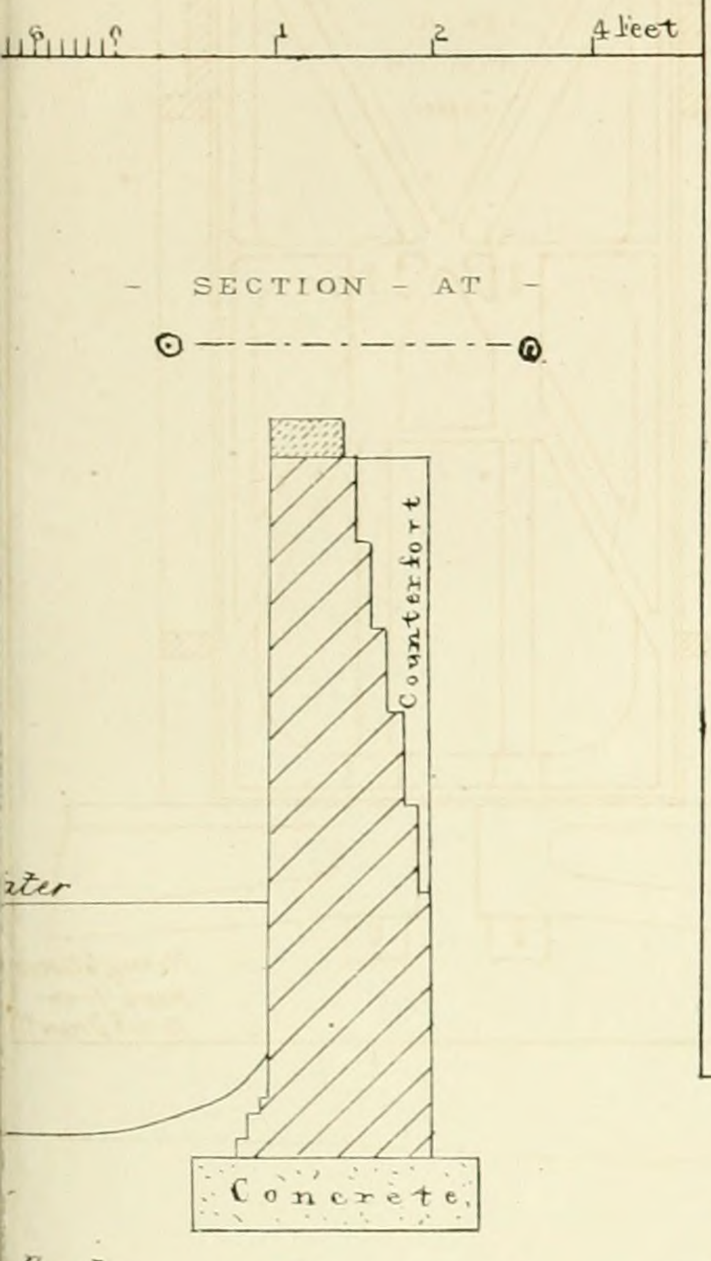
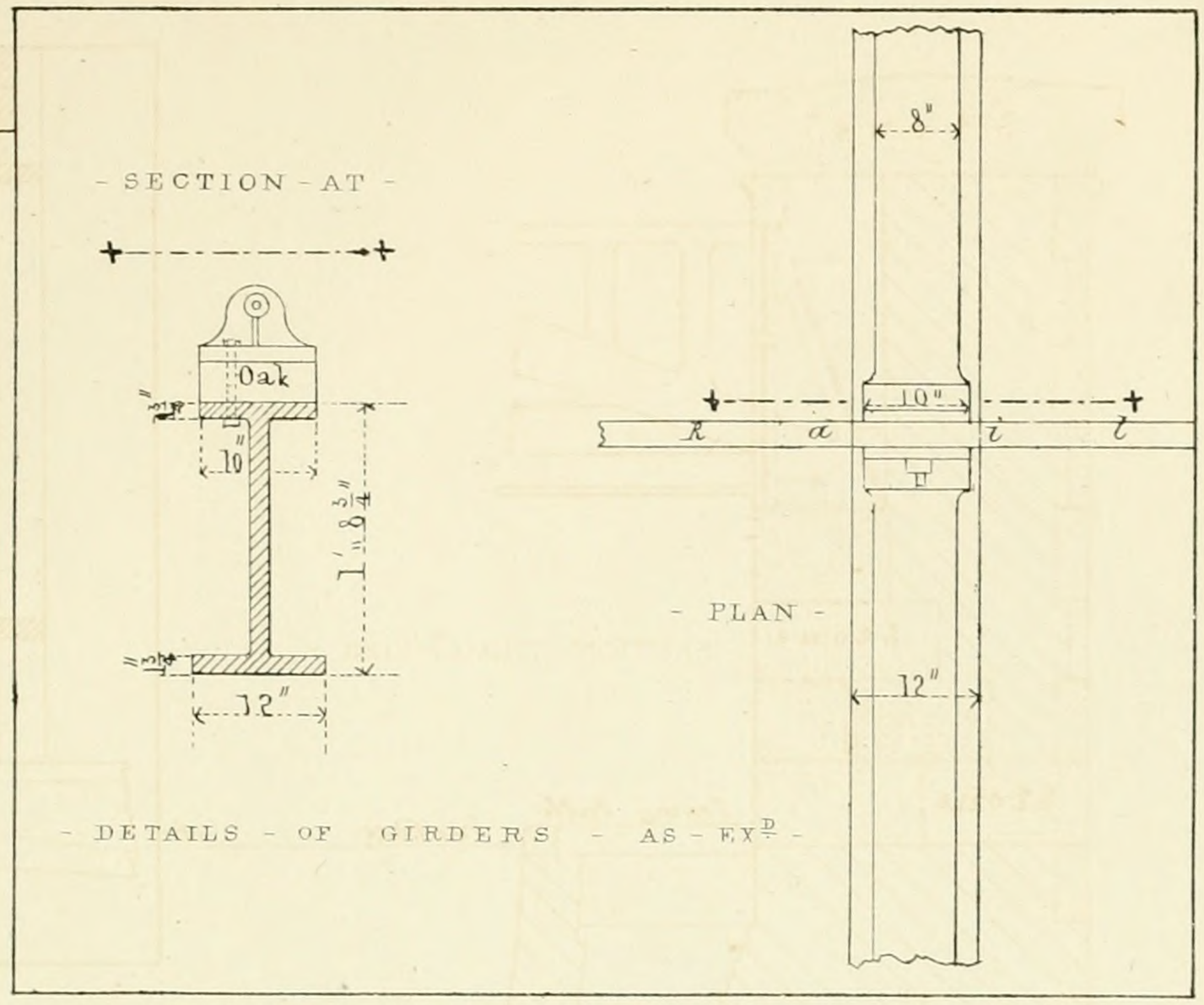
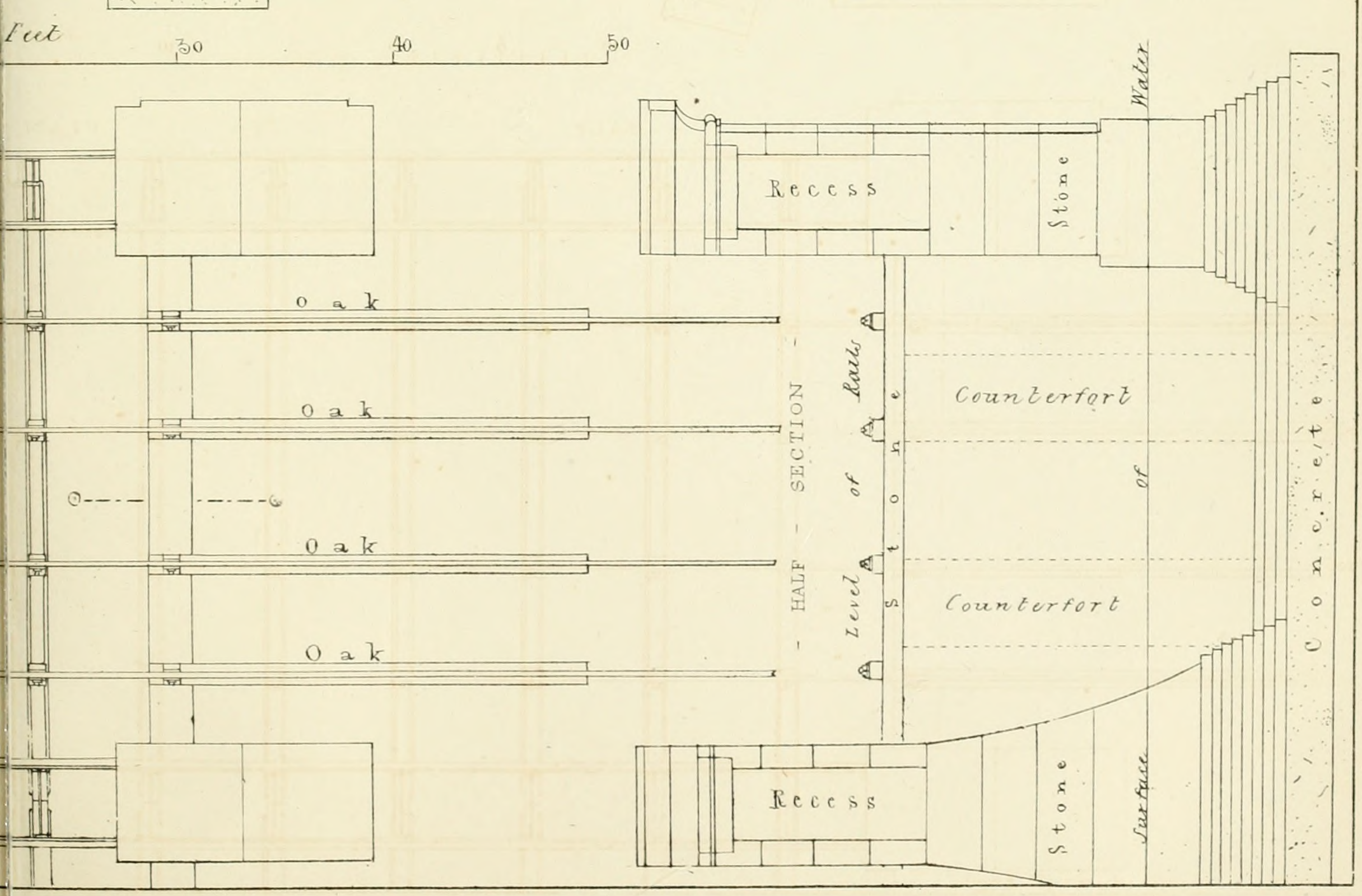
John Williams, Library of Science & Art, N°106 G^t Ru

LK - FARM - ALTERATIONS - AS - EXECUTED -







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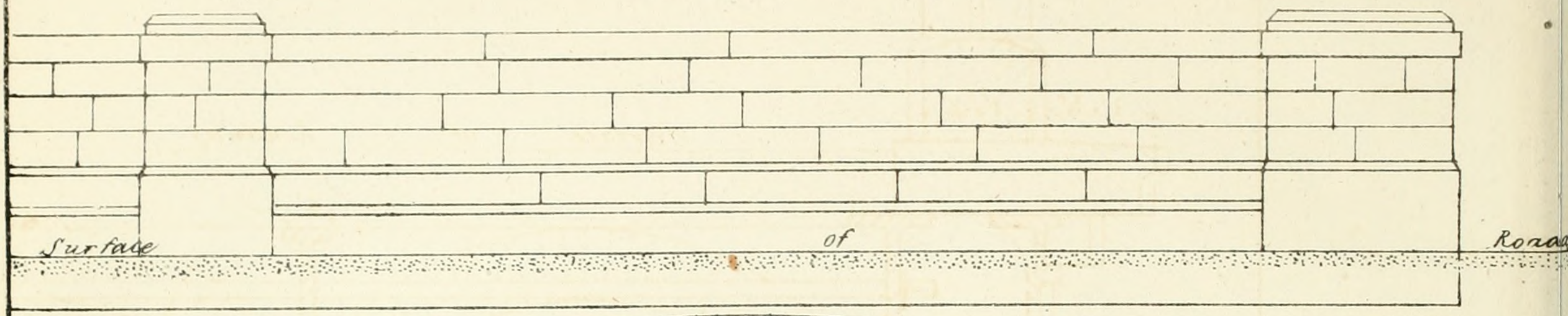
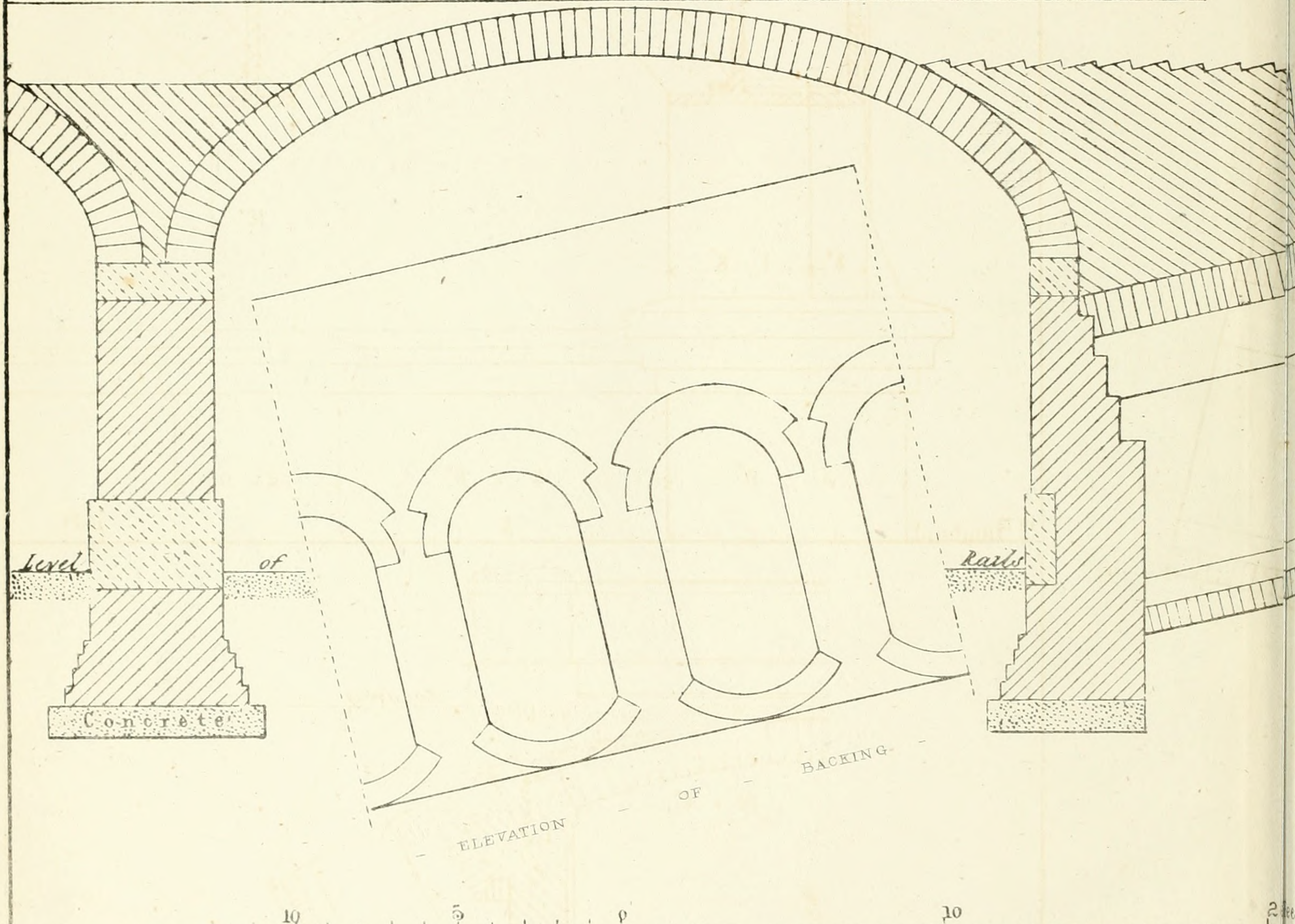
Bloomsbury

- FIG - 1 -

- BRIDGE - FOR - ' NTENDED - STREET - ON - THE - DUKE - OF - BEDFORD'S - EST

- LONGITUDINAL SECTION -





- ELEVATION - OF - BACKING -

10 5 0 10 2

- ALTERATIONS - MADE - IN - EXECUTION - TO - BRIDGES - UPON - THE - EX

- OF - THE -

- LONDON - AND - BIRMINGHAM - RAILWAY. -

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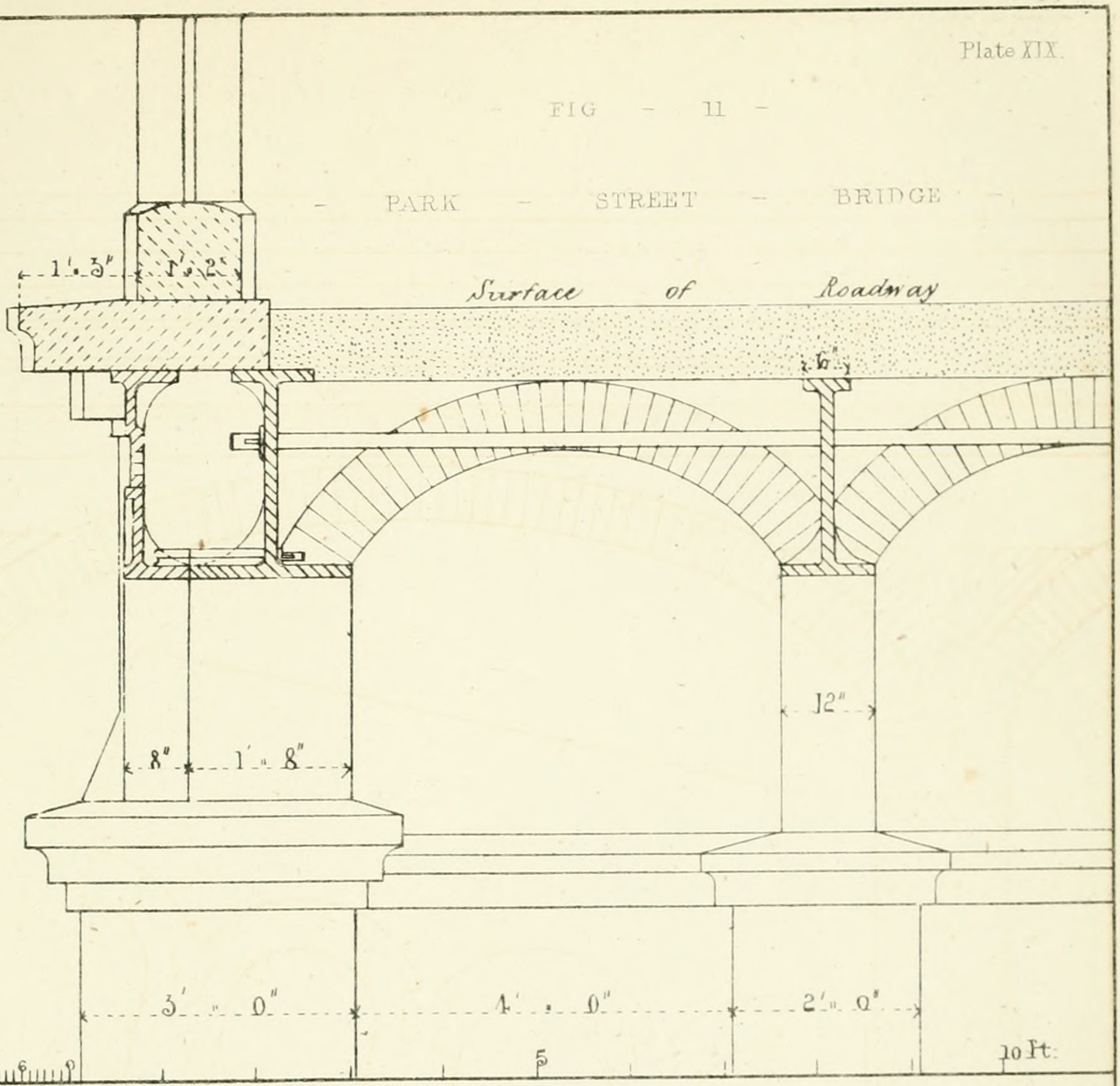
FIG - II -

- PARK - STREET - BRIDGE -



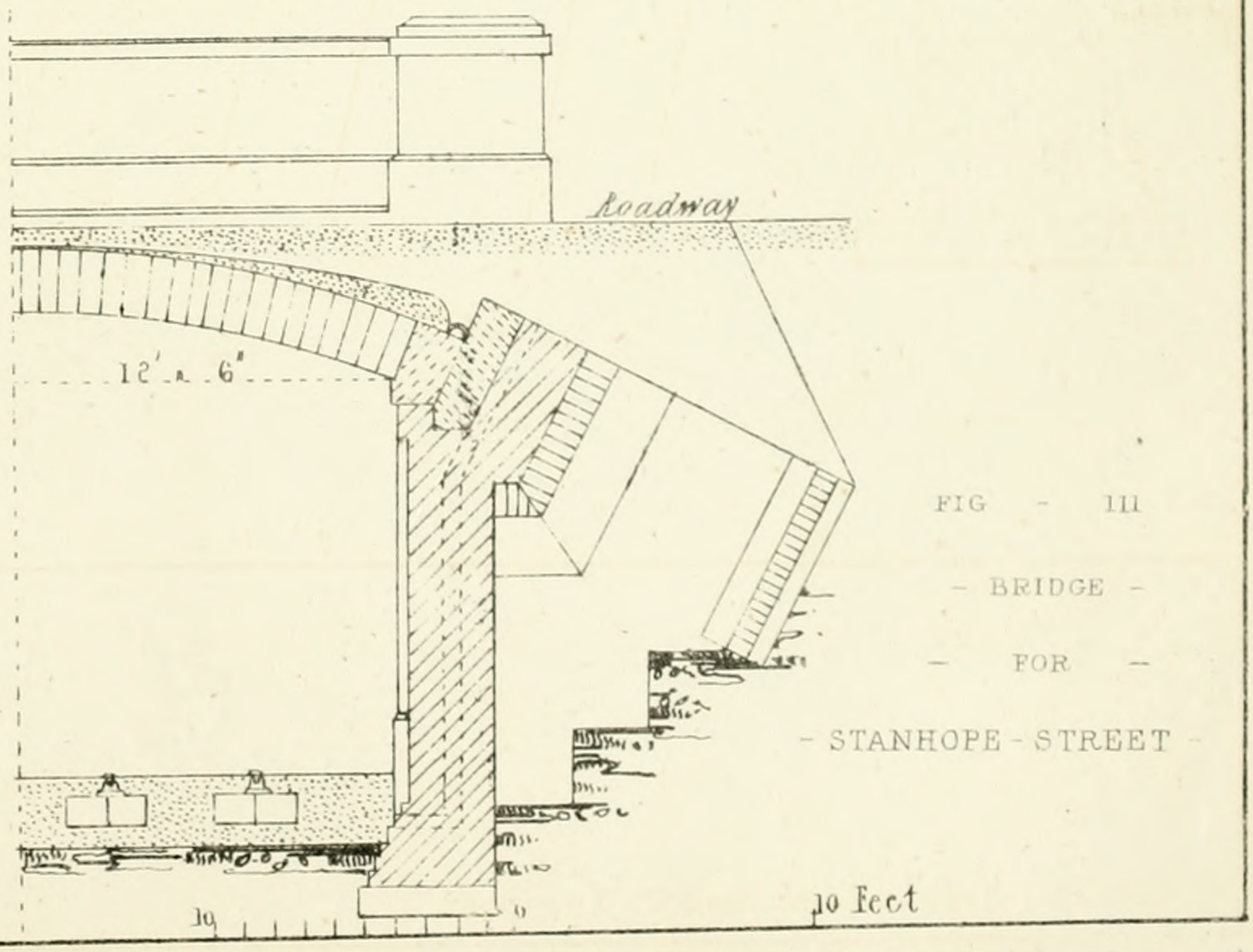


FIG - III

- BRIDGE -

- FOR -

- STANHOPE - STREET -

eet

NSION -

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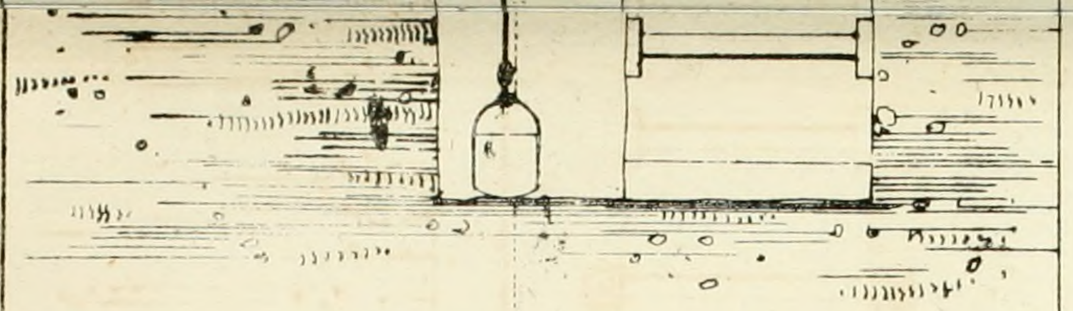


FIG - II -

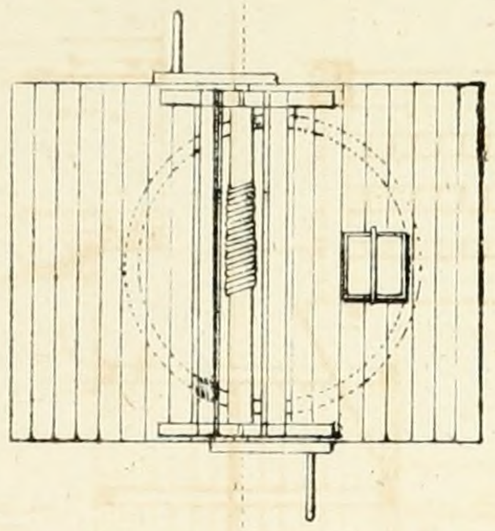


FIG - III -

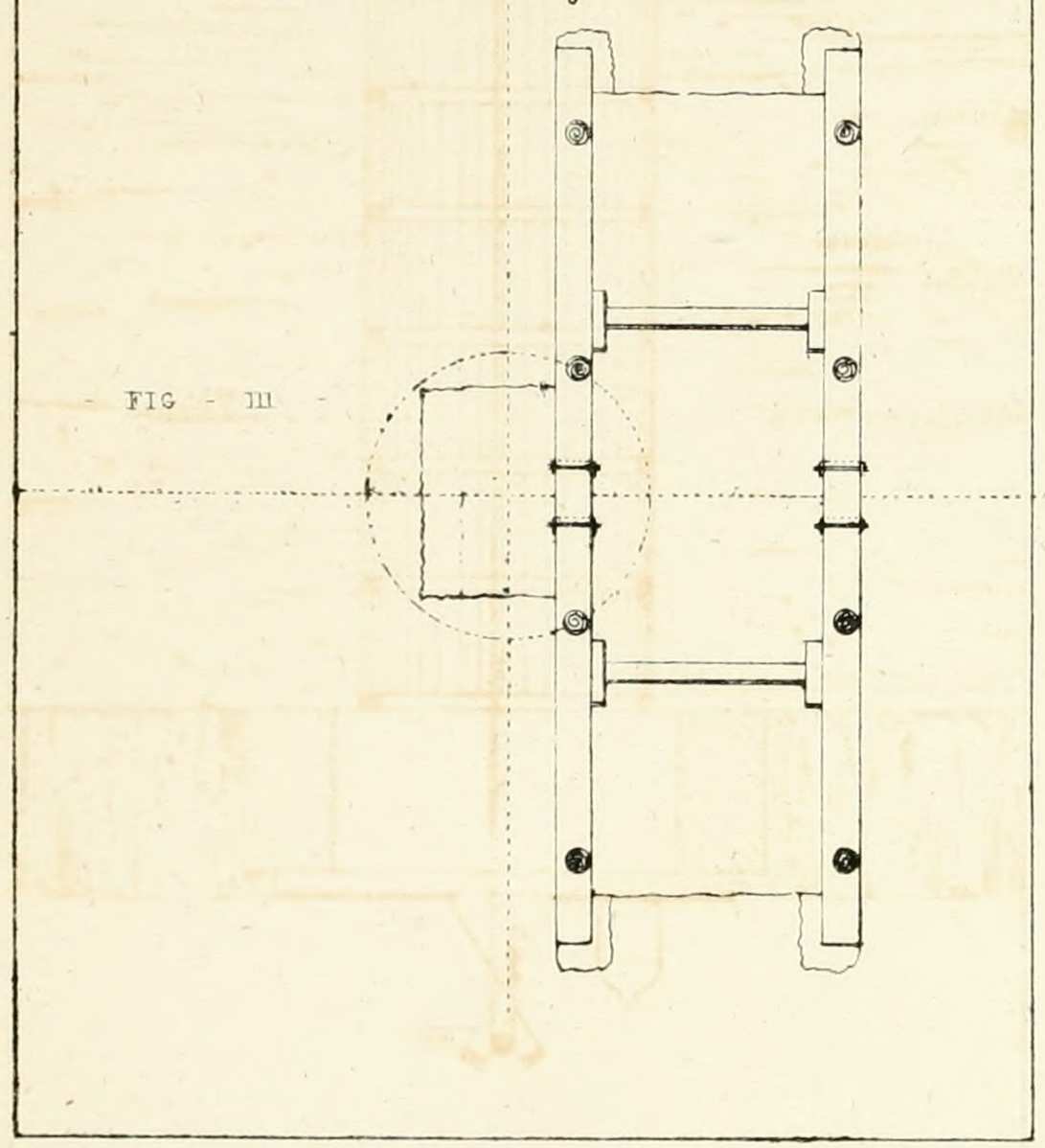
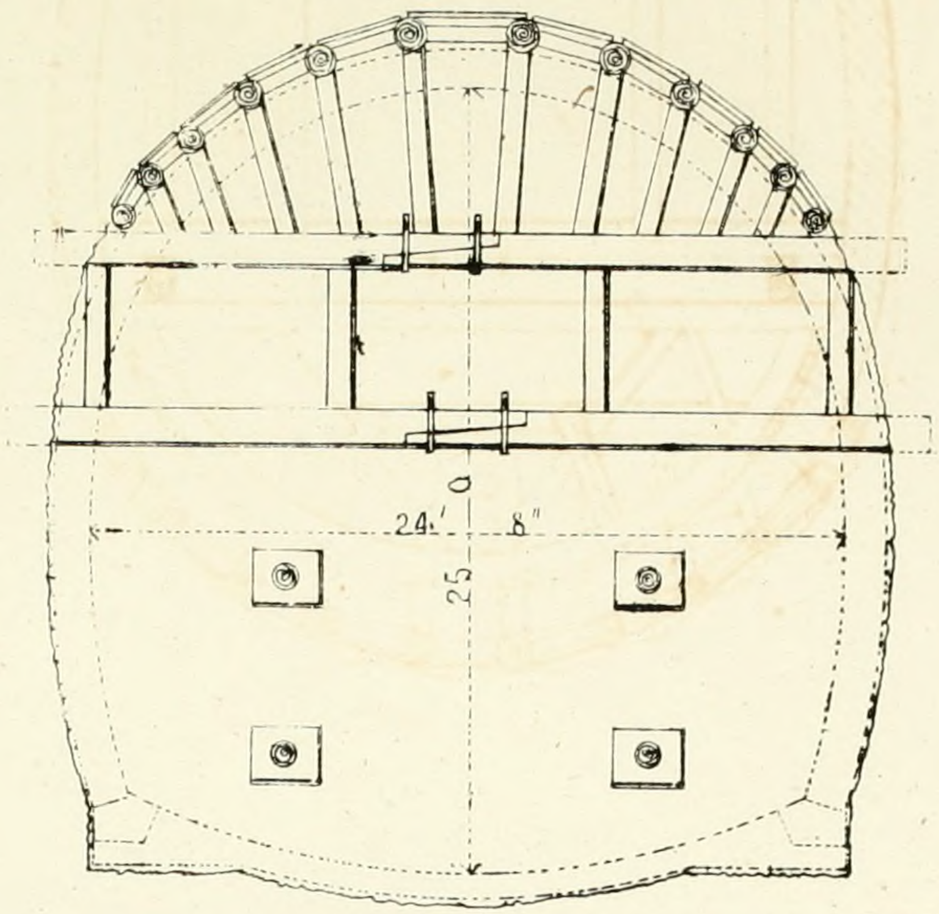


FIG - VI -



METHOD - OF - WORKING - THE - PRIMROSE-HILL-TUNNEL -
- UPON - THE - L - & - B - RAILWAY -

Scale of 0 5 0 10 20 30 40 50 feet

Robert Stephenson Esqrs Engineer

John Williams, Library of Science & Art, No 106, Great Rus

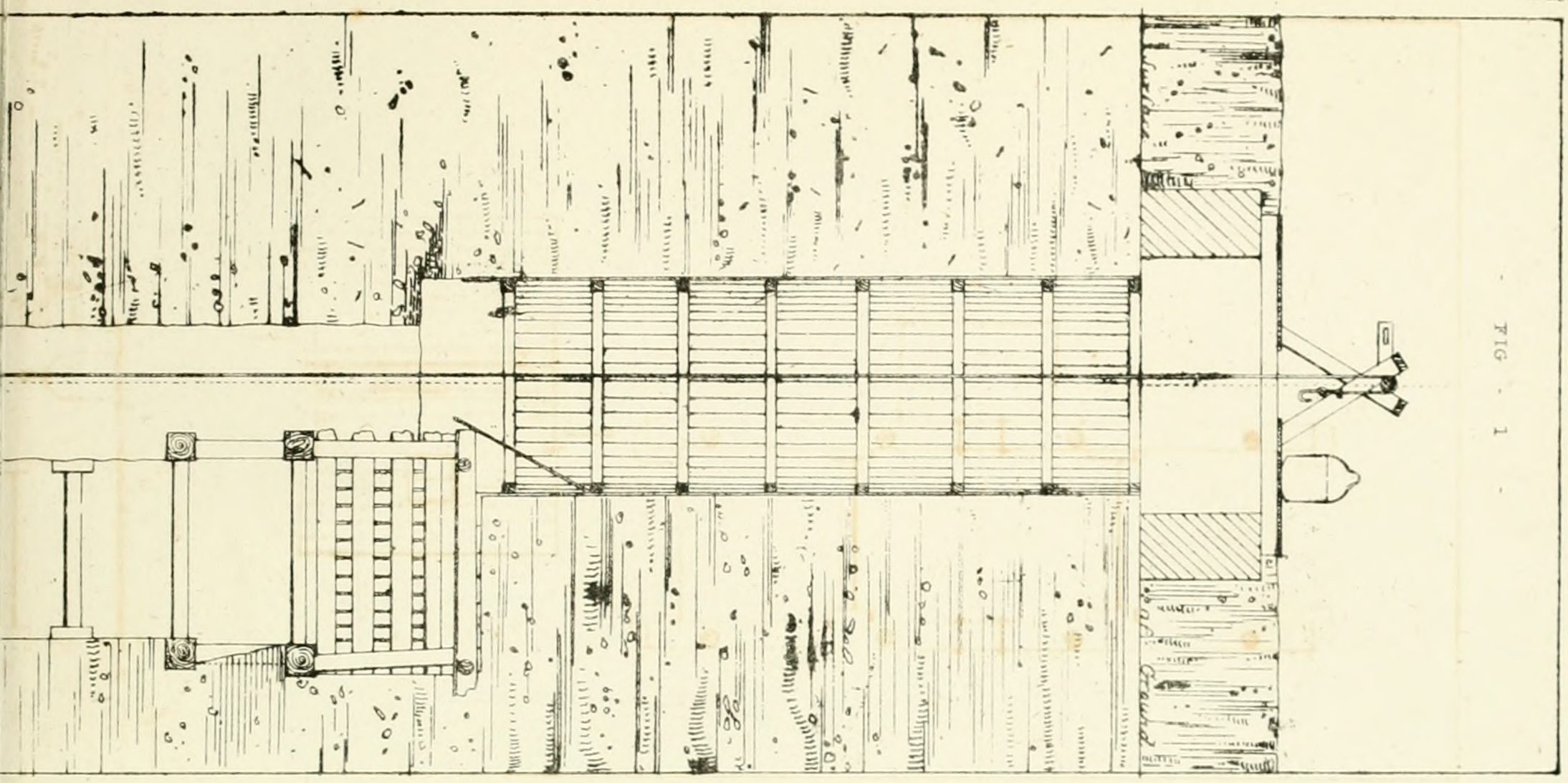


FIG - I -

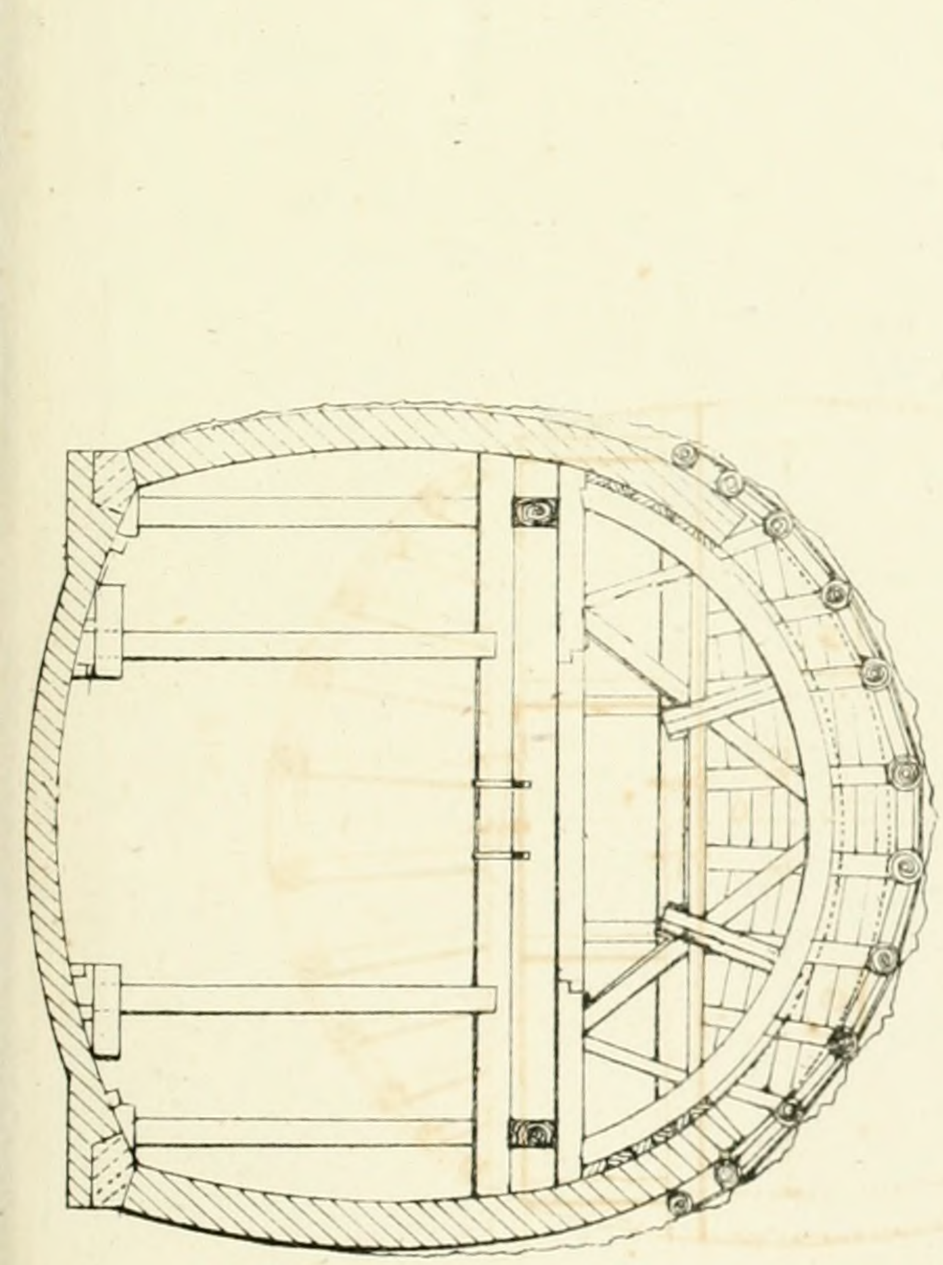


FIG - V -

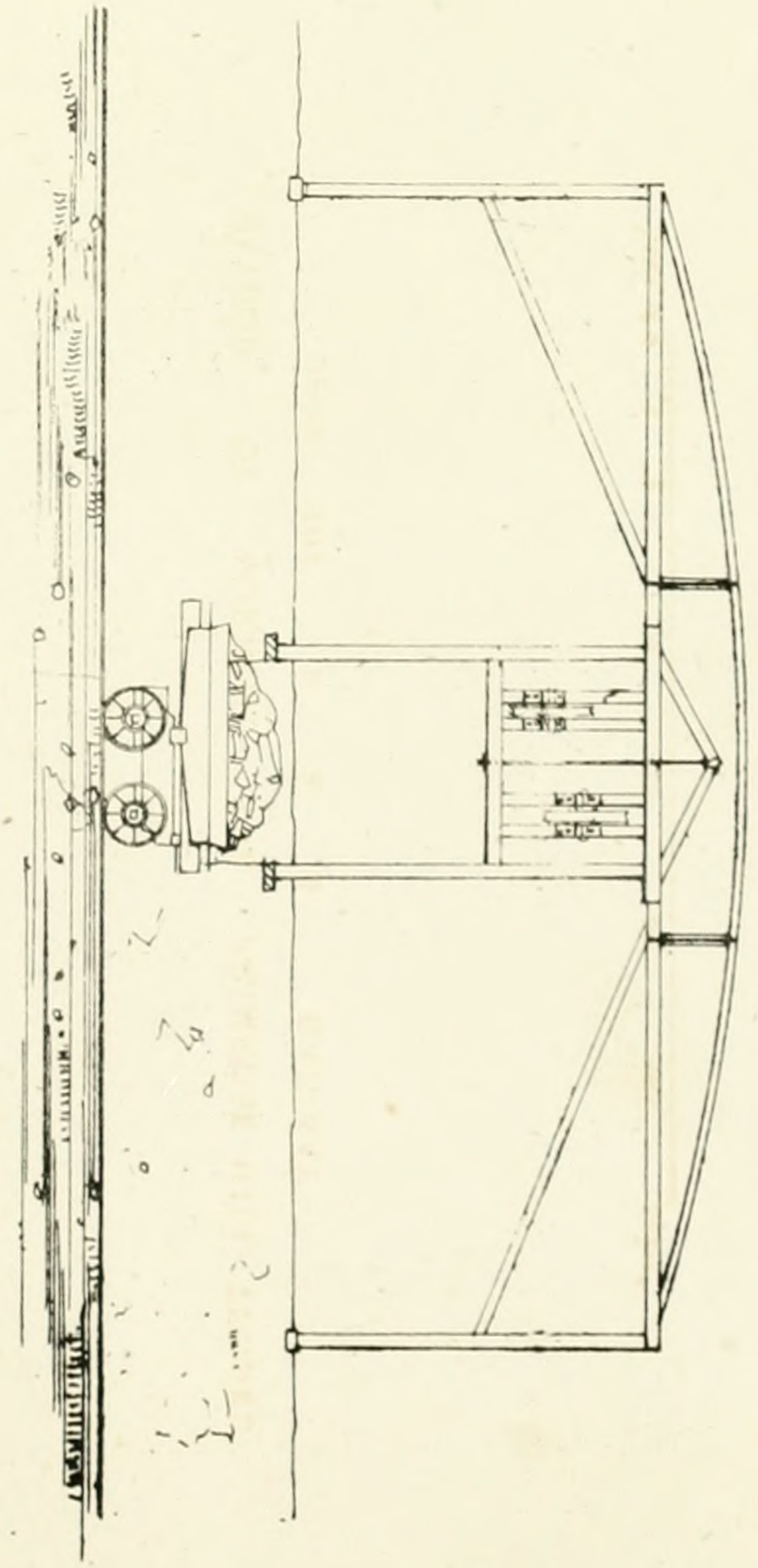


FIG - IV -

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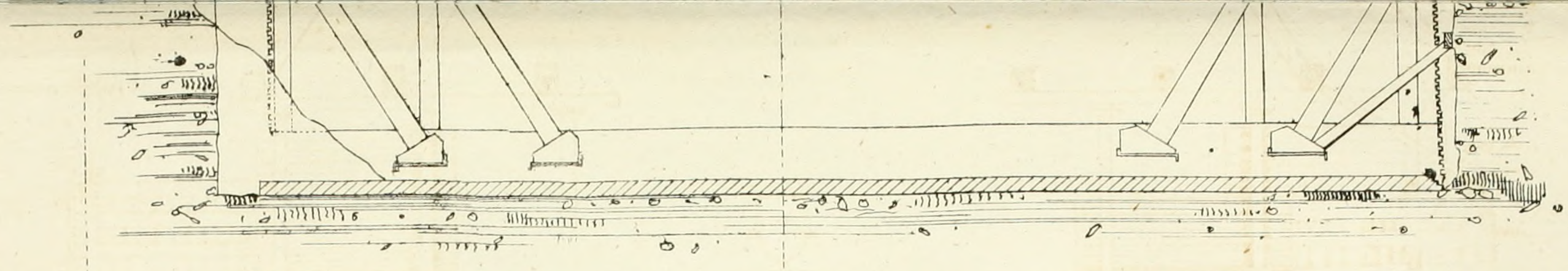
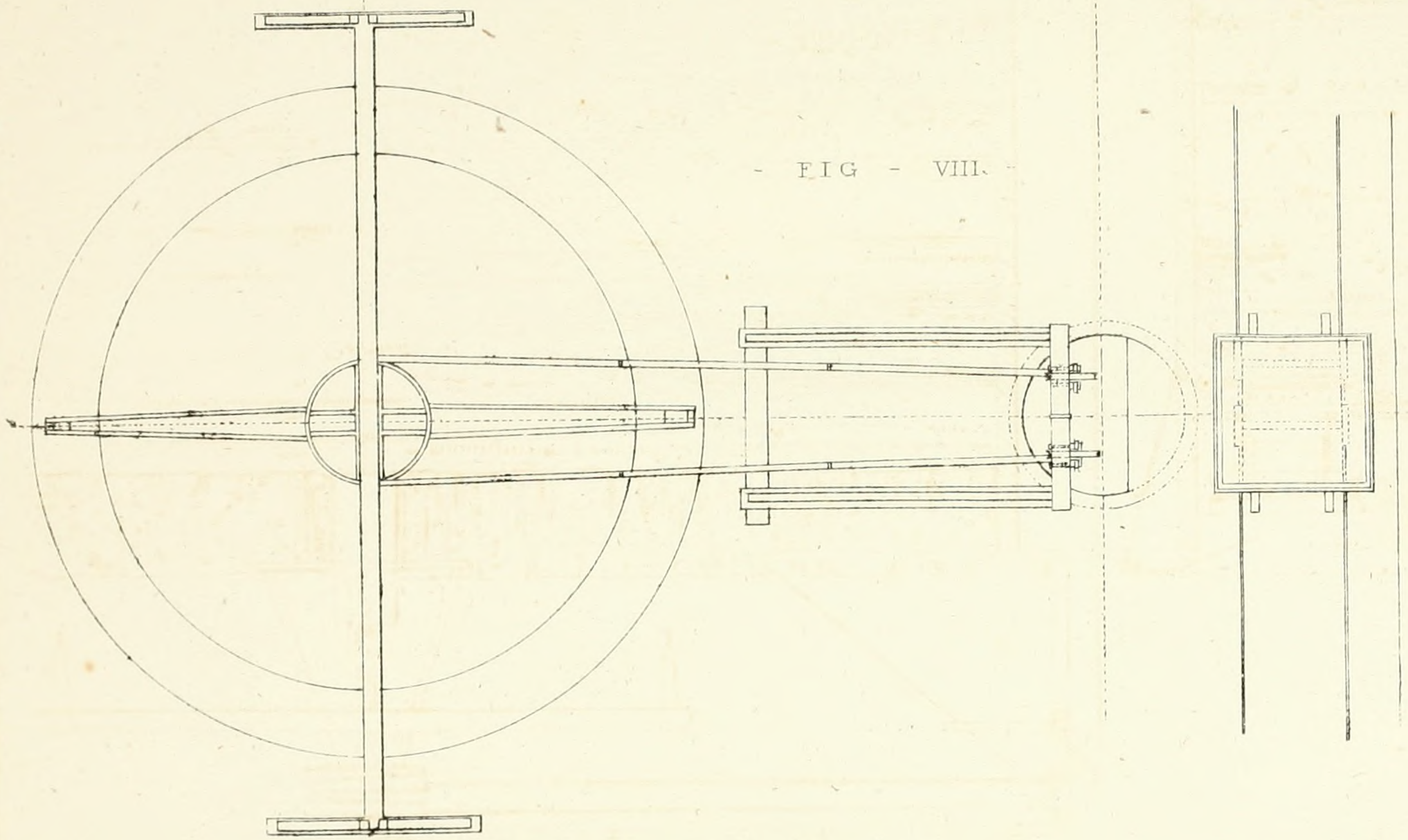


METHOD - OF - WORKING - THE PRIMROSE - HILL - TUNNEL -

FIG - VIII.



Scale of 10 0 10 20 30 40 50 Feet

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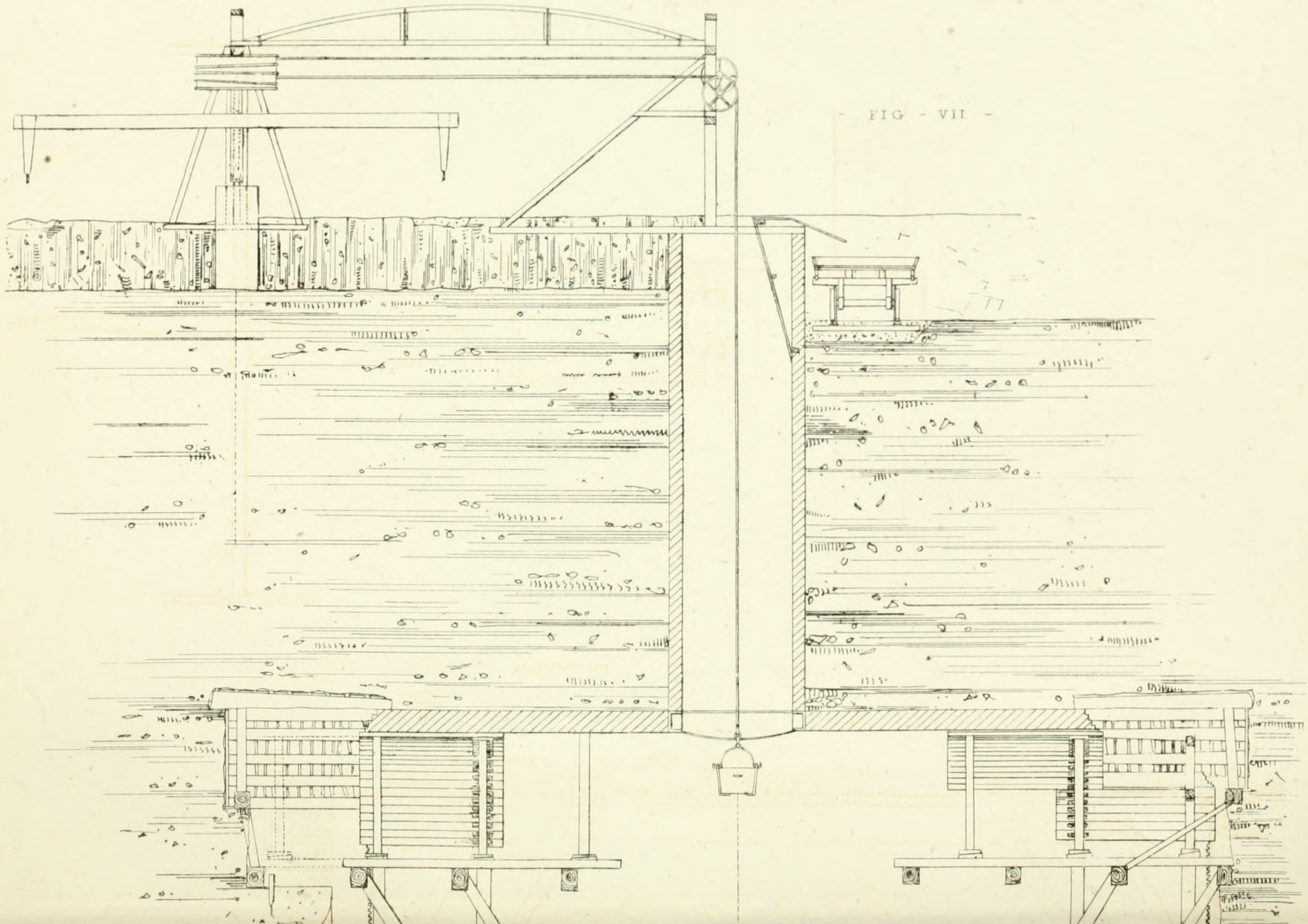
Plate XXI

- LONDON - AND - BIRMINGHAM - RAILWAY -

- FIG - VII -



Printed by W. Clerk 202 High Holborn

Published by J. Weale 59 Bloomsbury

6'

100 Fe

Iron Bolt

2"

3/4"

1' " 6"

2 1/2"

2 1/2"

- A -

6"

2 1/2"

2 1/2"

- B -

- SECTIONS - AT -

2"

- C -

1' " 6"

3"

3"

7"

2 1/2"

1 3/4"

1 3/4"

2 1/2"

3/4"

3/4"

3/4"

Iron Bolt

Stone

1'-9"

8"

Line of Rails

1'-2"

3'

DRAIN

4'

Oxford Road

9' " 11"

21' " 5"

at Springing

Radius 27' 6"

Plate

Plate XXII.

DETAILS OF IRON PLATES FOR FRONTS L AND B RAILWAY

Each ring is to contain 5 courses of brick's more than the rag bond

Scale of 12" 6' 0

TUNNEL.

ELEVATION.

PLAN

Robert Stephenson Esqre
Engineer

Iron Bolts

Iron Plate

Iron Bolts

Radius - 11' 9"

& Art. N°106 Gt Russell St Bloomsbury

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- HALF - PLAN - UNDER - COPING -

- HALF - PLAN - AT - FOUNDATIONS

Line

Centre

Line of Railway

Brick on edge

Foot of Embankment

14' 0"

17' 6"

17' 6"

4' 6½"

5' 0"

3' 0"

3' 0"

6' 9"

6' 4"

5' 11½"

3' 2"

3' 0"

2' 5"

1' 10"

2' 3"

- SEC. WING-WALL -

1' 6"

1' 10"

2' 7"

3' 4½"

4' 10"

5' 4½"

6' 0"

5' 9"

Batter one inch to the foot.

Robert Stephenson Esq: Engineer

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Plate XLII.

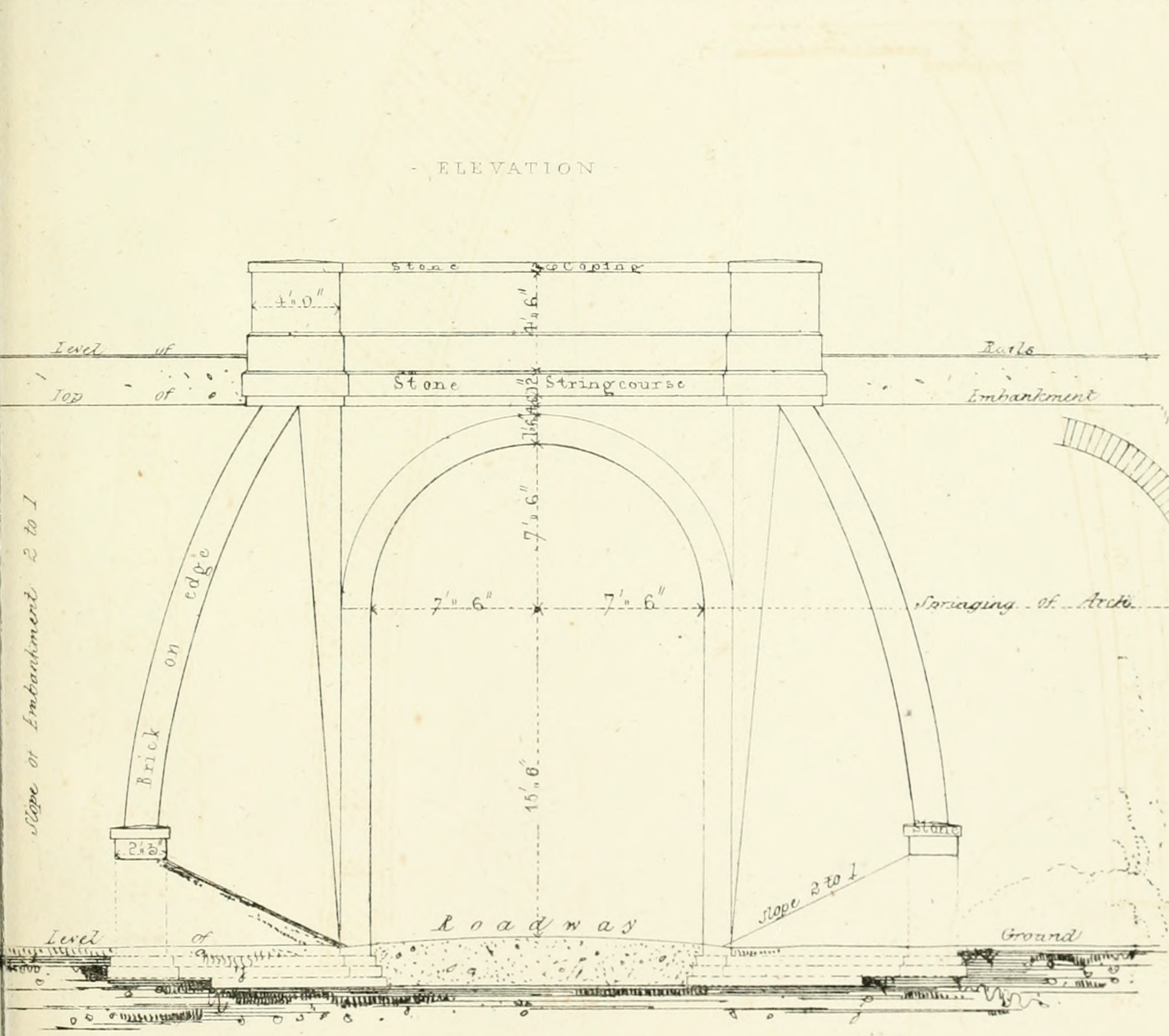
BRIDGE - FOR - THE - BOURNE - END - ROAD -

- UPON - THE LONDON - AND - BIRMINGHAM - RAILWAY. -

Scale of Feet

0 10 20 30 40 50

- ELEVATION -



- SECTION -



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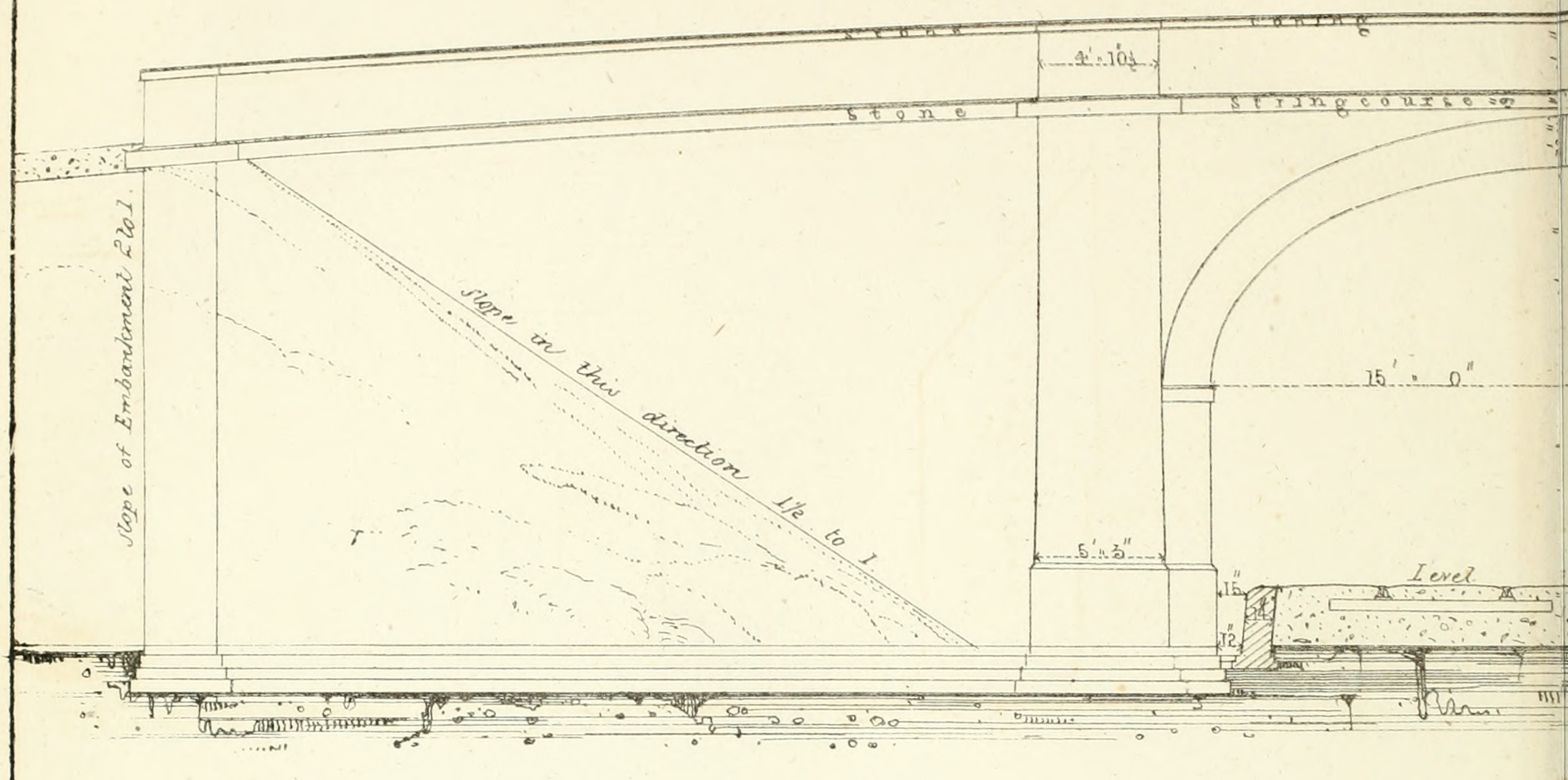
BRIDGE FOR HAXTERS END LANE UPON

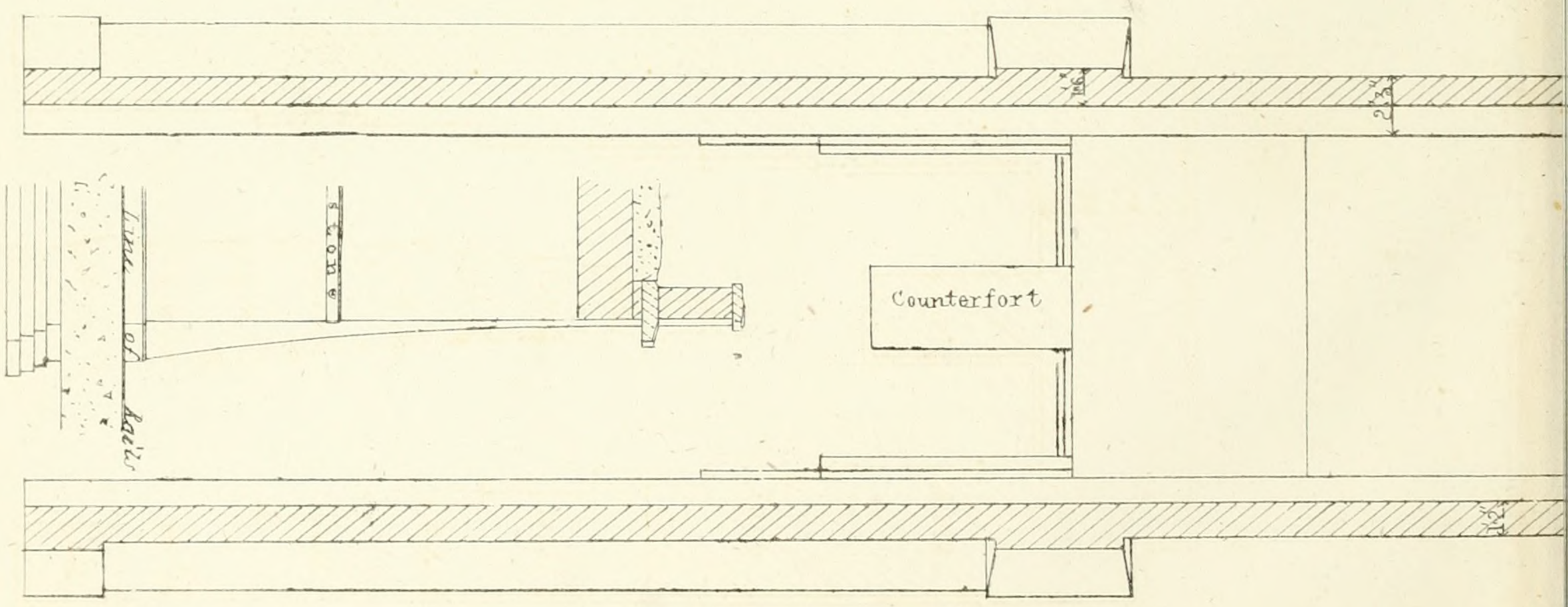
HALF ELEVATION



Scale

10 5 0 10

PART OF SECTION UNDER ARCH



HALF PLAN UNDER COPING

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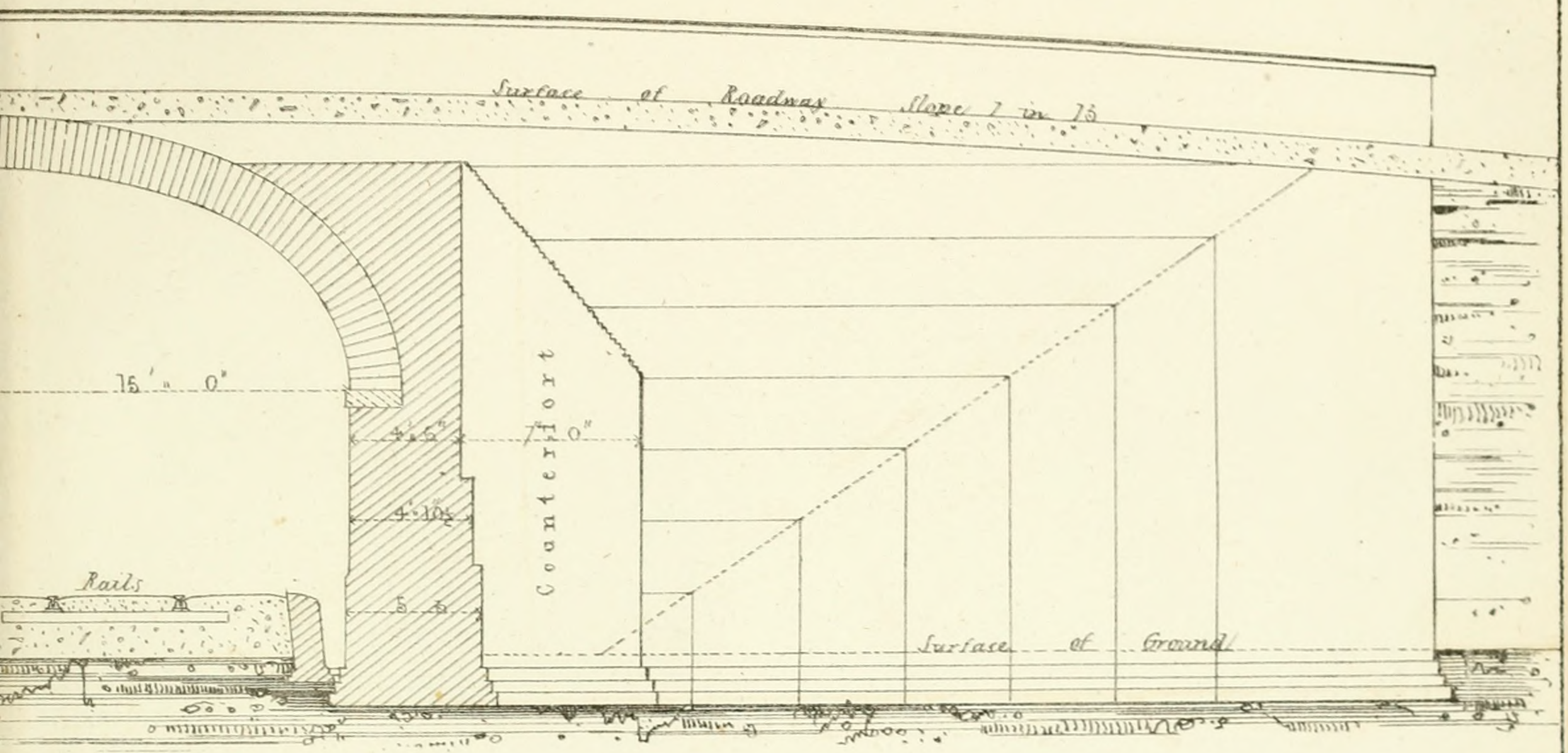
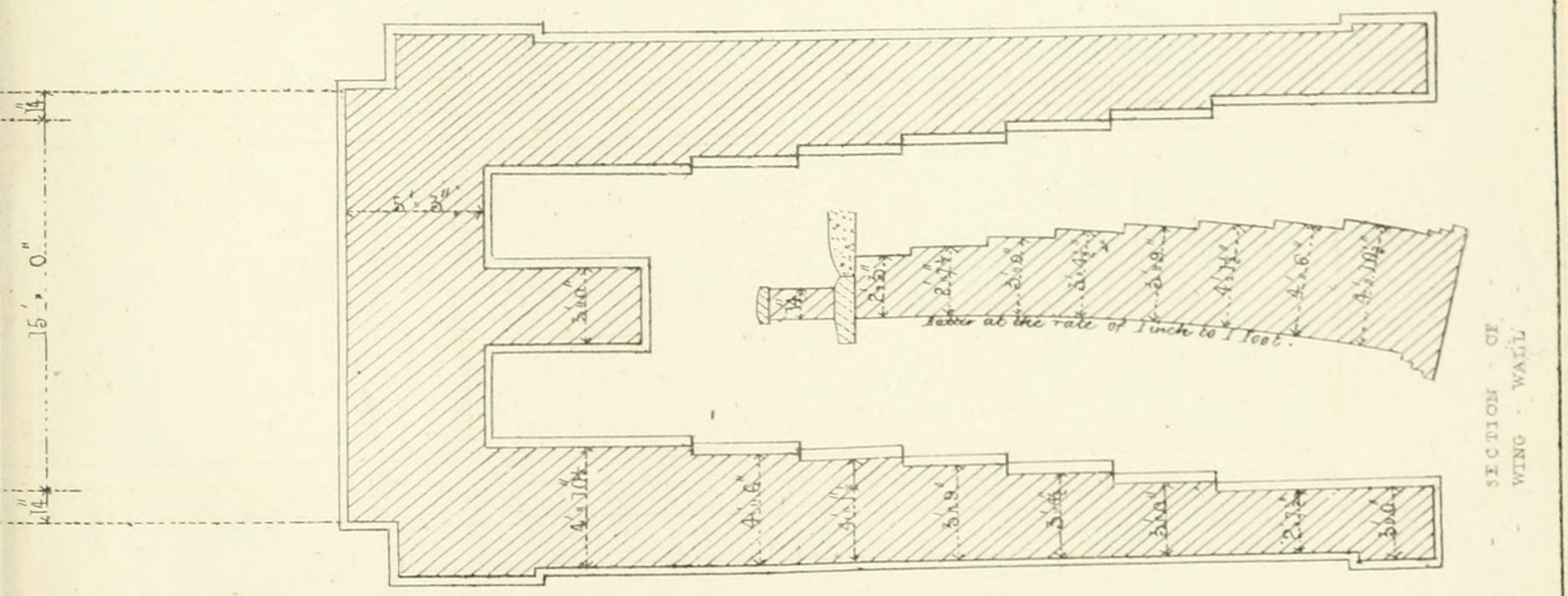
THE - LONDON - AND - BIRMINGHAM - RAILWAY

- HALF - SECTION -





- HALF - PLAN - AT - FOUNDATIONS -

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Slope ... of ... Approach 2 to 1

ELEVATION - AT + ...

SECTION - AT + ...

HALF - PLAN -

HALF - PLAN -

BRIDGE - FOR - ROAD -

L - &

Scale of Feet

0 10 20 30 40

Stone Coping

Brick on edge

Natural Surface

Level of Rails

Ditch

Ditch

Gravel

Line

Centre

Line

4'.4" 2'.3" 7'.0" 12'.0" 7'.0" 3'.0"

15'.0"

15'.0"

4'.2"

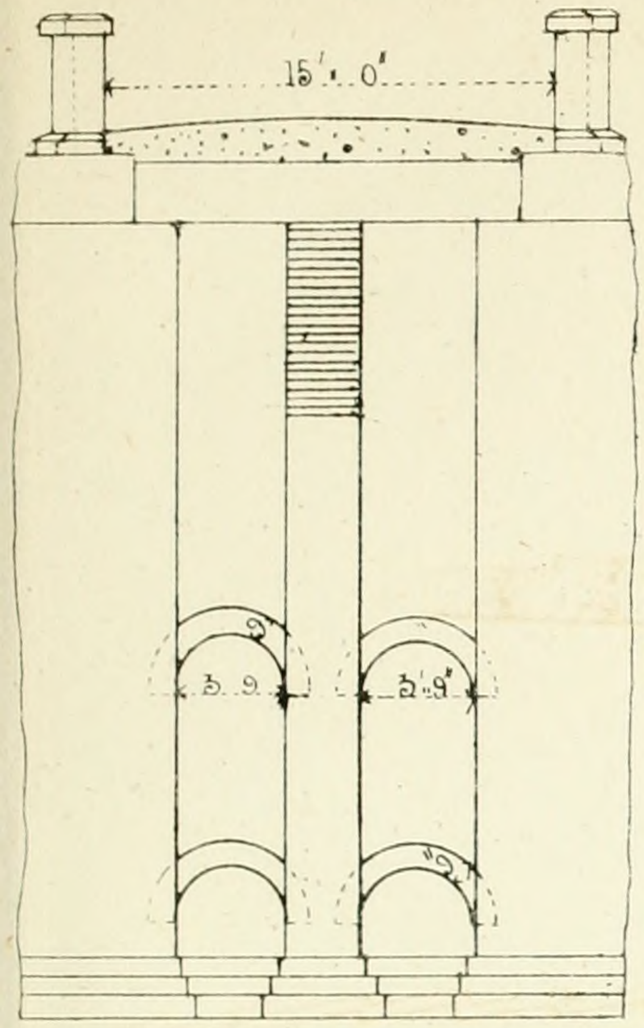
2'.3"

1'.6"

1'.6"

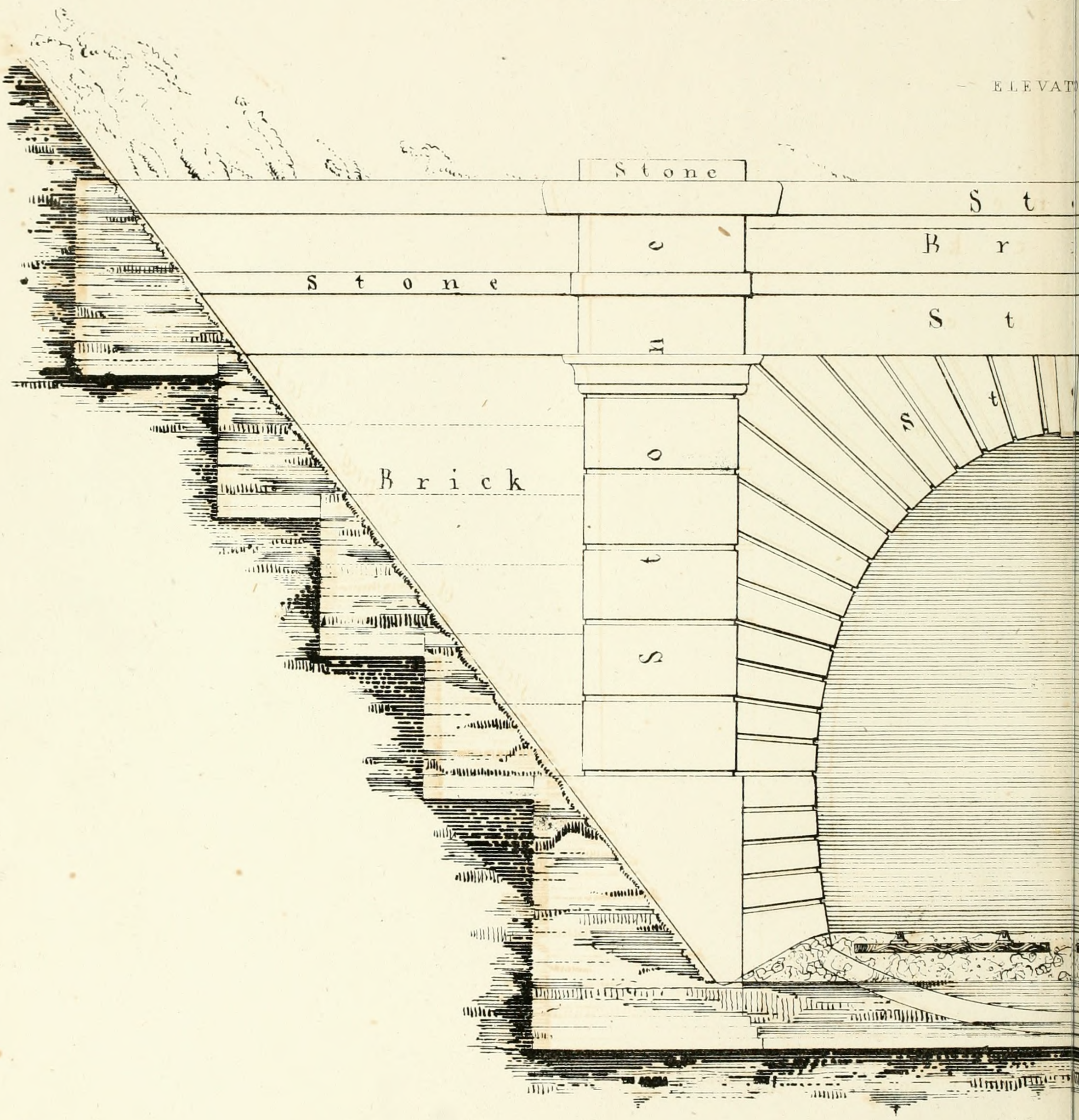
Plate XXV

Slope of Approach 2 to 1



- FRONT - OF - NORTHCHURCH - TUNNEL - UPON

- ELEVATI



Scale : being 1½

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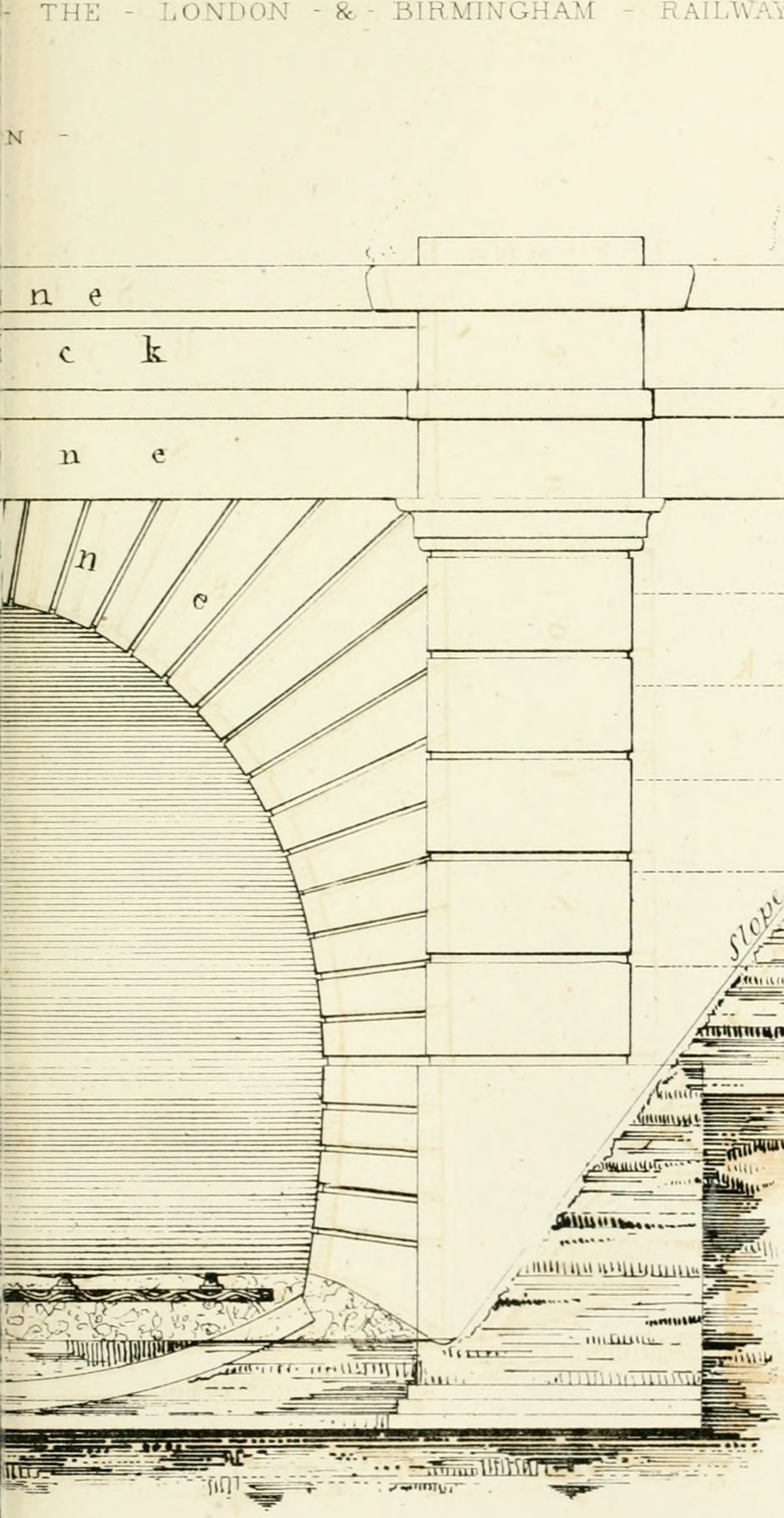
- THE - LONDON - & - BIRMINGHAM - RAILWAY -

N -



inches to 10 Feet.

20 30 40 Feet

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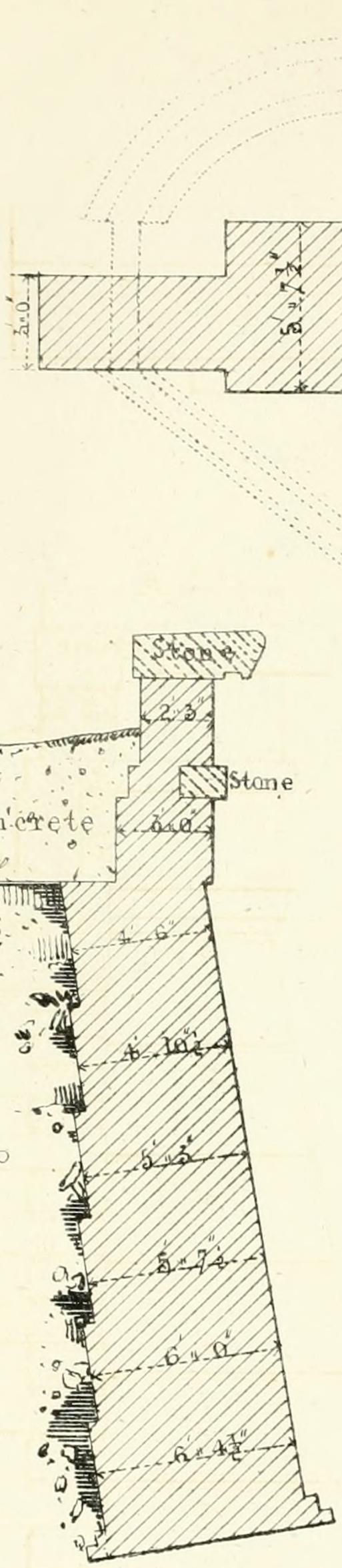
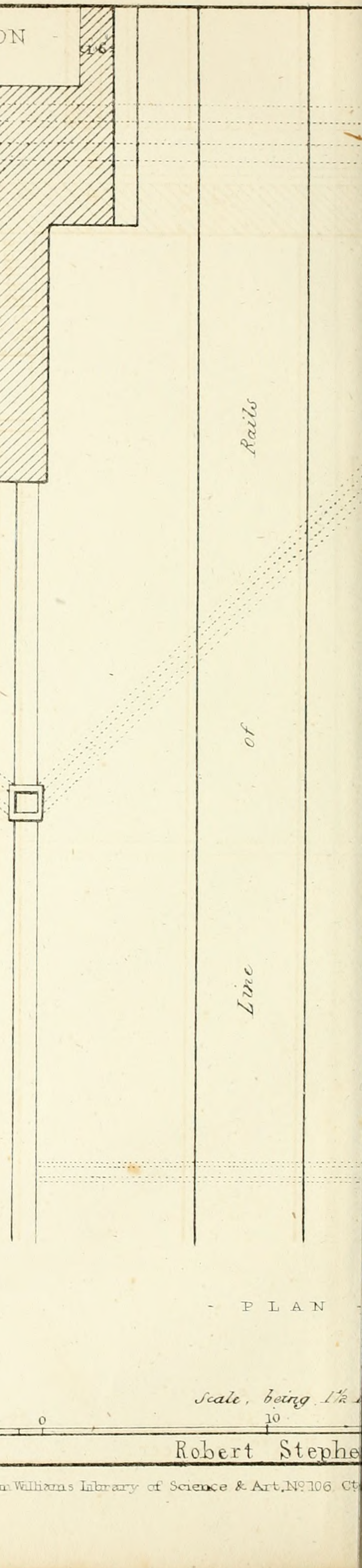
FRONT - OF - NORTHCHURCH - TUNNEL - UPON -



- SECTION -

AT O-------O



- AT - FOUNDATIONS -

- PLAN -

Scale, being 1½ in

10 5 0 10

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THE - LONDON - & - BIRMINGHAM - RAILWAY

Plate XXVII.

in cement

Stone

Stone

Batter of Wing Wall

Batter

Batter of Plinth

Rails

Line

UNDERNEATH - CORNICE

- LONGITUDINAL -

- SECTION -

Stone

Stone

Concrete

Drain laid in cement

Level of Rails

res to 10 Feet.

20 30 40

on Esqre Engineer.

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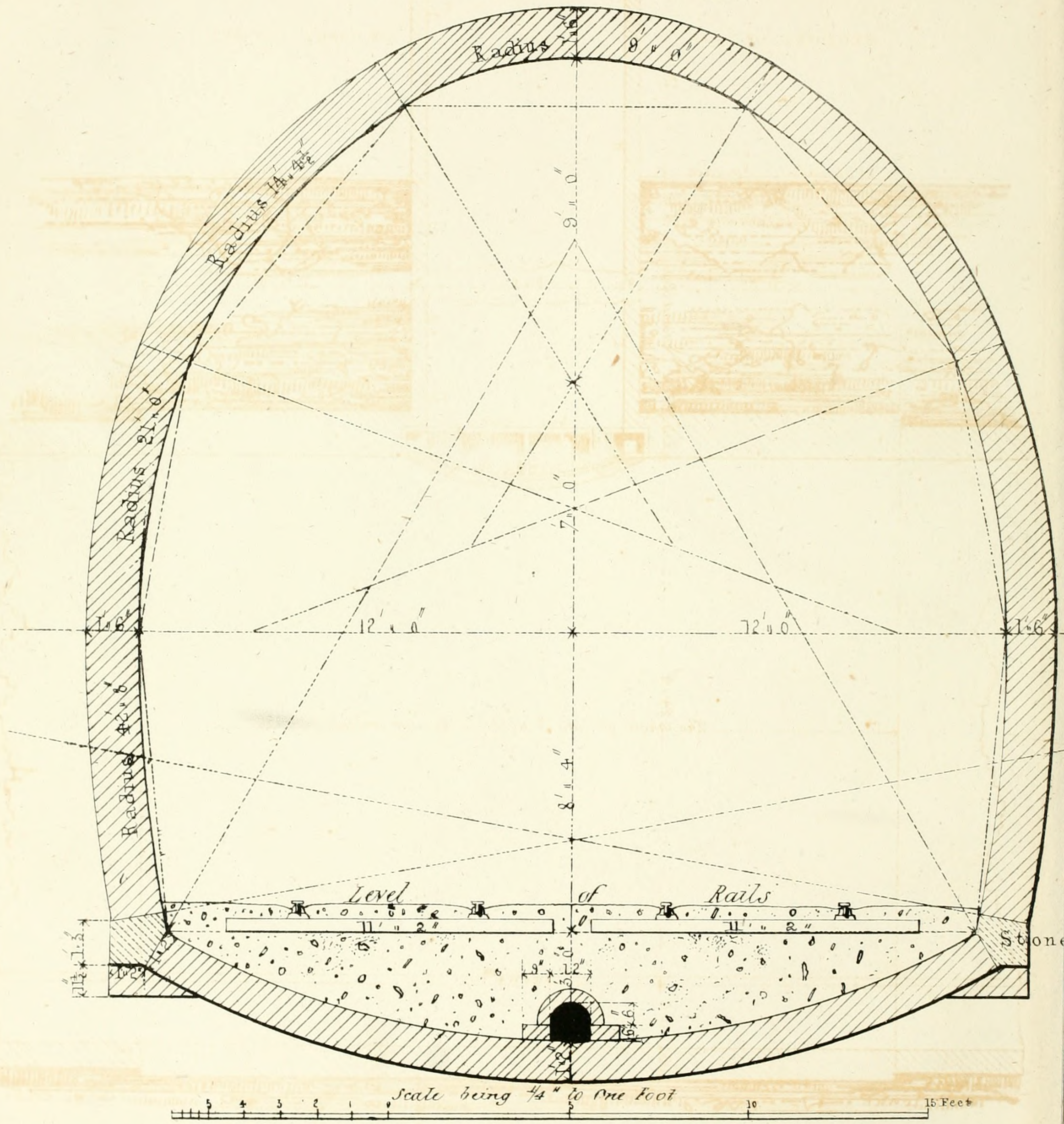
FRONT - OF - NORTHCHURCH - TUNNEL - UPON - TH

CROSS - SECTION - OF - TUNNEL -



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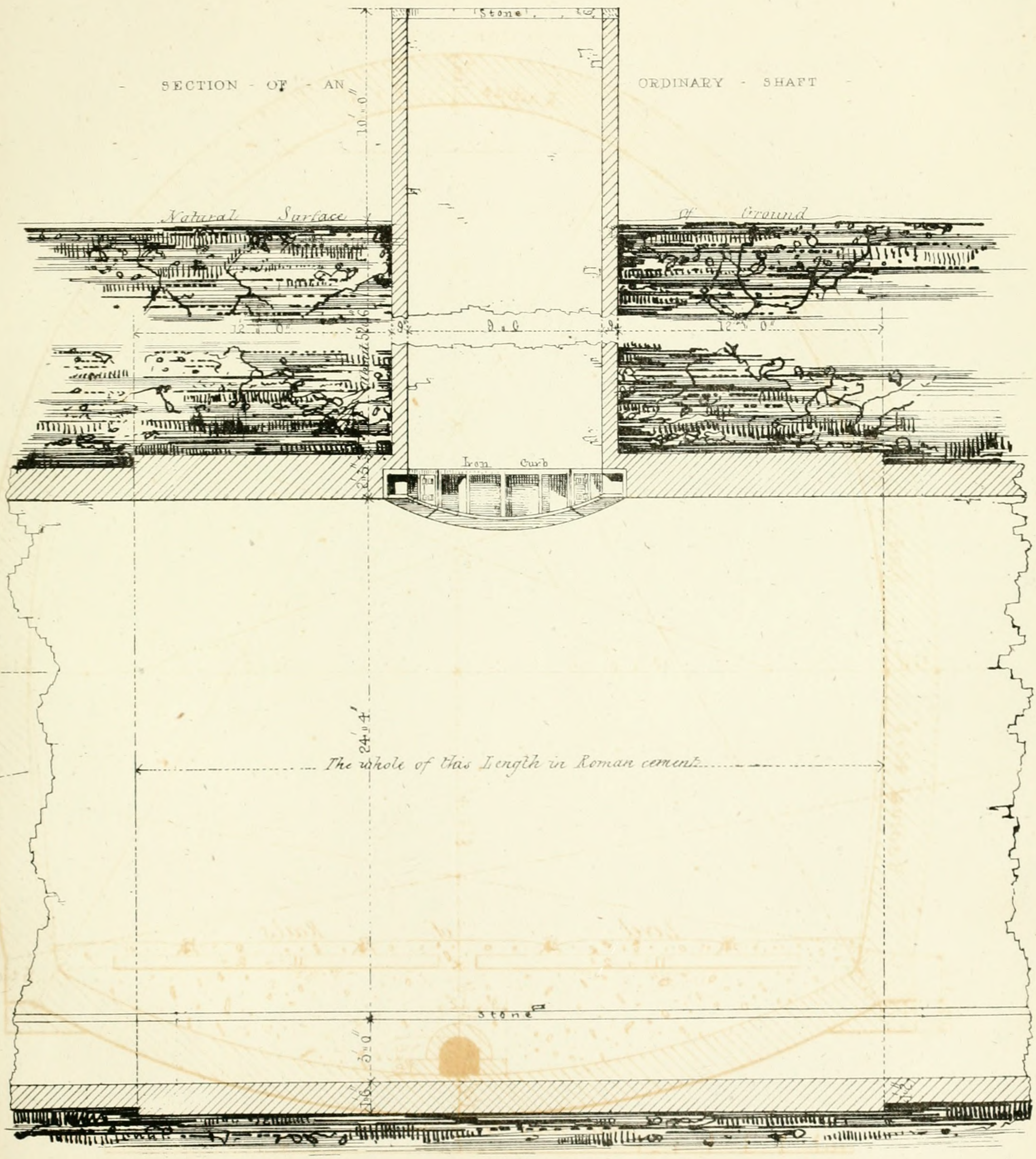
LONDON AND BIRMINGHAM RAILWAY

SECTION OF AN ORDINARY SHAFT



Scale 1½" to 10 Feet.

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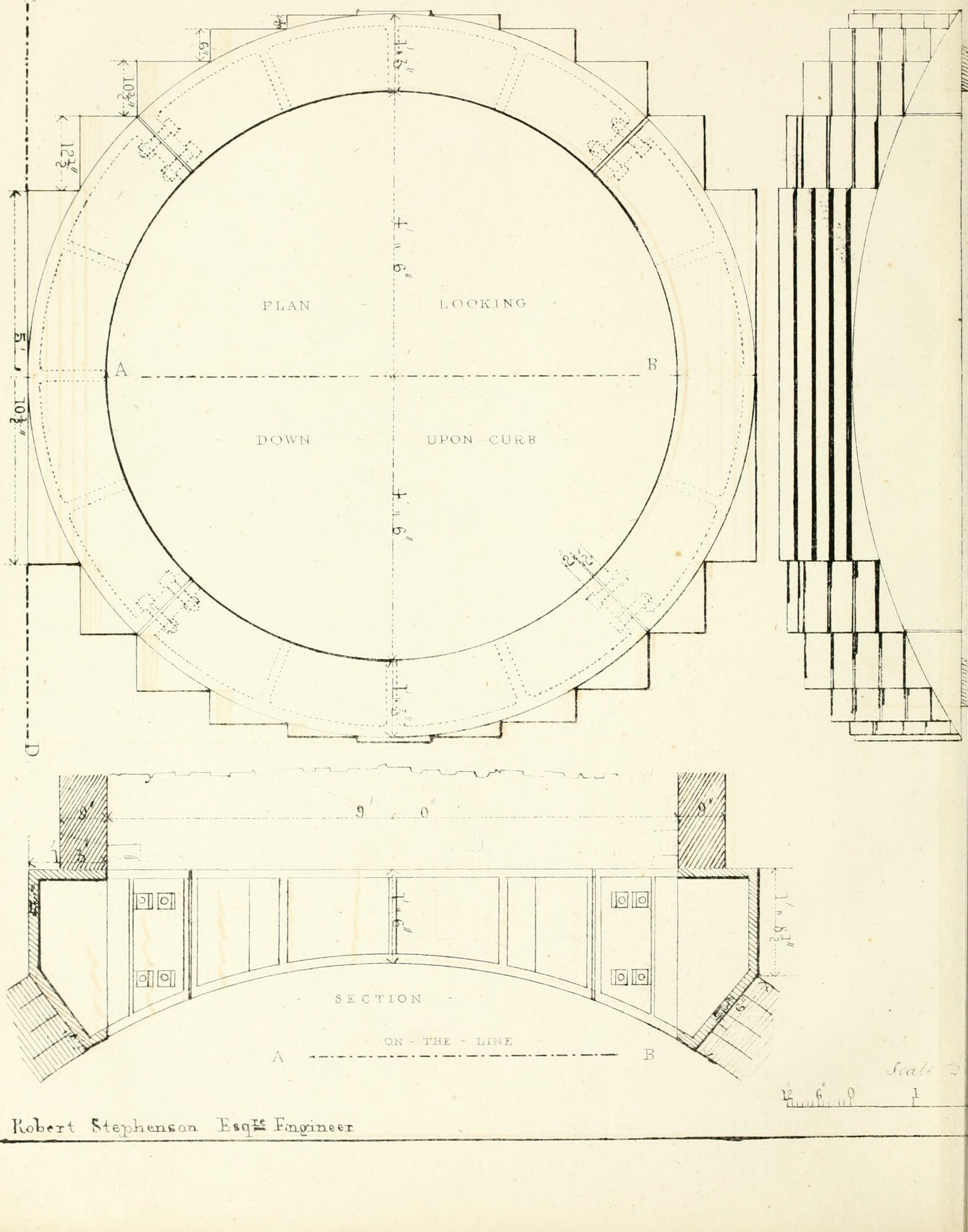
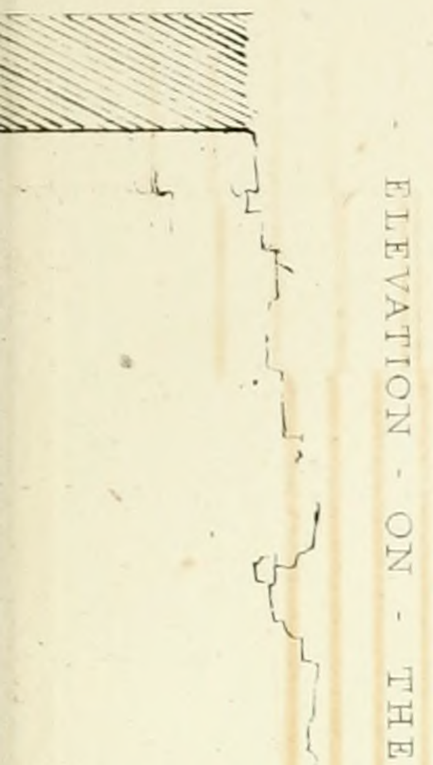
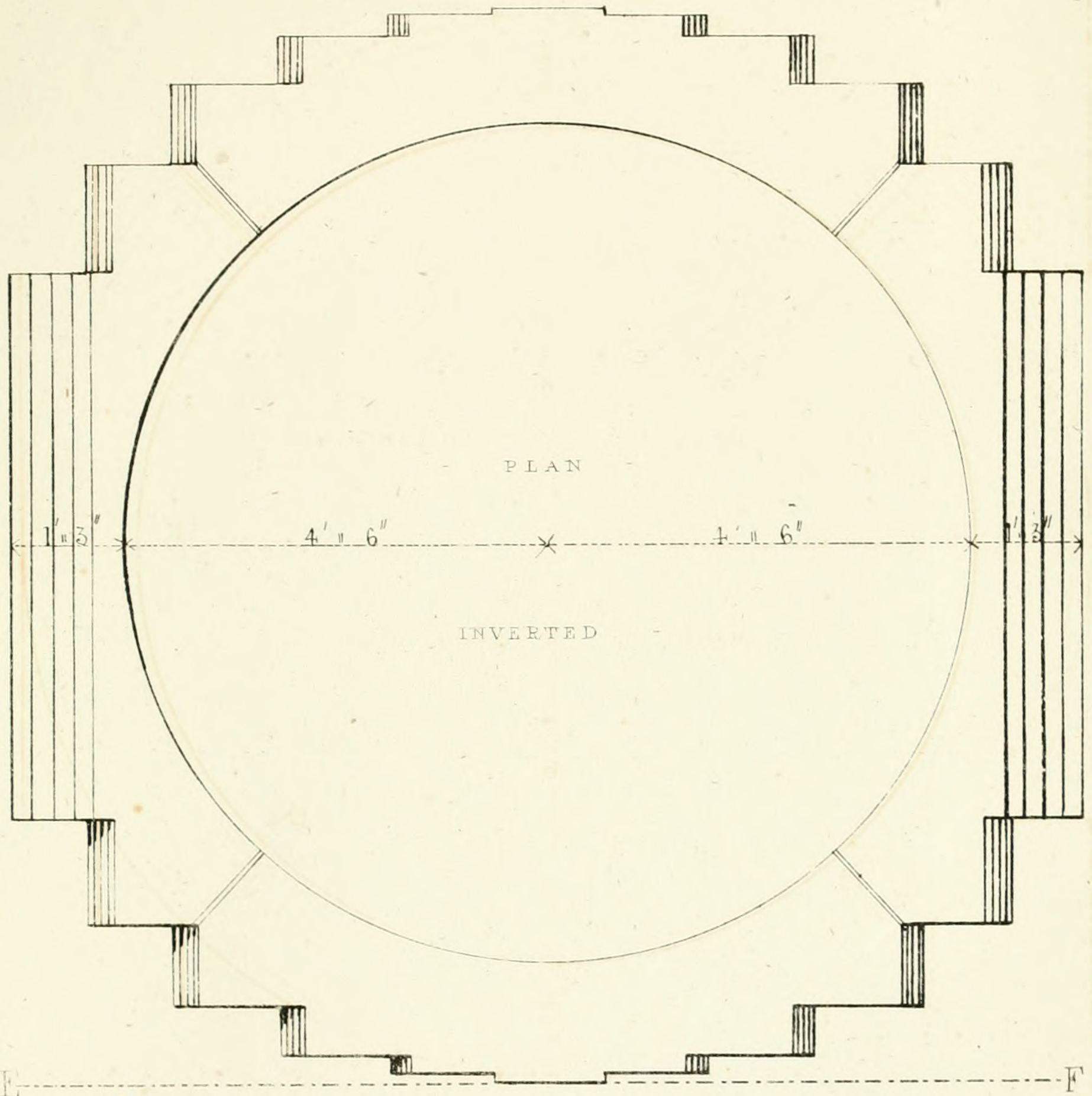
DETAILS - OF - NORTHCHURCH - TUNNEL - IR

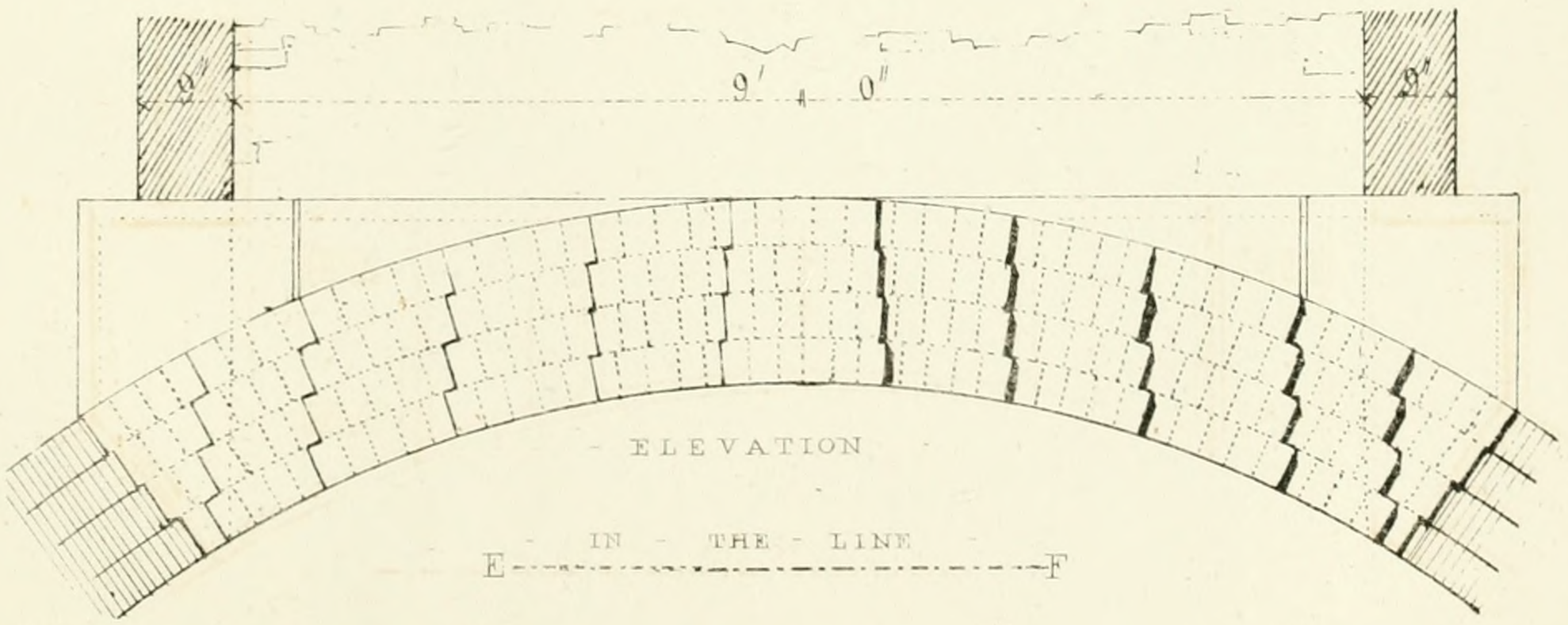


ON - CURBS - TO - SHAFTS -



ELEVATION - ON - THE - LINE - C





1 Foot.

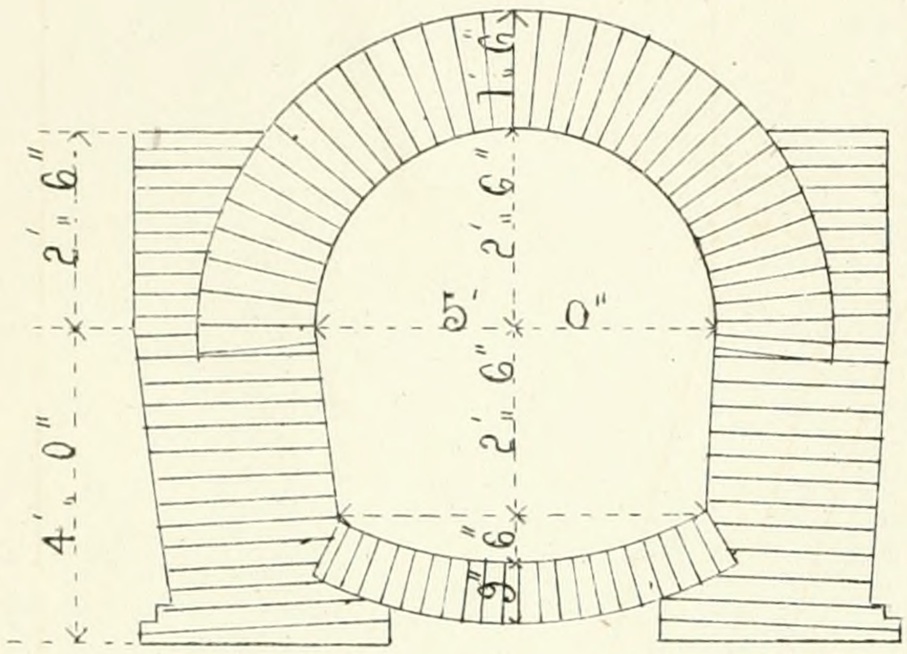
0 1 2 3 4 5 Feet.

CULVERTS - FROM - THE - LONDON - AND - BIRMINGHAM - RAILWAY -

Scale of Feet

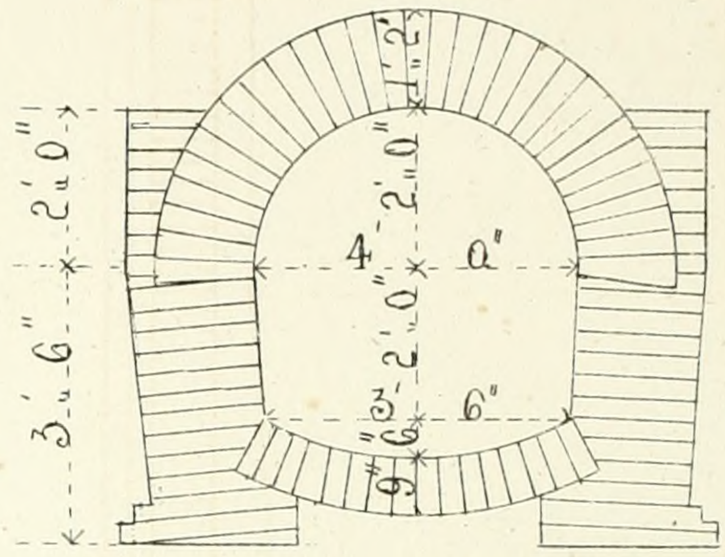
0 5 10 15 20

Robert Stephenson Esqre Engineer -



- SEC - OF - A - FIVE - FEET - CULVERT -

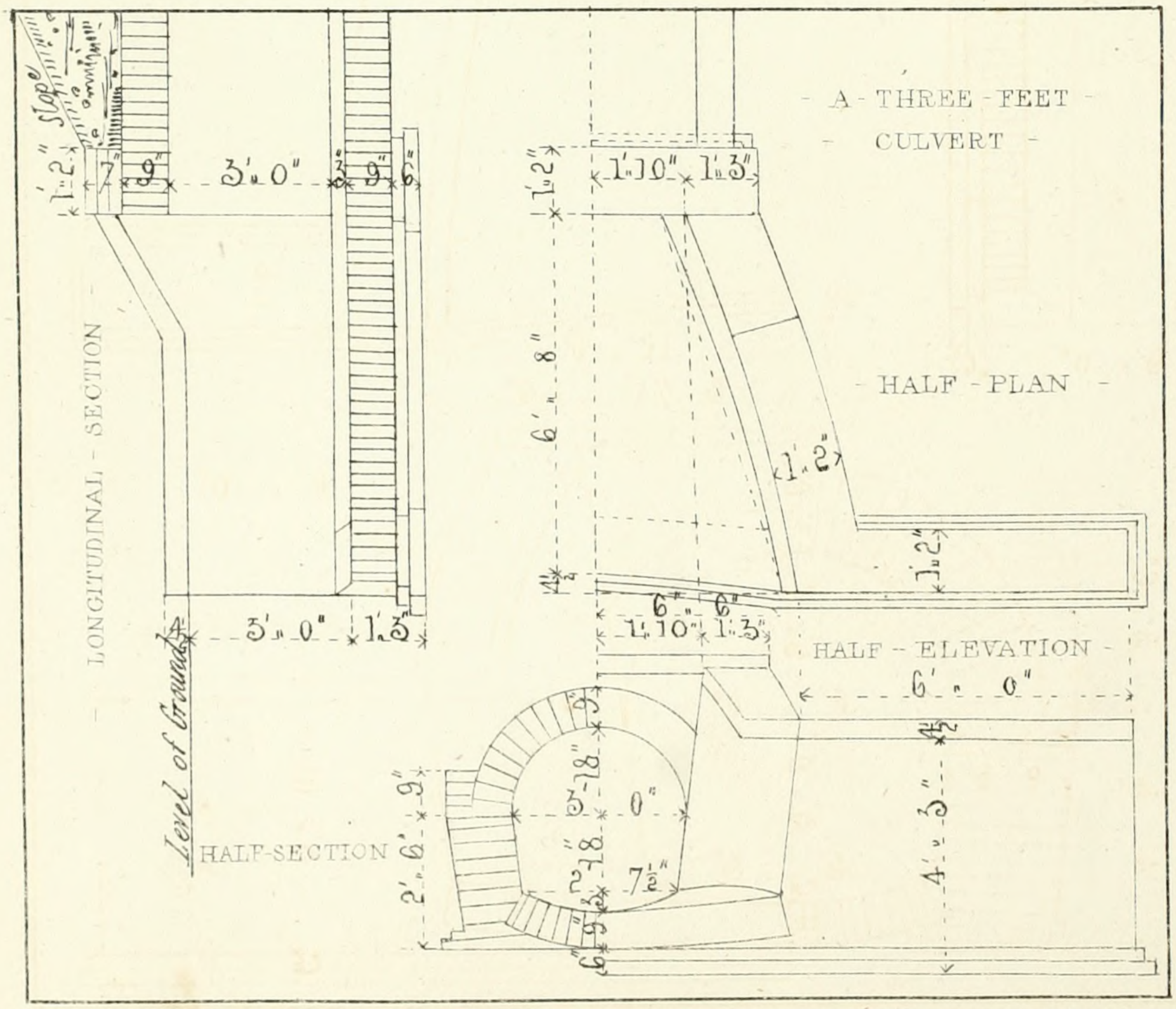
*Apron similar to that described for the 6 Ft Culv^t^*



- SEC - OF - A - FOUR - FEET - CULVERT -

*Apron similar to that described for the 5 Feet Culv^t^*

"



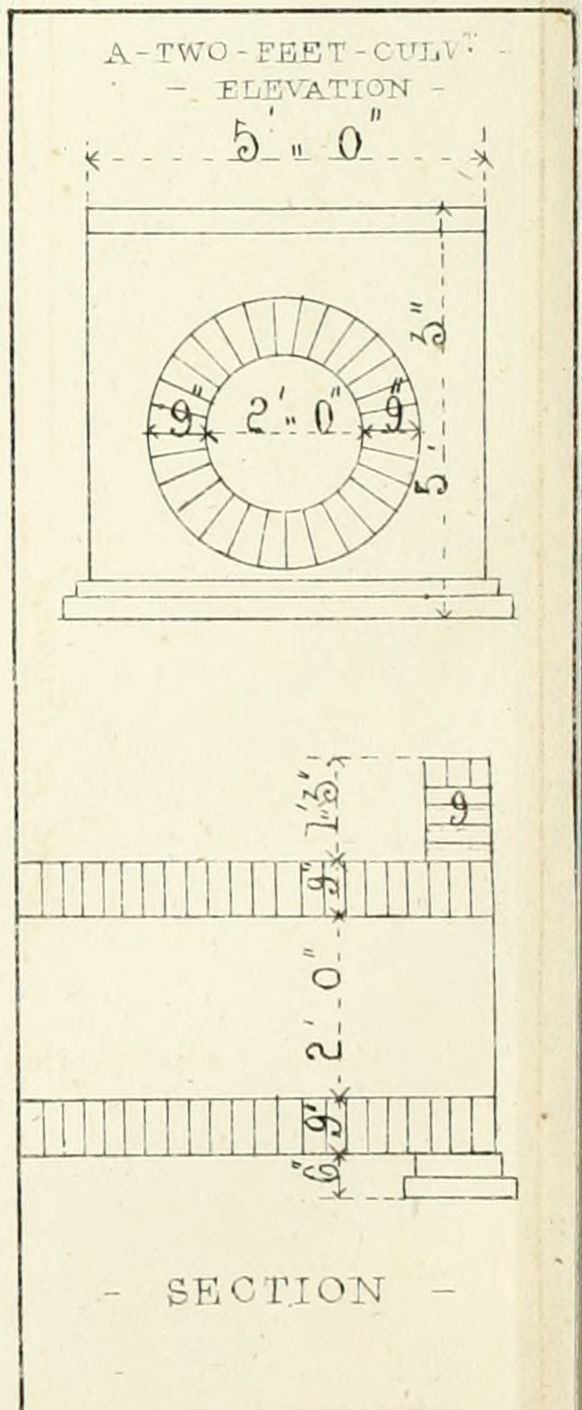


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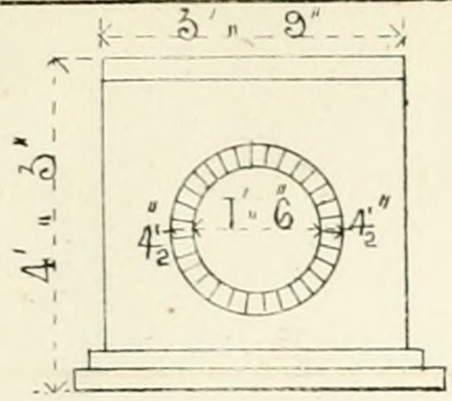
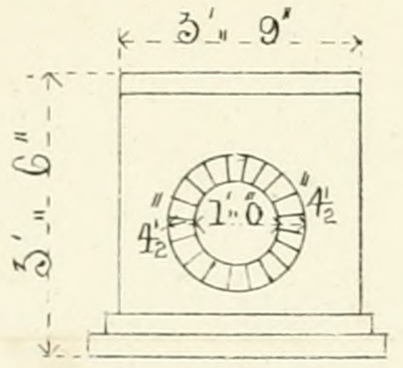
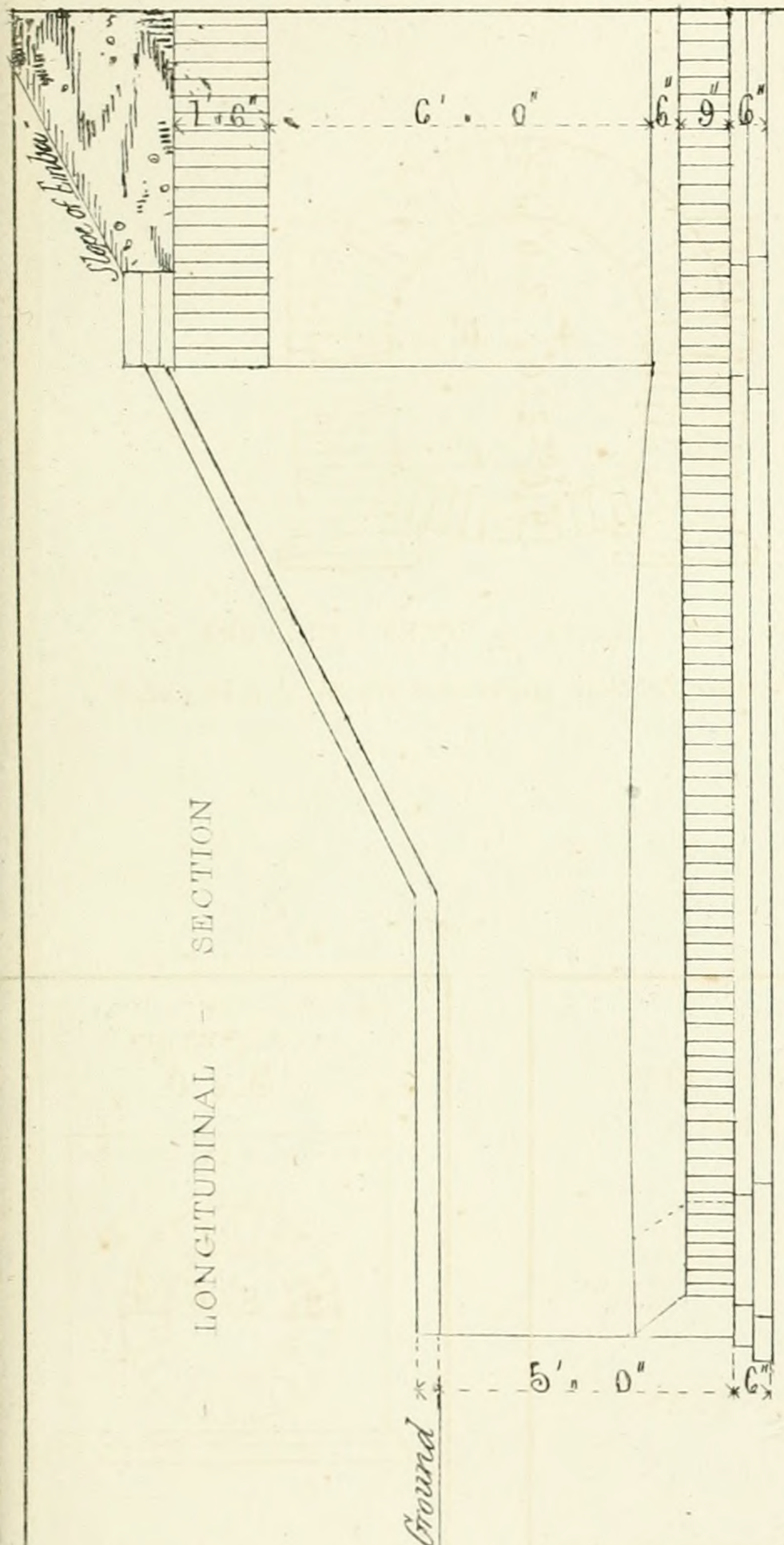
Plate XXX.



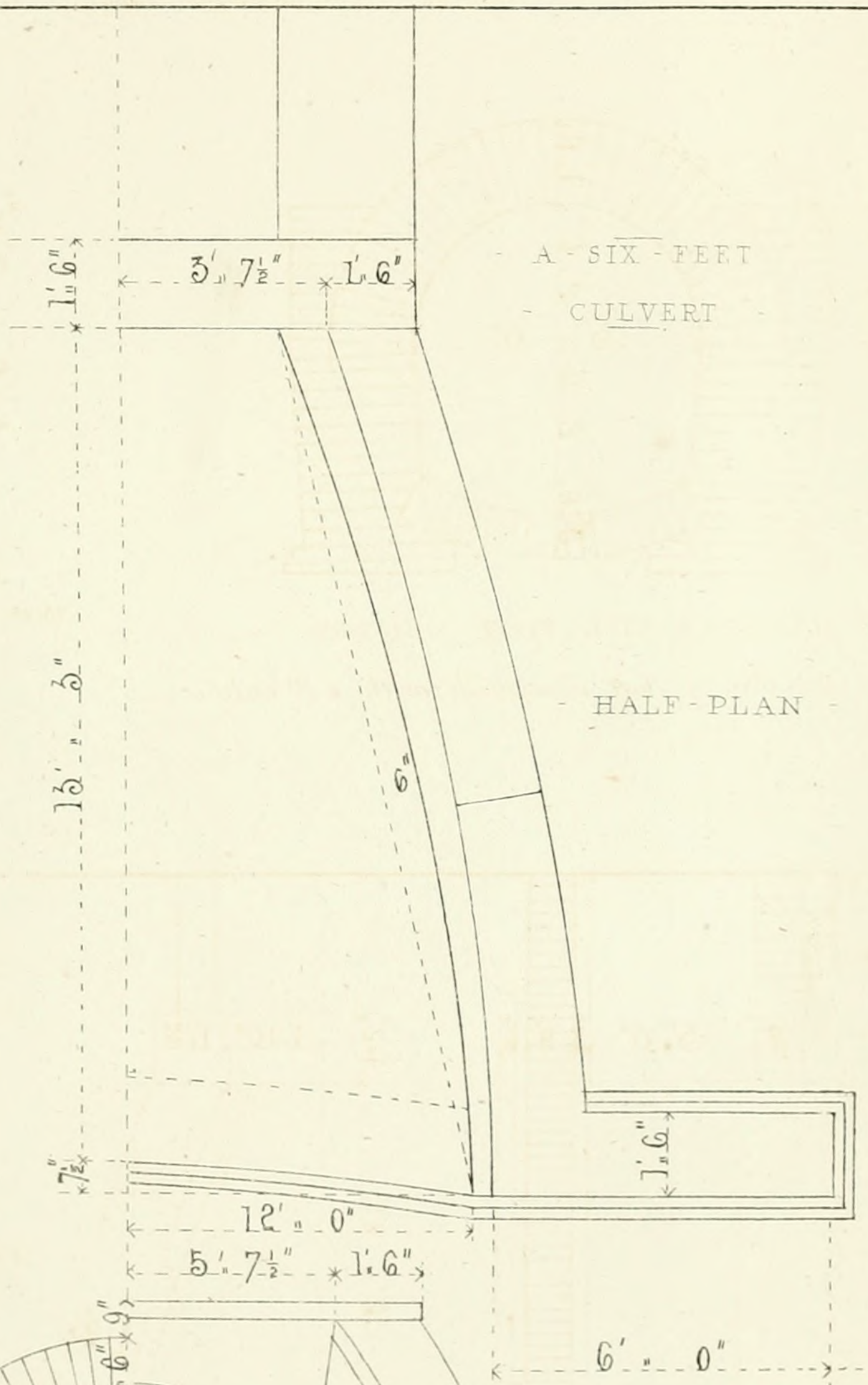
SECTION OF A ONE FOOT CULVERT



SECTION OF A SIX FEET CULVERT



LONGITUDINAL SECTION



HALF PLAN

HALF SECTION

HALF ELEVATION

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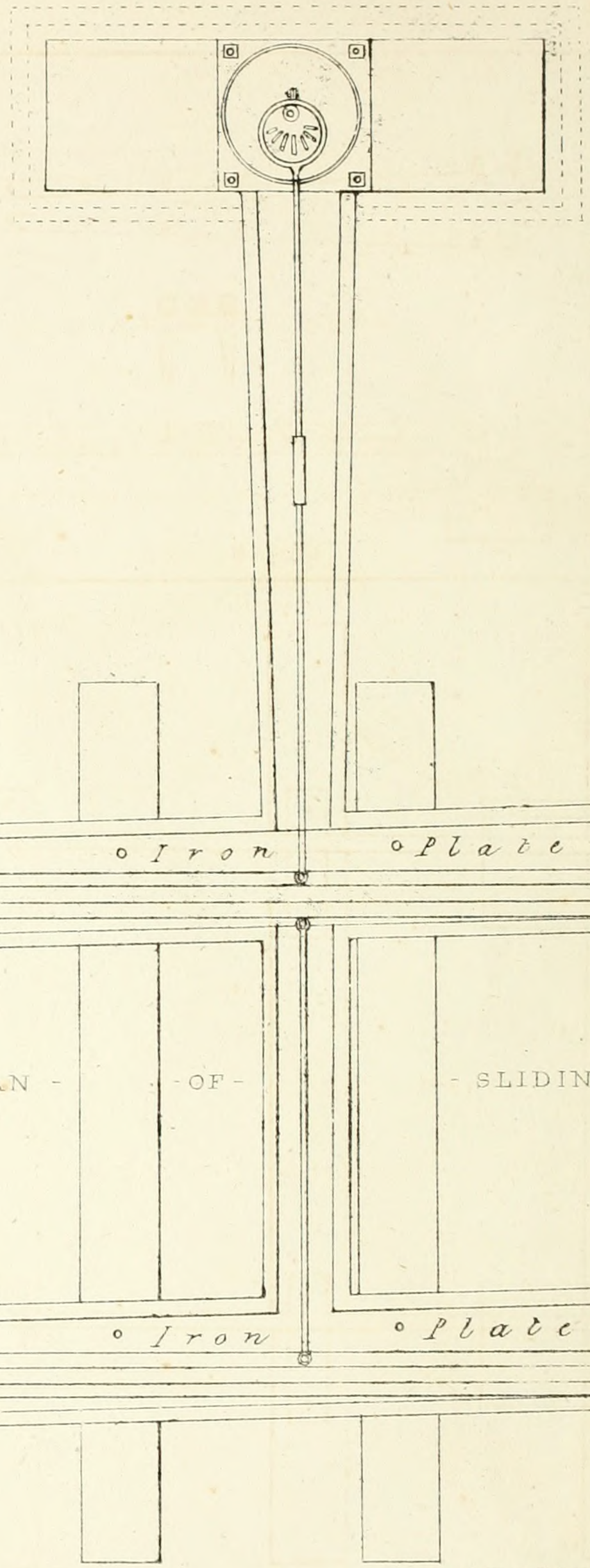
- PLAN - OF - A - SLIDING -

- OR - PASSING - PLACE -

- AS DRAWN - IN - THE - CONTRACTS - L & B - R^Y -



- - SECTION

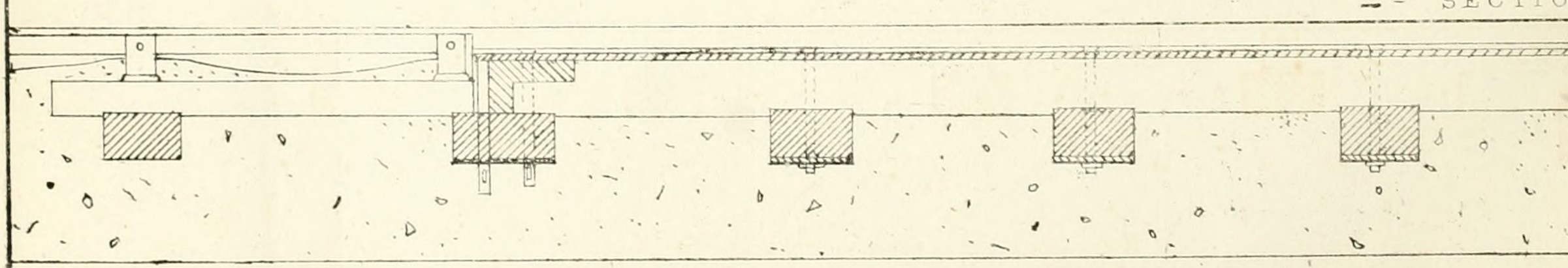


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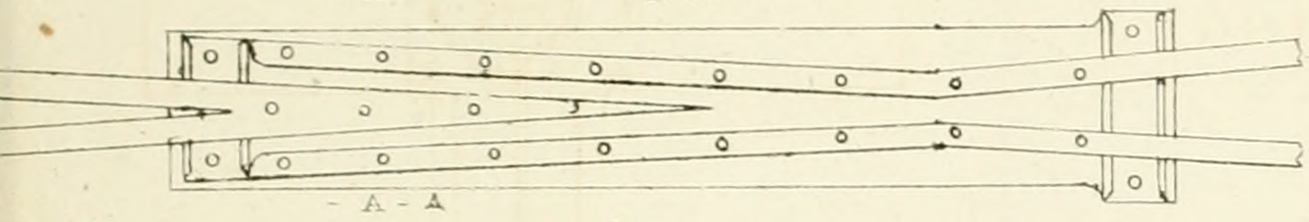
Plate XXXI.

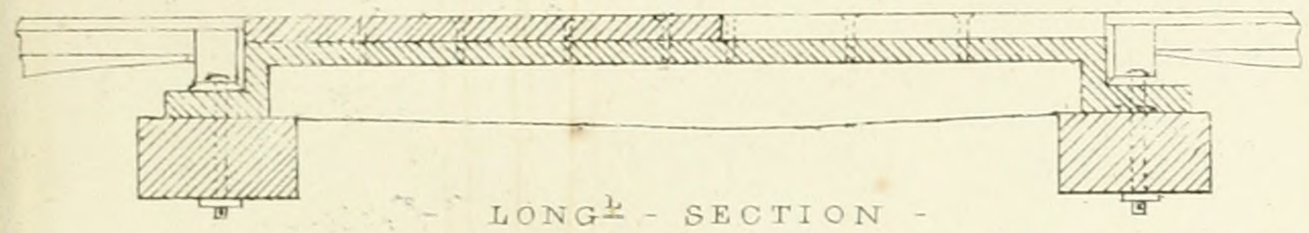
- A - FIXED - POINT - PLATE -

- A - PLAN -

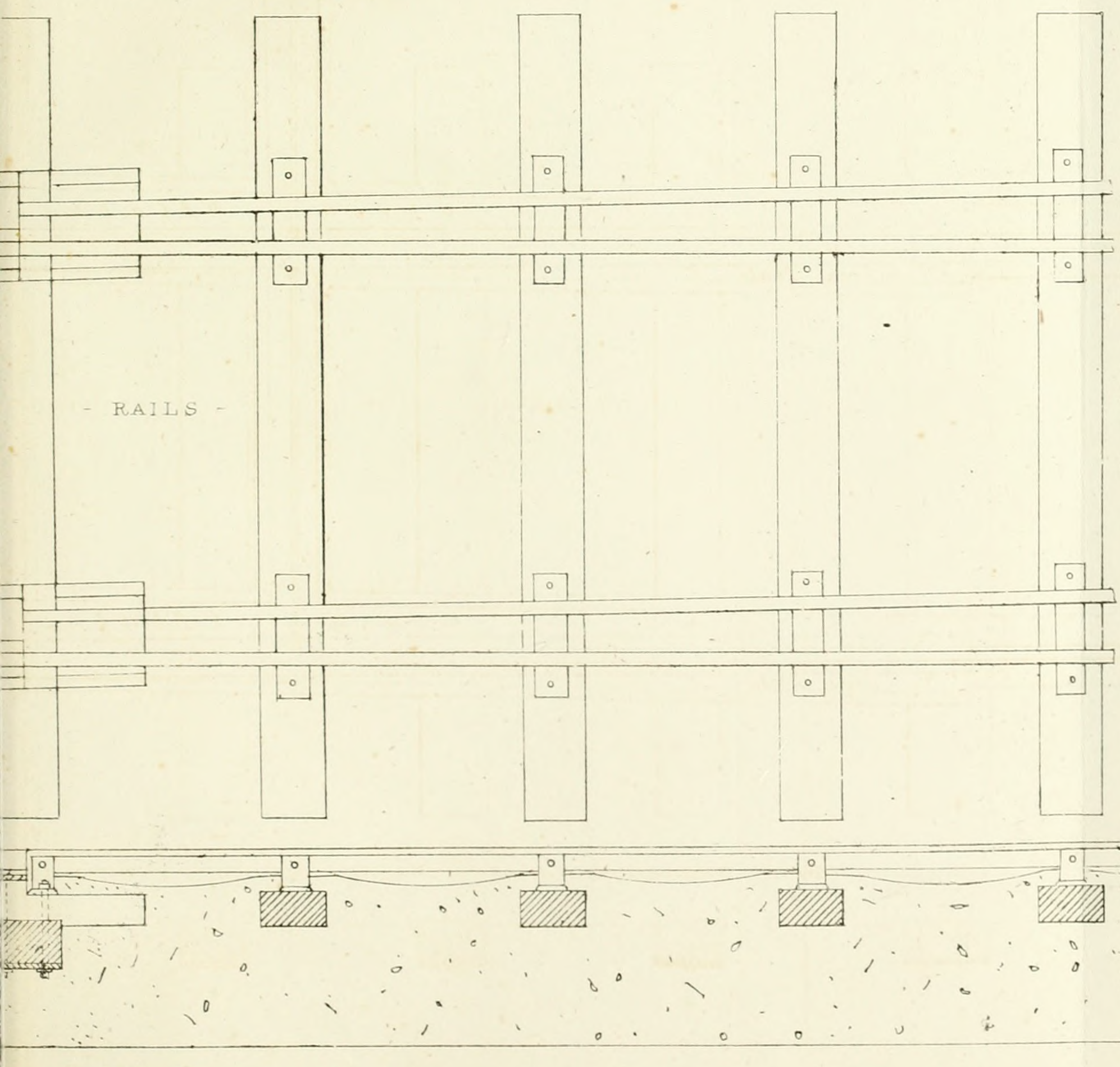


- A - A

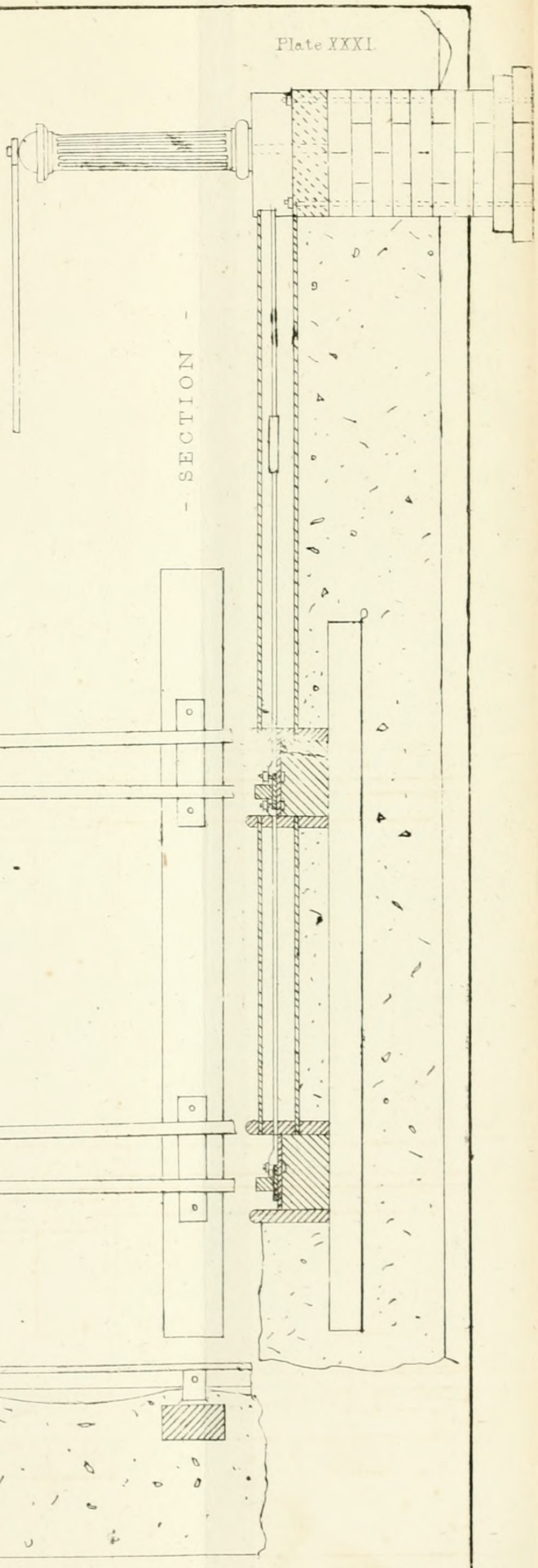
- SEC : - AT A A -



- LONG^L - SECTION -



- RAILS -



- SECTION -

15 20 Feet

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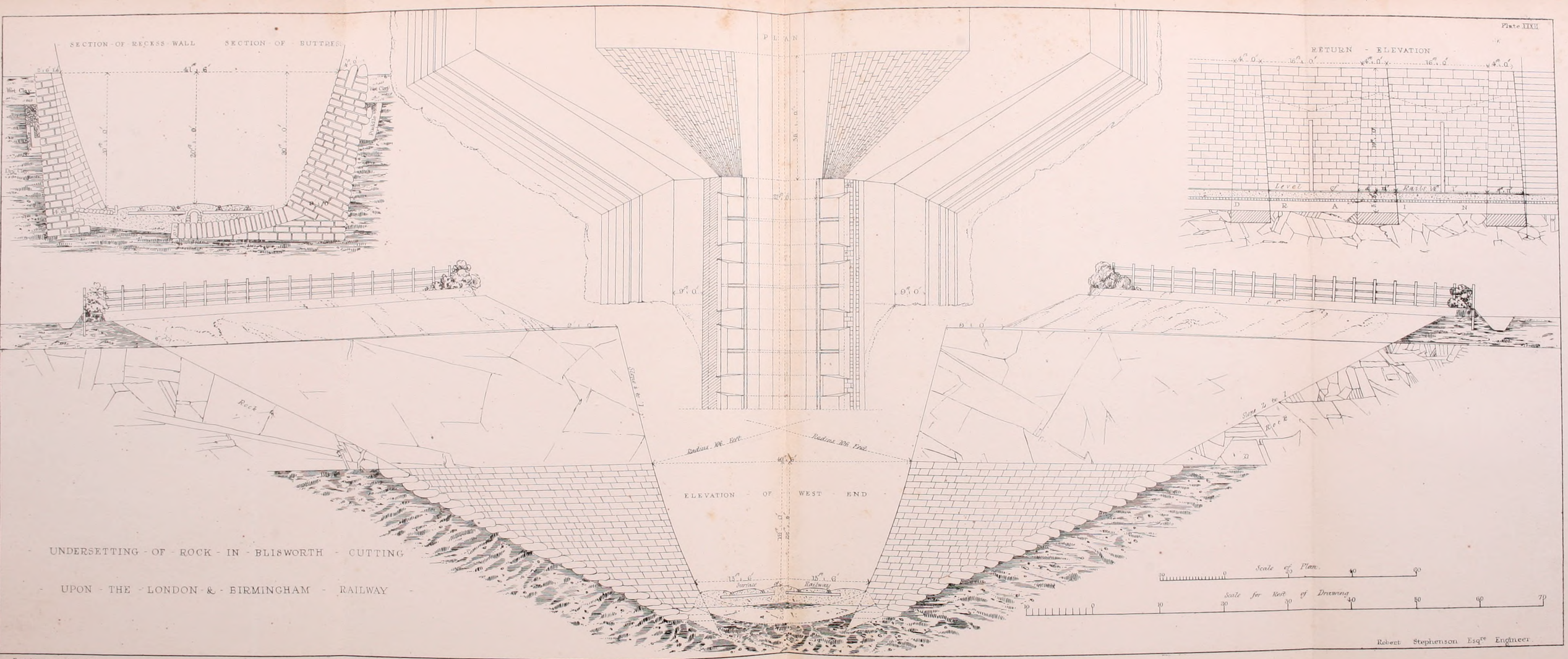

UNDERSETTING OF ROCK IN BLISWORTH CUTTING

UPON THE LONDON & BIRMINGHAM RAILWAY

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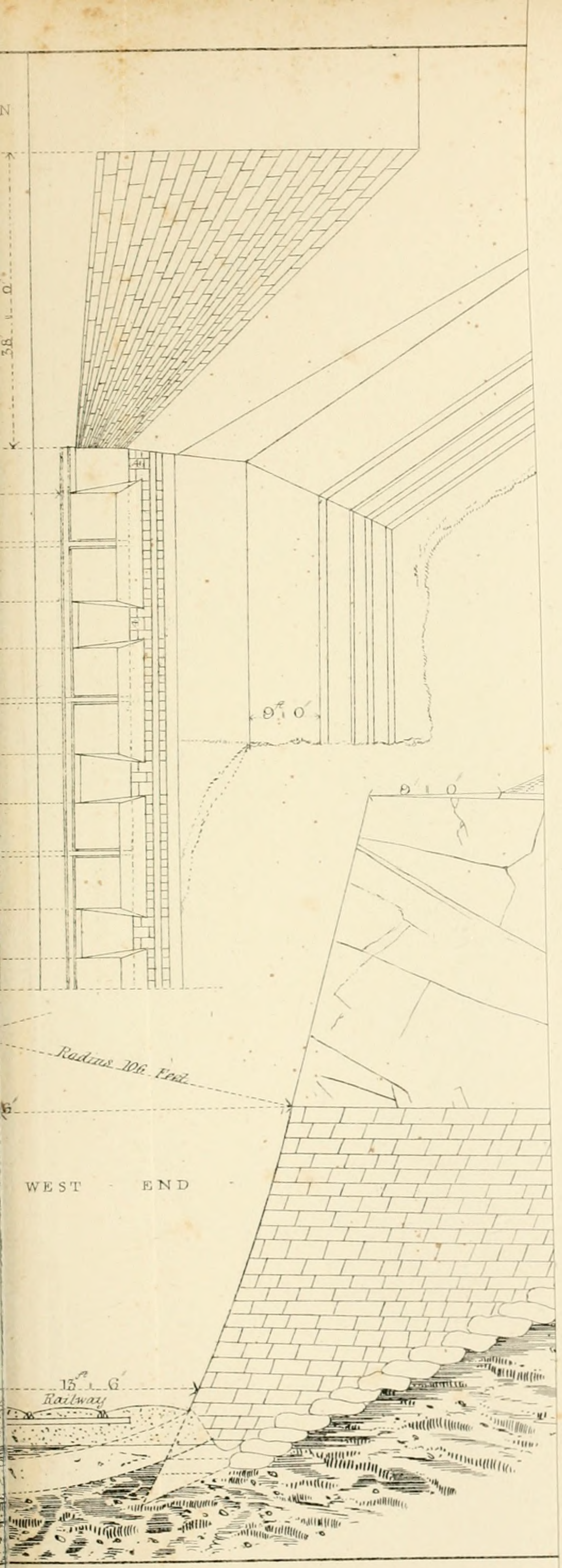

106, Ct Russell St Bloomsbury

Stone

Stone

Stone

Stone

Stone

Stone

Brickwork

15'-0"

ELEV

Natural Surface of Ground

Road

SECTION - THROU
PARAPET - &c -

3/4" to

1'-9"

1'-2½"

1'-9½"

1'-7½"

1'-2"

1'-9"

BRIDG

17'-0"

14'-0"

2'-6"

Line

Springing

4'-0"

4'-7"

9'-2"

Springing

Stone

1'-6"

4'-0"

Centre

SECTION THROU - CENTRE - ARCH - SECTION - THROU - SIDE - ARCH

Scale

10 5 0 10 20

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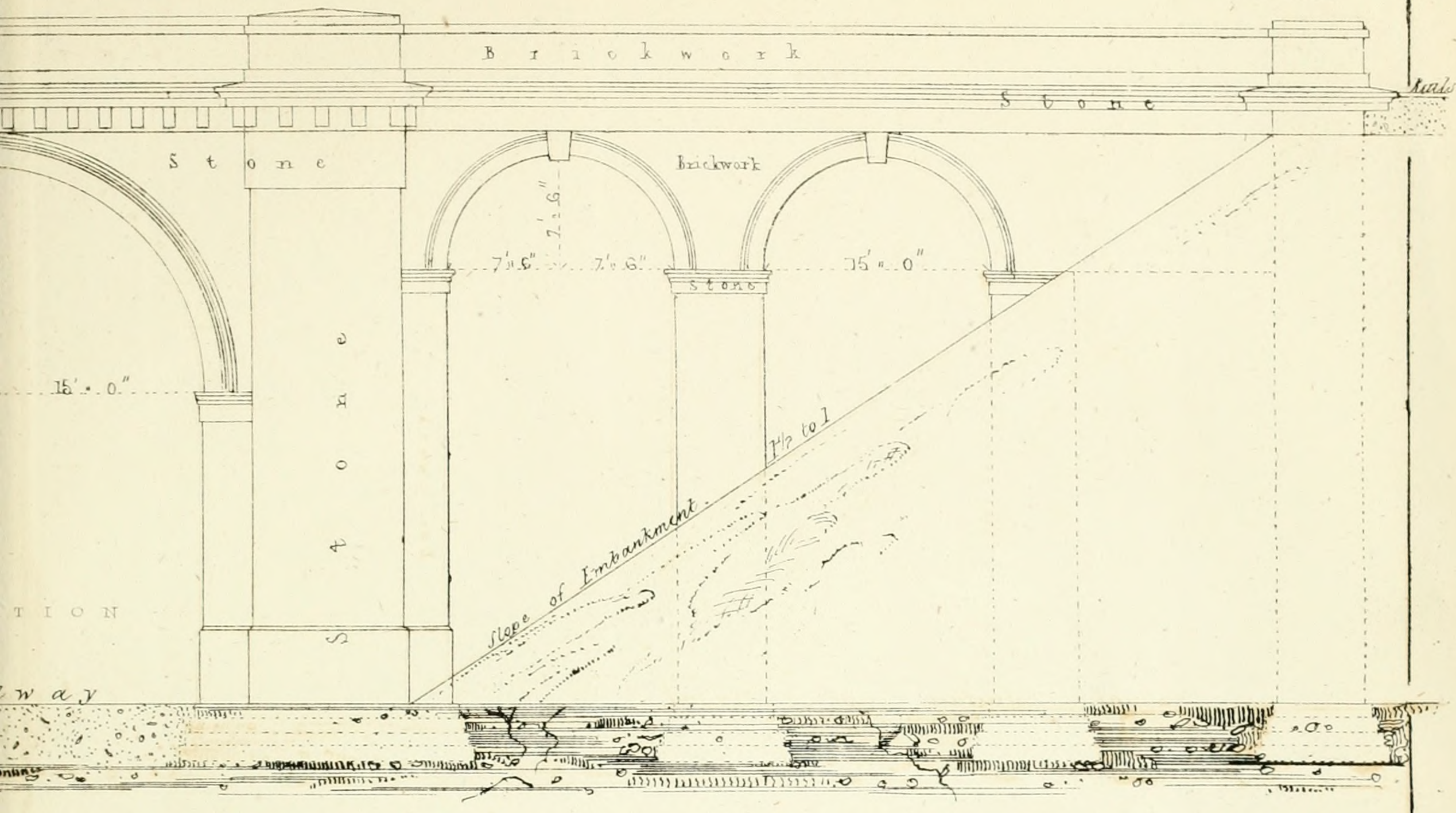
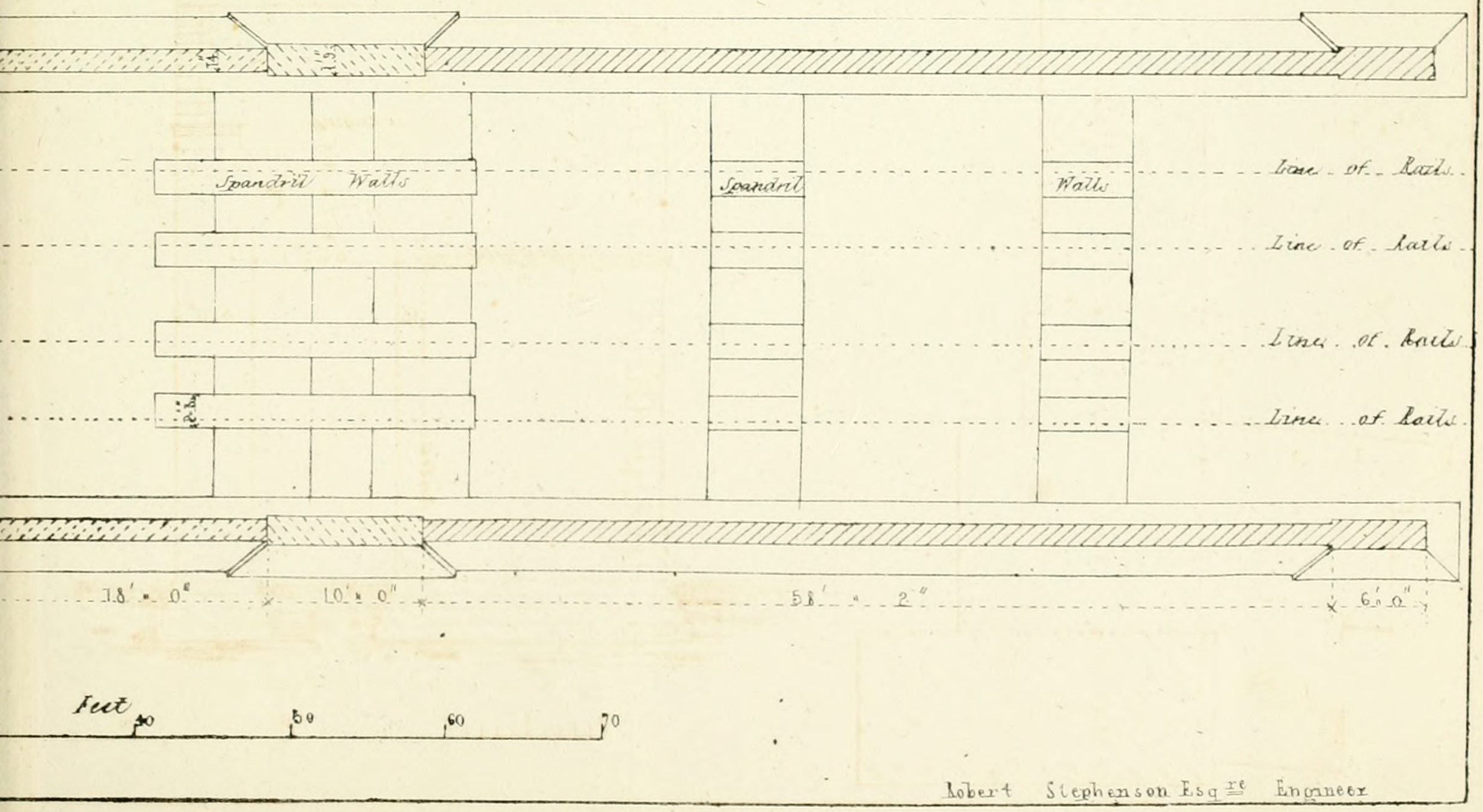
Plate XXXIII



FROM - TOWCESTER - TO - COTTON - END - L - & - B - RAILWAY -

- HALF - PLAN -



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Russell St Bloomsbury.

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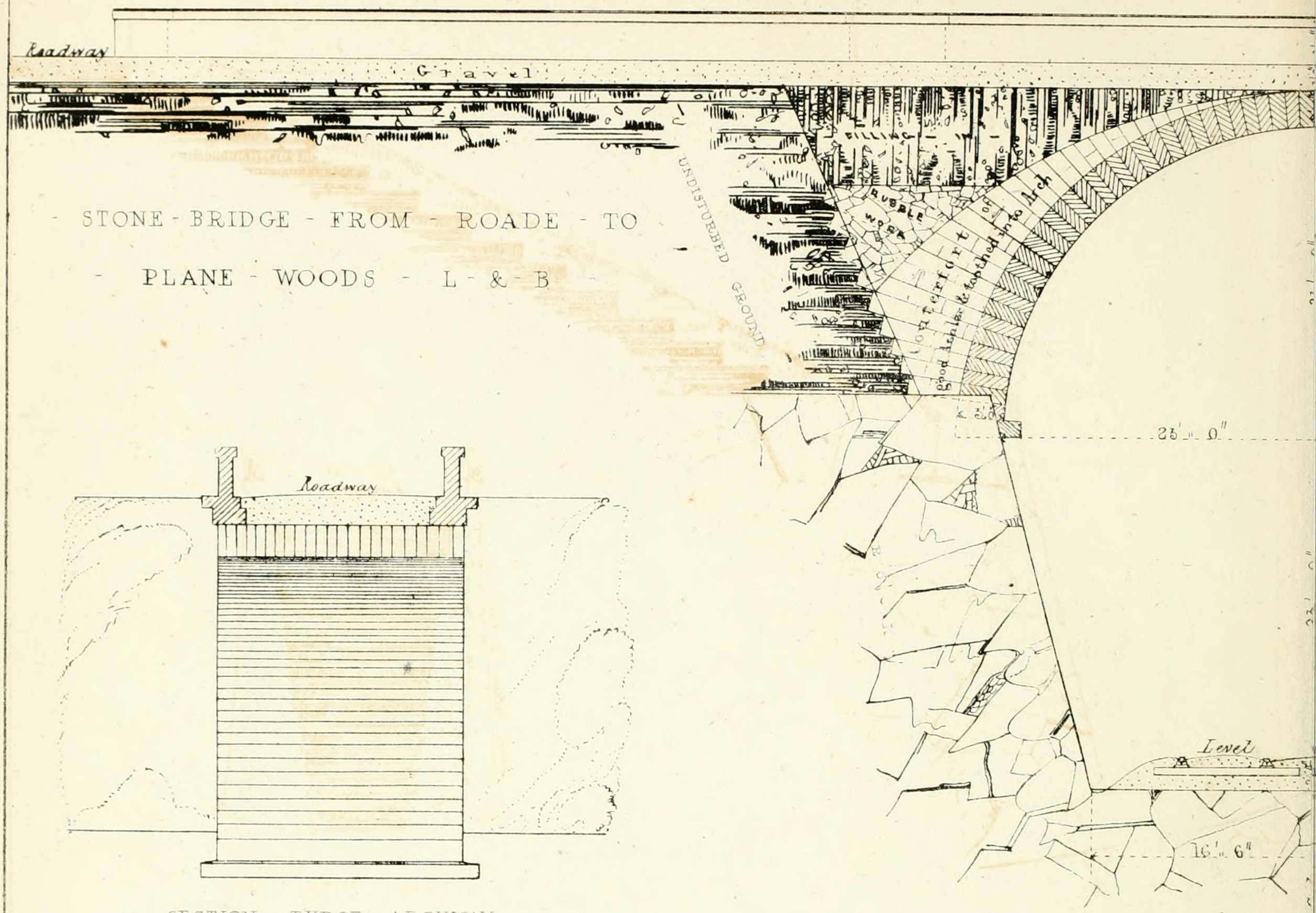
- HALF - SECTION -

- STONE - BRIDGE - FROM - ROADE - TO - PLANE - WOODS - L - & - B -



- SECTION - THROH - ARCHWAY -

- HALF - PLAN - THROH - FOUNDATIONS -

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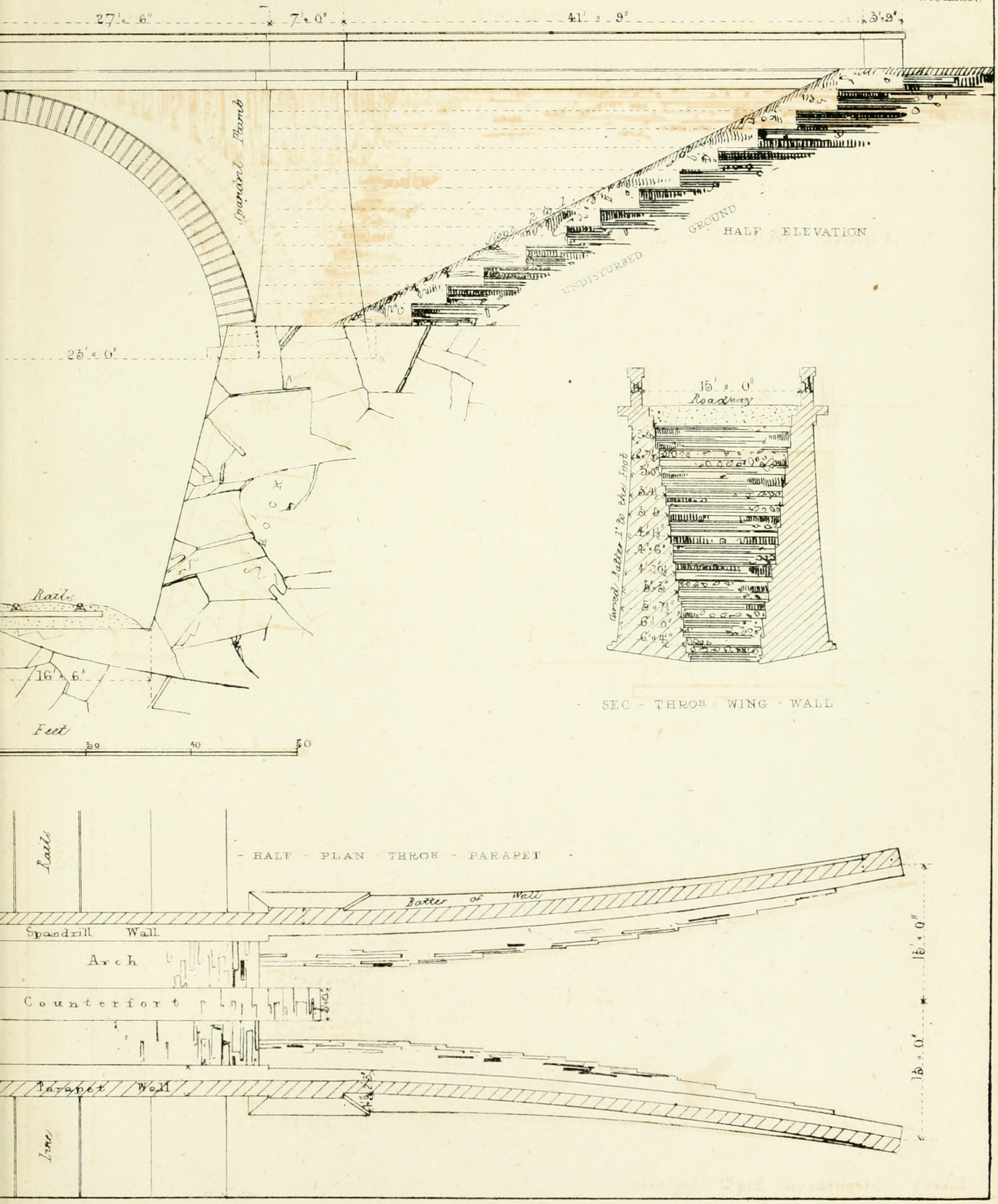

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Undisturbed Ground

Filling in Broken Stone

Coarse Filling

HALF - SECTION -

Counterfort of good Ashlar work toothed into Arch. The backing between counterfort & Wings to be Rubble

Stones 12 in the Soffito & chamfered

61' 6"

- BRIDGE -

AT - ROAD - FRO

- BLISWORTH -

TO

COURTENHALL -

Roadway

Crown of Arch

SECTION - THROH - CROWN - OF - ARCH

Level of

Line

Centre

Line

Spandrill Wall

Rubble backing

Counterfort

61' 0"

Rubble backing

PLAN - TAKEN - UNDER - STRINGCOURSE

Rails

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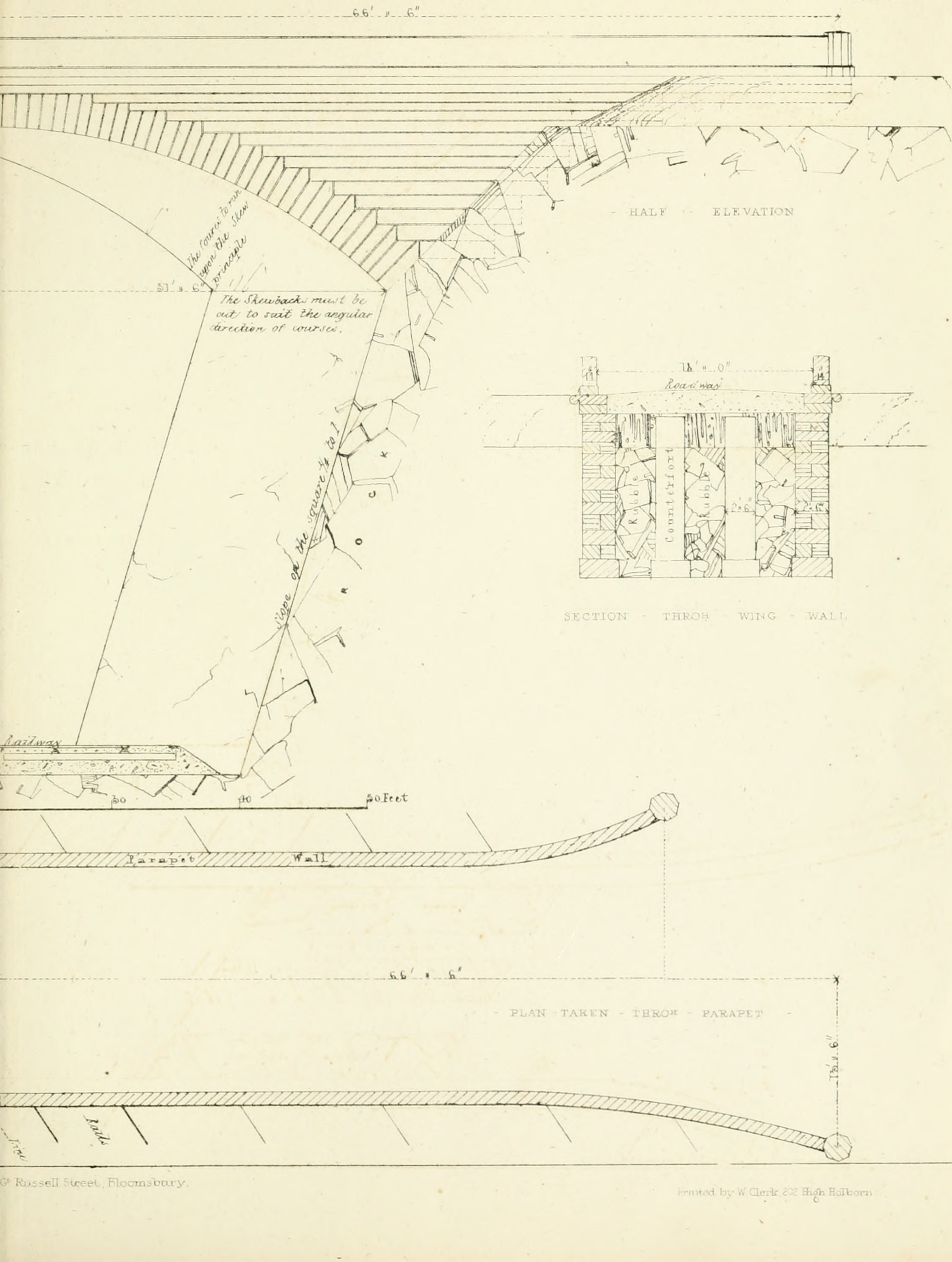

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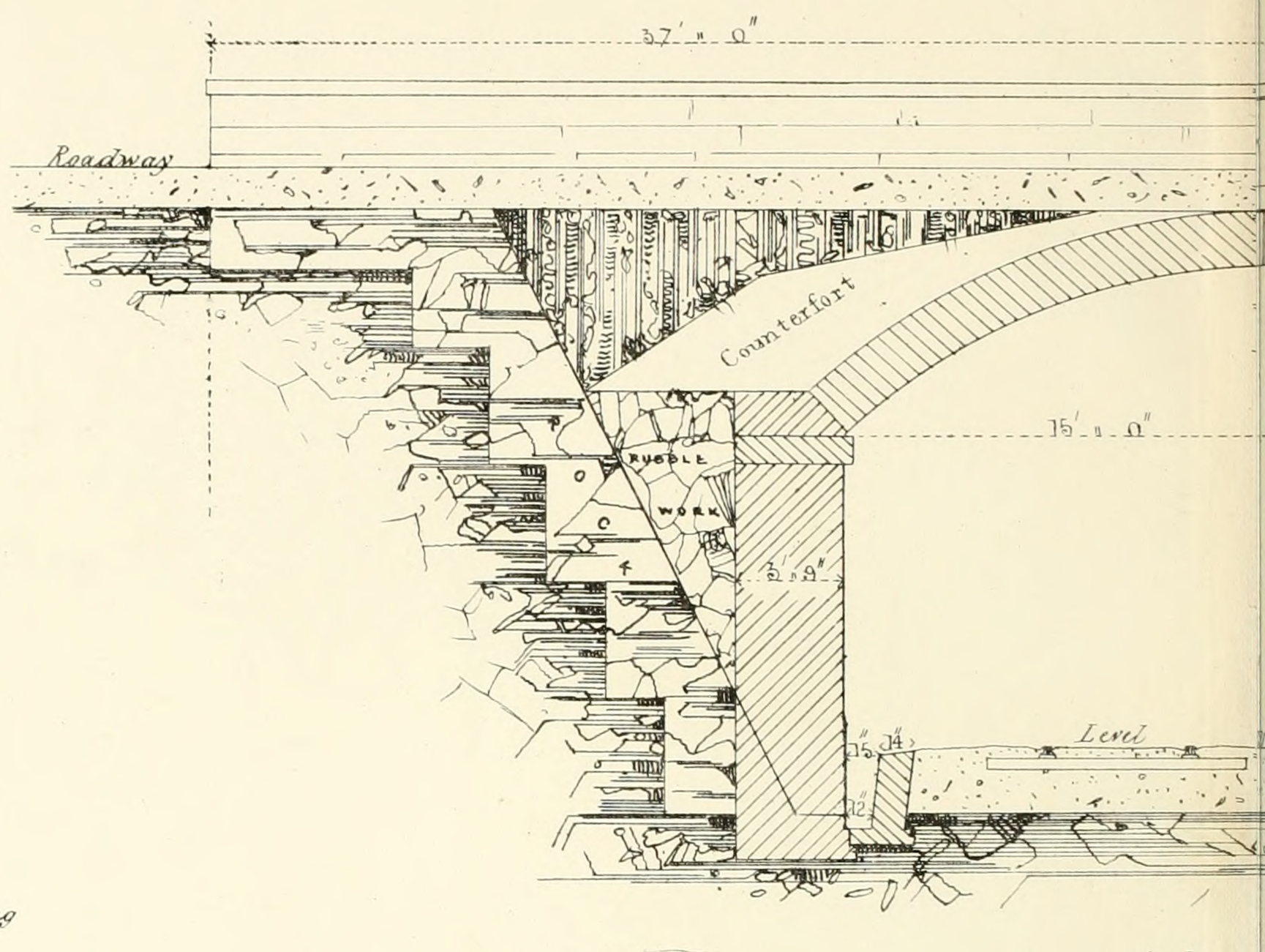
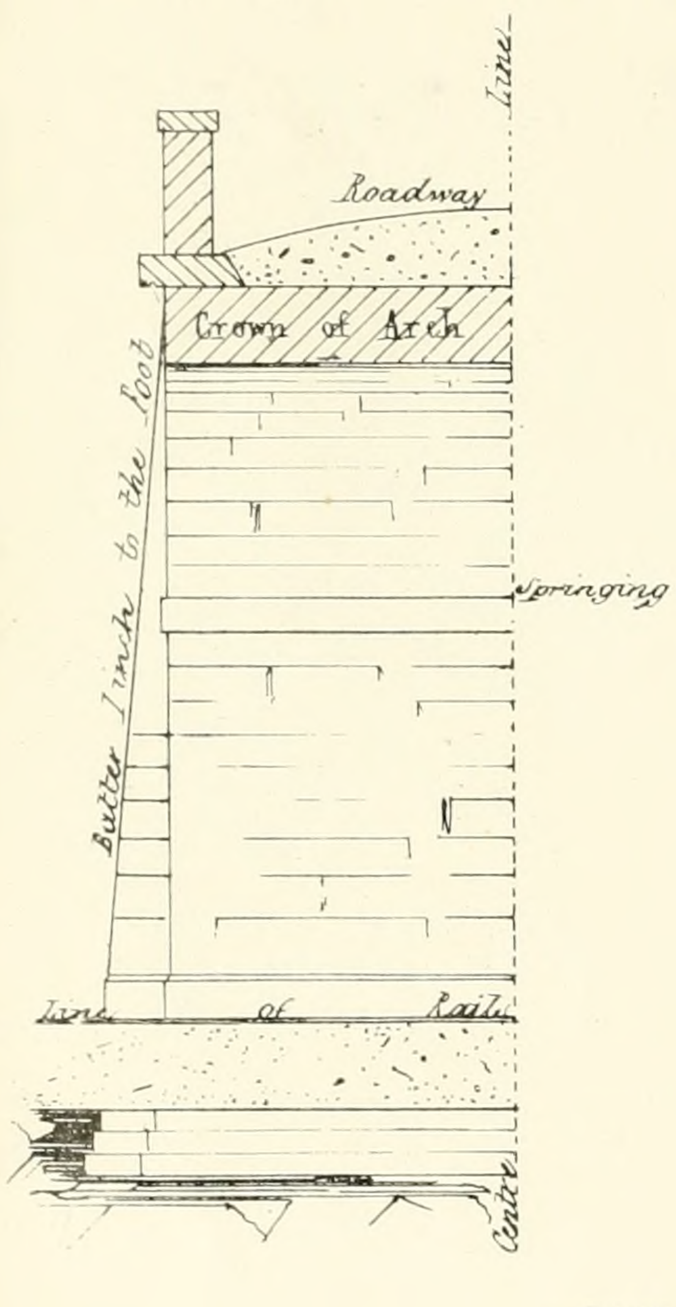
STONE - BRIDGE - FROM - STIVICHAL - TO - HEARSALL

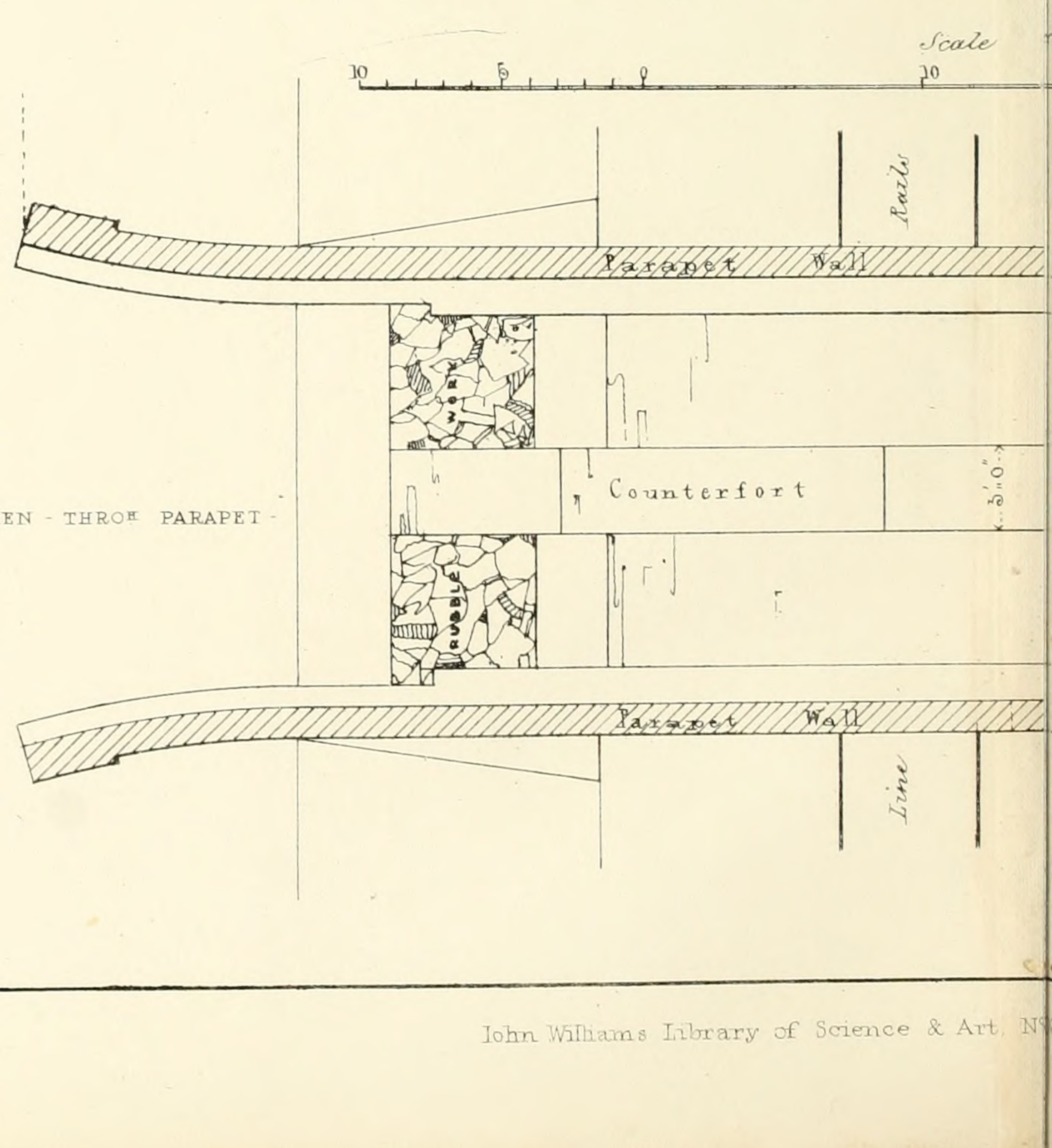
- HALF - SECTION -



- HALF - SECTION - THRO^{H} - ARCH -



- HALF - PLAN - TAKEN - THRO^{H} PARAPET -



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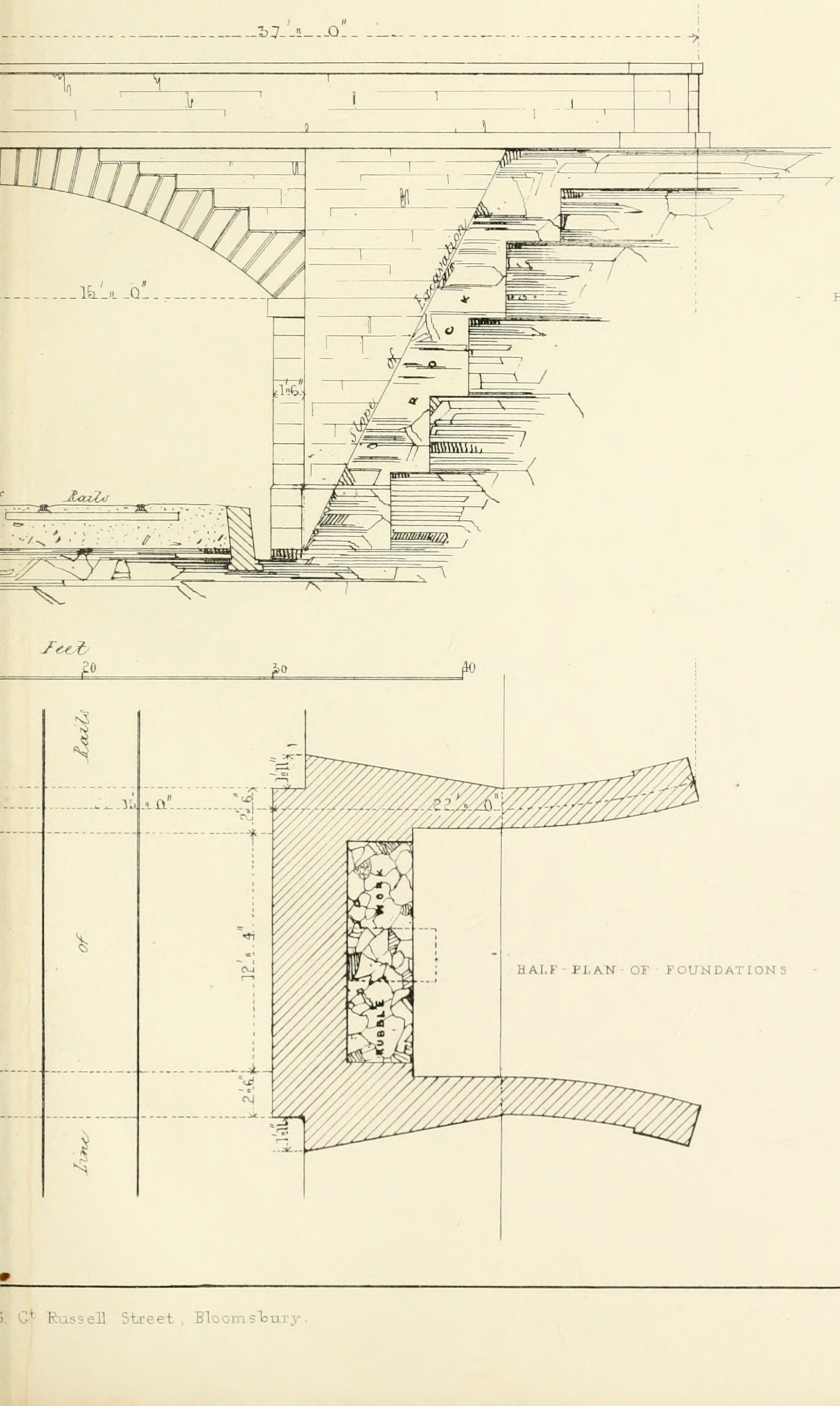
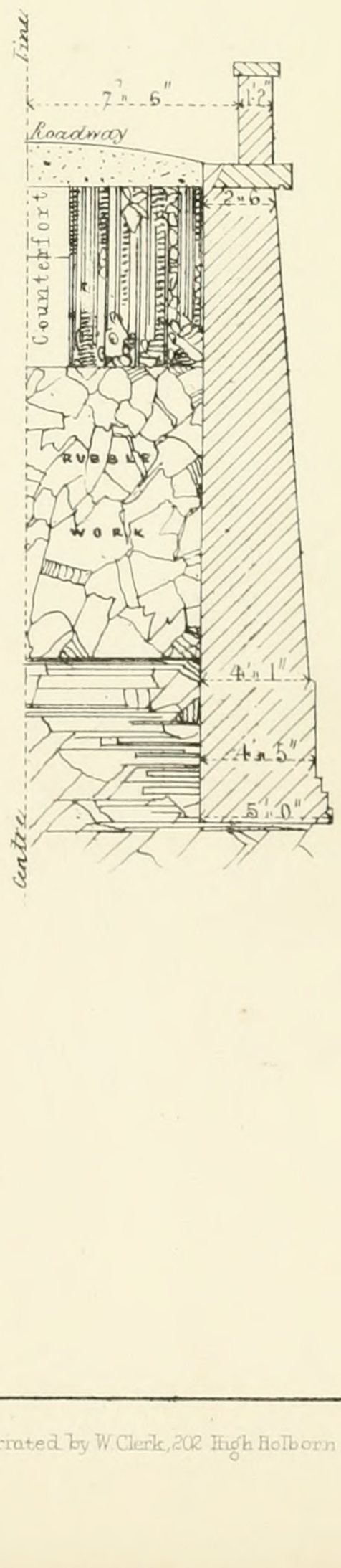
COMMON - UPON - THE - L - & - B - RAILWAY -

- HALF - ELEVATION -



- HALF - SECTION - THRO^H WING - WALL -



- HALF - PLAN - OF - FOUNDATIONS -

S. C^t Russell Street, Bloomsbury.

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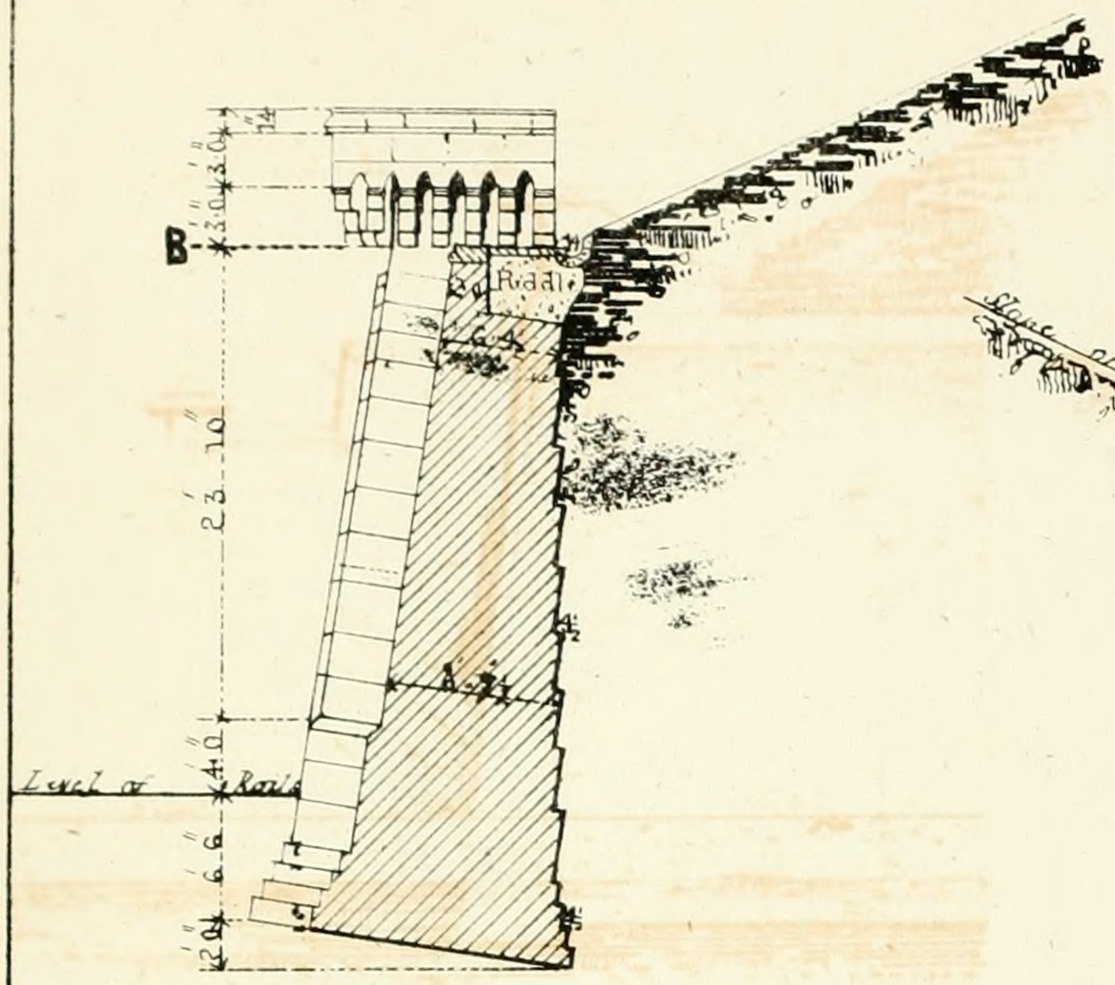
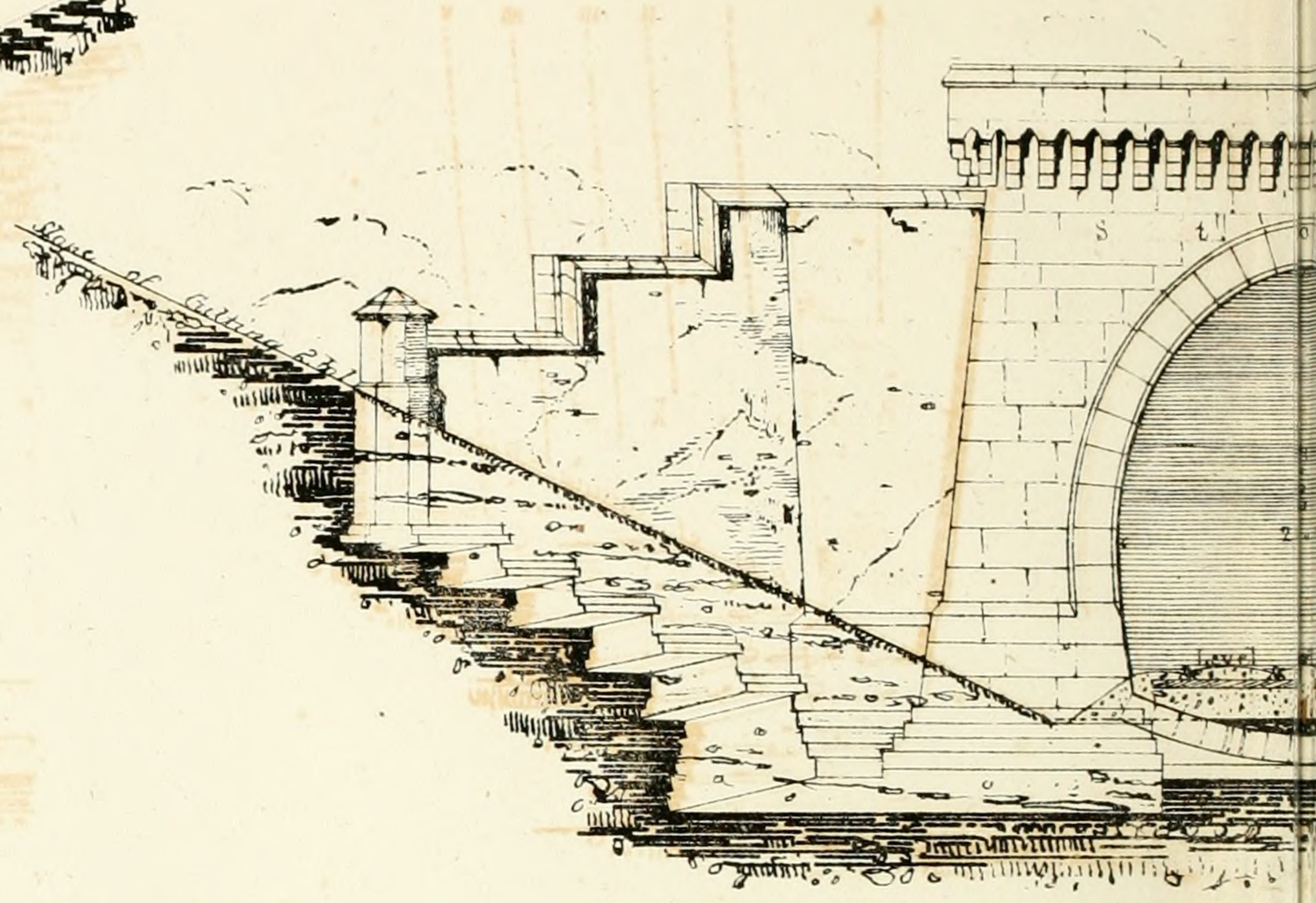
FRONT - OF - KILSBY - TUNNEL - UPON - THE

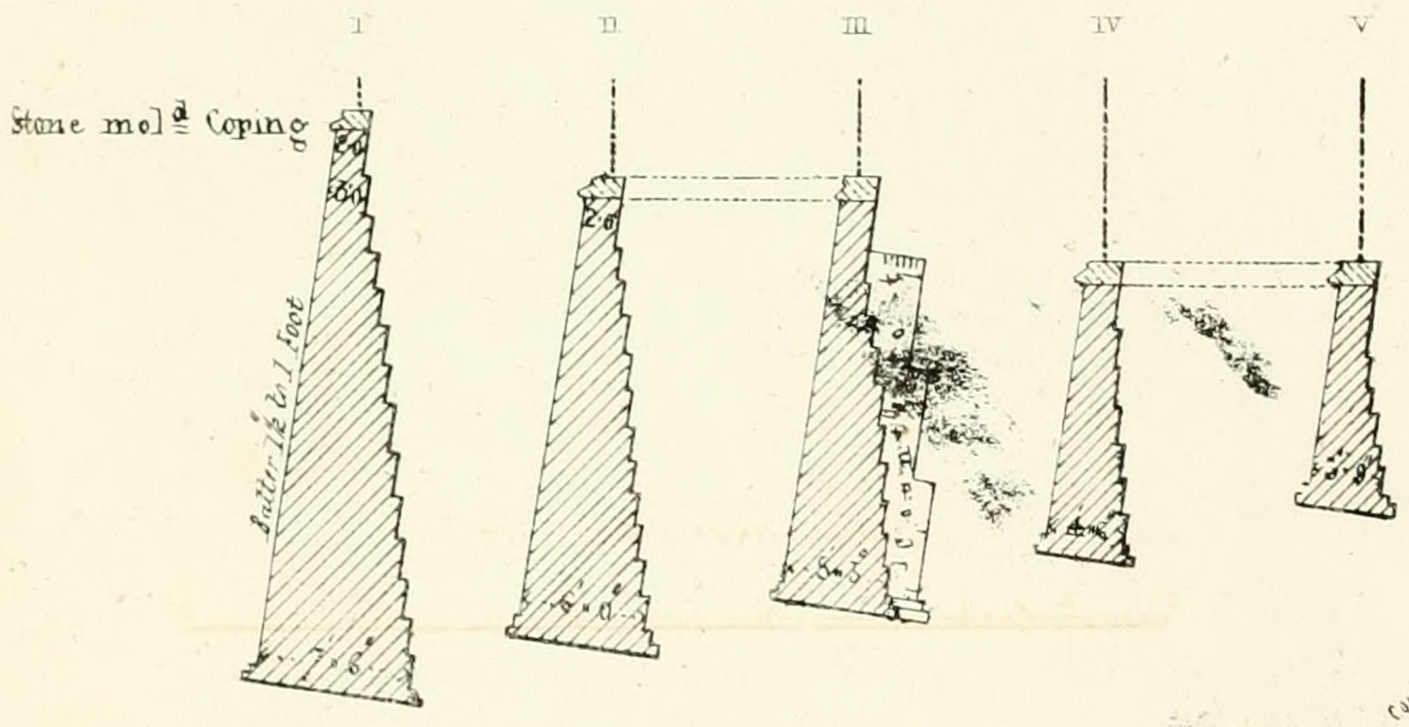
- SECTION - AT - A



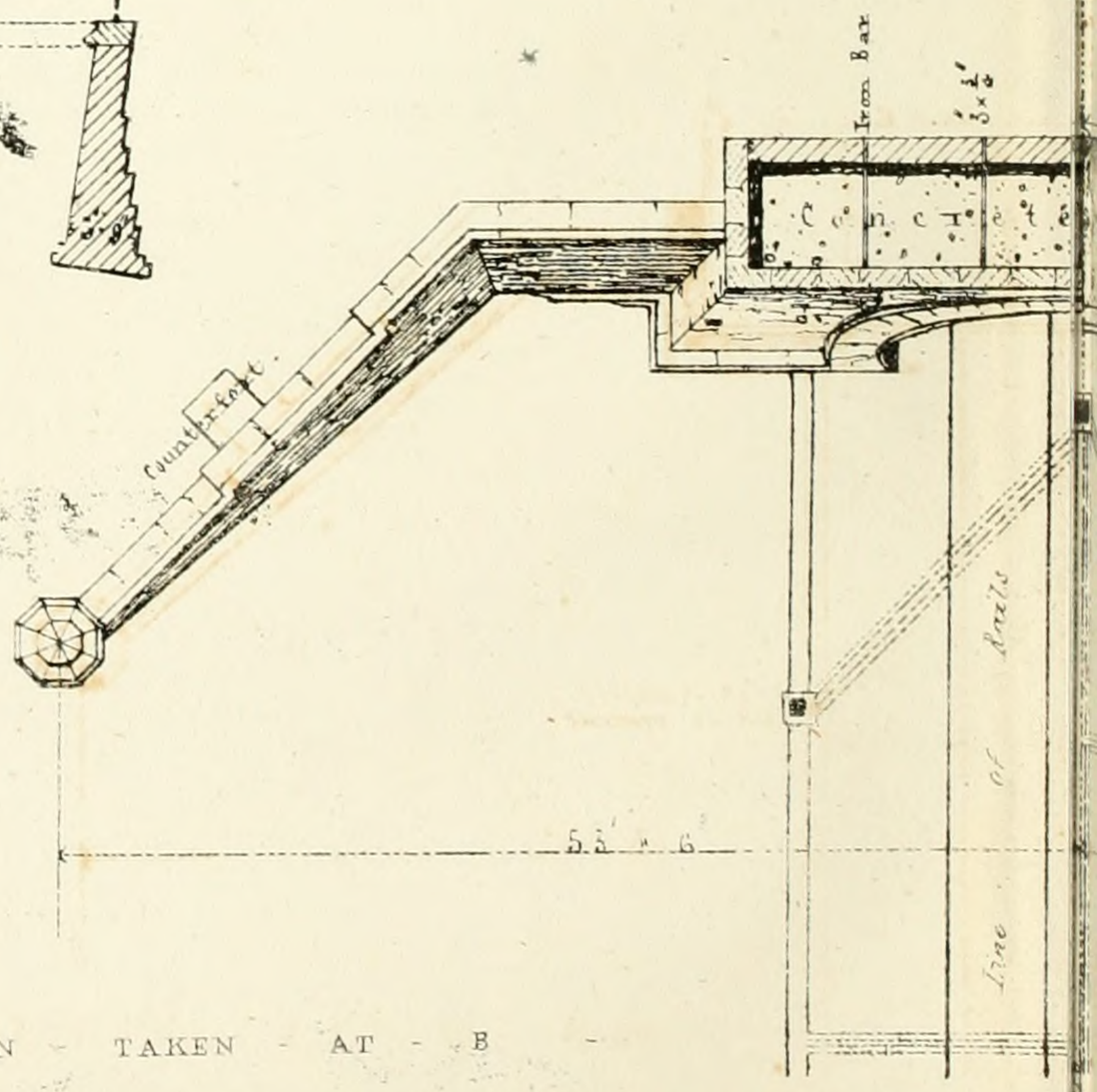
- ELEVATION - OF - FRONT -



- SECTION - OF - WING - WALL -



- PLAN - TAKEN - AT - B -



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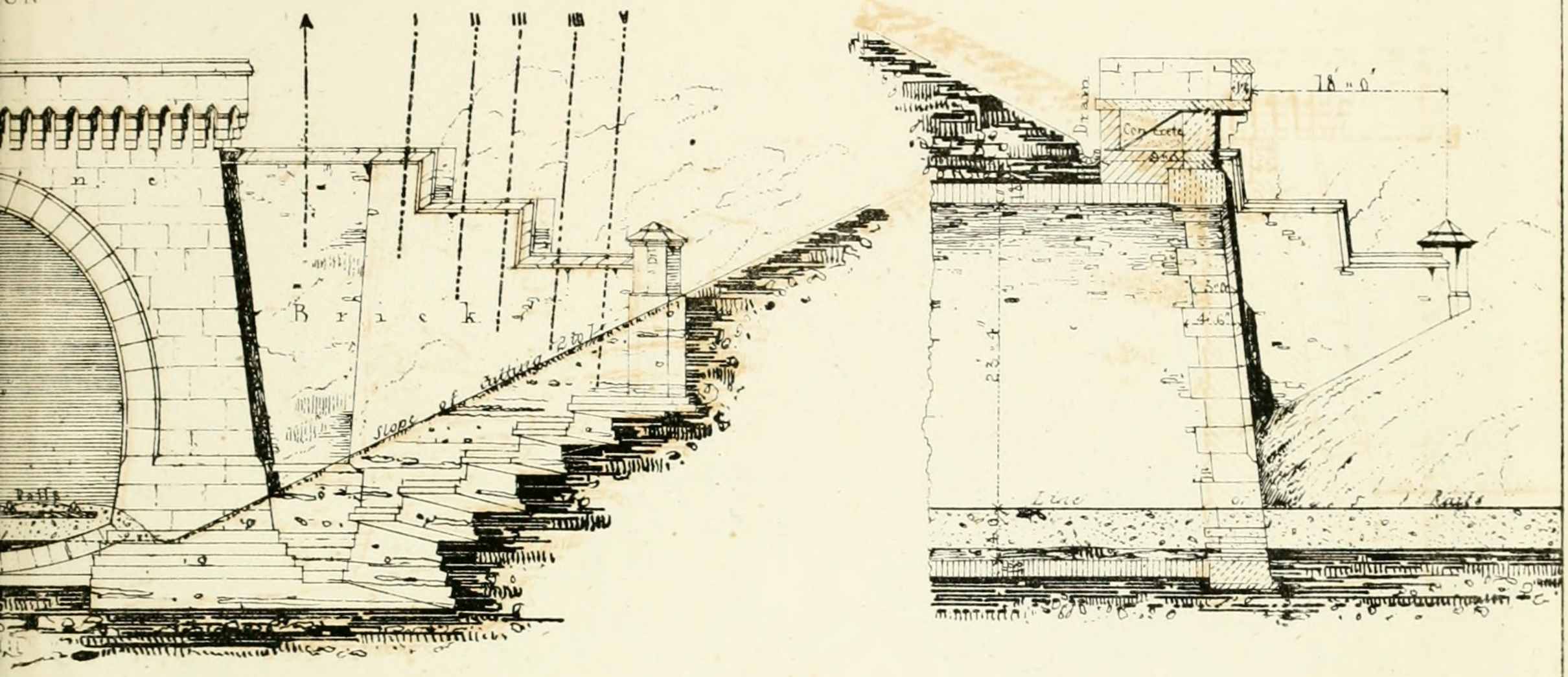
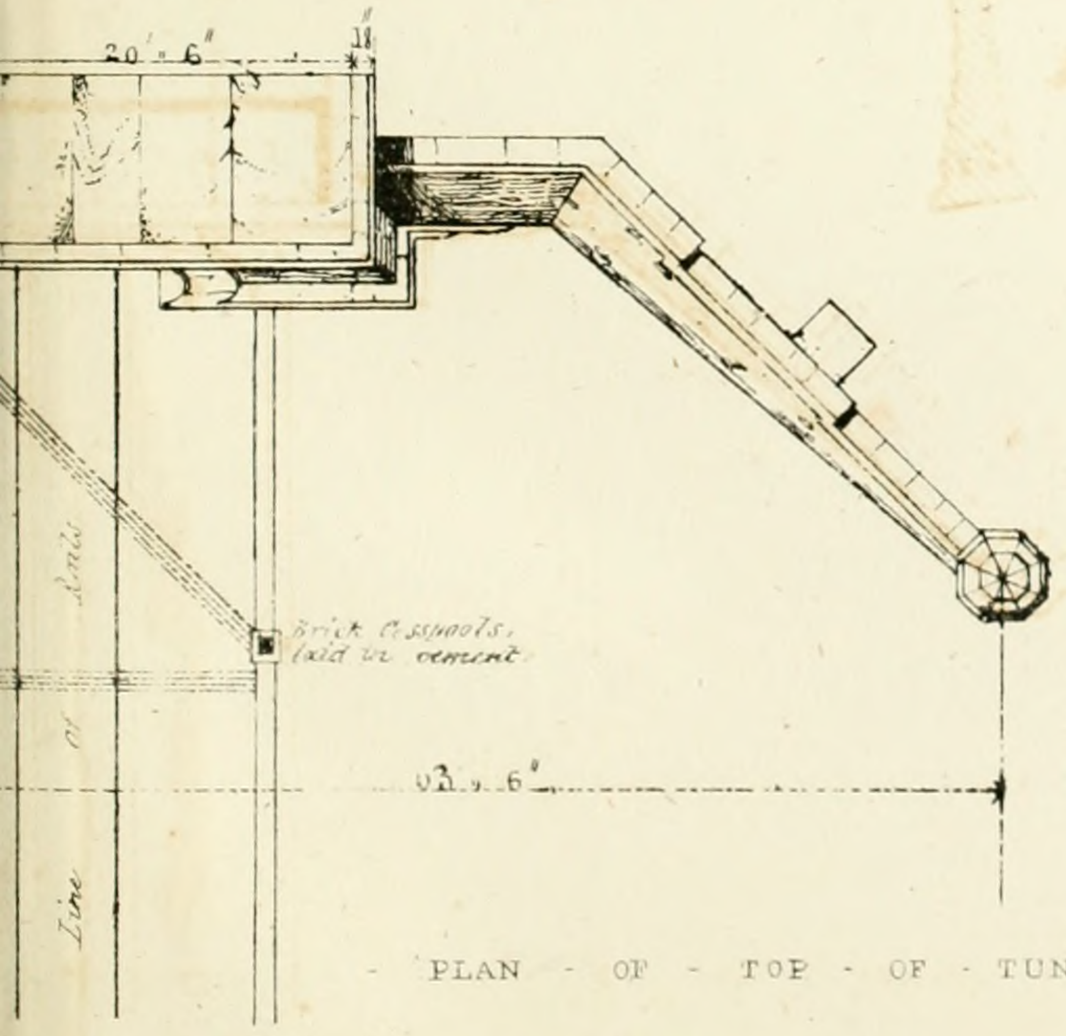
LONDON - & - BIRMINGHAM - RAILWAY -

- LONGITUDINAL - SECTION -

ON -





Scale being 5/8" to 10 Feet

10 5 0 10 20 30 40

- PLAN - OF - TOP - OF - TUNNEL -

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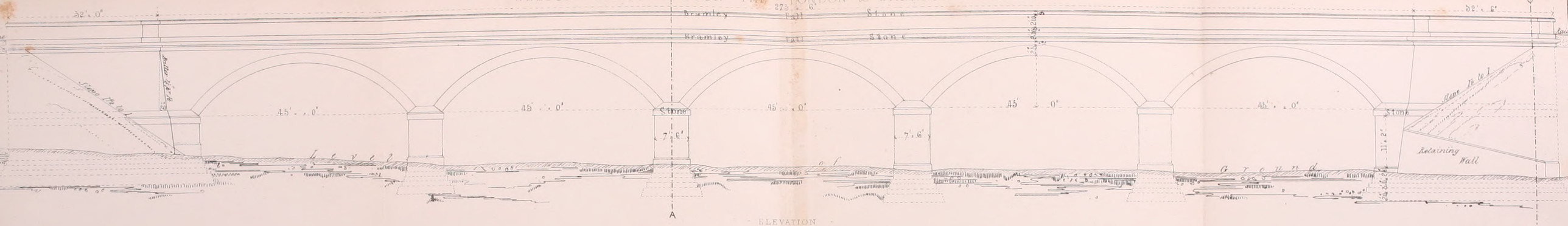
WEEDON - VIADUCT - UPON - THE - LONDON - & - BIRMINGHAM - RAILWAY

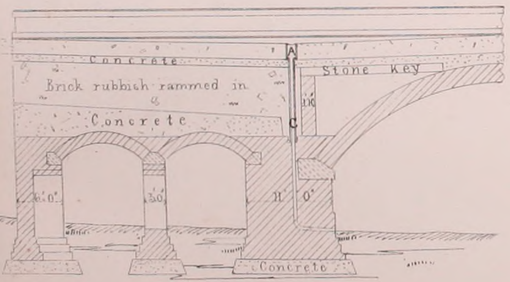


- ELEVATION -

Scale of Feet

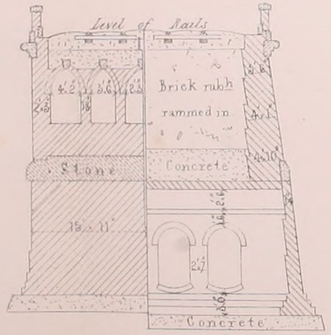
10 5 0 10 20 30 40 50

- LONGITUDINAL - SECTION - OF - ABUTMENT -

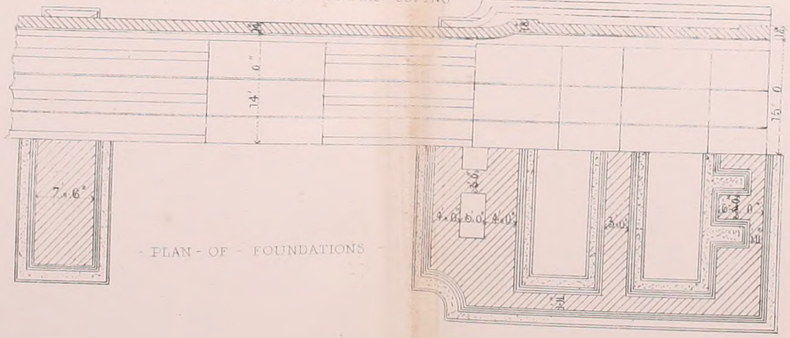


- SECTION AT - A ---- A

- SECTION AT - B ---- B

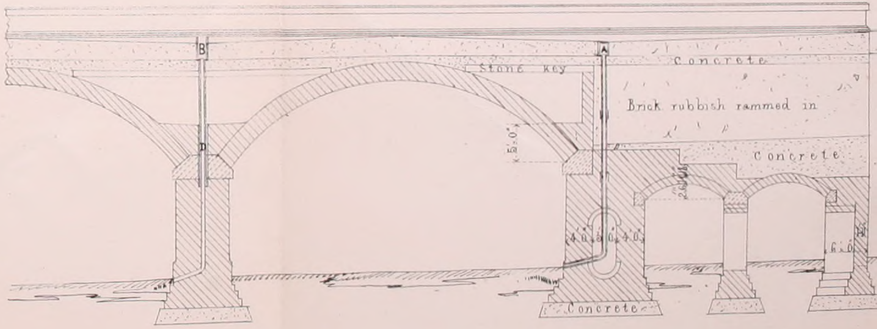


- PLAN - OF - ONE - END - TAKEN - UNDER - COPING



- PLAN - OF - FOUNDATIONS -

- LONGITUDINAL - SECTION - OF - PIER - ABUTMENT - &c -



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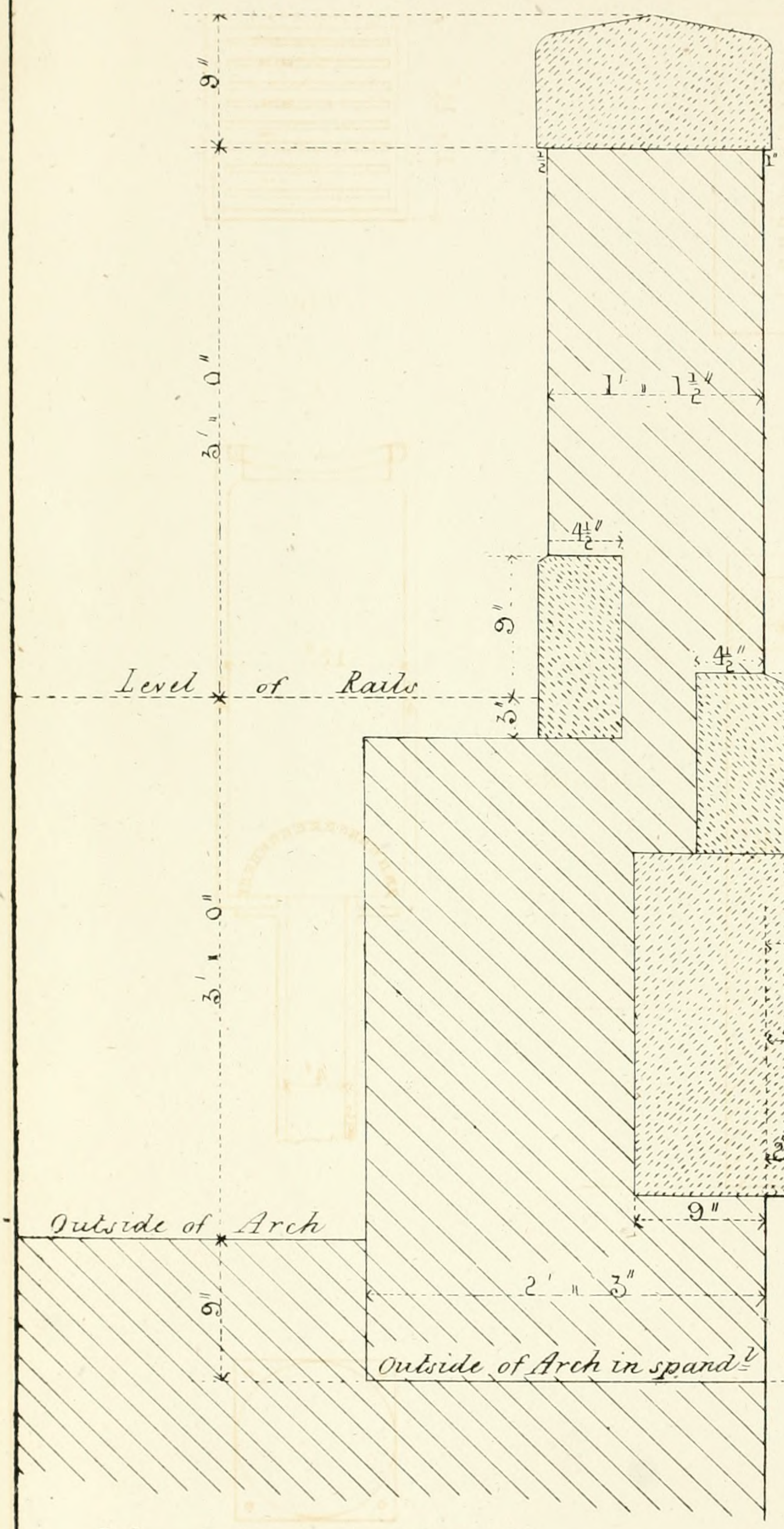
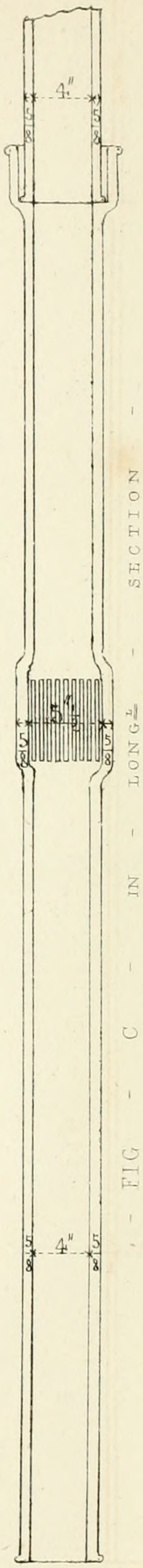
- WEEDON - VIADUCT - UPON

- SEC: - OF - PARAPET - WALL - &c. -





- FIG - C - IN - SECTION - LONG½ -

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Scale

Ins 12 6 0 1 2 3

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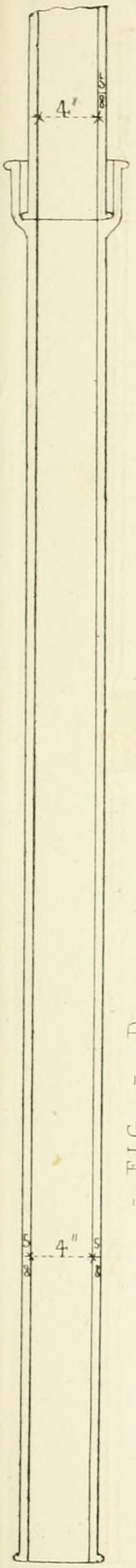
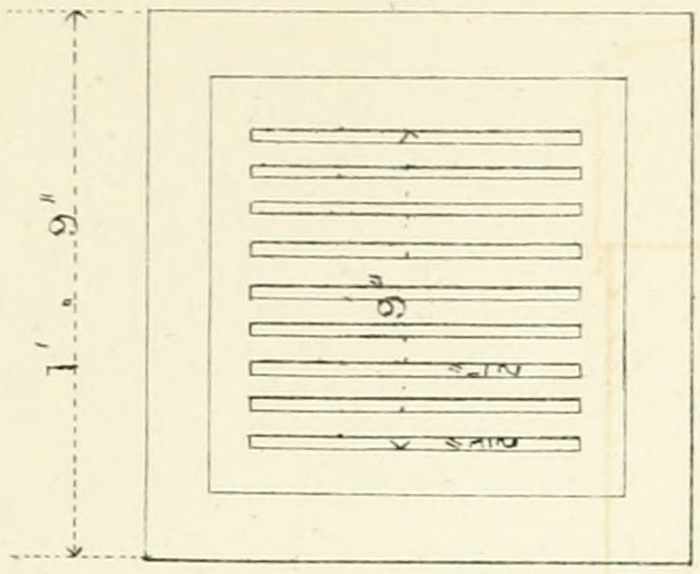
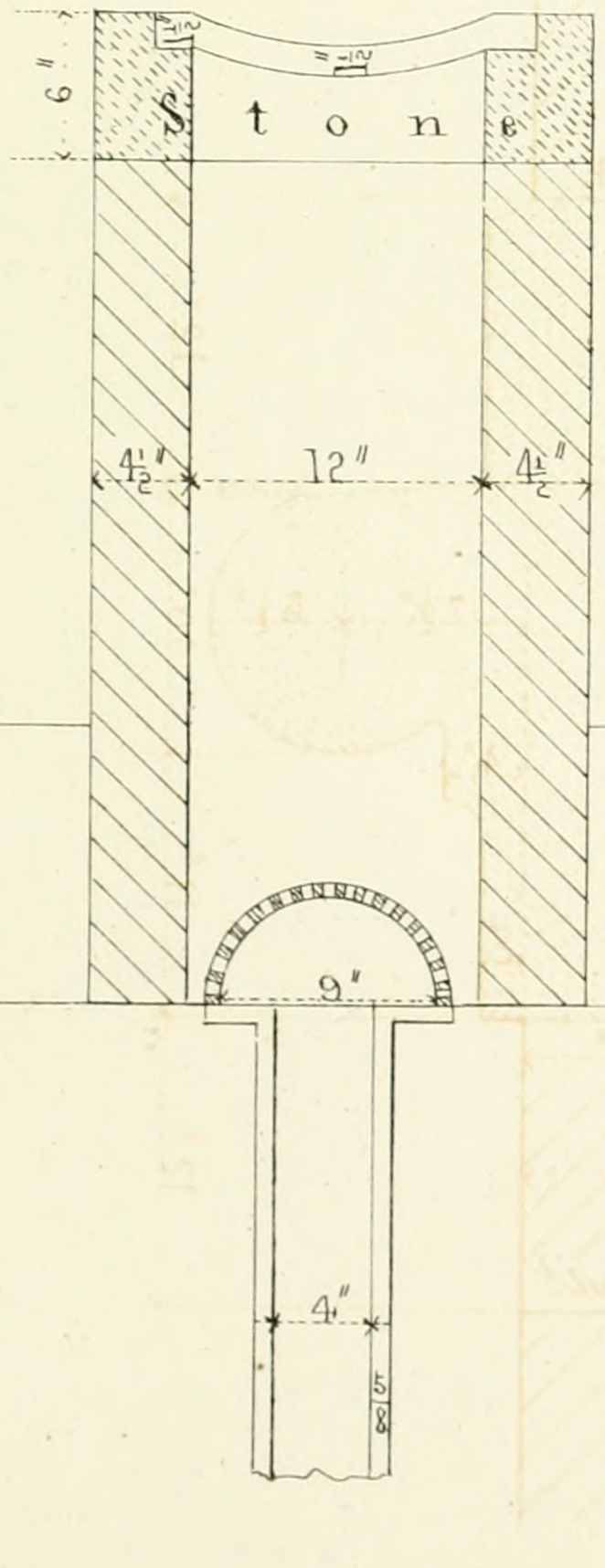


- FIG - D -

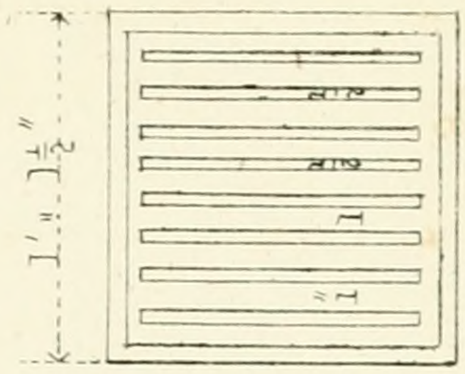


- FIG -

- B -

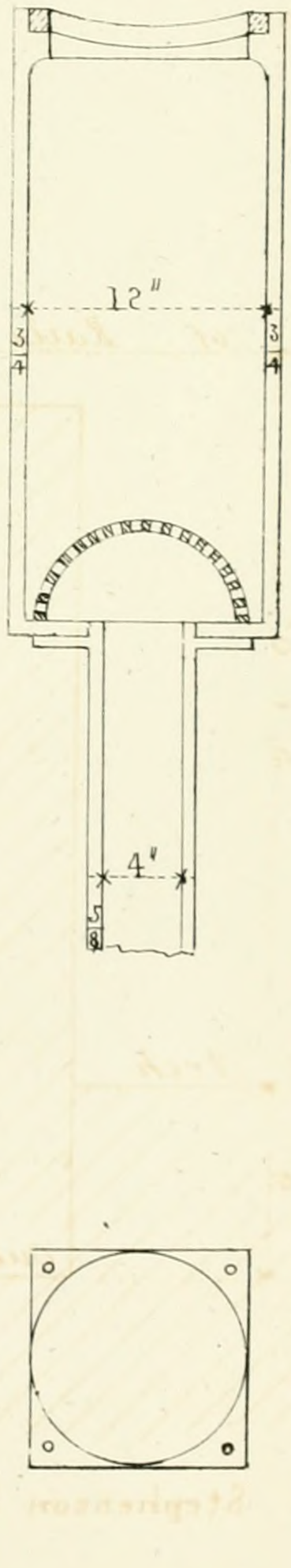


- DETAILS - OF - DRAINS -



- FIG -

- A -



Feet

5 6 7 8 9

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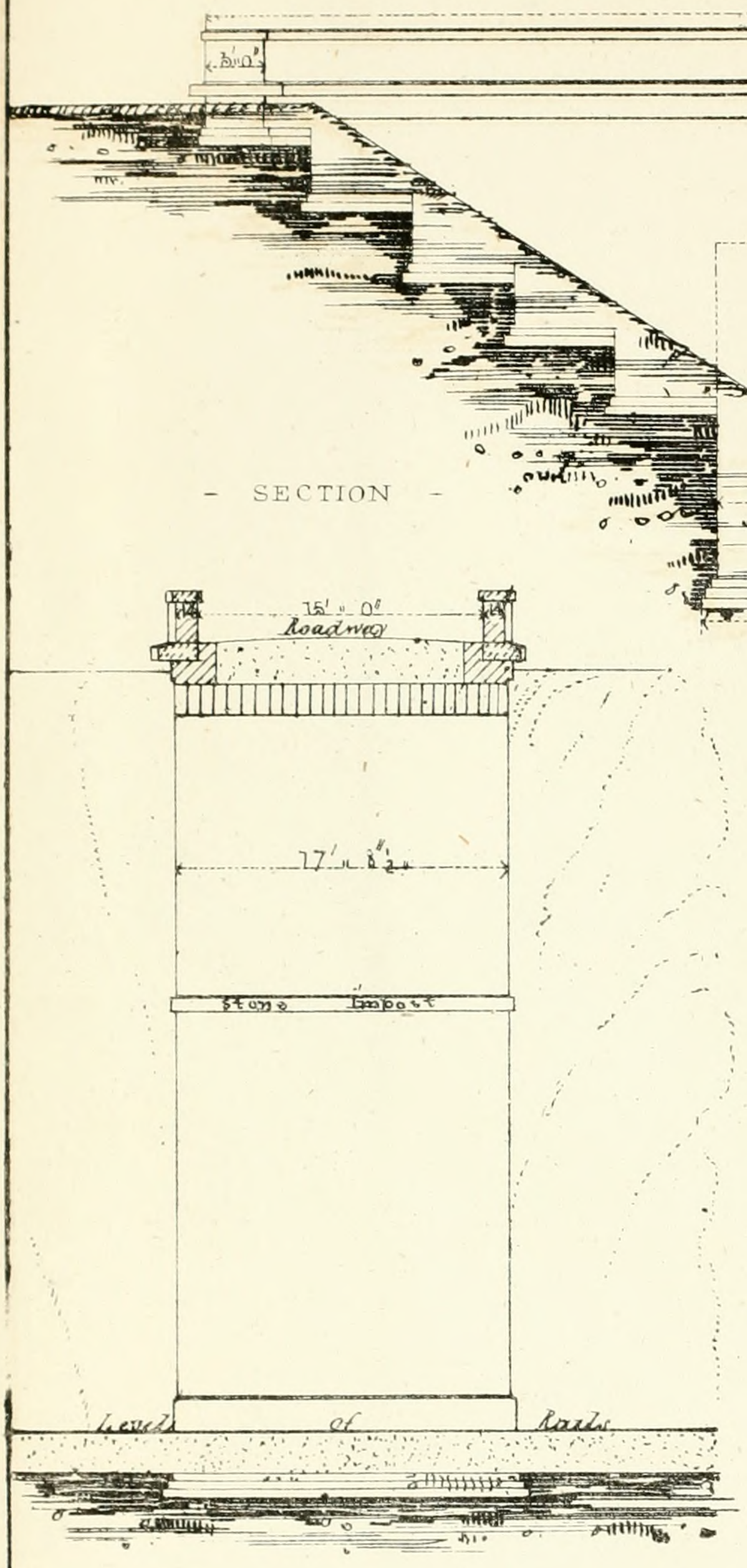
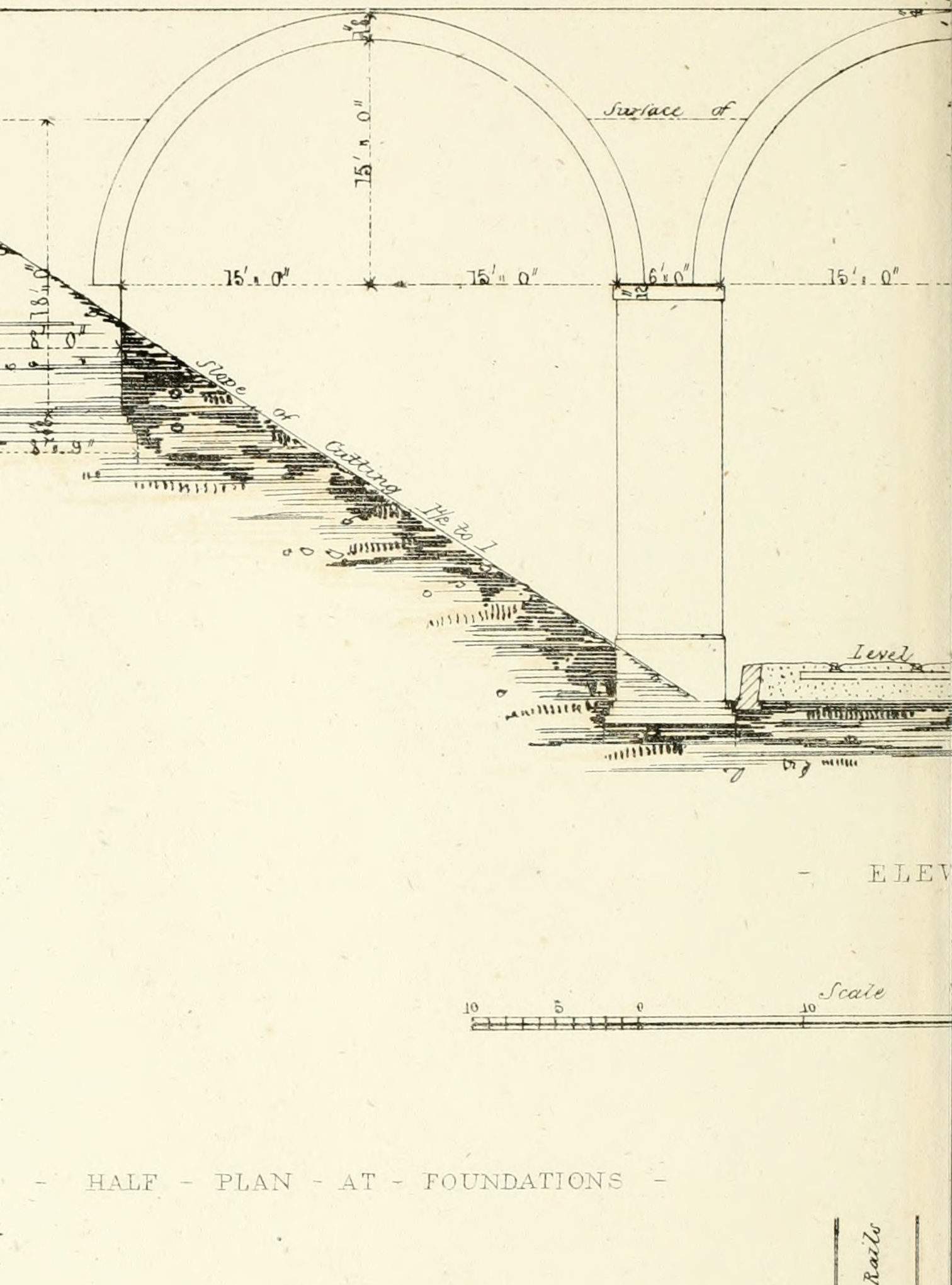
BRIDGE - AT - ROAD - IN - YARDLEY - - PARISH - - UPON

- SECTION -

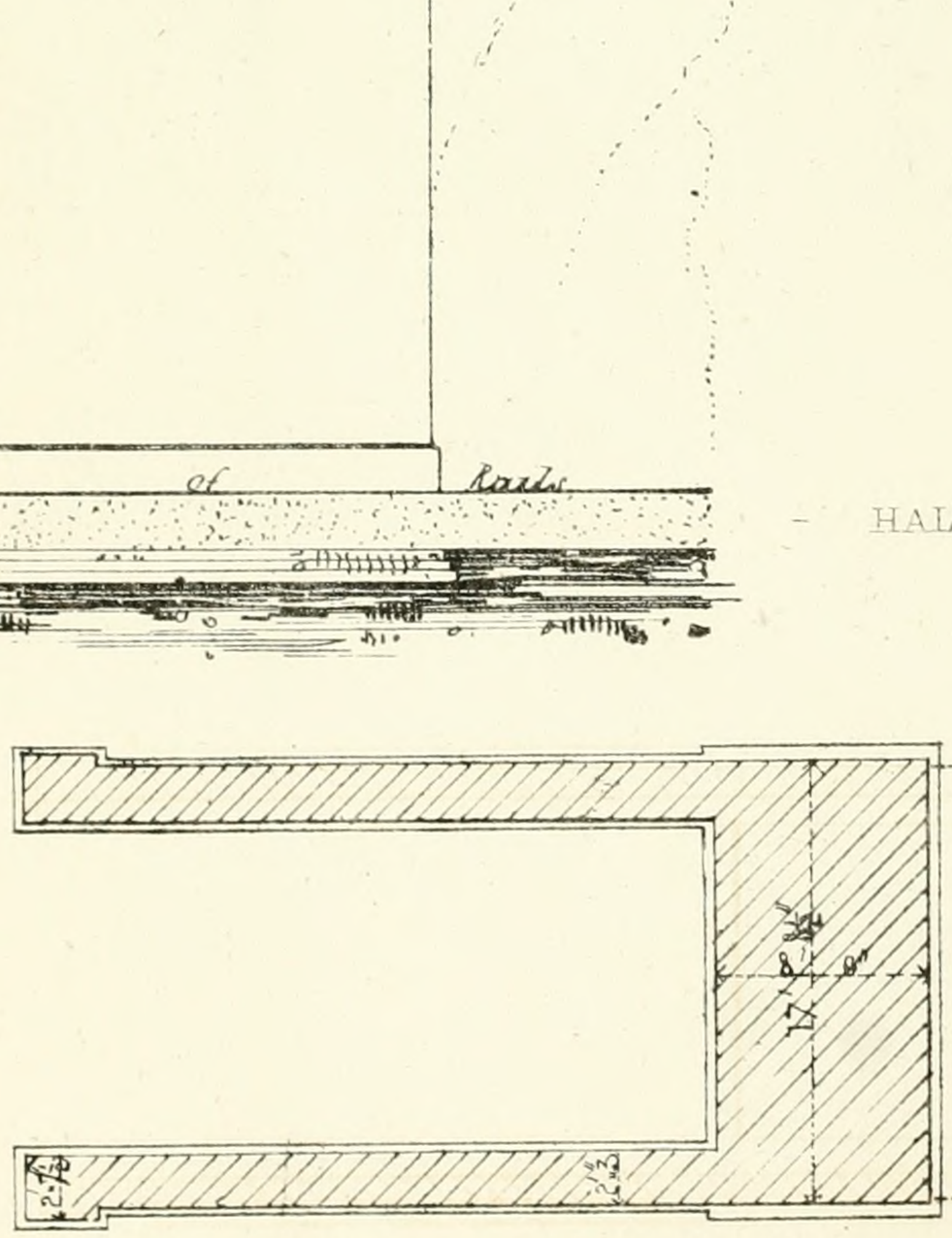




- ELEV

Scale
10 5 0 10

- HALF - PLAN - AT - FOUNDATIONS -

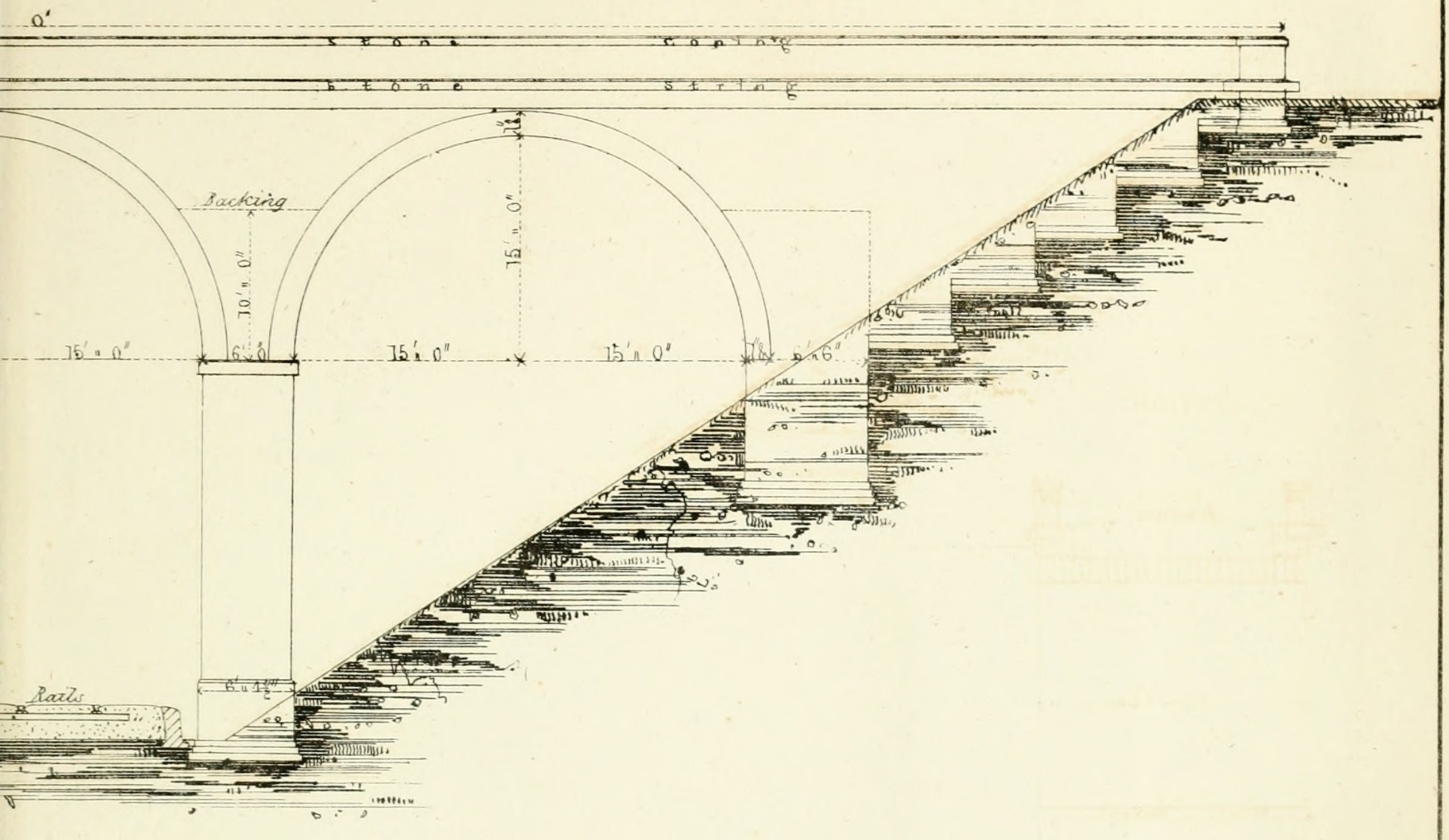


Rails of Line

Robert Stephenson Esq Engineer

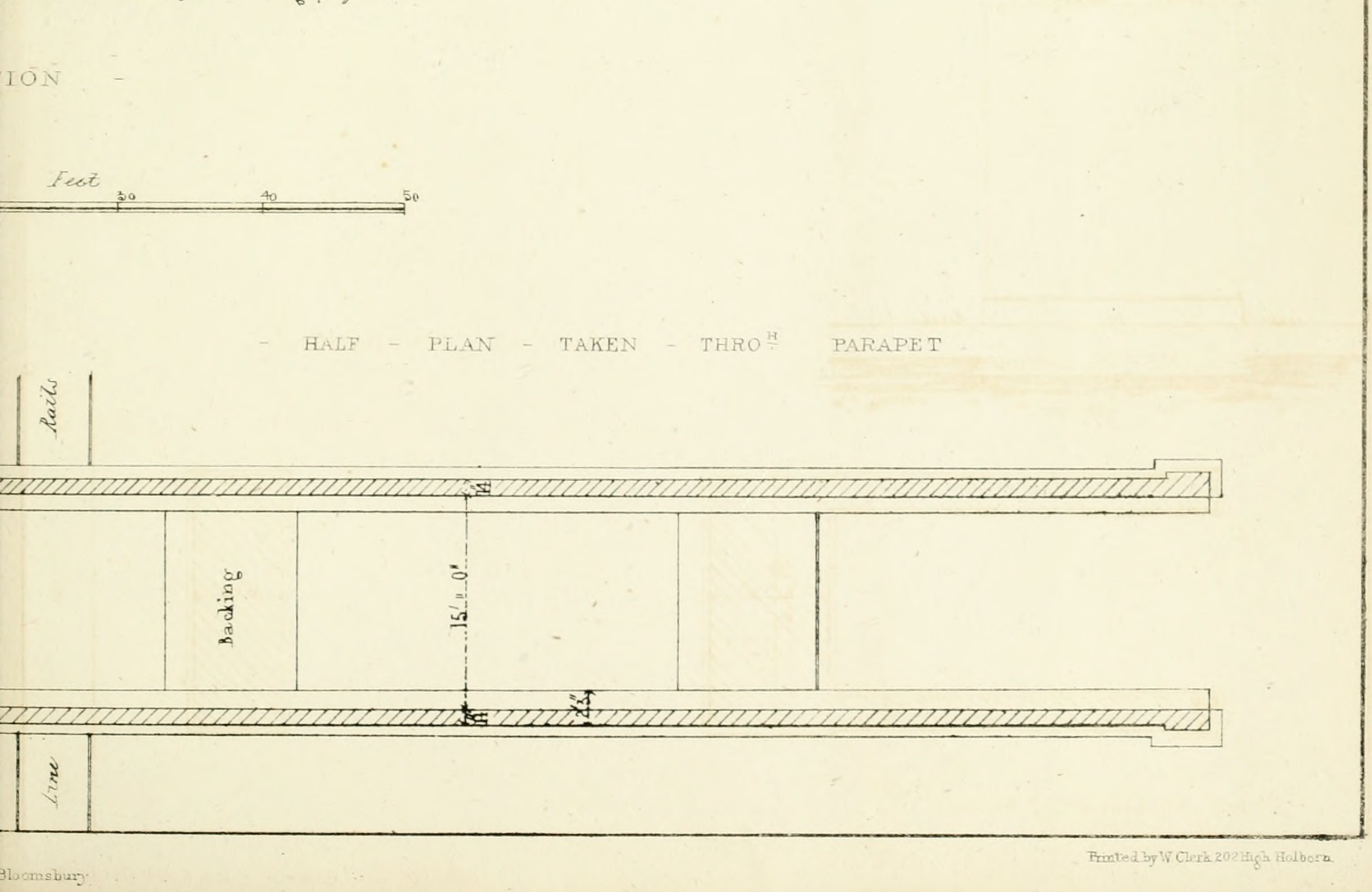
John Williams Library of Science & Art, N°106 Gt Russe

- THE - LONDON - AND - BIRMINGHAM - RAILWAY -



- ION -

- HALF - PLAN - TAKEN - THRO^H - PARAPET -



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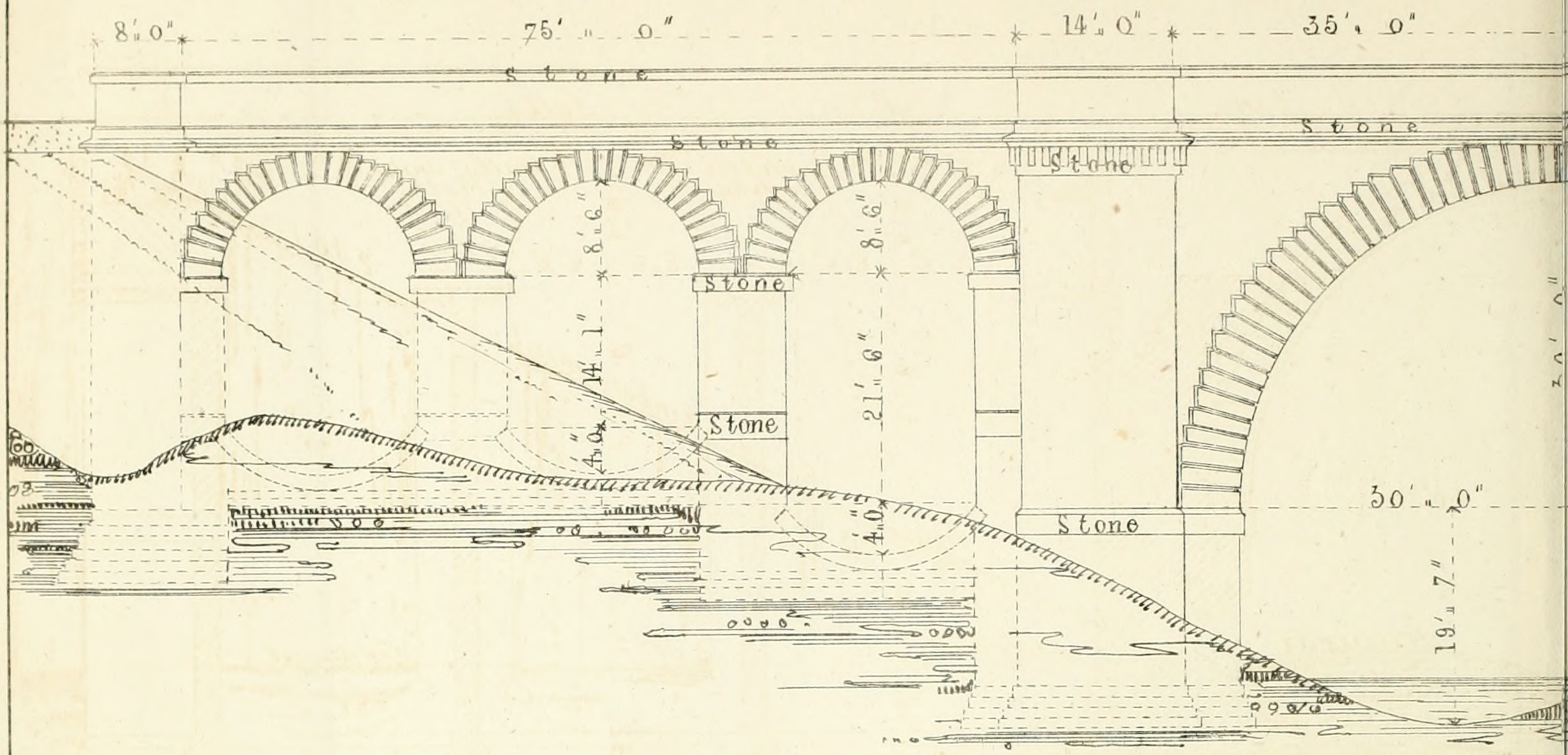
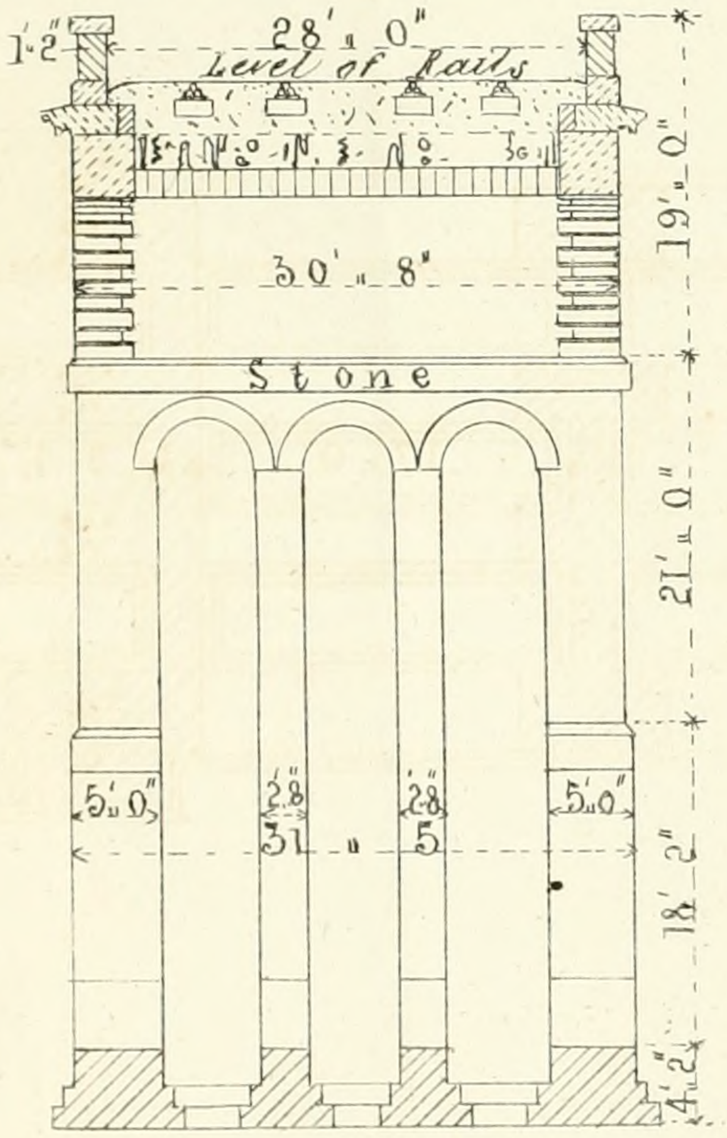
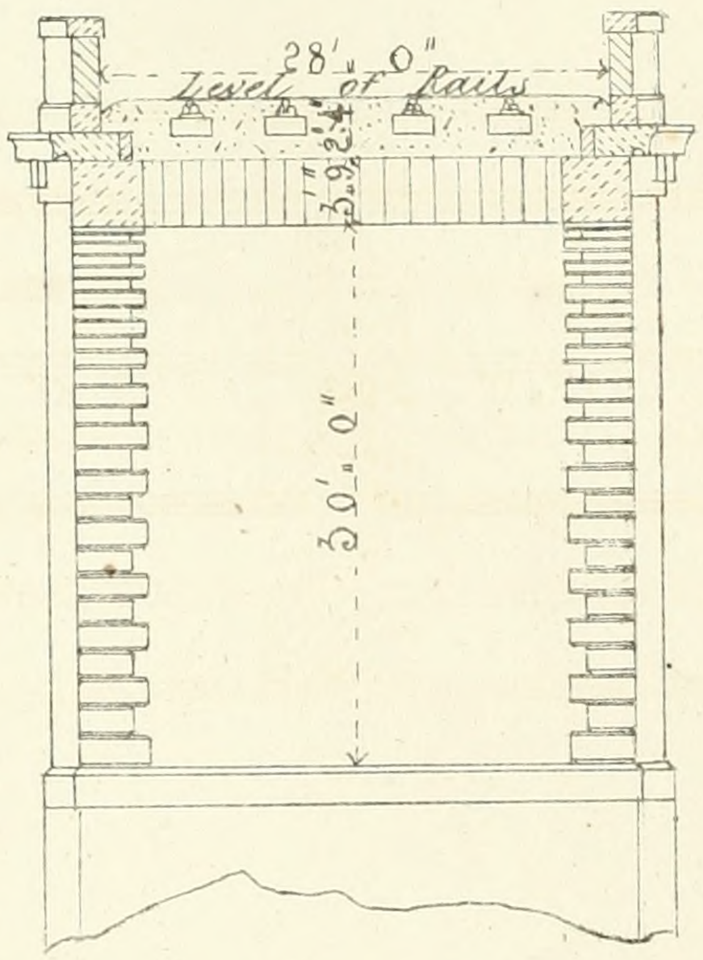
HALF - ELEVATION - - BRIDGE - OVER - THE - R



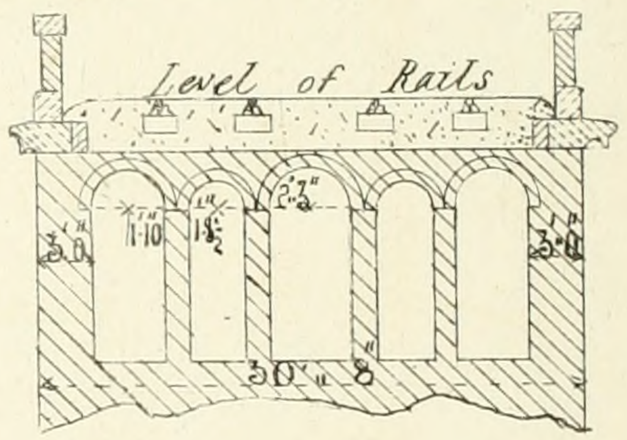
SEC: THROH - SIDE - ARCHES

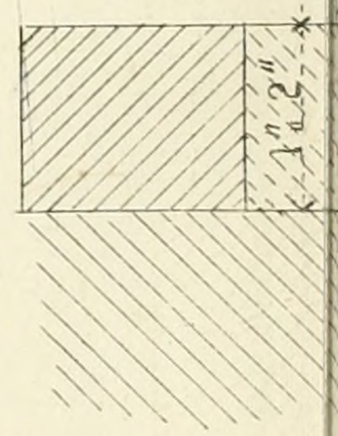


SEC:-THROH - CENTRE - ARCH



SEC.- SPANDRILL - ARCHES - AT ✳





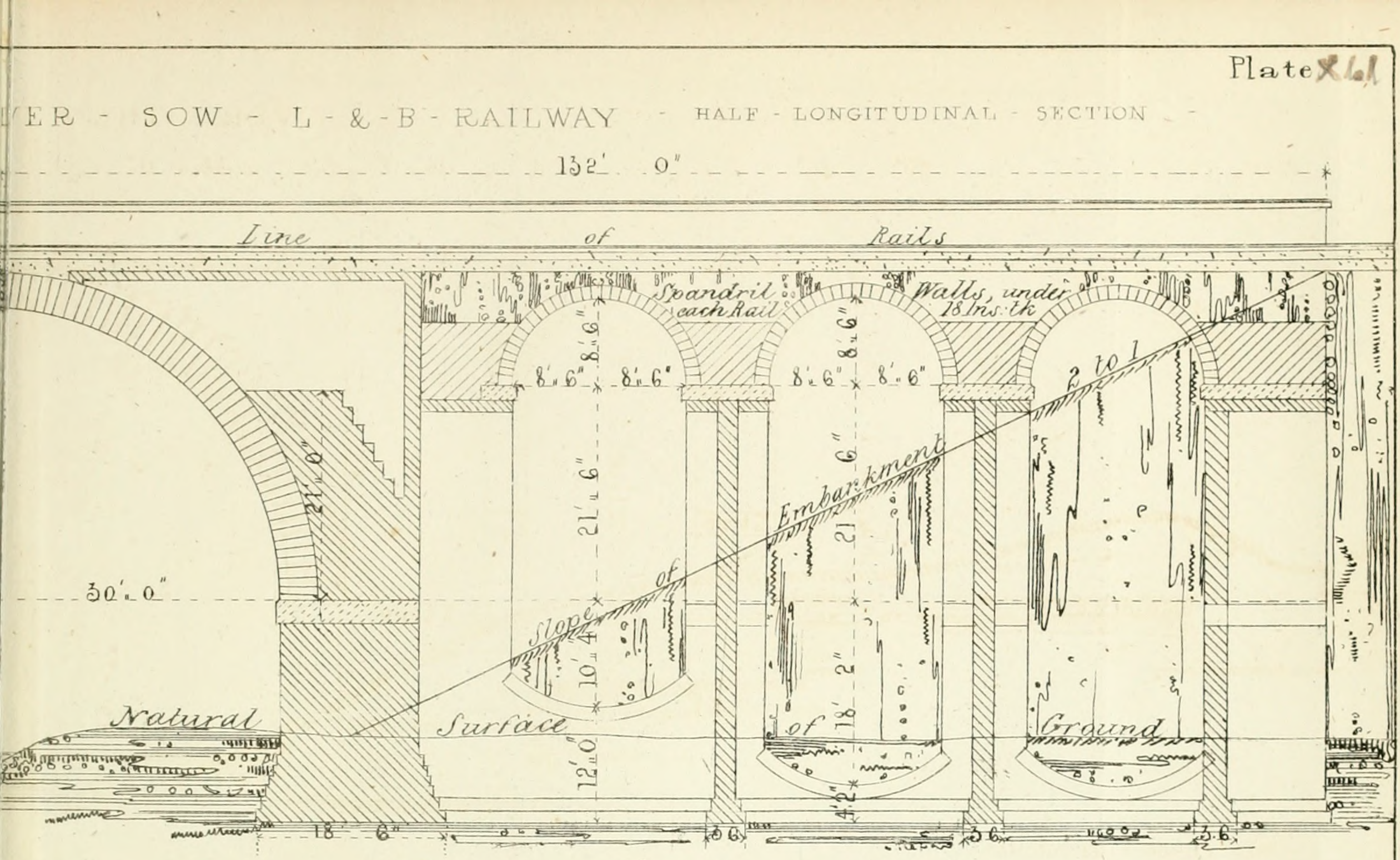
Scale 10 5 0 10 20 30

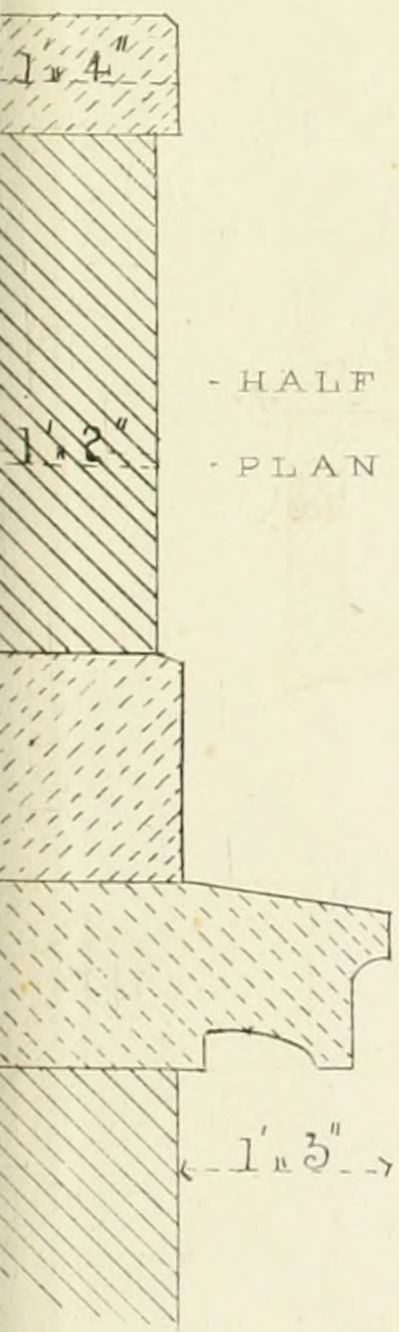
Robert Stephenson Esq Engineer

John Williams Library of Science

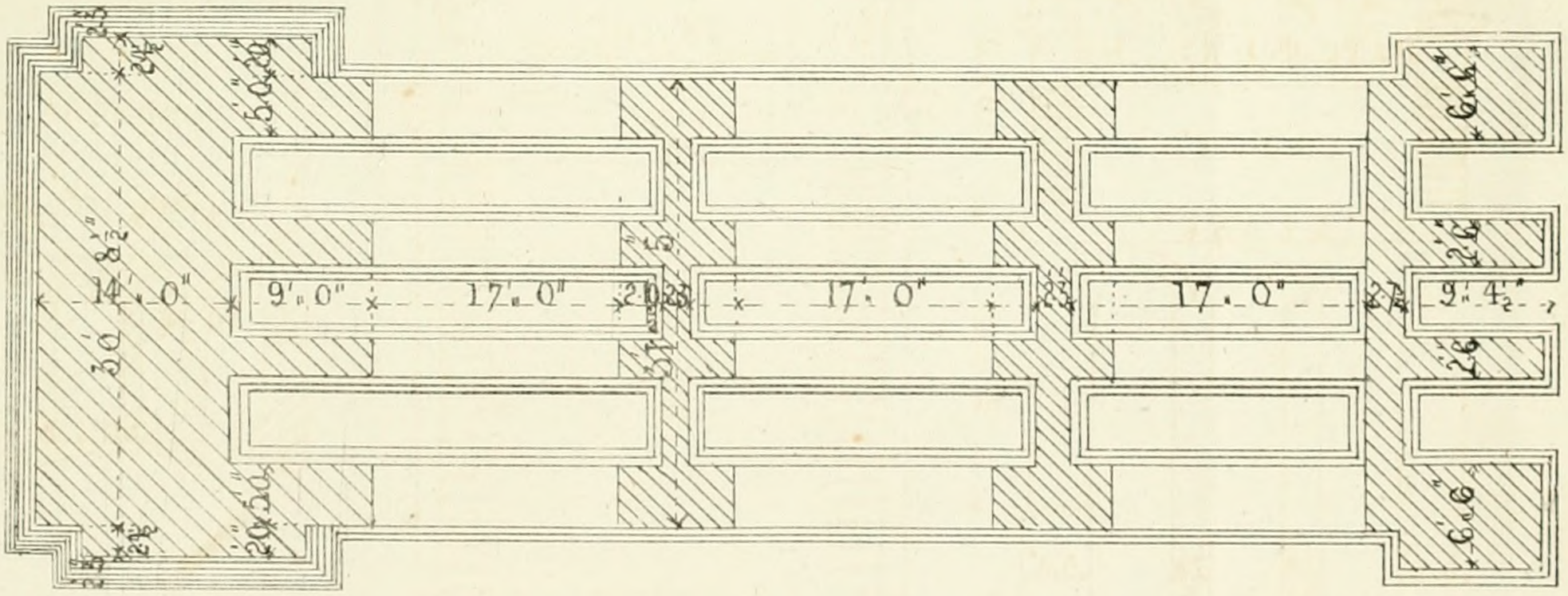
Plate XLI

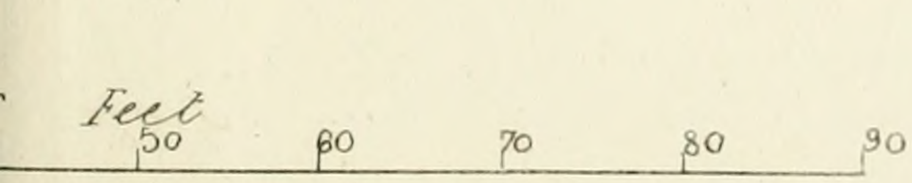
VER - SOW - L - & - B - RAILWAY - HALF - LONGITUDINAL - SECTION





- HALF -
- PLAN -





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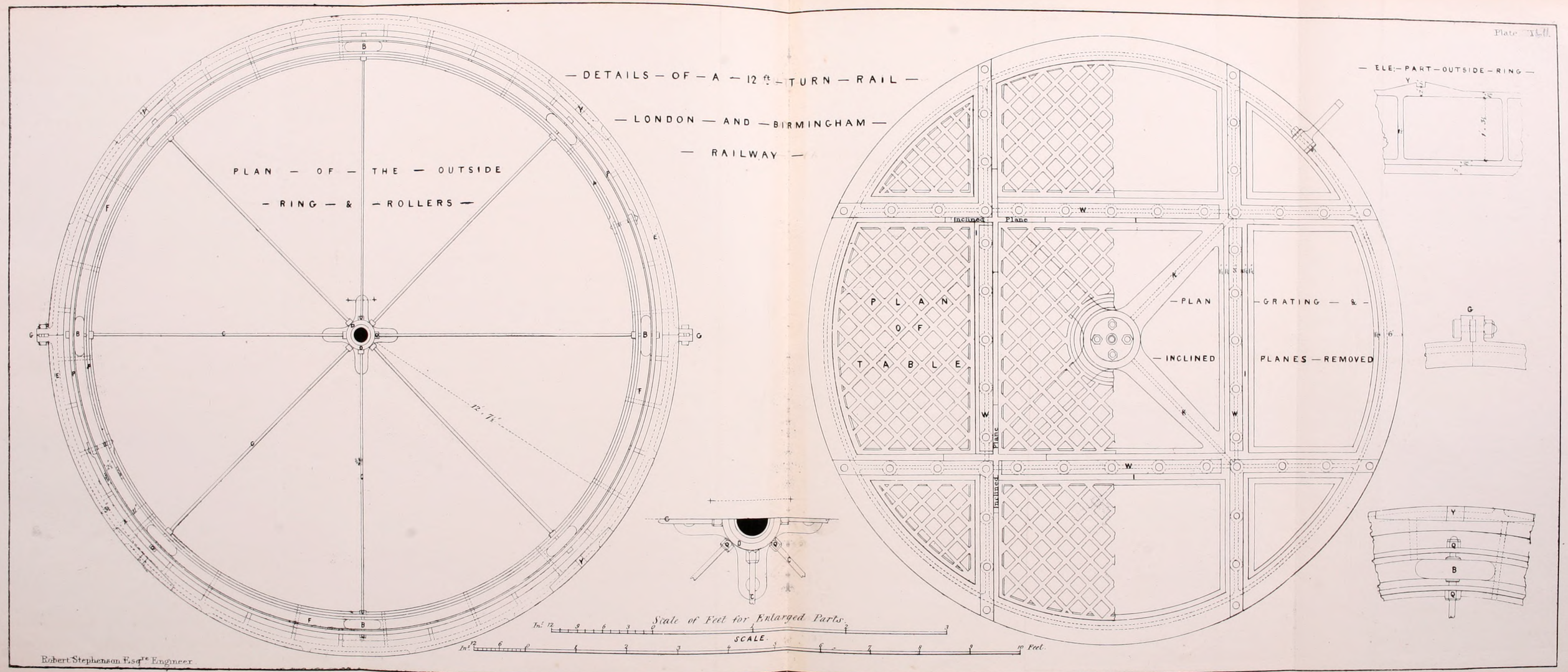
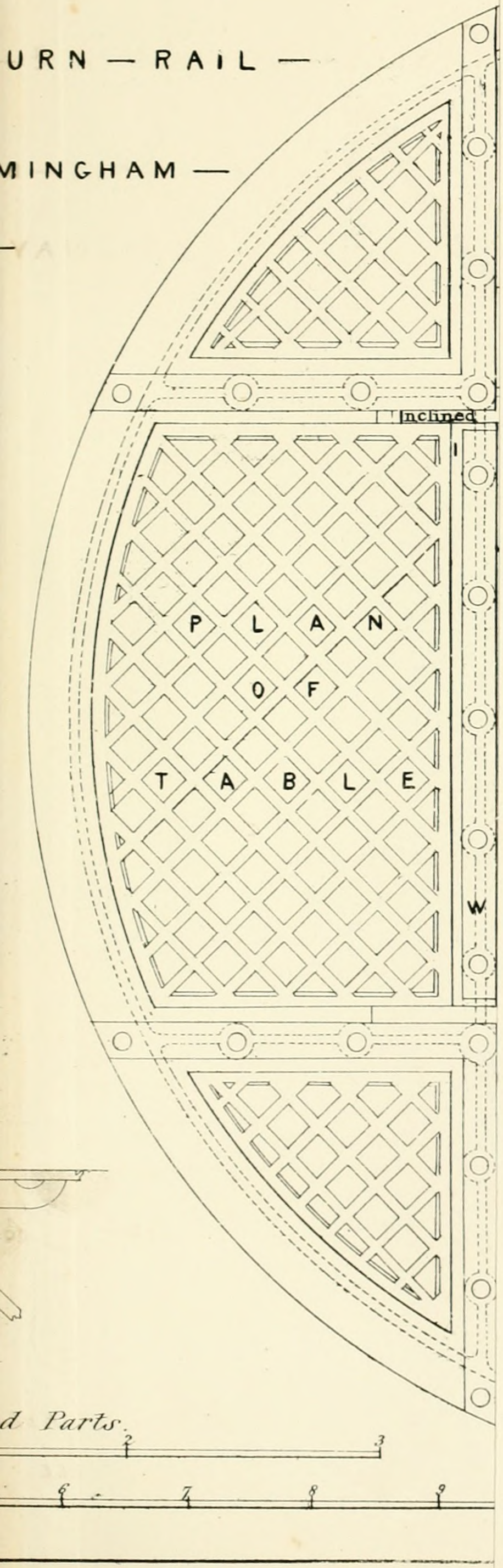


JOHN WILLIAMS, LIBRARY OF SCIENCE & ART, 106 Great Russel Street

URN — RAIL —

MINGHAM —



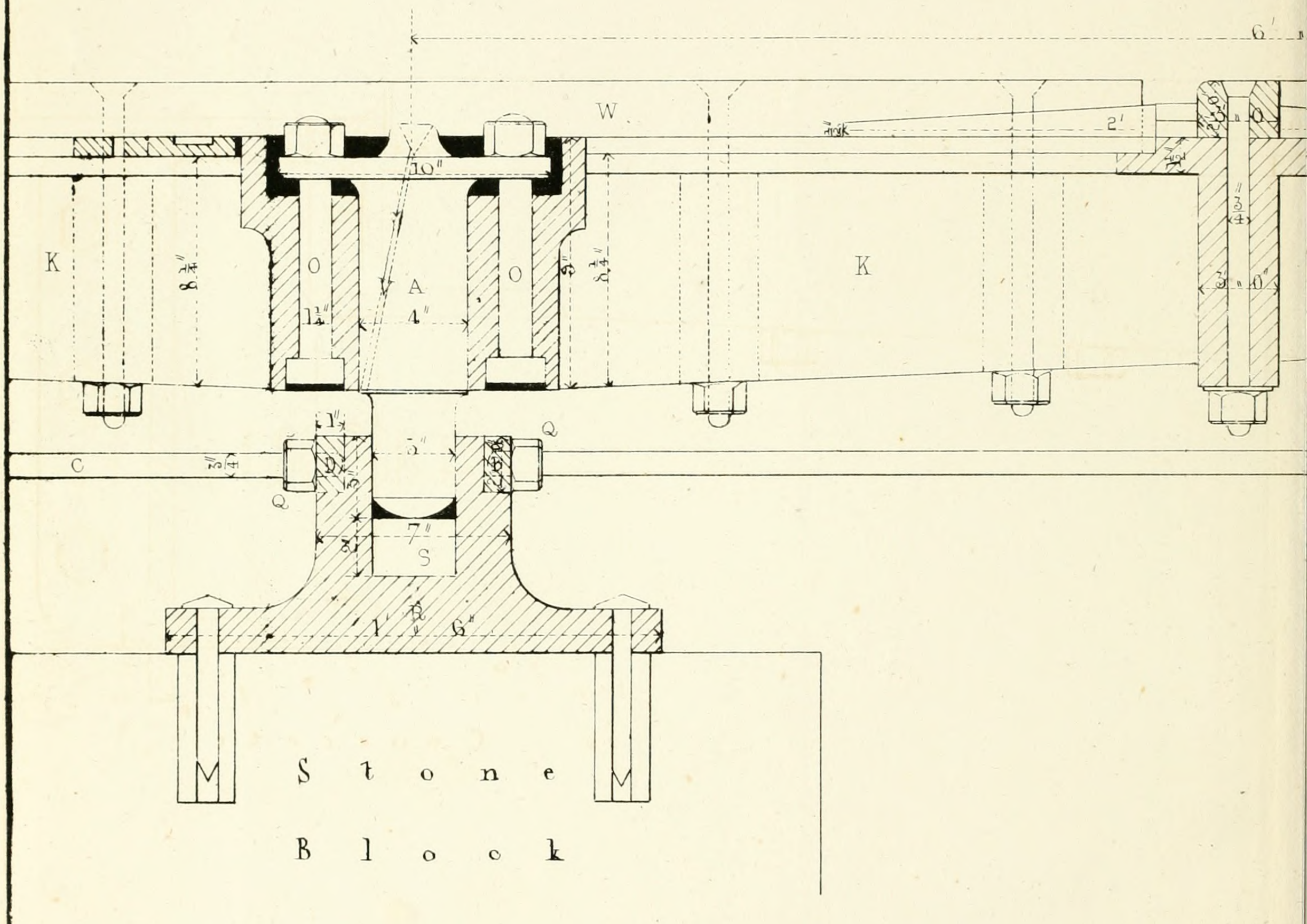
d Parts.

106 Great Russel Street.

- DETAILS - OF -

- LONDON - &

- SECTION - THROU



Stone Block

Scale

12 9 6 3 0 1

Robert Ste

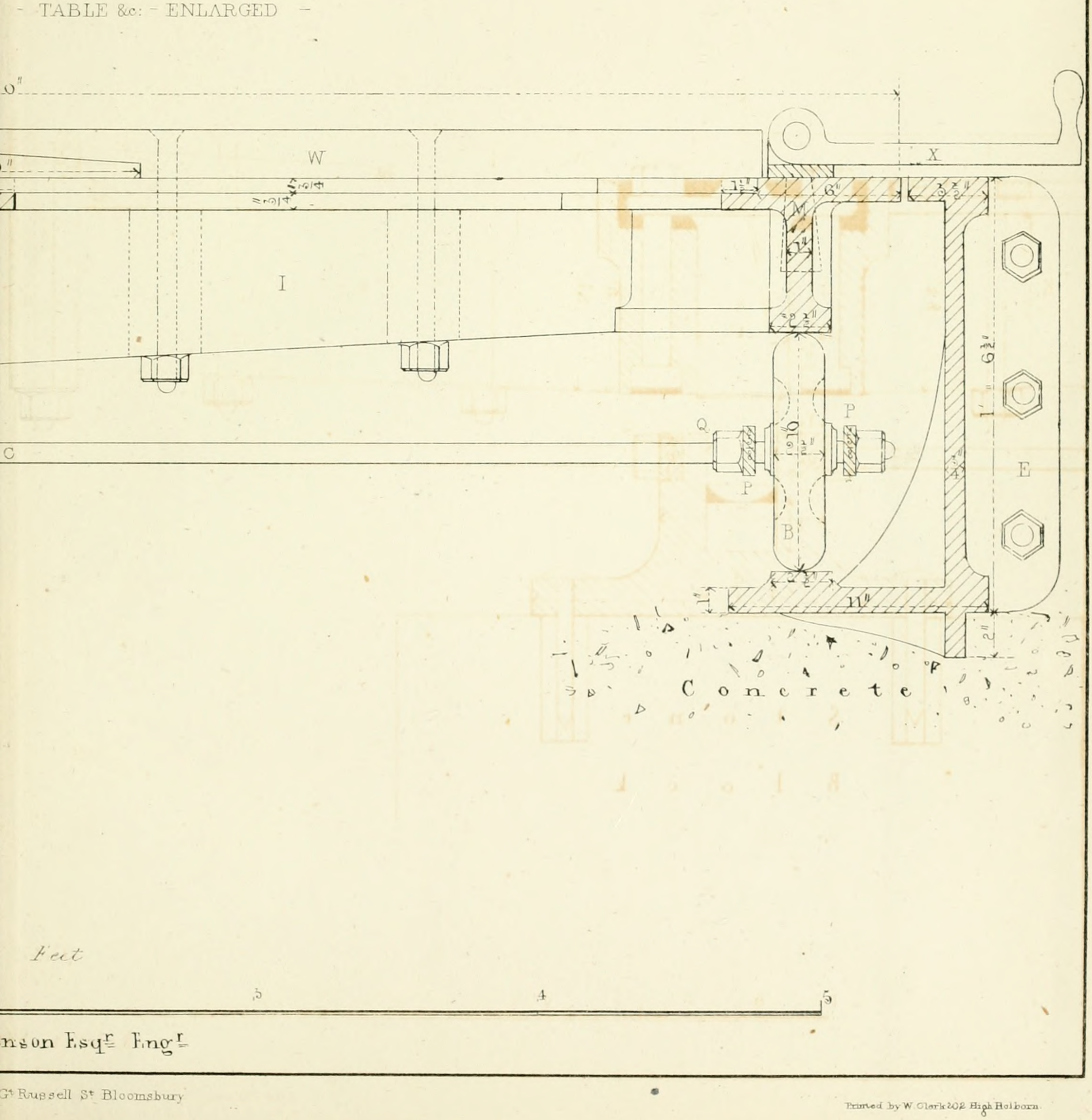
John Williams Library of Science & Art N

Plate XLIII.

– 12 Ft:- TURNRAIL –

MINGHAM – RAILWAY –

– TABLE &c: – ENLARGED –



Feet

5 4 5

nson Esqr Eng^r

G^t Russell St Bloomsbury

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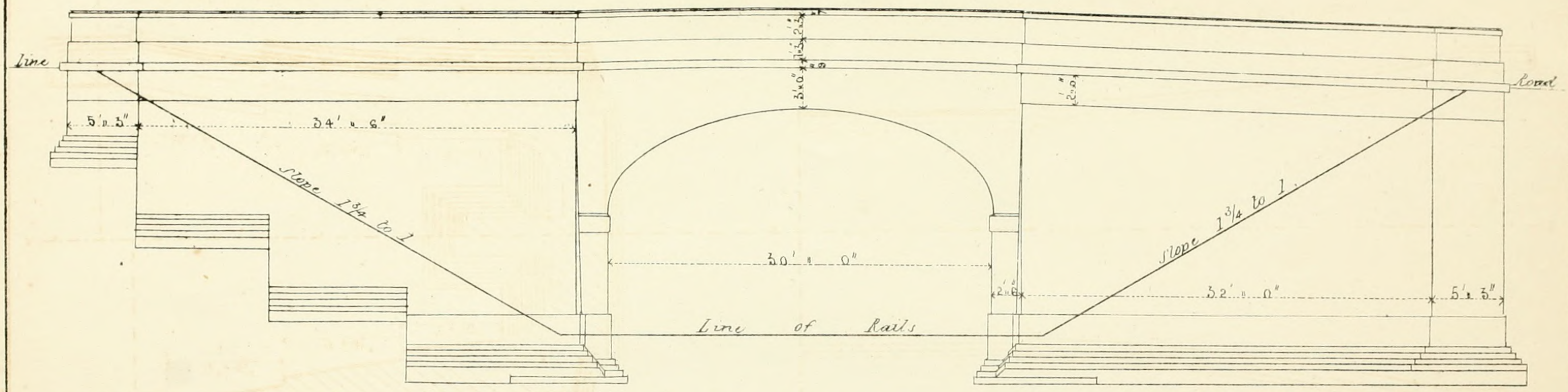
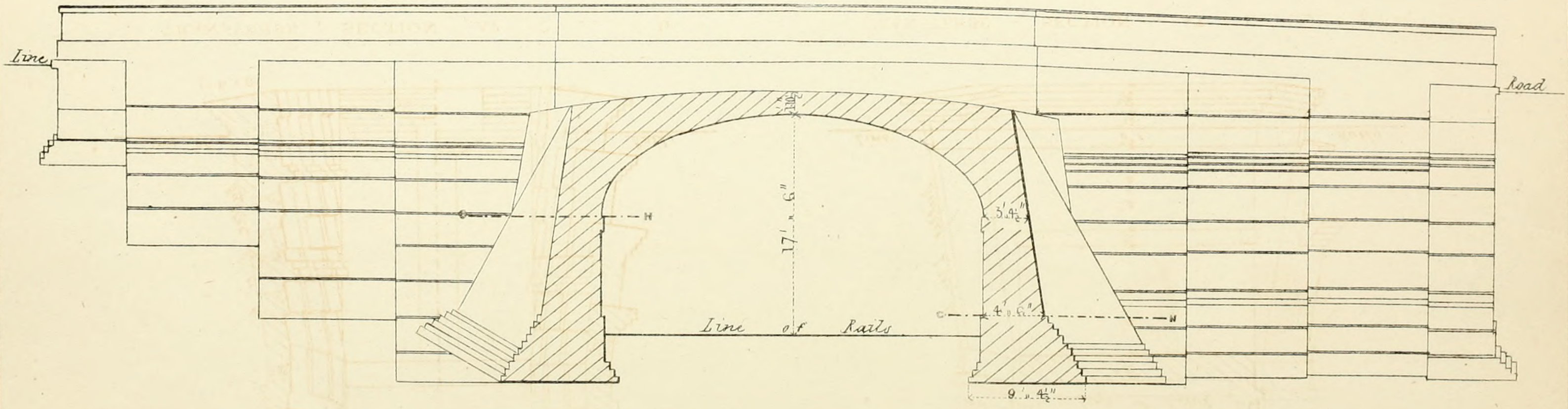
Plate XLIV.

- BRIDGES - OVER - THE - GREAT - WESTERN - RAILWAY - AS - EXECUTED -

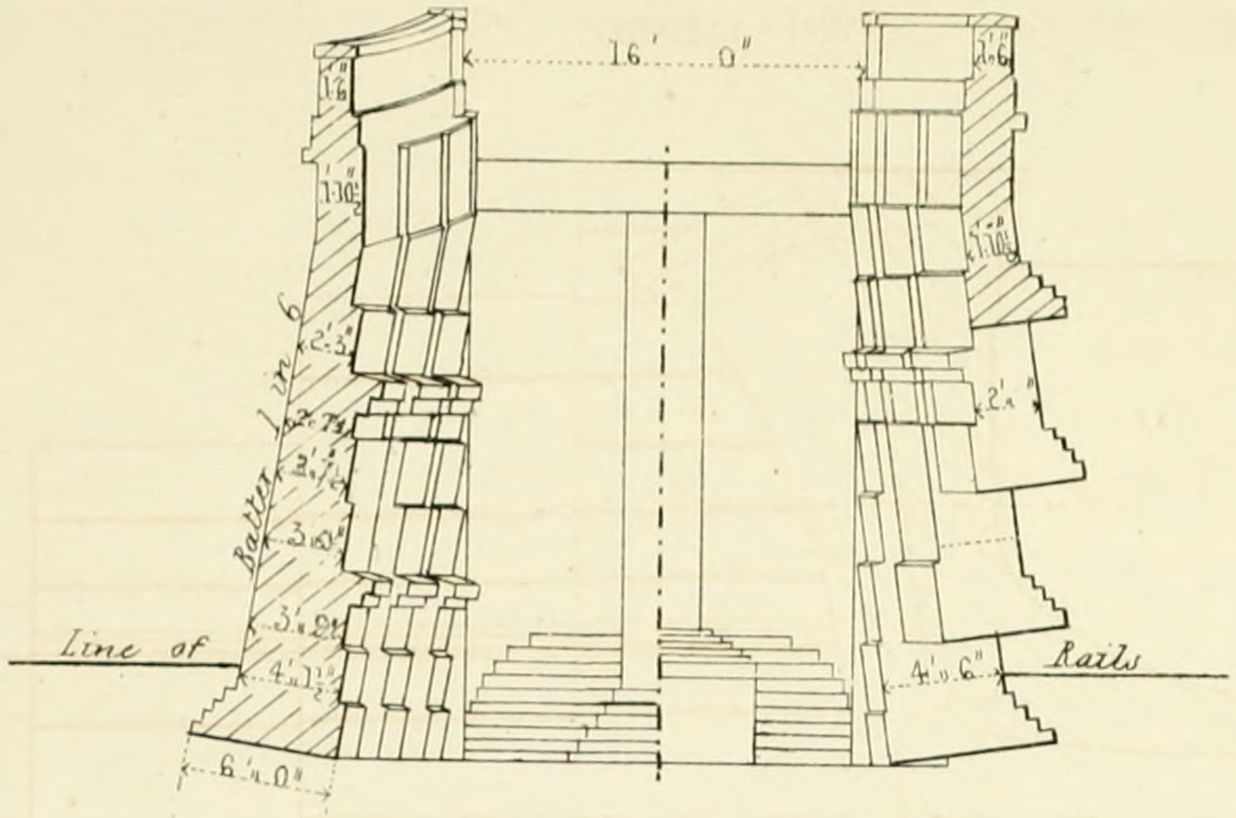


- ELEVATION -

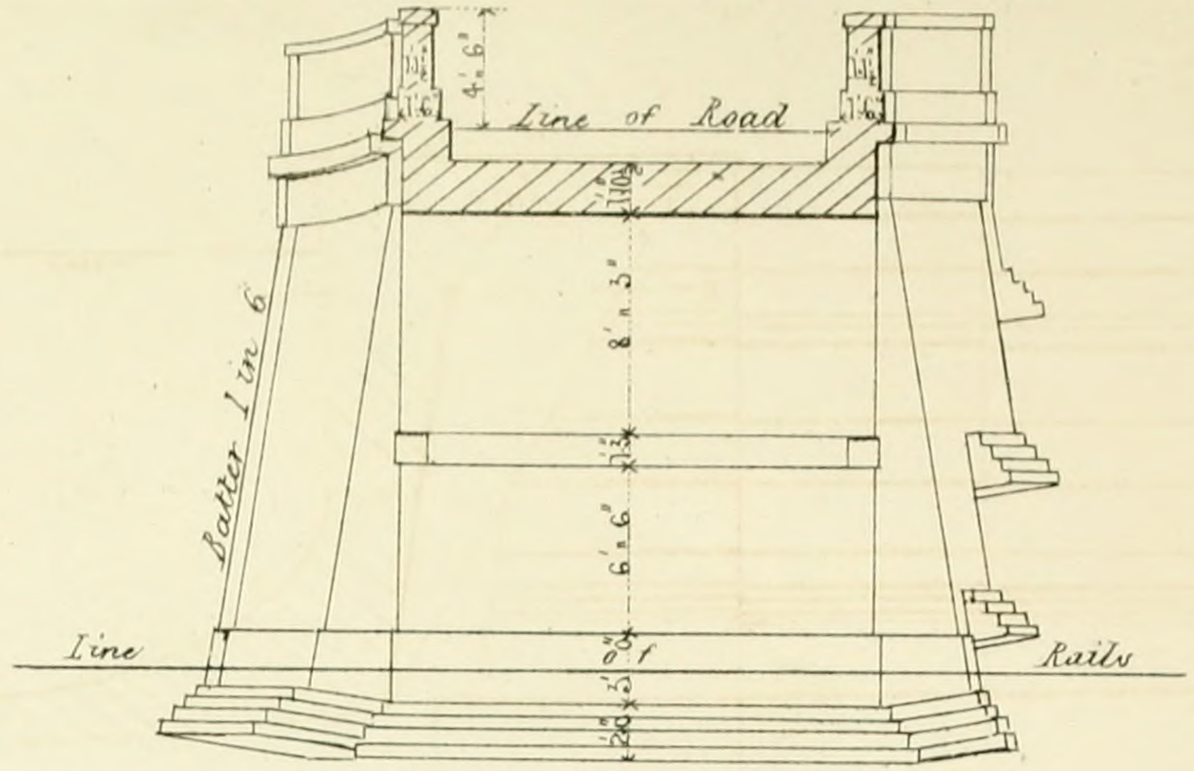
- *In Cutting* - - *In Embankment* -



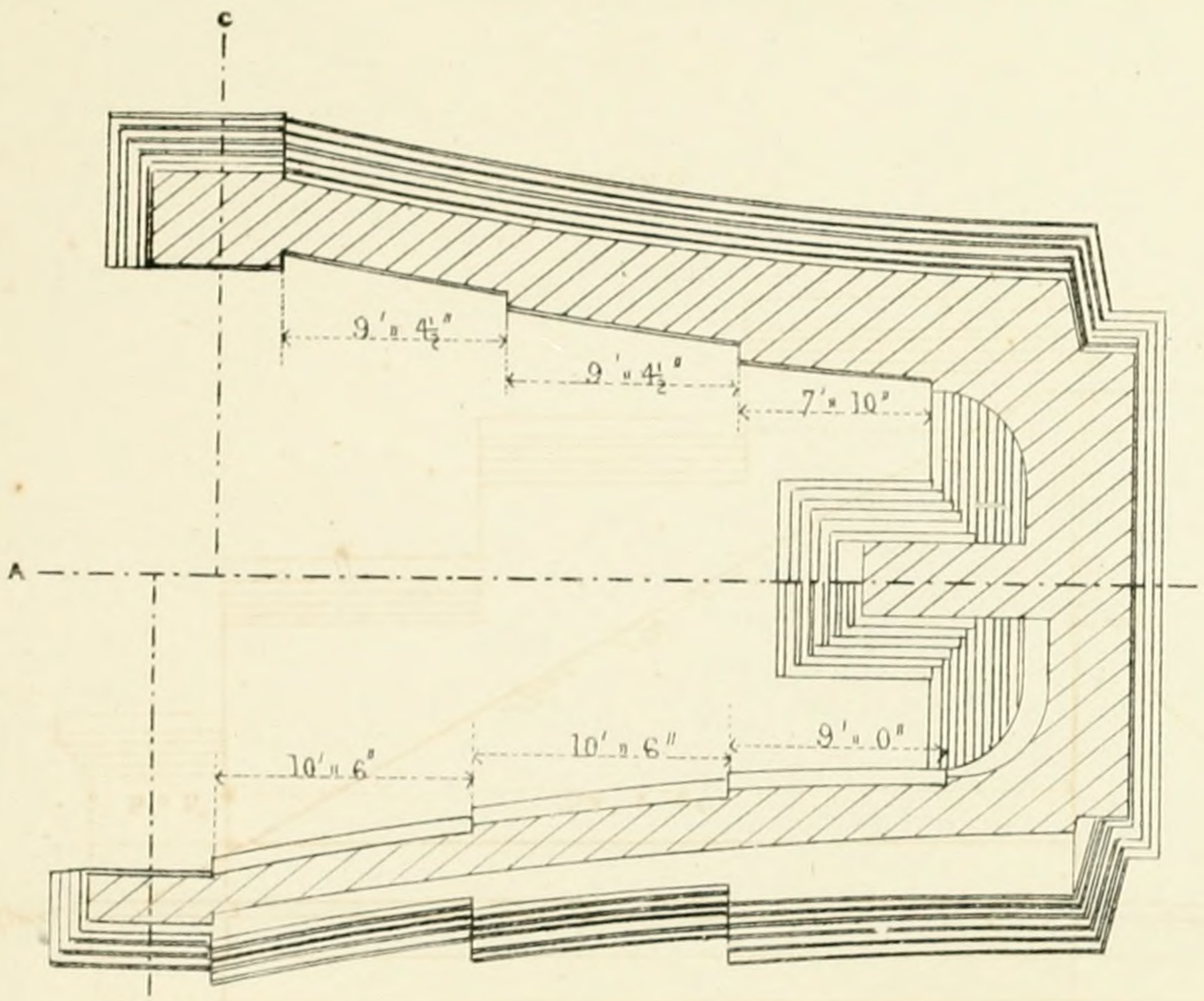
- LONGITUDINAL - SECTION - AT - A ——— B -



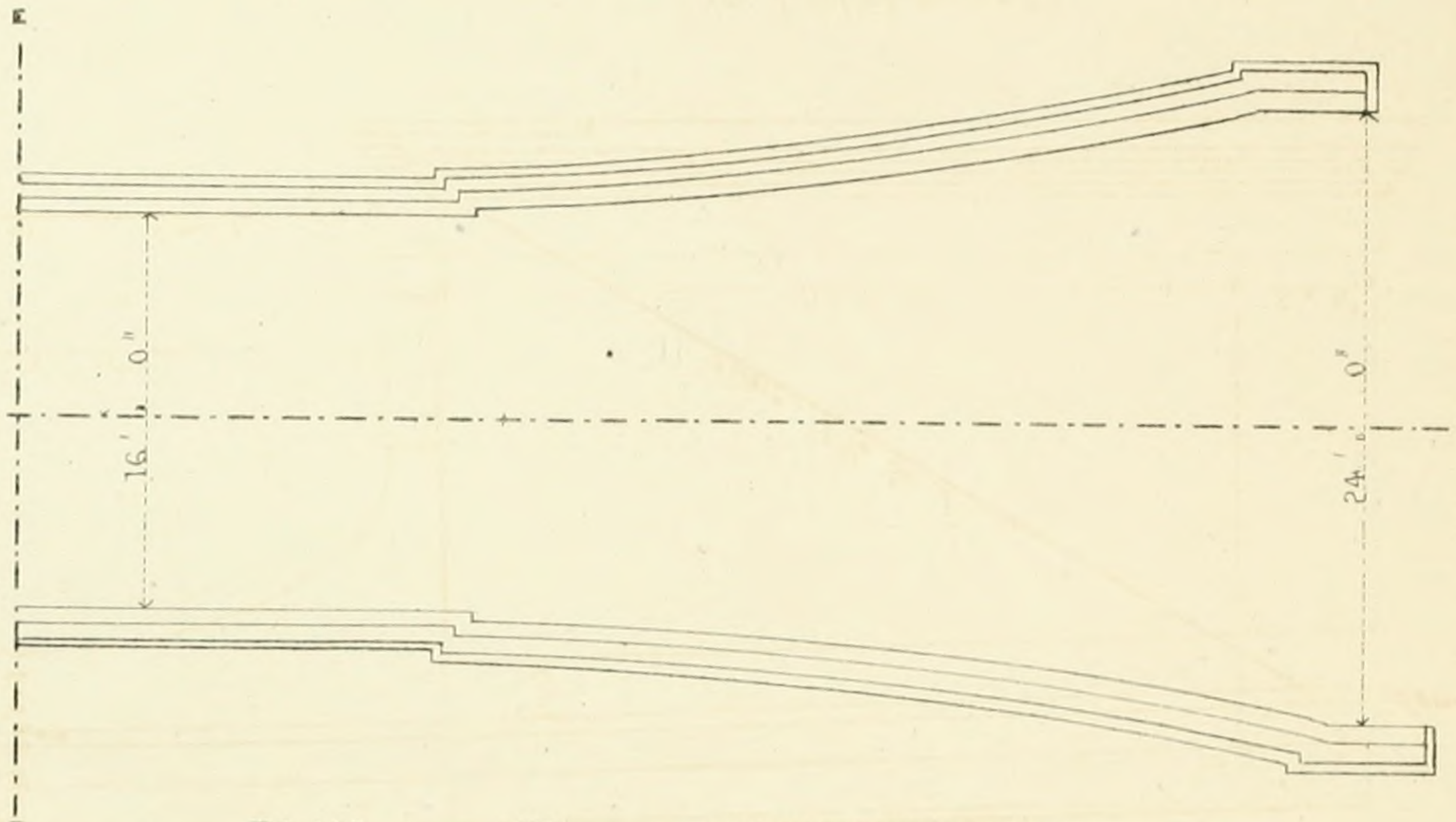
TRANSVERSE - SECTION - AT - C_____ D -



- TRANSVERSE - SECTION - AT - E_____F -



PLAN OF FOUNDATIONS AT C_____H -



- PLAN - OF SUPERSTRUCTURE -

Scale of Feet
10 5 0 10 20 30 40 50

I. K. Brunel. Esqr Engineer.

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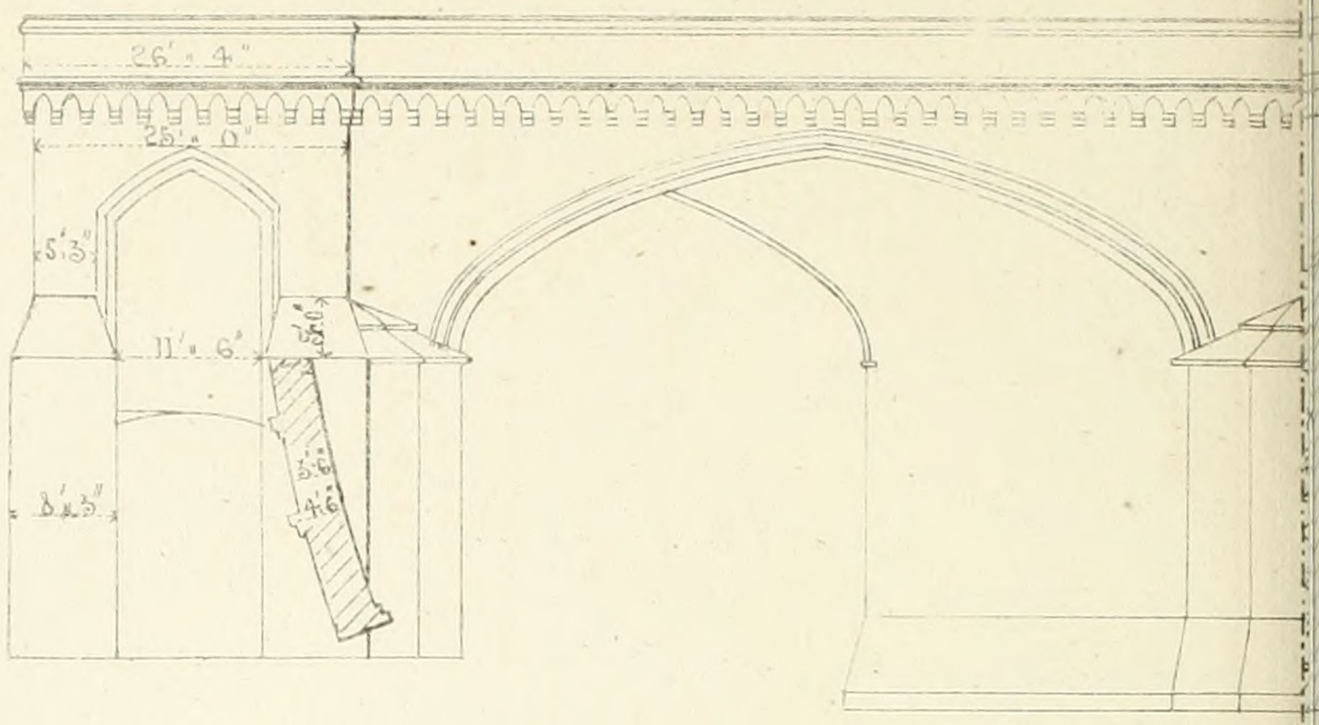
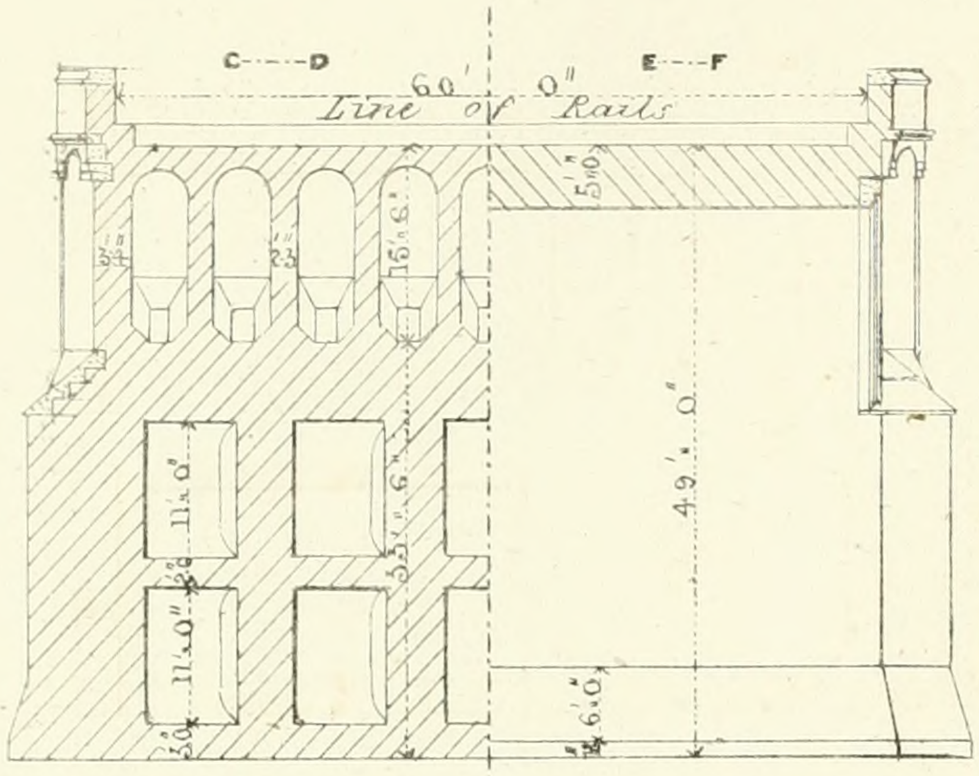
- GREAT - WESTERN -

- RAILWAY -



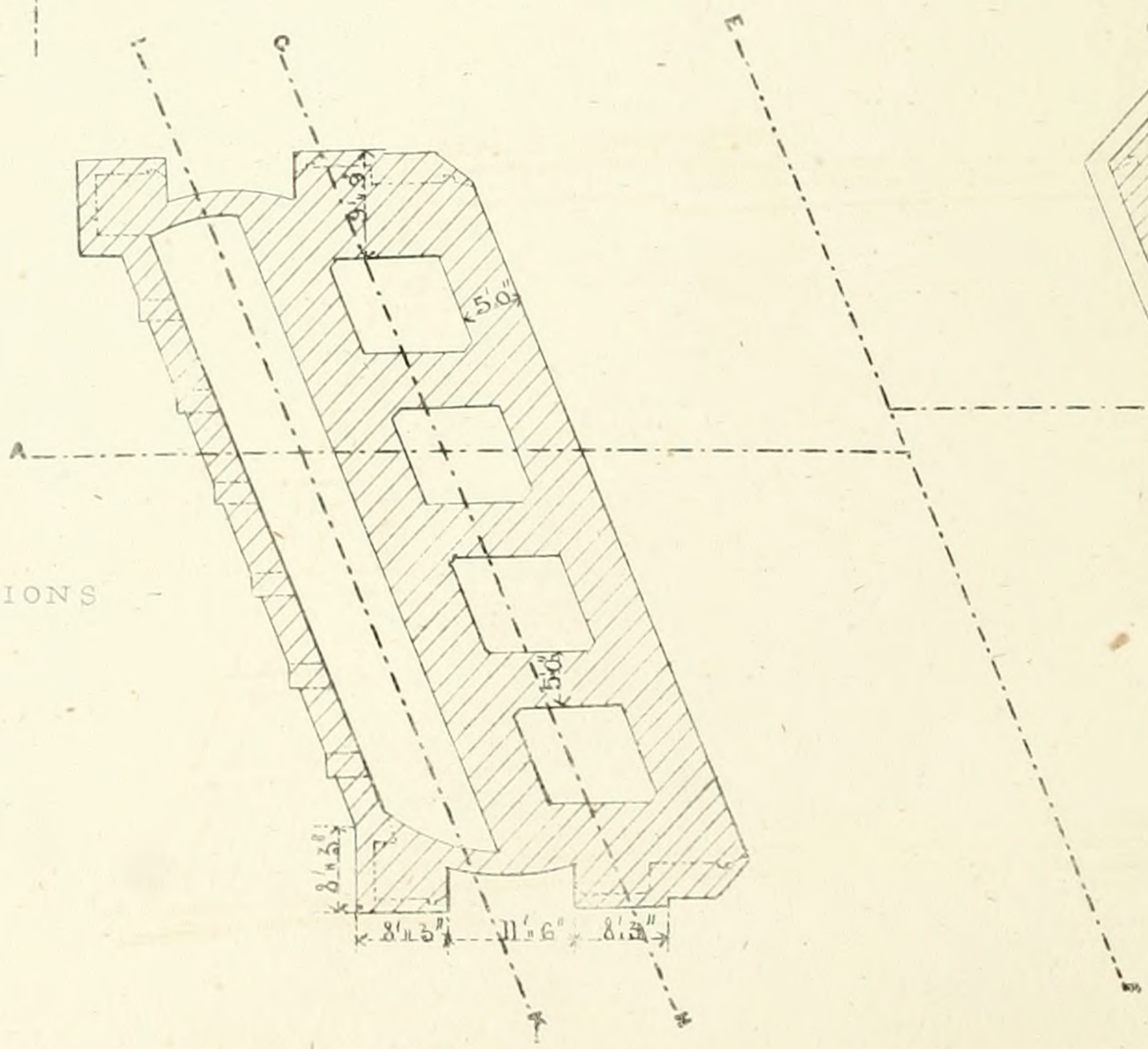
- ELEVATION -



- TRANSVERSE - SECTIONS -

- I. K. Brunel Esq

Scale of
10 0 10 20 30



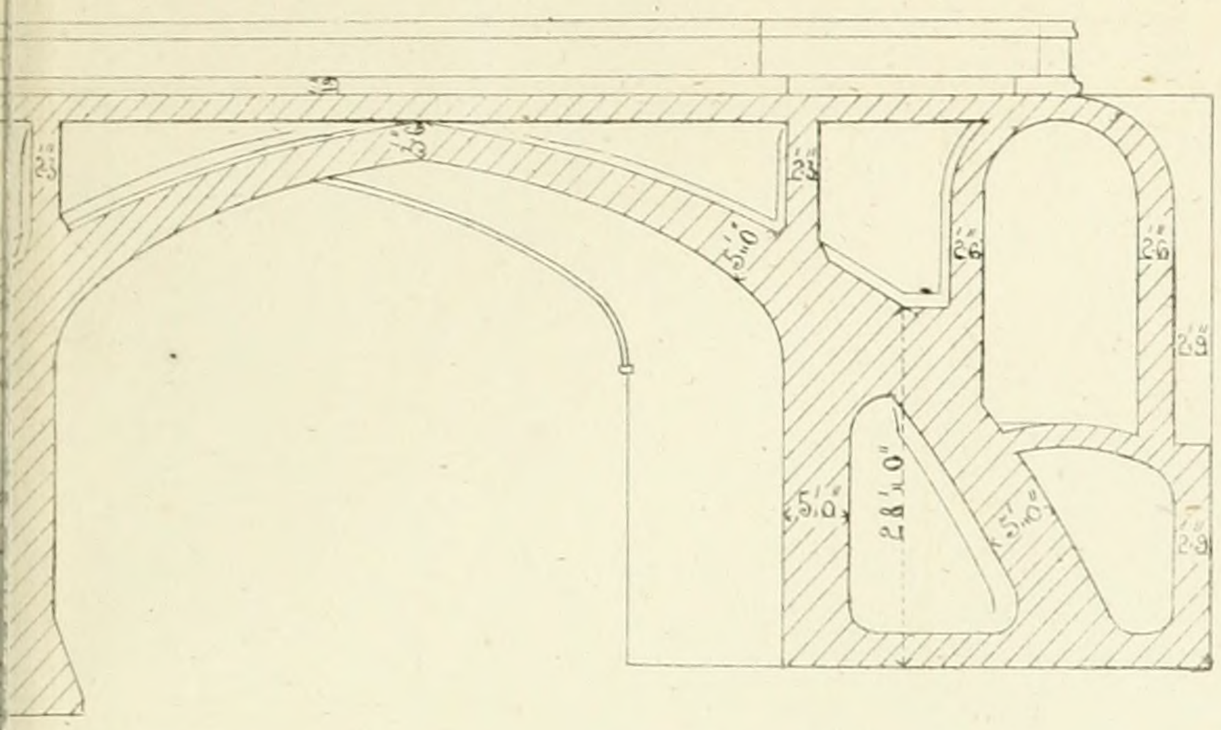
- PLAN - OF - FOUNDATIONS -

John Williams, Library of Science & A

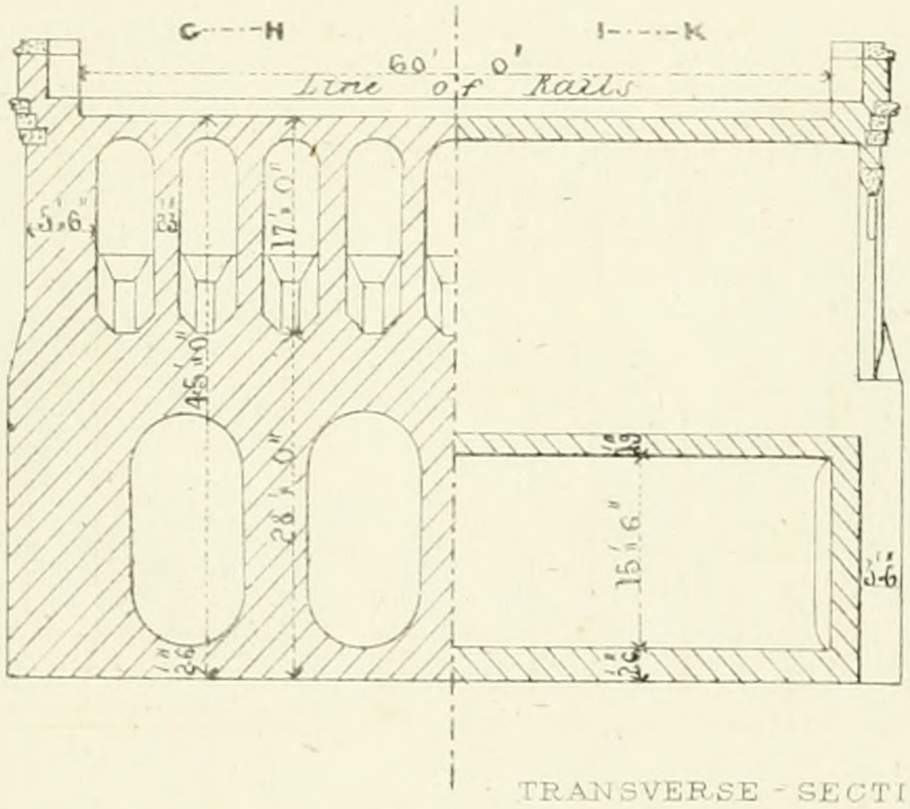
- BRIDGE -

- CROSSING - THE - FLOAT -

- AT - BRISTOL -



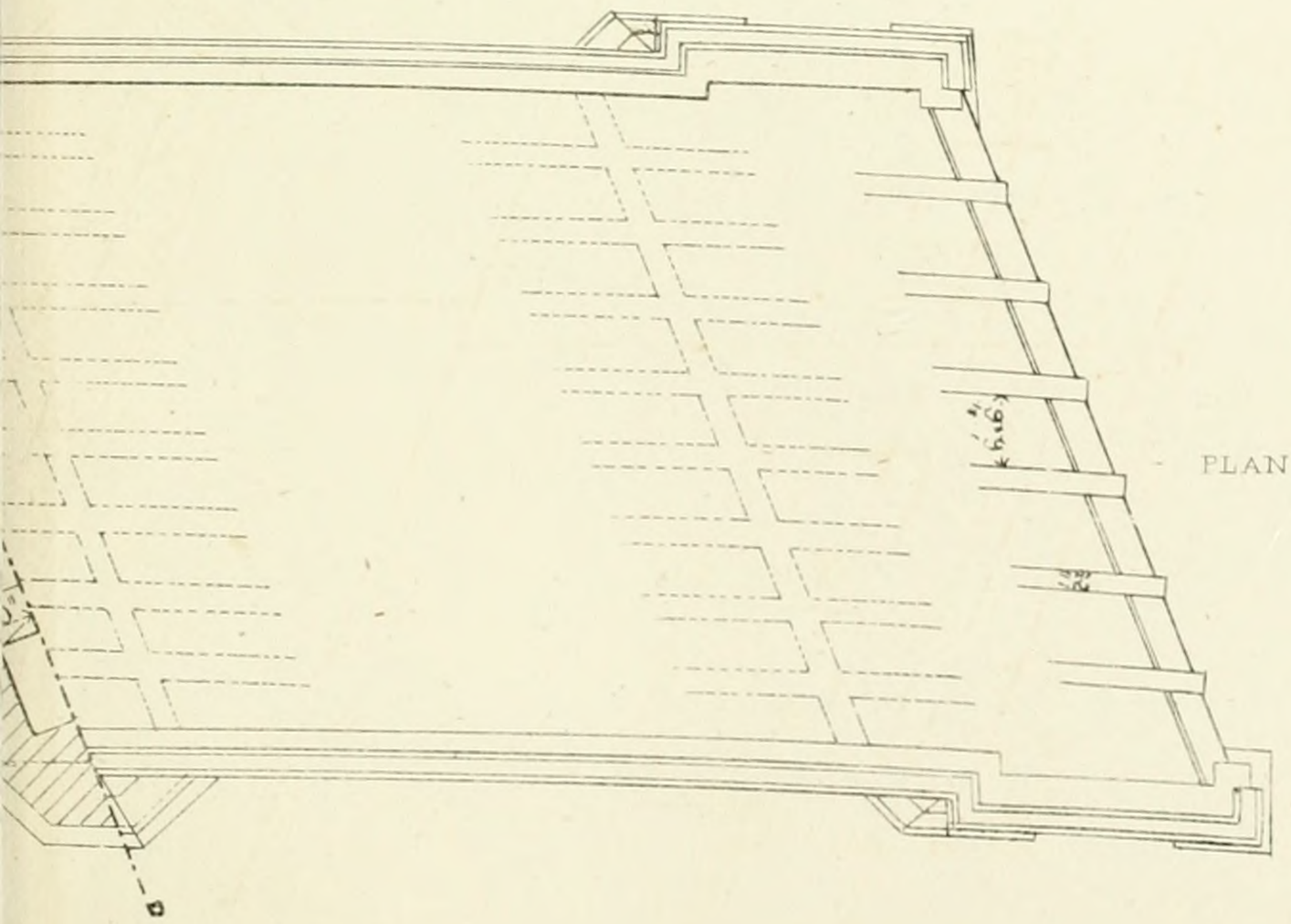
LONGITUDINAL - SECTION - AT - A B -



TRANSVERSE - SECTIONS .-

Engineer. -

Feet
10 50 60 70



- PLAN - OF - SUPERSTRUCTURE -

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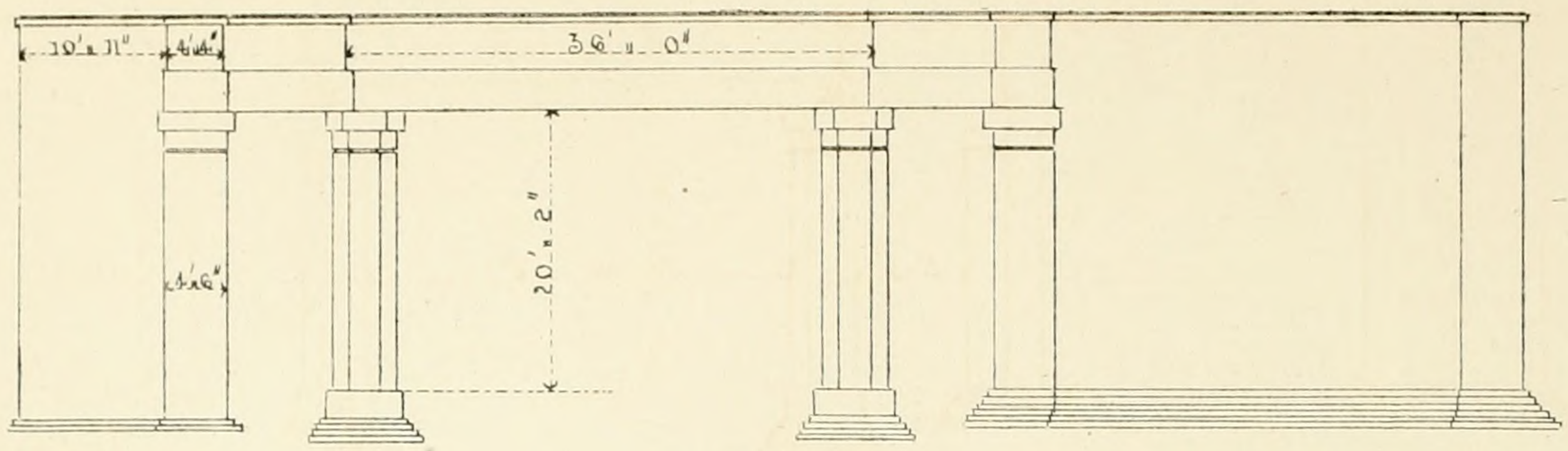
GREAT - WESTEN

- DETAILS

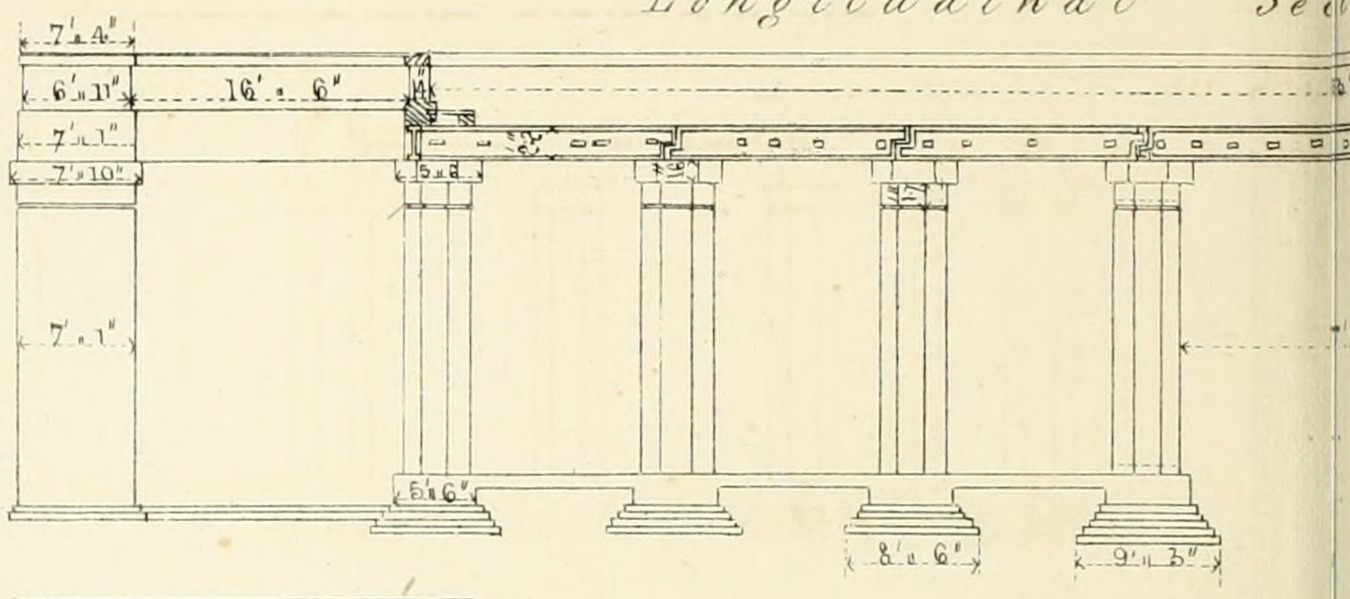
- UXBRIDGE

- BRID

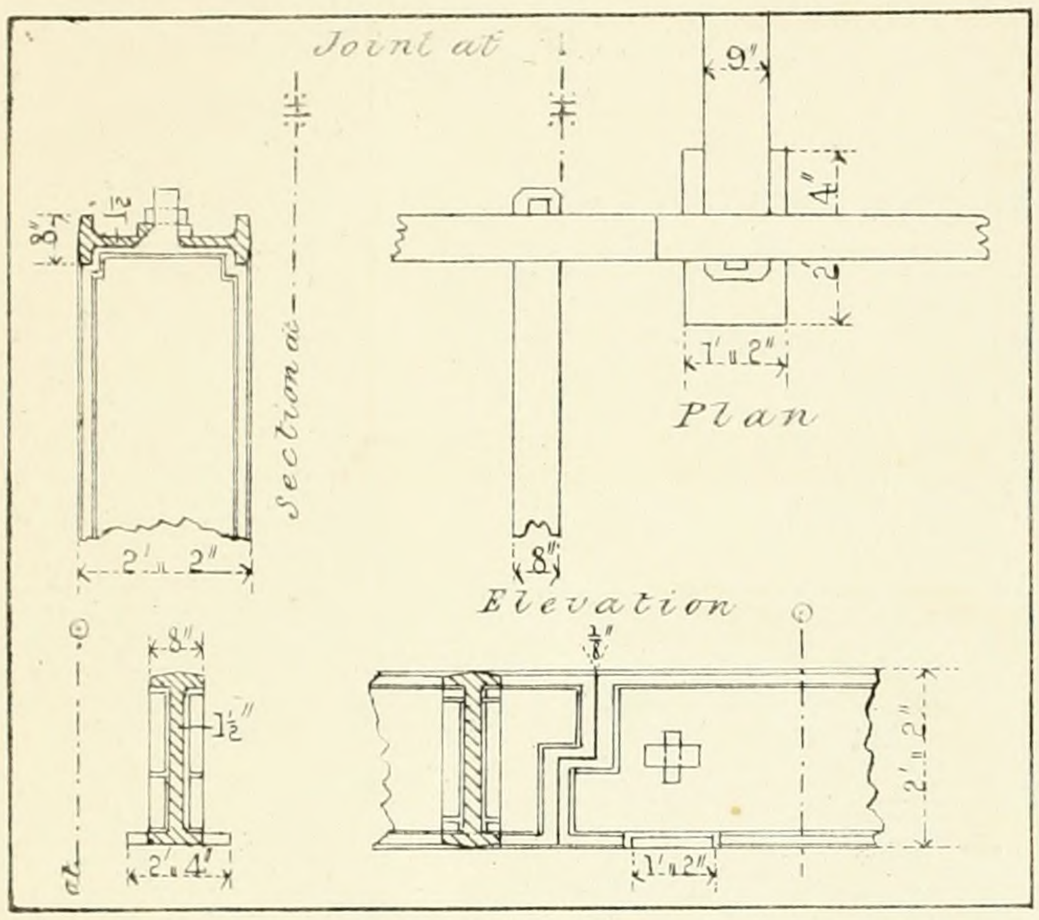
Elevation



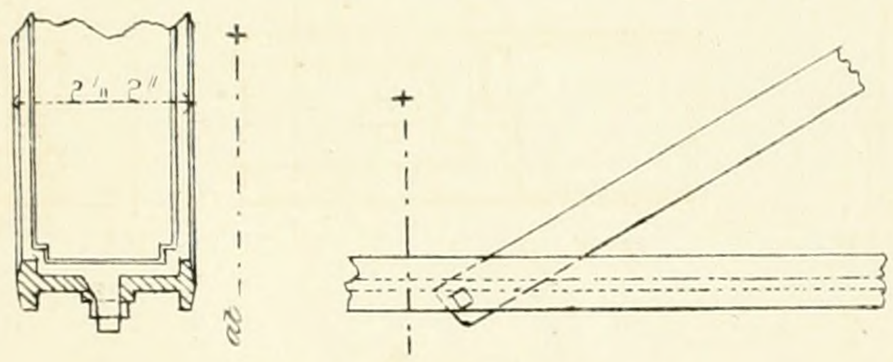
Longitudinal Se

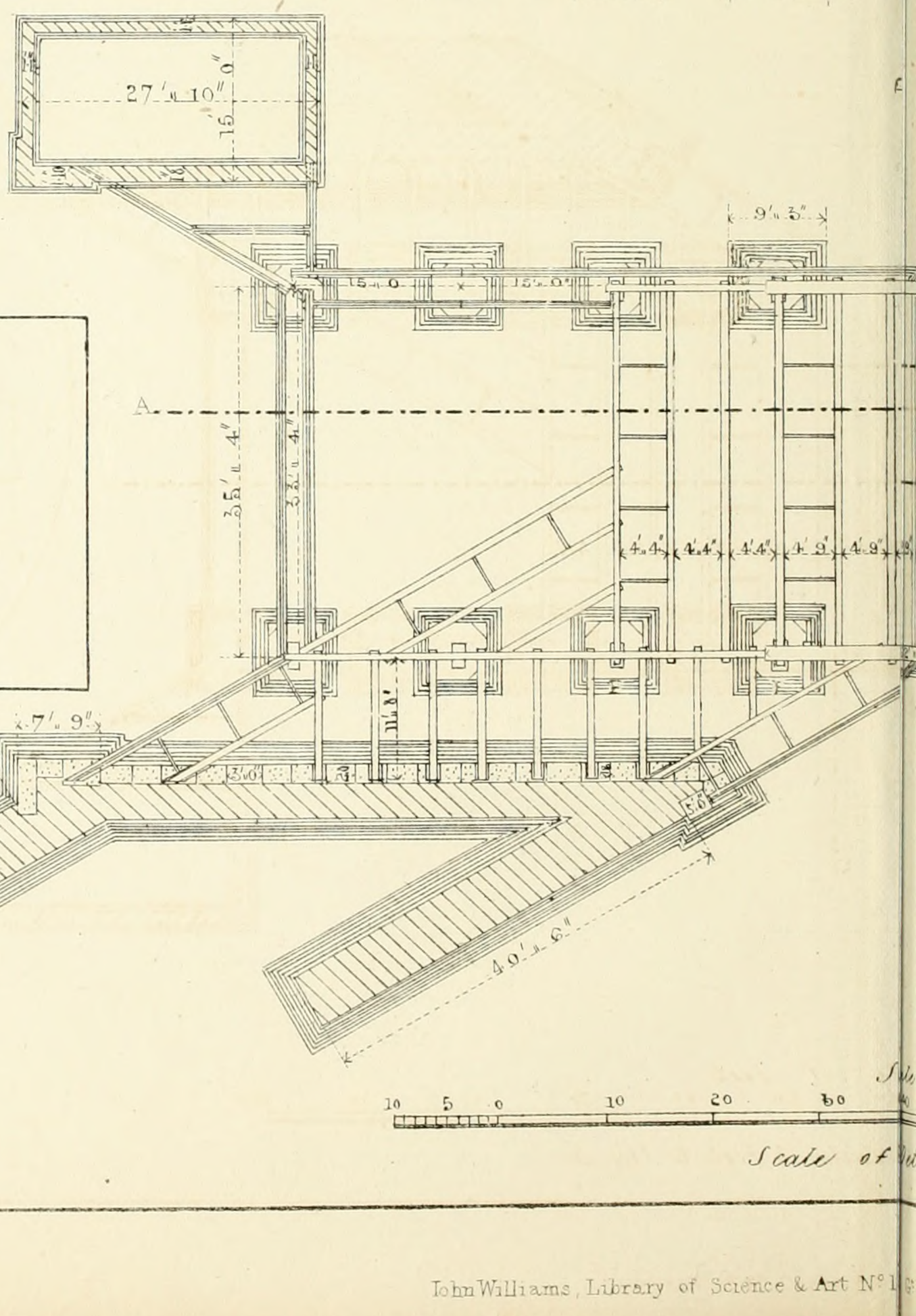


Joint at



Plan of a Skew Joint





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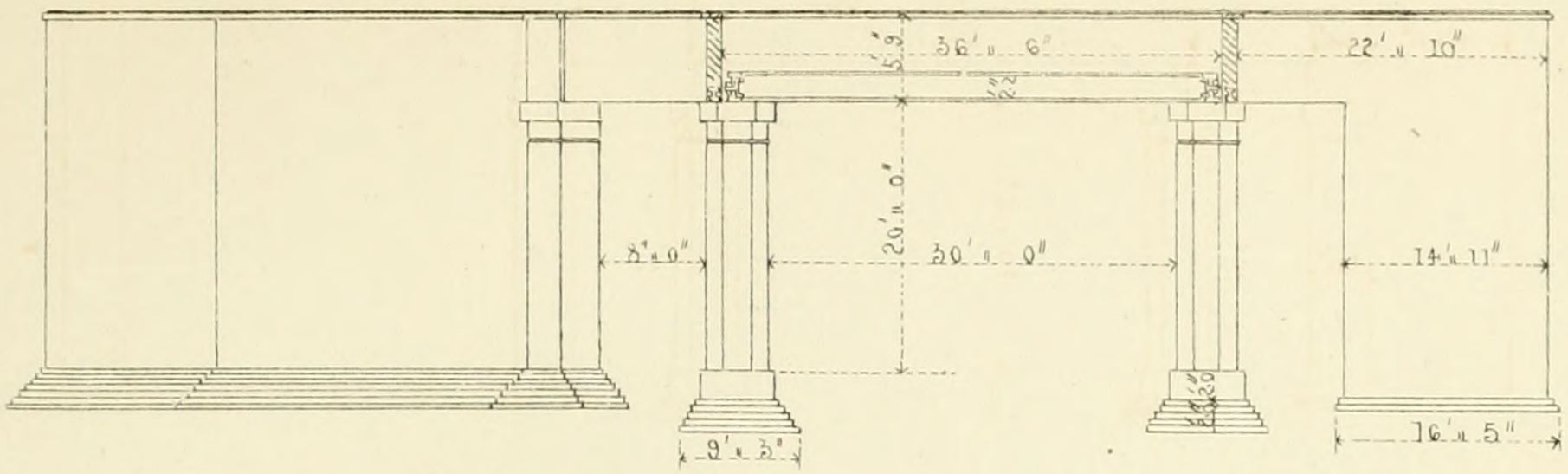
N - RAILWAY *Transverse Section thro* - C ..... D

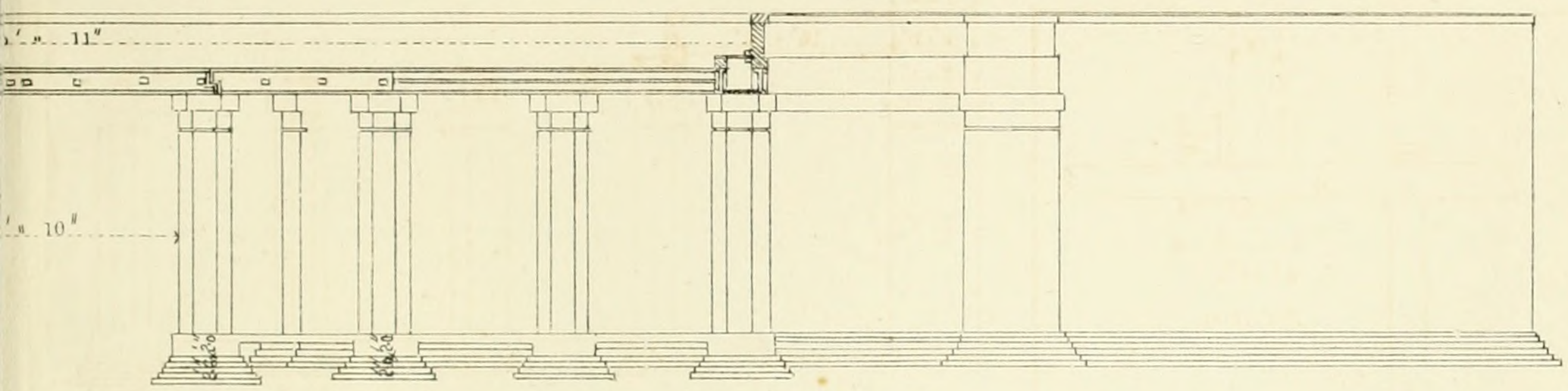
- OF -

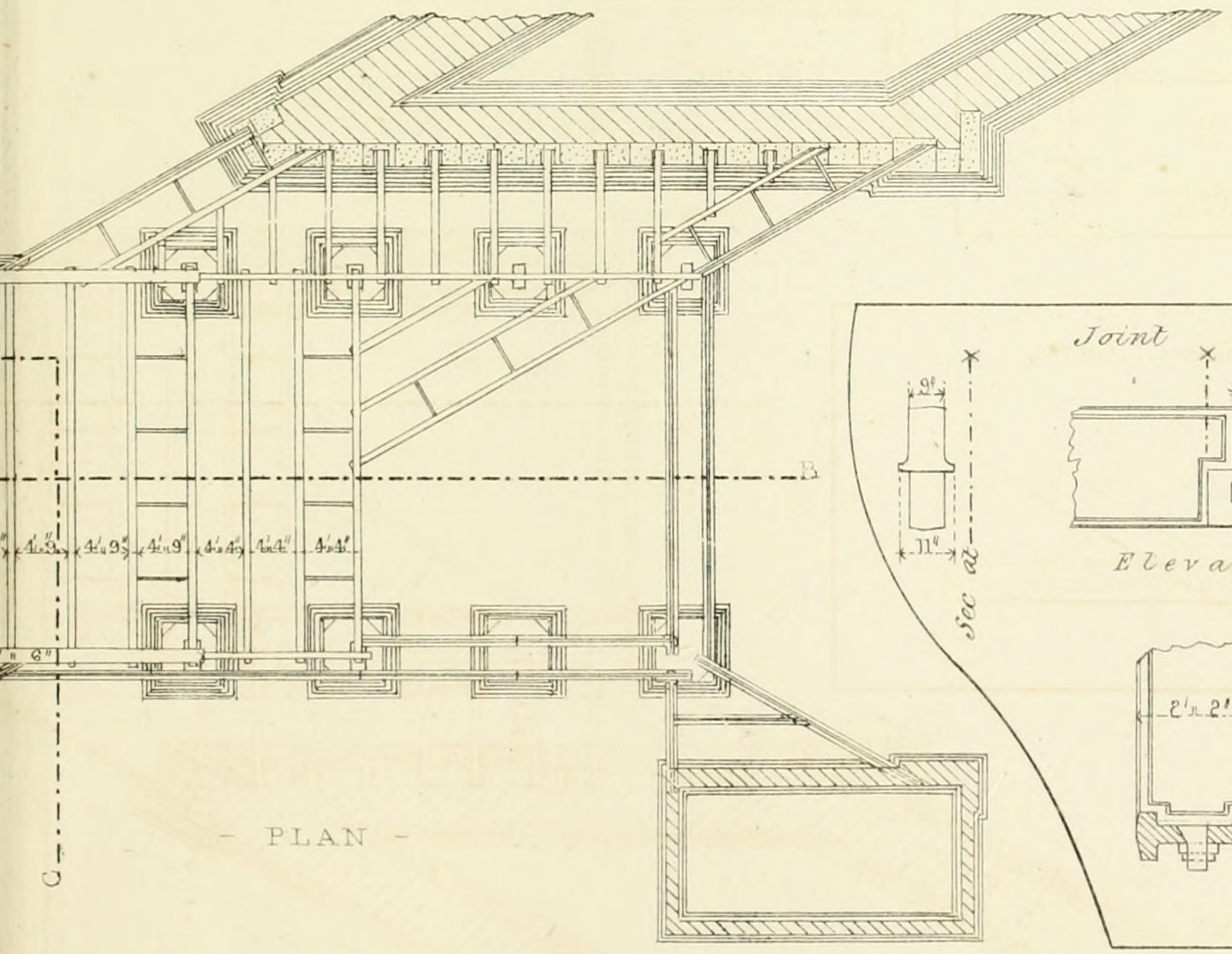
- ROAD

E -

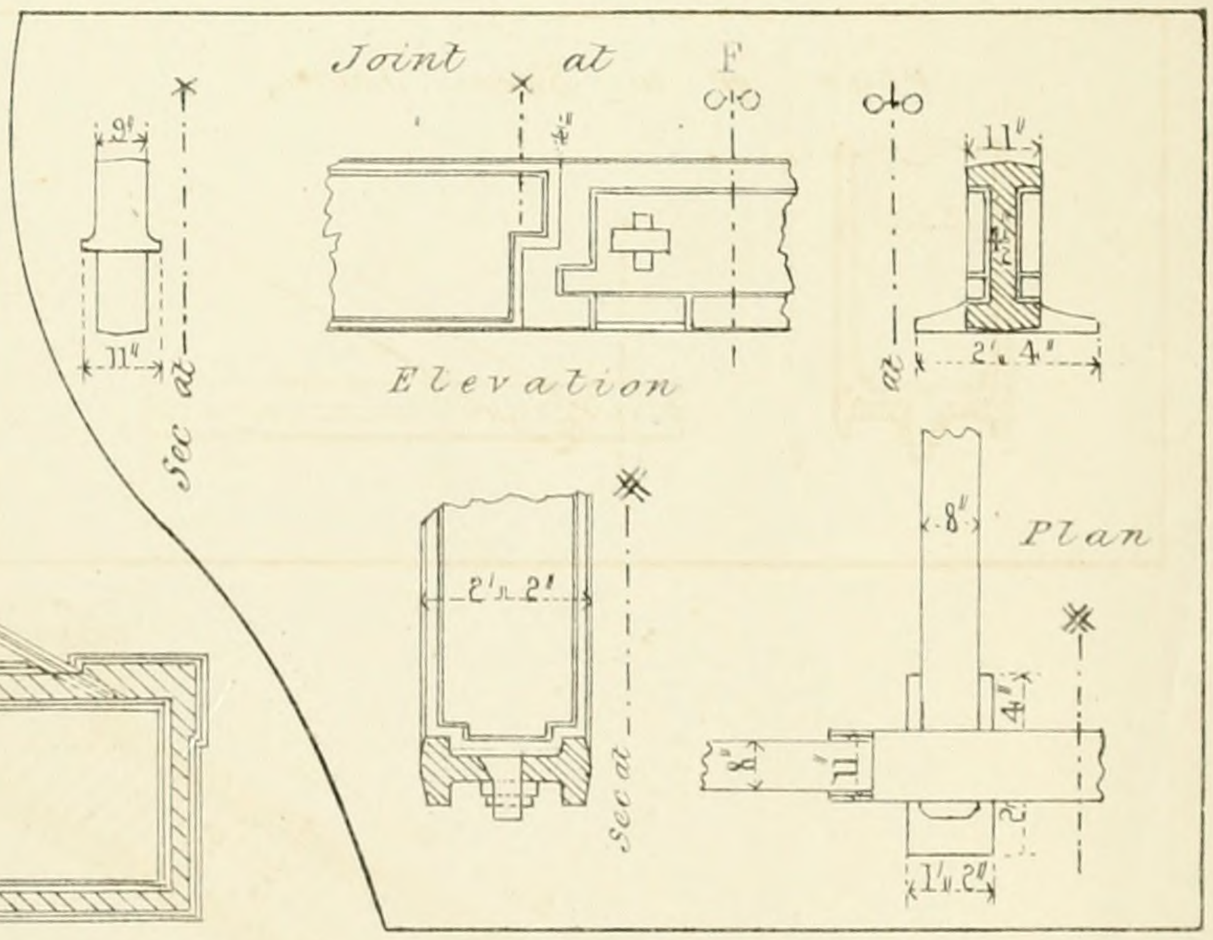


ion thro A ..... B





- PLAN -



le of Feet.

0 50 60 70 80 90 100

etails 4 Feet to the In:

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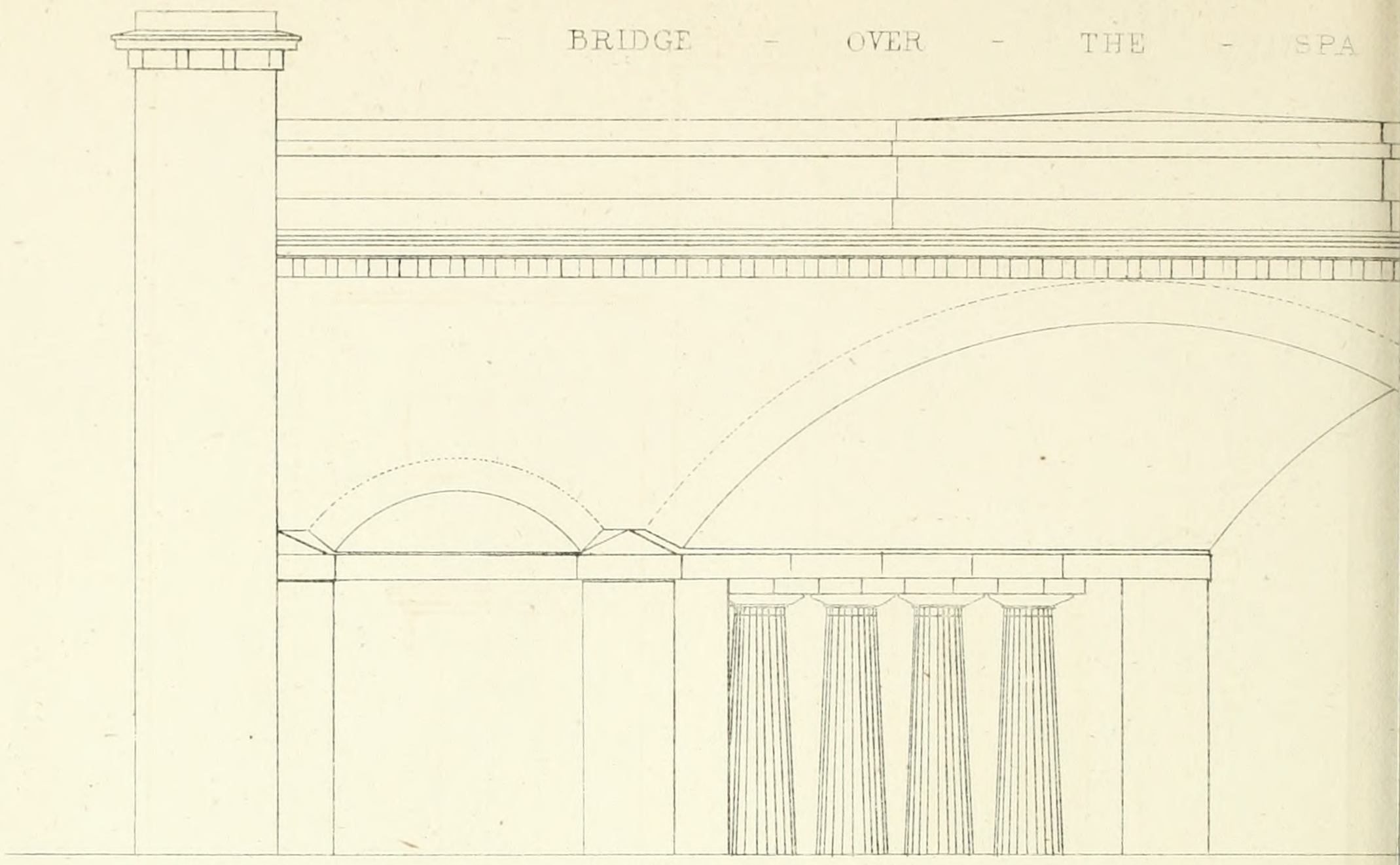
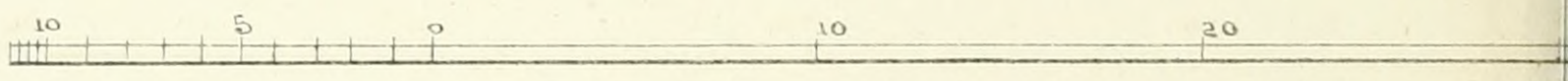
- LONDON - AND - GREENWICH - RAILWAY -

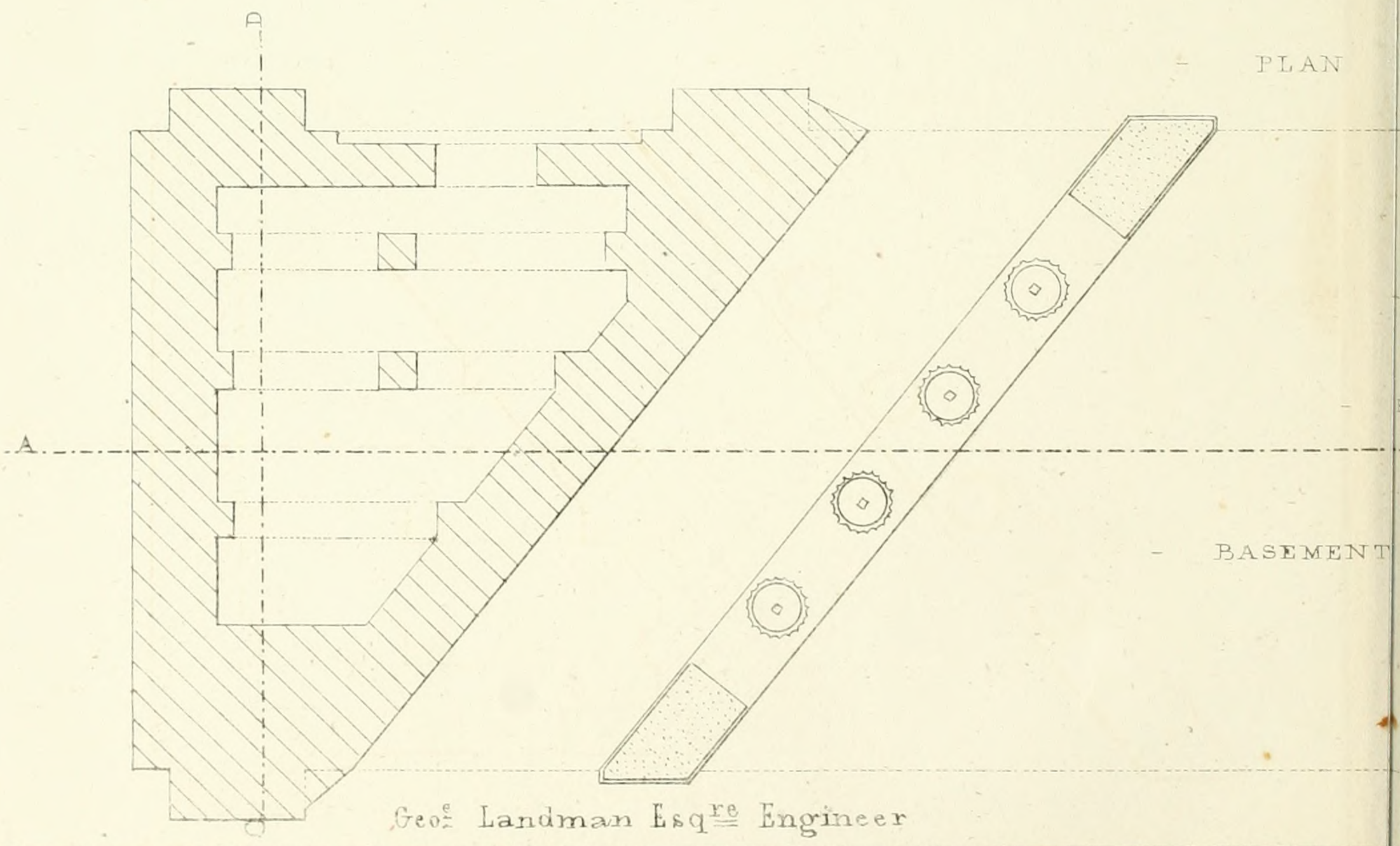
- BRIDGE - OVER - THE - SPA



- ELEVATIO



- PLAN

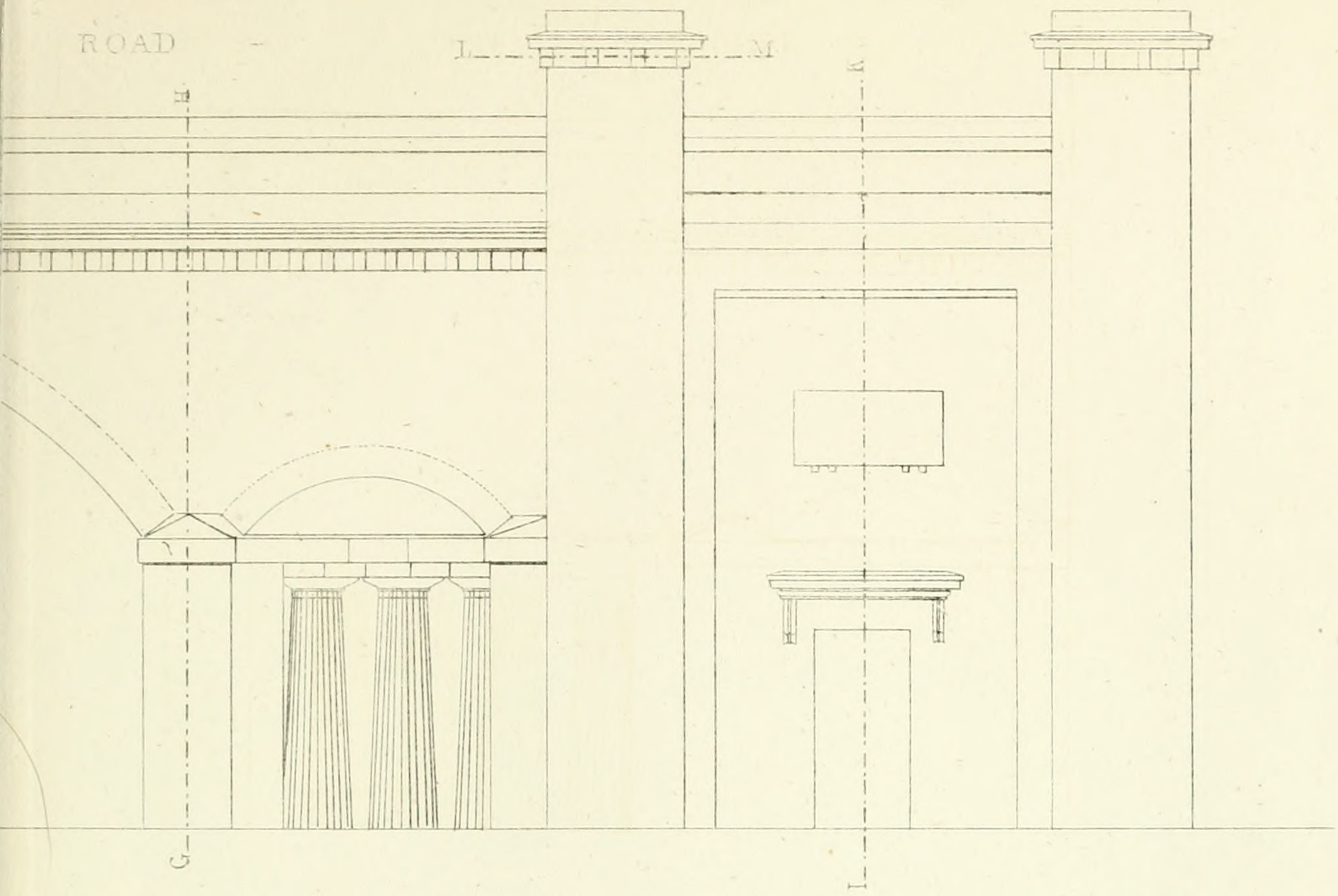


- BASEMENT

Geo.e Landman Esq.re Engineer

John Williams, Library of Science & A

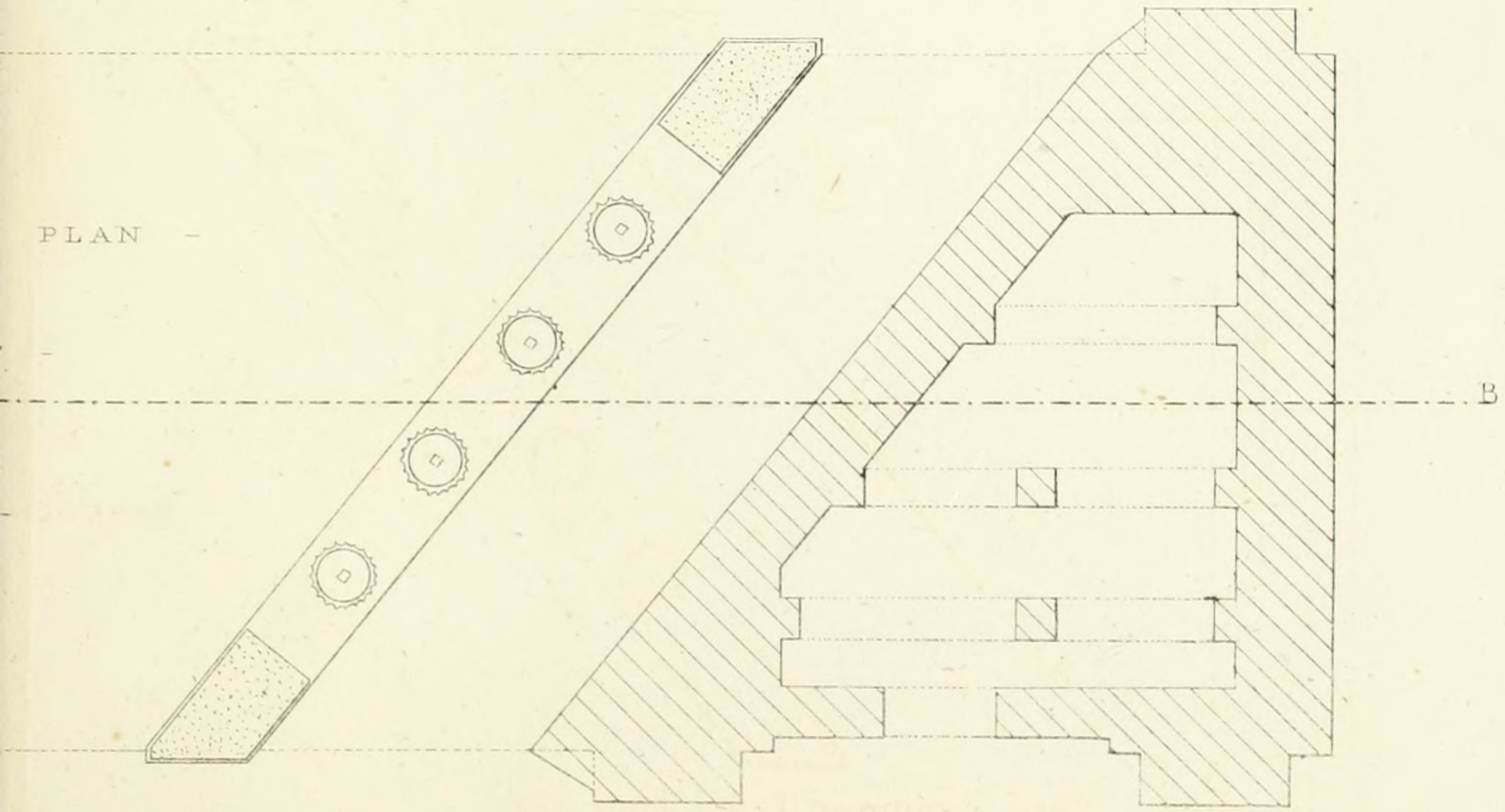
ROAD -



40 50 60 70 Feet

OF - PIERS -

PLAN -



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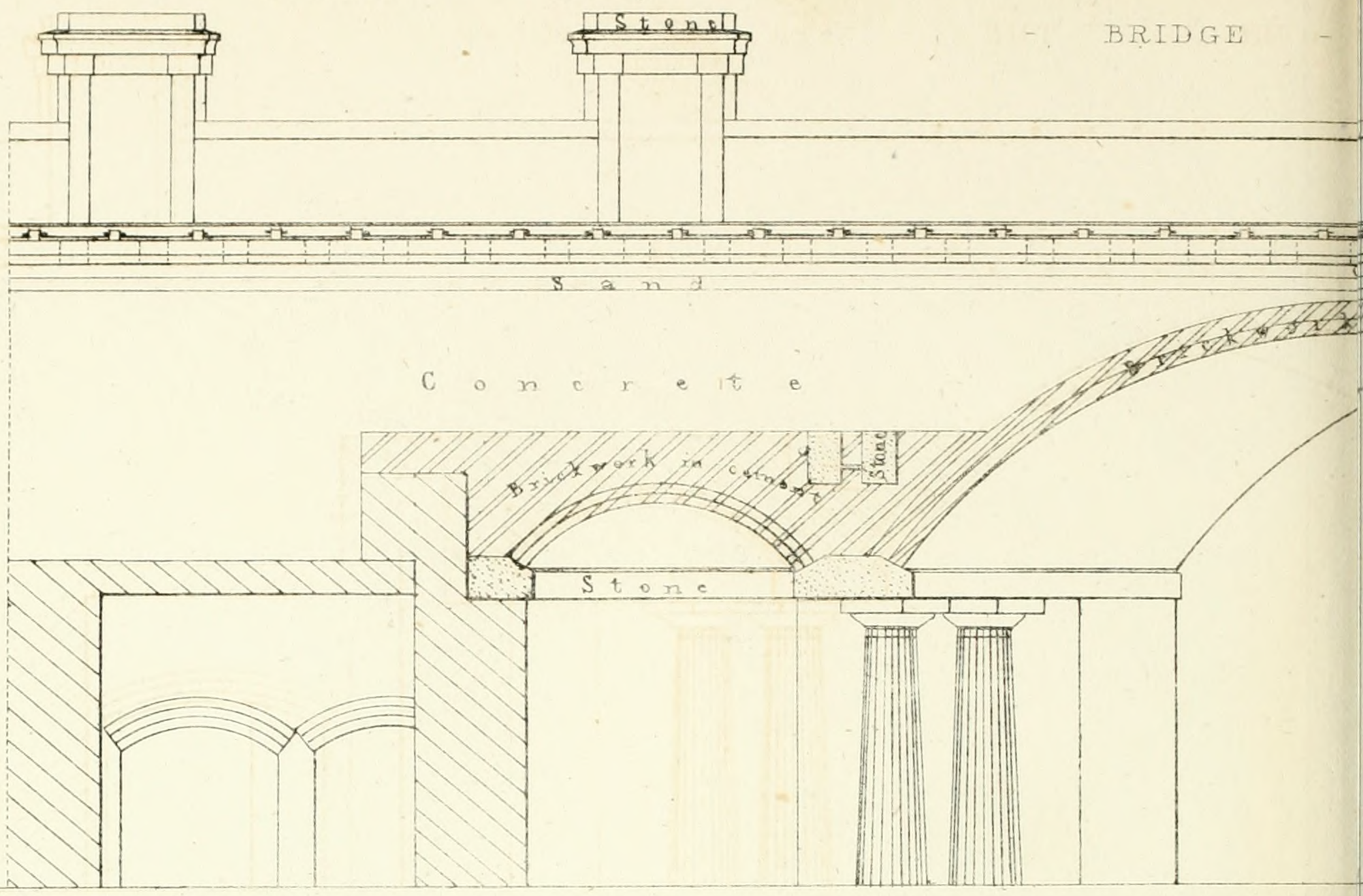
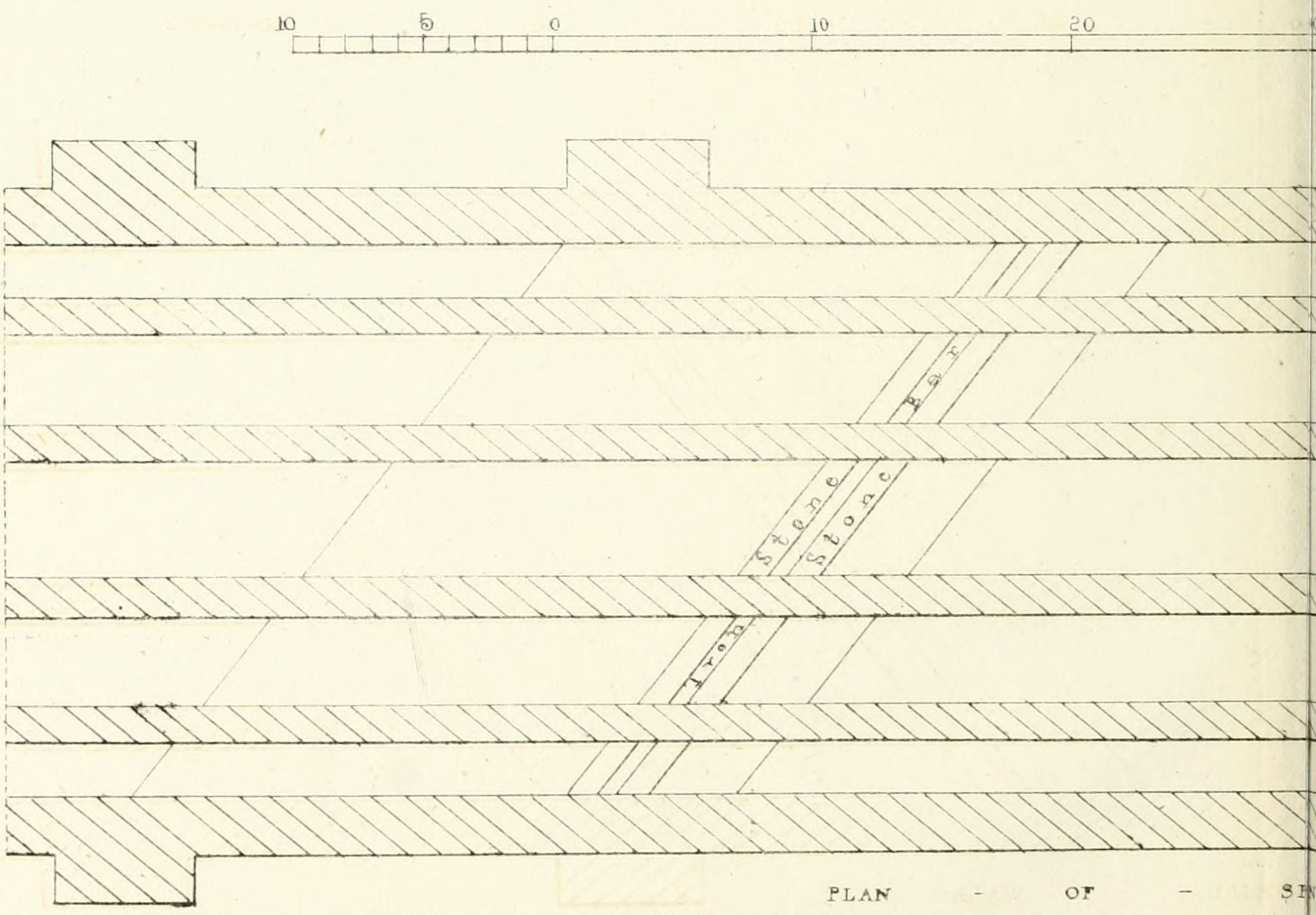
- LONDON - AND - GREENWICH - RAILWAY -

- BRIDGE -



- LONGITUDINAL - SECTION - ON - THE -



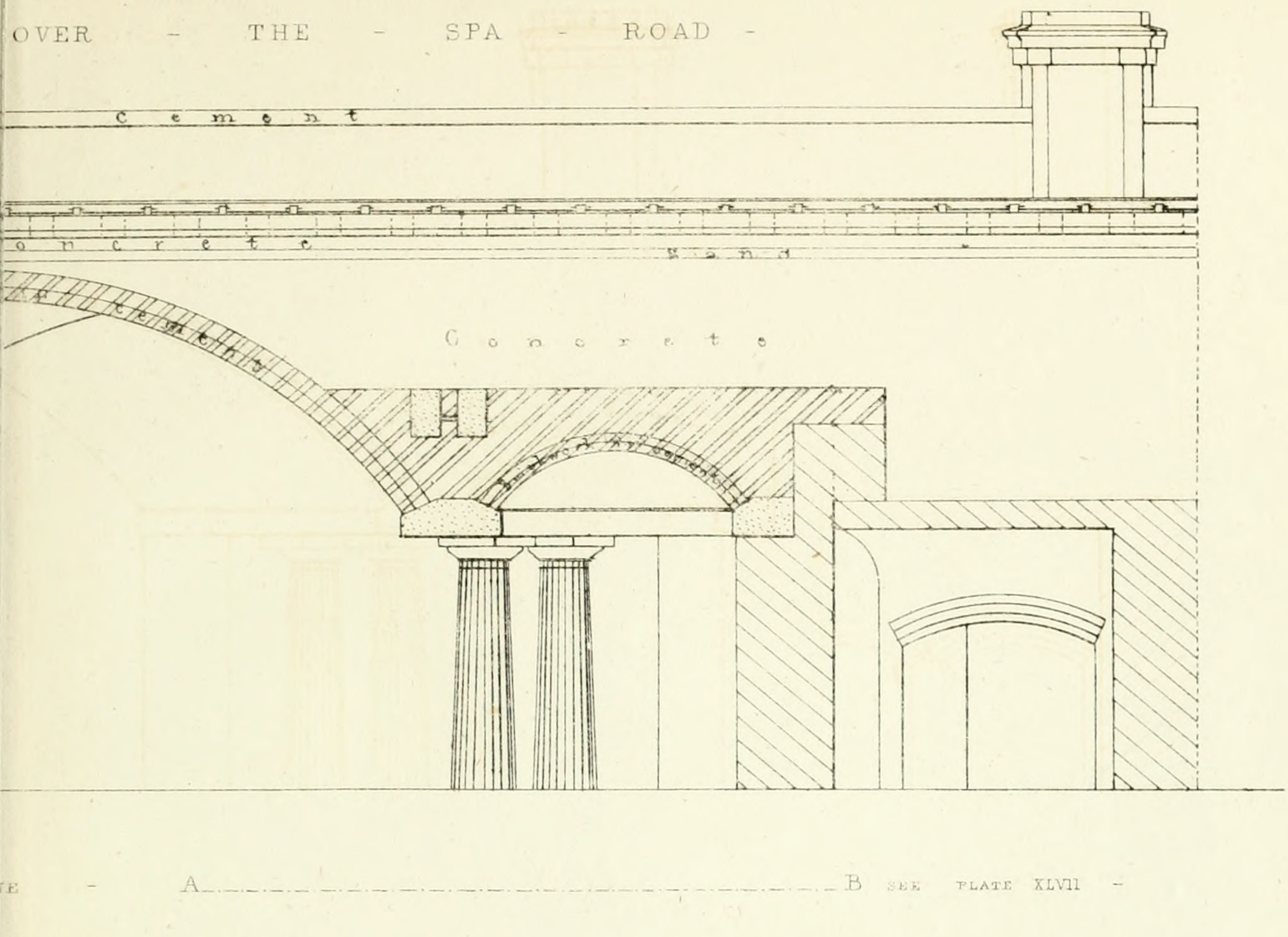
PLAN - OF - SE

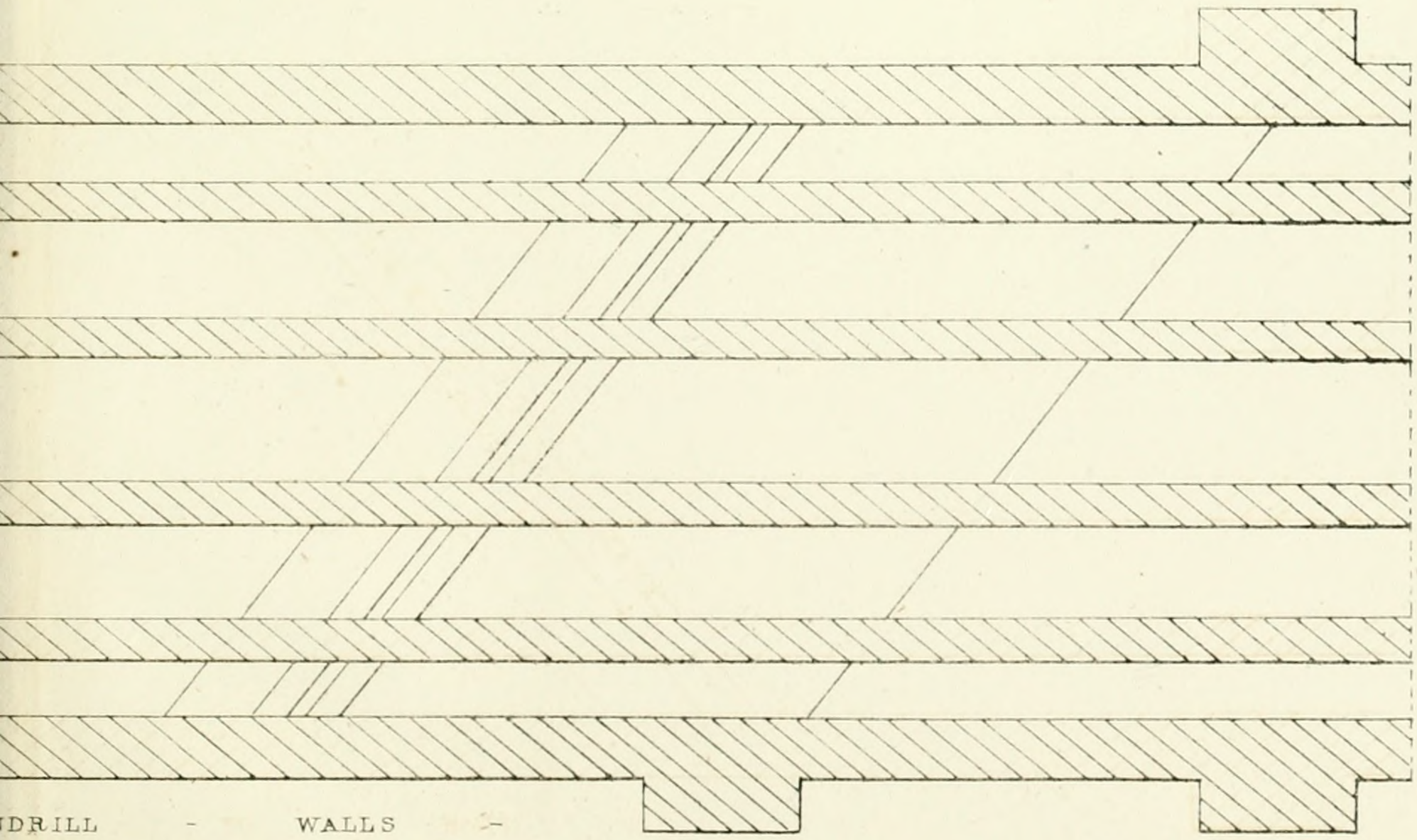
Geo^s Landmann Esq Engineer

John Williams Library of Science & Art, N°1

Plate XLVIII.

OVER - THE - SPA - ROAD -





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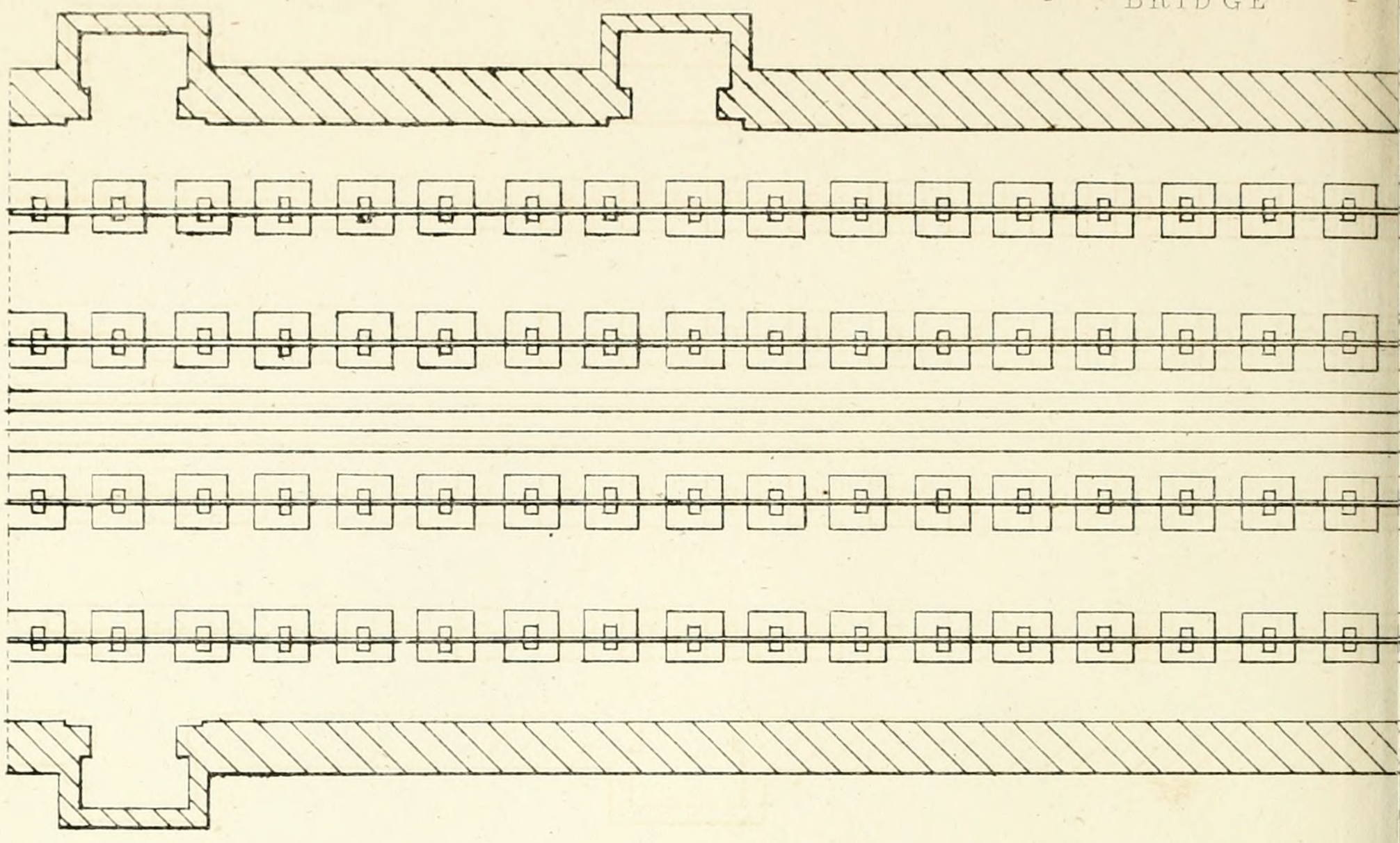
- LONDON - AND GREENWICH - RAILWAY -

- BRIDGE -



- PLAN - AT - LEVEL - OF

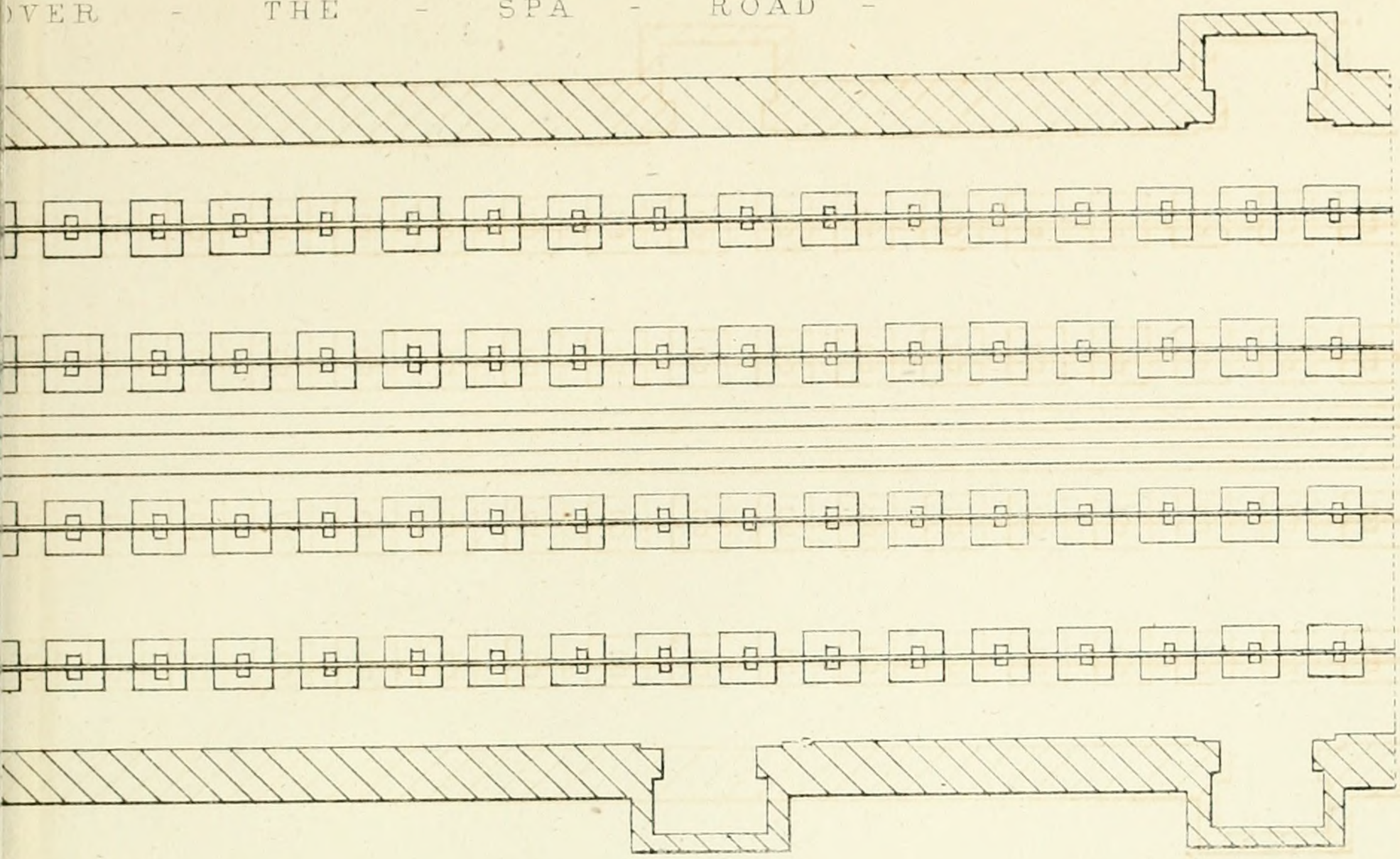
- TRANSVERSE - SECTIONS

- SEE - PLATE - XLVII. -

Geo.ᵉ Landmann Esqʳᵉ Engineer

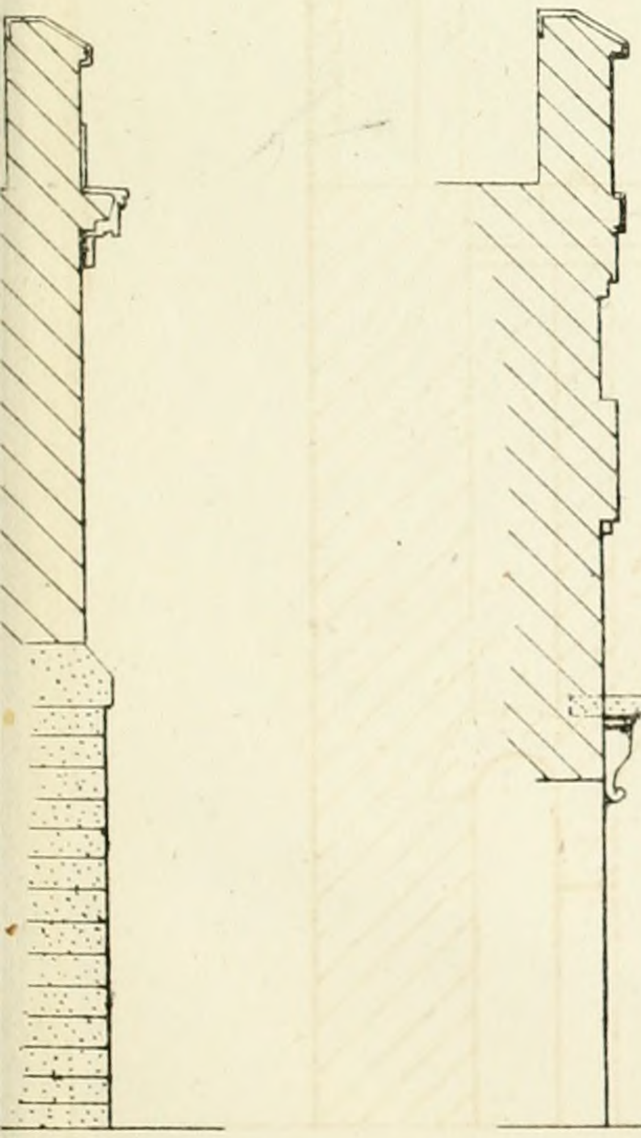
John Wilhams, Library of Science & Art

)VER - THE - SPA - ROAD -



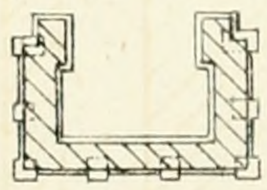
- RAILS -

40 50 60 70 Feet



- SECTION -

- ON - THE - LINE -



L M

H I K

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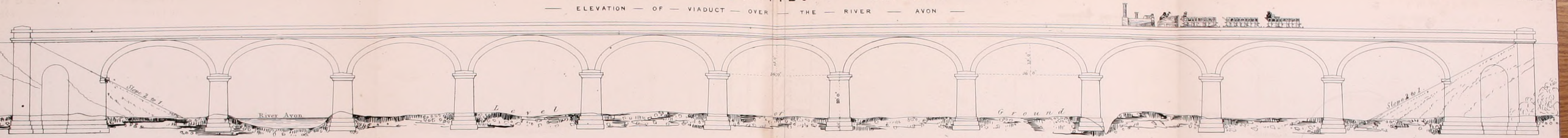
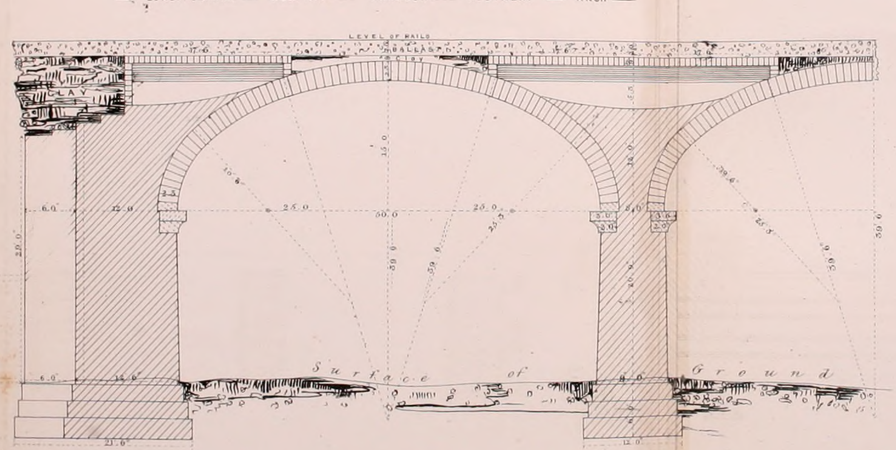
106 Gt Russell St Bloomsbury

MIDLAND COUNTIES RAILWAY

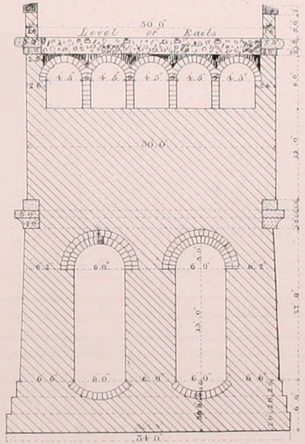
ELEVATION OF VIADUCT OVER THE RIVER AVON



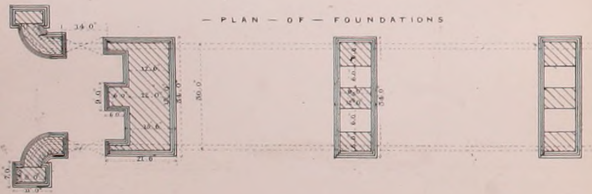
LONGITUDINAL SECTION THROUGH ABUTMENT ARCH



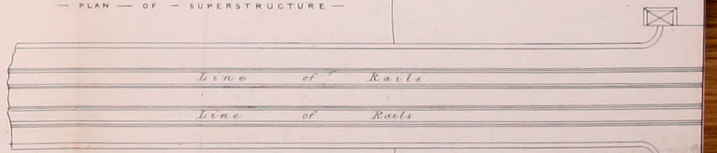
SECTION THROUGH PIERS



PLAN OF FOUNDATIONS



PLAN OF SUPERSTRUCTURE



Scale of Feet for Sections.

Scale of Feet.

Charles Vignoles Esqre Engineer.
Thos J. Woodhouse Esqre Resident Engineer.

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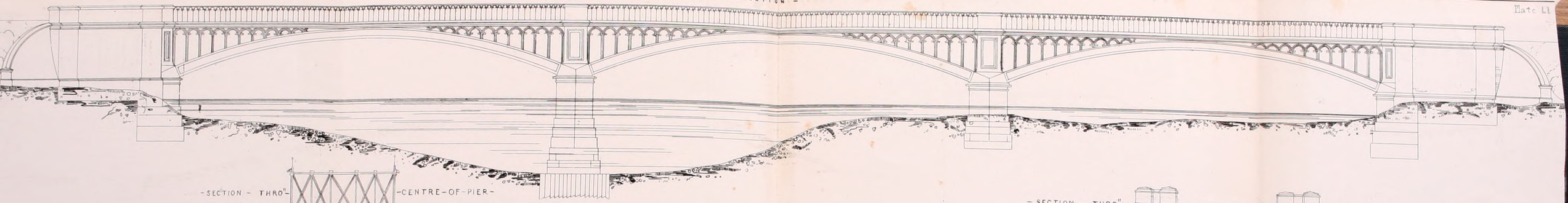
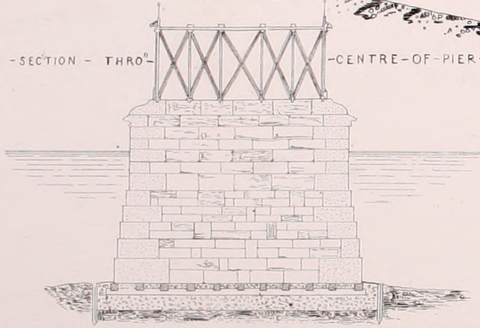
– ELEVATION –



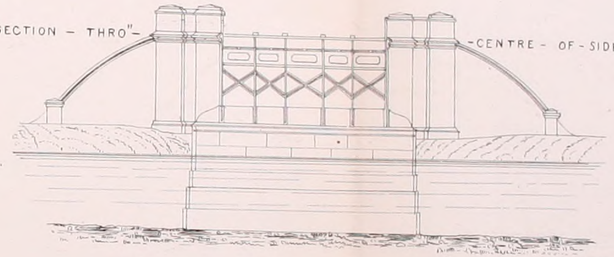
– SECTION – THRO" – CENTRE – OF – PIER –

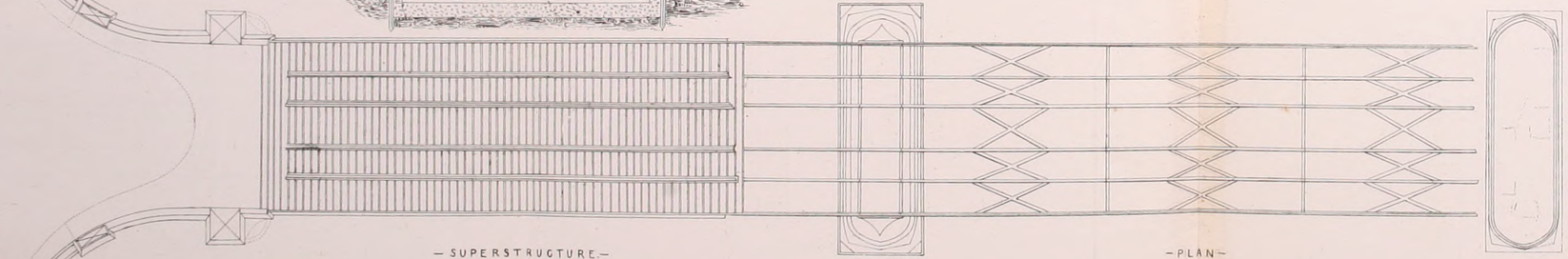


— MIDLAND — COUNTIES — RAILWAY —

CAST — IRON — BRIDGE — OVER – THE — TRENT.

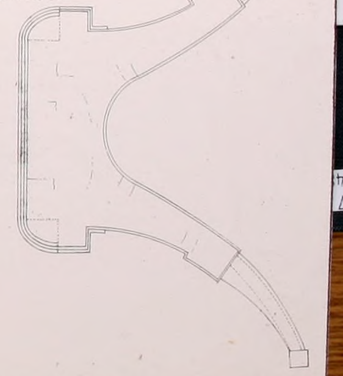
– SECTION – THRO" – CENTRE – OF – SIDE – ARCH –





– SUPERSTRUCTURE. –

– PLAN –



– FOUNDATIONS –

		Ft	in
Span of Arches		100	0
Versed Sine of D°		10	0
Depths of Ribs	at Springing	3	0
	at Crown	2	6
Piers at Springing		10	0
Width in clear of Parapets		27	0

Scale of Feet.

10 0 5 50 100

Charles Vignoles Esqre Engineer.
Thos J. Woodhouse Esqre Resident Engineer

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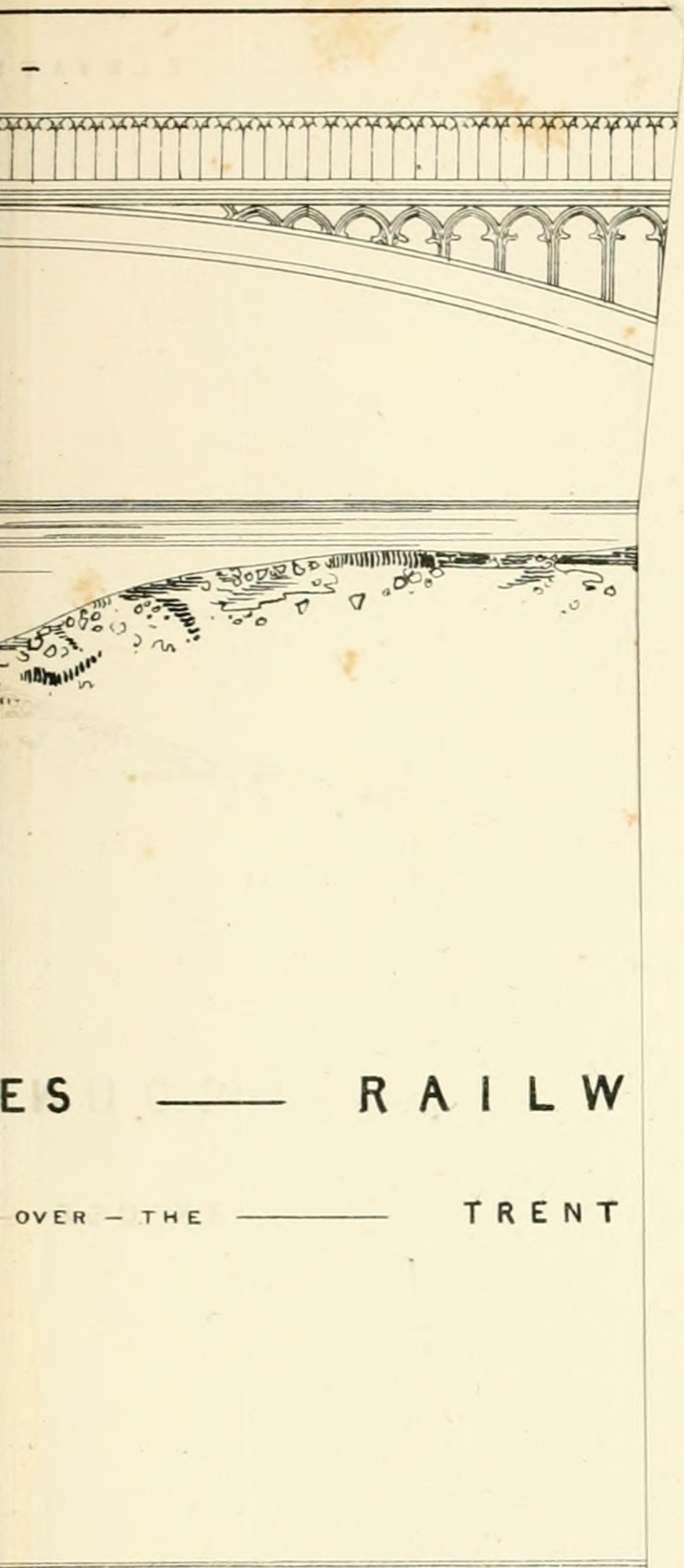
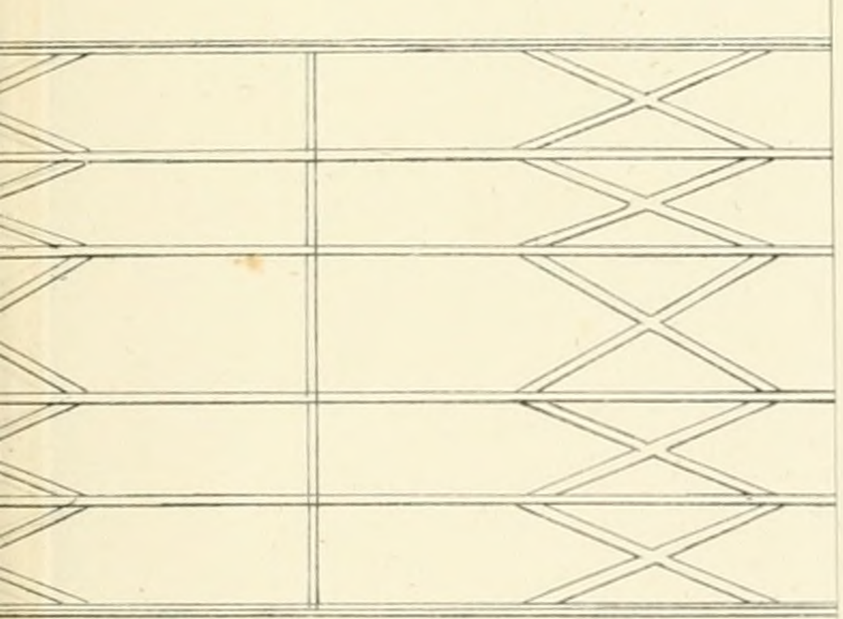
Day & Haghe Lith^rs to the Queen 17 Gate St



ES —— RAILW

OVER — THE —— TRENT



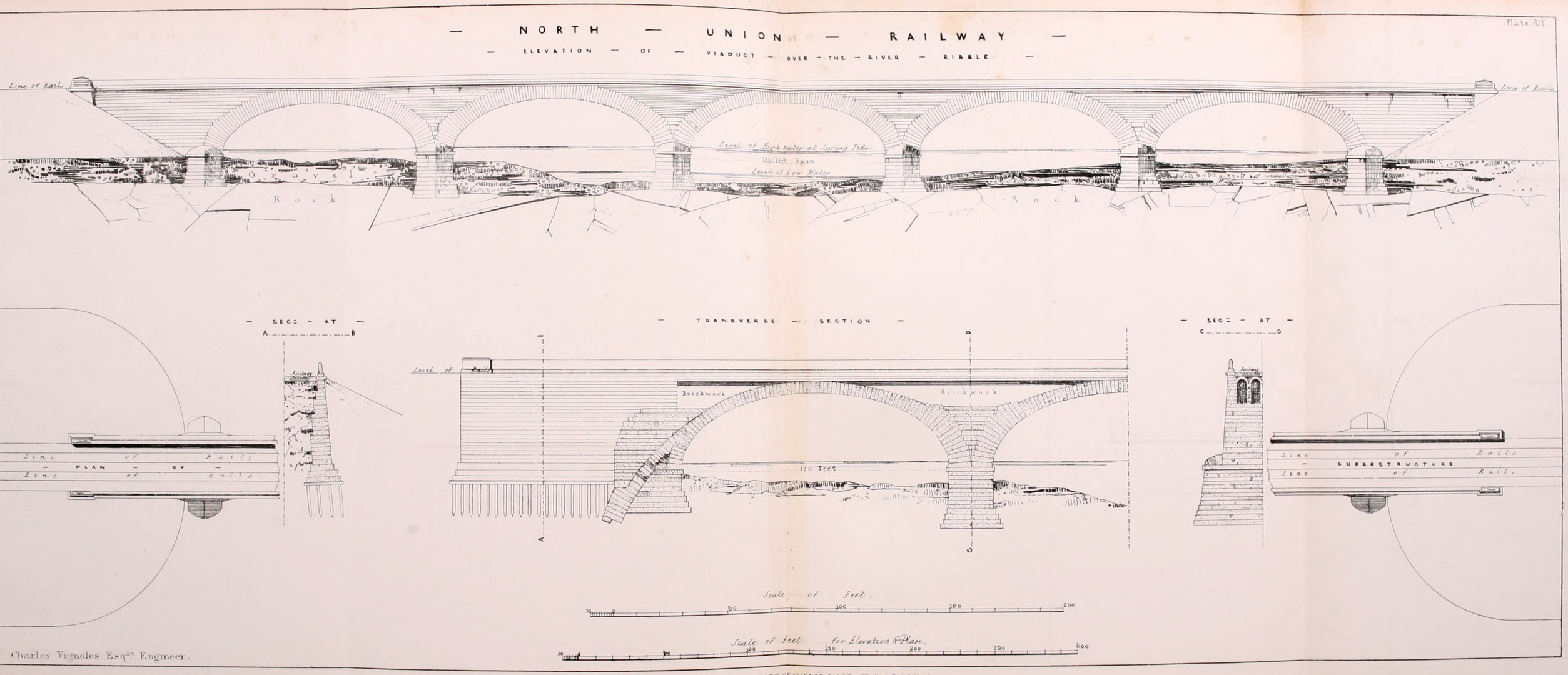
N —

Feet.

50

NCE & ART 106 Great Russel Street.

Pt to the Queen 17 Gate St

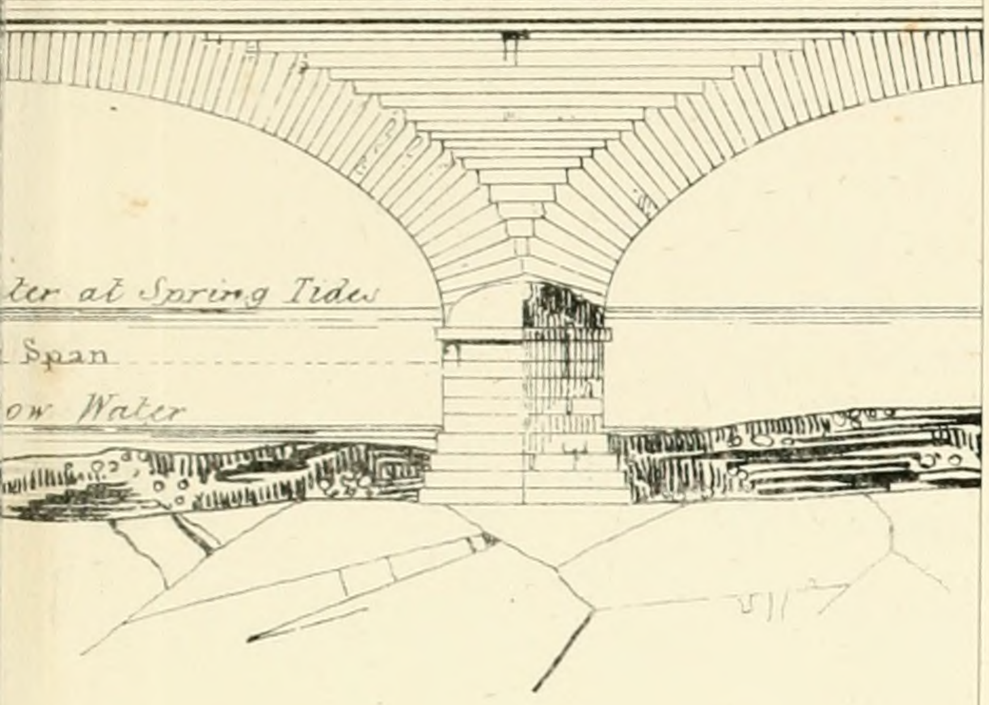


JOHN WILLIAMS LIBRARY OF SCIENCE & ART, 106 Great Russel Street.

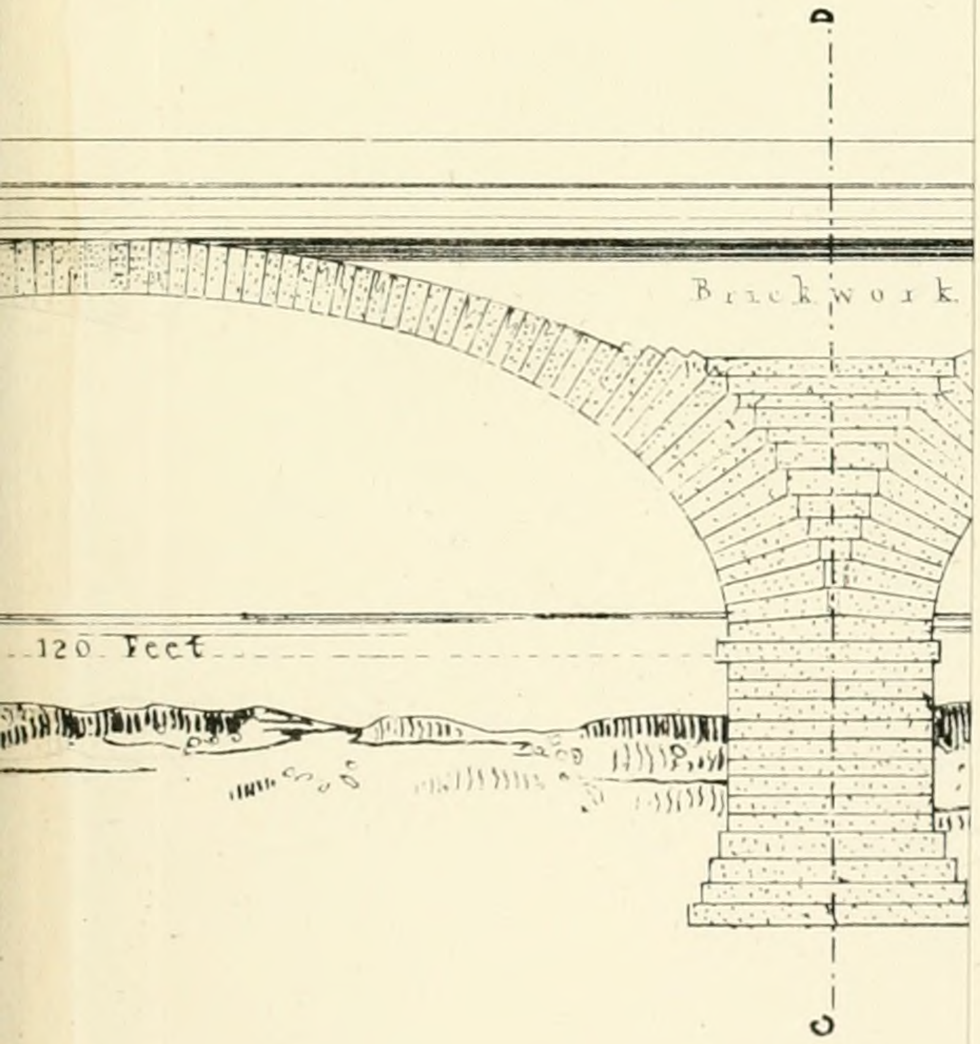
Day & Haghe Lithrs to the Queen

— RAILWA

VER — THE — RIVER — RIBBLE



— SECTION —

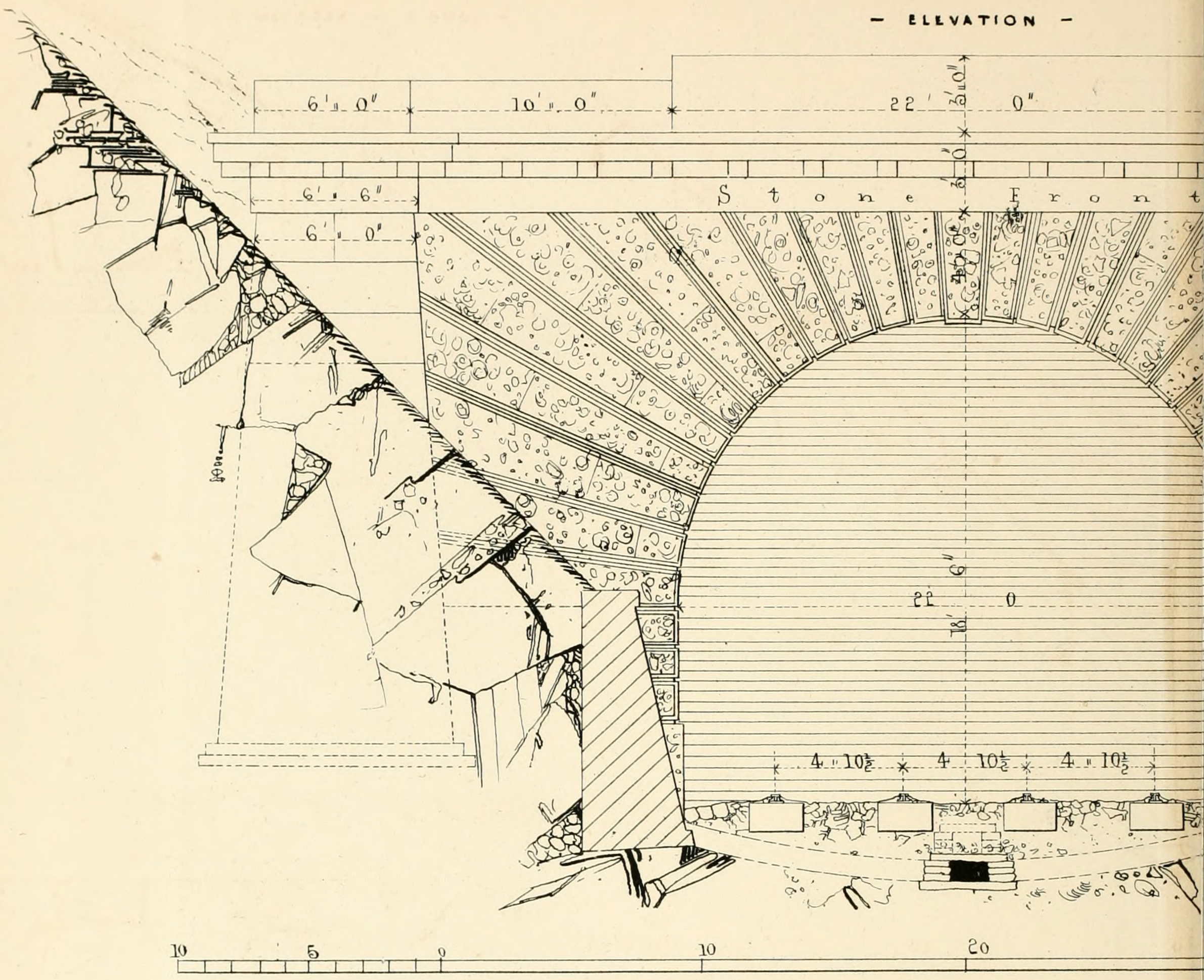


SCIENCE & ART, 106 Great Russel Street.

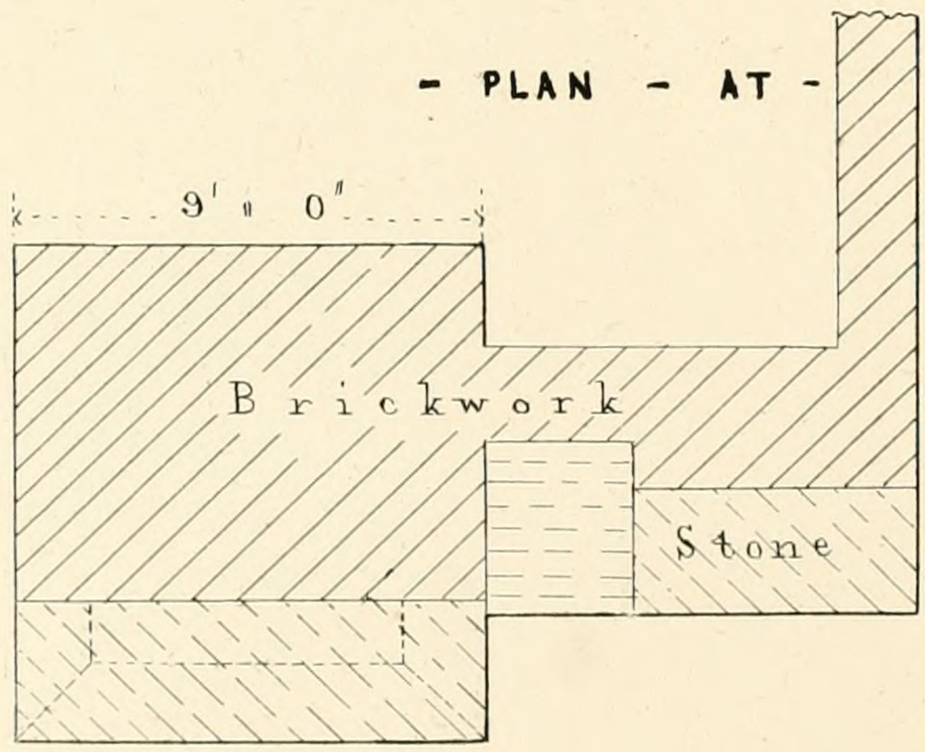
& Hagbe Lithrs to the Queen

- LEEDS - & - SELBY -

- ELEVATION -



- PLAN - AT -



James Walker Esqre Engineer
Geo^e Smith Esqre Resident Engineer

Line of Railroads

Line of Railroads

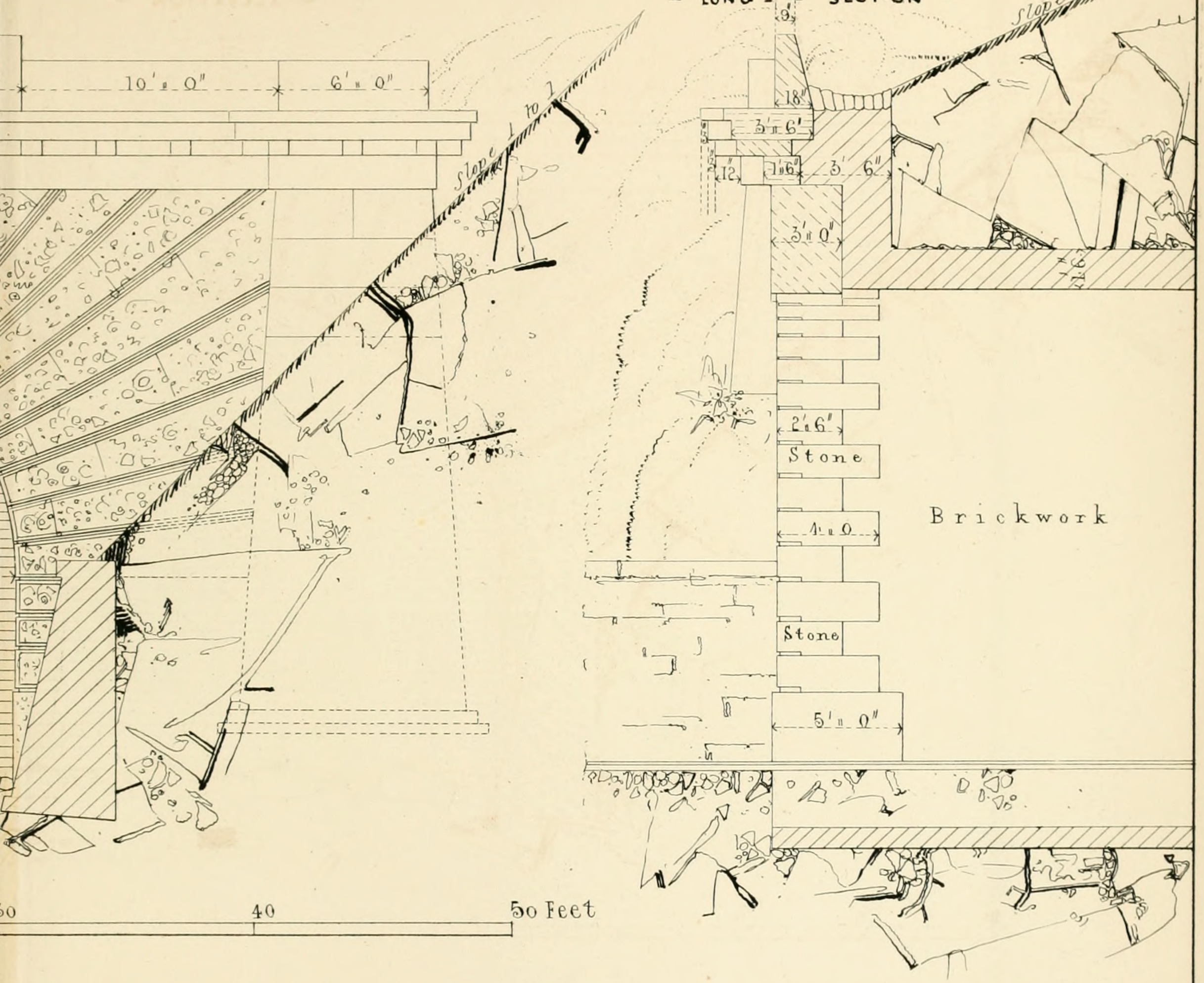
JOHN WILLIAMS, LIBRARY OF SCIENC

Day & Haghe Lith^rs

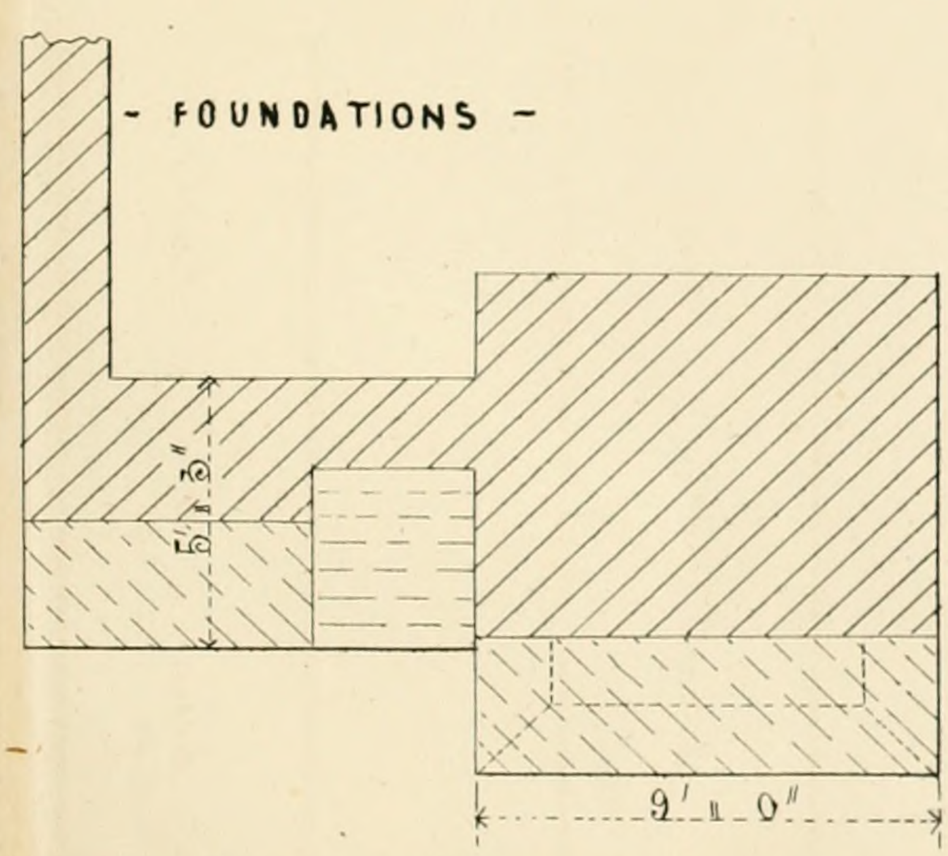
Plate L[illegible]

AILWAY - DETAILS - OF - TUNNEL - FRONT -

- LONG L - SECTION -



- FOUNDATIONS -



ART CHARLES St SOHO SQUARE.
e Queen

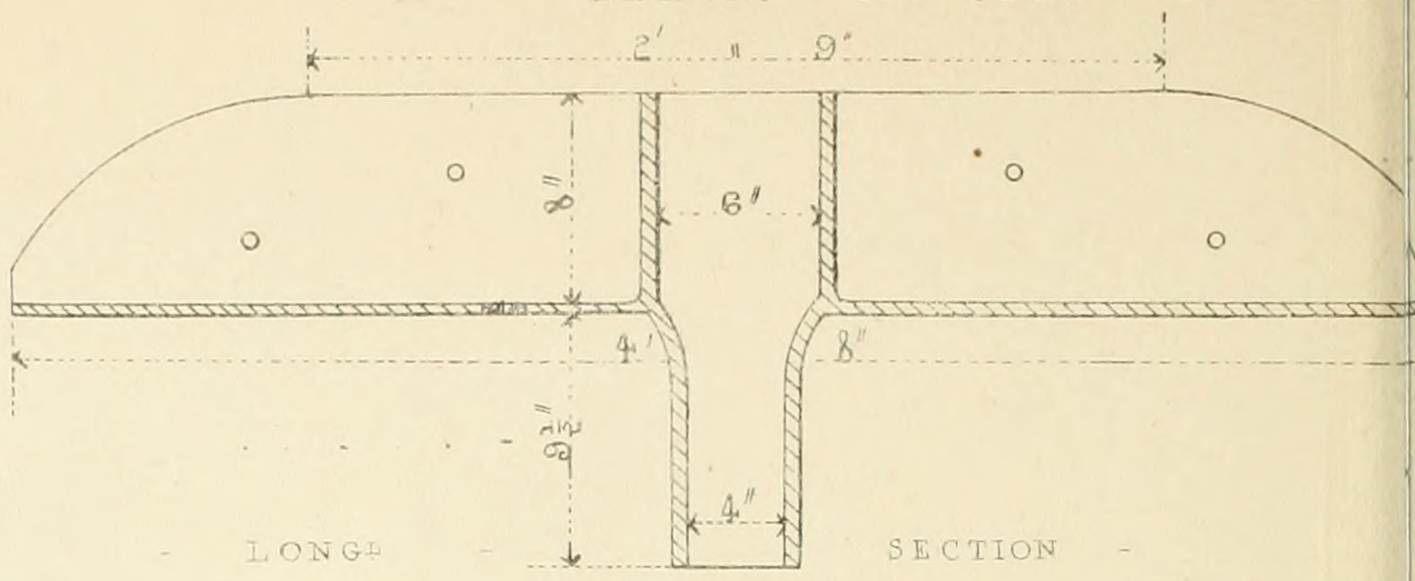
LEEDS - & - SEL

DETAILS OF - SHED - AT - THE

- DETAILS

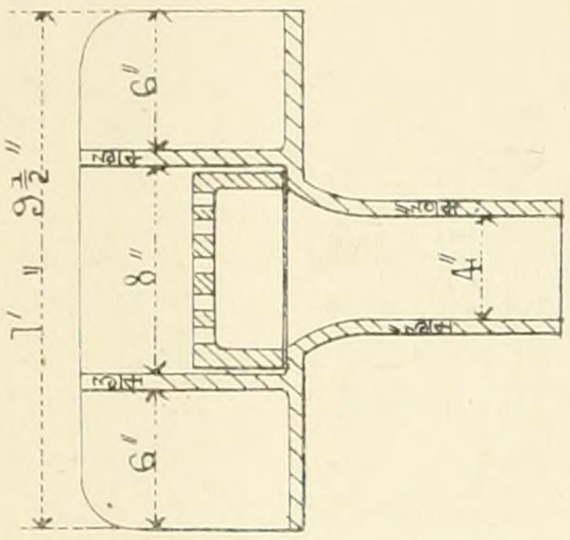
- OF -

- IRON - BRACKETS -



- LONG. - SECTION -

- PLAN -

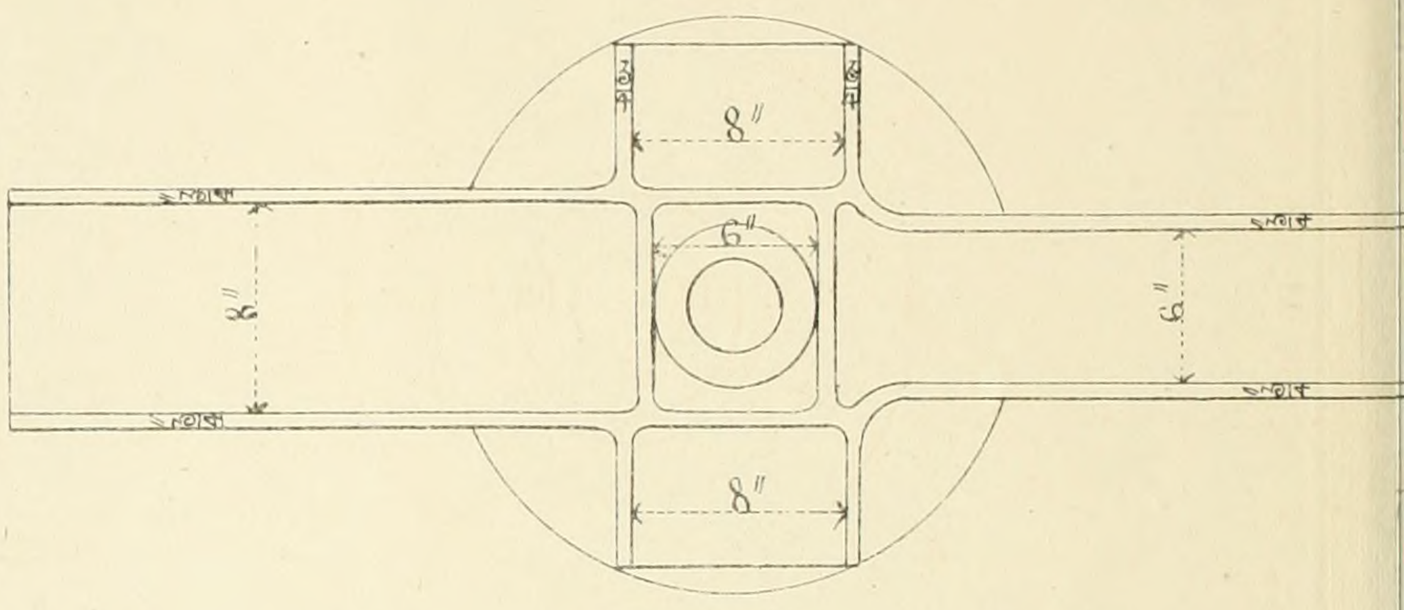


TRANSVERSE - SECTION -

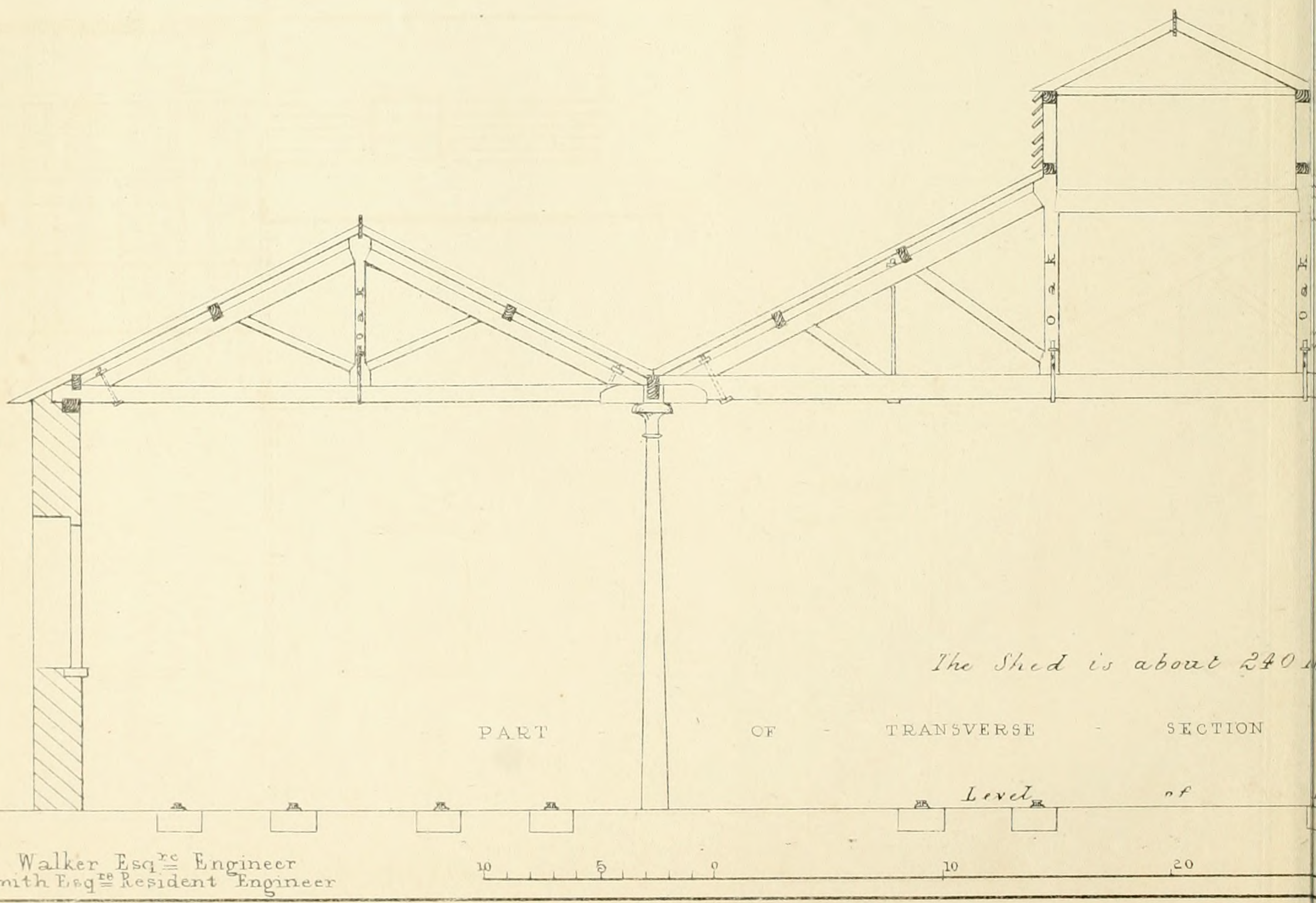


- PLAN - OF - GRATING

- PLAN -



PLAN



PART - OF - TRANSVERSE - SECTION

The Shed is about 240 f

Level of

James Walker Esqre Engineer
Geo^e Smith Esqre Resident Engineer

10 5 0 10 20

John Williams Library of Science & Art, N°106, Gt Russell St

- RAILWAY -

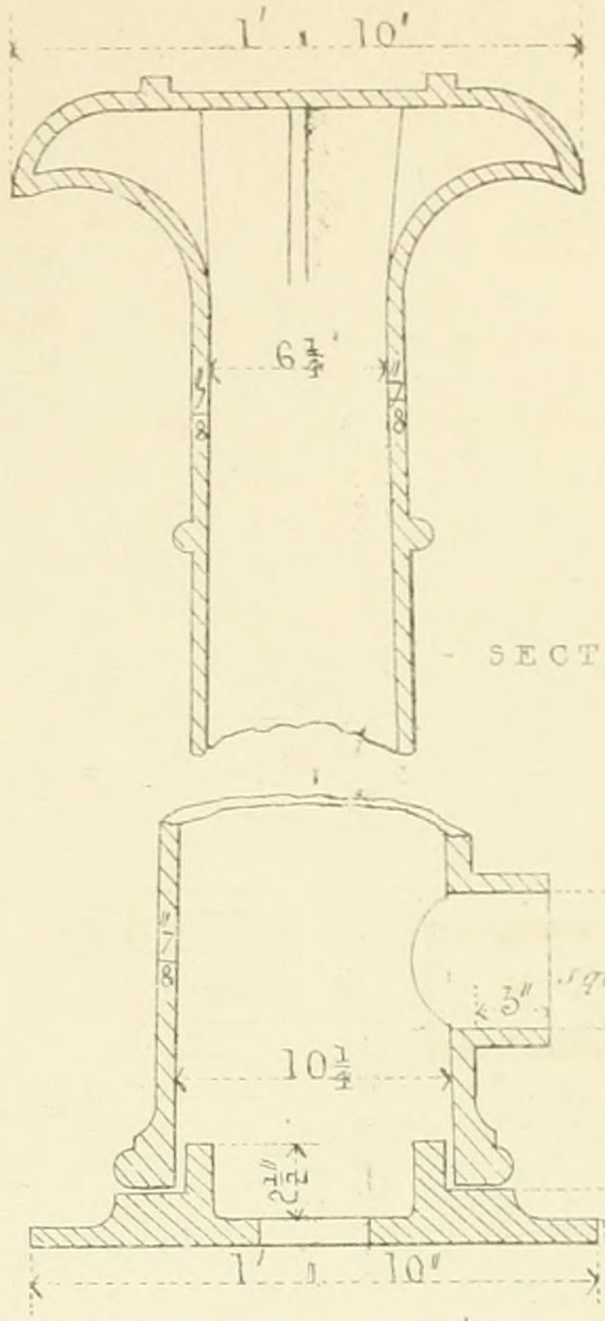
Plate, LIV.

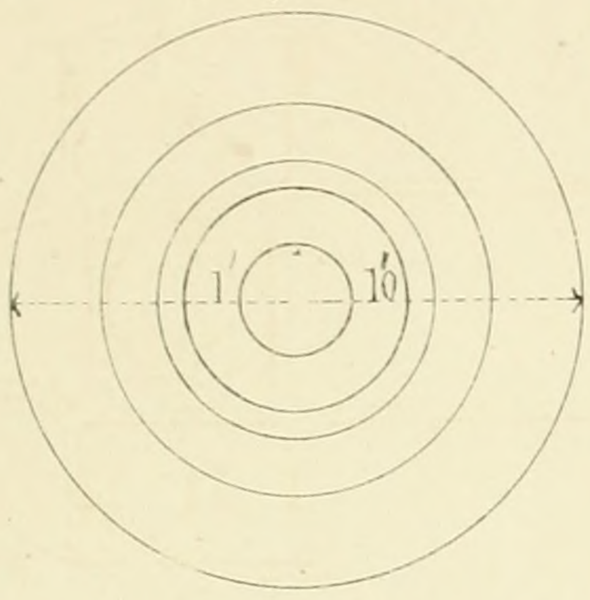
SELBY - DEPOT -

- DETAILS -

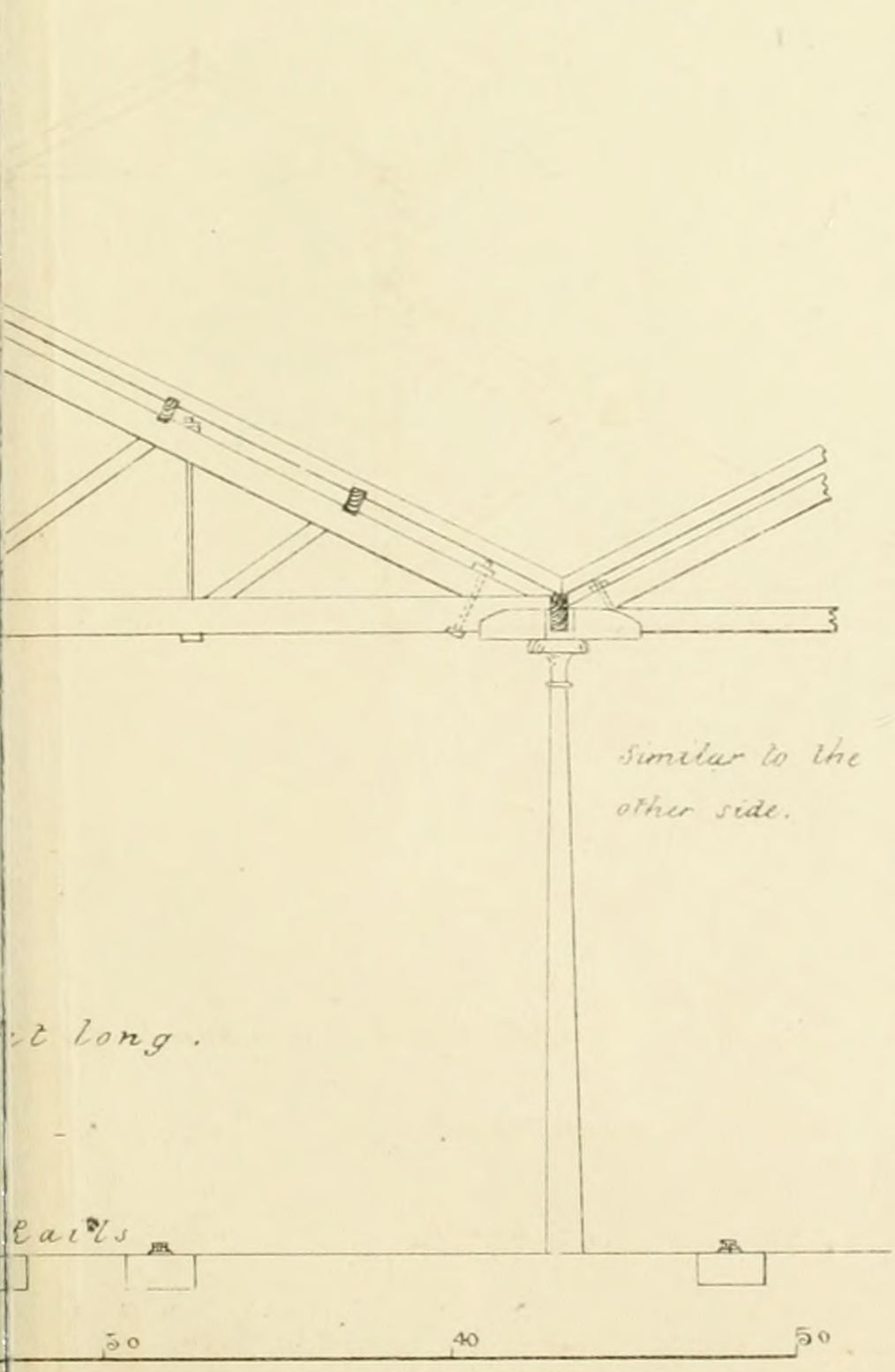
- OF -

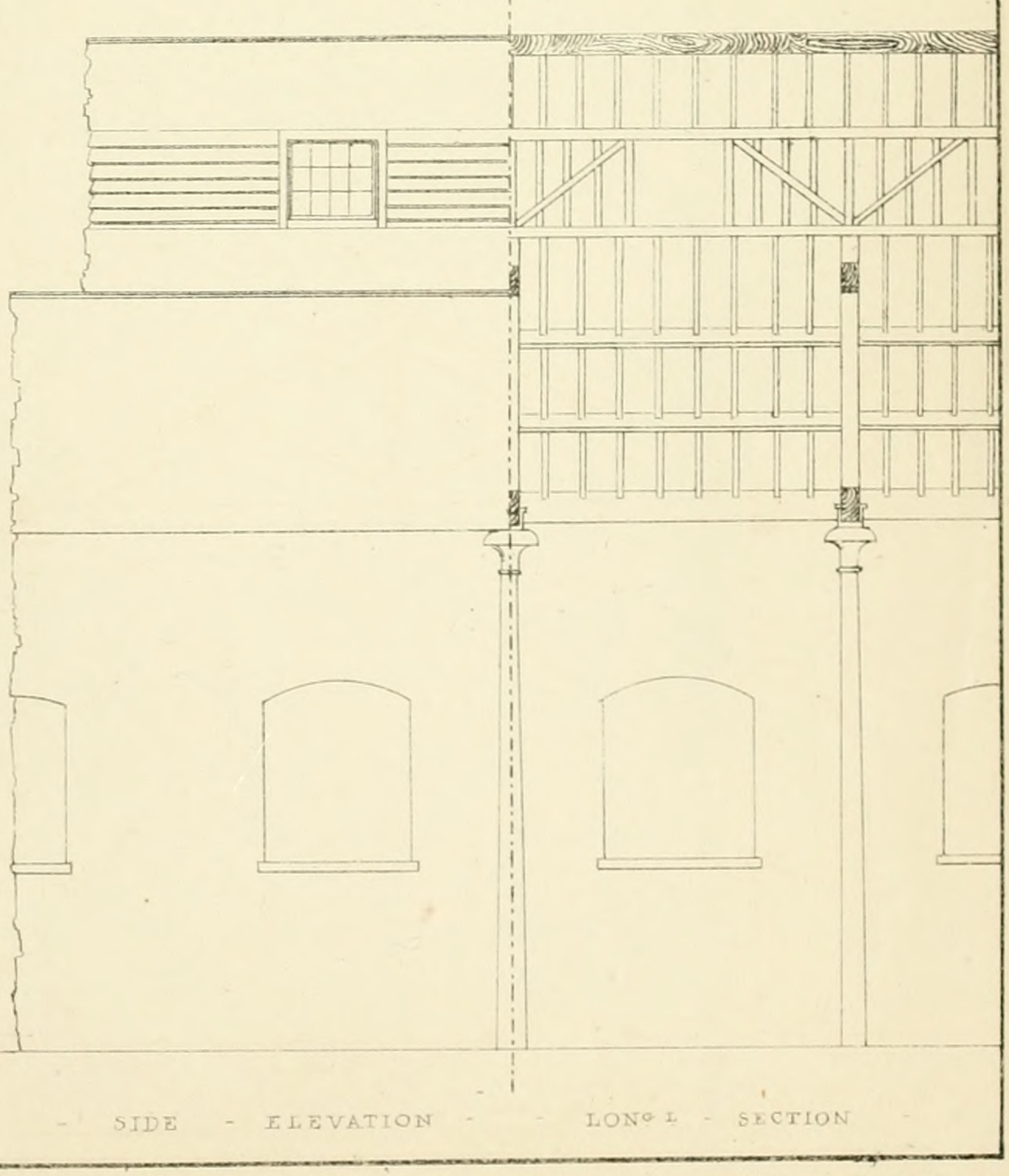
- IRON - COLUMNS -





- PLAN -





- SIDE - ELEVATION - - LONG L - SECTION -

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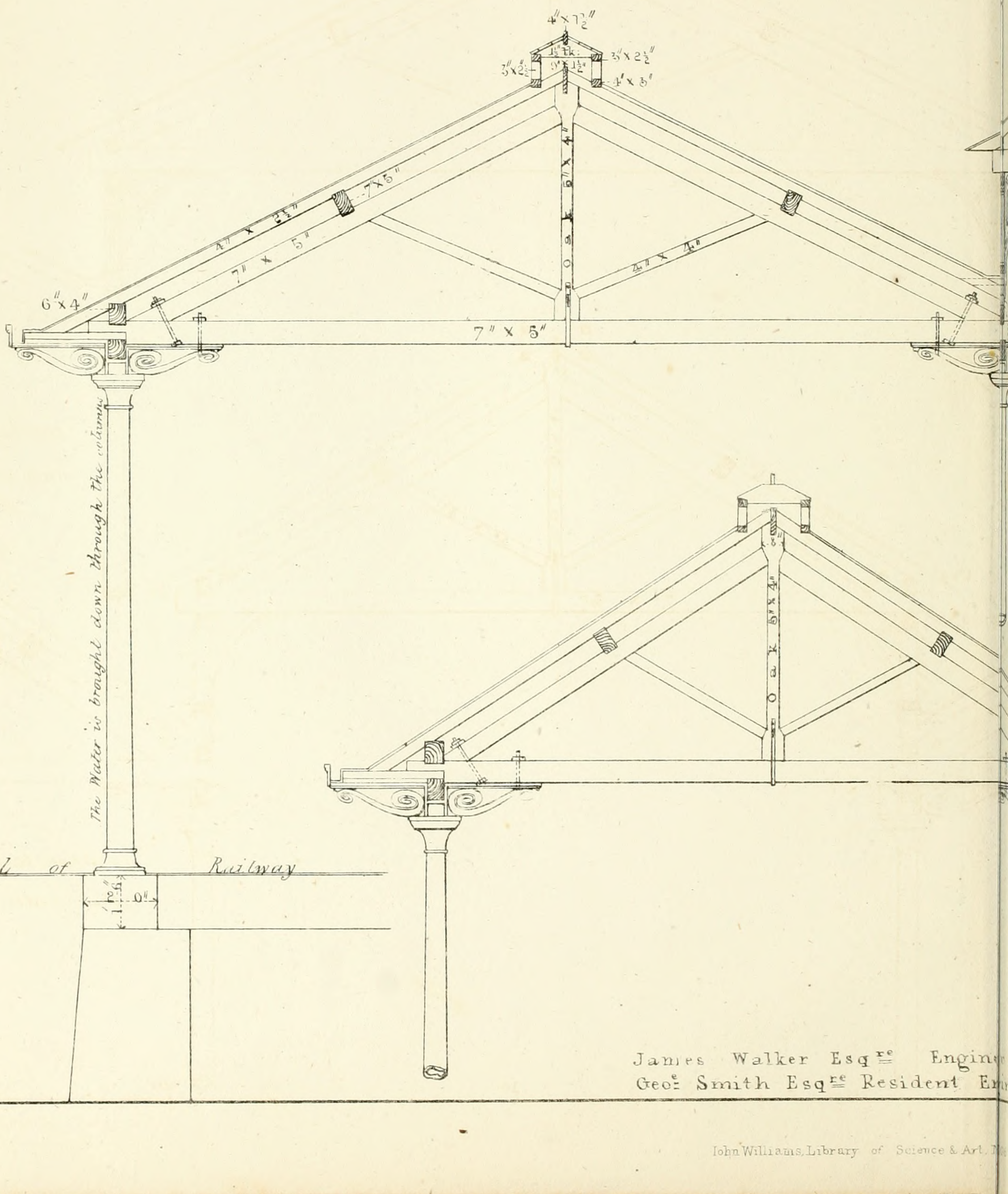
mbury

- LEEDS - & - SEL

- DETAILS &c - OF - SHED -

The Sections below are take
the Sides are not parellel ;



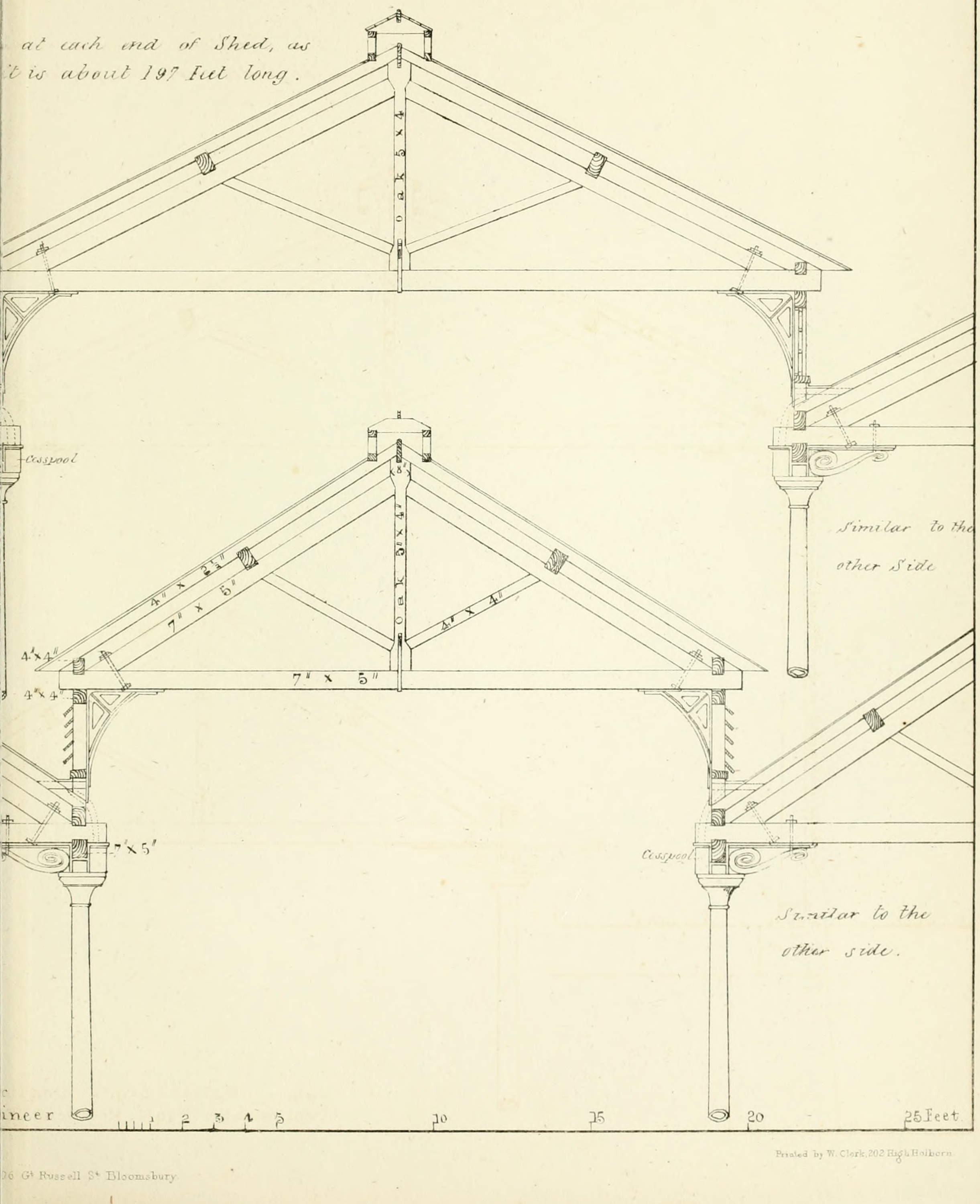
James Walker Esqre Engine
Geoe Smith Esqre Resident En

John Williams, Library of Science & Art, N

Y - RAILWAY -

T - THE - LEEDS - DEPOT -

at each end of Shed, as it is about 197 Feet long.



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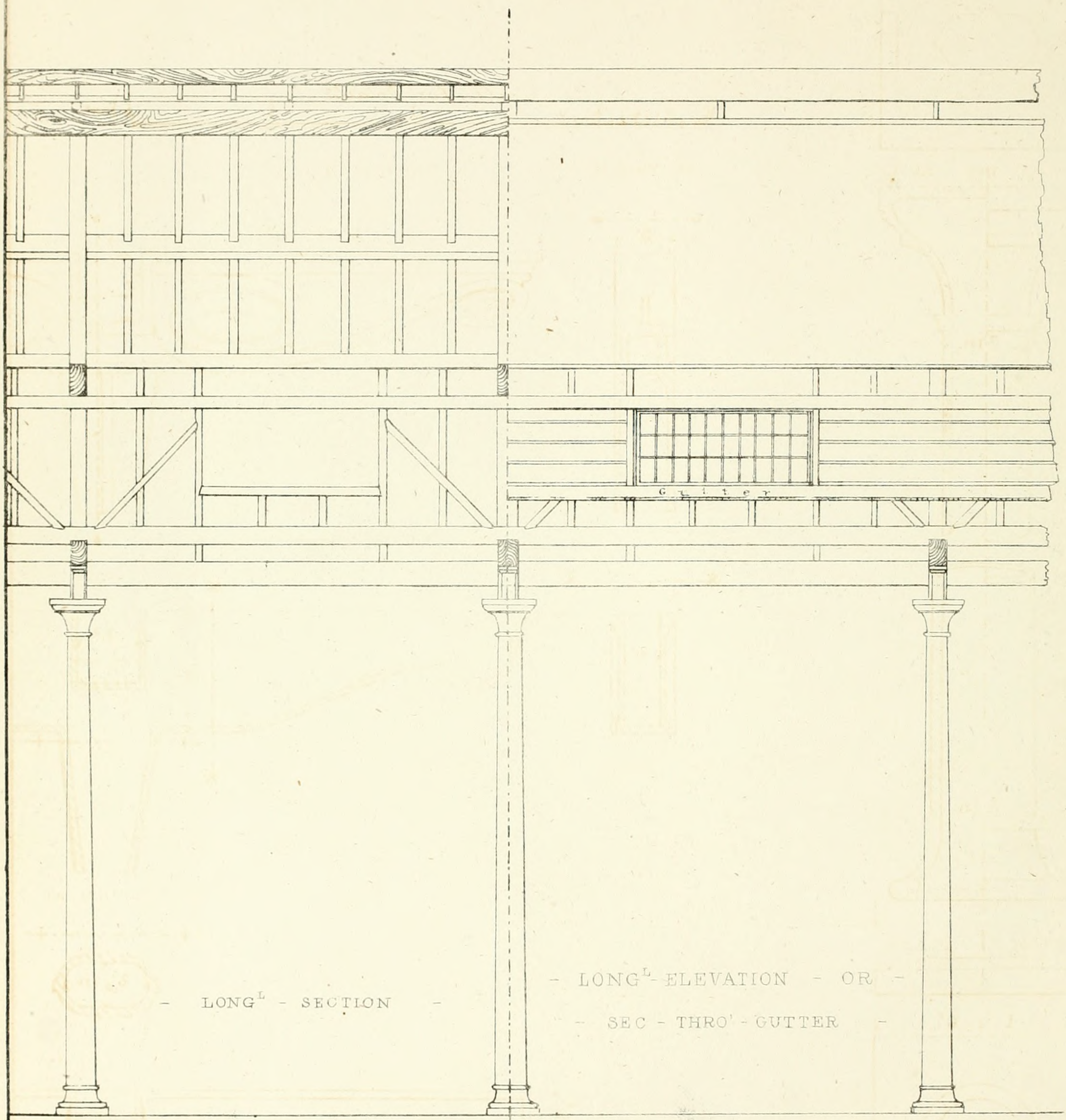
- LEEDS - & - SELBY - RAILWAY -

DETAILS - OF - SHED - LEEDS - DEPÔT -

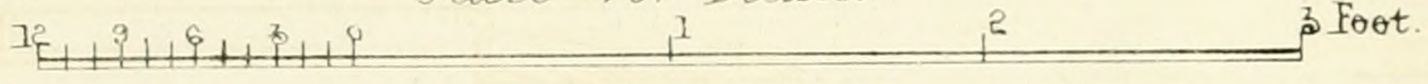


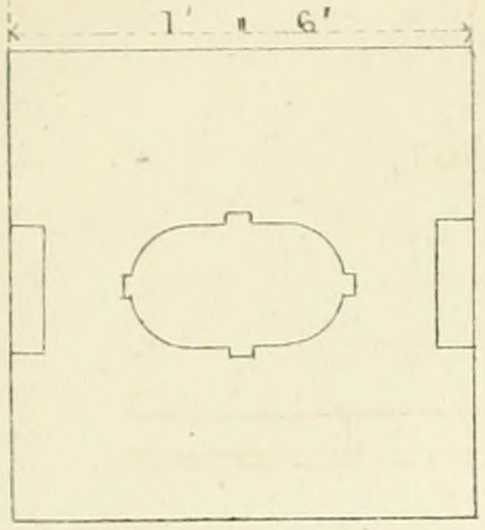
James Walker Esqre Engineer
Geo^e Smith Esqre Resident Engineer

John Williams, Library of Science & Art, N

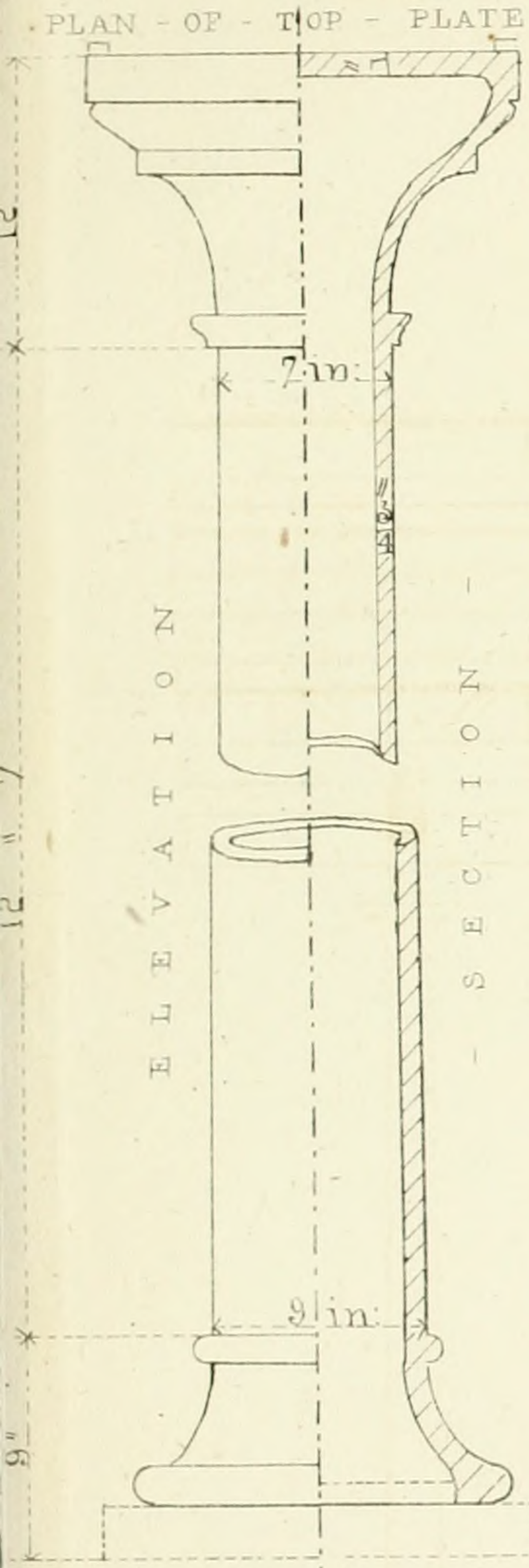
- DETAILS - OF - IRON - COLUMNS - & - BRACKETS -

Scale for Details

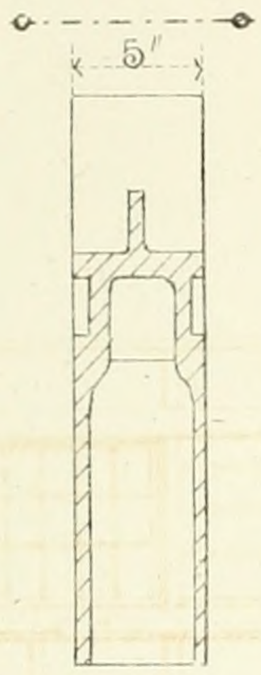




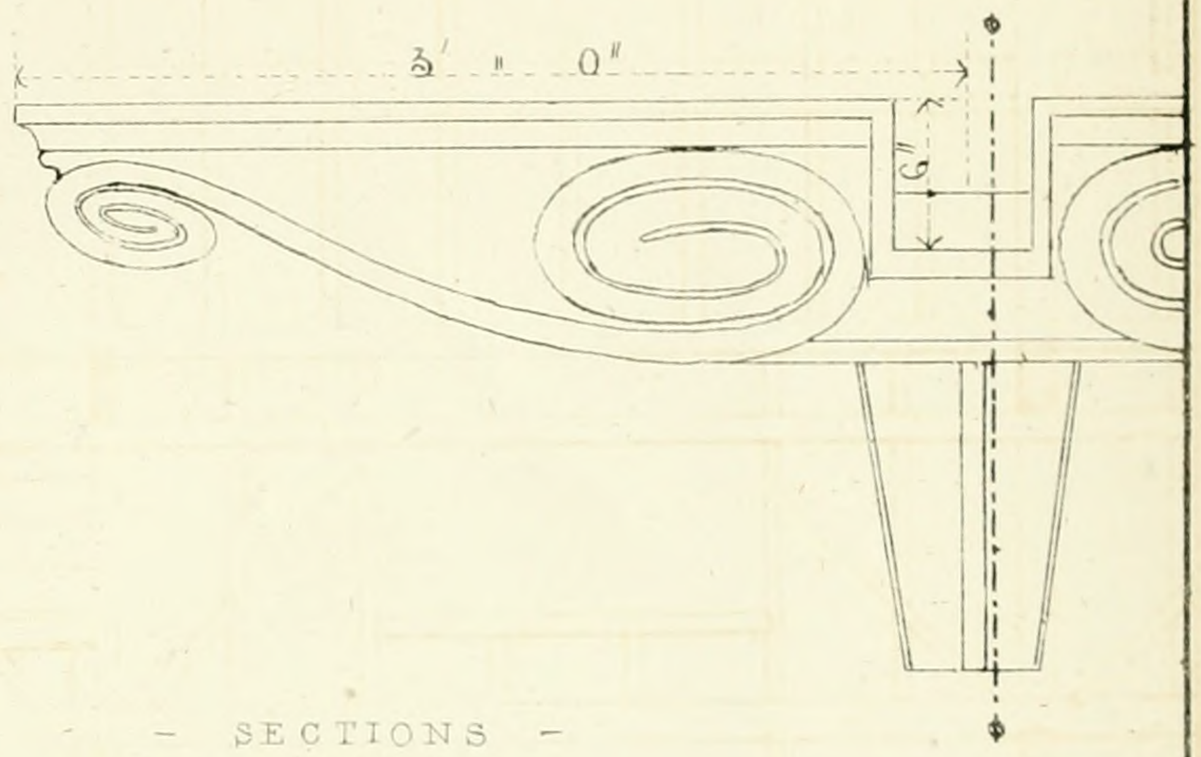
- PLAN - OF - TOP - PLATE -



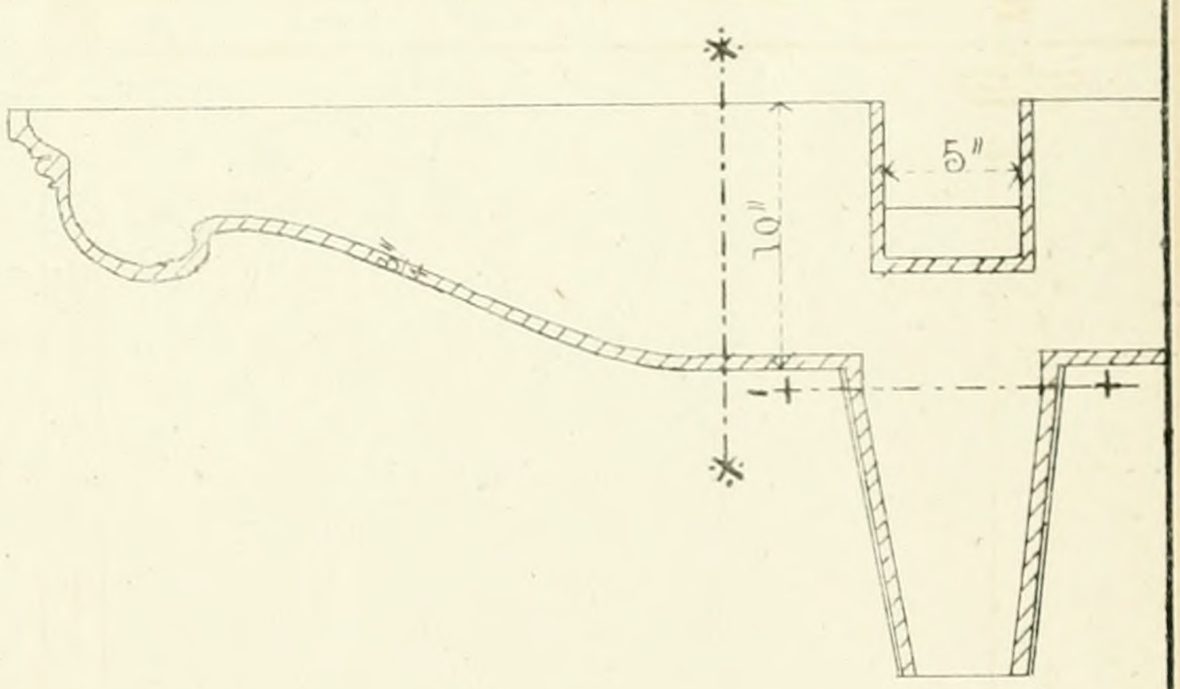
- SECTION AT -

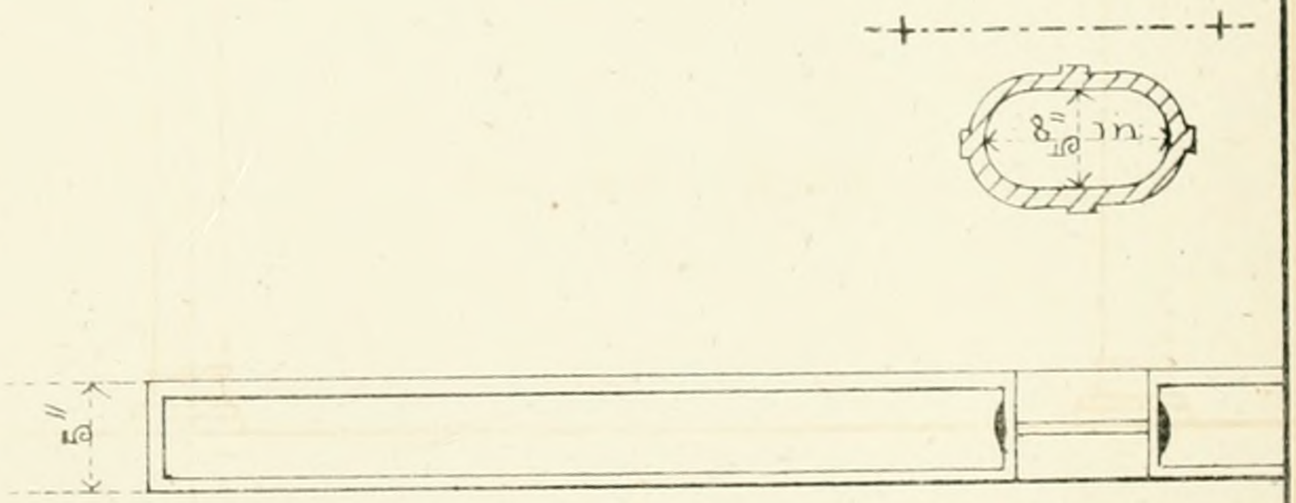


- ELEVATION -



- SECTIONS -





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6 Gt Russell St Bloomsbury

- PLAN -

LEEDS - & - SE

- DETAILS - O

8′ " 0″

- SECTION -

James Walker Esqre Engineer

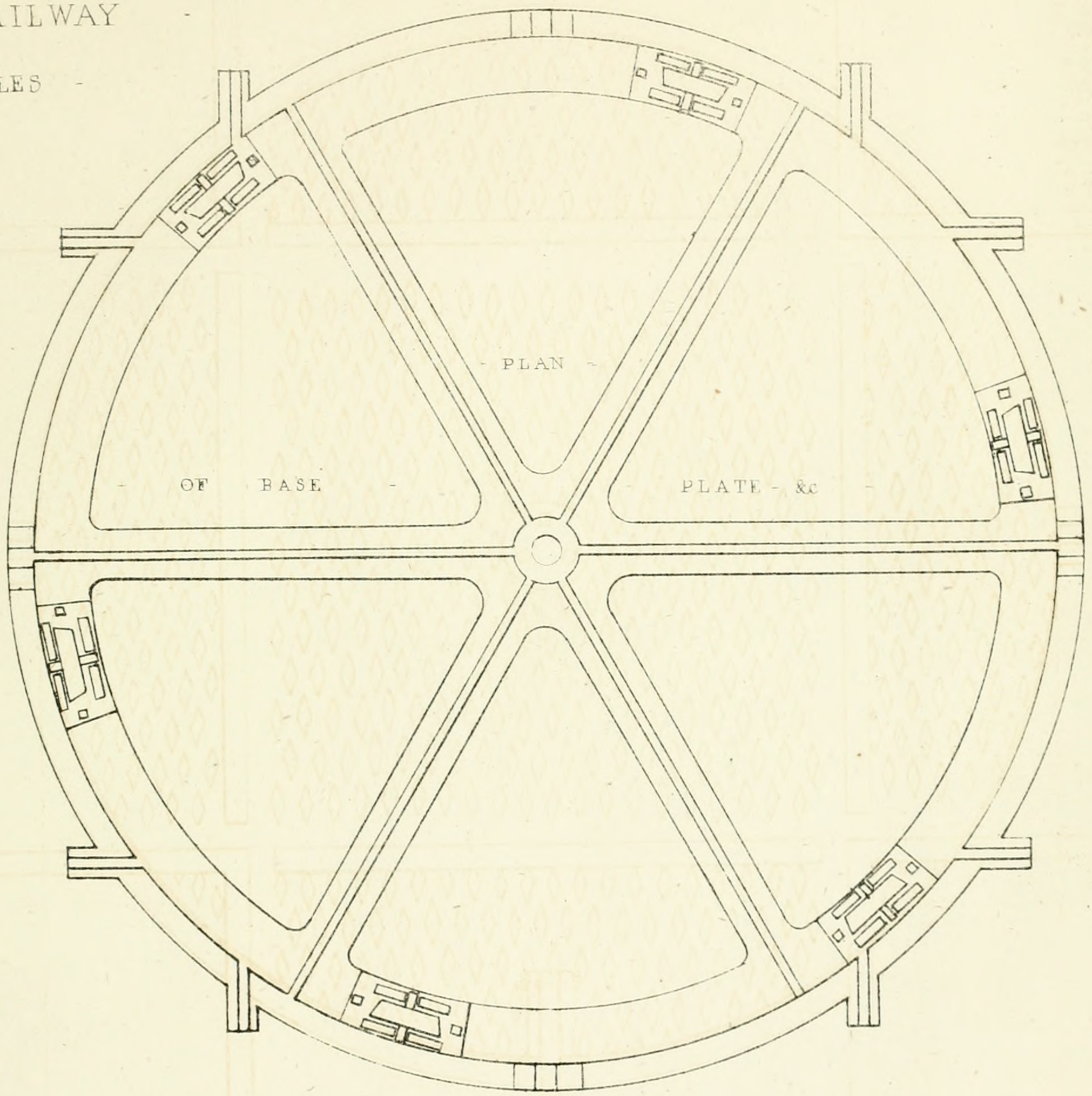
Geo: Smith Esqre Resident Engineer

Ins.

John Williams Library of Science & Art

BY - RAILWAY -

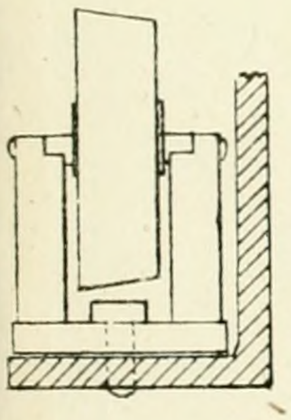
- TURNTABLES -



- PLAN -

- OF BASE -

- PLATE - &c -



MLS - OF FRICTION - ROLLERS

- SECTION - THRO' - CENTRE - PIN -

Scale 1½ to One Foot

3 4 5 6 7 Feet

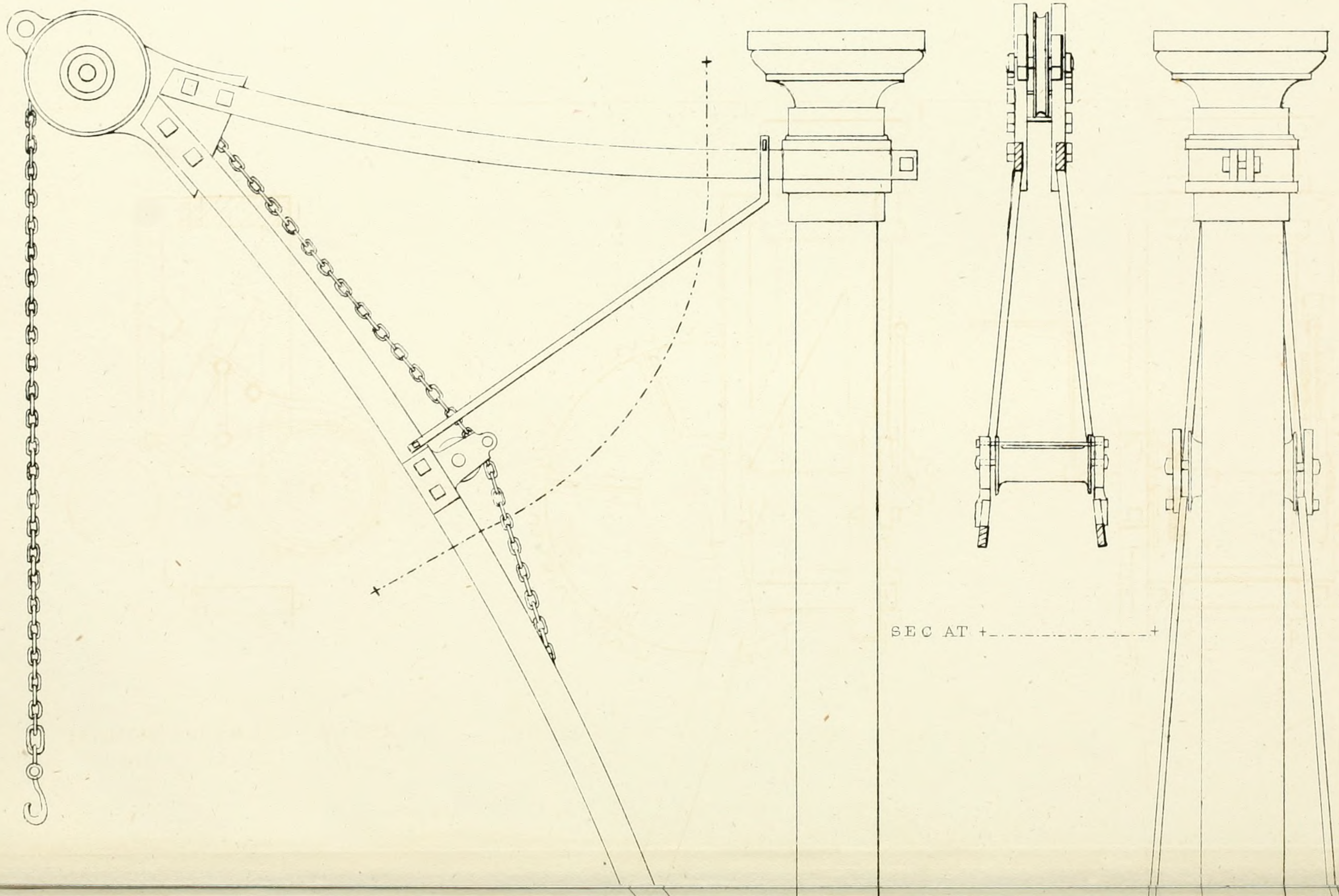
106. Gt Russell St Bloomsbury.

Printed by W Clerk 202 High Holborn

Plate LVIII.

- LEEDS - & - SELBY - RAILWAY -

- CRANES - IN - THE - SHED - LEEDS - DEPOT -



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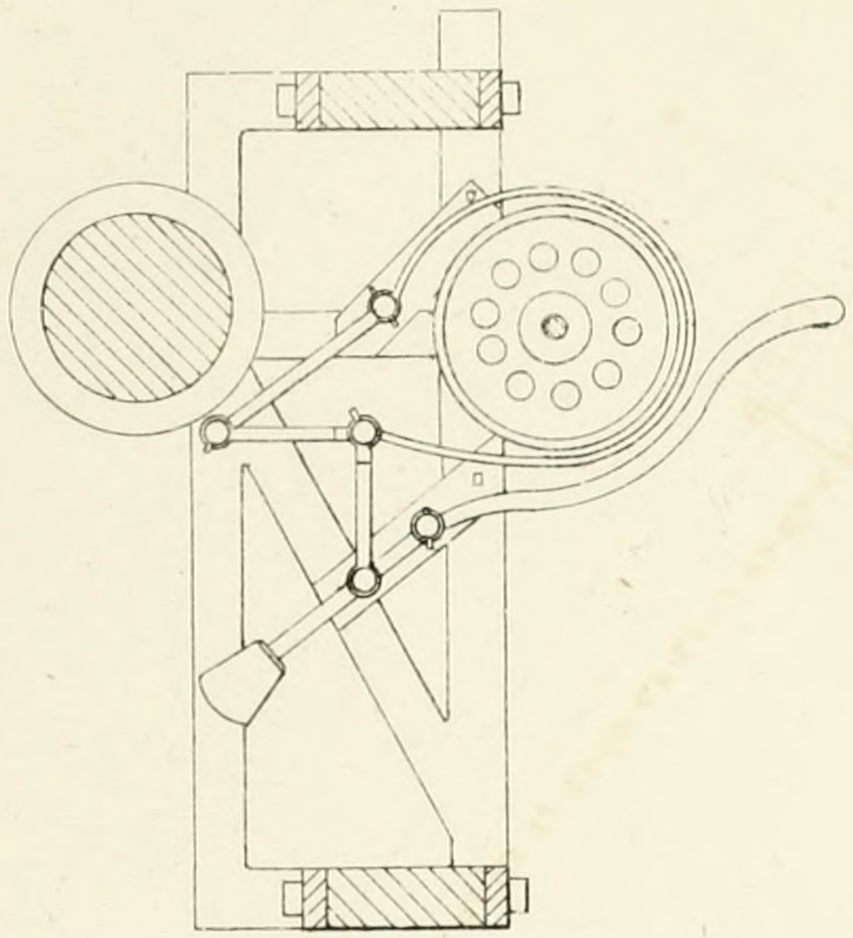
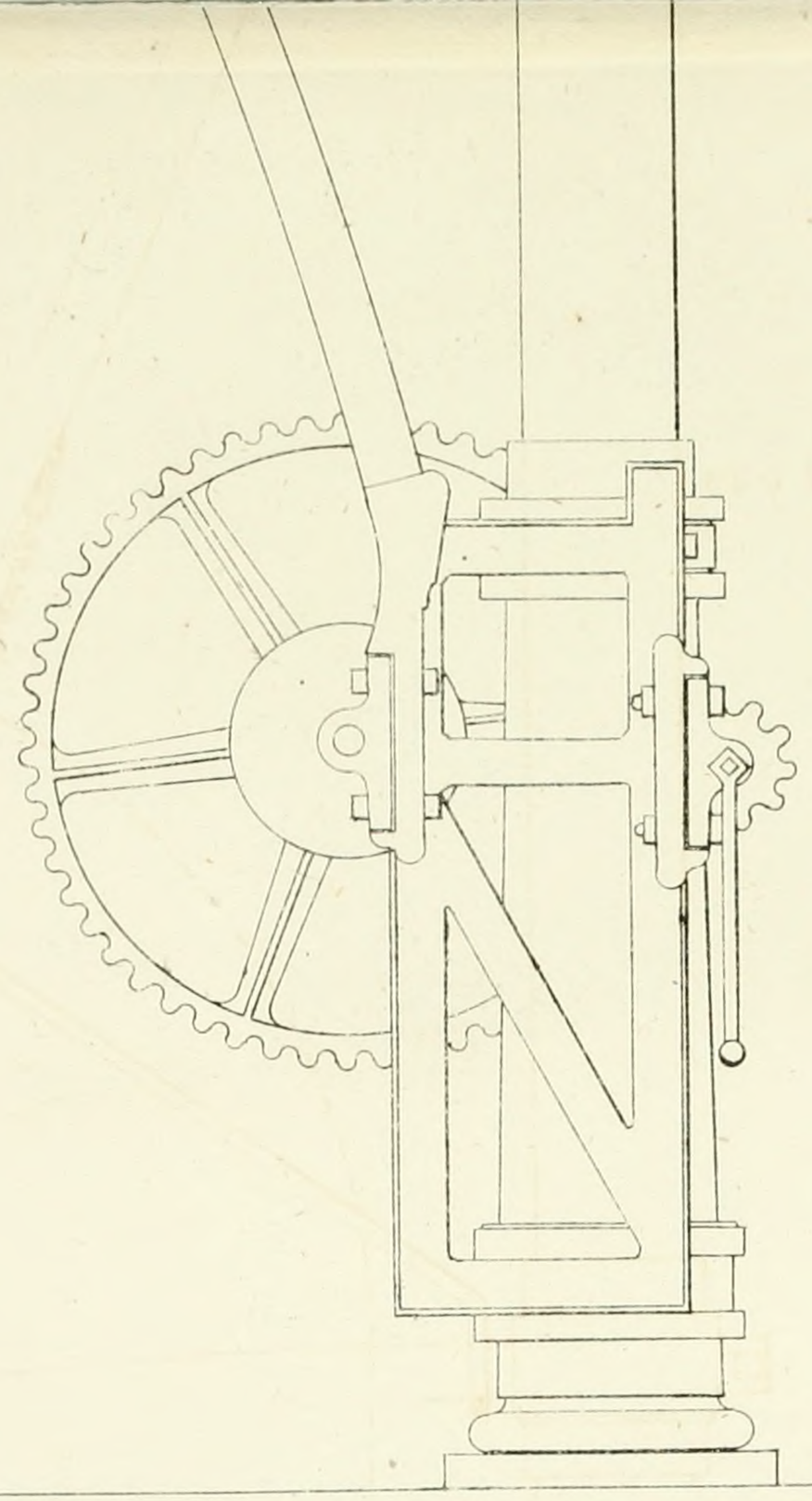
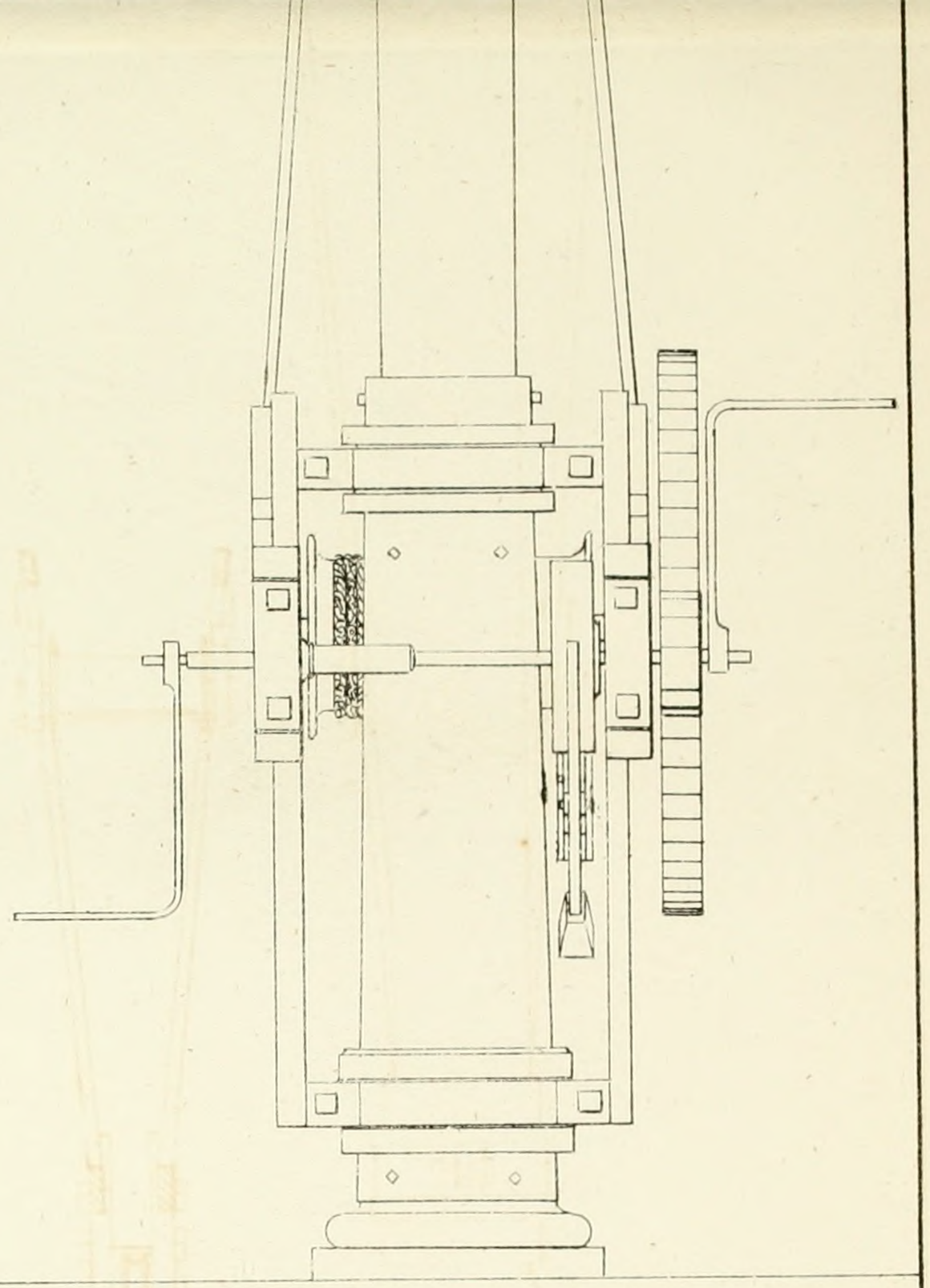
Nº 106 Gt Russell St Bloomsbury.

- SECTION - SHEWING - BREAK -

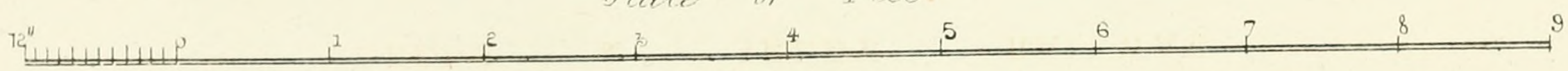






- SIDE - ELEVATION - - END - ELEVATION -

Scale of Feet.

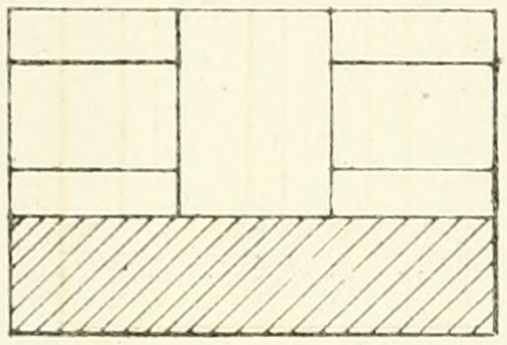


James Walker Esqre Engineer
Geos Smith Esqre Resident Engineer

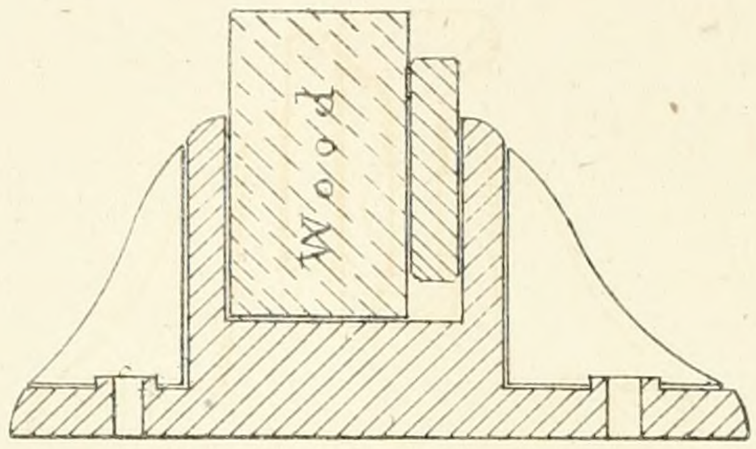
John Williams, Library of Science & A

- LEEDS - & - SEL

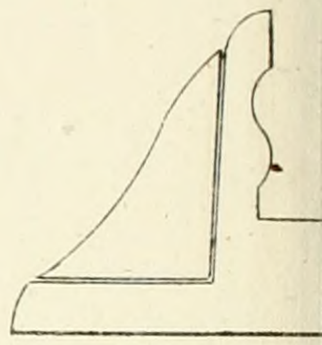
- PLAN - OF - CHAIRS - WITH - VERTICAL -



Section A ---------- B



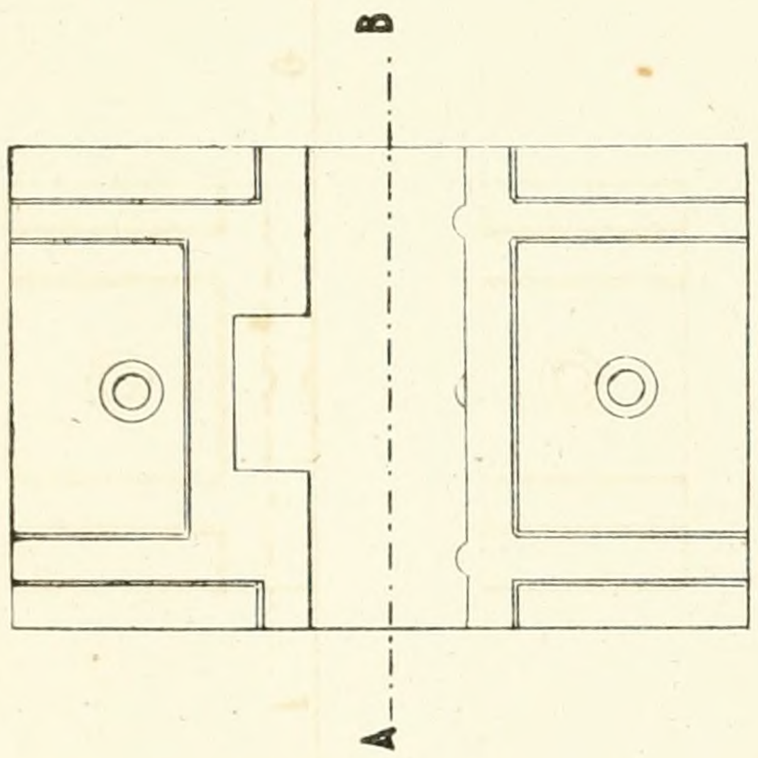
Section C ---- D shewing Wood Plug.



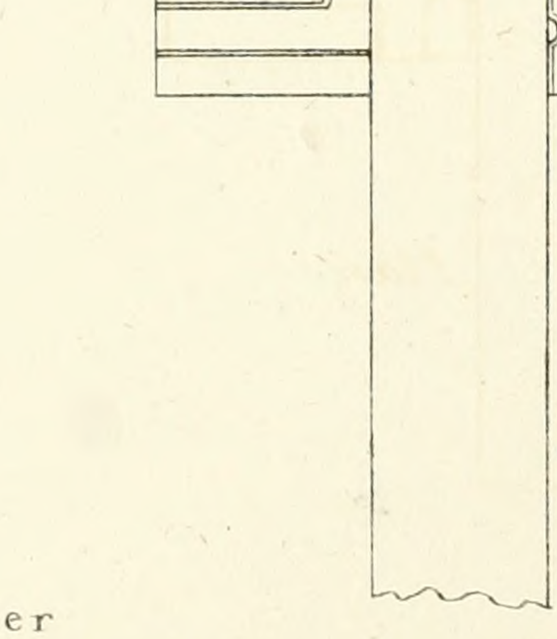
Elev

- JOINT - CHAIRS - 20 - OR - 30 - YDS - APART -

- TO - ALLOW - FOR - EXPANSION -



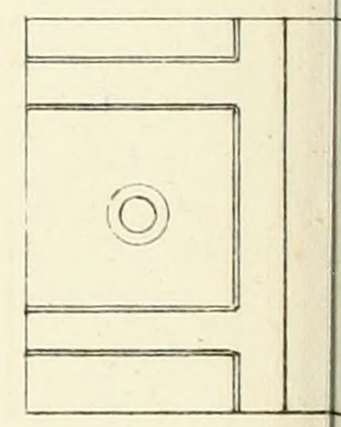
Plan



Plan

- COMMON

- MIDDLE



P

James Walker Esqre Engineer
Geo^e Smith Esqre Resident Engineer

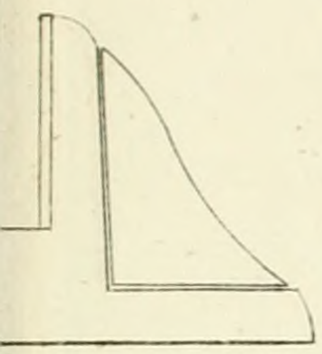
John Williams, Library of Science & Art, No 16

Y - RAILWAY -

Plate LIX.

EYS - TO - SECURE - RAILWAY - BARS -

9 12 Ins.



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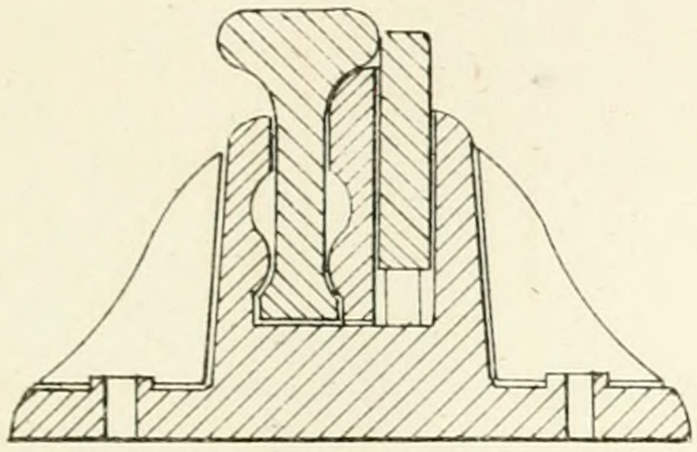

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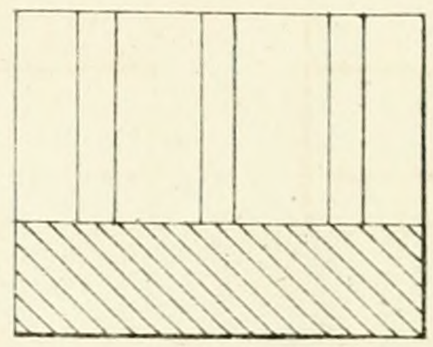
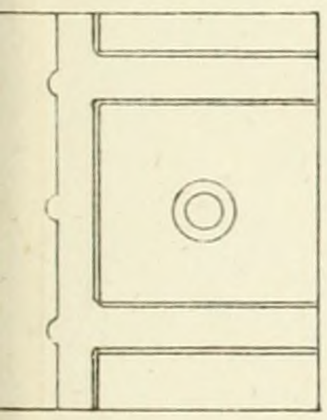
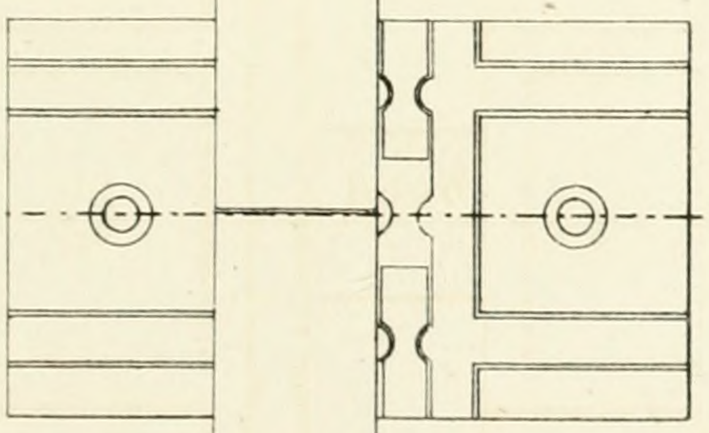


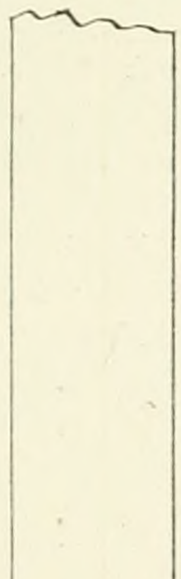
Section F ---------- G

- JOINT - OR -

- CHAIRS -

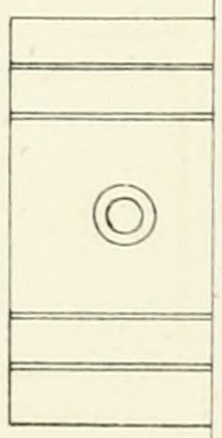




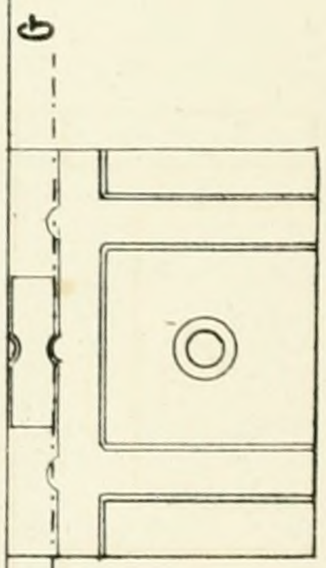


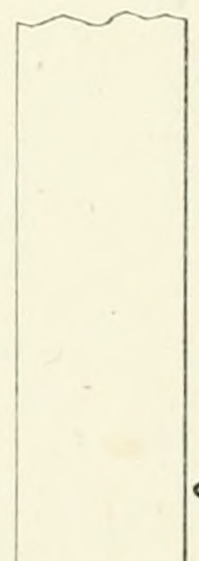
Plan

- MIDDLE -



- CHAIR -





Plan

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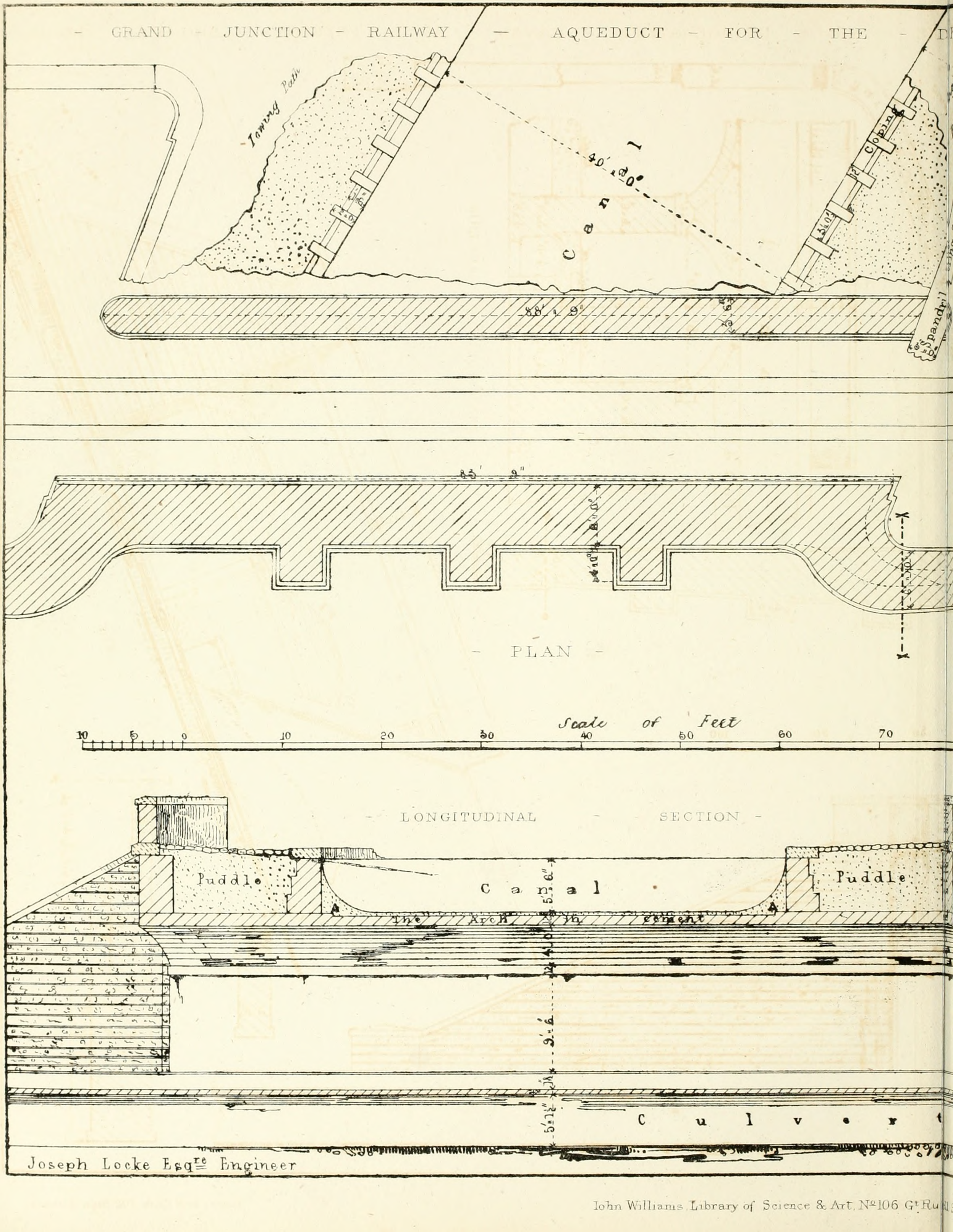
St Russell St Bloomsbury.

- GRAND - JUNCTION - RAILWAY — AQUEDUCT - FOR - THE - D



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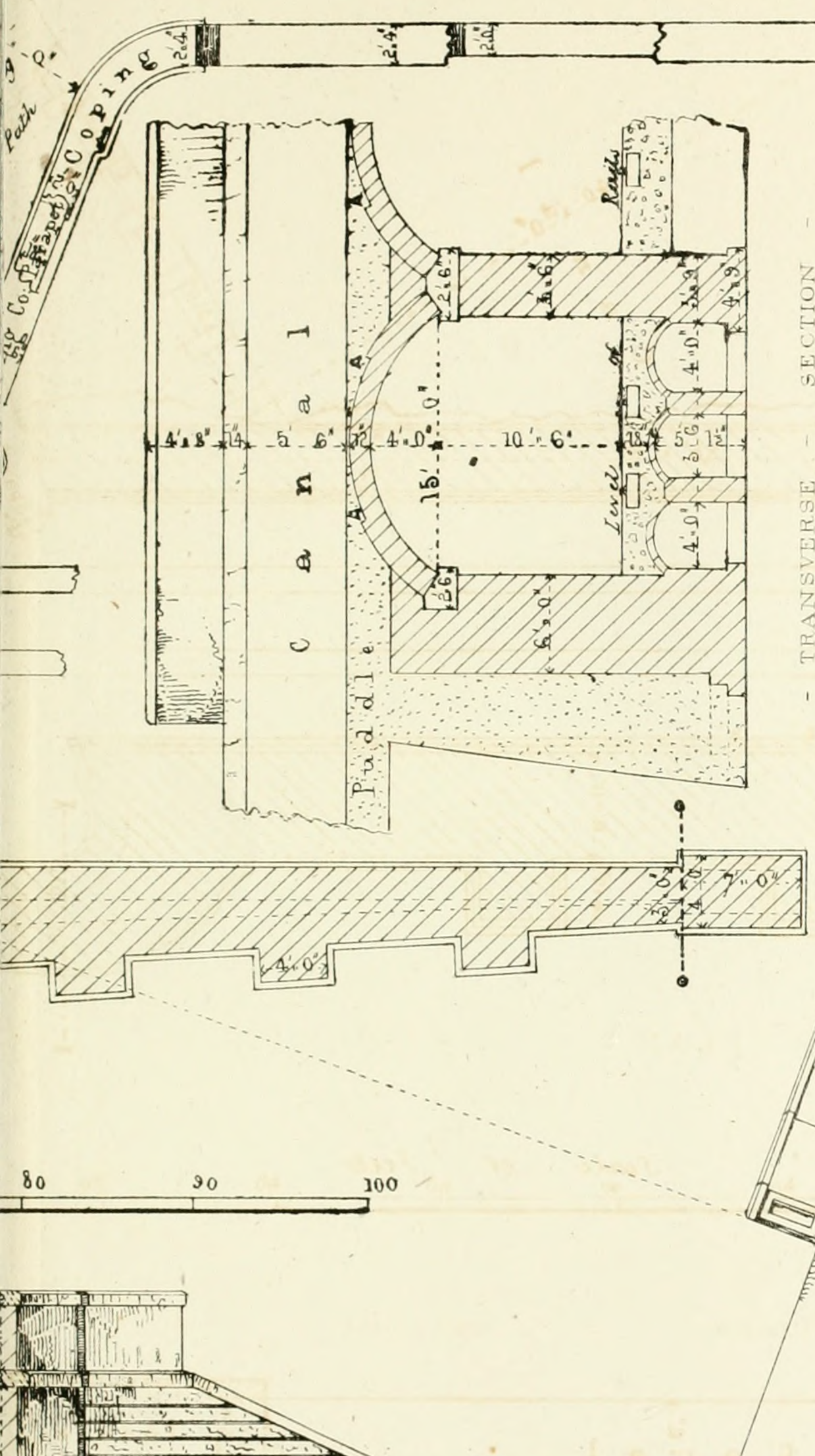
KE - OF - BRIDGEWATER'S - CANAL - AT - PRESTON - BROOK - Plate. LX.

- TRANSVERSE - SECTION -



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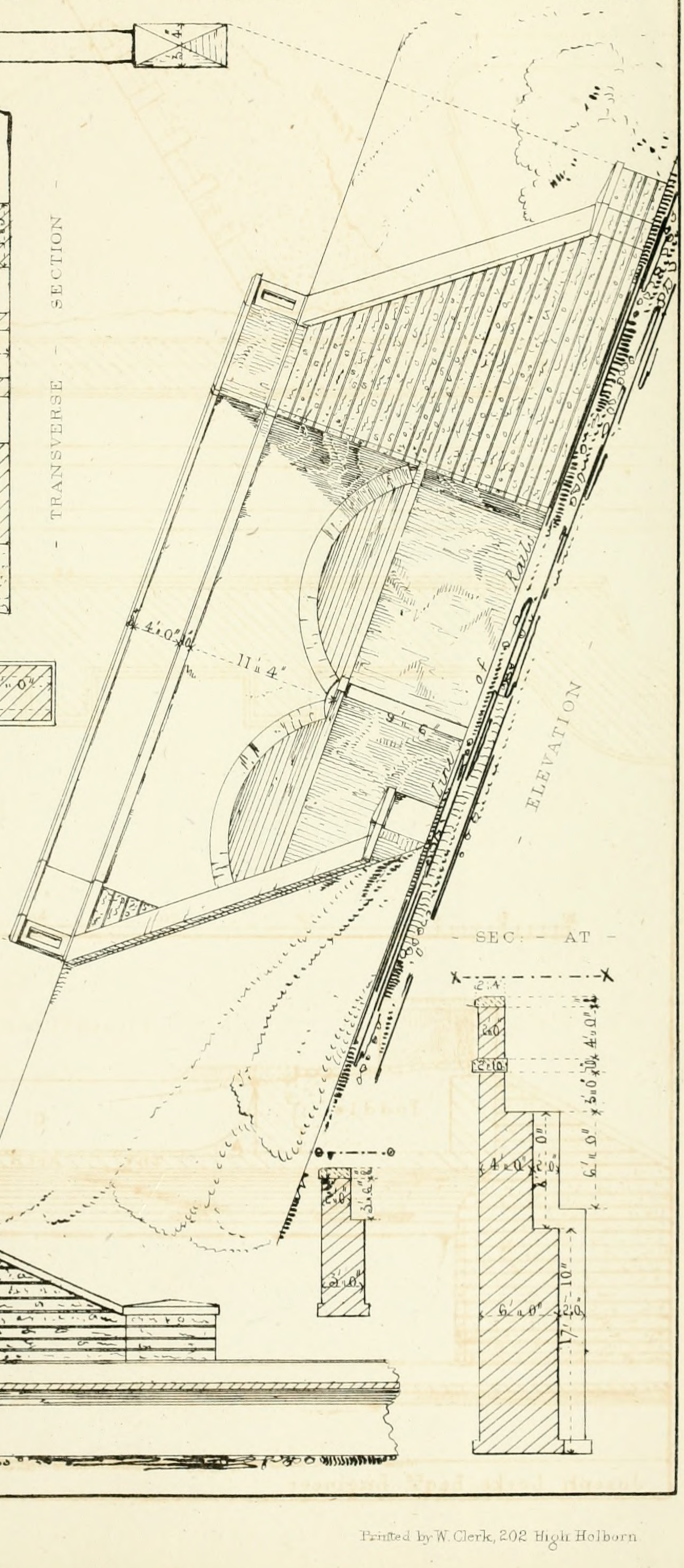

- SEC: - AT -

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- ELEVATION -

- LONGITUDINAL

- PLAN - OF - FOUNDATIONS

- FOUNDATIONS

PLAN OF ROADWAY PLATES WITH RECESSES FOR THE CHAIRS

Top of Beam

- SECTION - OF PIER - WITH - VIEW - OF - BED - PLATE -

Top of Outside

Scale of Feet

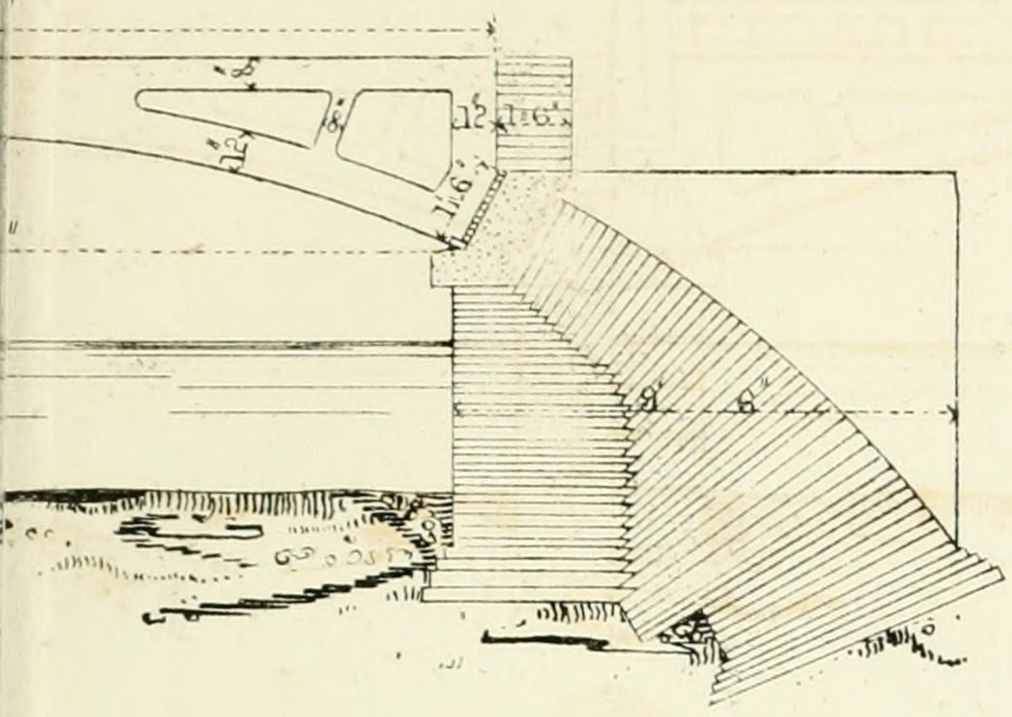
Joseph Locke Esqre Engineer

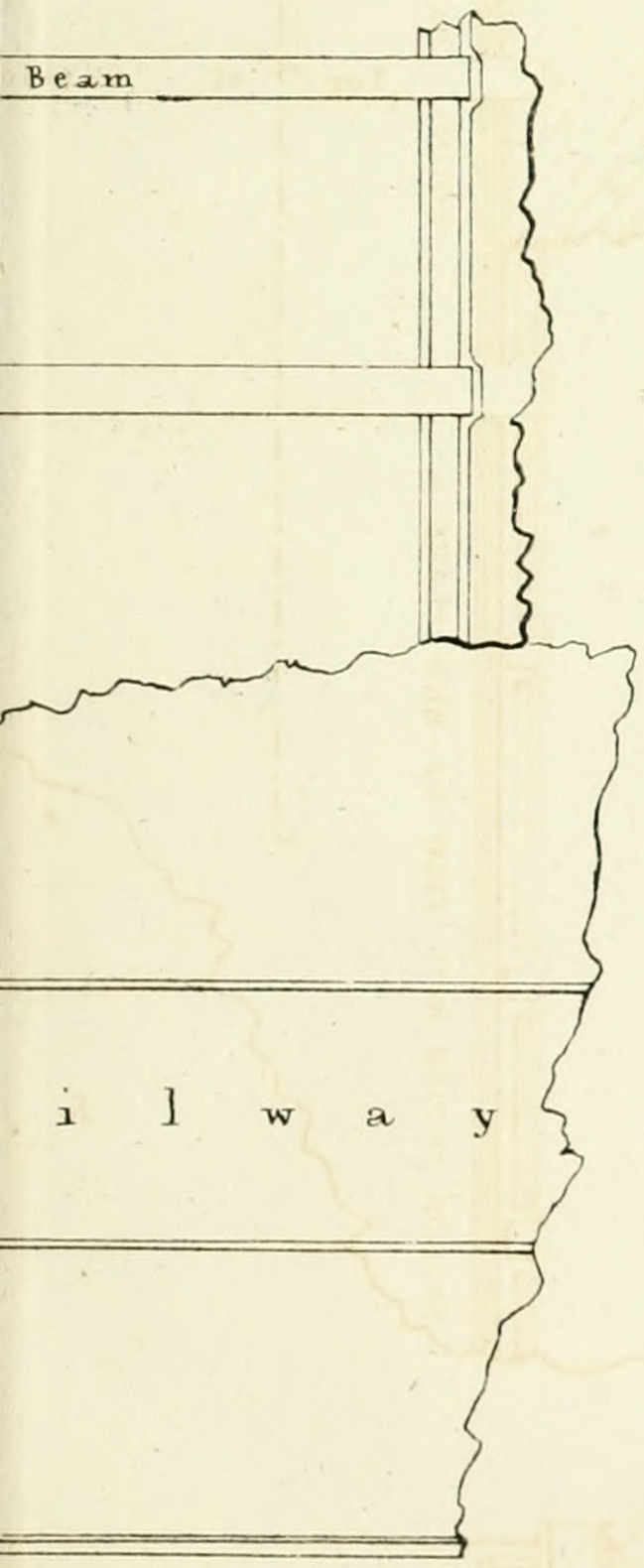
John Williams Library of Science &c

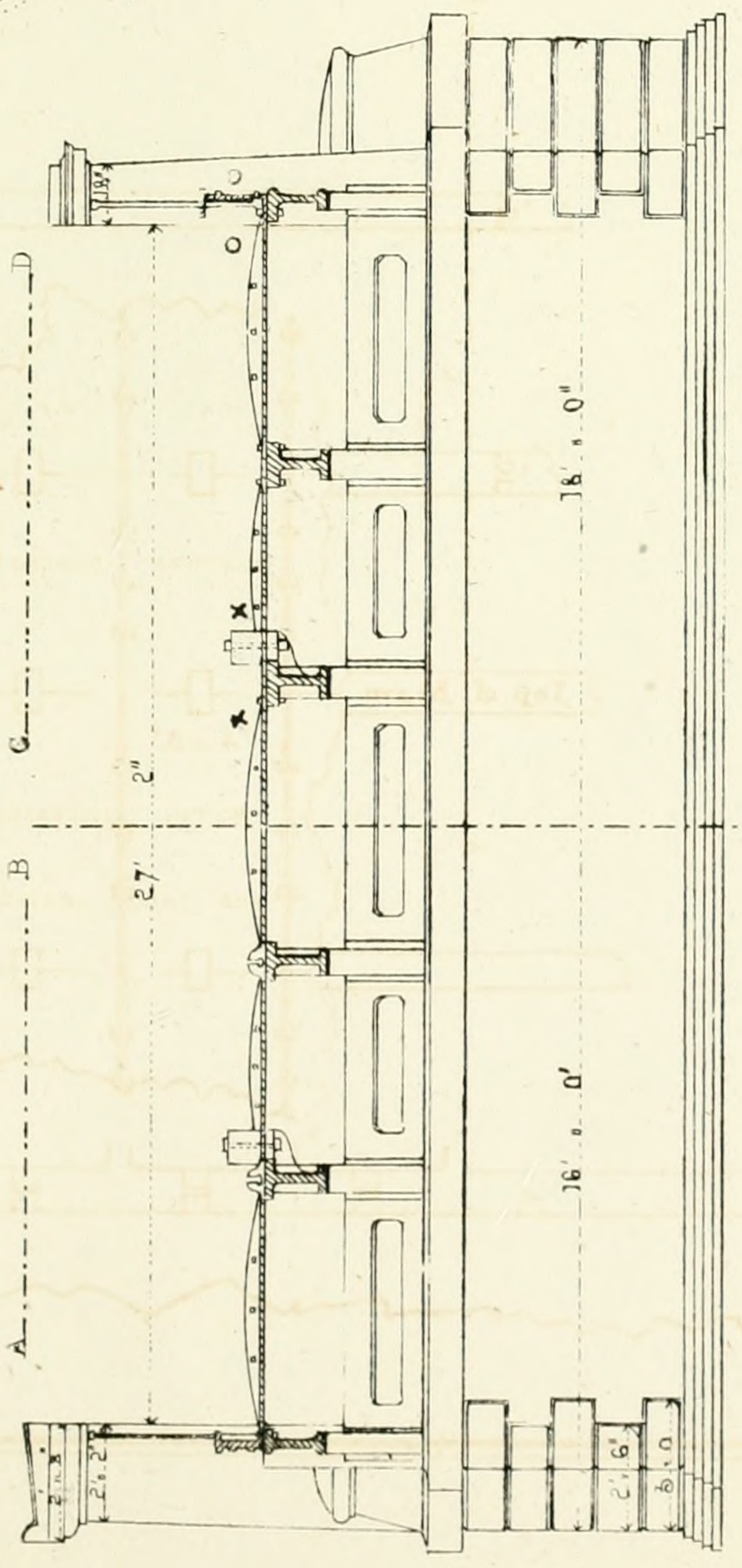
Plate LXI.

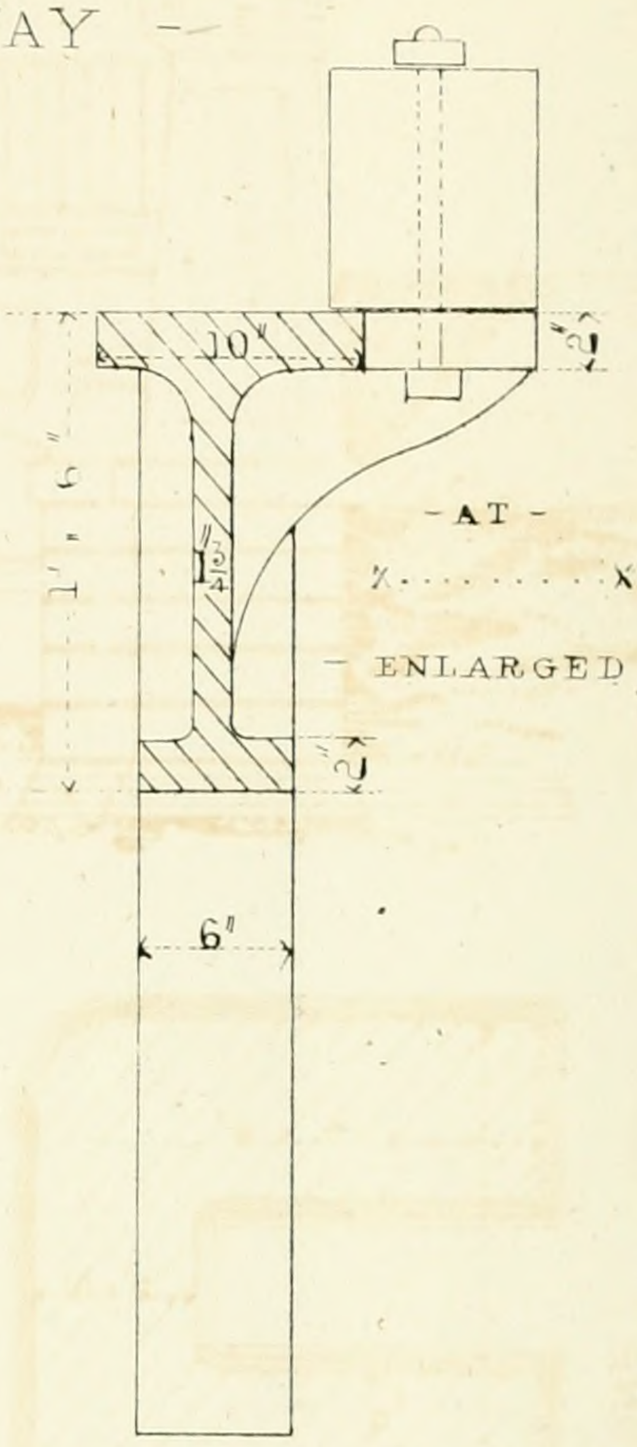
- GRAND - JUNCTION - RAILWAY -

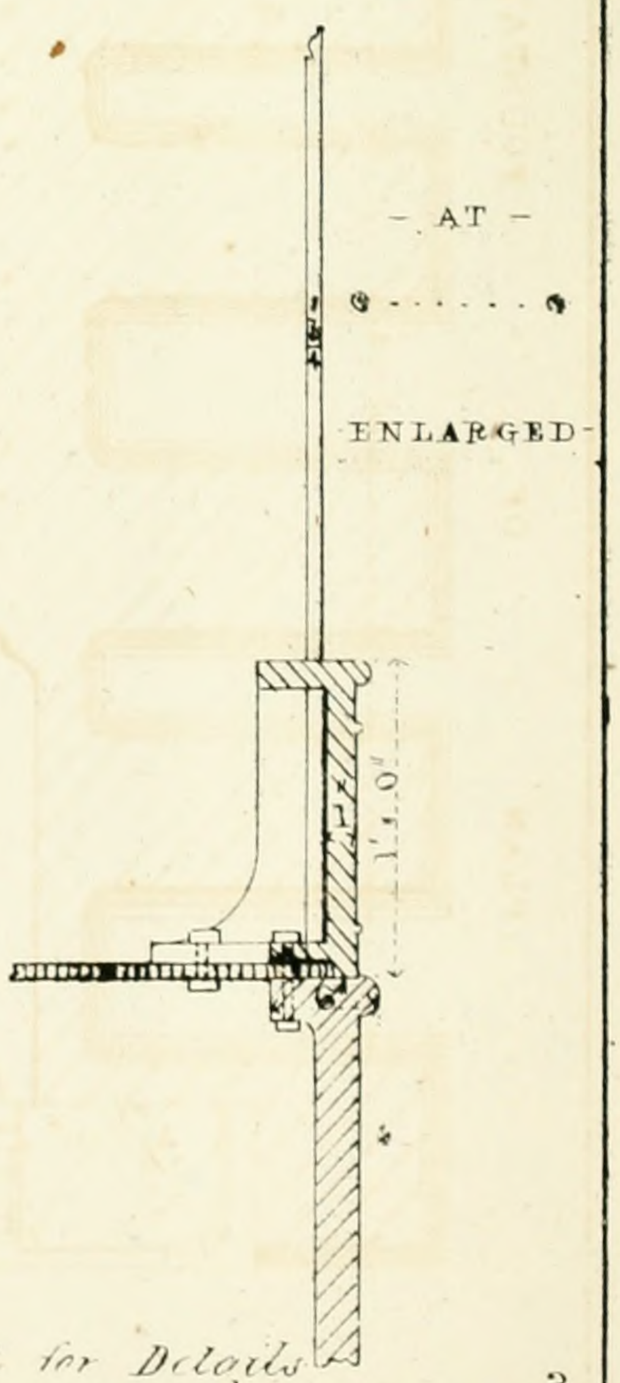
SECTION - - DETAILS - OF - IRON - BRIDGES -











Scale of Feet for Details
Ins. 12 6 0 1 2

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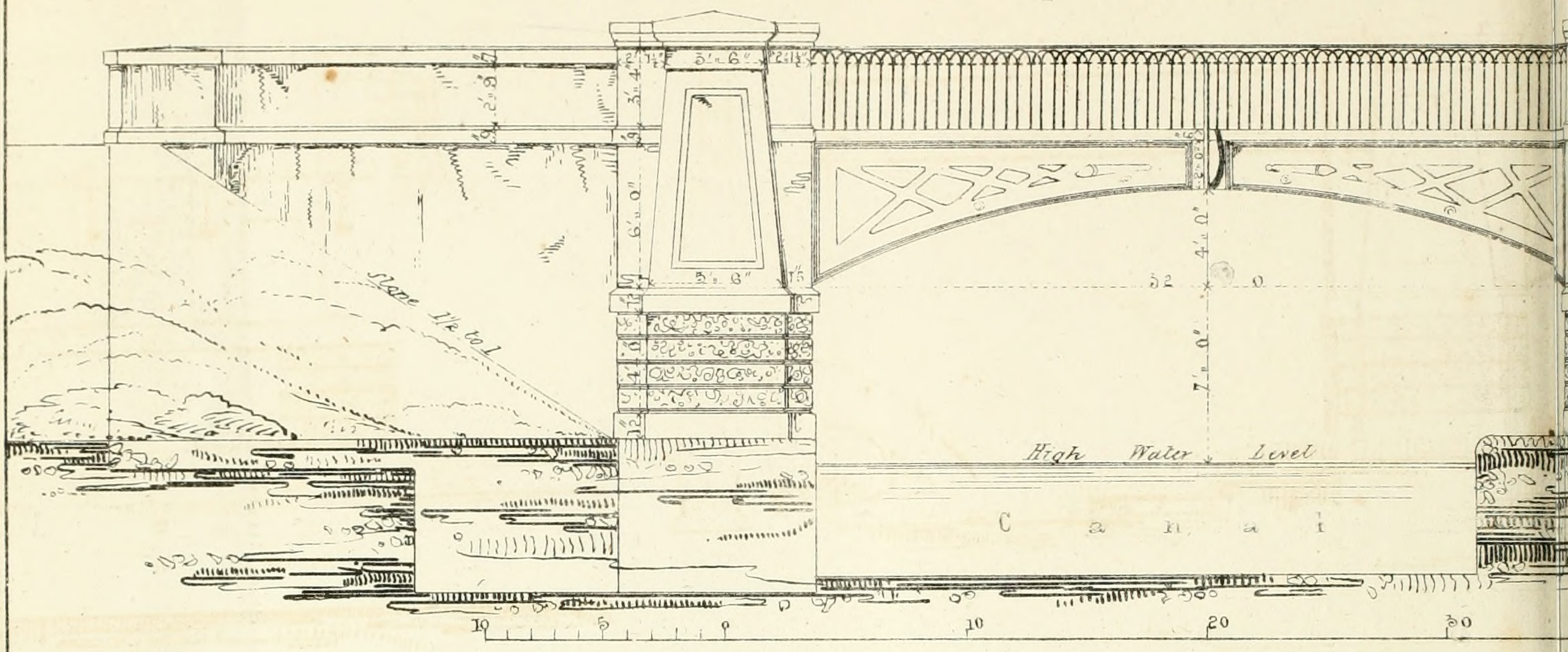
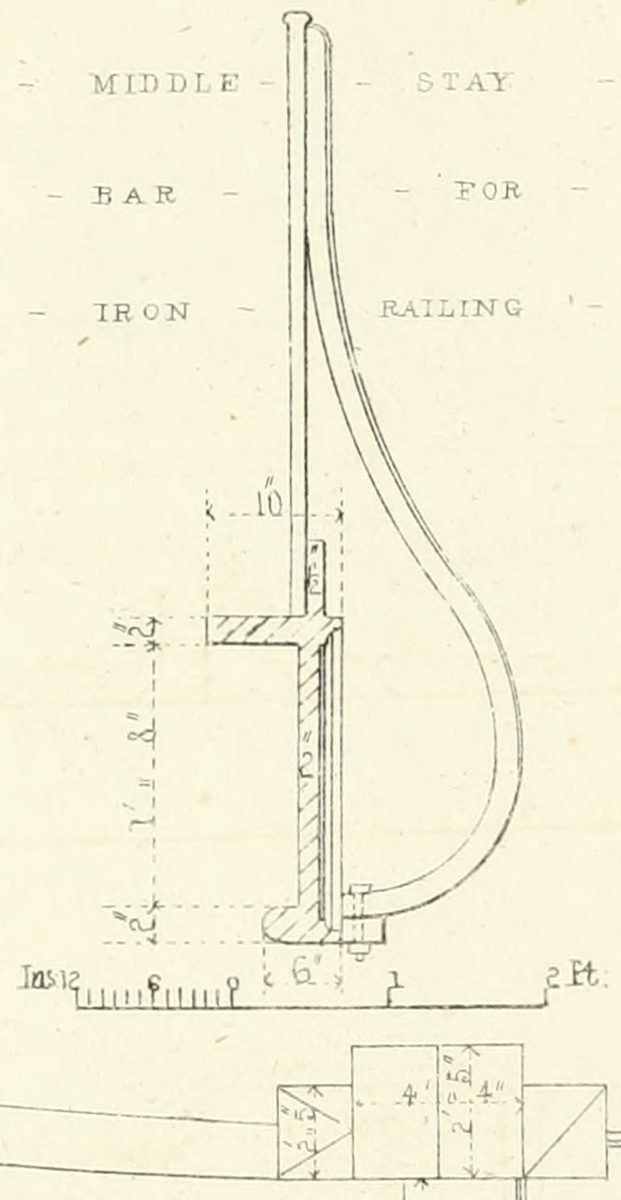
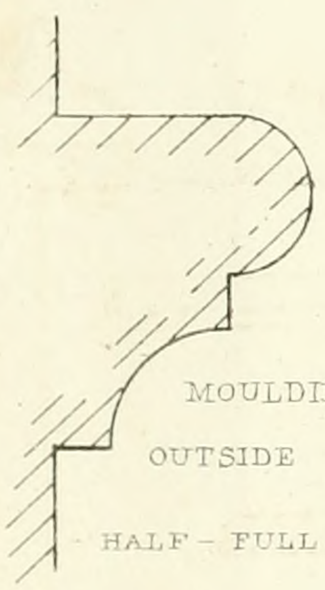
- GRAND - JUNCTION - RAILWA

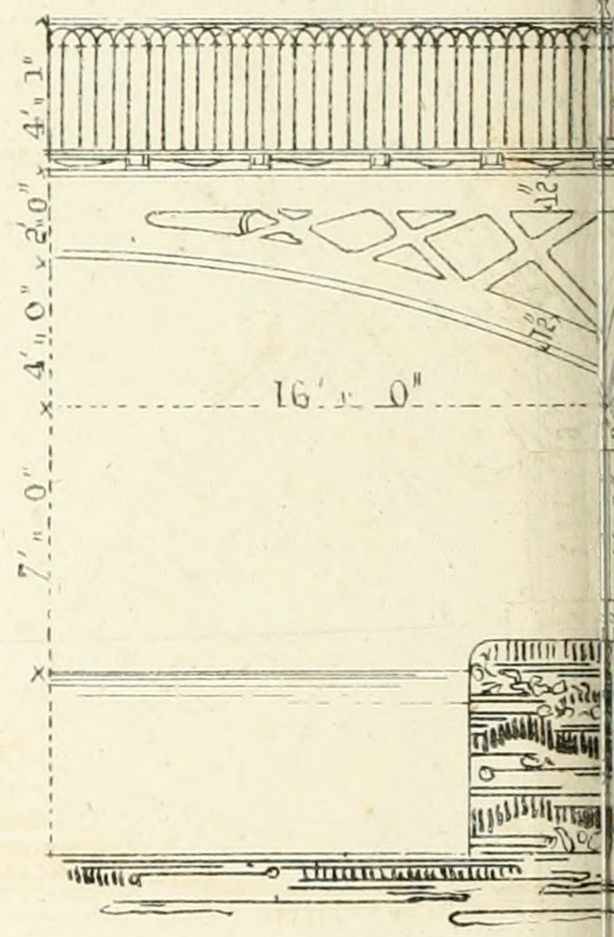
- ELEVATION -



- MIDDLE - STAY - BAR - FOR - IRON - RAILING -

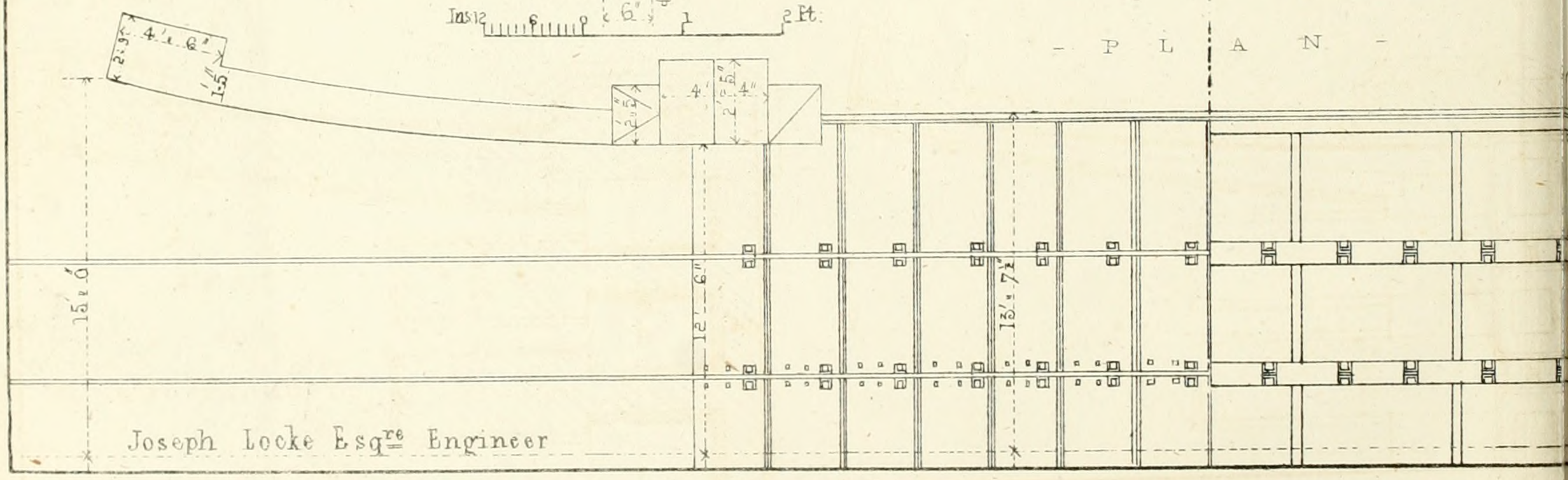






- LONGITUDINAL - SECT

- P L A N -



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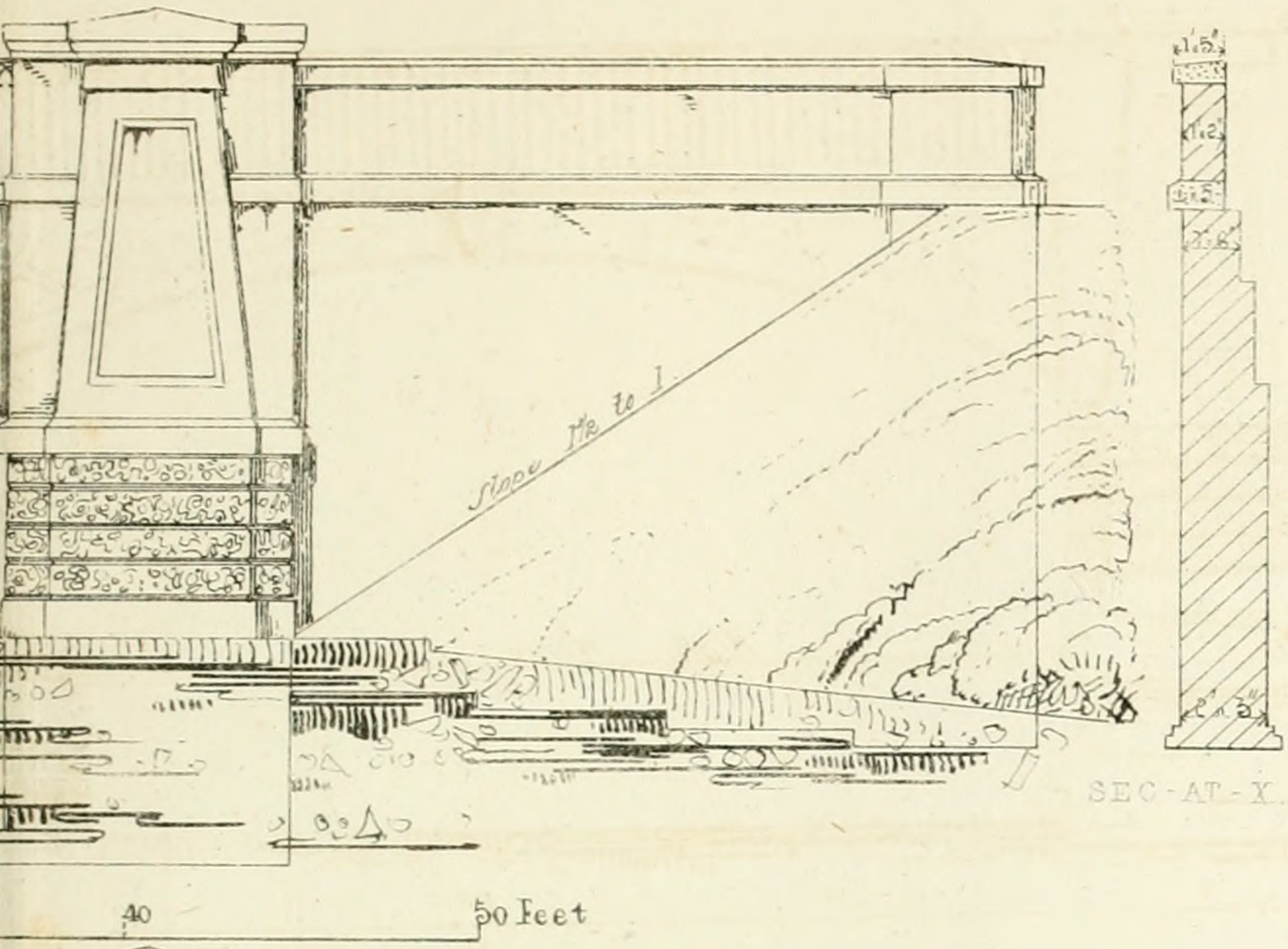
- - BRIDGE - AT - SLADE-HEATH - NEAR - WOLVERHAMPTON



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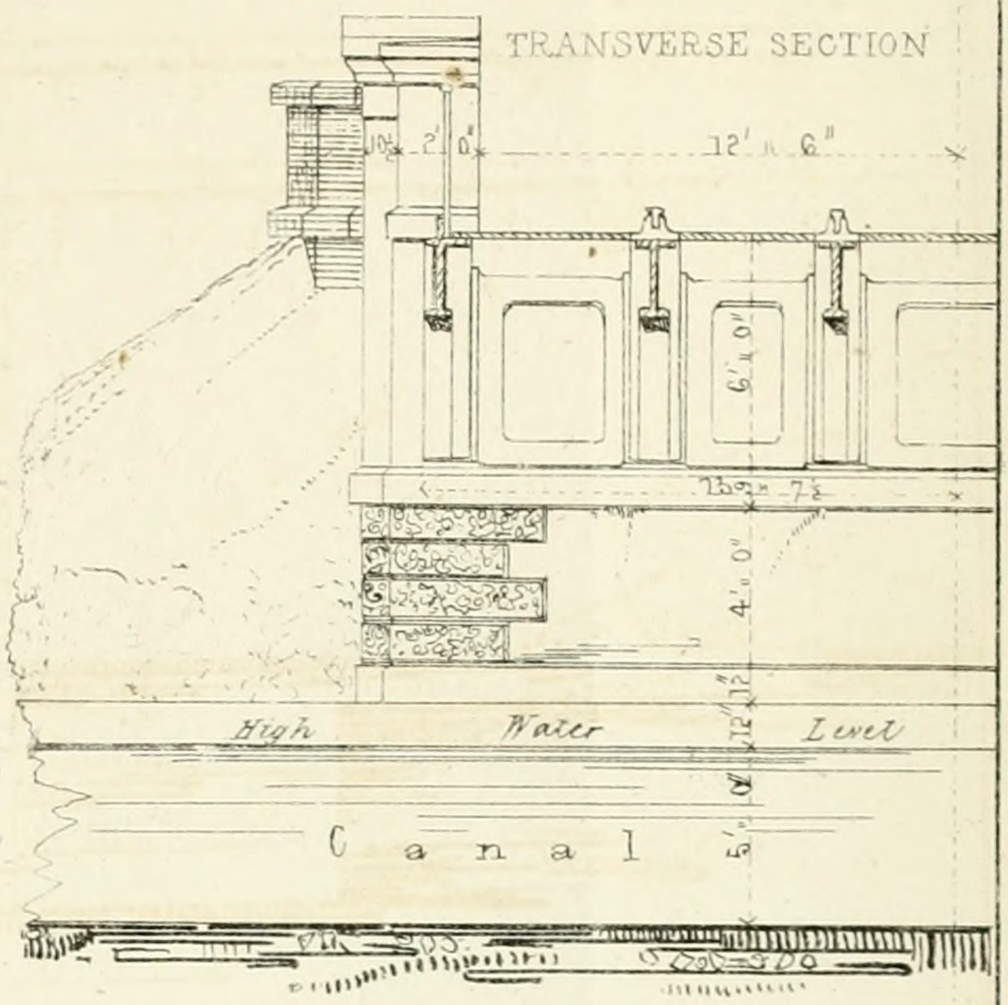
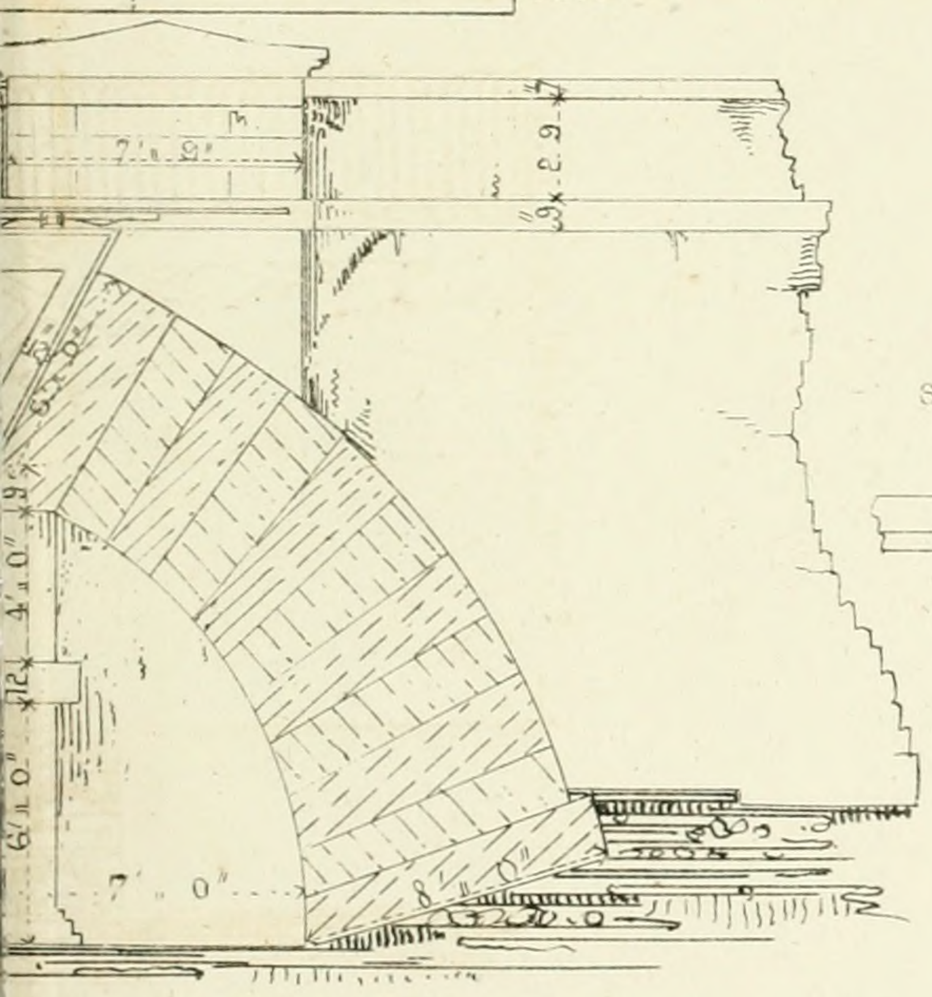
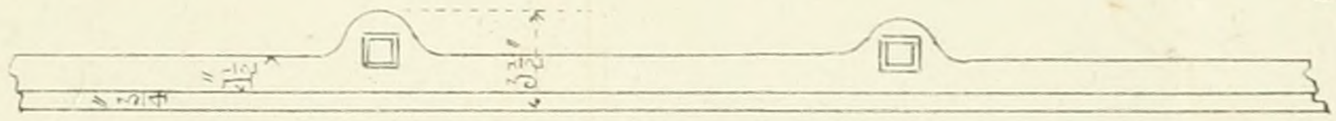


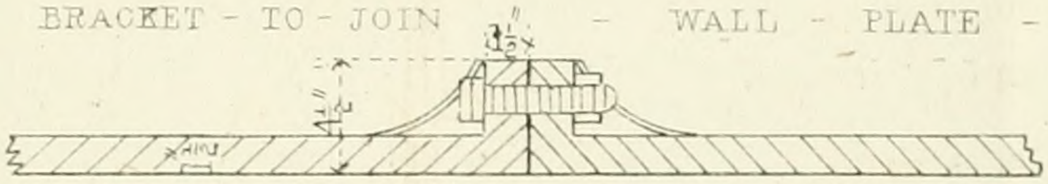
- SEC:- - OF - 9"x5"x3" WALL - PLATE -



SEC:- OF - COVERING - PLATE - SHEWING - FLANGE



- BRACKET - TO - JOIN - WALL - PLATE -



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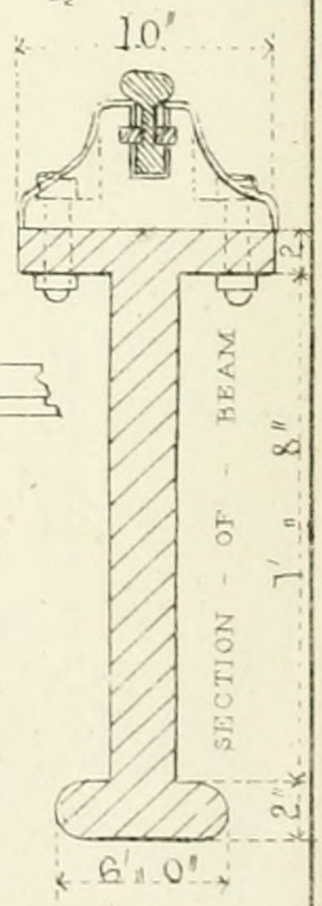

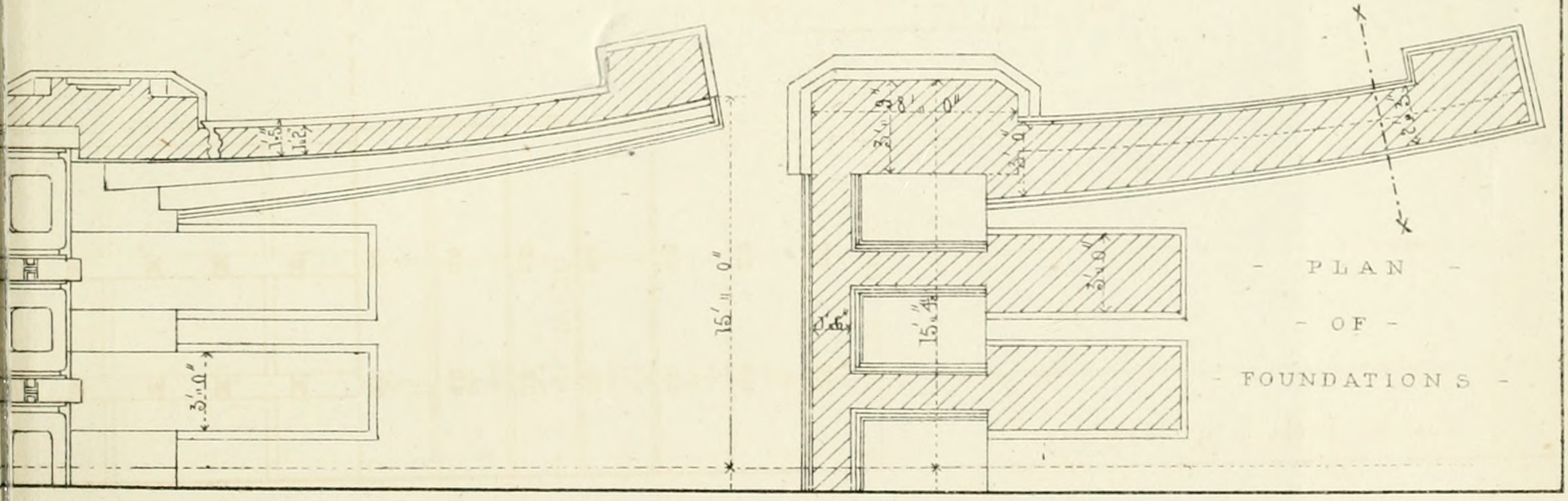

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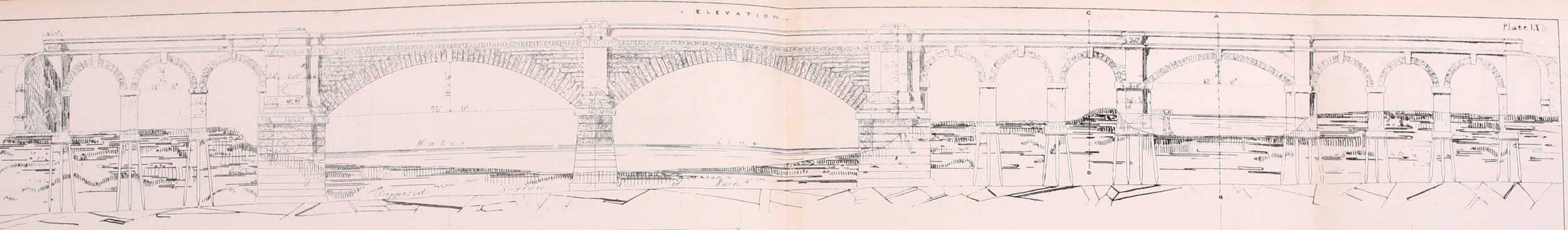
Plate LX

- ELEVATION -

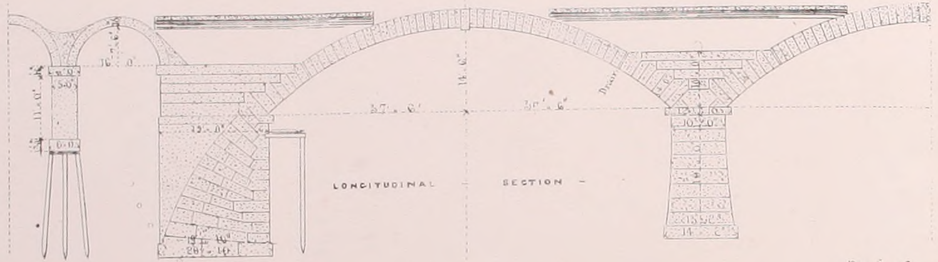


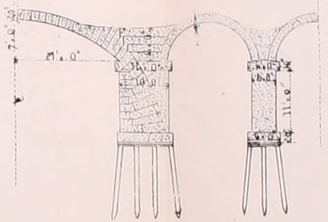
- GRAND — JUNCTION — RAILWAY —

- BRIDGE - OVER - THE - RIVER - MERSEY -

- AND - CANAL -

Joseph Locke Esqre Engineer





- LONGITUDINAL - SECTION - OF - CANAL - ABUTMENT -

Scale of Feet

0 10 20 30 40 50 60 70 80 90 100 200 250 300 350 400 450 500 550 600



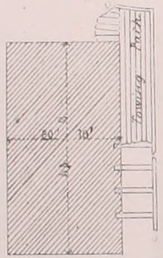
- PLAN - OF - BASE - COURSE -



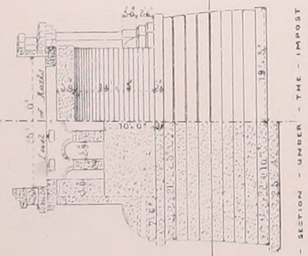
- PLAN - OF - PIER -



- PLAN - OF - ABUTMENT -



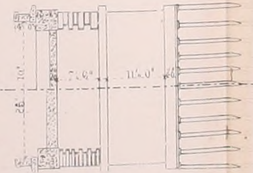
- SECTION - THRO' PIER - SECTION - THRO' KEYSTONE -



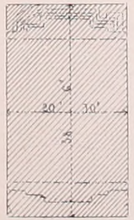
- SECTION - UNDER - THE - IMPOST -



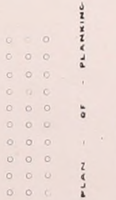
- SECTION - AT - A-B - SECTION - AT - C-D -



- PLAN - OF - ABUTMENT -



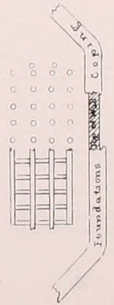
- PLAN - OF - PILES -

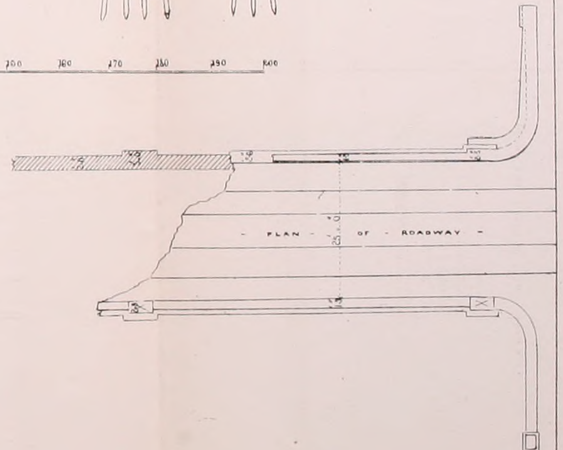


- PLAN - OF - PLANKING -



- PLAN - OF - PILES - AND - PLANKING -





- PLAN - OF - ROADWAY -

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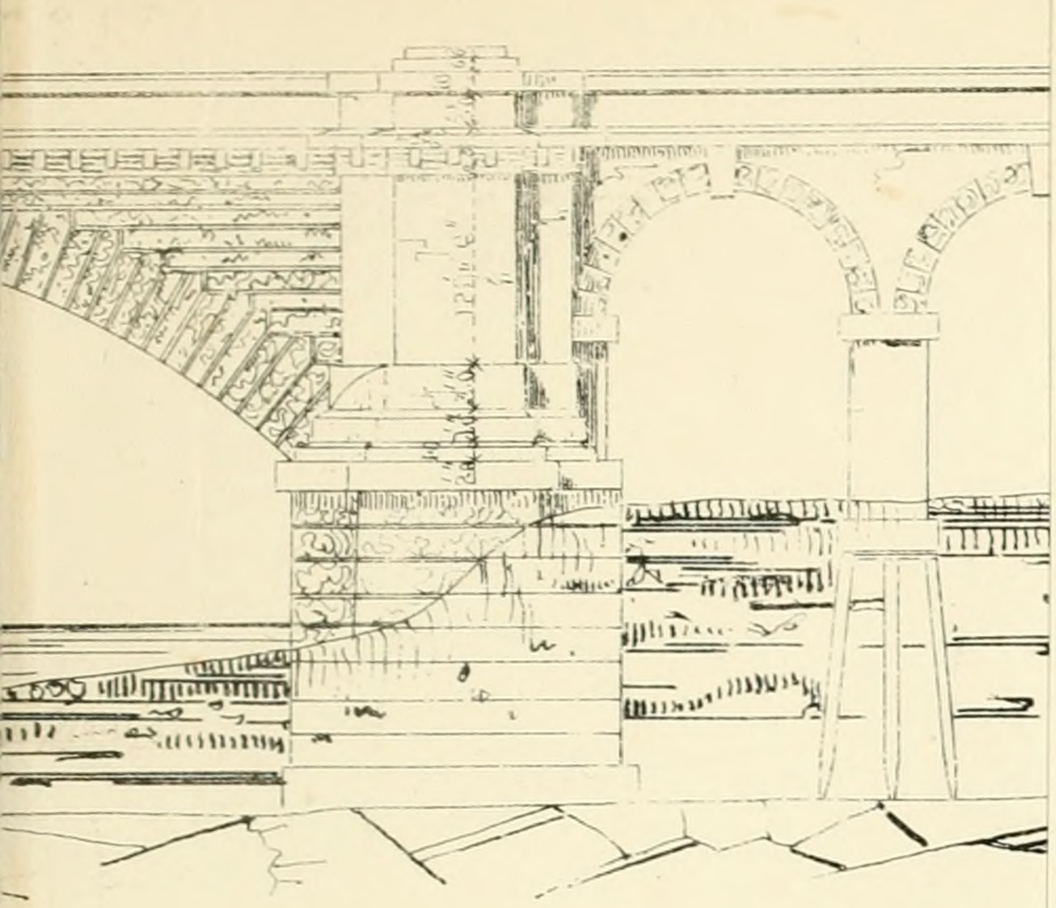


GRAND — JUNCTION —

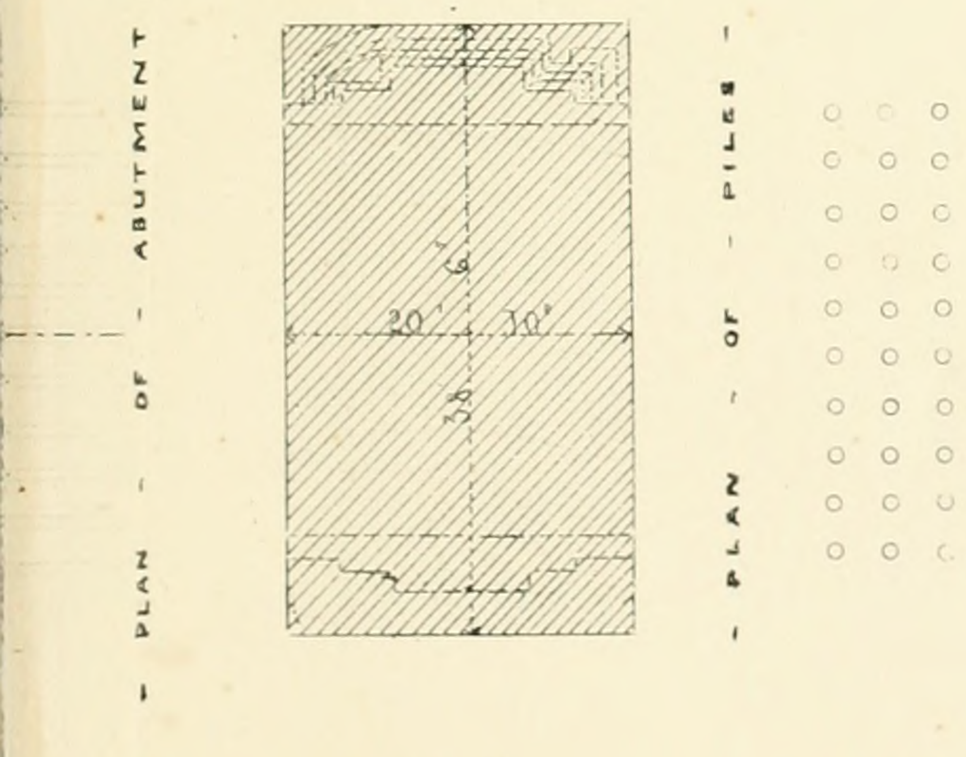
OGE - OVER - THE

— AND - CANA

Joseph Lock Esqre

Scale of Fe

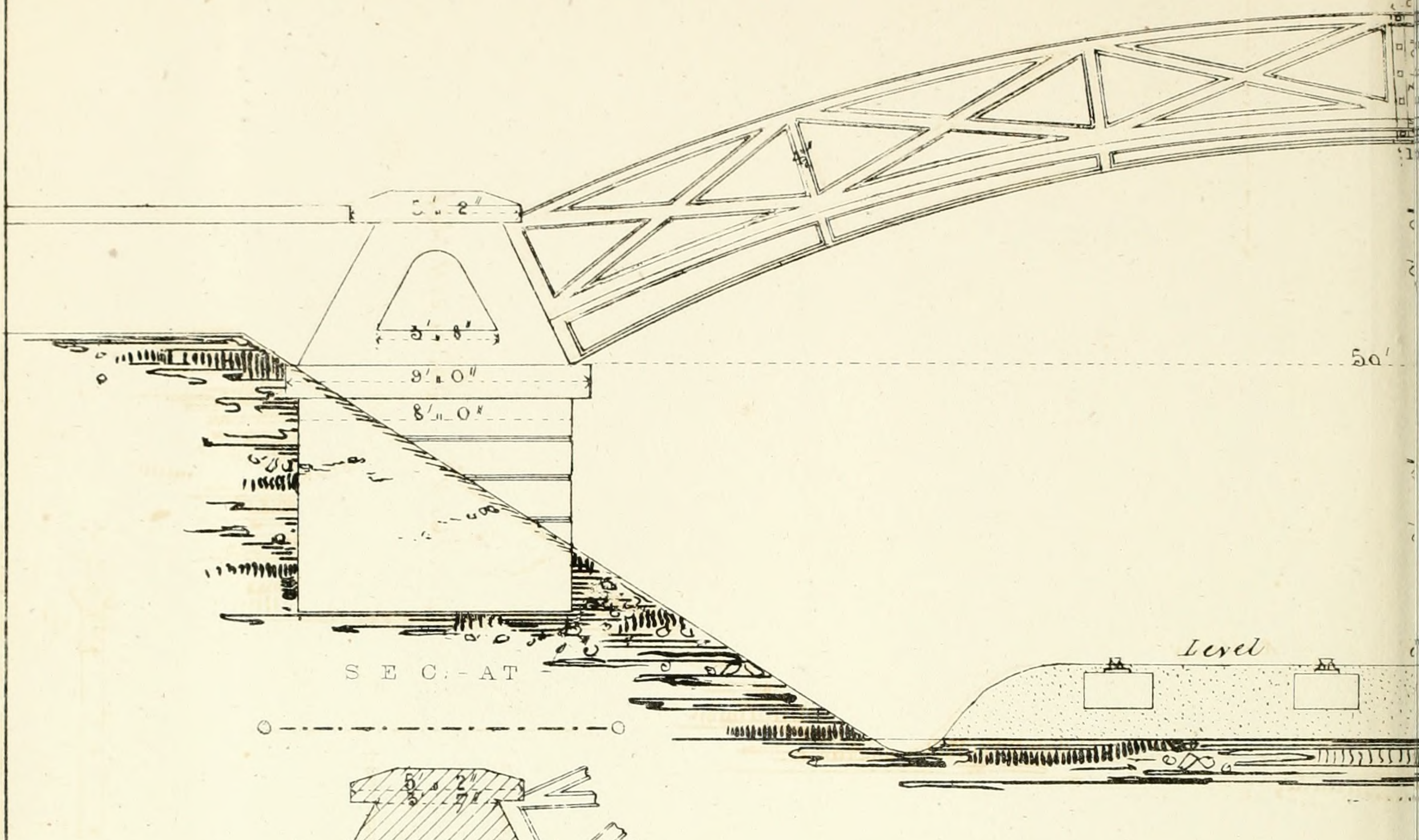
30 40 50 60 70 80



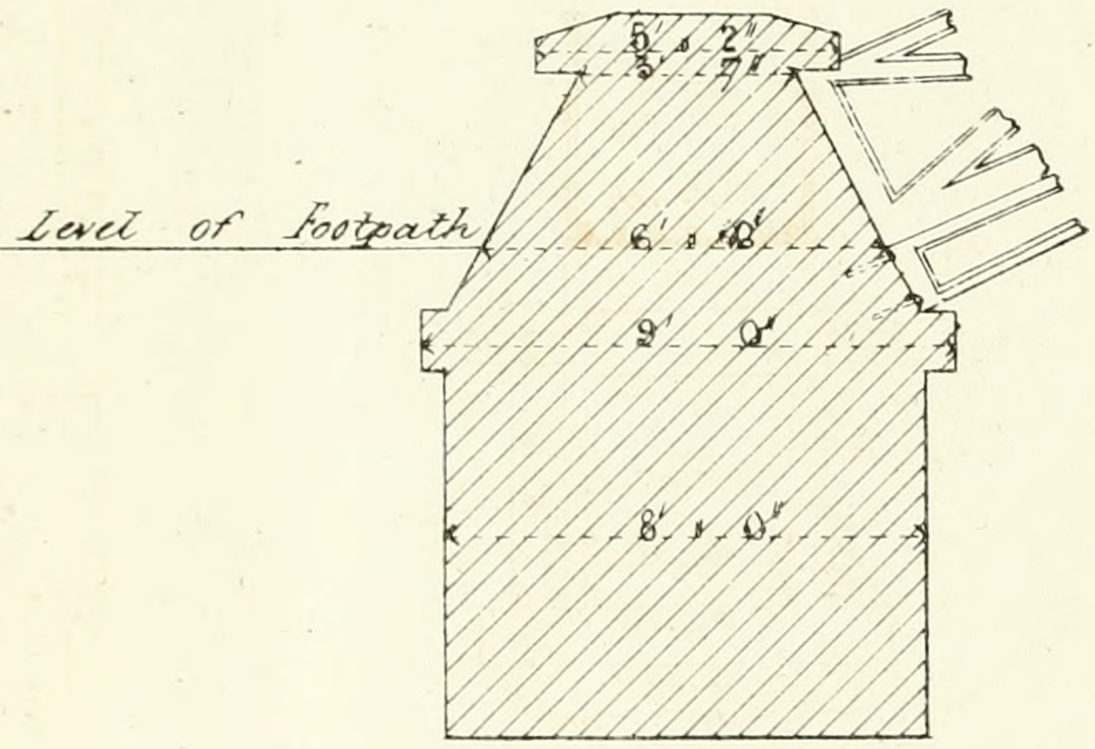
SCIENCE & ART 106, Great Russel Street.

Engrd Lith^d to the Queen.

- E L E V



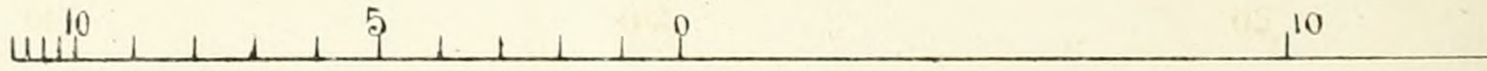
S E C:- A T -



- G R A N D - J U N C

- D E T A I L S - O F - P R O P O S

Scale



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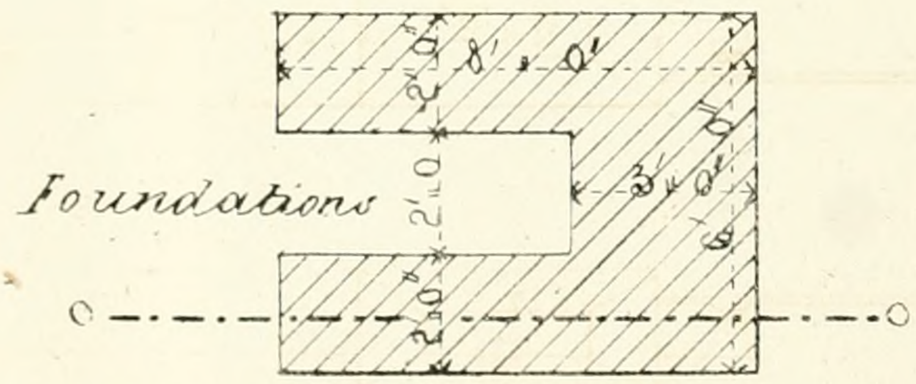

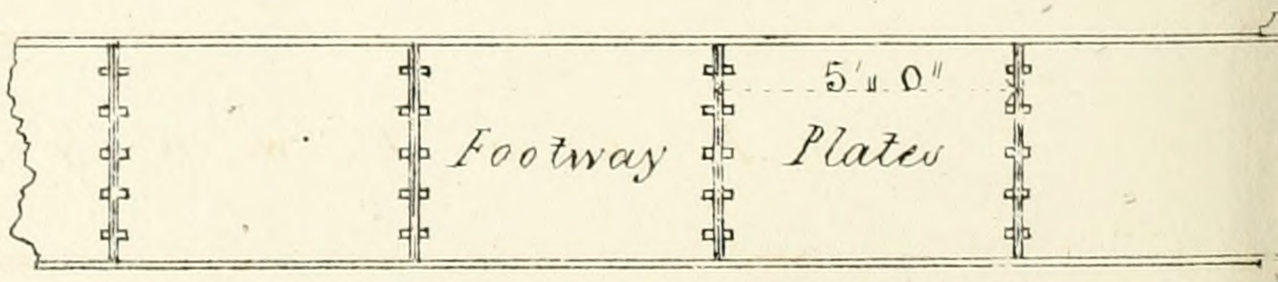

Joseph Locke Esqre Engineer

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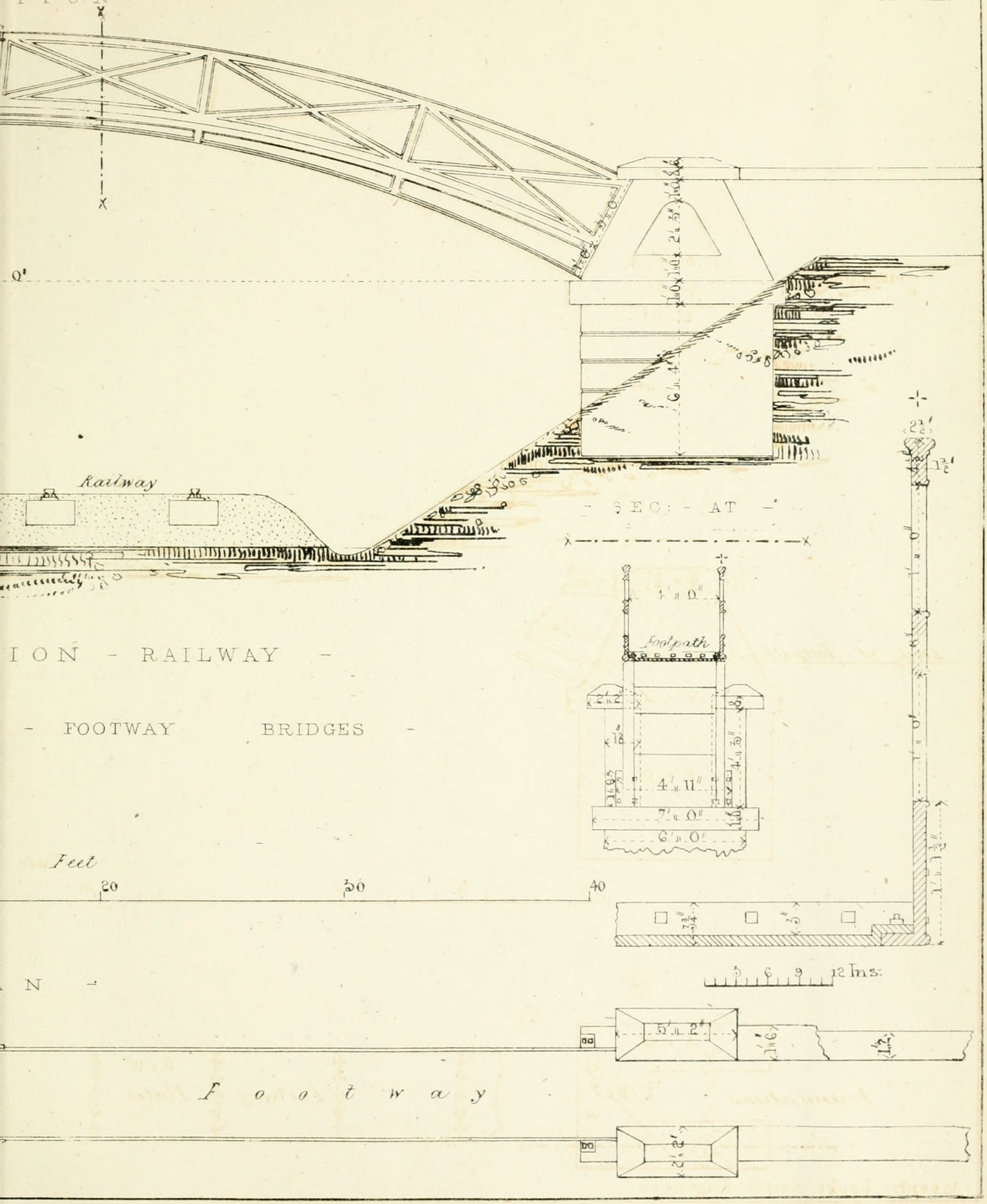

I O N - RAILWAY -

- FOOTWAY BRIDGES -

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f o o t w a y

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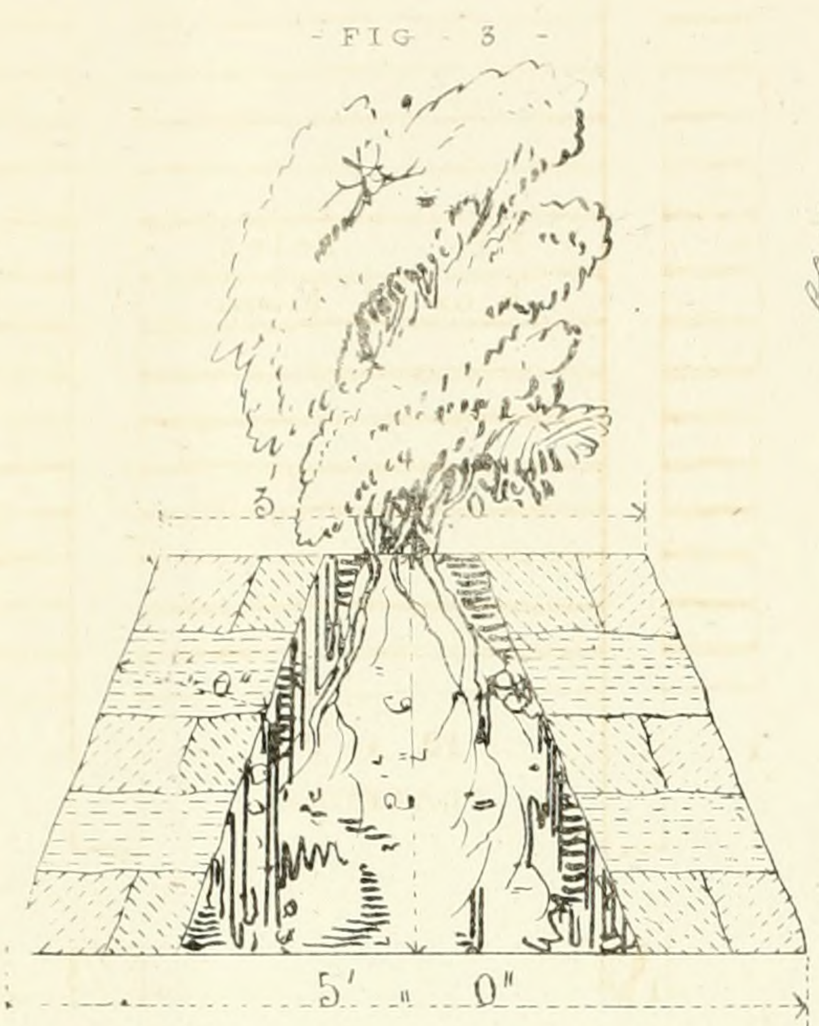
SLAMANNAN

- FIG 3 -



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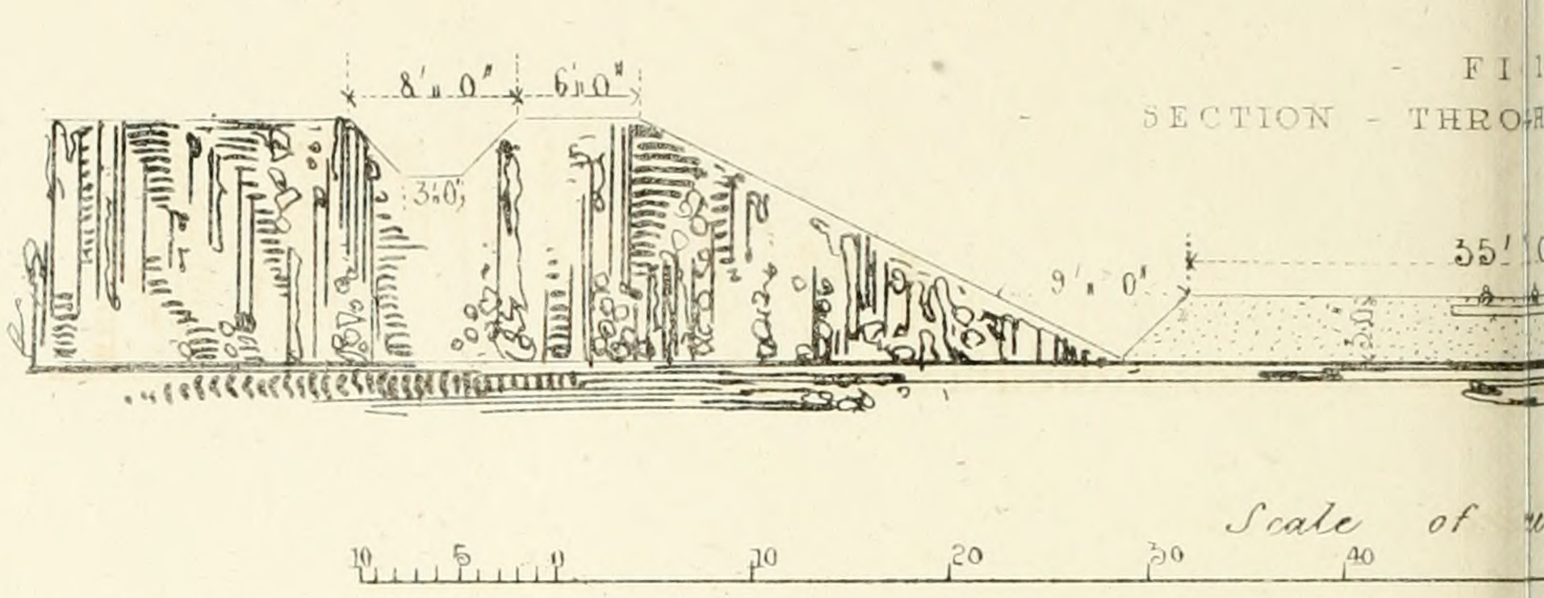

Scale of

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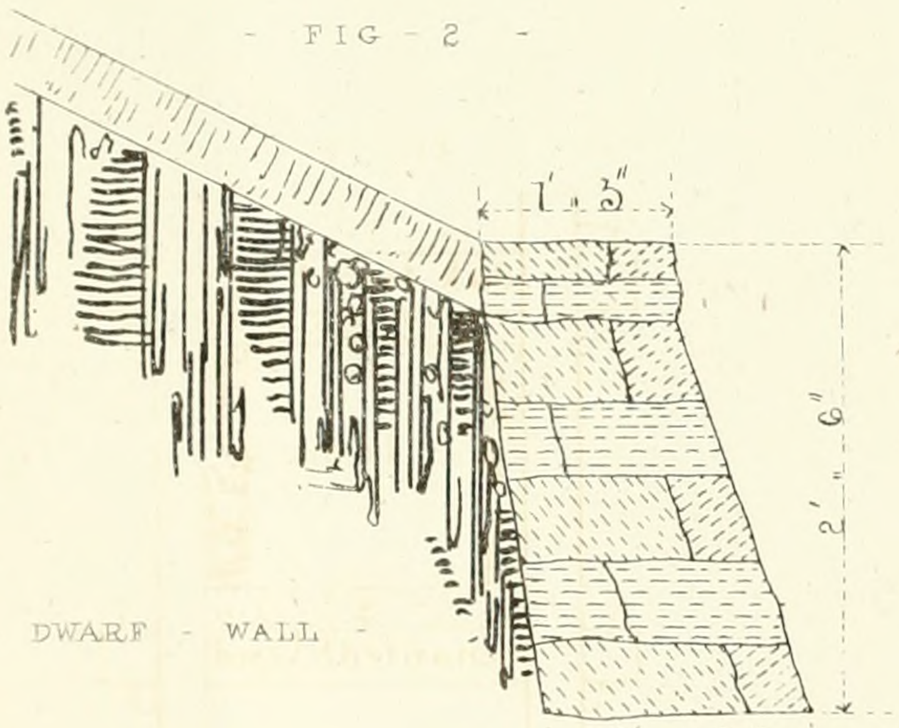

- DWARF - WALL -

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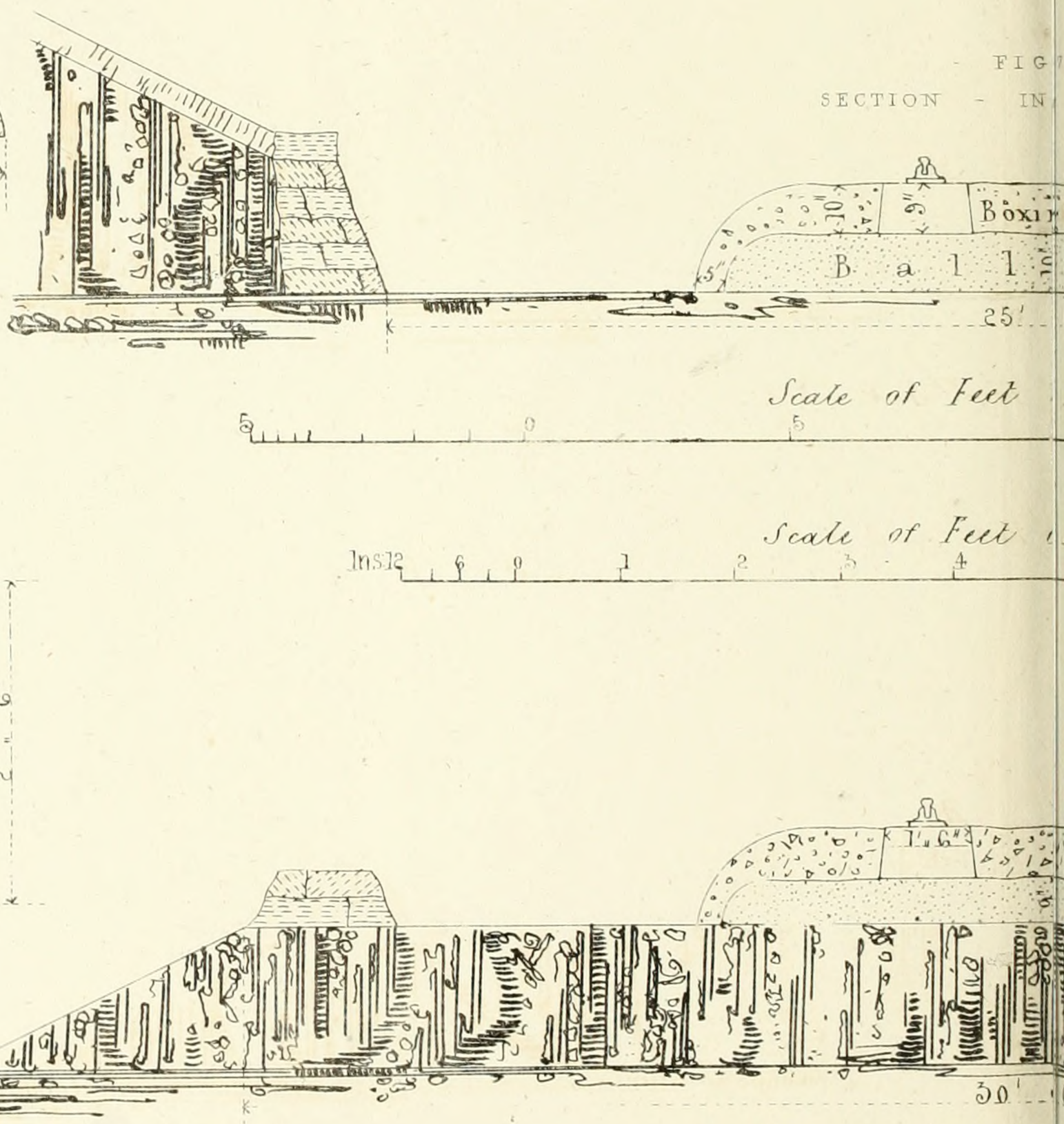

Scale of Feet

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Scale of Feet

Inches 6 0 1 2 3 4

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RAILWAY -

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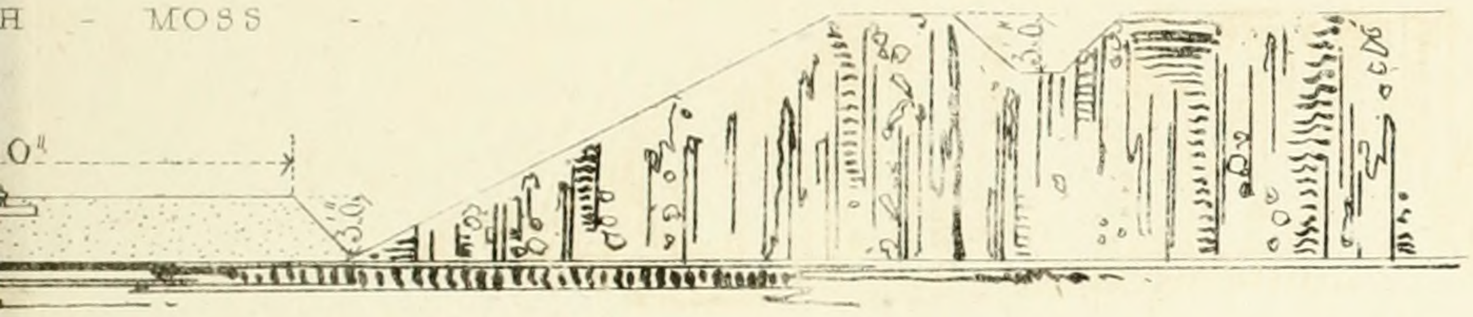

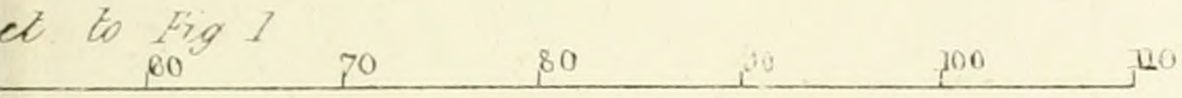

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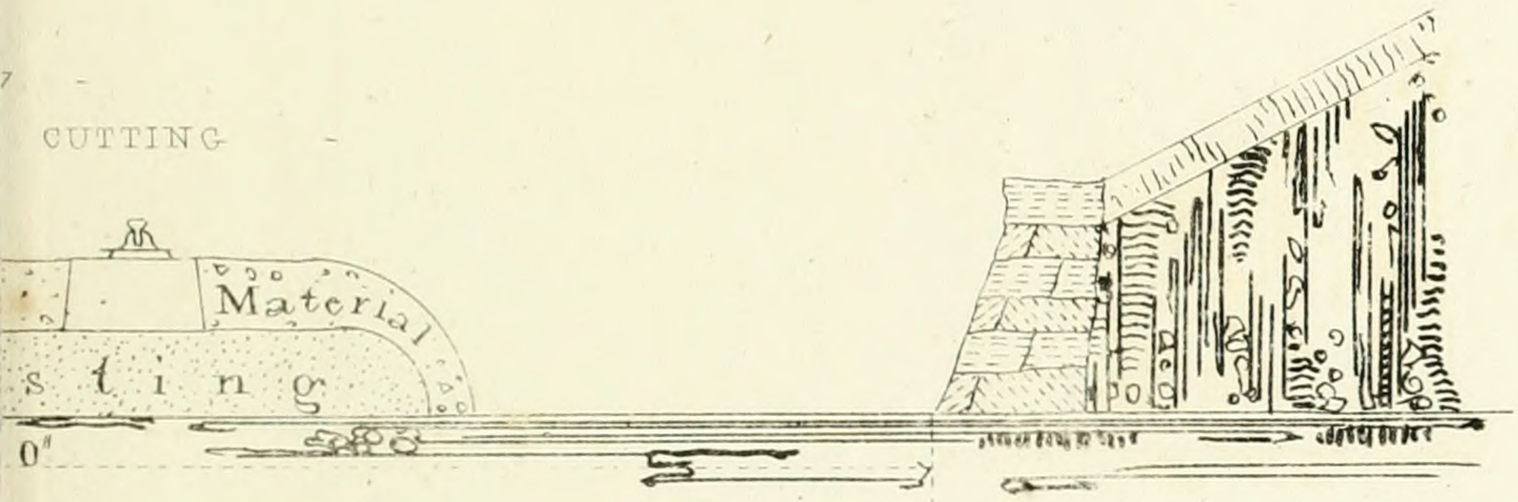

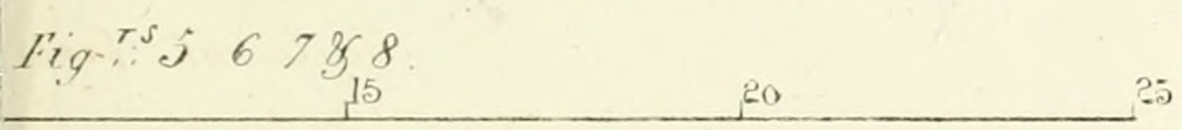

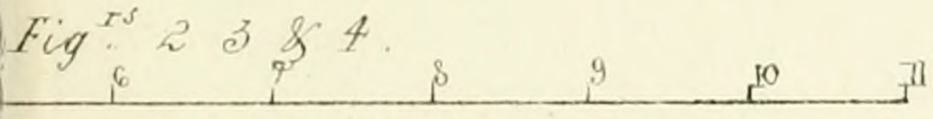

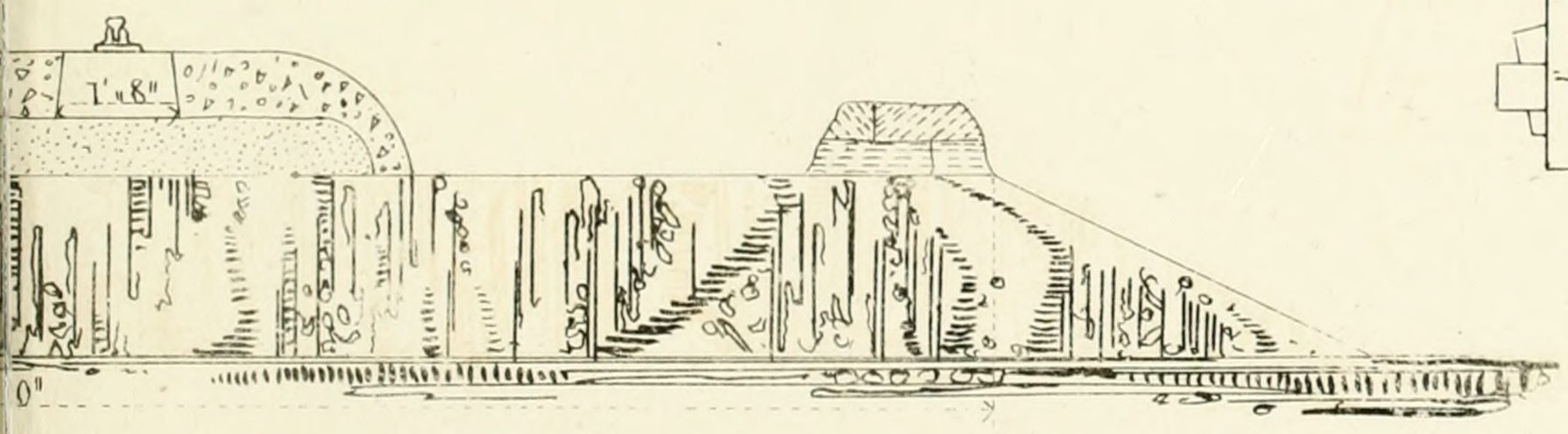

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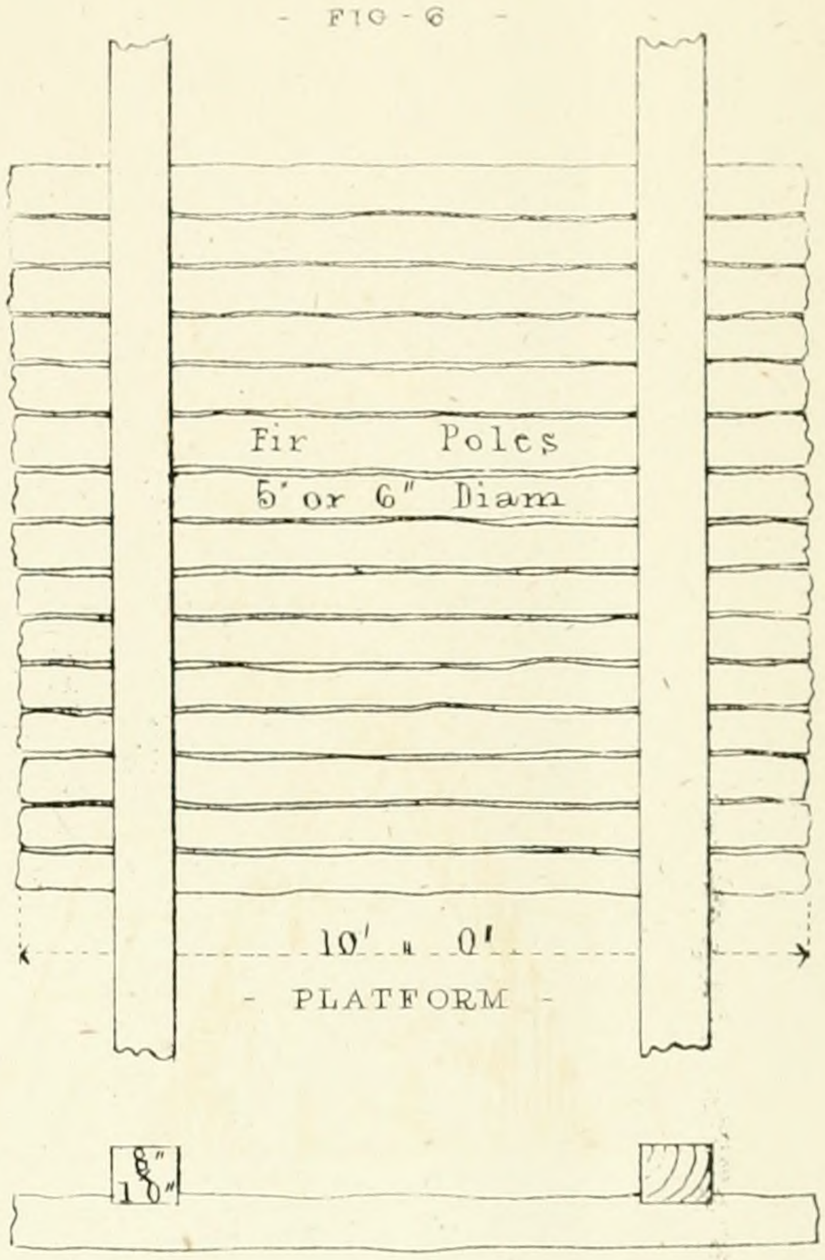
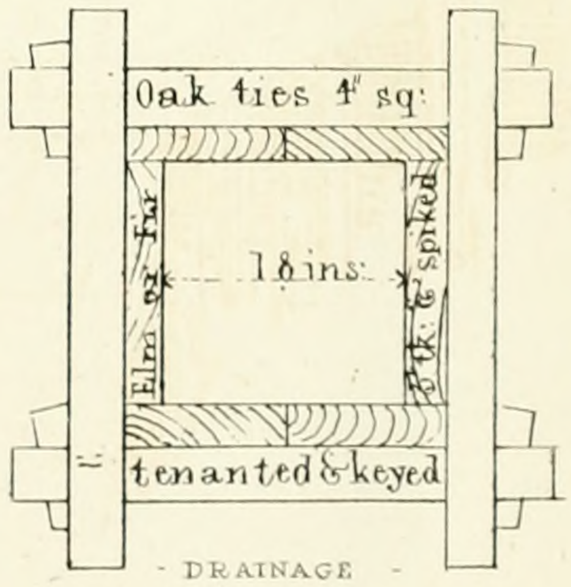
- FIG - 6 -



- FIG - 6 -

- FIG - 4 -



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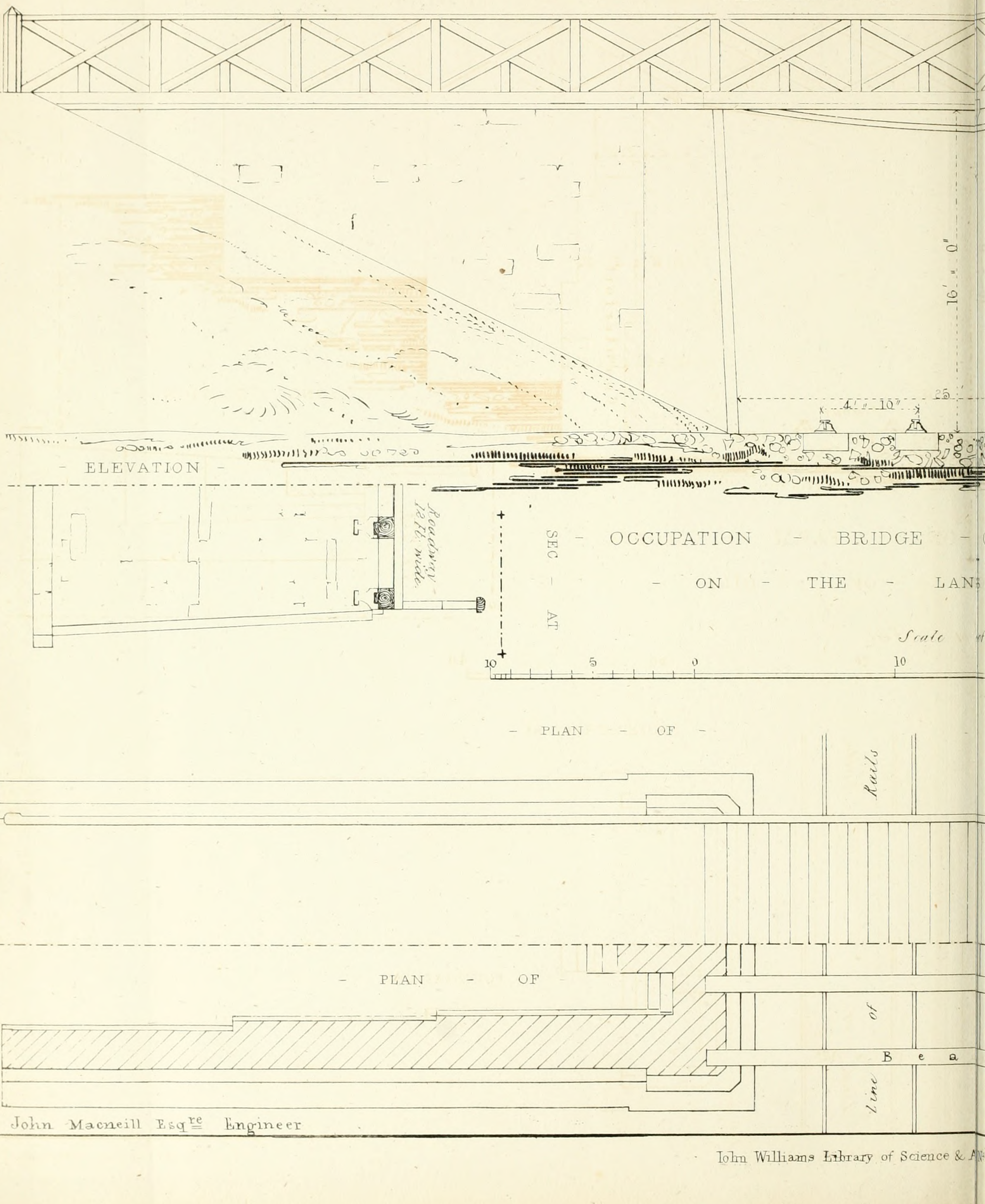
- SLAMMANNAN -



- ELEVATION - OCCUPATION - BRIDGE - ON - THE - LANS

- PLAN - OF -

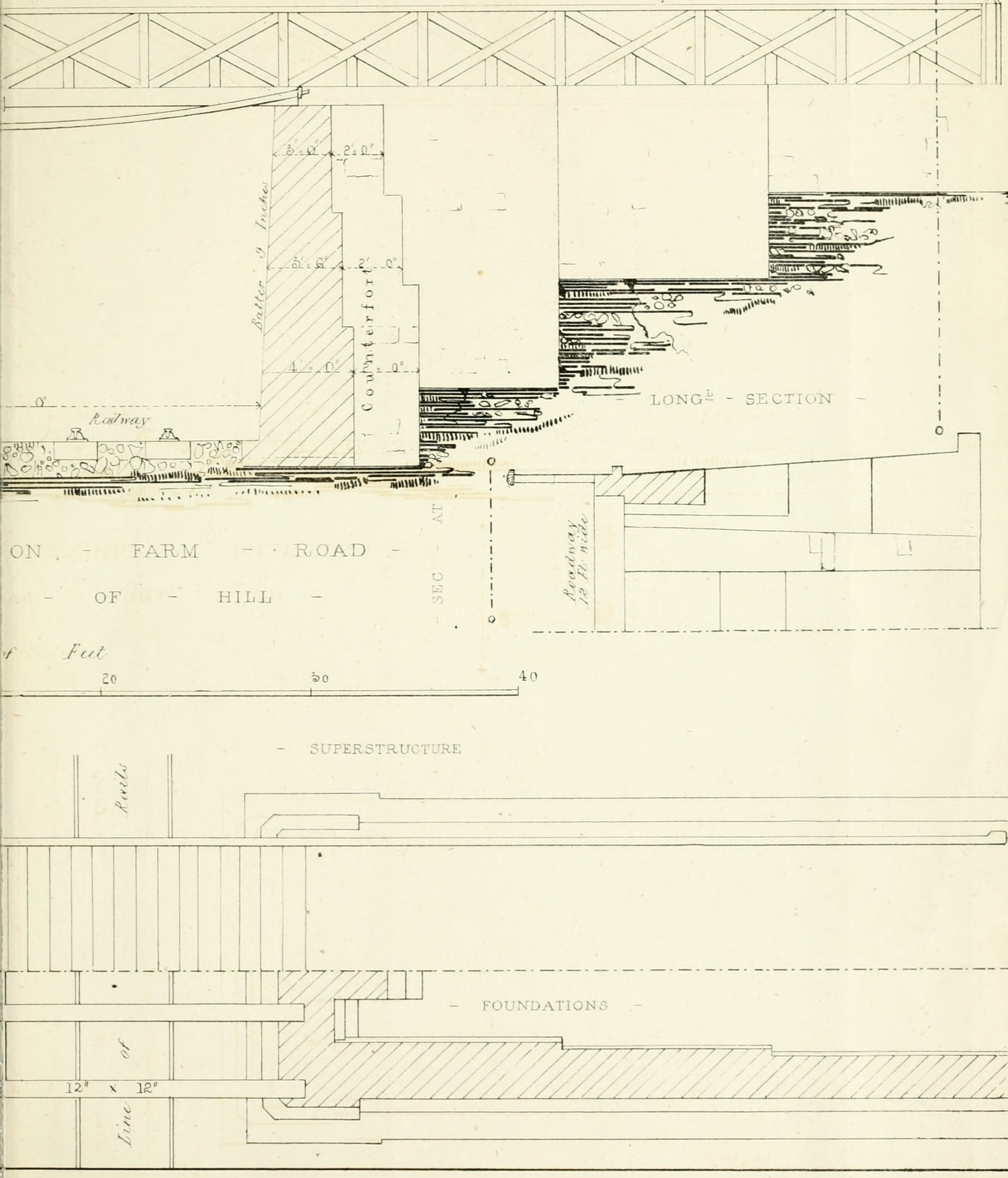
- PLAN - OF -

John Macneill Esqre Engineer

John Williams Library of Science & A

Plate LXVI.

RAILWAY —



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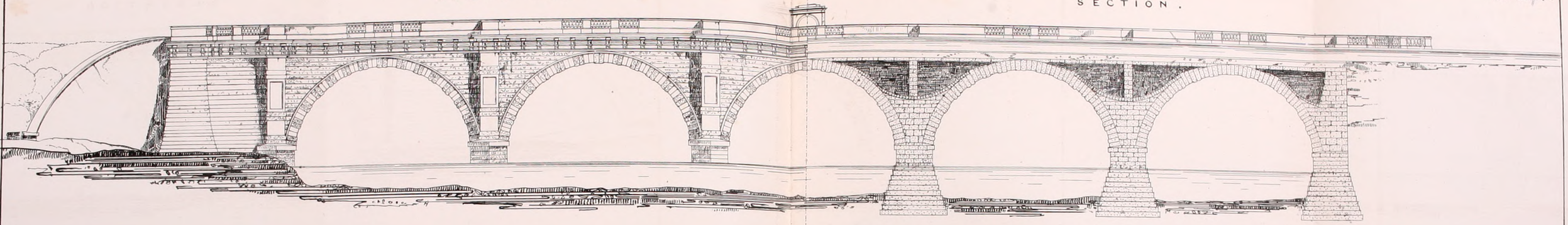
ELEVATION SECTION.



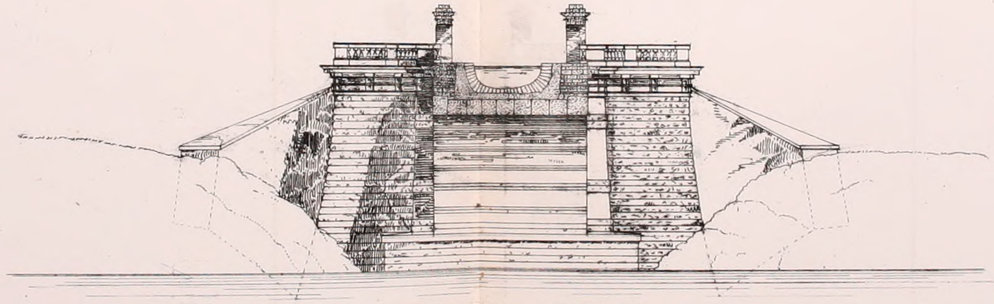
LANCASTER CANAL

AQUEDUCT OVER THE RIVER LUNE

John Rennie Esq.re Engineer.



TRANSVERSE SECTION OF THE ARCHES IN THE SPANDRILLS.

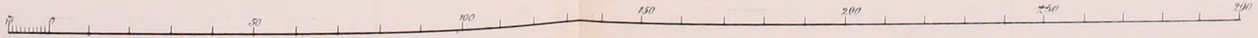


TRANSVERSE SECTION



HORIZONTAL SECTION AT THE SPRINGING OF THE ARCHES IN THE SPANDRILLS

Scale of Feet.



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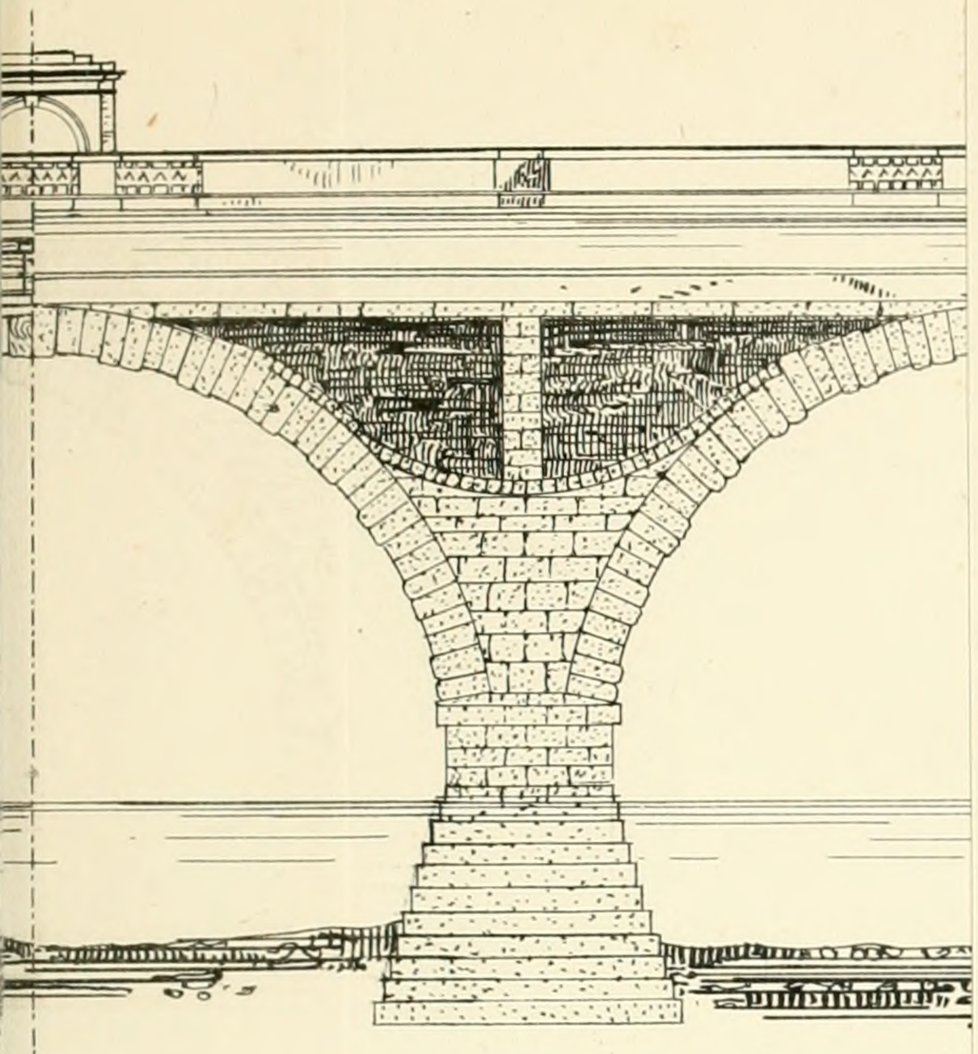
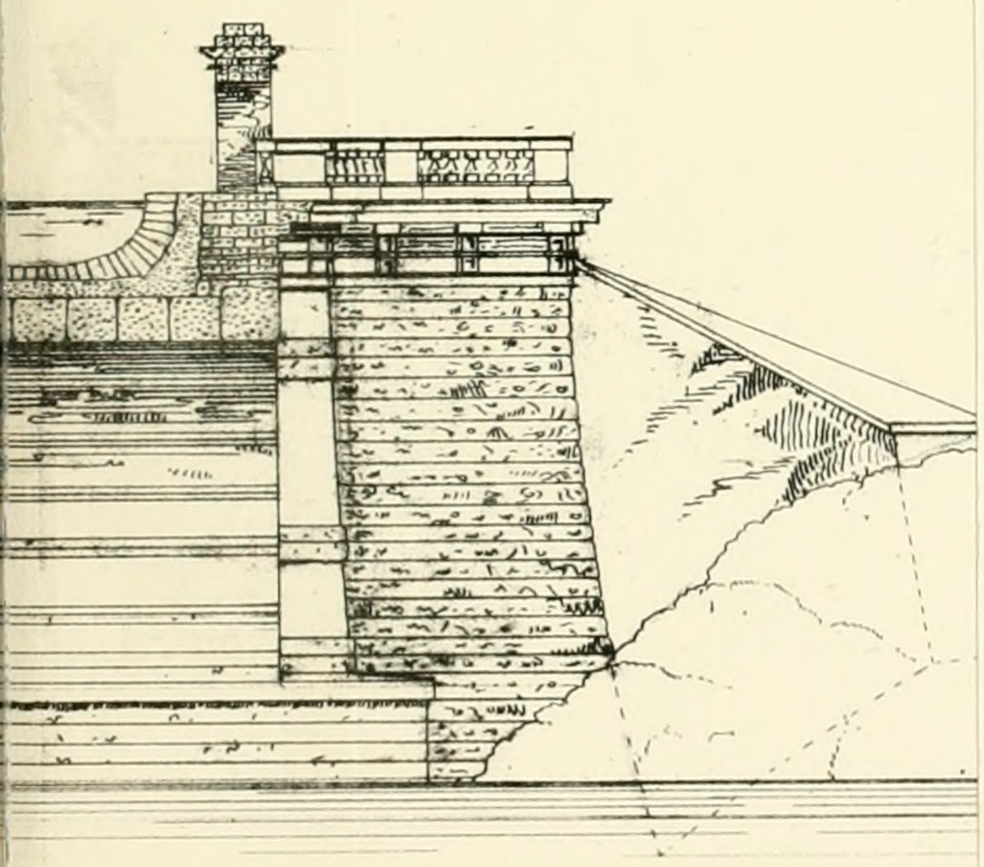


— CANAL —

— RIVER — LUNE —

Esqre Engineer .



— E — SECTION —

Scale of Feet.

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SCIENCE & ART, 106 Great Russel Street.

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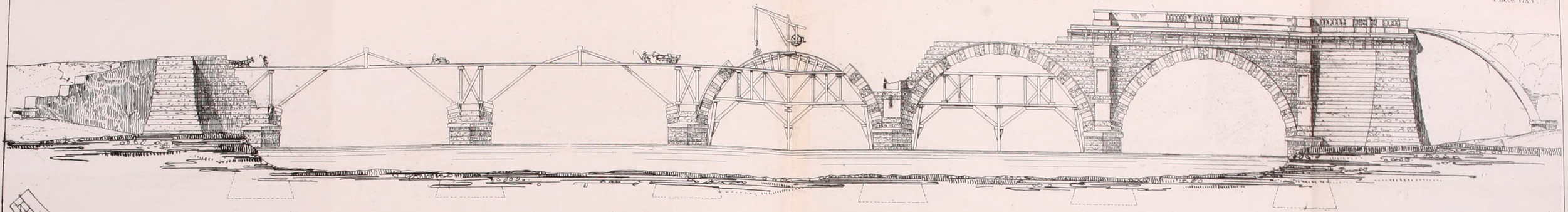
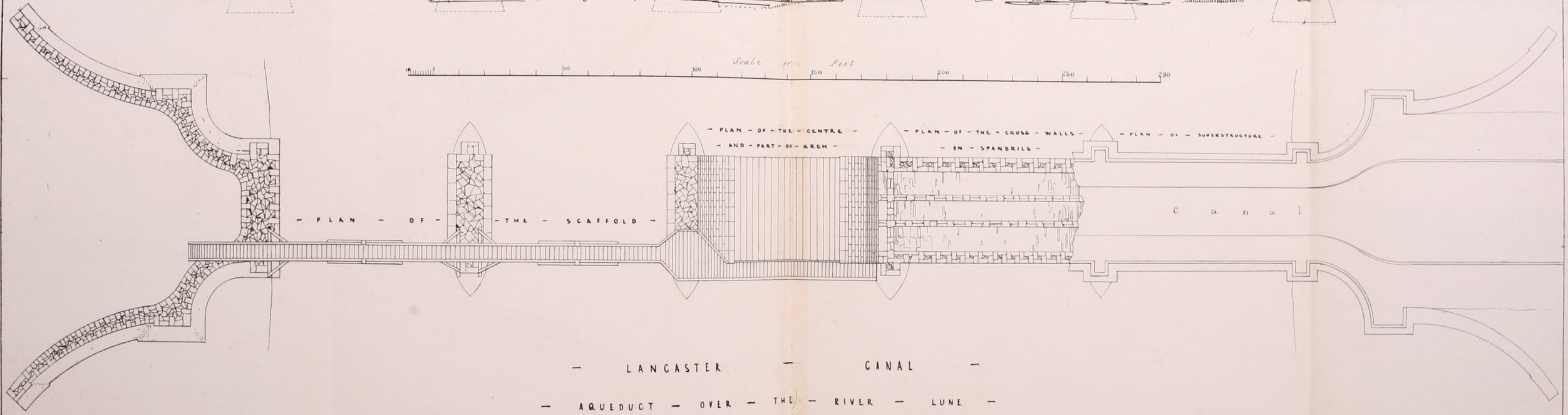
Plate LXV.

— ELEVATION — SHEWING — THE — WORKS — AS — THEY — APPEARED — IN — SEPTEMBER — 1795 —





— LANCASTER — CANAL —

— AQUEDUCT — OVER — THE — RIVER — LUNE —

John Rennie Esqre
Engineer.

JOHN WILLIAMS, LIBRARY OF SCIENCE & ART, 106 Great Russel Street.
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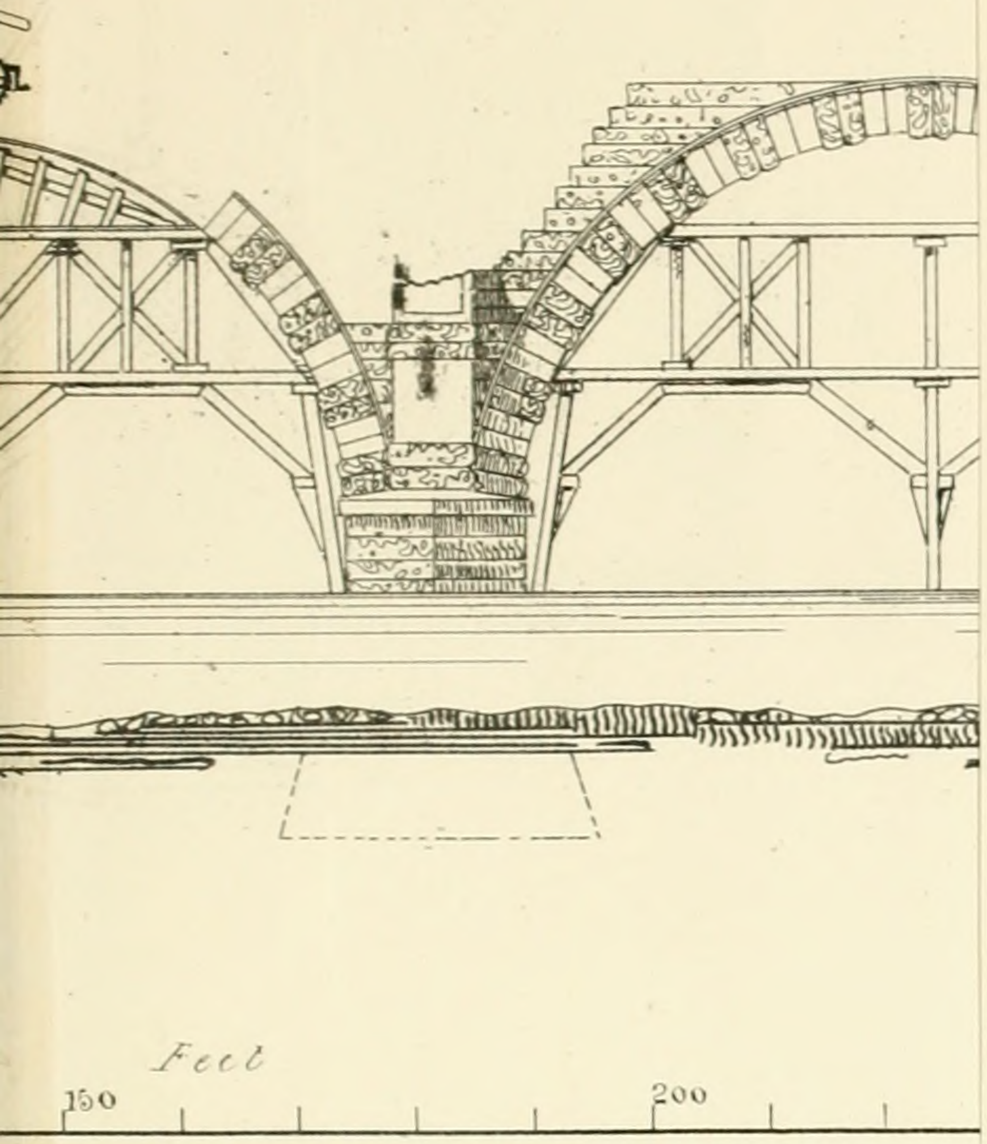

— CENTRE — — PLAN — OF — THE — C

— ARCH — — ON — SPAND

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— RIVER — LUNE —

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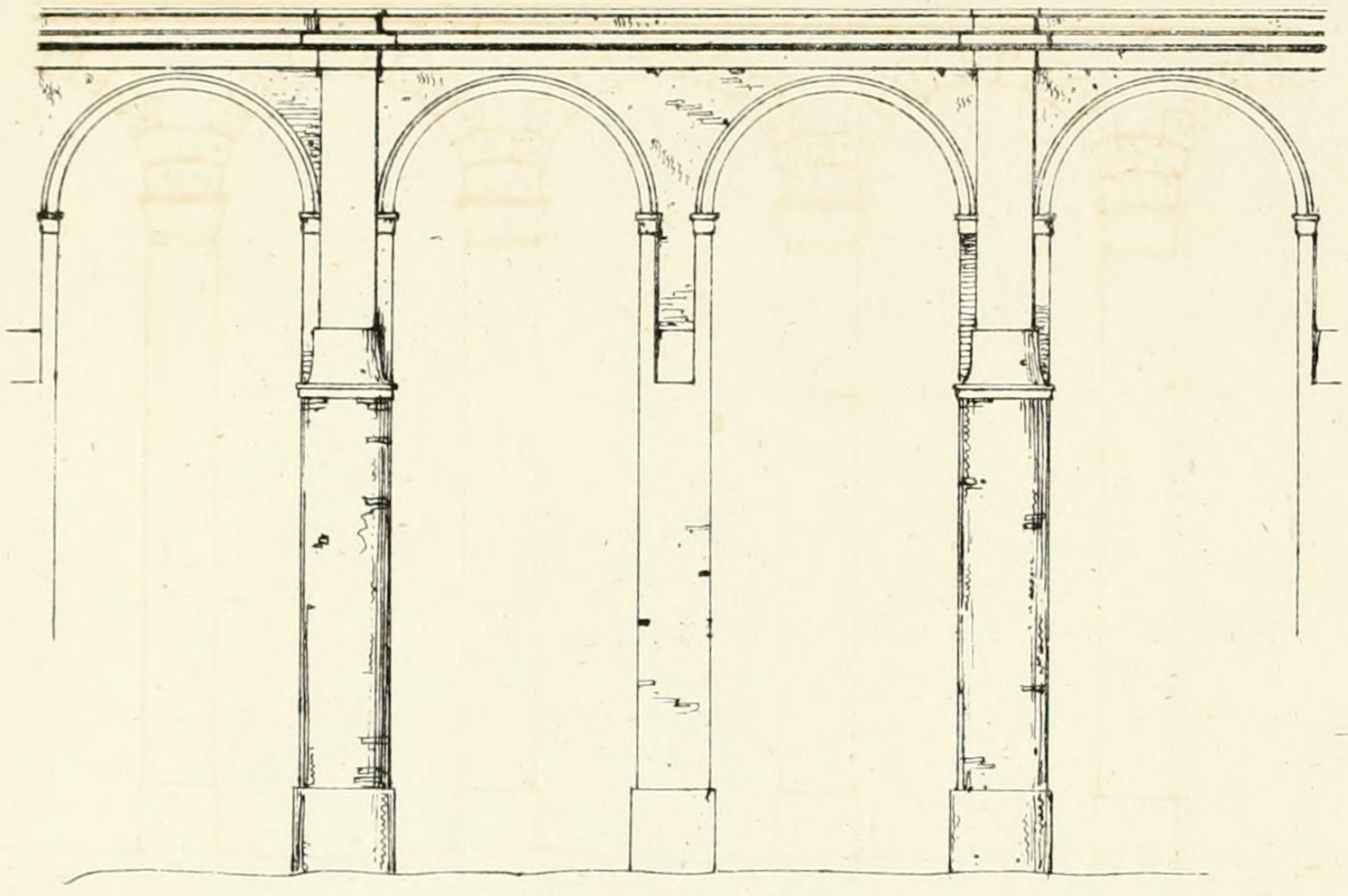
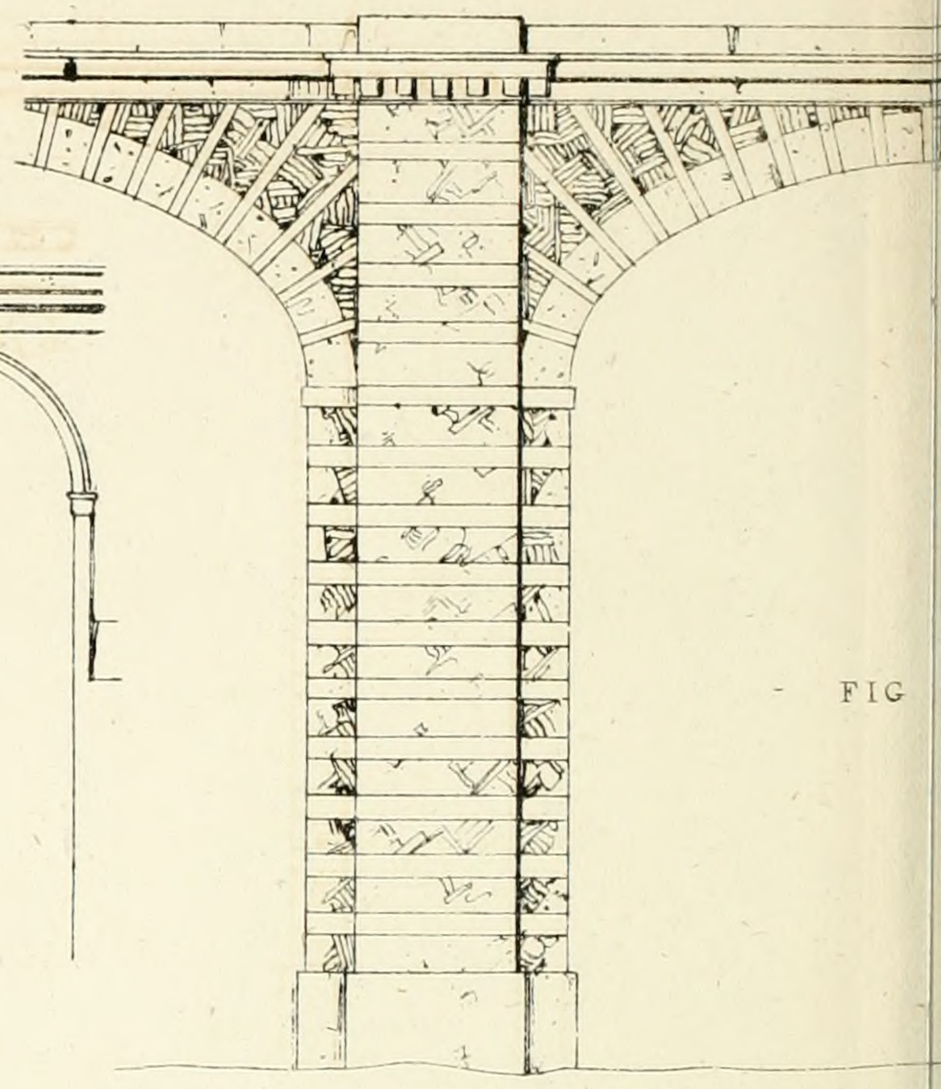
- FIG - 3 -





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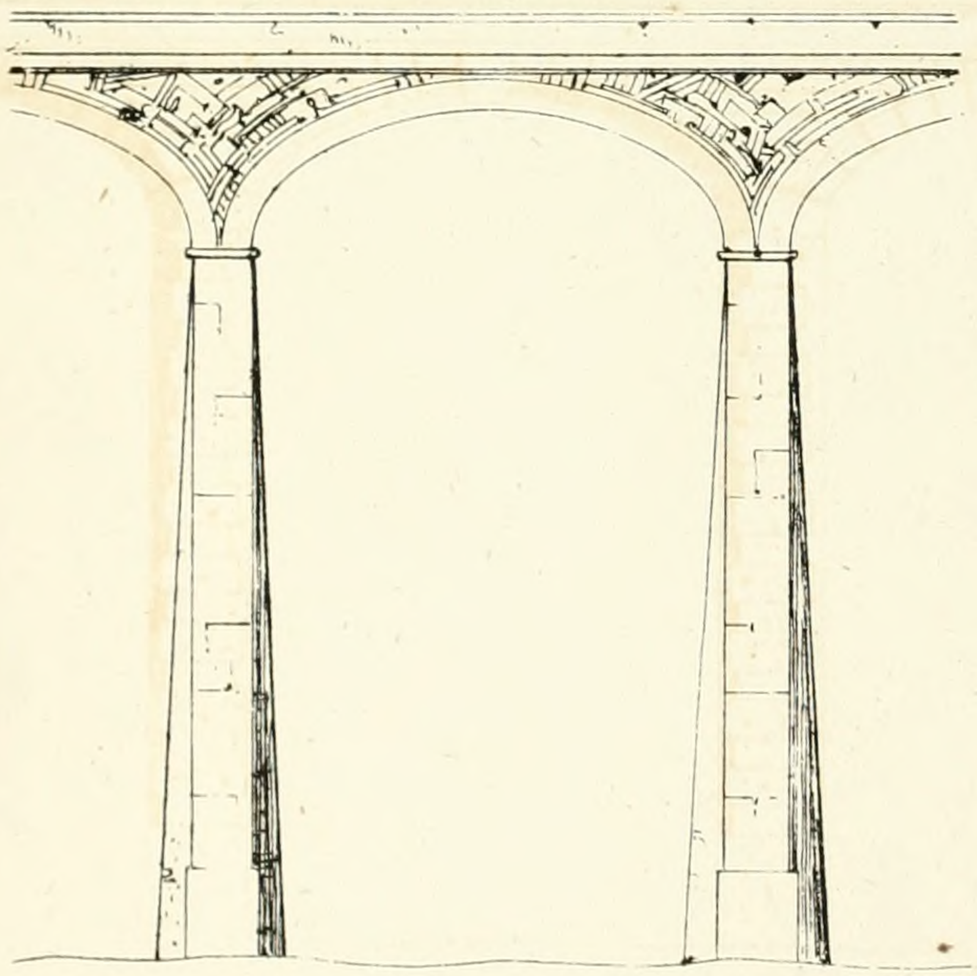

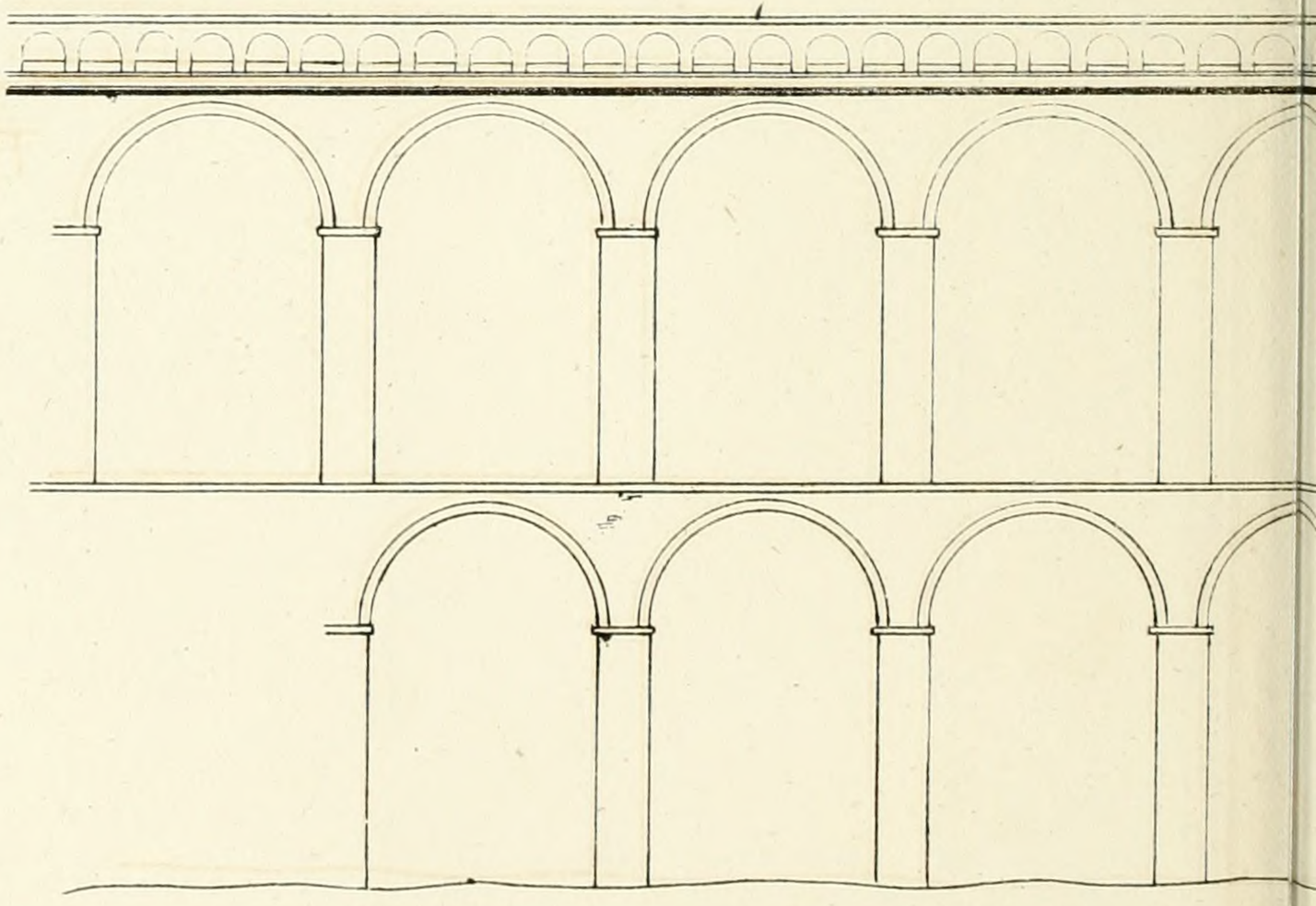

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VIADUCTS

FIG - 1

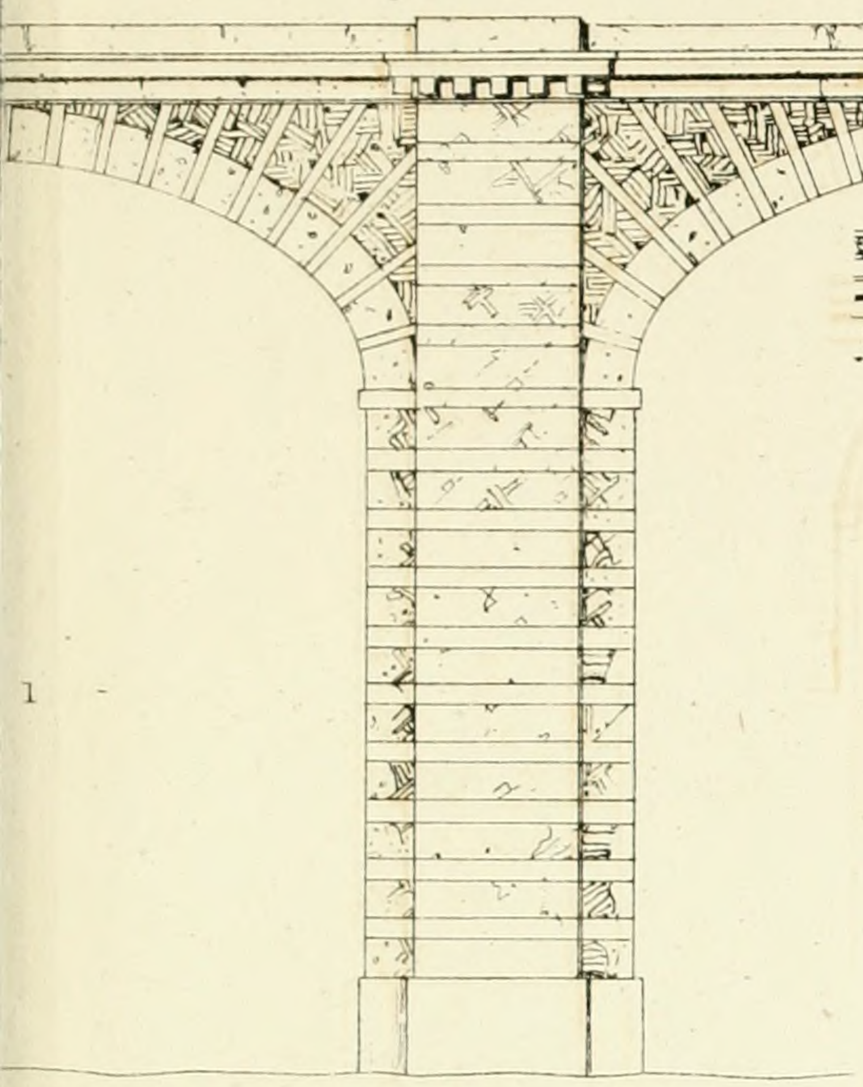


FIG - 4

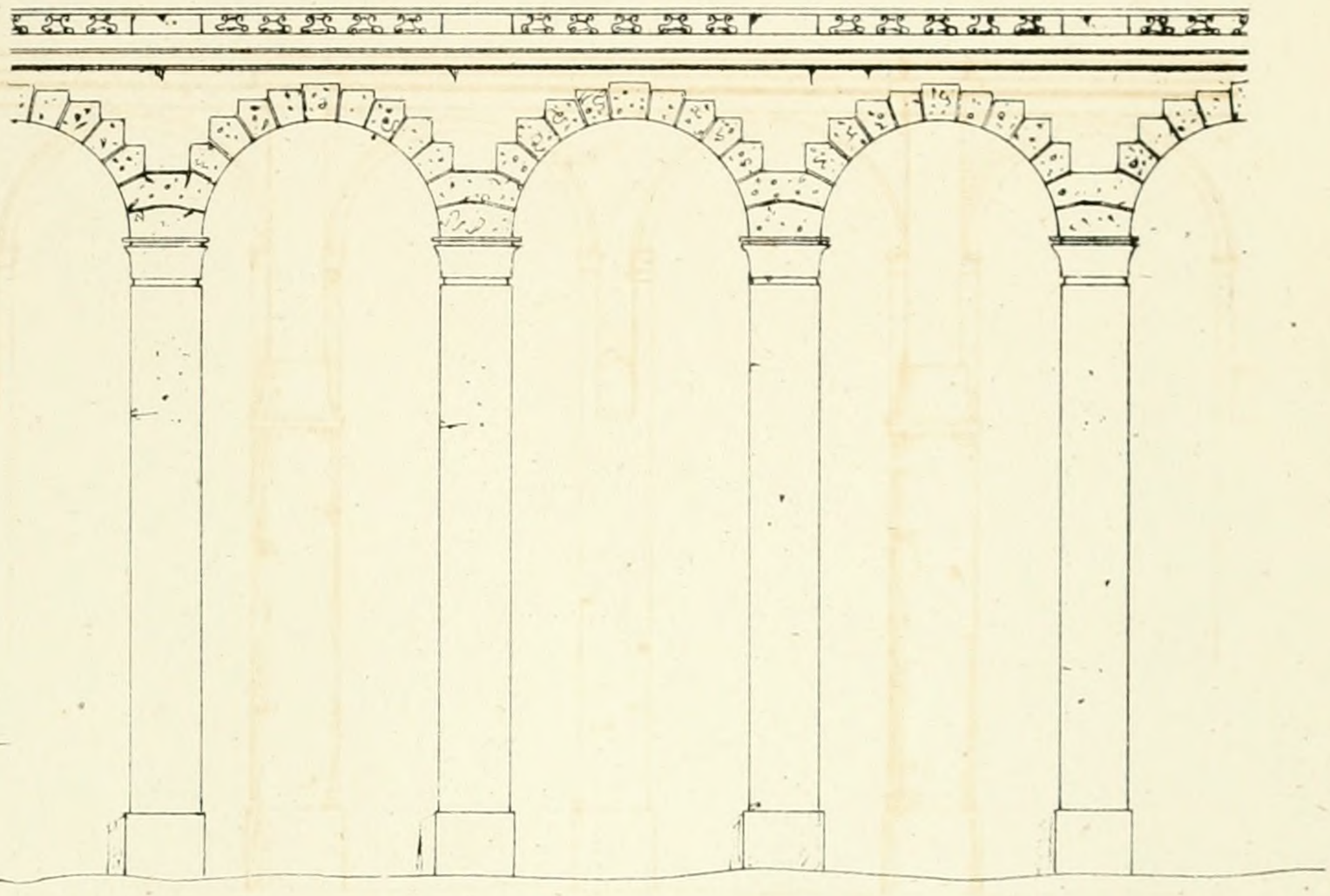


FIG - 2

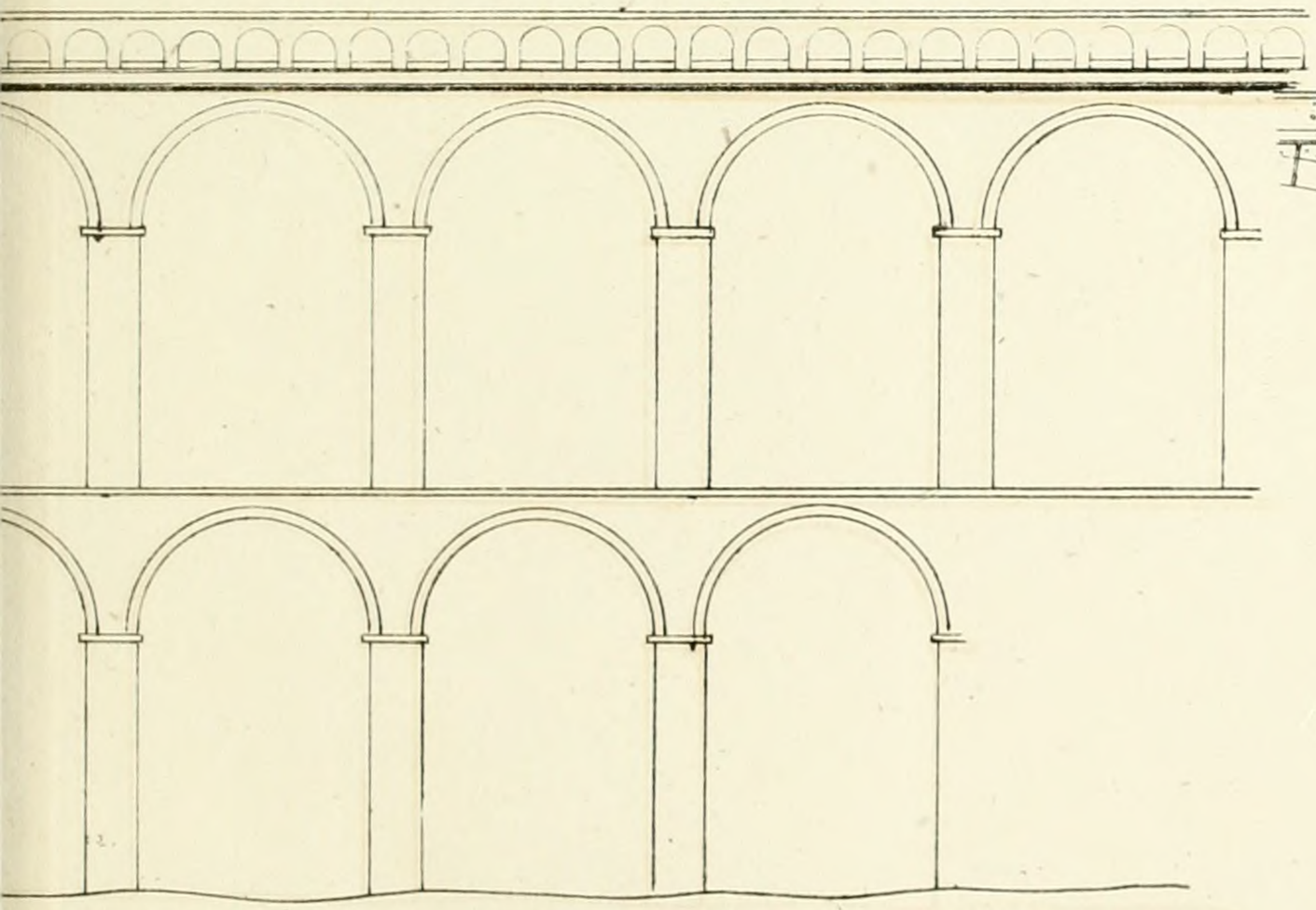
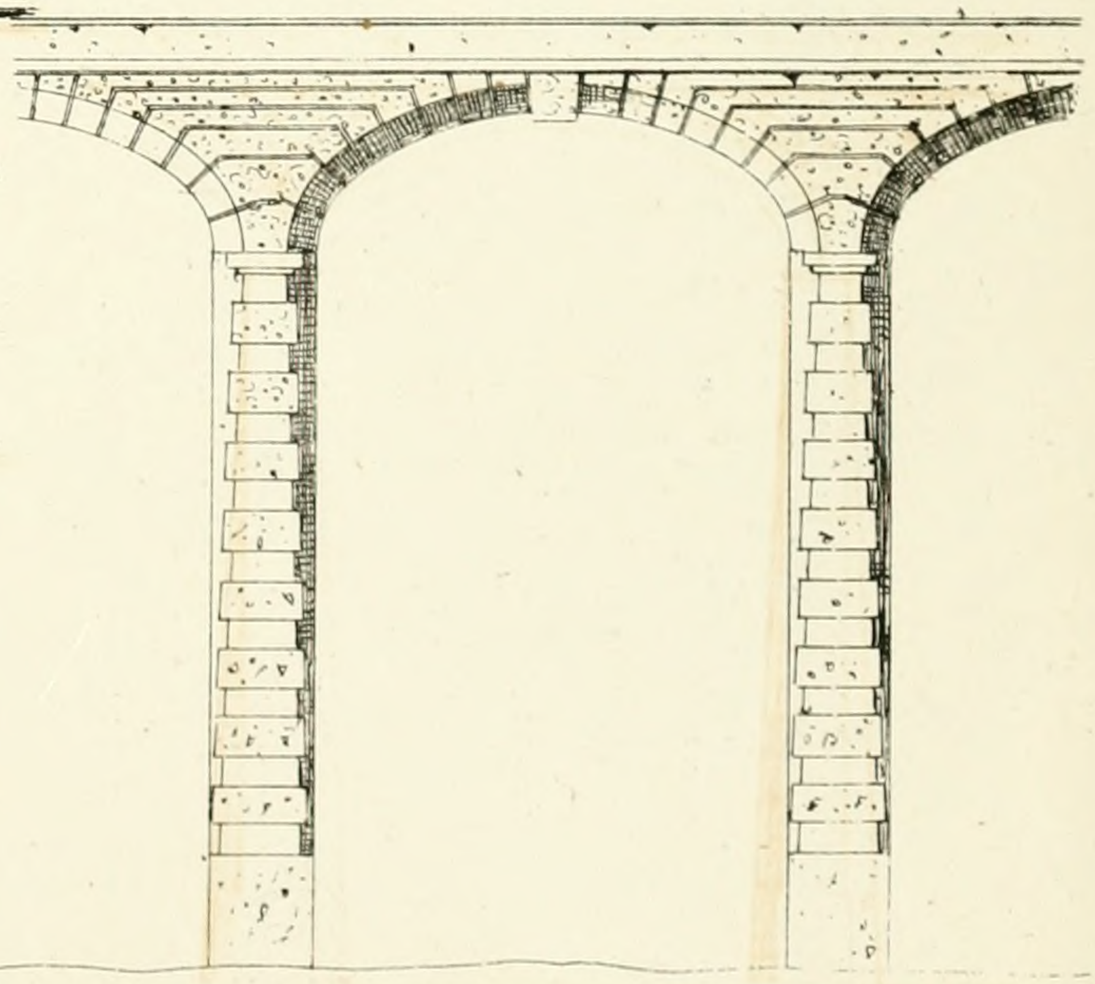


FIG - 6



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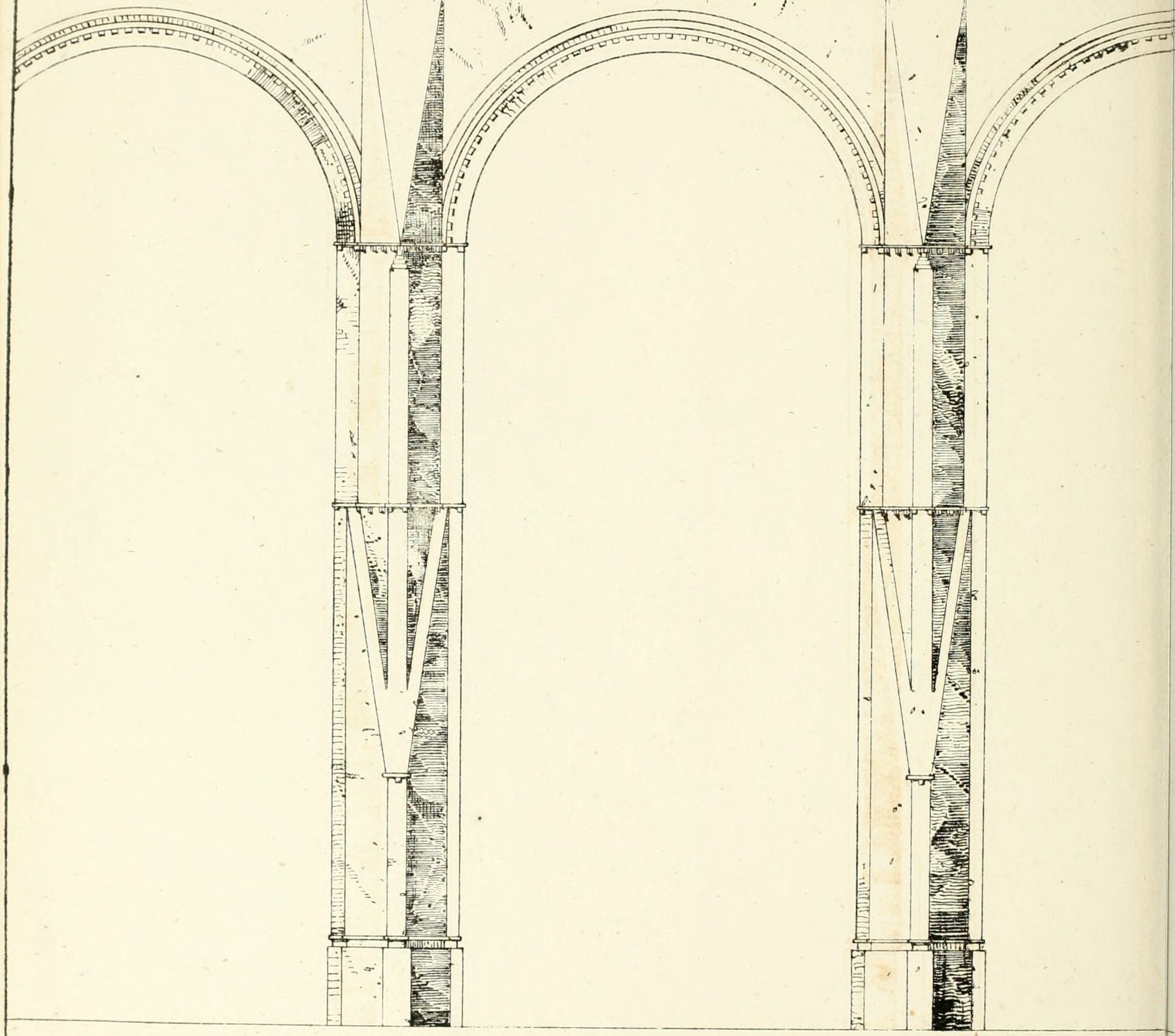

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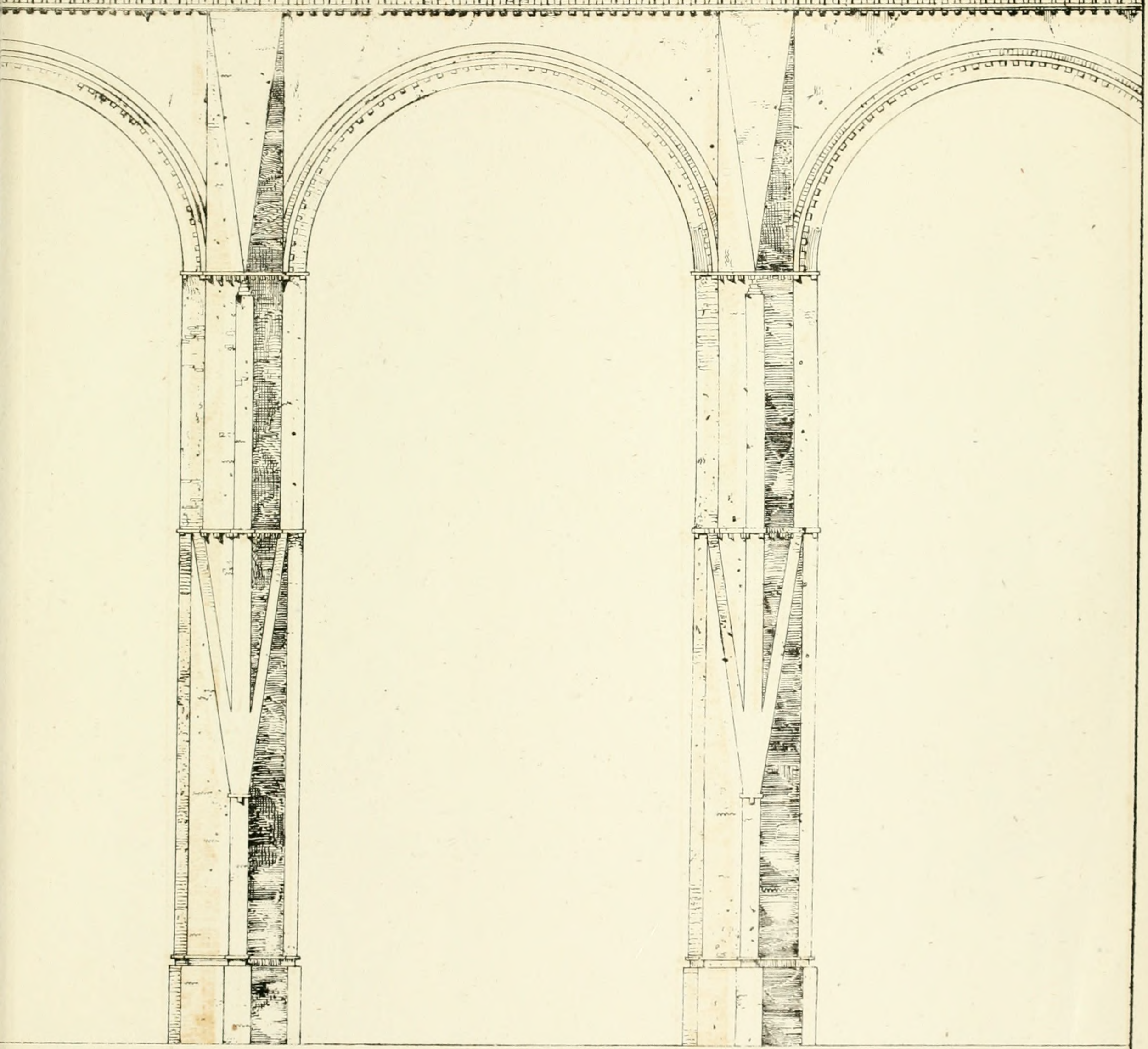

Feet to 1 Inch.

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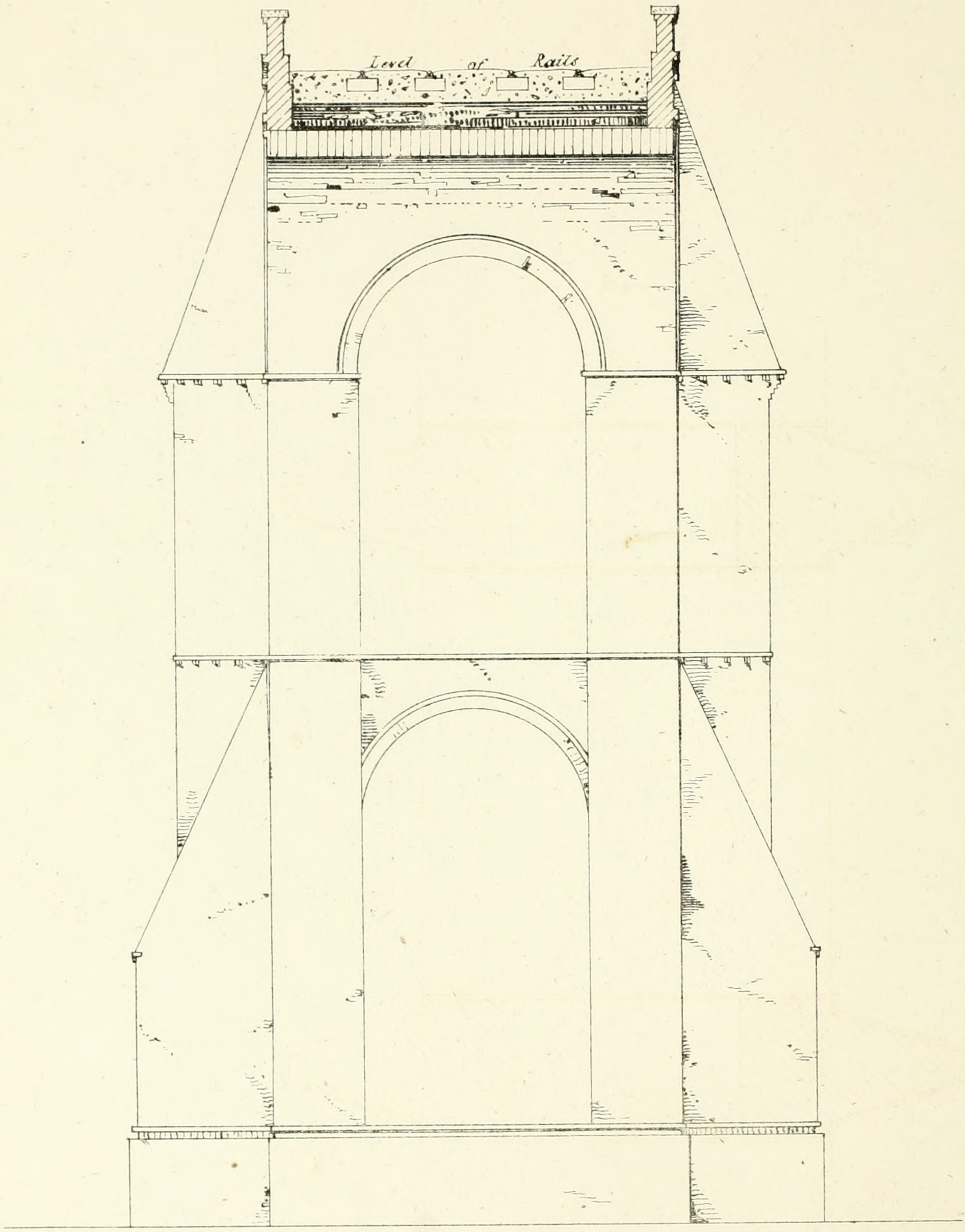
TRANSVERSE SECTION



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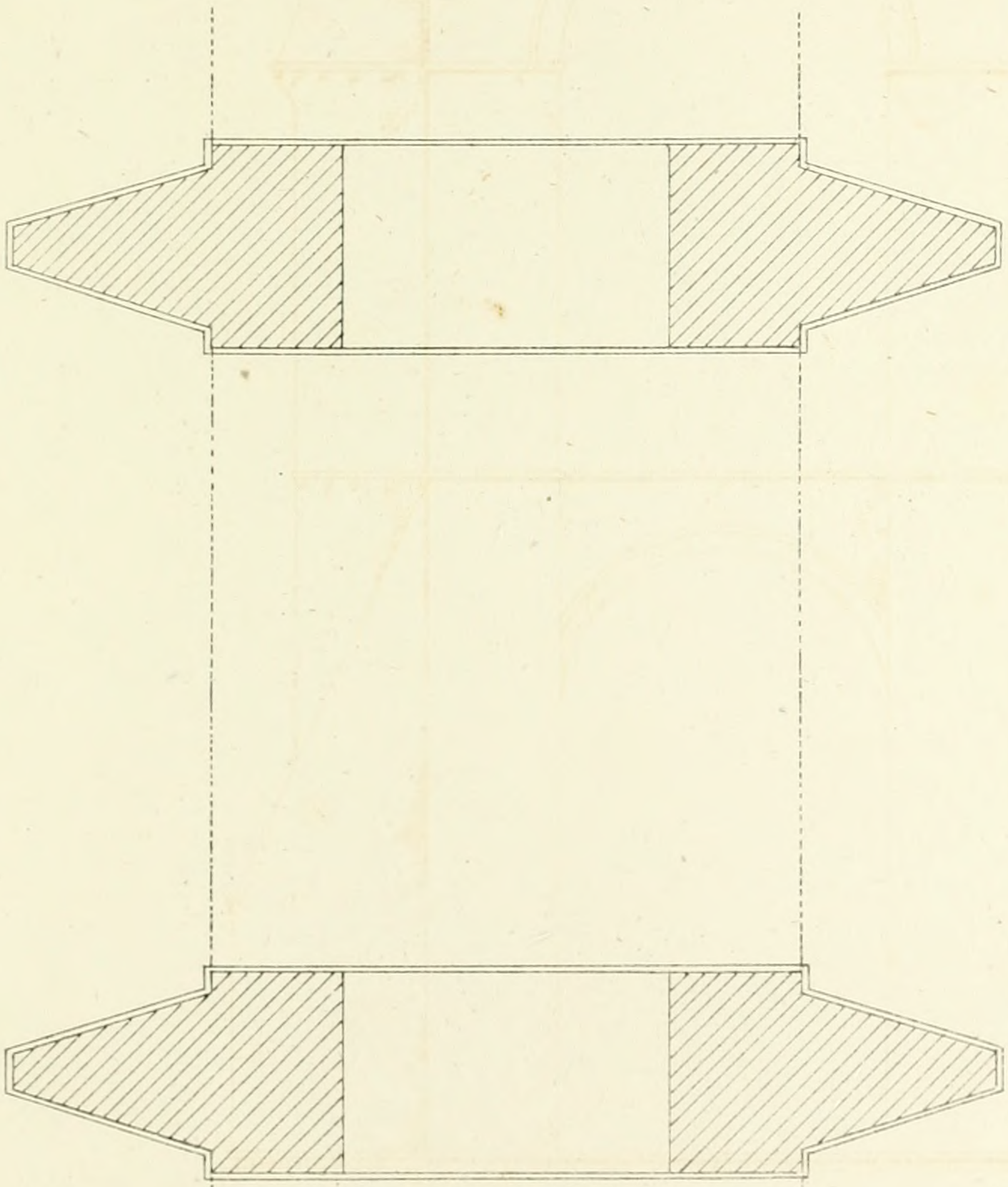
- PLAN -



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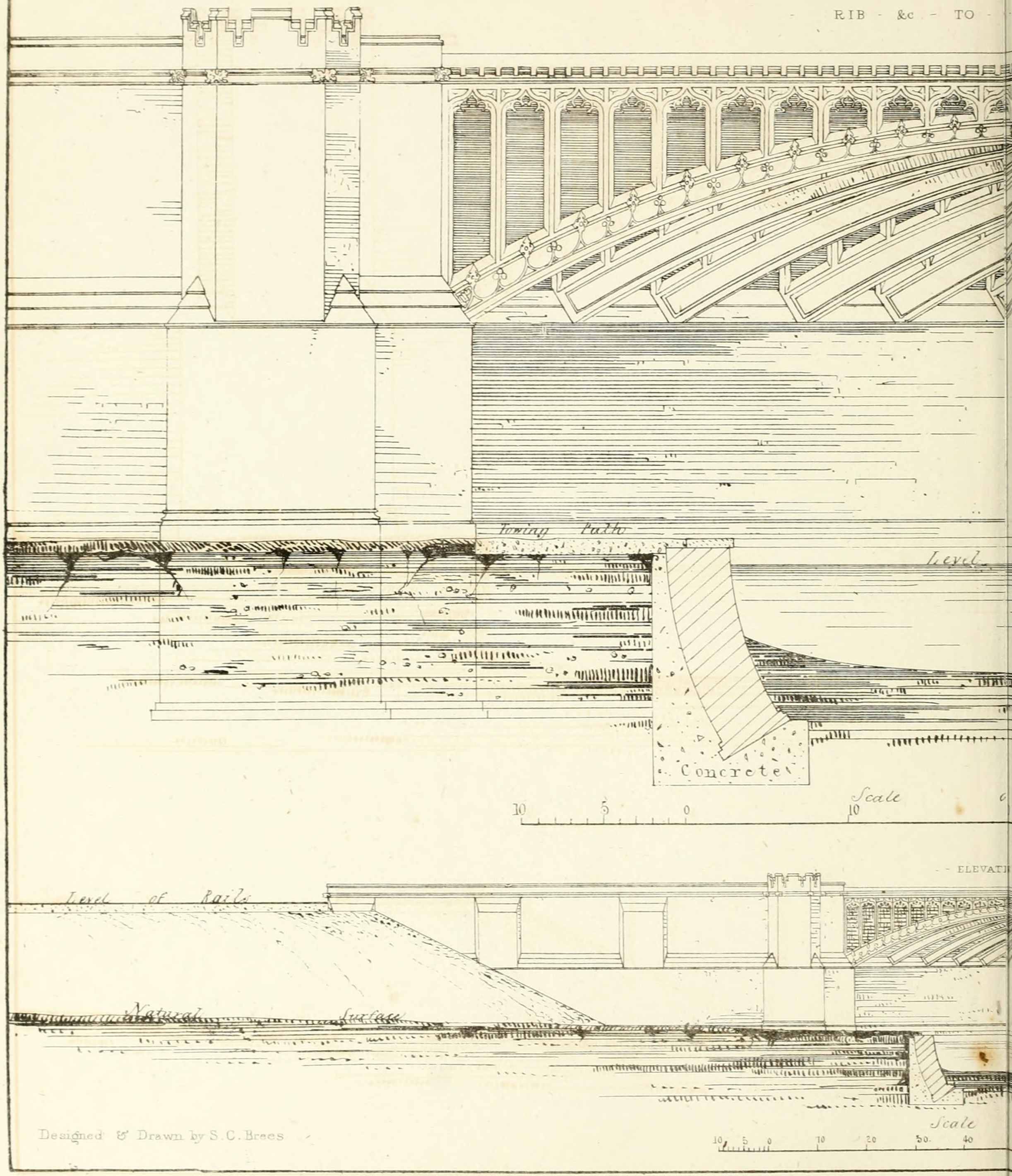

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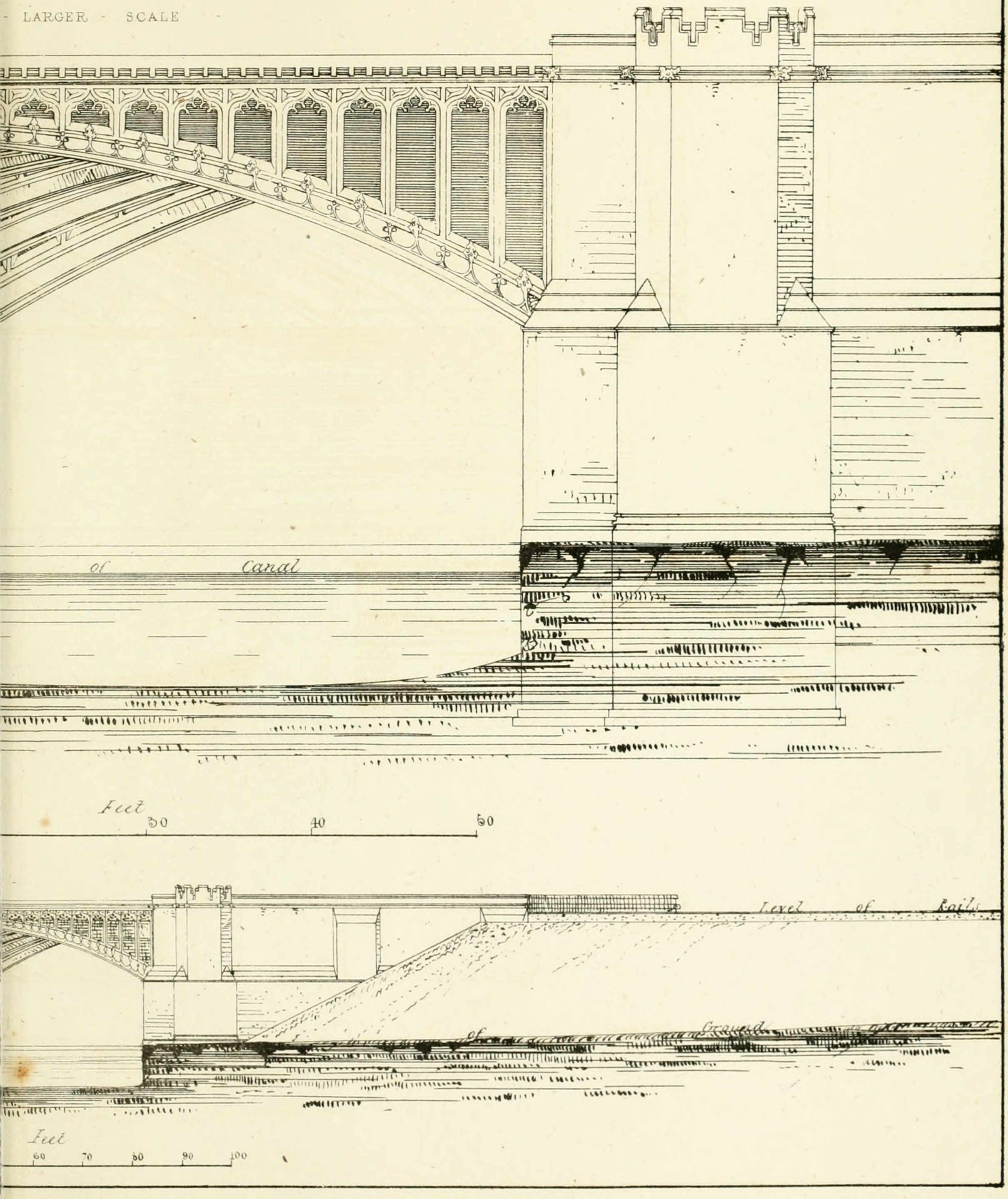
Plate LXXII.

- BRIDGE - OVER - A - CANAL

- LARGER - SCALE -



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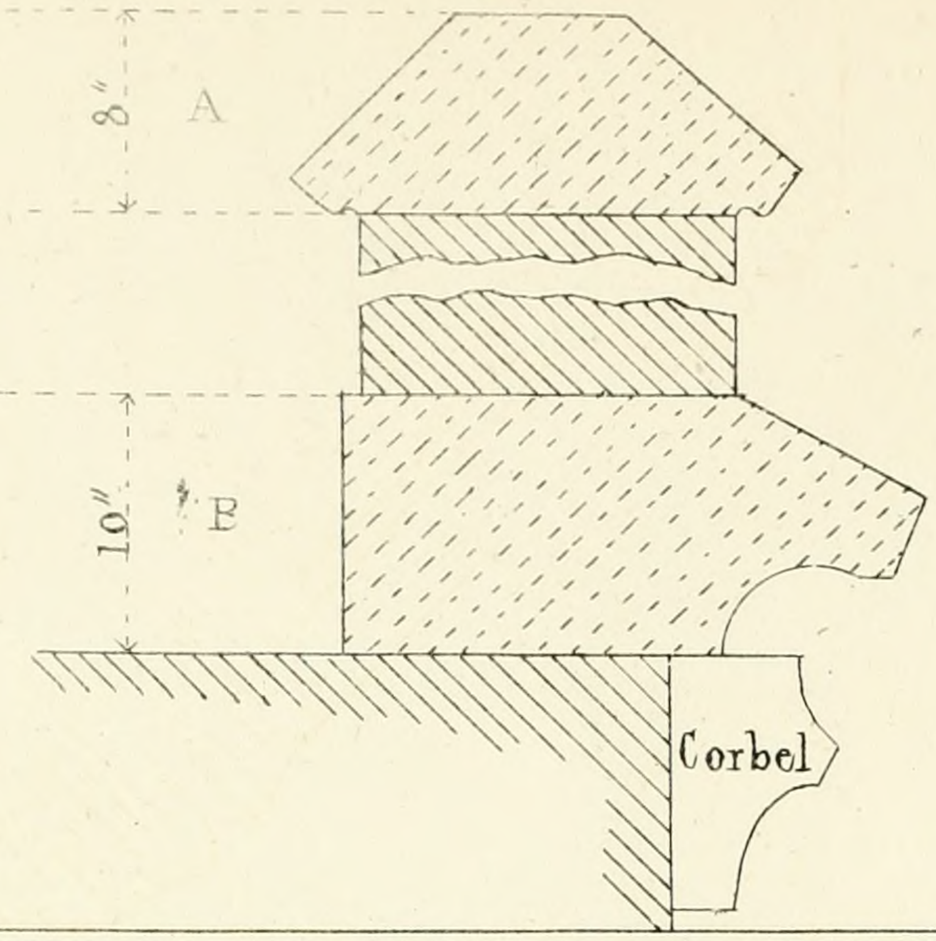

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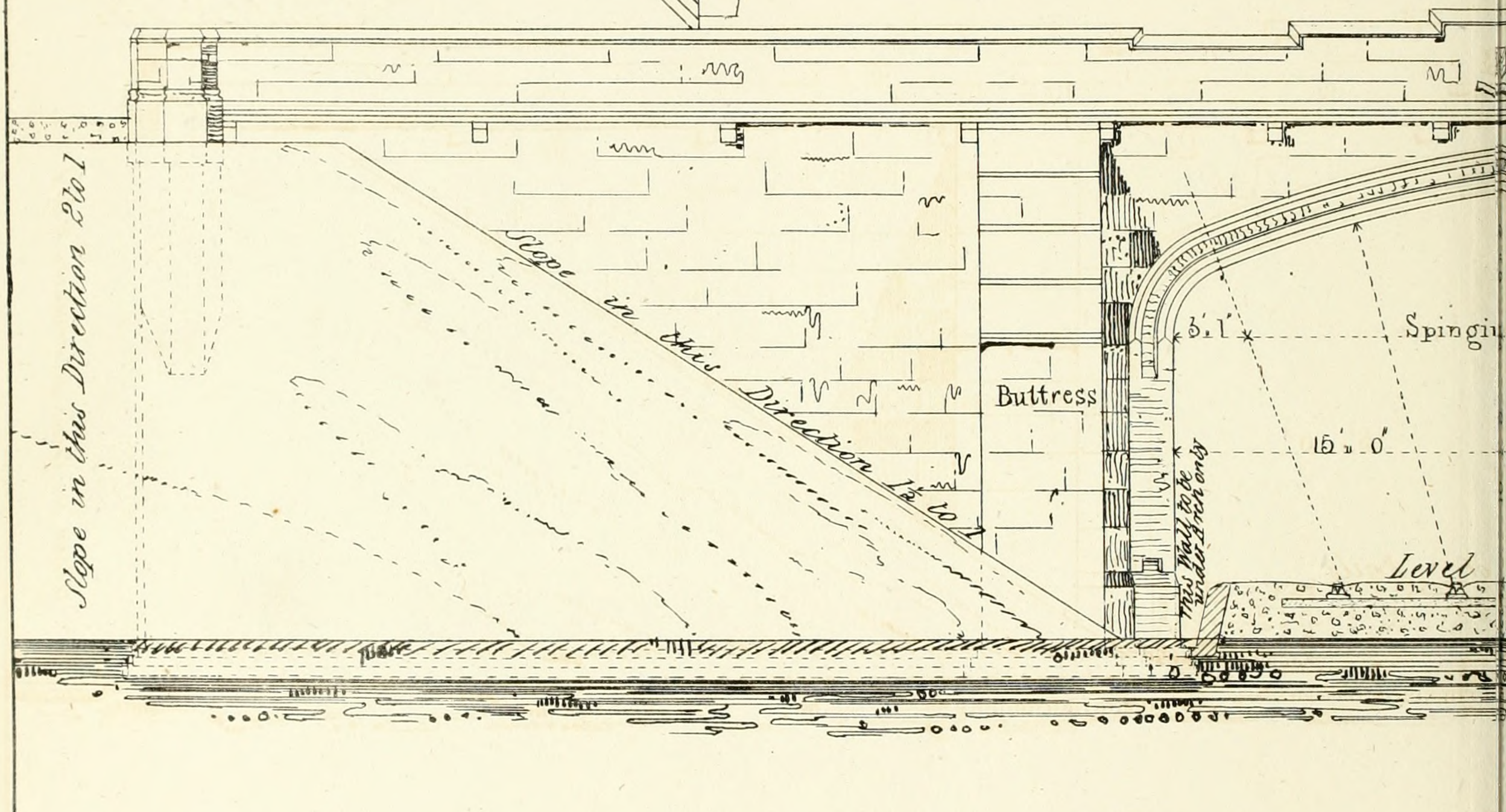
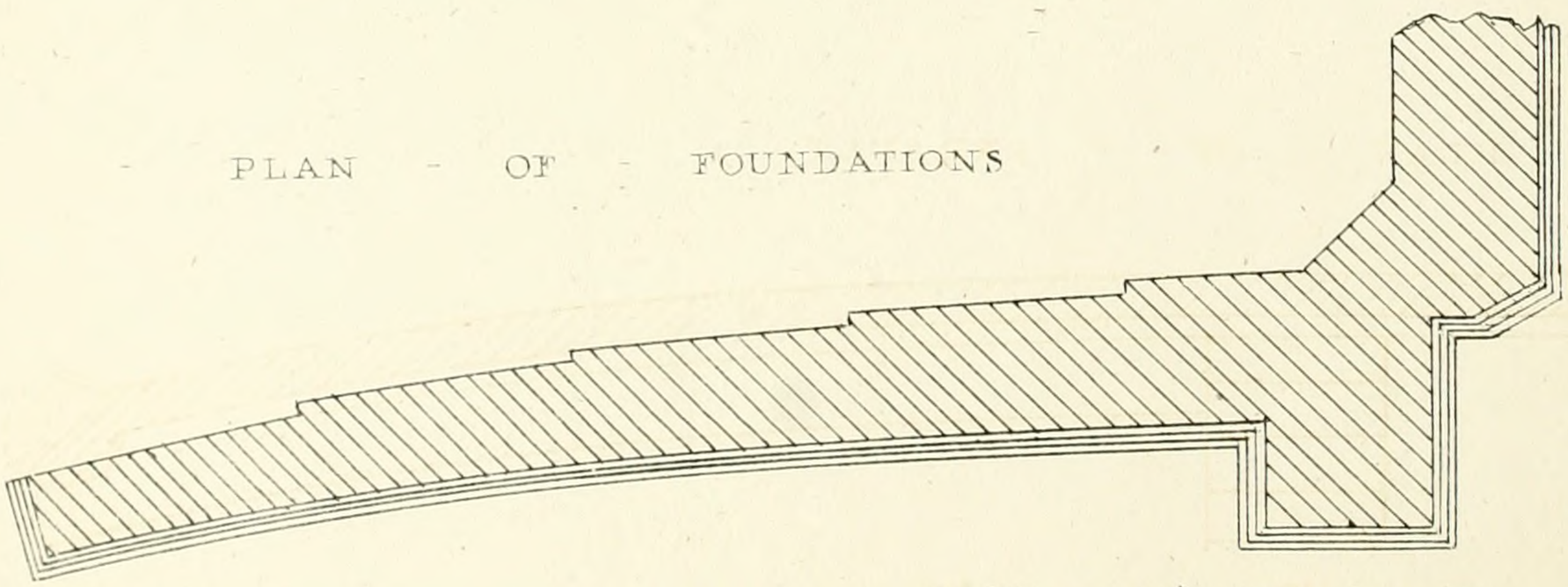


- PLAN - OF - FOUNDATIONS



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IDGE - OVER - RAILWAY -

IIC - STYLE -

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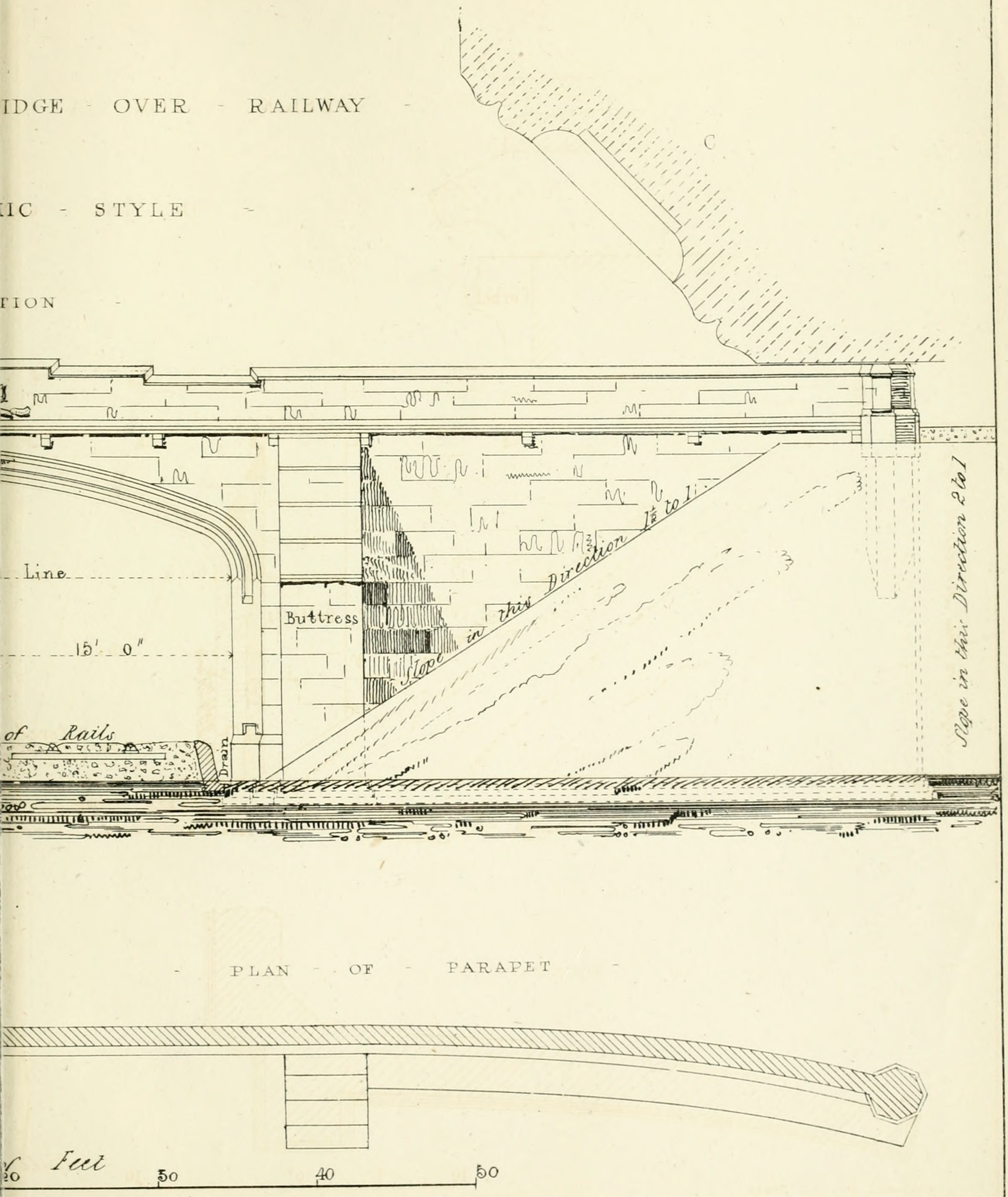

- PLAN - OF - PARAPET -

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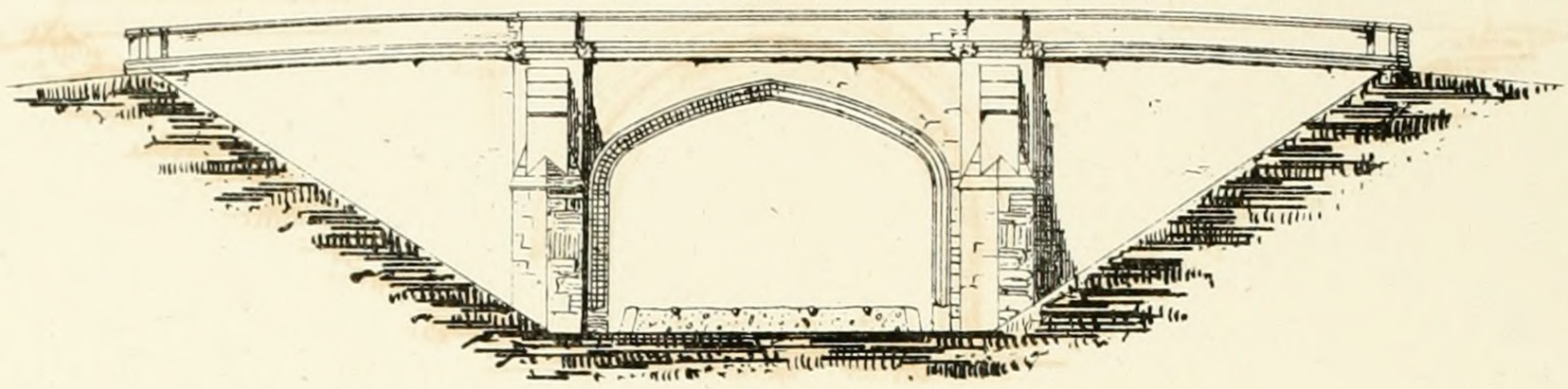
FIG - 1



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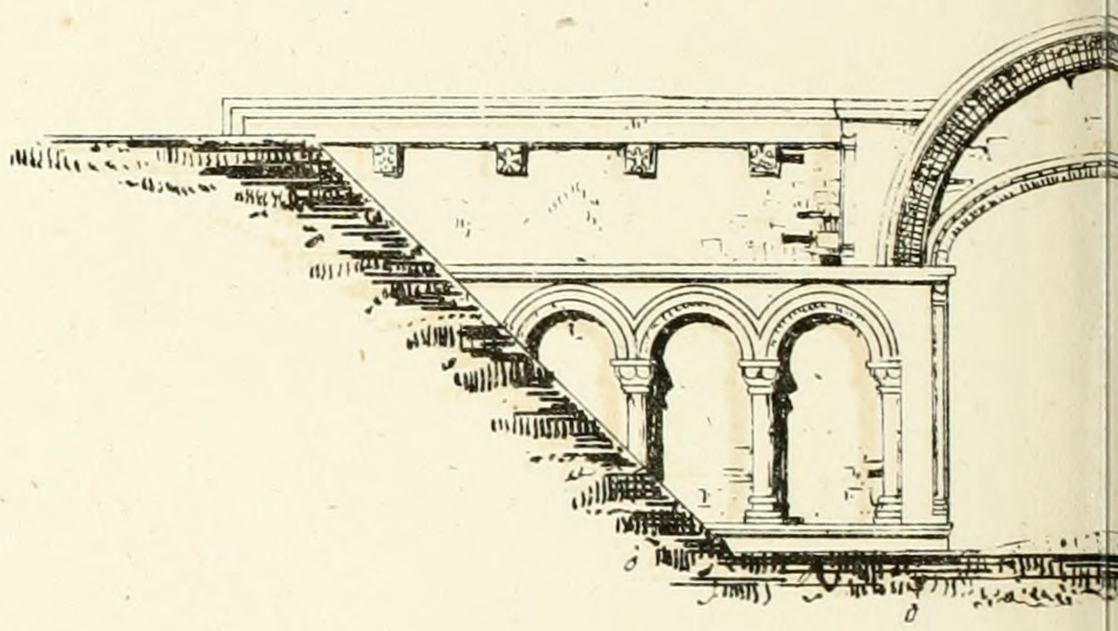

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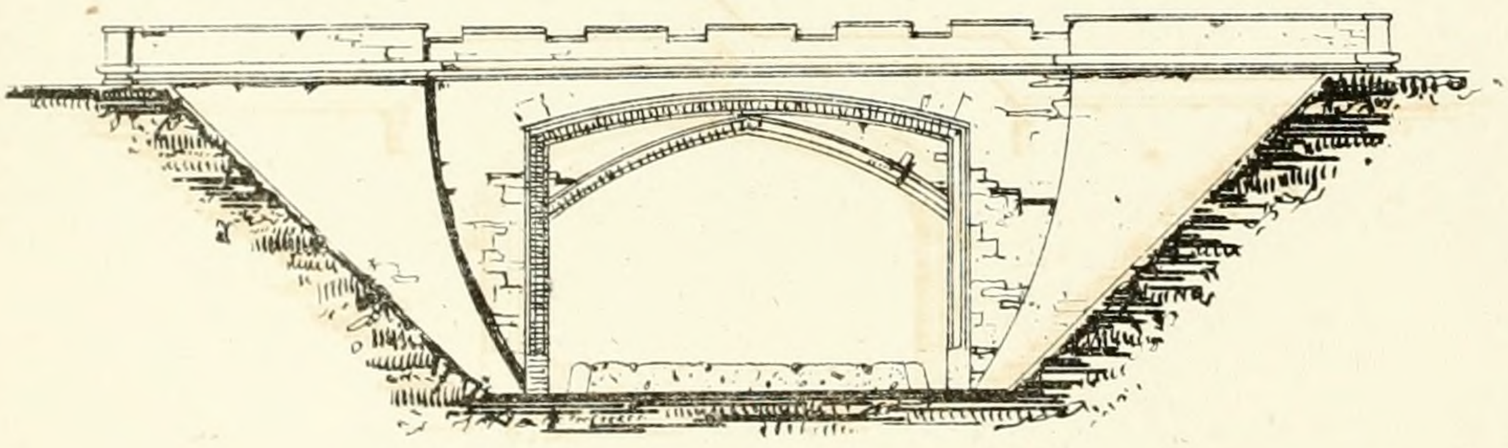

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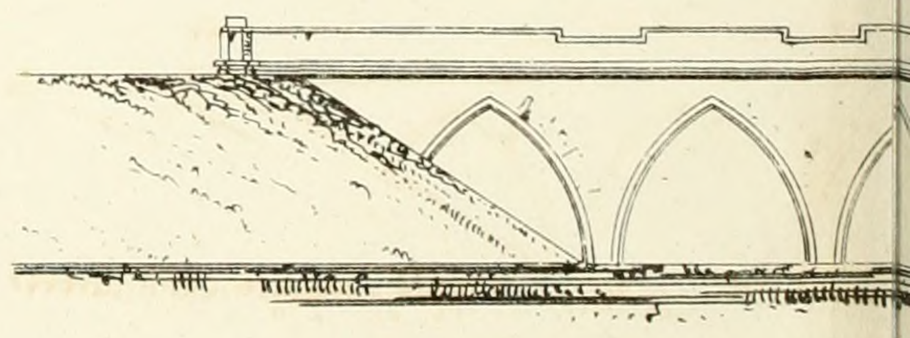

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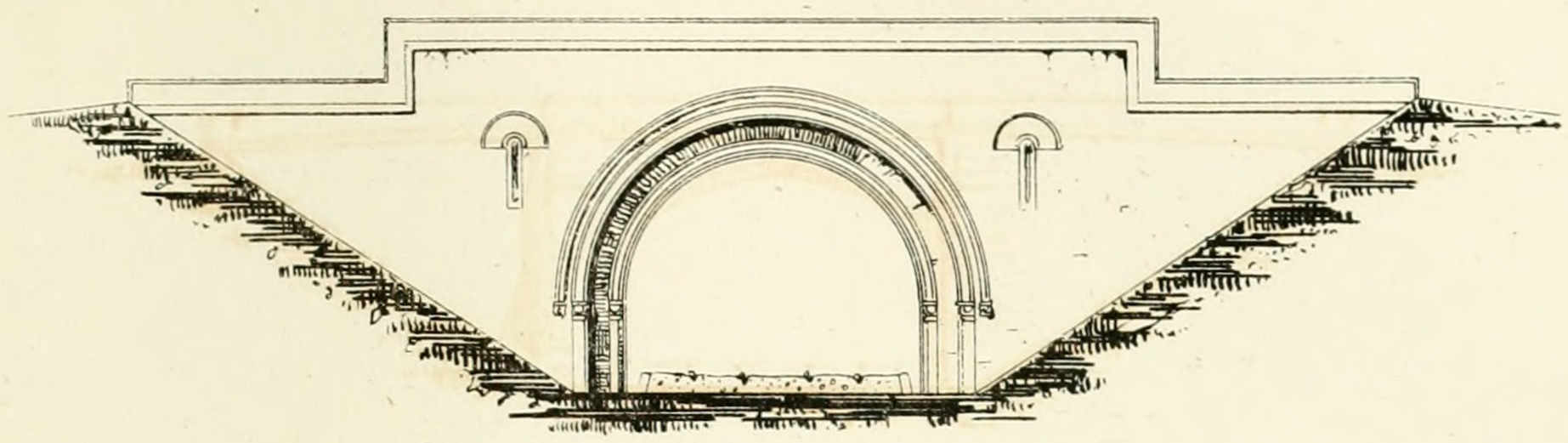
FIG - 2 -



ENTAL - BRIDGES -

OF - GOTHIC - ARCH^E -

3 -

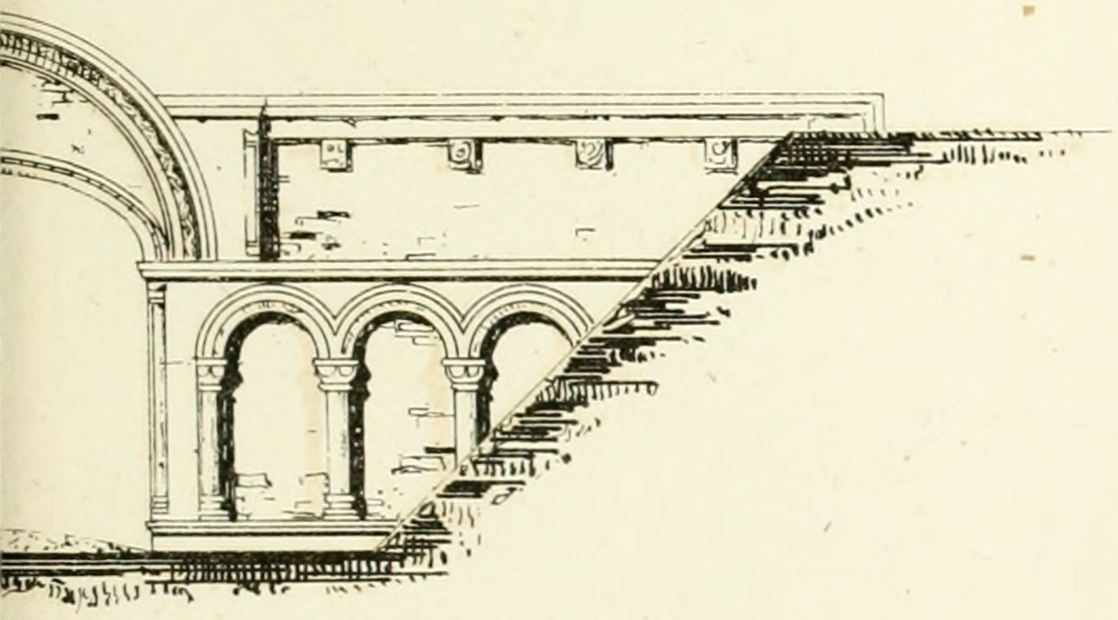


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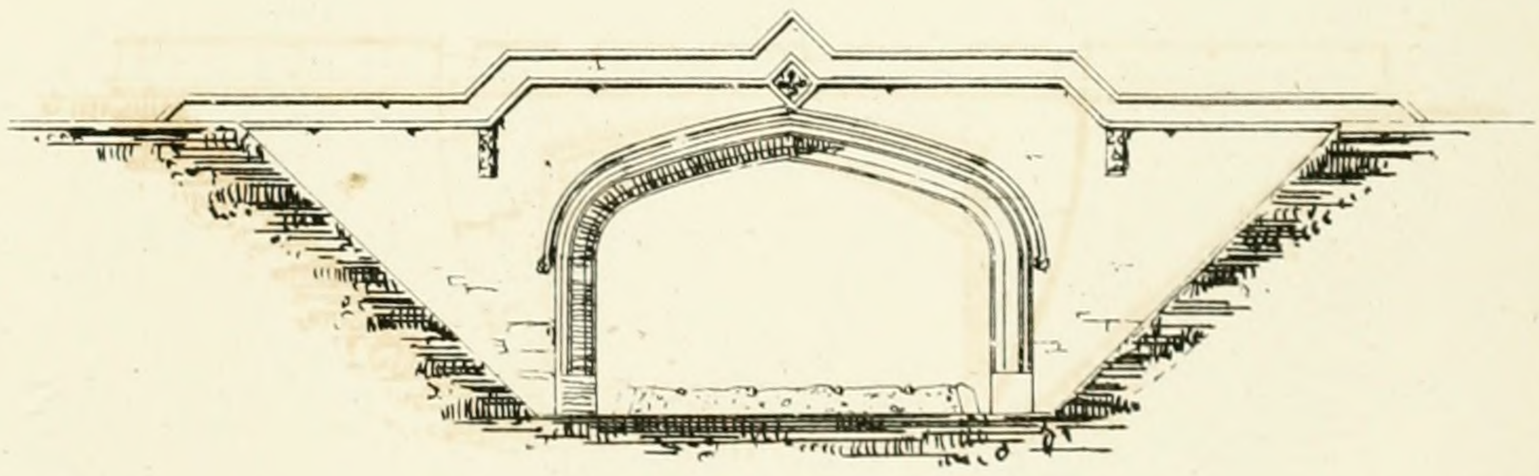
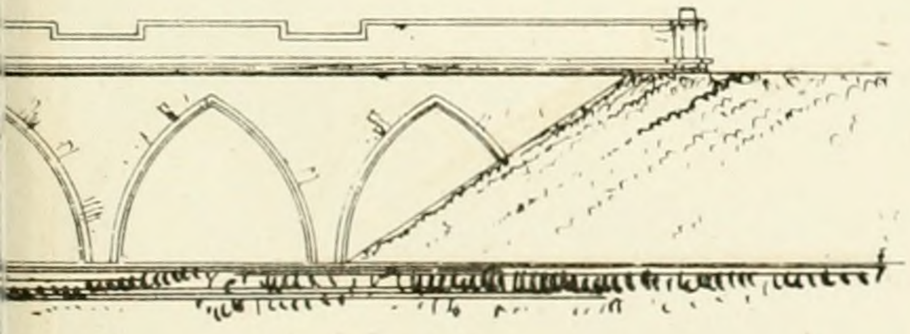
FIG - 6 -





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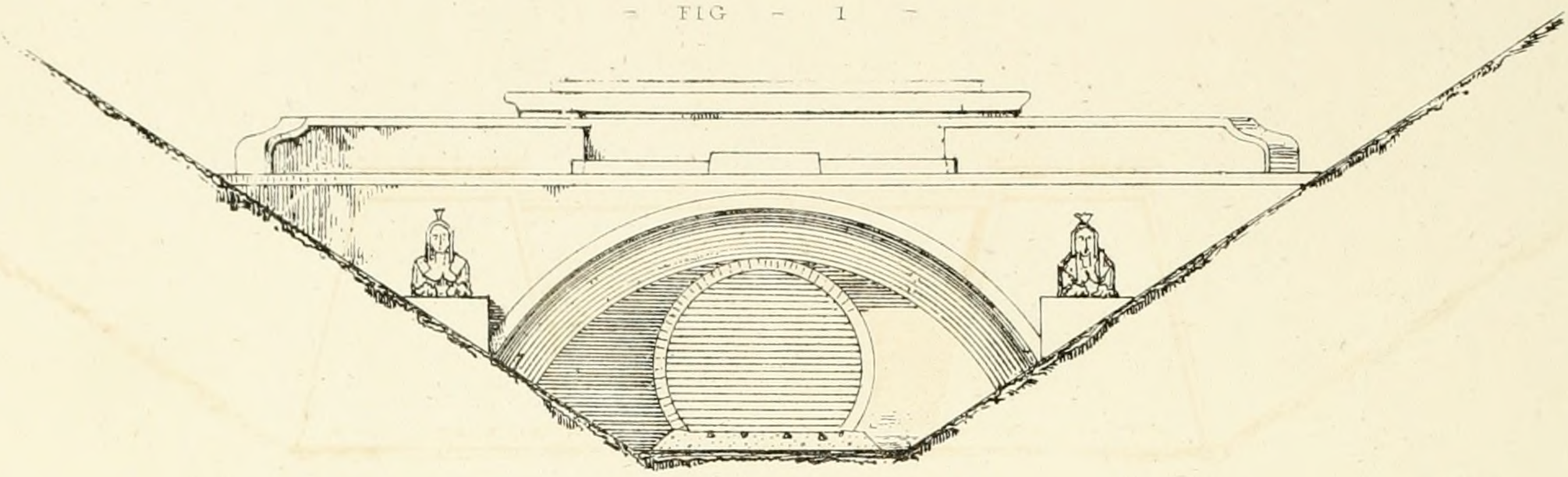
– DESIGNS – FOR

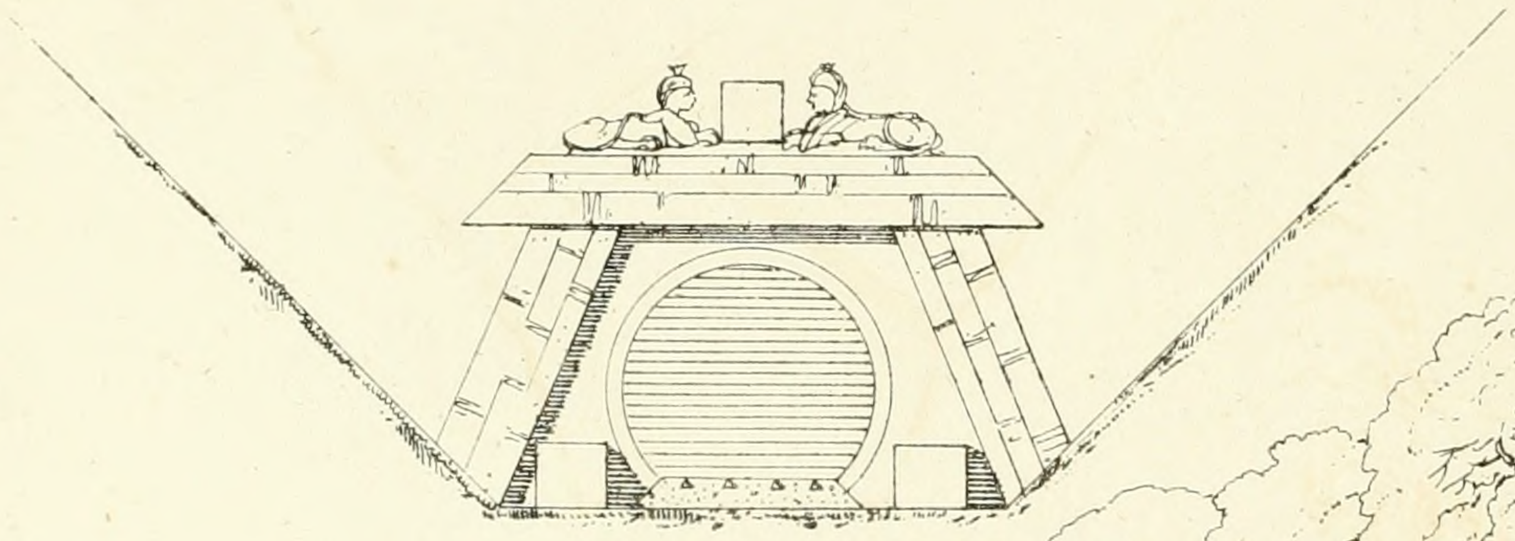
– FIG – 1 –

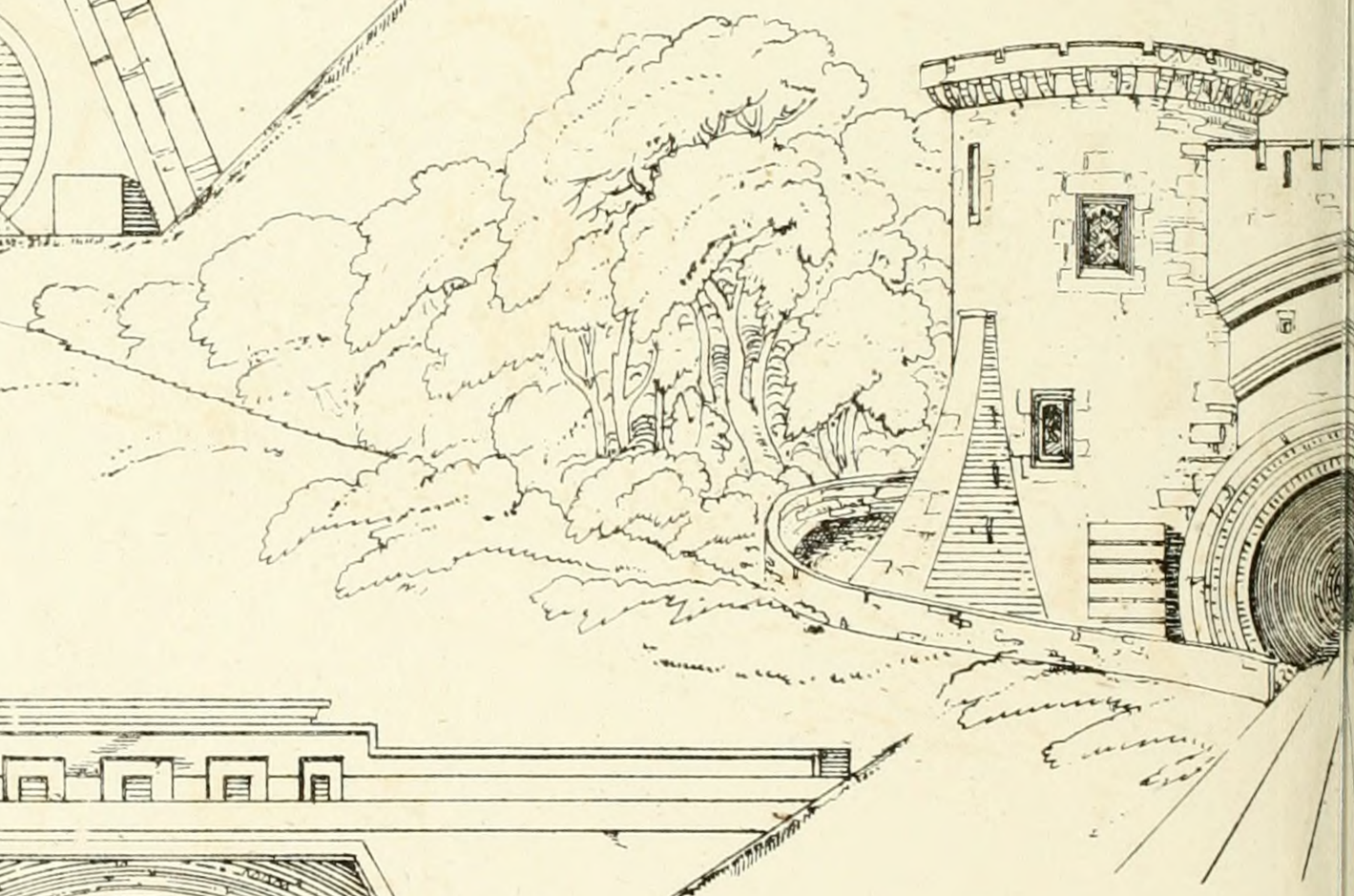


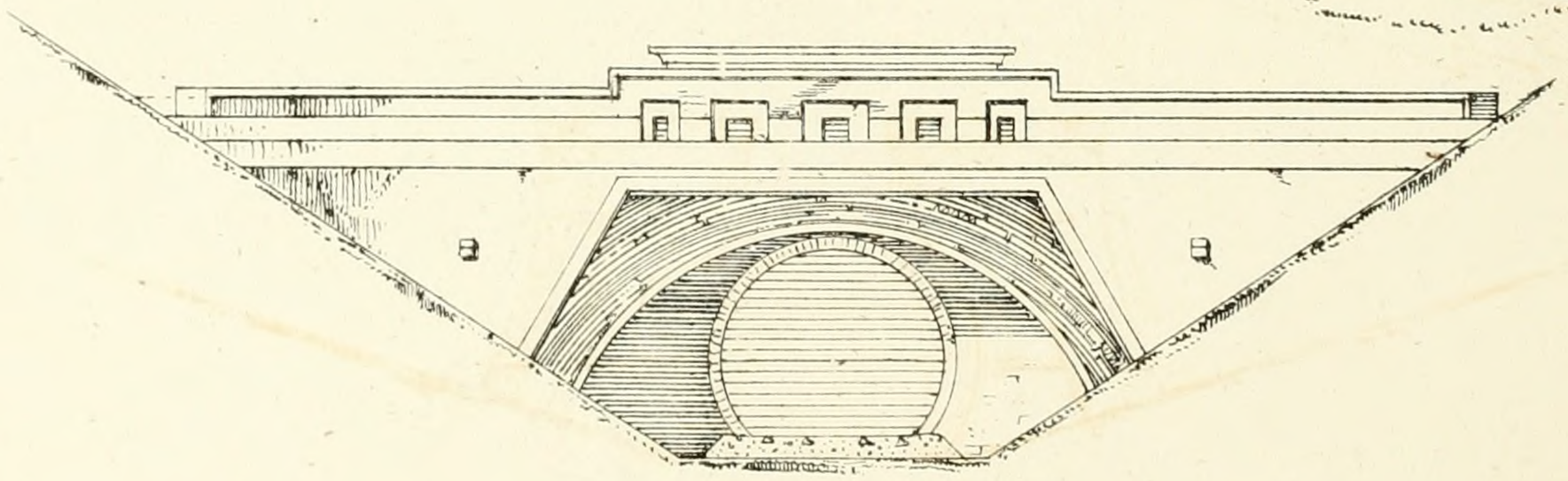
– FIG

– TUNNEL – FRONT –

– FIG – 4 –







– FIG – 6 –

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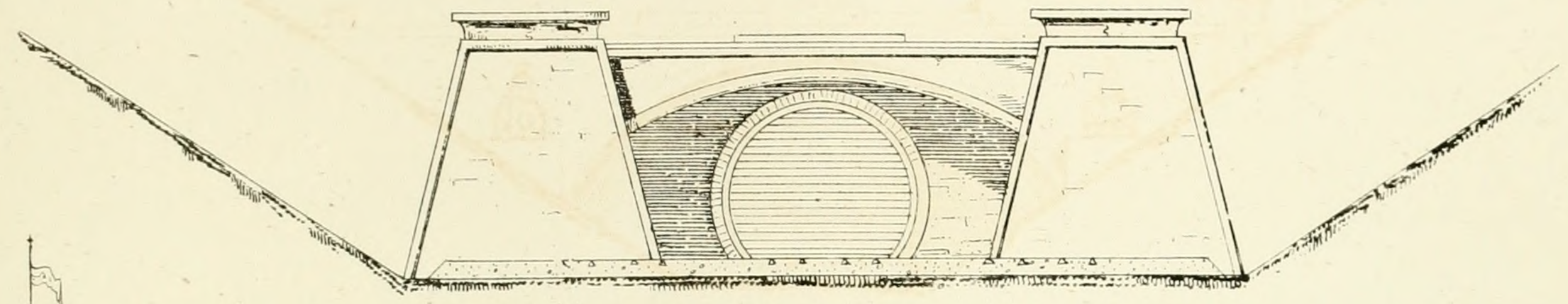
TUNNEL - FRONTS -

- FIG - 2 -



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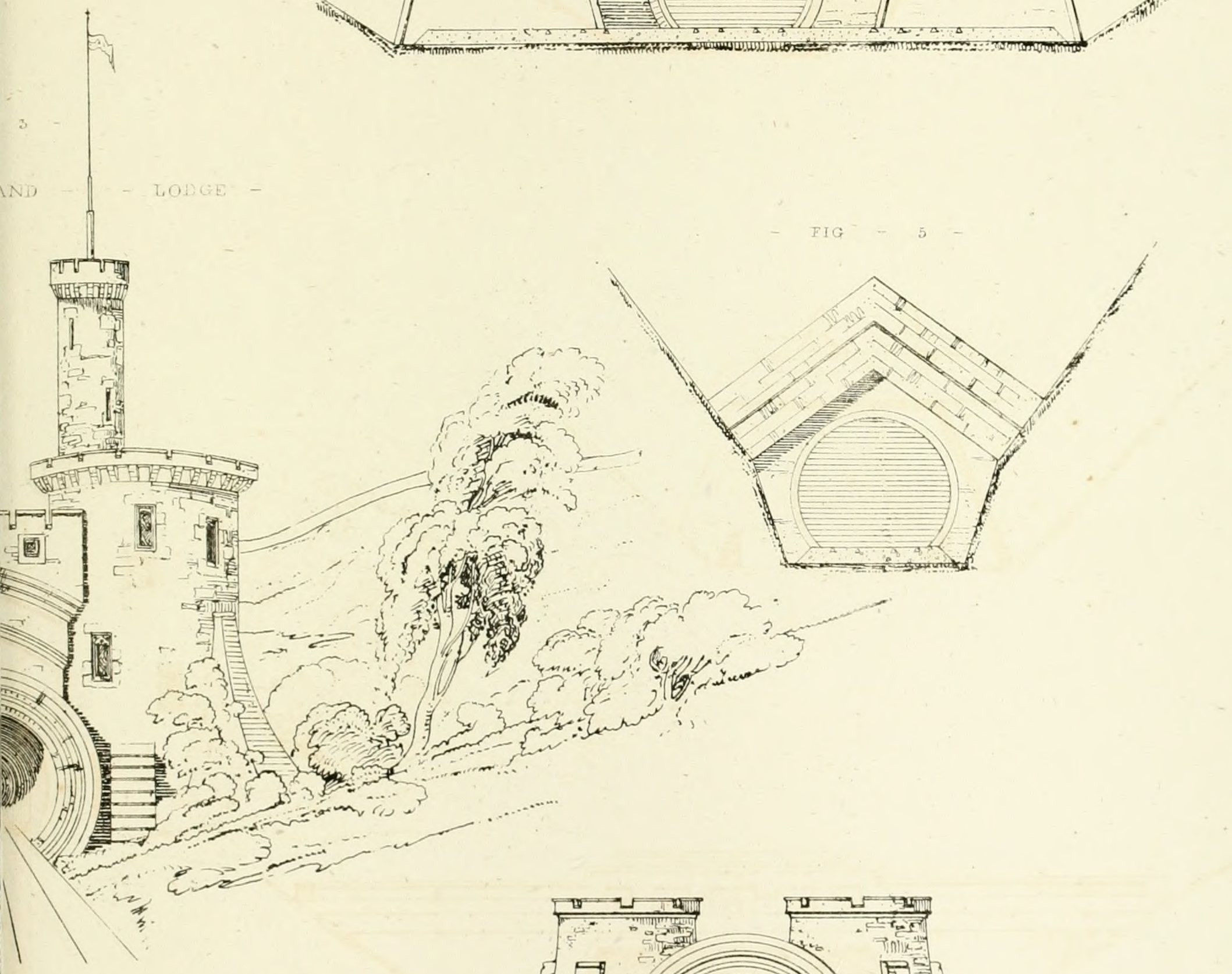
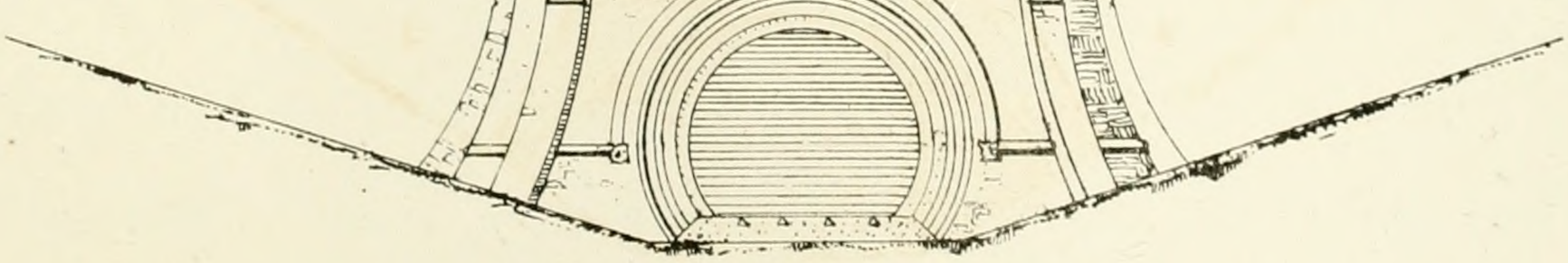


- FIG 7 -



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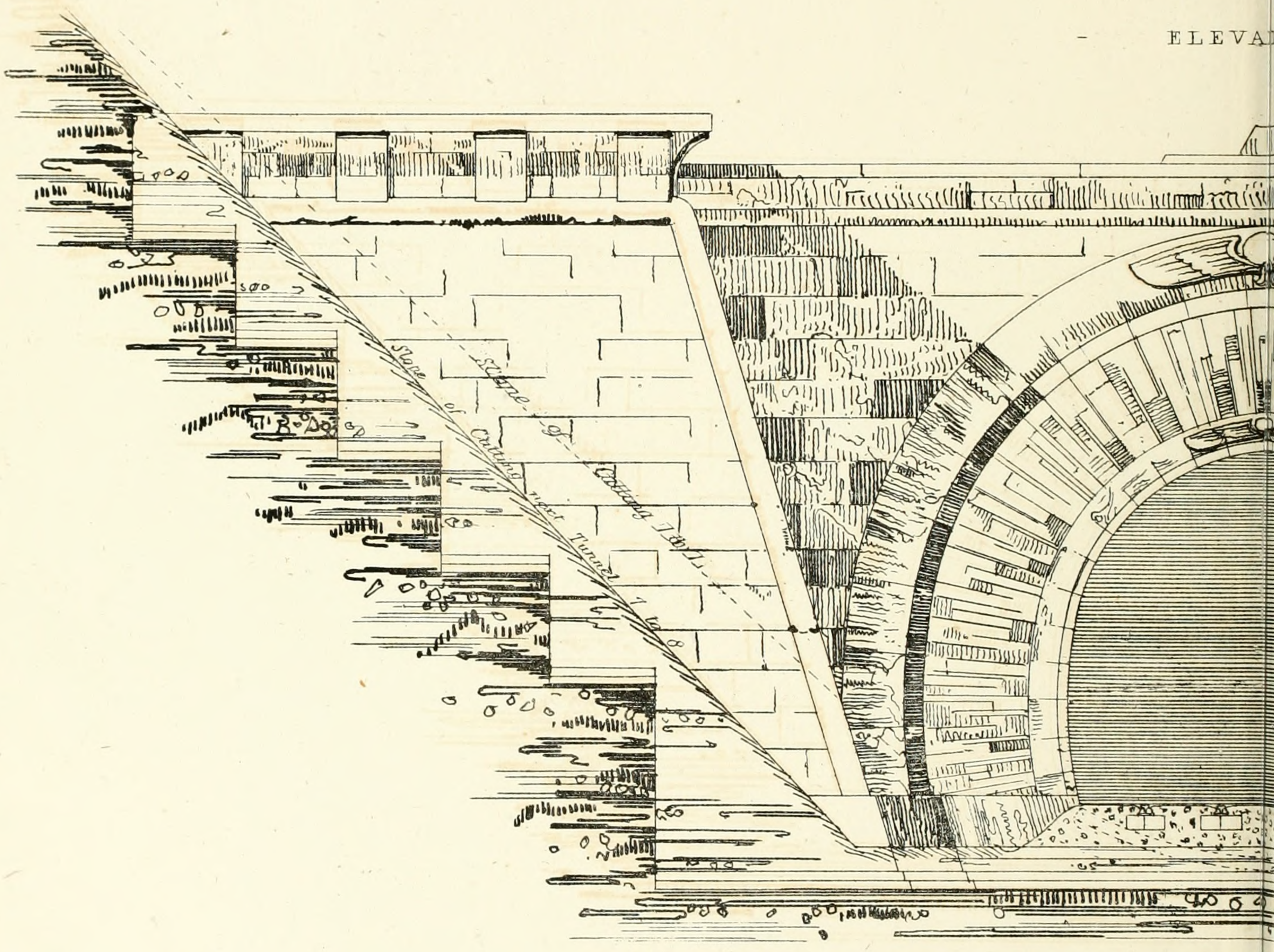

Scale being 8 Feet

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TUNNEL - FRONT -

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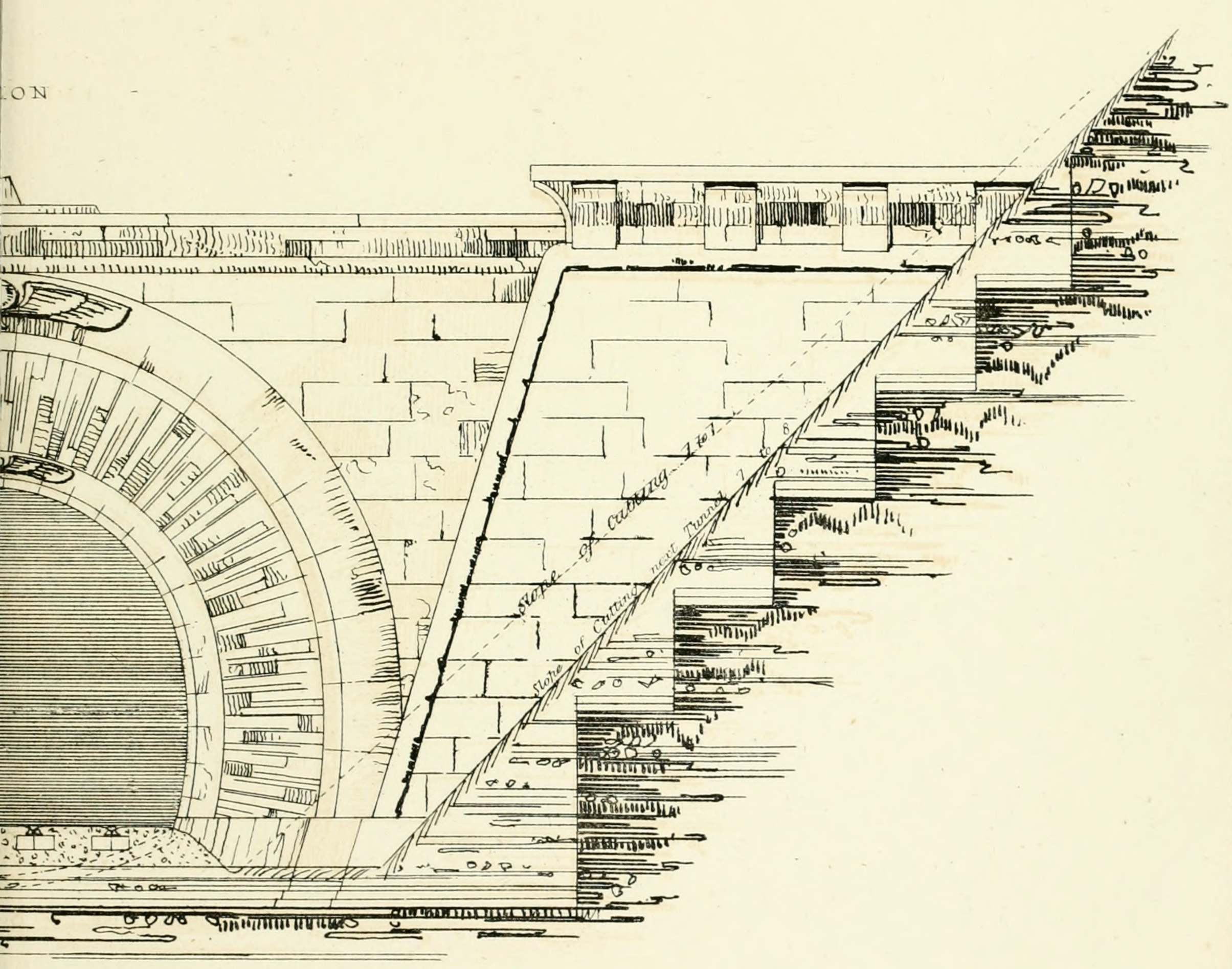

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ce & Art No 106, Gt Russell St Bloomsbury

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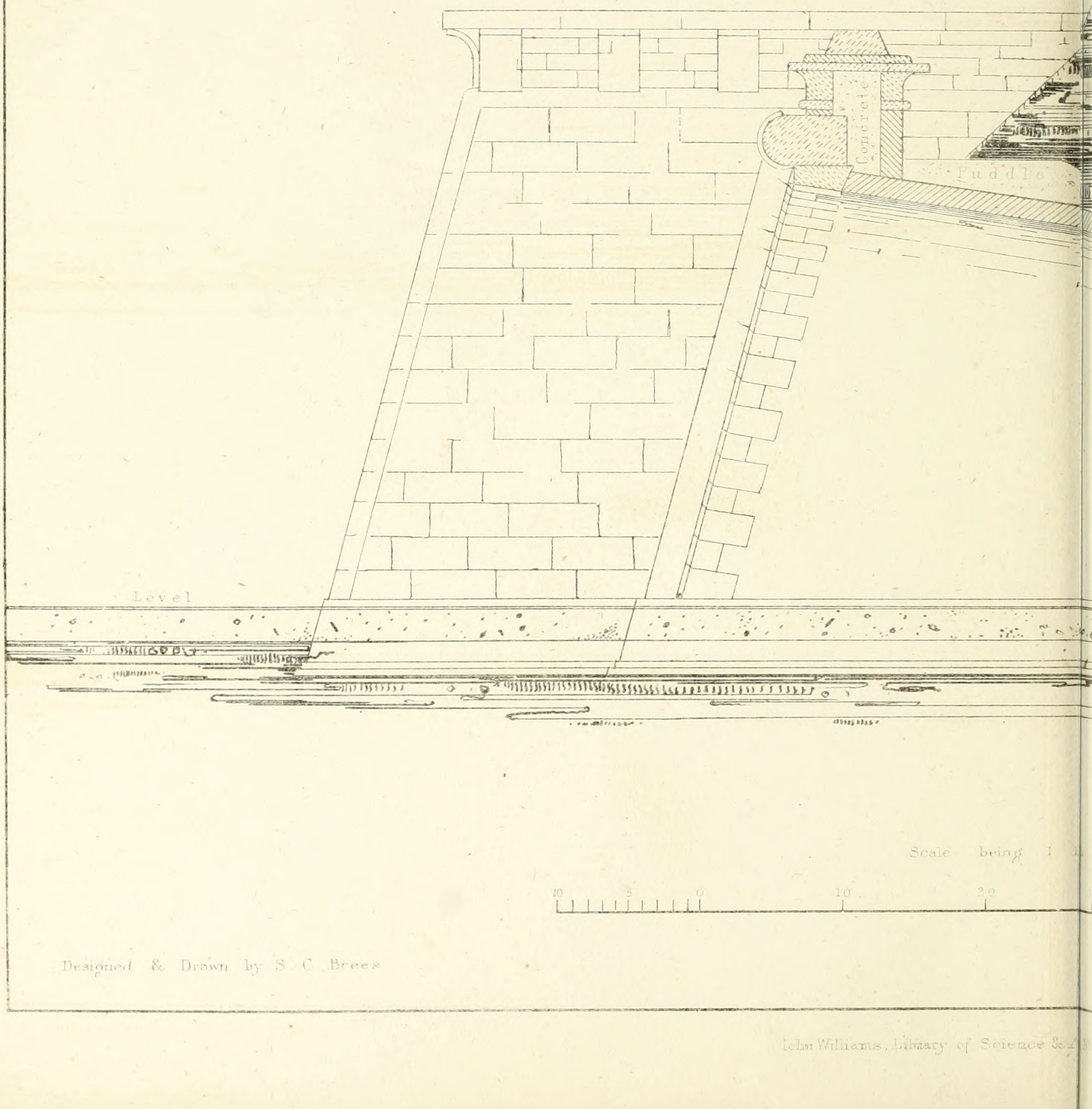
DESIGN FOR A TUNNEL FRONT

IN THE EGYPTIAN STYLE



Scale being 1 1

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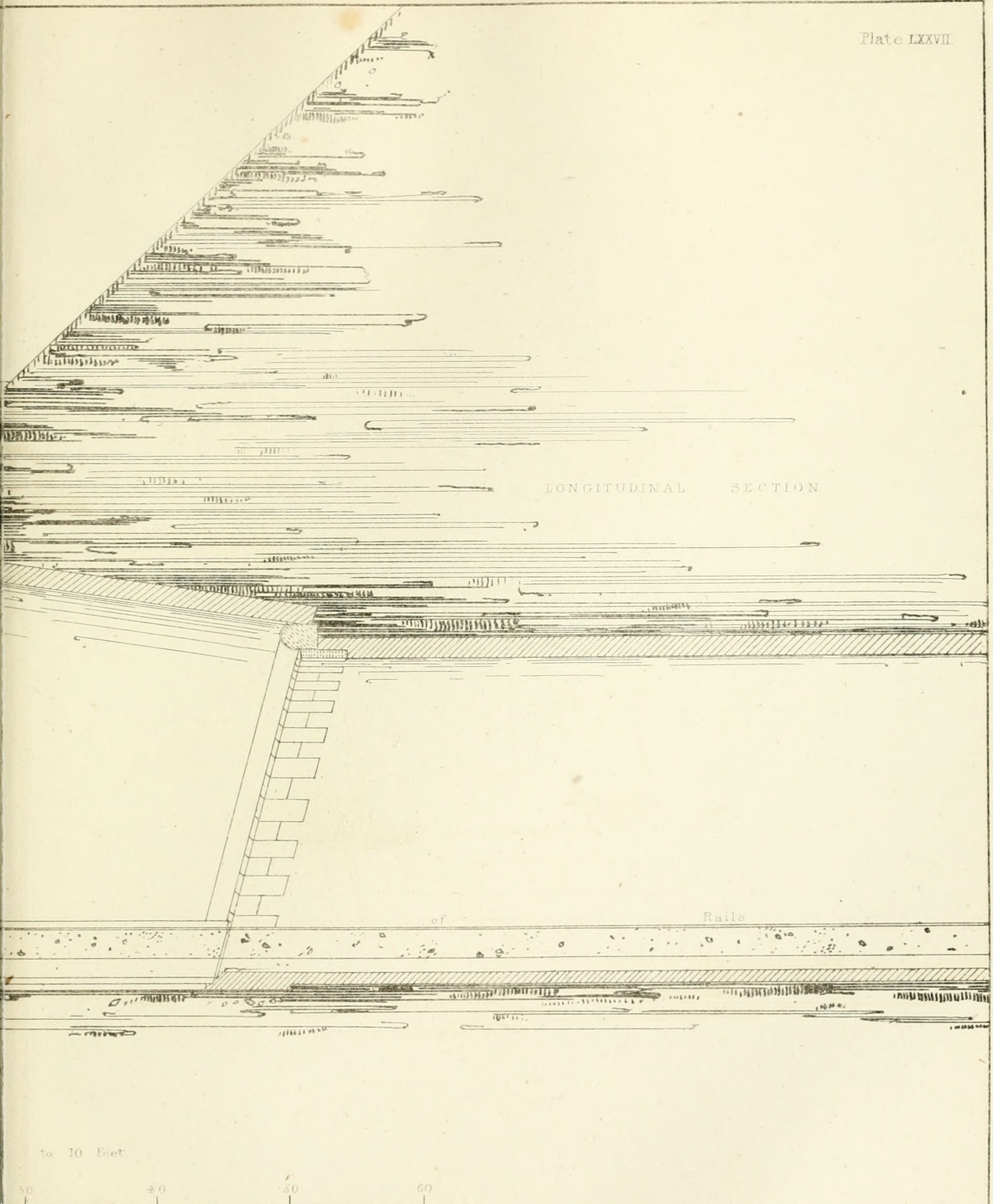

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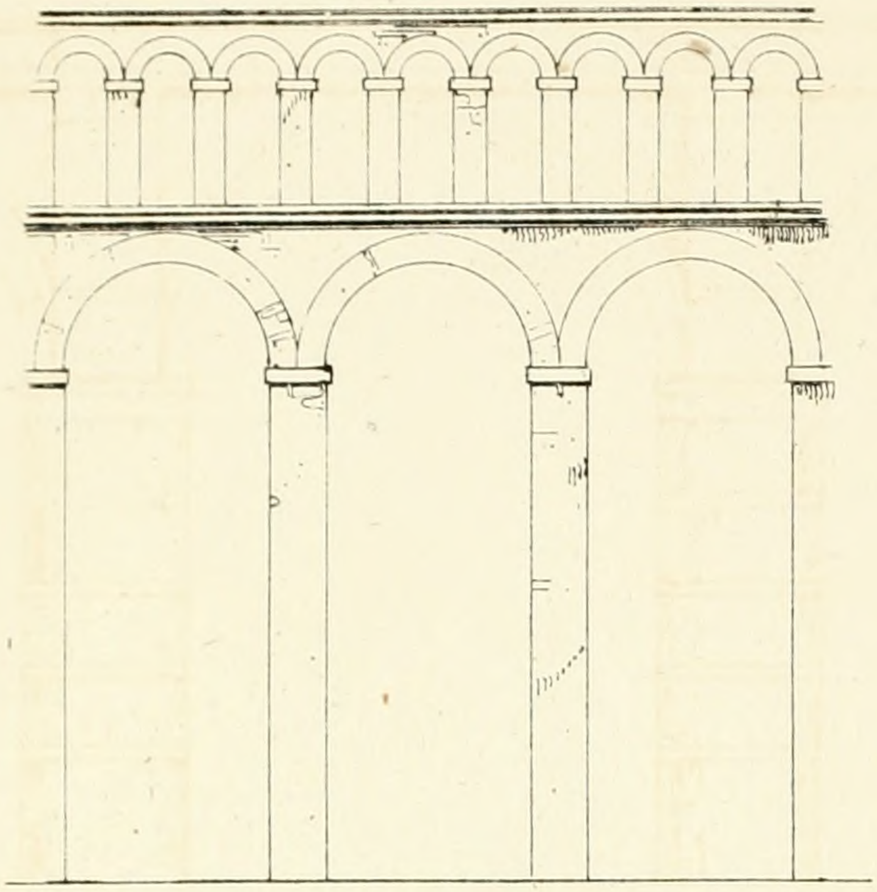
FIG 2



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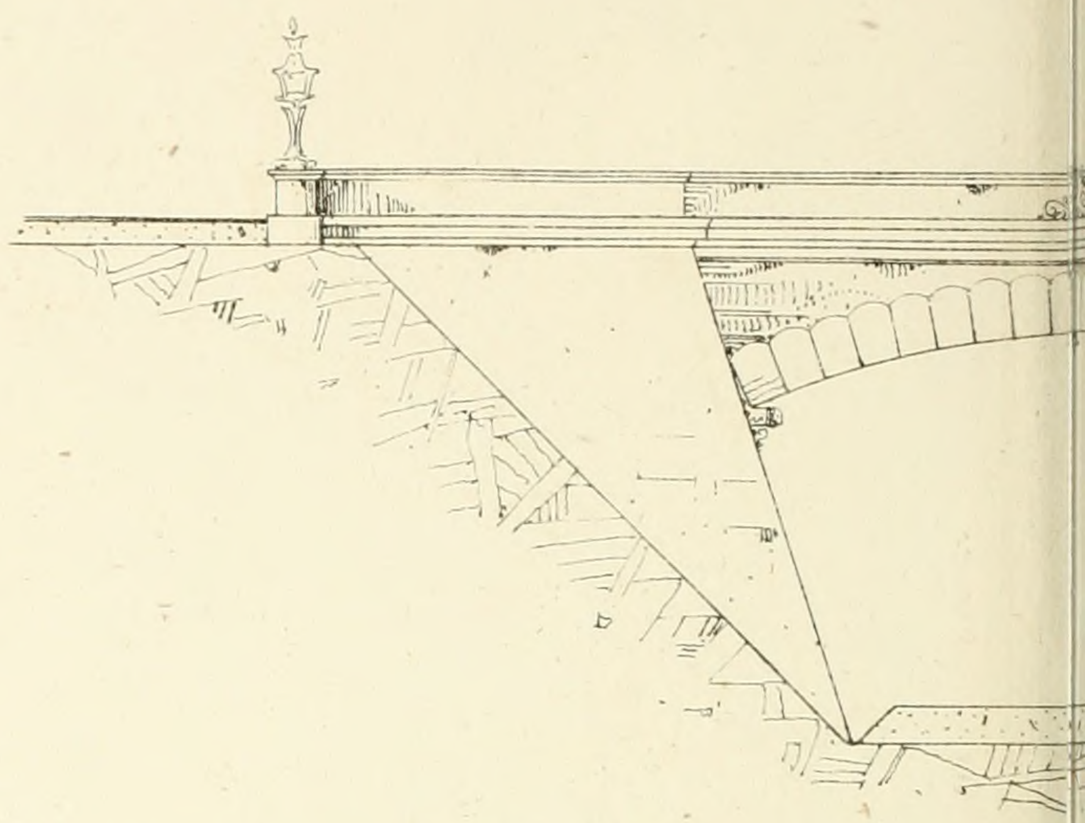

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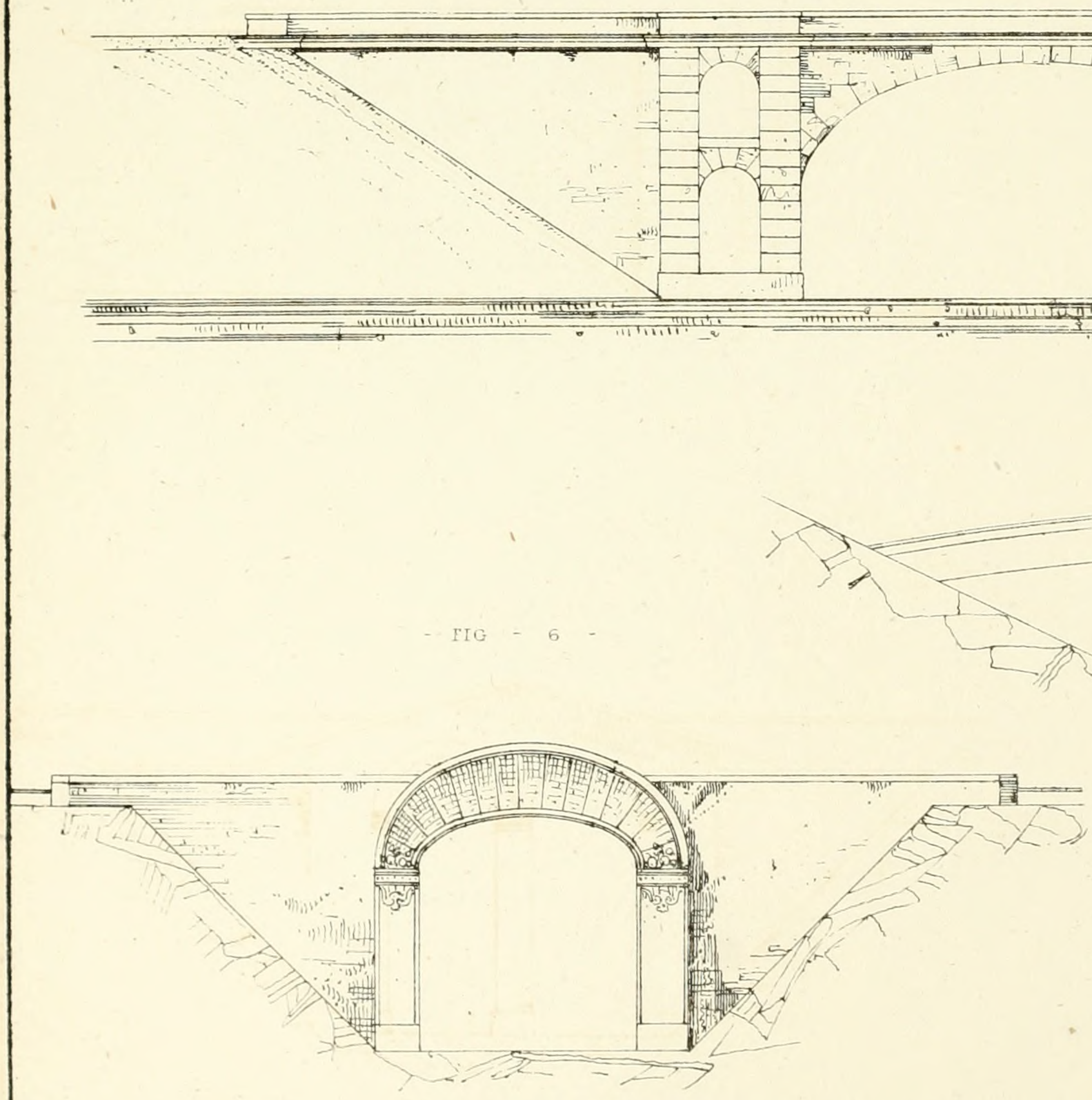

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ENTAL - BRIDGES -

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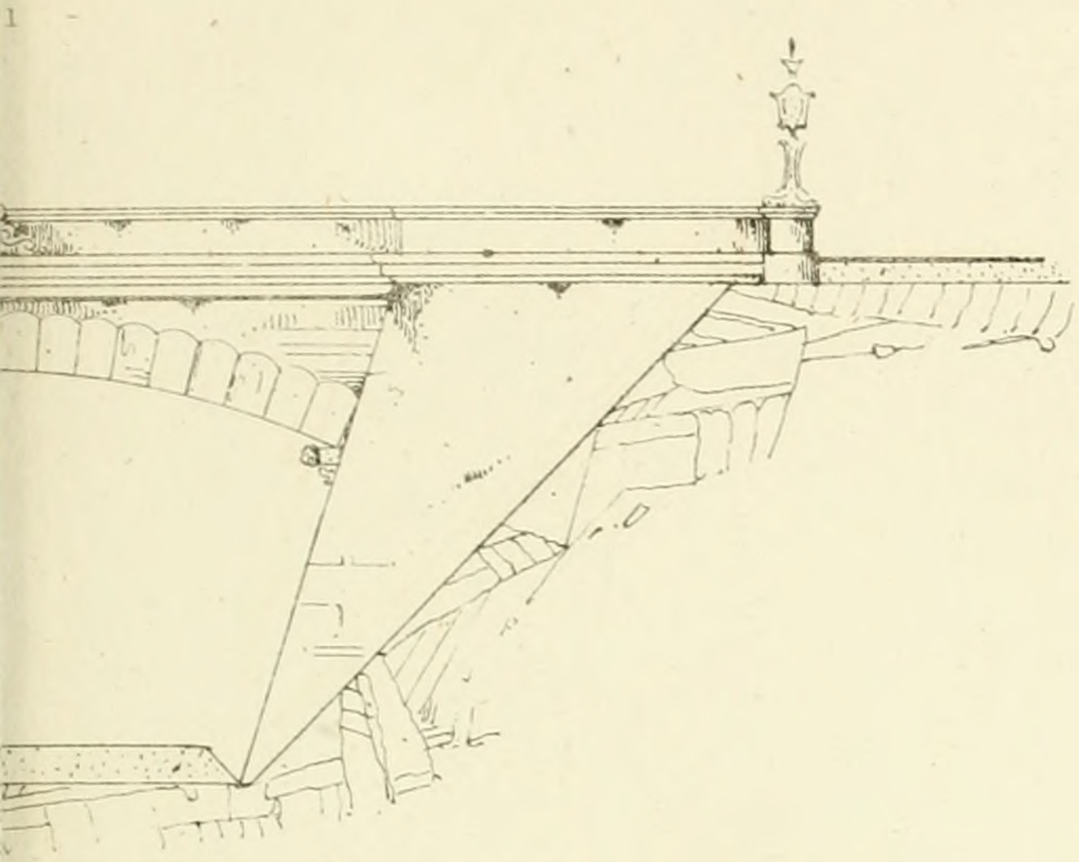

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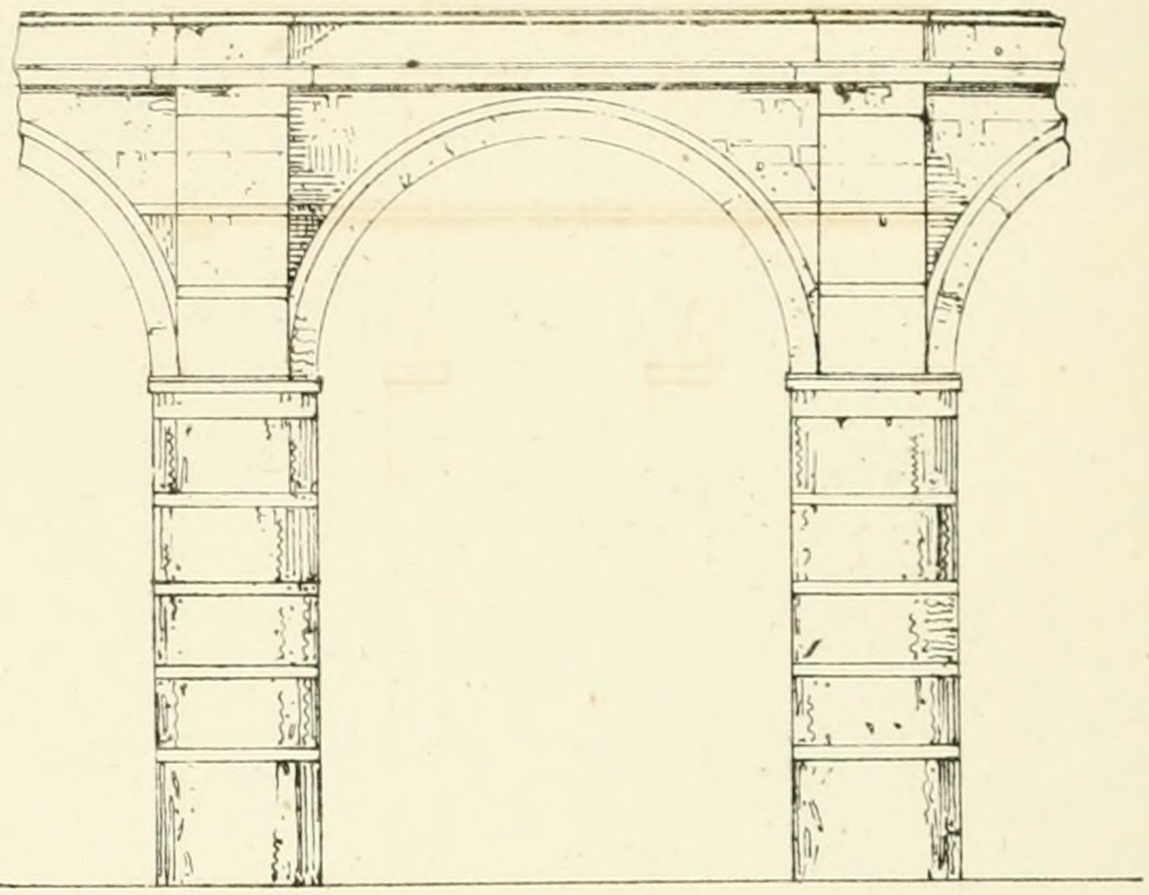
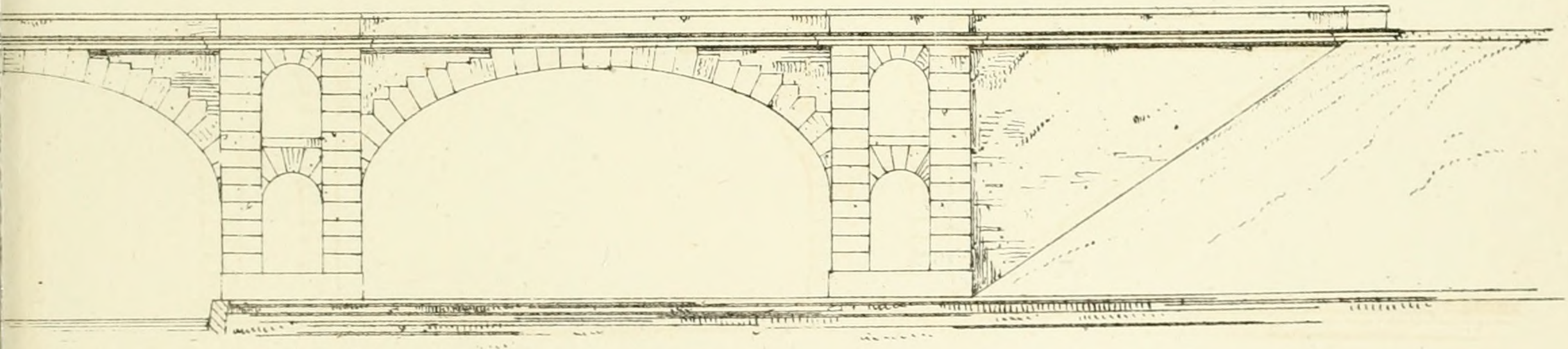
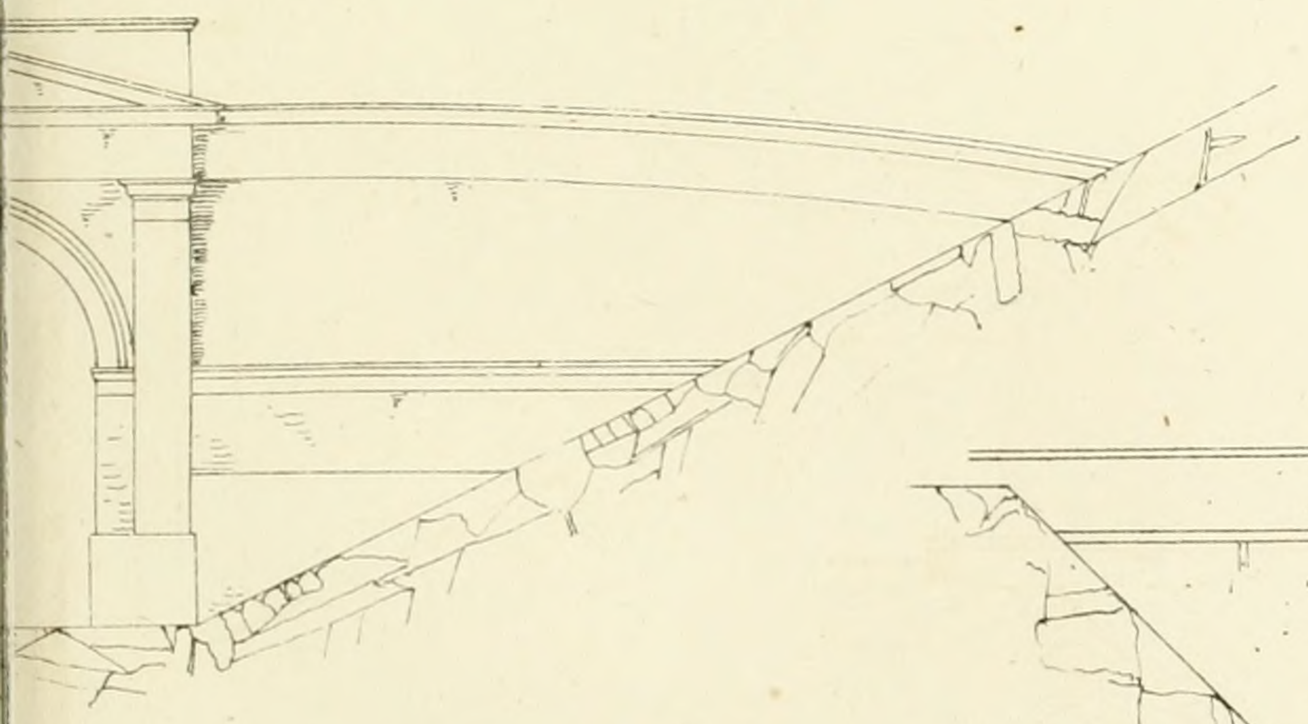
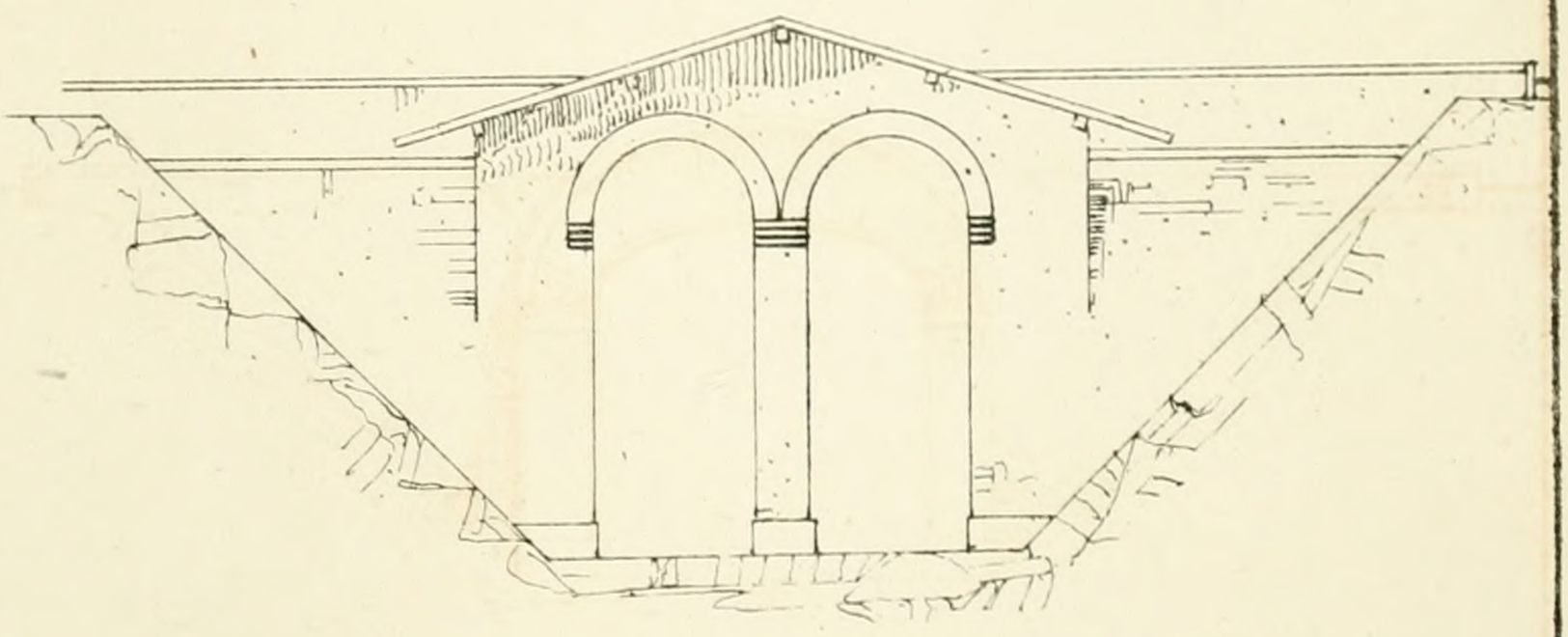






- FIG - 7 -



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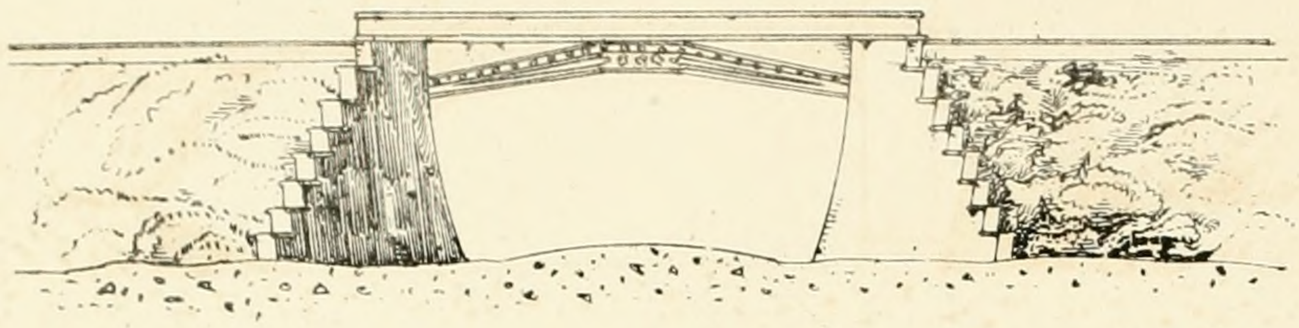

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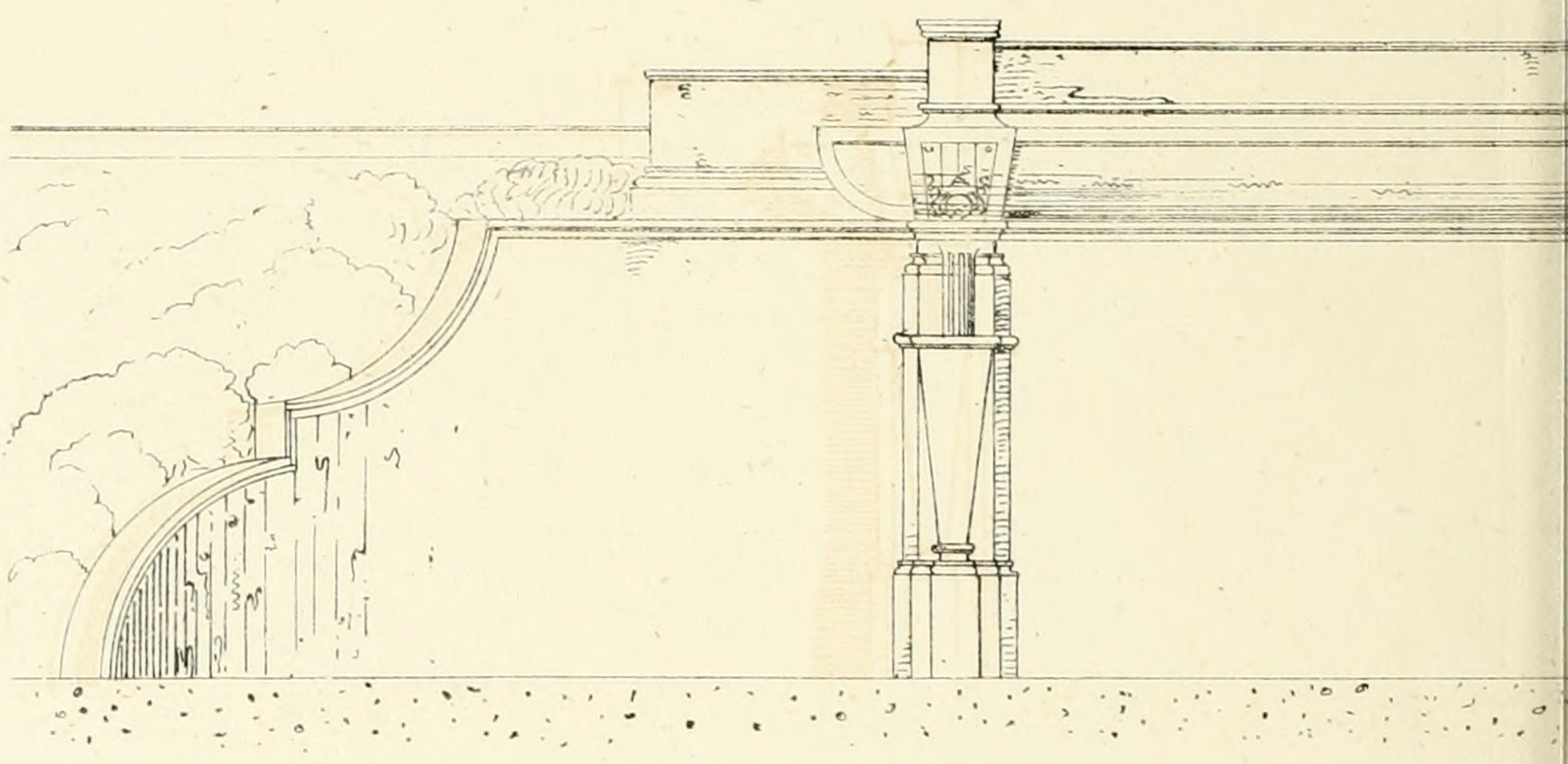
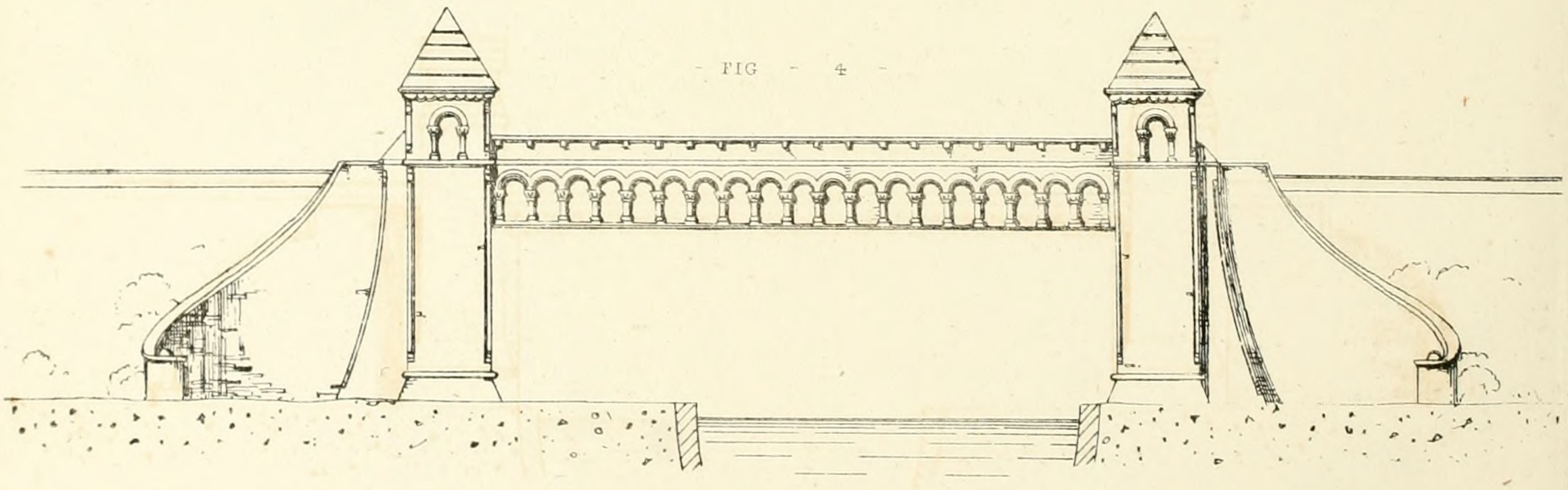


- FIG - 4 -



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MENTAL - BRIDGES -

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- RAILWAY -.

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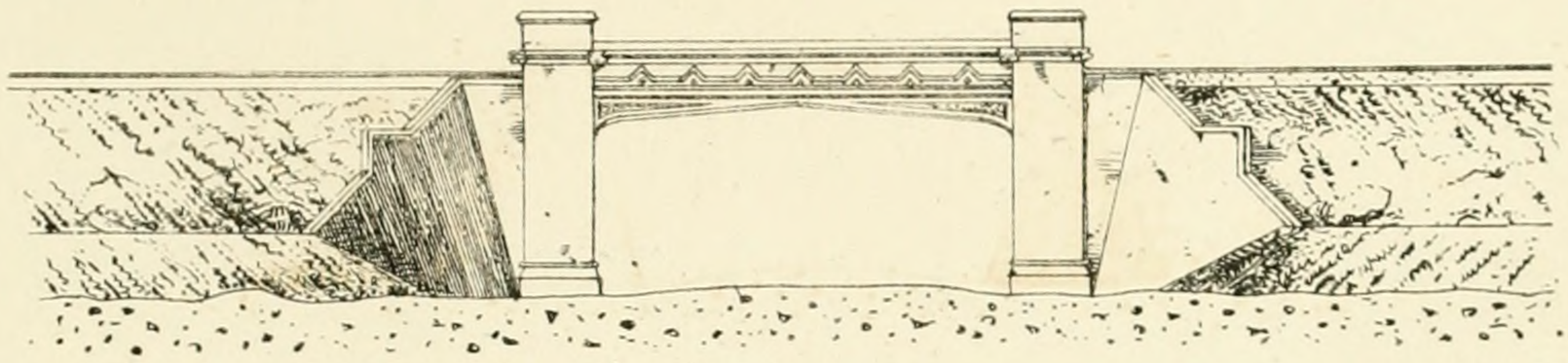
- FIG - 2 -



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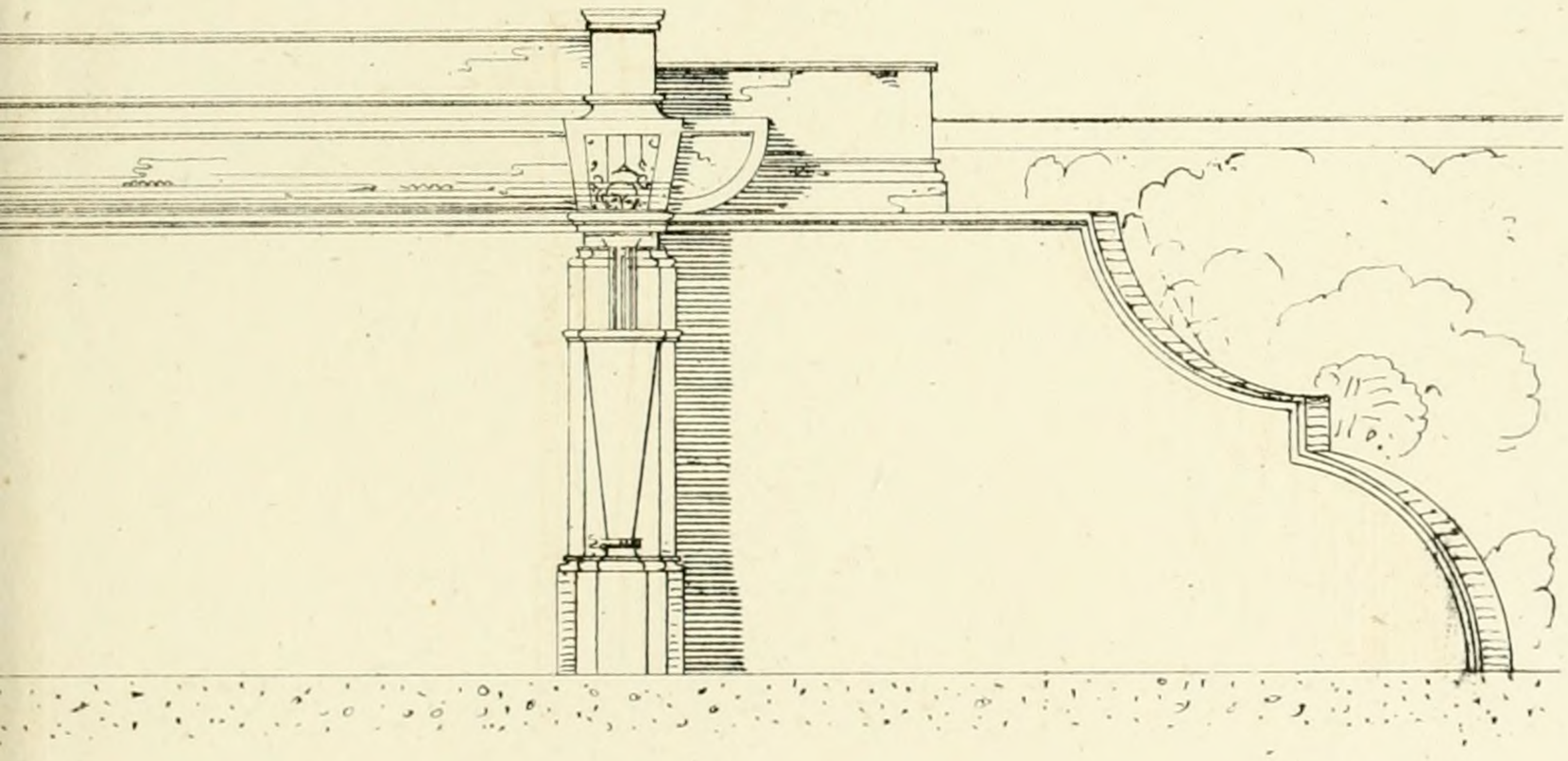
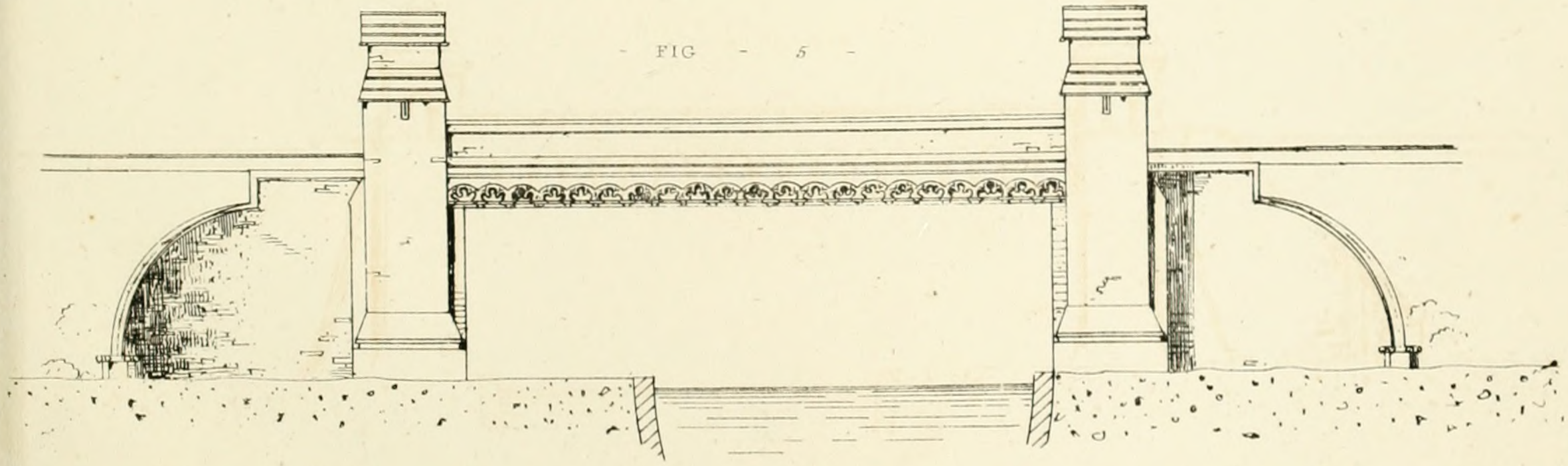


- FIG - 5 -



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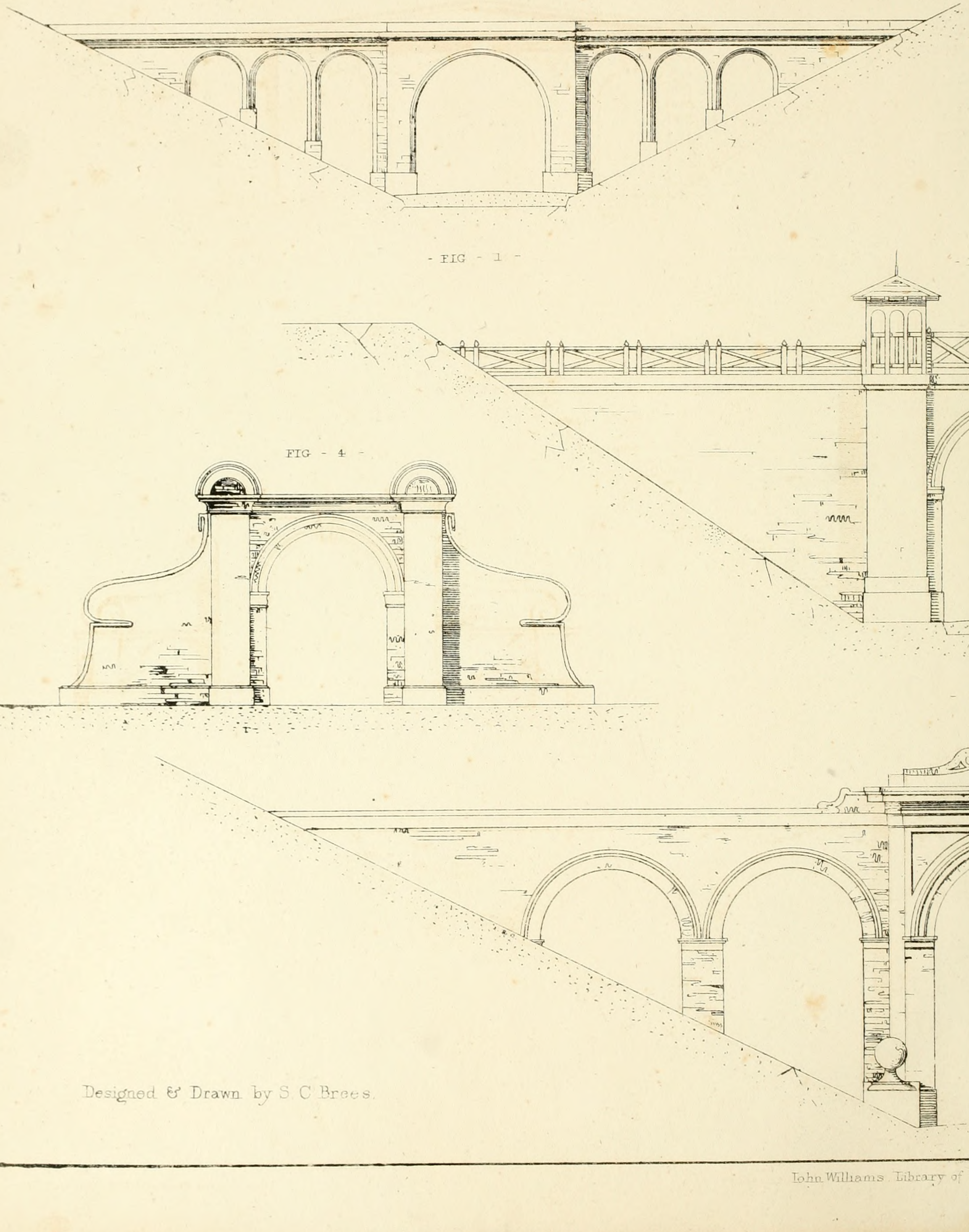

- FIG - 1 -

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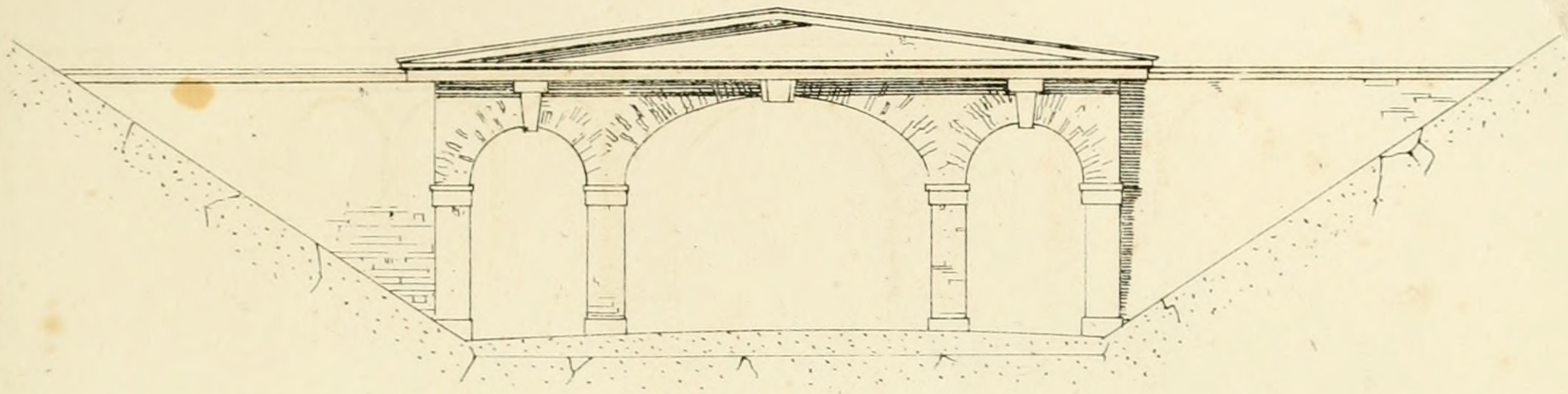
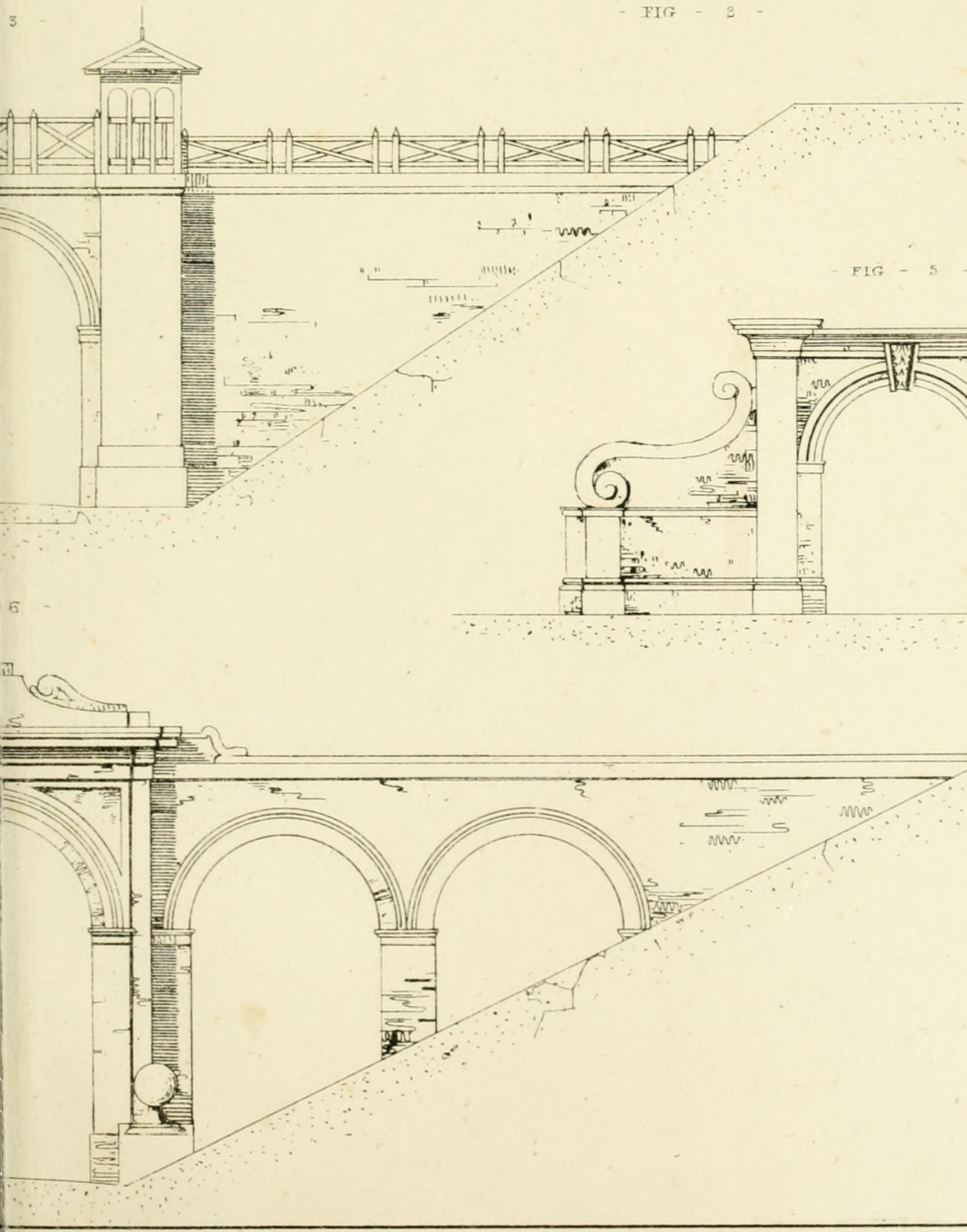
NTAL - BRIDGES -



- FIG - 2 -



- FIG - 5 -

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