THE ROYAL ENGINEERS JOURNAL.

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CONTENTS.

OFFICERS OF THE SPECIAL RESERVE, TERRITORIAL FORCE, AND THE TEMPORARY LIST, ROYAL ENGINEERS AND MEMBERSHIP OF THE CORPS ASSOCIATIONS AND CLUBS.

PROCEEDINGS of Meeting of the R.E. Corps Committee held in Room 230, War Office, July 21st, 1919 (in accordance with the resolution agreed to at the Annual Corps Meeting on 14th June, 1919.)

The following were present:—Major-Generals Sir P. G. Twining, (D.F.W.), *S. H. Powell, (C.E., Forces in Great Britain), *L. Jones, (C.E., Eastern Command); Brig.-Generals T. A. H. Bigge, (A.A.G., R.E.), *A. L. Schreiber, (C.S.M.E.), *G. S. Cartwright, (C.E., Aldershot), A. W. Roper, (I.R.E.), *G. Walker, (C.E., London); Major L. Chenevix-Trench, (Hon. Sec., R.E. Corps Committee).

* Specially attended with power to vote in accordance with resolution dated 3rd July, 1919.

AGENDA.—To discuss Major-General Sir P. G. Twining's proposal:—

That in the opinion of this Committee it is not only desirable but is necessary that all possible steps be taken towards preserving the feeling of friendship and *cameraderie* which existed during the war between the Regular Corps of R.E. and the Special Reserve, Territorial, and Temporary Officers and Men, and that as a means to this end the R.E. Institute, and as far as possible other Corps Institutions, should be thrown open to these officers, and that steps be taken to bring this as far as possible to the notice of all such officers.

ACTA.—The opinions of the Presidents of the several R.E. Corps Institutions were read, and following conclusions reached:—

R.E. Widows' Society, R.E. Band Fund.—The Deed of Settlement in the one case and Army Orders in the other preclude the possibility of an extended Membership.

R.E. Institute.—Already accepts *all* R.E. Officers (including S.R., T.F., and T.C.).

R.E. Charitable Fund.—Already accepts *all* R.E. including S.R., T.F., and New Armies.

R.E. Games Fund.—Terms of admission to be considered by Games Committee.

R.E. Entertainment Fund, R.E. Dinner Club, R.E. Luncheon Club.—Officers of the T.F. and S.R. and Temporary Officers will be welcomed at the Annual Dinner and the Annual Evening Entertainment, and the Luncheon Club tent will be open to them.

R.E. Old Comrades' Association.—Already open to *all* Members of Corps of R.E. including S.R., T.F., and New Armies.

CONTENTS.

Authors alone are responsible for the statements made and the opinions expressed in their papers.

MONTGOMERIE PRIZE.

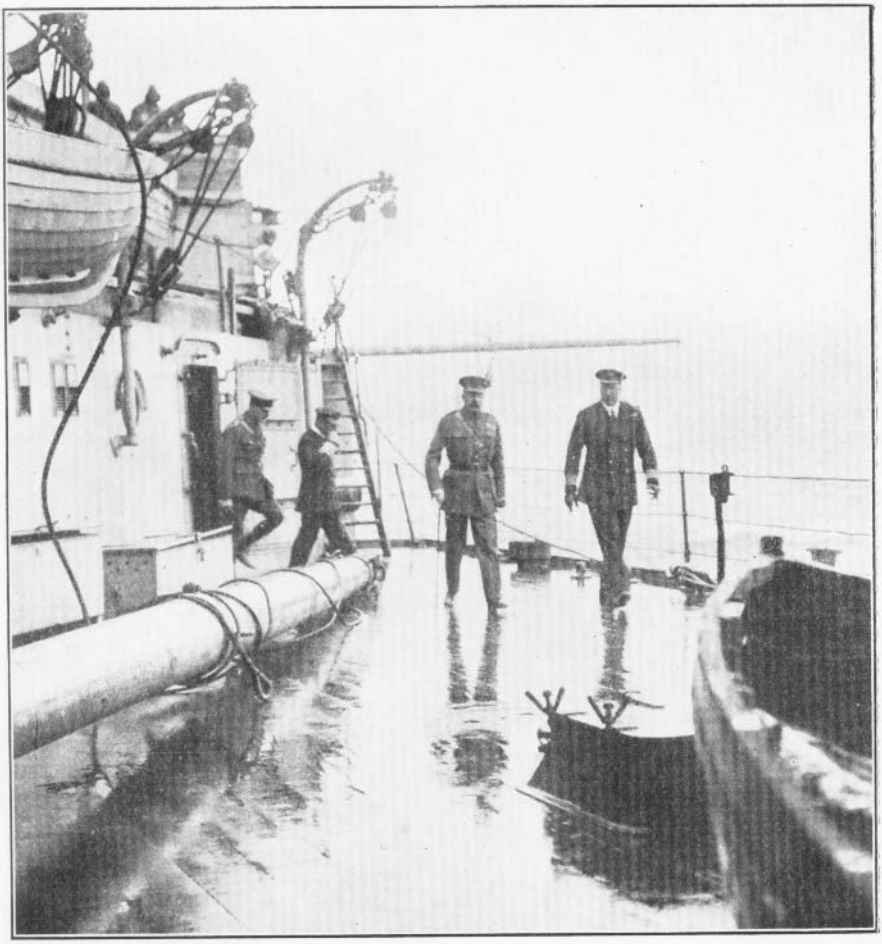
ATTENTION is invited to the conditions under which this prize, in value about £10, is offered for competition each year.

1. The Prize shall be awarded annually by the Institute Council in the manner they consider best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. For the present the prize shall be confined to officers on the active list below the rank of Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie coat-of-arms in gilt on the cover and the Montgomerie book-plate with inscription inside. (*b*) The remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

VISIT OF LORD KITCHENER TO THE GRAND FLEET AT SCAPA FLOW.



Lord Kitchener being shewn round H.M.S. "Iron Duke" by Capt. Dreyer, R.N. Admiral Jellicoe in the background.

VISIT OF LORD KITCHENER

VISIT OF LORD KITCHENER TO THE GRAND FLEET AT SCAPA FLOW.

THE photograph on the opposite page is one of a series of four which were taken on the occasion of the visit of Lord Kitchener to Admiral Jellicoe on board H.M.S. *Iron Duke*, the day on which he met his death by the sinking of H M.S. *Hampshire*, and which have been presented to the R.E. Museum by Sub-Lieut. G. Coffin, R.N., son of Major-General Clifford Coffin, V.C., D.S.O. The incident which is recorded in Admiral Lord Jellicoe's book, *The Grand Fleet*, 1914—16, is thus described by Lieut. Coffin :—

Lord Kitchener arrived at Thurso on 5th June, 1916, and was conveyed over to Scapa Flow in H.M.S. *Oak*, tender to the *Iron Duke*. He arrived aboard H.M.S. *Iron Duke* at about 11 a.m. and a tour of the ship was commenced. Lord Kitchener was shown round the ship by Capt. F. C. Dreyer, Flag Capt. to Admiral Jellicoe. He visited the conning tower, bridge, one of the turrets, and also the mess decks. After the tour the Field Marshal and his staff lunched with the Admiral, and at 2.30 Lord Kitchener left the *Iron Duke* in a drifter to embark aboard H.M.S. *Hampshire*. It was raining hard and a high sea was running.

This was the last seen of Lord Kitchener by the officers and men of the *Iron Duke*.

THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

(Continued).

BRIDGING. (PART III., SECTION 4).

CHAPTER I.

ORGANISATION AND SUPPLY OF MATERIAL.

Introduction.—First Orders for Steel Spans.—Heavy Pontoon Bridging Material.—Subsequent Orders for Steel Spans.—Characteristics and Developments of Types.—Bridging Depôts and Stores.—Special Bridging Staff Units.—Transport of Stock Spans.

1. *Introduction.*—At the beginning of the war the British Army not only was unprovided with special material for heavy bridging, but technical intelligence on which to base possible requirements was almost entirely lacking.

The need for heavy bridges was first experienced on the Aisne.

Some heavy timber girder and trestle bridges were built, but took too long to make and to erect, and the B.G., R.E. at General Headquarters promptly sent home a demand for steel spans.

At the end of November, 1914, Lieutenant Colonel W. A. Liddell (now Major-General Sir W. A. Liddell, K.C.M.G., C.B.) was appointed to the B.G., R.E.'s office for executive charge of roads and bridges in rear of Divisional R.E.

At that time there was only one army—later when a second was formed, the executive functions in respect of roads passed to Chief Engineers of Armies.

Compilation of Road and Bridge Maps.—The investigation of information regarding roads and bridges was at once commenced, and the work was done entirely in the B.G., R.E.'s office until the spring of 1916, when it was taken over by the Intelligence Section of the General Staff. The information was obtained with great difficulty, because most of the French departmental records of the area were left in Lille, and those of Belgium in Antwerp or Brussels—however, by the time the work was handed over to the Intelligence Section road and bridge maps as far south as the Somme, and as far east as the Escaut were practically completed.*

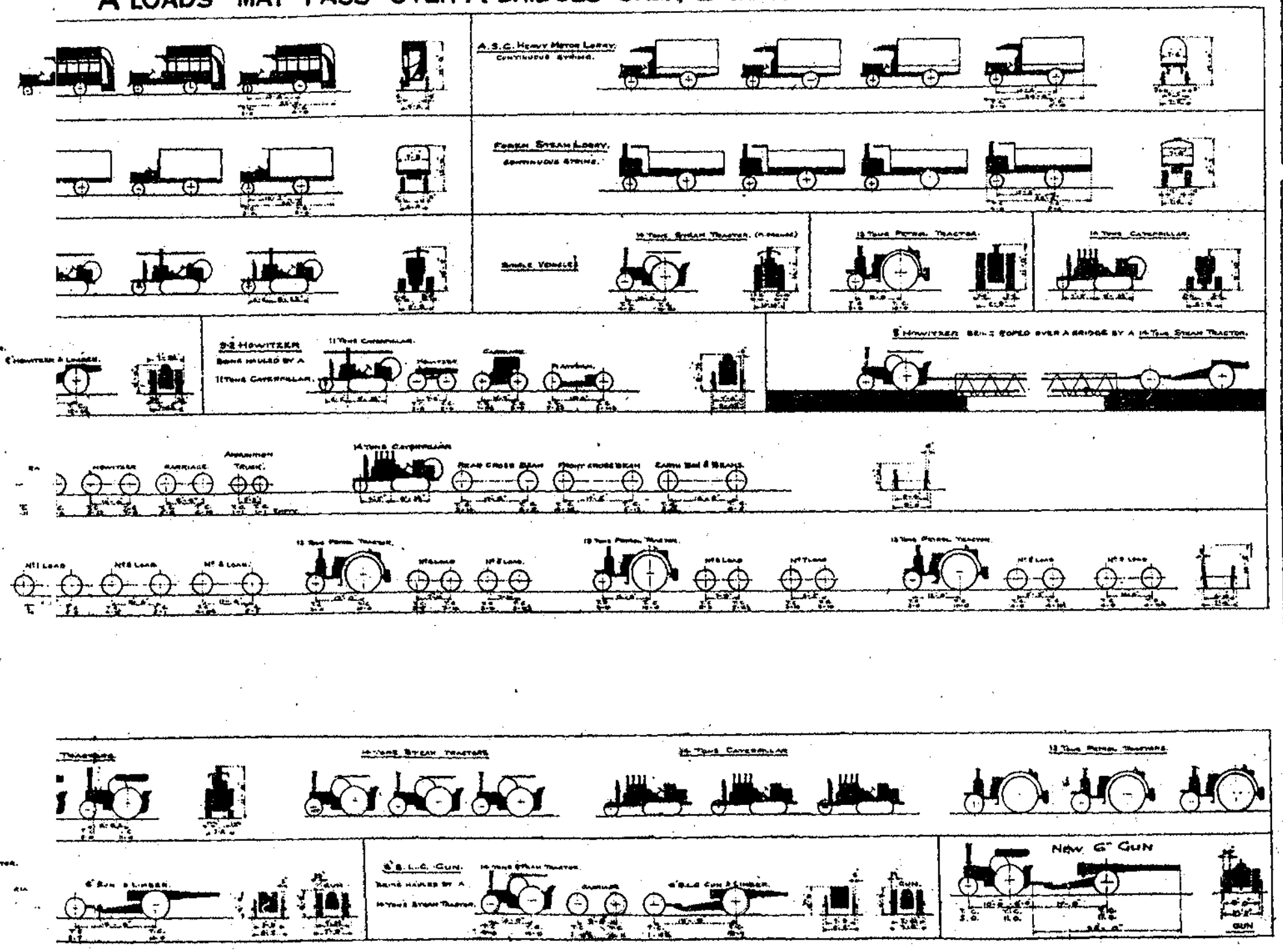
Details of the waterways in the area traversed by the Lys and its

*Further information on this subject will be found in a separate report on Engineer Intelligence.

PLATE I

DIAGRAM OF LOADS & BRIDGES

"A" LOADS MAY PASS OVER "A" BRIDGES ONLY, "B" LOADS MAY PASS OVER "A" & "B" BRIDGES.



CLASS OF BRIDGE

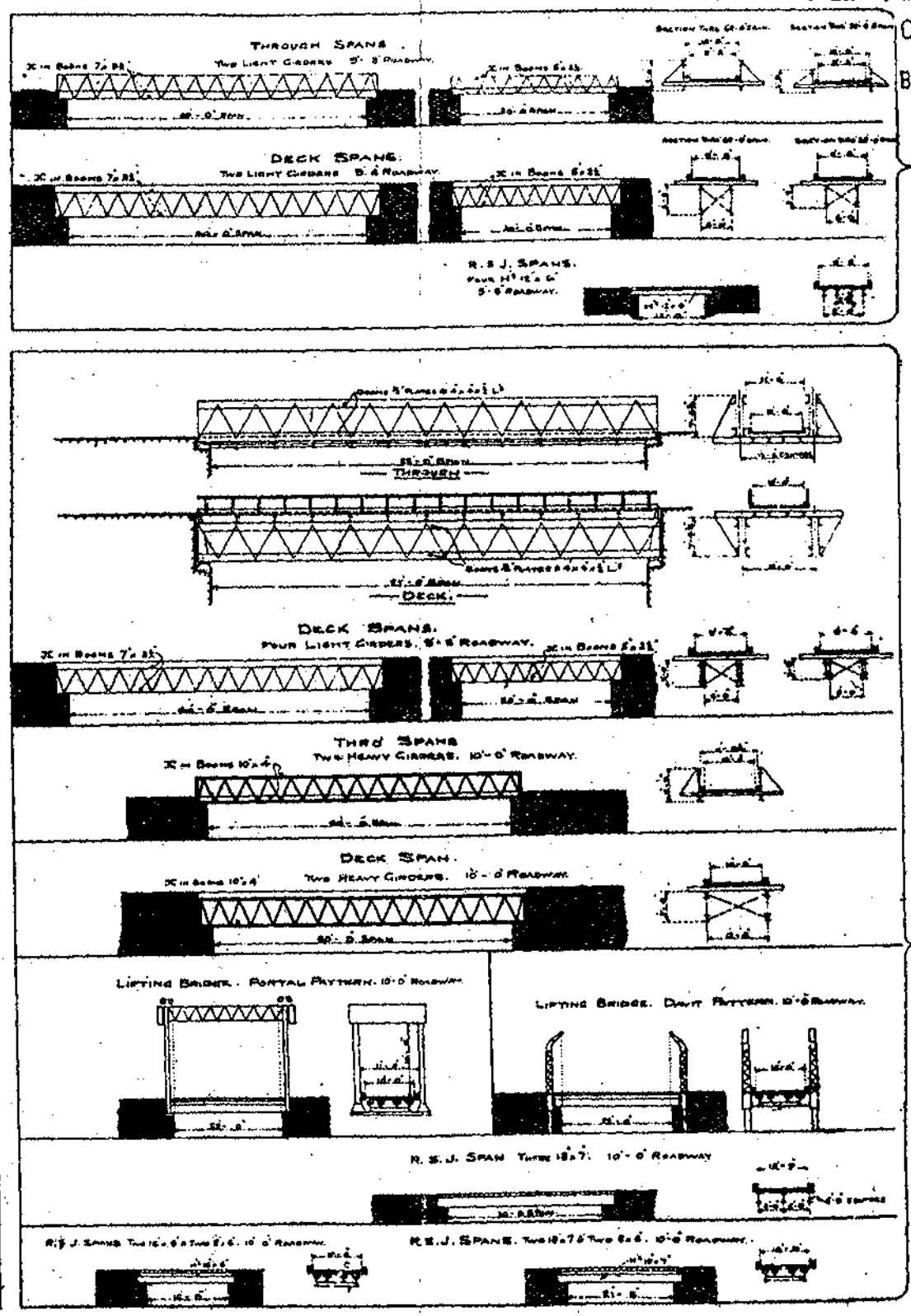
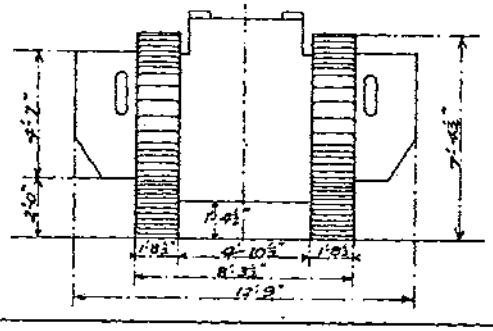


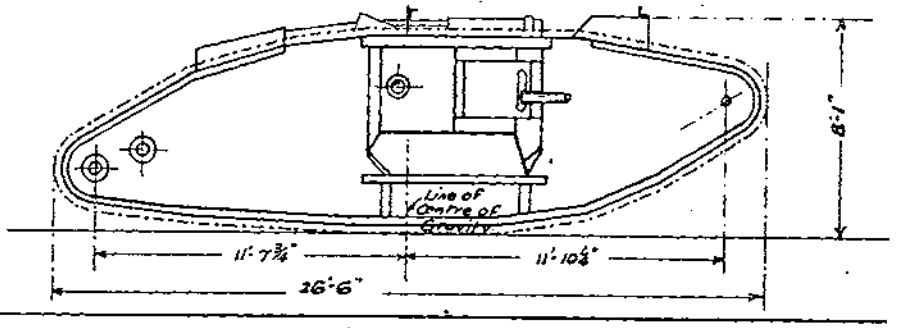
PLATE IA.

— DIAGRAM OF TANKS. —
— Scale 6 Feet = 1 Inch. —

— MARK IV. TANK. —

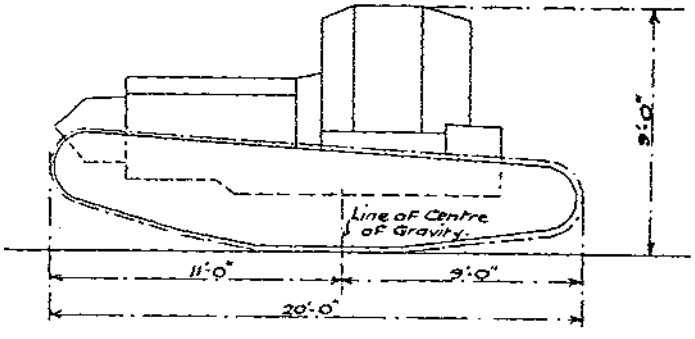
— APPROX. TOTAL WEIGHT —
FULL FIGHTING ORDER = 30 TONS.





— WHIPPET TANK. —

— APPROX TOTAL WEIGHT —
— FULL FIGHTING ORDER = 18 TONS. —



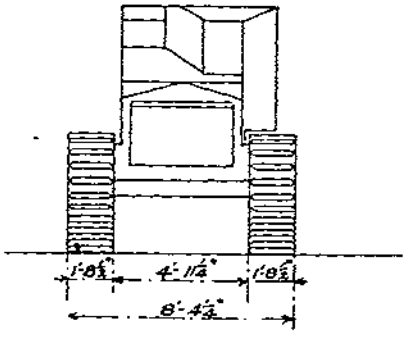


PLATE II.

STANDARD BRIDGE DRAWINGS AND APPURTENANCES.

D/189.	30 ft. Reinforced Span.
D/246/1 to 4.	21 ft. 6 in. Class " A " Mark II. Bridge.
D/248/1 to 4.	16 ft. Class " A " Mark II. Bridge.
D/270/1 to 10.	60 ft. Class " A " Mark II. Bridge.
D/275/1 to 17.	21 ft. 6 in. Span Pont Levis Bridge, Class " A "
DP/282/1 to 22.	Hopkins, 120 ft. Type Bridge.
DP/315/R.	Aerial Ropeway.
DP/288/M.	Monkey, 8¾ for Pile Driver.
DP/364.	Berthon Boats.
DP/365.	" "
DP/400.	Launching two 60 ft. Class " A " Girders Bolted Together.
DP/247/1 and 2.	Steel Lattice Derrick (Diagram of Test).
DP/413/1 to 16.	Hopkins 75 ft. Type Span.
DP/415/1.	Wearing surfaces for Bridges.
DP/416.	French Motor Pile Drivers.
DP/420.	Pont Levis, 21 ft 6 in Class " A " on Piles See DP/530
DP/446.	Pont Levis (Balance Weight revised).
DP/447.	Duplicating of 21 ft. 6 in. Spans, Class " A," Mark II.
DP/448.	Piling by Water Pipes, etc.
DP/458/A.	Centre of Gravity, Medium Mark " A " Tanks.
DP/503/A1 to A4.	Tank—Male and Female, Mark IV.
DP/504.	Derrick Ring for Hopkins Bridges.
DP/512/1 to 5.	30 ft. Mark II. Span Bridge.
DP/514.	Drawing of Fish Plates for 16 ft. and 21 ft. 6 in. Mark II. Spans (See DP/551).
DP/515/1 to 5 DP/515/8	19 ft. Span Tank Bridge.
DP/519/1 to 3.	Emergency Bridge for First Line Transport.
DP/530.	Pont Levis on Piles (supersedes DP/420).
DP/541.	Launching Diagrams, 60 ft. Span, Class " A "
DP/542	" " " "
DP/542/M.	" " " " (supersedes DP/542)
DP/542/MM.	" " " " (supersedes DP/542/M).
DP/543/1 to 9R.	Portal Bridge (Emergency) for First Line Transport.
DP/550/1 to 6.	Timber Bearings (Bank Seats) for 120 ft., 85 ft., 60 ft., 30 ft., 21 ft. 6 in. and 16 ft. Spans, and Splayed curb for same.
DP/551.	Fish Plates for 21 ft. 6 in. Span and 16 ft. Span, Mark II.
DP/552/1 and 2.	Timber Bearing and Bearing Plate for Inglis Rect. Bridge.
DP/557/1 to 15M.	Pont Levis Bridge Mark II.
DP/556/1 to 5.	21 ft. 6 in. Span Mark III.
DP/563/1 to 10.	Portal Emergency Bridge for 12T Axle.
DP/566/1R and 2.	Alteration to Portal 21 ft. 6 in. Lifting Bridge.
DP/573/1 and 2.	Pier Trestle for Class " A " Bridges.
DP/575/1.	60 ft. Span Mark II. Detail, showing Method of Strengthening Struts.
DP/578/1R. to 3.	Detail of Strengthening 85 ft. Span for Tanks.
DP/586.	Pile Piers. Detail of junction of 19 ft. Span and Portal Span.
DP/587/1 and 2.	Erection and Launching of 85 ft. Span.
DP/590.	Detail of Splice for 12 in. × 12 in. Piles.
DP/597/1 to 4.	30 ft. Reinforced Span as Lifting Portal.
DP/598.	Pier for junction of 85 ft. Class " A " and 30 ft. Reinforced.
DP/603/1 and 2.	Pile Pier of 85 ft. Class " A " Spans.
DP/705/1 and 2.	Pile Pier for junction of 85 ft. and 30 ft. Spans, Class " A."
DP/709.	Girder for 30 ft. Reinforced Span in one Length.
DP/724/1 to 12.	Hopkins Lorry Bridge.
DP/732.	Emergency Short Span Bridge for Tanks (for rapid Bridging). This was a special case.
DP/734.	Diagram showing Distribution of a Heavy Bridging Company for Simultaneous Work on an Army Front.
DP/735/1Z.	Proposed Method of Transporting and Launching 21 ft. 6 in. Span Bridge.
DP/735/2Z.	Mobile Girder Bridge and Pontoon Bridge for 200 ft. River.
DP/736/1 and 2.	Standard Field Bridge, 20 ft. Span, for Tanks, now superseded by DP/755.
DP/737/1 and 2	18 ft. Standard Field Bridge to carry Tanks. Superseded by DP/756.
DP/741/1 to 3.	20 ft. Standard Field Bridge for 12T Axle Load. Superseded by DP/755/1 and 2
DP/742/1 to 3.	18 ft Standard Field Span for 12T Axle Load. Superseded by DP/756.
DP/743/1 to 3.	20 ft. Standard Field Span for First Line Transport.
DP/744/1 to 3.	18 ft. " " " "
DP/745/1 to 4.	Standard Field Davit Span for 12T Axle.
DP/755/1 to 3.	22 ft. R. S. J. Standard Field Bridge.
DP/756/1 to 3.	20 ft. " " "
DP/757/1 to 7.	American Steel Lattice Girder Bridge, 90 ft. Span.
DP/766.	Standard Trestle for use with R.S.J. Field Spans.
DP/767.	Pile Piers for R.S.J. Standard Field Spans.
DP/768/1 and 2.	Launching Diagram for 180 ft. of Hopkins 120 ft. Type Span.
DP/770.	Mark V. Male Tank—34 Tons. Mark V. Male Tank—30 Tons.
DP/755/1 and 2.	Fittings for Hopkins 180 ft Span, 120 ft Type.
DP/779.	Launching Roller for Item 152. H.B.23.A.
DP/781/1 to 3.	33 ft. Standard Field Span for Tanks and 12T Axle Load.
DP/786.	Special Spanners for Hopkins Bridge.
DP/785/Z.M.	Motor Driver Friction Winch.
DP/791.	Cube Pier. Supersedes Plate 15, Revised.
DP/796/12.A.	Alteration to Pont Levis Bridge Mark II. for Lifting Arrangement; Modification of A.13.
DP/797	Wire Rope Slings and Forged Steel Shackles.

tributaries and the adjoining canals (Aire-La-Bassee, Ypres-Menin, etc.) were first obtained, and before the battle of Loos in September, 1916, maps and books for the immediate British front had been issued—a portion of one of the earlier sheets is reproduced (*Map* A.).

Diagrams of Loads, etc.—The next step was to work out technical details for the transport, assembling, and launching of the steel spans under order from England.

Great progress had already been made before the end of 1914, and many details were sent to England together with a diagram of loads, all of which were elaborated by the Inspector of Iron Structures, and incorporated in a book termed *Portable Road Bridges, and Diagrams of Roads and Bridges* issued from that office. A second volume was issued later to show the A.A. type bridges, and a complete new edition was in preparation at the time of the Armistice.

Plate I. is the original diagram of loads, and *Plate* IA. a diagram of tank loads.

Base Depôt, Havre.—Steel spans began to arrive early in 1915, and by the end of that year bridges of all types had been received, and were erected at the Base Park, Havre. Work of the very greatest value was done at this park, where not only were experiments of every kind carried out which led to many improvements in methods of erection, etc., but instruction was also given to a large number of R.E. officers and other ranks.

During practically the whole of 1915 and 1916 classes were continually held under the supervision of the O.C. Base Park in addition to his normal duties. The work ultimately became far too heavy, and the formation of a proper bridging school was finally approved. This is fully described in the Appendix.

Memo. on Road Bridges.—During the summer of 1915 the first edition of *Memo. on Construction and Repair of Road Bridges* was issued from the Engineer-in-Chief's office. This was mainly compiled from the results of experience obtained by the O.C. Base Park, to whose foresight, zeal, and unremitting work much of the later success of the organisation for heavy bridging operations is due.

At the end of 1917, a pamphlet on *The Organisation of Bridging Work* was issued based on the practical experience gained in the crossing of the Somme at the beginning of that year.

During the summer of 1918 a completely new edition of *The Memo. on Road Bridges* was brought out in which the contents of all the previous publications were embodied and brought up to date.

A regular series of drawings and publications dealing with stock spans and bridging appurtenances was issued from time to time during the war from the Engineer-in-Chief's office.

A complete list of these is given on *Plate* II.

Development of Organisation.—It will be easily understood that an enormous amount of work was involved in developing the details

of what was comparatively a new subject in field military engineering; of course there had been a great deal of rapid railway bridge work in the South African War, but the conditions in France were different, and it was seen that the rate of advance of an army fed and supplied mainly by motor transport, and with a very large proportion of heavy artillery, would depend in a measure on the rapidity with which heavy bridges could be constructed.

The width of the front demanded a large number of bridges to be constructed simultaneously, with labour which could only be partly skilled, consequently the organisation of supply of materials, namely—storage, sorting, loading and despatch, reception near site, and transport, had to be perfected, and full instructions for erection had to be formulated, based on local conditions. Types of bridges had to be standardised after experiment, and also methods of erection to compensate for the lack of fully skilled labour and superintendence.

Field Engineers.—The appointment of field engineers (civil engineers of good technical experience) made early in 1915 was partly designed with a view to the superintendence of heavy bridging work. At the time the amount of bridging work in progress did not require specially appointed officers, but as demands for bridges increased, the field engineers gradually were taken on to the staff of C.E.'s of corps and armies as bridging officers; similarly in the E. in C.'s office a succession of temporary field engineers and the staff of the bridging school all contributed to the gradual development of the organisation.

Engineering Stores Directorate.—On the formation of the Directorate of Engineering Stores in the summer of 1918, the whole supply of heavy bridging materials and stores was taken over by the new director, who was also responsible after the Armistice for the disposal of all surplus material and stores, as well as for the sale of bridges *in situ* to the French and Belgians. The compilation of exact records of all the bridges erected was a long and difficult job. This was done in the office of the Engineer-in-Chief, as well as the valuation of all bridges, the statistics being finally handed over to the D.E.S. for completion of the business part of the sales.

Steel bridges were valued solely on the weight of metal at an agreed price per ton, all timber and fittings being thrown in gratis.

French, Belgian and American Organisation.—The French had six heavy bridging specialist companies in 1915—16, but their bridge spans were largely improvised from ships' plate, and the companies were manned by dockyard *personnel.*

The types of bridges were not satisfactory; they would not carry our heaviest ordnance nor their own, and the roadway and clearances were also insufficient; these were revised later on.

The Belgians depended mainly on wooden girder bridges on wooden piles, but their material and stock were very scanty.

The French bridging on the Yser Canal during the Passchendaele attack in 1917 was done almost entirely with material supplied to them by the British Army.

The Americans fully recognised the necessity for large supplies of steel bridges, and decided to adopt the British types generally. After careful investigation they decided to produce a modified pattern of the 60-ft. span, in which the cross girders and flooring were raised so as to allow the sponsons of tanks to ride over the girders.

An agreement was made under which a number of these new spans were to be supplied to us by the American Army in return for an equivalent weight of Hopkins' 30-ft. and 21-ft. 6-in. bridges—none of the new type had been actually delivered before hostilities ceased.

2. *First Orders for Steel Spans.*—At the beginning of October, 1914, a letter was drafted by the Brigadier-General, R.E., at G.H.Q., and sent to the War Office under the signature of the Commander-in-Chief, asking for the provision of material for 16 steel girder bridges, together with an adequate supply of pile drivers and monkeys. These bridges were to be capable of carrying the heaviest loads then in the country (8-in. howitzer—13 tons on one axle).

The actual designs were made at the office of the Inspector of Iron Structures, with the following limitations laid down by the B.G., R.E., France :—

(*a*) Maximum length of one piece not to exceed 25 ft.
(*b*) Width of one piece not to exceed 7 ft. 6 in.
(*c*) Weight of one piece not to exceed 3½ tons.

The first order was actually placed at the beginning of December for 4,140 ft. run in 13-ft., 30-ft. and 60-ft. lengths, and deliveries were promised to begin by the end of December. Before many of these were received, the introduction of the 6-in. Mark VII gun on Naval Carriage had increased the maximum axle load to 17 tons, and in March, 1915, another order was given for bridges to carry this load in lengths of 16 ft., 21 ft. 6 in., 30 ft., 60 ft. and 85 ft.; also in January, 1915, the first order was given for Lifting Bridges for use on navigable canals. The design for these was got out in the office of the B.G., R.E., France.

The bridges to carry 13 tons axle load were termed B type bridges. Those to carry 17 tons axle load A type bridges.

Manufacture of these first two orders was pressed on with the greatest possible speed.

At the beginning of 1915 the military situation made it clear that there would be no immediate use for these bridges, and considerable difficulty was found in providing storage space for them at the base as they arrived.

The War Office pointed out that extraordinary exertions had been

made by all concerned in the bridge production, and that it was very desirable that there should be no delay in accepting delivery.

With some difficulty yard room was arranged at Havre, and this developed into the permanent heavy bridging depôt, and remained as such throughout the whole of the war.

3. *Heavy Pontoon Bridging Material.*—In the early days of the war the War Office took up the question of heavy floating bridges that might be required for the passage of the Rhine in the event of operations being carried into the enemy's country.

The design was got out for a heavy pontoon to carry the maximum load of a 14 tons traction engine across a river 500 yards broad, with a minimum current of five miles an hour. A special steel pontoon was designed 45 ft. long, 4 ft. deep, and 8 ft. beam, weight of each pontoon approximately 5 tons, weight of super-structure of each pontoon 3½ tons, clear waterway 12 ft. The earliest date of delivery quoted was the end of July, 1915.

At the beginning of March, 1915, the War Office wrote to the C.-in-C., B.E.F., France, asking :—

(i) Whether it was desirable to arrange for supply of this material.
(ii) Whether the design was considered suitable.
(iii) Whether two bridges, each of 500 yards length, should be provided for, or one only.
(iv) Whether the date of earliest delivery was considered suitable.

The higher authorities in France were unanimous in expressing the opinion that the British Army was unlikely to be called on to bridge the river Rhine in the course of active operations.

The Chief of the General Staff considered that material should be provided for not less than 20 bridges, capable of carrying the heaviest loads over the Upper Scheldt, the Dendre, and the Meuse, and 10 over the river Lys.

The B.G., R.E., insisted on the advantages of steel girders resting on fixed foundations over any form of floating bridge, and a reply was accordingly sent to the War Office deprecating the expenditure of valuable time and material on floating bridge equipment.

Owing to the enormous pressure of other work at home, the additional steel bridges required by the C.G.S. were not ordered for the moment.

Meanwhile experiments were continued by the Deputy Director of Works attached to the office of the B.G., R.E., in the fitting out of standard French 280 tons barges so as to form road bridges with cuts for canal traffic.

4. *Subsequent Orders for Steel Spans.*—At the beginning of October, 1915, the Engineer-in-Chief obtained authority to order approximately

10,000 ft. run additional steel bridging in spans varying from 16 ft. to 85 ft. The reasons given for the necessity of this order were, first, that the size of the British Army had been more than doubled, secondly, that we had a liability to provide the French Army with material for 12 heavy bridges in case of an advance as far as Valenciennes, and that we should probably also have to supply the Belgian Army. The total amount now on order was calculated to allow about 10 bridges per Army Corps, which was thought to be the minimum that was likely to be wanted, allowing for 20 Corps British and French in line.

The situation was next reviewed by the Engineer-in-Chief in January, 1916, in a letter to the Quartermaster-General, giving details of material received up to date. He also reported that three fleets of equipment barges were completed, and a fouth nearly ready. A certain number of Inglis type bridges had also been ordered.

The E. in C. pointed out that there was no alteration in the military situation, and recommended that no further orders for bridging material should be given at present.

In April, 1917, the Engineer-in-Chief wrote to the C.G.S., and to Q.M.G., again reviewing the situation in the light of the experience gained by the Fourth Army in crossing the Somme, and also of the much fuller information that had become available as to bridges in the country in front of us.

He also pointed out that neither the French nor Belgians appeared to have made any serious provision for heavy bridging, and also drew attention to the extra requirements of light railways. A table was drawn up showing the number of bridges that might be required for an advance of 50 miles beyond the present line, and numbers of spans actually available.

Authority was asked to order 50 each of the following Class A spans—85-ft., 60-ft., 21-ft. 6-in., and 16-ft.

Changes due to Introduction of Tanks.—During 1917 considerable modifications had to be made to practically all the type spans owing to the introduction of tanks, which increased the maximum load to be carried from 17 tons to 30 tons. Certain of the stock spans could not be converted to carry this increased load, and consequently fell into disuse later on. The question of roadway clearance and head room was carefully investigated, and the G.O.C. Tank Corps decided that no alteration of design was required in these respects.

The stock spans generally gave a clear roadway of 10 ft., which, although insufficient for tanks with sponsons out, was ample when sponsons were turned in, and no difficulty was anticipated in doing this when necessary. In actual experience this view was not confirmed, and during the first half of 1918 a certain number of tanks were probably lost owing to the impossibility of turning in sponsons in emergency.

The new and converted bridges were termed A.A. type.

The retreat in March and April, 1918, also cost the loss or destruction of a quantity of heavy bridging material, estimated to amount to about 17,000 ft. run.

These points were brought forward in a letter from the E. in C., to the C.G.S. in May, 1918. For these and other reasons it was considered that the material still in hand or under order would only provide for a 30-mile advance, instead of 50 miles, and a further large order was recommended calculated on an additional 50-mile advance.

It was also recommended that 25 per cent. of the new bridges should be of an increased width to allow of the passage of tanks with sponsons out.

During the year 1918 the situation was constantly reviewed, and every effort made to hasten deliveries, though this was found to be almost impossible owing to the very full programme of work at home, and difficulties in the supply of raw material.

Only a portion of the spans ordered were received before the Armistice, when outstanding orders were at once cancelled.

In October, 1918, a further extensive order was made out to be spread over most of the following year, but this was cancelled after the Armistice.

The following is a summary of the quantities of heavy bridging material ordered during the war :—

October, 1914.—4,140 ft. run (B type span). Length of spans—13 ft., 30 ft., 60 ft.

March, 1915.—7,473 ft. run (A type span). Length of spans—16 ft., 21 ft. 6 in., 30 ft., 60 ft., 85 ft.

October, 1915.—10,425 ft. run (A type span). Length of spans—16 ft., 21 ft. 6 in., 30 ft., 60 ft., 85 ft.

April, 1917.—9,130 ft. run (A type span). 16 ft., 21 ft. 6 in., 60 ft., 85 ft.

May, 1918.—21,250 ft. run (A and A.A. type spans). 21 ft. 6 in., 30 ft., 75 ft., 120 ft.

Supplies of heavy baulk and other timber for piles, seatings, roadway, etc., in proportion in each case.

5. *Characteristics and Development of Types.—B Type Bridges.*—The 13-ft. bridge consisted of four 12 in. × 6 in. rolled steel joists.

The 30-ft. and 60-ft. types each consisted of two light Warren girders.

The earliest of these sent to France were all deck spans, but modifications were introduced to make them capable of being used as either deck or through spans, as it was found that in many cases the deck span did not allow sufficient head room on navigable canals.

A Type Bridges.—The 16-ft., 21-ft. 6-in. and 30-ft. were all manufactured rolled steel joist spans.

The 60-ft. and 85-ft. consisted of heavy Warren girders. The 21-ft. 6-in., 30-ft. and 60-ft. types are illustrated in *Plates* III. to IX.

A.A. Type Bridges.—Modifications were made in the 16-ft., 21-ft. 6-in., 30-ft. and 60-ft. bridges, to carry the extra load. In the case of the 60-ft. all that was found necessary was an increase in the size of the bolts.

The 30-ft. A span was weak, and to use up the existing spans, the 30-ft. reinforced bridge was designed, in which four existing girders were used instead of three as in the A span. In the A span the rolled steel joist girders are jointed, but when new spans were ordered the girders were made in a single piece 33 ft. long. This extra length had been made feasible by the introduction of Berna lorries, fitted with a special arrangement of rollers for carrying long timbers or girders.

The 85-ft. type had never been popular owing to the great weight (66 cwt.) of a single section, so the opportunity was taken to design a new bridge. *Photograph* I. shows an 85-ft. span.

Hopkins' 120-ft. Type Span.—The following specification was laid down :—

(*a*) The bridge should carry tanks.
(*b*) The total weight of the bridge should not be more than the weight of the old 85-ft. span.
(*c*) The heaviest single piece should not weigh more than 30 cwt.
(*d*) The number of bolts should not be unduly increased.

These conditions were completely satisfied by the Hopkins' bridge. The bridge can be made up in any multiples of 15-ft. spans, and carries tanks over a 150-ft. span, and a 17-ton axle load up to 195-ft. span. The total weight of the steel work is 43 tons for a 90-ft. length, as compared to 53 tons for the original 85-ft. span. The heaviest section only weighs 10½ cwt., and the number of bolts for a 90-ft. length is the same as that in the 85-ft. class A span.

The main feature of this bridge is the depth of the lattice girders, which are 16 ft. 3 in. over all, with overhead bracing.

The general arrangement of this bridge is shown on *Plate* X. *Photographs* II. to IV. illustrate erecting and launching at the bridging school.

Hopkins 75-ft. Type.—The Hopkins' 120-ft. type was found so satisfactory, that at the beginning of 1918 a similar bridge of slightly lighter design was ordered in 75-ft. span, and would have ultimately replaced the 60-ft. type bridge.

This 75-ft. Hopkins carries tanks up to 90-ft. span, and 17-ton axle load up to 105-ft. span. It weighs a few tons less for a 60-ft. length than the 60-ft. class A bridge. See *Photographs* V. and VI.

Hopkins Lorry Bridge.—In the autumn of 1918 a very light lattice

girder bridge was designed to carry loads up to 5-ton lorries over a 75-ft. span. This bridge was still in the experimental stage at the time of the Armistice. The only one that was actually received in France was erected at the bridging school during the last class held there. Both instructors and students were unacquainted with the bridge, but a 60-ft. length was built, launched, decked, and approach ramps fitted ready for traffic in five hours. This is illustrated in *Photographs* VII. and VIII.

Lifting Bridges.—Belgium and Northern France are cut up by a network of canals, along which a great quantity of war material was conveyed, and which it was consequently necessary to keep open for traffic. These canals could often be bridged by erecting high level bridges, but in very many cases the same result was more easily attained by using lifting bridges.

The maximum width of locks is 6·50 metres (21 ft. 4 in.), so 21 ft. 6 in. was made the standard span for British lifting bridges.

The first types supplied were 21-ft. 6-in. class A spans, with the addition of lifting gear. These were made in three patterns, the Davit Bridge, the Portal Bridge, and the *Pont Levis*. Of these the first two were supplied by the War Office, and the third was manufactured in France, from designs got at the Base Park, Havre, and modelled on the local French 16-ft. span *pont levis*.

The Davit Bridge consisted of four lattice davits, with a lifting gear of differential blocks, by means of which the four corners of the bridge could be raised.

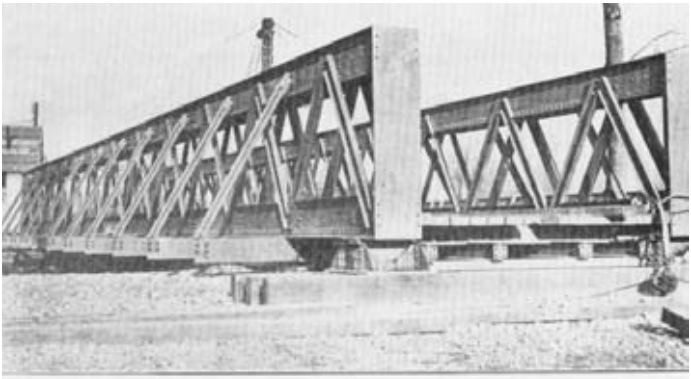
There was no counter-weight of any kind, and if the four corners were not lifted evenly the bridge was apt to jamb.

It was difficult to erect accurately, and required four men to raise or lower it, and not being found satisfactory, was soon given up for field use.

This type was originally intended for improvised low level bridges on canals where the footings of formerly existing bridges had been damaged by explosion.

The Portal Bridge consisted of four columns braced together with shallow lattice bracing girders at the top, both across the roadway and across the canal, and the lifting gear consisted of a worm gear arrangement with a hand chain for working it, and there was also a counter-weight equal to the weight of the bridge. The lifting arrangement was weak, and trouble was also caused by the fact that bridges were supplied by four different makers, each to their own detailed drawings, so that spares were not interchangeable. It was an easy bridge to erect, and failing a better pattern a good many were used.

The Pont Levis consists of two independent towers with overhead arms carrying a counter-weight between them at one end, the bridge being suspended by wire ropes at the other end. The lifting apparatus



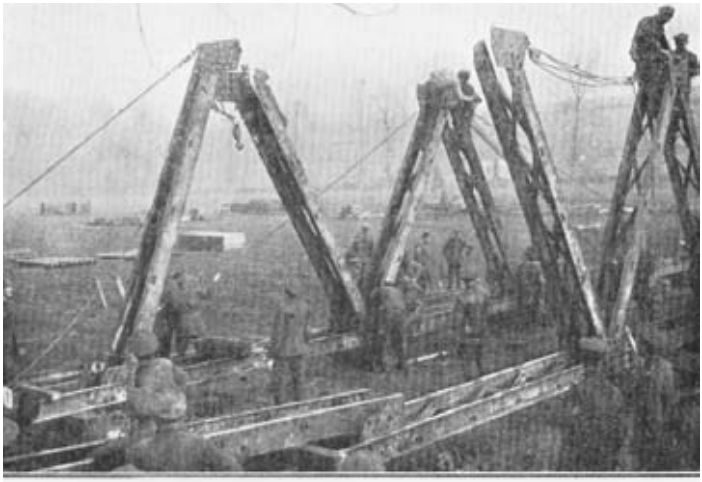
Photograph I.—85-Ft. Class "A" Span.

Photograph II.—Launching Hopkins 120-Ft. Type Span.
View from near bank, showing temporary wire rope cross bracing.

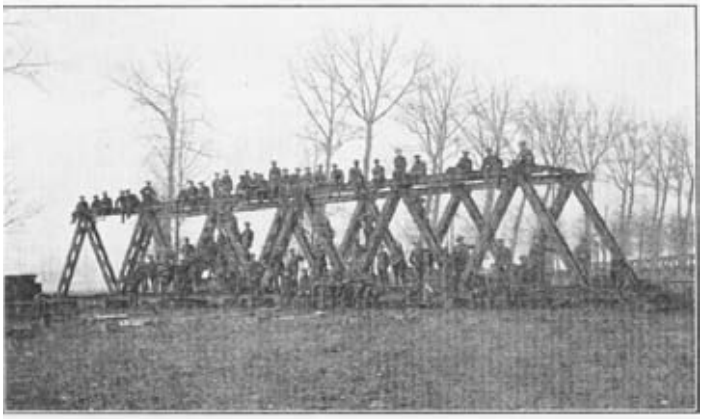
GIRDER BRIDGE

Photograph III.—Launching Hopkins 120-Ft. Type Span.
Span launched 45 ft. Fixing slings for main launching tackle.

Photograph IV.—Launching Hopkins 120-Ft. Type Span.
Span launched 110 ft.

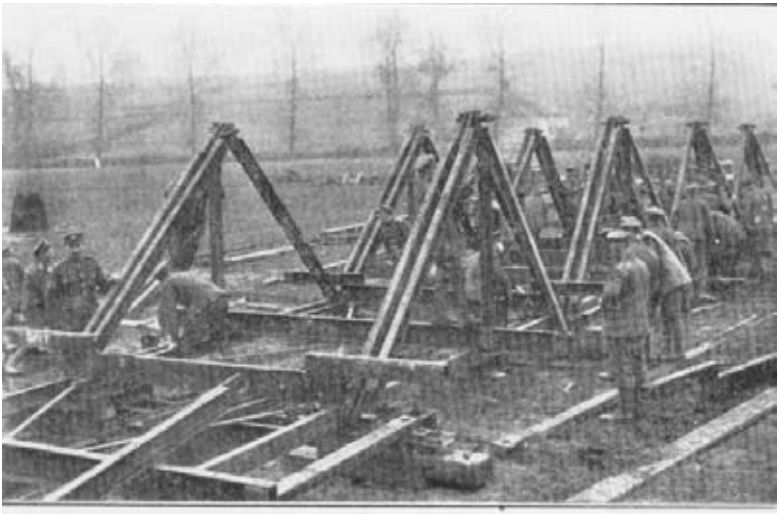


Photograph V.—Hopkins 75-Ft. Type.



Photograph VI.—Hopkins 75-Ft. Type.

GIRDER BRIDGE



Photograph VII.—Hopkins Lorry Bridge.

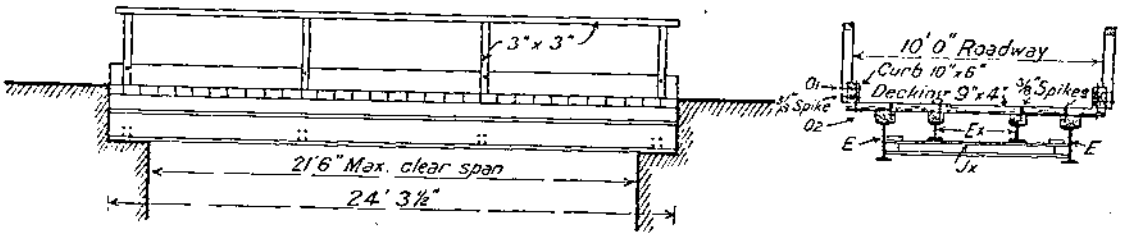
Photograph VIII.—Hopkins Lorry Bridge.

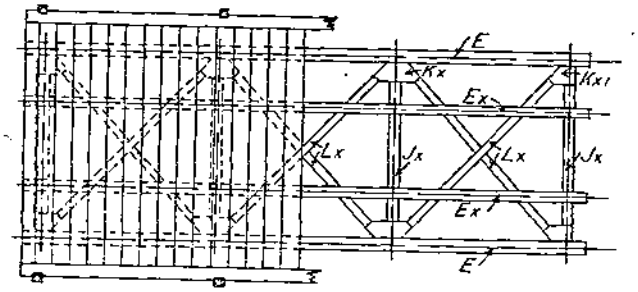
GIRDER BRIDGE

PLATE III.

R.S.J. SPAN. (FIXED) 21' 6" SPAN. CLASS "A."

The 16' 0" Class "A" is similar

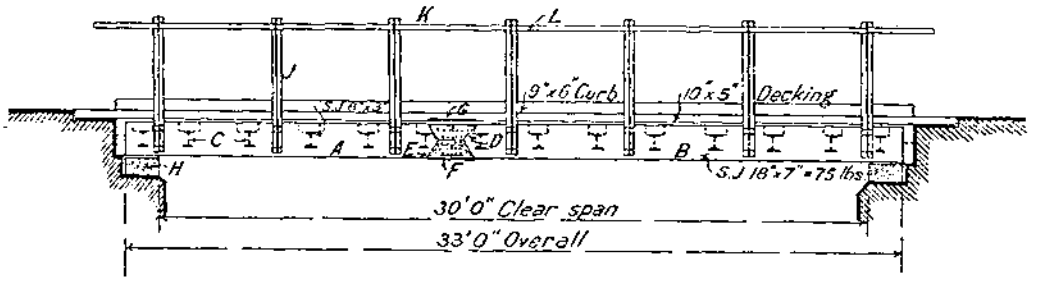


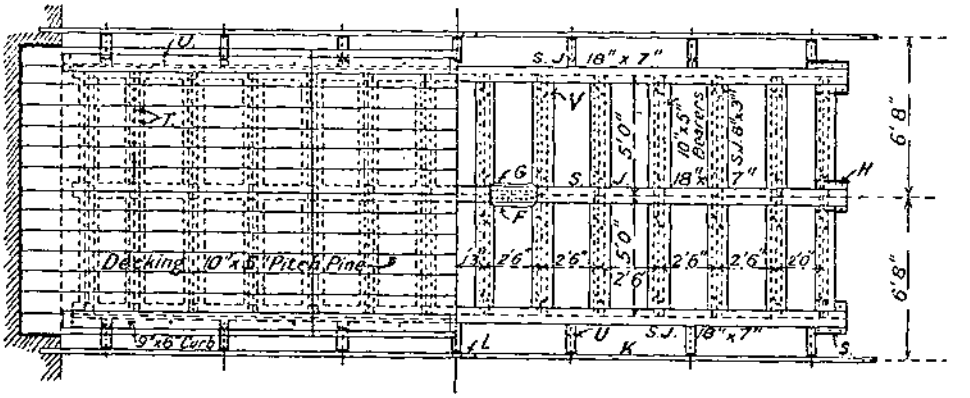


	T.	C.	Q.	L.
Weight of Bridge.....	6	3	3	6
" " I Girder.....	1	0	0	20
Heaviest Member.....	1	0	0	20

PLATE IV.

PORTABLE ROAD-BRIDGE, 30-FT. SPAN—CLASS "A."





	T.	C.	Q.	L.
Weight of Bridge	11	10	1	25
" " 1 Girder	1	5	3	12
Heaviest Member	-	9	0	0

PLATE V.

CROSS-SECTION.

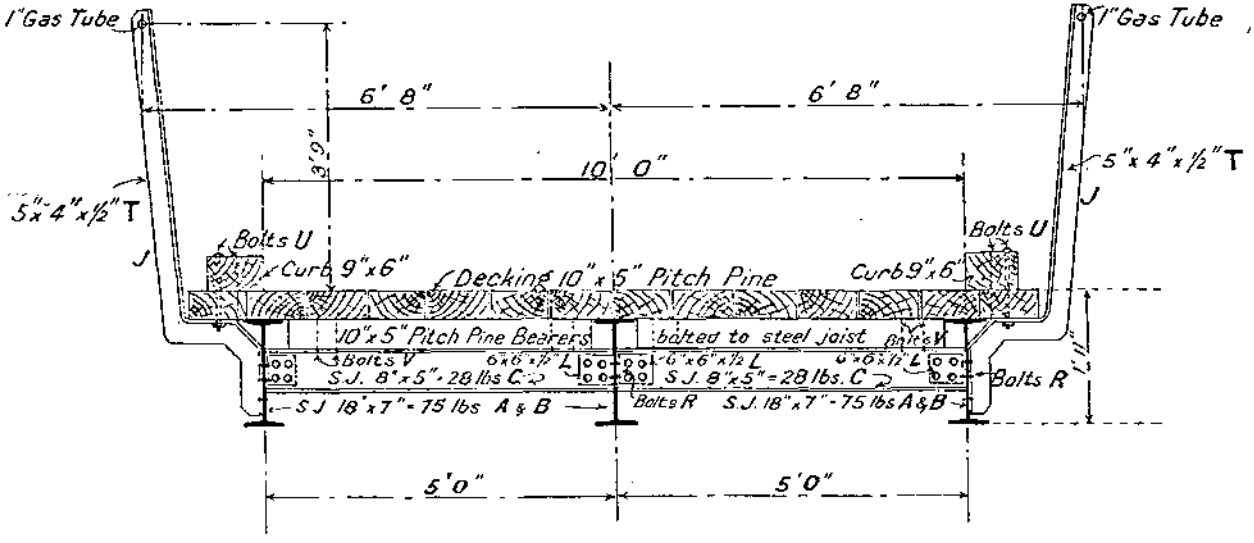
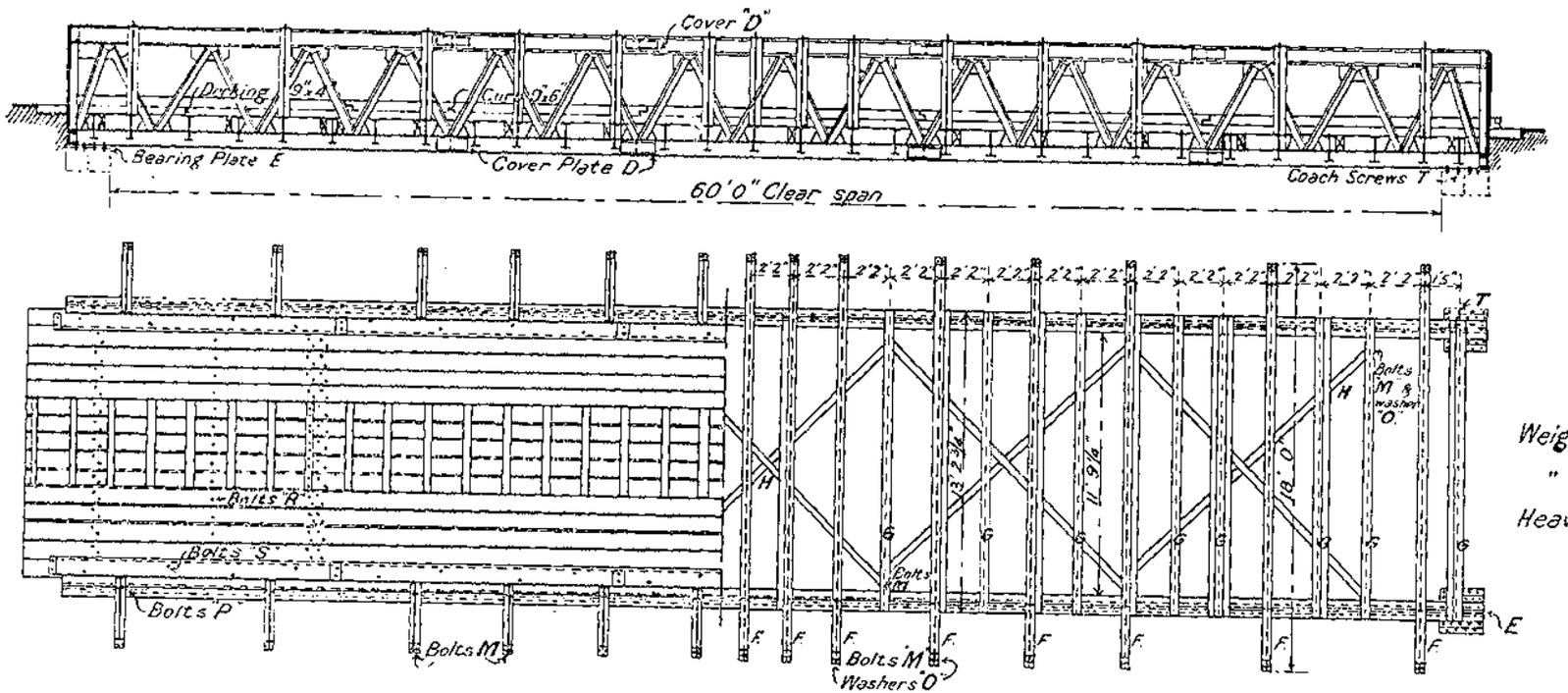


PLATE VI.

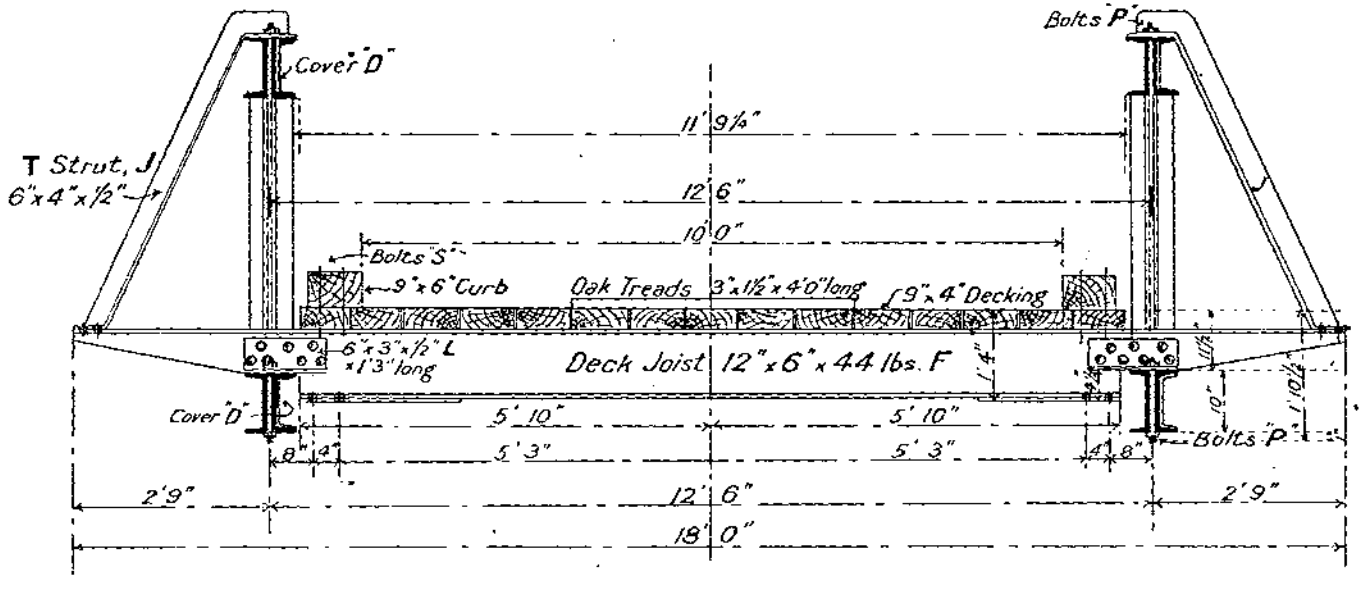
PORTABLE ROAD-BRIDGE, CLASS "A" (THROUGH SPAN) 60-FT. CLEAR SPAN, 10-FT. ROADWAY.



	T.	C.	Q.	L.
Weight of Bridge	32	12	2	3
" " 1 Girder	6	3	3	21
Heaviest Member	1	8	1	17

PLATE VII.

CROSS SECTION.



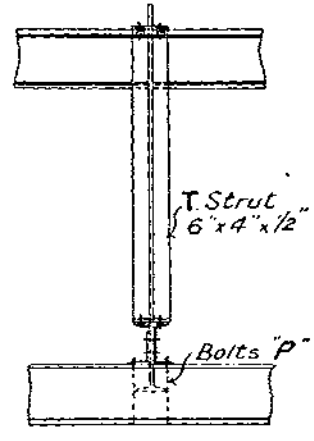
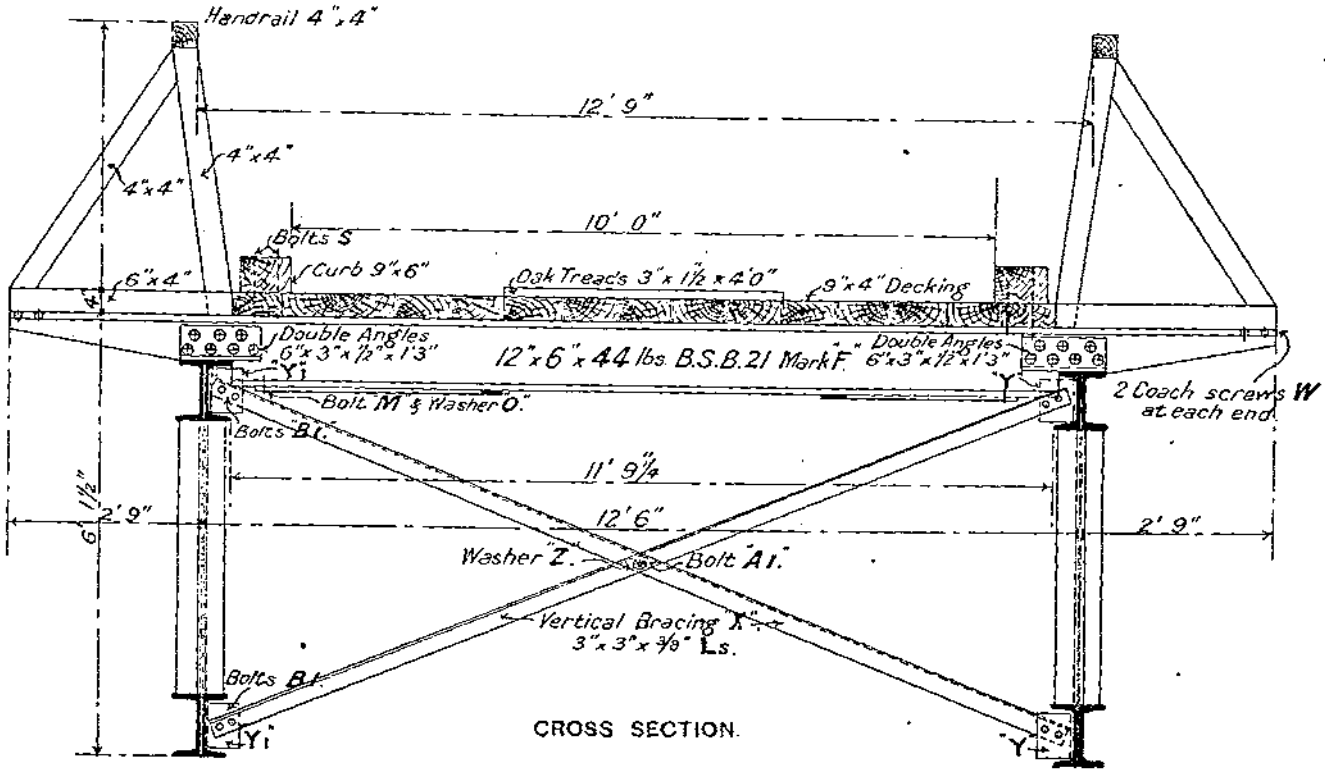


PLATE VIII.

60-FT. SPAN—CLASS "A."



PORTABLE ROAD BRIDGE — HOPKINS 120 Ft. TYPE.

PLATE X.

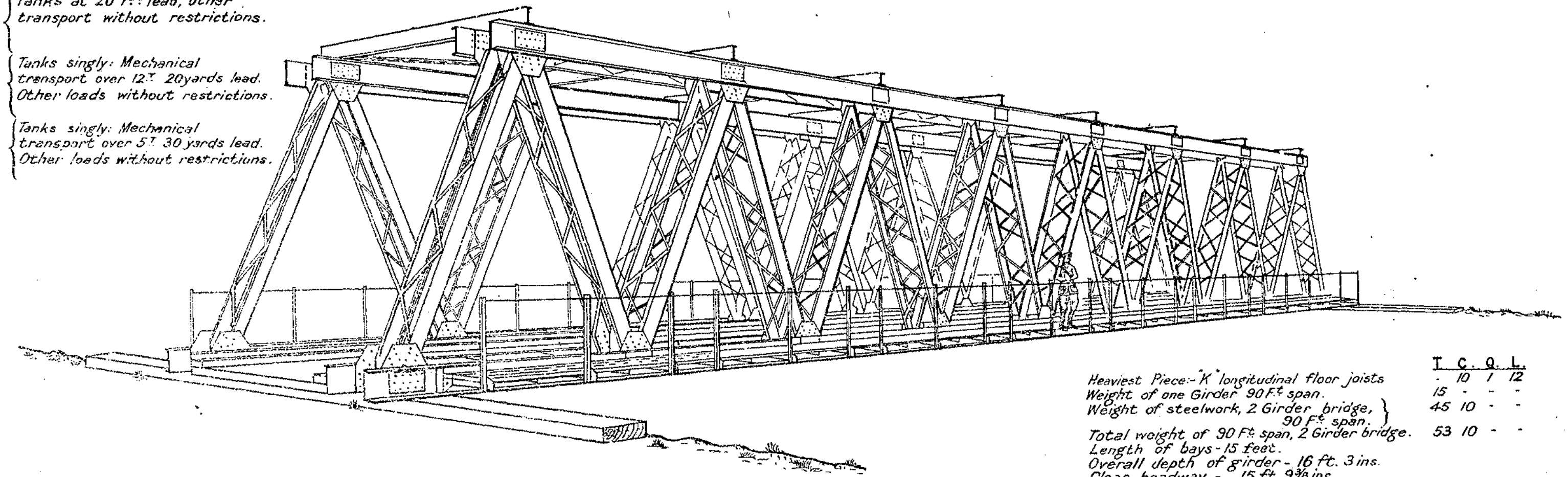
LOADS.

PAN { FIRST SIDE :- All traffic including Tanks.
SECOND SIDE :- All "A" transport with following restrictions:-
1. No tanks can cross Second side.
2. No mechanical transport can cross Second side when Tanks are crossing First side.
3. No vehicle over 13.T to cross Second side if three or more vehicles over 13.T are on First side.

PAN { Tanks at 20 Yds lead, other transport without restrictions.

N { Tanks singly: Mechanical transport over 12.T 20 yards lead.
0 { Other loads without restrictions.

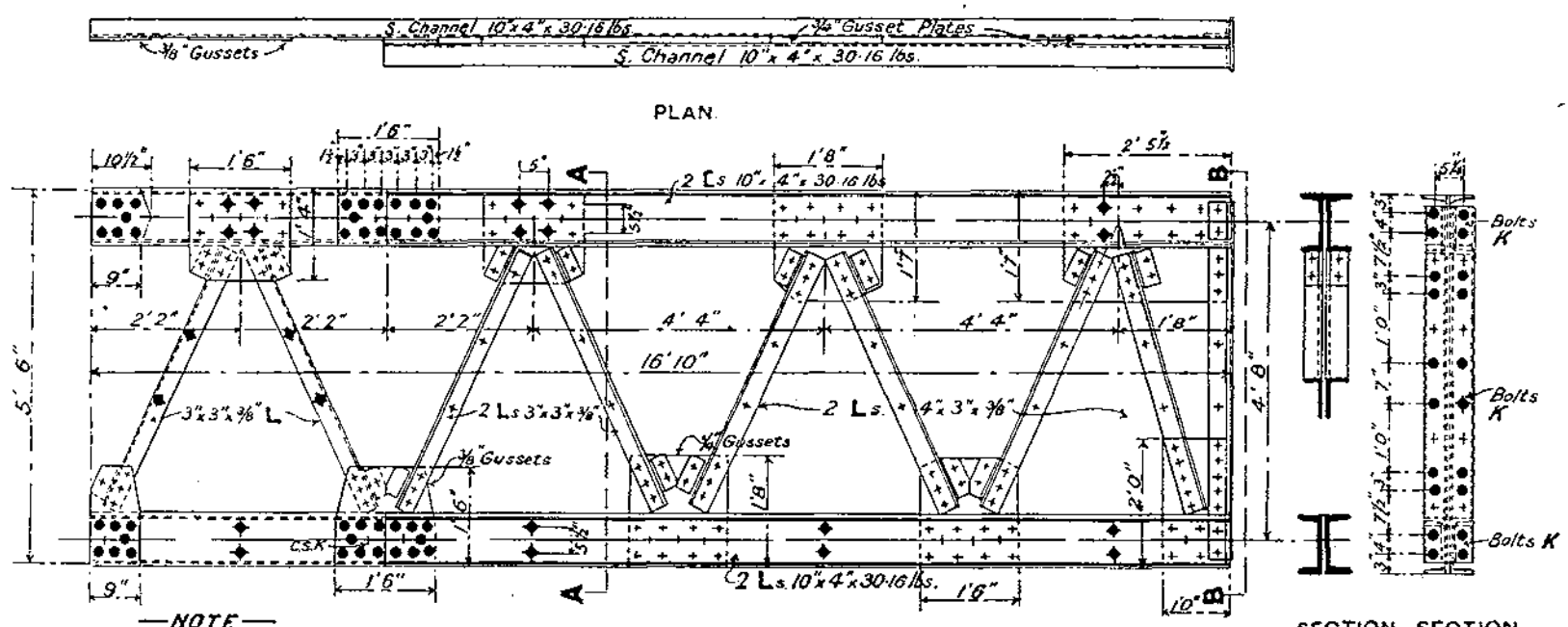
N { Tanks singly: Mechanical transport over 5.T 30 yards lead.
R { Other loads without restrictions.



	T	C.	Q.	L.
Heaviest Piece:- "K" longitudinal floor joists	-	10	1	12
Weight of one Girder 90 Ft. span.	15	-	-	-
Weight of steelwork, 2 Girder bridge, 90 Ft. span.	45	10	-	-
Total weight of 90 Ft. span, 2 Girder bridge.	53	10	-	-

Length of bays - 15 feet.
Overall depth of girder - 16 ft. 3 ins.
Clear headway - 15 ft. 9 3/8 ins.
Weight of complete bridge for any span .6 Tons per foot run.

PLATE IX.



END SECTION "A."

NOTE.

All rivets ⅞" diameter.
All holes for ⅞" turned bolts. Driving fits shown thus.... ●
⅞" Diameter holes for ¾" black bolts shown ✦
All holes carefully drilled from templates so that each section of girder is interchangeable, and may be fixed in any position.

consisted of a wire rope attached to the bridge, and led through a pulley at the top of the tower, thence being taken on to a 1-ton winch by means of which the bridge was lifted. This bridge was rather difficult to erect because it required very accurate setting out. *Photograph* IX. shows a bridge that had just been erected at the school. The derrick on the left was used for erection purposes only.

Pont Levis Mark II.—Later a new design was got out, in which the bridge proper consisted of two special plate girders with cross girders and longitudinals in place of the standard 21-ft. 6-in. class A span. The two columns were erected on a pier of rolled steel joists, which tied them together; the hinges of the bridges were carried on the column bases, so that no setting out was required once the base joists were laid. This bridge was heavier than the others, but was the most satisfactory type produced, and the weight of each individual piece was actually less than in the Pont Levis Mark I. The general arrangement of this bridge is shown on *Plate* XI.

The Emergency Portal.—This was an emergency design to carry 12-ton axle loads. It was only erected in places where it could normally remain either up or down, and would only be moved in cases of emergency.

The bridge consisted of four uprights braced together at the top as in the ordinary Portal, but with standard rolled steel joists instead of lattice bracing. For lifting apparatus the differential tackles from the discarded Davit Bridges were used.

Rolled Steel Joist Spans.—A type of bridge that was extensively used during the last months of the war was built up of stock rolled steel joists from the base. A large number of 12 in. × 5 in. × 22 ft., and 10 in. × 5 in. × 20 ft. joists were ordered specially for bridge work, and in addition use was freely made of supplies imported for gun emplacements and other defensive work.

Designs were prepared in the Engineer-in-Chief's office for standard field spans to carry various loads. They consisted of rolled steel joists laid side by side in the number necessary for the traffic that the bridge was to carry, *e.g.*, 6 joists for a 12-ton axle load, 8 for a 16-ton axle load, and 12 for a 30-ton tank. The decking of these bridges consisted of local timber, generally 2 to 3 in. layers, which was normally supplied ready cut from the base. These bridges were very easily and quickly erected. They were economical for light loads, but rather extravagant for heavy loads. The 22-ft. patterns for tanks and 12-ton axle load are shown on *Plates* XII. and XIII.

Inglis Bridges.—The Inglis pattern portable bridge consists of a series of identical bays formed of weldless steel tubes. In the original or light type, the bays were pyramidical, each 8 ft. long, 8 ft. wide, and 8 ft. high, and the bridge was designed to carry infantry in single file over a span of 120 ft.

At the first demonstration with this bridge in France, a 108-ft

span was thrown across a canal in 13 minutes by an untrained party of Army Service Corps.

The second pattern was similar to the first, but the bays were 12 ft. long, 12 ft. wide, and 12 ft. high. This was designed to carry all arms, with their first line transport, up to not exceeding 7 tons in weight, over a span of 96 ft. The triangular section of this bridge made it unsuitable for the passage of mechanical transport, and in practice it was never used. (See *Photograph* X.)

Both types were also designed to be used in pairs with a central suspended decking. (See *Photograph* XI.)

Early in 1917 a rectangular pattern Inglis bridge began to arrive in France capable of carrying A loads over a span of 96 ft. or B loads over 108 ft. This bridge was easily erected or dismantled, and was in great request during the final advance. It was not strong enough to carry tanks over any span, and also had the disadvantage of being just too low for the passage of motor buses. *Photograph* XII. shows one bay under test, and *Photograph* XIII. a completed bridge.

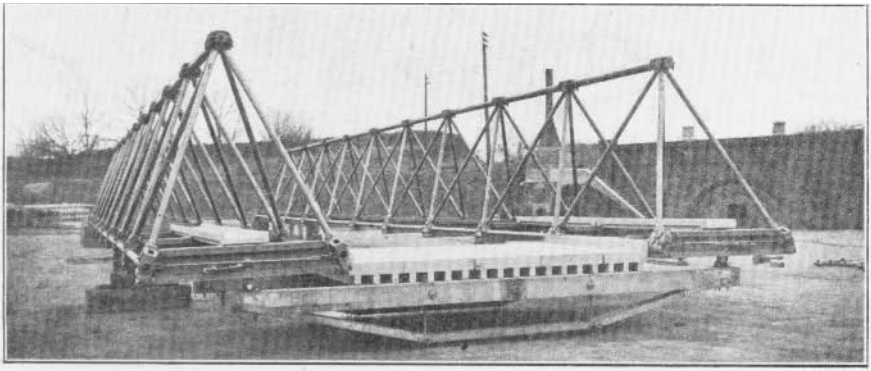
A drawback to all bridges of this type is the expense and also slowness of manufacture.

At the end of the war a strengthened type was under experiment to carry tanks—this is shown in *Photographs* XIV. and XV.

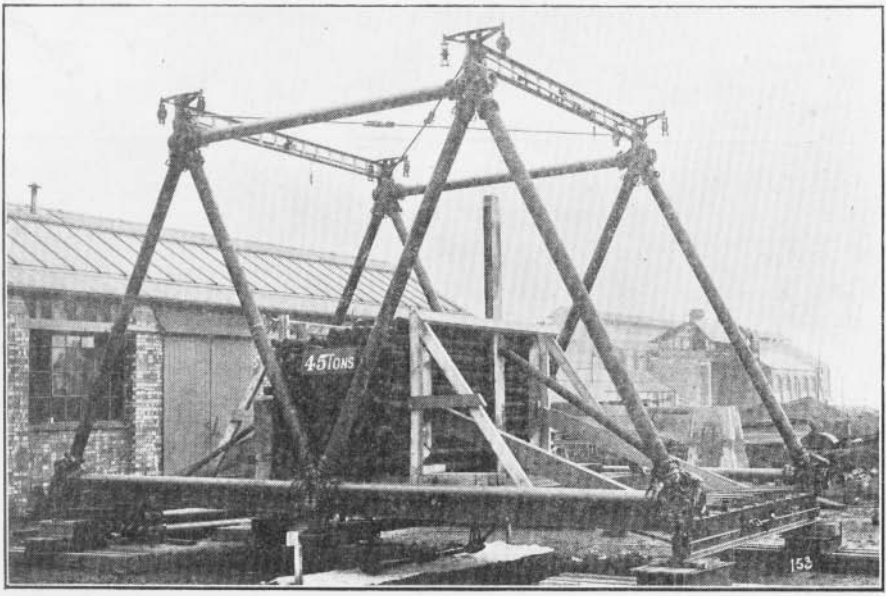
Barge Bridges.—For each of the Army Barge Bridge Depôts two specially fitted up turn-table barges were provided, each equipped with double roadway and cut span for floating bridges, one 60-ft. class B through span erected on turn-table, one set of shore trestles complete with roadway and cut.

When it was required to bridge a gap, the 60-ft. span could be swivelled round, and water pumped into the barge to lower it until the bridge came to bear on the abutments. In addition, each of the six store barges in each Army Depôt was fitted with trestles and superstructure calculated to carry an axle load of 16 tons, and could be used as a pier for a floating bridge, with double roadway. It was calculated that with three such barges and shore trestles, a bridge could be made across most of the French or Belgian canals. In actual practice these bridges were never utilised owing to the destruction of canals and great difficulty and length of time experienced in re-opening them for traffic.

Special Barge Bridge.—In July, 1917, a special floating bridge was designed for the passage of the Yser River, to be used in connection with a proposed landing from the sea. This bridge was to consist of four 60-ft. A spans, carried each on two sea-going Thames lighters (60—70 tons). The barges were to be lashed together for conveyance of the bridges to the site, and there spread apart so as to be one under each end of the span. In this case the spans were fixed at right-angles to the barges, and not along them as in the case of the turn-table bridges. Owing to the cancellation of the military

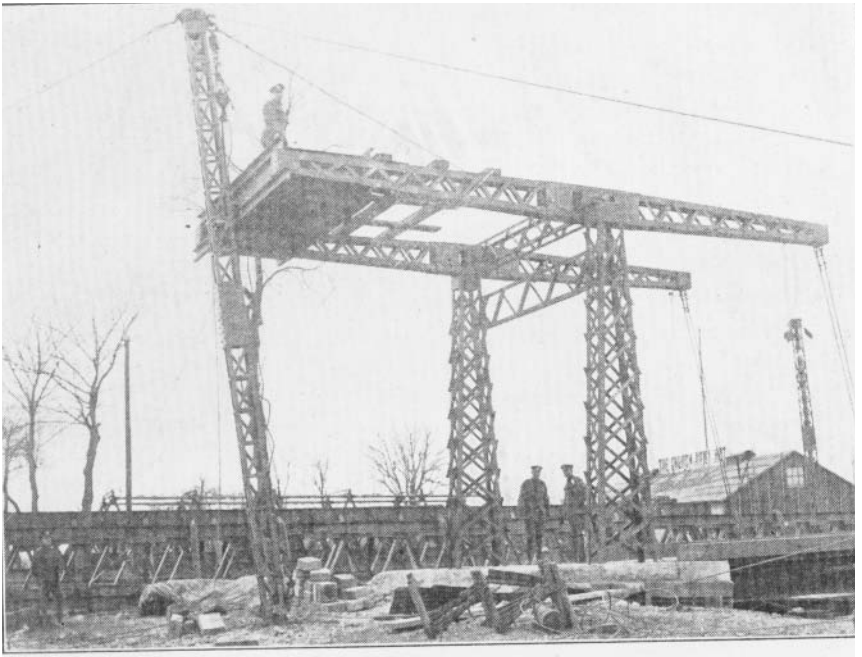


Photograph XI.—Inglis Bridge.



Photograph XII.—Inglis Bridge : Rectangular Pattern.

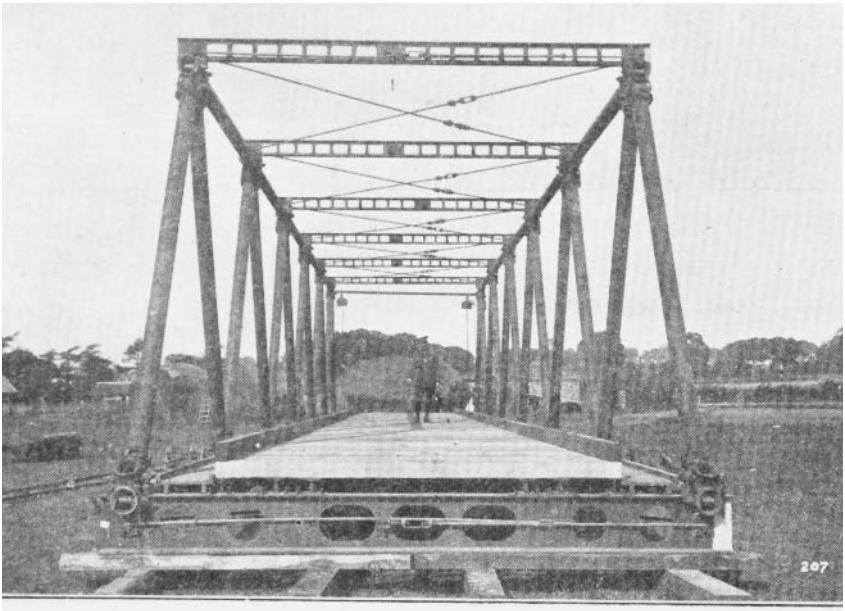
INGLIS BRIDGE



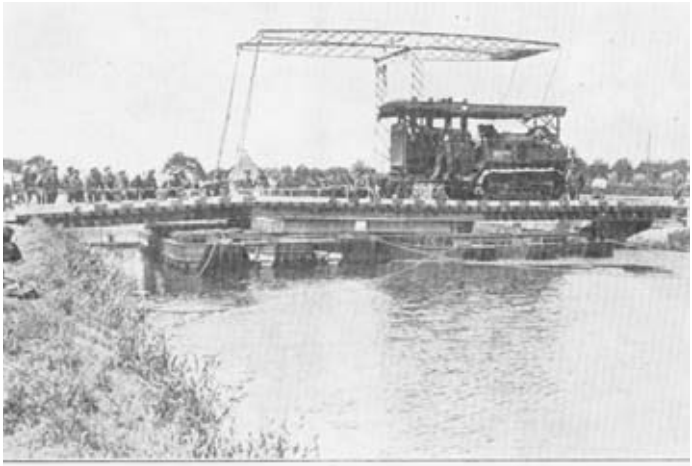
Photograph IX.—Pont Levis.
Showing derrick used in erection.

Photograph X.—Ingle Bridge: Second Pattern.

PONT LEVIS



Photograph XV.—Inglis Bridge: Strengthened Type.

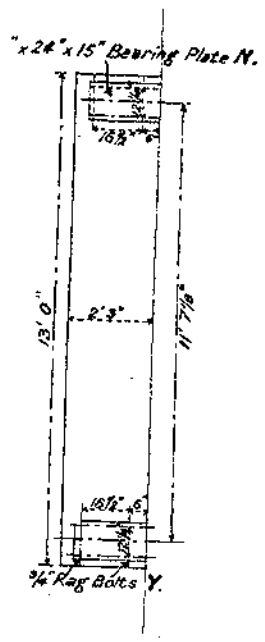


Photograph XVI.—Bridge "B."
Showing Caterpillar—Weight 14 Tons.

INGLIS BRIDGE

PONT LEVIS BRIDGE – MARK II.

GENERAL ARRANGEMENT.



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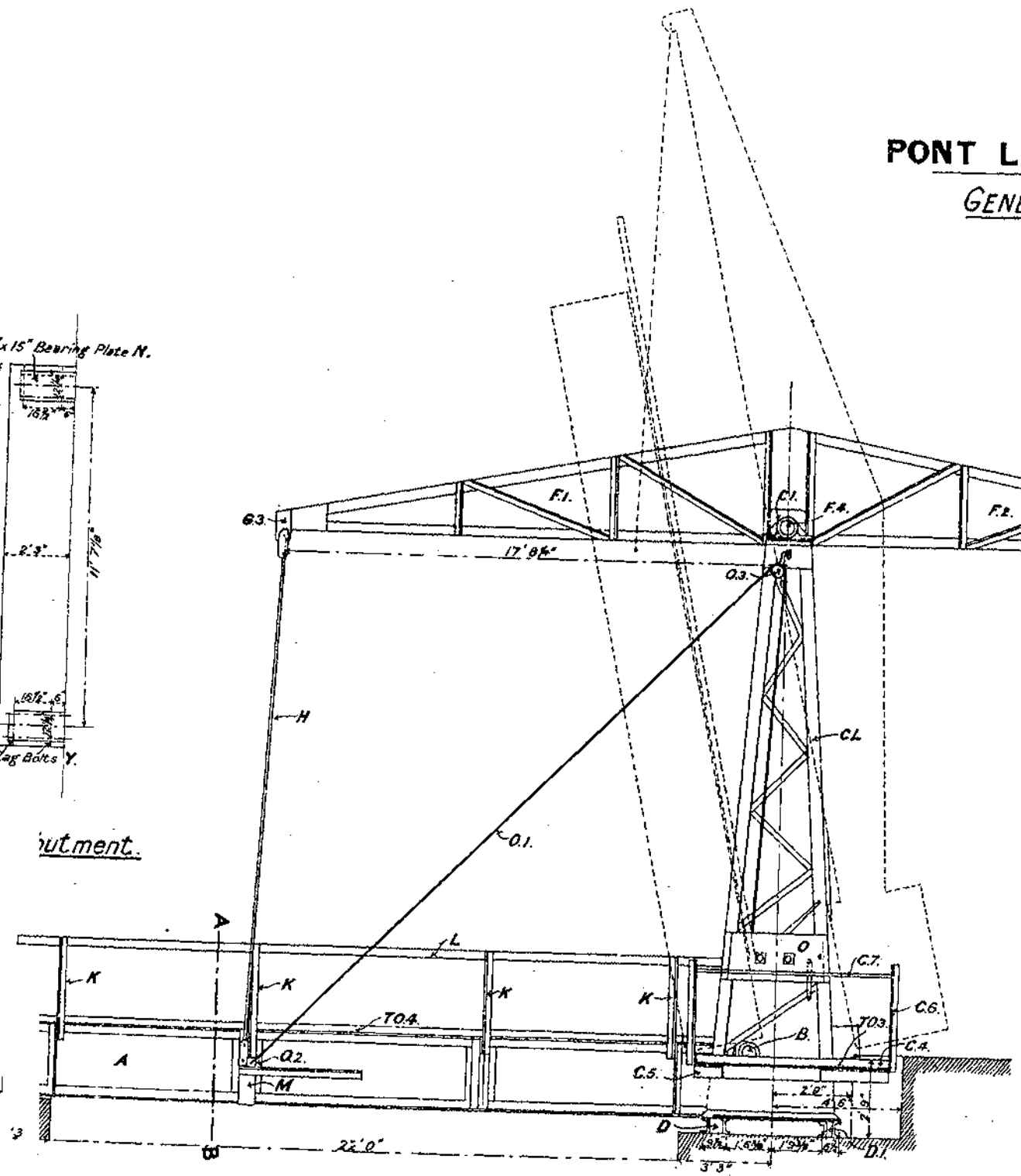
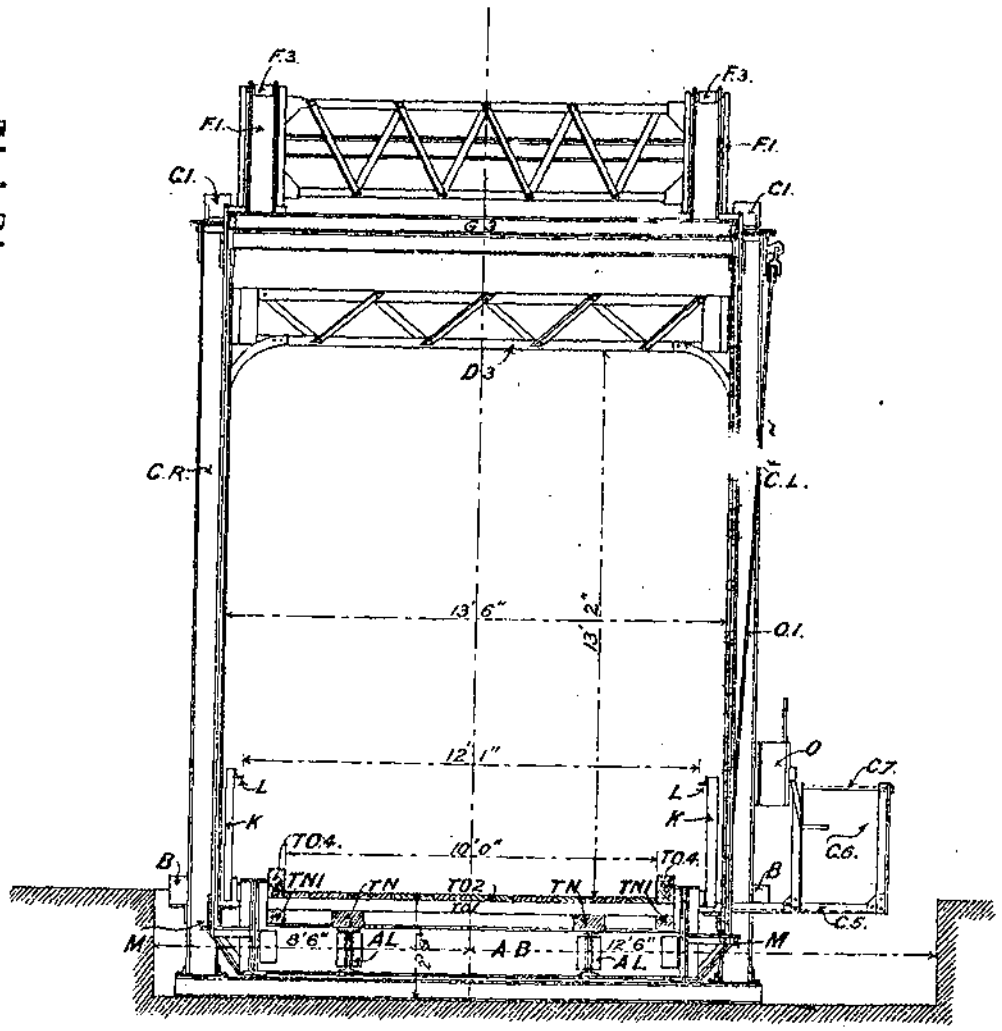
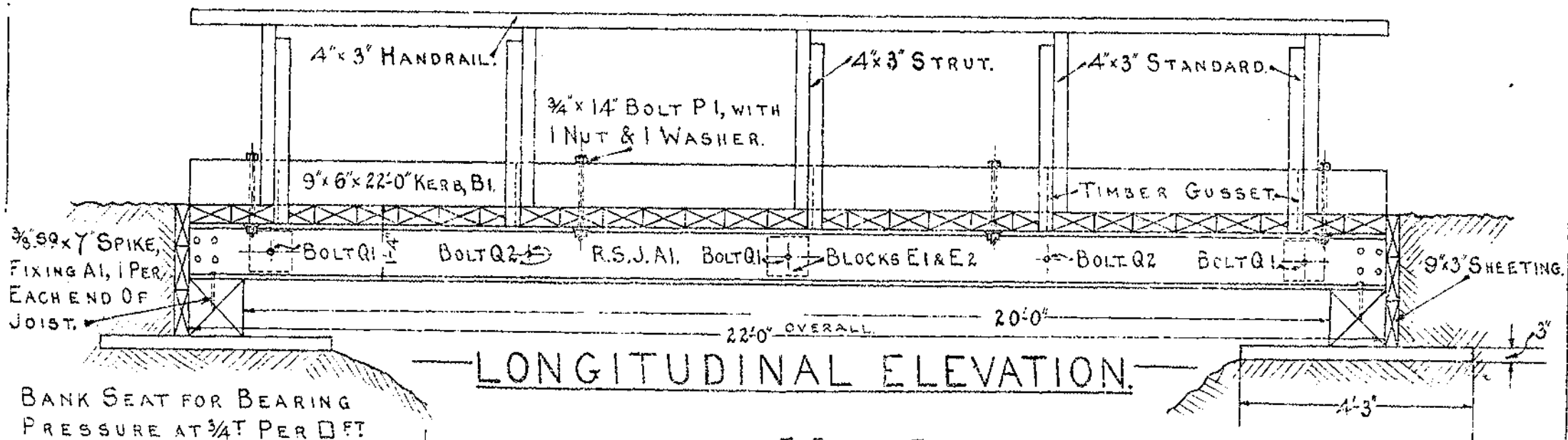


Side Section.



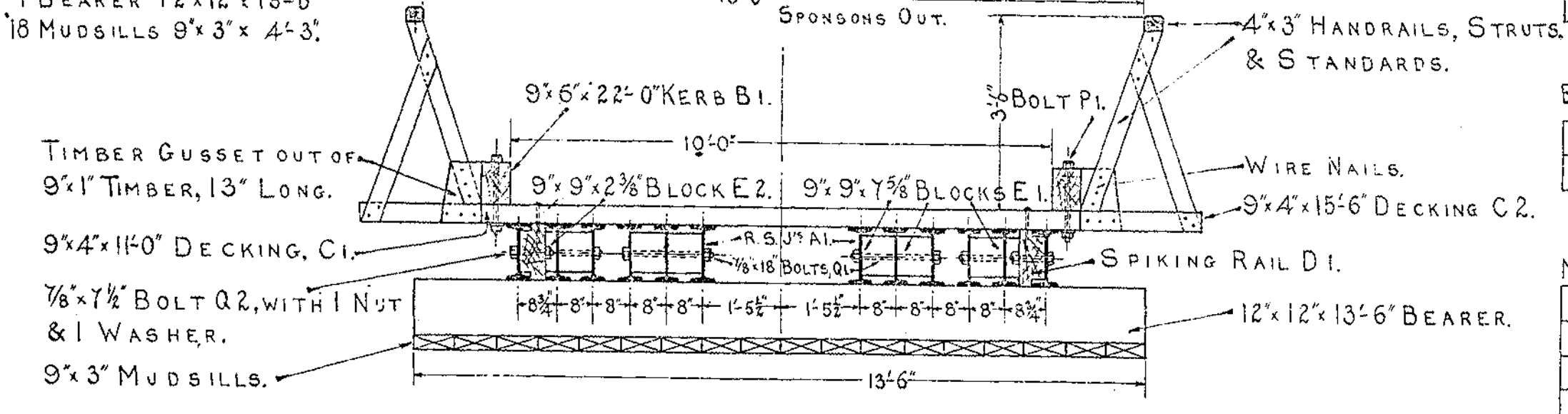
Section A-B.

22 FT R.S.J. STANDARD FIELD SPAN TO CARRY TANKS.



LONGITUDINAL ELEVATION.

BANK SEAT FOR BEARING PRESSURE AT ¾T PER □FT
1 BEARER 12"x12"x13'-6"
18 MUDSILLS 9"x3"x 4'-3".



CROSS SECTION.

MATERIAL LIST FOR ONE SPAN.

REF	Nº	DESCRIPTION.	GROSS WT T	C	Q	L
A1	12	12"x5"x32 LBS x 22'-0" R.S.J's	3	15	1	20
B1	2	KERBS, 9"x6"x22'-0"		6	1	4
C1	24	DECKING, 9"x4"x11'-0"	1	5	3	20
C2	5	DECKING, 9"x4"x15'-6"		7	2	13
D1	2	SPIKING RAIL, 12"x6"x22'-0"		8	1	22
E1	18	BLOCKS, 9"x9"x7⅝"		2	1	22
E2	6	BLOCKS, 9"x9"x2⅜"			1	1
160 FR		4"x3"; RAILS, STRUTS, ETC		5	0	14
	12 FR	9"x1" TIMBER FOR GUSSETS.			1	4
P1	9	¾"x14" BOLTS (EACH WITH 1 NUT & 1 WASHER.				20
Q1	13	⅞"x18" BOLTS WITH NUTS			1	21
Q2	4	⅞"x7½" BOLTS (EACH WITH 1 NUT & 1 WASHER.				9
	90	SPIKES, ⅜" SQ x 7" LONG				25
	10 LB	5" & 6" WIRE NAILS				10
TOTAL WEIGHT OF 1 SPAN:-			6	12	3	9

EXTRA MATERIAL FOR EACH CONTINUOUS SPAN.

T1	24	FISH PLATES, 8"x⅜"x1'-2".		2	2	8
R1	104	¾"x2¼" H.R.H. BOLT & NUT.			2	24
TOTAL EXTRA WEIGHT PER JOINT:-				3	1	4

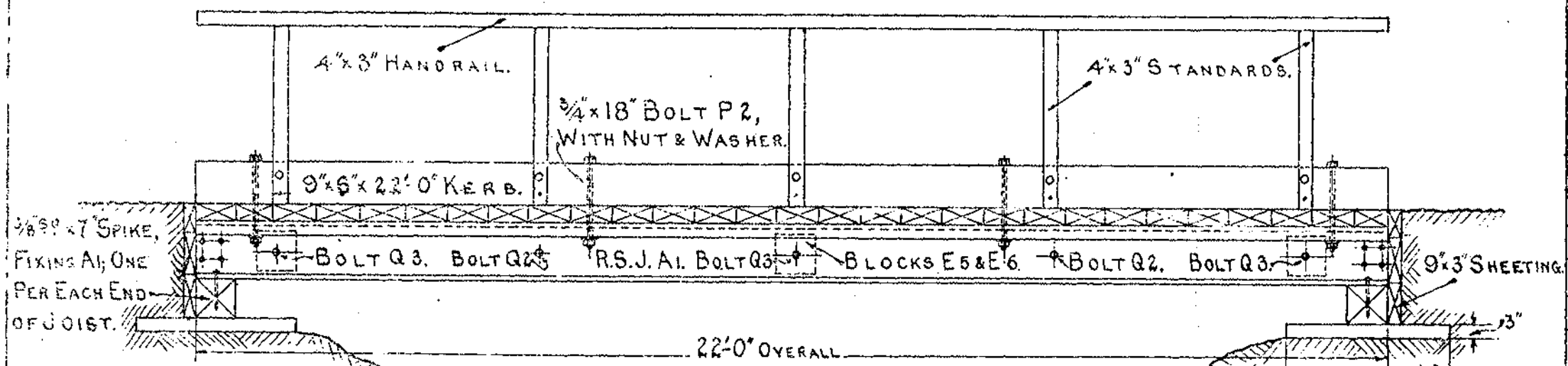
MATERIAL FOR ONE SET ¾T BANKSEATS.

	2	BEARERS, 12"x12"x13'-6"		10.	1	13
	36	MUDSILLS, 9"x3"x4'-3".		10	3	20
	6	SHEETING, 9"x3"x13'-6".		5	3	4
	10 LB	6" WIRE NAILS.				10
TOTAL WEIGHT OF 1 SET BANKSEATS			1	7	0	19

NOTE:- 10% SPARES HAVE BEEN ADDED TO ALL BOLTS & SPIKES.

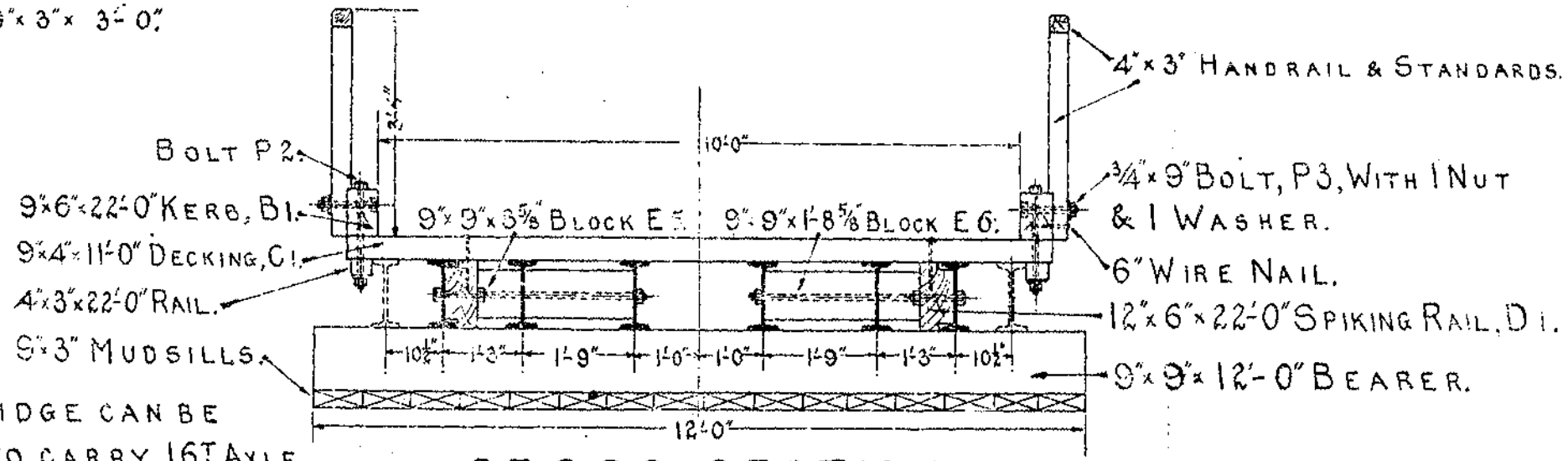
22FT R.S.J. STANDARD FIELD SPAN TO CARRY 12T AXLE LOAD.

D.P/755/2.
(SUPERSEDES D.P/741/1,2&3)



LONGITUDINAL ELEVATION.

BANK SEAT FOR BEARING PRESSURE AT 3/4T PER □FT
1 BEARER 9"x9"x12'-0"
16 MUDSILLS 9"x3"x3'-0"



CROSS SECTION.

NOTE:- BRIDGE CAN BE ADAPTED TO CARRY 16T AXLE LOAD, BY ADDITION OF 2 OUTSIDE R.S.J's (SHOWN DOTTED)

REF.	Nº	DESCRIPTION.	GROSS WT. T	C	Q	L
A1	6	12"x5"x32 LBS: x22'-0" R.S.J.	1	17	2	24
B1	2	KERBS, 9"x6"x22'-0"		6	1	4
C1	29	DECKING, 9"x4"x11'-0"	1	11	1	9
D1	2	SPIKING RAIL, 12"x6"x22'-0"		8	1	22
E5	6	BLOCKS, 9"x9"x8 5/8"			3	19
E6	6	BLOCKS, 9"x9"x1'-8 5/8"		2	0	23
140 F.R		4"x3" RAILS, STANDARDS ETC.		4	2	0
P2	9	3/4"x18" BOLTS {EACH WITH 1 NUT & 1 WASHER.				25
P3	11	3/4"x9" BOLTS -do- -do-				19
Q2	4	7/8"x7½" BOLTS -do- -do-				9
Q3	6	7/8"x3½" BOLTS, EACH WITH 1 NUT.			1	15
	80	SPIKES, 3/8" Sq" x 7" LONG.				23
	10LB	6" WIRE NAILS.				10
TOTAL WEIGHT OF 1 SPAN:-			4	12	2	7

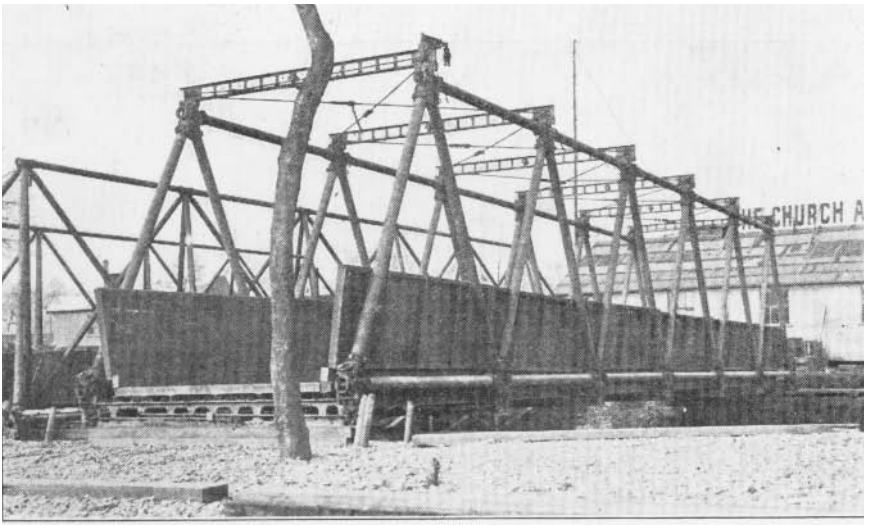
EXTRA MATERIAL FOR EACH CONTINUOUS SPAN.

T1	12	FISH PLATES, 8"x3/8"x1'-2"		1	1	4
R1	52	3/4"x2¼" H.R.H. BOLT & NUT.			1	12
TOTAL EXTRA WEIGHT PER JOINT:-				1	2	16

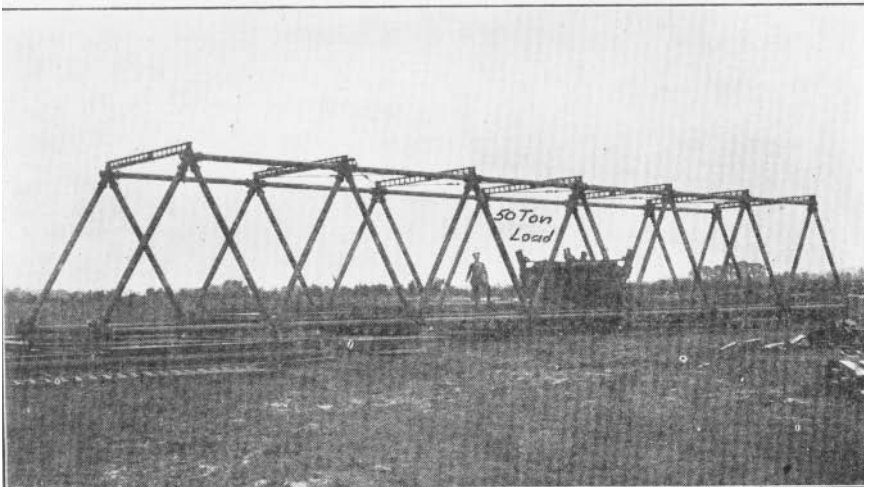
MATERIAL FOR ONE SET 3/4T BANKSEATS.

	2	BEARERS, 9"x9"x12'-0"		5	0	16
	32	MUDSILLS, 9"x3"x3'-0"		6	3	12
	6	SHEETING, 9"x3"x12'-0"		5	0	16
	10LB	6" WIRE NAILS.				10
TOTAL WEIGHT OF 1 SET BANKSEATS				17	0	26

NOTE:- 10% SPARES HAVE BEEN ADDED TO ALL BOLTS & SPIKES.



Photograph XIII.—Inglis Bridge: Rectangular Type.
Inglis Bridge, Heavy Type, in background.



INGLIS BRIDGE

operations for which the design was made, these bridges were never used, and the barges were dismantled during the summer of 1918.

Sankey Bridge.—The piers of this floating bridge were formed by the standard pontoons, and the roadway was carried by stock rolled steel joists. The bridge was designed to carry loads up to 14-ton caterpillars. It was made use of several times during the advance in the autumn of 1918, and was found quite satisfactory for sluggish currents, for which clear waterway between pontoon piers need not be considerable.

The three types are illustrated on *Plates* XIV. to XVII.

Types B and C require steel joists and certain other special stores.

Type D requires nothing except pontoon equipment and stores, to be obtained from any Corps dump.

Bridge B will carry all B loads, and with proper precautions, is capable of taking A loads in emergency.

Bridge C will carry the heavy commercial lorry, and bridge D loaded 3-ton lorries. (See *Photographs* XVI. and XVII.)

6. *Bridging Depôts and Stores.—Base Depôts.*—Reference has been made in Para. 2 to the formation of a heavy bridging depôt at Havre.

As the size of the forces increased a general division of supply was made between the northern and southern lines of communication.

The Northern Armies were based on Calais and Boulogne, the Southern ones on Havre and Rouen.

A second heavy bridging base depôt was therefore formed early in 1917, at Les Attaques, near Calais.

The D.E.S. automatically took over both these depôts in the summer of 1918.

Barge Depôts.—As soon as steel spans began to arrive in France arrangements were started to provide each army with a heavy bridging depôt. These were at first designed to be barge depôts for canal traffic and were formed mainly to provide mobile storage of bridging plant at a time when the wholesale destruction of canals seemed unlikely; we had then full power of movement by canal up to Armentieres, beyond Bethune and on the Somme.

Each army was provided with a fleet of 280-ton barges consisting of one fully equipped workshop barge; two store depôt barges, each carrying two 60 ft. spans, two 30 ft. spans, and two 13 ft. spans, with launching gear, roadway, and erection stores; two timber depôt barges, each carrying pile drivers and 30 ft. lattice steel derricks, in addition to timber; two turn-table barges.

By the end of 1915 three fleets were completed, and a fourth nearly so.

Early in 1917 these barge depôts were dismantled, and the barges handed over to the Inland Water Transport Department. This was primarily due to the urgent demand for transport barges by the

I.W.T., but by this time it was realised that canal transport was not likely to prove feasible for bridging material during an advance.

As a subsidiary matter the barges were fitted for use as floating bridges; details are given in para. 5; they were intended for use as such behind our lines, and might have proved of great value in the first half of 1918 if they had not been already dismantled.

Army Bridging Store Depôts.—The absence of canals over a large portion of the front at the beginning of 1917 necessitated the formation of bridging store depôts in army areas.

These were first started on a small scale by the Fourth Army when the Germans withdrew across the Somme after blocking the canal, and by the Third Army for the battle of Arras.

More information will be found on this subject in the introduction to Chapter 3.

From the very first the great importance of the supply of all accessory stores required in the execution of heavy bridging was fully realised, and a complete list for each type of bridge was carefully worked out and published in the original *Memo on Construction and Repair of Road Bridges*. Of these stores the larger and more expensive were kept only at the base park, whilst the lighter stores, timber, etc., were kept in the army barge depôts. The original lists remained unaltered until the spring of 1917, when they were revised, and published on a special form.

Early in 1918 a revised list of stores was got out for an army bridging store depôt, the stores being divided into sets which were calculated to be sufficient for the erection of any three bridges; three such sets forming a complete army bridge store depôt. (See *Plate* XVIII., Copy of Form H.B., 23A.).

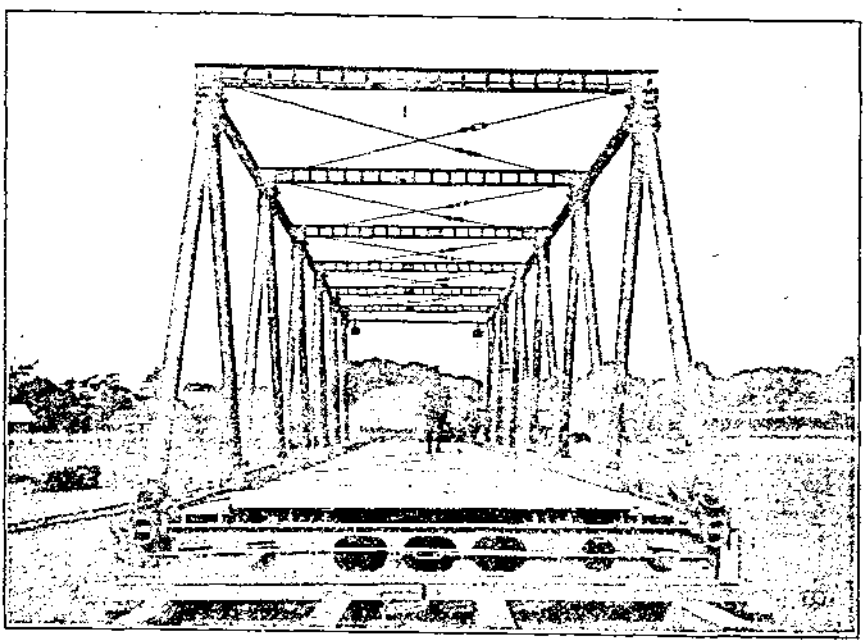
Considerable difficulty was always found both in the storing and the transport of these stores, as they were supplied from various sources.

The ideal was that every bridge sent up from the base, for erection by the army during operations, should be accompanied by all the stores required in the erection of the bridge. This was not practicable, and would also have been wasteful of transport, as many of the stores already existed in army and corps advanced parks.

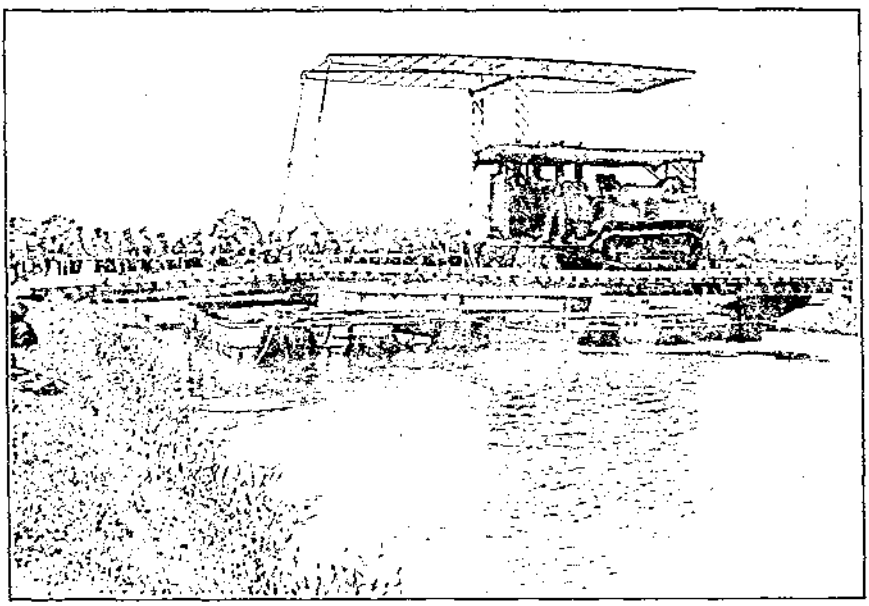
To the end of the war no completely satisfactory solution had been arrived at, and each army made the arrangements that seemed best for the provision of such stores.

Special Bridging Stores.—In addition to the stock spans stored, full new details were worked out of suitable cribs, piles and trestles for bridges across the normal waterways. Materials for such were kept both at the base parks, and at the army barge depôts. *Plate* XIX. gives details of a standard trestle as adapted for use with R.S.J. field spans.

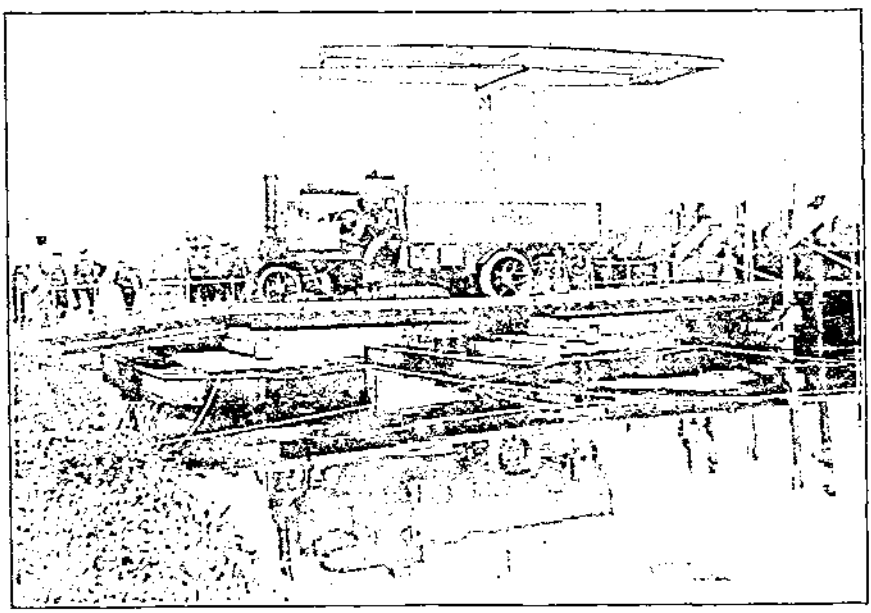
Steel Cube Piers.—Mild steel cubes 3 ft. high were stocked at the



Photograph XV.—Inglis Bridge: Strengthened Type.



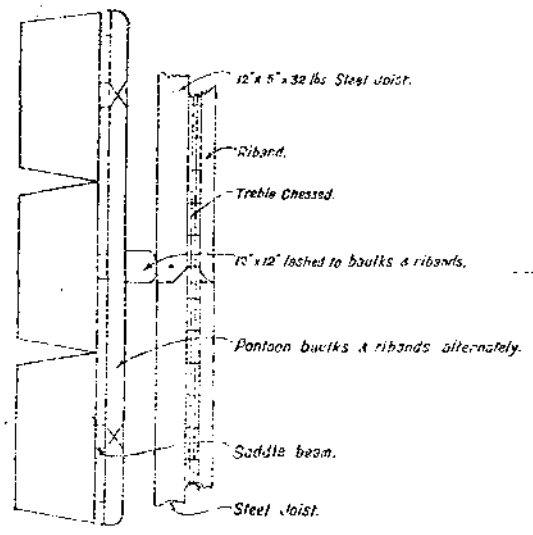
Photograph XVI.—Bridge "B."
Showing Caterpillar—Weight 14 Tons.



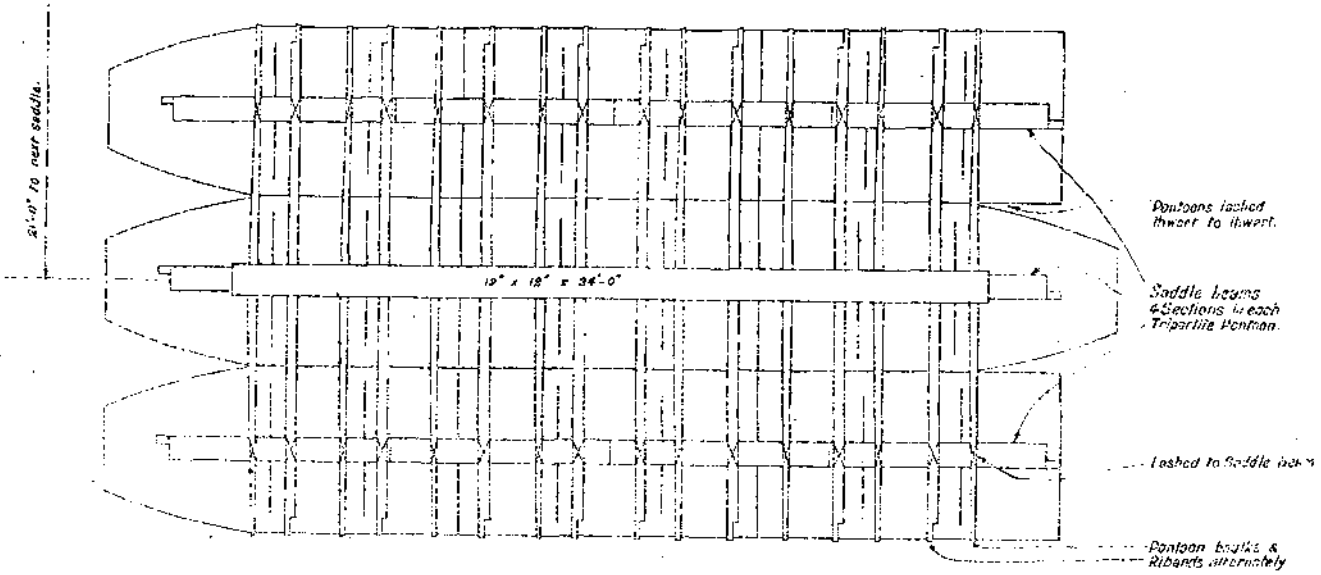
Photograph XVII.—Bridge "C."
Showing Loaded Foden Lorry—Total Weight 11 Tons.

BRIDGE "B"

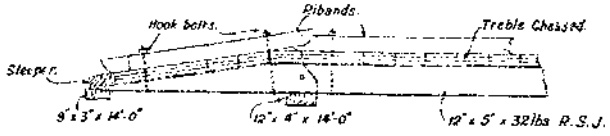
PLATE XIV.



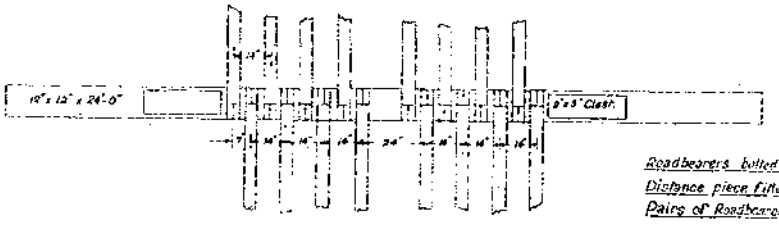
Transverse Section.



Plan omitting Main Roadbearers.

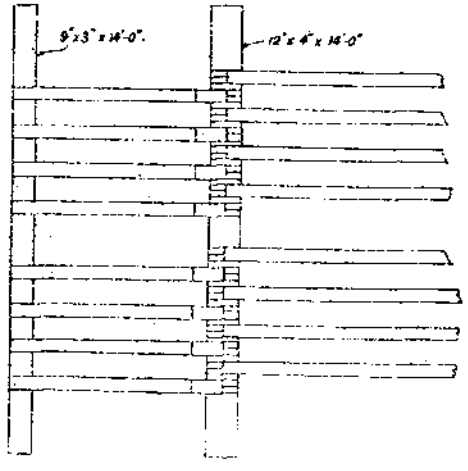


Shore Ramp. Side Elevation.

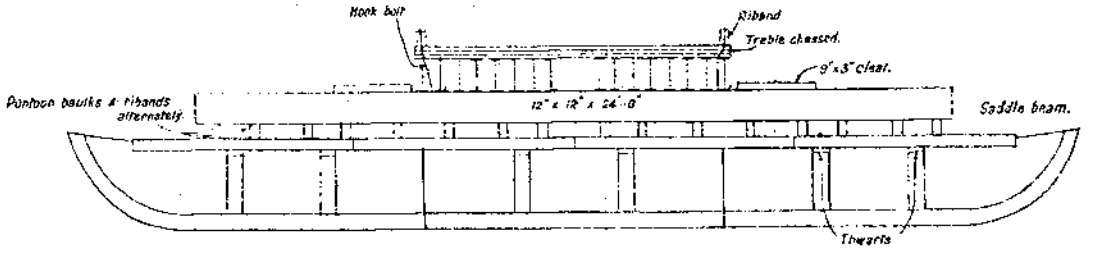


Roadbearers bolted together in pairs with distance piece.
Distance piece fitted with cleats for 12"x 12" saddle.
Pairs of Roadbearers separated by 5" spikes.

Arrangement of Main Roadbearers.



Plan of Joists.

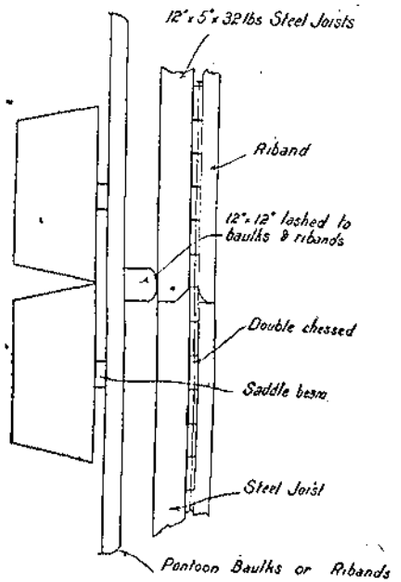


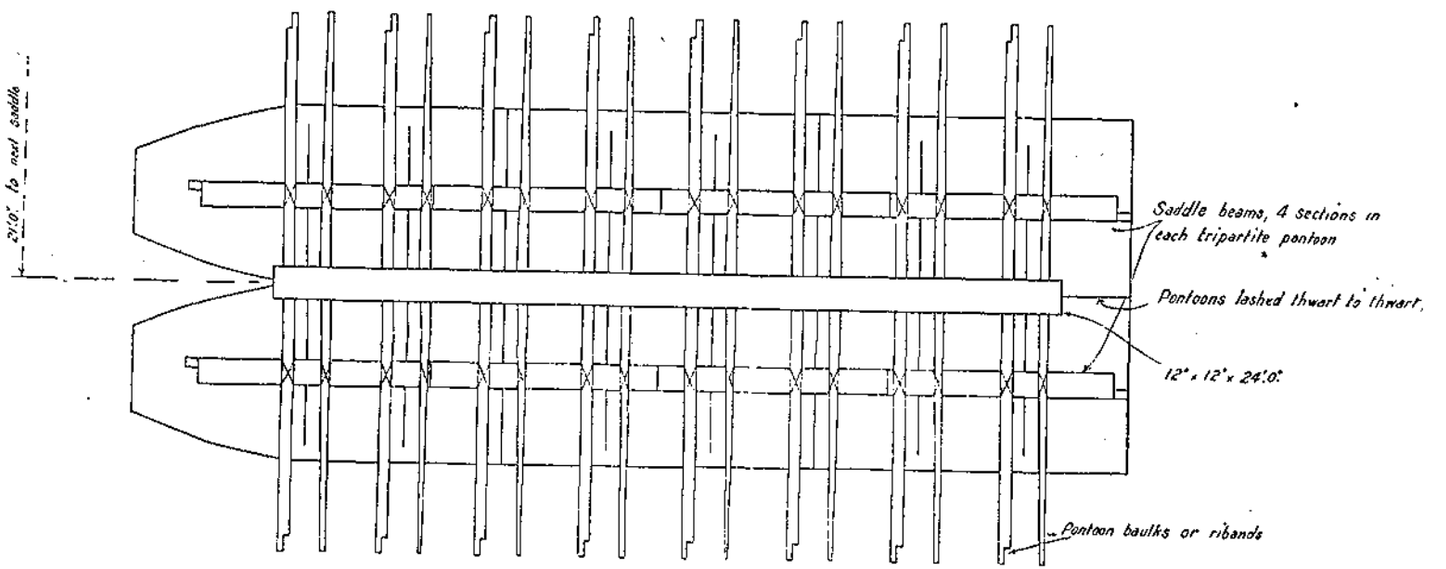
Longitudinal Section.

BRIDGE C

PLATE XV.

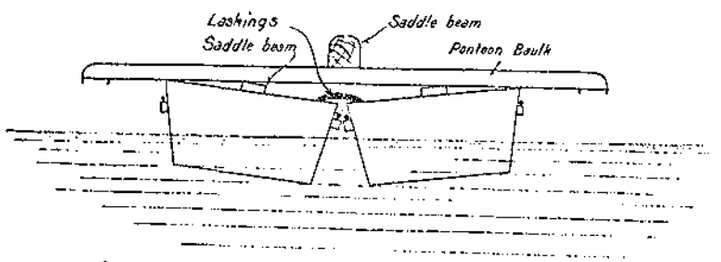
TRANSVERSE SECTION



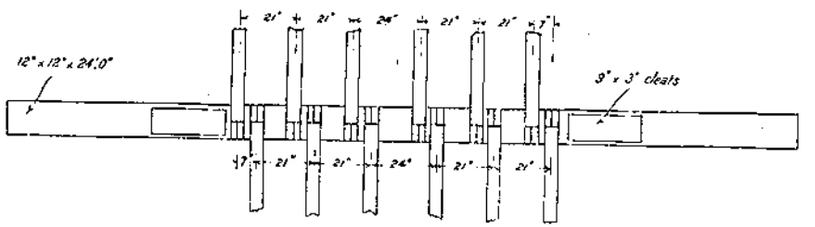


PLAN omitting MAIN ROADBEARERS.

LASHING PONTOONS

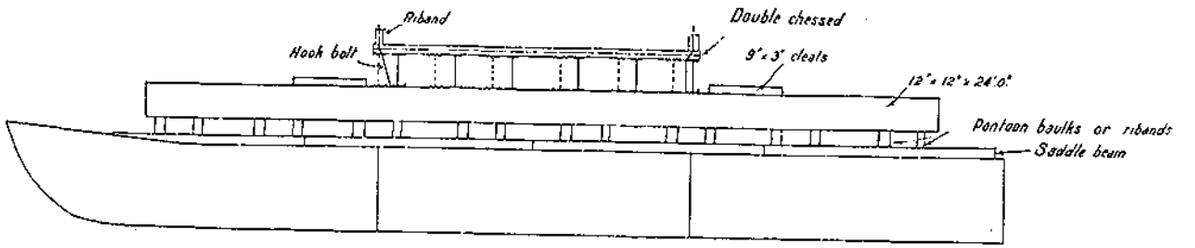


Shewing the result of lashing pontoons too tightly thwart to thwart.



ARRANGEMENT OF ROADBEARERS.

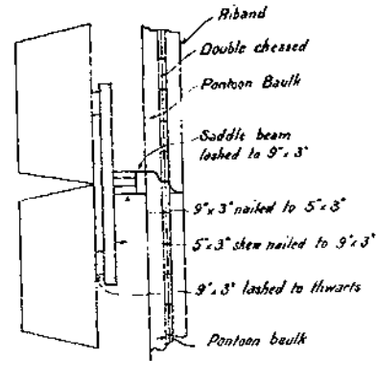
Roadbearers bolted together in pairs with distance piece.
Distance piece fitted with claws for 12"x12" saddle.
Pairs of Roadbearers separated by 6" spikes.



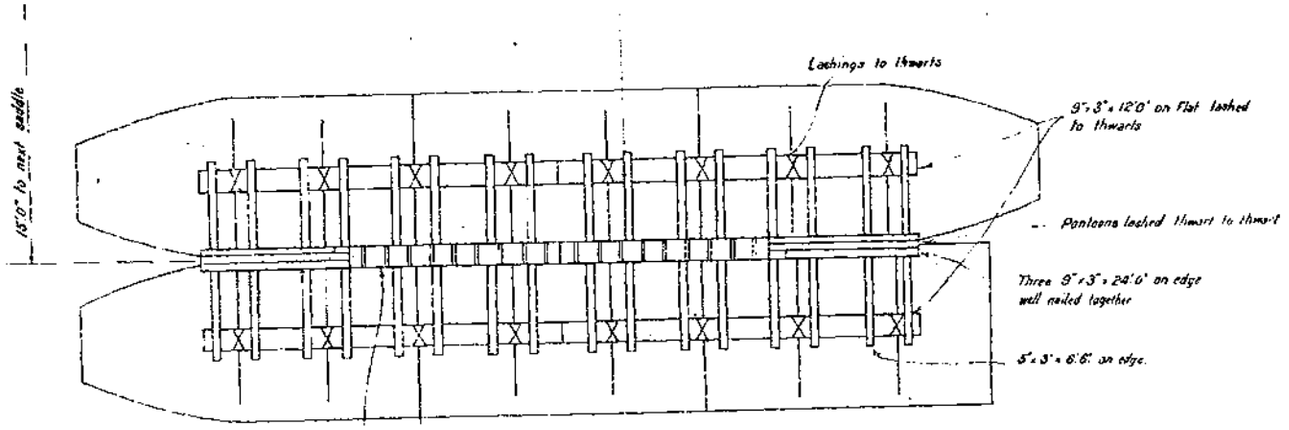
LONGITUDINAL SECTION

PLATE XVI.

BRIDGE D.



TRANSVERSE SECTION



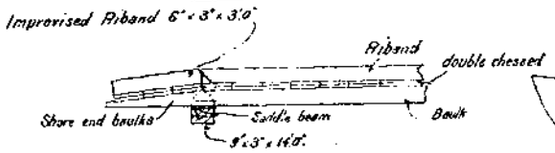
PLAN

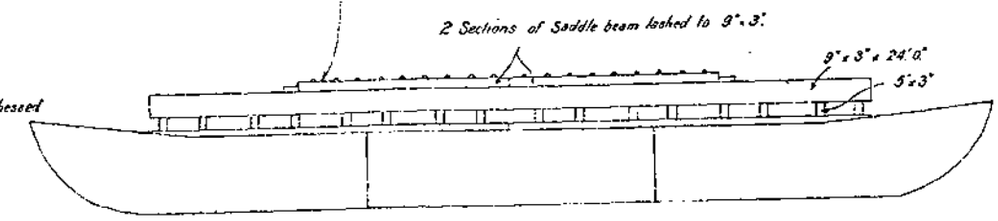
Superstructure consists of 18 pontoon baulks or ribands per bay, double chessed and racked down with ribands and racklashings.

Pontoon Baulks omitted for clearness

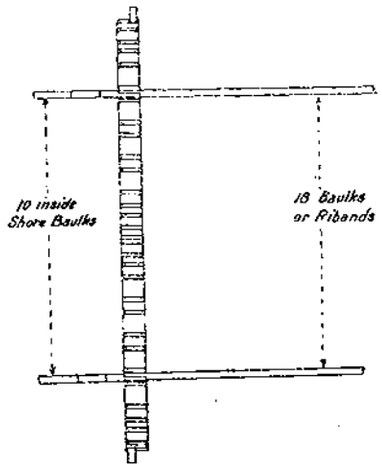
With more than one pier, the rafts might consist alternately of 4 bow sections. 2 stern sections. and 2 bow sections 4 stern sections

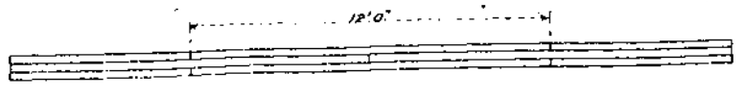
SHORE RAMP





LONGITUDINAL SECTION





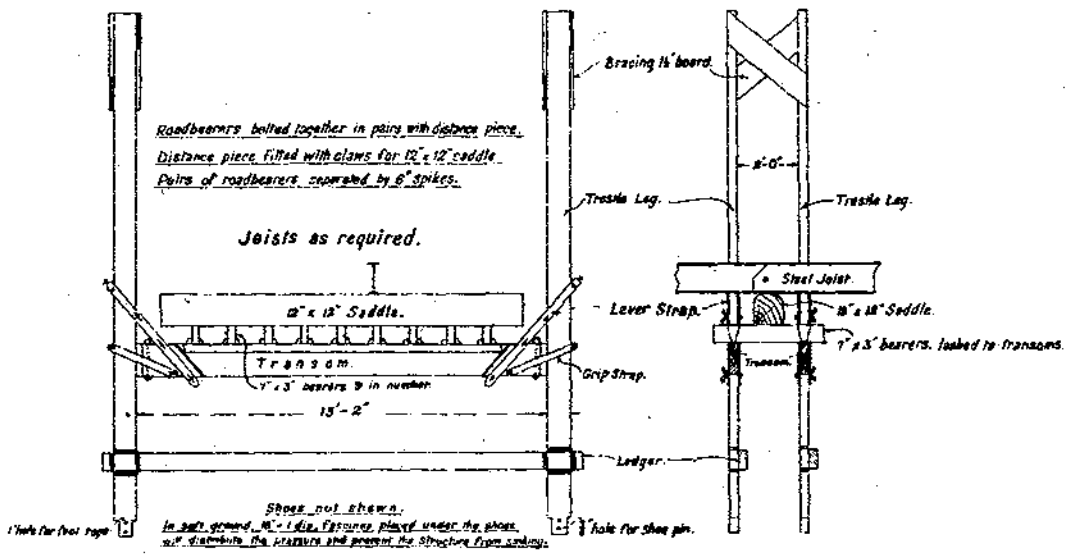
PLAN OF ARRANGEMENT OF 9" x 3"

Drawn by F.G. Hawtrey 2nd Lt. R.E.

ARMY PRINTING AND STATIONERY SERVICES A—7011—

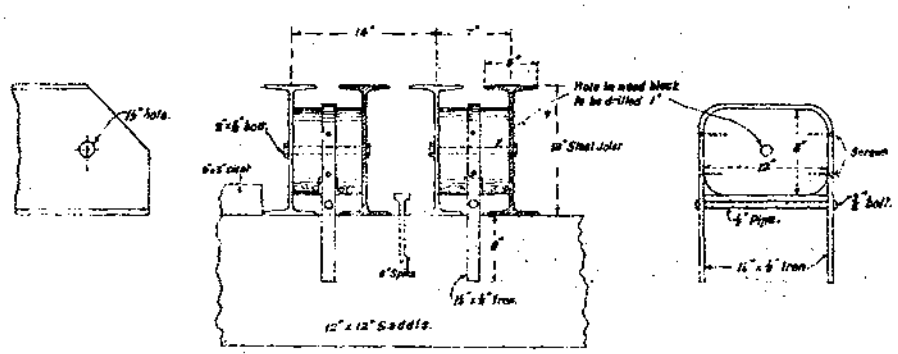
TRESTLE TOWER.

PLATE XVII.

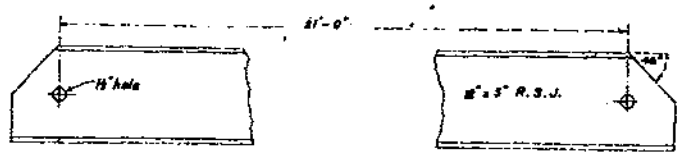


Front Elevation.

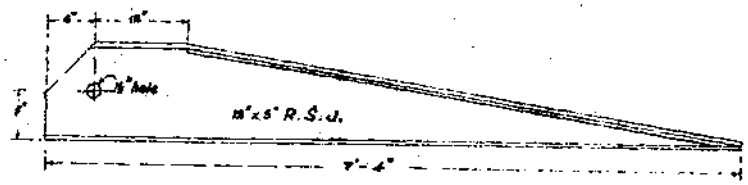
Section.



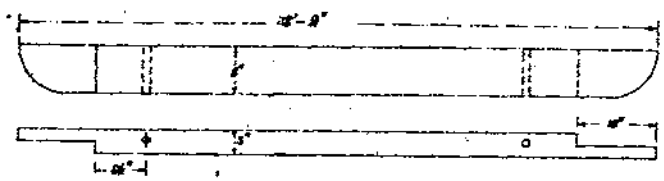
Distance Blocks.



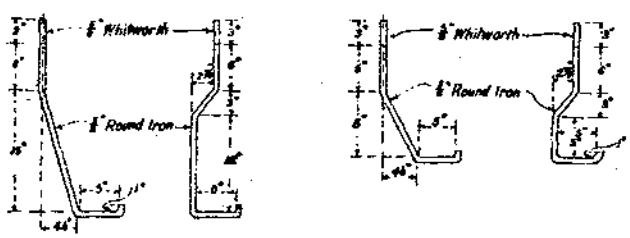
Steel Joist.



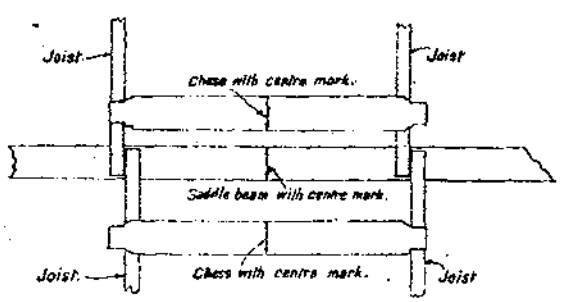
Shore End.



Riband.



Hook Bolts.



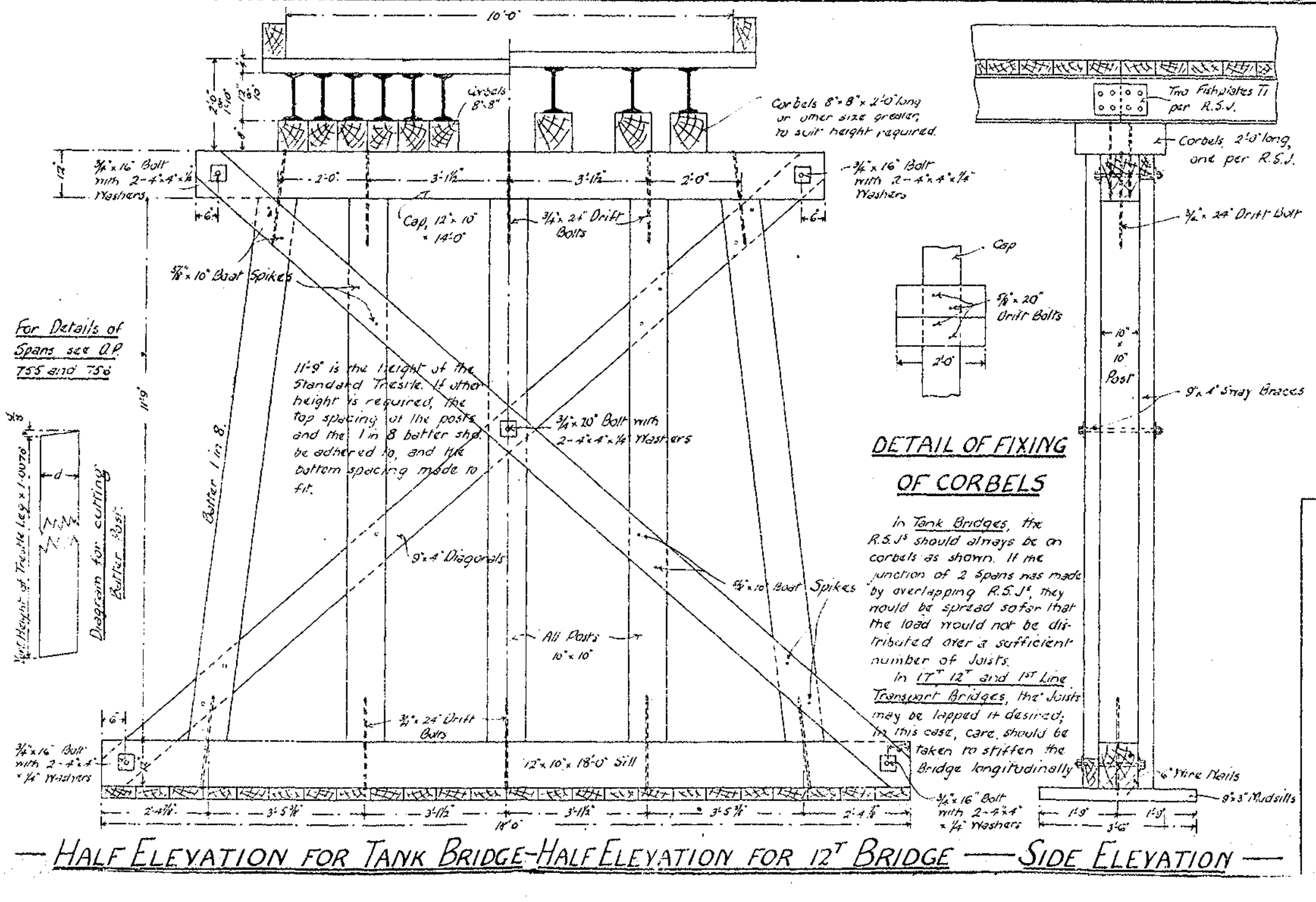
Showing method of spacing joists by using chase as template.

Drawn by E. Shadgett Cpl. R.E.

PLEASE INSERT PLAN 155

FROM BOOK 155

STANDARD TRESTLE ADAPTED FOR USE WITH R.S.J. STANDARD FIELD SPANS



DETAIL OF FIXING OF CORBELS

In Tank Bridges, the R.S.J's should always be on corbels as shown. If the junction of 2 Spans was made by overlapping R.S.J's, they would be spread so far that the load would not be distributed over a sufficient number of Joists.

In 17T 12T and 1st Line Transport Bridges, the Joists may be lapped if desired; in this case, care should be taken to stiffen the Bridge longitudinally

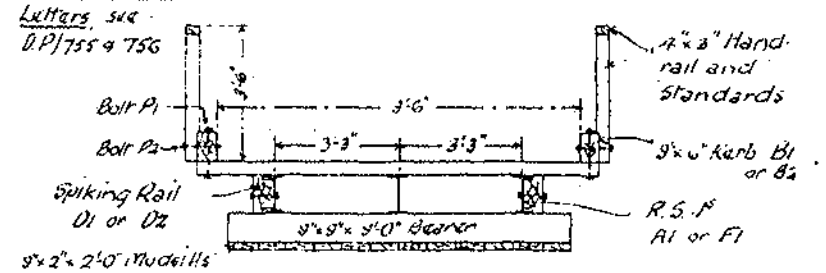
Material List

No	Description	Section	Length
3	Posts	10"x10"	11'-9"
2	Batter Posts	10"x10"	11'-11"
2	Sway Braces	9"x4"	21'0"
1	Sill	12"x10"	18'-0"
1	Cap	12"x10"	14'-0"
24	Mudsills	9"x3"	3'-6"
* 12	Corbels	8"x8"	2'0"
1	Bolt	3/4"	20"
4	Bolts	3/4"	16"
10	Washers	4"x4"x1/4"	
10	Drift Bolts	3/4"	24"
* 24	Drift Bolts	5/8"	20"
16	Spikes, boat	5/8"	10"
10 lbs	Nails, wire		6"

* These quantities halved for 12T Axle Load Bridge

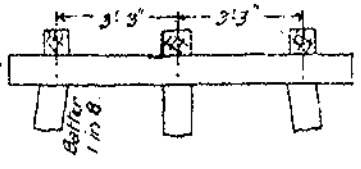
R.S.J. STANDARD FIELD SPANS FOR 1ST LINE TRANSPORT

For Reference Letters, see D.P. 755 & 756



CROSS SECTION

For junction of 2 Spans on Trestle, arrange with corbels and 3-legged trestle as opposite. Timber to be about 8"x8" square.



HALF ELEVATION FOR TANK BRIDGE — HALF ELEVATION FOR 12T BRIDGE — SIDE ELEVATION

base depôts for the erection of cube piers. This type is economical and light, and will stand a weight of 40 tons on each cube. They were very suitable for quick erection on land, but difficult to place in water.

Pile Drivers.—The standard hand pile driver was 24 ft. high, with 15-cwt. monkey. Although this was extensively used, no two units ever agreed as to its merits or demerits, and demands for a mechanical driver were general. It was noticeable that when mechanical drivers were supplied, units generally went back in a short time to the hand machines.

Petrol Pile Driver.—A standard petrol driven pile driver winch was provided, but although received at first with acclamation, was actually very seldom used. This may have been due to the absence of special heavy bridging units with *personnel* trained in the use of such appliances.

Such machines required a permanent crew, and were seldom made full use of if transferred from one unit to another without *personnel* accustomed to work them.

They must also be provided with spare parts and repair materials.

For 9-in. to 12-in. piles a petrol driven driver with a 15-cwt. monkey and a 24-ft. frame would appear to be generally suitable.

Steam Pile Drivers.—Eight steam pile drivers with monkeys from 20 to 30 cwt. were obtained, but were never actually used, and in only a few cases were there sufficient piles to be driven at one site to warrant the erection of such a driver. Similar pile drivers erected on rafts were used very successfully by the Inland Water Transport, but in their case they always had a large number of piles to drive at a given place, also all the work was carried out on navigable waterways.

One very heavy steam pile driver with an overhang of 30 ft., capable of driving two piles simultaneously, was obtained for the construction of viaducts across a waterway or flooded country, but was never actually used.

Air Compressor Plant.—During the final advance it was often found possible to salve damaged girders of the destroyed bridges, and to re-erect them *in situ*. For this type of work and also in drilling existing girders for reinforcement to carry tanks, a portable air compressor plant was found most valuable. Each plant weighed about three tons, and could be conveniently mounted on and worked from a 3-ton lorry, or a 7-ton trailer. One of these plants, with a complete set of tools, was being supplied to each army, but did not arrive in time to be of much use.

Storekeeping and Issuing.—One of the most technical, and certainly among the most important branches of bridging organisation was the care and issue of stores. As the amount of bridging material increased, a very great strain was brought on the *personnel* at the

base, whilst formations had to make use of any skilled *personnel* that they could find, and which was at any time liable to be moved.

The earliest practical bridging operations, *i.e.*, the crossing of the Somme in March, 1917, made very clear the primary importance of skilled organisation in the supply of material. This was improvised, and during the intensive operations of 1918, and in spite of the greatest difficulties, there is hardly a case on record of any breakdown in the organisation.

One of the great difficulties that had to be faced during the greater part of the war was the storage and care of the steadily increasing accumulation of bridging material at the bases.

During 1916 there was a feeling in some quarters that shipping and ports were being blocked by the large quantities of material for which the actual need was still open to question.

As a result, the Director of Fortifications and Works came to France as President of a Committee, which investigated the whole question of R.E. stores. This committee entirely concurred in the demands that had been made and were being made, and the supply of bridging and other stores proceeded unchecked.

When the great final advance began there were many anxious moments, during which it seemed impossible to keep pace with the requirements of heavy bridging, but although at times reserves of all stock spans fell to a dangerous point, there was never any actual failure to supply what was required.

7. *Special Bridging Staff and Units.*—It has been already mentioned that for the greater part of the war there was no special bridging *personnel.* In 1915 a qualified officer was attached to the office of the Engineer-in-Chief as acting Bridging Officer.

He made reconnaissances of various routes behind our lines and calculation of the strength of the bridges on these routes, with a view to the passage of heavy guns or tanks.

He also worked on the classification and collation of bridging stores, and also on details of the application of various stock spans to certain canal and river crossings. This officer remained about a year.

In March, 1917, another specially qualified officer came to G.H.Q. and remained as bridging officer until the end of the war. His first work was the design of the new bridge to replace the 85-ft. A span.

Subsequently he worked out details of all the various rolled steel joist bridges, as well as the revised lists of stores, and various technical details connected with the erection of the various spans. In addition to these duties a lot of practical work was carried out in the field, including at times the direct superintendence of the erection and dismantling of bridges, as well as regular liaison with the Bridging Officers of Armies and Corps. This officer came on the authorised staff of the Engineer-in-Chief in July, 1917.

During 1918 the work increased enormously, and two officers, Instructors at the Bridging School, were brought into G.H.Q. to assist. During times of special stress one or more of these officers were attached to the Chief Engineer of the army most busily employed, to give assistance in the heavy bridging work. It was very noticeable that in such cases Chief Engineers almost invariably chose to put these officers in charge of the supply and issuing of bridging spans and stores, rather than employ them in superintendence of actual bridging operations.

The training given at the bridging school had by this time been sufficient to ensure a fairly general acquaintance with the erection of all stock spans among the R.E. field units, but the preparatory work in assembling both bridge sections and stores needed very special technical qualifications. This is dealt with more fully in Chapter II.

In every operation which entails bridging on any considerable scale, both Army and Corps concerned found it essential to detail a special officer for this work alone.

It was not until the autumn of 1918, when the increased scale of field engineers on the staff of C.E.'s of Armies and Corps came in, that a permanent bridging officer could be appointed in each formation. The training of complete units was always a problem of the greatest difficulty, and was never really solved.

The advantages to be gained if such training had been possible were forcibly illustrated by the very high degree of skill attained by one Army Troops company that had the opportunity of practical training. (See para. 3, Chapter II.)

When the final advance began, and it was obvious that heavy bridging was becoming one of the most important duties, if not the most important, of the Royal Engineers, a scheme was worked out in the Engineer-in-Chief's office for the formation of special bridging companies. These companies were to be formed from a certain number of existing Army Troops companies with special equipment and transport. The idea was that one such company should be allotted to the Chief Engineer of each army, and would be divisible into small sections, which would form the nucleus round which other R.E. units could work on the erection of bridges.

This proposal was not generally concurred in by Chief Engineers of armies, and was finally dropped.

8. *Transport of Stock Spans.*—The most useful transport which could normally be obtained by Chief Engineers of armies were the pontoon wagons of the M.T. Pontoon Parks. These vehicles would carry practically any of the standard sections—the only ones that gave difficulty were those of the 85-ft. span, and long rolled steel joists, or long timbers for piles.

After 1916 the Engineer-in-Chief had at his disposal twelve 5-ton

Berna lorries, and twelve 7-ton trailers. The Berna lorry has a frame with top transom fitted behind the cab, and another frame carrying a roller and winch fitted on the rear of the chassis. They will take girders, long timber or piles up to 32 ft. in length. The 7-ton trailer hauled by a F.W.D. lorry was the most suitable type of all vehicles for heavy bridging material. They could be loaded up to 6 tons, and could be fitted with planks so that small stores as well as large sections could be carried. Twelve additional trailers were on order when hostilities ceased.

Other types of transport that were sometimes used are :—

(1) 5-ton steam Foden—
This was suitable for all loads up to 24 ft. in length.

(2) 5-ton Clayton steam lorries—
These are similar to the Foden, but have shorter bodies. They will take loads up to 18 ft. in length.

(3) 3-ton petrol lorries—
These are suitable for all loads except for girders or girder sections over 20 ft in length.

(To be continued).

THE 5th (FIELD) COMPANY, R.E., AT POLYGON WOOD, 11th NOVEMBER, 1914.

EXTRACT FROM REPORT OF C.R.E., 2ND DIVISION.

(With Sketch Plan).

AT about 9.30 a.m., on 11th November, 1914, the 5th (Field) Co., R.E., were in dug-outs in Polygon Wood, and a heavy shell-fire had been going on for some hours. Major Tyler was informed by the Brigade Headquarters that the Germans had broken through. Some twenty men, under Sergt. Lethbridge, were sent to the south side of Polygon Wood to the trenches there, and the rest of the sappers, with all the officers, went south into the open, and occupied a disused trench and a short length of hedge on the left rear of it. The latter was under Lieut. Gowland, with Corpl. Curtis and six sappers, and a few men of the Connaught Rangers. Some Germans from the wood on the right enfiladed this trench, and the right flank was turned back by six or eight men under Corpl. Chambers. In signalling up more men to protect this flank, Lieut. Collins was killed. Sapper Farmfield at great risk to himself, lifted Lieut. Collins into the trench.

The men on the right flank were unable to hold on owing to smoke from a house in the wood, which the Germans had set on fire. The Company was therefore ordered to fall back along the trench to a new position.

The second position consisted of the hedge on the left rear of the first position. There was also a detached right flank, well thrown back, behind a slight rise in the ground, consisting of 15 R.E., under Lieut. Gowland, and 20 to 30 infantry (Connaught Rangers, etc.) This flank fired into the wood on the right and enfiladed a party of Germans who had started entrenching in rear of it. The Germans brought up a machine-gun in the wood to enfilade this detached right flank, and an officer of the Connaught Rangers called for a volunteer to cross to the main line, some 150 yards away, and ask for orders. No. 19541 Sapper T. Wilson offered to go, and, in spite of heavy machine-gun fire he got the message through, falling once on the way to avoid the machine-gun fire which followed him. He brought back an order to advance on the right of the line, joining on to the Oxfords, who were now advancing through the wood and driving the Germans back.

The whole line now advanced, shooting and bayoneting from

90 to 100 of the enemy outside the wood, and the R.E. and some of the infantry took up a position in the original support trench, from the right of which a good fire was kept up into the retreating Germans. This line was occupied only for a few minutes. A further advance was made, chiefly by the R.E., and there seems to have been some lack of cohesion. Part under Lieut. Gowlland, and apparently under orders from within Polygon Wood, advanced half-left, and reached the edge of Polygon Wood, where they advanced along the H.L.I. trench, so as to bring a cross-fire in front of the rest of the advance. Corpl. Chambers, however, with three sappers, advanced half-right to Lieut. Renny-Tailyour's party. Part, under Lieut. Renny-Tailyour and a Connaught officer, went across the open turnip-field, and a third party, under Major Tyler and Lieut. Vibart, who was wounded in the wrist, along the communication trench. The Oxfords appear to have advanced some 200 yards to the right of this trench and to have stayed there.

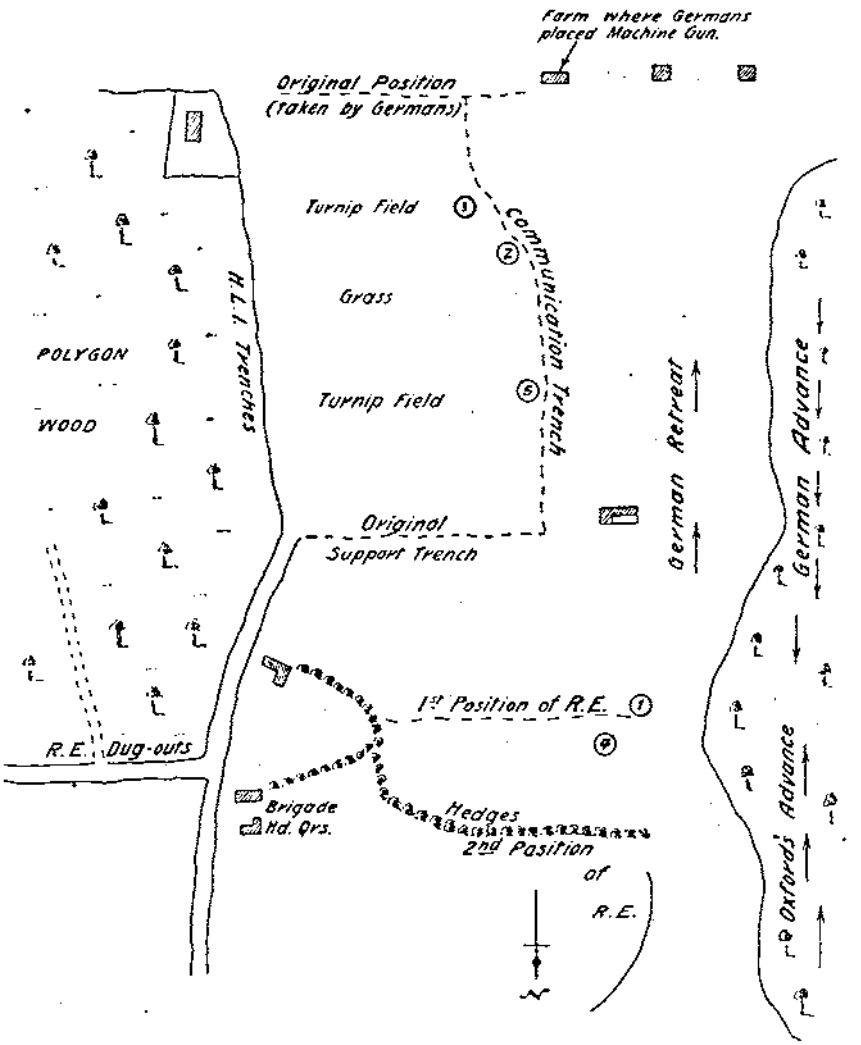
After crossing the turnip field the men under Lieut. Renny-Tailyour converged towards the communication trench, and came under very heavy machine-gun fire from a farm on the right front. Corpl. Curtis and three men, who were in a shell-hole, got into the trench, and heard a message sent to Major Tyler to come and speak to an officer of the Leinster Regiment. Major Tyler went on with Corpl. Curtis and some R.E., telling them to keep their heads down. He himself must have shown his head over the parapet and was shot. The Leinster officer then ordered Corpl. Curtis with L.-Corpl. Jack and Sappers Farmfield, Keelog, Vyse, Hope and Stewart, to hold the end of the trench, and they did so under heavy fire for half an hour.

Meanwhile, Lieut. Renny-Tailyour's party came under heavy machine-gun fire, and tried to get into the communication trench. Two were killed and three wounded. An infantry officer, who was bringing on some men of the Connaughts, got into the trench, and when Lieut. Renny-Tailyour tried to follow he was shot. Corpl. Chambers, who was within six feet of him, and the three sappers with him (Sappers Harlow, Wroe and Moriarty) were unable to follow owing to machine-gun fire, and, hearing Lieut. Gowlland calling them from the wood, they wriggled back in that direction. Sapper Wroe got up at great risk and helped a wounded man of the Connaughts into the wood. The man fell once but Sapper Wroe again got him up.

Meantime, the six men under Corpl. Curtis were under shrapnel fire from the rear and had to retire. Sappers Farmfield and Kellog carried Major Tyler's body down the communication trench until stopped by infantry holding the trench, where they had to leave him.

The advance to capture the original position having failed, presumably for want of support, the retirement of the R.E. took place about 4.30 p.m., by two routes, *i.e.*, from the communication and

DIAGRAM OF ACTION OF 5TH FIELD COY. R.E.
11: 11: 1914.



REFERENCE.

① Lt. Collins shot.
② Maj. Tyler shot.
③ Lt. Renny Tailyour shot.
④ Approx. position of Lt. Collins' grave.
⑤ Probable position of Maj. Tyler's grave.

support trenches, and from Polygon Wood. The latter was also under shrapnel fire from the rear, but in both cases reference was made to Brigade Headquarters before retirement. Sapper Wilson again took this message for the Captain of the Connaughts, under fire, from the support trench.

On the same date, at 9.30 a.m., when the company was called up from its bivouac to assist in driving back the Germans, who had broken through, five sappers (W. Vye, J. Carman, G. Hope, A. Duckett, and J. Stuart), who were employed as cooks, were left behind. These men went and joined a French battery in the vicinity, and stayed with it at the request of the O.C., who spoke English. A French gunner was shot, and the O.C. asked the sappers if they would find out if there were any Germans in a house 300 or 400 yards away. The sappers advanced in skirmishing order, under the leadership of Sapper Vye, under fire. When within 100 yards of the house, three sappers were left to maintain a covering fire, while Sappers Vye and Duckett advanced on the house, which was found to contain five Germans, three of whom fled and two were made prisoners. The prisoners were handed over to the French battery. The sappers then rejoined a part of their company under 2nd Lieut. Vibart, and took part in the final counter-attack on the enemy, in which Sapper Duckett was wounded.

ORDER OF BATTLE OF ROYAL ENGINEER UNITS IN ALL THEATRES ON NOVEMBER 11TH, 1918.

THE following amendments to the lists published on pages 50—67 of *R.E. Journal* for August, 1919, have been notified:—

(*a*). On pages 50 and 51:—

After "Mesopotamia" *insert* new theatre "North Russia" and *add* against "Field Companies" under that heading:—

492nd Field Co.
548th Field Co.

(*b*). On pages 53 and 54:—

Against "Fortress Companies" under the heading "Foreign Garrison" *insert*:—

27th Bermuda
28th Malta
36th Sierra Leone
40th Hong Kong
41st Singapore
43rd Mauritius
44th Jamaica
45th Gibraltar
48th Ceylon (since renumbered 31st)

R.E., T.F., REORGANIZATION SINCE AUGUST, 1914, TO FEBRUARY, 1919.

Pre-War Unit.	Present 1st Line.	Present 2nd Line.	Present 3rd Line.
R.E. (T.F.) *Divisional Field Cos.* *Highland Div. H.Q.*			
No. 1 Field Co.	1/1 400th Field Co., 51st Div., France.	2/1 403*rd Field Co.* Disbanded when 64th Div. was broken up. 20/Engrs./5334.	3/1 merged into Scottish Group Reserve Field Co. 408th. See Note against 3rd line below.
„ 2 „	1/2 401st Field Co., 51st Div., France.	2/2 404*th Field Co.* 51st Div., France.	3/2 405th Field Co. Disbanded. when 64th Div. was broken up 20/Engrs./5334. See note against 3rd line of 2/3 Co. as regards the 4/2 Co.
„ 3 „ ... ... (Not pre-war.)	1/3 *Not* pre-war. 402nd Field Co. Disbanded when 64th Div. was broken up.	2/3 merged into Scottish Group Reserve Field Cos. A.C.I. 2420 of 1916. See 3rd line.	The 3/1, 4/2 and 2/3 Highland and 2/1 Renfrew formed the 408th Highland Reserve Field Co. of the Scottish Group, which on reorganization of R.E. Reserve Battns. was absorbed into 6th Reserve Battn. R.E. 20/Engrs./5214 (A.G.7.B.) of 12. 1. 18. The 6th R.B. now reduced to Cadre. 91/Engrs./1311.
Signal Co. (Highland Divl. Signal Co.)	1/1 now 51st (Highland) Divl. Signal Co.	2/1 *Signal Co.* was broken up when the 64th Div. was disbanded. 20/Engrs./5334.	3/1 *Signal Co.* merged into Signal Service Training Centre. See A.C.I. 1438 of 1916 and 615 of 1917.
Lowland Div. H.Q.			
No. 1 Field Co.	1/1st 409th Field Co., 1st Div., France.	2/1 412th Field Co., 52nd Div., France.	414th Field Co. (3/1) } Ireland Remains of 65th Div.
„ 2 „	1/2nd 410th Field Co., 52nd Div., France.	2/2 413th Field Co., 52nd Div., France.	415th Field Co. (3/2) } Ireland Remains of 65th Div.
		The 4/1, 4/2, 2/3 Lowland and the 2/1 City of Edinburgh Field Cos. formed the 418th Lowland Reserve Field Co. (Scottish Group) and later the 6th Reserve Battn., R.E. See Note against 3rd line of Highland R.E.	
„ 3 „ ... ... (Not pre-war.)	1/3 *Not pre-war.* 411th Field Co., 1st Army, France. (Went to France as a unit of the re-mobilized 72nd Div.).	Amalgamated with Scottish Group Reserve Field Cos. 408 and 418th, which on the reorganization of Royal Engineer Reserve units in January, 1918, were absorbed into 6th Reserve Battn. R.E. 20/Engrs./5214 (A.G.7), dated 12. 1. 18. The 6th Reserve Battn., R.E., is now being closed down. 91/Engrs./1311.	

R.E., T.F., REORGANIZATION SINCE AUGUST, 1914, TO FEBRUARY, 1919.—*Cont.*

Pre-War Unit.	Present 1st Line.	Present 2nd Line.	Present 3rd Line.
Signal Co. (Lowland Divl. Signal Co.)	1/1 now 52nd (Lowland) Divl. Signal Co.	2/1 was the 65th Divl. Signal Co., Ireland, but on the break-up of 65th Div., some of the *personnel* went into the Signal Service Training Centre and some were retained for the Special Signal Co. for Ireland. It cannot be said, however, that the Special Signal Co. for Ireland is the 2nd line unit which should be considered as disbanded. 3/1 was merged into the S.S.T.C. See A.C.I.'s 1438 of 1916 and 615 of 1917.	
West Lancashire. H.Q.			
No. 1 Field Co.	1/1st 419th Field Co., 55th Div., France.	2/1 422nd Field Co., 55th Div., France.	The 3/1, 3/2 and 2/3 became the 426th W. Lancs. Reserve Field Co. of the Western Group Reserve Field Cos., of which group 300 went to 4th Reserve Battn., Deganwy, and remainder to Royal Monmouth Reserve Battn., R.E., W.O. letter 20/Engrs./5214 (A.G.7.B.) d. 12. 1. 18. The two Reserve Battns. R.E. are being reduced. 91/Engrs./1311 (A.G.7.B.).
,, 2 ,, ...	1/2nd 420th Field Co. was in 42nd (E. Lancs.) Div. Now in Army Troops, Salonika.	2/2 423rd Field Co., 55th Div., France.	
,, 3 ,, ...	1/3rd *Not* pre-war. 421st Field Co., 57th Div., France.	2/3 Amalgamated with Reserve Field Co. (426th) Field Co.	
Signal Co. (W. Lancs. Divl. Signal Co.)	1/1 55th Divl. Signal Co.	2/1 57th Div. Signal Co., France.	3/1 merged into S.S.T.C. See A.C.I.'s 1438/1916 and 615 of 1917.
Note.—The 55th (W. Lancs.) Div. had its own (territorial) units, but the 57th (W. Lancs.) Div. was composed of 1/3 (421st) W. Lancs., 1/3 and 2/3 (502nd and 505th) Wessex Field Cos., and 2/1 Wessex (57th Divl.) Signal Co.			
East Lancashire. H.Q.			
No. 1 Field Co.	1/1 427th Field Co., 42nd Div., France.	2/1 430th Field Co., 66th Div.	The 3/1, 3/2 and 3/3 E. Lancs. Field Cos. formed the 435th E. Lancs. Reserve Field Co., Western Group, as to disbandment of which see Note against 3rd line, West Lancs. R.E.
,, 2 ,, ...	1/2 428th Field Co., 42nd Div., France.	2/2 431st Field Co., 66th Div.	
,, 3 ,, (*Not* pre-war.)	1/3 *Not* pre-war. 429th Field Co., 42nd Div., France.	2/3 432nd Field Co., 66th Div.	
Signal Co. (East Lancs. Divl. Signal Co.).	1/1 42nd (E. Lancs.) Divl. Signal Co.	2/1 66th Divl. Signal Co.	3/1 merged into S.S.T.C. See A.C.I.'s 1438 of 1916 and 615 of 1917.

R.E., T.F., REORGANIZATION SINCE AUGUST, 1914, TO FEBRUARY, 1919.

Pre-War Unit.	Present 1st Line.	Present 2nd Line.	Present 3rd Line.
Welsh Div. H.Q.			
Cheshire Field Co.	1/1 438th Field Co., 3rd Div., France.	2/1 439th Field Co., 74th Div., France.	3/1 440th Field Co. disbanded when 68th Div. was broken up. 4/1 merged into 445th (Welsh) Reserve Field Co. with 3/1 (Welsh) and 3/1 Glamorgan Field Cos., and formed part of Western Command Group Reserve Field Cos. The Western Group was reorganized. See note against 3rd line of W. Lancs. R.E.
Welsh Field Co.	1/1 436th Field Co., 53rd Div., Egypt.	2/1 437th Field Co., 53rd Div., Egypt.	3/1 (Welsh) merged into 445th (Welsh) Reserve Field Co. See 4/1 Cheshire above.
Glamorgan Field Co. (*Not* pre-war.)	1/1 *Not* pre-war. 441st Field Co. Disbanded when 68th Div. was broken up. 20/Engrs./5334.	2/1 442nd Field Co. disbanded when 68th Div. was broken up. 20/Engrs./5334. 2/1 550 *Field Co.* This unit was converted from the 2/1 Glamorgan Works Co. for the 72nd (Home Service) Div. until it was designated 550th (Field) Co. by 9/Engrs./7611 (A.G.7.) of 8. 1. 17 it was known as the 72nd Glamorgan Field Co. (Home Service). The 72nd (H.S.) Div. was broken up (114/Gen. No./5763). The 550th Co. was re-mobilized for the new 73rd Div. and went to France on 22. 6. 18. 2/2 551*st Field Co.* was converted from 2/2 Works Co. for the 72nd (Home Service) Div., which was disbanded (114/Gen. No./5763). The 551st Co. was disbanded 3. 6. 18 (R.O. Returns/273 A.G.7.b.)	3/1 Glamorgan Field Co. was merged into the 445 (Welsh) Reserve Field Co. See note against 4/1 Cheshire Field Co. above.

Note.—It will be observed that there were two Field Cos. designated 2/1 Glamorgan and that there was no 1/2 Glamorgan *Field* Co. The 1/2 Glamorgan was an Army Troops Co., *i.e.*, the 557th. See Fortress Units.

R.E., T.F., REORGANIZATION SINCE AUGUST, 1914, TO FEBRUARY, 1919.—*Cont.*

Present War Unit.	Present 1st Line.	Present 2nd Line.	Present 3rd Line.
Signal Co. (Welsh Divl. Signal Co.).	1/1 53rd (Welsh) Divl. Signal Co.	2/1 68th (Welsh) Divl. Signal Co. Being disbanded since October, 1918. 20/Engrs./5334.	3/1 Signal Co. merged into S.S.T.C. See A.C.I.'s 1438 of 1916 and 615 of 1917.
Divisional Field Cos., R.E. (T.F.) Northumbrian Div. H.Q.			
No. 1 Field Co.	1/1 446th Field Co., 50th Div., France.	2/1 449th Field Co., 28th Div., Salonika.	3/1 451st Field Co., 15th (Indian) Div., Mesopotamia. See also note below.
,, 2 ,, ...	1/2 447th Field Co., 50th Div., France.	2/2 450th Field Co., 15th (Indian) Div., Mesopotamia.	See Note below.
,, 3 ,, ... (Not pre-war.)	1/3 not pre-war 448th Field Co., 15th (Indian) Div., Mesopotamia.	2/3 merged into 454th(Northumbrian) Reserve Field Co. (Northern Group), which was subsequently merged into R.E. Reserve Battns. 20/Engrs./5214. See 3rd line.	No 3/3 Field Co. formed.
		Note.—The 4/1, 3/2 and 2/3 became the 454th Reserve Field Co., Northern Group. The Northern Group was merged into the R.E. Reserve Battns. 600 to R. Anglesey Reserve Battn., remainder to Royal Monmouth Reserve Battn. 20/Engrs./5214 of 12. 1. 18. The two latter Reserve Battns. are being reduced. 91/Engrs./1311.	
Signal Co. (Northumbrian Divl. Signal Co.).	1/1 50th Div. Signal Co., France.	2/1 Signal Co. was in the 63rd Northumbrian Div., but the Royal Naval Div. (which had its own Signal Co.) was re-designated 63rd Div., so the 2/1 Northumbrian Signal Co., was broken up.	3/1 Signal Co. was merged into the Signal Service Training Centre. See A.C.I.'s 1438 of 1916 and 615 of 1917.

(*To be continued*).

CORRESPONDENCE.

ACOUSTIC PHENOMENA OF THE WAR.

To the Editor, R.E. JOURNAL.

SIR,

In the September issue of the *R.E. Journal* it is stated that throughout the summer of 1916 the rumbling of gun fire was heard in Sussex. I should like to place on record the fact that it was continuously audible in my garden at Rochester, but there was no rumbling. The reports, though faint, were separate, distinct, and clear, averaging from 35 to over 50 rounds a minute. It gave the impression of a distant *feu de joie*, very slow and irregular. Its monotony became wearisome. I assumed that we only heard the heavies. The garden front of my house faces roughly E.S.E., and the ground in that direction is open.

It was understood at the time, from tests in France, that the main factor in the transmission of sound from great distances is the state and direction of the air in the upper regions above the ground wind, the waves descending here and there where favourable conditions exist. Unfortunately they must have been unduly favourable in my case.

Yours faithfully,

H. D'ARCH BRETON, *Colonel*,
Mayor.

Guildhall, Rochester, 8th September, 1919.

[NOTE.—It will be seen from the conclusion of Colonel Sir E. Thackeray's review of the article in the *Rivista* that the writer of the article arrives at the same conclusion.—EDITOR, R.E.J.]

REVIEW.

MOLESWORTH'S POCKET-BOOK OF ENGINEERING FORMULÆ. 28th Edition. Price 10s.—(Spon & Co., 10, Haymarket, S.W.1.)

A new edition of this extremely useful pocket book has now been published—comprising 872 pages (index additional). It gives a great deal of new information, especially on the subjects of Steam, Boilers, Locomotives, Petrol Engines and Aerodynamics, the sections on which have been re-written and re-arranged. It is noted that the 1907 British Standard Specification for concrete is still referred to, though the latest specification came out in 1915. A short note on Reinforced Concrete is now inserted.

H.L.L.

NOTICES OF MAGAZINES.

BULLETIN OF THE INSTITUTION OF MINING AND METALLURGY.

April, 1919.

The Work of the Miner on the Western Front, 1915—18.—By H. Standish Ball, M.Sc. (late Assistant Inspector of Mines, G.H.Q., France).—To give some idea of the exceptional value of this article to all readers of the Royal Engineers, it will suffice to reproduce the list of sub-heads:—

I. Formation of Companies.
II. Principles of Mine Warfare.
  (*a*) Geology.
  (*b*) Crater Formation.
  (*c*) Explosives.
  (*d*) Mining Tactics.
III. Mine Listening Instruments and their Application.
IV. Mine Rescue Work.
V. Mining Operations.
  (*a*) Somme Offensive, July, 1916.
  (*b*) Arras Offensive, April, 1917.
  (*c*) Messines Offensive, June, 1917.
  (*d*) Miscellaneous.
VI. German Offensive, March, 1918.
VII. Allied Offensive, August, 1918.
VIII. German Traps and Land Mines.
IX. Technical Training.

The article is lavishly illustrated, and some of the descriptions, especially in the case of sub-head III., "Mine Listening Instruments," and sub-head VIII., "German Traps and Mines," are given in considerable detail, in fact it is surprising how much information the writer has been able to include in the short space of a single lecture. That it is of engrossing interest throughout is a proof that it is by no means a barren list of official details. It bears ample testimony to the gallant and heroic actions of the tunnellers, which are well recognized in Field Marshal Sir Douglas Haig's Order of the Day:—"Their fighting spirit and technical efficiency has enhanced the reputation of the whole Corps of Royal Engineers and of the Engineers of the Overseas Forces." By the courtesy of the Institution of Mining and Metallurgy, sanction was given for the reproduction of this article in the *R.E. Journal*, but, on account of the pressure of other matter, it is regretted that this generous sanction cannot be taken advantage of. It should, however, be mentioned that copies of this article can be obtained at the offices of the Institution, 1, Finsbury Circus, London, E.C.2, at the price of five shillings.

F.E.G.S.

MILITÄR WOCHENBLATT.

June (continued).

The translation of Lord French's "1914" is continued. Each number contains a summary of events in Poland calculated to show that the Poles are preparing to invade Germany, and a number of advertisements calling for volunteers for "freecorps," defence corps, and the regular army; the military spirit is not dead yet. There is also a review of the Press, with extracts from the English, French, and American papers which show any softening towards Germany.

No. 146.

How we lost the War.—The situation at the end of 1916 was critical; the battles at Verdun and of the Somme had cost very heavy losses and worn the troops engaged to the utmost limit, and yet it was necessary to send strong forces to Russia to meet the Brussilov offensive and to crush Rumania. The failure of Nivelle's offensive in May, 1917, the subsequent mutiny of French troops, and the German retirement to the Hindenburg Line saved the situation. It is asserted that 40 French divisions mutinied, and that on one day alone 200 men of one regiment were shot by order of court-martial. During the summer the trouble was overcome by the French, but was beginning to be felt in the German Army. There was a regular planned boring and nibbling at the pillars of our strength, the sense of duty and discipline of our men. Letters from home narrating conditions there worked on the soldiers' feelings; there was an increase of marauding and desertion, unwillingness to fight, and mistrust of leaders. Much of the trouble at home was due to profiteers (*Kriegsgewinnler*), and to many of the requirements of the State having got into the hands of business men who with their narrow-minded selfish training could not work unselfishly for a great cause. The worship of the golden calf even affected official classes.

The Ministry of War and the D.O.B.—There is apparently some difference of opinion between the Ministry of War and the Union of German officers as to the rights and functions of the Union.

There is significant conservatism in *Answers to Correspondents.* Retired Lieut.-General is informed:—"Your *Excellency's* note has been passed on to Mittler & Co." So the old titles of respect go on.

No. 147.

How we lost the War (continued).—The Army of 1917 was not to be compared with that of 1914, there was still, however, a good leaven, which had its effect in battle. On the other hand there were plenty of units which provided a breeding ground for the bacteria of unrest. The first actual trouble arose in the Navy. The success of the winter of 1917—18 had a great effect, and even workmen in the Army blamed the strikers at home; unfortunately, the revival of a good spirit was choked by the arrival in the West of troops from Russia, impregnated with the revolutionary tone, and of recruits contaminated by home influences.

In the spring of 1918 the Germans had superiority of numbers in France, units were full up and the men rested. The writer ascribes the failure to push on at Amiens to lack of motor transport due to want of raw materials. When in June the men found the enemy merely driven back and not annihilated, the "will to victory" disappeared. The third offensive, towards Rheims, completely failed, partly on account of bad luck, but partly also through whole bodies of troops failing in their duty. For instance, north of Soissons a whole division left the field almost without fighting; as a good division went forward to restore the situation the men of the former shouted "You damned strike breakers, you are going to block the hole that we have just made." The writer, however, claims that the army was still strong enough to cause the Allies heavy loss, although they had then numerical superiority. He makes the absurd statement that in Champagne the French-Americans would not attack when a German machine-gun appeared, and that French officers had to drive their men on by threatening them with pistols. Finally, he asserts that the revolution was the "stab in the back" which finished the war.

Roll of Honour of *No. 13 Infantry Regiment.*—172 officers killed (this is the largest total yet noticed).

No. 148.

Military Competitions.—Notice of sports to be held at Potsdam, 14th—16th August:—Swimming, gymnastics, cycling, riding, team racing, etc. This is quite a new feature of German Army life.

Roll of Honour of *No.* 10 *Pioneer Battalion* (*Field Companies*).—32 officers killed.

No. 149.

A Word in the Last Hour.—By Colonel von Livonius.—An article full of hate and revenge. He calls on clergy of all confessions to preach "holy hate as a morally purifying and liberating power," and ends with a quotation from the poet Felix Dahn: "All Europe shall stand in flames when Germany goes down."

The Economic Position of Officers.—Demands compensation for officers compulsorily placed on half-pay.

The Old Pension Scale.—Bitter complaints of its inadequacy. A captain after 20 years' service is only entitled to 1,141 marks per annum, majors after 25 years, to 1,361 marks, etc.

Infantry Regiment No. 130.—A notice with regard to the disbandment of this Lorraine Regiment.

Can Remounts be Trained quicker than in the Former Regulation Manner.—Mentions among other things that the German horses were very soft and could not stand exposure, and generally condemns the official methods.

Roll of Honour of Infantry Regiment No. 82.—92 officers killed.

Posts open to Officers.—A list of four only.

Advertisements.—There are more than the usual number of calls for volunteers for frontier guards, old and new army. One for the West

Prussian Frontier begins: "For the protection of the liberty of our sore pressed East Mark, the 35th Division and the Volunteer Jäger Corps, Giesecler, calls on all students and true German sailors to unite as a defence against the mad and immoderate action of the Polish vultures."

No. 150.

How our Horses stood the War, by Major General von Poseck.—An article of interest. It ascribes the failure of the horses (given as one of the causes of the German collapse by the General Staff) to their being too much coddled in peace time. A number of instances are given of the cavalry being unable to move, *e.g.*, as early as the 11th August, 1914, von der Marwitz's Cavalry Corps had to halt for rest and good food; on the 2nd September, the 2nd Cavalry Division had to stop pursuit, as its horses were tired out. Richthofen's Cavalry Corps had to be given a rest day on the 8th August, on the 29th August the horses were incapable of a trot across country, etc., etc. No wonder the German cavalry accomplished so little.

Protest of the German Officers' Union against the Peace.

Co-operation of the Arms ensured by War Establishments.—A plea that artillery should form part of infantry regiments.

No. 151.

Generals for Signing the Peace Treaty.—Insinuates that no soldier will sign it.

Officers' Unions and the Defence Chamber (Wehrkammer).—The article endeavours to show that officers can belong to both—the Unions protect their personal interests; the so-called Defence Chamber is a political institution (nominally to guard the interests of the Army, practically to organize and train the nation for war independently of the War Ministry).

How our Horses stood the War (continued).—Contains a comparison of the true value of the various breeds of horses. It is claimed that the East Prussian horse was the best army horse, and advocates that a smaller horse should be bred.

Roll of Honour of Infantry Regiments No. 82.—87 officers killed; No. 77.—109; N. S. Foot Guards—66.

No. 152.

Appeal of the Officer Corps of the Prussian Army and Navy to the Queen of the Netherlands and the Netherlands States General.—This appeal that the ex-Kaiser shall not be handed over is printed in large type.

Regimental and other Unions of the Old Army.—An editorial appeal to found military unions to maintain remembrance of the honourable and glorious old units "never defeated by enemy arms," and to prepare for the future.

Hindenburg's Farewell.—This has already appeared in the British Press. He particularly thanks the "Volunteer formations that had held the watch on the Eastern frontier."

General Oberst von Moltke's Memoirs.—With reference to a notice in

the Press that the younger von Moltke's memoirs will not be published, announces that the General Staff will shortly issue a pamphlet dealing with the causes of the war, covering the years 1911—14.

The French Deployment in 1914.—With reference to M. Engerand's book *Le secret de Charleroi*, the M.W.B. warns its readers against believing that the French were surprised by the Germans violating Belgian neutrality.

Rolls of Honour.—No. 17 Hussar Regiment, 24 officers killed; No. 67 Infantry Regiment (Magdeburg) and its machine-gun battery, 134 officers and more than 300 N.C.O.'s and 3,000 men killed; No. 55 Infantry Regiment (Westphalia), 110 officers killed.

July, 1919.

HISTORICAL.

The General Inspection of the Engineer and Pioneer Corps, Berlin, begs all officers of the Pioneer arm (*i.e.*, what we call field units) to write down anything of interest which they may have experienced and to send it to the Engineer Committee, Section 4, where documentary sources are also available.

The History of the Pioneers in the World War, which is being prepared by the Engineer Committee, will, it is hoped, be a memorial to the great services and heroism of the Pioneers.

Everybody who co-operates in the work will earn the special thanks of the Pioneer Corps.

J. E. EDMONDS.

REVUE MILITAIRE SUISSE.

No. 7.—July, 1919.

THE GERMAN AND FRENCH CAVALRIES IN THE GREAT WAR.

A further instalment of the article on the above subject by Colonel Poudret, begun in the number of the *Revue* for March last, appears in the number under notice, the text is accompanied by a number of sketch maps. The account of the German "push" which began on March 21st, 1919, is continued; the chief episodes which occurred between the 23rd and 30th *idem* are detailed.

The Germans succeeded in crossing the Somme below Ham on the 24th *idem* and on the following day Nesles fell into the enemy's hands in spite of the vigorous counter-attacks of the British infantry and cavalry. The 22nd Infantry Division forming part of Robillot's Command, however, succeeded in checking the enemy's advance from Nesles, and at the same time French cavalry, belonging to the same command, was pushed west to gain touch with the British troops. In the meantime the retirement caused a gap in the line between the British 18th and 19th Corps; the French 2nd Cuirassier Regiment was consequently rapidly

moved to the neighbourhood of Chaulnes, to repair this break in the line, and came into action at Ingron, where it fought stubbornly.

On the 26th *idem*, the Germans gained the Roye-Noyon road and a gap was thus made in the French line near Lassigny. In consequence, the French 1st Cavalry Division made a night march, from the hard-fought fields of Noyon, and made good the breach in Robillot's right wing; this Division suffered severely in casualties in carrying out its task, but the men were not to be deterred by the heavy sacrifice which had to be made by them.

The situation on Robillot's centre was critical but some French Squadrons re-took Roye, in a dismounted action, from the Germans; unfortunately they were not able to retain their hold on this place. On the other hand, the 5th Cavalry Division managed to hold on in the Avre Sector between St. Aurin and l'Echelle-St. Aurin; touch with the British right wing was thus maintained. This cavalry was on the 26th *idem* transferred to Debeney's Army, which had just reached the Pierrepont Sector.

The 27th *idem* was a still more critical date. Pellé's Command, being strongly supported in a position favourable for defence, was able to maintain its line; Robillot, however, was not so well placed, and in consequence, had to retire. On this date the French 4th Cavalry Division, which had disentrained at Moreuil on the previous date, was able to act in support of the infantry N. of the Avre, in the direction of Erches. Unfortunately, the Germans had seized Guerbigny; in consequence this Division could not carry out the mission entrusted to it.

On the 28th *idem* was fought the Battle of Montdidier. Six additional German Divisions reinforced the 13 already in their line. The Germans were thus able to gain a footing on the plateau S. and W. of Montdidier. A part of the French Cavalry Division, however, re-took Monchel, Mesnil-St. George and Fontaine-sous-Montdidier at the point of the bayonet and restored the French line in this neighbourhood.

Fighting continued with varying success. Finally Robillot was able to establish himself on the line Cuvilly—Mortemer—Rollot; here the French 1st Cavalry Division held on tenaciously to the positions assigned to it. During this period, this Division had carefully kept its horses out of the fighting line and had engaged *exclusively in dismounted action*.

On the 30th *idem* the Germans made a great effort to break through along the whole front. It was already too late; reinforcements had arrived and Debeney had succeeded in reorganizing his Command in a position N. of Montdidier, the junction of the British and French Armies was fortunately still intact; in consequence Amiens had not been reached.

Of the troops that had proved a strong shield to the *heart of France* none had played a greater and more glorious part than the French cavalry. The Cavalry Divisions that had undergone the severe trials of this period showed how valuable can be the services which a modernized cavalry force, properly instructed and imbued with the right spirit, can render on the field of battle.

At the time that the Germans launched their Great Offensive in March,

1918, the only part of their cavalry which remained mounted was that employed on the Eastern Front. To-day the German leaders must be regretting the mistake they made in retaining in the Ukraine and in Finland the whole of their cavalry.

A short account follows of the German "push" in Flanders in April, 1918; this was launched on April 9th on a 15-mile front between Mont Kemmel and La Bassée with 20 Divisions. The Portuguese troops were driven back and the British 1st Army forced to retire across the Lys.

The French G.H.Q. in consequence, ordered the 2nd Cavalry Corps (under Robillot) from Blangy to the region St. Omer-Steenwoorde. The last-named place was reached at 8 a.m. on April 15th. This was a remarkable performance under the circumstances prevailing—one of the Divisions of this Corps marched no less than 435 miles in 27 consecutive days.

The task assigned to the French 2nd Cavalry Corps was to fill the gap caused by the retirement of the Portuguese troops and to maintain touch with the British 1st and 2nd Corps. It constructed *point d'appuis* on the hillocks of Flanders on a line facing S. This Corps bore the brunt of the fighting on the 16th and 17th *idem*; it was finally relieved by French infantry on the 21st *idem* and went into rest quarters.

Between the 25th and 29th *idem* the Germans made two desperate attacks on the line Mt. des Chats-Kemmel; and the 2nd Cavalry Corps was therefore sent into the line again at Mt. Kemmel. It proved a strong support to the troops which had been tried by severe fighting and for 20 days held on to the positions confided to its charge, in spite of the severe bombardment and the furious assaults of the enemy.

On May 27th, the Germans began their third great "push," this time on the line Pinon Forest—Rheims; they succeeded in crossing the Aisne and reached Chateau Thierry and the borders of the Forest covering Paris. The French 1st Cavalry Division met the shock between Fismes and Dormans; whilst the 5th Cavalry Division operated in conjunction with the 20th Infantry Division, the 1st Cavalry Division was employed in filling up gaps in the line and in supporting the infantry generally. Eventually the Germans were brought to a halt for a second time on the Marne, and a new front was created by the Allies and was held until July 15th.

The French 2nd Cavalry Corps was again called upon to play a decisive *rôle* in these operations. On May 28th it was stationed in the region of Aumale and received orders on that day to move southwards. By forced marches it reached the line Betz—Mareuil-sur-Ourcq on the evening of the 31st *idem*, and it subsequently took part, in support of the infantry, in the fighting in the neighbourhood of Dammard.

At the date of the German "push" in July, 1918, the French 1st Cavalry Corps (Féraud) was in rear of Gouraud's Army, in the region of Chalons. When the German Artillery opened fire against the front Prunay Massiges on the night of July 14th—15th, the 5th Division of this Corps was ordered to the region of La Veuve, but the circumstances having altered the move was cancelled. The German attack having failed, this Corps was no longer wanted in the neighbourhood of Chalons

and it was consequently moved, so as to be in a position to support the troops on the Marne.

On the evening of the 16th *idem*, the Germans were on the line Nesle —le Repons—Montvoisin. The G.O.C. 2nd Cavalry Corps issued orders for a concentric attack on Oeuilly to be launched at 11 a.m. next day, the cavalry under Moinville being assigned to the sector extending from the River Marne on the right to La Cense-Carée (exclusive) on the left. The attack began at the hour named, the artillery coming into action as arranged. It was not, however, till 8.30 p.m. on the 18th *idem* that the French Cavalry succeeded in capturing Montvoisin; the loss of Montvoisin rendered the position of the Germans, who were S. of the Marne, extremely precarious.

During the night of July 18th—19th, the 1st Cavalry Corps was, for tactical purposes, placed under the G.O.C. French 9th Army. Orders were now given for an attack on the heights on the S. bank of the Marne to begin at 8 a.m. on the 19th *idem*, the 5th Cavalry Division was directed to cover the right of the infantry attack in the Marne Valley. Towards evening of the 19th *idem* this Division succeeded in establishing a hold on the ground between Oeuilly and the Marne, S. of l'Echelle. During the night of July 19th—20th the Germans recrossed to the N. of the Marne. The task allotted to the 1st Cavalry Corps in this sector was at an end; it had played a conspicuous part in saving Epernay.

The use to which the cavalry was put in the operations connected with the capture of Montvoisin exhibits a true appreciation on the part of the superior commanders of the art of handling this arm; it shows how well the lessons which had been taught in relation to the employment of cavalry on the modern battlefield had been learnt.—(*To be continued*).

Permanent Fortifications in the Great War.

(*Western Front, August—October*, 1914).

Colonel Grosselin, the author of the original article, points out in an introductory section, that the true value of permanent fortifications was not always appreciated by the public during the Great War. This probably was due to the fact that a fortress which was considered impregnable fell in the short space of 12 days.

In a succeeding section definitions are provided of the terms field, semi-permanent and permanent fortifications. Explanations are also given of the prominent features of the several types of fortification, and the various stages in the development of these types is traced historically from the time of Vauban down to the present day.

The aim and object of fortifications are next discussed. An extract from Napoleon's *Notes* on the defence of Italy, written at Valladolid on January 14th, 1809, is given wherein he states briefly that the advantage one hopes to obtain from the use of fortified lines is "*To gain time.*" The four short statements in which the Great Corsican gave his views as to the circumstances under which permanent fortifications should be utilized are also reproduced in the original article.

Brief notes explain the successful use made of fortifications, in 52 B.C. at Alesia, by Vercingetorix, and in 1799 A.D. at Acre (Palestine) by the Turks, *to gain time*. In the first case the defence works at Alesia gave the Gauls time to raise and organize an army of 240,000 infantry and 80,000 cavalry; and, in the second case the result was, as Napoleon himself admitted, that the defence works at Acre alone prevented the Great Consul from reaching India and proclaiming himself "Emperor of the East."

In a fourth section, the author of the original article calls attention to the the fact that, in all ages, a military commander who desired to seize a fortified place has always carefully weighed the *effort* that would have to be expended by his troops to accomplish the task proposed to be set them; and when he had finally arrived at a decision on the point he set to work to make the most complete preparations from the technical point of view to effect his purpose. In order to give some idea of the *effort* that is required under the conditions of modern war, Colonel Grosselin briefly examines some of the important situations on the Western Front in 1914, in which fortified places played a part. He considers first the defence of Liège (5th—17th August). Liège with its 25,000 men held up the Germans for 13 days, inflicting serious loss on them, estimated by the besiegers at 42,000 men, which gives some measure of the German *effort* against this place. The defence of Namur (19th—25th August) is dealt with next. The Belgian 4th Division and the detachment of French troops, which had taken part in the defence of this place, withdrew from this region on the 23rd August. The experience at Liège made the Germans more cautious and they brought heavy guns, including four Austrian 12 in. howitzers and one 16·5 in. howitzer. The German *effort* at this point is represented in part by the expenditure of 97,000 rounds, weighing some 7,710 tons and requiring 25 trains of 30 wagons each for their conveyance. The defence of Maubeuge (25th August to 8th September) is the last of the fortresses dealt with in this number of the *Revue*. The attack on Maubeuge was entrusted to the German 7th (Reserve) Army Corps and a Cavalry Brigade; a Division (probably belonging to the 7th (Active) Army Corps) was in support and a Siege Corps was also detailed to take part in the attack on this French fortress. Maubeuge held up 60,000 German troops for 15 days, who were thus unable to march to the Marne.

The siege train employed by the Germans comprised, *inter alia*, 12·5 in. and 16·5 in. pieces and also the Austrian Automobile Battery of 12 in. howitzers. The casualties suffered by the French garrison amounted, during the attack, to 5,000 men, the remainder were taken prisoners on the fall of the fortress. The Germans admit that they lost 12,000 men.—(*To be continued*).

INCREASE OF PAY AND INDISCIPLINE.

Major de Vallière, the author of the original article, expresses the opinion that of all the measures adopted during the past few months to improve the position of the Swiss soldier, for not one of them was there so little justification as that relating to the increases granted in the soldier's

pay ; such a step was bound to create grave difficulties. By admitting the principle that the pay of a soldier should be equal to the wages of a labourer, the road has been opened wide, it is pointed out, to all sorts of claims and to political agitation in the army. The pay of a Swiss soldier has, by stages, been raised from 80 centimes to 8 frs. 50 cent. per *diem*.

Everybody agrees, says Major de Vallière, that it was necessary to improve the material comfort of the soldier and his family : there were many ways of doing this other than by the increase of pay. It would have been preferable to increase the scale of *rations*, to provide better *quarters* and to give *aid to soldiers' families*. The high pay is in the majority of cases of no real benefit to the soldier or his family, it finds its way into the pockets of the inn-keepers.

The effect of granting increases of pay has been to make the " question of pay " a subject for politico-military controversy to be exploited by agitators. The principal mistake consists in comparing the pay of the *citizen soldier* with the remuneration of the *professional soldier* and the wages of the labourer. It is quite right, says Major de Vallières, to give a high rate of remuneration to the volunteers who keep guard on Switzerland's frontiers and to those who devote their life-time to soldiering. The pay of the *citizen soldier* has never been considered anything but an indemnity to enable him to make good the minor wear and tear of his equipment. The confusion of ideas which has resulted from the Federal Council acceding to popular clamour on the question of the *citizen soldiers'* pay is one which, it is expected, will lead to considerable trouble in Switzerland in connection with the maintenance of discipline in the army.

Notes and News.

Switzerland.—Regret is expressed that Colonel Wildbolz, who has been in command of the 2nd Army Corps, has, for family reasons, been obliged to retire from the Swiss Army. The vacancy caused by this retirement has been filled by the promotion of Colonel Steinbuch, commanding the 5th Division.

Criticisms are directed against the " Directives " now being issued by the new Federal Military Department to the Instructional Staff responsible for the training of recruits. It is suggested that these " Directives " should be addressed to the medical officers in charge of recruiting and not to the Instructional Staff.

There are already indications that the Swiss Military Authorities will look westward and not northwards for the model on which the Federal Army of the future is to be organized and trained. Parties of Swiss officers have recently been touring the battlefields of France and were received officially in France by a high officer of the General Staff. There has also been a visit of a private nature to Verdun, arranged by one of the Officers' Societies ; other private visits are to follow.

Portugal.—The terms of the Peace Treaty are briefly reviewed by a special correspondent, who lays emphasis on the fact that the most recent Treaty of Versailles, unlike former treaties which have ushered in

Peace, contains clauses the object of which is not exclusively to regulate the relations between the conquerors and the conquered, but also to endow the whole human race with a new Law with a view to inaugurating cordial relationship between the peoples of the Universe by compulsion, if necessary. Napoleon's treaties, it is pointed out, were framed in the interests of a dynasty, Bismarck's in the interest of a military autocracy whereas the latest treaty is the first which can be truly said to have been framed in the name of Liberty and Democracy—its foundation is not laid on the doctrine that Might is Right, it attempts to provide protection for the Small Powers.

Portugal has spent much of her treasure in the prosecution of the Great War and a feeling exists in the country that unless Germany is made to contribute towards the financial expenditure imposed upon the Portuguese people, the country will be ruined. The hope is expressed that the Great Powers will see justice done in this matter.

The number of the *Revue* under notice concludes with a list of books received for review.

*W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

May, 1919.

AUDITORY ZONES AND ZONES OF SILENCE.

(*Concluded*).

Another acoustic phenomenon which calls for special attention during these years of war, is the so-called *zone of silence*. Observations show that intense sounds, such as those produced by explosion, are not always regularly propagated, but there occurs frequently an auditory zone, a zone of silence in which the explosions are not heard, and beyond this a second zone of audition.

Now, for some time before the present war, the existence of a zone of silence was noticed in different circumstances. Some examples of this are given by Professor Munro in his work entitled: *Zones of Silence in Sound Areas from Explosions*, published in the American review already quoted. During the battle of Perryville the sound of the first cannon shots was heard at a distance of about 11 km., while General Buell and his staff, who were at a much less distance from the battle-field were not aware of the cannonading which lasted from five to six hours. This anomaly is attributed to the topography of the district and the direction of the wind. In an explosion of about nine tons of powder that happened at Winchester station in Kentucky in 1884, the sound of the explosion was noticed at a distance of beyond 24 km., while the Chief Engineer of the railway and other persons who were at a distance of only 40 m. from the point where the explosion took place, and who were on the platform of a wagon, only heard a slight noise. While the windows

of the houses were broken at a distance of a kilometre from the place of the explosion, these spectators were not aware of any effect of the concussion of the air. These facts, which seem scarcely credible, were reported by scientific men and confirmed by Professor Munro in the review *Nature*.

The existence of a zone of silence which separates two distinct zones of hearing is stated to be proved in twenty explosions that occurred before the war, of which two were caused by artillery fire, four by dynamite and gunpowder explosions, and the others by volcanic eruptions in Japan. It was generally reported that the normal zone of direct audition extended to about 100 km., and that there frequently occurred another abnormal zone of audition at a distance of 160 km., which extended to about 230 km.: and that between the two zones of audition there was a zone of silence of about 60 km.

Eleven eruptions of the volcano Asamagana in Central Japan, 1909—1913, allowed of observations on the phenomena of a zone of silence; in the greater number of these cases it was decided that the zones of silence were of less dimensions than those of audition, and were grouped in an approximately symmetrical manner around the area of the fall of the cinders. The final result was of a very elongated and narrow form, and developed approximately in the direction of the upper currents of the air that traversed the clouds of smoke of the volcano, a direction which oscillated between north-east and south-west.

Of other explosions which presented phenomena of zones of silence there may be mentioned that of Hayle (Cornwall) in 1904, of Forde (Westphalia) in 1903, of the Jungfrau railway in 1908, of Wiener Neustadt in 1912, with external zones of audition at the greatest distances of 144, 179, 179 and 298 km. Another quite recent example is the very violent explosion which happened in London on the 19th January, 1917. The interior zone of audition, with the very exceptional form of an L, extended to a distance varying from 19 to 104 km.; the intermediate zone of silence had dimensions varying from 26 to 86 km., and the greatest distance of its exterior limit from the point of explosion was about 96 km.; the exterior zone of audition was situated with a longitudinal axis towards the north of about 210 km. and transverse axis of 88 km.

There being no doubt as to the existence of a zone of silence how is this phenomenon to be explained?

Some have desired to found an explanation in the transmission of sound through the earth; if it can be supposed that the sound is heard over a particular geological formation, and that after a certain space covered by other formations, it is transmitted through a vein to a distant observer, while in the intermediary formations the sound was not heard.

Munroe cites some examples which seem to confute this hypothesis; and Esclangon observes that the phenomenon of a zone of silence happens when the sound is noticed not only on the ground but also in the atmosphere at great heights, such as in the case of firing against aircraft.

It would seem then that perhaps the geological nature of the soil may be excluded as a cause of the phenomenon, and Esclangon proposes an

explanation of a more general character. It is known that the atmosphere is the seat of important movements which vary according to meteorological conditions; the wind changes frequently in velocity and direction according to the height of the strata from the ground. He therefore deduces that given certain meteorological conditions due to movements of masses of the air, the sonorous rays may be affected by these conditions.

To show a practical case:—Above a stratum of calm air there may be found another stratum animated by a velocity that increases according to its height from the ground; the sonorous rays starting from the origin of the sound and directed upwards meet this wind zone and are bent downwards and directed towards the ground. This is especially the case in the zone situated at about 13,000 m. from the ground, due to special circulation of masses of air independent of the movements of the lower atmosphere.

The extension of the zone of silence and the conditions of audition depend upon atmospheric conditions, on the velocity of the wind, and the depth of the atmospheric stratum in which the wind blows, etc. Together with these conditions there is another cause for the phenomenon, viz., the higher temperature near the ground, a cause well placed in view by Schaffers, Davidson, and in Japan, where the zone of silence is ascertained to be regular during the warmer months of the year.

In the pages of the *Meteorologische Zeitschrift* many cases are cited of important strategical events being decided by the sound of cannon. But it is necessary to eliminate all possible causes of error in order to obviate deception. It should now be opportune in a time of peace to undertake with rigorous scientific criticism a series of numerous trials to ascertain in different localities, by day and night, and under various meteorological conditions, etc., the existence and the laws of sound. To terrestrial observation should be added those made in the air, now so much facilitated by the means of aerial exploration.

E. T. THACKERAY.

BRIDGING EQUIPMENT—STOCK SHEET AND STATEMENT OF DEMANDS.

1 Item.	2 "Engineer" or "Ordnance" Supply.	3 DESCRIPTION	4 Base Park Bridging Depot, each consisting of	5 Army Bridging Depot of three Sections, each consisting of	6 Total Stock authorised.	7 Present Stock.	8 Quantities demanded.
			One Depot.	One Section.			
1	O	Adzes, carpenters		8			
2	O	Anvils, 1¼ cwt.		3			
3	O	,, 3 cwt.	2				
4	O	Augers, handles, 18 in.		3			
5	O	,, ,, 16 in.		9			
6	O	,, ,, 13½ in.		30			
7	O	,, ,, 12 in.		38			
8	O	,, screw, 2 in.		3			
9	O	,, ,, 1⅛ in.		3			
10	O	,, ,, 1 in.		6			
11	O	,, ,, ⅞ in.		12			
12	O	,, ,, ¾ in.		18			
13	O	,, ,, ⅝ in.		18			
14	O	,, ,, ½ in.		12			
15	O	,, ,, ⅜ in.		8			
16	O	Axes, felling		12			
17	O	,, pick, helved		24			
18	O	Bags, sand		250			
19	O	Bars, pinching		12			
20	O	Barrows hand, single		6			
21	O	Baskets, tool, web-handled, circular, carpenters		6			
22	E	Belting, balata, 3 in., feet		40			
23	E	Belt fasteners		20			
24	E	,, composition, lbs.		5			
25	E	Bench, circular saw	1				
26	E	,, ,, ,, blades, 18 in.	3				
27	O	Blocks, anvil, 1¼ cwt.		3			
28	O	,, tackle, G.S., 3 in. cordage, double		4			
29	O	,, tackle, G.S., 3 in. cordage, treble		12			
30	O	,, tackle, G.S., 3 in. cordage, snatch		6			
31	O	,, tackle, G.S., 2 in. cordage, double	40	10			
32	O	,, tackle, G.S., 2 in. cordage, treble		4			
33	O	,, tackle, G.S., 2 in. cordage, snatch		6			
34	E	,, wire rope, 3 in. double, 4 in. sheaves	24				
35	E	,, wire rope, 3 in. treble, 4 in. sheaves		16			
36	E	,, wire rope, 3 in. snatch, 14 in. sheaves		12 (6 for 10 ton load)			
37	E	,, wire rope, 2 in. double, 10 in. sheaves	24				
38	E	,, wire rope, 2 in. treble, 10 in. sheaves	24				
39	E	,, wire rope, 2 in. snatch, 10 in. sheaves	24				
40	O	Boards, drawing, double elephant	3				
	E	Bolts, with nuts and washers, hexagon head :—					
41		⅞ in. × 2½ in.	20000				
42		⅞ in. × 9 in.	8000				
43		⅞ in. × 12 in.	4000				
44		⅞ in. × 15 in.	8000				
45		⅞ in. × 18 in.	4000	100			
46		⅞ in. × 21 in.	4000	100			
47		⅞ in. × 24 in.	4000				
48	E	Bolts, ⅝ in. diameter, heads and ends for, with nuts, sets	4000	100			
49	E	,, ⅝ in. diameter, heads and ends for, each 12 in. long, with nuts, sets	20000	200			
50	E	,, ⅝ in. diameter, heads and ends for, each 18 in. long, with nuts, sets	8000	200			
51	E	,, 1 in. diameter, heads and ends for, each 18 in. long, with nuts, sets	4000	200			
52	E	,, drift, ⅞ in. × 24 in.	2000	200			
53	E	,, ,, ⅝ in. × 20 in.	2000	200			
54	O	Braces, ratchet, 18 in.		6			
55	O	,, ,, 18 in. drills, 1½ in. to ¼ in., sets		12			
56	O	Brushes, tar, long		12			
57	O	,, ,, short		6			
58	O	,, sable, writing, duck, large		6			
59	O	,, paint, oval		12			
60	E	Butt pieces, C.I., large, sets	2				
61	O	Cans, oil, lubricating, G.S.		6			
62	E	Carbide, cwts.	50	2			
	O	Chests, tool, filled :—					
63		Bricklayers and masons		4			
64		Carpenters		4			
65		Plumbers		1			
66		Smiths		4			
67	O	Chalk, white, lbs.		1			
68	O	Chisels, brick, 18 in.		12			
69	O	,, cross-cut, 8 in. × ⅜ in.		12			
70	O	,, firmer, 1½ in.		12			
71	O	,, hand, cold, 1 in. × 12 in.		12			
72	E	Clips for 3 in. wire rope	1000	80			
73	O	Cordage, manilla, 2 in., fms.		500			
74	O	,, ,, 3 in., ,,		500			
75	E	Cranes, 1 ton, hand		1			
76	E	,, 4 ton, ,,	3				
77	O	Crowbars, 5 ft. 6 in.		12			
78	E	Cubes, steel, 3 ft. × 3 ft. × 3 ft.		16			
79	E	Cylinders, acetylene	150	10			
80	E	,, oxygen	300	20			
81	E	Derricks, steel lattice 30 ft.	3	1			
82	E	Derrick poles 6 in. to 10 in. diam. 20 ft. long, wooden		2			
83	E	,, 12 in. × 12 in. × 24 ft. timbers for		2			
84	E	,, rings, with shackles, for timber derrick		2			
85	E	,, straps		2			
86	O	Dogs, R. and S., 12 in. straight		100			
87	O	,, ,, 15 in. ,,		50			
88	O	Drifts, taper, ½ in.		6			
89	O	,, ,, ⅝ in.		6			
90	O	,, ,, ¾ in.		12			
91	O	,, ,, ⅞ in.		12			
92	O	Drilling machine, hand, metal		6			
93	O	Drills, 1½ in. × ½ in. for above, sets of		12			
94	O	Files, bastard, round, 10 in.		24			
95	O	,, ,, square 8 in.		12			
96	O	,, regular cut, half-round, 14 in.		12			
97	E	Flares, portable, acetylene	50				
98	O	Forges, field, G.S.		2			
99	O	Forge, double bellows		2			
100	O	Grease, lubricating, yellow, lbs.		10			
101	O	Grindstones		2			
102	O	Hammers, claw, 32 oz.		12			
103	O	,, smiths, sledge, 10 lb.		18			
104	O	,, ,, uphand, 7 lb.		18			
105	O	,, masons, mash		24			
106	O	Handles, file, middling		50			
107	O	Handspikes		20			
108	E	Hooks, lug		12			
109	O	Instruments, drawing, G.S., sets	3				
110	O	,, drawing, R.E., Mark II.	3				
111	E	Jacks, hydraulic, lifting, 40 ton	4				
112	E	,, railway, French pattern, 6 ton		12			
113	E	,, lifting and traversing, with foot, 12 ton		2			
114	E	,, lifting and traversing, hydraulic, French pattern, 20 ton, or G.S., 22½ ton.		2			
	E	Joists, R.S. :—					
115		12 in. × 5 in. × 32 lbs., 22 ft. long	500	72			
116		10 in. × 5 in. × 30 lbs., 20 ft. long	500	72			
117		9 in. × 4 in. × 21 lbs., 18 ft. long	500	72			
118		8 in. × 4 in. × 18 lbs., 16 ft. long	500	72			
119	O	Lamps, brazing, 1 pint		4			
120	O	Lanterns, bull's eye		6			
121	O	Lashings, 2 in., 6 fms.		20			
122	O	Lines, Hambro		12			
123	O	Levels, F.S., 4 ft.		6			
124	O	,, spirit, rule		3			
125	O	,, telescopic, 15 in.		1			
126	O	Marline spikes		3			
127	O	Mauls, G.S., helved		12			
128	O	Mallets, carpenters		12			
129	O	Nails, wire, iron, grooved, 6 in., cwts.		3			
130	O	Nails, wire, iron, grooved, 5 in., cwts		3			
131	O	,, wire, iron, grooved, 3 in., cwts.		1			
132	O	Nailpullers		3			
133	E	Oil, lubricating, mineral, galls.		2			
134	O	,, linseed, boiled, galls.		2			
135	E	Oxy-acetylene metal-cutting plant	6	1			
136	O	Packings, leather, jacks, hydraulic, G.S., 22½ tons, sets	8				
137	O	,, for jacks, hydraulic lifting, 40 ton, sets	4				
138		Paint, lead, red, prepared for use, cwts.		10			
139	E	Pevee		4			
140	E	Piledrivers, hand, frames, 24 ft., with 15 cwt. monkey, complete	10	2			
141	E	Piledriver, with 8 h.p. Lister engine and friction winch		1			
142	E	Pile rings, 9 in.	100				
143	E	,, 12 in.	100				
144	E	Pile shoes	1000				
145	O	Pliers, side-cutting, 8 in., pairs, with cutters		4			
146	O	Posts, picket, 5 ft.		100			
147	O	Pumps, lift and force, complete with 60 ft. hose		2			
148	E	Pumps, engine-driven	2				
149	E	Railway sleeper hand boring machines, with bits		4			
150	O	Rods, boning sets		3			
151	O	,, measuring, common, 6 ft.		6			
152	E	Rollers, fixed, launching, special (60 ft. spans)		4			
153	O	,, ground, 2 ft. × 5 in. diameter		16			
154	E	,, oak, 9 in.		8			
	O	Rope wire :—					
155		3 in., fms.		600			
156		3 in. (100 fm. lengths)		5			
157		2 in., fms.		720			
158	O	Rules, G.S., fourfold		12			
159	O	,, masons, plumb 2 ft. 6 in. with bob		6			
160	O	Saws, hand		8			
161	O	,, cross-cut		12			
162	O	Scales, mathematical, boxwood, No 10, sets	3				
163	O	Saws, hack, 10 in.		4			
164	O	,, hack, blades		24			
165	O	Sets, saw, hand		2			
166	E	Shackles, 2½ in.		8			
167	E	,, 1½ in.		12			
168	E	,, ¾ in. or ½ in.		12			
169	O	Shovels, R.E.		50			
170	E	Slings, wire rope, 2 in. × 6 ft. long		12			
171	E	,, wire rope, 3 in. × 10 ft. long	30	20			
172	E	,, wire rope with hooks and rings, double, 4 in. × 12 ft. long		4			
173	E	,, chain, with hooks and rings, single, ¾ in. × 6 ft. long		3			
174	E	,, chain, with hooks and rings, double, ¾ in. × 12 ft. long		3			
175	O	Spanners, adjustable, 15 in.		6			
176	O	,, ,, 11 in.		3			
177	E	,, box, 1¼ in.		12			
178	E	,, ,, ⅝ in.		6			
179	E	,, set, 7/16 in. and ⅜ in.		6			
180	E	,, box, ⅜ in.		6			
181	E	,, set, ⅝ in. and ½ in.		12			
182	E	Spikes, boat, ⅝ in. × 10 in.	2000	200			
183	E	,, dog, ⅝ in. × 4 in.	1000	100			
184	E	,, cut, ⅝ in. × 8 in.	1000	250			
185	E	,, ,, ⅝ in. × 7 in.	10000	500			
186	E	Screws, coach, ⅝ in. × 6 in.	2000	100			
187	E	,, ,, 3 in. × ½ in.		300			
188	O	Spunyarn, cwts.		1			
189	O	Squares, carpenters, 12 in.		6			
190	O	Staves, levelling, 14 ft.		1			
191	O	Steel, mild, round, 1 in., cwts.		1			
192	O	,, ,, ,, ⅞ in., cwts.		1			
193	O	,, ,, ,, ¾ in., cwts.		1			
194	O	,, ,, ,, ⅝ in., cwts.		1			
195	O	,, ,, angles, 2½ in. × 2½ in. × ½ in., in 12 ft. lengths (for kerbs)	300	20			
196	O	,, mild, plate, ⅜ in. × 10 in., cwts.	40				
	O	Steel, tool, grade "B" :—					
197		Flat, 1½ in. × ½ in., lbs.		28			
198		Square, ¾ in., lbs.		28			
199	O	Tackles, differential, 6 ton	2				
200	O	,, ,, 2 ton	13	1			
201	O	,, ,, 15 cwt.		3			
202	O	Tapes, measuring metallic woven, 100 ft.		4			
203	E	,, measuring, steel, 100 ft.		2			
204	O	Tar, coal, 40 gall. casks		3			
	E	Timber :—					
205		For anchorages, 12 in. or over diameter, 24 ft. long		6			
206		For anchorages, 12 in. or over diameter, 16 ft. long		4			
207		16 in. × 8 in., F.R.	8000				
208		14 in. × 12 in., F.R.	2000	100			
209		12 in. × 12 in., F.R.	12000	800			
210		12 in. × 6 in., F.R.	5000	400			
211		10 in. × 10 in., F.R.	17000	400			
212		10 in. × 5 in., F.R.	2000	250			
213		9 in. × 9 in., F.R.	12000	400			
214		9 in. × 6 in., F.R.	2000	100			
215		9 in. × 4 in., F.R.	45000	1000			
216		9 in. × 3 in., F.R.	15000	1000			
217		9 in. × 2 in., F.R.	10000	1000			
218		6 in. × 6 in., F.R.	22000	200			
219		4 in. × 3 in., F.R.	4000	500			
	O	Tools, screw-cutting, bolt and nut :—					
220		Chests, "A" filled		1			
221		,, "B" ,,		2			
222		,, "C" ,,		1			
223	O	Trowels, masons, 15 in.		12			
224	O	Turpentine, galls.		2			
225	O	Twine, whipping, lbs.		6			
226	O	Vices, standing, 36 lb.		2			
227	O	Wedges, sawyers, 7 in.		4			
228	E	Winches, 1 ton	20	2			
229	E	,, 2 ton	6	1			
230	E	,, 3 ton, small	6	1			
231	E	,, 3 ton, large	8	3			
232	E	,, 5 ton		2			
233	E	Washers, 3 in. square × 1/10 in., for ⅞ in. bolts	4000	400			
234	E	,, 4 in. square × ⅛ in., for 1 in. bolts	4000	400			
235	E	,, taper, for ⅞ in. bolts	5000	100			
236	E	,, for ⅞ in. bolts	5000	200			
237	E	,, for 1 in. bolts	5000	200			
238	O	Wrenches, pipe flat link, ¼ in. to 2½ in.					
239							
240							
241							
242							
243							
244							
245							
246							
247							
248							
249							
250							

.....†*Depots.* *Signature*.....

Date.....

† State Army or Base Park and No. of depots, *e.g.*, Second Army, 1½ depots.

NOTE.—This statement should be forwarded to the Engineer-in-Chief on the last day of each month, or at any time when it is necessary to demand equipment.

Bridging stores in army area should be included in Col. 7 though they are not at Depot.

Stores that can be easily obtained locally should not be included in Col. 8.

An Army Bridging Depot is composed of three Sections, each Section consisting of the Stores detailed in Col. 5.

ROAD AND BRIDGE MAP.

SHOWING ROADS NORMALLY SUITABLE FOR MOTOR TRAFFIC, ROAD BRIDGES, AND LIGHT RAILWAYS.

BELGIUM 1:100,000

VALENCIENNES AND PART OF LENS

THIRD EDITION

FOR OFFICIAL USE ONLY

G.S.G.S., Nº 3083.

O.S.O. 1917.

REFERENCE

Bridges
- (a) ● indicates Spans 11ft. and under.
- (b) " " 11ft. to 22ft.
- (c) " " 22ft. " 30ft.
- (d) " " 30ft. " 60ft.
- (e) " " over 60ft.
- (f) ○ Particulars not obtained.
- (g) ● Railway Bridges.

Passerelle:– Footbridge for Infantry only.

ROADS. Width of metalling: 3-3.50 metres Minor; 3.50-5 " Principal; 5 " or more — Pavé, Macadam

Unmetalled or inferior surface

LIGHT RAILWAY

" " in course of construction

AUTHORITIES

VALENCIENNES
- Notice descriptive et statistique sur le département du PAS-DE-CALAIS.
- Notice descriptive et statistique sur le département du NORD.
- Michelin Road Map.
- Taride Road Map.
- Belgian Mission.
- Information from Refugees.

LENS
- Notice descriptive et statistique sur le département du PAS-DE-CALAIS.
- Michelin Road Map.
- Taride Road Map.
- Belgian Mission.
- Information from Refugees.

REFERENCE.

Railways — Normal gauge, double line. / " " single line.

Bridges ● Span shown in ft. and inches, 2 x 6'0" = 2 spans each 6ft.

Only cuttings and embankments of 13ft. or over are shown.

REFERENCE

Townships — Thuin
Hamlets
Canal or waterway
Chateau, Farm
Church or Chapel, Tower
Fort
Heights in metres (10 metres 32.8 feet)

Scale 1/100,000 or 1 Inch to 1.58 Miles

Mile 1 0 1 2 3 4 5 6 7 8 9 10 Miles

Kilometre 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Kilometres

1 Centimetre to 1 Kilometre

Contour interval 10 metres; every 100 accentuated. Woods shown in green.

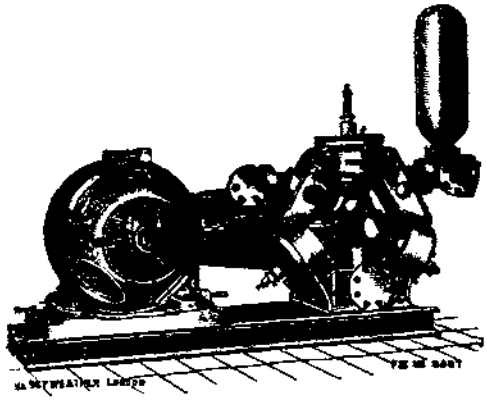
REFERENCE

MERRYWEATHERS'

PATENT

"HATFIELD" PUMP

IN STATIONARY OR PORTABLE FORM.



Specially adapted for working with Electric or Petrol Motor.

Constructed in several sizes

Renowned for its great lifting powers without priming device.

An efficient high pressure pump at low cost.

Write for particulars.

MERRYWEATHER & SONS

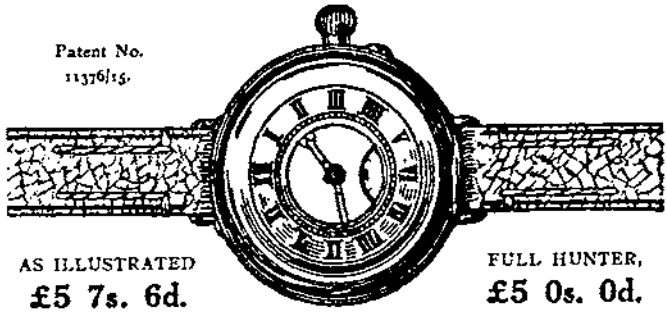
FIRE ENGINEERS,

GREENWICH, S.E., LONDON.

JEWELLERS & SILVERSMITHS TO H.M. THE KING

The "Military" Luminous Watch.

Patent No. 11376/15.



AS ILLUSTRATED **£5 7s. 6d.**

FULL HUNTER, **£5 0s. 0d.**

THE "Military" Luminous Watch illustrated is fully luminous at night, and is contained in a one-piece solid silver screw case that makes it dust and damp-proof; it is fitted with a patent cover to protect the glass. An accurate timekeeper, this watch is indispensable for Naval or Military Service, being of highest quality and of proved reliability.

THE

GOLDSMITHS & SILVERSMITHS COMPANY LTD.

with which is incorporated The Goldsmiths Alliance Ltd. Est. 1751

112, REGENT STREET, LONDON, W.1.