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SOME NOTES ON FIELDWORKS.

THE following notes have been compiled from the fieldwork reports of 1913 and will probably prove of interest. For facility of reference they have been divided into four subheads, viz.: Field Defences, Bridging Expedients, Mining and Demolitions, and Miscellaneous, corresponding to the similar Parts of Military Engineering.

FIELD DEFENCES.

Concealment of Fire Trenches.—A point often lost sight of in commencing a work is that, sooner or later, turf must be cut for concealment of the parapet. It is economical therefore to remove the turf on the area over which the parapet will extend before excavation of the trench is commenced, and assimilation to surrounding ground is improved if the turf is cut in strips of say 15 ft. in length perpendicular to the line of the trench, which are rolled up towards the front and afterwards unrolled in their proper places on the parapet. Although these rolls are apt to break off they unroll again and fit into their places. Care should be taken not to allow the last portion of the roll to break off from the uncut turf (see *Fig.* 1 below).

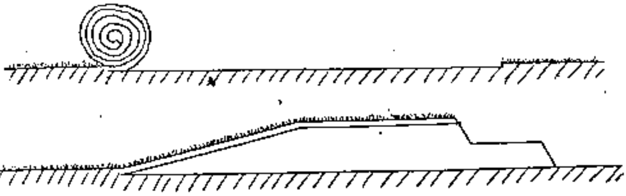


FIG. 1.

Screen during Construction of Trenches.—A screen as shown in the sketch can be conveniently made of latrine screen canvas. The canvas should be daubed with green, blue and red paint and the top of the canvas should be jagged to avoid any sharp line. The screen (*Fig.* 2) appears exactly like a grassy mound and proved invisible at 250 yards even in direct sunlight. Behind such a screen men in exposed positions can work unseen by any but aerial observers.

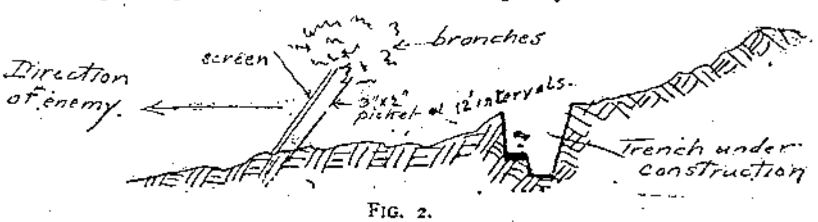


FIG. 2.

Loophole Screens.—Loophole screens as in *M.F.E., Plate* 11, *Fig.* 2, with sandbag canvas daubed with green paint instead of turf as illustrated in the plate were found less clumsy and just as effective.

Clearance of Foreground.—An old and strongly-rooted hedgerow of white thorn, and bank, 65 yards long, and mean section 8 ft. by 2 ft. 6 in. by 2 ft. at top, to be removed from rifle range.

The hedge was removed and collected for firewood, and the earth scattered. The work was given as a task, and actually occupied 76 man-hours. Rate per man-hour $\frac{8}{10}$ yard-run.

Forest Devil.—A contrivance used by woodmen for pulling down trees is known as a "forest devil," and might easily be improvised and be useful. The principle of it will be clearly seen by reference to *Fig.* 3. It consists of a stout chain secured to the tree to be felled, into the links of which, hooks from two shorter lengths of chain are alternately placed. These short chains are secured to a lever that is worked backwards and forwards, and the tree is gradually pulled over bodily. The lever is anchored back, generally to another tree, and it is estimated that two men can develop a pull of about 80 tons.

Flares and Alarms.—The following points were noticed :—

(1). Flaked dry guncotton intended for priming for flares should be kept away from oil, or it will not ignite.

(2). Ignition is made more certain if a piece of safety fuze is lashed crosswise to the instantaneous fuze within the bag of priming.

(3). Precautions must be taken to prevent cattle being driven over the line of attack to trip wires and set off mines, etc. An ordinary wire fence outside the trips, etc., would prevent this.

(4). A rifle hidden behind a tree trunk was fired by a falling weight when the wire was either tripped over, or cut. In the latter case, a spring was released and dropped the weight (*Fig.* 4).

Smoke Signal.—A "smoke signal" was made, in connection with brigade training, as a signal for a simultaneous daylight attack. The smoke signal consisted of cotton waste, saturated with thick creosote, thin creosote, turpentine and paraffin, in approximately equal quantities. This was carried in a tin, and when required for use the tin was emptied on to the ground and the contents spread out. By stirring the waste with a stick as it was burning, a thick column of black smoke was given off.

Fougasse in Rock.—The 1st fougasse was sunk in rock which had to be blasted out at the bottom. The charge used was 100 lbs. This was fired successfully, but some portions of rock or stone came

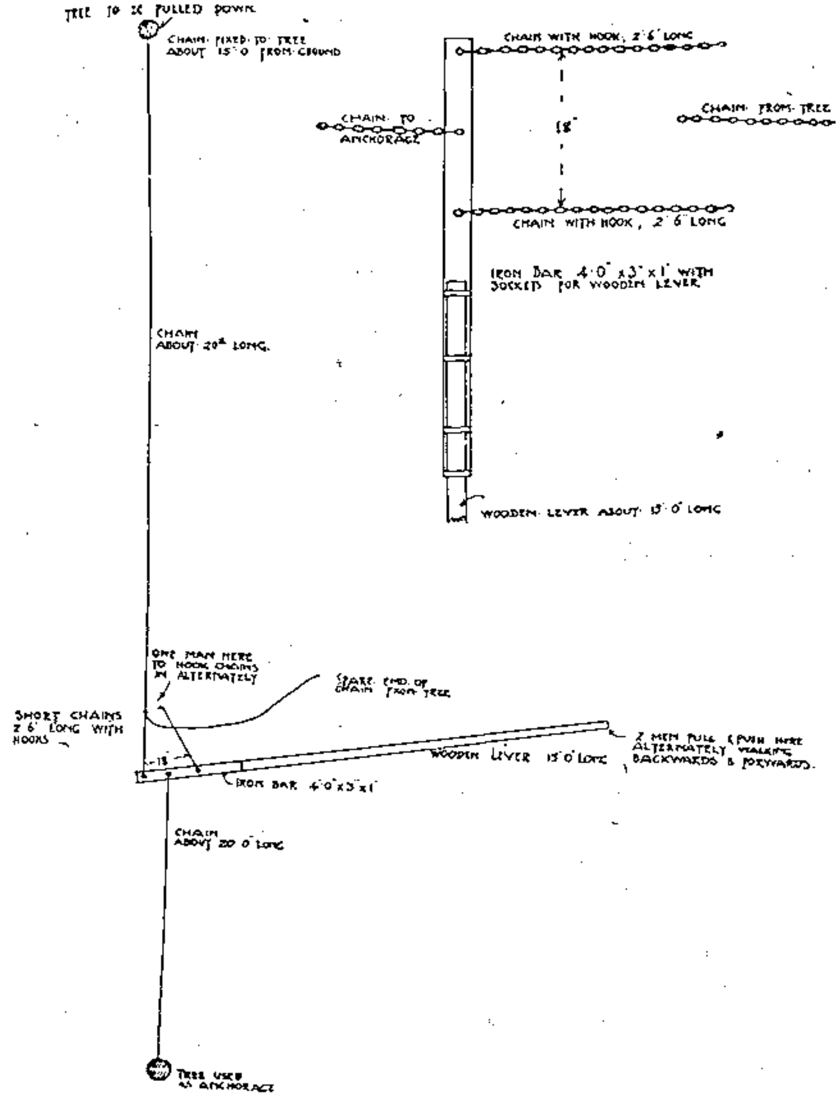


FIG. 3.—"*Forest Devil.*"

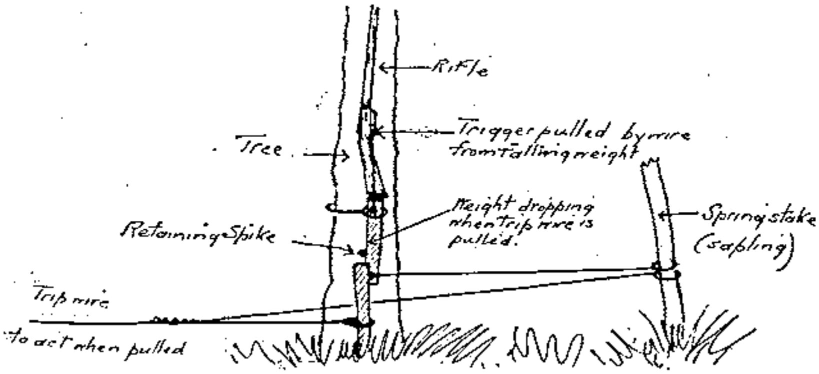


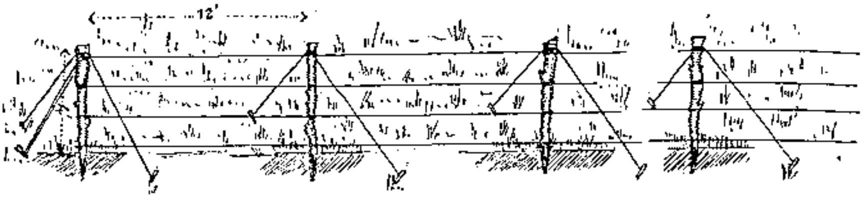
FIG. 4.

back about 100 yards and went out sideways to the same extent. This was probably due to the fact that the débris from the excavation was put at the back of the fougasse, and to the rock itself being considerably shaken by the blasting which was done in the making of the fougasse.

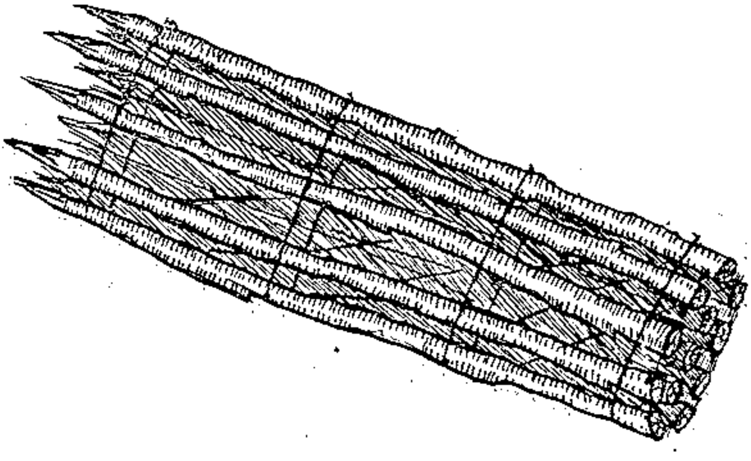
Similar results could be prevented by arranging that nothing but *earth* is put at the back and sides of the fougasse, and, if possible, filled sandbags should be used at the bottom and for the interior slopes of the tamping.

The other two fougasses were dug in earth, except for the last foot which was in the rock. The charge in each was 80 lbs. The above precautions were adopted; the charges were fired electrically, in series, and the result was satisfactory.

Portable Wire Entanglement.—A sketch (*Fig.* 5) is given of this.



Detail. (i.). About 30 yds. to 40 yds. long.
(ii.). Height 4 ft.
(iii.). Distance between posts about 12 ft.



View when rolled up for transport.

FIG. 5.—*Portable Wire Entanglement.*

High Wire Entanglement at Night.—Materials were got ready in the daytime, stakes and brushwood were cut and pointed, pads for driving them in in silence were prepared, wire was re-coiled in suitable lengths. During construction observers were sent out and the only thing they noted was the sound of hammering or driving stakes. The following notes may be of value :—

(*a*). Stakes are best not driven into unprepared ground, as heavy driving is necessary. It is better to prepare a hole for their reception with a crowbar.

(*b*). Noise of driving stakes with a maul can be very considerably reduced by pointing the upper ends of the stakes, on which the maul is to impinge. Such points mushroom out under blows, thus forming natural pads for muffling the noise of blows.

(*c*). A more troublesome but more efficacious method for deadening sound is to prepare balls or pads of spun yarn which are held on the tops of stakes while they are being driven.

(*d*). A combination of (*b*) and (*c*) was not tried but may be found the most satisfactory, if at all workable.

(*e*). Pads of empty and folded sandbags and also leather linings to the faces of the mauls were tried but were not satisfactory.

(*f*). Owing to the difficulty of driving long stakes when standing on the ground it is advisable to have boxes on which to stand.

(*g*). It is advisable to have the wire in small coils, but it is necessary to have some simple method of locating the ends of these coils when working in the dark.

(*h*). Hedging gloves are advisable.

(*i*). Caution in handling the barbed wire at night should be impressed upon the men as they are likely otherwise to cause injury to themselves or their neighbours.

Experiments in placing live wires in connection with an entanglement led to the following conclusions :—

(i.). The live wires cannot be incorporated in the entanglement.

(ii.). If placed in front, they would easily be destroyed and might constitute a danger to the defenders' patrols, etc.

(iii.). If placed inside, they fail to protect the entanglement and are dangerous to the defenders.

Bridging Expedients.

Sounding Apparatus.—Made of two chesses crossed and nailed together. A bent nail, in default of pulley,* or if the latter is available use it, and have an eye to guide the sounding line to it,

* A cotton reel makes a very good pulley supported on a nail with a washer on either side.

carries the sounding line, which must be very light and as non-elastic as possible (see *Fig.* 6).

The pulley must be on the down-stream side so as to not get under the bow wave in a rapid stream.

The amount of line let out at each sounding plus the distance of bottom of plummet from water level when at zero gives the depth.

P.S.—A salmon line makes a suitable sounding line.

Detail at A.

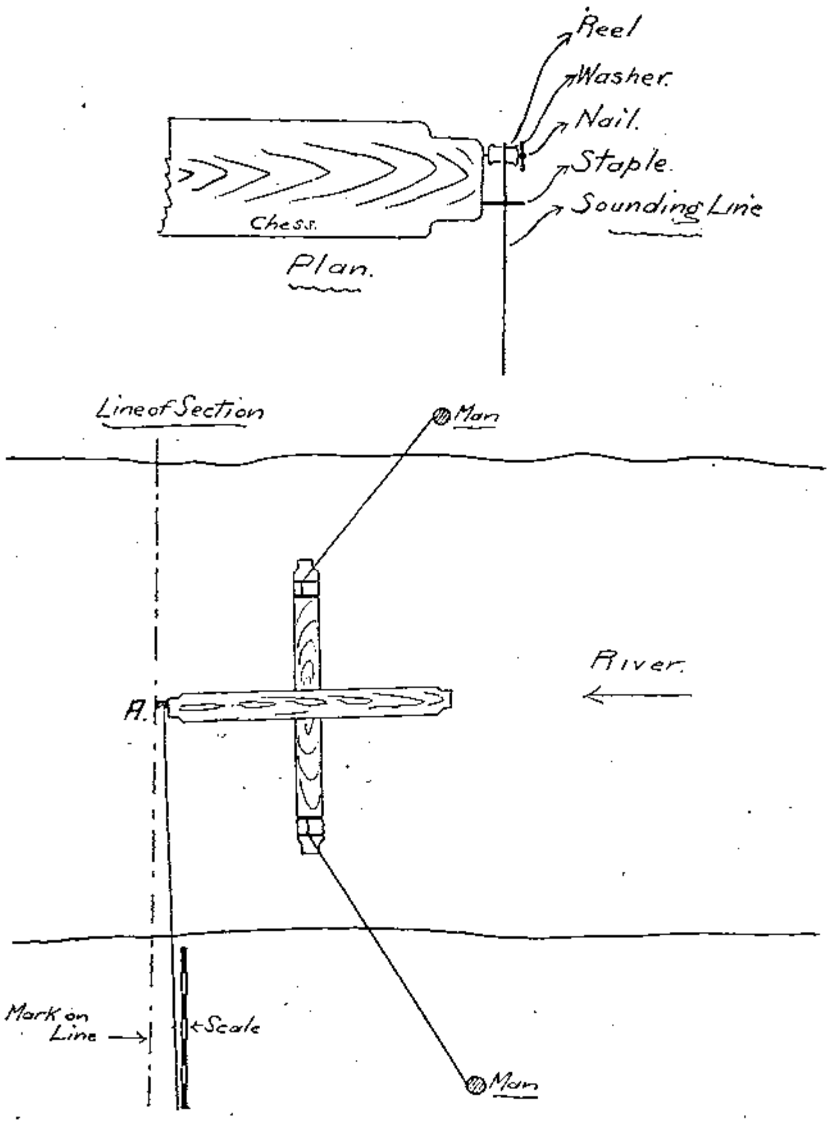


FIG. 6.

Spiked Trestle.—A type of spiked trestle made of fresh-cut round fir is shown in *Fig.* 7. These trestles proved to be rapid in construction and easy to handle subsequently. The legs were about 6 in.—7 in. butts, and the transom was double, each part about 6-in. diameter resting on half-round chocks let in to the leg, spiked and bound with wire or hoop iron. The transoms were also spiked to the legs, and the two parts secured to one another by small dogs of ¼-in. square iron; the spikes and dogs were made in a field forge. The ledger was double and spiked to the legs. The diagonals were spiked to the legs and lashed with wire at their crossing. Mud shoes of slats were placed on the bottoms of the legs and also across the bottoms of the ledgers; 8-in. sinkage was allowed in soft mud, but this allowance proved rather excessive.

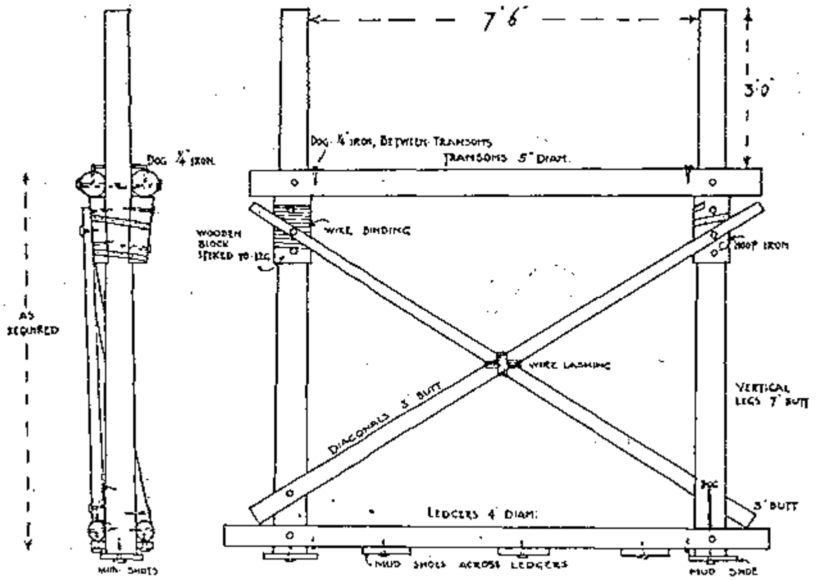


FIG. 7.—*Spiked Trestle of Fresh-Cut Round Fir.*

Launching Trestles.—When the gap to be bridged is not very wide, it was found that a rapid method of placing trestles was to launch them with foot ropes and guys to both banks. This method gives complete control of the trestle, and unless the bottom is very soft, ways are unnecessary.

Floating Footbridge.—A footbridge was made of rushes. These were cut in lengths of about 6 ft. and bound into fascines about a foot in diameter; these fascines were then made into a continuous roadway by a thin rope in the form of a Malay hitch, and the bridge completed by a central plank to walk on. The bridge was exceedingly steady and stiff.

Raft of Thames Pleasure Punts, to carry a Limbered Vehicle of 38 *cwts.* (*Double Tool Carts, R.E.*).—The punts to be found on the Thames vary considerably in width, those used were wider than the average but are of a common width (see *Fig.* 8).

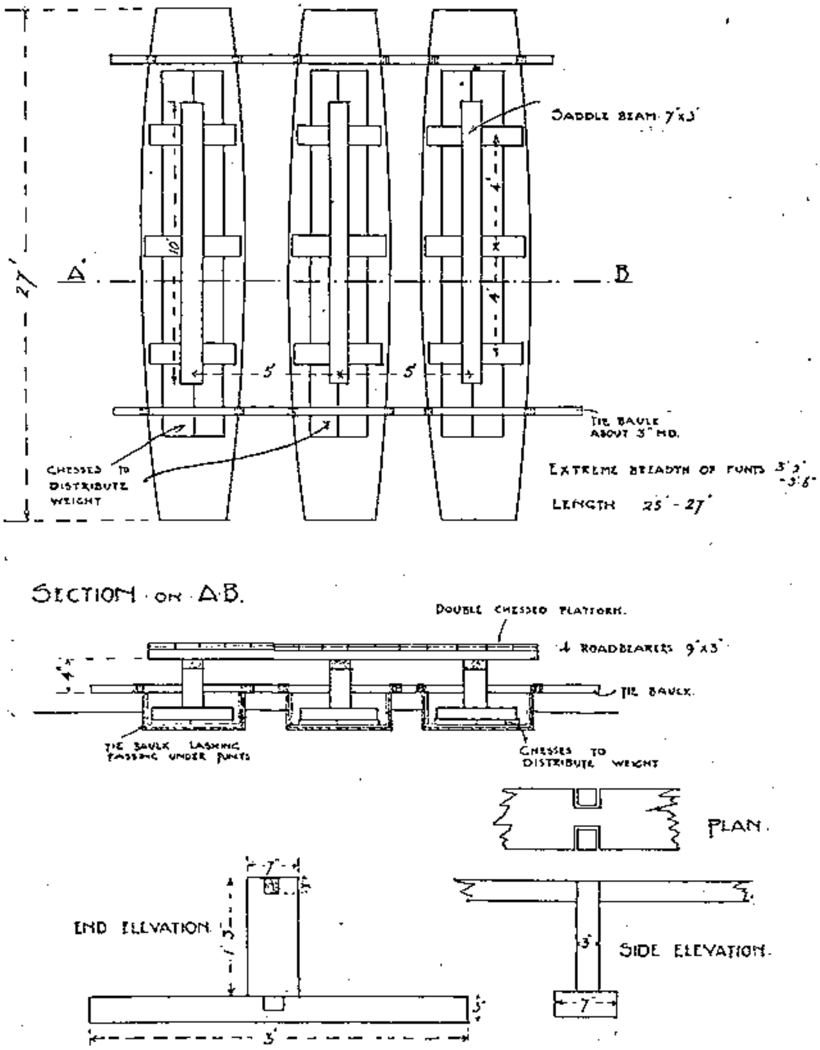


FIG. 8.—*Improvised Raft made of* 3 *Punts to take the Double Tool-Cart* (38 *cwts.*).

The principal difficulty is due to the tendency of the punts to tip over when the load is being brought on to the raft.

To obviate this, end-loading was adopted and proved quite practicable and satisfactory.

The saddles were carried on small trestles and the weight distributed over the bottom of the punts by means of a couple of chesses.

The scantlings used for saddles and roadbearers were of material which happened to be available, any other scantlings of the required strength would have done as well.

Raft of Double-Scull Rowboats.—A raft of five double-scull rowboats was made to carry a loaded double tool cart, R.E.

A plan of the raft at different stages of completion is given, a cross-section of a boat and a longitudinal section of a boat (*Figs.* 9, 10, 11).

The interval between boats in raft is 6 in.

The raft was formed by booming out, *i.e.* the five roadbearers were lashed to the saddle of one boat and another boat introduced inshore and retained in its proper position whilst the five roadbearers were lashed to its saddle.

The roadway is 10 ft. in the clear.

The raft was loaded with a loaded double tool cart and 16 officers and men and the boats sank till the water was about 7 in. below the top of the gunwale.

No difficulty was experienced in running the tool carts (single) on to the raft owing to the rigidity of the raft.

Combined Bridge Suitable for Unhorsed Vehicles.—A bridge as above was constructed. The width of the river at the point selected was 122 ft. 9 in.

One unit made a raft of four pleasure punts, making a roadway 12 ft. long, and was also responsible for the shore bay, length 9 ft.

A second unit placed in position two trestles, producing 23 ft. of roadway; in addition the Service equipment of the other two units was requisitioned and further roadway was made of five boats of this equipment, to produce 45 ft. of bridge. This unit was responsible for the bay between the 2nd and 3rd unit which was 7 ft. in length.

The third unit made a raft of five double-scull rowboats and produced a roadway of 18 ft. 9 in. This unit was responsible for the bay between the 1st and 3rd unit which was 10 ft. in length.

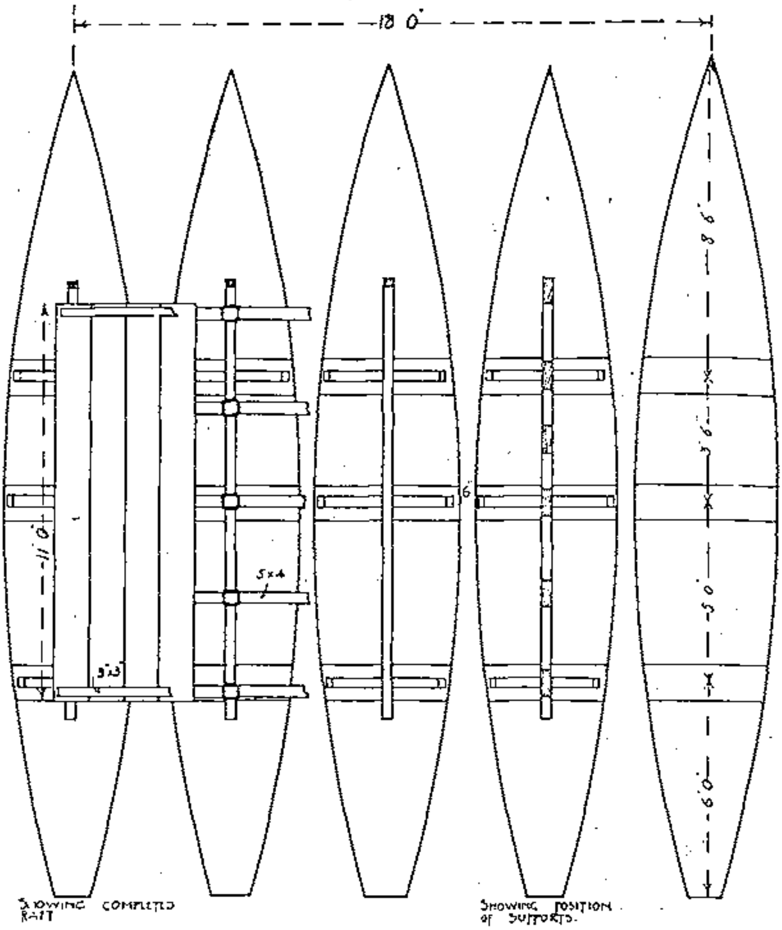
The last-mentioned raft formed the cut which was worked twice before dismantling.

The bridge was anchored up and down stream.

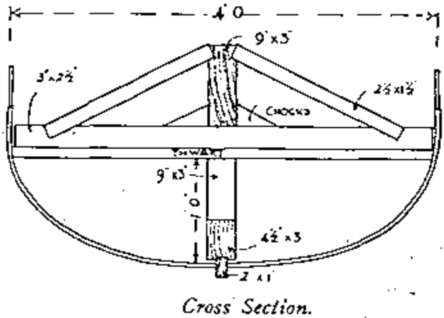
A difficulty was experienced in attempting to use an odd number of boats (Service equipment) in bridge, owing to the wheelways of one bay being dependent for support on the wheelways of the next bay.

This difficulty was overcome by reducing the length of the outside bay and lashing the wheelways to the saddle of the boats.

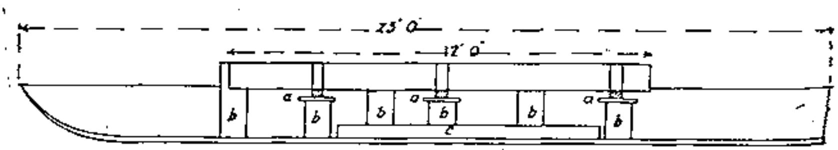
A sketch of this bridge is given (*Fig.* 12).



Plan.



Cross Section.



Longitudinal Section.

a. Thwart. *b.* Supports to saddle. *c.* Spar ($4\frac{1}{2}'' \times 3''$) distributing weight on keelson.

FIG. 9.—*Raft of 5 Double-Scull Row-Boats.*

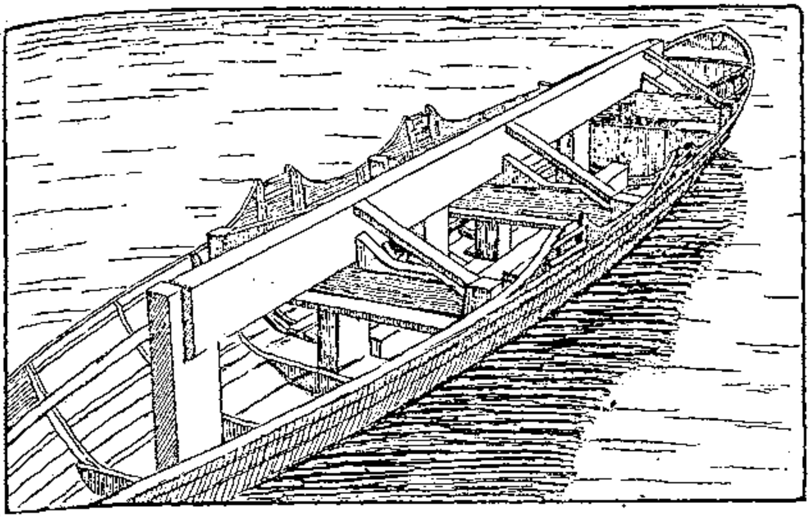


FIG. 10.

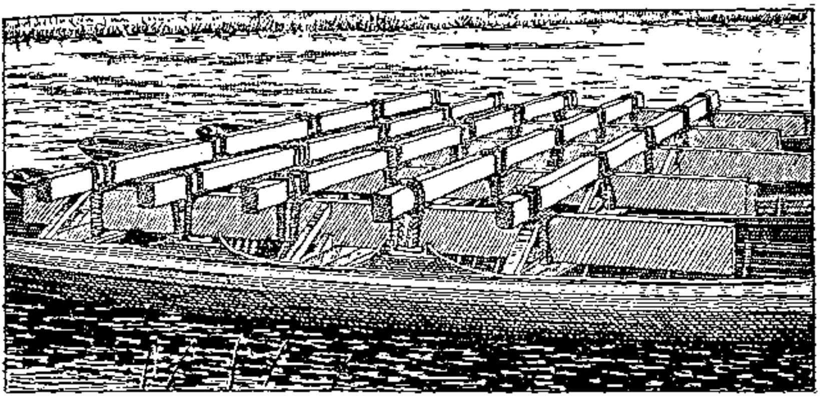


FIG. 11.

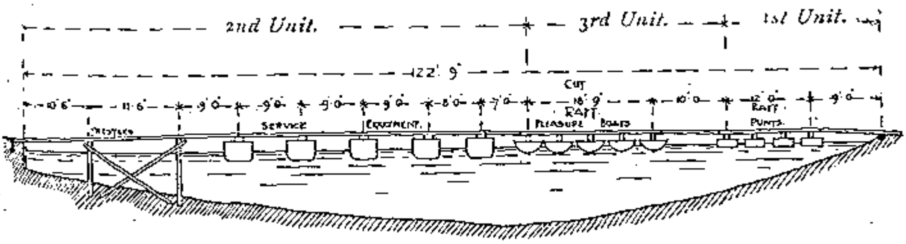


FIG. 12.—*Combined Bridge for Horseless Vehicles.*

Bridging Expedients to test the Value of Horse Troughs stuffed WITH STRAW *for a Floating Bridge.*

Length of bridge, 45 ft. Time, 2½ hours. 2 N.C.O.'s and 12 men. Stores :—

- 4 troughs ready laced.
- 25 chesses.
- 4 spars, 18 ft. by 3 in. for lashing to troughs and connecting to rafts.
- 19 spars, 9 ft. by 3 in., for roadbearers and connecting piers.
- 38 1-in. lashings.
- 6 1½-in. lashings for hauling out piers when dismantling.
- 8 pickets for shore bays holding chesses together.
- 40 trusses of straw, 36 lbs. each. Total, 1,440 lbs.

It was tested and found to safely take a weight of 15 cwts., distributed over 4-ft. lengths it left 2 in. of trough clear of the water as Sketch A (*Fig.* 13).

A G.S. wagon, weight 1 ton, left about ½ in. of trough out of the water.

A timber wagon, weight 1 ton 1½ cwts., just flooded the trough.

An infantry machine gun, double wagon, fully loaded, weighs 1½ tons or 15 cwts. each (maximum) so by unlimbering they could be passed over separately.

18-pr. Q.F. gun, weight 24 cwts., is beyond the capacity of the bridge.

Description of Making Bridge.—The troughs are stuffed tightly with straw, about 2 ft. in the centre is lightly stuffed to allow the trough to bend, the ends are then brought together to form a double cylinder as Sketch A (*Fig.* 13).

The transoms of light spars are lashed over the lace holes, and in three places turns are taken right round the troughs to keep them together.

The piers can now be launched, care being taken to lift them well up to avoid tearing.

Eight roadbearers are lashed across to connect the piers, the two centre ones about 1 ft. apart to take the end of the chesses, the end bearers over the end of the piers and the remainder distributed along between them and fastened by round turns.

The piers are lashed 2 ft. apart, and end roadbearers lashed securely to keep the raft square.

The two rafts are now connected by the transoms and lashed 5 ft. apart, and chessed by placing one row down the centre and two rows each side over the troughs as Sketch B (*Fig.* 13).

The chesses as far as possible are butt jointed and lashed, and are placed parallel to the line of the bridge.

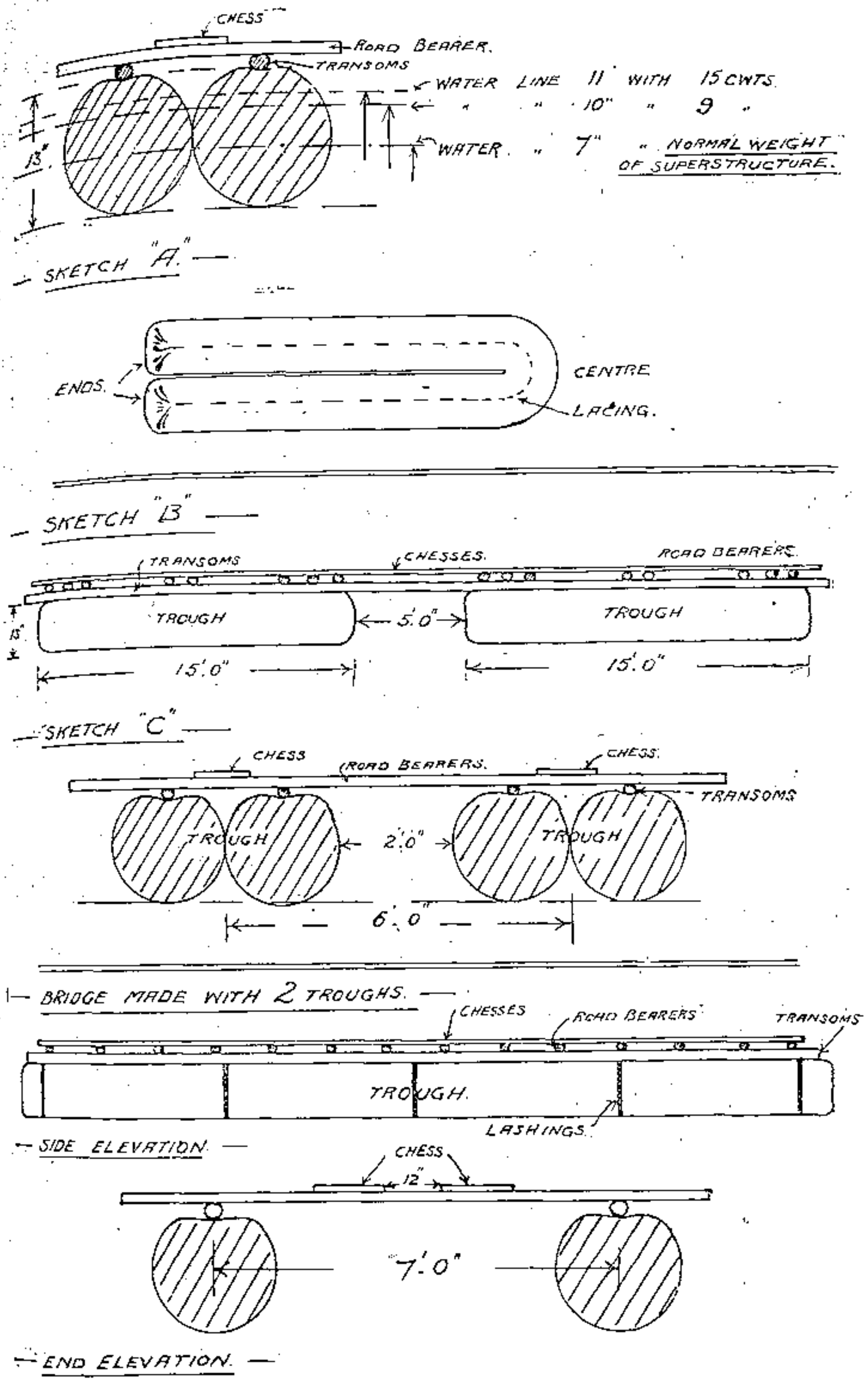


FIG. 13.—*Bridging Expedients.*

Tests with a Raft made with Four Horse Troughs stuffed with Straw. Roadway, 15 ft. by 9 ft. 6 in. Size of Raft, 15 ft. by 15 ft. Time, 45 minutes.

2 N.C.O.'s and 12 men (6 men stuffing trough ½ hour).
Stores :—

4 troughs (laced).
17 spars, 16 ft. by 3 in.
38 1-in. lashings.
4 1½-in. lashings.
15 planks, 10 ft. × 1½ in.
1,200 lbs. of straw.

It was tested and safely took 38 cwts., consisting of a timber wagon and 17 men, this weight drew 9½ in. of water leaving 5 in. of trough clear of the water.

It would safely take an 18-pr. Q.F. gun=24 cwts. in calm water. The water drawn by the different weights were as follows :—

Height of trough stuffed, 14½ in.; 9½ in. (38 cwts.); 7 in. (26 cwts.); 5-in. superstructure.

3½-in. trough stuffed and made into a pier ready to connect into raft.

The rafts were stuffed tightly with straw, about 2 ft. in the centre being only lightly stuffed to allow the trough to be turned into position as Sketch B (*Fig.* 14). Two light transoms are lashed over the trough lacings to keep them rigid and to take the weight evenly, the lashings are taken three times round the trough to keep them together, and round turns taken all down the transoms through the lace holes, the trough is then launched and the four troughs placed close together and the distance pieces lashed over the ends of the transoms, five roadbearers are placed on, chesses laid on and racked down. Owing to the roadway being supported every 2 ft. by the transoms, the roadbearers can be very light.

No spars larger than 3-in. mean need be used.

Bridge made with Two Troughs.

Length, 45 ft. Time, 1½ hours. 2 N.C.O.'s and 6 men.
Stores :—

2 troughs, ready laced.
12 chesses.
17 light spars, about 8 ft. by 3 in.
18 1-in. lashings.
20 trusses of straw, 36 lbs. each. Total, 720 lbs.
8 pickets.

This was tested and 9 cwts. just flooded it.
6 cwts. give 2½ in. out of water.

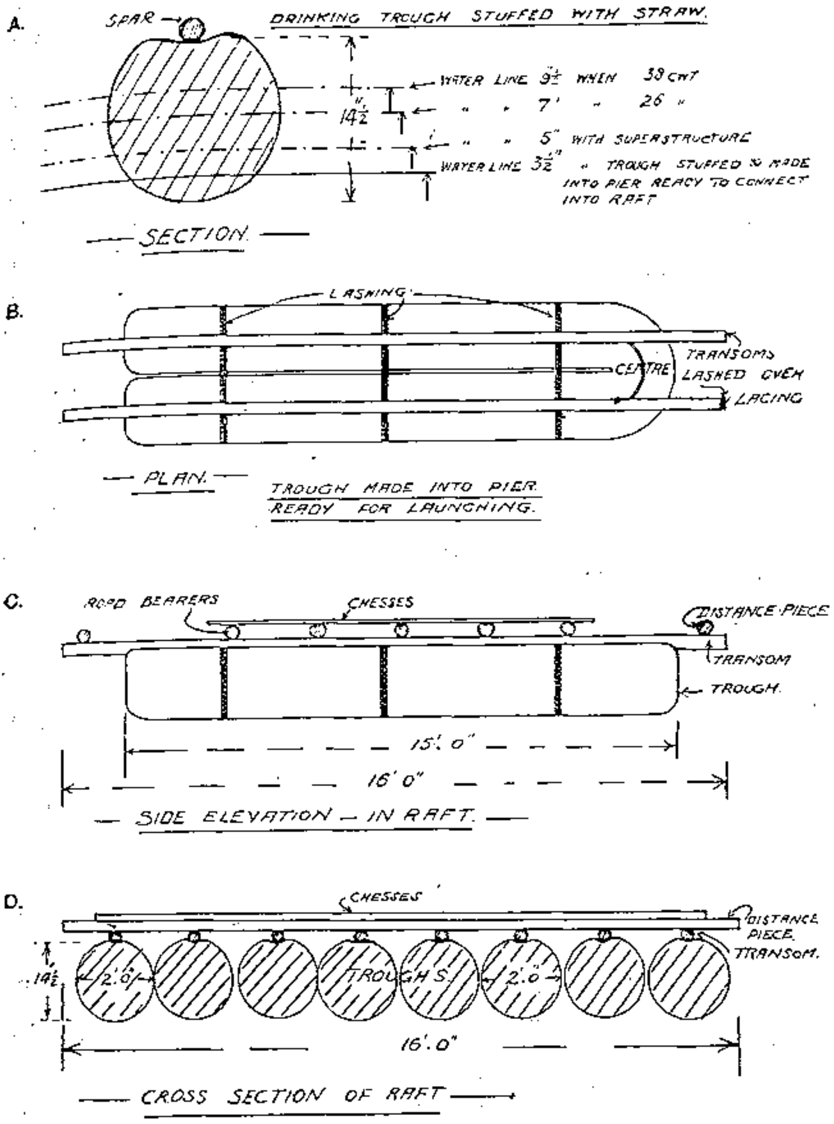


FIG. 14.—*Bridging Expedients.*

Infantry in file gives 2 in. out of water.

The troughs are stuffed tightly with straw and the transoms and roadbearers lashed on and then launched at right angles to the banks and chesses are then placed on and lashed and the shore ends picketed.

A machine-gun wagon empty 5 cwts. could be taken over but the chesses would have to be opened to 5-ft. 3-in. wheel base in centre of chesses.

Improved Footbridge with Casks.—The following method employed for making piers for footbridge out of single 108-gallon casks was tried and considered an improvement on the ordinary method.

A frame is made, consisting of two long spars, two 5-ft. pickets (or other suitable timber) and one chess and six lashings. No dimensions can be given as they vary with the different sorts of barrel met with, but the distance apart of the long spars should be somewhat less than the diameter of the barrel and they should be slightly splayed. The distance apart of the 5-ft. pickets should be about 1 in. greater than the height of the barrel. The chess is simply a stiffener and keeps the splayed ends of the long spars apart. When the frame is completed the barrel is rolled into the water and the small end of the frame fitted over it, the chess resting in the water. No further lashing is required. The planks of the bridge are then lashed to the frames, and the bridge completed, the weight of the bridge and the buoyancy of the barrel keeping the frame in position.

The advantages claimed for this method are as follows :—

(1). Rapidity of construction.

(2). Ease in launching.

(3). Lashings never slip as they are bound to do however well they are put on if the spars are lashed to the barrel.

(4). Anybody who can tie a knot can make it, whereas it requires much practice and ingenuity to lash two spars to a barrel longitudinally successfully.

(5). Wire can be used for lashings. Wire would be quite useless on the old system as it would not have sufficient grip on the barrel and would be sure to slip off.

For sketch see *Fig.* 15.

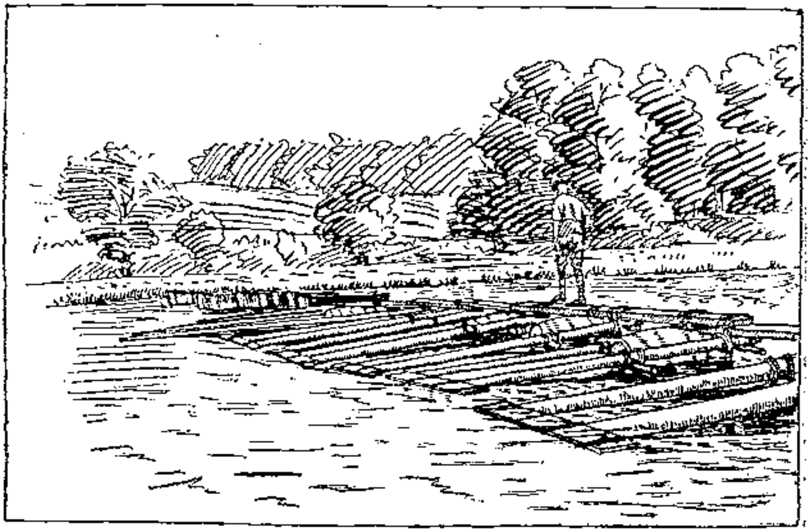
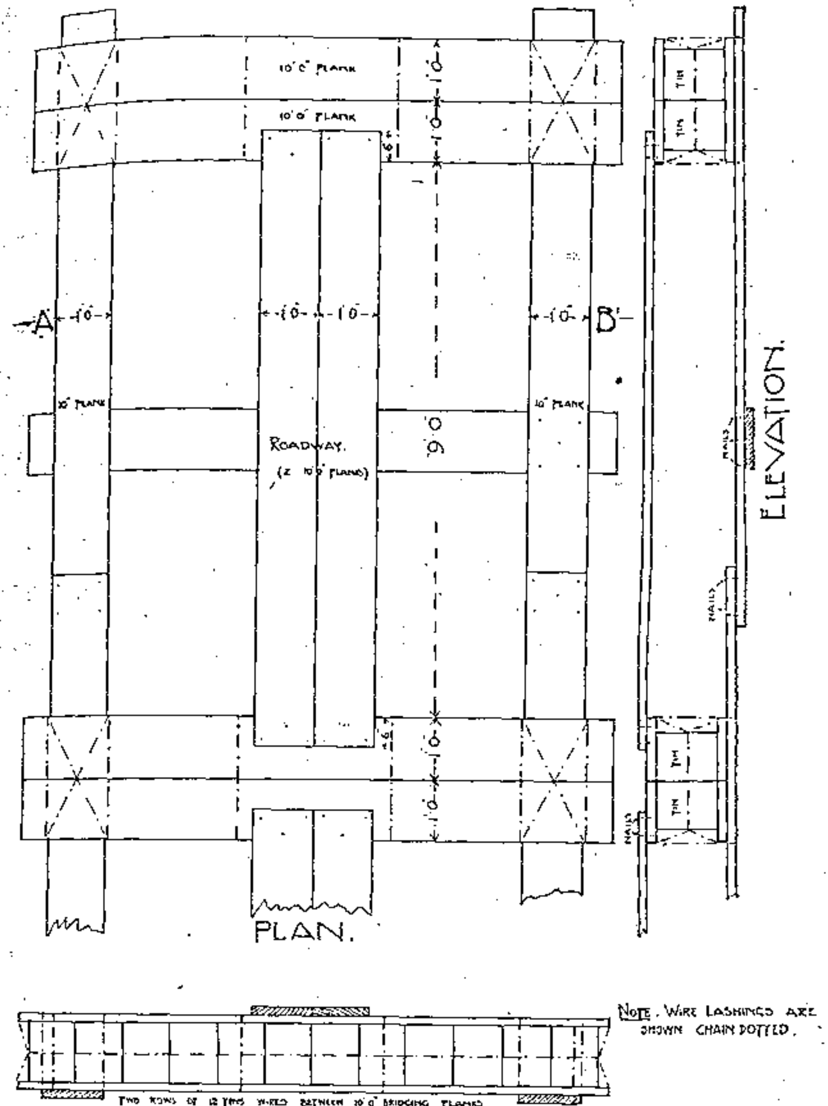


FIG. 15.

Fig. 16 shows piers made of paraffin tins.



SECTION A·B.

FIG. 16.—*Piers of Paraffin Tins.*

Landing Stage for Boats.—In order to make a landing stage for boats, a framed trestle 30 ft. long was made; this had six legs, pointed at the bottom to drive into the ground. The trestle was put in place, but the ground at the site selected was too hard to allow the trestle legs to be driven, and the whole trestle kept floating up again and eventually broke up. It was then decided to change the site of the landing stage to a place where the bottom was muddy. The mud in this new site was very deep, 8 ft. or more, and it was considered wasteful to drive piles down to firm bottom. The first alternative tried was to nail cross-pieces on each pile and short boards across these latter. This arrangement no doubt would have kept the pile from sinking more than a short way, but the cross-pieces jarred off when the piles were driven. The method finally adopted was to drive dogs vertically into the side of the pile, but not quite home; a row of piles was then driven in a line, till the lower part of the dog reached the mud. A plank was then inserted through all the dogs of the row of piles; it was found that this plank, after a few more blows with a maul on each pile, prevented any further sinking. The piles were only 2 ft. or 3 ft. in the mud.

The details of the landing stage are given in *Fig.* 17.

Pile Driver.—Instead of having a separate pile driver, the guides for monkey were lashed to the pile itself, and the whole then upended into position; the monkey was then raised into position and iron girders fixed to keep it in place. This was thought to be quicker than having a separate pile driver with separate staging (*Fig.* 18).

Another Pile Driver.—This pile driver (*Fig.* 19) was constructed by three carpenters, a blacksmith and striker in 18 hours.

A party of 16 men pulled direct on the rope to raise the monkey.

The monkey could be dropped by the men letting go of the rope. But a slightly higher speed of working and more efficient blows were obtained by the use of an automatic catch to work the release. Six blows (of 15-ft. drop) a minute were delivered without special effort.

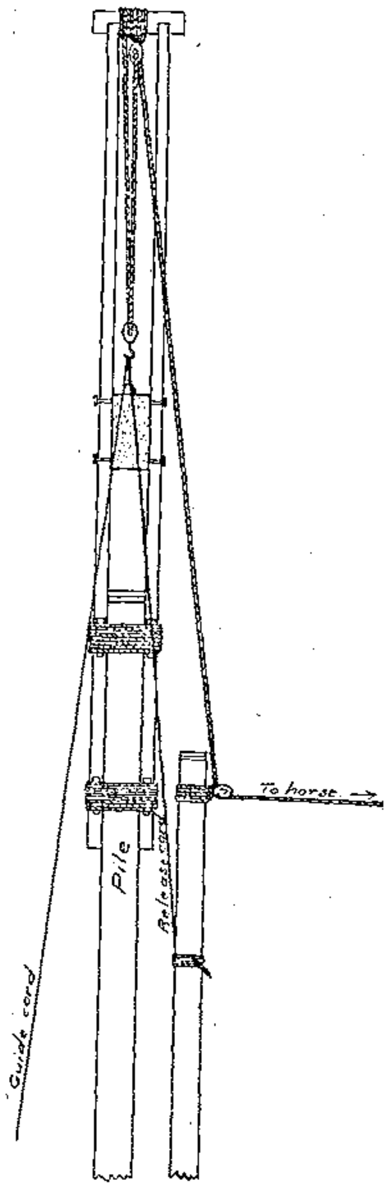
Although the men pulling on the rope were on the bank, no difficulty was experienced in mooring the raft.

Improvised Pile Driver.—*Fig.* 20 shows a pile driver improvised from Service equipment. The pile driver consists of two Weldon trestle legs standing on a half-sleeper, as base, which is spiked to the platform or bridgehead on which the driver works. A cross-bar is lashed to the tops of the legs to support the monkey, which is worked up and down by means of a pulley block lashed to the cross-bar. The monkey consists of a block of wood, 200 lbs. in weight, through which two holes are bored to take iron bolts 2 ft. 3 in. long. These bolts work up and down between the trestle legs, thereby keeping the monkey in position. The monkey has ½-in. iron bands round it, as shown on sketch. The pile driver is prevented from falling by four guys attached to any convenient holdfast.

The Weldon trestle legs are placed side by side on the head of the driver, fixed up and guys fastened. They can then be raised by the guys and shifted into position by mauls.

The monkey can then be put on. Six men will put up this pile driver in half an hour and get it into position. (It takes four men

PILE DRIVERS.



Front Elevation.

FIG. 18.—*Pile Driving with Guides and Monkey all One Piece with Pile.*

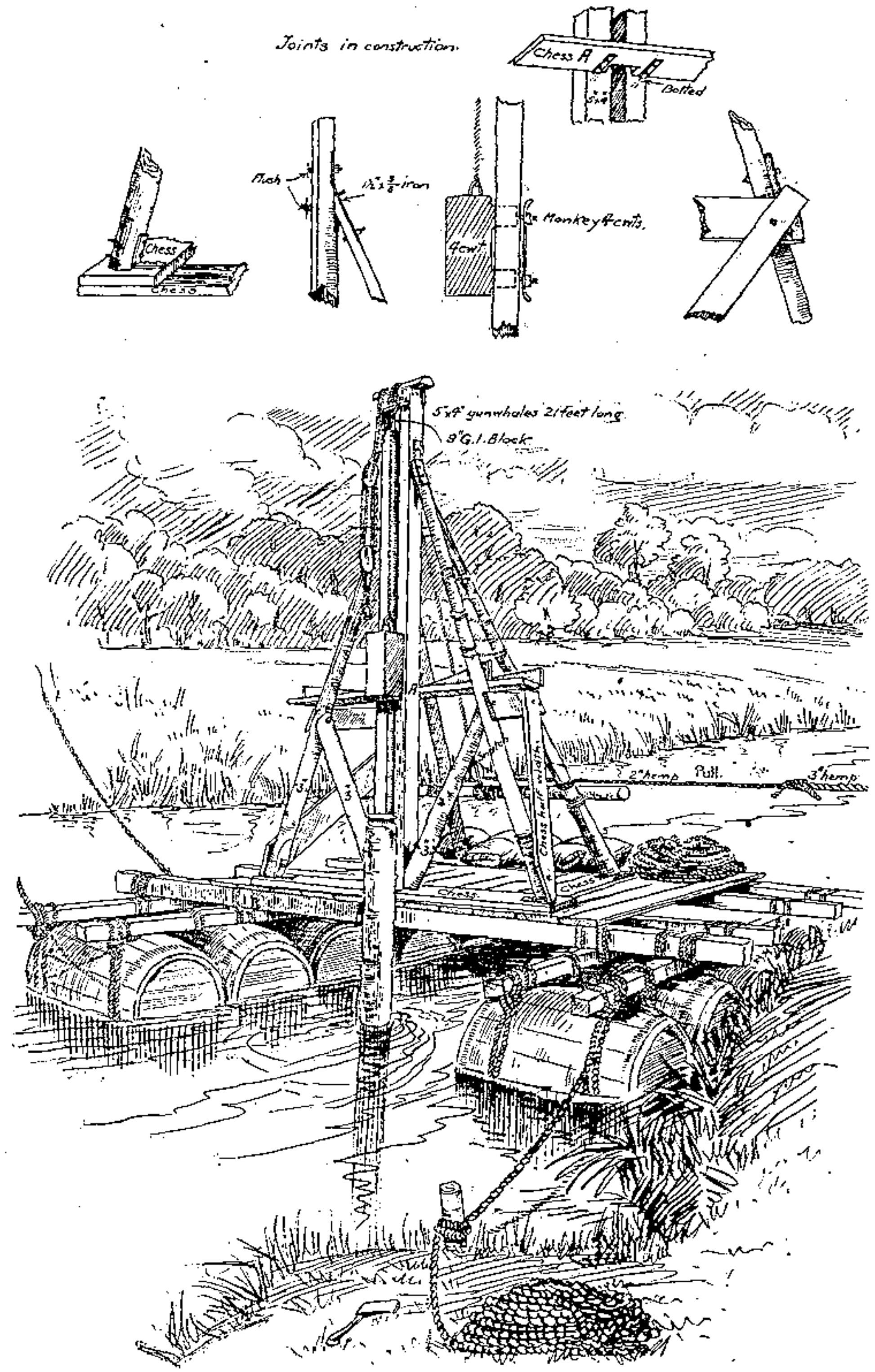


FIG. 19.—*Sketch of Pile Engine constructed of Gunwhales, Chesses, and Light Spars.*

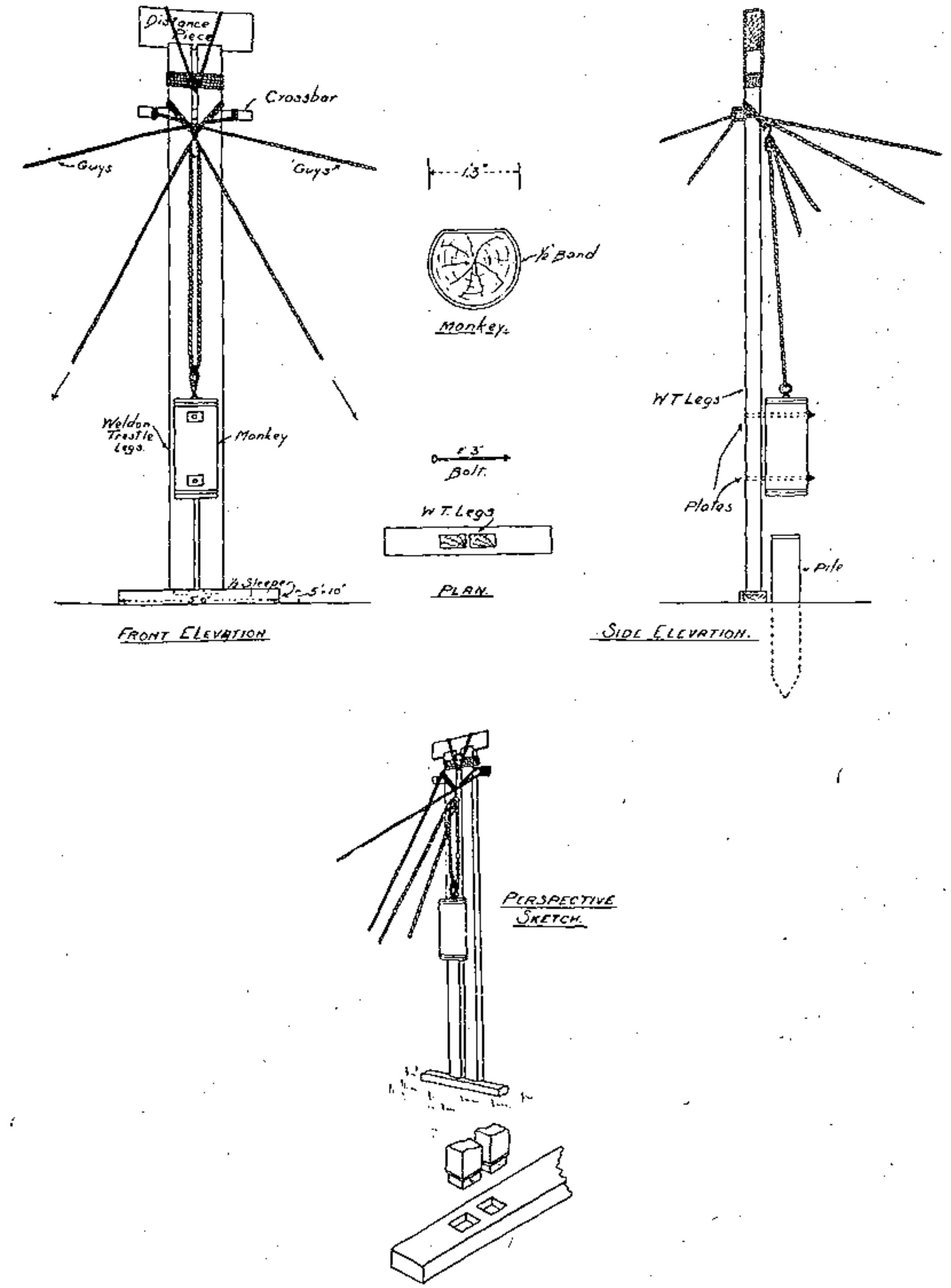


FIG. 20.—*Improvised Pile Driver.*

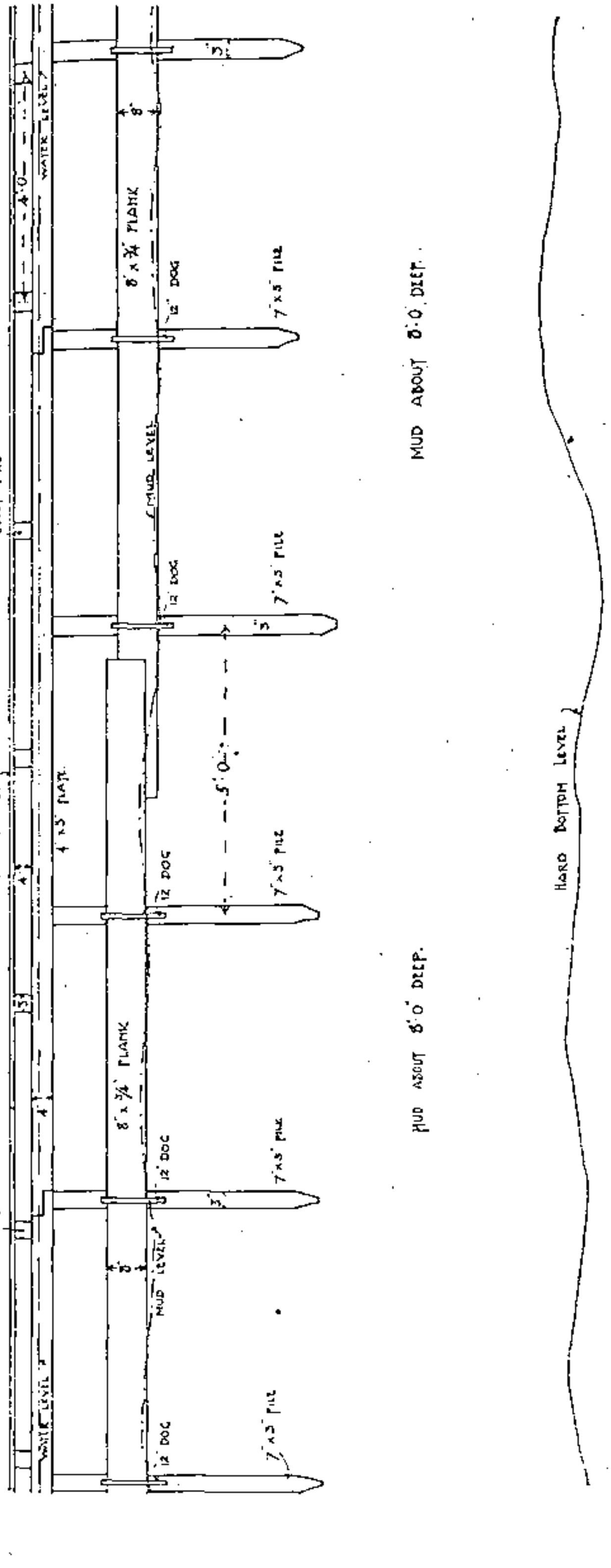


FIG. 17.—*Landing Stage in Mud.*

to work it, and two reliefs are required; so that the whole detachment for working should consist of an N.C.O. and eight men).

Detail of Stores required:—The following are the stores required for the pile driver:—

2 Weldon trestle legs.
Blocks, 2 in.—1.
Lashings, 2 in.—12.
Pickets, 5 ft.—4.
2 half-sleepers halved for W.T. legs.
$2\frac{7}{8}$-in. bolts, 2 ft. 3 in. long, with nuts and plates.
Iron band, $\frac{1}{2}$ in. wide, $\frac{1}{4}$-in. stuff, 10 ft. length, for monkey.

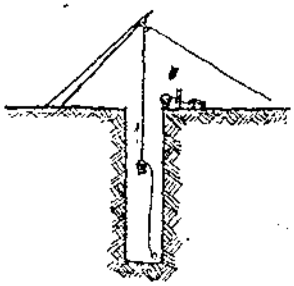
A spar 3 ft. long and 15 in. diameter to act as the monkey (weight about 200 lbs.) is also required. This would not need to be carried as it could probably be obtained locally.

A good deal of pile driving was done with this machine last summer with a detachment consisting of an N.C.O. and eight men; the average time taken was one hour per pile—this included fixing the pile driver each time and placing the pile in position. Each pile was driven in 5 ft. to 6 ft. and the time taken in actual driving was half an hour per pile. The bed of the river was of gravel, and at a depth of 3 ft. some hard rock was usually met with.

MINING AND DEMOLITIONS.

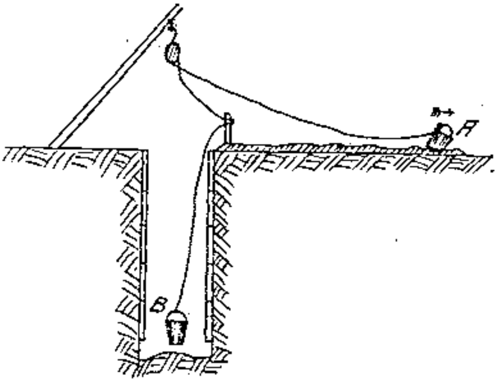
Methods of removing Excavated Earth from Shaft.

(*a*). Two buckets were used. The miners' bucket was not found convenient, owing to its small capacity and to the difficulty of emptying the wet clay out of it. The ordinary pails, I.G., were most useful.



Each bucket has a light rope, longer than the depth of the shaft, attached to it. As soon as the excavator has filled a bucket the spreader assists the hoisters to raise it with the sheers. Meanwhile, the N.C.O. in charge (or fifth man) lowers the other bucket by the hand rope, the excavator calling out where he wants it. This is done as soon as the up-going bucket is clear of the shaft. The N.C.O. takes a turn round the picket with the hand rope, and the excavator starts filling the bucket. As soon as the first bucket has been detached the hook is lowered and one of the hoisters "fishes" for the bucket handle. This is quite easy after a little practice, and does not interfere with the excavator. The hand rope is then cast off the picket and the bucket is ready to be raised when full, the first bucket being placed ready by the shaft, to be lowered in its turn. It is convenient when working in this wet clay for the excavator to work directly into the bucket, and to have the bucket suspended a few inches above the floor of the shaft, hence the necessity for the picket.

(*b*). A rope is passed through the block, and a bucket is permanently attached to either end of it. The length of this rope must be not less than the depth of the shaft plus the distance that the spreader has to go to empty the bucket.



As soon as bucket A is filled it is hauled up by the hoisters pulling the rope through the block, and, as soon as it is clear of the shaft, the N.C.O. (or fifth man) lowers bucket B, and secures it with a turn round the picket, as in method (*a*). Meanwhile the spreader, assisted by one of the hoisters, walks away with bucket A and dumps the contents. This has the effect of hauling the slack through the block, the operation being assisted by the other hoister. As the slack is passing through the block the N.C.O. (or fifth man) casts the rope off the picket and the weight of the bucket B comes on the block. Bucket A is brought back to the shaft and placed ready in the position occupied by bucket B in figure.

This method was found very convenient, and was used for most of the time.

The simple method of using buckets attached by hooks to the ends of a rope equal in length to the depth of the shaft plus twice the height of the block, one bucket descending while the other ascends, was not found convenient, as the buckets fouled each other when passing in the shaft.

These methods were evolved owing to the necessity of having a bucket always at the excavator's hand. As he was working in several inches of water, it was quite useless for him to dig unless it was there for him to deposit the clay into.

The practice of lowering the empty bucket before raising the full one, the excavator changing the hook from one to the other, was found to waste time, and did not enable the buckets to be suspended clear of the floor.

Demolition of Lattice Girder.—A lattice girder was attacked three times, the charge being calculated by a modification of the method given in the text book for a plate girder, each case being completely successful, with the exception of one in which one of the detonators did not go off.

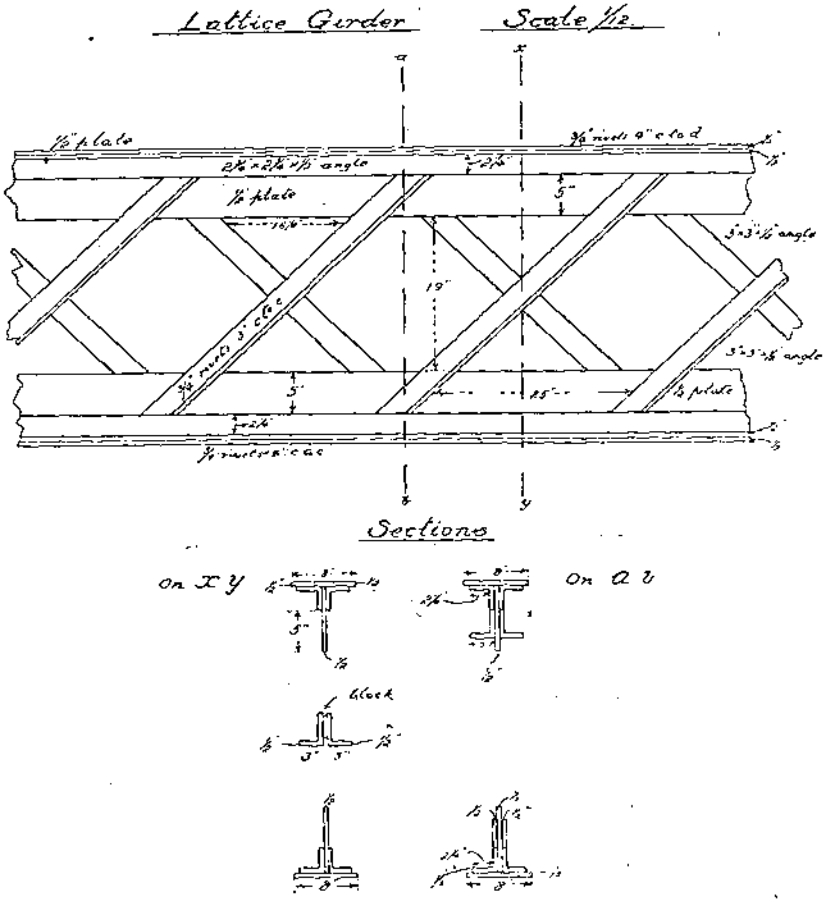


FIG. 21.

The charges were arranged in two different ways:—

(1). Three charges, one on each flange and one on the junction of the braces.

(2). Two charges on the flanges, so placed that no portion of the bracing was cut by a line joining them.

The latter appears to be the better, as although the charges on the flanges are rather larger, owing to the gusset plates of the braces, etc., the third charge on the brace is saved and the total is not practically any greater; whereas a saving of time, as well as a greater chance of success, is attained by having two charges instead of three. This would apply to *Fig.* 4, *Plate* 36, *Mil. Eng.*, Part IV.

Grenade-Throwing Catapult.—The idea of the catapult was to make a weapon capable of throwing a grenade about 1 lb. in weight at least twice the distance a like grenade could be thrown by hand. The catapult was to be light, so that it could easily be carried about.

The construction of the catapult is shown on *Fig.* 22; (A) shows the complete catapult, including tripod stand (not absolutely necessary for the use of the weapon).

The grenade (see *Figs.* (B) and (C)) consists of:—

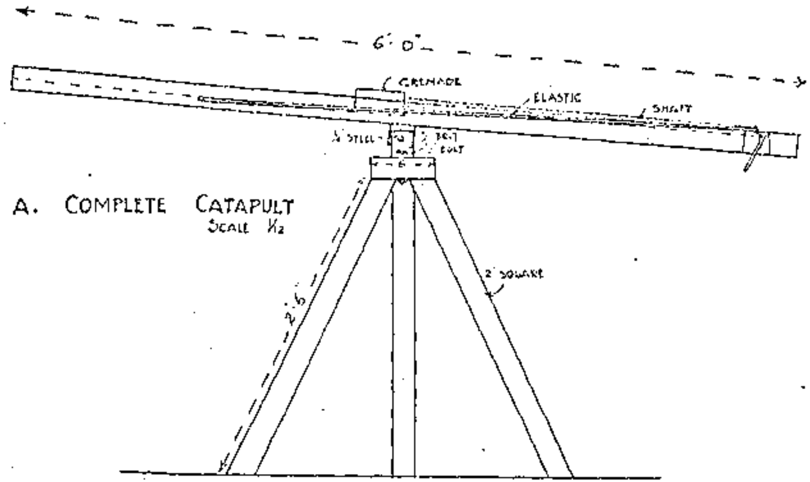
1. The effective portion, *i.e.*, 4½ in. of 1½-in. iron pipe nearly divided into 48 pieces by hack-saw cuts as shown. Weight, 10 ozs., *i.e.*, each piece weighs about ⅕ oz.
2. The shaft, and plug for attachment of shaft (fixed by three ordinary ½-in. wood screws). Weight, 4 ozs.
3. The charge, which may be either one or two 1-oz. guncotton primers. Weight, 1 or 2 ozs.
4. Detonator and fuze, inserted from rear as shown, and bound in place by fine string. Weight, say 1 oz.
5. Clay tamping to keep the primer in place. Weight, say 1 oz.

Total weight of grenade:—

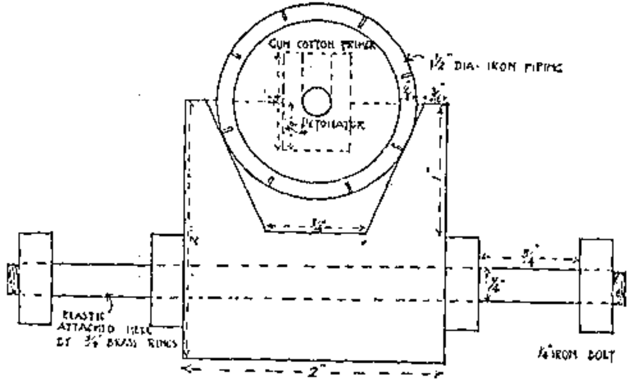
Shaft and plug	4 ozs.	
Detonator and fuze	1 oz.	
Iron piping	10 ozs.	
Primers	2 ozs. or	1 oz.
Clay tamping	1 oz.	
Total ..	18 ozs. or	19 ozs.

The head of the grenade slides in a V-shaped groove (see B). The shaft, ¾ in. by ½ in., slides in a groove ⅜ in. deep by ½ in. wide. The shaft is 3 ft. long, and is fitted with a 3-in. by 2-in. vane of copper sheet (24 gauge), to make the grenade fly true, and is notched at the back for reception of trigger-piece (see E). The trigger arrangement is shown in *Fig.* D.

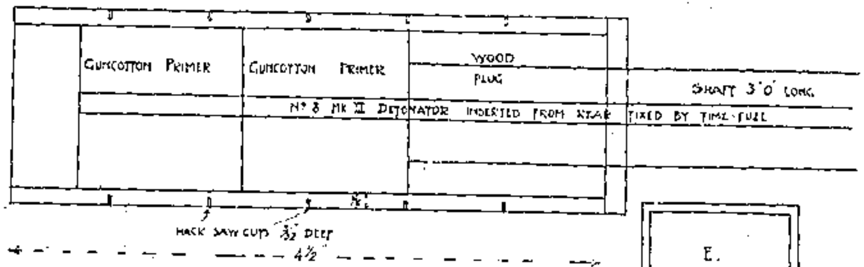
The *Motive Power* consists of 8 strands of ⅜-in. elastic and 10 strands of $\frac{3}{16}$-in. elastic, each strand 1 ft. 3 in. long (unstretched) was stretched to a length of 4 ft. 3 in. when in loaded position. Each strand is fitted with a ¾-in. brass ring at each end, and is attached in front as shown in (B). The rear ring is looped over the turned-back portions of (E).

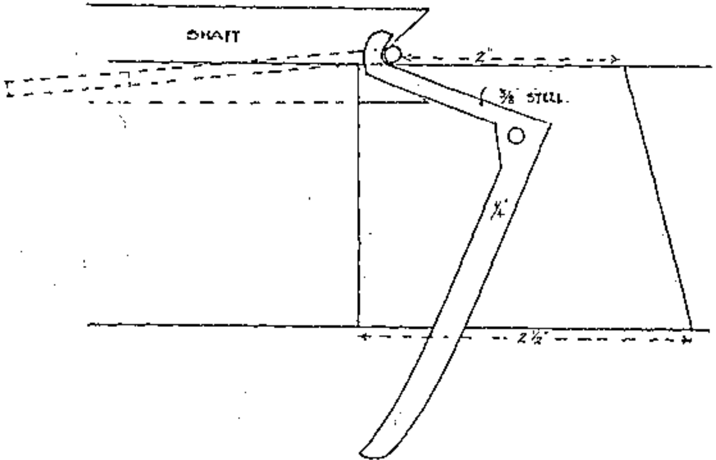


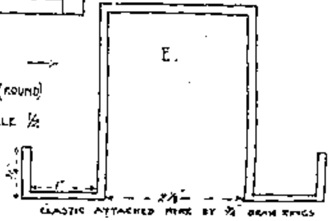
A. COMPLETE CATAPULT
SCALE ½



B. Elevation from Front.
Scale—Full Size.

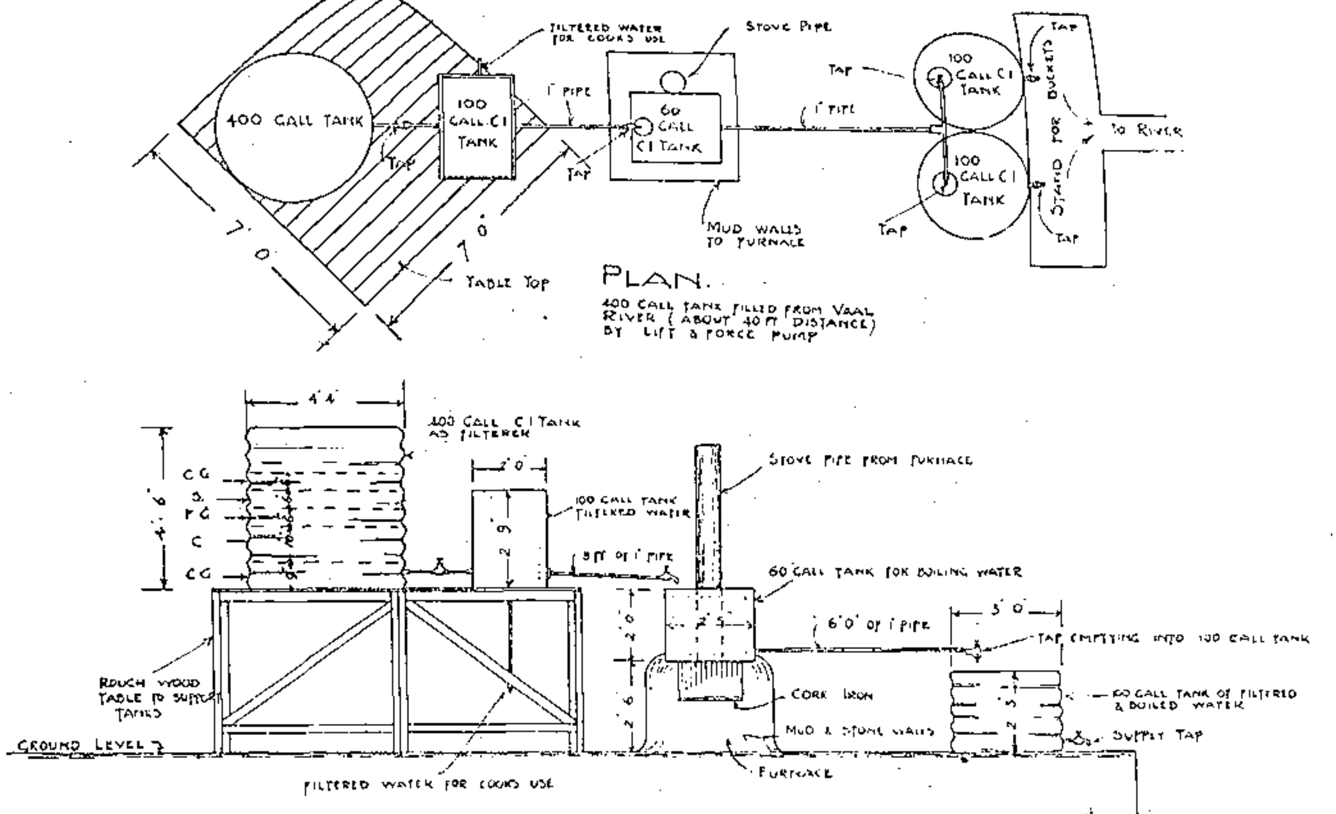






Weights.

Shaft and plug	4 ozs.
Detonator and fuze	1 oz.
Iron piping	10 ozs.
Primers	2 ozs.
Clay tamping	1 oz.
Grenade charged 2 ozs. G.C.	1 lb. 2 ozs.



Elevation of Filtering and Boiling Apparatus.

NOTE.—C.G. Coarse gravel. S. Sand. F.G. Fine gravel. C. Charcoal, powdered and rammed. C.G. Coarse gravel.

FIG. 23.—*Drawing showing Method of Water Supply used at Venterskroon Camp*, 1913.

The catapult is first loaded with one strand on each side and the remaining strands are put on in pairs, one on each side.

Pull required to stretch one strand $\frac{3}{8}$-in. elastic = 16lbs.

Pull required to stretch one strand $\frac{3}{16}$-in. elastic = 4 lbs.

Range was found to be 80 yards, nearly.

A trial was made by placing five dummies in the crater formed by the 150-lb. mine and firing from a range of 75 yards. The fourth grenade landed in the crater and exploded, hitting three out of the five dummies, one being very badly wounded.

There is no reason why the catapult grenade should not make a certainty of hitting a circle of 10-ft. diameter.

It is claimed that :—

(1). Its range is twice that of a hand grenade.
(2). Its accuracy is many times that of a hand grenade.
(3). It is sufficiently portable for use even by the besiegers, and is most suitable for the defenders to deny the occupation of a crater.

MISCELLANEOUS.

Field Kitchens.

The type actually used by regimental cooks on manœuvres usually consists either of a simple trench or of a fire with the camp kettles built up round and over it. For a small detachment, an excellent arrangement for holding pots over a fire can be made by fixing three or four iron dogs in the ground, and building the fire underneath.

Notes on Entraining 4-Wheeled Vehicles without Derricks or Sheers, etc.

(*a*). G.S. Wagon :—

(i.). Unload the wagon.
(ii.). Run it head first up to the door of truck and remove pole.
(iii.). Lock fore-carriage round square, insert pole under fore axle.
(iv.). Lift fore-carriage bodily into railway truck, manning up rear wheels to assist.
(v.). When well inside truck wheel fore-carriage up to one end and cross-lift rear wheels into truck.

The completed work should not take more than 3 minutes.

(*b*). Trestle or Pontoon Wagon :—

(i.). Unload wagon.
(ii.). Remove fore-carriage and lift it into railway truck and wheel to one end.
(iii.). Bring up remainder of wagon, the frame leading, and work the hind wheels through door.
(iv.). Roll the rear wheels to the opposite end of the truck and key up frame to fore-carriage.

The wagon can then be reloaded.

Water Supply.

An apparatus for filtering and boiling water for water supply is shown in *Fig.* 23.

AN ACCESSORY TO THE BRIDGING EQUIPMENT.

By Lieut. G. Le Q. Martel, R.E.

A Field Company often has to bridge a small river or ditch from 15 to 20 ft. wide, and with the present bridging equipment, if the river is even 15½ ft. wide, a support has to be used in the centre, as the baulks are only 15 ft. long. The following is a short account of a collar that has been made for joining baulks side by side, so as to avoid having to use a support for spans just over 15 ft., and from the calculations shown below, it will be seen that by using five pairs of baulks in this way, it is possible to bridge a 19-ft. gap for field guns or infantry in fours. This is also very useful when the last span in a bridge is just over 15 ft.; for instance, if a river is 48 ft. wide, it could be bridged by a Field Company by using two pontoons, and the last span could then be crossed with baulks joined up for an 18-ft. span; this would save using a trestle (which generally causes some little delay), and the bridge built in this way would be just as strong as if the trestle had been used.

Fig. 2 shows, in plan, two plain baulks connected up for a 19-ft. span. *Figs.* 1 and 3 show details of the joint. The parts required

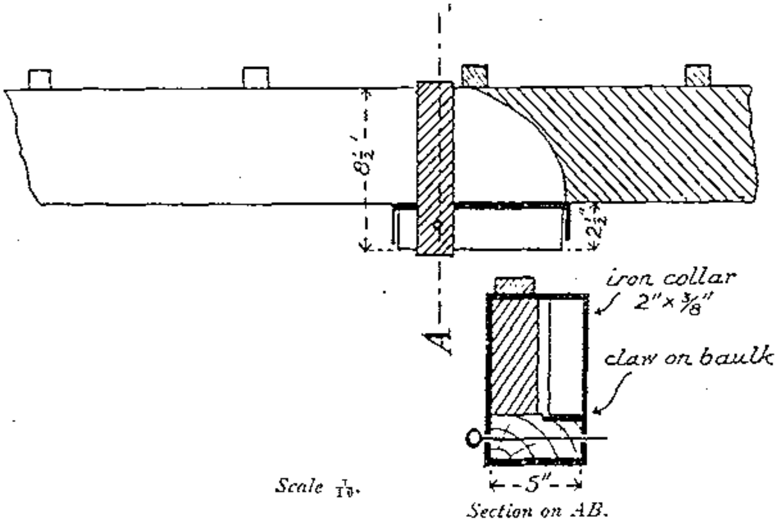
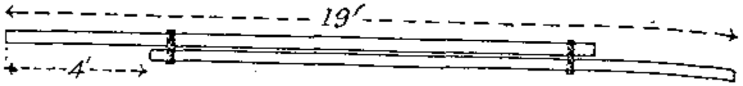


Fig. 1.—*Elevation showing joint of two button baulks.*

are an iron collar $8\frac{1}{2}$ in. high, and 5 in. wide, and a block of wood 5 in. wide and $2\frac{1}{2}$ in. thick. To connect up, two button baulks are first taken and placed as in *Fig.* 2. The most usual distance required is 19 ft., as this will take guns, but one of the baulks can be slid in or out to any required distance so long as it is an exact number of feet, so as to bring the buttons of one baulk opposite the buttons on the other. The iron collar is then slipped over one end of one baulk and pushed beyond the claws of the second baulk; the wood block is placed between the claws, and the iron collar slipped back to a position as shown in *Fig.* 1. The other end is treated in the same



Scale, 1" = 5'.

FIG. 2.—*Plan of two plain baulks joined for a 19' span.*

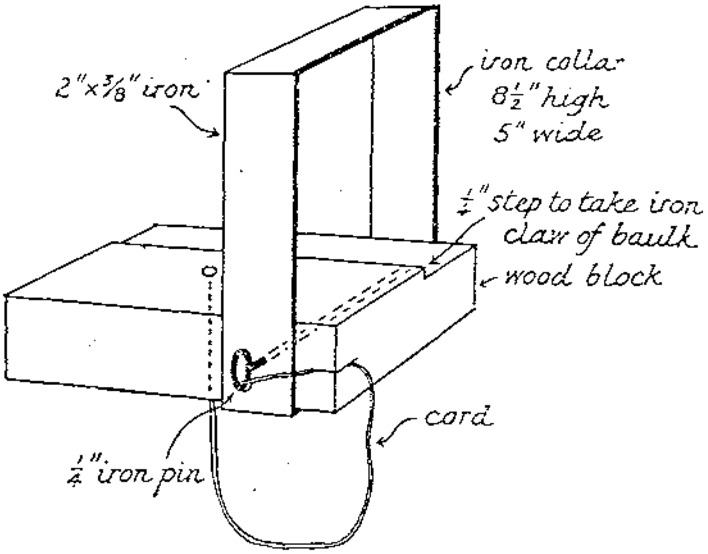


FIG. 3.—*Sketch showing parts required for joining baulks.*

way, and we have then a baulk 19 ft. long, and as strong, comparatively, as a single 15-ft. baulk. It is useful to remember that to get 19 ft., the first button on one baulk must be put opposite the fifth button on the other baulk. The plain baulks can be connected in the same way, but, in this case, the block can be put straight in its place, and the iron collar slipped over from the end, as there are no buttons to foul the collar. The wood block cannot slip out because it is held by the claws at the end of the baulk, but the iron collar might slip, and a pin of $\frac{1}{4}$-in. iron is therefore used, which passes through the collar and block. This pin is attached to the block by a piece of strong cord. In order to prevent the pin from falling out of its place, a saw cut is made as in *Fig.* 3 on the corner of the block, and when the pin has been pushed home the cord is forced into the cut, thus holding the pin. This avoids having to use a small contrivance, such as a hinged end to the pin or some similar arrangement, which would possibly jam or break. A $\frac{1}{4}$-in. step has to be cut on one side of the wood block to allow room for the iron claw on the end of the baulk. After a little practice a set of baulks can be connected up for a 19-ft. span in a few minutes.

Calculations.—Take first of all the ordinary bridging baulk 15 ft. long. Five of these will take infantry in fours crowded at a check, *i.e.* each baulk takes a distributed equivalent dead load of $\frac{5}{4}$ cwt. per foot-run.

Hence the M_E

$$=\frac{wl^2}{8}=35 \text{ ft.-cwt.}$$

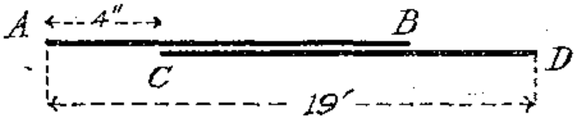
and the M.R.

$$=\tfrac{1}{6}rbd^2=\tfrac{1}{6}r\times\tfrac{3}{12}\times\left(\tfrac{6}{12}\right)^2 \text{ ft. units}=\frac{r}{96}.$$

Equating these

$$r=96\times 35 \text{ cwt. per square foot.}$$

This comes to 24 cwt. per square inch, which can therefore be taken as a safe working load.



Now take a pair of baulks extended to 19 ft.

In the above figure AB represents one baulk and CD the other.

Taking the load, as before, of $\frac{5}{4}$ cwt. per foot-run the B.M. at the centre is

$$\tfrac{5}{4}\times\tfrac{1}{8}\times(19)^2=56 \text{ ft.-cwt.}$$

and the M.R. is

$$r\times\tfrac{1}{6}\times\tfrac{6}{12}\times\left(\tfrac{6}{12}\right)^2=\frac{r}{48} \text{ ft.-units;}$$

hence

$$r=\frac{48\times 56}{144} \text{ cwt. per square inch}=19 \textit{ cwt.} \text{ which is quite safe.}$$

Now take the point C.

The B.M. at this point is

$$\frac{5 \times 19}{8} \times 4 - \frac{3}{4} \times 4 \times 2 = 37 \cdot 5 \textit{ ft.-cwt.}$$

And the section of the beam at this point is $2\frac{3}{4}$ in. × 6 in.;

hence M.R. $= \frac{1}{6} rbd^2$

$= \frac{11r}{1152}$;

hence $r = \frac{1152 \times 37 \cdot 5}{11 \times 144}$ cwt. per square inch

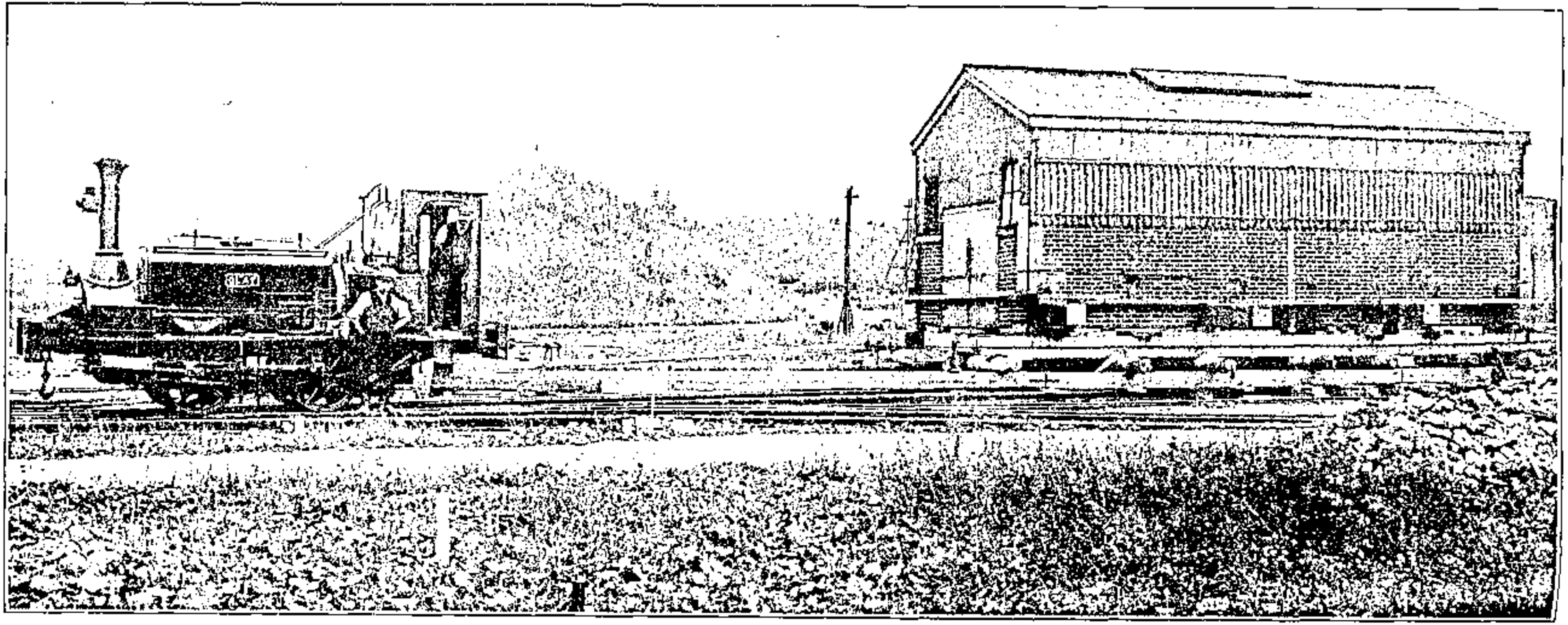
$= 27$ *cwt.* per square inch.

This is just slightly more than the working stress for the ordinary 15-ft. bay with single baulks, but it must be remembered that infantry will very seldom be crowded up sufficiently close on a 19-ft. bay to give a distributed load of 5 cwt. per foot-run.

A bridge made with double baulks extended to 19 ft. was tested with infantry crowded in fours, both marking time and standing still, and stood the test satisfactorily. Field guns were also taken over the bridge, but these bring a considerably smaller load on to a 19-ft. span than infantry in fours crowded.

The strain in the iron collar is quite small and a large factor of safety is provided by using 2-in. × $\frac{3}{8}$-in. iron.

REMOVAL OF A BUILDING INTACT.



REMOVAL OF A BUILDING INTACT.

By MAJOR N. M. HEMMING, R.E.

ALTHOUGH the removal of large buildings bodily to a new site is a comparatively common occurrence in America, it is less common in this country, and it is thought that an account of such a removal, although on a small scale, which has lately been carried out in the Royal Arsenal, may be of interest to officers of the Corps, as instances may occur in other places where conditions favour this mode of removal.

An improvement to a railway approach involved the taking down and rebuilding of a steel-framed building with brick panel walls 6 ft. high, filled in above with sashes and corrugated iron to eaves. The size of the building was 30 ft. × 15 ft. × 11 ft. 3 in. and the approximate cost for reconstruction, including taking down, was estimated at £100.

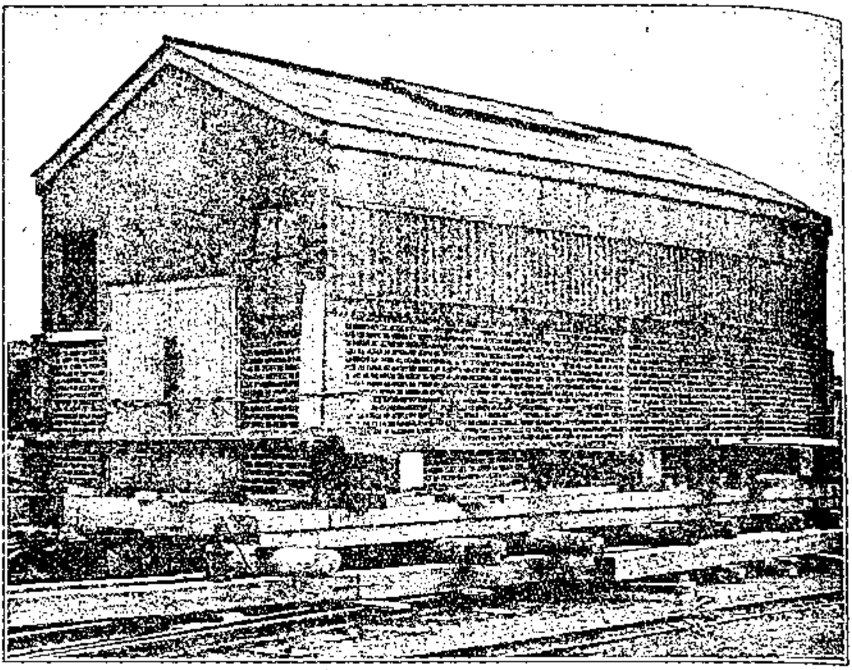
It was decided to move the building bodily to its new site, as the Arsenal Railway passed both the old and the new site, the distance between the two being some 70 yards; but the building might equally well have been moved any distance served by the railway as the traction presented no difficulties. The removal was successfully carried out at a cost of £35, and no portion of the building showed any signs of having been strained.

The method adopted was as follows:—

Four holes were cut in the brickwork close above floor level on each side wall, through which were passed four No. 12-in. × 12-in. timber needles. These were left projecting beyond each wall 4 ft.

In order to stiffen the building four stiffening pieces of 10-in. × 10-in. timber were cut and fixed across the building (inside) between the top longitudinal beams of building and vertically over the needles. 9-in. × 3-in. deals were laid on the top of the brick side walls, and short upright 10-in. × 10-in. timbers were fixed in between the 3-in. deal and 10-in. stiffeners referred to above. Four pairs of cross struts were fixed from the 10-in. × 10-in. stiffeners, on the one side, to the needles on the other. Four pairs of longitudinal braces, two at each side wall, were also fixed between the 10-in. stiffeners and the needles.

The bottom course of brickwork was cut away and the six stanchions of building sawn off close to the top of the old foundation. A 2½-in. wire rope was passed around the building about 3 ft., above floor level and was tightened up with a union screw. Hydraulic jacks were then placed under the timber needles and the building was lifted up 3 ft., this allowed of 10-in. × 10-in. timbers being placed under the side walls of building, two on each side about 3 ft. apart to act as roller paths to carry the 10-in. rollers, as shown in the photograph.



A wooden cradle, the size of the building, had been previously prepared, made from 14-in. × 14-in. timbers, halved together and secured by iron knees.

This was now placed under the lowest course of brickwork, and the six stanchions were secured to the cradle by six pairs of steel knees. The building and cradle were then lowered down on to the rollers and another wire rope was passed around the cradling, to which was secured a 4-in. tackle. The actual hauling was done by a standard gauge locomotive engine.

On arriving at the new site, the building was with a little trouble turned through a right angle and got into its proper position over the new foundation which had, of course, been previously prepared; jacks were again placed under the needles and the weight taken off the rollers; the rollers and roller path were removed, the cradling unbolted from the stanchion knees and hauled out of the way, and the building lowered down on to its new foundation. The six pairs of stanchion knees were utilized for securing the building to the new foundation.

The whole of the above work was carried out without the smallest hitch under the direction of Capt. H. Mitchell, and, as will be seen above, a considerable saving was effected by thus removing the building bodily.

DELHI CORONATION DURBAR, 1911.

By COLONEL R. S. MACLAGAN, C.B., C.S.I., R.E.

1. THE Committee appointed to make preparations for the Durbar was constituted as follows:—

PRESIDENT.

Sir J. P. Hewett, G.C.S.I., C.I.E.

MEMBERS.

Representative of Foreign Office.—Sir A. H. McMahon, G.C.V.O., K.C.I.E., C.S.I., Foreign Secretary.

Railways.—Sir T. Wynne, K.C.S.I., K.C.I.E., President of the Railway Board.

Civil Representative.—Colonel Dallas, C.S.I., I.A., Commissioner of Delhi.

Military Representative.—Brig.-General H. V. Cox, C.S.I., I.A.

Representative of His Majesty.—Brig.-General Sir R. Grimston, K.C.V.O., C.I.E.

Public Works Department.—Colonel R. S. Maclagan, C.B., C.S.I., R.E.

Medical and Sanitary.—Colonel C. J. Bamber, M.V.O., I.M.S.

Finance.—Mr. W. M. Hailey, C.I.E., C.S.

Representative of His Excellency the Viceroy.—Lieut.-Colonel Maxwell, V.C., C.S.I., D.S.O.

Supply and Transport.—Lieut.-Colonel Murray, M.V.O., Supply and Transport Corps.

Secretary.—Mr. E. V. Gabriel, C.V.O., C.S.I., C.S.

2. All matters connected with public works (except railways which were dealt with by Sir T. Wynne, President of the Railway Board, and works in military camps which came under the Military Member, Brig.-General Cox) were brought before the committee by the Public Works Department member, who was responsible also for seeing that the works sanctioned were properly carried out.

The chief departments under him and the officers in charge of them were:—

(A). Electrical.—Mr. J. S. Pitkeathley, C.V.O.

(B). Water Supply.—Mr. D. W. Aikman, Sanitary Engineer, Punjab.

(C). Roads and Buildings.—Major Crookshank, M.V.O., R.E.

(D). Canals.—Mr. Ward, C.I.E., M.V.O., Superintending Engineer, Irrigation Branch, Punjab.

Telegraphs and Post Office were directly under the Government of India and not under the Durbar Committee.

For the garden party, which the committee decided to hold in the Fort, the general arrangements for preparing the buildings and gardens inside the archæological area were carried out by the Local Public Works Department, under Rai Sahib Bishamber Nath, Executive Engineer, Punjab. The electric light was in charge of Capt. Malan, R.E., Military Works Services, and arrangements outside the archæological area by Capt. A. Campbell, R.E., Military Works Services.

3. A report on the electrical works will I understand be presented by Capt. Barker, M.V.O., R.E., who was Mr. Pitkeathley's senior assistant, and on canals by Lieut. Sopwith, R.E. Other Royal Engineer officers will also report on the works of which they were in charge. It remains therefore for me to briefly describe only those two items on which no Sappers were employed, viz., waterworks and preparation of archæological buildings in the Fort.

WATER SUPPLY.

1. This was in charge of Mr. D. W. Aikman, C.E., Sanitary Engineer, Punjab.

The Delhi Municipality at the time when the preparations for the Durbar were taken in hand, early in 1911, contemplated an increase of their water supply by adding extra pumping plant and filter beds and a new rising main from their head works on the Jumna to the Reservoir on the Ridge. The Durbar Committee entered into an agreement with the Municipality whereby the latter agreed to allow the Durbar Committee to take from their reservoir, on payment of a sum of Rs.90,000 to cover the cost of supplying temporary plant extra establishment, coal, use of existing plant, etc., the following quantities of water :—

Month.	Total Quantity in Gallons per Month.	Maximum in One Day.
July	9,000,000	500,000
August	9,000,000	500,000
September	9,000,000	500,000
October	18,000,000	1,000,000
November	30,000,000	1,500,000
December	45,000,000	1,700,000
	120,000,000	

These figures were based on the anticipated consumption calculated from the demands in the Durbar of 1903, but as a matter of fact were largely exceeded, the actual quantity supplied being:—

Month.	Total Quantity in Gallons per Month.	Maximum in One Day.
July	8,187,000	672,000
August	19,387,000	1,010,000
September	26,851,000	1,407,000
October	23,265,000	1,309,000
November	26,155,000	1,864,000
December	48,935,000	3,097,000
Total	152,780,000 gallons.	

In addition, the following quantities were given by temporary pipes to working parties :—March, 899,000 gallons ; April, 3,480,000 ; May, 3,596,000 ; June, 3,480,000 ; total gallons, 11,455,000.

That is, a total of 164,235,000 were pumped to the Durbar area up to end of December, 1911.

2. As the head works and rising main were in charge of the Municipality, the Durbar supply proper commenced from the Reservoir on the Ridge, though Mr. Aikman in his capacity as Sanitary Engineer, Punjab, was also responsible for the new work carried out by the Municipality which comprised :—

(*a*). Providing and erecting a triple expansion pumping engine with Babcock and Wilcox boiler (all manufactured in England shipped and erected within six months).

(*b*). New rising main to settling tank.

(*c*). 3 large slow sand filters.

(*d*). 1 large Jewell filter with engine, buildings, etc.

(*e*). Constructing two covered clear-water reservoirs of 1¼ million gallons capacity.

(*f*). Supplying and erecting 2 new compound pumping engines and other minor items.

3. In the Durbar area the following work was done :—C.I. pipes from 3 in. to 20 in., 52 miles, weighing 4,152 tons ; galvanized iron pipes, 65 miles ; tanks :—3 of 100,000 gallons, 1 of 50,000 gallons, 1 of 781 gallons, 144 of 400 gallons, 18 of 300 gallons; total, 413,781 gallons ; hydrants, 48 gallons ; standposts and taps, 2,234 gallons.

4. The work was carried out by Messrs. Martin & Company of Calcutta, all C.I. pipes above 4 in. in diameter being obtained from England. The firm were given the contract on 17th February, 1911, and water was delivered to all parts of the Durbar area by 18th September. Under the terms of their contract they were responsible

for maintenance of the pipes laid by them up to end of December, and they were paid at the rate of Rs.6/13/- per cwt. of pipe laid over 5-in. diameter, and Rs.6/10/- per cwt. for pipes of under 5 in. which were of Indian manufacture.

5. With regard to maintenance, Mr. Aikman reports "The maintenance was particularly difficult as all the pipes were brought out and laid in the blazing sun between the end of May and the end of August. There was hardly any rainfall during this period. The pipes got so hot that the pipe layers could scarcely handle them. The contraction due to cooling in the cast-iron mains was very great. Something had to go. Luckily there were only 3 bursts, and 4 or 5 pipes split slightly due to the strains of contraction. About 28 leaks occurred, due to the contraction pulling the spigot partly out of the socket. There were no leaks in the mains after December the 1st onwards.

I had the same difficulty, but in a lesser degree, with the distribution pipes—these being galvanized wrought iron could stretch against the contraction from cooling, but the strain caused leaks at the threads of the joints. Owing to the consignment of taps being delayed on the railway, I had to use, as a temporary measure, country-made plug taps which with very little rough usage soon began to leak, and more complaints were received from this cause than any other until they were replaced by taps of English manufacture."

6. The system adopted for maintenance was to form depôts at convenient centres where gangs of men with material for repairs were kept ready to start off when notice of a burst was received. Five such depôts in all were formed, and they were, whenever possible, connected with the telephone system. Mr. Aikman reports "Repairing cards were printed as shown below :—

DURBAR WATER SUPPLY.

Camp No.

Send men to repair 1, leak in tap; 2, leak in G.I. pipe; 3, leak in main pipe; 4, burst in main pipe.

Note.—A large X should be put on the line applicable to the nature of the repair opposite 1, 2, 3 or 4.

Bundles of these cards were sent to each camp officer, with printed instructions asking the camp officer, after filling in the card with the number of his camp and cross opposite the repair required, to send it with a verbal message to the repairing depôt for his camp. On receipt of the card one of the gang mistries at the depôt would send a man on a bicycle with (1) a new tap—if it referred to a tap—the defective tap being removed and taken to the depôt for repair; (2), with the necessary repairing tools if a leak; and (3) with keys to turn off the ferrule or valves in case of a burst—and follow up with his repairing barrow and gang. Luckily there were no bursts on the mains during the Durbar period. The system worked well, but the reporting from camps was not always good, the repairing cards being often sent to me by post and hand instead of to the nearest repairing depôt. In most cases when taps were reported leaking the tap was found to be in good order but had not been turned off properly." In addition the mains were patrolled one man to every 2 miles. In all there were 137 men employed in the repair and patrol gangs.

7. The accounts have not yet been finally closed but the probable cost will be 4,46,666 gross, 2,35,122 net.

In addition Rs.2476 was spent in sinking wells for the Imperial Service Troops camp which was too far off to be connected with the rest of the system; 90,000 was paid to the Delhi Municipality as stated in paragraph (1) and Rs.100871 was spent on distribution pipes for water supplied to the several camps and paid for by them.

8. The water supply was, on the whole, very satisfactory but improvements might have been made in the following points:—

(1). The repairing gangs and system of reporting were not introduced early enough. It should have been started as soon as water was supplied and pipes drawn on.

(2). It would have been better to purchase taps of the best English manufacture, and to issue them to contractors rather than to allow them to provide them. It would have been worth the slight extra cost.

Garden Party.

The Durbar Committee selected the archæological area within the Fort as the place in which to hold a garden party on the afternoon of the 13th December. During 1910, a portion of this area, known as the Hayat Bakhsh Garden, 3·63 acres in extent, had been restored from archæological funds, the old water channels reconstructed and plots between them laid out in grass lawns and flower beds. It was decided that the remainder of the archæological enclosure, a space of 6·87 acres, should be laid out in the same manner. This had always been contemplated by the Archæological Department, but would, but for the occasion of Their Majesties' visit, have been carried out gradually when funds admitted instead of being done in one year. The total estimated cost of the improvements in the Fort was Rs.99,700, of which the Durbar Committee contributed 25,000.

The works consisted chiefly of the following:—

(*a*). The ground, which was largely composed of débris from old buildings demolished at the time of the Mutiny, was first cut down to its original level, and the old water channels of the Moghul time were marked out by bajri paths, the borders of which were edged with low brick walls coped with red sandstone: the plots between these paths were laid out in grass lawns and shrubberies, the latter marking the sites of the old Moghul buildings which had been subsequently demolished.

(*b*). Water supplied for an elevated reservoir, which had been constructed in 1910 behind the building known as Bhadon in the Hayat Bakhsh Garden, was laid on to the marble channel which runs down the centre of the Palace buildings from the Hamman to the Rang Mahal, and also to the fountains and cascades in the Hayat Bakhsh Garden, and these played throughout the afternoon of the garden party the cascades being illuminated after dark by electric lights placed in the recesses behind them.

(*c*). A low ornamental parapet of red sandstone was erected on the Fort wall on the east side overlooking the Bela to replace an old and unsightly iron fence.

(*d*). As the old historical "jharokha"—a marble balcony projecting from the Fort wall at the Summun Burj—was too small for two chairs, the projecting balcony between the Sammun Burj and Rang Mahal was adapted as a "jharokha," by slightly raising a portion of the marble platform behind it, and here Their Majesties on the afternoon of the 13th December sat in state to watch the Badshahi Mela which was being held below.

(*e*). All the archæological buildings in Fort were repaired or restored, the chief works being the following:—

(1). The Mumtaz Mahal—formerly used as a Sergeants' Mess—was restored, modern additions to the building being removed, and was occupied by the Museum of Archæology which had hitherto been housed in the small rooms on the ground floor of the Naubat Khana. A fine collection of articles of historic and archæological interest, mostly obtained on loan from ruling chiefs and Indian gentlemen, were here exhibited during the period of the Durbar.

(2). The roof of the Diwan-i-Khas was restored and regilded.

(3). The Rang Mahal was thoroughly repaired and a new ceiling put on.

The above works were carried out under the superintendence of Mr. Gordon Sanderson, Superintendent, British and Muhammadan Buildings, Northern Circle, by Rai Sahib Bishamber Nath, Executive Engineer, Public Works Department, Punjab.

In addition to the above, the Punjab Public Works Department staff made temporary arrangements for the accommodation of pardah nashin ladies on the roof of the Mumtaz Mahal and Naubat Khana.

By the same agency, also, an insanitary ditch in the Bela just below the Fort wall was filled up and the jungle on the Bela cleared.

There was nothing in the execution of these works which were of special interest from an engineering point of view.

EARLY INDIAN CAMPAIGNS AND THE DECORATIONS AWARDED FOR THEM.

(*Concluded*).

By Major H. Biddulph, R.E.

These notes have now embraced the period referred to in the introduction, viz. :—1799—1849; but, as the war with China in 1840–2 was carried through almost exclusively by troops from India, a few remarks on the composition of the force and the medal granted for that campaign may not be out of place. The same medal (with the omission of the date) was granted for the subsequent war with China in 1857–60, and notes on this medal necessarily include the clasps granted for that war; and, on account of the fact that the Indian Army was in a transition stage, after the Mutiny, a list of the H.E.I.C. troops employed in China, 1857–60, is given with their designations taken from the medal rolls. In an appendix a similar list is given for the Persian Campaign of 1857; as also certain naval lists which will prove of interest to the collector who specializes.

China War, 1840–2.

The occasion of this war was the destruction by the Chinese of British property, valued at £2,500,000, in a violent effort to stop the opium trade. On account of the sea voyage the only Native troops sent from Bengal were volunteers, the bulk of the force being supplied by the Madras Presidency. A good deal of hard fighting took place, before the Chinese sued for peace, which they did just before the British prepared to advance on Nanking. The British possession of Hong Kong dates from this period.

H.E.I.C. Troops that served in the War.

Madras Artillery :—
- C Troop, Horse Brigade.
- B and C Cos. 2nd Battn.
- D Co. 3rd Battn.
- A, B, C, D Cos. China Gun Lascars.

Madras Sappers & Miners :—
- A, B and F Cos.
- Details of C, D and E Cos.

Bombay Artillery :—
- Native detachments serving on board ship.

Infantry :—

1st Regt. Bengal Volunteers.

2nd Regt. Bengal Volunteers.

2nd, 6th, 14th, 37th and 41st Madras N. Infantry.*

Rifle Company and details of 36th Madras N.I.

List of Officers of the Madras Engineers who served in China, 1840-2.

Capt. T. T. Pears.
Lieut. F. C. Cotton.
Lieut. W. I. Birdwood.
Lieut. J. C. Shaw.
Lieut. J. W. Rundall (wounded).
Lieut. J. Ouchterlony.
Lieut. J. G. Johnston.
Lieut. H. W. Hitchins.

For this war a silver medal (described below) was granted, without any clasps ; the suspender being a straight German-silver bar secured to the medal by two concealed pins.

For the war in 1857–60, the same medal (with the date 1842 omitted) was granted, but with a modern curved silver-bar and swivel mounting; and five clasps in all were authorized for the war; a sixth clasp, "China 1842," being granted to those few individuals who were in possession of the medal for 1842.

Medal :—China, 1840–2, 1857–60.

Silver 1·4-in. diameter.

Obverse.—Crowned head of Queen Victoria. Legend "Victoria Regina."

Reverse.—A trophy. Inscription "Armis exposcere pacem." "CHINA 1842."

N.B.—"1842" is omitted from the medal struck for 1857–60.

Ribbon.—1¼ in. wide. Red with yellow edges.

Mounting.—(*a*) 1842. Straight German-silver bar.
(*b*) 1857–60. Curved silver bar with swivel.

Clasps.—"China 1842."
"Fatshan 1857" (Navy only).
"Canton 1857."
"Taku Forts 1858" (Navy only).
"Taku Forts 1860."
"Pekin 1860."

* The 37th M.N.I. was sent out from India in 1840 ; the 36th M.N.I. in 1841 ; the 2nd Regt. Bengal Volunteers, and 2nd, 6th, 14th, and 41st M.N.I. in 1842.

The 39th M.N.I. garrisoned Hong Kong in 1842, but did not receive the medal.

H.E.I.C. Troops which served in China, 1857–60.

Artillery :—A Co. 5th Battn. Madras Artillery (1860).
1st Supplemental Co. 5th (Golundaz) Battn. Madras Artillery (1860).
Detachment of Bombay Artillery (and Infantry) serving as Marines.

Sappers & Miners :—A and K Cos. Madras Sappers & Miners (1860).

Cavalry :—1st Sikh Cavalry (later 11th Bengal Cavalry) (1860).
Fane's Horse (later 19th Bengal Cavalry) (1860).

Infantry* :—7th (late 47th) Bengal N.I. (1858–60).
10th (late 65th) Bengal N.I. (1858–9).
11th (late 70th) Bengal N.I. (1858–9).
Detachment 3rd (late 32nd) B.N.I. serving with the 10th (late 65th) B.N.I. (1858–9).
New 15th Bengal N.I. (Ludhiana Sikhs) (1860).
" 20th Bengal N.I. (late 8th Punjab) (1860).
" 22nd Bengal N.I. (late 11th Punjab) (1860).
" 23rd Punjab Pioneers (late 15th Punjab) (1860).
" 27th Bengal N.I. (late 19th Punjab) (1860).
Detachment 12th, 29th and 38th Madras N. Infantry (1857).
5th Bombay N. Infantry (1860–2); details of 3rd Bo.N.I.
Detachment 21st Bombay N.I. (Marine Battn.) serving as Marines.

From the despatch of the Secretary of State for India to the Governor-General on the subject, and from the 1857–60 medal rolls, it is quite clear that those men who served in *both* wars received in the first instance *only the clasps* to which they were entitled, including the "China 1842" clasp.

It appears to have been overlooked that the suspender of the "China 1842" medal was not adapted for the addition of clasps; but this seems to have been discovered after the issue of the loose clasps had commenced, and medals from the 1857–60 die were then sent out to enable the clasps to be properly fixed. How many of the recipients did this cannot be determined, as the majority were in the Royal Navy, whose medals in 1860 were issued unengraved; but some undoubtedly had already fixed their clasps to the 1842 medal by altering the original suspender at their own expense.

It may be safely said that very few of the unengraved China

* The 21st Madras N.I. garrisoned Hong Kong in 1860, but did not receive the medal. The 3rd Bombay Infantry were also despatched from India to China in 1860, but only a few details earned the medal.

medals with the "China 1842" clasp are *bona-fide* issues. The number of men who earned the "China 1842" clasp are as follows :—

Royal Navy :—93 in all (including 24 officers).

Army :—6 Europeans and 16 Natives.

Indian Marine :—1 European.

Several of these Natives died before the issue took place, and their medals and clasps were returned to the Horse Guards to be melted.

APPENDIX I.

H.E.I.C. TROOPS WHICH SERVED IN PERSIA, 1857.

Artillery :—Detachments of Bombay Artillery.

Sappers & Miners :—Detachments from Madras and Bombay.

Cavalry :—3rd Bombay Light Cavalry.
Detachment Poona Irregular Horse.
Scinde Irregular Horse.
Aden Irregular Horse.

Infantry :—1st and 2nd Bombay European Regiments.
4th, 20th, 23rd and 26th Bombay N.I.
2nd Belooch Battalions.
Detachments of 2nd, 3rd, 5th, 6th, 8th, 9th, 11th, 15th, 19th, 22nd, 25th, 28th, 29th and Marine Battalion (21st) Bombay N.I.

APPENDIX II.

LISTS OF VESSELS OF THE INDIAN NAVY EMPLOYED IN VARIOUS CAMPAIGNS.

CHINA, 1840–2.

Bengal Marine.

Enterprise.
Hooghly.
Madagascar.
Nemesis.
Phlegethon.
Pluto.
Proserpine.
Queen.
Tenasserim.

Indian Navy.

Ariadne.
Atalanta.
Auckland.
Medusa.
Sesostris.

CHINA, 1857–60.

Indian Navy.

Auckland.
Berenice
Coromandel.
Ferooz.
Prince Arthur.
Zenobia.

Scinde Campaign, 1843.

The list of vessels employed has been given previously. 110 men in all of the "Indus Flotilla" earned the Meeanee medal, and 115 men that for Hyderabad.

Punjab Campaign.

154 Europeans served with the "Indus Flotilla" and earned the medal; some of them receiving the clasp for "Mooltan" as well.

Army of India Medal.

300 medals with the clasp for "Ava" were issued to the Royal Navy, and 46 to European survivors of the Indian Marine. The names of the vessels employed have been given on p. 237, Vol. 18.

Burma, 1852–3. (Medal and clasp "Pegu").

Bengal Marine.	*Indian Navy.*
Bhageruttee.	Berenice.
Damoodah.	Ferooz.
Enterprize.	Medusa.
Fire Queen.	Moozuffer.
Indus.	Sesostris.
Krishna.	Zenobia.
Lord Wm. Bentinck.	
Luckea.	
Mahanuddy.	
Nemesis.	
Nerbuddah.	
Phlegethon.	
Pluto.	
Proserpine.	
Soane.	
Spy.	
Sutledge.	
Tenasserim.	

Persia, 1857. (Medal and clasp "Persia").

Indian Navy.

Ajdaha.	Euphrates.	Planet.
Assaye.	Falkland.	Punjaub.
Assyria.	Ferooz.	Semiramis.
Berenice.	Hugh Lindsay.	Victoria.
Clive.	Lady Falkland.	
Comet.	Napier.	
Constance.	Nitocris.	

Indian Mutiny.

300 Europeans of the Indian Marine received the medal. These medals are marked as a rule "Indian Naval Brigade," that being the designation of the force. No clasps were earned by this force.

As regards the Royal Naval Brigade, H.M.S. *Shannon* earned 530 medals, and H.M.S. *Pearl* 232 medals.

In nearly all these campaigns a certain number of Bombay Native Artillerymen received medals, who served on board ship as Marines. The numbers given above do not include these men, as they were only lent by the Army.

FINIS.

ERRATA.

Vol. XVIII., 1913.

P. 41, line 28.—*Omit* sentence in brackets.
P. 42, line 17.—*For* "first" *read* "second."
P. 89, line 41.—*For* "64" *read* "73."
P. 96, line 10.—*For* "Divisions" *read* "Division."
P. 96, line 24.—*For* "J. Robertson" *read* "T. Robertson."
P. 98, line 26.—*For* "J. Robertson" *read* "T. Robertson."
P. 98, line 31.—*For* "Gohna" *read* "Gohad."
P. 98, line 39.—*For* "ATTACK" *read* "CUTTACK."
P. 171, line 36.—*For* "1-4th M.N.I." *read* "1-2nd M.N.I."
P. 178, line 20.—Add the name of Lieut. J. Peckett, Bengal Engineers.
P. 236, line 12.—*For* "to" *read* "for."
P. 288, line 3.—*For* "2-6th Brigade" *read* "2-6th Battalion."
P. 291, line 3.—*For* "are" *read* "is."
P. 298, line 21.—*For* "Dalhousie" *read* "Ellenborough."
P. 338, line 18.—*For* "R. Blackall, 50th B.N.I." *read* "J. Anderson 50th Foot, vice Blackall, sick."

Vol. XIX., 1914.

P. 41, line 2.—*For* "W. Wallace" *read* "N. Wallace."

TRANSCRIPT.

ON AN INDIAN CANAL.

By MAJOR-GENERAL G. K. SCOTT-MONCRIEFF, C.B., C.I.E.

(*Reproduced from Nos.* MCXII., MCXIII. *and* MCXIV., BLACKWOOD'S MAGAZINE, *with the permission of the Proprietors*, MESSRS. WM. BLACKWOOD & SONS, LONDON AND EDINBURGH).

A STORY was current in the Punjab a few years ago that a young and zealous district officer, who had just been transferred to the province from some other place, and had made his first cold-weather tour of his new territory, reported that he had in the course of his wanderings come across a broad and majestic river. He further stated that this river was not marked on any of the survey maps in his possession, and, improving the occasion, he took the opportunity to criticize in scathing periods the administration of Government departments (other than the covenanted civil service) in general, and the shortcomings of the Survey of India in particular. The story goes on to say that the report of this officer, after passing through the usual channels of correspondence, eventually found its way to Simla, that there it passed about from one branch to another until it was ultimately answered, and the zealous officer in question was informed that, from circumstantial evidence, it appeared that he must have discovered the Sirhind Canal!

This story sounds absolutely incredible, and yet to those who see one of the noble irrigation canals of Northern India for the first time, it is not only possible to mistake it for a river, but it is, in the case of the older canals, difficult to believe that the swift-flowing stream, full of life and energy, is wholly artificial.

To one acquainted with the canals of England, and indeed of Europe generally, the word recalls only a more or less stagnant ditch with a towpath at one side, an old cart horse plodding slowly and wearily along, dragging an elongated barge peopled by folk uncouth in speech and lazy of habit. The canal itself may be useful as a commercial highway, a cheap method of inland transit, but it presents a picture of all that is essentially inert and sluggish, and except to schoolboys in hard winters, when it is frozen and affords glorious skating for miles, it cannot evoke enthusiasm even in the most ardent admirer of rural simplicity.

But a canal in Northern India is very different, a thing of vital vigour, taking its rise in the great rivers that bring from the eternal snows the treasures of the deep which, as the Psalmist says, are laid up in storehouses—viz., the glaciers of the Himalayas. Down the waters roll in a current that by and by will be spread out over the length and breadth of the country, carrying with them wherever they go new life in the shape of corn and fruit, seed for the sower and bread for the eater. A navigation canal is merely a waterway between two places; an irrigation canal takes into its broad influence the whole of a countryside. It is an artificial river; only, unlike a natural river, it spreads out into innumerable branches as it progresses instead of gathering tributaries into its embrace.

To understand this, take the leaf of any tree you like—an oak or a sycamore,—or even a humble cabbage. Nature has worked out in countless variety—and every spring the miracle is repeated in millions of different ways in every forest—the perfect irrigation system which human engineers endeavour to imitate with only partial success. There is the stalk of the leaf—the main line of the canal. Then at the leaf itself we arrive at the irrigated area. In some cases (as in the oak) the main channel continues along the main axis, sending distributaries right and left. Or in other cases (as in a vine) there is a bifurcation into branch canals as soon as the irrigation begins, and these again into major and minor channels until the whole area partakes of the moisture from the parent tree, returning it as we know in the form of valuable material, worked in nature's wonderful laboratory, to build up the vigour and strength of the plant as a whole. So in our irrigation channels. They are dissipated over the surface of the land, first in the form of branches, then in distributaries (some of these carrying water enough to supply a city as big as Glasgow or Birmingham), then again in "village minors," and finally in little water courses which lead to the fields of wheat or maize or rice, and return to the parent state which has provided the means of nourishment, vigour and strength in the fruits of harvest and in the vigorous tillers of the soil.

Some of the older canals, too, are exquisitely beautiful. The Ganges Canal, for instance, issues from the parent stream at Hardwar, where white temples cluster at the base of low-wooded hills on the banks of a noble river, with swirling rapids and pools of clear blue water, reflecting on their surface the far-distant snowy peaks of the Himalayas against the deep cloudless blue of an Eastern sky. Here a weir has curbed the river, causing part of the water to flow down a new channel, forming a stream about 50 yards wide, about 10 ft. deep, and with a current so strong that no man can swim against it. Just below the entrance into this new channel there is a bridge of several arches under which the water rushes, eddying in whirlpools behind the piers, and if your eyes are good you will see gliding in and out of these eddies the noble *mahseer*, the Indian salmon (so called, though the fish is of a different genus), olive-backed and orange-finned, and a glorious fighter. Spin a minnow or a spoon in the current and you will probably hook him, but see that you have plenty of line and the best of tackle, for your rod will bend into a perilous curve, and your reel will scream with the music that brings a thrill to the angler's heart, and your gallant fish, with that current in his favour, will be far out over the rushing water before you can bring any pressure to bear on him. There is a shingle bank about a hundred yards down where you may hope to land him, but if he takes you beyond that, as well he may, you will have many an anxious moment before you gaff him. When that proud achievement has been accomplished, you will be ready to declare that an Indian canal is first cousin to a Scotch salmon river.

For the next 17 or 18 miles of its course that canal is a thing of beauty, an engineering triumph, a sportsman's paradise. It winds along between wooded banks, a grassy road on either side, following the base of hills where every sort of game that man desires to shoot, from an elephant to a snipe, can be found by those who know where to seek it. Elephants, by the way, are preserved by the State, and a herd of them is not a thing which the sportsman desires to meet, for he cannot shoot them, and they are distinctly dangerous. But there are tigers and leopards, deer of many kinds, jungle fowl, partridges, ground game, geese and ducks of varieties and beauty too numerous to mention, so that the man behind the gun is hard to please if he cannot get what he wants.

Then in the open ground on the borders of the forest region the "grim grey boar" has his well-known haunts, and the sport he gives is about the most exciting in the world. A good start from a covert at home on a hunting morning in a grass country, when hounds are running hard and the hunter between your knees is going well up to his bit, perhaps catching hold of you a little at his fences, is delightful, but it does not touch the keen excitement of a race for first spear after the mighty boar. The ground one gallops over is such that in cold blood one would not attempt to ride there at the slowest pace, and how one's gallant steed manages to keep on his legs is a marvel. Hurtling through grass and bushes in front is the grey back of the old boar, champing his jaws viciously, and ready at any moment to jink out of the way or wheel suddenly, and with a grunt charge like lightning. It is indeed a royal sport.

Within a radius of a few miles of one of the inspection-bungalows, which occur at intervals of about 10 miles along the main line of the canal, all these sports can be enjoyed; but it may be doubted whether the band of soldiers who, in the early days of Queen Victoria's reign, engineered the Ganges Canal, can have had much time for such amusement. For they must have had plenty to do in the designing and executing of the many engineering masterpieces which abound in the first 17 miles of the main canal. In addition to bridges which span the stream at regular intervals, there are at least two "super passages," where the canal is crossed by mountain torrents from the hills, and where in the rainy season one may see the extraordinary sight of one stream crossing another at right angles, the natural torrent above and the canal below. Then there are artificial falls, dear to the angler, where the canal bed has to pass from a higher to a lower level; and one place where, by a cunning arrangement of gates and sluices, the waters of a hill-torrent pass through the new canal, and escape down their old accustomed channel. But the mightiest work of all is the Solani Aqueduct, where the canal crosses a valley about three miles in width, and there, not only in the rainy season but at all times, one may see the swift stream of the canal above and the Solani River flowing peacefully below. All these great works were carried out between 1846 and 1854, at a time when there were no railways in the country, and when the resources of modern machinery and other adjuncts to engineering works were unattainable. The chief engineer was Sir Proby Cautley, an artillery officer. He and his lieutenants had to devise their great works entirely from local resources, and they certainly succeeded in producing a monumental work which has aroused the admiration of all who have ever seen it. A young civil officer, who has since risen to be the lieutenant-governor of a province, said to me, years ago, "I would sooner have been the man who engineered the Ganges Canal than the greatest Governor-General that ever ruled India: the work of the civil governor passes away and leaves no trace, the work of the other benefits every generation who comes after him."

It was not only Englishmen who carried out work of this description. When the British first took over Northern India, a century ago, they found a canal on the western side of the Jumna, which traversed the country to the west of Delhi, and had fertilized an otherwise scantily productive region. This canal, now called the Western Jumna Canal, was originally made by the Emperor Tuglak Shah somewhere about the 14th century A.D., to convey water to a sporting property which he had at Hissar, on the edge of the great Indian desert. In the time of Akbar (about 1580 A.D.) this canal, which had fallen into disrepair, was improved, and early in the 17th century the Emperor Shah Jehan made a branch of it, which still exists, to his new capital at Delhi. The engineer of this great work was one Ali Mardan Khan, a name that deserves to be ranked with that of Cautley, Cotton, and many others as a pioneer of this branch of engineering.

There are some exquisite stretches of scenery on the branches of this canal. Tall shady trees stretch their boughs across its waters, and troops of monkeys swing their way across from one side to the other. Birds of every variety of colour—scarlet finches, bronze-green bee-eaters, flocks of chattering green parrots, and turquoise-blue kingfishers—delight the eye at every turn. There are quaint old bridges built of old-fashioned red bricks, with pointed arches and thick piers, which tell of their origin from purely Oriental ideals. The country, however, has in the past found the canal not an unmixed blessing. It was taken across the main lines of drainage of the country in such a way as to produce swamps that were haunts of waterfowl and snipe, but also nurseries of malaria. The British cantonment of Karnal, built in the early years of the 19th century, and at that time one of our most important frontier stations, became such a hotbed of fever that it had to be abandoned early in the forties, and the materials were taken away, as far as practicable, to be used in the building of the modern cantonment of Umballa Now almost the only traces of the former station are three huge cemeteries, full of fast-crumbling tombstones to the memory of British officers and men, their wives and children, who died there between 1820 and 1843.

The natives of the country, however, still remained; for although one might move a regiment or even a barrack, it is impossible to uproot the villages and their inhabitants, who were just as liable to malaria as the white men. So the rearrangement of the canal had to take place, and after infinite care and skill was carried out. The snipe and ducks have sought other haunts, but the people are now healthy.

It seems impertinent and presumptuous to say that the great engineers of the past did imperfect work, and yet it would be no more an accusation or a disparagement than to say that George Stephenson's "Puffing Billy" was an inferior engine to a modern Great Northern express locomotive. Science has advanced in many directions during the past half-century, and in the intricate matter of the flow of water in channels there has been perhaps as much discovery as in any other branch.

About the time that Shah Jehan was planning his canal into Delhi, the great Galileo was making patient observations at Florence, where the floods of the Arno were giving much anxiety to the municipal dignitaries of that fair city. Galileo made some discoveries regarding the relations between the velocity of a stream and its longitudinal slope, which are at the foundation of our science to-day, and if he had lived longer, or perhaps been able to devote his whole mind to this subject, he might have gone a little further, and discovered the relations of the form of the cross section and the nature of the river-bed to that velocity. But he passed away, and as often happens the science got into the hands of purely doctrinaire professors, who, relying on mathematics only, built up theories which were based on imperfect observation. These heresies were accepted in one form or another for more than two centuries after Galileo had passed away. It was not until the latter half of the 19th century, at the time when Sir Proby Cautley and his able assistants were completing their great work in India, that a French engineer, M. D'Arcy, began a series of patient experiments in Paris that gave the clue to a genuine unlocking of Nature's secrets in this matter.

Nowadays we know that (owing to the imperfect knowledge that then prevailed) the Ganges Canal is made with too steep a longitudinal slope. "Steep" is a curious adjective perhaps to apply to a gradient of a foot and a-half in a mile, but the result is that the waters flow with too great a velocity, and for that volume of water even a foot in a mile would be too great. Then, again, if the Ganges Canal had been designed nowadays it is doubtful whether all the splendid works near the head would have been required at all. The length of the main line—the stalk of the leaf—would have been much shorter, and we should have lost all the charming scenery and variety of the first 17 miles or more. We live in a utilitarian age.

The actual work of distributing the waters all over the face of the land is in the hands of the irrigation engineers, although it might be said that the work involves not so much engineering as knowledge of law, of agriculture, and of the social life and economic conditions of the people,—knowledge which is essentially the province of the officers of the Civil Service. If, however, canal administration were to be committed entirely to the civil officers, their numbers would have to be largely increased (and it must be remembered that they are the most highly-paid officials in the country), and they would require every now and then technical advice, so that one could not reduce the engineer establishment very much.

The Indian peasant farmer lives in a village with others of his fellows, each village having its own petty government and its own clearly defined land, the landmarks of the fields being the same from ancient times, and all duly registered and assessed in the records of the State.

Formerly the village community was left to make its own water channels from the irrigation distributaries, but this led to so much wrangling and general iniquity that now the State does all that part of the work, leaving the outlets to be paid for by the beneficiaries. In Italy and South France, where irrigation is carried out on a comparatively small scale, but very systematically and well, the farmer pays for the actual water that he uses, measured by means of various ingenious devices. The water there is managed by a public trust, and it is considered as low a trick to take water out of one's turn as it would be to steal a neighbour's ox or his ass or anything that is his. Public opinion would soon make the delinquent's life a burden to him.

Unfortunately no such sense of honour prevails in the Orient. Water is paid for, therefore, indirectly—*i.e.*, the State undertakes to give the farmer as much water as is necessary for the maturing of his crop, and the farmer in return has to pay an enhanced revenue at so much per acre according to the crop, some requiring more water than others. The fundamental principle is that the farmer as tenant pays to the State as landlord a proportion of the yield of the land, or a sum equivalent to that proportion. If the crop should fail, if there is a visitation of locusts, or blight, or any other disastrous and unforeseen calamity, the State undertakes to remit the revenue, wholly or in part; while, on the other hand, there is a law which provides adequate punishment for unauthorized irrigation, or waste of water, or other misbehaviour.

The lowest actual agent of this administration is a functionary called a *patwàri*. He is a person of some technical knowledge, and before appointment he has to pass an examination in reading and making village maps, in measuring ground, and in estimating roughly the areas of land, in calculating the discharge (in cubic feet per second) of a watercourse, and in keeping the accounts of areas irrigated in a village. Now although the pay of such a functionary is very small, and his work is considerable,—for he is responsible for the administration of affairs in at least half-a-dozen villages,—yet there is always a number of applicants for every vacant post. From which it is evident that the income of a *patwàri* is derived, like that of a steward on board a P. and O. steamer, not so much from his pay as from his "perks." What and how much these are, no white man probably has ever discovered; but before a white man can attempt to prevent it, he must cease to countenance the tipping of railway porters and gamekeepers, or even of housemaids. Where, however, the danger lies is in the corruption that takes away the water from the poor man and gives it to the rich. That may be reduced to a minimum by constant supervision.

A friend of mine was much amused once to see how the principle of *backshish* worked in a huge fire in a native city. The fire brigade turned out, there was plenty of water, and soon a stream was hissing on the burning buildings, without much result. There were, however, certain shops somewhere in the vicinity which, being at some little distance, the fire had as yet not touched. First one shopkeeper approached the fireman, and giving him a few rupees asked him to direct his stream of water on the donor's shop. This was promptly done, the burning building being left to itself. Then another shopkeeper came, gave more rupees, and the stream consequently went to *his* shop. And so on, until many shops had been drenched and many rupees passed to the fireman. And in course of time the fire burnt out, and everybody went home quite satisfied, except the owner of the burnt house, who regarded the calamity as an inexorable fate.

I am not in the least defending the corruption of the Oriental, but it is a ridiculous hypocrisy which assumes that it does not exist, and that a system so ingrained in the customs of the people can be eradicated all at once.

The outward and visible sign of a *patwàri* is a yellow turban. It is useful to be able to recognize these and other functionaries of the irrigation department at a glance, and as a uniform is out of the question, the colour of the head-dress is a simple solution of the matter. There are certain men whose duty is to patrol the banks and do petty repairs, whose distinctive head-dress is bright orange, visible from afar, so that the English officer who has detected something wrong—a rat-hole in a bank or an accumulation of weeds at an outlet—can descry one of these guardians of maintenance from a distance by the brilliant colour of his headgear. But this very brilliancy has its little drawbacks. There was once a superintending engineer, with an irascible temper and an indifferent seat on horseback, who found the startling colour a trial to his horse's nerves and his own equilibrium. Consequently the unfortunate wearers of the obnoxious colours were greeted by him with such execrations that they, poor men, perhaps from a guilty conscience, imagined that their misdeeds had been found out and that the more they avoided the great man the better. One of them one day was coming round a bend in a canal when, to his horror, he met the superintending engineer and his retinue riding towards him Escape was useless, so he hid behind a bush. But as the sahib was just passing, the instinct of politeness was too strong for him, and he suddenly shot out of his place of concealment with an aggressive but obsequious salutation. Naturally the horse shied most violently, nearly throwing his rider into the canal. Language was inadequate to express the wrath of the great man, who, not unnaturally, imagined that he was the victim of a diabolical plot ; but long before he could recover his seat and thunder forth his wrath, the luckless offender had fled in terror, with the now loosened orange head-dress streaming behind him as he raced headlong from the scene of his wickedness.

The executive engineer of a running canal has to be continually travelling about his district. To enable him to do so in some degree of comfort, and indeed to make it possible for him to do so at all, there are little inspection houses dotted about at intervals of 10 or 12 miles. Some of these are charming little places. A whitewashed bungalow, surrounded by a cool, arched verandah, and often adorned with lovely flowers, with a flat roof, on which one may sleep in comparative coolness even on the hottest night, with the starry canopy overhead, is situated in a garden with orange and banana and loquat bushes and trees that afford a grateful shade. The canal is close at hand, and one hears the murmur of the water. Inside, the house is plainly but sufficiently furnished, and usually there are a few books to lighten official cares. Often have I found in such places old volumes of "Maga," and no more charming intellectual feast could one desire,—a veritable refreshment after a day spent in the endeavour to unravel some of the tangled skeins of Eastern intrigue.

For an irrigation engineer's life is a strenuous one. Very early in the morning he has to be out and away. In the bracing sharp air of the cold season this is invigorating and delicious, but in the middle of June or July, when the hot winds are blowing and all nature is clamouring for water, when the ground is like iron and the heavens like brass, it takes some effort to rise before dawn and swing into the saddle. It must be done, however, for there is much to supervise. Some new improvements devised since last inspection, some engagement to meet a complainant, some endeavour to settle on the spot disputes between rival parties both clamouring for what they think their rights, and, above all, the unexpected visits to outlying places where waste of water or unauthorized use thereof may occur, and where the *patwàri* may imagine he can carry out his own little plans without interference. All this will take several hours of travel on horseback, usually in the company of a *zilladar*, a native subordinate, who is the superintendent of about a dozen or more *patwàris*, generally a man of good family and education, and, as far as my experience goes, always a well-informed man much interested in his work.

By the time the sun has risen high in the heavens, and all nature is beginning to be hushed in the glare of the heat, the engineer has reached the next stage of his tour at the inspection house, to which in the meantime his baggage has preceded him. Native servants are so well accustomed to the routine of such travel that he will find everything ready for him, his office papers all laid out on his table, his breakfast ready to be served. A delicious bath, and possibly a short siesta, precedes his breakfast, or rather *déjeûner* (for it corresponds to the midday meal of continental Europe), and then follows some hours of steady office work. Later in the day the native secretary brings in a huge pile of papers written in the vernacular, and, squatting on the floor with his inkstand and reed pens, proceeds to read forth petitions, complaints, reports relating to the administration of the whole district. To these replies are briefly dictated, which the secretary writes on the papers and the officer initials. Persian handwriting is very difficult for an Englishman to read, and although every canal officer has to pass an examination in the reading of these petitions, it is comparatively rare that any ordinary man can read one offhand without assistance. Thus, one is obliged to depend very much on the honesty of the secretary, and it says a good deal for these men that one scarcely ever hears of a case where they deliberately wrote a false answer to a petition.

By the time this is over the day is far spent. Possibly our hard-worked officer may find a little time for relaxation, and if he is in a sporting neighbourhood he may get an hour's shooting before sunset. But it is not always so, and a short walk in the evening is about as much as most men can manage. Then dinner, and early to bed. The same routine follows next day, and practically every day. For a few days each month he may be at his headquarters, and may then see a few of his countrymen, men employed in various other branches of the public service; but for the most part an irrigation engineer's life is, so far as European society is concerned, a solitary one, and lived apart from domestic or social relaxation.

This solitude is perhaps not much felt when a man is in vigorous health, but in a life of much exposure there is the constant possibility of sickness, and with recurring attacks of fever or rheumatism the loneliness, and the consciousness that medical advice is far out of reach, may become a very heavy burden to the weary worker. Worse than fever or rheumatism, also, are the two dread spectres of Eastern life, "the pestilence that walketh in darkness and the destruction that wasteth at noonday"—cholera and sunstroke. There are few canal officers who have not at least a slight acquaintance with one or other, or both, of these grim destroyers, and there are many who, at some time of their career, have had to grapple with them at close quarters. Happy the man who can look such foes fair and square in the face with unflinching calmness. The result may be a somewhat weakened body, but the *man* is stronger and better ever afterwards.

A canal life, too, in spite of its solitariness, has its compensations to a man who is a naturalist, or in some places to a sportsman, and in rarer instances to the high-souled enthusiast who is imbued with the generous desire to benefit his fellow-men, and in some way help to ameliorate the lot of the poor.

Whole-hearted enthusiasts of this sort are, however, not always to be met. I knew such a man, who had spent twenty-five years of his life on this work, and, in spite of the loneliness, thoroughly enjoyed it, even though most of his time had been spent in very hot and trying parts. His whole soul was in his work,—not in the engineering part of it, for in that he took little interest, although he had passed high examinations. What he lived for was the helping of the people of the land by every possible means. He spoke their language perfectly—not merely the polished Urdu of the gentlefolks, but the rough *patois* of the peasant. What he did not know about their crops and their methods of cultivation was not worth knowing. They regarded him with intense admiration and affection, and he dealt with them with the most infinite patience, listening to their interminable yarns and quietly reasoning with them, settling their quarrels and helping them in their difficulties. But the effect on the man himself was curious. He had lived apart from his fellows so much that in many little matters he had become a law to himself. His clothes were cut in a fashion that suited him. His food was peculiar, and the times of his meals were at such hours as were most convenient to himself, not those of ordinary society. He took an interest, keen and intelligent, in all that was going on in the Western world, and he was a great reader; but he regarded all progress that did not directly bear on philanthropic schemes as of very small value. As for the mere politician, the M.P., the man of letters, the financier, the business man,—he regarded them with contemptuous pity. He was *the* influential authority in a district as large as a big English county, and as densely populated, and although there were other Englishmen in that district who were the responsible representatives of the ruling race, none of them was, or could be, brought into such daily contact with the people as he. And in this life-work he was supremely content.

A somewhat similar character must have been the great Sir Arthur Cotton. To the present generation, perhaps, it is necessary to state who he was, for when he died at a very advanced age, *The Times* obituary notice stated "he was employed by the Public Works Department in the making of roads, the construction of bridges, and other engineering works." These last words are truly delicious. The correspondent had apparently never heard that the veteran soldier had been one of the greatest engineers of his day, and had harnessed some of the mightiest rivers in Southern India—the Godavery in particular*—to the work and service of men, had by his skill transformed enormous tracts of country from barrenness to fertility, thereby rendering incalculable service to generations of his fellows. I had the privilege of hearing this great and good man lecture in 1874 at Chatham, on the work to which he had devoted so many years. The lecture was full of statistics which I fear had little interest for an audience composed chiefly of young Engineer officers, though I remember he made one rather remarkable prophecy. Talking of inland transit and the demands upon the Engineer to provide greater facilities for it, he said that the time would soon come when the bicycle, then the plaything of the few, would be the necessity of the many, and that working men would go to and from their work on these machines. It seemed a far-fetched idea then, but the speaker lived to see it fully accomplished. At the conclusion of his lecture the old man drew his tall, spare figure up to its full height and said—

"Gentlemen, my young brother officers, I envy you. Many of you are going to a distant country, to a life which, although it is an arduous one, is full of compensations. You will, if you are employed on irrigation work, find it in itself intensely interesting, and you will have the satisfaction of knowing that it is of infinite value to the people. You will thereby exert an influence on many who can never know you, but who will bless the unknown Englishman who has brought to them such advantages. What nobler career can any man desire?"

* *Blackwood's Magazine*, June, 1897—"An Indian Romance: A Lesson of the Famine"; May, 1900—"Value of the Water of the Great Rivers of India."

(To be continued).

NOTICES OF MAGAZINES.

REVUE MILITAIRE SUISSE.

December, 1913.

OPERATIONS OF THE 7TH AND 2ND BULGARIAN DIVISIONS DURING THE FIRST BALKAN WAR.

By A.—This article is divided into two parts. The first contains a short account of the operations of these two divisions from the outbreak of war up to the end of November, 1912, during which period, while keeping touch with the Servians and Greeks to the west and the main Bulgarian forces to the east, they cleared the whole of the country north of the Ægean Sea, between the rivers Vardar and Maritza. It includes the capture of Salonika (claimed also by the Greeks) and of Dedeagatch, and the final overthrow of the Turkish Army of the Rhodope at Bedekli. The Turkish losses at the last named were Javer Pasha and his staff, 2 divisional generals, 265 officers, 10,000 R. & F., 2 mountain batteries, 2 mitrailleuses, 1,500 horses, and quantities of ammunition and stores.

The second part deals with the investment, siege, and capture of Adrianople. The strategic value of this capital of Thrace is considerable; situated as it is at the confluence of the Tunja and Arda with the Maritza, and commanding the railway, it is the key to the doors leading from Bulgaria to Constantinople and the Ægean and Marmora Seas. The defences of the city were in process of transformation at the commencement of the campaign, but in spite of their backward state were capable of offering considerable resistance. As a result of this, and of the energy of the commander, Chukri Pasha, large forces of the allies were immobilized for five months, during which period also the Bulgarians were deprived of the use of the railway for the conveyance of supplies. A short account of the salient incidents of the siege is given, and the question is asked as to what would have occurred had Kirk Kilisseh, commanding the second route into Thrace, been fortified as recommended by Marshal von der Goltz.

THE COMMUNICATIONS OF THE GRAND ARMY IN 1806–07.

When it became necessary to extend the Line of Communications beyond Bamberg, the choice of the central route through Schleiz was inevitable owing to its greater security than the flank routes, and also because Kronach lay on it and had been carefully organized as a *point d'appui*. After the victory of Jena (14th October) Weimar, Naumberg and Buttelstadt fell rapidly with their stores of horses, carts, flour, oats, etc. Erfurt did not fall until the 16th, and then became a valuable acquisition owing to the further supplies it contained, and ovens capable of baking 25,000 bread rations daily. By the 20th this strong citadel was organized as a post on the line of communications. However on the 17th a column of prisoners, escorted by three companies and a few cavalry, was ambushed between Gotha and Eisenach and all the prisoners liberated. After this Napoleon was obliged to detail four regiments of the line and three of dragoons to the L. of C. The enemy's troops in Hesse had retreated after the 14th, and the circuitous line of communications was changed to Mayence-Fulda-Erfurt by Army Order of 18th.

IX. *Notes on Material and Various Services.*—The artillery consisted of 3, 4 and 8-pr. field guns, 6-in. and 8-in. mortars, 12-pr. guns and 16 and 24-pr. siege guns. The artillery commander complained of the variety of calibres and consequent complication of the ammunition supply. To these, however, must be added captured weapons. Some particulars of the composition of the Corps and Army Parks are given.

The medical services left much to be desired, frequently some of the surgeons were only engaged for the campaign. The administration of the hospitals was entrusted to a Board of Directors, whose probity was not above suspicion.

The postal service was practically non-existent.

The troops were badly clothed and shod. After Jena all conquered towns were requisitioned for materials, but owing to haste the workmanship was poor.

Transport was carried out by contract with Government horses and harness, but the result was unsatisfactory as no one firm had sufficient capital. If Napoleon had not shrunk from the expense he would soon have given up this system.

The supply accounts, preparation, and distribution were confided to three Boards.

X. *Summary.*—The Grand Army was an unsurpassed military instrument, whose power lay in the prodigious knowledge and genius of its chief, in its warlike experience, and in the spirit of its soldiers. Organization of the departmental services had little influence on the results obtained. Instead of this, success in battle was the great remedy. However, Napoleon's organization of his communications was sound, and is still worthy of study. If the results did not always fulfil his expectations it was due to material difficulties impossible to overcome at that date. Means of transport were meagre—carts and a few waterways—distances were considerable, atmospheric conditions were of great moment, and there was no arsenal capable of supplying all an army's needs. The Emperor was thus led to utilizing local resources, the endurance of the troops and civil population, less used to comfort, less luxurious and less educated than at the present day, allowed of reducing transport to a minimum and even of omitting the provision for the sick and wounded and of the Post Office. In our day the large numbers in the field, the complicated weapons, and the greater necessities of the troops, make the utilization of local resources difficult, and render essential the forwarding of supplies from the rear. On the other hand telegraphs, railways and motors facilitate these services. The difficulty is not so much the quantity to be transported, but the vulnerability of the extended line.

The Battle of Cressier.

This article is concluded with the account of the assault of the position. It is noteworthy that each man of the troops detailed for the decisive attack carried a sandbag, half filled in the firing line, filled in the reserve who marched with rifles slung. The advance was made by night, and fire trenches excavated under cover of the half-filled sandbags, supplemented by earth from the filled sandbags passed up by the reserve. The bags were again and again passed to the rear to be filled, in order to hasten the provision of bullet-proof cover for the firing line in the shortest possible time. The supports also entrenched themselves, the reserve utilized existing cover. Meanwhile sappers were sent on, rolling gabions or barrels filled with earth in front of them, to make practicable breaches in the obstacles, which entrenched scouts prevented the enemy from closing again. The attack was made soon after daylight, preceded by heavy artillery fire, and was successful. The defence had, however, fulfilled its object, and reinforcements came up in time to check any further advance of the attackers.

A.R.R.

Rivista di Artiglieria e Genio.

October, 1913.

Under the heading of "Tactical Lessons of the War in the Balkans," a valuable article by Lieut.-General von Reichenau appears in the *Militär-Wochenblatt* of the 30th September, 1913. The following extracts are taken from it as showing some of the lessons to be learnt from the campaign :—According to verbal reports of competent persons who took part in the war, various incidents connected both with field warfare and with selected position confirmed the teachings of previous wars, and accentuated the evolution taking place in certain tactical requirements.

Facts have especially shown that the artillery now dominates the combat. Throughout the war in the Balkans, the infantry was unable to undertake offensive action of any importance or to resist tenaciously in the defensive without the continuous support of the artillery. Hence the tendency to establish constant co-operation between the two arms. Although this principle between the infantry and artillery is insisted upon in the regulations of all armies, it is only partially applied in peace times, as the infantry constantly undertakes unaided, attacks which, as the war in the Balkans shows, would certainly prove ineffectual owing to the enormous losses which would be incurred at the start.

Infantry attacks on a large scale by day have become exceptional, and they seldom succeed in keeping under the fire of the defence sufficiently to allow of a successful result. The attacker is therefore driven to rely greatly on night operations. The fact that in these night attacks the bayonet was generally preferred, may be attributed both to the naturally impulsive character of the combatants, to the difficulty of aiming the rifle, and the want of confidence in its efficacy.

Judging by this last war, writes then General von Reichenau, the question may be asked whether the old aphorism of Suwaroff "la pallotola è stolta, la bayonetta e saggia"—"the bullet is foolish, the bayonet is wise"—may not still hold good; and without doubt it may do so in the hands of men who do not properly understand the use of their rifles, but who are acquainted with the value of the bayonet and use it energetically. But in the case of a firearm in the hands of a competent man the medal is reversed, and the dicta of Frederick the Great and Napoleon are verified. Whilst Frederick in the first period of his great career gave only a restricted importance to firearms, his opinions changed—the result of experience. In fact the great King in his military testament declared that battles were won by a superiority of fire in the case of a decisive attack. Napoleon, too, pronounced in a manner more precise, "Le feu est tout, le reste est peu de chose." When it is considered that these fundamental maxims, derived from rich experience of wars, were delivered in times when firearms were primitive as contrasted with those of the present day, it is reasonable to attribute exceptional value to them. But, in spite of all this, there is a strong opinion in favour of the bayonet, based on the experience gained in the Russo-Japanese War and the wars in the Balkans. An appreciation of the efficacy of weapons can only be correct when account is taken both of the quality of the troops and of the general tactical situation, and it should be remembered that both in the Far East and also in the Balkans, one of the belligerents remained essentially and constantly on the defensive, a circumstance that explains the superiority of the other side in matters of strategy, tactics and *morale*.

The superiority of the attack allowed of methods of fighting which under other conditions would not have been successful. The Japanese, and in a measure the Bulgarians, obtained successes mainly through the ill-aimed fire of their adversaries, which the Austrians, confronted by the needle-gun, and the English, face to face with the well-aimed fire of the Boers, were unable to obtain. If, in spite of the deficient intuition of the Turkish troops—among the rank and file of whom there were men who in peace time had never fired a shot—the Bulgarians suffered enormous losses in their attacks, it is fairly evident that they would have failed in front of an enemy proficient in musketry. The lesson, then, that we learn from the recent events of the war is not the value of a skilful use of the bayonet, but that troops should be instructed in making efficient use of their rifles, and in placing full confidence in those weapons. And this is a warning that should be seriously taken to heart to ensure efficient preparation for war.

Hundreds of millions are expended on modern armaments, and it is only right therefore that musketry instruction should be efficient. Not only is it necessary to explain to the soldier what a powerful weapon he possesses in the modern rifle, but also that he should learn how to make the best use of it. Instruction which does not give such results is deficient. A weapon of small value in skilful hands is better than a perfect arm badly used. If the infantry soldier places full confidence in his weapon—confidence that has been inculcated by instruction—and is supplied with sufficient ammunition, he has nothing to fear from the bayonet.

Endurance on the march and skilful marksmanship are together the qualities that form the characteristics of good infantry. Artillery and infantry are more closely linked together than was formerly the case, and in the lines of combat they should always be grouped together if possible. The need of directing and timing the fire gives the commandants of detachments, and especially to the commandants of batteries, ample scope for selecting targets and for timing the opening of fire. Besides, against momentary targets, only the most rapid fire can produce any useful effect.

In the application of trenches, especially in the offensive, the Bulgarians showed considerable skill. They frequently made use of three lines of trenches for riflemen, placed one above the other, which were out of view of their opponents until the moment of opening fire.

In the lines of Citalja, the Turks excavated trenches of such width and depth that they were able to move their guns and mortars under cover. In conclusion ; " Cover, cover, and always cover."

Whilst all artillery during the last decade has increased its ammunition supply in accordance with the tendency of modern tactics, the measures taken are still far from providing for the exigencies of modern warfare. The deceased General Langlois considered a supply of 3,000 rounds per piece to be indispensable. Considerations should also be given to the newly established arrangements for assuring an adequate reserve supply of ammunition on the battlefield. In the Balkan War, sending fresh supplies of ammunition to the firing line by means of ammunition wagons under fire from the enemy's artillery caused enormous losses ; so much so that they had to resort to carrying the ammunition on men's shoulders, or by beasts of burden. But even in the Balkans—although the roads were in a wretched condition—good results were obtained by convoys of motor cars to transport the ammunition from the depôts in rear.

An important lesson may be learnt from the insufficient mobility of the field artillery which was too heavy for rapid offensive movements.

With regard to mobility, there seems to be a tendency in some armies to utilize the mountain guns for field artillery. This, however, would seem to be a retrograde step, as mountain guns can never be completely substituted for field guns. Although firing against aeroplanes is now one of the most important problems engaging the attention of all countries, there seems to have been few opportunities of learning anything on the question during the Balkan War.

The above considerations refer to the principal lessons that are to be learnt from the war in the Balkans. With regard to the attack and defence of fortified places there is not much to learn, possibly because the besieged places were of an antiquated type, or because the artillery material employed by the besiegers, as well as by the defenders, was far below the standard which is now to be found in the siege parks of all the great armies. The war in the Balkans has given a new impulse to the solution of various questions of a tactical and technical character, viz. :—(1), To acquire a field gun with a projectile that can be used equally against a land or an aerial target; (2), to modify the shells of field guns so as to make them efficient against aerial objects; (3), to increase the supply of ammunition both for guns and mortars; (4), to ensure by new methods a constant supply of ammunition to batteries in action; (5), to find means for improving the fire against momentary targets; (6), to adopt the increased necessity for cover to the greatest possible efficacy of fire; (7), to establish more efficient methods of fire against masked targets, and cover, by means of aeroplanes for reconnoitring and observation; (8), to inspire the infantry with greater confidence in their weapon; (9), to acquire tactical formations of a less vulnerable kind for manœuvres and for war, in relation to the increased efficacy of fire; (10), to link more closely the relations between the infantry and the artillery especially in the attack.

E. T. THACKERAY.

CORRESPONDENCE.

MASONRY ARCHES AND MECHANICAL TRANSPORT.

SIR,

Now that heavy mechanical transport has been provided for a large number of the Army Service Corps units of the Army, a task that a R.E. officer on service will probably often have to undertake in the future, will be the reconnaissance of a certain number of miles of some country road, with a view to ascertaining whether the various bridges and culverts are strong enough to carry the heavy mechanical transport vehicles, and he will also have to prepare schemes for strengthening them, if necessary.

In the case of timber, steel, or flat ferro-concrete bridges, no great difficulty presents itself, as the new *Instruction in Military Engineering*, Part III. (*a*), gives tables showing the maximum bending moments produced by these vehicles on various spans. But the bridges most commonly met with on rural roads are of the arched-masonry type, and, if he encounters one of this type, the average R.E. officer will probably find himself out of his depth at once.

Although the general principles of such structures are taught to the recently-joined officer during his construction courses at the S.M.E., comparatively few R.E. officers have practical experience in the design and construction of them. The average D.O. uses steel joists, or ferro-concrete beams to span a gap, and the officers who do know a good deal about masonry arches, are generally those who have specialized in civil engineering, and have gained their experience while employed in Public Works Departments in India or elsewhere. Such officers do not, as a rule, come back to the field units of the Corps.

The reconnaissance described above would therefore have to be carried out by some officer whose knowledge of masonry arches is confined to what he learned at the S.M.E. His only official guide on the subject is the *Manual of Masonry Structures*.

Now in this Manual, on p. 107, *et seq.*, will be found the following remarks with regard to external rolling loads on arched bridges:—

"In dealing with the design of an arch ring that has to stand a rolling load, there is the difficulty of determining the effect of the weight of that rolling load, and what to allow for it.

"A convenient graphic way of obtaining this is to draw what is called a load contour . . ."

"In dealing with rolling loads the weight to be considered for ordinary vehicular traffic is very small.

"If it can be ensured that the arch ring is thoroughly strong and will be able to carry the dead load, the chances are that the small additional stress caused by the moving load will be met by a very slight addition to the thickness of the arch ring.

" Practically a design is made for the dead load, and, as an approximation, a small percentage added for occasional and moving loads deduced by a rough comparison of equivalent weights.

" In the case of a very heavy rolling load, it is only when such loads are over the centre of the span, or very close to it, that the stress can be anything like accurately calculated.

" It is not possible to determine exactly what is the effect or influence that occasional and rolling loads exert upon an arch ring."

Again on p. 96 :—

" The calculations in connection with the stability of arch rings are somewhat involved, but by using a simple graphic method, the desired result may be obtained by a series of approximations."

" A segmental or semicircular arch tends to fall by sinking at the crown, and rising at the haunches.

" A pointed arch tends to fail by rising at the crown and falling at the haunches.

" A straight arch tends to fail by the voussoirs sliding vertically down."

It will be seen, from the above extracts, that the investigations as to whether a particular design is strong enough to carry its own dead load, involve either somewhat abstruse mathematics or approximate graphic solutions, or reliance on standardized dimensions that have been found suitable in the past, and can be found in engineering pocket-books. The far more complicated problem of rolling external loads was avoided by the original designs of country bridges owing to the fact that the ordinary vehicular traffic produced stresses that were small in comparison with the dead load of the bridge.

If it could be said that the A.S.C. motor vehicles came under the heading of ordinary vehicular traffic, the examination by the R.E. officer could be confined to seeing whether the joints in the arch ring were sound, or whether there was decay in the masonry.

But it is extremely doubtful whether the original designer had in his mind external loads anything like so heavy as those produced by the A.S.C. vehicles.

Now, if the calculations for the ordinary dead load are so abstruse and indefinite and the distortions due to overloading so peculiar, those for heavy rolling loads must be very much more so. Obviously they would be quite beyond the powers of an officer on service, working against time, and equipped with neither drawing instruments nor mathematical text books. A knowledge of the axle loads of the commercial vehicles, if any, used in the district, would help him, but they might very likely not be obtainable.

What appears to be wanted are some rough rules of thumb, based on measurements that the officer can take, *i.e.* the span, rise, thickness of arch ring, and depth of filling, to enable him to decide whether or not the weights of the vehicles he has to consider, may be taken as ordinary vehicular traffic in comparison with the dead load of the bridge, and further—in the case of the larger spans, and flatter arches, where it will probably be necessary to introduce additional supports, the kind of distortion which is likely to take place, and the direction and amount of the extra stresses that would have to be provided for.

Possibly something of the kind is being provided in the new *I.M.E.*, Part III. (*b*), which has not yet been published. If not, should some officer with sufficient experience in the mathematics of this subject care to undertake the task, his work would, it is certain, be blessed by any R.E. officer who may in future be faced with the problem on service.

Yours truly,
"One of the Average R.E. Officers."

The Editor, *R.E. Journal.*

THE "OTTER."

Sir,

With reference to Notes on Fieldworks published in the *R.E. Journal* of September, 1913:—

I have found that the construction of an "otter" as used by Lt.-Col. Tylden-Pattenson on the Cabul River is not generally known. Perhaps the following extracts from an Anglers' Library may be found instructive.

For those of your readers who are not anglers I would point out that the "otter" as described in these extracts is nowadays regarded as a poachers' instrument, and is illegal.

Yours faithfully,
R. N. Harvey, *Lieut.-Colonel.*

Fortification School, S.M.E., Chatham,
28th January, 1914.

The Editor, *R.E. Journal.*

Description of "Otter."

(Extract from *The Erne, its Legends and its Fly Fishing.** By the Reverend Henry Newland. Pp. 53, 54, and 55).

An otter is a thin piece of board, about 4 ft. long and a foot or so broad, cut into the shape of a fore-and-aft midship section of a ship. This is leaded on the edge that represents the keel, so as to swim edgeways. The principle on which it acts is that of a river barge, where the towing line is so adjusted, that the barge proceeds in a straight line through the water, though the line acts at an angle.

In the case of the otter, that part of the towing line nearest the float, which is technically called the back line, is made of three-fold barbers' silk, light, but very strong, to which, at intervals of 3 or 4 ft., are looped all manner of flies, to the number of from 15 to 30; to this is attached an ordinary salmon reel line, which generally leads through the rings of a short, stiff rod.

When all is ready, the float is launched by an attendant, the fisherman, with the rod in his hand, either taking a boat or following the line of

* Published by Chapman & Hall, 1851.

the coast, and giving line or reeling up, as occasion requires. On account of the particular angle at which the line acts, the otter, on being pulled, slips out to sea, somewhat on the principle of a boy's kite, keeping nearly at right angles with the fisherman's course, and, consequently, exhibiting all the flies to any fish that may be lying between it and him.

The line being fastened to the upper edge of the float-board, a strong pull from either fish or fisherman would lay it flat on the water; and then the fisherman is always able to draw it towards him, though, as long as the draft is not too great to prevent it from swimming on its edge, its tendencies are slightly outward.

To balance and manage such a machine as this requires considerable ingenuity; but, for all that, it finds small favour with sportsmen, because it necessarily pricks and frightens ten times as many fish as it catches.

(Extract from *The Practice of Angling, particularly as regards Ireland.** By O'Gorman. Vol. II., pp. 56 and 57).

The machine called an otter consists of a deal board, about 4 ft. in length, and a foot or more in diameter, shaped somewhat like the keel of a boat. One side of the board is much thicker than the other, and bored with holes about an inch in diameter, for about 6 in. in depth, into which lead is poured, which renders it steady in the water. The upper edge of the board is much thinner: three or four small holes are made in the centre of the side of the board, through which whipcord is run, and it requires some dexterity to arrange these cords, as on them depends the success of its operation. To these cords is attached a strong cross line, with any number of flies that may be deemed requisite, and it certainly will make its way against even a strong wind, and with such effect, as to fatigue the rower of the boat opposite, from which it is always keeping away . . . . rods are not necessary—a wheel and line, or a long cord, are sufficient, and one, or, at most, two persons, can manage it . . . . the tackling must be course, as the board generally acts the part of the angler . . . .

* Published by William Curry, Junr., & Co., 1845.