



PROFESSIONAL PAPERS, No. 30
CORPS OF ENGINEERS, U. S. ARMY

REPORT
ON THE
ENGINEER EQUIPMENT OF THE ALLIED TROOPS
SERVING WITH THE
CHINA RELIEF EXPEDITION
1900-1901

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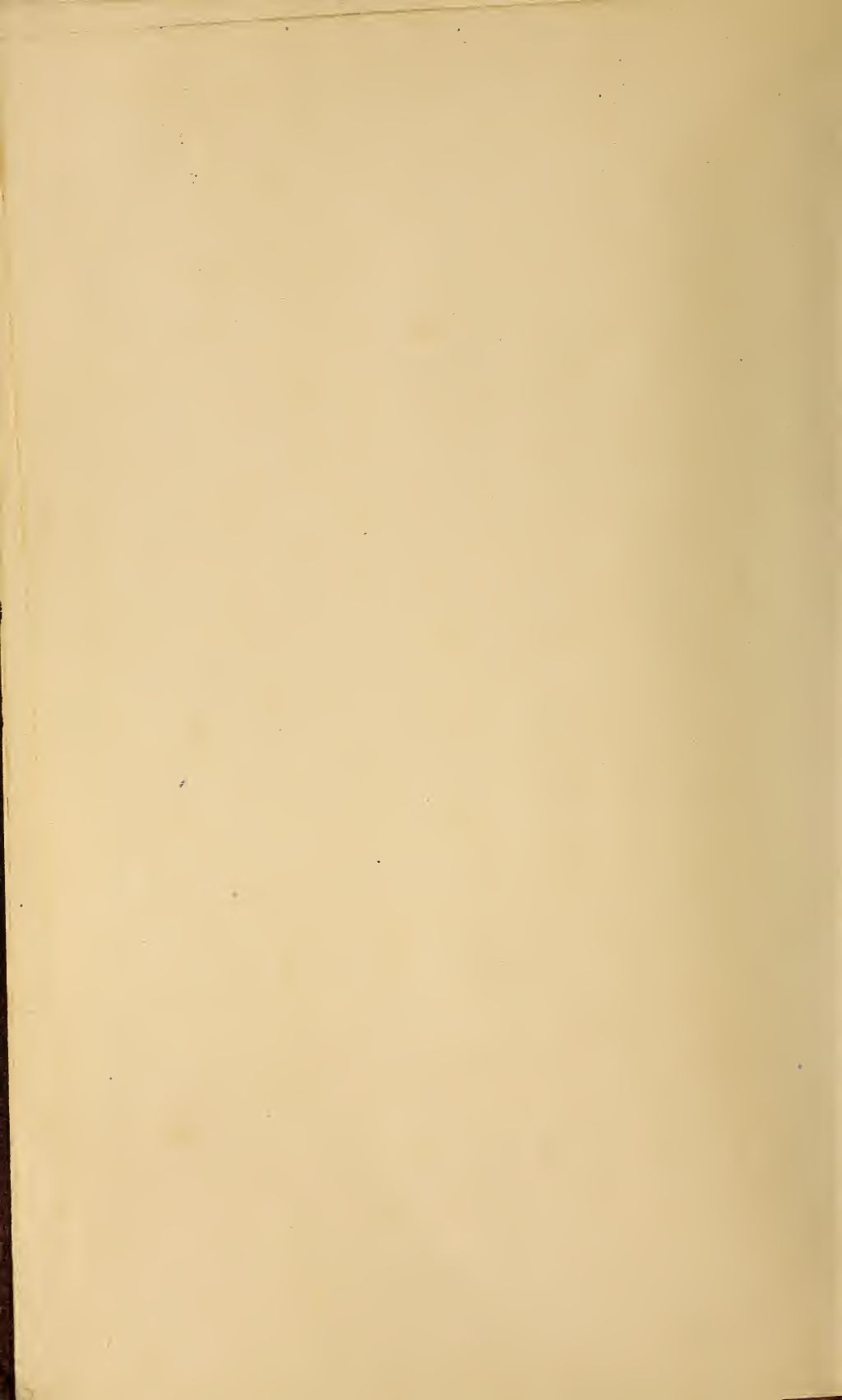
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BY

FIRST LIEUTENANT HARLEY B. FERGUSON,

CORPS OF ENGINEERS, U. S. A.

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WAR DEPARTMENT,
Document No. 148.
OFFICE OF THE CHIEF OF ENGINEERS.

James H. ...
...
...

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,

Washington, September 4, 1901.

SIR: I have the honor to submit herewith a report from Lieut. H. B. Ferguson, Corps of Engineers, on the Engineer Equipment of the Allied Troops serving with the China Relief Expedition. As this report is of great value to the officers of the Corps of Engineers and to the Army at large, authority is requested to publish 1,000 copies, to be distributed by this office.

Very respectfully, your obedient servant,

JAS. L. LUSK,

Acting Chief of Engineers.

Hon. ELIHU ROOT,

Secretary of War.

[First indorsement.]

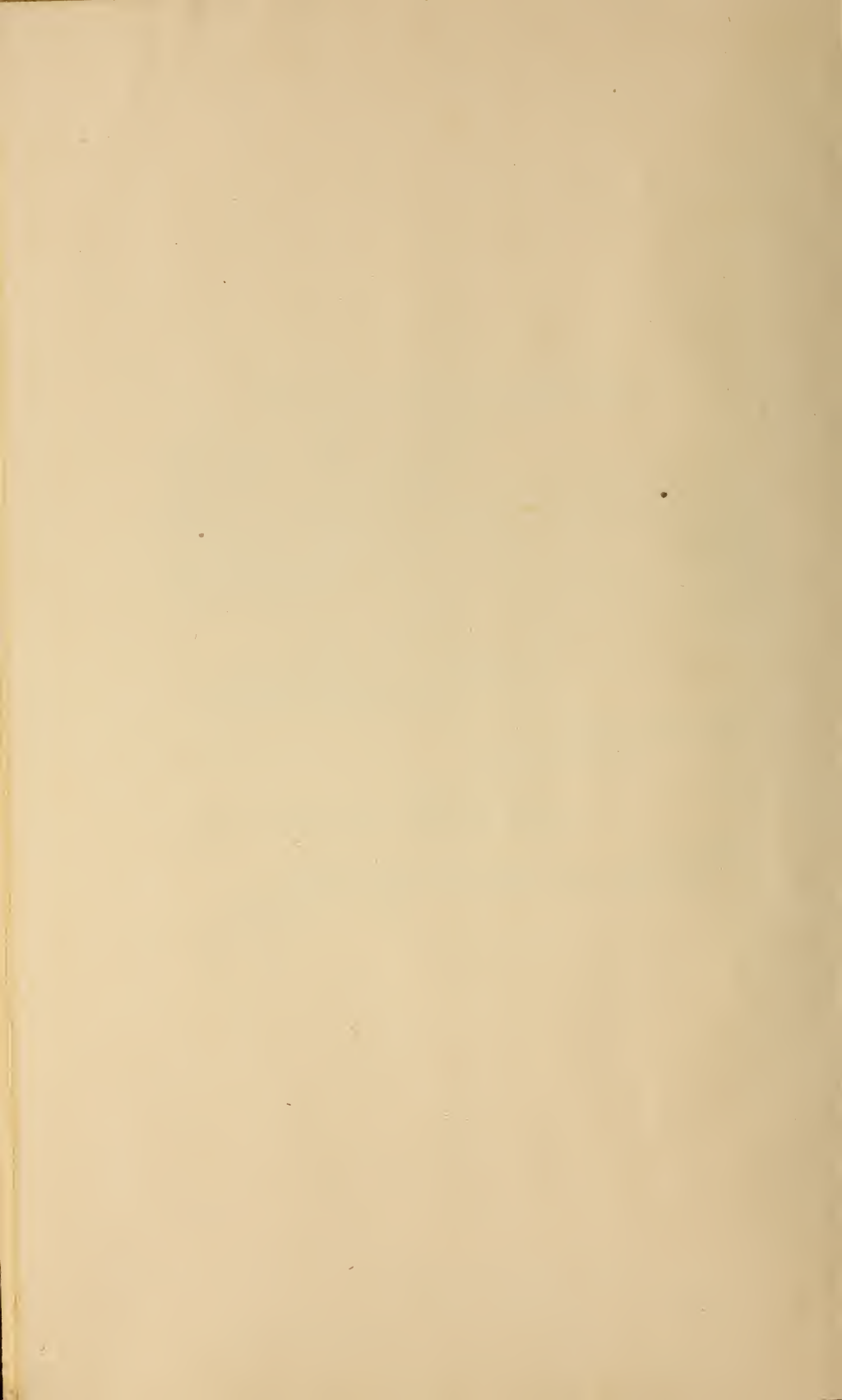
WAR DEPARTMENT, *September 11, 1901.*

Approved.

By order of the Acting Secretary of War:

JOHN C. SCOFIELD,

Chief Clerk.



REPORT.

MANILA, P. I., *June 30, 1901.*

GENERAL: I have the honor to submit the following report on the organization, transportation, and equipment of the foreign engineer troops serving in north China in 1900 and 1901:

BRITISH.

The following royal engineer officers and engineer troops were on duty in north China November 1, 1900:

^a Maj. Gen. A. R. F. Dorward (Wei-Hai-Wei), major-general on staff and commanding troops.

Lieut. Col. G. H. W. O'Sullivan (Indian Establishment), acting adjutant-general and quartermaster-general.

^a Lieut. Col. G. K. Scott-Moncrieff (Indian Establishment), commanding royal engineer troops.

Brevet Lieut. Col. J. R. L. Macdonald, director of railways.

Capt. R. E. Picton-Jones (Indian Establishment), adjutant, royal engineer troops.

Maj. J. C. Day (Indian Establishment), brigade major.

Maj. F. V. Jeffrays (Indian Establishment), field engineer.

Lieut. H. E. C. Cowie (Indian Establishment), field engineer.

Maj. T. F. B. Renny-Tailyour (Indian Establishment), superintendent survey party.

Capt. C. H. D. Ryder (Indian Establishment), survey party.

Capt. W. A. Harrison, special service officer.

Capt. G. H. Griffith (Indian Establishment), in charge of royal engineer field park.

Lieut. Col. W. T. Shone was commanding royal engineer troops from December, 1900, to March, 1901, when he was relieved by Col. F. T. H. Spratt-Bowring.

^a Local rank.

Telegraph section from Indian Establishment—70 men (British and natives), 1 officer (lieutenant).

Detachment of Royal Engineers from Fortress Company at Wei-Hai-Wei—40 men, 2 officers (a captain and a lieutenant).

Fourth company, Bengal Sappers and Miners.

Third company, Queen's Own, Madras Sappers and Miners.

Second company, Bombay Sappers and Miners.

The Malor Kotta Sapper Company.

Mounted detachment of sappers and miners—24 men and 1 officer (lieutenant).

Fourth balloon section—40 royal engineer soldiers and 40 native drivers, 2 officers (a captain and a lieutenant).

DETACHMENT OF ROYAL ENGINEERS.

The detachment of 40 men and part of the telegraph section were the only engineer troops present during the engagements around Tientsin and the advance to Peking. They did not have a complete field equipment, being short in transportation and material. They have several pack mules. In the advance the detachment was divided, part going up the river with the 8 boats carrying engineer tools and material (R. E. field park), and part marching with the column.

SAPPERS AND MINERS.

The composition of one company is as follows:

	Peace.	War.
British officers.....	2	4
British noncommissioned officers.....	2	2
Native officers.....	3	3
Hospital attendant.....		1
Native noncommissioned officers, Havildars.....	6	6
Native noncommissioned officers, Naicks.....	10	10
Sappers.....	150	150
Buglers.....	2	2
Driver establishment.....	20	20
Ward orderly.....		1
Total enlisted.....	195	199
Public followers.....	18	18
Private followers.....	18	18
Officers' horses.....	2	8
Officers' ponies.....		4
Hospital pony.....		1

Recruits are obtained when possible from men having some mechanical trade, and they serve two years' apprenticeship in the depot companies before they are put into the service companies. The pay is for sapper (private) 10 rupees per month; niack (corporal), 13 rupees per month; havildar (sergeant), 17 rupees per month. One, 2, or 3 rupees extra pay per month is given for good conduct. In India a company commander will bid on public work and do this work with his company, dividing the money received pro rata among the men.

The company is armed as infantry, and each man carries 60 rounds of ammunition. Their service uniform is khaki, and very similar to the infantry. On parade they wear a red coat, very fantastic head gear, and black trousers.

The transportation and equipment is fixed, being maintained as prescribed in the "Engineer Equipment Tables for the Corps of Sappers and Miners." The following is taken from those tables, and shows how thoroughly all the details have been worked out. This organization and equipment is not experimental, but the results of years of continuous field service.

EXPLANATORY NOTES TO TABLE A.

General description: As this equipment always accompanies a service company in the field and on the march it has been adapted throughout, as regards size and weight of stores, for mule carriage. Each mule load is, as nearly as possible, 160 pounds, exclusive of harness and saddlery.

The equipment provides for all the ordinary duties which a service company of sappers and miners is likely to be called on to perform.

Organization and transport: The equipment is divided into three parts, viz, the first, second, and third lines.

The first line is composed of 16 loaded and 2 spare mules, with 1 havildar, 1 niack, and 18 drivers. This line always parades and maneuvers with the company.

The first 16 loads, as shown in the detail of loading, usually compose the first line of equipment, being those which are most likely to be required under ordinary circumstances; but it is, of course, not intended that any invariable rule should be laid down as to the composition of the different portions of equipment, which must obviously vary according to the country operated in.

Similarly, the second line is usually composed of the loads numbered 19 to 36, carried on 18 mules with 10 drivers.

The third line consists of stores which are less frequently required; it is carried on 14 mules with 5 drivers.

In the case of the 12 companies detailed for the field army, the 18 mules of the first line are permanently attached to companies.

10 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

The 18 mules forming the first line of the remaining companies, not so detailed, and the mules of the second and third lines of all companies are supplied to companies on mobilization by the commissariat-transport department.

Saddles and harness are maintained in regimental charge for the first and second lines; the saddles have special fittings for particular loads (sketch 3, photographs 1, 2, 3, 4). Saddles and harness for the third line are supplied by the commissariat-transport department (photograph 5, sketch 2).

The loading of the equipment is so arranged that, in the event of its being desired to detach a half company for work, exactly half the equipment can be detached with it, without any alteration or shifting of loads.

It is seen that a half company first line equipment can be still subdivided into very nearly equal parts. Each mule carries its own picketing and cleaning gear.

For the loads of the second and third line mules, only the general headings are given below, but the tables give the detailed list for every load.

Besides these 50 mules, about 30 more are furnished to carry ammunition, medical supplies, water, and baggage. The baggage allowed is 25 pounds for each man, 40 pounds for each native officer, and 80 pounds for each British officer. The rations are handled by the proper department and are issued on halting.

TABLE A.

EQUIPMENT FOR A SERVICE COMPANY AND DETAIL FOR LOADING.

N. B.—Materials and appliances for testing gun cotton (weighing 3 pounds 6 ounces each) are not carried in the field; 36 whips for first and second line mules (weighing 7 ounces each) are also excluded, being carried in the driver's hands.

No. of mule.	Articles carried.	Quantity.	Weight.	Total weight.
	FIRST LINE.			
	<i>Load.</i>			
	Near side:		<i>Lbs. oz.</i>	<i>Lbs. oz.</i>
1. Axes, felling and pick, and shovels.	Axes, felling, 6 pounds .....number..	1	8 0	
	Axes, pick, 6½ pounds.....do....	5	40 0	
	Kajawahs, mule, mamooties .....do....	1	11 8	
	Shovels, universal .....do....	4	22 0	
	Off side:			
	As above, except that there are 4 pick-axes and 5 shovels.			81 8
	Saddlery:			
	Saddles, modified.....number..	1		79 0
	Harness in wear:			
	Bits, bridoon .....do....	1	1 1	
	Breast pieces, short (or long) ....do....	1	2 2	25 0

ENGINEER EQUIPMENT OF THE ALLIED TROOPS. 11

TABLE A.—*Equipment for a service company and detail for loading—Cont'd.*

No. of mule.	Articles carried.	Quantity.	Weight.	Total weight.	
	FIRST LINE—continued.				
	Load—Continued.				
	Harness in wear—Continued.		<i>Lbs. oz.</i>	<i>Lbs. oz.</i>	
1. Axes, felling and pick, and shovels—Cont'd.	Breechings, short (or long).....number..	1	2 1		
	Collars, head.....do....	1	1 8		
	Cruppers, saddle, ordnance, small (or large), number.	1	1 0		
	Girths, long (or short).....number..	2	2 4		
	Pannels, stuffed.....pairs..	1	15 0		
	Reins, leading.....number..	1	1 0		
	Straps, meter {	crupper.....do....	1	0 5½	
		girth.....do....	4	2 0	
	Wrappers, canvas.....do....	1	6 0		
		Line gear on top of saddle in bag:			34 5½
		Bags:			
		Line gear, small.....number..	1	0 10	
		Nose.....do....	1	1 6	
		Bits, bridoon.....do....	1	1 2	
		Brushes:			
		Harness, hard.....do....	1	0 7	
		Horse.....do....	1	0 10	
		Cloths, dusting.....do....	2	0 4	
		Combs, curry.....do....	1	0 2	
		Fringes, eye, string.....do....	1	0 5	
	Pickers, hoof.....do....	1	0 2		
	Ropes, heel, 10½ feet.....do....	1	1 0		
	Rubbers.....do....	1	0 5½		
	Shackles:				
	Fore foot, ordnance, mules and ponies, number.	1	1 8		
	Hind foot.....pairs..	1	2 0		
	Sickles, Mark II.....number..	1	0 7		
	Sponges.....do....	1	0 1		
	Tents, pins, iron.....do....	2	4 12		
	Total weight.....pounds.....			15 1½	
	Near side:				
2. Crowbars and jumpers.	Bars—				
	Crow, steel, 4 feet 6 inches.....number..	1	20 0		
	Jumping, 1½-inch hole, 4 feet 8 inches, number.	1	24 0		
	Hammers, miners', sledge, 14 pounds, number.	1	15 8		
	Kajawahs, mule, bars, crow.....number..	1	10 0		
	Off side:			69 8	
	As above.....do....			69 8	
	On saddletree:				
	Bars, tamping, ½-inch hole, 4 feet.....do....	1	2 0		

12 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

TABLE A.—*Equipment for a service company and detail for loading—Cont'd.*

No. of mule.	Articles carried.	Quantity.	Weight.	Total weight.	
	FIRST LINE—continued.				
	Load—Continued.				
	On saddletree—Continued.		Lbs. oz.	Lbs. oz.	
2. Crowbars and jumpers—Cont'd.	Cases, leather, scrapers and worms, number.	1	2 0		
	Needles, priming, 4 feet	1	2 0		
	Scoops and scrapers, 1½-inch hole, 4 feet, number.	1	3 2		
	Worms, miners', 4feet, 1½-inch hole, number.	1	3 10		
	Saddlery:			12 12	
	Saddles, stuffed	1	25 0		
	Harness and line gear as above. do....	1	52 12		
				77 12	
	Total weight.....	pounds.....			229 8
	3. Explosives and mining stores. (Sketches 1 and 7.)	Near side:			
Boxes, mule, empty, 2 feet 6 inches, number.		1	33 0		
Chalk, white.....		pounds.. 1½	0 8		
Fuse, safety, No. 9 *.....		fathoms.. 24	3 12		
Gun cotton:					
Dry primers, 1½ by 1½ inches, pounds.		6¼	6 4		
1 perforation, 1½ by 1½ inches, pounds.		6¼	6 4		
Wet, slabs, 6½ by 6½ by 1½ inches, pounds.		7½	9 0		
2 perforations, 6½ by 6½ by 1½ inches, pounds.		6	7 0		
Line, log, ½-inch		skeins.. 1	2 0		
Pliers, side-cutting, 7-inch		pairs.. 2	1 4		
Reels, log-line.....		number.. 1	1 5		
Tapes:					
Measuring, 100 feet		do.... 1	1 3		
Tracing		do.... 2	7 8		
				79 0	
Off side:					
Axes, hand, 2-pound		do.... 5	10 0		
Boxes, mule, empty, 2 feet 6 inches, number.		1	33 0		
Detonators No. 8, Mark III ^c		number.. 50	1 14		
Hooks, bill ^d	do.... 6	12 0			
Knives, gabion	do.... 6	1 14			
Matches:					
Vesuvian	boxes.. 12	0 6			
Bryant and May's	do.... 2	0 3			
Rectifiers, gun-cotton primers, Mark III, number.					
Saws, hand, 26-inch.....	number.. 1	1 8			

* In 3 boxes.

^b dry slabs.

^c In 2 cylinders.

^d Or Kookeries.

ENGINEER EQUIPMENT OF THE ALLIED TROOPS. 13

TABLE A.—*Equipment for a service company and detail for loading—Cont'd.*

No. of mule.	Articles carried.	Quantity.	Weight.	Total weight.
	FIRST LINE—continued.			
	Load—Continued.			
	Off side—Continued.		Lbs. oz.	Lbs. oz.
3. Explosives and mining stores—Continued. (Sketches 1 and 7.)	Twine, country, No. 2 .....pounds..	5	5 0	
	Wedges, sawyers' steel, 8-inch, number.	2	10 0	
	On saddletree:			75 13
	Cases, leather, for field levels and measuring rods, number.	1	2 0	
	Levels, 4 feet.....number..	1	4 10	
	Rods, measuring, common, 4 feet, number.	2	2 8	
	Saddlery:			9 2
	Saddles, stuffed .....number..	1	25 0	
	Harness and line gear, as above ..sets..	1	52 12	
	Total weight.....pounds.....			77 12
4. Axes, felling and pick, and shovels.	Load same as No. 1.....			241 11
5. Axes, felling and pick, and shovels.*	.....do.....			234 15
6. Crowbars and jumpers.	Load same as No. 2.....			234 15
7. Explosives and mining stores.	Load same as No. 3, but no case, leather, level, F. S., or rods, measuring.			229 8
8. Axes, felling and pick, and shovels.	Load same as No. 1.....			232 9
9. Axes, felling and pick, and shovels.	.....do.....			234 15
10. Crowbars and jumpers.	Load same as No. 2.....			234 15
11. Explosives and mining stores.	Load same as No. 3.....			241 11
12. Axes, felling and pick, and shovels.	Load same as No. 1.....			234 15
13. Axes, felling and pick, and shovels.	.....do.....			234 15
14. Crowbars and jumpers.	Load same as No. 2.....			229 8
15. Explosives and mining stores.	Load same as No. 7.....			232 9

14 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

TABLE A.—*Equipment for a service company and detail for loading—Cont'd.*

No. of mule.	Articles carried.	Quantity.	Weight.	Total weight.
FIRST LINE—Continued.				
<i>Load—Continued.</i>				
16. Axes, felling and pick, and shovels.	Load same as No. 1	4	<i>Lbs. oz.</i>	<i>Lbs. oz.</i> 234 15
Saddlery:				
17. Spare	Bits, bridoon	2	2 2	
	Blankets, shaped	1	10 0	
	Collars, head	1	1 8	
	Reins, leading	1	1 0	
	Rollers, small, with pads	1	2 2	
	Tent, pins, iron	2	4 12	
	Wrappers, canvas	1	6 0	
	Line, gear	1	15 1½	27 8 15 1½
	Total weight			42 9½
18. Spare	Load same as No. 17, with addition of straps, baggage	2	8 0	8 0
	Total weight			50 9½
SECOND LINE.				
<i>Load.</i>				
19 and 20	Gunpowder and surveying stores			
21 and 22	Saws, sand bags, and spare helves			
23 and 24	Rope, charcoal, and spare helves			
25 and 26	Blocks, stocks and dies, nails, etc.			
27 and 28	Carpenters' and smiths' tools			
29 and 30	Forge, iron, steel, etc.			
31 and 32	Gun cotton			
33 and 34	Grindstones, bellows, nails			
35 and 36	Blocks, rope, and twine			
THIRD LINE.				
<i>Load.</i>				
37 and 38	Iron, steel, and crowbars			
39 and 40	Saddlers' and tinsmiths' tools			
41 and 42	Bricklayers' and miscellaneous tools ...			
43 and 44	Carpenters' and smiths' and miscellaneous tools.			
45 and 46	Pickaxes and shovels			
47 and 48	Cordage and line gear			
49 and 50	Line gear			

The following intrenching tools are carried with each battalion of British Indian infantry: Eight axes; 80 picks; 40 billhooks; 60 shovels. Three mules are allowed to each company and 8 for the two wings.

MOUNTED DETACHMENT.

This detachment consists of 1 British noncommissioned officer and 24 sappers selected from a Bengal company, men having some experience in riding being selected. The equipment was decided upon and the pack saddles were made at an engineer depot in India. The saddles are of the same pattern as the special saddle of the sappers and miners, but made for large pack horses instead of the small mules, which would not be able to keep up with the cavalry to which the detachment is attached. Four pack horses are kept with the detachment. Counting out the 4 sappers that lead these horses and those who hold the detachment horses on halting, the officer in command stated that he had available a working party of 13 men. The tools are carried in leather bags and a box of gun cotton is carried on top of each saddle.

This detachment was mounted as an experiment, and was on duty with the column marching from Peking to Pao-ting-Fu. The commanding officer of the Royal Engineers in Peking, as well as the officer in command of the detachment, was very enthusiastic over its success.

Below is a list giving each load in detail, also sketches of the pack saddle and the link saw. (Photographs 6, 7, 8, 9; sketches 1 and 3.)

Tools carried.	1 horse.		2 horses.		3 horses.		4 horses.	
	Near.	Off.	Near.	Off.	Near.	Off.	Near.	Off.
9 pickaxes	1	.....	1	.....	1	.....	6	1
4 crowbars, 2 feet 6 inches	1	.....	1	.....	1	.....	.....	1
3 spare helms	1	.....	1	.....	1	.....	.....	.....
3 axes, hand	1	.....	1	.....	1	.....	.....	.....
3 augers, 1½ inches	1	.....	1	.....	1	.....	.....	.....
3 chisels, 1 inch	1	.....	1	.....	1	.....	.....	.....
3 cold chisels, 8 by 1 inch	1	.....	1	.....	1	.....	.....	.....
3 screw-drivers, 6 inches	1	.....	1	.....	1	.....	.....	.....
3 gimlets, one-fourth inch	1	.....	1	.....	1	.....	.....	.....
3 hammers, claw, 20 ounces	1	.....	1	.....	1	.....	.....	.....
saws, hand, 26 inches	1	.....	1	.....	1	.....	.....	.....
15 gun-cotton primers, 1-ounce tins	5	.....	5	.....	5	.....	.....	.....
3 safety fuses, 8 fathoms	1	.....	1	.....	1	.....	.....	.....
3 rectifiers	1	.....	1	.....	1	.....	.....	.....
3 iron wires, 1 pound	1	.....	1	.....	1	.....	.....	.....
3 saw links, Stanley .....	.....	.....	.....	.....	.....	.....	.....	.....
3 strings, country, 1 pound	1	.....	1	.....	1	.....	.....	.....
2 90-foot Manila picket ropes, 1½ inches	1	.....	1	.....	.....	.....	.....	.....

16 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

Tools carried.	1 horse.		2 horses.		3 horses.		4 horses.	
	Near.	Off.	Near.	Off.	Near.	Off.	Near.	Off.
3 line diri, 2 pounds	1		1		1			
4 axes, felling		1		1		1	1	1
9 shovels		1		1		1		
2 hammers, miners', 7 pounds				1		1		
3 nippers, wire, Hercules		1		1		1		
3 pliers, side-cutting		1		1		1		
2 spanners, pocket, universal				1		1		
9 sandbags		3		3		3		
3 21-fathom Manila rope, 1½ inches		1		1		1		
9 gun-cotton primers, 2 ounces, 1½ inches		3		3		3		
3 matches of 7 boxes		1		1		1		
8 picketing pegs		2		2		2		2
4 shackles and rope		1		1		1		1
8 holdalls	1	1	1	1	1	1	1	1
2 spanners		1				1	62	62
Gun cotton, 14-pound boxes on top of saddle		1		1		1		1

Above loads, excluding box on top of saddle, weigh from 58 to 62 pounds each side of horse.

	Pounds.
Pack saddle and saddlery	55
2 holdalls, 60 pounds each	120
Gun cotton and box on saddle	16

191

Besides the 4 horses loaded as above and kept with the detachment, there are 4 mules with the transport train. These carry second line supplies, extra rope, spare helms, etc. Lieutenant Pattenson, commanding the detachment, has recommended that 6 other mules (total 10) be allowed, which will give him material for a collapsable boat and a skin raft, and also the wire rope and pulleys for an improvised trolley.

BALLOON SECTION.

This section consists of 40 R. E. soldiers sent from England and 40 Indian helpers and drivers. They have several balloons of various sizes and keep secret their exact dimensions, so that ranges can not be calculated from these data. The balloons are constructed at the Government works, being made of gold-beaters' skin. The car is held fast to the framework of the balloon proper and the seat does not remain horizontal, being

affected by swaying of the balloon. Their ordinary working balloon is about 80 feet in longest diameter. When packed up, it can be transported on one 4-horse wagon and the detail can unpack it, inflate it, and send it up in about forty minutes.

It is held by a three-fourths-inch wire rope and can be carried inflated at the rate of 2 miles an hour against a 20-mile head wind. The hydrogen (at 100 atmospheres) is kept in long tubes, which are hauled on 4-horse spring wagons, each carrying about 10 tubes; 20 tubes are required to inflate the balloon. A plant for supplying this hydrogen was set up at Wei-Hai-Wei. This balloon can ascend to 1,500 feet, and can stay at 800 feet for ten hours with 2 men aboard. They have telephonic connection through the core of the wire rope. Their method of signaling is very complete and simple. A system of code signals is made by the various combinations of 4 small balloons of different shapes, sent up in a vertical row.

SPECIAL SECTIONS AND R. E. PARKS AND DUTIES.

Other sections and the R. E. parks are organized as follows:

	B. Pontoon section.	C. Field photo- graphic and lith- ographic section.	D. Field printing section.	Field park.	Siege park.
British officer.....	1			1	1
British warrant officer.....				1	1
British noncommissioned officers.....	2	2	1	2	2
Native officers.....	2				
Hospital attendant.....	1				
Native noncommissioned officers and men:					
Havildars.....	3			1	1
Niacks.....	4			1	1
Sappers.....	64	4	4		
Bugler.....	1				
Ward orderly.....	1				
Public followers:					
Water carrier.....	1	1	1	1	1
Cooks.....	2	1	1	1	1
Letter bearers.....	6			6	6

B.—Bridge-train equipment. (R. E. Equipment Table.)

Description:—This equipment allows for the construction of an “advance bridge” 120 yards long, consisting of 30 yards

of trestles and 90 yards of pontoons, or of a "heavy bridge" 60 yards long.

It contains all artificers' tools and other stores necessary to make the equipment quite complete in itself and independent of the company equipments.

Transportation:—The equipment is carried on 36 four-wheeled wagons, each drawn by 6 bullocks, and 4 store carts, each drawn by 4 bullocks, being distributed as follows:

Eighteen wagons carry 1 pontoon and 15 chess each.

Nine wagons carry 14 balks, 1 heavy bridge saddle beam, and 2 tie-rods each.

Six wagons carry 3 sets of trestle standards, 1 transom, 2 keys, 2 shoes, and 15 chess each.

Three wagons carry 14 balks and spare stores.

Four store carts carry miscellaneous stores.

In addition to the above loads each wagon carries a few intrenching tools and other stores.

The wagons are all of similar pattern, and can be used for pontoons, balks, and trestles indiscriminately.

Buoyancy:—"Advance bridge" will carry infantry in column of fours; "heavy bridge" will carry 133 pounds per superficial foot of roadway, with fair margins.

Construction of pontoon:—The pontoon is a boat with decked ends and partly decked sides, with four rowlock blocks on each side. The undecked portion is 15 feet by 4 feet 7 inches, and is surrounded by coamings 2 inches high.

The principal dimensions are:

	Feet.	Inches.
Length on deck	22	.....
Width:		
Amidships on deck	5	7
Amidships at bottom	4	10
Depth:		
From deck	2	2
From top of coaming	2	4

One end is curved in section, the other being square, to facilitate the coupling of the pontoons in "heavy bridge." The pontoon consists of 6 sets of framed ribs, connected by a keelson and side and bottom streaks, and covered with copper sheeting. It has a cleat at each end for the cables, 2 plug

holes at the bottom to let rain water out, and 2 side rails outside, with 18 handles to carry it by.

The saddle beam is supported by 3 thwarts. The pontoons are coupled together in "heavy bridge" by means of iron tie-rods on each side at the bottom, which are pinned to flanged plates connected inside the pontoons with other tie-rods secured to the saddle beams. The saddle beams are thus thrown into compression, and the thrust is taken by a movable teak beam 10 feet 10 inches by 9 inches by 6 inches, which is hollowed out at the ends to fit over the pontoon saddle beams, and is placed centrally over the junction of the pontoons, the whole system becoming a double truss, throwing the weight vertically on the pontoons, which are thus protected from undue strain.

The trestles, saddle beams, balk, and chess are of teak.

C.—(1) The lithographic equipment copies sheets 16 by 13 inches, and can begin turning out copies in about two hours after the originals are handed in. (2) The photographic equipment is for taking photographs $8\frac{1}{2}$ by $6\frac{1}{2}$, and printing in the field. This equipment (C) is carried on 3 mules. (Table B, page 21.)

D.—The printing equipment prints pages of quarto size, and is carried on 5 mules. (Sketch 7.)

The duties performed by the sappers and miners include all the engineer work on an advance and the building of quarters for troops in the field when they remain in one place long enough to justify this. In India the building of permanent quarters is not a part of their work. They are engaged in building or repairing bridges and roads and in engineer drills and active or practice campaigns. When a division (about 4,000 men) takes the field, one company is sent with each brigade and one company held as divisional troops to build bridges, etc., of more permanent character, and pioneers are assigned to do heavy road work when necessary to convert the route into a line of supply.

Though a company carries surveying and sketching instruments, very little of this kind of work is done, except by officers when specially detailed.

The organization and distribution of the Indian Corps of Sappers and Miners, with the roster of officers in November, 1900, is given on pages 23 to 26. It is seen that the service

companies are maintained intact and sections for special work are trained and taken from the depot companies. As yet they have no regular railway companies, but they contemplate organizing these as well as permanent mounted detachments.

The duties of royal engineer officers in India are, first, with companies of sappers and miners, or of royal engineers; second, as garrison engineers, who do the constructive work at military posts, employing civilian labor; third, civil work, Government railways, etc.

THE INTELLIGENCE DEPARTMENT OF THE BRITISH INDIAN ARMY.

Though this is a separate department and is independent of the Royal Engineers, royal engineer officers are detailed in the map-making branch of the department (taken from the Survey of India department), and in China most of the reproducing and copying of information for distribution was done by the equipment of the Sappers and Miners. The work of the engineer officers on duty in this department is confined to the instrument work of triangulation. Unlike our service, the information obtained in time of peace is available in the field. When orders came to India for the movement of troops to China, the intelligence department of India had on file all the British military information concerning this part of the world, and maps of the probable field of operation could be compiled and lithographed for distribution to the officers of the expedition.

In the field all the information obtained by the chief intelligence officer and his assistants through interpreters, natives, etc., concerning the country in advance, the watering places, the present state of variable conditions, as well as the enemy liable to be encountered, is written out in full, source and probable reliability being stated. Multiple copies are made of this on the cyclostyle and distributed, as well as the general orders for the next day's march and camping place.

All sketches made by the intelligence officers, reconnoitering parties, patrols, and advance posts are roughly combined and copied with the hectograph (if weather permits its use) or lithograph. Meantime the native sketchers with the main body are mapping the country along the line of march. For this work they use a traverse wheel for distance and fill in with the plane table.

After reaching Peking the Royal Engineer survey parties located the principal cities and landmarks. The filling-in work was done by the native Indian expert sketchers (about 40) from the Survey of India establishment. They use the plane table. The paper is stretched on the boards and the points that have been located in the section assigned to each man are plotted on his board in the central office under the supervision of the officer in charge. An interpreter, and if necessary a guard, is sent out with each sketcher, who completes the map of his section, which is usually made on the scale of 1 inch to 1 mile and then reduced half, or, as they call it, to the "half-mile scale."

The work of the intelligence department includes not only map making, but the collecting and classification of all sorts of information of possible military or commercial importance.

PIONEER REGIMENTS.

In addition to the troops given above, there were two pioneer regiments stationed along the lines of communication. These regiments are organized and used as infantry, but receive some instruction in road making, etc., and are the first troops to be called on to assist the engineers.

TABLE B.
FIELD LITHOGRAPHIC EQUIPMENT, ROYAL ENGINEERS.

No. of mule.	Articles carried.	Number or quantity.	Weight.	Total weight.	
	LOAD.				
	Near side:		<i>Lbs. oz.</i>	<i>Lbs. oz.</i>	
1. Lithographic stores.	Boards, mill, thickest.....pounds..	2	2 0		
	Boxes, mule, empty, 2 feet 9 inches x 15 inches, number.	1	28 0		
	Cloths, sponge.....dozen..	4	0 7		
	Ink, lithographic, printing....pounds..	1	1 0		
	Mullers, zinc.....number..	1	5 0		
	Presses.....do....	1	40 0		
	Stone, pumice.....pounds..	1	1 0		
	Wrenches, tap, small.....number..	1	1 2		
	Off side:				78 9
	Acid, sulphuric.....pounds..	1	*1 8		
Books, quarter foolscap.....number..	1	1 6			
Boxes:					
Field, 15 x 12 inch plates.....do....	1	5 0			
Mule, empty, 2 feet 6 inches..do....	1	33 0			

*Includes weight of bottles.

22 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

TABLE B.—*Field lithographic equipment, Royal Engineers—Continued.*

No. of mule.	Articles carried.	Number or quantity.	Weight.	Total weight.	
	LOAD—continued.				
	Off side—Continued.		Lbs. oz.	Lbs. oz.	
1. Lithographic stores—Cont'd.	Cloths, sponge.....dozen..	½	0 7		
	Cotton, waste, colored.....pounds..	½	0 8		
	Galls, bruised.....do....	1	1 0		
	Gum, Arabic.....do....	1	1 0		
	Instruments, drawing, Royal Engineers, sets.	1	1 6		
	Measures, glass, 40-ounce.....number..	1	1 0		
	Paper, transfer, writing.....quires..	2	4 0		
	Pens, mapping.....dozen..	2	0 2		
	Plates, zinc.....number..	6	18 0		
	Rollers, handles.....do....	4	0 4		
	Sand, graining, silver.....pounds..	2	2 0		
	Sieves, 120 holes.....number..	1	1 8		
	Sponges.....do....	10	0 10		
	Stone, snake.....pounds..	2	2 0		
	Varnish, middle, lithographic..quarts..	1	3 0		
		Total weight.....pounds..			78 11
				157 4	
	Near side:				
2. Lithographic stores.	Boxes, mule, empty, 2 feet...number..	1	28 0		
	Cans, oil.....do....	1	1 7		
	Frames, printing, 15 x 12 inches.do....	2	20 0		
	Rollers:				
	6-inch.....do....	2	3 0		
	6-inch, gelatine.....do....	1	3 9		
	Saucers, ink.....do....	4	0 8		
	Scrapers.....do....	3	1 2		
	Soda, crystals.....pounds..	20	20 0		
	Turpentine, spirits of ^a.....pints..	2	2 0		
		Off side:			
	Acid:				
	Oxalic.....ounces..	12	0 12		
	Phosphoric.....do....	8	0 8		
	Boxes, mule, empty, photographers', number.	1	38 0		
	Frames, printing, 8½ x 6½ inches, number.	3	5 4		
Ink, lithographic:					
Transfer.....ounces..	1	0 1			
Writing, Abney's.....bottles..	2	0 8			
Knives, palette, 9-inch.....number..	2	0 8			
				79 10	

^a In tin box.

TABLE B.—*Field lithographic equipment, Royal Engineers—Continued.*

No. of mule.	Articles carried.	Number or quantity.	Weight.	Total weight.
	LOAD—Continued.			
	Off side—Continued.			
	Paper:		<i>Lbs. oz.</i>	<i>Lbs. oz.</i>
2. Lithographic stores—Cont'd.	Demy, printing.....ream..	1	10 0	
	Papyrotype.....sheets..	100	6 4	
	Potash:			
	Bichromate .....pounds..	½	0 4	
	Caustic.....do....	½	0 4	
	Rollers, 6-inch, gelatine .....number..	1	3 9	
	Towels, damping.....do....	4	0 12	
	Total weight .....pounds..			66 10
				146 4
	Near side:			
3. Tent	Tents, complete, officers'.....number..	1	84 5	
	Straps, baggage.....pairs..	1	4 0	
	Total weight (near side only), pounds.			88 5

RECAPITULATION OF WEIGHTS. •

Mules.	Weight of load of each.	Total.
	<i>Lbs. oz.</i>	<i>Lbs. oz.</i>
No. 1.....	157 4	157 4
No. 2.....	164 4	146 4
No. 3 (near side only).....	88 5	88 5
Total weight .....pounds..		391 13

ROSTER OF INDIAN SAPPERS AND MINERS.

November, 1900.

BENGAL.

Cabul, 1842; Ferozeshuhur; Punjab; Mooltan; Goojerat; Delhi; Lucknow; Ali Musjid; Charasia; Kabul, 1879; Ahmed Kheyl; Afghanistan, 1878-1880; Burma, 1885-1887; Chitral.

Headquarters, Roorkee, N. W. P.

Commandant, Lieut. Col. M. C. Barton, D. S. O.; superintendent of instruction, Maj. F. G. Bond; superintendent of

park, Maj. R. D. Petrie; adjutant, Capt. W. E. R. Dickson; warrant officers, Honorary Lieut. A. Watt, Sergt. Maj. J. Hall.

Company.	Station.	Names of officers.	Appointment.
First company.....	Peshawar (Camp, Nowshera-Dargai Railway).	Capt. A. H. Cunningham ...	Company commander.
Second company ..	Roorkee	Lieut. H. S. Sheppard. Capt. P. Maud	Do. Company officer.
Third company ...	Chitral	Lieut. E. C. Tylden-Patterson. Capt. R. F. G. Bond	Do. Company commander.
Fourth company ..	China expeditionary force.	Lieut. M. R. Elles	Company officer.
		Lieut. W. H. Evans	Do.
		Lieut. A. S. F. Hill	Do.
Fifth company....	China expeditionary force.	Capt. H. R. Stockley	Company commander.
		Lieut. C. M. Carpenter	Company officer.
		Lieut. H. D. Pearson	Do.
		Lieut. M. R. Elles	Do.
Sixth company....	Roorkee (one-half company with Mishmi Expedition Assam).	Capt. H. J. Sherwood	Company commander.
A (pontoon and telegraph) company.	Peshawar	Capt. W. H. Beach	Do.
	Roorkee	V. C. Capt. J. M. C. Colvin ...	Do.
		Lieut. F. W. Brunner	Company officer, telegraph department.
		Lieut. B. W. Mainprise.....	Company officer, (Government telegraph department, Sialkot.)
B (depot) company	do	Maj. C. E. Salvesen	Company officer.

MADRAS "QUEEN'S OWN."

(The Royal Cipher within the Garter.)

Carnatic; Sholinghur; Mysore; Seringapatam, 1799; Egypt (with the Sphinx), 1800-1802; Assaye, 1803; Java, 1811; Nagpore, 1817; Mahidpore, 1817; Ava, 1824-1826; a dragon wearing an imperial crown, with the word China; Meeanee; Hyderabad, 1843; Pegu; Persia; Lucknow, 1857; Central India, 1857; Taku Forts; Pekin; Abyssinia; Afghanistan, 1878-1880; Egypt, 1882; Tel-el-Kebir, 1882; Suakin, 1885; Tofrek; Burma, 1885-1887; Chitral; Punjab Frontier; Malakand; Tirah.

Headquarters, Bangalore (St. John Hill). Arrived on the 11th March, 1865, from Dowlaishweram.

Honorary colonel, H. R. H. Albert Edward, Prince of Wales and Duke of Cornwall, K. G., K. T., K. P., G. C. B., G. C. S. I., G. C. M. G., G. C. I. E., Field Marshal; commandant, Lieut. Col. S. Grant (on leave); superintendent of instruction, Maj. B. B. Russel; superintendent of park and train, Capt. E. P. Johnson (on leave); adjutant, Lieut. W. Robertson; warrant officer, Honorary Lieut. W. C. Reader; warrant officer, Sergt. Maj. H. T. Gasson.

Company.	Station.	Names of officers.	Appointment.
No. 1 Company....	Secunderabad	Capt. C. H. Roe	Company commander.
		Second Lieut. E. K. Molesworth.	Company officer.
No. 2 Company....	Bangalore	Capt. H. J. M. Marshall.....	Company commander.
		Lieut. C. M. Wagstaff.....	Company officer (acting company commander, No. 5 Company).
No. 3 Company....	China expeditionary force.	Capt. J. A. S. Tulloch.....	Company commander.
		Lieut. E. G. Henderson	Company officer.
		Lieut. R. E. D. Goldingham .	Do.
No. 4 Company....	Bangalore	Lieut. J. A. Garstin	Do.
		Lieut. W. S. Traill.....	Company commander (acting superintendent of pontoon and telegraph sections).
		Lieut. H. E. Winsloe	Company officer (acting company commander, A Company).
No. 5 Company....	do	Capt. U. W. Evans.....	Company commander.
		Lieut. F. D. Irvine	Company officer (acting company commander, B Company, and quartermaster).
No. 6 Company....	Malakand	Capt. C. Ainslie	Company commander.
		Lieut. J. B. Barstow.....	Company officer.
		Lieut. W. R. Izat	Company officer (attached).
A (depot) Company.	Bangalore	Capt. C. H. Heycock	Company commander (on leave).

26 ENGINEER EQUIPMENT OF THE ALLIED TROOPS.

Company.	Station.	Names of officers.	Appointment.
A (depot) company—Cont'd.	Bangalore	Lieut. S. G. Loch	Company officer (telegraph section, China expeditionary force).
B (depot) company.	.....do	Capt. T. Fraser	Company commander (South Africa).
		Lieut. F. G. Howard	Company officer (on leave).
Burma Company ..	Mandalay	Capt. F. F. Weedon	Company commander.
		Lieut. P. E. Hodgson	Company officer.

BOMBAY.

Beni-Boo-Ali; Ghuznee; Afghanistan; Kelat; Punjab; Mooltan; Goojerat; Persia; Reshire; Kushab; Bushire; Central India; Abyssinia; Kandahar, 1880; Afghanistan, 1878-1880; Burma, 1885-1887.

Headquarters, Kirkee.

Commandant, Lieut. Col. G. C. P. Onslow; superintendent of instruction, Lieut. Col. G. E. Shute; adjutant, Capt. F. H. C. Burne (on leave); conductor, J. R. Hudson; warrant officer, Sergt. Maj. F. Broadrib.

Company.	Station.	Names of officers.	Appointment.
No. 1 Company	Chaman	Lieut. C. W. Singer	Company commander.
		Lieut. W. Bovet	Company officer.
No. 2 Company	China expeditionary force.	Lieut. G. H. Boileau	Company commander.
		Lieut. G. R. Pridham	Company officer.
		Lieut. J. E. E. Craster	Do.
		Lieut. W. H. Chaldecott	Do.
No. 3 Company	Chaman	Maj. C. E. Baddeley	Company commander.
No. 4 Company	Aden	Lieut. F. S. Garwood	Company commander (on leave).
		Lieut. J. B. Corry	Company officer.
A (depot) Company.	Kirkee	Capt. W. B. Lesslie	Company commander.
		Lieut. W. F. Maxwell	Company officer (telegraph duty, Rawal Pindi).
B (depot) Company.	.....do	Lieut. E. S. Sandys	Company commander (acting adjutant).

FRENCH.

The following French engineer troops were on duty in north China: Three companies (6th, 7th, and 9th), (777); 1 railway company (259), 1 balloon company (110), one-half telegraph company.

The composition of one engineer company was given as follows: Officers, 3; sergeants (including sergeant-major), 9; corporals, 12; privates, 138; add in war, privates (sappeurs), 100; total enlisted, peace 159, war 259.

A railway company is the same as above.

The balloon company has 3 officers, 10 sergeants, 8 corporals, 92 privates; 108 total enlisted.

The engineer soldiers are armed and equipped as infantry. (Photograph 11.)

TRANSPORTATION AND EQUIPMENT.

One company has 2 tool wagons and 1 cart. The tool wagon weighs 3,200 pounds when empty, and 6,000 pounds when loaded. It is drawn by 4 to 8 mules. There are four compartments in the wagon for tool boxes, each of which has its proper place and has marked on it the tools it contains. Carpenters', smiths', and intrenching tools, heavy hammers, crowbars, rope, and nails are included in the load carried. There is a compartment for provisions near the rear of the wagon; the crate under the wagon is for miscellaneous articles. The arrangement for carrying ropes on hooks on either side for drawing their own or other wagons when necessary is shown in photographs. (Photographs 12, 13.) The two wagons ordinarily carry duplicate loads, and the company and equipment can be divided into two complete and equal parts. While the detailed arrangement of the load is excellent, a serious objection to this wagon is that it is heavier than the ordinary transport wagon.

The cart weighs (empty) 1,100 pounds; it is drawn by one mule and is used for carrying explosives. Milenite is the explosive used; it is claimed to be as effective as twice its weight of dynamite. (Photograph 14.)

The following loads are carried by the men (photograph 15): Twelve axes, 66 picks, 66 shovels, 4 folding saws, and 12 hatchets (corporals), and each sergeant carries a ruler. It is

seen that the shovel handle is detachable; the other handle shown fits an ax, a pick, or an adz.

The folding saw is about 4 feet long, being in ten sections. (Sketch 5.)

The plane-table method is used in making maps. This work is usually done by a corps of civilian experts; the engineers do such work when necessary in laying out military works, or when no one else is present to do it.

The balloon in China was about 10 meters in diameter; it is more nearly round than the British balloon. It is made of a rubber and silk composition. The car swings from the frame work of the balloon proper and the seat remains horizontal. The balloon can be packed in a box about 5 feet by 5 feet and weighs about 250 pounds, and is transported on a 2-mule wagon.

It was claimed that this balloon can ascend to 500 meters, and that it has remained in air for eight hours, carrying three men. It is held by a hemp rope having a wire core used for telephonic communication. The hydrogen is carried in small cylinders about 2 feet long and 1 foot in diameter.

GERMAN.

The following German engineer troops were on duty in China: Three engineer pioneer companies, 2 railway companies, 1 pioneer detachment (with marine expedition).

The following is the composition of one pioneer or one railway company: Three officers, 5 sergeants, 12 corporals. Privates, peace 134, war 234; total enlisted, peace 151, war 251.

Each army corps has 1 battalion (4 companies) of pioneers and 1 railway company (one of the above railway companies was a pioneer company detailed to assist the regular railway company.)

Recruits for the pioneers are selected as a rule from mechanics. They are drilled in infantry drill for the first three months and then begin the engineer drills. Twice each year they have an extensive practice march, during which they build bridges from timber cut and prepared in the woods. These bridges are afterwards blown up to teach the men how to handle explosives. The daily routine prescribes one hour's theoretical instruction for the privates by noncommissioned officers.

The pioneers carry the same rifle and equipment as the infantry, except that the bayonet has a saw edge to within 8 inches of the point, and each private also carries an ax, spade, or pick; each corporal carries a hatchet and a tape measure. The leather case for these tools hooks on the belt, and the tool handles are held vertical by a strap on the haversack (photograph 16.)

The transportation for one company is ordinarily two tool wagons (others to be gotten from transport service when necessary). The wagon is the same as the ordinary transport wagon (photograph 17), except that the bed is larger and the wagon is heavier.

One wagon carries 100 axes, 100 spades, 100 picks, 6 cross-cut saws, 6 crowbars, 1 carpenter's tool chest, 1 leather bag of assorted nails, forge and blacksmith's tools, rope, and blocks.

PONTONS.

Advance guard pontons (photographs 18, 19, 20). The half-boats are made of sheet steel and weigh about 250 pounds each. They are 10 feet long and have a 4-foot beam. They are fastened together by hook-and-eye at the bottom and a bolt on each side near the gunwale. They are carried on 6-horse wagons of very light construction and are supposed to keep up with cavalry. The wagons also carry two platforms each, to substitute for balk and chess. Between the two rear wheels there is a box for explosives and mining tools.

The boats and wagons are as yet experimental. Some of the boats are made of aluminum.

At Tientsin one half of a pioneer company was mounted on Chinese ponies, to go with the advance guard and have charge of these boats. The detachment was also equipped for other engineer work. Each man carried two tools (pick and spade, ax and shovel, etc.), which were in leather cases strapped on either side of the saddle.

The regular German ponton is 21 feet long with 4-foot beam; it is made of galvanized sheet iron strengthened by angle-iron ribs and transoms; it weighs about 1,500 pounds, and can be carried by 16 men on their shoulders. The truss shown in photograph is not part of the equipment, but was made at Tientsin (photograph 21).

They also have a larger size, 32 feet long with 6-foot beam, which is used around fortresses for carrying heavy ordnance (photograph 22). They had boats of both kinds in China, and in the wagon bridge at Hankow they used both kinds, the small boats being used in pairs, held together with a kind of tapering crib work whose last traverse was on a level with the gunwales of the larger boats. The balk and chess were improvised, 6-inch by 8-inch and 2-inch by 12-inch pine lumber being used.

Canvas pontoons, 12 feet by 4 feet, are built by the cavalry. The frames are formed with their lances. A raft of 2 boats will carry 6 cavalymen and their equipment. The horses swim alongside.

RAILWAY COMPANIES.

These companies are trained in the construction of railroads, heavy bridges, etc., and in running locomotives. They brought 4 locomotives to China. The railroad bridge at Hankow was rebuilt by the German pioneers, in order to get the experience for the men. The bridge was about 300 feet long and 30 feet above water. They made a pile bridge, driving the piles about 40 feet deep. The piles were 12-inch by 12-inch and were built up by binding together 6-inch by 6-inch timbers, breaking joints.

MAP MAKING.

The noncommissioned officers do very little of this work; enlisted men with previous experience in this line are sometimes so employed under the supervision of engineer officers, but for the most part civilian experts are employed.

ITALIAN.

A small engineer pioneer detachment was in China. They had no special transportation, but all tools were carried by the men. One of their tools was a half ax and half pick. Each tool is carried in a leather case, that has a strap passing from one corner up the tool handle to opposite the man's shoulder, where a turn is taken around the handle; then the strap passes over the shoulder and back to the other corner of the leather case (photograph 23).

The men are armed with a carbine, having a bayonet permanently attached with a hinge, held open or shut by a lock spring (photograph 24).

JAPANESE.

The following Japanese engineer troops were on duty during the advance to Peking:

One battalion of engineers (3 companies); 1 railway company (500 men); telegraph section.

The composition of one engineer company is as follows:

Officers (1 captain and 3 to 7 lieutenants)	4 to 8
Sergeants (including sergeant-major and first sergeant).....	18
Privates (first, second, and third class).....	234
Total enlisted	252

Three companies form one battalion, commanded by a lieutenant-colonel, whose staff consists of 1 adjutant (first lieutenant), 1 quartermaster, 2 surgeons, 2 sergeants, 1 surgeon-sergeant, 1 quartermaster-sergeant, 11 privates, making total enlisted 771 in battalion.

A division consists of 2 brigades of infantry, 1 regiment of cavalry, 1 regiment of artillery, and 1 battalion of engineers, one company belonging (not attached) to each brigade, the other company being held as divisional troops. The railway companies are in addition to these.

The arms and equipment of the engineer soldiers are the same as those of the infantry. The uniform is distinguished by the maroon facings.

TRANSPORTATION AND EQUIPMENT.

There are ordinarily 28 pack horses to each company (in the advance to Peking each company had 40 horses, the extra horses carrying powder and rations). The horses are small, spirited animals and require one man to lead each horse. The loads are about 200 pounds each, being prescribed as follows:

Number of horses.	Load.
Class 1.—1, 2, 3, 4, 5, and 6.	4 axes, 4 picks, 4 combination pick and mattock, 20 shovels, 2 spades.
Class 2.—7, 8, and 9. Carpenter tools, electric supplies, sketching boards.	2 boxes containing— First box: 2 coils insulated wire on reels, 40 detonators, 1 coil rubber band wrapping, 1 coil of fuse, 1 magnetic firing machine (French make), 1 hollow rubber tube 4 feet long, 4 insulator clamps (small hinge inclosing two rubber pads), 1 flint, 1 brass hammer, 1 brass chisel, piece chamois, piece emery cloth, can of rubber paste, tin box (2 inches by 3 inches by 8 inches) of nails. Second box: Matches and candles, 1 monkey wrench, 2 augers, chisels (assorted), 3 folding saws, 2 sketching boards in tin box.

Number of horses.	Load.
Class 3.—10, 11, and 12.....	Gunpowder.
Class 4.—13. Dynamite, surveying instruments.	2 boxes containing— First box: 2 coils of wire, 1 small box of dynamite (in sticks), 1 tape line, 1 box of drawing instruments, pens, ink, etc. Second box: 2 small boxes of dynamite, 4 coils of fuse, 1 plane table (complete).
14	Spare.
Class 5.—15 to 28	Forage, cooking utensils, officers' chests (official and private).

A Japanese company is divided into 3 platoons, and it is seen that this equipment (except class 4) can be divided into 3 equal parts without shifting loads.

The following tools are carried by some of the men, as seen in photograph 25: 6 axes, 80 shovels, 16 picks and combination pick and mattocks; these men form 3 working parties.

The pack saddle is the same as their ordinary transport saddle; it is not of very substantial construction and the details are not worked out so thoroughly as in the British saddle. The loads are held on the small hooks near the top of the saddle (photograph 26). The arrangement for loads of class No. 1 is shown in photographs 27 and 28. The elliptical ring is made of $\frac{3}{8}$ -inch rod iron, and is 2 feet 6 inches long by $4\frac{1}{2}$ inches across.

The boxes containing small tools, etc., are 8 inches by 16 inches by 30 inches, and are made of light wood; the edges are bound with hoop iron, and the boxes are further strengthened by two heavier iron bands, of which the hinges form parts. One side of the box is hinged at the bottom and fastens with clasps at the top. It can be opened without removing the pack from the horse. (Photograph 29.)

The tools carried are lighter and of weaker construction than ours. The folding saw is of the French pattern, but not as strong and well made. (Sketch 5.)

The plane-table attachments and drawing instruments are of French make.

The sketching board is simply a large envelope (13 inches by 16 inches) made of stiff leather; a small detachable compass is clamped on the edge; the paper is held in place by rubber bands, the sights being taken along the edge of a ruler; the

board is held suspended by a string fastened at opposite corners and passing around the neck. Extra paper is kept in the envelope. (Sketch 6.)

All the sergeants are trained in sketching work.

RUSSIANS.

Information obtained concerning the Russian engineer was very meager.

The roster published December 11, 1900, gave the following Russian engineer troops on duty in the province of Chili: Two railway companies (500); two pioneer companies (500).

A battalion consists of about 1,000 men and is divided into 4 companies.

Their tools are carried in the Russian transport carts (photograph 30). These were the best one-horse carts observed. Each can carry 600 pounds over rough roads. They are driven by men belonging to a service corps or by soldiers in the lowest conduct grade. Transportation in these small carts allows for the division of a company and its equipment into smaller parts.

The progress of the work done by the railway companies was very slow, due perhaps in part to conditions and in part to policy.

The engineers seem able to get all the transportation they need, and engineer troops were always seen near the head of the column on the march, and were at the head in the parade through the Forbidden City.

COMPARISON.

In comparison with the foreign engineer soldiers, our enlisted men are perhaps equal in physical endurance and excel in natural intelligence, mechanical ingenuity, and reserve energy that can be relied on in emergencies, but it seems unreasonable to expect the most satisfactory results in the field with insufficient numbers, inadequate transportation, and the lack of well-established methods.

ORGANIZATION OF ONE COMPANY.

In regard to organization, it is seen that the organization and transportation of all the foreign engineers is such that a company can be divided into fully equipped and equal parts—

the British, French, and German companies into 2 parts; the Japanese into 3 parts. The pack transportation of the British and Japanese and the carts of the Russians allow still further subdivision into sections equipped for different kinds of work. If necessary, the French cart for explosives could be used to carry the equipment of a section less than a half company. The carrying of tools by the men, in addition to their infantry equipment, is utterly impracticable in a tropical country.

The subdivisions referred to are complete in themselves; transportation, paper work, and blank books are arranged to that end. In the minor engineer works all of a company is rarely engaged on one work. If the sections do happen to come together no complication arises, as is the case in trying to subdivide a company not organized into complete sections.

In order that a company may be divisible into complete sections the company must be at all times complete in itself. This is admirably accomplished with the British Indian sappers, where the "service companies" remain intact and the "depot companies" only are broken up and furnish all the minor details and sections for special work which it is not considered necessary for all the men to know. With the French this result is attempted on a larger scale, tending to specialize entire companies, as the balloon company.

That these subdivisions may at all times be complete, necessitates a system of instruction that requires that at all times there must be in each section a certain number of men who, besides understanding the usual engineer drills, can do certain things, so many carpenters, so many blacksmiths, etc., and that in each section of a special company there must be a certain number of men who understand thoroughly reconnaissance, the duplicating methods adopted, field photography, or whatever else requires special instruction. With a system so thoroughly established and the minimum number of men who can do special work so definitely fixed that discharges and transfers do not reduce the efficiency of a section, complete sections, and therefore complete companies, can at any time be put into the field, and each man is thoroughly familiar with the work he has to do.

On account of the small number of engineer troops in our service the importance of this divisibility and of the completeness of small units is greater than with any other engineers.

Besides the more extensive work along the route of army or corps trains, there is engineer work to be done with each column, however small, that has its own wagon train or artillery. If there are not enough engineer soldiers to do all the work, it seems desirable that all the work should be under their direction, and the troops detailed to assist should be employed where the greatest number of men can work in a body.

The importance of railway construction requires larger bodies of specially trained troops, and the organization of railway companies and battalions, such as those given above, is well known. Without special troops and officers trained for rapid construction of railroads, no amount of energy can accomplish the results that in case of war should be accomplished by the Corps of Engineers or otherwise. A definite decision whether this work belongs to the Engineer or the Quartermaster's Department is of first importance.

TRANSPORTATION.

The most important point about the transportation of the foreign engineers is that they have transportation. The division of transportation into the first, second, and third lines is excellent, and too much importance can not be attached to the fact that at least the first line transportation should be at all times part of an engineer company. Half of a company with proper transportation can do more efficient work than a whole company with no transportation. The importance of transportation is readily realized in the field, but it is then too late. Experience since the beginning of the Spanish war shows that if it is difficult in time of peace to obtain all or part of the transportation necessary for service conditions, it is next to impossible to obtain it when most needed in active operations. To depend on our Quartermaster's Department for transportation, when our requests and needs are not made definitely known, until that department is crowded with work and has stores of its own to haul, is very hopeful, but successful only when the commanding general or quartermaster present has had actual experience that emphasizes the necessity of properly equipped engineers in the field.

The character of the transportation best adapted to our needs can only be determined by experiments with a company

working and drilling with field-service equipment carried on its wagons or pack animals (or both) under conditions of field service, actual or imitated, as they can be for engineer troops more nearly than for any other troops. Wherever wagons can be taken our quartermaster's escort wagon is entirely satisfactory for simply transporting stores, but the engineer tools and stores must be readily accessible, and arrangements to this end must be made before active campaign. The arrangement in the French tool wagon is excellent, but this wagon, as well as that of the Germans, is heavier than their ordinary transport wagon, and this is liable to be a very embarrassing defect.

For the divisional engineer troops (reference is made to the duties actually performed and not to designation in orders) wagon transportation alone is probably sufficient, but for the companies or sections moving with the brigades this should be supplemented by smaller detachable transportation, either carts or pack animals, which would also be useful in distributing intrenching tools. The engineer pack saddle of the British was the best saddle observed, but it is heavier than seems absolutely necessary.

The idea of combining wheel and pack transportation is carried out in the British Indian transport cart (photograph 10).

Two actual cases are given to illustrate conditions where such an arrangement would apply to our 4-mule wagons. The wagon train was compelled to stop about three-fourths of a mile behind the line taken up and to be intrenched by the troops. If two of the mules in each wagon had been equipped for packing, the large intrenching tools could have been carried up and distributed promptly and without confusion. On another occasion a broken bridge had compelled the wagon train to stop 2 miles from a town taken and occupied by the troops. Within this 2 miles there were another broken bridge and two ravines. Eighty engineer soldiers were present and a company of infantry was detailed to assist them. Only about 30 men could work at the first bridge. Two pack mules from each engineer wagon could have carried tools to the breaks ahead, and if all the wagons had been so arranged two mules from each could have carried one day's rations ahead to the troops and returned before the road could have been repaired. It seems practicable to make pack saddles that would serve

the purpose in cases as above and be but little heavier than the McClellan saddles carried by each of our artillery horses.

I have the honor to recommend that whatever transportation is adopted it be turned over to the engineer troops, who shall have complete charge of it in peace or war. The most desirable arrangement would be to have the wagons and animals carried on engineer papers and the teams driven by engineer soldiers. This transportation, unlike most of the other transportation for an army, would not remain idle in time of peace, but would be very useful in all engineer drills where field conditions are imitated.

EQUIPMENT.

Arms.—All the foreign engineer soldiers are armed with the infantry rifle except the Italians, who are armed with the carbine, which is more easily carried and would seem best suited for engineer troops.

Tools.—For road and bridge work our tools are, as a rule, equal to any observed. A folding saw, such as that of the British, would be a useful addition. Unlike the other engineers, our company equipment is not fixed. Of course this can not be fixed absolutely, but it can be fixed between limits and the probable components can be decided on and packed in prescribed, compact, portable shape. For example, the absolutely necessary tools of a carpenter's or smith's set to be taken when transportation can not be had for a complete set, which would only be necessary for finer work. We have no adopted explosive to be had in certain size and shape, so that with a few samples on hand the men can be taught how to handle it.

The distinction between the tools and material of a company equipment under ordinary conditions and the reserve tools and material of the engineer field depot should be made clear, and the former should always be ready for transportation, which could not apply to the depot material, that would only be required for special or more extensive work.

RECONNAISSANCE AND MAP MAKING.

Reconnoitering, making maps for military purposes, and collecting certain kinds of information in active campaign are, by Army Regulations, among the duties of the Corps of Engi-

neers. This is in addition to the work performed by the engineers in most of the other armies. Our duty in this line begins in the field. The desirability of beginning with all information previously obtained is apparent, and it is important that there should be on file in military engineer offices all information that has been previously obtained and which may be needed before it can be transmitted from Washington.

To properly do this reconnaissance work and record the information obtained would require some fixed organization and equipment. To do the work without mounted men is difficult, if not impossible. With the proper number of mounted engineers, officers, or enlisted men, a certain number to a brigade front, the country could be covered to the screen or most advanced pickets, and with proper duplicating equipment sketches and other information could be submitted on short notice and distributed. If anyone in an army is mounted, it seems that those men whose duties properly performed require them to cover the most ground should be mounted.

Attention is respectfully called to the fact that the Engineer Department has four different instruments for making maps: The Batson sketching case, the cavalry sketching case, the prismatic compass, and the box compass to be used with the notebook or drawing board. There is no precise system for doing this work, nor for teaching the enlisted men to do it. The variety of notes and sketches turned in causes unnecessary confusion. I have the honor to recommend that one method and one instrument, to the exclusion of all others, be adopted to be used by the officers and enlisted men of the engineers, and by other officers or enlisted men making maps under the direction of the Engineer Department. It seems reasonable to expect the best results from a system in which the improvements in instruments or methods become part of the system which is thus fixed at any one time, and at all times is the best yet offered.

There seems to be no perfectly satisfactory method of duplicating maps and sketches in the field. Blue printing is not well adapted to this work. The most satisfactory results observed were those obtained by the field lithographic equipment of the Royal Engineers. This equipment weighs less than 500 pounds. The importance of this work and of photography

would seem to warrant study and experiments that will develop compact equipments adapted to field conditions.

The use of balloons for signaling and for obtaining information is being developed by the engineers in other armies, and it seems that its use for the second purpose would come under the Engineer Department in our Army.

MOUNTED ENGINEERS.

The value of mounted engineers is recognized by the Germans and the British. The work of a mounted detachment will be important, not so much in itself, but in that it is done at a critical time. Their utility with cavalry commands sent to destroy railroads, bridges, etc., is evident.

Their employment is more economical than at first appears; most of the energy of the men is expended in engineer work and not in trying to keep their place in the column that is usually marching while the engineers are at work.

In some circumstances in the Philippines 15 men with horses could have done the engineer work of 30 men on foot, and with less fatigue. The organization of a mounted detachment was suggested by the chief engineer (Capt. W. L. Sibert, Corps of Engineers, U S. A.) in the Philippines about eighteen months ago, but it was then out of the question to obtain horses. It is a question of organization whether the mounted men should be from a base or depot company (as with the British) or should be part of a field company (as experimentally tried by the Germans at Tientsin). The men on reconnaissance could very properly belong to this detachment.

If with the section of 50 men moving with a division 20 engineers were mounted and had 3 or 4 pack mules, they could march near the head of the column and make all minor repairs to roads or bridges, which should not delay the artillery or wagon train at all; more serious breaks could be reported promptly to the detachment in rear. In the case of a movement of detached cavalry two or more of these mounted detachments could be assembled to accompany it.

I have the honor to recommend the forming of at least a small mounted detachment with their own pack mules especially, in order that the equipment and pack saddles can be tried and perfected. In any country where cavalry can

operate I believe that the success of such a detachment will be so decided that it will not be difficult to mount other detachments.

The accompanying photographs were taken by Capt. C. F. O'Keefe, Thirty-sixth United States Volunteer Infantry. The finished sketches were made by First-class Private Tschappat, Company B, Second Battalion of Engineers.

Respectfully submitted.

H. B. FERGUSON,

First Lieutenant, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,

Chief of Engineers, U. S. A.

(Through Chief Engineer, Division of the Philippines.)

ILLUSTRATIONS.

SKETCHES.

	Figures.
Sheet 1—	
Standard blocks of gun cotton and accessories, Royal Engineers.	1
Method of fastening loads on British ordinary transport pack saddles.	2
Sheet 2—	
Pack saddle, Royal Engineers	3
Stanley patent link saw, Royal Engineers	4
Sheet 3—	
French and Japanese folding saw	5
Japanese sketching case and compass	6
Sheet 4—	
Standard box for pack mules, Royal Engineers	7

PHOTOGRAPHS.

BRITISH.

Special saddle for first and second line equipment.	1, 2, 3, 4
Ordinary transport saddle	5
Special saddle for mounted detachment (same as above, except leather bag for tools).	6, 7, 8, 9
Cart drawn by pack mule	10

FRENCH.

Engineer soldiers	11
Tool wagon	12, 13
Cart for explosives.	14
Soldier's pack	15

GERMAN.

Pioneer soldiers	16
Tool wagon	17
Advance guard half boats.	18, 19, 20
Larger pontons.	21, 22

ITALIAN.

Engineer pioneer soldiers	23
Pioneers from Bersaglier, showing method of carrying tools	24

	Figures.
JAPANESE.	
Engineer soldiers	25
Pack horse, saddle without load	26
Load of class 1	27
Same on horse	28
Load of class 2 on horse	29
RUSSIAN.	
Ordinary transport cart used for engineer tools	30



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200

2

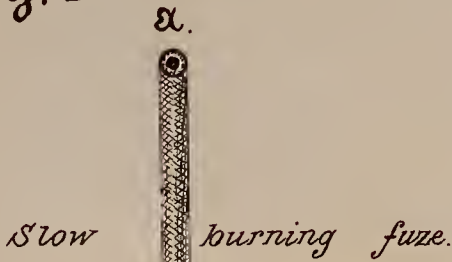
Board blocks

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Fig. 1.



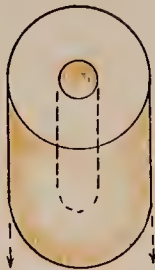
Detonator. Non com-
officer in his

b.



carried by
-misioned
cartridge box.

Dry
carried in



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in tubes.

[Photo. 223]

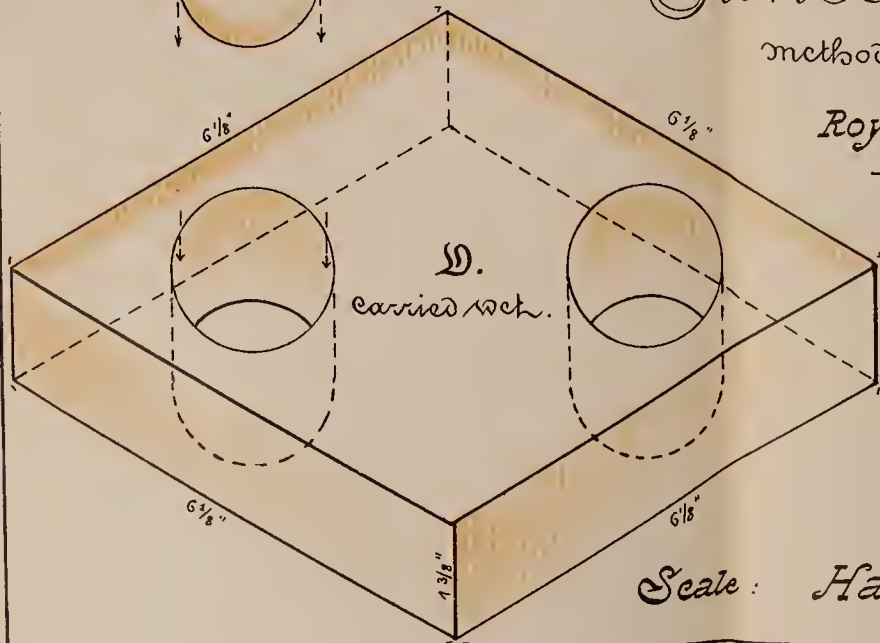
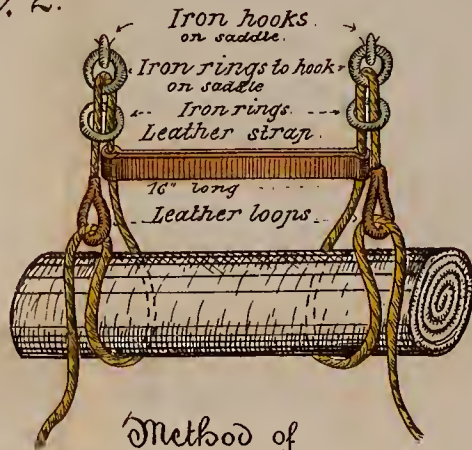


Fig. 2.



Method of
fastening loads on British ordinary
transport Pack-saddles [R.E. 3rd line.]
[Photo. 219]

D.

Standard blocks

of Guncotton and

method of Detonating.

Royal Engineers.

Weight

Scale: Half Size.



Handwritten text, possibly a name or title, appearing as "St. George" or similar.

Handwritten text, possibly a date or location, appearing as "London 1875".

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Handwritten text, possibly a name or title, appearing as "St. George".

Handwritten text, possibly a date or location, appearing as "London 1875".

Small handwritten text, possibly a name or title, appearing as "St. George".

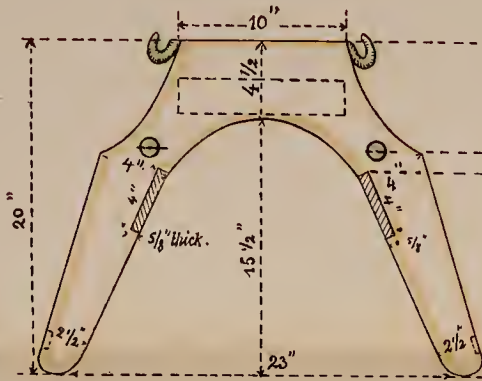


Handwritten text, possibly a name or title, appearing as "St. George".

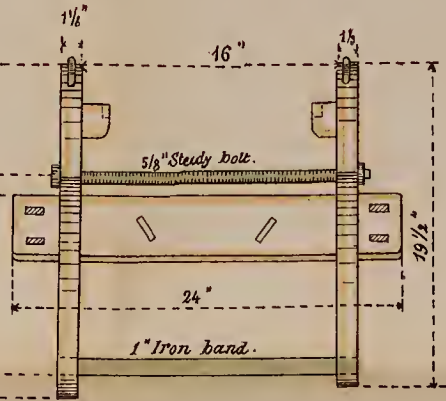


Stanley

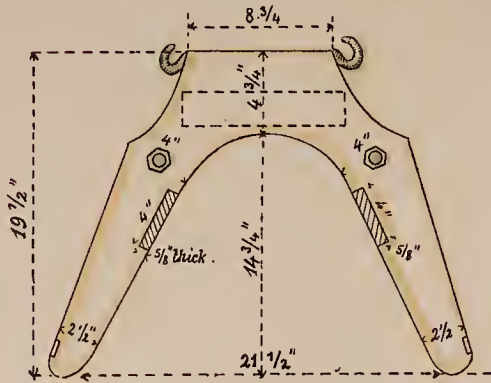
Fig. 3.



Rear View.



Side View.



Front View.

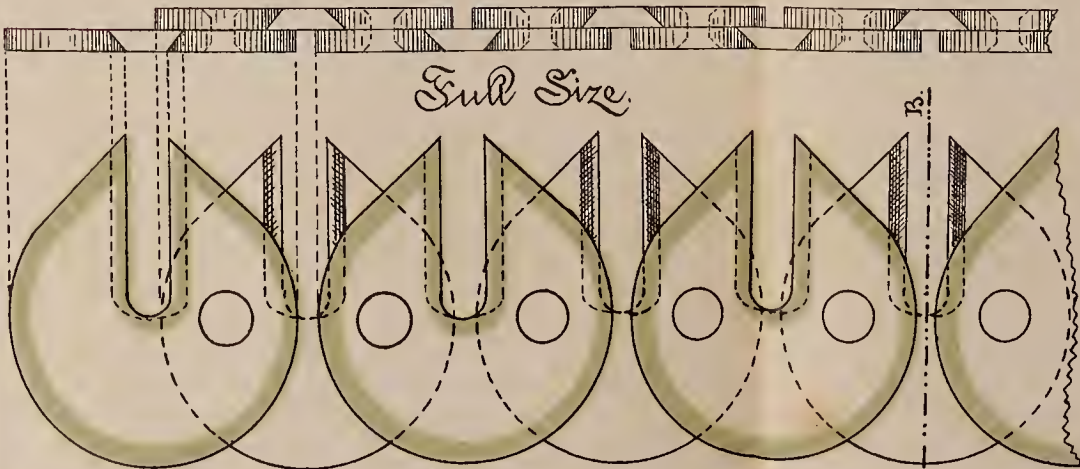
Back-saddle

Royal Engineers

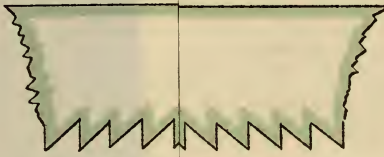
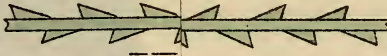
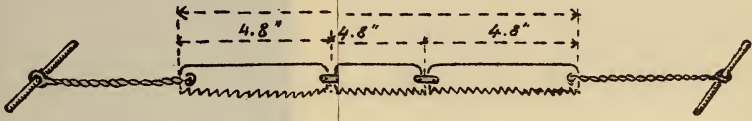
Iron bound.

Scale $\frac{1}{10}'' = 1$ inch.

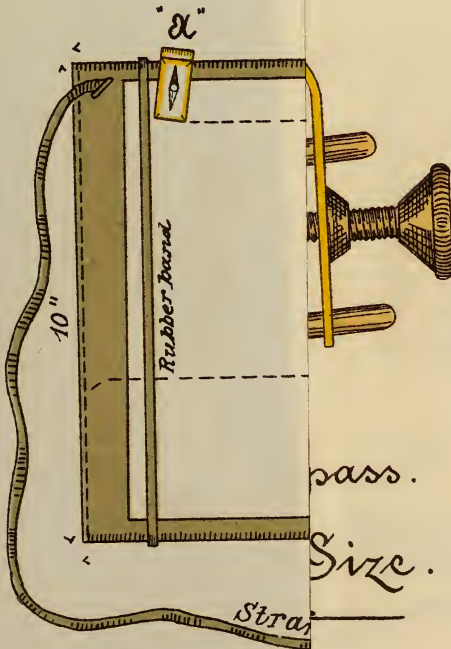
Fig. 4.



Stanley Patent Link Saw. Royal Engineers.

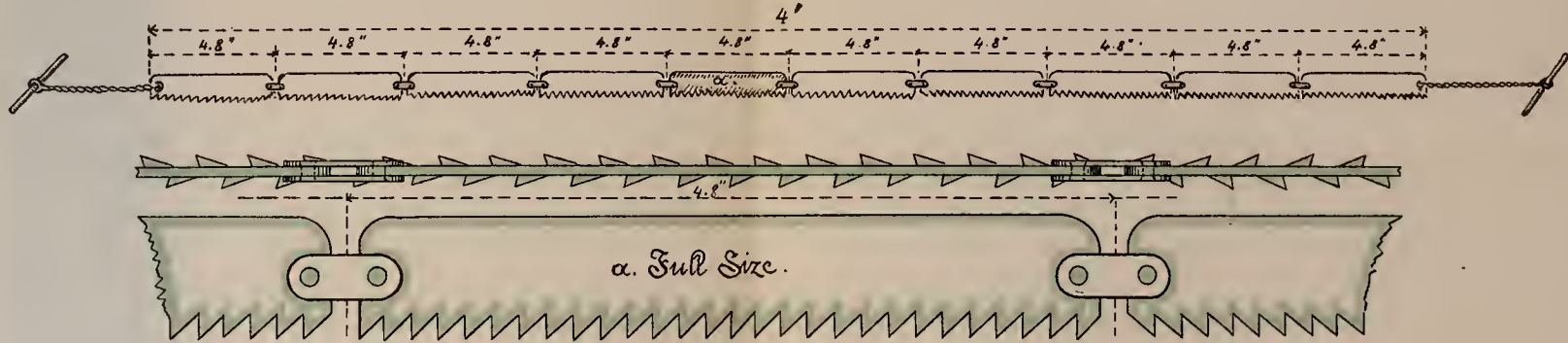


v.



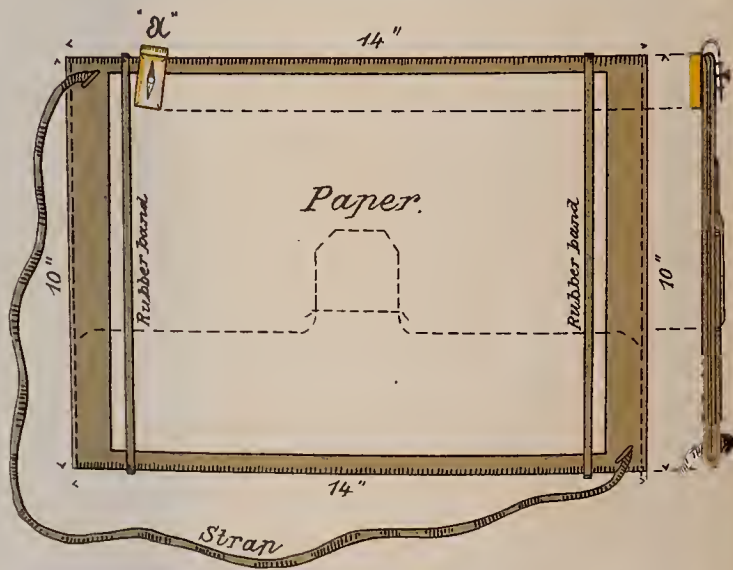
Japanese

Fig. 5.

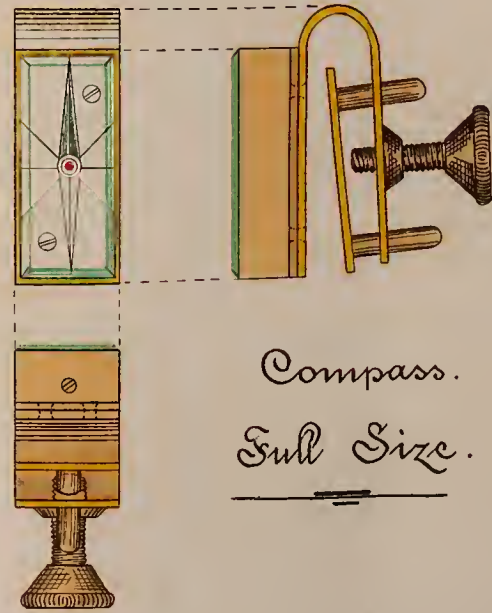


French and Japanese folding saw.

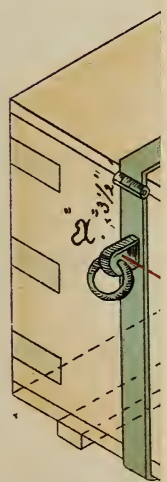
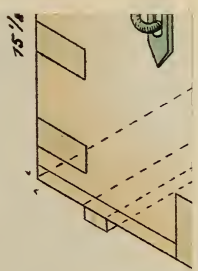
Fig. 6. "α"



Japanese sketching case. (Leather.)



*Compass.
Full Size.*



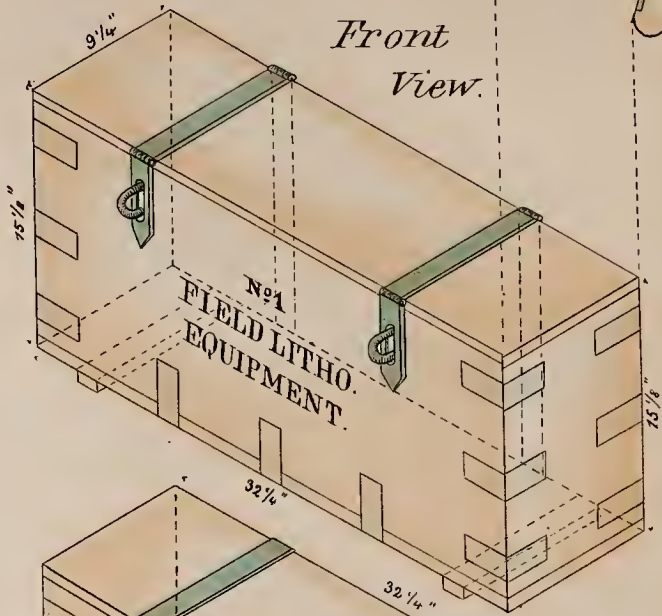
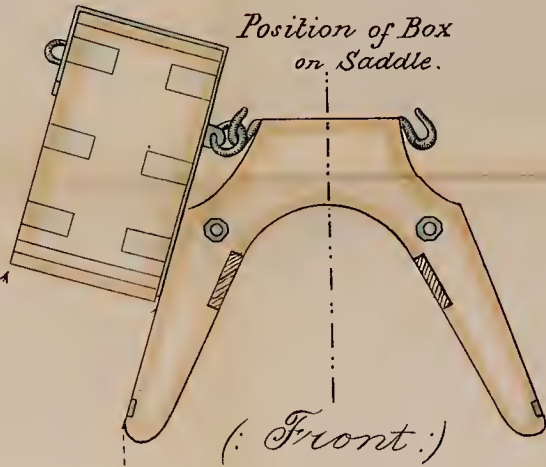
Rear
View

Scale 1/2

Fig. 7.

Royal Engineers Standard Box

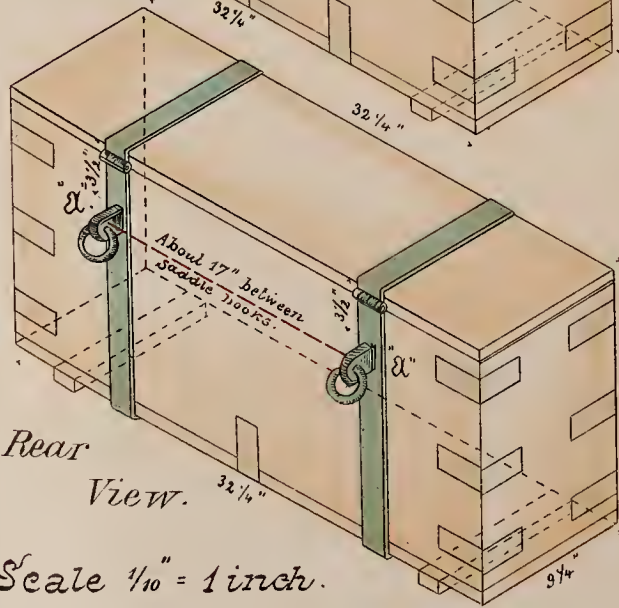
for
Field Litho., Photo. or
Printing Equipment also
Explosives or smaller Tools.



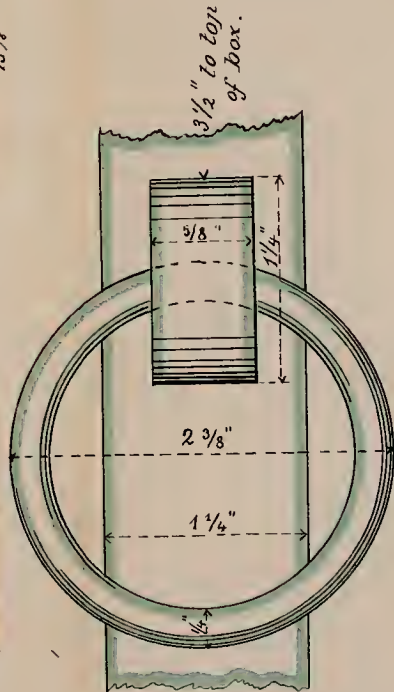
Front View.

Detail "A".

Full Size.



Rear View.



Scale 1/10" = 1 inch.



BRITISH ENGINEER PACK TRANSPORTATION. FIRST-LINE MULE.



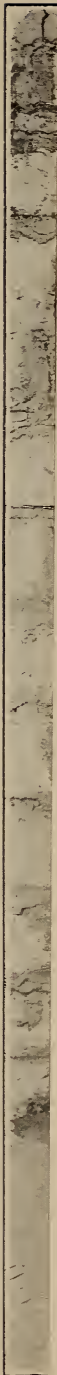






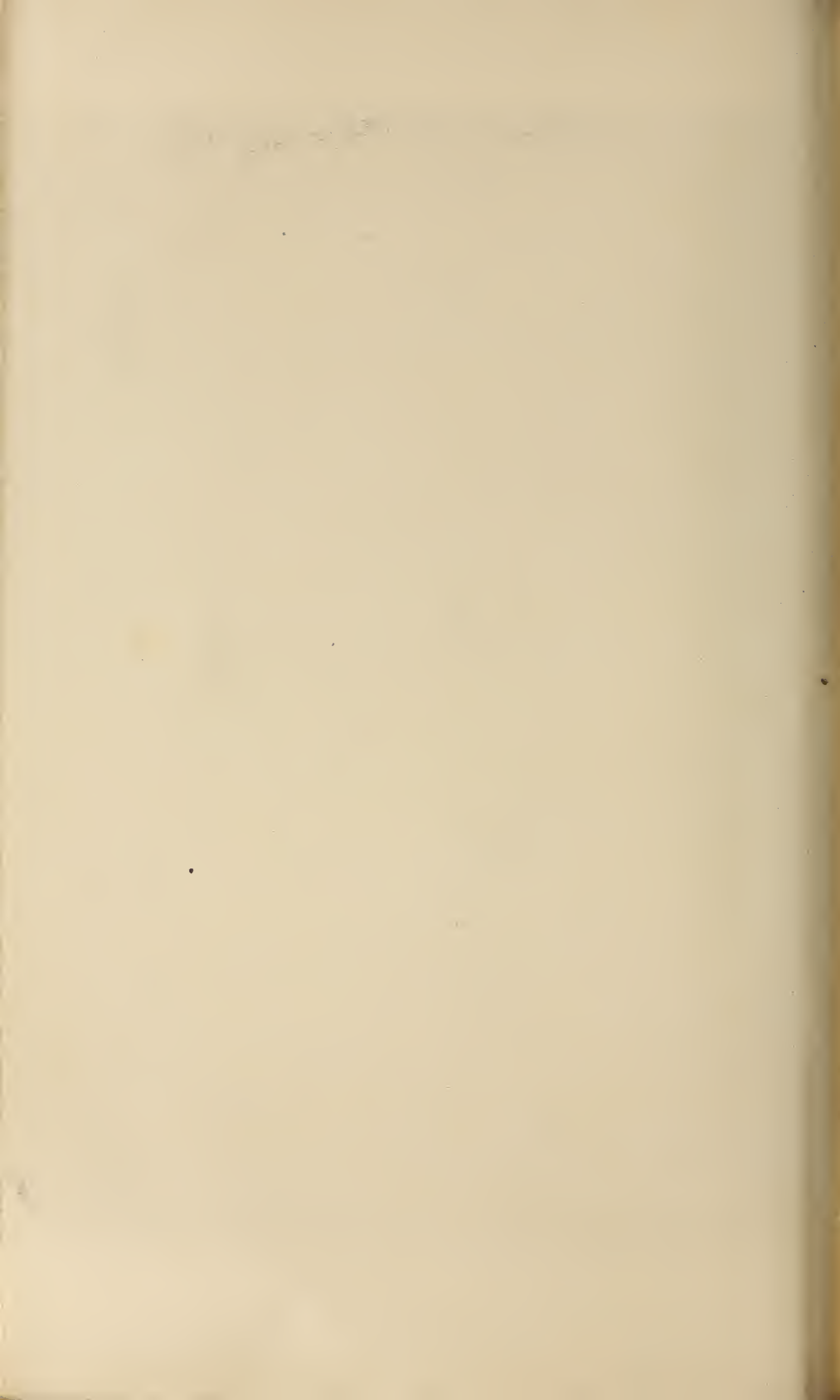




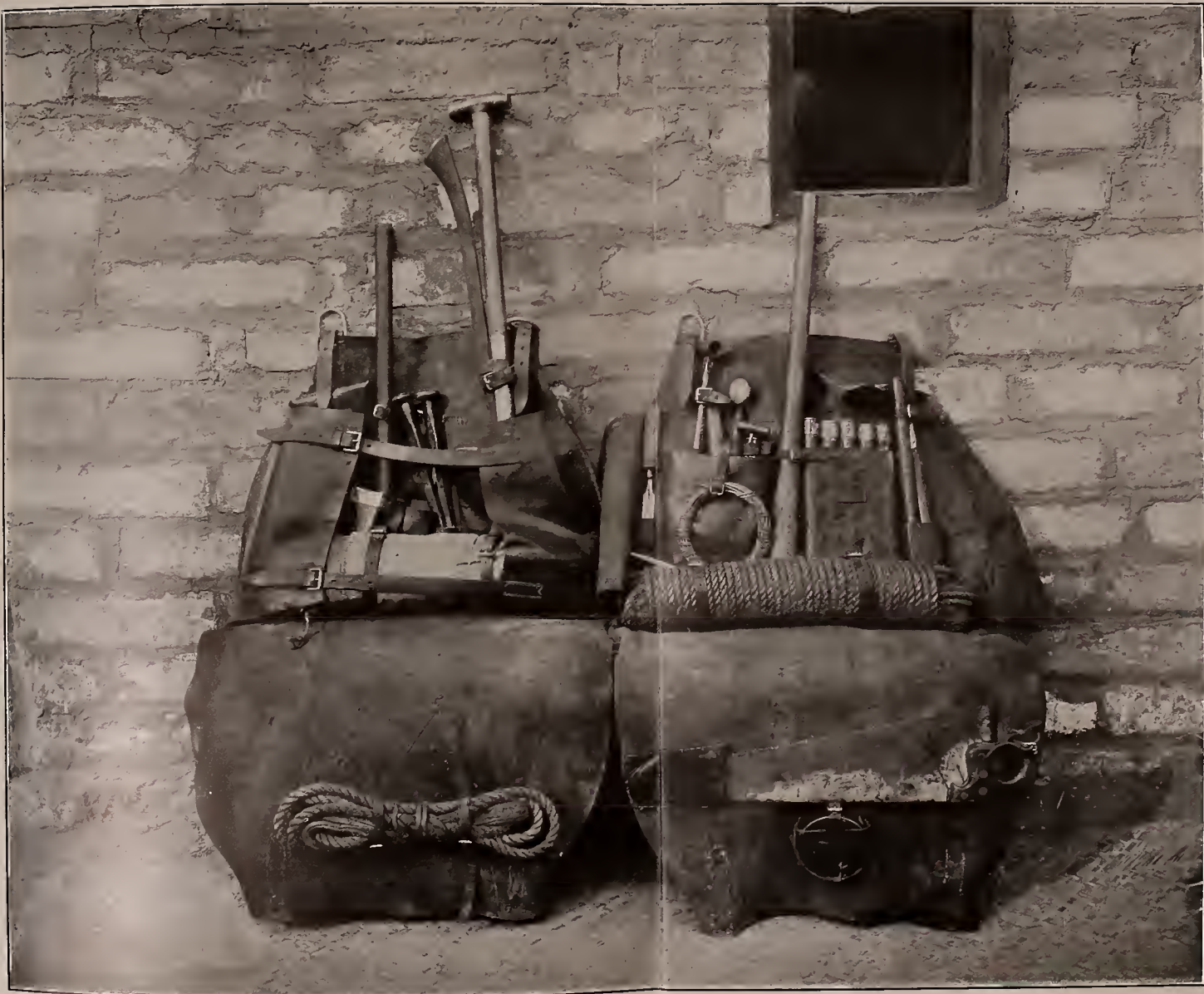








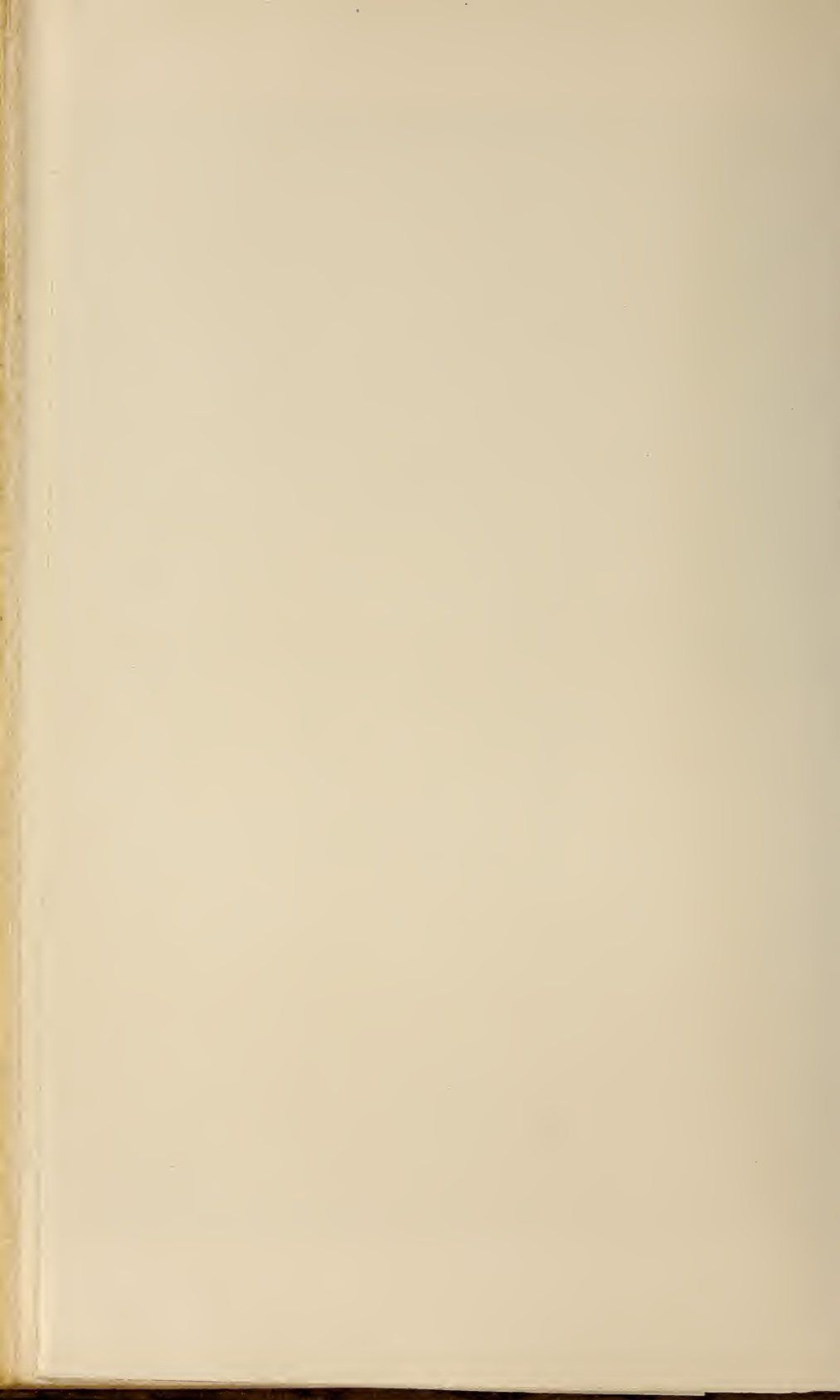




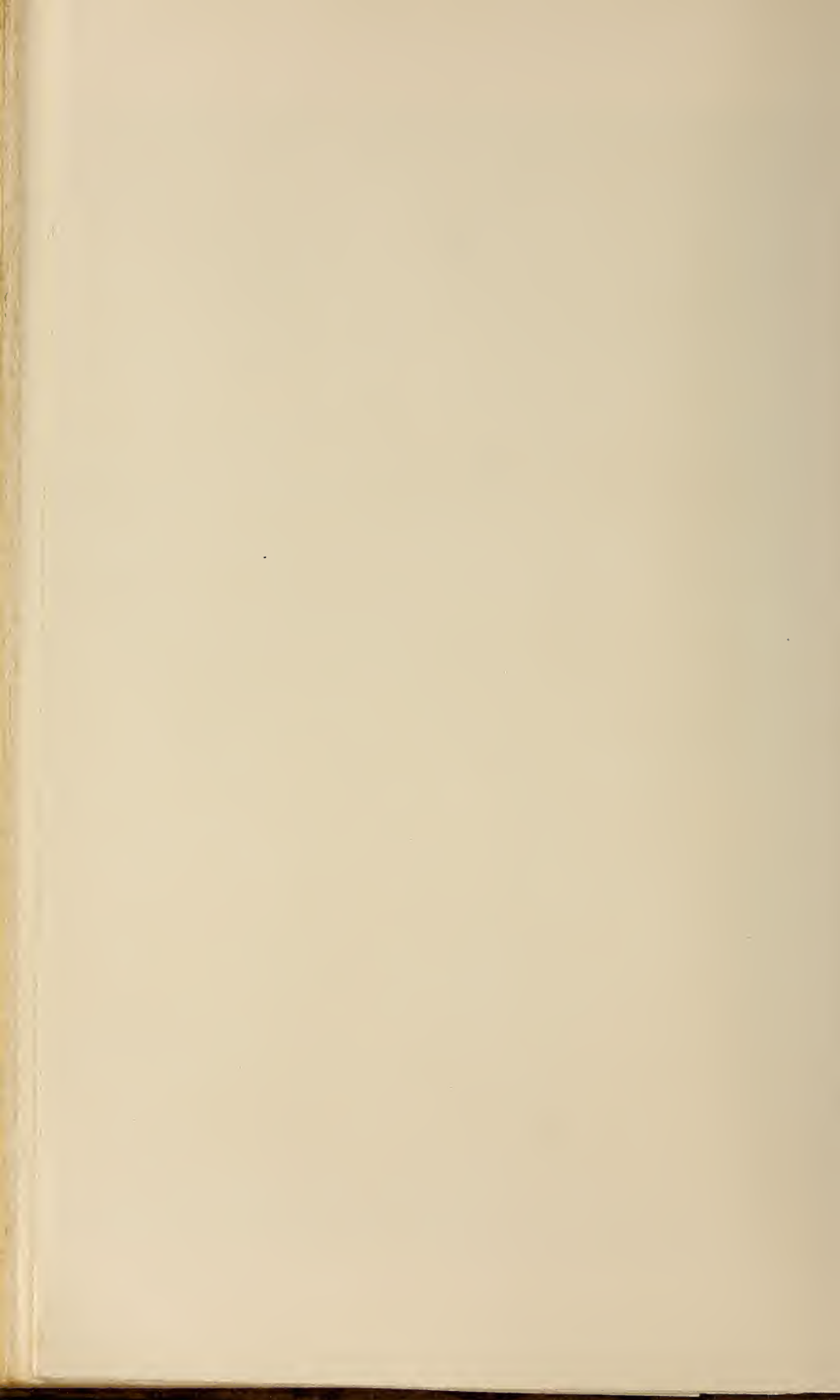


BRITISH TRANSPORTATION CART.

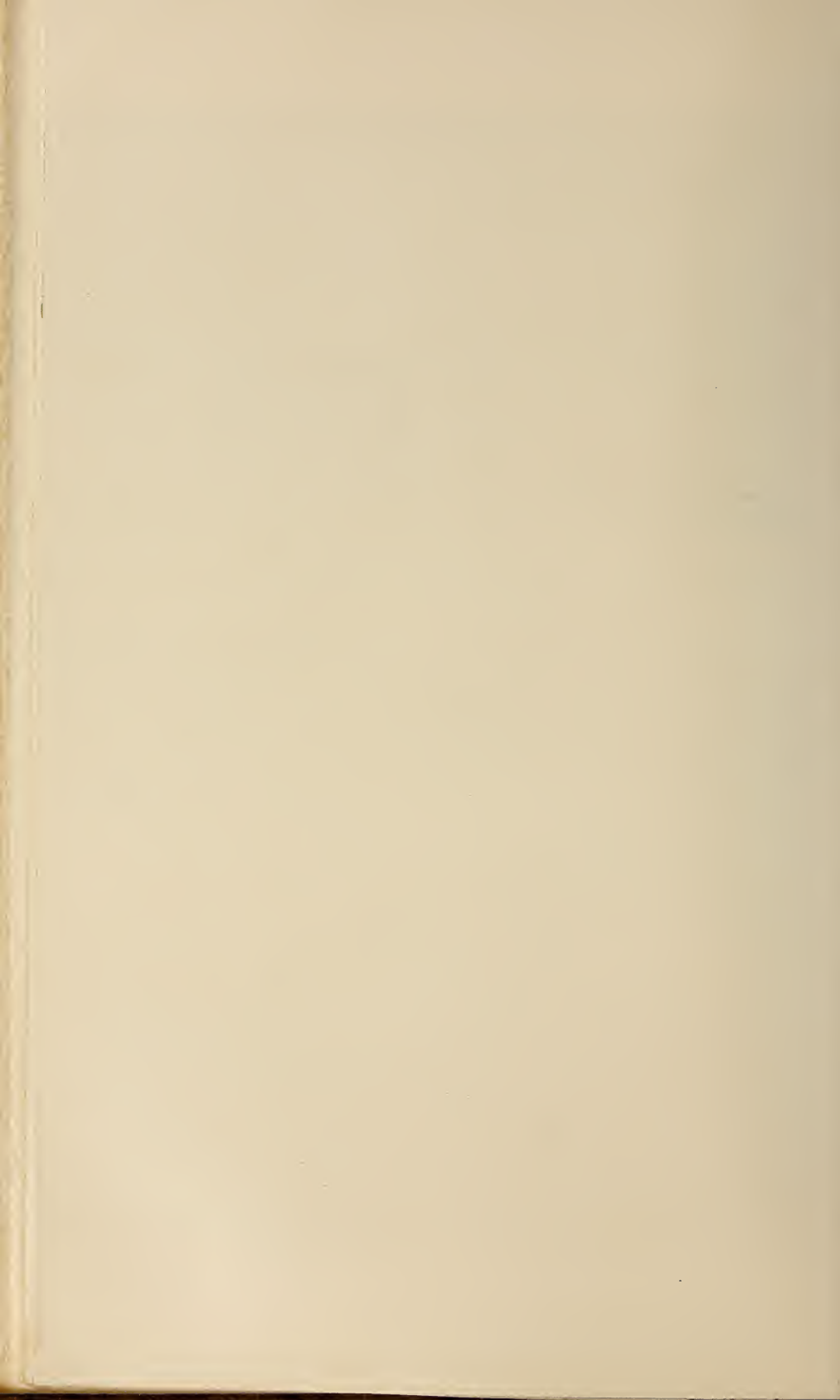


















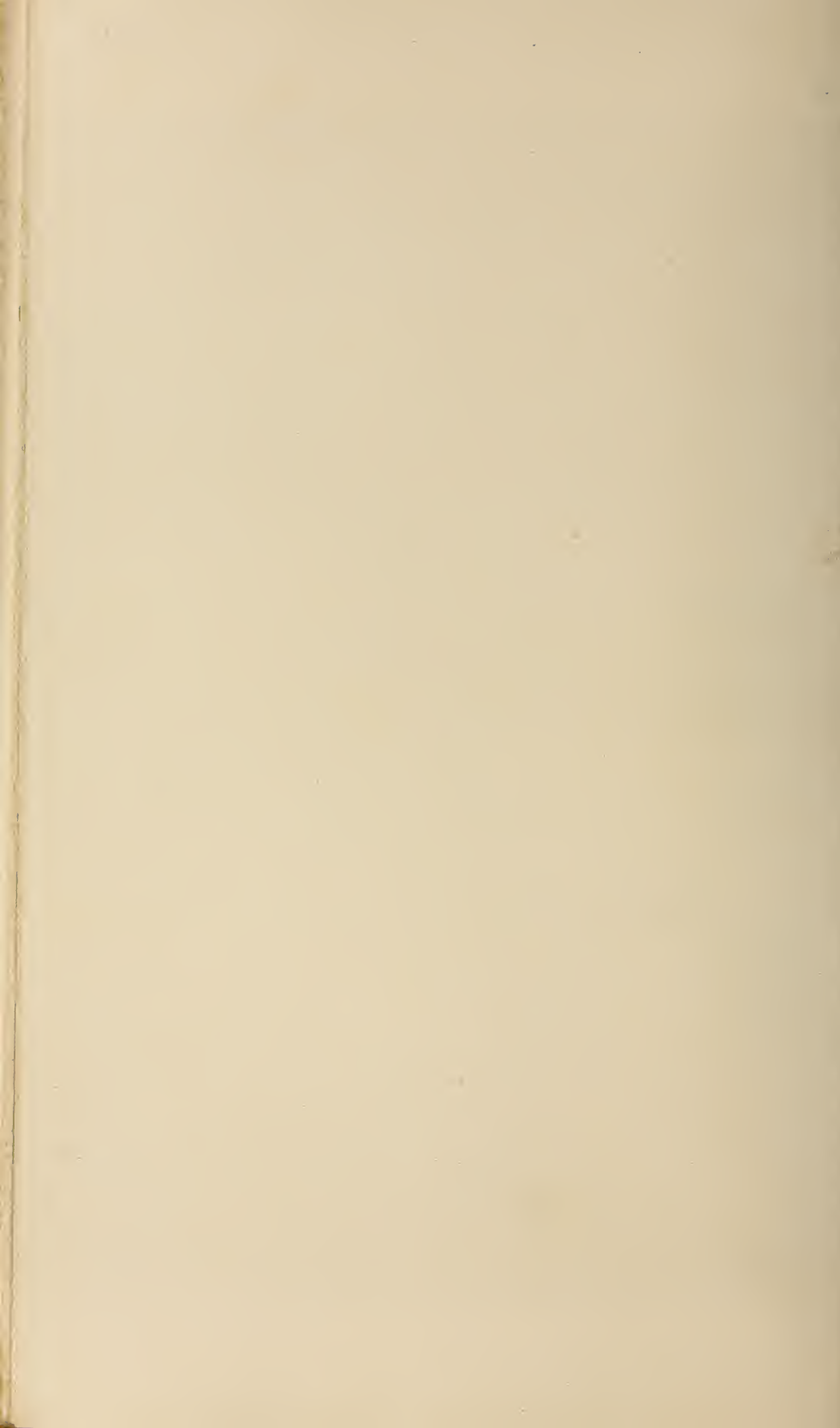




GERMAN PONTON WAGON CARRYING TWO HALF BOATS (ADVANCE GUARD), TIENSIN, 1900. FRONT VIEW.



171
GERMAN PONTON WAGON CARRYING TWO HALF BOATS (ADVANCE GUARD), TIENSIN, 1900. REAR VIEW.















JAPANESE ENGINEER SOLDIERS.



JAPANESE PACK HORSE.



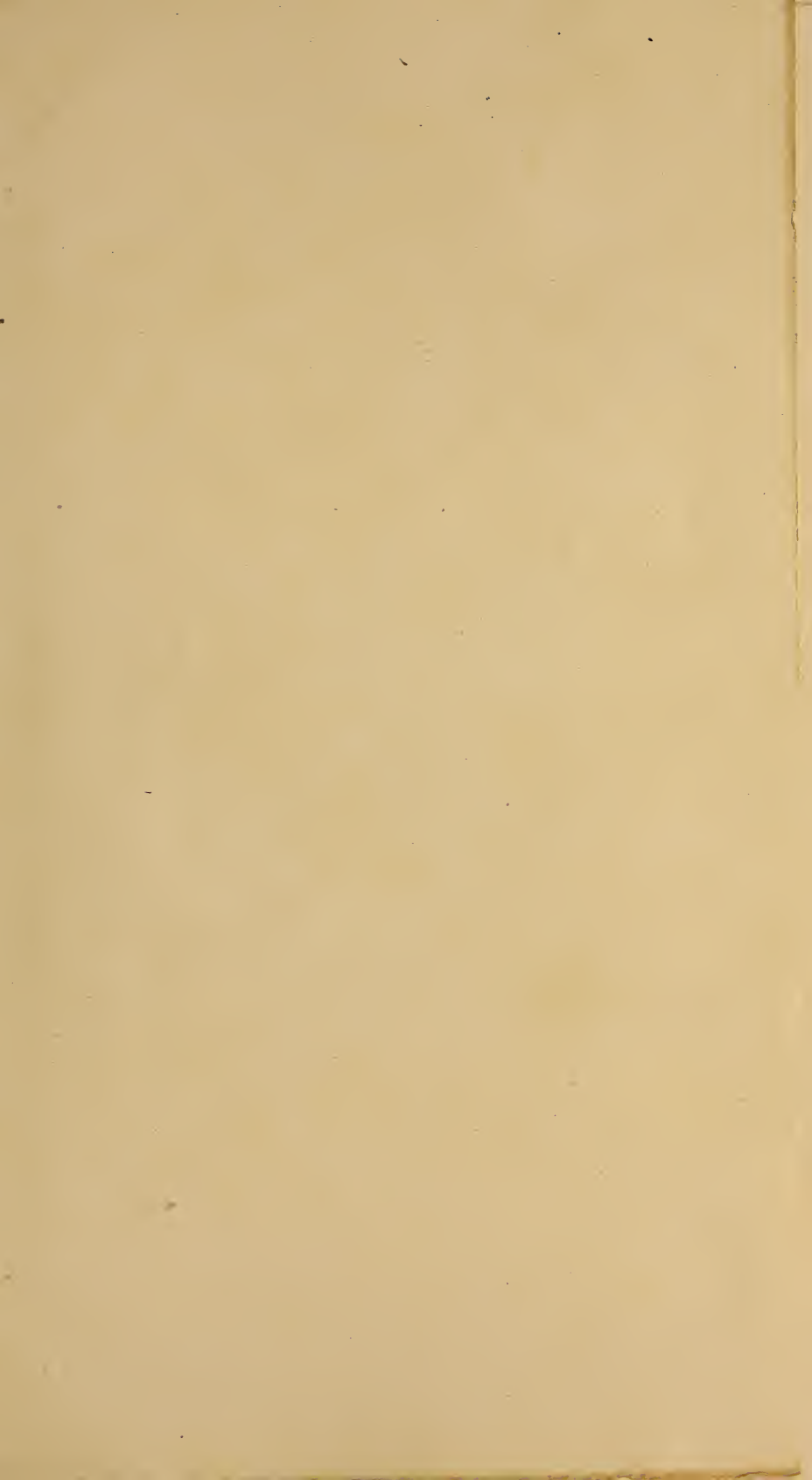




JAPANESE ENGINEER PACK HORSE, LOADED. CLASS 1. PICKS, SHOVELS, ETC.







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c.1

Ferguson, Harley Bascom

Report on the engineer equipment of
the allied troops:

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