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HANDBOOK

OF

FIRE-CONTROL EQUIPMENT FOR FIELD ARTILLERY

3513

TWENTY-TWO PLATES

AUGUST 31, 1916

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WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
Washington, August 31, 1916.

This manual is published for the information and government of the Regular Army and National Guard of the United States.

By order of the Secretary of War:

WILLIAM CROZIER,
Brigadier General, Chief of Ordnance.

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TOTAL ORDNANCE EQUIPMENT FOR THE HEADQUARTERS COMPANY OF A REGIMENT OF HEAVY, HORSE, OR LIGHT ARTILLERY.

(9)

Statement of total ordnance equipment for the headquarters company of a regiment.

Equipment.	Light artillery.	Horse artillery.	Heavy artillery.
Reel, complete	3	4	4
Cart, complete	3	4	4
Battery commander's telescope, model of 1915, complete [1]	3	4	4
Battery commander's rulers, wooden	30	40	40
Steel tape, 100 feet	3	4	4
Flash lights, with hoods	9	12	12
Harness, artillery, lead, set	3	4	4
Harness, artillery, wheel, set	3	4	4
Harness sacks	6	8	8
Set of blacksmith's tools [2]	1	1	1
Set of saddler's tools [3]	1	1	1
Set of carpenter's tools [4]	1	1	1
Cleaning and preserving material, set [4]	1	1	1
Saddler's material, set [5]	1	1	1
Arms, personal and horse equipment [6]	.....	.....	.....
Garrison equipment [7]	.....	.....	.....
Targets, mobile artillery [8]	.....	.....	.....
Flash targets [8]	.....	.....	.....
Smoke bomb, pole type [8]	.....	.....	.....

[1] One B. C. telescope, model of 1904 or 1905, complete, and 1 observation telescope, complete, may be issued in lieu of the B. C. telescope model of 1915.
[2] See page 15.
[3] See page 15.
[4] See pages 16.
[5] See pages 17.
[6] See page 14.
[7] See U. A. E. M. for Field Artillery.
[8] See G. O. No. 27 of 1914.

Statement of total headquarters company equipment of a regiment.

Light artillery.	Heavy and horse artillery.	Article.	Where carried.	Property classification. Class.	Property classification. Section.
		WHEELED MATÉRIEL.			
3	4	Reel			
3	4	Cart			
		TOOLS AND ACCESSORIES FOR REEL.			
3	4	Adjusting wrench	In tool box		
3	4	Chain repair block			
3	4	Lantern	In bracket		
3	4	Lantern-bracket pad			
3	4	Lock-washer holder	On left side of rail		
3	4	Oiler	In front of tool box on frame		
3	4	Lantern strap	In fasteners on bracket		
3	4	Pole prop	On cross rail front		
3	4	Spanner for 56-inch wheel	On left side of rail		
3	4	Seat cushion	On seat		
3	4	Tool wrapper containing—			
		1 socket wrench	In tool box		
		1 screw driver			
		1 wrench, 0.5 by 0.375			
		1 wrench, 0.75 by 0.625			
3	4	Screw driver, 3-inch blade			
3	4	Screw driver, 10-inch blade			
		Straps:			
3	4	Lock washer	In fasteners on vehicles		
3	4	Pole prop			
3	4	Spanner			
3	4	Wrench			
3	4	Neck yoke	On pole		
6	8	Singletrees	On double tree		
3	4	Wire guide	Fits in collar on the rear roller		
		SPARE PARTS FOR REEL.			
3	4	Adjusting-ring lock	In cart chest	IV	9
6	8	Adjusting-ring lock screws			
6	8	Crown nuts, 0.375 inch			
9	12	Crown nuts, 0.5 inch			
6	8	Crown nuts, 0.625 inch			
3	4	Doubletree bolt and nut			
3	4	Drum latch brake shoe			
3	4	Drum latch pawl spring			
3	4	Drum latch plunger spring			
6	8	Handy oilers, 0.312 $\frac{5}{16}$ inch			
9	12	Handy oilers, 0.375 inch			
3	4	Oiler spring			
6	8	Pintle-bearing bolts with nuts			
3	4	Pintle-latch spring			
3	4	Roller chain 67.5 long with cotter pin connection link.			
3	4	Roller chain 69.75 long with offset connecting link.			
		Roller chain parts:			
9	12	Cotter pin connecting link			
9	12	Roller link, complete, common.			
9	12	Offset connecting link			
18	24	Outside links, common			
		Split pins:			
18	24	0.093 $\frac{3}{32}$ by 1 inch			
30	40	0.125 by 1.25 inch			
9	12	0.156 $\frac{5}{32}$ by 1.5 inch			
3	4	0.25 by 2.25 inch			
1	1	Wheel, 56-inch, complete	Where most convenient		
3	4	Wheel fastening, complete	In cart chest		
3	4	Driving ring with pins			
24	32	Carriage bolts			
3	4	Pintle with bearing, complete			

Statement of total headquarters company equipment of a regiment—Continued.

Light artillery.	Heavy and horse artillery.	Article.	Where carried.	Property classification. Class.	Property classification. Section.
		TOOLS AND ACCESSORIES FOR CART.			
3	4	Ax	On right side of chest	IV	9
6	8	Dust guard for 56-inch wheel	On wheels	IV	9
6	8	Hatchet	On left and right sides of chest	IV	9
3	4	Paulin, 12 by 12 feet	On top of chest	IV	9
3	4	Pickax	On bottom of chest	IV	9
3	4	Picket rope	In straps on front of chest	IV	9
3	4	Shovel, short-handled	On top of chest	IV	9
3	4	Storage oil can	Inside of chest	IV	9
9	12	Watering buckets, canvas	On rear of chest	IV	9
3	4	Wireman's staff	By individual	IV	9
		Straps:			
3	4	Ax	In fasteners on vehicle	IV	3
3	4	Bucket	In fasteners on vehicle	IV	3
6	8	Grip	In fasteners on vehicle	IV	3
6	8	Hatchet	In fasteners on vehicle	IV	3
6	8	Paulin	In fasteners on vehicle	IV	3
3	4	Pick head	In fasteners on vehicle	IV	3
12	16	Picket rope	In fasteners on vehicle	IV	3
3	4	Pole prop	In fasteners on vehicle	IV	3
3	4	Shovel handle	In fasteners on vehicle	IV	3
3	4	Tripod (telescope)	In fasteners on vehicle	IV	3
		SPARE PARTS FOR CART.			
6	8	Brake shoe tap bolts	In chest	IV	9
3	4	Brake spring	In chest	IV	9
6	8	Rail bolts with nuts	In chest	IV	9
3	4	Lunette	In chest	IV	9
3	4	Lunette nut	In chest	IV	9
		FIRE-CONTROL EQUIPMENT.			
		Furnished by Ordnance Department.[1]			
30	40	B. C. rulers, wooden [2]	In cart chest	V	1
3	4	B. C. telescope, model of 1915, complete, in case.[3]	In cart chest	V	1
3	4	B. C. telescope tripod, in case [3]	In cart chest	V	1
9	12	Flash lights with hoods	....do	V	3
3	4	Steel tape, 100 feet	....do	V	1
		Furnished by Signal Corps.[4]			
		HARNESS.			
3	4	Lead harness, set	On horses	IV	8
3	4	Wheel harness, set	On horses	IV	8
6	8	Harness sacks	Not carried in field	IV	8

[1] F. A. plotter and case are not part of the regular equipment. Organizations having them may retain them, if desired.

[2] Metal B. C. rulers with cases are no longer part of the equipment. Those on hand may be retained.

[3] 1 B. C. telescope model of 1904 or 1905 with tripod and cases, and 1 observation telescope and tripod with cases may be issued in lieu of the B. C. telescope model of 1915, tripod and cases.

[4] For list of these parts see unit accountability equipment manual.

Statement of total headquarters company equipment of a regiment—Continued.

Heavy, horse and light artillery.	Article.	Where carried.	Property classification. Class.	Section.
	PERSONAL EQUIPMENT.			
	The equipment of the enlisted men will be as follows:			
	(*a*) For each enlisted man—			
1	Can, bacon	Carried by man	IX	1
[1] 1	Canteen, model of 1910			
[1] 1	Canteen cover, dismounted			
21	Cartridges, ball, pistol, or 20 cartridges, ball, revolver.	do	VII	2
1	Cup, model of 1910	do	IX	1
1	Fork			
1	Knife			
2	Magazines, pistol, extra, if pistol is used	do	VII	2
1	Meat can	do	IX	1
1	Pistol or revolver	do	VII	2
1	Pistol belt or revolver cartridge belt without saber ring.	do	IX	3
1	Pistol holster or revolver holster			
1	Spoon	do	IX	1
1	Pouch for first-aid packet			
1	First-aid packet (Medical Department) furnished by Quartermaster Corps—			
1	Identification tag	do		
1	Shelter tent, half			
1	Shelter-tent pole			
5	Shelter-tent pegs			
	(*b*) For each enlisted man individually mounted in addition to (*a*)—			
1	Currycomb	On horse	IX	5
1	Horse brush			
1	Link			
[2] 1	Saddle, McClellan, Field Artillery			
1	Saddlebags, pair			
1	Spurs, pair	Carried on man	IX	2
1	Spur straps, set			
1	Bridle, Field Artillery	On horse	IX	5
	(*c*) For each driver, in addition to (*a*)—			
1	Currycomb	On horse	IX	5
1	Horse brush			
1	Spurs, pair	Carried on man	IX	2
1	Spur straps, set			
	(*d*) For noncommissioned staff officers and drum major, in addition to (*a*)—			
1	Cavalry saber and scabbard, old model	By man	VII	5
1	Saber attachment	do	IX	2
1	Saber knot			
2	Saber straps	do	IX	5
	The revolver or pistol cartridge belt to be provided with a saber ring.			
	HORSE EQUIPMENT, FOR EACH HORSE.			
[3] 1	Halter tie rope	Carried on horse	IX	5
[3] 1	Halter headstall			
1	Feed bag			
1	Grain bag			
[3] 1	Saddle blanket			
1	Surcingle	On horse		
1	Horse cover	Not carried in field		
	MISCELLANEOUS EQUIPMENT.			
1	Marking outfit for stamping leather	Where convenient	X	5
1	Marking outfit for stamping metal	do		
1	Stencil outfit	do		
1	Stencils, personal equipment set	do		
1	Stencils, wagon set	do		
1	Pistol-cleaning kit	do	X	9

[1] Until these articles are supplied the canteen, cavalry and canteen strap, cavalry, may be used.
[2] Saddles to be equipped with two stirrup guidon sockets per regimental headquarters company.
[3] Part of harness for all draft horses.

Statement of total headquarters company equipment of a regiment—Continued.

Heavy, horse and light artillery.	Article.	Where carried.	Property classification. Class.	Section.
	BLACKSMITH'S TOOLS.[1]			
1	Anvil, 100 pounds		X	9
2	Apron, blacksmith's			
2	Bags, canvas, for nails			
1	Box, shoeing, leather			
1	Chisel, cold, 8-inch			
1	Chisel, handled for cold iron, 2 pounds			
1	Chisel, handled for hot iron, 1.5 pounds			
1	Clinching iron			
6	Drills, flat			
1	File, flat, 12-inch bastard, double cut			
1	Fire rake			
1	Fire shovel			
1	Flatter, handled, 1.5-inch square face			
1	Fore punch and creaser, double headed			
1	Forge, Empire, portable, modified for Army use			
1	Hammer, hand, 2 pounds			
1	Hammer, riveting, 1 pound 2 ounces			
1	Hammer, shoeing, 10 ounces			
1	Handle, file, aluminum			
1	Hardie, 0.75 square shank, 1.25 bit			
1	Cutting nippers, 14-inch			
1	Oiler			
1	Pritchel, 0.75 flats, 9-inch			
1	Punch, round, 0.375-inch			
1	Punch, round, 0.312($\frac{5}{16}$)-inch			
1	Nail punch			
1	Punch, square			
1	Ratchet drill for square shank drills			
5	Rivet sets, sizes 0.187 ($\frac{3}{16}$), 0.25, 0.375, 0.5, and 0.625.			
1	Rule, boxwood, 2-foot, 4 fold			
1	Screw plate, taps and dies, with tap wrench, including chest.			
2	Shoeing knives			
1	Shoeing pincers, 14-inch			
1	Shoeing rasp, 16-inch			
1	Sledge, 11 pounds			
1	Square			
1	Toe knife			
1	Tongs, horseshoers', 1.5 pounds, 12 inches			
1	Tongs, for 0.25 iron			
1	Tongs, for 0.5 iron			
1	Vise (for horse and light only)			
1	Vise (for heavy only)			
1	Whetstone, farriers, 10-inch			
1	Wrench, forge			
1	Wrench, screw, 12-inch			
	SADDLER'S TOOLS.[1]			
12	Awl blades, harness, assorted, Nos. 43 to 48 inclusive.	In saddler's chest		
1	Awl, pegging	do		
1	Awl, seat, handled	do		
1	Carriage, pricking, 3 wheels, Nos. 7, 8, and 10	do		
1	Compass, 6-inch	do		
1	Creaser, double, lignum vitae	do		
1	Edge tool, No. 1	do		
1	Edge tool, No. 2	do		
2	Extra blades with followers for draw gage	do		
1	Gage, draw, brass, without guard	do		
1	Hammer, No. 3, riveting	do		
1	Handle, peg, awl, with wrench	do		
2	Hafts, patent, awl, rosewood, with wrench	do		
1	Knife, round	do		
1	Knife, splitting, 6-inch	do		
1	Needle case, leather	do		
1	Needles, Glover's No. 3, paper	do		
2	Needles, harness, No. 4, papers	do		
2	Needles, harness, No. 5, papers	do		
2	Needles, harness, No. 6, papers	do		
12	Needles, sacking, assorted, sizes 4 and 4½ inches	do		
1	Nippers, cutting, 10-inch	do		
1	Oilstone, 1.125 by 2 by 8 Washita unmounted	do		

[1] A forge and battery wagon will be provided for these tools.

Statement of total headquarters company equipment of a regiment—Continued.

Heavy, horse and light artillery.	Article.	Where carried.	Property classification.	
			Class.	Section.
	SADDLER'S TOOLS—continued.			
1	Pliers, 6-inch	In saddler's chest		
4	Punches, hand, Nos. 5, 7, 8, and 10	do		
1	Punch, revolving, 4 tubes, Nos. 4, 5, 6, and 7	do		
1	Rivet set	do		
1	Rule, boxwood, 2-foot, 4-fold	do		
1	Screw driver, 3-inch blade, 8 inches over all	do		
1	Sewing palm, leather	do		
1	Shears, 10-inch bent trimmers	do		
1	Shoe knife, square toe	do		
1	Shoe knife, broad point	do		
1	Slicker, steel	do		
2	Thimbles, best aluminum lined, steel	do		
1	Tool claw	do		
1	Saddler's chest			
	CARPENTER'S TOOLS.[1]			
1	Ax, bench	In carpenter's chest		
2	Bags, canvas, for small stores	do		
1	Bevel, 8-inch, flush lever	do		
6	Bits, auger, sizes $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$ inches	do		
1	Bit, wood, countersink, $\frac{5}{8}$-inch diameter	do		
1	Bit, expansive, 2 cutters, $\frac{1}{2}$ to 3 inch	do		
3	Bits, screw driver, sizes $\frac{3}{8}$, $\frac{5}{8}$, and $\frac{3}{4}$ inch	do		
1	Brace, ratchet, 10-inch sweep	do		
3	Chisels, socket, framing, sizes $\frac{3}{4}$, 1, and $1\frac{1}{2}$ inch	do		
1	Divider, wing, 10-inch	do		
4	Drills, twist, sizes $\frac{6}{32}$, $\frac{7}{32}$, $\frac{8}{32}$, and $\frac{9}{32}$ inch	do		
1	File, 10-inch flat bastard	do		
6	Files, saw, sizes 4 and 6 inches	do		
1	Gage, marking, brass thumb screw, shoe and face	do	X	9
2	Gouges, socket firmer, sizes $\frac{1}{2}$ and 1 inch	do		
1	Hammer, claw, adze eye, bell face, 1 pound 4 ounces.	do		
1	Handle, tool, containing 10 tools	do		
2	Handles, file, aluminum alloy	do		
1	Knife, drawing, 9-inch blade	do		
1	Mallet, $2\frac{3}{4}$ by 5 inches	do		
1	Nail set	do		
1	Oiler	do		
1	Oilstone, unmounted, 1 by 2 by 8 inches, Arkansas, soft.	do		
1	Pincers, small, 8-inch	do		
1	Plane, jack, wood, 16-inch, $2\frac{1}{4}$-inch double bit	do		
1	Plane, smoothing, wood, 8-inch, 2-inch double bit.	do		
1	Plate, auger handle	do		
1	Rasp, wood, 10-inch, half round	do		
1	Reamer, half round, for wood or soft metal	do		
1	Rule, boxwood, 2-foot, 4-fold	do		
1	Saw, crosscut, 24-inch, 7-point	do		
1	Saw, rip, 24-inch, 5-point	do		
1	Saw set	do		
1	Screw driver, 5-inch blade, 10 inches over all	do		
1	Spoke shave, adjustable, raised handle, $2\frac{1}{8}$-inch cutter.	do		
1	Square, steel, 12-inch body, 8-inch tongue	do		
1	Tape line, linen, metallic warp, 100 feet, marked 12 ths.	do		
1	Vise, table, $2\frac{1}{2}$-inch jaws, 3-pounds	do		
1	Wrench, screw, 12-inch	do		
	MATERIALS FOR CLEANING AND PRESERVATION. [All expendable.]			
1	Brush, camel's hair, No. 1, round			
1	Brush, sash, No. 3			
1	Brush, varnish, No. 5–0			
$\frac{1}{2}$	Cloth, emery, No. $\frac{1}{2}$, quire		X	10
$\frac{1}{2}$	Cloth, emery, No. 0, quire			
$\frac{1}{2}$	Cloth, No. 00, quire			
1	Cosmic, No. 80, soft, quart			

[1] A forge and battery wagon will be provided for these tools.

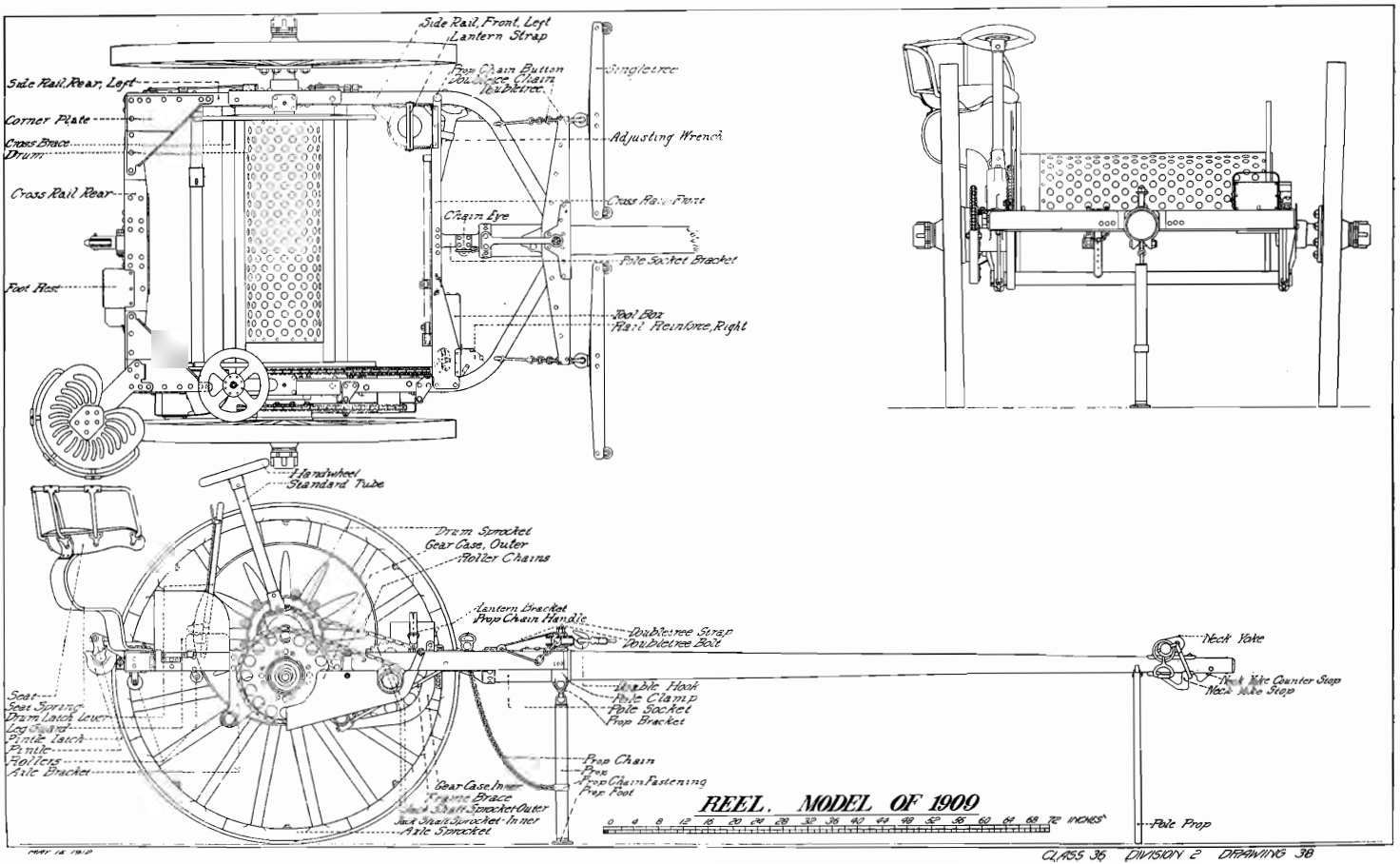
Statement of total headquarters company equipment of a regiment—Continued.

Heavy, horse, and light artillery.	Article.	Where carried.	Property classification.	
			Class.	Section.
	MATERIAL FOR CLEANING AND PRESERVATION—continued.			
1	Chamois skin		X	10
1	Dressing, russet leather, box			
1	Lye, powdered, can			
10	Naphthalene, pounds			
1	Oil, clock, ounce			
½	Oil, linseed, boiled, gallons			
3	Oil, lubricating (engine No. 1), gallons			
5	Oil, neat's-foot, gallon			
1	Oil, sperm, pint			
1	Oil, coal, gallon			
10	Paint, olive-drab, second coat, pounds			
10	Paint, olive-drab, third coat, pounds			
1	Primer, brown enamel, quart			
10	Sal soda, pounds			
½	Sandpaper, No. 2½, quire			
½	Sandpaper, No. 1½, quire			
20	Soap, castile, pounds			
3	Soap, H. and H., cakes or "paco"			
20	Soap, saddle, Frank Miller's, pounds			
75	Sponges, 5 inches			
3	Sponges, 5½ or 6 inches			
1	Turpentine, gallon			
3	Waste, cotton, pounds			
9	Everready tungsten batteries, No. 793			
3	Everready, 2.7-volt, Mazda bulb, No. 1197			
	SADDLERS' MATERIAL.[1] [All expendable.]			
3	Awl blades, harness, assorted		X	9
1	Awl haft, patent, with wrench			
4	Buckles, bar, 1-inch, Saalbach		X	10
4	Buckles, bar, tongueless, ⅝-inch			
16	Buckles, bar, tongueless, 1-inch			
4	Buckles, bar, tongueless, 1½-inch			
34	Buckles, center bar, ⅝-inch			
14	Buckles, center bar, ¾-inch			
8	Buckles, center bar, ⅞-inch			
4	Buckles, center bar, 1-inch			
8	Buckles, center bar, 1¼-inch			
8	Buckles, center bar, 1⅜-inch			
5	Buckles, roller, ⅝-inch			
1	Buckle, roller, ¾-inch			
4	Buckles, roller, ⅞-inch			
1	Buckle, roller, 1-inch			
8	Buckles, roller, 1¼-inch			
1	Buckle, roller, 1½-inch			
4	Buckles, satchel, ½-inch			
7	Buckles, wire, ½-inch			
3	Buckles, wire, ⅝-inch			
30	Buckles, wire, ¾-inch			
7	Cheek, "D"			
3	Conway loop, ⅛-inch			
15	Duck, cotton, olive drab, 22-inch, No. 1, yards			
12	End buckle, 1-inch			
6	End clip, ⅝-inch			
22	End clip, 1-inch			
16	End clip, 1½-inch			
8	Foot staples, high		IX	5
16	Foot staples, low			
8	Foot staples, semicircular			
1	Hook, back strap		IV	8
1	Hook, breast strap			
1	Hook, collar strap			
1	Hook, side strap			
3	Hook, wire (for link)		IX	1
2	Leather, bridle, backs		X	10
2	Leather, collar, backs			
60	Leather, harness, backs, pounds			

[1] Carried where convenient.

Statement of total headquarters company equipment of a regiment—Continued.

Heavy, horse, and light artillery.	Article.	Where carried.	Property classification. Class.	Section.
	SADDLERS' MATERIAL—continued.			
6	Nails, saddle			
1	Needles, glover's No. 3, paper			
1	Needles, harness, No. 4, paper		X	9
1	Needles, harness, No. 5, paper			
1	Needles, harness, No. 6, paper			
5	Ornaments, brow band			
7	Ovals, saddle		IX	5
4	Ovals, saddle-bag			
1	Pin, screw, brass, ¾-inch, No. 2, gross			
8	Rings, ⅞-inch diameter, saddle-bag			
1	Ring, 1-inch diameter, rifle scabbard			
16	Rings, 1¼-inch diameter, saddle			
1	Ring, 1⅝ inch diameter, back strap			
4	Rings, 1¾ inch diameter, throat strap			
1	Ring, 1¾ inch diameter, breeching			
8	Rings, 2-inch diameter, halter			
8	Rings, 4-inch diameter, quarter strap		IX	10
8	Rings, "D," 1-inch diameter, feed bag			
1	Ring, "D," 1⅛-inch diameter			
1	Ring, "D," 1¾-inch diameter			
1	Ring, "D," 2-inch diameter, special			
½	Rivets and burs, brass, ⅜-inch, No. 12, pounds			
½	Rivets and burs, brass, ⅝-inch, No. 10, pounds			
½	Rivets and burs, brass, 1-inch, No. 8, O. H., pounds			
1	Roller, lead rein			
470	Rope, ½-inch, halter, feet		IV	8
1	Screw, brass, 1-inch, No. 6, gross		X	10
6	Sheepskins, with wool on			
1	Shield, saddle, 11-inch		IX	5
1	Shield, saddle, 11½-inch			
2	Shield, saddle, 12-inch			
4	Snap hook, canteen, cavalry			
1	Snap hook, covert, ⅞-inch			
1	Snap, covert, 1-inch			
4	Snap, German, ⅞-inch			
4	Snap, swivel, 1-inch, No. 16			
8	Snap, German, 1-inch		IX	5
20	Squares, halter			
1	Strap loop, coupling ⅞-inch			
8	Strap loop, feed bag			
1	Stud hook			
4	Studs, saddle bag			
1	Thimble, aluminum-lined steel, 0.75-inch			
1	Thread, shoe, No. 3, brown, pounds			
1	Thread, shoe, No. 10, brown, pounds			
½	Wax, stitching, brown, pounds		X	10
6	Webbing, olive drab, cotton, heavy, ⅞-inch, yards			
27	Webbing, olive drab, cotton, heavy, 1-inch, yards			
9	Webbing, olive drab, halter, 1½-inch, yards			
12	Webbing, olive drab, jute, 3½-inch, yards			
	For polo equipment.			
2	Buckles, wire, ½-inch			
2	Buckles, wire, ⅝-inch			
12	Buckles, wire, ¾-inch		X	10
4	Buckles, wire, ⅞-inch			
2	Buckles, stirrup strap, 1⅜-inch			
6	Buckles, girth, 1-inch			
4	Rings, ⅞-inch diameter		IX	5
5	Web, linen straining, 3½-inch, yards		X	10
7	Web, linen straining, 5-inch, yards			


Side Rail, Front, Left
Lantern Strap
Prop Chain Button
Doubletree Chain
Neckstrap
Singletree
Side Rail, Rear, Left
Corner Plate
Cross Brace
Drum
Adjusting Wrench
Cross Rail, Front
Cross Rail Rear
Chain Eye
Pole Socket Bracket
Foot Rest
Tool Box
Rail Reinforce, Right
Handwheel
Standard Tube
Drum Sprocket
Gear Case, Outer
Roller Chains
Lantern Bracket
Prop Chain Handle
Doubletree Strap
Doubletree Bolt
Neck Yoke
Neck Yoke Counter Step
Neck Yoke Step
Pole Hook
Pole Clamp
Pole Socket
Prop Bracket
Seat
Seat Spring
Drum Latch Lever
Leg Board
Pintle Latch
Pintle
Rollers
Axle Bracket
Prop Chain
Prop
Prop Chain Fastening
Prop Foot
Gear Case, Inner
Truss Brace
Jack Shaft Sprocket, Outer
Jack Shaft Sprocket, Inner
Axle Sprocket
Pole Prop
REEL, MODEL OF 1909
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64 68 72 INCHES

REEL, MODEL OF 1909.

[Plate 1.]

NOMENCLATURE OF PARTS.

No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
2	Wheels		IV	9
2	Wheel fastenings, complete			
2	Axle arms	Riveted to axle brackets		
2	Axle arm plugs	In axle arms		
1	Axle bracket, left	Riveted to side rails		
1	Axle-bracket cap, left	Bolted to axle bracket		
1	Axle bracket, right	Riveted to side rails		
1	Axle-bracket cap, right	Bolted to axle bracket		
4	Axle-bracket cap bolts, short	Secure caps to brackets		
2	Axle-bracket cap bolts, long			
2	Axle-bracket cap bolts, right			
1	Side rail, rear, left			
1	Side rail, front, left			
1	Side rail, rear, right			
1	Side rail, front, right			
1	Cross rail, rear	Riveted to side rails		
1	Cross rail, front			
1	Cross rail, reinforce	Riveted to cross rail rear		
1	Rail reinforce, left	Riveted to side rail and front cross rail		
1	Rail reinforce, right			
1	Oiler spring	Riveted to rail reinforce, right		
16	Separators	Riveted to side rails		
1	0.312 ($\frac{5}{16}$) separator	Riveted to left front side rail		
6	0.375 separators	Riveted to front side rails		
1	Tool-box hinge plate	Riveted to front cross rail and rail reinforce, right.		
2	Frame braces, right and left, with 4 nuts	Braces frame and axle brackets		
2	Cross braces	Between axle brackets		
4	Cross-brace nuts	On ends of cross braces		
2	Corner plates, right and left	On rear corners of frame		
1	Pintle seat	Riveted to rear cross rail		
1	Pintle bearing (in 2 parts)	Bolted into pintle seat		
2	Pintle-bearing bolts and nuts	Secure pintle bearing to seat		
1	Pintle	Seated in pintle bearing		
1	Pintle latch	On pintle		
1	Pintle-latch pin	Forms pivot of latch		
1	Pintle-latch spring	On pintle		
1	Pintle-latch rivet	Secures spring in latch		
1	Pintle spring	In pintle bearing		
1	Pintle spring pin	Hold pintle spring in place		
1	Pole-socket bracket	Riveted to cross rail, front		
1	Pole socket	Riveted to pole-socket bracket		
1	Pole pin	Secures pole in pole socket		
1	Pole-pin reinforce	Riveted to pole socket		
1	Pole clamp	Riveted to side rails		
1	Pole-clamp bolt	Clamps pole		
1	Pole, complete			
1	Prop, complete, includes—			
1	Prop tube			
1	Prop foot	Riveted on lower end of prop tube		
1	Prop eye	Riveted on upper end of prop tube		
2	Prop brackets	On pole clamp bolt		
1	Prop chain	Fastened to prop-chain fastening		
1	Prop-chain fastening	Riveted on prop tube		
1	Prop chain handle	On end of chain		
1	Prop-chain eye	Riveted on pole-socket bracket		
1	Prop-chain button	Riveted on joint of front cross rail and side rail.		
1	Doubletree	Same as on limber		
1	Doubletree strap	Riveted to pole-socket bracket		
1	Doubletree bolt and nut	In seat in pole clamp		
2	Doubletree chains	Connect ends of doubletree to frame		
1	Seat	Riveted to seat spring		
1	Seat spring	Riveted to frame		
2	Seat-rail feet, right and left	Riveted to seat		

PROPERTY OF U. S. ARMY

Nomenclature of parts—Continued.

No.	Name of part.	Location, etc.	Property classification. Class.	Property classification. Section.
1	Seat rail	Attached to seat-rail feet and seat-rail support.		
3	Seat-rail supports	Riveted to seat		
1	Seat reinforce			
1	Seat brace	Riveted to seat and seat spring		
1	Leg guard	Riveted to side rail, rear, right		
1	Foot rest	Riveted to cross rail, rear		
1	Drum complete, includes—			
1	Drum body			
12	Joint plates	Riveted to body		
1	Drum brace	In middle of drum		
1	Drumhead, right	In end of drum		
1	Drumhead, left			
1	Drumhead bushing, right	In drumhead, right		
1	Drumhead bushing, left	In drumhead, left		
2	Drum end plates, right and left	On ends of drum		
6	Toggle brackets, right and left	Riveted on drumhead, right		
1	Friction disk	On drum axle		
1	Friction-disk bushing	In friction disk		
1	Sprocket ring	On drum axle		
1	Sprocket-ring bushing	In sprocket ring		
1	Drum sprocket	On sprocket ring		
4	Drum-sprocket screws	Fastens drum sprocket to ring		
1	Adjusting ring	Screwed into drumhead, right		
3	Adjusting-ring locks	On drumhead, right		
3	Adjusting-ring lock screws	Fasten adjusting-ring lock to drumhead, right.		
1	Filler ring	Screws into clutch spider		
1	Screw	In filler ring and clutch spider		
1	Clutch spider	On drum axle		
2	Sliding keys	In clutch spider, slide with sleeve		
3	Radial links	Pivoted to clutch spider		
12	Toggle links	Connect radial links with toggle brackets and friction disk.		
3	Link pins	For clutch spider		
3	Link pins, short	For toggle links		
6	Link pins, long			
1	Relief spring	Between friction disk and sprocket ring		
1	Sleeve	In drum axle		
1	Drum axle	Supports drum in axle brackets	IV	9
2	Stoppers	In end of drum axle		
1	Sleeve bevel gear	In drum axle, screws on sleeve		
1	Standard support	Screws into axle-bracket cap		
1	Support bushing	In standard support		
1	Standard tube	Riveted into standard support		
1	Hub bearing	Riveted on top of standard tube		
1	Handwheel shaft	Turns in standard support		
1	Shaft bevel pinion	Meshes with sleeve bevel gear		
1	Handwheel spindle, with nut	Riveted in top of handwheel shaft		
1	Handwheel hub	On handwheel spindle		
1	Handwheel plate	Riveted to handwheel hub		
1	Handwheel rim	Riveted to handwheel plate		
1	Binding-post block	On left drumhead		
2	Block bolts, with nuts	Secure block to drumhead		
4	Washers	On block bolts		
2	Binding posts, with nuts	In binding-post block		
2	Telephone connections	On binding post		
1	Wire clamp			
1	Wire-clamp bolt and nut			
3	Wire clips	On left drum end plate		
1	Driving gear complete includes—			
1	Driving ring	Bolted to wheel hub		
4	Driving pins	Riveted to driving ring		
8	Carriage bolts, with nuts	Secure driving ring to hub		
1	Axle-sprocket hub	On axle bracket, right		
1	Axle-sprocket hub bushing	In axle-sprocket hub		
1	Axle sprocket	Bolted to axle-sprocket hub		
4	Cover plates			
8	Axle-sprocket bolts, with nuts	Secure axle sprocket, hub, and cover plates		
1	Axle-sprocket retainer	Secures axle sprocket to axle bracket, right		
2	Axle-sprocket retainer bolts, short, with nuts.	Secure axle-sprocket retainer to axle bracket, right.		
4	Axle-sprocket retainer bolts, long, with nuts.			
1	Jack-shaft frame	In side rail, front, right		
4	Jack-shaft frame bolts, short and long, with nuts.	Secure jack-shaft frame to side rail		
1	Chain tightener, with nut	In jack-shaft frame		
1	Jack shaft			

Nomenclature of parts—Continued.

No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
	Driving gear complete includes—Con.			
1	Jack-shaft sprocket, outer	On jack shaft		
1	Semicircular key	Keys sprocket, outer, to jack shaft		
1	Jack-shaft nut	On jack shaft		
1	Jack-shaft sprocket, inner	Riveted to jack shaft		
1	Gear case, outer	Bolted to gear-case supports		
1	Gear case, inner	Bolted to gear-case supports, eyebolt		
3	Gear-case bolts, with nuts			
1	Gear-case bolt, outer, with nut	Secures gear case, outer, flanges		
1	Gear-case separator	Between gear case, outer, flanges		
1	Gear-case bolt, inner, with nut	Secures gear case, inner, to eyebolt		
1	Eyebolt	Bolted to cross brace		
2	Gear-case straps, front and rear	Braces gear case, outer, to axle bracket, right.		
2	Gear-case strap bolts			
2	Gear-case supports, front and rear	Riveted to side rails, front		
1	0.75 pitch roller chain, 0.375 wide	Connects axle sprocket with jack-shaft sprocket, outer.		
1	0.75 pitch roller chain, 0.375 wide	Connects jack-shaft sprocket, inner, with drum sprocket.		
	Rollers, complete, consisting of—			
1	Forward roller	Behind drum between side rails		
2	Forward roller end plates	On ends of forward roller		
1	Forward roller bracket, right	Riveted to side rail		
1	Forward roller bracket, left			
4	Roller studs	In ends of front and rear rollers		
1	Rear roller	Below cross rail, rear		
2	Rear roller end plates	On end of rear rollers		
1	Rear roller bracket, right	Riveted to side rail		
1	Rear roller bracket, left			
1	Collar	On roller, holds wire guide		
1	Drum latch, complete, includes—			
1	Drum-latch bracket	Riveted to side rail		
1	Drum-latch bearing	Between bracket and leg guard		
1	Drum-latch bearing cap			
2	Drum-latch bearing bolts, short and long, with nuts.	Secure bracket, bearing, cap, and leg guard		
1	Drum-latch bearing bolt-washer	On long drum-latch bearing bolt		
1	Drum-latch lever	In drum-latch bearing	IV	9
1	Drum-latch segment	Riveted to leg guard		
1	Drum-latch block	Riveted to right drum end plate		
1	Drum-latch handle	Pinned to lever		
1	Drum-latch pawl rod	Pinned to handle		
1	Drum-latch pawl	Pinned to rod		
2	Drum-latch handle pins	Form pivots in handle		
1	Drum-latch pawl spring	On pawl rod		
1	Drum-latch plunger	In lever		
1	Drum-latch plunger spring	On drum-latch plunger		
1	Drum-latch brake shoe	On lever		
1	Drum-latch brake-shoe pin	Secure shoe to lever		
	Lantern bracket, complete, includes—			
1	Lantern-bracket bottom	Riveted to frame		
1	Lantern-bracket back	Riveted to bottom		
1	Lantern-bracket front	Riveted to back and cross rail, front		
2	Lantern-strap fasteners	Riveted to bracket		
	Tool box, complete, includes—			
1	Tool-box hinge plate	Riveted to cross rail, front		
1	Tool-box door	Riveted to hinge plate		
1	Tool-box hinge	Connects door and hinge plate		
1	Lock pin	Secured to upper lock-chain eye		
2	Padlock-chain rivets	On cross rail, front		
1	Padlock, bolt snap and chain			
1	Oil hole spring cover	On axle sprocket hub		
1	Name plate	On cross rail, front		
	Implement attachments:			
1	Pole-prop bracket No. 1	Riveted to front cross rail		
1	Pole-prop bracket No. 2			
1	Oiler spring	Riveted to right rail reinforce		
1	Lock-washer holder support	Riveted to left axle bracket		
1	Lock-washer holder clip	Riveted to left side rail		
1	Spanner support	Riveted to left axle bracket		
1	Spanner holder	Riveted to left side frame		
1	Spanner-strap fastener			
1	Lock washer holder strap fastener			
1	Wrench clip	Riveted to cross rail, front		
1	Adjusting-wrench strap fastener	On leather bracket		

DESCRIPTION OF REEL, MODEL OF 1909.

[Plate 1.]

The principal parts of the reel are the wheels, axle, frame, drum, sprockets, jack shaft, clutch, drive chains, pole, prop, doubletree and singletrees, neck yoke, pintle and pintle bearing, drum latch, and operator's seat.

The reel is designed to carry, lay, and recover up to 3 miles of the twin-conductor cable adopted for fire-control service. The action is as follows: In laying the cable the drum is left free to revolve upon its axis subject to control by the braking action of the drum latch or of the clutch when applied for that purpose. In recovering the cable the drum is geared to the right wheel by the engagement of the clutch and revolves, winding up the cable as the vehicle is driven along it.

The wheels, wheel fastenings, pole, neck yoke, doubletree and singletrees are identical with those on the carriage. The wheels are 56 inches in diameter.

The axle consists of three parallel tubes with ends firmly fixed in axle brackets, in the middle of which are set the axle arms. The uppermost of the three parallel tubes is of forged steel No. 3 and is finished all over. In finishing this part the bore must be concentric with the exterior, the slots for the sliding keys of the clutch must be truly opposite each other and centrally located, the finish must be smooth, and all burrs formed inside in drilling the oil holes, etc., removed. The axle brackets are of forged steel No. 2 or of cast steel No. 2. The axle arms are of forged steel No. 3. The axle bracket is attached by shriking it onto the axle arm.

The side rails, together with the cross rails, front and rear, pole socket, pole clamp and pole-socket brace, rail reinforces, pintle seat, pintle bearing, and frame braces, constitute the frame.

The side rails front are riveted in seats in the axle brackets and are parallel to a point in front of the jack shaft where they are connected by the cross-rail front. Beyond this point the side rails converge and are assembled to the forged-steel pole clamp which forms the front end of the frame. The attachment of the cross-rail front to the side rails is braced and strengthened by flange-steel reinforce and by a lantern bracket. A tool box with a hinged door is formed in the cross rail.

The pole clamp contains a tapering flange-steel pole socket whose rear end is closed and braced to the cross-rail front with a bronze pole-socket bracket. The pole socket is arranged with a pole pin to retain the pole in place and to prevent it from turning.

On the lower side of the pole clamp is an eye into which is welded the upper end of the prop. When not in use this prop is swung up under the frame by a chain attached to its lower end and running

up through an eye riveted on the pole-socket bracket, and is held in that position by hooking the chain handle over a button provided for the purpose.

In rear of the axle the rear ends of the side rails are connected by a heavy cross rail having in its middle a forged-steel seat for the pintle bearing. The rear cross rail is reinforced where cut out for the pintle bearing. The pintle is provided with a semiautomatic latch. It is given an all-round swiveling motion in its bearing to reduce the stresses on the frame of the cart when traveling over uneven ground. Beneath the rear cross rail is a wooden roller to protect the insulation of the cable as it is paid out under the frame. For the same reason all sharp edges and corners of the inner rear framework are removed.

The heads of the drums each have 12 lugs, to which are riveted the corrugated-steel drum end plate. The body of the drum is a perforated flange-steel cylinder, 12 inches in diameter, riveted to the drumheads.

The axle sprocket is bolted to a steel hub, with a bronze bushing assembled on a bearing of the right axle bracket. A flange on the inner end of the axle-sprocket hub is embraced by a bronze axle-sprocket retainer bolted to the axle bracket and securing the hub on its bearing. A bronze driving ring, fitted with four casehardened steel pins, is bolted to the hub box of the right wheel, with the four pins assembling in corresponding holes in the axle sprocket. Owing to the angularity of the axes of wheel and axle sprocket, the driving pins work in and out of the sprocket holes as the wheel revolves, while transmitting the turning motion to the sprocket.

The bronze jack-shaft frame is bolted in the right side rail front. The jack-shaft frame has 0.25-inch sliding movement on its bolts. The jack shaft is hollow and has a flange on the inner end, to which is riveted a sprocket of 52 teeth, and a tapering seat on its outer end, on which is keyed a sprocket of 21 teeth.

The roller chains are of the best quality chrome nickel steel, and are tested with a load of 2,000 pounds. *A mixture of lubricating oil and soap is used for lubricating these chains.* The chains and sprockets are protected by the inner and outer gear cases, bolted to the right side rail and axle bracket.

The drum sprocket is mounted on the hub of an annular disk revolving in a recess in the right end of the drum between an adjusting ring threaded into the end of the recessed drumhead, and a second friction disk arranged with a slight axial movement along the shaft. Three sets of toggle links connecting with the sliding collar on the shaft operate to clamp the sprocket ring between the friction disk and the adjusting ring, thus connecting the driving mechanism with the drum, or to withdraw the friction disk from contact, leaving the drum sprocket free to revolve upon the shaft.

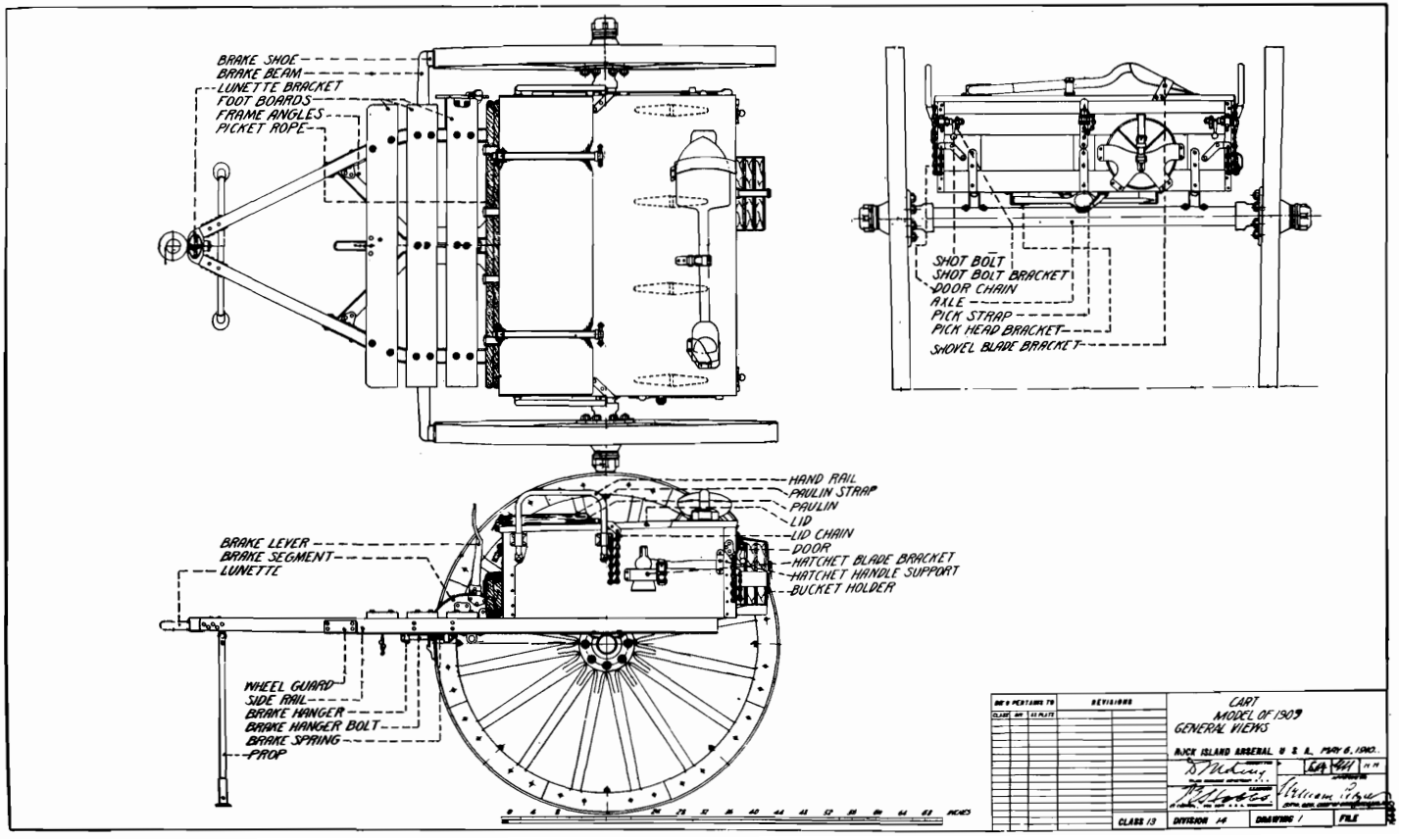
The sliding collar, or "clutch spider," is moved along the drum axle to lock or open the clutch by a sleeve sliding in the interior of the drum axle and connected to the clutch spider by keys working through slots in the axle wall. The sleeve is threaded on its outer end and is actuated by a nut formed in the hub of a bevel gear meshing with a pinion on the lower end of a hand-wheel shaft mounted on the right axle bracket.

The drum latch consists of a lever, swinging on a bearing at its lower end in a plane parallel to the right drum-end plate and having a spring plunger with a beveled head to engage a projecting piece riveted to the drum-end plate. A pawl, engaging notches in the flange of the leg guard, holds the latch in position to either lock or free the drum. The drum-latch lever is provided with a leather-faced brake shoe, which may be brought against the flanged rim of the drum-end plate to act as a brake. A seat for the operator is mounted on the right rear corner of the frame.

The operator should not be allowed to ride on the operator's seat when the cart and reel are limbered, as the balance will be made unsatisfactory.

To assist the operator in guiding the onwinding cable and provide the necessary tension, the following method is used:

A collar is arranged to slide along the rear roller. By means of lugs on this collar a staff with a wire helix can be attached. The cable passes through this helix and by means of the sliding motion of the collar on the rear roller the cable is wound uniformly on the drum.


BRAKE SHOE
BRAKE BEAM
LUNETTE BRACKET
FOOT BOARDS
FRAME ANGLES
PICKET ROPE
SHOT BOLT
SHOT BOLT BRACKET
DOOR CHAIN
AXLE
PICK STRAP
PICK HEAD BRACKET
SHOVEL BLADE BRACKET
HAND RAIL
PAULIN STRAP
PAULIN
LID
LID CHAIN
DOOR
HATCHET BLADE BRACKET
HATCHET HANDLE SUPPORT
BUCKET HOLDER
BRAKE LEVER
BRAKE SEGMENT
LUNETTE
WHEEL GUARD
SIDE RAIL
BRAKE HANGER
BRAKE HANGER BOLT
BRAKE SPRING
PROP
CART
MODEL OF 1909
GENERAL VIEWS
ROCK ISLAND ARSENAL U. S. A. MAY 6, 1910.
CLASS 13
DIVISION 14
DRAWING 1
FILE

CART, MODEL OF 1909.

[Plate II.]

NOMENCLATURE OF PARTS.

No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
2	Wheels	Same as on reel		
2	Wheel fastenings, complete			
1	Axle frame, complete, includes—			
1	Axle			
2	Side rails, right and left	Riveted to axle		
2	Frame angles, right and left	Riveted to side rails		
1	Fame-angle brace	Riveted to frame angles		
2	Frame-angle connections, front, right and left.	Riveted to side rails and frame angles		
2	Frame-angle connections, rear, right and left.			
1	Frame-angle separator	Between frame angles		
4	Separators	In side rail near frame-angle connections, front.		
2	Foot-rest clips	Between frame angles		
2	Wheel guards	Riveted to side rails		
1	Lunette bracket	Front end of side rails		
1	Lunette and nut	In lunette bracket		
1	Name plate	On lunette bracket		
1	Footboard No. 1	Fastened to side rails		
2	0.312 ($\frac{5}{16}$) by 2.5 bolts with 4 washers			
4	0.312 ($\frac{5}{16}$) by 1.625 bolts with washers			
1	Footboard No. 2	Fastened to side rails		
6	0.312 ($\frac{5}{16}$) by 1.625 bolts with washers			
1	Footboard No. 3	Fastened to side rails		
8	0.312 ($\frac{5}{16}$) by 1.625 bolts with washers			
1	Prop, complete	Pivoted to front end of frame		
	Includes—			
2	Prop hinges, right and left	Riveted to side rails		
2	Prop forks	Riveted to prop legs		
2	Prop pins	Pivot forks to hinges	IV	9
2	Prop legs	Riveted to forks		
2	Prop feet	Riveted to legs		
1	Cross bar	Connects prop feet		
1	Prop block	Fastened to footboard No. 1		
1	Prop strap	Fastens to prop block		
	Brake gear, complete, includes—			
2	Brake hangers, front, right and left.	Riveted to side rail		
1	Brake hanger, rear			
2	Brake-hanger bolts and nuts	Connects brake hangers		
1	Brake beam	Seated in brake hangers		
2	Brake shoes	On ends of brake beam		
2	Brake-shoe tap bolts	Secure shoes to beam		
2	Brake springs	On brake hanger bolts		
1	Brake-shaft bracket	Riveted to right frame angle		
1	Brake-shaft bearing (short)	In brake-shaft bracket		
1	Brake-shaft bearing (long)	In brake-segment bracket		
1	Brake-shaft end bearing	Riveted to left frame angle		
1	Brake segment bracket	Riveted to right side rail		
1	Brake segment	Riveted to brake-segment bracket		
1	Brake-segment angle	Riveted to footboard No. 3		
1	Segment rack	Riveted to brake-segment bracket		
1	Brake shaft	In shaft bearings		
1	Brake lever	On end of shaft		
1	Brake-lever catch	Riveted to brake lever		
1	Brake crank	On brake shaft		
1	Brake link	Pinned to brake crank		
1	Brake-link connection	Connects brake link to brake connection		
1	Brake connection	On center of brake beam		
1	Brake-connection bolt and nut	Connects brake beam and brake connection.		
2	Brake pins	Form pivots		

Nomenclature of parts—Continued.

No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
1	Instrument chest, complete	Bolted to side rails		
	Includes—			
1	Chest body			
1	Cover			
1	Chest lid			
1	Chest door			
4	Lid hinges	For securing chest lid		
3	Hinge for door	Hinge door to body		
2	Corner iron, rear, right and left.	Rear corners of chest		
2	Corner iron, front, right and left.	Front corners of chest		
2	Hasp	One for door, one for lid		
1	Hasp plate, door	For locking door		
1	Hasp plate, lid	For locking lid		
1	Hasp staple for lid			
1	Hasp staple for door	For locking door		
2	Lid-chain irons, right and left.	Riveted to lid		
1	Chain staple	Screwed to chest front		
2	Lid-chain eyes	Riveted to handrail		
2	Lid chains	For holding lid open		
2	Handrails	Riveted to chest		
4	Handrail brackets			
4	Handrail filler blocks	Riveted to handrail bracket		
2	Door-chain chest irons, right and left.	Riveted to corner iron, rear		
2	Chain fastenings on door, right and left.	Riveted to door		
2	Door chains	Holds door open		
2	Rail-bolt iron, front	Riveted to side rail		
2	Rail-bolt iron, rear			
8	Rail bolts, nuts, and 4 washers	Connect side rails and rail-bolt irons		
56	0.312 ($\frac{5}{16}$) rivets (special)			
2	Padlocks, with chains and bolt snaps.	For locking lids		
2	Shot bolts, right and left	At corners of rear door		
2	Shot-bolt brackets, right and left	Riveted to rear door		
2	Shot-bolt stops	Riveted to shot-bolt bracket		
1	Bucket holder	Riveted to rear door		
	Implement attachments:		IV	9
2	Pick-head strap fasteners	Riveted to chest bottom		
1	Pick-handle support			
2	Pick-head brackets, right and left.			
1	Shovel-blade bracket	Screwed to rear lid		
1	Shovel-handle pocket			
1	Zinc plate, large	Under shovel-blade bracket		
1	Zinc plate, small	Under shovel-handle pocket		
1	Shovel-handle strap fastener	Riveted to rear lid		
2	Hatchet-blade brackets	Riveted to side of chest		
2	Hatchet-handle supports			
1	Ax-head bracket			
1	Ax-handle support			
1	Ax-strap fastener			
2	Bucket-strap fasteners	For bucket strap		
2	Grip-strap fasteners	For grip straps		
2	Hatchet-handle strap fasteners	For hatchet-handle strap		
4	Paulin-strap fasteners	Front lid of chest		
6	Picket-rope strap fasteners	Front of chest		
1	List of instruments, etc	Pasted to lid		
	In rear section of chest:			
1	Observation telescope tripod rest, left.	Screwed to rear section, side		
2	Observation telescope tripod strap fasteners.	Riveted to rear section, back		
1	Block brace	Screwed to oil-can block		
4	Top supports	On inside of chest		
	In front section of chest:			
1	Block for pliers			
2	Breast reel filler	Compartment Nos. 11 and 12		
1	Breast reel partition (end)			
1	Breast reel partition (middle)	Between compartments Nos. 11 and 12		
2	Breast reel seat	Compartments Nos. 11 and 12		
1	Cushion	Compartment No. 3		
1	Cushion	Compartment No. 7		
1	Filler	Compartment No. 1		
1	Filler	Compartment No. 2		
1	Filler	Compartment No. 4		
1	Filler	Compartment No. 5		

Nomenclature of parts—Continued.

No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
	In front section of chest—Continued.			
1	Filler	Compartment No. 13		
9	Partitions	In chest		
18	Partition guides	Hold partitions in place		
4	Springs, B. C. telescope cushion	Compartment No. 6		
4	Springs, buzzer cushion	Compartment No. 3		
5	Springs, observation telescope cushion.	Compartment No. 15		
1	Tripod spring rest	Compartment No. 21		
1	Tripod spring rest clip	Compartment No. 21		
	Wood screws.			
44	0.75 No. 6			
85	0.75 brass, No. 6			
4	1.25 No. 6			
12	1.5 No. 6		IV	9
6	0.625 countersunk head, brass, No. 8			
2	0.875 countersunk head, brass, No. 8			
5	1 No. 8			
33	0.75 No. 10			
29	1 No. 10	In chest and partitions		
6	1.25 No. 10			
4	1.75 No. 10			
21	1 No. 12			
2	1.125 brass, No. 12			
4	1.25 No. 12			
19	1.5 No. 12			
17	2.25 No. 12			
2	1 brass, No. 14			
2	1 No. 14			

DESCRIPTION OF CART, MODEL OF 1909.

[Plate II.]

The cart forms with the reel a 4-wheeled vehicle, drawn by four horses, using the regular type of artillery harness. It is designed to carry the fire-control instruments for the regimental and battalion commanders.

The principal parts of the cart are the wheels, axle, frame, brake, prop, and instrument chest.

The wheels are the same as and interchangeable with those used on the reel.

The frame consists of two side rails of flange steel riveted to the axle, extending forward and parallel to a point in front of the tire of the wheel, beyond which they converge and are united in a forged-steel bracket for a lunette. From the point in the side rails which would contact with the wheel of the reel in making short turns diagonal angle steel braces are set, joining at the middle of the frame to form a support for the end of the brake shaft and returning to the side rails a short distance in front of the axle. Three foot-rest boards are placed across the frame and bolted to the rails and braces.

The axle, which is hollow, is made of forged steel No. 3 and is finished inside and out. The axle body is provided with lugs, to which the side rails are riveted.

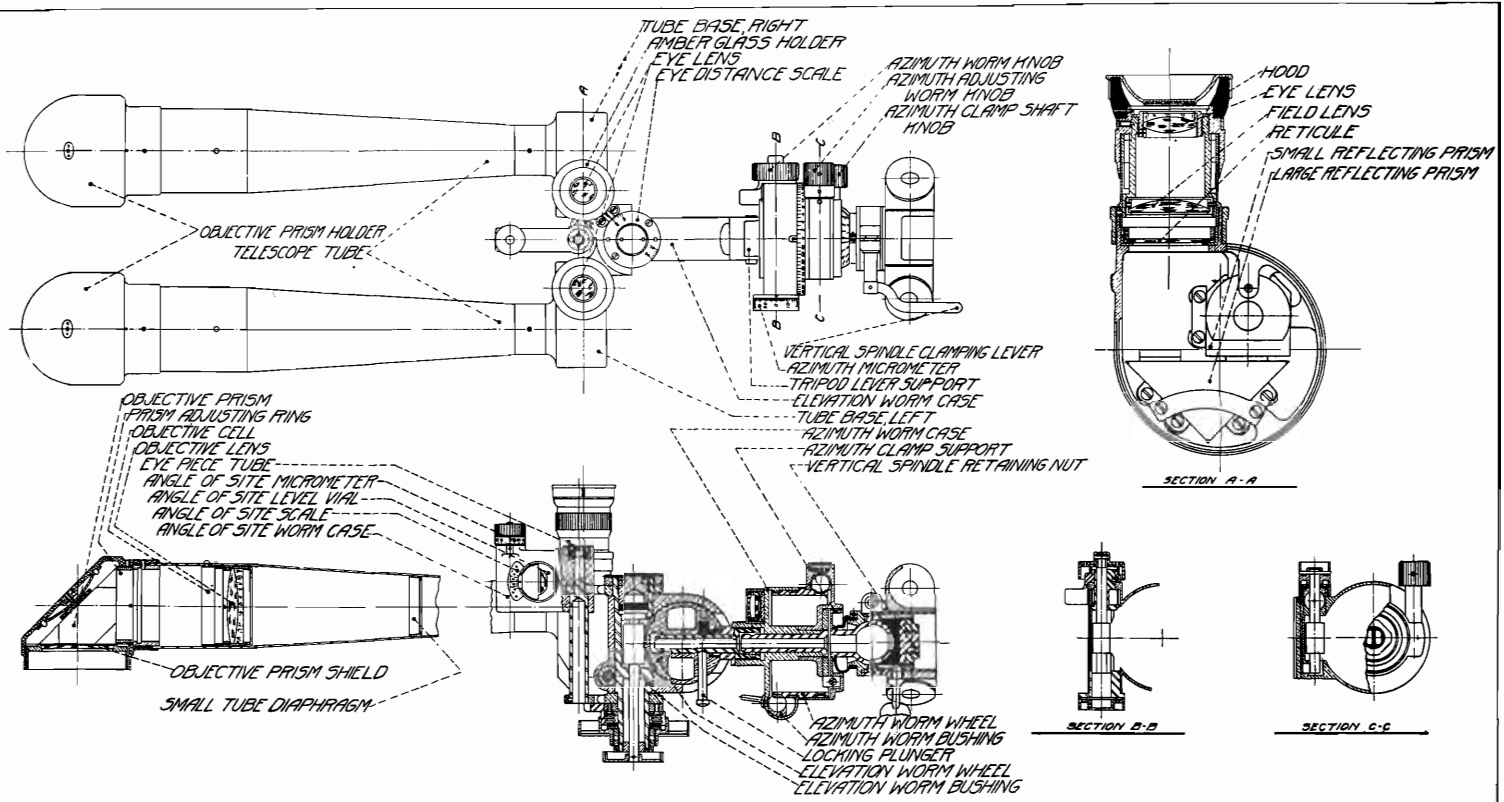
The road brake is a steel angle beam having cast-iron brake shoes on either end, supported on bolts underneath the side rails, and drawn to bear against the wheels by a crank and link at the center, operated by a lever on the right side of the vehicle. The brake-lever shaft is supported at the outer end in a forged-steel brake-segment bracket riveted to the side rail, and at the middle by bearings riveted to the frame angle braces. The brake segment for securing the brake lever in position has a tool-steel segment rack riveted on, mounted on the brake-segment bracket and braced to the end of one of the footboards. The brake lever is of tempered spring steel with a forged-steel pawl attached. Two helical springs, one on each brake-hanger bolt, tend to force the brake beam and shoes from contact with the wheel.

The prop is A-shaped and is hinged to lugs assembled in the arms of the lunette bracket in such a manner that when not in use it may be swung up to the rear against a stop block under the first footboard, to which it is secured by a leather strap.

The instrument chest is of wood, reinforced with metal corners and rail-bolt pieces for bolting to the frame. It is in two main divisions, the forward part being entered from the top, having a hinged lid opening from the front. This division has numerous padded and plain compartments for the reception of the various articles of fire-control apparatus indicated in the list of contents pasted on the inside of the lid. The rear of the chest is fitted with a door hinged at the bottom and opening to the rear. This compartment contains a storage oil can, and is fitted with straps and fastenings for articles of equipment, as mentioned in the list of contents. The lid, door, and bottom of the chest are paneled.

Pads and cushions are stuffed with curled hair of the quality known as No. 2.

The top of the chest is covered with cotton duck, oiled, and secured at the edges.



BATTERY COMMANDER'S TELESCOPE
MODEL OF 1915.

BATTERY COMMANDER'S TELESCOPE, MODEL OF 1915.

[Plate III.]

DESCRIPTION.

The battery commander's telescope is a binocular observation instrument of the scissors type. The telescope is designed so that the objective is 12 inches above the eyepiece when the tubes are in a vertical position, enabling the observer to remain covered behind the caisson or other shield and yet obtain a full view of the field. The tubes may be adjusted for various interpupillary distances in either a vertical or horizontal position; an eye distance scale is provided to facilitate this adjustment.

For the designation of parts and assembled and sectional views of the instrument see Plate III.

The principal parts of the instrument are the azimuth mechanism, the elevating mechanism, the leveling device, the angle of sight mechanism, the telescopes, and the tripod.

The azimuth mechanism consists of the azimuth adjustment and the azimuth device.

The azimuth adjustment consists principally of the azimuth adjusting worm, azimuth worm wheel, azimuth adjusting worm case, azimuth clamp support, azimuth clamp shaft, azimuth clamp shaft knob, and azimuth adjusting worm knob.

Pinned to the vertical spindle lower, just above the ball, is the azimuth clamp support, upon which the instrument rotates when released by the azimuth clamp shaft knob. When thus released the line of the sight may be freely moved to approximately the desired position, locked, and a finer adjustment made by turning the azimuth adjusting worm knob. Backlash between the azimuth adjusting worm and the azimuth worm wheel is removed by the azimuth plunger spring and plunger.

The azimuth device consists principally of the azimuth worm case, azimuth worm, azimuth worm bushing, azimuth worm wheel, azimuth worm knob, and azimuth micrometer. The azimuth worm is held in mesh with the azimuth worm wheel without perceptible backlash by means of the bushing spring. The eccentric azimuth worm bushing is so arranged that it may be disengaged by means of the azimuth worm lever; and when thus disengaged, the line of sight may be freely moved to approximately the desired position. The azimuth worm can then be thrown into mesh and the finer adjustment made by turning the azimuth worm knob. The azimuth scale on the azimuth worm wheel is graduated into 64 equal divisions; each division represents 100 mils. An index engraved on a German silver strip registers with the graduations on the azimuth scale.

The azimuth micrometer is graduated into 100 equal divisions, each division representing 1 mil. One complete revolution of the azimuth micrometer equals 100 mils or one division on the azimuth scale. The azimuth micrometer is locked in position by the micrometer lock nut.

Both the azimuth adjusting worm and the azimuth worm mesh with the azimuth worm wheel.

The azimuth mechanism is attached to the upper part of the vertical spindle (lower) and is held in place by the vertical spindle-retaining screw.

The azimuth mechanism may be removed from the instrument by releasing the locking plunger in the elevation worm wheel, lifting off the telescope, and then releasing the azimuth clamp shaft knob and removing the vertical spindle-retaining screw. The telescopes may then be used on the tripod without the azimuth mechanism.

The elevation mechanism consists principally of the elevation worm case, elevation worm wheel, elevation worm, elevation worm bushing, and the elevation worm knob. The elevation worm, seated in the elevation worm case, meshes with and travels about the elevation worm wheel, carrying with it the telescopes. The movement of the telescopes is 300 mils in elevation and 300 mils in depression, or total angular movements of approximately 36°, corresponding to the movement of the elevation worm wheel. Backlash between the elevation worm and the elevation worm wheel may be removed by adjusting the eccentric elevation worm bushing, which is locked in place by the bushing clamp plug.

The leveling device is comprised principally of the vertical spindle (lower), vertical spindle bushing, friction washer, and vertical spindle nuts. The vertical spindle (lower) is ball shaped at its lower end and is seated in a socket formed in the vertical spindle bushing. This ball-and-socket construction permits the instrument to be quickly leveled and locked in position by the vertical spindle clamping lever. The friction washer permits an adjustment of the vertical spindle nuts to give sufficient friction on the ball to support the instrument when the vertical spindle clamping screw is released. The vertical spindle stop screw prevents movement of the instrument in azimuth when leveling, and the spindle socket cover protects the ball-and-socket joint from dust and dirt. The instrument level is mounted on the azimuth worm case.

The angle of site mechanism consists principally of the angle of site worm, angle of site worm case, angle of site level vial holder, angle of site scale, angle of site micrometer, and the angle of site level vial. The angle of site micrometer is graduated into 100 equal divisions, each of which represents 1 mil. One complete revolution equals 100 mils or one of the equal divisions of the angle of site scale,

marked from 0 to 6 ("3" corresponding to the reading for zero angle of site). The angle of site micrometer is locked in place by means of the angle of site micrometer locking screw. Backlash between the angle of site level vial holder and the angle of site worm is removed by the angle of site plunger spring and plunger.

The telescopes consist principally of the eyepieces, the tubes, the tube bases, the objective prism holders and the optical systems. The lower ends of the tube bases are attached to and rotate about the elevation worm bushing and can be locked in any position to suit the desired interpupillary distance. A set of friction disks, contained in the friction disk sleeve can be adjusted by the friction adjusting nut to give sufficient friction on the tube bases to support the telescopes even when the friction clamp knob is released.

The eye distance index attached to the tube base (right) registers with the eye distance scale and shows the interpupillary distance of the eyepieces when the telescopes are in either vertical or horizontal positions. In either position the minimum reading is 60 millimeters, and the maximum reading is 70 millimeters, which corresponds to the scales on foreign instruments. Both eyepieces may be focused for the sight of any observer with the aid of a scale of graduations in terms of diopters. This scale is used for rapid focusing when the corrections of the eyes are known. A reticule located in the right eyepiece can be rotated by means of the reticule adjusting ring so that the etched lines on the reticule will be in the proper position, irrespective of the position of the telescope. The telescope tubes are screwed to the projections on the top of the tube bases. Two diaphragms are mounted on the inside of each tube. The objective is mounted in the objective cell. To the upper end of the telescope tubes are screwed the objective prism holders, which act as housings for the objective prisms. Adjustment in three directions is provided to properly align the objective prisms. The objective prism shields in the front end of the objective prism holders protect the objective prisms. Objective sunshades are provided and may be attached to the prism shield cells when needed.

The optical system consists of the objective prism objective, small reflecting prism, large reflecting prism, field lens and eye lens. The clear aperture of the telescope is 1.78 inches. Amber glass mounted in the amber glass holders may be used when required. The magnifying power of the instrument is 10 and the field of view is 4° 15′. The tripod consists principally of the tripod head, tripod legs (upper section), tripod legs (lower section), and the clamping parts. The upper sections are attached to the tripod head and are braced by the leg separators, the lower sections are of tubing and slide freely through the base of the upper sections. By means of the clamps they can be locked in any position to suit the height of the observer.

Eyepieces (diopter).—The eyepieces are adjustable for the eyes of the observer and are equipped with diopter scales. Before making an observation the eyepieces should be set for the visual distance of the observer, and if the distance be unknown to him the eyepieces should then be adjusted by turning, until the image of a far distant object (with the greatest possible amount of detail) appears absolutely sharply defined. The resulting numbers on the diopter scales should then be memorized for future use.

Interpupillary distance.—The tubes may be adjusted for various interpupillary distances in either a vertical or horizontal position, an eye distance scale is provided to facilitate this adjustment.

Leveling.—To adjust the levels, bring the level bubbles to the center of the level vials by means of the leveling device, so that they will remain in this position while the instrument is being turned 1,600 mils in azimuth. If there is no movement of the bubbles during this test, the levels are in adjustment. Continue the verification until the bubbles remain in the center of their vials during a complete revolution of the instrument.

Backlash between the elevation worm and the elevation worm wheel may be removed by adjusting the eccentric elevation worm bushing which is locked in place by the bushing clamp plug.

Backlash between the azimuth adjusting worm and the azimuth worm wheel is removed by the azimuth plunger spring and plunger.

Backlash between the angle of site level vial holder and the angle of site worm is removed by means of the angle of site plunger spring and plunger.

Adjustment of clamps.—Pinned to the vertical spindle lower, just above the ball, is the azimuth clamp support upon which the instrument rotates when released by the azimuth clamp shaft knob. When thus released the line of sight may be freely moved to approximately the desired position, locked, and a finer adjustment made by turning the azimuth adjusting worm knob. The ball and socket construction permits the instrument to be quickly leveled and locked in position by the vertical spindle clamping lever. The friction washer permits an adjustment of the vertical spindle nuts to give sufficient friction on the ball to support the instrument when the vertical spindle clamping screw is released.

Micrometers.—An index engraved on a German silver strip is set into the rear side of the azimuth worm case to register with the graduations on the azimuth scale. After adjusting the azimuth micrometer to the proper position it is locked in position by the micrometer lock nut. An index engraved on a German silver strip registers with the graduations on the angle of site micrometer. After adjusting

the micrometer to the proper position, it is locked in place by means of the angle of site micrometer locking screw.

The optical characteristics.—The magnifying power of the instrument is ten, the field of view is 4° 15′, and the clear aperture of the telescope is 1.78 inches.

CARE AND PRESERVATION.

The battery commander's telescope, being a delicate instrument, must not be subjected to rough usage. When not in use it should be kept in its leather case and stored in a dry place and all traces of dust or moisture should be removed before putting it away. To obtain satisfactory vision the glasses should be kept clean and dry. In case moisture collects on the glasses place the telescope in a gentle warmth. This is usually sufficient to remove it.

Cleaning cloth or chamois skin issued for cleaning of lenses alone should be used, care being taken that they should not contain any dirt or grit.

As all the joints are sealed when the instrument leaves the manufacturer, any disassembling will break the seal, thus permitting dust and moisture to enter.

Cleaning of the interior should be done by a competent person, and for this reason it is advisable to send the instrument to an arsenal.

All bearing surfaces should be carefully oiled and surplus oil wiped off so that in handling it will not be carried to the glasses.

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THE BATTERY COMMANDER'S TELESCOPE, MODEL OF 1904.

[Plate IV.]

This model of instrument is but little different from that of the model of 1905.

The details of some parts vary considerably, but the principle of operation is the same. The nomenclature of corresponding parts in the two instruments is different in some cases.

The tripod used on this model is the same as on the observation telescope for instruments under No. 129. Tripods for battery commanders' telescopes after No. 20 and before No. 129 differ from those for model of 1905 battery commander's telescope in the diameter of tripod head.

The battery commander's telescope (either model), complete, consists of the telescope and mount, tripod, carrying case for telescope, and carrying case for tripod.

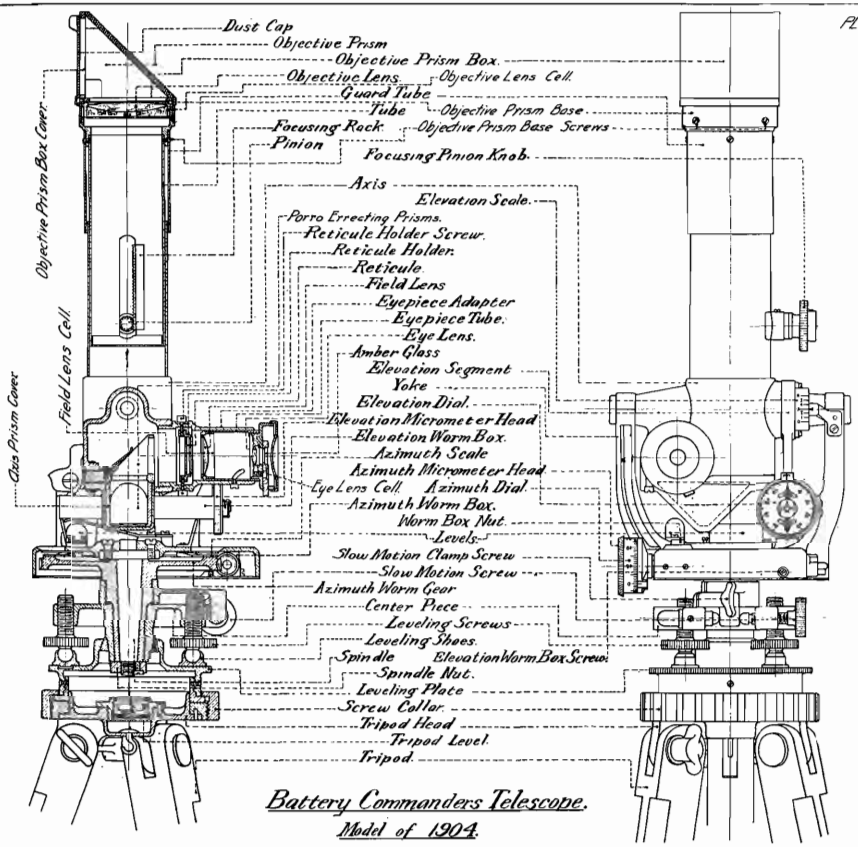
TO USE BATTERY COMMANDER'S TELESCOPE.

Extend the tripod legs to the desired length and firmly clamp them; set the tripod up in the selected position with tripod head approximately level and feet securely held in the ground. Assemble the instrument to the tripod, firmly clamping the leveling plate to the tripod head by the screw collar; focus the eyepiece by screwing it in or out of the eyepiece tube until the crosslines are in the position of distinct vision. Focus the objective by directing the telescope at a distant object and turning the focusing pinion knob until the image of the object is in the same plane as the crosslines of the reticule. In this position the crosslines will appear stationary as the eye is shifted across the eyelens.

Angles of site are measured by sighting directly at the object and reading the angle of elevation scale. For use on the angle of site or level scale of the range quadrant, the telescope elevation scale reading is used without change. The actual angle of site, however, is the difference between this reading and 300.

In measuring angles of azimuth the azimuth scale is set at 0 and the yoke revolved until the telescope is sighted on the aiming point; the scale is then clamped to the centerpiece and the telescope sighted at the target, the movement being effected by means of the azimuth worm and quick-setting device. The azimuth reading is then noted;

PLATE IV



Battery Commanders Telescope.

Model of 1904.

this azimuth is the angle between the two vertical planes joining the instrument with the aiming point and the target measured in a counterclockwise direction. The units of the azimuth scales of the telescope and the panoramic sight are the same. The measured values for the aiming point corrected for diference of position of the telescope and gun are transmitted to the gunner of each piece for use in laying that piece.

The telescope may be used for observing the accuracy of fire. In that case the telescope is laid upon the target and the distance of the point of impact or burst right or left and high or low is observed and measured. Lateral deviations not exceeding 30 mils may be read directly upon the reticule scale in the telescope; for larger deviations the azimuth scale of the instrument is used; the deviation in range is measured upon the elevation scale of the instrument; corrections corresponding to the measured deviations are made for the subsequent shots. The horizontal lines of the reticule are used in measuring the height of burst of shrapnel.

The telescope may be used in connection with another like instrument or a panoramic sight for approximate determination of ranges as described in the use of the panoramic sight.

ADJUSTMENT OF BATTERY COMMANDER'S TELESCOPE.

The instrument is in adjustment when the following conditions are fulfilled: Telescope properly focused; plane of the levels perpendicular to the vertical axis of revolution of instrument; elevation scales read 300 when line of sight is horizontal; lost motion in worm gears eliminated.

The method of focusing objective and eyepiece has been described above.

To adjust the levels, bring the level bubbles to the center of the level vials by means of the leveling screws of the instrument when the instrument is pointing in any given direction. Turn the instrument 1,600 mils in azimuth, noting the movement, if any, of the level bubbles. If there is no movement of the bubbles during this change in azimuth, the levels are in adjustment. If the level bubbles move from the center of their vials, correct by means of the level-adjusting screws sufficiently to bring the bubbles back over half the distance they have moved, and then bring them to the center by means of the leveling screws of the instrument. Continue the adjustment and verification until the bubbles remain in the center of their vials during a complete revolution of the instrument.

To adjust the elevation scales, the line of sight must first be made horizontal. Any convenient method may be used. The following is suggested: Set the instrument up in position, as A (fig. 1), in line with the pickets B and C, and with elevation scale set at 300 mark

the points B_1 and C_1 in which the line of sight cuts these pickets. Then move the instrument to D, and sighting in opposite direction with elevation 300, similarly mark the points B_2 and C_2. The points B_3, halfway between B_1 and B_2 and C_3, halfway between C_1 and C_2, are in the same horizontal plane. By means of the elevation worm, change the elevation of telescope at D until the line of sight cuts the pickets in points B_4 and C_4, equidistant from B_3 and C_3, respectively. The line of sight is then horizontal. Without changing the line of sight, shift in its seat the elevation scale until the division 3 registers with the index and similarly change the elevation dial until the division 0 is opposite its index. The elevation scale is shifted in position by loosening the three screws which hold it in place; the screw holes in the scale are elongated and permit sufficient motion of scale for necessary adjustment. The elevation dial is

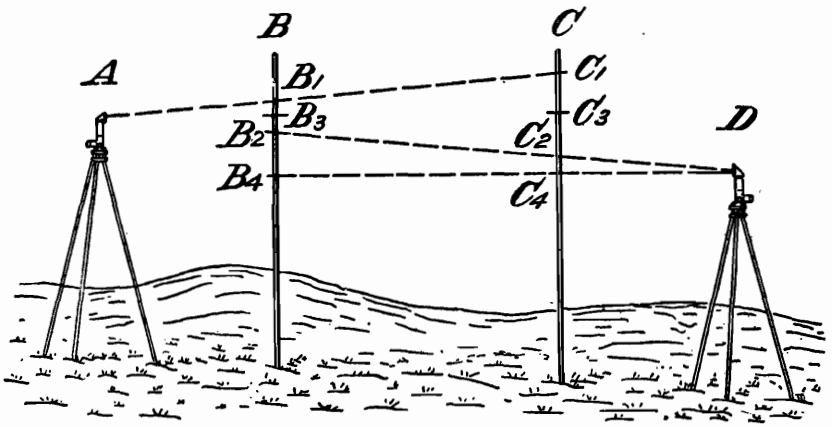


Figure 1.

secured to the elevation micrometer head by two screws, and is free to turn in its seat when the screws are loosened. The distance between the pickets B and C should not be less than 200 feet.

The elevation and azimuth worms are mounted in pivoted worm boxes, which are pressed toward their respective worm wheels by flat springs. Each worm box is provided with an adjusting screw, by which the amount of engagement of worm and worm wheel may be regulated. When lost motion between either worm and its worm wheel is noted, it may be eliminated by so changing the corresponding worm-box screw as to bring the worm into closer contact with its worm wheel.

CARE OF THE BATTERY COMMANDER'S TELESCOPE.

The battery commander's telescope should be handled carefully and kept in a clean, dry place. While not in use keep it in its carrying case.

Do not polish any bright surface of the instrument. Keep such surfaces, if steel, lightly oiled to prevent rusting.

The presence of dust and moisture on optical surfaces causes, chemical deterioration of glass.

The instructions given below are for such work as will ordinarily be found necessary by the battery. Do not, however, disassemble any parts for cleaning unless it is necessary. First clean the exposed parts, which ordinarily will be sufficient.

To clean the under surface of the objective prism and the objective lens remove the four objective prism base screws and draw off the objective prism box and objective prism base together. Unscrew the objective cell, clean parts, and replace. Do not remove the objective prism from its box or the objective from its cell. Do not separate the objective prism box and the objective prism base.

To clean the Porro erecting prisms release the elevation worm rotate the telescope 90° from its normal position, unscrew the three prism cover screws, and remove the axis prism cover. Clean the exposed surfaces and replace. Do not disassemble the prisms. The axis prism cover should be removed only in case it is plainly necessary.

To disassemble the eyepiece, take out the eyepiece screw and pull the eyepiece from the eyepiece adapter. The field-lens cell and eye-lens cell may be unscrewed from the eyepiece tube. Do not attempt to remove the lenses from their cells.

Do not remove the reticule nor disturb its adjustment. Clean it in position and wipe it off with a camel's-hair brush.

Use clock oil in oiling bearing surfaces. Do not use oil in places where it may run on the optical surfaces.

In case a level requires replacement, remove the level box and mail it to the designated arsenal. If the tripod level is unserviceable, the level support held in the tripod head by three screws should be shipped complete with level cup, level cap, and plug.

In placing the instrument in its carrying case, release the slow-motion clamp screw and the elevation worm.

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THE BATTERY COMMANDER'S TELESCOPE, MODEL OF 1905.

[Plate V.]

The battery commander's telescope is an instrument of precision for measuring horizontal and vertical angles, and combines the essentials of a surveyor's angle measuring instrument with those more particularly pertaining to the requirements of the military service. It was never intended for an observation telescope.

GENERAL.

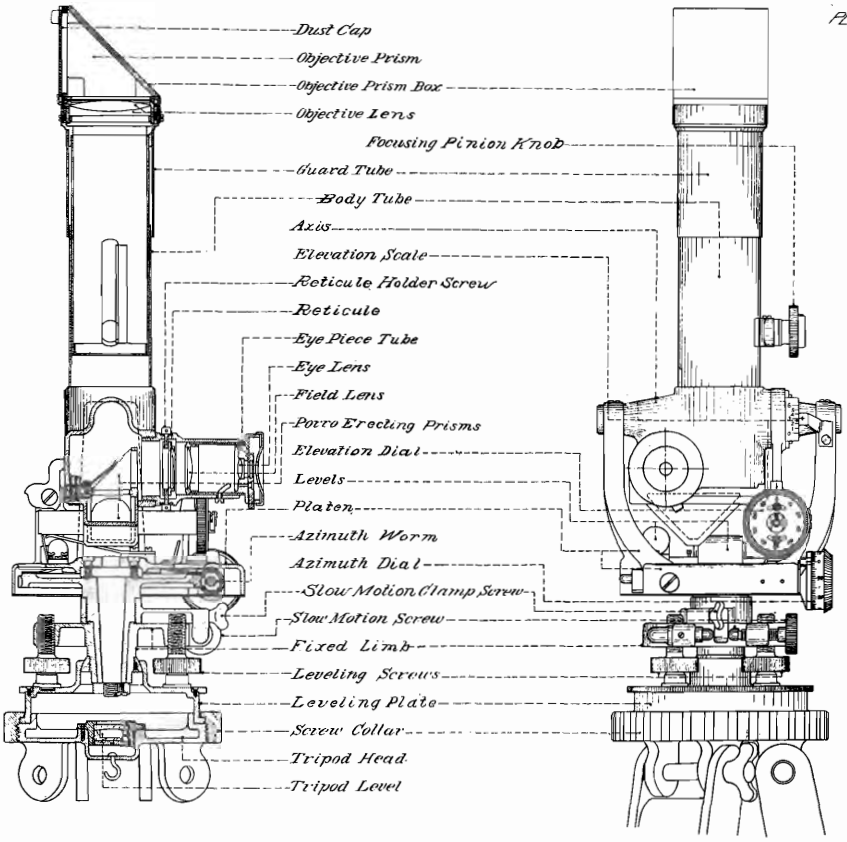
The instrument is mounted upon an extension tripod furnished with it; when folded for transportation the tripod is about 33.2 inches in length, but in use the legs may be extended to a length of about 60 inches. It has a tripod level on top to enable the tripod head to be roughly and quickly set nearly level to save time in leveling the instrument. The leveling plate or base of the latter is clamped to the head of the tripod by means of a coarse thread screw collar having a serrated circumference.

The principal parts of the instrument are the telescope and its mount, comprising, in addition to the tripod, the leveling plate, the center piece, the azimuth worm gear, the yoke, and the spindle.

THE MOUNT.

The leveling plate is provided with a screw collar for assembling the instrument to the tripod head. The fixed limb is connected to the leveling plate by a ball and socket joint and has four coarse pitch leveling screws which fit into leveling shoes resting upon the surface of the leveling plate. The fixed limb is bored out to take the hollow conical shank of the horizontal limb, which in turn affords a seat for the spindle. The spindle nut on the lower end of the spindle fastens the platen and horizontal limb to the fixed limb while permitting each a motion of rotation with respect to the other or to the leveling plate. The horizontal limb is broadened out at its upper end and has a worm wheel cut upon its perimeter. On its upper surface the circumference is graduated into a scale for reading azimuth angles. The platen spreads out into a cover or housing for this worm wheel and scale. The scale is read through two windows in the cover. To the lower side of the platen is attached the spindle mentioned above, by which the platen is assembled to the underlying parts and upon which it rotates. Above the cover project two arms terminating at their

PLATE V



Battery Commander's Telescope

Model of 1905.

0 1 2 3 4 5 6 Inches

upper ends in trunnion bearings which take the trunnions of the telescope. The axis of the trunnions is perpendicular to the axis of the telescope, so that when the axis of the trunnions is horizontal the axis of the telescope lies in a vertical plane. The horizontality of the trunnion axis is secured by two spirit levels mounted on the platen, one being parallel and the other perpendicular to the trunnion axis. The platen and other parts of the instrument are leveled for use by means of these two spirit levels and the four leveling screws mentioned above in the same manner as any surveyor's instrument of similar construction.

The platen affords seats for the elevation worm and the azimuth worm, one of which gives the telescope a motion in elevation and the other gives the telescope and platen a motion in azimuth. The azimuth worm is seated in the azimuth worm box and meshes with the horizontal limb, giving the telescope and the platen a motion of rotation with respect to the horizontal limb. The amount of this motion is read upon the scale through either of the windows in the platen.

Upon the scale the circumference is divided into 64 equal parts, numbered from 0 to 63 in a counterclockwise direction. One turn of the azimuth worm moves the index over one of these divisions. An azimuth dial on the head of the azimuth worm is divided into 100 equal parts properly numbered, and enables azimuth angles of $\frac{1}{100}$ of $\frac{1}{64}$ of 360° to be accurately read. This subdivision is the mil, and it is the usual subdivision in use on Field Artillery sights.

For giving the telescope motion in elevation the elevation worm seated in the elevation-worm box on the platen meshes with the teeth of the elevation segment mounted on the telescope near one of the trunnions. A scale of sixty-fourths of 360° on the telescope, with an index on the platen and an elevation dial divided into 100 parts on the elevation worm head, enables angles of elevation to be measured in units similar to those of the azimuth scale. The amount of vertical motion of the telescope is limited to $\frac{6}{64}$ of 360°, $\frac{3}{64}$ above and $\frac{3}{64}$ below the horizontal (approximately 17° in each direction), and the scale is numbered from 0 to 6, the division marked 3 corresponding to the horizontal position.

The elevation and azimuth worms are arranged in their bearings so as to be disengaged from the worm wheels by the motion of an eccentric crank through half a revolution. This arrangement permits quick setting in azimuth and elevation by throwing the worm out of gear, turning the instrument by hand to the desired setting, and then throwing the worm in gear.

By construction the telescope (with its platen) and the azimuth scale (horizontal limb) are capable of rotation on a vertical axis with respect to each other and to the leveling plate of the instrument. They are connected by the azimuth worm and worm gear, and the

azimuth worm with scale is arranged to be clamped to the centerpiece by a clamp screw. This arrangement permits the platen to be set at zero on the azimuth scale, the combination rapidly oriented upon any desired object, the scale then clamped, and azimuth angles measured from the selected object as an origin. The usual form of slow-motion screw for setting the azimuth scale is provided.

From the preceding it will be noted that the telescope mounted on the platen has an all-around azimuth motion and a limited motion in altitude or elevation. The amounts of these motions are measured on scales suitably graduated. The motion may be quick or slow, as the instruments are provided with quick-setting devices and slow-motion screws, with clamps for use as desired.

THE TELESCOPE.

The telescope proper is designed so that the objective is 7 inches above the eyepiece, enabling the observer to remain completely covered behind the caisson or other protection and yet obtain a full view of the field. The main tube of the telescope is vertical, fitting into the bore of the axis at its lower end. The axis has two trunnion arms upon which it rests in the platen. The achromatic objective lens is placed at the upper end of the tube; two prisms, one a Porro and the other a 90° reflecting prism, at the lower end near the focal plane, and the eyepiece in a small tube perpendicular to the main tube and opposite the last total reflecting prism. A 90° reflecting prism (called the objective prism) is mounted in the objective prism box above the objective lens and makes an angle of 45° with the axis of the telescope. The objective lens has a clear aperture of $1\frac{3}{4}$ inches and a focal length of 11 inches. The power of the instrument is 10 and the field of view 4°. The upper end of the main tube, carrying the objective prism and lens, is arranged with a 1.75 longitudinal movement for focusing the latter. This movement is imparted by a focusing rack and pinion actuated by a focusing pinion knob on the side of the tube. The eyepiece is achromatic and is independently focused by being moved in or out of the eyepiece adapter. In the focal plane of the instrument, between the eyepiece and the last erecting prism, is a glass reticule with horizontal and vertical cross lines (diameters), two shorter horizontal lines above the diametral one, and a horizontal scale marked on the latter. The divisions of this scale are each 5 mils and the scale is figured 30, 20, 10, 0, 10, 20, 30, at alternate divisions. The horizontal lines are 3 mils apart. The reticule is mounted in the eyepiece adapter by four reticule-holder screws, so that the intersection of the crosslines may be accurately brought into coincidence with the optical axis of the instrument. An amber glass disk is pivoted just in rear of the eyelens

and a sliding dust cap is assembled in front of the objective prism to close the aperture when desired.

The image of the object as seen through the eyepiece appears as if viewed directly by the unaided eye, except that it is magnified. The objective is properly focused when the image of the object is in the same plane as the crosslines of the reticule. The eyepiece is properly focused when the crosslines are in the position of distinct vision. If the telescope be moved until the image of the point sighted coincides with the intersection of the crosslines, the actual point sighted will be in the prolongation of the optical axis of the instrument. It is therefore only necessary in sighting to bring the image of the point sighted to coincide with the intersection of the crosslines.

THE OBSERVATION TELESCOPE, FIELD, MODEL OF 1908.

[Plate VI.]

The observation telescope is mounted on an extension tripod. When the legs are set on the circumference of a circle 30 inches in diameter and the line of sight is horizontal, the eyepiece is about 62 inches above the ground.

The tripod is provided with a tripod level to enable the tripod head to be roughly and quickly set nearly level. The base is clamped to the tripod head by means of a coarse thread-screw collar having a serrated periphery. The tripod and tripod head are the same that is used on battery commander's telescope, model of 1905, No. 129 and higher numbers.

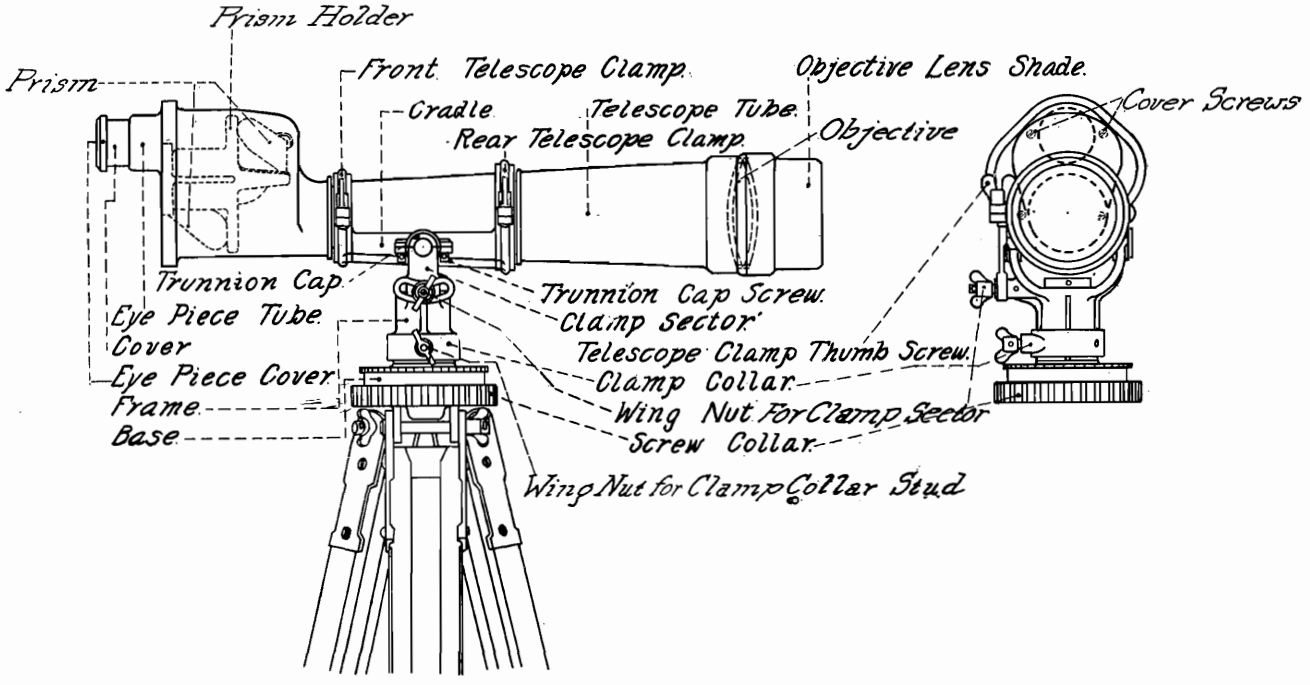
THE SUPPORT.

A retaining ring screwed to the base holds the screw collar in position on the base; but the fit of the screw collar is such as to permit free rotation, so that the base may be securely clamped to the tripod head. From the center of the base rises a cylindrical projection, forming the pintle of the instrument. Over this cylindrical projection fits the frame, the upper part of which provides trunnion seats for the cradle. The part of the frame fitting over the base is split, and a clamp collar, with stud and wing nut, are provided for locking in azimuth. A retaining nut and locking screw hold the frame to the base, though permitting relative rotation. The cradle is of aluminum zinc and forms a seat for the telescope. It has trunnions resting in the frame, permitting 25° elevation or depression. The front and rear telescope clamps, with their thumbscrews, lock the telescope in the cradle. A clamp sector is secured to the right trunnion of the cradle, and a wing nut on a stud projecting from the right side of the frame and passing through a slot in the clamp sector affords means for clamping the telescope in elevation. No provision has been made for slow motion in elevation or azimuth after preliminary clamping.

TELESCOPE.

The telescope tube is of aluminum zinc. In the front end is screwed the objective-lens cell, in which the objective lens is mounted and held in place by the objective-lens retaining ring. The objective lens has a clear aperture of 3 inches and a focal length of 24 inches. An objective-lens shade is provided and a telescope cap, of leather, to keep out dust. The telescope tube is provided with two cylindrical bearings to fit the cradle.

The cover is held by four screws to the rear end of the telescope tube. It forms a seat for the eyepiece, and the prism holder, of bronze, is secured to it. The Porro erecting prisms, of boro-silicate



Observation Telescope, Field, Model of 1908

crown glass, are held in the prism holder by two prism-retaining springs.

Two eyepieces are provided—one, 30 power, giving 1° 30′ field, and one, 15 power, giving 3° field. There are neither cross wires nor reticule. The instrument is focused by turning the eyelens cell, thereby moving the eyepiece in or out until the image is distinct. The eyepiece cover is graduated into 25 divisions and numbered for each fifth division. These graduations are for assistance in focusing, and an index is provided on the cover, so that the observer can quickly set the eyepiece by noting at which graduation the focusing is suitable for his eye. An amber glass is provided, which may be interposed between the eyelens and the eye to dim the image in case of bright sunshine.

The total length of the telescope is about 23 inches.

As the observation telescope is not a measuring instrument, the only adjustment to be made is to focus the instrument as explained above.

CARE OF THE TELESCOPE.

While there are few parts to get out of order, and the instrument has been designed to withstand rough usage, it should be handled as carefully as the conditions of service will permit. It should be kept in a dry place when not in use, as an office or storeroom of barracks, as a moist location will cause condensation of atmospheric moisture on the lenses and prisms, interfering with vision.

To clean the inner surface of the objective unscrew the objective-lens shade. Do not remove the objective from its cell.

The interior surfaces of the eyepieces may be cleaned after unscrewing the lens cells.

To clean the prisms remove the four cover screws and pull off the cover. Do not remove the prism holder from the cover nor the prisms from the holder. The prisms will not be cleaned except under the direct supervision of a commissioned officer or by a mechanic specially trained for such work.

Do not allow any oil on optical surfaces.

The presence of moisture and dust on optical surfaces causes a chemical deterioration of the glass.

In case the tripod level becomes unserviceable, the level support containing the level should be shipped for repairs.

Attention is invited to General Orders, No. 47, War Department, March 24, 1905, with reference to the care and repair of instruments, and to Form No. 1795, Instructions for the Care, Preservation, Repair, and Adjustment of Instruments for the Fire-Control Systems for Coast and Field Artillery.

The telescope and tripod, including support, are packed each separately in strong leather carrying cases with shoulder straps.

BATTERY COMMANDER'S RULER, WOODEN.

The battery commander's ruler is 6.7 inches long by 1 inch wide, with a cord about 24 inches long passing through a hole in the center. Two scales are placed at the edges of the ruler and are used for measuring azimuths. Two scales are placed in the middle of the ruler for determining the height of the trajectory in mils at any point of the range.

The scales at the edges of the ruler read from 0 to 300 mils and are graduated for every 2 mils and read in the same direction as the azimuth scale on the panoramic sight. They are used for quickly finding the azimuth between the target and the aiming point, the front of a position for determining errors of fire directions, etc.

One of the middle scales, called the trajectory scale, is graduated in mils from 0 to 710 and is marked for every 5 mils. The other scale, called the range scale, gives the range in hundreds of yards and is marked for each 200 yards.

USE OF BATTERY COMMANDER'S RULER.

When one end of the cord is attached to the top button of the coat or held in any other convenient way, and the ruler held horizontal and perpendicular to the taut cord at a distance of 20 inches from the eye, the scale on the edge of the ruler measures in mils the visual angle subtended by the corresponding portion of the ruler. The cord can be adjusted to the proper length by measuring, by means of the telescope or panoramic sight, the angle subtended by the two convenient objects, and then adjusting the length of the cord so that the ruler will give the same reading.

Practical use of the middle scales is made in determining whether it is possible to fire from a given position over intervening obstacles at a given target. The angle of site of the target, the height (or angle of site) of the obstacle in mils and the ranges of target and obstacle in yards being given, the height of trajectory in mils at the obstacle is determined for the given range as follows:

Read off on the height of trajectory scale the number of mils opposite the range of the target. Subtract from it the number of mils read on the trajectory scale opposite the range of the obstacle. This will give the height of trajectory at the obstacle at 0° angle of site. Then add or subtract the angle of site of the target according as the target is above or below the horizontal. If the resulting height of

trajectory is greater than the height of the obstacle in mils, the projectile will clear.

To illustrate (example for 4.7 gun matériel):

Angle of site of target = 285 (or −15).
Angle of site of obstacle = 380 (or +80).
Range of target = 2,800 yards.
Range of obstacle = 200 yards.

Reading opposite the range of the target or 2,800, the height of trajectory scale gives 84 mils, and for the range of the obstacle 200 the trajectory scale gives 4 mils. Subtracting the two gives 80 mils and adding the angle of site of the target, −15, gives the height of trajectory, at 200 yards, of 65 mils. As the height of the obstacle is 80 mils the projectile will not clear it.

BATTERY COMMANDER'S RULER, METAL.

This ruler is replaced by the battery commander's ruler, wooden, but may be retained in use while serviceable.

This ruler is a slide rule having on one side a slide and three stationary scales, two placed at the edges and used for measuring azimuths and the other called the trajectory scale, showing the height of trajectory in mils. The slide has on it the range scale showing the range for the 3-inch gun in hundreds of yards and with the trajectory scale is used for determining the height of trajectory in mils at any point of the range.

On the other side of the ruler is engraved a table of parallaxes computed for a base of 20 yards for different angles of obliquity of the aiming point.

The scales for reading azimuth with the cord are similar to those on the wooden ruler. The trajectory scale is graduated in mils from —20 through 0 to +710, and is marked for every 5 mils. The range scale gives the range in hundreds of yards and is marked for each 200 yards.

USE OF BATTERY COMMANDER'S RULER, METAL.

Use of the azimuth scales is described in use of wooden ruler.

Practical use of this slide rule is made in determining whether it is possible to fire from a given position over intervening obstacles at a given target. The angle of site of the target, the height (or angle of site) of the obstacle in mils, and the ranges of target and obstacle in yards are first measured. The height of trajectory in mils at the obstacle is then determined for the given range as follows:

Place the number corresponding to the angle of site of target opposite the number on the range scale corresponding to the range to the obstacle. Now read opposite the number on the range scale corresponding to the range to the target the height of trajectory at the

obstacle. If this height of trajectory is larger than the height of the obstacle in mils, the projectile will clear.

To illustrate (example for 4.7 gun matériel):

Angle of site of target = 285 (or − 15).
Angle of site of obstacle = 380 (or + 80).
Range of target = 2,800 yards.
Range of obstacle = 200 yards.

Using the setting − 15 on the trajectory scale opposite 200 on the range scale brings 65 on the trajectory scale opposite 2,800 on range scale; hence the height of the trajectory at 200 yards is 65 mils. As the height of the obstacle is 80 mils the projectile will not clear it.

The parallax table on the back of the ruler affords a means of quickly finding the parallax of any target or aiming point situated in any direction with reference to the front of the battery.

The term "parallax" is here used in a restricted sense, and by the parallax of a point is meant the angle in mils subtended at the distance of the point by one platoon front, or 20 yards.

The parallax of a point whose direction is normal to the front of the battery, usually true of the target, is easily obtained by dividing 20 by the number of thousands of yards in the range of the point; thus, the parallax of such a point whose range is 4,000 yards is 20 divided by 4, or 5 mils. If the direction of the point is not normal to the front of the battery, its parallax is equal to the normal parallax, obtained as above, multiplied by the cosine of the angle of obliquity; that is, the angle which the direction of the point makes with the normal to the battery front.

The two upper lines of figures in the table give angles of obliquity for each 100 mils in the two quadrants in front of the battery, while the two lower lines give similar angles for the two quadrants in rear. The figures opposite 1,000, 1,250, 1,500, and 1,750 are the parallaxes for these ranges at the different angles of obliquity given in the table. For higher ranges simple multiples of the tabular ranges are taken. Thus, for 3,500 yards take one-half of the parallax for 1,750 yards; for 5,000 yards take one-fifth of the parallax for 1,000 yards, or one-fourth of that for 1,250 yards, etc.

In using the table interpolation is, as a rule, unnecessary. It is sufficiently accurate for all practical purposes to take the direction of the point to the nearest 100 mils and the range to the nearest tabular one or to the nearest multiple. Thus, for a point whose range is 2,800 yards and whose direction, as given by the B. C. telescope, is 3,360, enter the table with a range of 3,000 yards (2 by 1,500) and take out the parallax corresponding to 34 (3,400), which in this case is found to be one-half of 13, or 6.5. As the actual range is 2,800 yards and the angle 3,360, both less than the tabular, 7 should in this case be taken as the parallax required.

In using the table note that the angle of obliquity of the point whose parallax is desired is measured from the normal to the front of the battery and is the azimuth of the point with reference to that normal. The target is always in the first or fourth quadrant and is usually, but not always, so nearly normal to the front of the battery that its angle of obliquity may be neglected. The aiming point may, however, be located in any direction, and its angle of obliquity may therefore vary from 0 to 6,400.

The values of the parallaxes obtained from the table are used by the battery commander in determining sight deflections, etc., in accordance with methods laid down in the drill regulations.

The battery commander's ruler, metal, is furnished with a leather carrying case with shoulder straps.

In the earlier models of the battery commander's ruler (metal) the height of trajectory scale is a slide and the range scale is fixed, the height of trajectory scale is graduated for every 2 mils from —24 through 0 to +284 and numbered every five graduations.

In the later models of the metal type the height of the trajectory scale is fixed and the range scale is a slide, the height of trajectory scale is graduated for every 5 mils from −20 through 0 to +710, numbered every four graduations.

THE FIELD ARTILLERY PLOTTER, MODEL OF 1907.

When the azimuths and ranges of the aiming point and the target from the observation station and the distance from the observation station to the gun are known, the plotter mechanically indicates the azimuths and ranges of the aiming point and target from the gun.

A full description of the field artillery plotter, model of 1907, with illustration, is contained in pamphlet No. 1667, issued by the Ordnance Department.

FLASH LIGHTS.

Commercial flash lights, slightly modified, are issued either with or without soft rubber hoods.

Those with hoods are issued for use in illuminating the reticules of the sights at night.

ADJUSTING INSTRUMENTS.

A complete detailed description of the method of disassembling and adjusting the different instruments is given in Ordnance Office Pamphlet No. 1795, Instructions for the Care, Preservation, Repair, and Adjustment of Instruments for the Fire-Control Systems for Coast and Field Artillery. Attention is invited to General Orders No. 47, War Department, March 24, 1905, with reference to the care

and repair of panoramic sights, battery commander's telescopes, and range finders.

No disassembling of instruments except as prescribed herein will be permitted. The disassembling of telescopic instruments allowed herein must be done only in the presence of a commissioned officer. Disassembling as permitted in pamphlet 1795 must be done only by officers or employees of the Ordnance Department.

TOTAL ORDNANCE EQUIPMENT

FOR THE HEADQUARTERS COMPANY OF A REGIMENT

OF MOUNTAIN ARTILLERY.

60007—16——4

Statement of total ordnance equipment for the headquarters company of a regiment.

Equipment.	Mountain artillery.
Battery commander's telescope, model of 1915 [1]	3
Battery commander's rulers, wooden	30
Steel tape, 100 feet	3
Flashlights, with hoods	9
Pack outfit, complete	1
Set of blacksmith's tools [2]	1
Set of saddler's tools [2]	1
Set of carpenter's tools [3]	1
Cleaning and preserving material, set [3]	1
Saddler's material, set [4]	1
Arms, personal and horse equipment [5]	1
Garrison equipment [6]	.....
Targets, mobile artillery [7]	.....
Flash targets [7]	.....
Smoke bomb, pole type [7]	.....

[1] 1 B. C. telescope, model of 1904 or 1905, complete, and 1 observation telescope, complete, may be issued in lieu of the B. C. telescope, model of 1915.
[2] See page 53.
[3] See page 54.
[4] See page 55.
[5] See page 51.
[6] See U. A. E. M. for mountain artillery.
[7] See G. O. No. 27 of 1914.

Statement of total headquarters company equipment of a regiment.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Property classification. Section.
	FIRE-CONTROL EQUIPMENT.			
	Furnished by Ordnance Department.[1]			
30	B. C. rulers, wooden [2]	In chest for fire-control equipment	V	1
3	B. C. telescope, model of 1915, complete in case.[3]	In chest for fire-control equipment	V	1
3	B. C. telescope tripod in case [3]	On pack	.....	.....
9	Flash lights with hoods	In chest for fire-control equipment	V	3
3	Steel tape, 100 feet	do	V	1
	Furnished by Signal Corps.[4]			
	PACK OUTFIT, COMPLETE.			
13	Pack harness sets, each consisting of—		VI	2
	1 halter bridle	Carried on mule		
	1 corona			
	1 saddle blanket			
	1 sobrejalma			
	1 crupper			
	1 aparejo cincha			
2	Blinders	Carried by man		
3	Pack frames, model of 1912	Carried on mule		
4	Heavy pack frames			
3	Pack reels, complete, with frame			
3	Cargo cinchas, long			
10	Pack covers			
5	Lash ropes			
5	Sling ropes			
10	Lair ropes			
3	Chests for fire control equipment, filled.	Chest called for in list of fire-control equipment.		

[1] F. A. plotter and case are not part of regular equipment. Organizations having them may retain them if desired.
[2] Metal B. C. rulers with cases are no longer part of the equipment. Those on hand may be retained.
[3] 1 B. C. telescope, model of 1904 or 1905, with tripod and cases, and 1 observation telescope and tripod with cases may be issued in lieu of the B. C. telescope, model of 1915, complete, with tripod and cases.
[4] For list of these parts see U. A. E. M.

Statement of total headquarters company equipment of a regiment—Continued.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	PACK OUTFITS COMPLETE—continued.			
3	Field desks, filled	Carried on pack		
1	Supply chest, blacksmith's, filled			
1	Supply chest, saddler's, filled			
4	Lantern boxes, containing 2 lanterns each.			
6	Ration crates			
1	Supply chest, miscellaneous, filled			
1	Supply chest, tools, filled			
3	Tripod and case for B. C. telescope	Called for in list of fire-control equipment.	VI	2
7	Axes	Carried on pack		
11	Picket rope sections			
14	Picket pins and eyes			
8	Rigging covers			
1	Schaller forge with vise	Called for in list of blacksmith's tools.		
1	Schaller forge tool chest			
28	Canvas buckets, watering	Carried on pack		
5	Lash cinchas			
7	Ax guards, with straps			
	ACCESSORIES FOR PACKS.			
2	Bags for borax and tacks	In chests	X	9
4	Bags for coal, sponges, thread, and wax.			
2	Bags for horseshoe nails			
3	Bags for tacks			
1	Blacksmith's apron for saddler			
2	Oil cans, rectangular			
1	Rope, 150 feet			
2	Bags for hardware	In chests		
3	Bags for rivets			
	PERSONAL EQUIPMENT.			
	The equipment of the enlisted men will be as follows:			
	(*a*) For each enlisted man individually mounted on horse or mule—			
1	Can, bacon	Carried by man	IX	1
[1] 1	Canteen, model of 1910			
[1] 1	Canteen cover, dismounted			
21	Cartridges, ball, pistol, or 20 cartridges, ball, revolver.	....do	VII	2
1	Cup, model of 1910	....do	IX	1
1	Fork			
1	Knife			
2	Magazines, pistol, extra, if pistol is used.	....do	VII	2
1	Meat can	....do	IX	1
1	Pistol or revolver	....do	VII	2
1	Pistol belt or revolver cartridge belt without saber ring.	....do	IX	3
1	Pistol holster or revolver holster			
1	Spoon	....do	IX	1
1	Pouch for first aid packet			
1	First aid packet (Medical Department).			
	Furnished by Quartermaster Corps—			
1	Identification tag	....do		
1	Shelter tent, half			
1	Shelter tent pole			
5	Shelter tent pegs			
1	Spurs, pair	Carried on man	IX	2
1	Spur straps, set			
	(*b*) For dismounted men (except members of band)—			
1	Bolo	Carried by man	IX	1
1	Bolo scabbard			
1	Can, bacon			
1	Can, condiment			
[1] 1	Canteen, model of 1910			
[1] 1	Canteen cover, dismounted, model of 1910.			

[1] Until these articles are supplied the canteen, cavalry, and canteen strap, cavalry, may be used.

Statement of total headquarters company equipment of a regiment—Continued.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	PERSONAL EQUIPMENT—continued.			
	(*b*) For dismounted men (except members of board)—Continued.			
21	Cartridges, ball, pistol, or 20 cartridges, ball, revolver.	Carried by man	VII	2
1	Cup	do	IX	1
1	Fork	do	IX	1
[1] 1	Haversack, model of 1910	do	IX	1
1	Knife	do	IX	1
2	Magazines, pistol, extra, if pistol is used.	do	VII	2
1	Meat can	do	IX	1
1	Pistol or revolver	do	IX	3
1	Pistol belt or revolver cartridge belt without saber ring.	do	IX	3
1	Pistol or revolver holster	do	IX	3
1	Pouch for first aid packet	do	IX	1
1	1 spoon	do	IX	1
1	First aid packet (Medical Department).			
	Furnished by Quartermaster Corps—			
1	Identification tag	do		
1	Shelter tent, half	do		
1	Shelter-tent pole	do		
5	Shelter-tent pegs	do		
	(*c*) For members of band—			
	Same as (*b*) except—			
1	Bolo		VII	5
1	Bolo scabbard		VII	5
	(*d*) Horse equipment for each man mounted on a horse—			
1	Bridle, Field Artillery	On horse	IX	5
1	Currycomb	On horse	IX	5
1	Feed bag	On horse	IX	5
1	Grain bag	On horse	IX	5
1	Halter headstall	On horse	IX	5
1	Halter tie rope	On horse	IX	5
1	Horse brush	On horse	IX	5
1	Link	On horse	IX	5
[2] 1	Saddle McClellan, Field Artillery	On horse	IX	5
1	Saddlebags, pair	On horse	IX	5
1	Saddle blanket	On horse	IX	5
1	Surcingle	On horse	IX	5
	(*e*) Horse equipment for each man mounted on a mule—			
1	Currycomb	On mule	IX	5
1	Feed bag	On mule	IX	5
1	Grain bag	On mule	IX	5
1	Halter bridle, model of 1910 (with leather reins)	On mule	IX	5
1	Horse brush	On mule	IX	5
1	Link	On mule	IX	5
1	Saddle, mule, riding	On mule	IX	5
1	Saddlebags, pair	On mule	IX	5
1	Saddle blanket	On mule	IX	5
1	Surcingle	On mule	IX	5
	(*f*) For pack mules in addition to pack harness—			
1	Currycomb	On mule	IX	5
1	Feed bag	On mule	IX	5
1	Grain bag	On mule	IX	5
1	Horse brush	On mule	IX	5
1	Surcingle	On mule	IX	5
	(*g*) For bell and spare horses and spare mules—			
1	Feed bag	On animal	IX	5
1	Grain bag	On animal	IX	5
1	Halter headstall	On animal	IX	5
1	Halter tie rope	On animal	IX	5
1	Saddle blanket	On animal	IX	5
1	Surcingle	On animal	IX	5

[1] Until the model of 1910 haversack is supplied, the haversack, old model, and two canteen haversack straps may be used.

[2] Saddles to be equipped with three guidon sockets per regimental headquarters company.

Statement of total headquarters company equipment of a regiment—Continued.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	PERSONAL EQUIPMENT—continued.			
	(*h*) For noncommissioned staff officers and drum major, in addition to (*a*)—			
1	Cavalry saber and scabbard, old model.	By man	VII	5
1	Saber attachment	do	IX	2
1	Saber knot	do	IX	2
2	Saber straps (The revolver or pistol cartridge belt to be provided with a saber ring.)	do	IX	5
	MISCELLANEOUS EQUIPMENT.			
1	Marking outfit for stamping leather	Where convenient	X	5
1	Marking outfit for stamping metal	Where convenient	X	5
1	Stencil outfit	Where convenient	X	5
1	Pistol-cleaning kit	do	X	9
	BLACKSMITH'S TOOLS.			
1	Schaller forge	On mule		
1	Vise, 2.5-inch jaws	In Schaller forge		
1	Schaller forge tool chest	On mule		
1	Anvil, 34 pounds	In Schaller forge tool chest		
1	Blacksmith's apron	In Schaller forge tool chest		
1	Shoeing box	In Schaller forge tool chest		
1	Tool kit for Schaller forge	In Schaller forge tool chest		
1	Chisel, handled for cold iron, 2 pounds	In blacksmith's tool kit		
1	Clinch cutter	In blacksmith's tool kit		
1	Clinching iron	In blacksmith's tool kit		
1	Creaser	In blacksmith's tool kit		
1	Cutting nippers, 14-inch	In blacksmith's tool kit		
1	Shoeing knife	In blacksmith's tool kit		
1	Shoeing rasp, 16-inch	In blacksmith's tool kit		
6	Drills, flat	For garrison use only	X	9
1	File, 12-inch, flat, second cut	In blacksmith's tool kit		
1	File, 8-inch, handsaw, taper	In blacksmith's tool kit		
1	Fire rake	In blacksmith's tool kit		
1	Fire shovel	In blacksmith's tool kit		
1	Hammer, rounding, 14-inch handle	In blacksmith's tool kit		
1	Hammer, shoeing, 10-ounce	In blacksmith's tool kit		
2	Handles, spare, for cold chisel	In blacksmith's tool kit		
1	Hardie 0.562 (9/16) square shank, 1-inch bit.	In blacksmith's tool kit		
1	Pritchel, 0.562 (9/16) flats	In blacksmith's tool kit		
1	Ratchet drill for square shank drills	For garrison use only		
1	Shoeing pincers, 14-inch	In blacksmith's tool kit		
1	Tongs, horseshoer's, 18.5-ounce	In blacksmith's tool kit		
1	Whetstone, farrier's, 10-inch	In blacksmith's tool kit		
1	Wrench, screw, 8-inch	In blacksmith's tool kit		
1	Sledge, 11 pounds	In blacksmith's tool kit		
	SADDLER'S TOOLS.			
1	Tool kit, sheepskin	In supply chest, left		
12	Awl blades, harness assorted, Nos. 43 to 48.	In tool kit		
1	Awl, pegging	In tool kit		
1	Awl, seat, handled	In tool kit		
1	Carriage, pricking, 3 wheels, Nos. 7, 8, and 10	In tool kit		
1	Compass, 6-inch	In tool kit		
1	Creaser, double, lignum-vitæ	In tool kit		
1	Edge tool, No. 2	In tool kit		
2	Extra blades with followers for draw gage.	In tool kit	X	9
1	Gage, draw, brass, without guard	In tool kit		
1	Hammer, No. 3, rivet	For garrison use only		
1	Handle, peg awl, with wrench	In tool kit		
1	Edge tool, No. 1	In tool kit		
2	Hafts, patent, awl, rosewood, with wrench.	In tool kit		
1	Knife, round	In tool kit		
1	Knife, splitting, 6-inch	In tool kit		

Statement of total headquarters company equipment of a regiment—Continued.

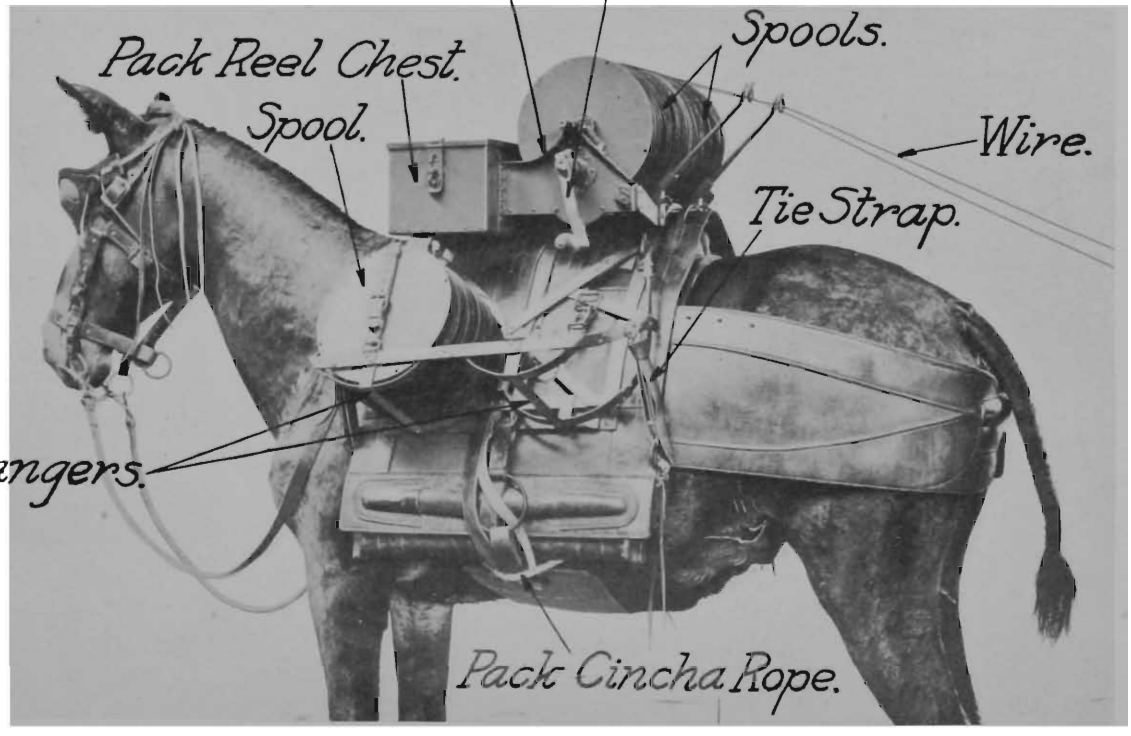
Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	SADDLER'S TOOLS—continued.			
1	Needle case, leather			
1	Needles, Glover's, No. 3, paper			
2	Needles, harness, No. 4, papers			
2	Needles, harness, No. 5, papers			
2	Needles, harness, No. 6, papers			
12	Needles, sacking, assorted sizes, 4 and 4½			
1	Nippers, cutting, 10-inch			
1	Oilstone, 1.125 by 2 by 8, Washita, unmounted			
1	Pliers, 6-inch			
4	Punches, hand, Nos. 5, 7, and 10, round			
1	Punch, revolving, 4 tubes, Nos. 4, 5, 6, and 7	In tool kit	X	9
1	Rivet, ret			
1	Rule, boxwood, 2-foot, fourfold			
1	Sewing palm, leather			
1	Screw driver, 3-inch blade			
1	Slicker, steel			
1	Shears, 10-inch, bent trimmers			
1	Shoe knife, square point			
1	Shoe knife, broad point			
1	Tool claw			
2	Thimbles, best aluminum lined steel			
1	Stitching clamp			
	CARPENTER'S TOOLS.			
1	Tool kit	In supply chest, left		
1	Bit, countersink, ⅝-inch, rose head			
6	Bits, auger, sizes ¼, ½, ¾, 1, 1¼, 1½			
1	Bit, expansive, two cutters, ¾ to 3 inches			
1	Bit, screw driver, size ⅜-inch			
1	Brace, rachet, 10-inch sweep			
1	Bevel, 8-inch, flush lever			
3	Chisels, socket framing, ¾, 1, and 1½			
4	Drills, twist, sizes, 5/32, 3/16, 5/32, 5/16			
1	File, saw, 6-inch			
1	File, 10-inch, flat bastard			
1	Hammer, claw			
1	Handle, tool, containing 10 tools			
1	Knife, drawing, folding and adjustable handle	In tool kit	X	9
1	Saw, crosscut, 20-inch			
1	Plane, smoothing, wood, 8-inch			
1	Saw, crosscut, 20-inch			
1	Saw set			
1	Square, steel, 12-inch body, 8-inch tongue			
1	Rule, boxwood, 2-foot, fourfold			
1	Screw driver, 5-inch blade			
1	Handle, file, aluminum alloy			
1	Oilstone, unmounted, 1 by 2 by 8, Arkansas soft			
1	Rasp, wood, 10-inch, half-round			
1	Wrench, screw, 12-inch, solid bar			
	MATERIALS FOR CLEANING AND PRESERVATION. [All expendable].			
1	Brush, camel's hair, No. 1, round			
1	Brush, sash, No. 3			
1	Brush, sash, No. 5			
1	Brush, varnish, No. 5–0			
1	Brush, varnish, No. 4–0			
1	Brush, varnish, No. 6–0			
1	Burner, lantern	In supply chest, left	X	9
1	Cloth, emery, No. ½, quire			
1	Cosmic, No. 80, soft, quart			
1	Chamois skin, 13 by 17	In supply chest, right		
1	Dressing, russet leather, box			
1	Globe, lantern	In supply chest, left		
2	Lye, powdered, 1-pound can			
5	Naphthalene, pounds			

Statement of total headquarters company equipment of a regiment—Continued.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	MATERIAL FOR CLEANING AND PRESERVATION—continued.			
1	Oil, clock, bottle, ounce			
1	Oil, linseed, boiled, gallon			
1	Oil, linseed, raw, pint			
3	Oil, neat's-foot, gallons	In supply chest, right		
1	Oil, sperm, pint			
10	Paint, olive drab, third coat, pounds			
1	Oil, lubricating, engine oil, No. 1, gallon.			
10	Salsoda, pounds			
1	Sandpaper, No. ½, quire			
20	Soap, castile, pounds	8 pounds in supply chest, right; rest in store	X	10
3	Soap, H and H, cakes	2 cakes in supply chest, right; rest in store		
20	Soap, saddle, Frank Miller's, pounds			
40	Sponges, 5-inch			
1	Sponge, large, size, 5½ or 6 inches			
10	Waste, cotton, white, pounds			
5	Wicks, lantern, size O	In supply chest, left		
9	Ever-ready tungsten batteries, No. 793			
3	Ever-ready 2.7 V. Mazda bulb, No. 1197			
	SADDLER'S MATERIAL (ALL EXPENDABLE).			
6	Awl blades, harness, assorted	In tool kit		
1	Awl haft, patent, No. 146, with wrench			
1	Beeswax, pound			
	Buckles, bar:			
12	⅝-inch			
6	¾-inch			
3	⅞-inch			
2	1-inch			
2	1-inch, Saalbach			
7	1⅛-inch			
3	1⅜-inch			
6	Tongueless, ⅝-inch			
8	Tongueless, 1-inch			
5	Tongueless, 1½-inch			
	Buckles, roller:			
2	⅝-inch		X	10
5	¾-inch			
5	¾-inch, tongueless			
1	1-inch	In tool kit		
6	1¼-inch			
3	Royal, 1½-inch			
	Buckles, wire:			
3	½-inch			
2	⅝-inch			
12	¾-inch			
6	Buckles, satchel, ½-inch			
3	Cheek D			
10	Chock plates, upper and lower			
5	Chock staples			
10	Duck, cotton, olive drab, 22-inch, No. 2, yards.			
3	Foot staples, high	do	IX	5
6	Foot staples, low			
3	Foot staples, semicircular			
14	End buckles, 1-inch, with clip	do	X	10
2	End clip, ⅝-inch			
10	End clip, 1-inch			
19	End clip, 1½-inch			
16	Hooks, double, brass wire	do	IV	8
16	Hooks, end, brass wire			
2	Hooks, wire, for link			
2	Leather, bridle, backs	do	X	10
1	Leather, collar, back			
150	Leather, harness, backs, pounds			
1	Leather, latigo, side			
2	Nails, saddle	do	X	9
1	Needles, glover's, No. 3, paper			
1	Needles, harness, No. 4, paper			
1	Needles, harness, No. 5, paper			
1	Needles, harness, No. 6, paper			

Statement of total headquarters company equipment of a regiment—Continued.

Mountain artillery.	Article.	Where carried.	Property classification. Class.	Section.
	SADDLER'S MATERIALS (ALL EXPENDABLE)—continued.			
2	Ornaments, brow band	In tool kit	IX	5
3	Ovals, saddle			
2	Ovals, saddlebag			
1	Pins, screw, brass, ¾-inch, gross, No. 2	do	X	10
3	Rings, ⅞-inch diameter, saddlebag	do	IX	5
6	Rings, 1½-inch diameter, saddle			
2	Rings, 1¾-inch diameter, throat strap			
14	Rings, 2-inch diameter, halter			
3	Rings, 4-inch diameter, quarter strap			
9	Rings, "D," 1-inch diameter, feed bag			
210	Rope, ⅜-inch (halter bridle, manila hemp), feet.			
600	Rope, ½-inch halter, feet			
½	Rivets and burrs, brass, ½-inch, No. 10, pound.	do	X	10
1	Rivets and burrs, brass, ⅝-inch, No. 10 oval head, pound.			
1	Rivets and burrs, brass, 1-inch, No. 8, oval head, pound.			
¼	Rivets and burrs, ¾-inch, No. 10, oval heads, pound.			
5	Rendering rings, 1⅝-inch diameter	do		
1	Screws, brass, 1-inch, No. 6, gross	do		
6	Sheepskins, with wool on			
10	Cincha straps, aparejo	In tool kit	IX	5
20	Duck, cotton, olive drab, 30-inch, No. 8, yards.			
18	Duck, cotton, olive drab, 22-inch, No. 1, yards.			
1	Shield, saddle, 11-inch			
1	Shield, saddle, 11½-inch			
1	Shield, saddle, 12-inch			
2	Snaps, German, ⅞-inch			
9	Snaps, German, 1-inch			
2	Snap hooks, canteen, cavalry			
8	Snap hooks, haversack, 1-inch			
5	Snaps, swivel, oval loop 1¼-inch			
2	Snaps, swivel, 1 inch, No. 16			
9	Sap loops, feed bag, 1 by 1½ inch			
15	Squares, halter			
2	Studs, saddle bag			
1	Tacks, copper, No. 12, ½-pound paper			
1	Tacks, copper, No. 20, ½-pound paper			
1	Thimble, aluminum lined, steel, size ¾-inch.			
1	Thread, carpet, No. 18, olive drab, pound.	In tool kit	IX	5
1	Thread, shoe, No. 3, brown, pound			
1	Thread, shoe, No. 10, pound			
2	Wax, stitching, winter, pounds			
2	Webbing, olive drab, linen, ⅝-inch yards.	do	X	10
22	Webbing, cotton, olive drab, 1-inch, yards.			
10	Webbing, olive drab, halter 1½-inch, yards.			
13	Webbing, olive drab, jute, 3½-inch, yards.			
	For polo equipment.			
2	Buckles, wire, ⅝-inch	In store		
2	Buckles, wire, ½-inch			
12	Buckles, wire, ¾-inch			
4	do			
2	Buckles, stirrup strap, 1⅝-inch			
6	Buckles, girth, 1-inch			
4	Rings, bronze, ⅞-inch diameter			
5	Webbing, linen, straining, ¾-inch			
7	Webbing, linen, straining, 5-inch			



Pack Reel Mule.

25083.

PACK REEL.[1]

[Plate VII.]

NOMENCLATURE OF PARTS.

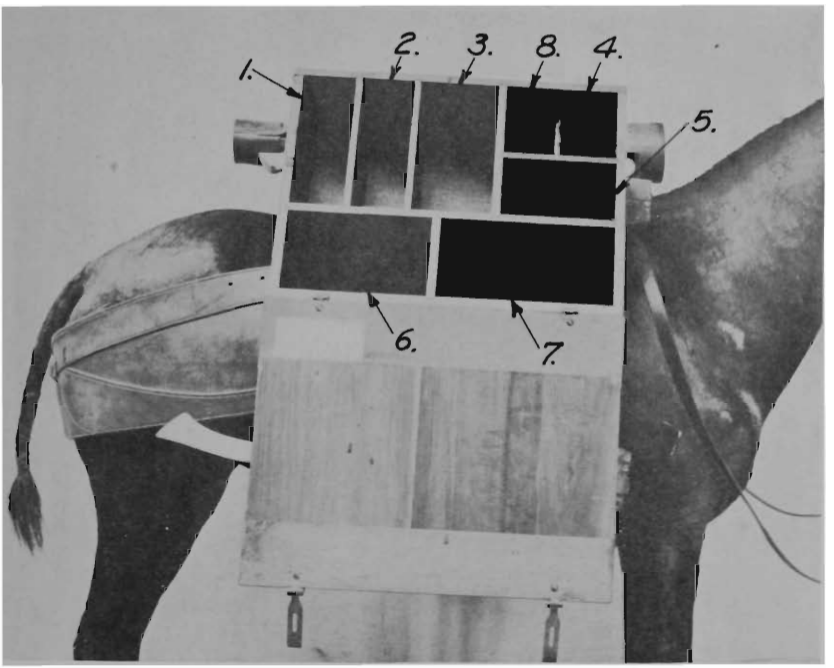
No.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
	Chest and frame:			
2	Bottom pads	On bottom of chest		
1	Brake-band stud	Set in reel frame, left, supports brake band.		
1	Brake-lever stud	Riveted to reel frame, left, inside		
1	Brake-lever washer	At brake lever stud, outside reel frame		
1	Bridge	Across top of chest at middle		
2	Cap-hinge pins	In shaft-bearing caps		
2	Cap latches	Lock the shaft-bearing caps		
2	Cap-latch bolts	Riveted to reel frame		
4	Cap-latch links			
2	Cap-latch lugs			
2	Cap-latch springs			
1	Chest back			
1	Chest bottom			
1	Chest front			
1	Crank rest	On reel frame, left		
1	Frame reinforce, left	Horizontal frame stiffeners		
1	Frame reinforce, right			
2	Hasps	Secure lids		
2	Hasp hinges			
2	Hasp-hinge pins			
2	Hinges	Riveted to bridge		
1	Hinge pin	In lid hinges		
2	Lids	Hinged to bridge of chest		
2	Lid pads	Glued to lids		
2	Link pins	In cap-latch links		
2	Pin brackets, chest	On chest bottom		
1	Pin bracket, frame, left	Riveted to reel frames and pin plates, frame.	IV	9
1	Pin bracket, frame, right			
2	Pin plates, chest	On front of chest		
2	Pin plates, frame			
1	Reel frame, left	In rear of chest		
1	Reel frame, right			
4	Reinforce washers	Inside of chest at wing nut-pin rivets		
2	Shaft-bearing caps	Hinged to shaft bearings		
1	Shaft bearing, left	Riveted to reel frame, left		
1	Shaft bearing, right	Riveted to reel frame, right		
2	Wing nuts	On wing nut pins		
2	Wing nut pins	Riveted on ends of chest		
2	Wing nut-pin washers			
	Operating mechanism:			
1	Brake band	In drum of crank shaft		
1	Brake-clamp bolt	Through brake lever		
1	Brake-band spring	To release brake		
1	Brake lever	On brake lever stud		
1	Brake segment clamp	Clamps brake lever to reel frame		
1	Chain for right crank			
1	Chain ring	On crank chain		
1	Collar	On shaft, near left end		
1	Crank bearing	The hub of crank, left		
2	Crank fastenings	Form a socket for right crank		
1	Crank retainer	Locks crank, left, in operating position		
1	Crank-retainer nut	Inside the crank shaft		
1	Crank, left	Hinged to crank bearing		
1	Crank, right	At right end of shaft		

[1] Pack reel, complete, consists of—1 pack-reel chest and frame with operating mechanism, arches, and pack-frame sides; 4 spools, 2 spool hangers, complete; 2 pack cincha ropes, 4 tie straps.

Nomenclature of parts—Continued.

No.	Name of part.	Location, etc.	Property classification. Class.	Property classification. Section.
	Operating mechanism—Continued.			
1	Crank ring	Attaches the chain to crank, right		
1	Crank shaft	Integral with large gear and brake drum		
1	Crank-shaft bearing	Riveted to reel frame, left		
1	Crank-shaft bearing bushing	In crank-shaft bearing		
1	Crank-shaft collar	On crank shaft		
2	Handles	Grips of cranks		
2	Handle washers			
1	Hinge pin	Secures crank, left, to crank bearing		
1	Key	In crank, right		
1	Lock screw	In crank-screw collar		
1	Pinion	On shaft		
1	Pinion washer, inner			
1	Pinion washer, outer	Riveted through pinion to pinion washer, inner.		
1	Shaft	In bearings, on reel frame		
2	Spindles	Crank-handle rivets		
2	Spindle washers	On spindles		
1	Spring	Crank retainer		
1	Stop pin	Retains a single spool on shaft		
1	Stop-pin retainer			
1	Stop-pin spring			
1	0.25 wing nut	On brake-clamp bolt		
	Wire guide:			
2	Guides	With helical rings on top		
2	Guide bases	Swinging on guide studs		
2	Guide bolts	Operate guide clamps		
2	Guide clamps	Secure guide bases in position		
2	Guide studs	In pin plates, frame		
2	Lock rings	Lock guides to guide bases		
2	Pins	Maintain guide clamps in position		
2	Wing nuts	On guide bolts	IV	9
	Pack frame:			
2	Arches			
2	Brace bars	The lower bars of the pack frame sides		
2	Brace-bar boards	On brace bars		
4	Hook hinges	At upper ends of side braces		
4	Pack frame pins	Assemble pack frame sides to arches		
2	Side bars	The upper bars of pack frame sides		
2	Side-bar boards	On side bars		
4	Side braces	Connect side and brace bars		
4	Spools:			
8	Spool flanges			
8	Spool hubs (half)			
16	Wood screws			
2	Spool hangers [1]:			
4	Braces, bottom			
2	Braces, center			
4	Braces, diagonal			
2	Cross braces, front			
2	Cross braces, rear			
2	Corner reinforces, left			
2	Corner reinforces, right			
2	Corner reinforces, right			
2	Hanger, eyes, left			
2	Hanger, eyes, right			
4	1.875 D rings			
4	1 strap fastener, style 8			
4	1.25 strap fasteners, style 15			
4	1.625 strap fasteners			
8	1 x .5 strap loops	4 on straps		
4	1.5 x 1.5 strap loops	In 1.25 strap fasteners		
2	Supports, front			
2	Supports, rear			
	Accessories:			
4	Angle strap shoes	Protect straps from sharp edges of spools		
4	Holding-down clips	Engage 1.5 x 1.5 strap loops		
2	Holding-down straps	Hold spools in spool hangers		
2	Pack cincha ropes	Hold spool hangers to aparejo		
4	Tie straps	Lash pack cincha rope to 1.875 D rings		

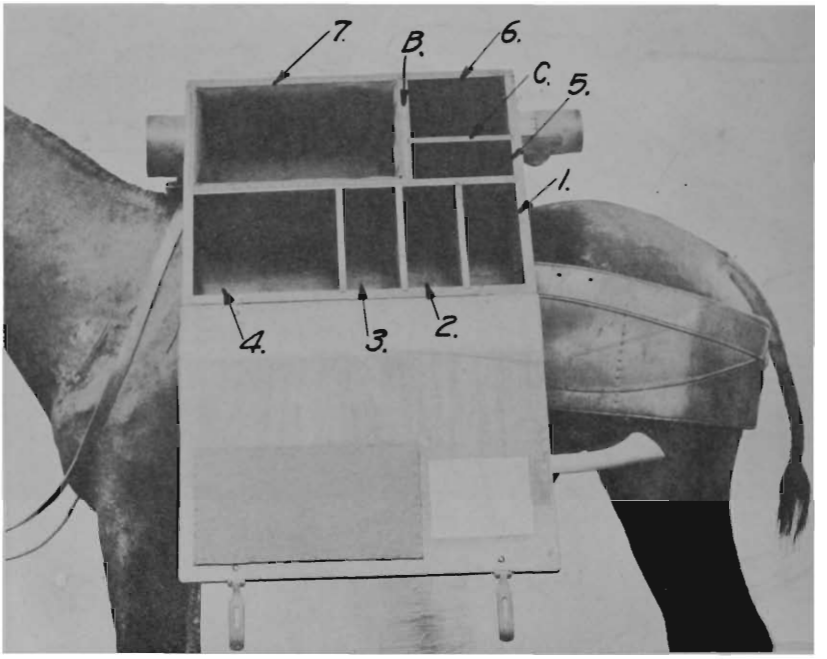
[1] One spool hanger includes: 1 spool hanger body, 2 holding-down straps, 2 holding-down clips, 2 1 x .5 strap loops, 2 1-angle strap shoes.



SIGNAL MULE. (RIGHT SIDE.)

Field desk, model of 1914. List of contents.	Comp. No.
File	1, 2
Books and orders	3
Stationery	4, 5
Field glasses, type E	6
Typewriter	7
Spare parts for buzzer (sets)	8

PLATE IX



SIGNAL MULE. (LEFT SIDE.)

Articles carried in chest for fire control equipment, model of 1914.	Comp. No.
Ground rod type D, with connectors type A	4
Plugs for buzzers: with connections, line	1, 2, 3
Buzzers, service, model of 1914, in cases	1, 2, 3
Spools buzzer wire	4
Hand reels	4
Time interval recorders, with chains	5
Wrist watches	5
Pocket compasses	5
Steel tape, 100 feet	5
Inspectors' pocket kits	7
Field glass, type E	4
Dry cells (6) in case, model of 1910	6
B. C. telescope in case*	7

*This chest is designed for telescope models of 1904 and 1905; if model of 1915 is used partitions B and C must be removed and contents of chest rearranged to suit.

PACK REEL.

[Plate VII.[

DESCRIPTION.

The pack reel provides conveniences for transporting, laying, and taking up 2½ miles of twin (or single) conductor cable.

Upon the side frames and arches of a light pack frame as a base is set a metal chest of sufficent size to contain a number of other articles of the equipment, and a connecting frame with a shaft for supporting two spools of wire. Cranks for rotating the spools and taking up the wire are provided on each side, the crank on the left being geared to produce rapid motion. When the wire is being paid out, these cranks are to be disconnected and the rotation of the spools controlled by the brake, which may be operated by a cord, or set at any desired tension.

The 2½ miles of wire are divided among four spools, which, for the best distribution of weight, are habitually carried in the spool hangers on either side of the pack. When two spools are to be used on the shaft of the reel, one should be taken from each hanger in order that the load may remain balanced.

The adjustable wire guides are intended to prevent the wire from touching the animal's back and to secure as even winding as possible.

Two breast reels with their spools of buzzer wire may be placed inside of the frame work of the pack reel for convenient transportation.

FIELD DESK.

[Plate VIII.]

The field desk is a chest, fitted with compartments in which books, stationery, field glasses, typewriter, and spare parts for the buzzers are stored. It is carried on the right side, on the pack harness of the signal mule.

CHEST FOR FIRE-CONTROL EQUIPMENT.

[Plate IX.]

The chest for the fire-control equipment is fitted with compartments in which the articles of the fire-control equipment are carried. If the battery commander's telescope, model of 1915, is carried, a rearrangement of the compartments and contents is necessary. It is carried on the left side, on the pack harness of the signal mule.

FIRE-CONTROL EQUIPMENT, PERTAINING TO BATTERY ONLY.

(61)

FIELD ARTILLERY RANGE FINDER, ONE METER BASE (BAUSCH & LOMB).

[Plates X to XVI.]

The instrument consists of the range finder, the tripod mount, and the tripod.

The principal parts of the range finder (Plates XI, XII, XIII, and XV) are:

Eyepiece.
Finder.
Range scale.
Correction wedge.
Measuring roller.
Measuring wedge.
Penta objective prism.
Left objective.
Right objective.
Halving adjusting roller.
Ocular prism.
Correction lens.

The optical parts of this range finder are embodied in a seamless steel tube covered with canvas and asbestos to minimize the effects of the change of temperature. The eyepiece is located in the center of the instrument and is equipped with a focusing device graduated in diopters. A soft rubber eyecap is furnished to protect the observer's eye from shocks and stray light. The angle of vision through the eyepiece is 50° from the horizontal plane. A ray filter, situated between the eyepiece and ocular prism, is provided having two shades of glass—i. e., smoked, for observing the rays of a searchlight or the sun, and amber, to moderate exceptionally bright daylight. These lenses are operated in and out of the path of the light by a small lever situated to the lower left of the eyepiece housing. An open sight is also provided on this eyepiece housing to facilitate training the instrument on the desired object.

Mounted and secured to the ends of the body tube are the pentagonal prisms, and the distance between their centers represents the base of the instrument. The objective openings on the end boxes are opened and closed by means of rotating shutters. Buffers are provided on the ends as a protection against shocks.

The two main objectives, correction lens, ocular coincidence prism and measuring wedge are mounted in an optical tube, made out of a

PLATE X

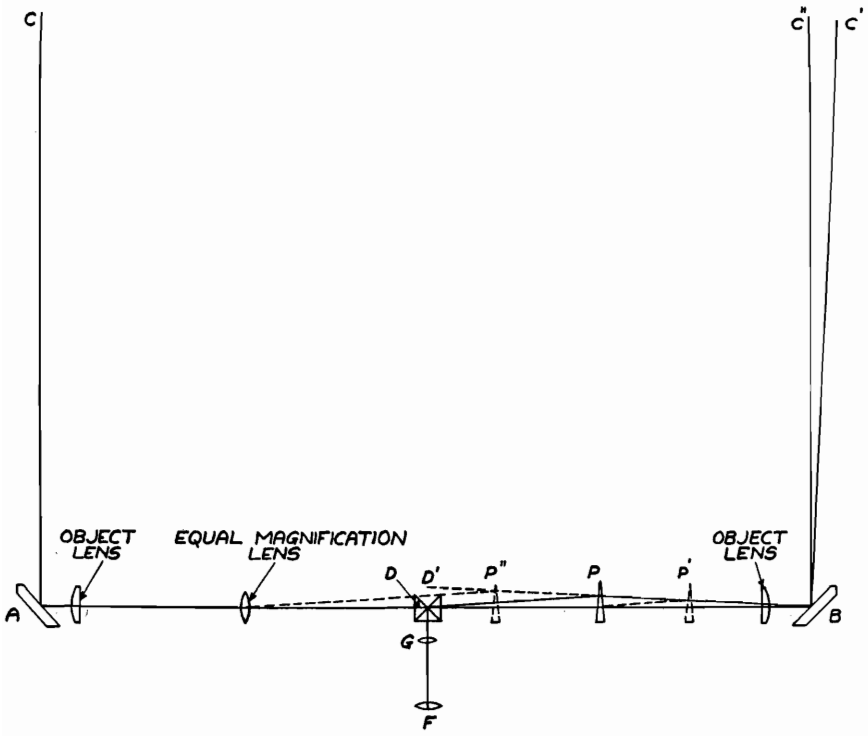
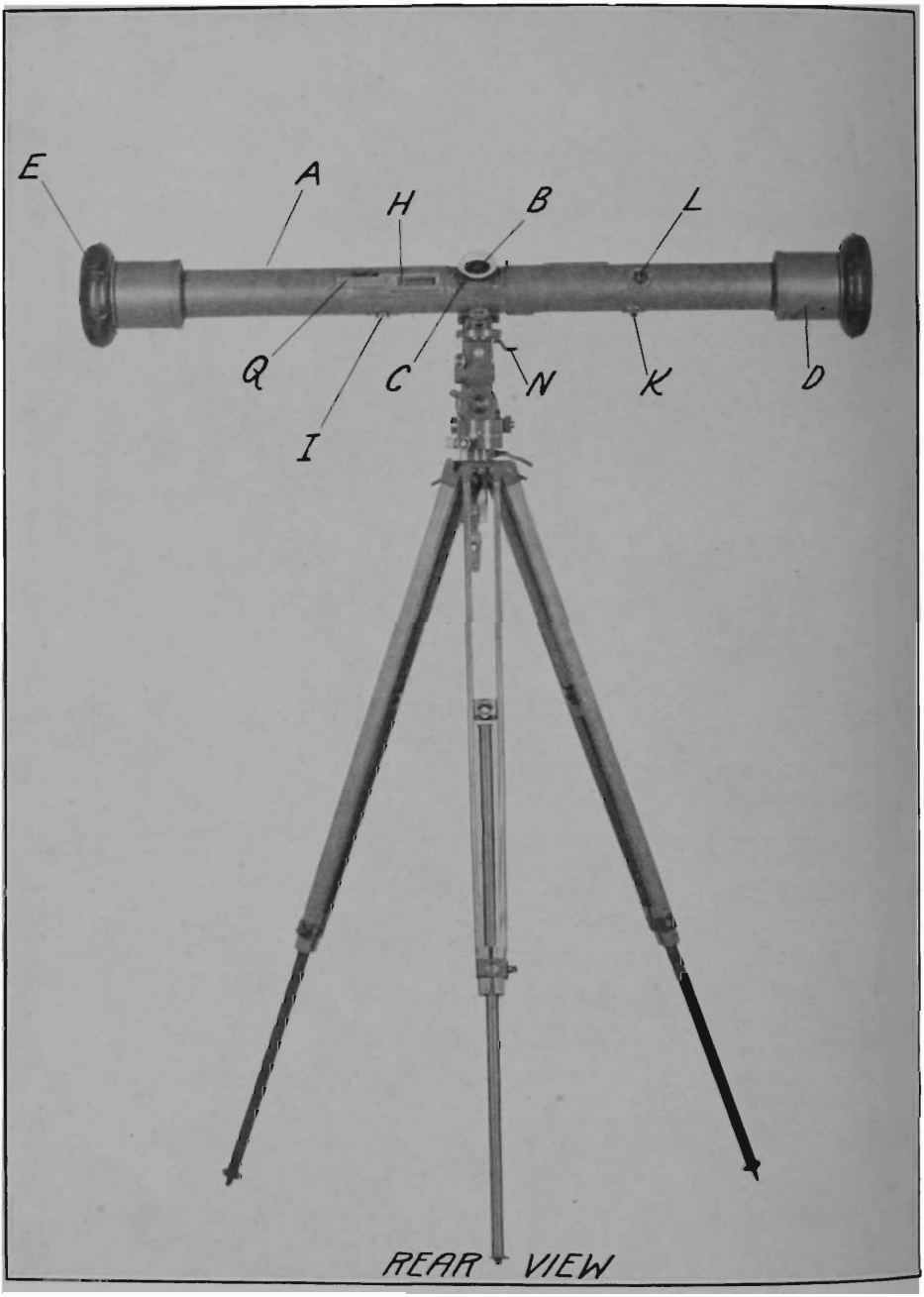
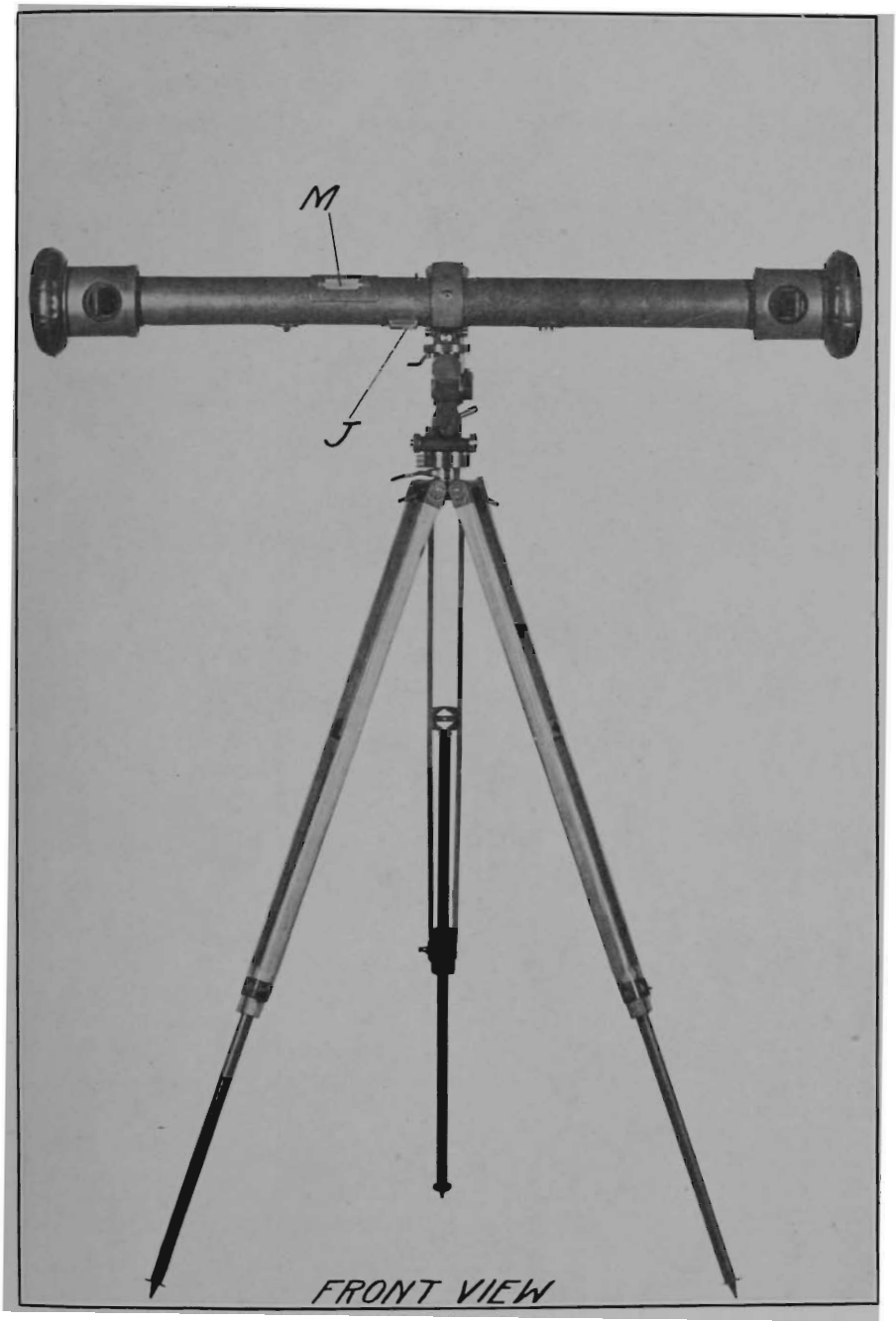


DIAGRAM TO ILLUSTRATE THE GENERAL PRINCIPLE OF RANGE-FINDERS.

PLATE XI

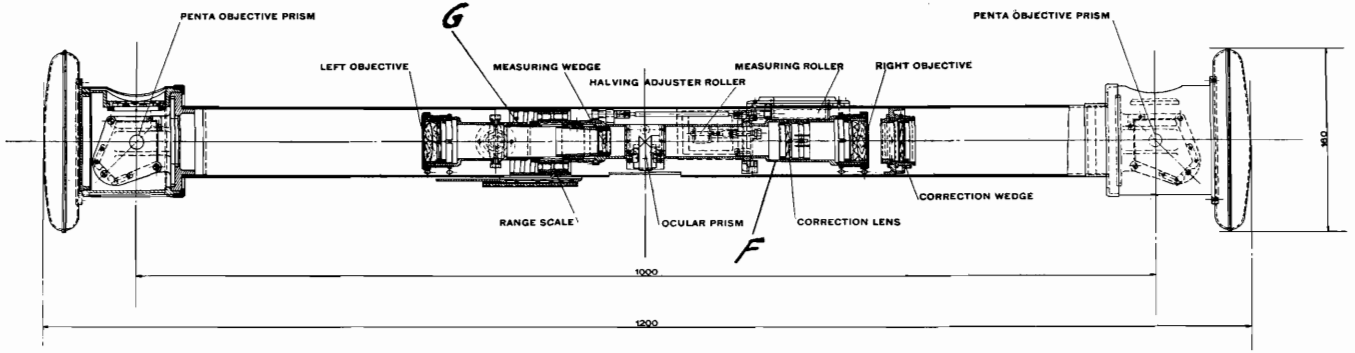


FIELD ARTILLERY RANGE FINDER, 1 METER BASE (BAUSCH & LOMB).

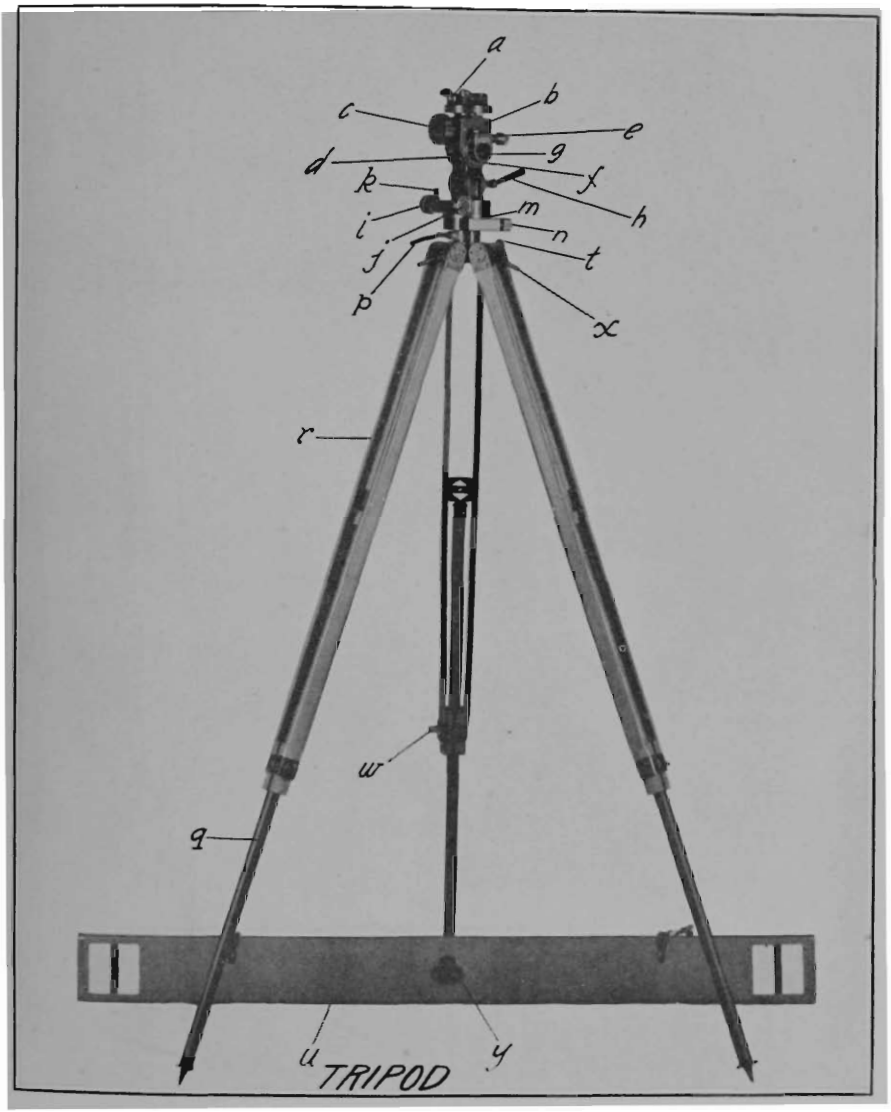


FIELD ARTILLERY RANGE FINDER, 1 METER BASE (BAUSCH & LOMB).

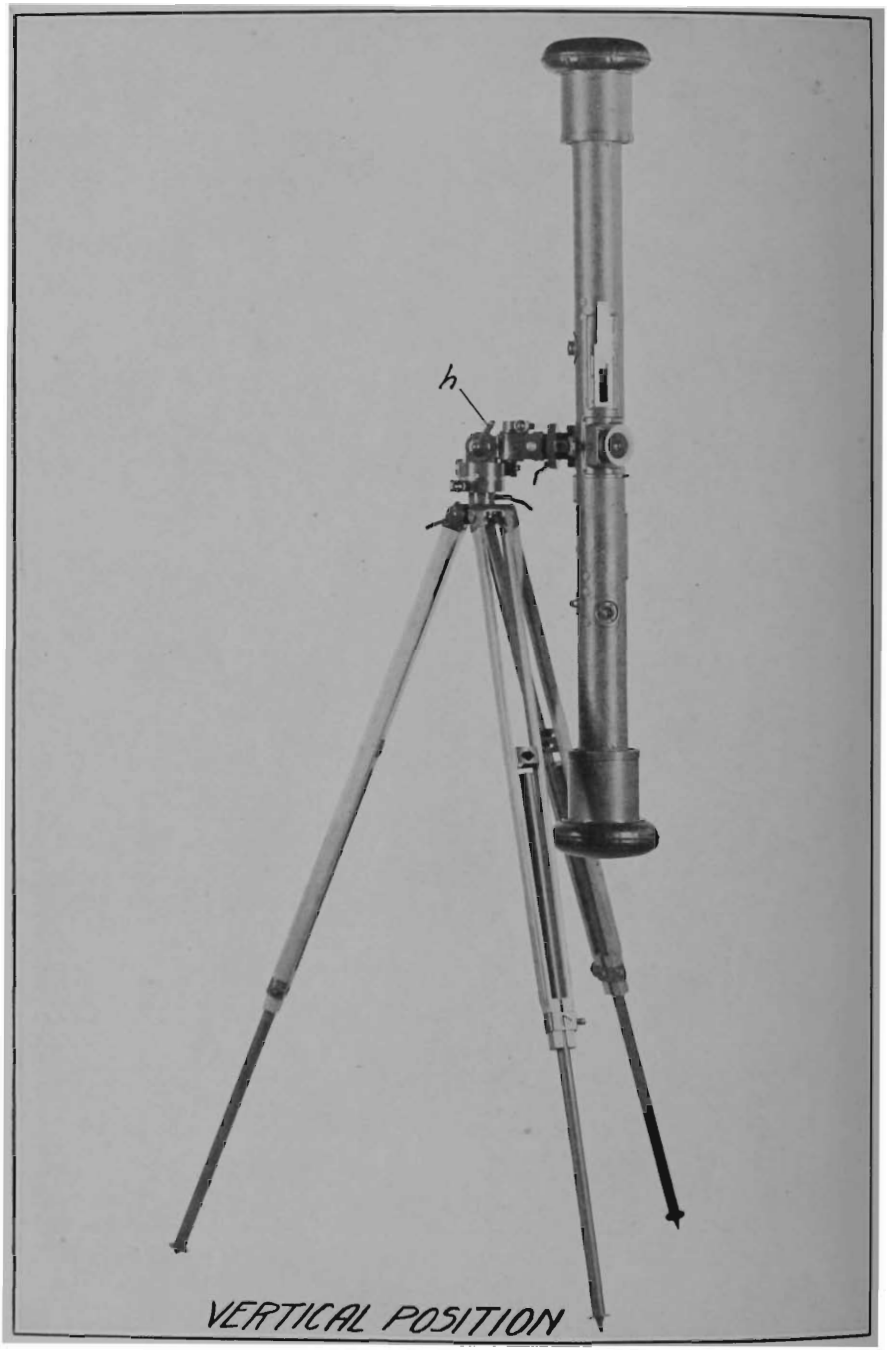
PLATE XIII



TRANSVERSE VIEW
FIELD ARTILLERY RANGE FINDER, 1 METER BASE (BAUSCH-LOMB).



FIELD ARTILLERY RANGE FINDER, 1 METER BASE (BAUSCH & LOMB).



FIELD ARTILLERY RANGE FINDER, 1 METER BASE (BAUSCH & LOMB).

solid piece of hammered steel, which in the various stages of manufacture is repeatedly annealed and thus becomes almost insensible to changes in temperature. In order to secure the maximum length of the range scale, the lateral movement of the measuring wedge is transmitted to a rotary drum, on the periphery of which is a graduated spiral scale and a guiding groove for the indicator. This optical tube is supported on the left end by a gimbal joint, which is secured to the body tube. The right end is provided with a device for raising or lowering this end to correct for any halving error of the images. This halving adjustment is actuated by a knurled roller, protected by a slide, and situated to the right of the eyepiece on the bottom of the body tube.

The correction wedge is located between the optical tube and the right end of the instrument. A small key, which fits a squared shaft protruding from the underside of the body tube, actuates this correction wedge. A window is provided on the eyepiece side of the body tube to observe the correction dial for checking purposes; to increase the accuracy of this adjustment it is advisable to take the mean of a series of observations as given on the graduated arc.

For instance, if the first setting on the correction dial should read 20, the second 18, and the third 22, the mean of these three settings would be 20, to which figure the dial should be set.

OPTICAL DATA.

Invert single coincidence type.
Magnifying power, 15.
Actual field of view, 3°.
Exit pupil, 0.1 inch.
Shortest distance measurable, 400 yards.

GENERAL PRINCIPLE.

If the length of one side and the value of any two angles of a triangle are known, the length of the other two sides of the triangle can be calculated.

Thus, in figure 1, if the length of the side AB and the angles BAD and DBA are known, the remaining sides AD and BD can be calculated.

If the length of the side AB is fixed and the angle BAD remains a right angle, then it is only necessary to measure the angle DBA in order to be able to calculate the lengths of the sides AD and BD. It will be seen from figure 1 that the longer the side AD becomes as AD′, the larger the angle DBA becomes as D′BA, and that for any given length of AD there will always be a corresponding value of the angle DBA.

Suppose, therefore, that a range finder be constructed by placing a telescope at the point A and so arrange it that its axis or line of sight makes a right angle with the line AB. Place another telescope at the point B and so arrange it that the angle DBA, which its line of sight makes with the line AB, can be measured. Then if the line AB is known and remains fixed, the length of the sides AD or the range of the object D from A can be computed. (See fig. 2.)

A table can be computed giving the length of the side AD of the triangle ABD for all values of the angle DBA from 0° to 90° and a fixed

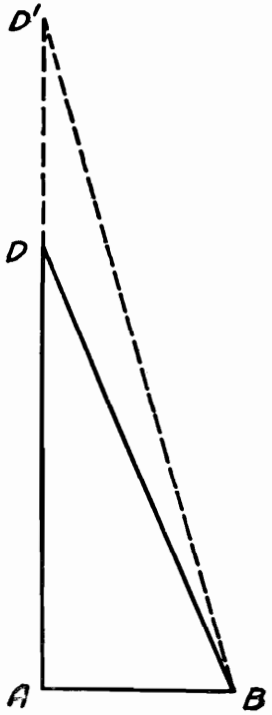


FIG. 1.

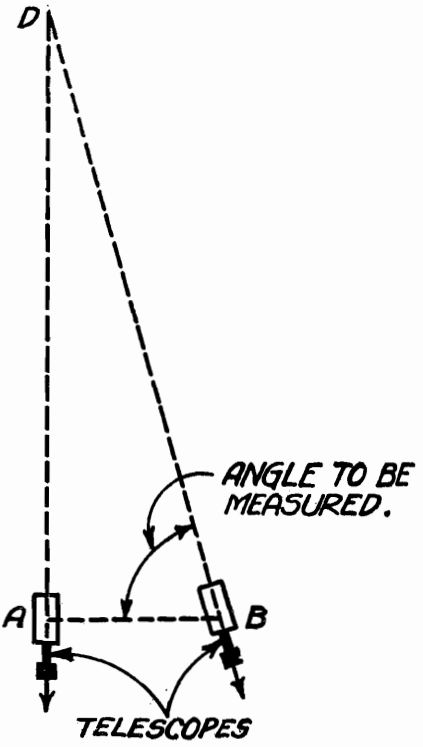


FIG. 2.

length of base AB. Then instead of graduating the angle-measuring scale on the telescope at B in degrees, graduate it with its corresponding value of the length of the side AD. We now have a range finder which by measuring the angle DBA with the telescope at B will read directly the range of the object D from A.

To use such a range finder the observer at the telescope A would lay his telescope on object D, whose range from A is desired. As the telescope A is rigidly connected at right angles to the base line AB, the whole apparatus together with the telescope at B would be moved

at the same time. The observer at B would then turn his telescope until the image of D coincided with the cross wire. The range AD could then be read directly from the angle scale on the telescope at B.

The single-observer range finder goes a step further and by means of reflecting prisms or mirrors permits a single observer to see the images from both telescopes A and B in a single eyepiece located midway between A and B. An observer looking into this eyepiece sees the field divided into two parts by a horizontal line. In the lower part of the field the observer sees the image from the telescope at A, and in the upper part of the field the image from the telescope at B. There are other types of range finders in which the field is divided into three parts.

In the single-observer range finder when the telescope at B is turned an object in the upper field observed through the eyepiece appears to move laterally across the field.

Plate X gives a diagrammatic sketch of a self-contained base, single-observer range finder.

A study of Plate X will show that the instrument is equivalent to two telescopes. On the left side is the fixed telescope at A in the improvised range finder just described. In this telescope the light traverses the objective lens, the coincident prism D and the eyepiece consisting of the field lens G and the eye lens F. The line of sight of the left-hand telescope is turned through 90° by means of the reflecting prism A. At the right-hand side is the movable telescope corresponding to the telescope at B in figure 2 of our improvised range finder. In this telescope the light traverses the objective lens, the reflecting prism the coincident prism D′, and the same eyepieces G and F. As before the line of sight of the right-hand telescope is turned through 90° by means of the reflecting prism B.

Instead of moving the telescope at the right-hand side mechanically, in order to measure the angle DBA (fig. 1), the line of sight of the telescope is moved optically by means of the reflecting prism P. This prism is sometimes called the angle-measuring prism or wedge. The reflecting prism P carries a range scale which is graduated directly in yards of range. Thus, moving the reflecting prism P laterally along AB corresponds to a movement of the line of sight of the right-hand telescope and the angle which the line of sight of this telescope makes with the line AB (fig. 1) is read in terms of the range AD (fig. 1) on the range drum attached to the reflecting prism.

Referring to Plate X, if CA and C′B are parallel rays of light from an object at an infinite distance, they will meet at the center D. If the object is at the finite CA and C″, then CA will be reflected to D as before, but C″B will be reflected to D′ The angle D′BD is equal to the angle C′BC″ and varies with the distance of the observed object. The ray BD′ could be made to take the direction of BD by

revolving the reflector B, but the amount of this revolution is so small for moderate changes in range and so difficult for accurate measurement that the same result is obtained by the use of the prism P, the reflecting angle of which is very small.

A position of the reflecting prism P can be found, varying with the distance of the observed object where the reflected ray will pass through the point D, thus meeting the ray CAD. The two coinciding images of the same prisms are so placed at the point D that they reflect the light from both ends of the range finder into the eye lens F, and the images are actually found at a point in front of the eye lens, the position of the images depending upon the type of the instrument. Since there is a certain position of the prism P which will bring the two halves of the object into coincidence, then a suitably graduated scale attached to the prism and moving with it will record the distance of the object corresponding to the position of the prism.

In the actual range finder various prism and lens combinations are employed in the place of the simple parts shown in Plate X, in order to obtain the desired erect or invert appearance of the partial images in the field of view.

In the actual range finder all the optical elements are inclosed in a tube. As the tube is liable to be distorted as a result of the effect of temperature changes, or of handling during the working of the instrument, it is necessary to adopt a type of end reflector that will not alter the direction of the beams of light entering the range finder even if its position were varied by small amounts. Nearly all, except the earlier range finders, are made with a prism to take the place of the reflecting prisms A and B, known as the pentagonal or Prandl prism.

A prism of this type, designed to bend the rays of light through an angle of 90°, consists of a block of glass having two reflecting faces placed at an angle of 45° to one another. It is necessary that these two reflecting faces should be silvered as the angle of incidence is within the critical angle of glass. Any rotation of such a prism about an axis perpendicular to the column normal plane of the two reflecting surfaces does not affect the direction of the double reflecting beam of light, as the effect of the rotation of one reflecting surface is exactly balanced by the equal rotation of the two reflecting surfaces.

Instead of using an angle-measuring prism like P (Plate X), which slides horizontally along the base of the range finder, two rotating prisms are often used. These prisms are rotated in opposite directions by gearing connected to the range drum.

MEASURING DISTANCES.

The eyepiece is provided with an adjustment for individual correction, equipped with a diopter scale. If this correction is not known it should be determined before any attempt is made to measure ranges. The determination of the individual correction is made

PLATE XVI



Fig. 1.



Fig. 2.



Fig. 3.

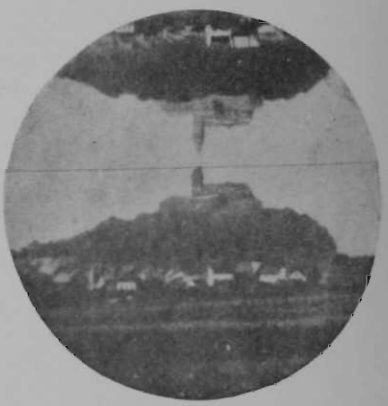


Fig. 4.



Fig. 5.



Fig. 6.

RANGE FINDER FIELDS.

by turning the eyepiece, until the details appear sharply defined in the field of the range finder. The resulting number on the diopter scale should then be memorized for future use. The color screen is provided to protect the eyes of the observer from a glare of light.

The range finder having been set approximately on the target, if necessary by means of the telescope finder, the object is looked for in the field of view.

Movement in azimuth is accomplished by turning the azimuth worm lever (*k*), disengaging the azimuth worm and the worm wheel, which allows the range finder to be rotated to suit. Finer adjustment in azimuth is made by turning the azimuth worm knob (*i*). The adjustment for elevation is effected by means of the elevation mechanism in the mount.

The range finder's field of view is divided into two parts by a horizontal line, the inverted position of the image above the line (figs. 1 and 2, Plate XVI). The range scale is visible through a window, on the left of the eyepiece protected by a sliding shutter (Q). To bring about a coincidence turn the measuring roller (M) until the image of the object is perfected (fig. 3, Plate XVI); then read the range.

With targets which have no prominent vertical lines or points, but show horizontal lines, such as tops of heights, entrenchments, etc., the distance is measured on the horizontal line by setting the range finder vertical. (Plate XV.) To do this the hinge clamp screw handle (*h*) is loosened, the range finder turned down to the right, and the screw clamped. Measurements are taken in the same manner as described above. The image first appears as shown in figure 5, Plate 7.

By turning the measuring screw the partial images are shifted so that the horizontal line is continued exactly on the dividing line. (Fig. 6, Plate XVI.) Errors in height of the instrument prejudice the exactness in measuring if the line sighted at does not run exactly horizontal.

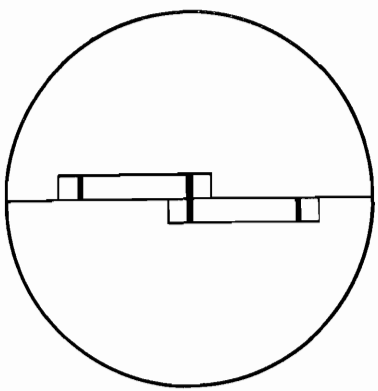


FIG. 10

DIRECTIONS FOR ADJUSTING.

Set up the range finder in the usual manner and place the adjusting bar at a distance of about 100 yards from it. Train the adjustment bar so that, when looking through the sight, the range finder appears in the center of the field. Set the range scale at infinity by turning the measuring roller (M) and make an observation on the adjustment bar. Bring the two center index lines into coincidence (see fig. 10) by turning the key fitting the square shaft (K)

which operates the correction wedge, and observe the correction dial. Repeat this operation three times, and set the dial at the mean of the three readings. The instrument is then in perfect adjustment for all ranges and ready for use.

This adjustment bar replaces an infinitely distant object, as the distance between the centers of the two index lines is exactly equal to the base of the instrument to be adjusted. It is essential for accurate results to have the adjustment bar parallel to the range finder and at all events not nearer than 75 yards.

When the images in the range finder are not symmetrically placed with respect to the line of separation, it is designated as a halving error. This may be at once recognized by the fact that when a prominent point in the erect image is made to touch the line of separation, the corresponding point in the inverted image is either some distance above the line or else vanishes below it. (See fig. 4, Plate XVI.)

To eliminate this defect push back the slide, marked "Halving adjuster," which exposes a knurled roller (J). Turn this roller until the images occupy the correct position and move the slide back to its former position.

ACCURACY OF MEASUREMENTS.

The error (E) which a practiced observer may make under most favorable conditions is proportional to the square of the distance (D) of the object, proportionate to the accuracy with which the observer is able to make this coincidence (expressed in angular measure, e), and directly proportionate to the base of the instrument (B), as well as to the magnification (V).

$$E=\frac{D^2}{BXV}Xe$$

The following table gives the smallest possible error with the 1-meter range finder, assuming the observer to be able to make his coincidence within 12 inches.

Distance.	Error.	Distance.	Error.
Yards.	*Yards.*	*Yards.*	*Yards.*
400	0.6	3,500	43.5
450	0.7	4,000	57.0
500	0.9	4,500	72.0
600	1.3	5,000	90.0
700	1.7	5,500	107.0
800	2.2	6,000	128.0
900	2.8	6,500	150.0
1,000	3.5	7,000	174.0
1,200	5.1	7,500	200.0
1,400	7.0	8,000	228.0
1,600	9.1	8,500	257.0
1,800	11.5	9,000	288.0
2,000	14.0	9,500	321.0
2,500	22.0	10,000	355.0
3,000	32.0		

With unsteady air conditions the error may increase to five times these figures, but in general will be less than double the values given.

GENERAL INSTRUCTIONS FOR RANGE FINDING.

1. The best defined part of an object should be selected to range on.

The tripod and mount should always be used if possible. If this can not be done it must be supported as conditions permit.

Coincidence should always be made in the center of the field of view and if possible with the dividing line at right angles to the object observed.

Upon the accuracy of the coincidence setting depends the accuracy of the range determination. No difficulty should be experienced on the part of the observer in obtaining good results after a little practice or even at the first attempt, but in range finding as in anything else accuracy increases with practice. It has been found that different observers have what might be called personal errors which diminish as their experience increases. The range observer should therefore be given every opportunity for practice in measuring angles and ranges, and in making the halving adjustments. When both edges of the object are equally well defined, the observer should always make his coincidence on the same edge, right or left. Individual observers have obtained better results by so doing than if they used the right edge sometimes and the left edge at other times. It is advisable when time permits to obtain the range by taking the mean of several consecutive readings

With targets moving laterally across the field, it is best to adjust the images on the edge from which the targets are moving and to make the measurements for range while the target runs across the field.

Before observing a range the adjustments for height and for distance should be tested and corrected, if necessary. Adjustments for height should always be made before adjustment to correct for errors in distance.

CARE AND PRESERVATION.

Under no circumstances shall any range finder be disassembled or adjusted except by a skilled mechanic upon order by an ordnance officer or by an arsenal especially equipped for instrument work. The interior is sealed against dust and moisture, and any disassembling will unseal the internal parts and may cause serious damage to the instrument.

It must be realized that, though a range finder is constructed to stand very much rougher use than scientific instruments are subjected to, it should be regarded as a delicate optical instrument and

should be treated with as much care as is given a telescope. Every precaution should therefore be taken to preserve the range finder from damage, and it should not be thrown on the ground or subjected to any avoidable shocks, strains, neglect, or other ill usage. To care for the instrument properly, those responsible for it should familiarize themselves with the functions of its various parts, the methods of adjusting, and the proper method of caring for the mechanical and optical parts.

The instrument should be kept in a dry place. The working parts should be oiled regularly, though sparingly, with oil issued by the Ordnance Department for fire-control instruments. Proper care should be taken that no oil drops upon or reaches the optical surfaces or other parts which do not require oiling.

The range finder should be protected as much as possible in wet weather. When rain ceases or operations are over, the outside of the range finder should be wiped off with a cloth.

The end windows, the scale window, and the eyepiece should be wiped with a piece of clean chamois skin especially kept for the purpose. Dry dust is removed with the brush.

The metal work should be rubbed down with a dry cloth. Cleaning paste must not be used on any part of the instrument.

The greatest care should be taken not to allow any oil or grease to get on any of the windows, lenses, or prisms; nor should they be touched with the fingers.

If in any case moisture is found collected on the inner surface of the windows or the internal optical parts, the end plates should be removed for a short time to allow a current of air to pass through the tube; but this should only be done in dry weather, never in rain or fog or if smoke or dust is about the range finder.

All work on the range finder, such as unnecessary turning of screws, etc., not incident to its use or cleaning must be strictly forbidden.

TRIPOD MOUNT.

[Plate XIV.]

The principal parts of the tripod mount:

Spring catch.
Support.
Elevation mechanism.
Hinge.
Angle of sight mechanism.
Azimuth mechanism.
Azimuth adjusting mechanism.

An adapter fastened to the range finder proper is the means by which it is secured to its place on the mount.

The hook attached to the adapter is locked in place by a spring catch (*a*) in the support. This catch forms a quick and efficient means of setting up and taking down the range finder.

The slots on the underside of the support and the clamping lever (N) (Plate XI), attached to the elevation worm case (*b*), is a means provided for adjusting the range finder to make it line up with the adjusting bar.

By turning the elevation worm knob (*c*) the correct elevation for the range finder is obtained. The elevation worm wheel is mounted on the worm-wheel bearing in the elevation worm-wheel support (*d*). The elevation worm, mounted in the elevation worm case (*b*), is provided at one end with a worm bearing, held in place by a spring and plunger that compensates for wear between the worm and the worm wheel. At the other end is a ball bearing, held in place by a worm-bearing ring. A movement of 36° is allowed, 18° elevation and 18° depression.

The angle of site mechanism, which is fastened to the elevation worm case, consists principally of the angle of site worm, angle of site housing (*f*), angle of site-level vial holder (*g*), angle of site scale, angle of site micrometer (*e*), and angle of site-level vial.

The angle of site micrometer is graduated into 100 equal divisions, each division representing 1 mil. One complete revolution equals 100 mils or one of the equal divisions of the angle of site scale marked from 0 to 6—"3" corresponding to the reading for zero angle of site. The angle of site micrometer is locked in place by means of the angle of site-micrometer locking screw. Backlash between the angle of site-level vial holder and the angle of site worm is removed by the angle of site-plunger spring and plunger.

By turning the hinge clamp screw handle (*h*) upward, the hinge clamp screw, which is fastened in the worm-wheel bearing and has a bearing on the extension piece, releases its hold, and the range finder can be turned to the right through an arc of 90°, permitting the use of the range finder in a vertical plane. (Plate XV.)

The azimuth mechanism consists of the azimuth adjustment and the azimuth device.

The azimuth device consists principally of the azimuth adjusting upper worm case, azimuth worm, azimuth worm bushing, azimuth worm wheel, azimuth worm knob (*i*), and azimuth micrometer (*j*). The azimuth worm is held in mesh with the worm wheel without perceptible backlash by means of the bushing spring. The eccentric azimuth worm bushing is so arranged that it may be disengaged by means of the azimuth worm lever (*k*); when thus disengaged the line of sight may be freely moved to approximately the desired position. The azimuth worm can then be thrown into mesh and the finer adjustment made by turning the azimuth worm knob (*i*). The azimuth scale (*m*) on the azimuth worm wheel is graduated into 64

equal divisions; each division represents 100 mils. An index engraved on a German silver strip registers with the graduations on the azimuth scale. The azimuth micrometer is graduated into 100 equal divisions, each division representing 1 mil. One complete revolution of azimuth micrometer equals 100 mils or one division on the azimuth scale. The azimuth micrometer is locked in position by the micrometer lock nut.

Both the azimuth adjusting worm and the azimuth worm mesh with the azimuth worm wheel.

The azimuth adjustment consists principally of the azimuth adjusting worm, azimuth worm wheel, azimuth adjusting lower worm case, and azimuth adjusting worm knob. When the line of sight has been moved to approximately the desired position, a finer adjustment is made by turning the azimuth adjusting worm knob (*n*)

Backlash between the azimuth adjusting worm and the azimuth worm wheel is removed by the azimuth plunger spring and plunger.

By turning the vertical spindle clamping lever (*p*) on the tripod head bushing and loosening same the mount assembled can be removed from the tripod.

TRIPOD.

[Plate XIV.]

The tripod consists principally of—

Tripod legs (upper section).
Tripod legs (lower section).
Tripod head.
Tripod head bushing.
Vertical spindle clamping screw.
Vertical spindle clamping lever.
Leg-clamping parts.

The tripod head bushing is held in its place in the tripod head by the vertical spindle bushing locking screw (*t*). The tripod legs (upper section) are attached to the tripod head and are braced by the leg separators; the lower sections are of tubing and slide freely through the base of the upper sections; by means of the clamping wing nuts (*w*) they can be locked in any position to suit the observer.

The tripod may be used by the observer in a standing or kneeling position; it can also be used in the prone position by supporting it with the hands.

For use in the standing position the tripod is taken from the storage chest and the legs extended by loosening the leg-clamping nuts (*w*), allowing the tubing extensions to drop out, after which the clamps are tightened.

With one leg pointing away from the observer the legs are spread out to form an equilateral triangle. When the legs have been spread enough to insure a rigid support they are clamped in that position by the locking clamp arm (*x*).

ADJUSTMENT BAR.

[Plate XIV.]

The adjustment bar (*u*) is for the purpose of examining range finders as to their exactness in measuring and their adjustment, if required. At both ends the bar is marked with a line, the distance between the lines being equal to that between centers of the objective openings, or the base of the range finder. The bar is fitted with an optical sight (*y*) at the center, by means of which it may be easily placed in the right position. It should be placed at a distance of about 100 yards from the range finder and be directly aimed at its center.

When using, the bar should be adjusted in a vertical plane so that it is parallel to the halving line of the instrument.

STORAGE CHEST.

The storage chest is weather proof. It is used for carrying the range finder and tripod. Provisions are made in the chest for carrying the accessories, such as ray filters, sunshades, cleaning brush, and chamois.

FIELD ARTILLERY RANGE FINDER, 1 METER BASE (GOERZ).

[Plates XVII, XVIII, and XIX.]

GENERAL DESCRIPTION.

The instrument consists of the range finder, the tripod mount, and the tripod. The principal parts of the range finder proper are:

A. Eyepiece.
B. Finder.
C. Measuring screw.
D. Range scale.
E. Protective cap for height adjustment screw.
F. Protective cap for range correction screw.
G. Scale for range correction screw.
H. Entrance aperture.
H′. Entrance aperture.

The tripod mount consists of—

N. Scale drum.
O. Scale ring.
P. Lateral adjustment screw with scale drum.
Q. Disconnecting lever for (P).
R. Locking lever for tilting joint.
S. Height adjustment screw.
T. Angle of site level.
U. Angle of site-level screw.
V. Lever for locking range finder in vertical position.
W. Hook for fastening range finder.
X. Tripod locking bolt.
Y. Hook bolt for range finder.
Z. Locking head for tripod.

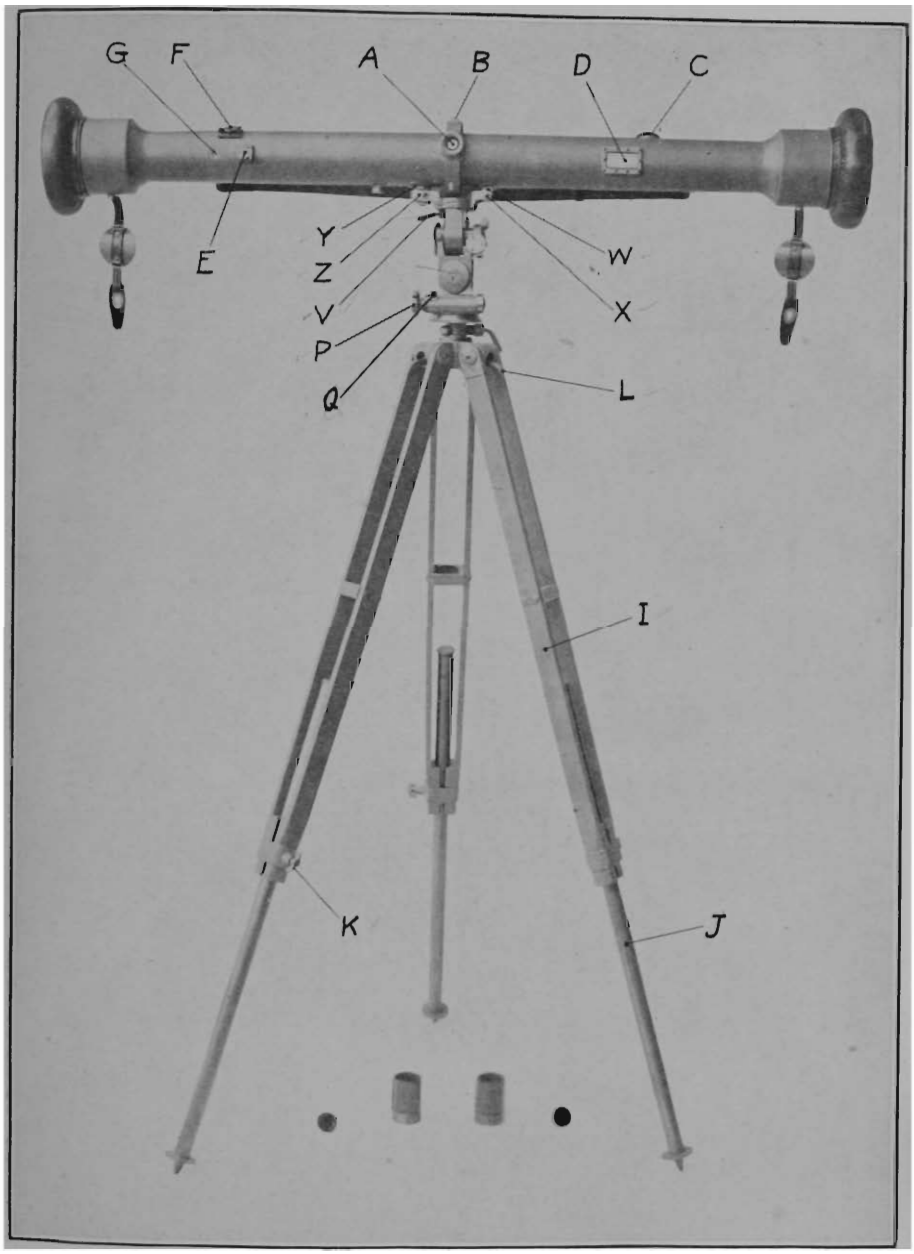
The tripod consists of—

I. Legs.
J. Metal tubing extensions.
K. Locking screws for (J).
L. Locking lever for (I).
M. Locking lever for pivot.

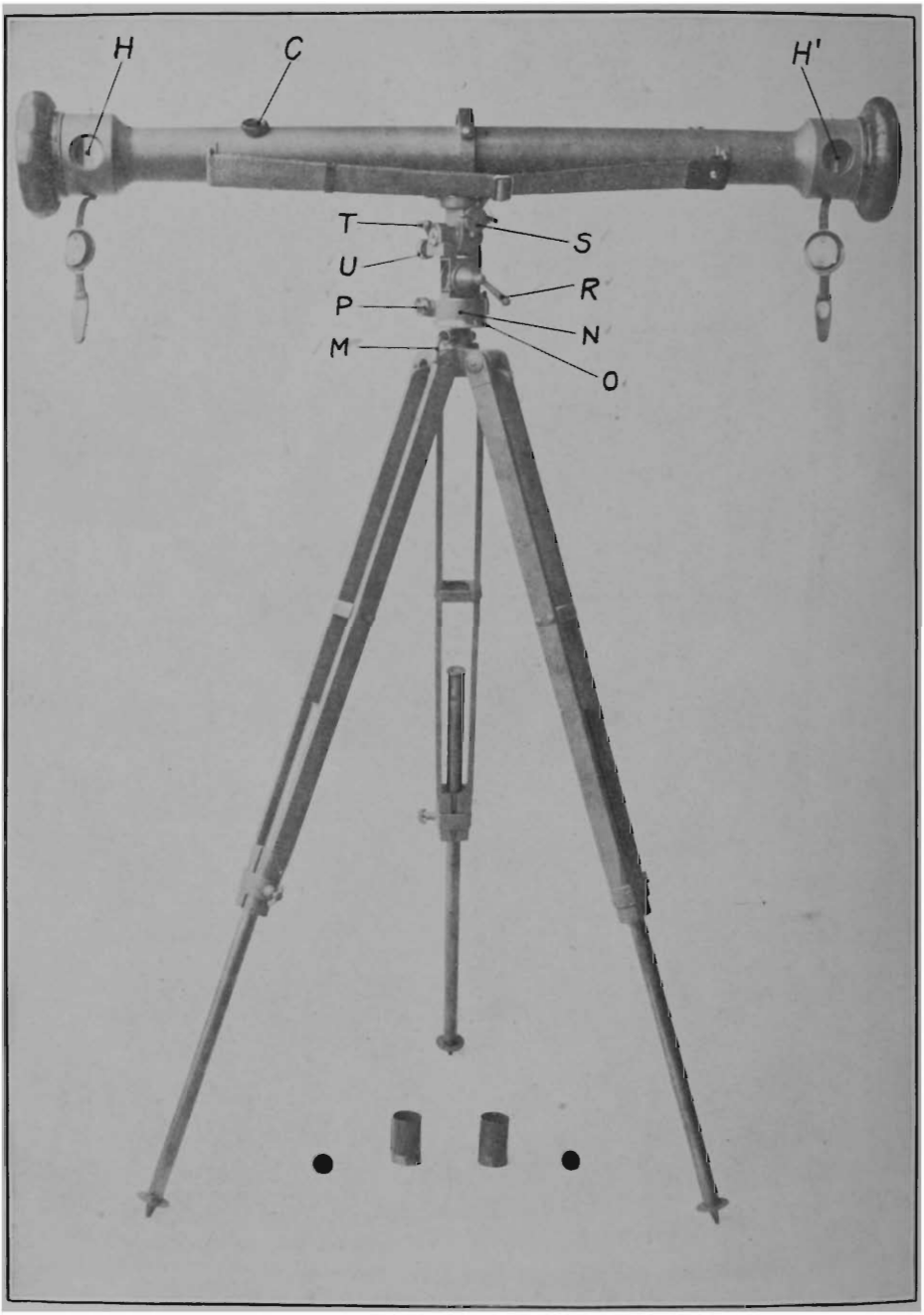
The following accessories are furnished:

Adjustment bar.
Color screens (2).
Sun screens (2).
Chamois skin.
Brush.

The storage box is a wooden box used for storage and transportation of all range-finder parts.



REAR VIEW. FIELD ARTILLERY RANGE FINDER, 1 METER BASE (GOERZ).



FRONT VIEW. FIELD ARTILLERY RANGE FINDER, 1 METER BASE (GOERZ).

GENERAL PRINCIPLE.

If the length of one side and the value of any two angles of a triangle are known, the length of the other two sides of the triangle can be calculated.

Thus, in figure 1, if the length of the side AB and the angles BAD and DBA are known, the remaining sides AD and BD can be calculated.

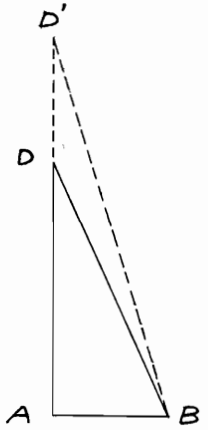


FIG. 1

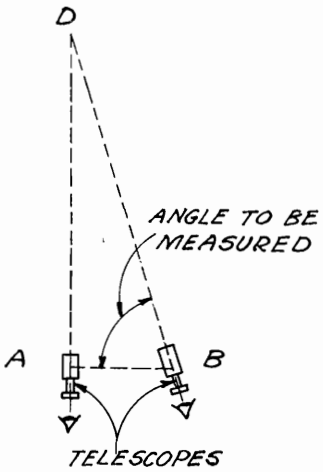


FIG. 2

If the length of the side AB is fixed and the angle BAD remains a right angle, then it is only necessary to measure the angle DBA in order to be able to calculate the lengths of the sides AD and BD. It will be seen from figure 1 that the longer the side AD becomes as AD', the larger the angle DBA becomes as D'BA, and that for any given length of AD there will always be a corresponding value of the angle DBA.

Suppose, therefore, that a range finder be constructed by placing a telescope at the point A and so arrange it that its axis or line of sight makes a right angle with the line AB, then place another telescope at the point B and so arrange it that the angle DBA which its line of sight makes with the line AB can be measured, if the line AB is known and remains fixed, the length of the side AD or the range of the object D from A can be computed. (See fig. 1.)

A table can be computed giving the length of the side AD of the triangle ABD for all values of the angle DBA from 0° to 30° and a fixed length of base AB. Then, instead of graduating the angle measuring scale on the telescope at B in degrees, graduate it with its corresponding value of the length of the side AD, thus forming a range finder which, by measuring the angle DBA with the telescope at B, will read directly the range of the object D from A.

To use such a range finder, the observer at the telescope A would lay his telescope on object D, whose range from A is desired. As the telescope A is readily connected at right angles to the base line AB, the whole apparatus together with the telescope at B would be moved at the same time. The observer at B would then revolve his telescope until the image of D coincides with the cross wire. The range AD could then be read directly from the angle scale on the telescope at B.

The 1-meter base artillery range finder goes a step further and by means of reflecting mirrors permits a single observer to see the images from both telescopes A and B in a single eyepicee located midway between A and B. An observer looking into this eyepiece sees the field divided into two parts by a horizontal line. In the lower part of the field the observer sees the image from the telescope at A, and in the upper part of the field image from the telescope at B.

In the 1-meter base artillery range finder when the telescope at B is turned an object in the upper field observed through the eyepiece appears to move laterally across the field.

Figure 2 gives a diagrammatic sketch of a self-contained base range finder.

A study of Plate X will show that the instrument is equivalent to two telescopes. On the left side is the fixed telescope at A in the improvised range finder just described. In this telescope the light traverses the objective lens, the coincident prism D, and the eyepiece consisting of the field lens G and the eye lens F. The line of sight of the left-hand telescope is turned through 90° by means of the reflecting mirror A. At the right-hand side is the movable telescope corresponding to the telescope at B in figure 2. In this telescope the light traverses the objective cell, the reflective prism, the coincident prism D′, and the same eyepieces G and F. As before, the line of sight of the right-hand telescope is turned through 90° by means of the reflecting mirror B.

Instead of moving the telescope at the right-hand side mechanically, in order to measure the angle DBA (fig. 1), the line of sight of the telescope is moved optically by means of the reflecting prism P. This prism is sometimes called the angle-measuring prism or wedge. The reflecting prism P carries a range scale which is graduated directly in yards of range. Thus, moving the reflecting prism P laterally along AB corresponds to a movement of the line of sight of the right-hand telescope, and the angle which the line of sight of this telescope makes with the line AB (fig. 1) is read in terms of the range AD (fig. 1) on the range drum attached to the reflecting prism.

Referring to Plate X, if CA and C′B are parallel rays of light from an object at an infinite distance, they will meet at the center D. If the object is at the finite CA and C″, then CA will be reflected to D′. The angle D′BD is equal to the angle C′BC″ and varies with the distance of the observed object. The ray BD′ could be made to take the direction of BD by revolving the reflector B, but the amount



FIG. 9

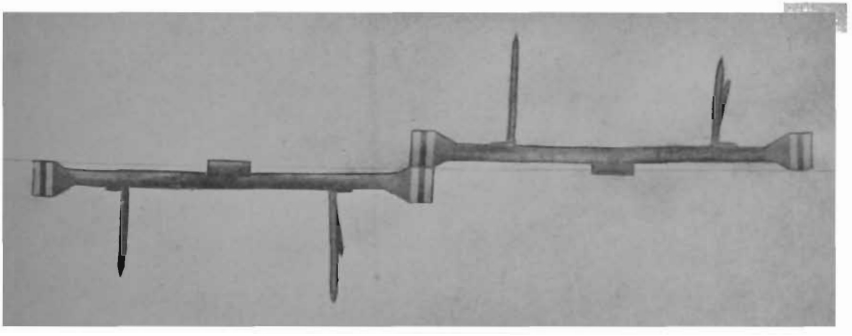


FIG. 10

VERTICAL POSITION
FIELD ARTILLERY RANGE FINDER,
1 METER BASE (GOERZ).

of this revolution is so small for moderate changes in range and so difficult for accurate measurement that the same result is obtained by the use of the prism P, the reflecting angle of which is very small.

In the actual range finder various prism and len combinations are employed in the place of the simple parts shown in Plate X, in order to obtain the desired erect or inverted appearance of the partial images in the field of view.

In the actual range finder all the optical elements are inclosed in a tube. As the tube is liable to be distorted as a result of the effect of temperature changes, or of handling during the working of the instrument, it is necessary to adopt a type of end reflector that will not alter the direction of the beams of light entering the range finder even if its position were varied by small amounts.

The objectives are simultaneously focused with one another and along the line DB; a position will be found varying with the distance of the observed object where the reflected ray will pass through the point D, thus meeting the rays CAD. The two coinciding images of the same prisms are so placed at the point D that they reflect the light from both ends of the range finder into the eye lens F, and the images are actually found at a point in front of the eye lens, the position of the images depending upon the type of the instrument. Since there is a certain position of the prism P which will bring the two halves of the object into coincidence, then a suitable graduated scale attached to the prism and moving with it will record the distance of the object corresponding to the position of the prism, also with the separating line, all of which therefore appear to be equally well defined in the field of view.

By turning the measuring screw the image is shifted laterally until the same vertical rim or similar points of the object are laterally exactly above one another. (Fig. 3, Plate XVI.) The distance is then read on the range scale.

With laterally moving targets it is best to adjust the images on the edge of the field of view corresponding to the direction of the movement and make the measurements while the image runs through the field.

With targets which have no prominent vertical lines or points, but show horizontal lines, such as tops of heights, intrenchments, etc., the distance is measured on the horizontal line by setting the instrument vertical. (Plate XIX.) For this purpose the locking screw is loosened, the range finder turned down on the left, and the screw tightened. If the rotating plane was not vertical and to get the range finder perfectly vertical, the locking lever is loosened, the instrument set exactly vertical and lever again tightened. Measurements are taken in the same manner as described above. The image first appears as illustrated on figure 5, Plate XVI. By turning the measuring screw the partial images are shifted so that the horizontal line is continued exactly on the dividing line . (Fig. 6, Plate XVI.)

The accuracy of the measurements even under the most favorable conditions will be unavoidably influenced by a known error. In the following table the lowest values of these errors are given, but when the air is unsteady or the target is unfavorable these errors may be increased five times:

	Yards.		Yards.
600 yards	1.2	3,000 yards	29
700 yards	1.5	4,000 yards	52
800 yards	2.1	5,000 yards	81
900 yards	2.6	6,000 yards	116
1,000 yards	3.2	7,000 yards	158
1,500 yards	7.5	8,000 yards	207
2,000 yards	13		

OPTICAL DATA.

Invert system:

Magnifying power, 15.
Actual field of view in degrees, 2° 40′.
Actual field of view at 100 yards, 46 yards.
Entrance pupil, 1.456 inches.
Exit pupil, 0.1 inch.
Brightness, 6.25.
Shortest distance measurable, 656 yards.

ASSEMBLING.

Hold the tripod by the head; loosen locking screws (K) and permit leg extension (I) to drop out; then tighten locking screws (H); spread legs so that tripod head is nearly horizontal and then press locking lever (L) upward.

Take range finder from box, with eyepiece turned toward observer, fastening hook pointing downwardly, slanting from left to right; push the hook (W) over bolt (X) of the tripod head and turn range finder downwardly with the left end until the hooking bolt (Y) snaps into the locking part of the tripod head. The instrument is then seated firmly on the tripod.

Remove protective hoods from eyepiece and entrance apertures, putting on the sun screen, if necessary. Loosen locking lever (M), turn range finder toward the target and fasten locking lever (M), loosen locking lever (R), turn range finder so that its longitudinal axis is horizontal and then refasten locking lever (R).

Dismounting is accomplished in the reversed order from that described in the preceding paragraph.

MEASURING DISTANCE.

The eyepiece is provided with an adjustment for individual correction and equipped with a diopter scale. If this correction is not known, it should be determined before any attempt is made to measure distances. The determination of the individual correction is made by turning the eyepiece until the details appear sharply defined

in the field of the range finder. The resulting number on the diopter scale should then be memorized for future use. The color screen is provided to protect the eyes of the observer from a glare of light.

The range finder, having been set approximately on the target (if necessary by means of the open sight), the object is looked for in the field of view. Lateral setting is accomplished by turning the range finder on the tripod pivot after loosening the locking lever (M). For use with stationary targets this lever is relocked after the range finder has been properly set. The adjustment for height is accomplished by means of the height adjustment screw (S).

The range finder's field of view is divided into two parts by a horizontal line. In the lower part, the image of the object appears upright, and in the upper part it is inverted. (Fig. 3, Plate XVI.)

CORRECTIONS.

There are two kinds:

(*a*) Correction for height.

(*b*) Correction for distance.

(*a*) *Correction for height.*—A shifting of the partial images as to height is apparent, when in sighting at an object they do not touch the dividing line with similar points, so that one image reaches the dividing line before the other. (See fig. 4, Plate XVI.) To eliminate such an error the range finder must be trained at an object having a sharply defined horizontal line or particularly prominent point; the images are brought laterally exactly opposite each other by means of the measuring screw. The height-correction screw is then loosened and the clearly defined line or prominent point is brought just to the dividing line (see fig. 2, Plate XVI), using therefor the height adjustment screw in the lower image and the height correction screw in the upper one. Then secure the height correction screw against the accidental or unauthorized shifting by placing the protective cap over it.

(*b*) *Correction for distance.*—The adjustment for the correction of errors in distance is made with the adjustment bar, which has two targets separated by a distance exactly equal to the base of the range finder, or the distance between the two central beams when they are parallel; that is, when set at infinity. To use the adjustment bar it is set up at some distance from the range finder, not less than 100 yards and parallel to it. The targets are made to coincide as shown in Plate XIX by means of the measuring screw and the reading of the range scale noted. This should be repeated several times to insure accuracy. If the average reading does not show infinity, correction must be made. This is done by bringing infinity setting of the range drum opposite the index and making coincidence of the targets by means of the range-correction screw. This should be done several times, noting the reading of the scale on the range-correction screw. The final adjustment should then be made by setting the range-correction screw at its average setting. The

protective cap should then be closed and secured with a locking screw to prevent accidental or unauthorized disarrangement.

CARE AND PRESERVATION.

Under no circumstances shall any range finder be disassembled or adjusted except by a skilled mechanic upon order by an ordnance officer, or by the manufacturer, or by an arsenal especially equipped for the instrument work.

It must be realized that, though the range finder is constructed to stand very much rougher use than scientific instruments are subjected to, it should be regarded as a delicate optical instrument and should be treated with as much care as is given a telescope. Every precaution should therefore be taken to preserve the range finder from damage, and it should not be thrown on the ground or subjected to any avoidable shocks, strains, neglect, or other ill usage. To care for the instrument properly those responsible for it should familiarize themselves with the functions of its various parts, the methods of adjusting, and the proper method of caring for the mechanical and optical parts.

The instrument should be kept in a dry place. The working parts should be oiled regularly though sparingly with oil issued by the Ordnance Department for fire-control instruments. Proper care should be taken that no oil drops upon or reaches the optical surfaces or other parts which do not require oiling.

The range finder should be protected as much as possible in wet weather. When rain ceases or operations are over, the outside of the range finder should be wiped off with a cloth.

The end windows, the scale windows, and the eyepiece should be wiped with a piece of chamois skin especially kept for the purpose. The chamois should be kept clean by frequent washing. Dry dust is removed with the brush.

The metal work may be rubbed down with a dry cloth. Cleaning paste must not be used on any part of the instrument.

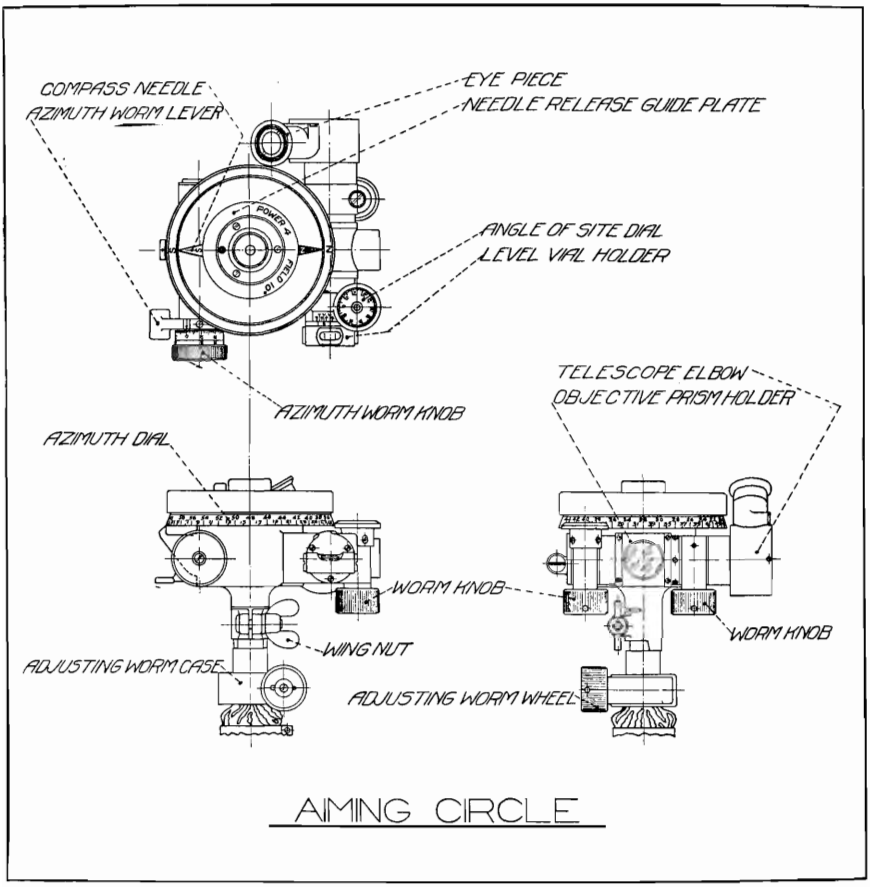
The greatest care should be taken not to allow any oil or grease to get on any of the windows, lenses, or prisms, nor should they be touched with the fingers.

If in any case moisture is found collected on the inner surface of the windows on the internal optical parts, the end plates or windows should be removed for a short time to allow a current of air to pass through the tube, but this should only be done in dry weather, never in rain or fog, or if smoke or dust is about the range finder.

All work on the range finder, such as unnecessary turning of screws, etc., not incident to its use or cleaning, must be strictly forbidden.

The instrument, after use, must always be replaced in the storage box. This must never be stored in the immediate vicinity of a hot stove in winter, nor be exposed to extreme cold, or to extreme heat from the sun in the summer.

PLATE XX



AIMING CIRCLE

36-22-30

AIMING CIRCLE, MODEL OF 1916.

[Plate XX.]

DESCRIPTION.

The aiming circle is an angle measuring instrument consisting of a telescope, angle of site device, azimuth circle and compass, mounted on a tripod.

For the designation of the parts see Plate XX.

The principal parts are the azimuth mechanism, the elevating mechansim, the angle of site mechanism, the leveling device, the compass mechanism, the telescope, the stand, and the tripod.

The azimuth worm which is housed in the body actuates the azimuth worm wheel mounted on ball bearings and is adjusted by the adjusting ball race, which is secured by the adjusting ball race locking screw. The azimuth worm knob is locked by means of the azimuth worm knob locking screw. The azimuth dial is graduated into 64 equal divisions, each division representing 100 mils, or one revolution of the azimuth worm. The azimuth dial, which is mounted on the azimuth worm wheel, is adjustable and is held in place by three azimuth dial retaining screws. The azimuth worm is mounted in the azimuth worm bushing, an eccentric bushing which is held in contact with the azimuth worm wheel by the bushing spring. The azimuth worm may be disengaged by the azimuth worm lever, so that the line of site may be freely moved to approximately the desired position, the azimuth worm thrown into mesh, and the finer adjustment made by turning the azimuth worm knob.

The angle of site mechanism consists principally of the angle of site level vial, level vial holder, angle of site bracket, angle of site worm, angle of site worm wheel, and the angle of site dial. The angle of site worm wheel meshes with and is rotated by the angle of site worm, carrying with it the level vial holder, in which is housed the angle of site level vial. One complete revolution of the angle of site dial equals 100 mils, or one of the six equal divisions on the angle of site scale marked from "0" to "6," figure "3" corresponding to the reading for zero angle of site. The angle of site dial is secured by the angle of site dial locking screw. The movement of the telescope elbow is 300 mils in elevation and 300 mils in depression or total angular movements of approximately 36°, corresponding to the movement of the angle of site worm wheel. Backlash between

the angle of site worm and the angle of site worm wheel is removed by adjusting the compensation bushing, which is held in place by the compensation bushing retaining screw.

The principal parts of the elevating mechanism are the elevation worm and the telescope elbow. Backlash between the elevation worm and worm wheel is removed by adjusting the compensation bearing, which is secured by the compensation bearing retaining screw.

The leveling device consists principally of the vertical spindle, vertical spindle bushing, friction washer, and the vertical spindle nuts. The vertical spindle is ball shaped at its lower end and is seated in a socket formed in the vertical spindle bushing. This ball and socket construction permits the instrument to be quickly leveled and locked in position by the vertical spindle clamping lever. The friction washer permits an adjustment of the vertical spindle nuts to give sufficient friction on the ball to support the instrument when the vertical spindle clamping screw is released. The vertical spindle stop screw prevents movement of the instrument in azimuth when leveling and the spindle socket cover protects the ball and socket joint from dust and dirt. A level is mounted at the top of and on the vertical axis of the instrument.

The compass mechanism consists principally of the compass needle, needle release slide, needle release plunger, and needle release button. When not in use the compass needle is held from rotating, but is released by pressing the needle release button, which lowers the compass needle onto the needle pivot. The compass needle is then automatically secured by releasing the needle release button.

The optical system consists of an objective prism, an objective, an erecting prism, an elbow prism, a reticule, a field lens, and an eyelens. The rays coming from the object are reflected by the objective prism through the objective, the erecting prism, elbow prism, field lens, and eyelens. A glass reticule marked with crosslines is located in the focal plane of the instrument, with the intersection of the crosslines coincident with the optical axis. The telescope has a universal focus and no adjustment of the eyepiece is provided. The magnifying power of the instrument is four, the field of view is 10°. A small window is provided to light the crosslines on the reticule, the window glass is cemented in place to seal the opening.

The stand has one edge parallel to the optical axis of the telescope which permits the instrument to be used as an aledade in sketching and map reading.

The tripod used on this instrument is of the same design as that used with the B. C. telescope model of 1915.

ADJUSTMENT.

Leveling.—The friction washer and the vertical spindle nuts are used to give sufficient friction on the ball of the vertical spindle to support the instrument.

Micrometer.—The angle of site dial is secured by the angle of site dial locking screw after the index line coincides with a graduation on the angle of site scale and an index line coincides with zero on the angle of site dial.

The azimuth worm knob is secured by the azimuth worm knob locking screw after the index line coincides with zero of the graduated scale on the azimuth worm knob.

Backlash.—Backlash between the angle of site worm and the angle of site worm wheel is removed by adjusting the compensating bushing which is held in place by the compensating bushing retaining screw.

Backlash between the elevation worm and its worm wheel is removed by adjusting the compensating bearing which is secured by the compensating bearing retaining screw.

CARE AND PRESERVATION.

The aiming circle is a delicate instrument which should be handled with care and when not in use should be kept in its carrying case.

To obtain satisfactory vision the glasses should be kept clean and dry. In case moisture collects on the glasses, place the instrument in a gentle warmth. This is usually sufficient to remove it. The cleaning cloth or chamois skin issued for cleaning the lenses should alone be used, care being taken that they do not contain any dirt or grit. As all the joints are sealed when the instrument leaves the manufacturer, any disassembling will break the seal, permitting dust and moisture to enter. Under no circumstances should any aiming circle be disassembled or adjusted, except by a skilled mechanic upon order by an ordnance officer or by a manufacturer or arsenal especially equipped for instrument work.

THE OBSERVATION TOWER, MODEL OF 1916.

[Plate XXI.]

NOMENCLATURE OF PARTS.

Number.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
	BASE SECTION.			
8	Bolts, for supports, main			
2	Braces	At upper ends of rails		
2	Catch springs	For locking handle catches		
2	Chest stops	On rails, bear against chest front in raised positions.		
2	Guy clamps	On lower guys		
2	Hooks	On lower side of rails		
2	Ladder stops, 1 right, 1 left	At upper end of rails		
2	Links	On lower guys, engage guy hooks		
2	Locking handles, 1 right, 1 left	At ladder stops		
2	Locking-handle catches	In seats in ladder stops		
2	Locking-handle studs			
2	Lower guys	From ladder stops to hooks at caisson rear handrail shanks		
2	Rails (base section), 1 right, 1 left			
2	Reinforces	On outside of rails near chest stops		
2	Reinforces	Fittings outside rails at trunnion bearings.		
2	Separators	At chest stop and hook rivets		
2	Supports (base section)	Riveted to lower ends of rails		
2	Supports (main)	On foot rest		
2	Support pins			
1	Tie rod	Connects upper ends of rails		
2	Tie rods	Cross braces at lower ends of rails		
2	Trunnion bearings	Riveted to rails		
1	Trunnion shaft			
2	Turnbuckles	1 on each lower guy		
2	Washer nuts	On locking handle studs, outside		
	LOWER SECTION.		V.	1
1	Block fastening	On upper rung (lifting bar)		
2	Guides (lower section)	At upper ends of rails		
1	Lifting bar	Upper ring of lower section		
1	Link	Attaches pulley block to block fastening.		
2	Locking-handle bearings	On rails		
1	Pulley block for 0.5-inch rope	Attached to upper rung		
2	Rails (lower section), 1 right, 1 left			
1	Rung for safety catch	First rung above transoms		
5	Rungs			
2	Safety catches	Actuated by gravity		
2	Safety-catch collars	Pinned on rung for safety catch		
2	Stops (lower section), 1 right, 1 left	Contact with guides on lower ends of upper section rails.		
2	Trunnions	Riveted to rails, rest in bearings of base section.		
2	Upper guys	¼-inch wire rope from drums to picket pins.		
	UPPER SECTION.			
1	Block fastening	On lower rung (dog shaft)		
1	Bolt snap	On lower end of rope		
2	Dogs, 1 right, 1 left	On dog shaft		
1	Dog shaft	Solid steel shaft forming the lower rung		
4	Dog-shaft collars, 2 inside, 2 outside	Inside collars pinned to dog shaft		
2	Dog springs (upper section), 1 right, 1 left			
2	Dog-spring supports	Riveted inside rails		
2	Drums, with washers, nuts, and split pins	Small reels for upper guy wires		
1	Drum bracket	At upper ends of rails		

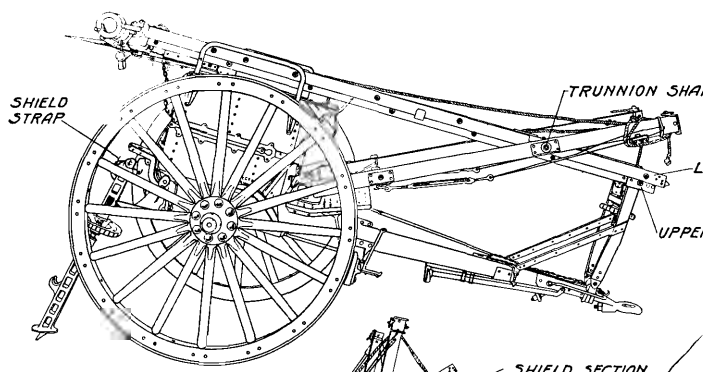


FIG. 1.

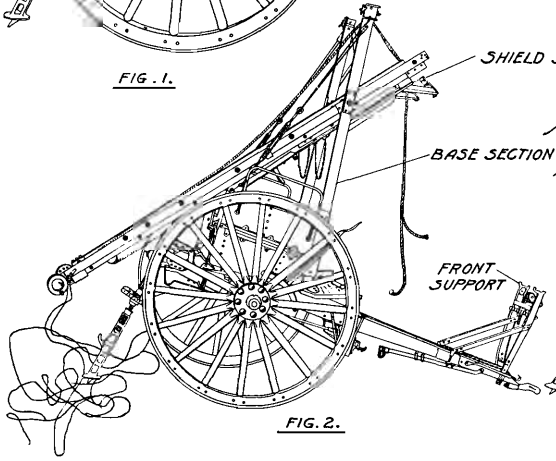


FIG. 2.

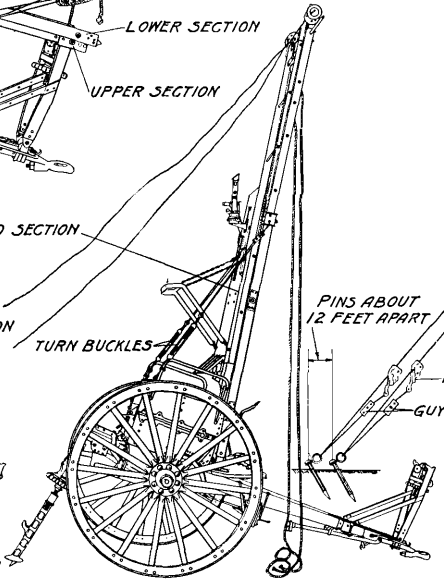


FIG. 3.

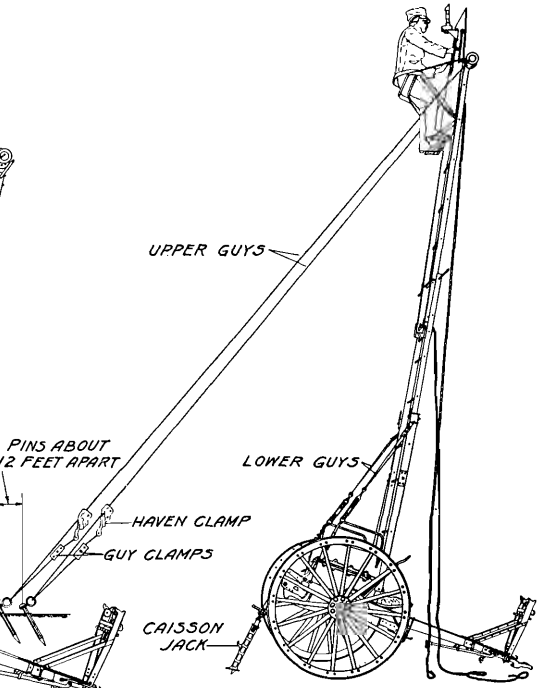


FIG. 4.

Observation Tower, Model of 1916.

Nomenclature of parts—Continued.

Number.	Name of part.	Location, etc.	Property classification. Class.	Property classification. Section.
	UPPER SECTION—continued.			
2	Field line picket-pin eyes	At lower ends of upper guys	V	I
2	Guides (upper section)	At lower ends of rails		
2	Guy clamps	Secure lower ends of guy wire		
2	Haven clamps	Tightening devices on guy wires		
1	Link	Attaches pulley block to drum bracket		
2	Pawls	Prevent dogs from engaging rungs when section is lowered		
2	Pawl pins	Hinge pins, pawls to dogs		
1	Pulley block for 0.5-inch rope			
2	Rails (upper section), 1 right, 1 left			
1	Rope, 20 feet long			
1	Rope thimble	In bight of rope at block fastening		
6	Rungs			
2	Sleeves	Form crank handles for drums		
2	Spindles			
2	Stops, for dogs	On dogs to limit movement		
2	Stops (upper section)	Inside rails, above dog shaft		
2	Stop pins (upper section)	Outside rails, above dog-spring supports.		
2	Stop plates	At drum bracket, limit movement of shield.		
	SHIELD SECTION AND SEAT.			
1	B. C. telescope support	Riveted to rear side of top shield		
1	B. C. telescope locking nut			
1	B. C. telescope locking screw	On B. C. telescope support		
2	Bearing blocks, 1 right, 1 left	Under seat, contact with top of chest in folded position.		
4	Bearing plates	On seat, contact with main shield		
1	Block fastening	On lower rung		
1	Bolt snap	On rope		
2	Chain-fastening eyes	Secure seat chains to shield		
2	Dogs, 1 right, 1 left	With pawls, pawl pins, and stops		
1	Dog shaft			
4	Dog-shaft collars, 2 outside, 2 inside			
2	Dog springs, 1 right, 1 left			
2	Fillers, shutter hinge	Under shutter hinges on shield		
4	Guides, shield section	Engage the rails of the upper section		
4	Hinges, sight-port shutter	2 on shutter, 2 on shield		
2	Locking handles	Assembled in locking links		
2	Locking-handle catches	On top of shield		
4	Locking-link bases	2 on top shield, 2 on main shield		
1	Lower locking link	Assembled to base on shield		
1	Main shield, armor plate			
2	Rails, 1 right, 1 left			
2	Reinforces	Outside rails at dog shaft		
2	Do	At upper ends of rails, engage safety catches in folded position.		
1	Rope, 30 feet long			
1	Rope thimble	At block fastening		
1	Rung			
1	Seat	Hinged to lower edge of main shield		
2	Seat chains			
2	Seat-chain bearing plates	Under seat at slot for seat chain		
2	Seat-chain hooks	For holding the seat against the shield when desired.		
2	Seat hinges, seat			
2	Seat hinges, shield			
2	Seat-hinge pins			
2	Separators	Between rails and shield on dog-spring bolts.		
2	Shield hinges	On main shield		
2	Shield hinges, top	On top shield		
2	Shield-hinge pins			
1	Shutter			
1	Shutter pin, with split pin			
1	Shutter-latch base	Riveted to shutter		
1	Shutter-latch plunger			
1	Shutter-latch spring			
1	Shutter support	Riveted to shutter		
2	Stops	Riveted to shield		
4	Stop supports, 2 right, 2 left			
1	Top shield			
2	Upper locking links, with			
2	Pins			

Nomenclature of parts—Continued.

Number.	Name of part.	Location, etc.	Property classification. Class.	Property classification. Section.
	FRONT SUPPORT.			
1	Bearing for nut	Riveted on cross channel	V	I
2	Brace feet, 1 right, 1 left	Lower ends of front-support braces	V	I
2	Brace-foot clips, 1 right, 1 left		V	I
2	Brace-foot bolts		V	I
2	Brace-foot clip studs		V	I
1	Catch	Locks nut of screw	V	I
1	Catch bearing	On cross channel	V	I
1	Catch handle	Pinned to catch	V	I
1	Catch spring		V	I
1	Collar for nut	With notches to engage catch	V	I
1	Cross channel		V	I
2	Fillers	Where front-support braces join support channels.	V	I
2	Front-support braces, 1 right, 1 left	Diagonal to caisson cross brace	V	I
1	Front-support foot	Above lunette bracket	V	I
1	Front-support clamp	Under lunette bracket	V	I
2	Front-support foot bolts		V	I
1	Front-support hook	Engages bottom rung of lower section, folded.	V	I
1	Front-support hook pin		V	I
1	Front-support screw	In nut on cross channel	V	I
2	Ladder rests, 1 right, 1 left	At tops of support channels	V	I
1	Nut	Revolves in bearing on cross channel	V	I
1	Screw	In lower end of front-support screw	V	I
1	Screw key	On cross channel, prevents rotation of front-support screw.	V	I
1	Screw stop		V	I
2	Support channels, 1 right, 1 left	Upper legs of front support	V	I
1	Wheel body, 8-inch	Riveted to nut of front-support screw	V	I
	CAISSON JACK.			
1	Caisson jack body, upper	Hinged at caisson pintle bearing	V	I
1	Caisson jack body, lower	With hook which engages the lifting bar in folded position.	V	I
1	Catch handle	Pinned to jack-wheel catch	V	I
1	Catch spring		V	I
1	Jack hinge	Assembled in caisson pintle bearing	V	I
1	Jack pin	Hinge pin of body to jack hinge	V	I
1	Jack-pin spring	Pinned to jack spring	V	I
1	Jack screw	In jack body, upper and lower	V	I
1	Jack-wheel body		V	I
1	Jack-wheel hub with taper pin	Pinned on jack screw	V	I
1	Jack-wheel catch	Small plunger in jack body, lower	V	I
	FASTENINGS.			
2	Guards	On caisson chest over hinges	V	I
2	Guys	At caisson rear hand-rail shank	V	I
2	Guy-hook clamps	At caisson rear hand-rail shank	V	I
2	Picket-pin brackets	Riveted on caisson foot rest	V	I
2	Picket-pin stops	Riveted on caisson foot rest	V	I
1	Sledge handle fastening	Riveted on caisson foot rest	V	I
1	Sledge holder	Riveted on caisson foot rest	V	I
4	Strap fasteners, No. 10	Riveted on caisson foot rest	V	I
	TOOLS AND ACCESSORIES.			
1	Sledge	Carried in fastenings on foot rest	IV	9
2	Field line picket pin bodies	Carried in fastenings on foot rest	IV	9
1	Sledge strap	In fasteners on foot rest	IV	9
1	Picket pin strap	In fasteners on foot rest	IV	9
1	Shield strap	Assembled to caisson jack body, upper	IV	9
	SPARE PARTS.			
1	B. C. telescope locking nut		V	I
1	B. C. telescope locking screw		V	I
2	Bolts, 0.437 ($\frac{7}{16}$) by 0.91		V	I
2	Bolts, 0.437 ($\frac{7}{16}$) by 1.44		V	I
2	Bolts, 0.5 by 1.032 ($1\frac{1}{32}$)		V	I
2	Bolts, 0.5 by 1.218 ($1\frac{7}{32}$)		V	I
2	Bolts, 0.5 by 1.75		V	I
2	Bolts, 0.5 by 4.09		V	I
2	Bolts, 0.5 by 4.25		V	I

Nomenclature of parts—Continued.

Number.	Name of part.	Location, etc.	Property classification.	
			Class.	Section.
	SPARE PARTS—continued.			
2	Catches		IV	9
2	Catch handles			
2	Catch springs			
4	....do			
4	Crown nuts, 0.437 ($\frac{7}{16}$)			
8	Crown nuts, 0.5			
2	Crown nuts, 0.75			
1	Dog spring (shield section), right			
1	Dog spring (shield section), left			
1	Dog spring (upper section), right with dog spring support.			
1	Dog spring (upper section), left with dog spring support.			
1	Jack pin			
2	Jack pin springs			
1	Jack wheel catches			
1	Locking handle, right			
1	Locking handle, left			
2	Locking-handle catches			
2	Locking-handle studs			
2	Pawls			
2	Pawl pins			
1	Pin, 0.25 by 2.2			
1	Pin, type A, 0.307 by 6.75 (A=6.3)			
2	Pins, type A, 0.368 by 2.5 (A=2)			
4	Pins, type A, 0.492 by 1.625 (A=1.05)			
2	Pins, type A, 0.492 by 2.125 (A=1.55)			
1	Pin, type A, 0.61 by 2.38 (A=1.76)			
1	Screw, 0.375 by 0.75 c'sunk head			
2	Split pins, 0.062 ($\frac{1}{16}$) by 0.375			
5	Split pins, 0.125 by 0.75			
2	Split pins, 0.093 ($\frac{3}{32}$) by 0.5			
14	Split pins, 0.156 ($\frac{5}{32}$) by 1			
4	Split pins, 0.203 ($\frac{13}{64}$) by 1.5			

OBSERVATION TOWER, MODEL OF 1916.

[Plate XXI.]

DESCRIPTION.

The observation tower, model of 1916, may be mounted on any 3-inch gun caisson, model of 1902, the attachment requiring—

A.—Drilling of a few holes through the caisson foot rest.

B.—The substitution of four longer three-sixteenths-inch rivets near the caisson door hinges.

C.—The assembling of the caisson jack, front support, and various fastening devices.

The tower consists of two sections of flat ladder (upper section and lower section) which slide, one upon the other, in the manner of an ordinary extension ladder. The lower ladder section is trunnioned in a frame or base section, which in turn is hinged to the foot rest of the caisson in such a manner as to allow the folding, for transportation, of the compacted ladders to a horizontal position on top of the caisson chest. A bracket for a battery commander's telescope, a seat and foot rests for the observer and armor for his protection are mounted on a third sliding section, which becomes the highest when the tower is fully extended. Spring-actuated dogs upon rungs of the upper and shield sections engage the rungs of the next lower section to maintain the observer at any desired elevation up to the full height of the tower. The "tower complete" includes the necessary guy wires and ground pins (with a sledge for driving the pins), ropes, and pulleys for raising and lowering the sections, a front support or frame to be clamped to the caisson frame for convenience in transportation, a caisson jack to insure the stability of the vehicle with ladders raised, and all the necessary fastenings.

The front support is provided with a screw and hook to secure the ladder in its folded position; the adjustable caisson jack has hook lugs for the same purpose. The shield is in two sections, with the top shield hinged for folding.

OPERATION.

(*a*) The caisson is unlimbered, the ropes uncoiled, the top shield strap disengaged, the caisson jack loosened and swung down to the ground, the top shield swung up into the plane of the main shield and locked with the locking handles and links, the hook of the front support is disengaged, the drum catches released, and the upper guys unwound and carried out to sides and rear.

(*b*) Two men, by means of the lifting bars, raise the ladders and shield clear of the chest; two other men take the shield section rope and pull until the shield section dogs are brought far enough above the rungs of the upper section to disengage, after which the shield section is allowed to slide forward and down to the lower end of the upper section, where its weight is more advantageous in the succeeding movements.

(*c*) The men at the lifting bars now lower the ladders until they rest on the guards over the chest hinges and by pulling back assist the men forward to swing up the base section to contact with the chest front, in which position it is secured by attaching the lower guys to the hooks at the hand rail brackets. The shield section is here prevented from sliding down by the safety catches. (See fig. 2, Plate XXI.)

(*d*) With two men standing on the chest, the others assisting, the ladders are revolved about the trunnions to an upright position and fastened by the locking handles, the seat is released from the folded position, and the battery commander's telescope is mounted. (See fig. 3, Plate XXI.)

(*e*) The upper section may now be raised to the desired height, the picket pins driven, and the guy ropes and caisson jack tightened, after which the shield section is raised and the tower is ready for the observer. (See fig. 4, Plate XXI.)

The lowering of the tower is in general a reversal of the operations of raising. It will be noted that the dogs are so designed that in order to engage they must be raised slightly above the desired rung; raised a little too far the pawl will operate to prevent such engagement and the section may be lowered.

In returning the shield section from the front support to the top of the chest the safety catches must be raised, as otherwise they prevent such movement. With ladders upright, however, they are released by gravity.

The guy wires should be carefully handled to prevent kinks, and frequently inspected. Ropes should not be slack in lowering, so as to allow the sections to strike their stops with force.

When the tower is assembled to a caisson, the caisson pintle, which is removed, should not be thrown away, but retained in the battery or store wagon as a spare part unless other instructions are received. The drilling of the foot rests of the caissons in service will be done by the battery mechanics, using jigs supplied by the Ordnance Department.

THE SEXTANT TELEMETER.

[Plate XXII.]

The sextant telemeter, type A, is primarily an angle-measuring instrument. By means of scales provided it may be used for the determination of distances and the measurement of angles of deflection and angles of site.

The sextant telemeter, type A, is common for all batteries, except that the height of trajectory slide rule must be made to suit the gun with which it is uesd.

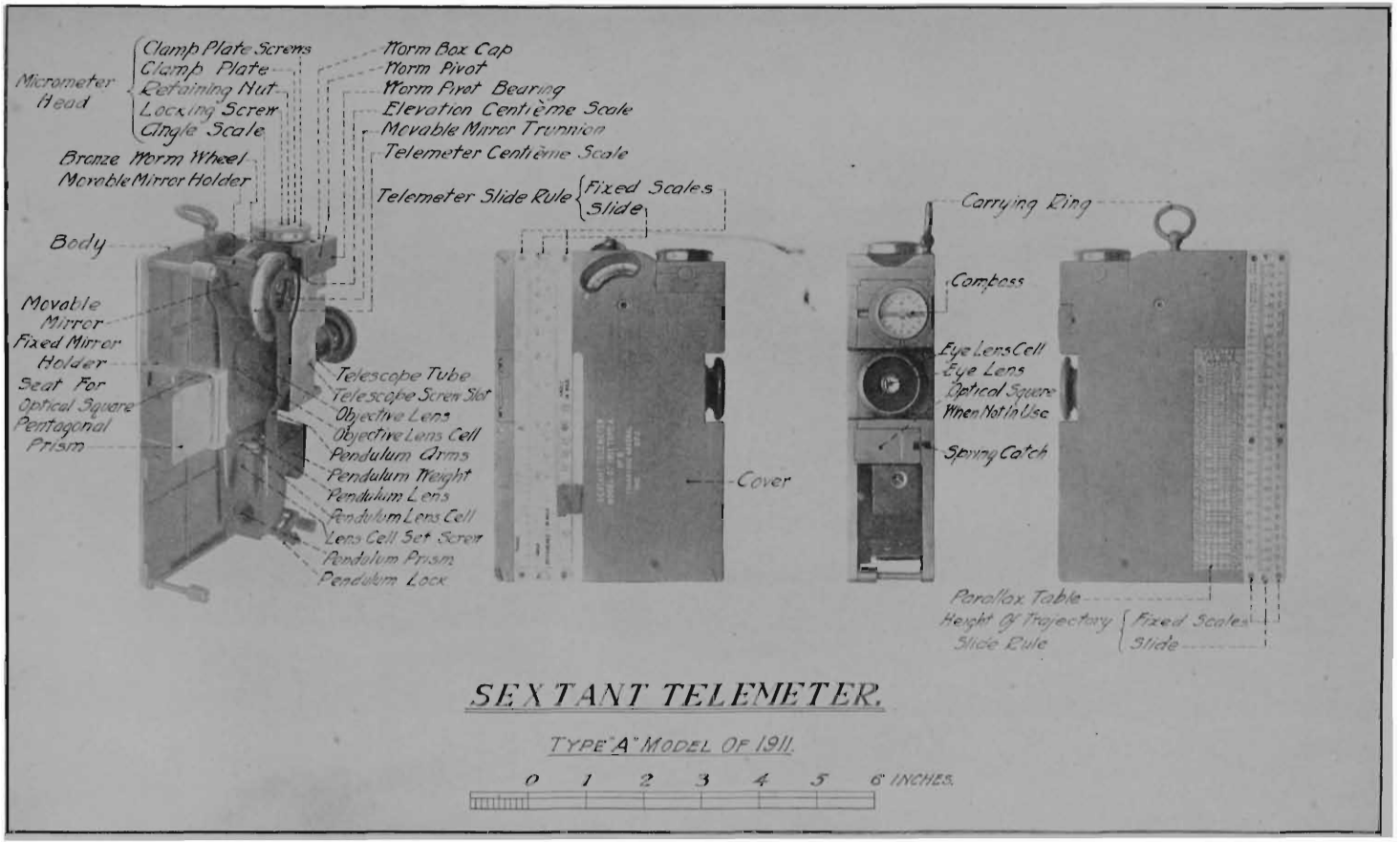
DESCRIPTION.

The principal parts of the sextant telemeter, type A, model of 1911, are: Frame, movable mirror, worm mechanism, fixed mirror, telescope, optical square, pendulum, telemeter slide rule, height of trajectory slide rule, and compass. The accessories consist of a leather carrying case, a screw driver, and a stadia.

Frame.—The frame consists of a body and cover, made of aluminum alloy castings, and fastened together by screws and dowel pins. Projecting parts of the body form seats for the worm box, telescope, and compass. Similar parts in the cover form bearings for a stop spring and stop plunger, also seats for the optical square when not in use, the pendulum lock spring, and the pendulum spring stop. In the cover is inserted the telemeter slide rule and in the body the height of trajectory slide rule. A parallax table is engraved on the face of the body.

Movable mirror.—In the frame is fitted a bronze worm wheel with teeth on 122° of its periphery and between the trunnions is milled the seat of the movable-mirror holder. To the upper surface of the worm wheel is attached an index dial, on which are engraved the telemeter centième scale and the elevation centième scale. The movable mirror is an accurately polished plane glass plate, silvered on its rear surface and held in the movable-mirror holder.

Worm mechanism.—The worm box, forming a housing for the worm, is pivoted between the bronze worm-box cap and a bronze bearing, which is dovetailed in the body. It is forced against the worm by a spring and plunger, seated at the end of the worm box. The worm is held in the worm box by a micrometer head, which is fitted on the square section of the worm shaft and locked on by means of a retaining nut and locking screw. The micrometer scale, graduated in mils, is adjustably clamped to the micrometer head by means of the clamp plate and four screws.



SEXTANT TELEMETER.

TYPE "A" MODEL OF 1911.

0 1 2 3 4 5 6 INCHES.

Fixed mirror.—The fixed mirror, a plane glass plate with its back partly silvered, is held in the fixed-mirror holder, which is, in turn, fastened to the frame by six screws. By means of two adjusting screws the fixed-mirror holder may be rocked in the frame. The mirror holder is slotted to expose the unsilvered portion of the fixed mirror, recessed for the fixed-mirror shutter, and milled for a slide in which the optical square may be seated. Pins and a catch spring are provided for retaining the optical square in its seat.

Telescope.—The telescope is of the Gallileon type, with an achromatic objective of 0.88 inch clear aperture. The power of the telescope is 3.5° and its field of view is 3.9°. The objective is mounted in the objective-lens cell, which is screwed into the telescope tube. The eye-lens cell, containing the eye lens, is screwed into a focusing sleeve, which works through the sleeve-retaining ring fastened to the telescope tube. Movement of the focusing sleeve permits the focusing of the telescope for all ranges. A scale is engraved on the focusing sleeve for assisting in adjusting the eyepiece. A key on the outside of the telescope tube prevents rotation of the telescope until it is withdrawn to its outermost position, when it may be rotated and locked by the telecope-lock screw engaging a slot in the body. The telescope bearing is so constructed that the telescope may be pushed into the interior of the telemeter when not in use.

Optical square.—The optical square consists of a pentagonal prism mounted in a frame with two faces of the prism exposed. The body of the frame is milled for a V-shaped guide, which fits slotted seats in the cover and in the fixed-mirror holder. While not in use the optical square is carried in its seat in the cover with the olive-drab enameled surfaces exposed. It may be inserted in the fixed-mirror holder to receive rays of light from the right or left of the observer. The purpose of the optical square is to deflect rays of light through a right angle. Light incident normally on an exposed surface of the optical square is twice internally reflected from the two silvered surfaces inclined to each other at an angle 45° and emerges perpendicular to the direction of the entering ray.

Pendulum.—The pendulum consists of a pendulum weight carrying a prism and a lens and two pendulum arms. While not in use it is locked in its extreme position by a pendulum lock. When unlocked, the pendulum is free to swing. The pendulum prism is held in place by a spring inserted under the prism cover and is locked in place by the pendulum arms. The arms are locked in V guides on the sides of the pendulum weight by a spring formed by punching through the pendulum arms. The pendulum-lens cell, holding the pendulum lens, screws into the pendulum weight and is locked by a set screw. The pendulum weight is counterbalanced by a lead weight, so that in

its normal position it lies 11° 15′ from the principal axis of the instrument. Its limit of motion is 300 mils either side of the normal or zero position. The screw in the back of the weight is for the adjustment of the center of gravity of the pendulum. The pendulum lens is adjusted so that the reference line, engraved on the exposed face of the pendulum prism, lies in its focal plane. Thus the light from the reference line after passing through the lens appears to come from an infinite distance. In this way without separate accommodation of the eye the reference line and a distant object are visible at the same time.

Telemeter-slide rule.—The two fixed parts of the telemeter-slide rule are secured to the cover by dowels and screws. The angle-scale index is used for setting off readings on the "angle in mils" scale. This slide rule is adapted for the solution of triangles by the law of sines. The "angle in mils" scale represents the logarithms of sines of angles formed at the observer between the base line and the line to the target. The least reading is 10 mils up to 1,000 mils, 50 mils from 1,000 to 1,500, and 100 mils between 1,500 and 1,600. The "difference in mils" scale represents the angle at the target subtended by the base line. Its least reading is 0.1 mil up to 15 mils and 0.5 mil from 15 to 30 mils. The "base" and "range" scales represent the length of the base and the distance of the target, respectively. The least readings of these scales are 1 and 100, respectively. Any unit of measurement may be used therewith, provided that the same unit is used with both scales.

Height of trajectory slide rule.—This slide rule is not the same on all instruments, but depends on the gun with which it is used.

Compass.—The compass is of the ordinary type with compass needle pivoted on a jewel bearing. The least reading on the compass dial is one centième. The end of the needle which is pierced by a bronze pin is the north seeking pole.

Stadia.—The stadia consists of two pieces of sheet metal, one of which has a red line enameled on a white background and the other a black line on a white background, connected by a cord. The distance between centers of lines is 1 yard.

OPTICAL SYSTEMS.

Telemeter systems.—The telemeter optical system consists of the fixed and movable mirrors and the telescope.

If the two mirrors are parallel to each other, a ray of light from a distant object reflected by the movable mirror and again by the fixed mirror enters the telescope coincident with a ray passing through the unsilvered portion of the fixed mirror. The images formed by the two rays in the telescope are therefore coincident. When the

mirrors are in this position the telemeter centième scale and the micrometer scale read zero.

If the movable mirror be rotated, the reflected ray of light from a given distant object will no longer coincide with the direct ray from the same object. Instead, a ray from an object at one side of the object seen directly after reflection enters the telescope parallel with the direct ray.

In this case images of the two different objects are formed by the telescope, the image in the upper part of the field being formed by the direct ray and the image in the lower part of the field by the reflected ray. The angular distance between two objects whose images are superposed is twice the angular rotation of the movable mirror from its zero position. The telemeter scales are graduated to read the angle between the two objects and not the angular rotation of the movable mirror.

When the pentagonal prism of the optical square is inserted in the path of the rays the direct ray is deflected 90°. In this case, if the mirrors are parallel to each other, the objects whose images are superposed are 90°, or 1,600 mils apart. For other positions of the mirrors the angular separation of the objects whose images are superposed is 1,600 plus the reading of the angle scales. (In case the angle scales read between 4,800 and 6,400, subtract the scale reading from 6,400 and add 1,600, or subtract from 8,000.)

Clinometer system.—The normal position of the movable mirror is 39° 22.5′ from its normal position for the telemeter system. The centième scales and indices therefor are separate for the two systems. With the movable mirror thus set the reflected ray originating at the reference line on the pendulum prism coincides before entrance into the telescope with the direct ray originating at some object lying in the same horizontal plane as the telescope. If now the instrument is rotated so that the telescope receives the direct ray from some object above the horizon, then the movable mirror must be rotated so that the ray from the reference line which has remained in the same position in reference to the horizon will coincide with the direct pencil. As in the case above, the angular rotation of the mirror is half the angle of site. The scales, however, read the angle of site directly. The reading 300 mils is for an angle of site of 0.

The image of the reference line appears in the right side of the telescope field as a dark horizontal line against a light background.

USE AND OPERATION.

For range finding.—Select aiming point as much over 45° as possible, but not over 90° from the target. Draw out the telescope to its rearmost position and focus it, observing directly the better illuminated object. Hold the instrument horizontally and direct it toward

the object to be viewed directly, then turn the micrometer until vertical lines of the images of the target and the aiming point coincide. Read the telemeter centième and micrometer scales. This reading is the angle between the aiming point and the target at the first station. Repeat this operation at the auxiliary observing station and measure the distance between the stataions.

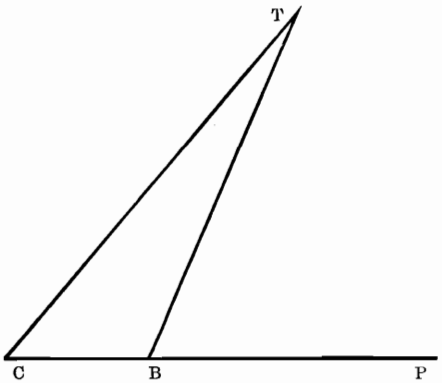


FIGURE 3.

FOR EXAMPLE: Let T (fig. 3) be the target of which range is to be determined, C the observing station, and P an aiming point. Measure angle TCP as described above. Let B be auxiliary observing station *in a straight line between C and P;* measure distance CB and read angle TBP,

$$\text{Then } \frac{TC}{\sin TBP} = \frac{CB}{\sin CTB}$$

$$\text{or } TC = \frac{CB\ (\sin TBP)}{\sin CTB}$$

But angle CTB = angle TBP − angle TCP (which are the angles read at the observing stations),

$$\text{Hence Range or } TC = \frac{CB\ (\sin TBP)}{\sin\ (TBP - TCP)}$$

This equation is solved on the telemeter slide rule as follows: Set the slide so that the value in mils of the difference between the angles TBP and TCP on the "difference in mils" scale is opposite the value of the second angle measured (angle TBP) on the lower or "angle in mils" scale; opposite the value of CB in yards on "base" scale read range in yards on the "range" scale. When first operating the slide rule the angle scale index will be found of assistance, but after extended practice the index may be dispensed with.

EXAMPLE: The angle between the aiming point and the target at the first station (angle TCP) is found to be 776 mils, the angle at the second station (angle TBP) is found to be 800 mils, and the length of the base (CB) measures 100 yards. The difference between the angles is 24 mils. The problem is solved as follows: Set the slide so that 24 on the "difference in mils" scale is opposite 800 on the "angle in mils" scale, then opposite 100 on the "base" scale read 3,001 on the "range" scale. The range desired is then 3,001 yards.

USE OF THE STADIA.

In case the stadia is used for measuring ranges, observation from one station suffices. The length of the stadia is the base line and the angle subtended at the instrument by it is measured. In figure 4,

AB is the length of the stadia and ACB the measured angle. The triangle ABC is an isosceles triangle, but because of the smallness of AB as compared with AC, the triangle may be solved as a right triangle In this case $AC = \frac{AB}{\sin ACB}$. This equation is a special case of the equation explained above, differing from it in that the sine of one angle is unity (as the angle is 90°). Therefore that term disappears in the equation. This method is of most value in measuring comparatively short distances, as the length of base lines, etc. The stadia is held horizontally at the point of which the range is to be measured. Set the scales at approximately zero. Draw out and focus the telescope. Make the images of the stadia formed by the direct and indirect rays coincide by turning the micrometer. Read the scales. At the same station, align the image of the vertical line on the left or right part of the stadia with that of the line on the right or left side. Read the scales. The algebraic difference of the two readings is the angle subtended at the instrument by the stadia.

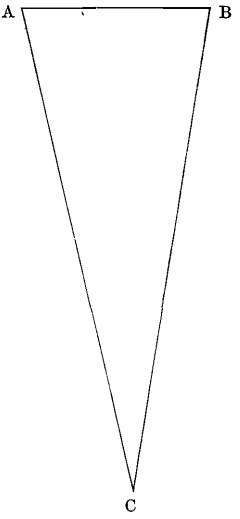


FIGURE 4.

To calculate the distance, set the measured angle on the "difference in mils" scale opposite 1,600 on the "angle in mils" scale and read the distance on the "range" scale opposite the length of stadia on the "base" scale.

For example, the measured angle is 4 mils and the stadia is 1 yard long. Set 4 on "difference in mils" scale of slide rule opposite 1,600 on "angle in mils" scale and read 2,550 on the range scale opposite 10 on the base scale.

Since the stadia is only 1 yard long and the smallest number on the base is 10, the distance in this case on the range scale must be divided by 10 to get the actual distance or 255 yards.

For measuring deflections.—Proceed as in measuring angles for range finding except that telemeter should be directed against the aiming point instead of the target, when reading will correspond to that of battery commander's telescope. In case the angle of deflection is greater than 90° the optical square is used, in which case face n a direction 90° from the aiming point and then bring the images of aiming point and target in superposition by rotating the movable mirror. In this case add 1,600 to the reading if between 0 and 1,600 and subtract 1,600 if between 6,400 and 4,800.

For measuring angles of site.—Release the pendulum; hold instrument vertically, allowing free oscillation of the pendulum. Direct the telescope at the target. Rotate the movable mirror by turning

the micrometer until the image of the reference line coincides with a horizontal line of the target. Read the angle of site from the elevation centième and micrometer scales.

NOTES ON OPERATION.

The minimum angular separation of the target and aiming point permitted by the instrument is 300 mils (16° 52.5′). The probable error of range finding is much increased if small base angles are used.

The accuracy of range finding varies directly with the lengths of base line used.

The second station of base line must lie *in* the straight line between the first station and the aiming point. Relatively large errors will arise if these three points are not in the same straight line.

Take similar positions at the first and second stations, holding the instrument in the same position relative to the stations.

For accurate results take a series of five readings at each station using the mean of the series in making calculations. Readings carefully taken in this manner should not vary more than 0.2 to 0.3 mil.

So far as practicable the objects selected as aiming point and target should be well defined and of small angular width.

When practicable, select objects in strong relief against the horizon.

In case the objects are of appreciable angular width, alignment of images should be made either for the extreme left or the extreme right edge of both objects.

When possible, select the aiming point so that it lies in the same horizontal plane as the target.

Take care that the indirect image is not elevated or depressed in reference to the direct image more than the objects. Relatively large errors will occur unless the instrument is held horizontally.

The relative illumination of the images of the aiming point and target may be varied by shifting vertically the position of the eye in respect to the eyepiece.

Keep the eye close to the eyelens cell.

When the object viewed indirectly is to the left of the object viewed directly some light may be cut off by parts of the instrument.

Check from time to time the distance from center to center of lines of stadia. Correct errors in length which are greater than $-\frac{1}{8}$ inch or $+\frac{1}{4}$ inch.

Errors easily arise if the stadia is inclined to the horizon or is not normal to the line whose length is to be measured.

The relative illumination of images of target and aiming point may be modified by the use of the shutter in the front surface of the fixed mirror holder.

For good results all optical surfaces must be kept clean.

The base and range scales of slide rule are universal. In case a problem arises outside of the limits of the scales, the measured length of base may be multiplied or divided by any factor, and the problem solved using the product or quotient, provided that the range is divided or multiplied by the same factor. Thus if angle in mils is 1,400, difference in mils 20, and length of base 200 yards, divide 200 by 2 (=100). Set 20 opposite 1,400 and read 5,000 opposite of 100. The range $5,000 \times 2 = 10,000$ yards.

In case the measured difference in mils is outside the limits of the scale, divide the measured value of the angle by any number, using the quotient to solve the problem, and divide the calculated range by the same factor. This rule is an approximation only, but is accurate enough for ordinary work.

ADJUSTMENTS.

Fixed mirror.—Bring the scales of the telemeter to read 0 and, holding the instrument horizontally on a stable mount, make the images of an object formed by the direct and reflected pencils coincident so far as vertical lines are concerned. If now horizontal lines of the images are not coincident, loosen but slightly the fixed mirror screw and rock the fixed mirror about a horizontal axis by adjusting the fixed mirror adjusting screws together with the fixed mirror screws.

When the mirror is brought to the correct position, that is, when horizontal lines of the two images coincide, carefully bring pressure to bear on each screw. Do not set up the screws too tightly. There is danger of straining the mirror and harming the optical qualities of the mirror. Do not, however, leave any screws loose. Test the adjustment after tightening the screws.

Micrometer.—Holding the instrument horizontally on a stable mount, bring into coincidence the vertical lines of the images of a distant object formed by the direct and reflected pencils of light. If the micrometer scale does not register zero, loosen the four micrometer head screws and, without rotation of the worm, slip the micrometer scale to read zero. Check the coincidence of the images, readjust if necessary, and set up the micrometer head screws.

Worm.—In case of longitudinal play in the worm, loosen the worm-locking screw and set up slightly the retaining nut and tighten the worm-locking screw. The worm should operate freely but without play. Wear of the worm and worm gear are automatically compensated by action of the worm plunger spring.

Slide rules.—If the slides of the slide rules become loose, remove them from their seat and curve them by hand *very slightly* in the direction of their length. Then reinsert in their seat.

DISASSEMBLING AND CLEANING.

Telescope.—The exposed optical parts of the telescope may be cleaned without removal of the telescope.

Mirrors.—The surfaces of the mirrors may be cleaned without removal.

Worm mechanism.—To clean the worm or the teeth of the worm wheel, rotate the worm wheel until the clinometer scale, which is engraved on the index dial, registers 6, draw back the stop plunger, and continue rotation of the worm wheel in the same direction until the worm is released. The worm wheel may then be rotated freely. After the worm is released, the teeth of both worm and worm wheel may be cleaned. After cleaning lightly, cover them with a layer of vaseline. Reassemble in the reverse order.

Worm.—If for any purpose it is necessary to remove the worm, unscrew the four worm-box cap screws and draw out the worm-box cap with worm, etc. To disassemble loosen the worm-locking screw, unscrew the retaining nut and draw off the micrometer head and worm-box cap. To remove the worm from the worm box first remove the worm-plunger screw and then the worm plunger and worm-plunger spring. Then push the worm and worm bearing out of the worm box, applying slight pressure on the end from which the micrometer head was removed, clean, lightly oil with clock oil all bearing surfaces except the worm teeth, which should be lightly coated with vaseline. Reassemble in the reversed order. Take special care that no dirt or grit remains on any bearing surface. Adjust the retaining nut to remove all longitudinal play and readjust the micrometer scale of the micrometer as described above. This work should be done only by a careful person with a delicate sense of touch.

Frame.—Do not remove the cover nor the fixed scales of the slide rules from the body. This also prohibits the removal and the disassembling of the pendulum.

GENERAL INSTRUCTIONS FOR CARE AND PRESERVATION.

While not in use keep the sextant telemeter in its leather case, and store it in a warm, dry place.

Keep all optical surfaces clean.

For the cleaning of optical surfaces use only the materials supplied by the Ordnance Department for that purpose.

Do not use on optical surfaces any cleaning material which is dirty or covered with oil or dust.

Do not allow oil to drop over any part of the instrument. Use no oil on the telescope.

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