WAR DEPARTMENT

TECHNICAL MANUAL

of

75-MM HOWITZER MATÉRIEL

June 21, 1941

TECHNICAL MANUAL
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WAR DEPARTMENT,
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75-MM HOWITZER MATÉRIEL

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Chief of Ordnance

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CHAPTER 1

GENERAL

1. Purpose.—This manual is published for the information and guidance of the using arms and services.

2. Scope.—*a.* This manual contains all the essential information of a technical character required by the using arms and services for the identification, use and care of the particular equipment described, as well as use and care of ammunition, spare parts and accessories, and sighting and fire control equipment.

b. Dissassembly and assembly, and repairs by battery personnel will be undertaken only under the supervision of an officer or the chief mechanic.

c. In cases where the nature of repair, modification, or adjustment is beyond the scope and/or facilities of the battery personnel, the local or otherwise designated ordnance service should be informed in order that trained personnel with suitable tools and equipment may be provided.

3. References.—The appendix lists all Technical Manuals, Field Manuals, Firing Tables, Standard Nomenclature Lists, and other publications for the matériel described herein.

CHAPTER 2

HOWITZERS AND CARRIAGES

SECTION I

GENERAL INFORMATION AND DATA

4. General Information.—The 75-mm pack howitzer is mounted on either of two types of carriages. The 75-mm pack howitzer consists of a 75-mm pack howitzer, M1 or M1A1, mounted on a 75-mm pack howitzer carriage, M1; and the 75-mm field howitzer consists of a 75-mm pack howitzer M1 or M1A1, mounted on a 75-mm field howitzer carriage M2A1, M3 or M3A1. The pack howitzer carriage is arranged for dismounting into six mule-packs. This type has wooden wheels, steel tires, and axle traversing mechanism. (See fig. 17.) The field howitzer carriage may be distinguished by its rubber tires and firing base (fig. 10). The howitzer tube, top and bottom sleighs, cradle and recoil mechanism are essentially the same on both types of carriages.

5. Data.—*a. 75-mm pack howitzer, M1 and M1A1.*

Weight with recoil mechanism, pounds 543.56
Length, calibers 15.9
Rifling: Uniform, right; one turn in 20 calibers; 28 grooves, 0.03 inches deep.

Diameter of bore between lands, inches---------- 2.95
Pressure, maxium pounds per square inch---------- 26,000
Muzzle velocity, feet per second, maximum---------- 1,250
Muzzle velocity, feet per second, minimum---------- 700
Life, approximate, rounds---------- 12,000
Breech mechanism----------Horizontal sliding wedge
Firing mechanism----------Continuous pull (firing lock, M13)

b. 75-mm howitzer carriages.

Carriage	M1 (pack)	M3A1 (field)	M3 (field)[1]	M2A1 (field)[1]
Range, maximum, yards	9, 489	9, 489	9, 489	9, 489
Rate of fire:				
Short bursts, rounds per minute	6	6	6	6
Prolonged firing, rounds per minute	3	3	3	3
Weights:				
Howitzer and carriage in firing position, pounds	1, 269	2, 089	2, 023	1, 949
Howitzer and carriage in traveling position, pounds		[2] 3, 334		
Tube with accessories, pounds	245			
Bottom sleigh with accessories, pounds	236			
Cradle and top sleigh with accessories, pounds	240			
Front trail with accessories, pounds	257			
Rear trail, axle, and sight with accessories, pounds	259			
Wheels and breechblock with accessories, pounds	250			
Total pounds	1, 487			
Recoiling parts, pounds	656	656	656	656
Projectiles, standard:				
Shell, HE, M48, with fuze, M48 or M54, pounds	14. 7	14. 7	14. 7	14. 7

[1] The data applying to the howitzer and carriage, M3A1, in general, will also apply with negligible error to the M2A1 and M3 carriages. These carriages are 66 pounds lighter and, in over-all length, 2½ inches shorter than the M3A1.

[2] Includes loaded limber.

NOTE.—Phillips pack saddle not included, weighs 94.5 pounds.

Carriage	M1 (pack)	M3A1 (field)	M3 (field)[1]	M2A1 (field)[1]
Recoil mechanism:				
Type: All hydropneumatic, constant, with floating piston.				
Fluid used, recoil oil, heavy, low pour point, pints	3	3	3	3
Pressure at 70° F., pounds per square inch	1, 250	1, 250	1, 250	1, 250
Length of recoil, inches:				
Normal	32.	32.	32.	32.
Maximum	33. 65	33. 65	33. 65	33. 65
Trail:				
Type	Modified box.	Split	Split	Split
Spread, maximum, degrees		46½	46½	45
Elevation:				
Maximum, degrees and mils (plus)	(45°) 800	(49.5°) 880	(49.5°) 880	(50°) 889
Minimum, degrees and mils (minus)	(5°) 89	(9°) 160	(9°) 160	(9°) 160
Elevation per turn of handwheel, mils	24	29. 5		
Maximum when firing from wheels with trails closed, mils		380		
Traverse:				
Type	Axle	Pintle	Pintle	Pintle
Maximum right, degrees	3	22½	22½	22½
Maximum left, degrees	3	22½	22½	22½
Maximum total, degrees and mils	(5.3°) 95	(45°) 800		
Traverse per turn of handwheel, mils	4. 1	24. 7		
Maximum when firing from wheels with trails closed, mils		425		
Lunette reaction, pounds		45		
Sighting system:				
Type	Dependent	Dependent	Dependent	Dependent
Components:				
Telescope, panoramic, model	M1	M1	M1	M1
Mount, telescope, model	M3	M16	M16	M16
Elbow, telescope, model		M5	M5	M5
Quadrant, range, model		M3	M3	M3

[1] The data applying to the howitzer and carriage, M3A1, in general, will also apply with negligible error to the M2A1 and the M3 carriages. These carriages are 66 pounds lighter and, in over-all length, 2½ inches shorter than the M3A1.

Carriage	M1 (pack)	M3A1 (field)	M3 (field)[1]	M2A1 (field)[1]
Dimensions in firing position, overall:				
Length, inches	145			
Width, inches	48			
Height, inches	37			
Height, center of bore at 0° elevation, inches	27. 5	29		
Dimensions in Traveling posi-ing, overall:				
Length, muzzle to lunette, inches		155		
Width, inches		68		
Height, inches		44		
Height, center of bore at 0° elevation, inches	27. 5	33. 57	33. 57	33. 57
Transportation	6-mule pack	6-horse team	6-horse team	6-horse team
Time to emplace, minutes	3	3	3	3
Tires:				
Size		5.50 by 20		
Recommended pressure, pounds per square inch		30		
Supplementary equipment:				
Pack saddles[3]				
Limber, light, M2 (with pole, M1)	717	717	717	717
Limber, light, M2 (with 22 rounds HE shell), pounds (approximate)	1, 300	1, 300	1, 300	1, 300
Caisson, light, M1	865	865	865	865
Caisson, light, M1 (with 52 rounds HE shell) pounds (approximate)	1, 965	1, 965	1, 965	1, 965
Setter, fuze:				
Type	Hand	Bracket	Bracket	Bracket
Model	M1912A4	[4]M1916A2		

[1] The data applying to the howitzer and carriage, M3A1, in general, will also apply with negligible error to the M2A1 and M3 carriages. These carriages are 66 pounds lighter and, in over-all length, 2½ inches shorter than the M3A1

[3] Phillips cargo pack saddles (or aparejo, QM type) with adapters, arches, brackets, frames, etc., for special loads.

[4] For shrapnel.

SECTION II

DESCRIPTION AND OPERATION OF 75-MM PACK HOWITZERS, M1A1 AND M1

6. 75-mm pack howitzer, M1A1.—The 75-mm pack howitzer, M1A1, is standard. This howitzer is in two groups, the tube assembly and the breech mechanism assembly. This division facilitates pack transportation. These assemblies may be readily and easily disassembled or assembled. (See fig. 12.)

7. Tube assembly.—The tube assembly is provided with a front eyebolt, A9195, lifting eye, A8979, and two studs, A12792 and A12793. The front eyebolt is used, in conjunction with a lifting bar (or trail handspike), as a means to screw the tube into the breech ring. It also serves as a lifting eye. The lifting eye, together with the front eyebolt, is used as a means of lifting the tube. The lifting eye folds down against the tube when the latter is assembled on the carriage. The studs guide the tube in and out of the breech ring and prevent jamming the threads. Lugs are provided as stops for the barrel when the barrel is being assembled to the breech ring. Interrupted threads enable rapid assembly and disassembly of the tube and breech ring, one-eighth turn being required. (See fig. 12.)

8. Breech mechanism.—*a. Description.*—The breech mechanism is the horizontal sliding wedge type, hand operated by means of a lever pivoted to the breech ring. The breech mechanism consists of the breech ring, breechblock, operating lever, trigger, firing lock, M13, C8662; gear cover, A12131; operating lever pivot, B8029; and trigger shaft, A12138. Interrupted threads enable rapid assembly of the breech mechanism and the howitzer tube. Two lugs projecting from the front face have cam grooves to guide the two studs on the tube when assembling the barrel to the breech ring. Two lugs, one on each side of the upward cylindrical portion, serve to lock the breech ring to the recoil mechanism. The leveling plates, A12121, are inlaid in the top of the breech ring to form seats for the gunner's quadrant. The trigger is provided with a trigger knob for attaching the lanyard to the trigger. (See fig. 12.)

b. Operation.—(1) To open the breech, grasp the handle of the operating lever, B8028, and press the latch, A12125, in against the latch spring, A12128, which unlatches the lever. Swing the lever

to the right and around to the rear until it strikes the breech ring. As the breechblock moves to the open position it actuates the extractor, B8027, which ejects the cartridge case. In opening the breech rapidly the operator should retain his hold on the lever to prevent rebound of the breechblock.

(2) To close the breech, reverse the manipulation of the operating lever.

9. Firing lock, M13.—*a. Description.*—The firing lock, M13, is an assembly consisting of the firing case, C3537; firing pin, A12755; firing pin bushing, A12579; firing pin holder, B8187; cotter pin, BFAX1BQ (for firing pin holder); firing pin holder sleeve, A12133; (firing) spring, A12134; trigger fork, A12132; sear, B8031; and (sear) spring, A12135. (See fig. 12.) The firing mechanism is of the continuous-pull type and fits into an axial hole in the breechblock. The firing lock is retained in position in the breechblock by sector lugs on the exterior of the lock engaging with lugs on the block. The firing lock is prevented from rotating out of engagement by the trigger shaft, A12138, which lies transversely in the breechblock and has near its left end a square section which fits into a square hole in the trigger fork of the firing lock. The right end of the trigger shaft has a partial spur gear which meshes with a similar gear on the trigger. The firing pin holder has a cylindrical head which slides in the bore of the firing case, and a flat stem, which passes to the rear through the firing spring, through the firing pin holder sleeve, and between the prongs of the trigger fork. The firing pin is loosely secured to the front end of the firing pin holder by means of a bushing and a cotter pin, forming an assembly. The sear rests in a groove below the center of the firing case. The rear end of the sear rotates about the trigger shaft, independent of the trigger shaft motion, and the forward end of the sear is pushed upward into contact with the firing pin holder through the action of the sear spring. A notch at the front end of the sear engages the head of the firing pin holder in the readiness position. The upper surface of the sear, to the rear of the notch, has a cam surface upon which the firing pin holder sleeve rides. This sleeve encircles the firing spring and has an enlarged portion at the top rear upon which the extreme end of the trigger fork presses. The trigger fork is a Y-shaped piece; the upper ends of the Y contact the sleeve, so that when the trigger is rotated the fork forces the sleeve forward. The fork straddles the firing pin holder and engages the T-head on the rear end of the holder. The lower leg of the fork has a square hole through which the trigger shaft passes. Firing is accomplished

by a rearward pull on the lanyard. The force of this pull has no effect on the force of the blow on the primer. As the trigger shaft is rotated by the trigger, with its connected lanyard, the trigger fork forces the firing pin holder sleeve forward, this action compressing the firing spring. When the proper amount of compression is reached, the sleeve engages the upper cam surface of the sear compressing the sear spring and releasing the firing pin and holder. (See fig. 2.) The firing pin holder flies forward under pressure of the spring, and the firing pin strikes the primer. (See fig. 3.) Upon release of the lanyard, the firing lock parts return to their readiness position in the following manner: The firing spring presses forward on the firing pin holder and rearward on the sleeve. (See fig. 4.) The ears of the T-head at the rear end of the firing pin holder thus press forward on the rear surface of the trigger fork, and the upper rear of the sleeve pushes rearward on the front surface of the extreme ends on the trigger fork. These efforts are equal in strength, but that of the sleeve acts against a longer lever arm, overcomes the pull of the firing pin holder, and rotates the trigger fork about the axis of the trigger shaft, drawing the firing pin holder back until its head is again engaged with the sear. (See fig. 4.)

b. Operation.—Firing is accomplished by a sharp pull on the lanyard. The firing pin returns automatically to the cocked position when the lanyard is slackened.

10. 75-mm pack howitzer, M1.—The 75-mm pack howitzer, M1, is identical with the 75-mm pack howitzer, M1A1, with the exception of the breech ring assembly and the breechblock assembly. These assemblies are not interchangeable on the two models of howitzers. (See fig. 12.)

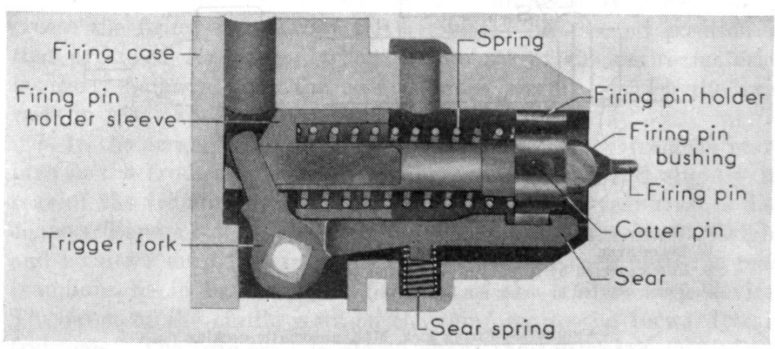


FIGURE 1.—Firing lock, M13, in firing position.

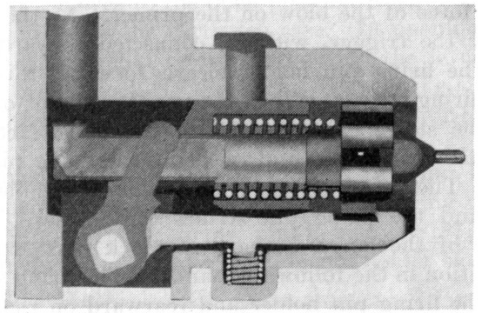


FIGURE 2.—Firing lock, M13, at moment of tripping the sear.

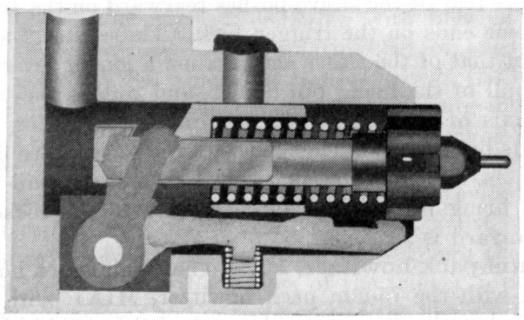
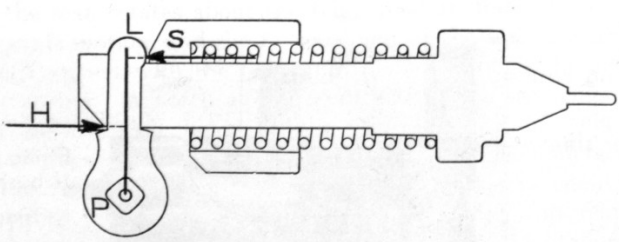


FIGURE 3.—Firing lock, M13, at moment of striking the primer.



P. Trigger fork pivot.
L. Lever arm.
S. Force exerted by firing pin holder sleeve.
H. Force exerted by firing pin holder.

FIGURE 4.—Firing lock, M13, automatic cocking.

SECTION III

DESCRIPTION AND OPERATION OF 75-MM PACK HOWITZER CARRIAGE, M1

11. 75-mm pack howitzer carriage, M1.—The 75-mm pack howitzer carriage, M1, is the standard for pack artillery. The design is for traverse on the axle. To compensate for the unbalanced weight about the trunnions, spring equilibrators are set within the front trails. Like the 75-mm pack howitzer this carriage may be separated, readily and easily, into groups suitable for pack transportation. The primary groups are the recoil mechanism, including the bottom sleigh, cradle and top sleigh, front trail, rear trail, and the wheels which are carried on the same pack load as the breech mechanism. (See fig. 5.)

a. The elevating mechanism, rockers, and equilibrators are assembled to the front trail and are carried in pack as a unit. The axle brackets, into which the detachable axle and traversing mechanism are assembled, are built into the front trail for two positions of the axle. In the first or firing position the axle is well forward where the weight of the axle and wheels is advantageously placed to increase the firing stability of the carriage. The second position is that arranged for towing when the weight of the entire matériel is nearly balanced over the axle. In the second position the axle rests in rear axle bearings.

b. In the arrangement for towing, the axle is moved from its bearings in the front of the trail to others underneath and slightly in rear of the trunnion bearings of the rockers. The rear trail is disconnected and a towing pole attached in its place. The cradle, sleigh, and howitzer are lifted from the rockers and set back until the rear trunnions lie in brackets just forward of the trail locking device. The front of the cradle rests on the reinforce to the forward trail transoms. The rear trail is placed above the top sleigh, spade end toward the towing pole and a cincha passed about the whole combination to hold it together.

c. During movements by rail, water, or truck, the matériel should be arranged as prescribed in *b* above and lashed together. This arrangement takes the weight off the elevating mechanism and reduces the possibility of damage.

12. Recoil mechanism.—*a.* When the howitzer is fired, the force which propels the projectile forward reacts upon the howitzer and drives it to the rear. It is necessary to check this force in a gradual manner so as not to cause displacement of the carriage. Also, the howitzer must be brought back into battery position before it can be fired again. These objects are accomplished by the recoil mechanism which is of the hydropneumatic type. It combines the recoil and counterrecoil systems housed within separate cylinders. The two cylinders, known respectively as the recoil cylinder and the recuperator cylinder, are fixed underneath the bottom sleigh and are screwed into the yoke. The piston rod is secured to the cradle by means of the piston rod latch. The yoke and cylinders move with the bottom sleigh and howitzer while the piston rod remains stationary. On each side of the bottom sleigh there are strips or slides which engage the slideways of the cradle which guide the sleigh in recoil and counterrecoil.

b. Oil index.—The recuperator cylinder front head is fitted with an oil index. The function of the oil index is to show the amount of reserve oil in the mechanism. Should the howitzer be fired with the oil index, A15893 (fig. 13), indicating a loss of oil in the system, considerable additional stress may occur in the recoil mechanism and cause damage. It is therefore necessary to force in enough reserve oil to move the oil index until it is flush with the extension on the oil index follower assembled in the recuperator cylinder front head, C5803.

c. (1) The recoil cylinder filling valve, A19763, is contained in the recoil cylinder filling valve housing, B105275. This valve is opened by means of the oil extractor when it is necessary to remove reserve oil, or by the oil screw filler when it is necessary to replenish recoil oil which may have leaked through the recoil piston stuffing box or through the oil index packing. It may also be necessary to replace the oil withdrawn from the system due to expansion of the oil caused by firing.

(2) The recoil cylinder is closed at the rear by the recoil cylinder rear head. As this head is on the low pressure side of the piston, elaborate packing is not required. In order to relieve the accumulation of oil that may pass the piston, a relief opening is provided in the cylinder head through which the oil may be ejected. Closing the relief opening is a ¼-inch hexagon head cap screw which pre-

vents the recoil cylinder (rear head) lock from becoming loosened, and prevents dirt from being sucked into the cylinder. The leaking oil may be released by removing the cap screw on the rear head.

13. Cradle.—The slides on the bottom sleigh are fitted to the ways on the cradle. The piston rod latch, B17569, slides vertically in ways in the front end of the cradle. When dropped behind the piston rod nut it secures the piston rod to the cradle, and, with the bottom sleigh and the howitzer in the cradle, it cannot be disengaged, as interference with the howitzer tube prevents the latch from rising. An automatic piston rod latch stem, A20726, is provided for holding the piston rod latch in either the open or locked position. The sight brackets are fitted with a sight retaining shaft, A37140, which is automatically returned to the locked position. A spring-controlled plunger, A37304, is provided to hold a lug of the telescope mount against headless screw, A37305, which may be adjusted by means of nut, BBDX1C. Accuracy of alinement of the sight in azimuth is thereby maintained and quick removal of the telescope mount is provided for. (See fig. 13.)

14. Equilibrators (fig. 16).—Two equilibrators are provided to overcome the preponderance of weight resulting from the position of the rocker trunnions so far to the rear of the center of gravity of the tipping parts. The equilibrator is composed of the barrel, B19613; stem, B19614; equilibrator helical spring, A21723; equilibrator stem plug, A21725; equilibrator pin lock, A3552; and screw, BCNX2AA, for fastening the lock in place. The equilibrator pressure is adjustable within limits to secure the lightest and most uniform resistance to elevation and depression. The rear end of the barrel and the plug are adapted to receive the equilibrator locking tool to hold the equilibrator compressed while it is being inserted or dismounted. The load on the spring when the locking tool is inserted is approximately 1,400 pounds.

15. Rockers.—The rockers are segments of internal gears, located on either side of the cradle in the space between inner and outer flasks of the front trail side elements. The rockers pivot on trunnion pins, A3486. (See fig. 15.)

16. Axle, traversing mechanism, and wheels.—*a.* The axle is fitted with left and right axle arms. The left arm, C1695, is pinned, whereas the right arm, C6586, is attached with a screw, A20723, for disassembling purposes. The axle is grooved to form an inner race for the traversing mechanism bearing balls. (See figs. 17 and 18.)

b. The axle is retained in its bearings in the trail by means of a sleeve. The sleeve may be inserted by matching the proper surfaces.

After assembling it may be locked by turning 90°, by means of the hinged handle lock, A3363, which, when released, becomes a lever by which the sleeve may be turned. The body of the axle is graduated in mils for traverse, the right end of the sleeve forming the index of the graduations.

c. The traversing mechanism is composed of the traversing nut, C8018; handwheel, C8019; machine screw, BCKX2CG; ball bearing, CAAX1AU; ball bearing cap, B13968; ball bearing nut, A15810; and seventy-one $\frac{5}{16}$-inch steel balls, CCAX1D. The dust cover, C1666, is provided to prevent the entry of dirt or foreign matter into the mechanism. When the matériel is transported on its wheels the handwheel is locked to the trail to prevent it from turning and running the axle off center.

d. The wheels (fig. 5) are 29 inches in diameter, steel-tired, and are secured to the axle arm by the linchpin, A15722 (fig. 17). A drag link, B17678 (fig. 5), is provided on the outer end of the hub ring.

17. Front trail.—Openings are provided at the front of each side member of the front trail to house the rockers. (See fig. 15.) At the front end, between the side members of the trail, the upper elevating gear case, D3848, the rocker pinion shaft tube, B13506, and rocker pinion shaft tube bearing are assembled. The elevating worm, A16, and the elevating worm wheel, A15, are inclosed within the gear case. The rocker pinion shaft, B5570, is inclosed within the rocker pinion shaft tube. Axle bearings are provided at the front end of the trail which retain the axle when the piece is in firing position. At the bottom and to the rear of the trunnion bearings, two additional axle bearings are fitted for retaining the axle when the matériel is transported by towing. Two bearings are assembled toward the rear of the front trail in which the rear ends of the equilibrator rest, the front ends being supported in bearing surfaces in the rockers. Brackets on the top, toward the rear, support the cradle when arranged for towing. Trail hinges are attached to the rear end of the trail. These hinges engage with other hinges on the rear trail for assembling the matériel in firing position. The trail fulcrum plungers, B6832, housed within the trail connecting mechanism housing, pass through the eyes of the hinges. The trail fulcrum plungers are moved in and out by means of the trail fulcrum, B6833, and two trail fulcrum links, A8690. By the use of a lifting bar, through the eye of the fulcrum, it may be turned 90°, which engages or disengages the plungers with the hinges. The trail connecting mechanism is also utilized when attaching the towing pole. (See fig. 15.)

18. Rear trail.—The rear trail is similar to the front trail in construction. It is fitted with a spade in order to prevent backward movement of the carriage when the howitzer is fired. It is also provided with a socket for the purpose of maneuvering the carriage by use of the handspike. The sponge staves are transported on the inside of the rear trail. The axle and traversing mechanism assembly is carried inside the trail with the right end of the axle in the bore of the handspike socket and the left end over the rear trail front transom. (See fig. 5.)

19. Top sleigh.—The top sleigh is composed of the top sleigh body, top sleigh clamping cam, B104254; top sleigh clamping latch, A18873; top sleigh clamping latch pin, A3872; cam bushing, A3580; and a thong, A17950, for retaining the latch pin. The top sleigh retains the howitzer in the bottom sleigh and also forms a covering for it. The cam, hand operated by means of the socket of the handspike, when turned to the locked position forces the top sleigh forward. By inserting the top sleigh clamping latch pin the two sleighs are locket together and retained in position. (See fig. 13.)

20. Bottom sleigh.—*a.* The bottom sleigh forms a seat for the howitzer and maintains alinement of the tube and breech ring when assembled.

b. The recoil indicator bracket, B104820, which carries the recoil indicator, A19262, with its spring, A1344, and handle, A1343, for recording the length of recoil, is bolted to the right side of the bottom sleigh near the front. The recoil indicator is a spring plunger arrangement and may be set so that its point will trace a path in grease or similar substance smeared on top of the cradle. The length of recoil may be read on a scale cut in the cradle. When not in use the recoil indicator is raised and retained out of contact with the cradle by its handle resting in a notch in the wall of the bracket. (See fig. 13.)

SECTION IV

DESCRIPTION AND OPERATION OF 75-MM HOWITZER CARRIAGE, M3A1

21. 75-mm howitzer carriage, M3A1.—The 75-mm howitzer carriage, M3A1, is the present standard designed especially for high speed travel. This carriage is a split trail type vehicle having pneumatic tired disk and rim wheels mounted on antifriction bearings and equipped with standard commercial automobile brakes. Spring equilibrators support the unbalanced weight of the tipping parts (See fig. 6.)

22. Recoil mechanism.—See paragraph 12.

23. Cradle.—The slides on the bottom sleigh are fitted to the ways on the cradle. The piston rod latch, B17569, slides vertically in ways in the front end of the cradle. When dropped behind the piston rod nut it secures the piston rod to the cradle, and with the bottom sleigh and the howitzer in the cradle it cannot be disengaged, as interference with the howitzer tube prevents the latch from rising. An automatic piston rod latch stem, A20726, is provided for holding the piston rod latch in either open or locked position. (See section D–D, fig. 13.) The sight brackets are fitted with a sight retaining shaft, B109189, which is automatically returned to the locked position. A sight clamping screw, A141500, is provided to hold a lug of the telescope mount, or of the range quadrant, against a headless screw, A141501, which may be adjusted by loosening the nut, BBDX1C. (See section C–C, fig. 13.) Accuracy of alinement of the sight in azimuth is thereby maintained and quick removal of the telescope mount is provided for.

24. Top carriage.—The top carriage has trunnion bearings at the top which support the cradle and cup-shaped bearings at the bottom to support the lower ends of the equilibrators. The elevating gear case and pads, for attaching the traversing and elevating handwheel shaft brackets, are fitted to the top carriage. (See fig. 10.)

25. Bottom carriage.—The bottom carriage is fitted with a pintle bearing, trail brackets, trail lock pin bracket, firing base hinge brackets, stops to locate the traveling lock in traveling position and a traversing rack. (See fig. 10.)

26. Elevating mechanism.—The tipping parts may be elevated or depressed by means of the elevating handwheel, C2247, located

on the right side of the carriage. Stops are provided at each end of the elevating arc, C59570, which regulate maximum elevation and depression. The rotating parts are mounted on oil-sealed antifriction bearings. (See figs. 9, 13, and 24.)

27. Traversing mechanism.—The carriage may be traversed in the desired direction by means of the traversing handwheel, C2247, located on the left side of the carriage. Stops are provided at each end of the traversing rack, C59562, to regulate maximum traverse. The rotating parts are mounted on oil-sealed antifriction bearings. (See figs. 9 and 14.)

28. Equilibrators.—Two equilibrators are provided to overcome the preponderance of weight resulting from the position of the rocker trunnions so far to the rear of the center of gravity of the tipping parts. The high speed howitzer equilibrator is composed of the equilibrator spring, A136543; equilibrator barrel, B108630; equilibrator cylinder assembly, and equilibrator trunnion pin lock, A3552. Adjustment of the spring trunnion is obtained by adjusting the equilibrator trunnion pins. The equilibrators for carriage, M3A1, are equipped with the bent pin, A158054. (See fig. 10.)

29. Trails.—When spread to their full open position the trails are locked by means of the trail lock pins, A157690. The pins are inserted in the trail lock pin brackets of the trail and through mating holes in the trail lock pin brackets on the bottom carriage. When the trails are closed to their traveling position they are locked together by means of a toggle type mechanism. In the operation of locking the trails together the trail lock hook, A18962, which is connected to the trail lock lever, A18960, on the right trail, is inserted into the trail lock loop, A157023, assembled to the left trail. When the trail lock lever is pressed down it draws the two trails together tightly, and by inserting a cotter pin through the trail lock lever and the trail connection bracket they are locked in traveling position. (See fig. 9.)

30. Wheels.—Each wheel consists of disk and rim, pneumatic truck-bus balloon tire, puncture-sealing or bullet-sealing inner tube, and a tire locking ring. (See fig. 19.)

31. Brake mechanism.—The brake mechanism for the 75-mm howitzer carriage, M3A1, is the internal expanding type. The brake shoes, C62667, actuated by the hand brake lever, B150601, are attached to the brake cam shaft, B150584. Movement of the brake lever forces the brake cam, B144968, against the brake cam rollers, B144955, of the brake shoes causing them to expand against the brake drums which are rigidly attached to the wheels. When the brake lever is

placed in the "off" position the brake shoes are forced toward the center of the wheel by means of the brake shoe retracting spring, B144956 and B144957. (See fig. 21.)

a. Movement of the hand brake lever, B150601, is controlled by the brake ratchet pawl engaging teeth of the brake ratchet rack, B150685.

b. The brake shoes may be adjusted for wear by means of the brake adjusting wedge.

32. Wheel carriers.—The wheel carriers for the carriage, M3A1, are designed to facilitate changing the carriage from the firing to traveling, or from traveling to firing positions. They are assembled to the bottom carriage by wheel carrier pins. Bronze washers, A140573, and slotted nuts are assembled on the wheel carrier pins to retain the wheel carrier to the bottom carriage with just enough tension to allow a revolving movement of the wheel carrier without undue end play. The wheel spindle, B144817, assembled to the wheel carrier, is retained in a rigid position by means of tapered surfaces on the shank and secured by a washer and slotted nut assembled to the wheel spindle. (See fig. 21.)

33. Wheel latch.—The wheel latch mechanism secures the wheel carriers in traveling and firing positions. To release the wheel carrier press down on the wheel latch plunger, A161606 (A157080 for carriages M2A1 and M3). The wheel latch lever actuates the wheel latch bolt, A161602 (A140408 for carriages M2A1 and M3), which engages mating holes in the spring carriers and wheel carriers when in either traveling or firing position. The movement of the wheel latch bolt is controlled by slots cut on the side of the wheel carrier brackets. (See fig. 21.)

34. Firing base.—The firing base, pertaining to the 75-mm howitzer carriage, M3A1, is designed to combine the functions of the firing base and traveling lock. When traveling the firing base is swung up until the slotted bearing of the base engages the cradle lock pin, B108609, and is secured by turning the cradle lock pin handle, B13942, parallel with the cradle. (See fig. 6.)

35. Firing base lock.—The firing base lock of the 75-mm howitzer carriage, M3A1, consists of a firing base lock plunger, B144943, actuated downward by a compression spring and withdrawn by depressing the firing base lock pedal. The plunger is retained in a housing on the bottom carriage. The firing base lock spring retainer, A157735, which is screwed into the upper end of the housing, controls the motion of the upper end of the plunger. The lower end of the plunger is enlarged to fit the inside of the opening in the firing base and to retain the compression spring at its lower end. When the

firing base is dropped into firing position the compression spring automatically actuates the plunger locking the firing base. (See fig. 7.)

36. Cradle lock.—The cradle lock consists of a cylindrical pin, B108609, flattened on two sides and rotated by the cradle lock pin handle which in turn is secured to the cradle by means of a turnbuckle. When the cradle lock pin handle, B13942, is in a vertical position it allows the traveling lock to be seated. Turning the cradle lock pin handle to a horizontal position locks the traveling lock to the cradle. (See fig. 6.)

SECTION V

DESCRIPTION AND OPERATION OF 75-MM HOWITZER CARRIAGES, M3 AND M2A1

37. General.—The 75-mm howitzer carriages, M3 and M2A1, have the same general appearance as the M3A1 carriage. The major differences in construction are as follows:

a. The M3 carriages have spring carriers at the present time, whereas the M2A1 and M3A1 models have springless carriers. However, changes are to be made on all of the M3 carriages which will embody replacement of the spring carriers by the M3A1 type springless wheel carriers.

b. The M3 and M2A1 carriages have a traveling lock, whereas on the M3A1 carriage this function is performed by the firing base when in traveling position.

c. The M3 carriages have external brake mechanisms while the M3A1 and M2A1 carriages have the internal type. However, it is contemplated that the present external brakes on the M3 carriages are to be replaced by the internal type.

d. The position of the cradle lock pin hole of the M3A1 carriage is changed.

e. The shape of the trails is changed, and the lunette of the M3 carriage is placed on the left trail while that of the M3A1 carriage is attached to the right trail.

f. The equilibrator trunnion pins are changed according to paragraph 43.

38. Brakes.—The brake band is actuated by means of a brake lever, C59579, hinged to the carriers, D7291 and D7304, by the brake shafts, B108597 and B108598. Movement of the brake lever causes the brake band to hug the brake drum, creating enough friction to bring the vehicle to a stop. The brake band may be adjusted by means of the brake band adjusting nut, A137462, and equalized by means of the fillister head screw, A137598, in the guide. (See fig. 20.)

39. Spring carriers.—*a.* The spring carriers of the 75-mm howitzer carriage, M3, are designed to absorb the road shocks in conjunction with the pneumatic tired wheels and thereby improve the riding qualities of the carriage. (See fig. 20.)

b. The spring carrier bracket is a steel casting containing two bored cylinders. Each cylinder contains a helical spring, A140597; spring carrier shaft upper bushing, A140586; and spring buffer, A140584. The top of each cylinder is closed by means of a bracket buffer cap screwed to it and retained in position by means of a set screw, BCTX1BF. Spring carrier shafts, B108606, are assembled through the cylinder and attached to the wheel carrier by nuts at each end of the shaft.

40. Firing base.—The firing base pertaining to the 75-mm howitzer carriages, M3 and M2A1, is designed to support the weight of the carriage when in firing position. The base swings on pins which connect the firing base to the bottom carriage. When traveling, the base is swung upward and is locked to the traveling lock by the spring actuated lock plunger, B144334. (See fig. 10.)

41. Firing base lock.—The firing base lock pertaining to the 75-mm howitzer carriages, M3 and M2A1, is assembled near the bottom of the front of the bottom carriage. The mechanism is composed of the two spring actuated latches actuated by a toggle action which is operated by the firing base lock release. The release, B108619, is operated by the foot and when pressed down will disengage the latches and permit the firing base to be swung into traveling position. The latches return to their engaged position by the tension of the springs and will automatically latch the firing base when dropped into firing position. (See fig. 11.)

42. Traveling lock.—The traveling lock of the 75-mm howitzer carriages, M3 and M2A1, supports the cradle and firing base when in traveling position. The traveling lock is hinged to the bottom carriage and when in traveling position it is locked to the cradle by means of the cradle lock pin, B108609. In firing position the traveling lock is disengaged from the cradle and lowered until the

stop at the bottom of each leg comes in contact with the bottom carriage. (See fig. 10.)

43. Equilibrators.—The equilibrators for the M3 and M2A1 carriages are identical with those on the M3A1 carriage except that the equilibrator on the left side of the carriage is equipped with a straight equilibrator trunnion pin, A21724, (fig. 16), whereas the equilibrator on the right side has a bent pin.

SECTION VI

DISASSEMBLY AND ASSEMBLY

44. General.—*a.* Incidents of wear, breakage, cleaning, and inspecting make necessary the occasional disassembly of various parts of the howitzer and carriage. This work comes under two headings—that which can be performed by the battery personnel, and that which must be performed by ordnance personnel.

b. The battery personnel may, in general, do such dismounting as is required for the assembly of parts indicated in Standard Nomenclature Lists Nos. C–20, C–26, and C–29. Such work should be done in the manner prescribed. Any difficulty which cannot be overcome must be brought to the attention of ordnance personnel.

c. The battery personnel will not attempt to disassemble any part of the recoil mechanism not authorized nor do any filing on the sights or howitzer parts other than outlined and only by order of the battery commander.

d. The use of wrenches which do not fit snugly on any parts should be avoided. They will only fail and will damage the corners of nuts and bolt heads.

e. When assembling, the assembly of subassemblies should be completed before attempting to assemble the larger assemblies in which the subassemblies are placed. In all assemblies the bearings, slide surfaces, threads, etc., should be cleaned and lubricated.

45. Disassembly of breech mechanism.—*a.* (1) Open the breech to the point where the assembling line on the top of the operating lever is parallel with the side of the breech ring and lift out the operating lever pivot, B8029. (See fig. 12.)

(2) Slide the breechblock out to the right far enough to clear the crosshead, A12124, and lift off the operating lever.

(3) Take the breechblock out to the right. This will leave the extractor, B8027, free, and it may be removed. Prior to removing the breechblock of the field howitzer, the breech ring must be removed from the bottom sleigh.

(4) The breechblock bushing, A21299, will not be removed.

(5) Lay the breechblock on its rear face.

(6) Slide out the gear cover, A12131, pull out the trigger, start the trigger shaft, A12138, by engaging a screw driver or the knob of the trigger shaft in the partial annular slot in the trigger shaft gear, and pull out the trigger shaft.

(7) Turn the breechblock up. Rotate the firing case 60° in either direction and pull it out of the breechblock.

b. Firing lock.—(1) Pry the trigger fork, A12132, out of the firing case, C3537, with a screw driver, first through the trigger shaft hole, then from the outside of the case. (See fig. 12.)

(2) Insert the trigger shaft to engage one of the yoke ends of the sear. Press the front end of the sear out of engagement with the firing pin holder, B8187, insert a screw driver in rear of the firing pin holder sleeve, A12133, and pry the sleeve and holder forward until they can be grasped by the fingers and pulled from the case.

(3) Remove the trigger shaft and draw out the sear, B8031, and sear spring, A12135.

(4) Hold the front end of the firing pin holder, B8187, in one hand and place the rear end of the sleeve against the edge of a bench or some convenient part of the carriage. Push against the front end of the firing pin holder to compress the spring and press the rear end of the holder down to unhook it from the rear end of the sleeve. Allow the holder to recede out of the sleeve, freeing the spring.

(5) Remove the cotter pin, unscrew the firing pin bushing, A12579, and push the firing pin, A12755, out of the bushing.

c. Operating lever.—Press the operating lever latch, A12125, into the operating lever until they are parallel. This alines the keyways in the two pieces. Push the operating lever latch pivot, A12127, out and remove the latch and spring, A12128. Drive out the crosshead pin, A12126, and remove the crosshead, A12124. (See fig. 12.)

46. Assembly of breech mechanism.—*a. Operating lever.*—Assemble the crosshead, A12124, on the stud of the operating lever and drive in the crosshead pin. Place the latch spring in the handle of the lever. Put the latch in position with the stud on the latch into the spring and press in on the latch to the point where the pivot holes and keyways are in alinement and insert the pivot. (See fig. 12.)

b. Firing lock.—(1) Insert the firing pin, A12755, into the firing pin bushing and screw the bushing into the firing pin holder. Put in the cotter pin and spread the ends so that they will not rub the firing case.

(2) Assemble the firing spring over the firing pin holder and the firing pin holder sleeve over the spring and holder. Force the sleeve against the spring, compressing the spring to allow the beveled surfaces on the sleeve and holder to hook together. This can be accomplished by grasping the holder with one hand and guiding the sleeve with the other while pushing the rear end of the sleeve against the edge of a bench or convenient part of the carriage to compress the spring.

(3) Insert the sear spring into its seat in the bottom of the firing case, using a screw driver between two coils of the spring for the purpose. Assemble the sear into the case, locating the stud into the sear spring. Press the sear down against the spring with the fingers and insert the trigger shaft temporarily into the firing case and through the sear.

(4) Using a small screw driver press the sear down and insert the assembled firing pin holder and sleeve into the case. Withdraw the screw driver and push the holder fully home.

(5) Remove the trigger shaft and insert the trigger fork into the opening in the bottom of the case with the part marked "muzzle face" toward the front, in which position the rounded ends of the fork bear against the rear face of the firing pin holder sleeve. Push the trigger fork in until it snaps into position.

c. Breech mechanism.—The breech mechanism of the pack howitzer may be assembled with the breech ring mounted or dismounted; however, in the case of the field howitzer, the breech ring must be dismounted (see fig. 7).

(1) Place the extractor, B8027, in the breech recess with its lower trunnion resting at the forward end of the curved groove in the breech ring.

(2) Slide the breechblock part way into the breech recess from the right side. Leave the groove across the top of the block exposed for entry of the crosshead attached to the operating lever.

(3) Hold the operating lever about parallel with the side of the breech ring and place the crosshead in the groove in the breechblock. Push the breechblock into the breech recess far enough to aline the operating lever pivot holes in the breech ring and lever. Move the lever to aline the keyways and insert the pivot.

(4) Close the breech. Assemble the firing lock into the breechblock by pushing it in until the sectors on the firing case strike those

in the breechblock. Push gently on the firing case, and at the same time rotate it in either direction to match up the sectors on the case with the spaces between the sectors in the breechblock, so that the case slides forward until the head strikes the block. Rotate the case until the lines on the case and the breechblock marked "TOP" coincide.

(5) Insert the trigger shaft into the breechblock and through the firing case. The assembly line on the gear of the trigger shaft must match the line on the breechblock to enter the square on the trigger shaft through the hole in the trigger fork.

(6) Assemble the trigger into the breechblock, matching the assembly line with a similar line on the trigger shaft.

(7) Open the breech and push the gear cover down in the breechblock to retain the trigger shaft and trigger.

47. Recoil mechanism.—The recoil mechanism is a complicated mechanism and not suited for successful disassembling except at an arsenal or shop equipped for the work. The high pressure present in the system at all times makes it extremely dangerous to attempt unauthorized disassembly. It is, therefore, forbidden to perform any disassembling of the inside parts of the recoil mechanism. In order to relieve the accumulation of oil that may pass the recoil piston, the cap screw and spring lock in the recoil cylinder rear head may be removed and the piece elevated until the oil drains off.

48. Disassembly and assembly of 75-mm pack howitzer carriage, M1.—In general, no disassembling of the carriage will be undertaken by the battery personnel other than into the various pack loads. Certain complete assemblies and minor individual parts may be removed and replaced if necessary. These are all indicated in Standard Nomenclature List No. C-20. (See appendix.)

49. Disassembly and assembly of 75-mm howitzer carriages, M3A1, M3, and M2A1.—*a. Dismounting top and bottom sleighs, howitzer tube, and breech ring.*—(1) To disengage the top sleigh, pull the top sleigh clamping latch pin, A3872, from the top sleigh clamping latch, A18873, and turn the latch one-quarter of a turn. Move the top sleigh to the rear, disengaging it from the lugs on the bottom sleigh, and lift it off. (See fig. 13.)

(2) To disengage the howitzer from the bottom sleigh, insert a trail handspike in the forward lifting eye of the howitzer tube, turn the tube until the eye is vertical, and force the tube forward until it is free of the breech ring. Two men, one at either end of the tube, may then lift the tube clear of the bottom sleigh by grasping a lifting eye with one hand and inserting the other hand in the bore.

(3) Two men may then lift the breech ring straight upward until it is free of the bottom sleigh.

(4) To remove the bottom sleigh, disengage the piston rod latch, B17569, and push the sleigh to the rear and free of the cradle by using two pairs of men at opposite ends of the bottom sleigh.

b. Assembling the top and bottom sleighs, howitzer tube, and breech ring.—To mount the bottom sleigh, breech ring, tube, and top sleigh, reverse the order of procedure as outlined in *a* above.

c. Disassembly of equilibrator group from carriage.—To remove equilibrator group assembly from the carriage the procedure is as follows (see fig. 10):

(1) Elevate the howitzer to zero elevation.

(2) Insert the equilibrator assembling bolt, A140673 (an accessory), through the opening in the cup-shaped bearing of the bottom carriage and through the barrel, B108630. Advance the bolt until it comes in contact with the equilibrator spring guide tube plug, A140626; screw it into the plug as far as it will go.

(3) Elevate the howitzer to its maximum elevation and remove the equilibrator group assembly.

d. Assembly of equilibrator group.—The mounting of the equilibrator group assembly is the reverse order of dismounting.

e. General.—Except for necessary disassembly operations in the care and preservation of the matériel as given in section X and the replacement of parts as authorized in Standard Nomenclature List No. C–26, the battery personnel will not undertake further disassembly of the carriage.

SECTION VII

PROCEDURE TO PLACE MATÉRIEL IN FIRING AND TRAVELING POSITIONS

50. Operation in dismounting matériel for pack.—*a. General.*—Four men, equipped with two lifting bars, are required. The carriage must be in firing position with the cradle level and with telescope mount removed.

b. To disengage top sleigh.—Pull the top sleigh clamping latch pin, A3872, from the top sleigh clamping latch, A18873, and apply the socket of the handspike to the top sleigh clamping latch and turn it one quarter of a turn. Move the top sleigh to the rear, disengaging it from the hooks or lugs on the bottom sleigh. Thrust a lifting bar through the 1½-inch hole in the top sleigh and lift it off. Lay the top sleigh to one side until the cradle is dismounted. (See fig. 13.)

c. Insert a lifting bar in the forward lifting eye of the howitzer tube, turn the howitzer until the eye is vertical and pass the lifting bar through the lifting eye. Two men grasping the bar, force the tube forward free of the breech. When free, pass a second lifting bar through the eyebolt on the rear and place the tube on the pack. Put on and adjust the tube and muzzle covers.

d. Insert a lifting bar through the eyebolt on the breech ring. The breech ring is lifted off. The breech ring cover is put on and the breech ring placed on the pack.

e. Disengage the piston rod latch, B17569, and start the bottom sleigh to the rear, passing a lifting bar through the rear bar holes. When the forward lifting bar opening passes the wheels, insert a lifting bar. Slide the bottom sleigh out, turn it upside down, and place it on the pack. (See fig. 13.)

f. Place the top sleigh upside down in the cradle. Disengage the trunnion hooks, right and left, B103545 and B5568. Insert the front lifting bar. Lift the front end of the cradle until the rear lifting bar can be inserted. Remove the cradle and top sleigh and assemble the combination to the pack. (See fig. 15.)

g. To dismount the trail.—(1) Insert a lifting bar through the eye of the fulcrum and turn it in a horizontal arc to the right and withdraw the bar. Supporting the trail on both sides, raise the center until the joint is broken and then allow the trails to rest on the ground. The rear trail is turned upside down and placed on the pack.

(2) The axle sleeve lock, A3363, is disengaged and the axle sleeve revolved to the position of disengagement. The front end of the front trail is supported while the wheels and axle are run out. The front trail is mounted on the pack. (See fig. 17.)

h. The axle is supported and the wheels removed. The wheels are mounted on the pack carrying the breech ring; the axle is mounted on the rear trail pack.

51. Operation in mounting matériel for firing.—To mount the matériel for firing, reverse the order of procedure as outlined for the operation in dismounting the matériel for pack.

52. To change M3A1 carriage from traveling position to firing position.—Proceed as follows:

a. Dismount the sighting equipment chest from the trails. Release the trail lock lever, A18960 (fig. 9). Spread the trails to approximately a parallel position.

b. Release the cradle lock pin, B108609, and lower the firing base until it is latched by the firing base lock plunger, B144943. (See figs. 6 and 7.)

c. Place the handspikes in the socket of the wheel carriers and relieve the weight on the wheel latch bolt, A161602. Push down on the wheel latch plunger, A161606, then withdraw the wheel latch bolt. Lower the carriage by revolving the wheel carriers until the firing base rests on the ground. (See fig. 21.) Spread the trails to their open position and insert the trail lock pins, A157690. (See fig. 9.)

53. To change M3A1 carriage from firing position to traveling position.—Proceed as follows:

a. Withdraw the trail lock pins, A157690. Close the trails to approximately a parallel position by means of the handspikes inserted in the trail handspike sockets. Release the hand brake levers.

b. Push down on the wheel latch plungers, A161606 (fig. 21), rotate the wheel carriers and wheels by means of the handspikes placed in the wheel carrier handspike socket toward the rear until the wheel carriers come in contact with wheel latch stops, A140327 (fig. 7), then engage the wheel latch bolts.

c. Release the firing base lock by stepping on the pedal. Swing the firing base up and secure it to the cradle by means of the cradle lock pin, B108609. (See fig. 6.)

d. Close the trails and lock them together by the trail locking mechanism. Mount the sighting equipment chest on the trails.

54. To change M3 and M2A1 carriages from traveling position to firing position.—Proceed as follows:

a. Dismount the sighting equipment chest from the trails. Release the trail lock lever, A18960 (fig. 8). Spread the trails to approximately a parallel position.

b. Release the spring actuated latch plunger, B144334, and lower the firing base into position. Disconnect the traveling lock from the cradle. (See fig. 10.)

c. Place the handspike in the socket of the wheel carrier and release the weight on the wheel latch bolt, A140408. Release the wheel latch, A140326, and withdraw the wheel latch bolt, A140408. Lower the carriage by revolving the wheel carriers until the firing base rests on the ground. (See figs. 20 and 21.) Spread the trails

to their open position and insert the trail lock pins, A155843. (See fig. 8.)

55. To change M3 and M2A1 carriages from firing position to traveling position.—Proceed as follows:

a. Withdraw the trail lock pins, A155843. Close the trails to approximately a parallel position by means of the trail handspikes. Release the hand brake levers.

b. Release the wheel latches, A140326 (fig. 21), rotate the wheel carriers and wheels by means of the handspike toward the rear until the wheel carriers come in contact with wheel latch stops, A140327 (fig. 7), and then engage the wheel latch bolts, A140408 (fig. 21).

c. Connect the traveling lock and secure it to the cradle by means of the cradle lock pin, B108609. Release the firing base lock by stepping on the pedal of the firing base lock release, B108619, then swing the firing base, C60298, up until it is locked to the traveling lock by the spring actuated latch plunger, B144334. (See figs. 10 and 11.)

d. Close the trails and lock them together by the trail locking mechanism. Mount the sighting equipment chest on the trails.

SECTION VIII

INSPECTION AND ADJUSTMENT

56. Inspection and adjustment.—The following instructions should be scrupulously observed.

Parts to be inspected	Points to observe
a. The howitzer as a unit.	*a.* General appearance; smoothness of operation of the breech mechanism in opening and closing; the bore for copper deposits on the lands and grooves; erosion at the origin of rifling; condition of threads on the exterior of the tube and interior of the breech ring.
b. Breech ring.	*b.* Condition of the eyebolt; burs or roughness on the leveling plates.
c. Breechblock.	*c.* Indication of burs, roughness, or scoring.

Parts to be inspected	Points to observe
d. Firing lock, M13.	*d.* Condition of all parts; weak or broken springs; cracked or broken sear.
e. Adjustment.	*e.* The howitzer is so designed that it requires no adjustment. If any of the parts show excessive wear they are to be replaced.
f. The carriages as units.	*f.* General appearance. Whether the lubricating fittings are painted red and a red ring has been painted around all oil holes, and the carriages are painted in accordance with regulations.
g. Recoil mechanism.	*g.* That the proper amount of oil is in the system. (See par. 12*b*.) Whether the oil index functions correctly.
h. Elevating mechanism.	*h.* Whether operation is smooth and mechanism is properly lubricated. Elevate and depress, and note whether the equilibrators and all rockers are performing their functions properly. Turn the handwheel back and forth, and note the amount of backlash. If it exceeds one-quarter turn of the handwheel notify the ordnance personnel.
i. Traversing mechanism.	*i.* Whether operation is smooth and the parts properly lubricated. Turn the handwheel back and forth, and note the amount of backlash. If it exceeds one-quarter turn of the handwheel notify the ordnance personnel. On the pack howitzer carriage note condition of the dust cover and axle sleeve lock.
j. Brake mechanism (M3A1, M3, and M2A1).	*j.* Test the brakes by placing the carriage in firing position. Set the brake levers. Note position of brake ratchet pawl on brake rack. If in last tooth the brake should be adjusted. Release the brake levers to the "off" position. Note whether wheel revolves freely without drag.

Parts to be inspected	Points to observe
k. Trails (M3A1, M3, and M2A1).	*k*. Note that the trails swing freely and that the trail hinge pins are properly lubricated. Examine the trail connecting lock. Note that it performs its function without undue force. Note that the lunette turns freely. Examine all supports and fastenings welded to the trail for defects.
l. Trails, front, rear (M1).	*l*. Condition of axle bearings. Smoothness of operation and lubrication of trail connecting mechanism. Condition of hinges, spades and spade points, and straps and fastenings.
m. Wheels (M3A1, M3, and M2A1).	*m*. Examine the disk and rim wheel nuts. Note condition and that they are set up tight. Note whether the rim of the disk is deformed. Examine the tires. Note whether the crown of the tire is taking the wear. If worn to the left or the right test alinement of wheels with a string or tape, measuring the horizontal distance between the centers of the tires on a wheel diameter. The maximum allowable variation is ½ inch.
n. Traveling lock (M3A1, M3, and M2A1).	*n*. Examine the traveling lock. Note that it swings into position without force.
o. Traversing rack (M3A1, M3, and M2A1).	*o*. Examine the traversing rack for broken or deformed teeth. Note that the traversing stops are in place and in good condition.
p. Firing base (M3A1, M3, and M2A1).	*p*. Examine the firing base for defects. Swing it to and fro and note action of latches.
q. Sighting system.	*q*. Inspect for general appearance and lubrication. Note undue lost motion in the operation of the various gears. Check the level vials to insure that they are tightly secured in their holders. Inspect the alinement and, if necessary, adjust.

SECTION IX

MALFUNCTION AND CORRECTION

57. General.—The functioning of the matériel as a whole is so closely allied with description and operation that it has been included in sections II, III, IV, V, and VII, and is not repeated hereunder.

58. Malfunction of howitzer.

Malfunction	Cause	Correction
a. Fails to fire; no percussion on primer.	*a.* Broken firing spring. Broken or deformed firing pin.	*a.* Disassemble firing lock and replace broken or deformed part.
b. Fails to fire until after several percussions on primer.	*b.* (1) Firing mechanism parts not working freely.	*b.* (1) Disassemble firing lock and examine carefully for burs and roughened surfaces. Remove burs and smooth roughened surfaces with crocus cloth or an oilstone. Wash parts with dry cleaning solvent to remove gummy oil; dry thoroughly and lubricate with oil SAE 10W or SAE 20, depending on temperature before reassembly.
	(2) Weak firing spring.	(2) Replace.
c. Fails to fire when proper percussion on primer is obtained.	*c.* Defective primer.	*c.* Replace.
d. Fails to extract empty case.	*d.* Broken extractor.	*d.* Carefully remove the case by operating from the muzzle end. Examine the edge of the chamber for deformation or burs which might cause difficult extraction. Disassemble mechanism. Replace extractor if necessary.

59. Malfunction of carriage.—Abnormal conditions and their corrections.

Malfunction	Cause	Correction
a. Oil index projects less than the required distance.	*a.* (1) Loss of reserve oil.	*a.* (1) Drain the remainder of the reserve oil and refill.
	(2) Loss of gas pressure, either through the cylinder rear head or past the floating piston.	(2) Gas escaping by the floating piston is indicated by an emulsified condition of the reserve oil drained off. If, when proceeding to fill the recoil mechanism with oil, the oil index does not move out and the oil screw filler works easily, the gas pressure probably has been lost. Substantiate this by an attempt to drain the mechanism. Oil will not spurt from a mechanism without at least some pressure. Notify the ordnance personnel.
b. Oil index remains stationary when the reserve is pumped in against evident pressure.	*b.* The packing is too tight or the index is broken or locked by some foreign substance.	*b.* Drain off all reserve oil and refill with heavy low pour point recoil oil. While injecting the oil, tap the oil index gently with each turn of the screw filler. If the oil index fails to move after employing the screw filler, notify ordnance personnel.
c. Howitzer returns to battery with too great a shock.	*c.* Too much reserve oil.	*c.* Assemble the oil release and withdraw oil until the index is halfway in. When the mechanism is cooled off refill to normal.

Malfunction	Cause	Correction
d. Howitzer fails to return to battery.	*d.* (1) Insufficient oil reserve.	*d.* (1) Withdraw the reserve oil. Establish a new full reserve.
	(2) Low nitrogen gas pressure.	(2) Notify ordnance personnel.
	(3) Excessive friction.	(3) Notify ordnance personnel.
	(4) Damaged slides, piston rod, or piston.	(4) Notify ordnance personnel.
	(5) Leakage of oil past recoil piston.	(5) Remove cap screw in rear head of recoil cylinder, elevate piece, and allow oil to escape through screw opening.

SECTION X

CARE AND PRESERVATION

60. Howitzer.—*a.* (1) It is important that whenever the rate of fire permits, the cannoneer examine the bore before each loading to ascertain whether or not particles of cartridge case, wadding, or unburned powder remain in the bore. The presence of such particles may cause damage to the piece. During night firing the sponge should be used between rounds.

(2) Should enemy shell burst near the weapon, be sure before firing that the weapon has not been damaged to a dangerous degree. Damage of a serious nature should be reported to the ordnance officer.

(3) In cleaning after firing, wash the bore with a solution of half a pound of soda ash or a pound of sal soda in a gallon of water. Use the bore brush or a piece of burlap or cleaning cloth around the

metal end of the rammer staff for swabbing. When all powder fouling has been removed, swab the bore with clear water and dry with a piece of clean burlap or cleaning cloth. Finally coat the bore with lubricating oil, SAE 10W for temperatures less than 32° F., and SAE 20 for temperatures greater than 32° F.

(4) The leveling plates should be protected. Tools or other articles will not be placed upon them. In case of injury repair must be made by ordnance personnel.

(5) Lubricating instructions are given in paragraph 65.

(6) When the matériel is not in use covers must be used.

(7) When the weapon is to be unused for a considerable time the bore, breech mechanism, and bright and unpainted surfaces should be cleaned with dry cleaning solvent and the surfaces coated with medium rust preventive compound.

b. Breech mechanism.—(1) Should be kept clean and the parts well lubricated. When not in use disassemble periodically, especially for detection of rust. When in use disassemble frequently and clean and oil. It should be so cared for immediately after firing.

(2) In removing rust preventive compound the greater part should be scraped off. That remaining should be removed with dry cleaning solvent used on a rag or waste.

(3) A steel hammer must not be used directly on any part of the mechanism. A buffer such as a hardwood block should be interposed, or a copper hammer used.

(4) If the breechblock does not slide smoothly it should be examined for burs or scoring. Burs should be removed and the breechblock should be coated with Engine Oil SAE 10W for temperatures below 32° F. and Engine Oil SAE 20 for temperatures above 32° F. If the breechblock is scored, the condition should be reported to the ordnance maintenance company.

c. Firing mechanism.—(1) The parts require the same attention as the breech mechanism. Therefore, frequent disassembly for the purpose of cleaning and oiling is required.

(2) Fouling of the firing pin, or the use of a thicker oil than authorized will cause absorption of the energy of the spring and firing pin holder and may result in misfire. This is especially true in cold weather.

(3) Wear in this mechanism is negligible. Deformation of the front end of the firing pin may cause sticking in the breechblock bushing. If the firing pin is examined after each firing, replacement can be anticipated.

61. Carriage.—*a.* Attention should be given to cleaning, lubrication and loose or broken parts. Lubrication, with the method and frequency of application, is covered in detail in paragraphs 65 and 66.

b. Bearing surfaces, revolving parts, springs, gear teeth, breech mechanisms, screw threads, and exterior parts must be clean and free from dirt. Special attention should be given to exposed gear teeth and bearing surfaces. In disassembling and assembling operations, precautions must be taken to prevent the entrance of foreign matter.

c. The carriage should be given a general inspection periodically.

d. The care and maintenance of the carriage require the use of the cleaning and preserving materials issued by the Ordnance Department.

e. When the carriage is stored, or is to remain unused for a considerable length of time, all bright and unpainted surfaces should be protected with a coat of medium rust preventive compound. Before applying the compound the surfaces should be cleaned with dry cleaning solvent.

62. Recoil mechanism.—*a.* Before firing, the recoil mechanism should be examined for leakage of oil and to assure that the proper amount of reserve oil is in the system, and that the howitzer sleigh slides are well lubricated.

b. During firing, the action of the mechanism should be noted, and the following operations checked:

(1) Howitzer recoils its prescribed distance.

(2) Howitzer returns into battery without shock.

(3) Leakage of oil from the filling and drain hole, oil index recess, and the front of the recoil cylinder is not excessive.

c. Oil reserve.—Firing should not be undertaken with an excess or lack of reserve oil. The amount of oil reserve in the system is shown by the position of the oil index with reference to the extension on the oil index follower assembled in the recuperator cylinder front head, as follows:

(1) *No reserve.*—The indicator is well into the recess.

(2) *Full reserve.*—The end of the indicator is flush with the extension on the oil index follower.

(3) *Excess reserve.*—The oil index does not of itself show when there is an excess of oil reserve, as the addition of excess oil does not move the index out beyond the follower.

d. To reduce or exhaust oil reserve.—In draining the reserve oil from the recoil mechanism, provide a clean receptacle of at least

1-pint capacity. Unscrew the filling plug, using the ratchet wrench and the ½-inch socket. Assemble the oil release into the filling hole. The reserve oil will spurt out in a stream and suddenly drop at right angle to the flow. At this point the flow of oil should be stopped by unscrewing the filling and drain valve release. It will be noted that the oil index has moved out of sight. If the oil index has not moved tap it gently with a small piece of wood, as it may be bound by the index packing.

e. To establish a new oil reserve.—(1) Fill the body of the oil screw filler with low pour point heavy recoil oil. Hold the filler nozzle up and give the screw a turn or two until a small amount of oil runs out, in order to expel all air from the filler. Screw the nozzle of the oil screw filler into the filling hole; give the handle of the filler another turn to force out any air in the filling hole; then tighten the oil screw filler. Operate the oil screw filler, using both hands to avoid forcing it to one side and breaking off the threaded nozzle.

(2) When the oil index has reached its extreme outward position, that is, flush with the extension on the oil index follower, a full oil reserve is present in the mechanism.

(3) In the event of the oil index's not moving into position after filling the system with reserve oil the ordnance maintenance company should be notified.

(4) In emergency if the oil index fails to register, the reserve oil in the system should be drained. The flow and sudden stoppage of the oil will prove that the mechanism is serviceable. Refill the mechanism with one-half screw filler of oil and proceed to fire the piece.

(5) Remove the oil screw filler and replace the filling plug.

f. Nonfunctioning of oil index.—(1) Sometimes the oil index does not register when oil is being injected. On this account, an excessive amount of oil may be injected.

(2) An excessive amount of oil is dangerous as during recoil the control rod will jam. This will damage or may cause destruction of the recoil mechanism.

(3) If the oil index does not move in when the oil is being extracted, or if it does not move out when oil is being injected, it is probable that the packing around the oil index is too tight. On the other hand the index may be broken or frozen.

(4) In order to test the oil index, drain, by means of the filling and drain valve release, all the oil that will run out. After removing the filling and drain valve release, inject the oil by means of the oil screw filler. While injecting the oil tap the index lightly on each turn of

the oil screw filler. If the index does not move out after about half the capacity of the oil screw filler has been injected, it is an indication that there is something wrong with the mechanism and the ordnance officer should be notified. Should the index work properly after the operation described the reserve oil supply should be injected and drained off about three times to insure that the index is in working condition.

g. Use of recoil mechanism in emergency.—In an emergency it may become necessary or desirable to fire the howitzer without reference to the action of the oil index. The procedure is to assemble the filling and drain valve release and extract all the reserve oil. Refill the mechanism with one-half fill of the oil screw filler. Remove the oil screw filler and assemble filling and drain plug. Firing may then proceed until the howitzer returns into battery with shock. Shock indicates that heat has expanded the reserve oil and that some of it should be released. If the mechanism is losing oil through leakage around packing, firing may continue until the howitzer does not return into battery position.

h. General care.—All nonbearing surfaces should be kept painted. Bearing surfaces must be clean and lubricated.

63. Recoil oil.—*a. General.*—(1) The recoil mechanisms use heavy recoil oil with low pour point. Care must be taken not to use other than that prescribed.

(2) Water must not be introduced into recoil mechanisms that use oil.

(3) Exposure of recoil oil in an open can may result in accumulation of moisture. Condensation in a container partly filled with oil, or pouring from one container to another which has moisture on its inner walls, results in moisture being carried along with the oil into recoil mechanisms.

(4) It is advisable that recoil oil be tested for water. Use a clean glass bottle of 1-pint capacity filled with recoil oil. The oil should be allowed to settle. If water is present, the water being heavier than the oil, will sink to the bottom. With the bottle slightly tilted, drops or bubbles will form in the lower portion. Invert the bottle and hold to the light. Drops or bubbles of water, if present, may be seen slowly sinking in the oil. If the oil has a cloudy appearance the cloudiness may be ascribed to particles of water. Another test is to heat a shallow pan of oil to boiling. Water in the oil will appear on the surface as minute bubbles. This test will disclose water not determinable by the settling test.

(5) Should either of these tests show water, the oil on hand should be turned in.

b. Care of recoil oil.—The transfer of recoil oil to a container not marked with the name of the oil may result in the wrong oils getting into recoil mechanisms, or in the use of recoil oil for lubricating purposes. Recoil oil must not be put into any container not marked with the name of the oil. The following should also be observed. Recoil oils should not be left in open containers or subjected to excessive heat. The greatest care must be taken with recoil oils to exclude moisture and dirt. Strain through clean cloth before inserting in recoil mechanism. Do not mix recoil oils with any other type of oil.

64. Brake mechanism and wheel bearings.—*a.* Brake adjustment of the 75-mm howitzer carriage, M3A1, is accomplished by rotating the brake shoe adjusting wedge, B144959, which extends to the outside of the brake housing plate, C62668, in the desired direction. The outside end of the adjusting wedge is machined with a square for turning with a wrench. The correct procedure for adjusting the brakes is as follows: (See figs. 21 and 22.)

(1) Set brake lever at full released position.

(2) Jack up the wheel.

(3) Adjust the brake adjusting wedge until a drag is felt on the wheel. Then back off just enough so that the brake does not drag. Brake must be cold when making adjustment.

b. (1) To adjust the external brake of the 75-mm howitzer carriages, M2A1 and M3, clean and lubricate the exposed parts of the brake mechanism.

(2) Set the brake lever to full released position.

(3) Jack up the wheel.

(4) Advance the brake band adjusting nut, A137462, on the brake band adjusting screw, A137994, until the brake lining just touches the brake drum. Equalize the brake band about the brake drum by means of screw, A137598. (See fig. 20.)

(5) Revolve the wheel and see that it turns freely and without drag.

(6) Set up on the brake lever and note position of the brake ratchet pawl on the ratchet rack. If the pawl is beyond the center of the rack release the brake lever and advance the adjusting nut, A137462, one or two turns. Continue these operations until the pawl is in about the center of the rack. Then release the brake lever to its full "off" position and revolve the wheel to see that it turns freely and without drag.

c. Wheel bearings should be adjusted to prevent brake drag due to loose bearings.

d. The brake cam, B144968, and rollers, B144955, are lubricated through a button head fitting. Lubrication must be held to the correct amount to keep the brake lining from becoming saturated with oil or grease. This condition will demand heavy brake lever pressure and the replacement of brake linings prematurely. Molded lining may be cleaned with dry cleaning solvent to remove oil or grease. (See fig. 21.)

e. Roller bearings in the wheel hubs should be examined every 6 months when in service, washed in dry cleaning solvent, and hand packed with wheel bearing grease. The hub should also be cleaned but not packed. All lost motion should be eliminated (without binding the bearings) by means of the slotted nuts, BBHX2A, on the wheel carrier (fig. 21) and on the spindle (fig. 19). After the spindle bearings are adjusted, the adjustment should be checked by placing a bar between the raised tire and the ground, at the same time holding one finger on the cage of the outer bearing. When, in working the bar up and down, a barely perceptible shake is felt, and the wheel will rotate when given a slight spin, the adjustment is correct. This adjustment is obtained normally by tightening the wheel spindle nut with a wrench having an 8-inch handle and then backing off the nut to the nearest castellation.

f. Tires should be kept inflated at a pressure of 30 pounds per square inch.

NOTE.—The pressure stamped on the tires should be disregarded.

65. Lubrication instructions.—*a.* Excessive wear can be prevented by keeping the matériel clean and well lubricated. The life of the matériel depends on proper lubrication. Particular attention should be given to sliding and bearing surfaces of the cradle and breech mechanism.

b. Lubricating oils and greases as shown in the lubrication chart must be used as prescribed.

c. Gear cases and other parts packed with grease should be cleaned and repaced every 6 months. Other moving parts, not specifically mentioned, should be cleaned and a film of oil, SAE 10W below 32° F. and SAE 20 above 32° F., applied.

d. Lubricating fittings will be painted red for ease in locating. Oil holes are encircled by a red ring.

e. The oil gun should be worked slowly and the parts oiled should be maneuvered to insure proper distribution of the lubricant.

f. Should an oiler valve stick and prevent the passage of the oil, it may be loosened with a piece of wire pushed through the hole. Care should be taken not to damage the valve.

g. Care must be taken when cleaning oil and grease compartments to insure the complete removal of all residue or sediment. Dirt or other foreign matter should not be allowed to drop into any of the lubricating compartments.

h. When cleaning the gun, operating personnel are cautioned to refrain from playing water from the high-pressure hose directly against the trunnion bearings or trail pin housings, since this will result in water entering into the bearings and cause nonfunctioning of the operating parts.

i. Lubrication frequencies are based on continuous use of the matériel with frequent firing.

j. No lubricants will be used other than those prescribed, without the authority of the Ordnance Department.

66. Lubrication charts.—The following lubrication charts are provided:

a. 75-mm pack howitzer, M1A1 and M1; carriage, M1, pack, lubrication instruction chart

Parts lubricated		Frequency (time)	Method and/or application	Required lubricants		Amount	Remarks
Name	No.			Below 32° F.	Above 32° F.		
Elevating mechanism:							
Rocker pinion bearing (right and left)	1	Daily	Oil hole	SAE 10W	SAE 20	Fill	
Elevating arc and pinion (right and left)		do	Hand	do	do	Light film	Clear and lubricate. Avoid waste.
Elevating crank handle (right and left)		do	Oiler	do	do	do	Lubricate at contact surfaces.
Elevating crankshaft bearing (right and left)	1	do	do	do	do	Fill	
Upper elevating gear case	1	Monthly	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Several turns on grease gun.	
Lower elevating gear case	1	do	do	do	do	Do.	
Lower elevating gear case bushings	2	Daily	Oil hole	SAE 10W	SAE 20	Fill.	
Traversing mechanism: (Not to be dismantled in the field. Only qualified shop personnel allowed to handle mechanism.)							
Axle:							
Drag link (right and left)		do	Hand	do	do	Light film	Avoid waste.
Linch pin (right and left)		do	do	do	do	do	Do.
Axle arm (right and left)		do	do	do	do	do	Do.
Wheel hub (right and left)	1	do	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0	Several turns on grease gun.	Also pack on assembly.
Axle sleeve lock		do	Oiler	SAE 10W	SAE 20	Light film	
Axle—exposed portion		do	do	do	do	do	Do not use high-pressure hose. Keep clean always. Before traversing clean and lubricate.
Axle sleeve	1	Monthly	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Several turns on grease gun.	

a. 75-mm pack howitzer, M1A1 and M1; carriage, M1, pack, lubrication instruction chart—Continued

Parts lubricated		Frequency (time)	Method and/or application	Required lubricants		Amount	Remarks
Name	No.			Below 32° F.	Above 32° F.		
Cradle:							
Recoil slides and grooves		Daily	Oiler	SAE 10W	SAE 20	Light film	
Front and rear cradle locking pins		do	do	do	do	do	Avoid waste.
Cradle trunnion hook and latch mechanism		do	do	do	do	do	Do.
Rocker trunnion pin (right and left)		do	do	do	do	do	Do.
Recoil indicator		do	do	do	do	do	Do.
Top sleigh clamping latch and pin		do	do	do	do	do	Do.
Trail, spade, etc.:							
Front trail bearing (right and left)		do	do	do	do	Light film	
Trail connecting mechanism—moving parts		do	do	do	Do.		
Trail connecting mechanism housing	1	Monthly	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Several turns on grease gun.	
Howitzer:							
Bore		Daily	Hand or oiler	SAE 10W	SAE 20	Light film	Follow prescribed instructions in manual for car and cleaning.
Bearing surfaces of tube		do	do	do	do	do	Do.
Interrupted threads—breechring and tube		do	do	do	do	do	Do.
Breechblock, firing lock, and operating mechanism.		do	do	do	do	do	Do.
Piston rod, latch, and lever		do	do	do	do	do	Do.
Miscellaneous:							
Lifting eye pin		do	Oiler	do	do	do	Avoid excess.
Telescope mount and bracket—moving parts		do	do	do	do	do	Do.
Equilibrator pin (right and left)		do	do	do	do	do	Do.
Equilibrator bearing (right and left)		do	do	do	do	do	Do.

b. 75-mm field howitzer matériel, M2A1, M3, M3A1, lubrication instruction chart

Parts lubricated		Frequency	Method and/or application	Required lubricants		Amount	Remarks
Name	No.			Below 32° F.	Above 32° F.		
Traversing mechanism:							
Traversing gear case bearings		6 months	Hand	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Pack	Disassemble, clean, and repack every 6 months.
Traversing shaft, flexible joint		Daily	Oiler	SAE 10W	SAE 20	Film	Avoid waste.
Traversing handwheel handle		do	do	do	do	do	Do.
Traversing rack and pinion gear		do	Hand	do	do	do	Clean and recoat daily.
Traversing handwheel shaft bracket	1	2 weeks	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Several turns on grease gun.	
Pintle pin	1	do	do	do	do	do	
Traversing worm, wheel, and gear		Monthly	Hand	do	do	Coating	Avoid excess.
Traversing worm shaft bearings		6 months	do	do	do	Pack	Disassemble, clean, and repack every 6 months.
Elevating mechanism:							
Elevating pinion shaft roller bearings		do	Hand packed	do	do	do	Do.
Elevating worm, wheel, and gear bearings		do	Hand	do	do	do	Do.
Elevating worm, wheel, and worm gear	1	Monthly	Grease fitting	do	do	Several turns on grease gun.	
Elevating handwheel shaft bracket	1	2 weeks	do	do	do	do	
Elevating arc and pinion		Daily	Hand	SAE 10W	SAE 20	Film	Clean and lubricate daily.
Elevating shaft flexible joint		do	Oiler	do	do	do	Avoid waste.
Elevating handwheel handle		do	do	do	do	do	Do.
Axle assembly:							
Hand brake lever moving parts (right and left)		do	do	do	do	do	Do.
Wheel latch sliding surfaces (right and left)		do	do	do	do	do	Do.
Wheel bearings (right and left)		6 months	Hand packed	Wheel bearing lubricant No. 2.	Wheel bearing lubricant No. 2.	Pack, bearings only	Do not pack hubs. Clean and repack every 6 months.

b. 75-mm field howitzer matériel, M2A1, M3, M3A1, lubrication instruction chart—Continued

Parts lubricated		Frequency	Method and/or application	Required lubricants		Amount	Remarks
Name	No.			Below 32° F.	Above 32° F.		
Axle assembly—Continued.							
Wheel carrier bearing (right and left)	1	Monthly	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No 0.	Several turns on grease gun.	
Brake cam shaft	1	6 months	do	do	do	One turn on grease gun.	*CAUTION.*—OVERLUBRICATING WILL CAUSE LOSS OF BRAKING SYSTEM.
Howitzer:							
Tube assembly		Daily	See "Remarks"	SAE 10W	SAE 20	Light film	Follow prescribed instructions for care and cleaning.
Breech and firing mechanisms		do	Oiler or hand	do	do	do	Avoid waste.
Breech ring		do	do	do	do	do	Do.
Cradle:							
Cradle lock pin and turnbuckle		do	do	do	do	do	Do.
Recoil slides and grooves (right and left)		do	do	do	do	do	Do.
Equilibrator trunnions, socket and cylinders (right and left).		do	do	do	do	do	Do.
Top sleigh, clamping latch and cam		do	do	do	do	do	Do.
Pistol rod latch and lever		do	do	do	do	do	Do.
Top and bottom sleigh sliding surfaces		do	do	do	do	do	Do.
Recoil indicator		do	do	do	do	do	Do.
Cradle trunnion pin (right and left)	1	2 weeks	Grease fitting	Chassis lubricant No. 0.	Chassis lubricant No. 0.	Several turns on grease gun.	
Cradle trunnion bearings (right and left)	1	do	do	do	do	do	
Trail, spade, etc.:							
Trail hinge pins (right and left)	1	do	do	do	do	do	
Trail lock pin (right and left)		Daily	Oiler	SAE 10W	SAE 20	Light film	Avoid waste.
Trail lock loop		do	do	do	do	do	Do.
Trail lock hook and lever—2 pins		do	do	do	do	do	Do.

Miscellaneous:							
Firing base lock plunger and pedal pin		do	do	do	do	do	Do.
Firing base (traveling lock) hinge pin (right and left).		do	do	do	do	do	Do.
Lifting eye pin		do	do	do	do	do	Do.
Telescope mount and bracket moving parts		do	do	do	do	do	Do.
Sighting chest hinge strap		do	do	do	do	do	Do.
Staff support—2 pins		do	do	do	do	do	Do.
Range quadrant and bracket—moving parts		do	do	do	do	do	Do.

67. Cleaners and abrasives.—See TM 9-850 (now published as TR 1395-A) for those prescribed and their application and use. The following are prescribed:

Burlap, jute, 8-ounce (40 inches wide).
Cloth, crocus.
Cloth, emery.
Compound, cleaning.
Compound, rust preventive, medium.
Lime, hydrated.
Paper, for cleaning optical glass.
Paper, flint (sandpaper).
Polish, metal, paste.
Remover, paint and varnish.
Soap, castile.
Soda ash.
Soda, caustic (lye), for cleaning purposes.
Solvent, dry cleaning.
Sponge.
Waste, cotton, white.

a. Soap, castile.—(1) Used for cleaning leather equipment and as a component of saddle soap.

(2) The action of soap depends upon a chemical combination of alkalies in the soap and the grease which is to be softened and removed. The resulting soapy compound is readily washed off, leaving nothing to hold the dirt. The soap will thus remove some of the oil in the leather and repeated washings will probably require replacement of oil to prevent the leather from becoming harsh and brittle.

(3) Nearly all ordnance leather equipment is russet leather. When it becomes soiled it should be cleaned by carefully removing all hardened grease with a sliver of wood (not glass or knife) and washing with a sponge saturated with a heavy lather of castile soap and clean tepid water. Rinse thoroughly and rub vigorously with a dry cloth until the leather is dry. Straps and other articles of unvarnished harness leather which become dry and brittle should be cleaned as described and while the leather is still slightly moist, be given an exceedingly light coat of neat's-foot oil by rubbing with a soft cloth moistened (not saturated) with the oil. Wipe off any oil that the leather does not absorb. In cold weather the oil may be heated luke warm (never hot) and the article, after being oiled, hung in a warm place. Shellacked sole leather cases do not require oiling.

(4) Russet leather, as manufactured, is stuffed with a dubbing of cod liver oil and tallow, which is absorbed to the extent that the quality of the leather is improved and its life prolonged, but not enough oil remains on the surface to soil the clothing if the equipment is properly cared for. It should be noted that in the washing and oiling described above, if more than a light coat of oil be given, the leather will be greatly darkened and will quickly soil the clothing. No method of cleaning will then restore the original light color of the leather or remove stains from it.

(5) Articles of black leather may be cleaned with castile soap, rinsed, and, when nearly dry, lightly sponged with a mixture of 1 teaspoonful of lampblack in 1 pint of neat's-foot oil, the mixture having been first stirred until it has a glossy black appearance. The mixture should then be well rubbed into the leather. Leather equipment which has become wet should be dried in the shade. Wet leather exposed to the sun or to too high a heat from a stove or radiator becomes hard and brittle.

b. Sponges.—Used for washing and cleaning material. Natural sponges may be substituted by cellulose sponges in sizes Nos. 4, 6, 8, and 10 (approximate dimensions 1¼ by 3⅛ by 4⅝; 1⅝ by 3½ by 5¼; 2 by 3⅞ by 6¼; 2½ by 4⅝ by 6½). These latter sponges must not be wrung. Squeezing only is the proper method.

c. Waste, cotton.—There are two grades, colored and white.

(1) The colored cotton waste is used for general cleaning purposes on the exteriors of ordnance matériel such as gun carriages and automotive vehicles. It is also used as calking for cracks from which it is desired to exclude dust and dirt.

(2) White waste is used for general cleaning purposes on finished surfaces of ordnance matériel. In lieu of white cotton waste an equivalent amount of clean wiping cloths may be used.

68. Preservatives.—See TM 9-850 (now published as TR 1395-A) for information on rust, corrosion, inspection for corrosion, rust preventives, preparation of metal surfaces for slushing, method of slushing, inspection of grease films, and storage conditions.

a. Naphthalene, flake.—(1) A flaked form of moth ball.

(2) Used as a moth repellant to preserve the linings of helmets, felt wads, felt packings of instrument chests, carpet, gun sponges, and paint and varnish brushes. It is sprinkled thickly on the articles, which should, if possible, be then wrapped in paper covers and tightly boxed. The matériel should be thoroughly brushed and aired before packing and should be periodically inspected. If there are any signs of devastation by the moth larvae the articles must be unpacked, cleaned, and recharged with naphthalene.

b. Naphthalene should be used in airtight receptacles in order to obtain a concentrated naphthalene vapor.

69. Paint and related materials.

Enamel, red, water-resisting.
Enamel, synthetic, olive drab. lusterless (QM specification ES No. 474b).
Enamel, white.
Lacquer.
Lead.
Mixture, liquid, for red lead paint.
Oil, linseed, raw.
Paint, ready mixed, red, commercial.
Paint, stencil, black.
Paint, stencil, white.
Thinner (for enamel, synthetic, olive drab, lusterless) (QM specification ES No. 370a).
Turpentine.
Varnish, shellac, orange.

a. Oil paints and their application.—(1) Paint is used for preservation against rust, deterioration, and decay of metals and woods. Some paints adhere to metal surfaces better than others, the liquids of the first or base coat seeming to penetrate very minute depressions or pits in the metal or to etch themselves into the surface and thus form a good bond for following coats. The paints are issued mixed and ready to apply, except in a few instances. Paint stored in large containers should be well stirred before transfer to smaller containers. Ordnance matériel is well painted before issue and one maintenance coat per year should be ample for protection. The final coat must in all events be olive drab lusterless enamel ES No. 474b.

(2) Red lead paint is a good base coat on iron or steel. Red lead possesses no particular advantages as a base coat on nonferrous metals. Red lead paint does not keep well and must be mixed as needed. The formula for 1 gallon of it is 20 pounds of dry red lead with 3 quarts of liquid mixture. The usual process of mixture is to place a small amount of dry red lead in a suitable container, work a little of the mixture into it to form a paste, and then stir the rest of the liquid mixture into it.

(3) All ordnance material shall be painted with lusterless flat enamel.

(4) Olive drab flat lusterless enamel may be applied over the present long oil enamel and oil paint issued by the Ordnance Department. Method of application may be by brush or spray. It may be brushed on satisfactorily when used unthinned in the original package con-

sistency; or when thinned no more than 5 percent of volume with thinner, QM specification ES No. 370a. The enamel will spray satisfactorily when thinned with 15 percent by volume of thinner. If sprayed it dries hard enough for repainting within one-half hour. It dries hard in 16 hours. A few exceptions have been made to the requirements for painting all ordnance matériel with paint that will produce a dull, lusterless finish; fire control instruments which require the crystalline finish and matériel which has already been finished with a lusterless finish are examples.

(5) Care must be used in preparing the surface for painting. It should be made thoroughly clean, dry, and smooth.

(6) All paint should be well stirred before using. If too thick, turpentine should be used as a thinner, but not to such an extent that the paint does not cover. The exact and proper thickness of each coat can be learned only by experience. If too thin, it often cracks in drying, and if too thick it becomes blistered, wrinkled, and unequal. The first coat may, however, be much thinner than any of the succeeding coats.

(7) Parts to be painted may be washed in a liquid solution of ½ pound of soda ash in 8 quarts of warm water, then rinsed in clean water and wiped thoroughly dry.

(8) When artillery is in fair condition and only marred in spots, the marred places should be touched with lusterless enamel and permitted to dry. The whole surface should then be sandpapered with No. 1 flint paper and repainted with a finish coat and allowed to dry thoroughly before use.

(9) When material is in bad condition, all parts should be thoroughly sandpapered with No. 2 flint paper, given a coat of enamel or olive drab second-coat paint, and permitted to dry. It should then be sandpapered with No. 00 flint paper. Finally apply a finishing coat of enamel, synthetic olive drab, lusterless, ES No. 474b, and permit the parts to dry thoroughly before using.

(10) After repeated paintings the paint may become so thick as to scale off in places or present an unsightly appearance. It may then be removed by the use of a lime-and-lye solution, the paint and varnish remover, or cleaning compound. It is important that every trace of lye, remover, or cleaning compound be rinsed off. In preparing wooden parts, because of the porosity of the wood, lye must never be used, as it will result in blistering soon after painting. In addition to the cleaning, woodwork should be properly putty-stopped after the priming coat and before the second coat is applied.

(11) Oil cups, grease-gun fittings, spring oil-hole covers, and similar lubricating devices, as well as a spot three-quarters inch in

diameter around each oil hole, are painted red so that they may be readily located.

(12) At the conclusion of a job of painting, the brushes must be carefully washed clean with dry cleaning solvent and kept in water, except that camel's-hair brushes, after thorough cleaning, should be laid flat on a shelf or other convenient, clean surface, in order that the hair may not be distorted. Worn paint brushes should be retained for use in spreading rust preventive compounds. Any usable paint remaining in the paint pot should be kept tightly covered.

b. Enamel, red, water-resisting.—Used around oil holes and fittings for lubricants to attract attention and furnish ready identification. Also for target-marking disks and aiming posts.

c. Enamel, white.—Used on aiming posts.

d. Lacquer.—A rapidly drying and very transparent liquid. Sets to touch in 3 minutes. Used on sandblasted metal surfaces of fire control and sighting equipment because of its transparency and to prevent tarnishing and deterioration. The lacquer, which must be thin enough to flow easily, is applied with a camel's-hair brush. Alcohol may be used as a thinner but only when absolutely necessary.

e. Lead.—(1) *White, basic sulfate or carbonate, paste.*—Used as an extra heavy rust preventive coating on exposed metallic surfaces. Various materials have been used to reduce the stiff lead paste to a more plastic and workable material. Since freedom from corrosive elements is desired, rust preventive compound is preferable to lubricating oil for this purpose. Melted tallow is sometimes used. The white lead coating may be used for the preservation of material in stand-by condition, the idea being that it is more adhesive under extremes of temperature than rust preventive compound. It should not be used on intricate working surfaces where it cannot be readily removed without damaging those surfaces.

(2) *Red, dry.*—(*a*) Separate requisition is required for the necessary liquid mixture for making red lead paint.

(*b*) Red lead paint is used as a base coat on iron and steel nonbearing parts of ordnance matériel. It has the effect of slightly etching the surface and so secures a good bond for succeeding coats.

f. Mixture, liquid, for red lead paint.—Used for mixing red lead paint.

g. Oil, linseed, raw.—Used as an auxiliary thinner for ready mixed paint. As a thinner add small quantities of the raw oil at a time, stirring constantly until the paint flows freely under the brush. Linseed oil must not be used as thinner for the enamel, synthetic, olive drab, lusterless, ES No. 474b.

h. Enamel, synthetic, olive drab, lusterless, No. 474b.—Used for

painting all types of ordnance matériel unless otherwise specifically excepted.

i. Stencil, black.—Used for stenciling equipment, material, and emplacements, on white or light colored background.

j. Stencil, white.—Used for stenciling equipment and material, on black or dark colored background.

k. Varnish, shellac, orange.—Used for finishing the inside of wooden chests.

70. Lubricants.

Chassis lubricant No. 0.
Oil, engine, SAE 10W.
Oil, engine, SAE 20.
Oil, lubricating, for aircraft instruments and machine guns, U. S. A. Spec. 2–27 of latest issue.
Wheel bearing lubricant No. 2.

a. Oil, lubricating, for aircraft instruments and machine guns.—Used to lubricate delicate bearings of fire control and sighting instruments, unless otherwise prescribed. To be applied by dropping from a dropper or from the end of a piece of clean wire.

b. In the oiling of fire control instruments, only a few drops are needed. If more than necessary is used, it may run into the optical elements of the instrument and so affect the serviceability of the instrument as to require complete disassembly to remove the oil.

71. Miscellaneous materials and tools.—For the purpose for which used, see TM 9–850 (now published as TR 1395–A). They are—

Brushes:
- Artist, camel's-hair, round, No. 1.
- Flowing, skunk's-hair, No. 3 (2-inch).
- Sash-tool, oval, No. 1 ($2\frac{7}{32}$ by $1\frac{3}{4}$ inches).
- Sash-tool, oval, No. 3 ($1\frac{3}{32}$ by $2\frac{1}{8}$ inches).
- Scratch, painter's, handled (14 by $\frac{7}{8}$ inches).
- Varnish, oval, ($1\frac{7}{8}$ inches).

Needle, sacking.
Palm, sailmakers'.
Twine, jute.

a. Care of brushes.—The bristles of brushes are subject to attack by moths. Brushes in storage should be protected by naphthalene.

b. Camel's-hair brushes.—After being thoroughly cleaned with turpentine, camel's-hair brushes should be laid flat on a horizontal surface (not in water). Other paint brushes should be cleaned after using and kept with bristles submerged in fresh water.

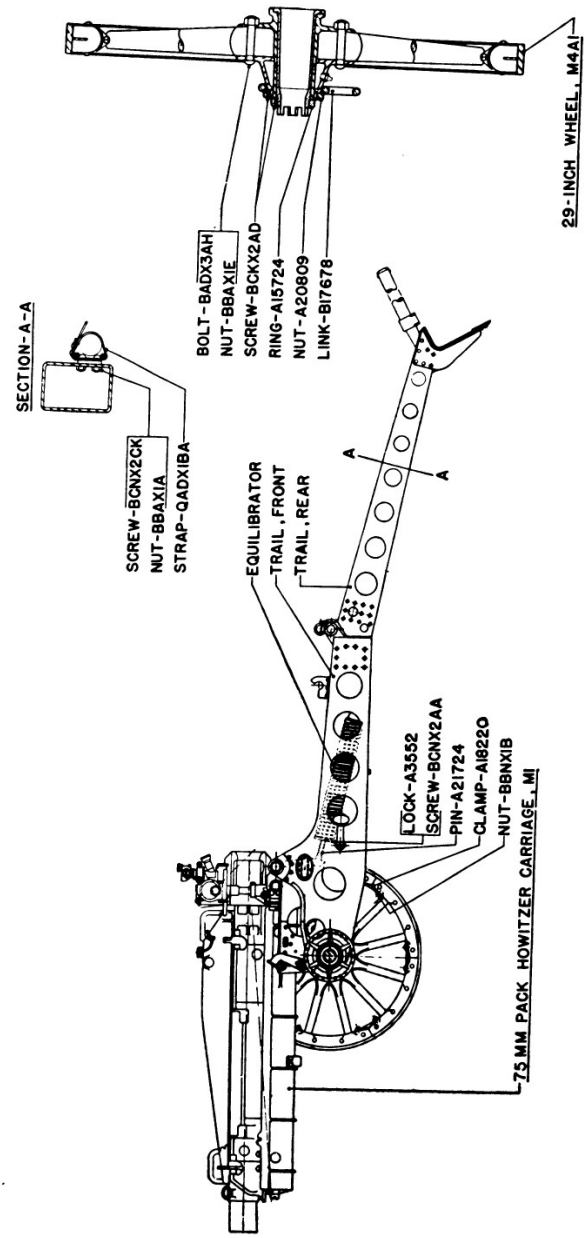


FIGURE 5.—75-mm pack howitzer carriage, M1, and wheel, 29-inch, M4A1.

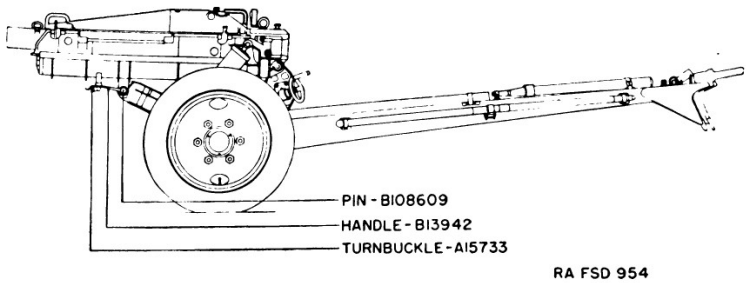


FIGURE 6.—75-mm howitzer carriage, M3A1—traveling position.

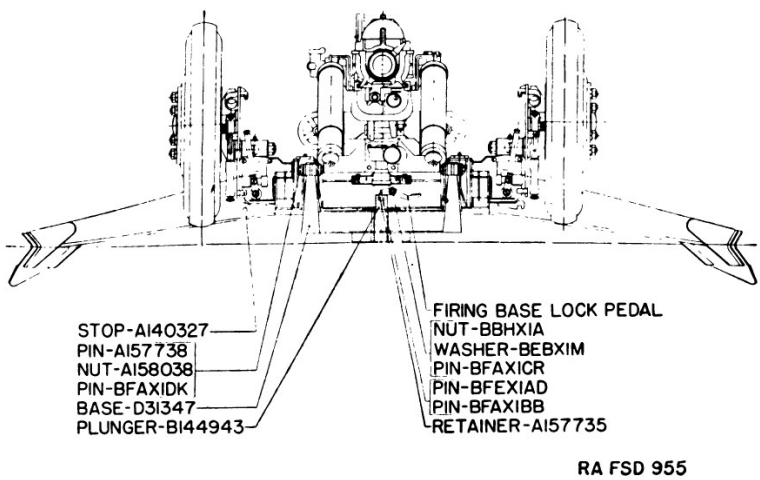


FIGURE 7.—75-mm howitzer carriage, M3A1—front view, firing position.

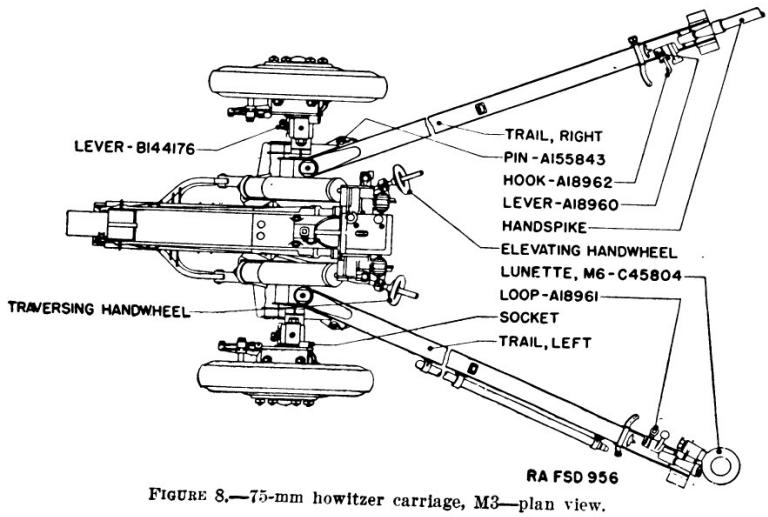


FIGURE 8.—75-mm howitzer carriage, M3—plan view.

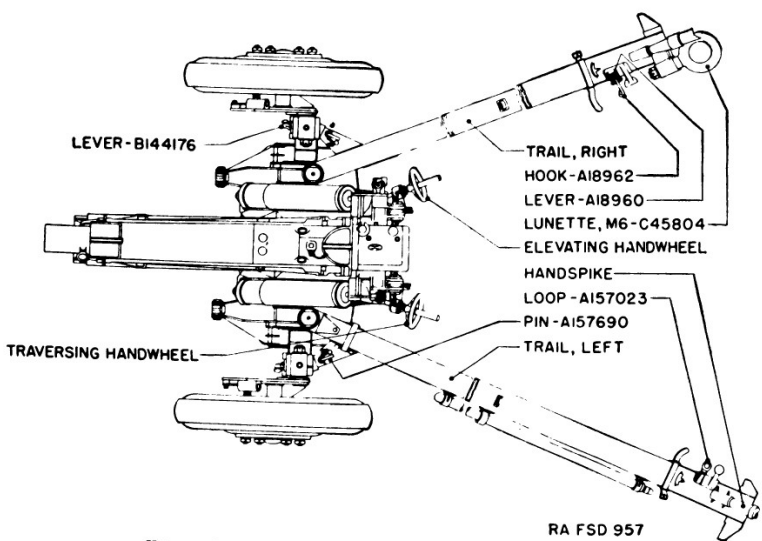


FIGURE 9.—75-mm howitzer carriage, M3A1—plan view.

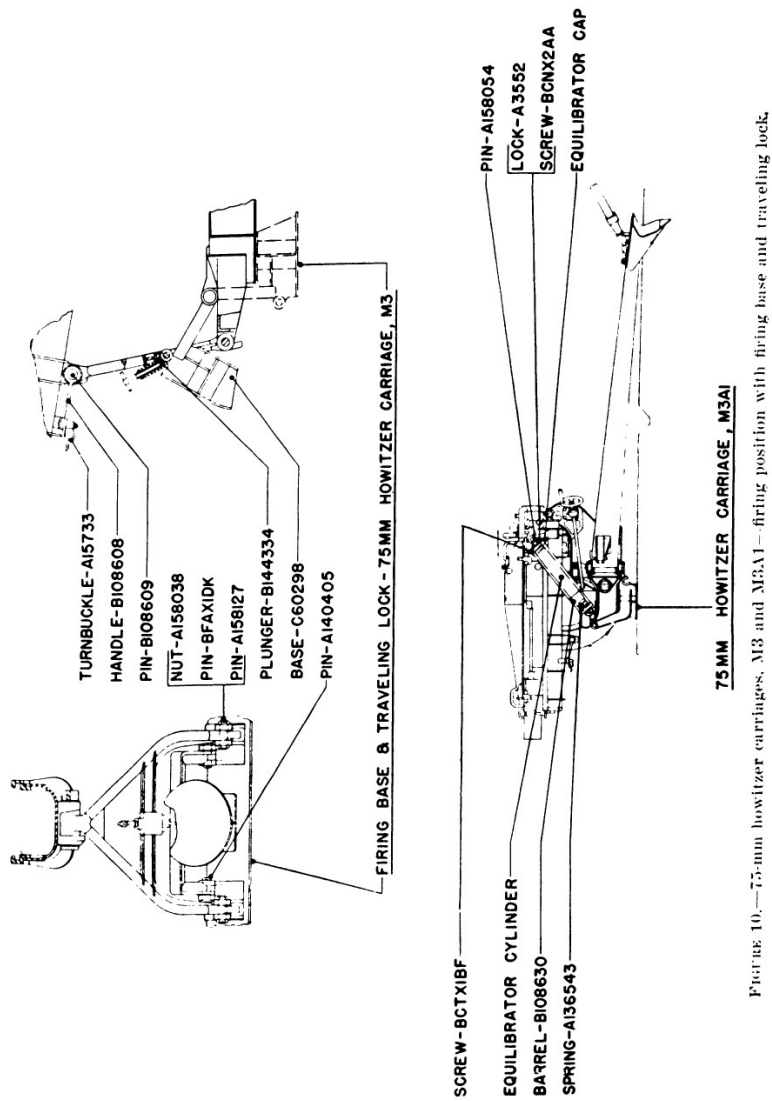


FIGURE 10.—75-mm howitzer carriages, M3 and M3A1—firing position with firing base and traveling lock.

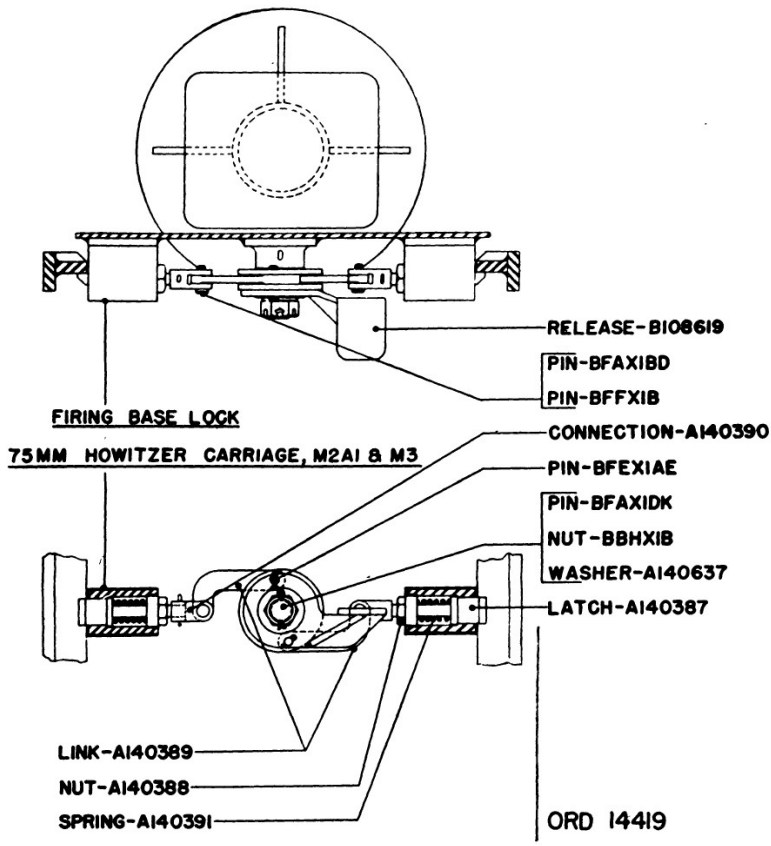


FIGURE 11.—75-mm howitzer carriage, M2A1 and M3—firing base lock.

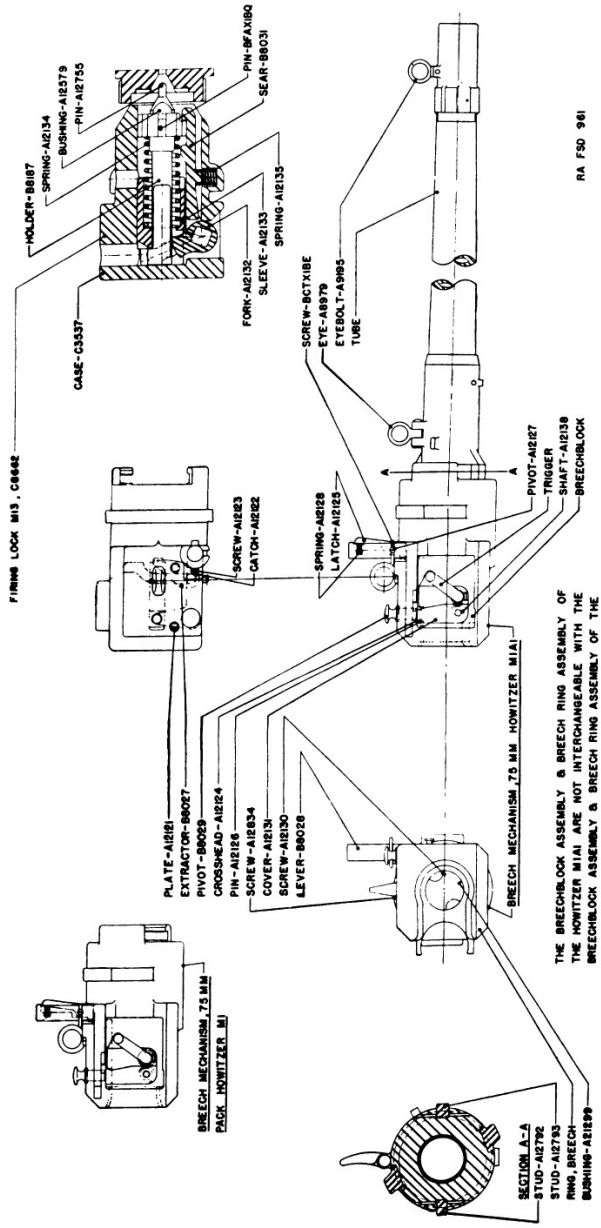


FIGURE 12.—75-mm pack howitzer, M1 and M1A1—with breech mechanism and firing lock, M13.

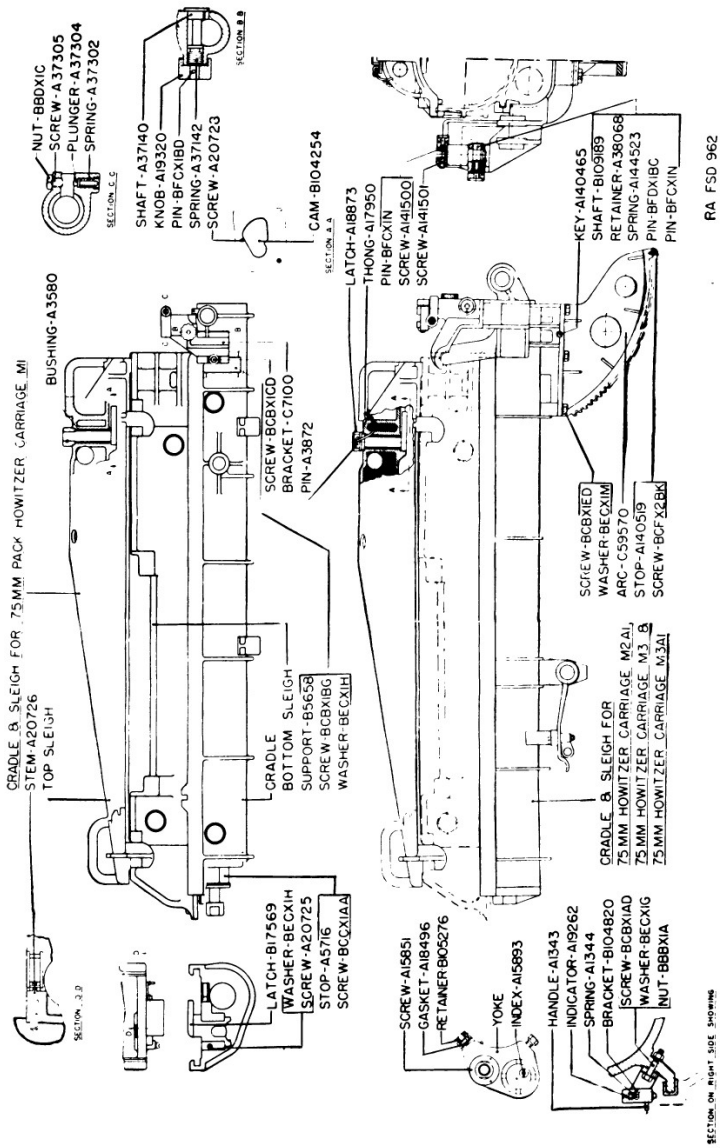


FIGURE 13.—75-mm pack howitzer carriage and 75-mm howitzer carriages—cradle and sleigh.

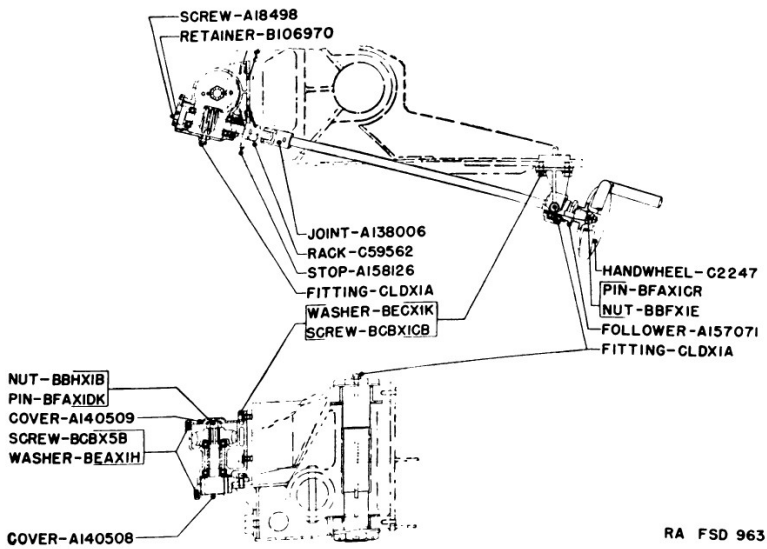


FIGURE 14.—75-mm howitzer carriages, M3A1, M3, and M2A1—traversing mechanism.

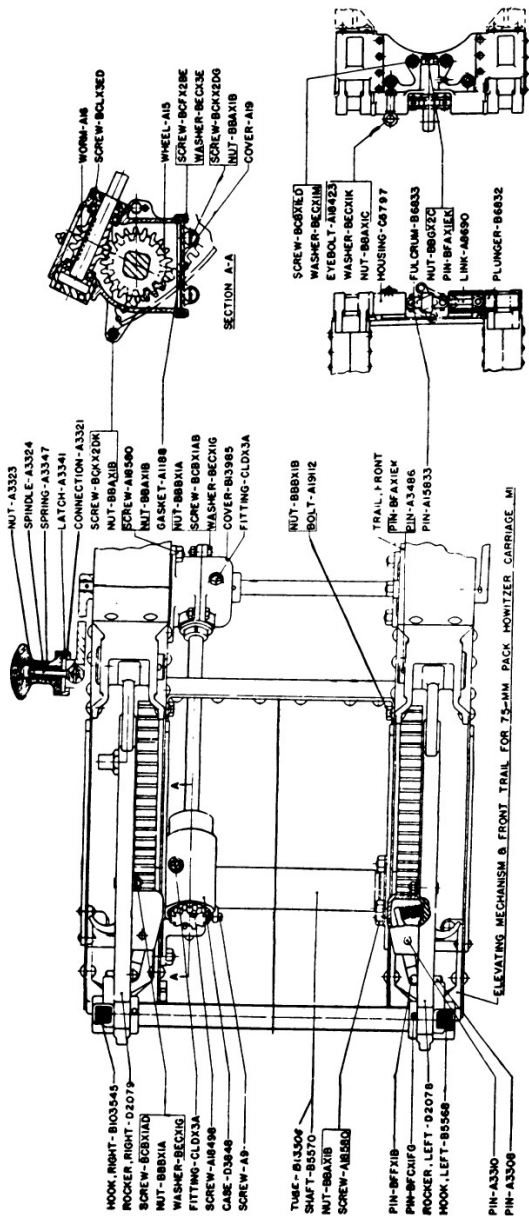


FIGURE 15.—75-mm pack howitzer carriage—elevating mechanism and front trail.

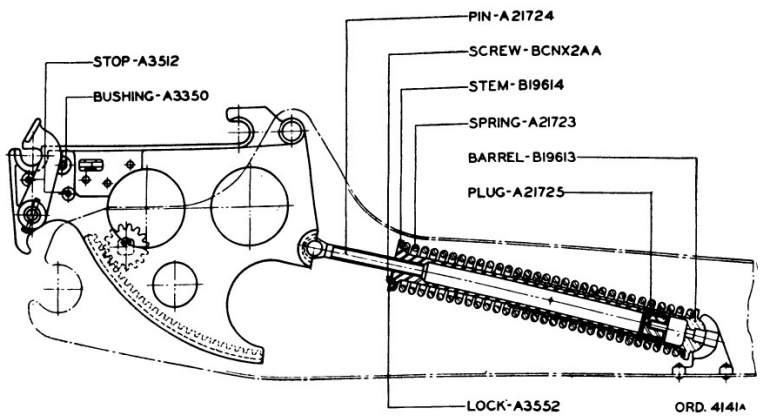


FIGURE 16.—Sectional view of 75-mm pack howitzer carriage, M1, equilibrator assembly.

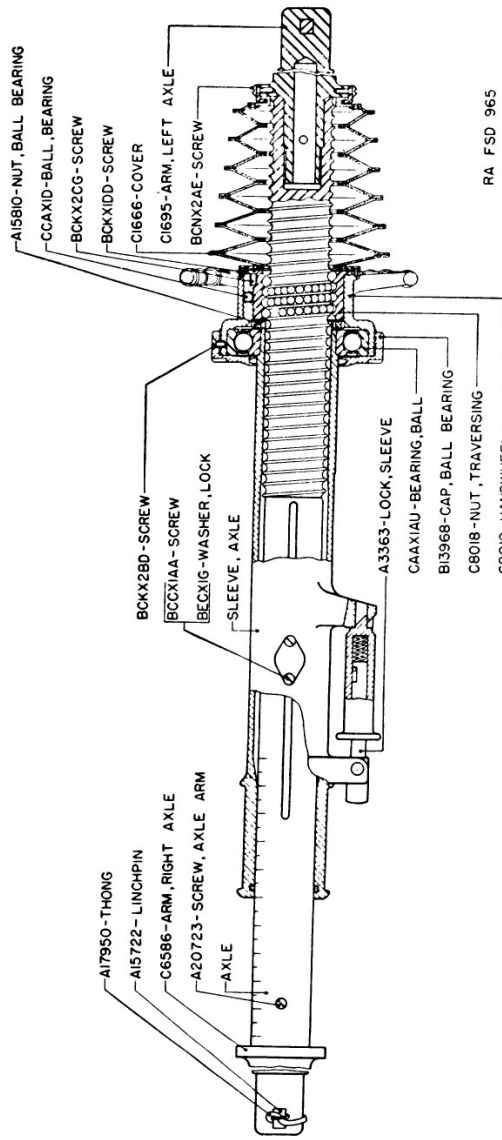


FIGURE 17.—75-mm pack howitzer carriage—axle and traversing mechanism.

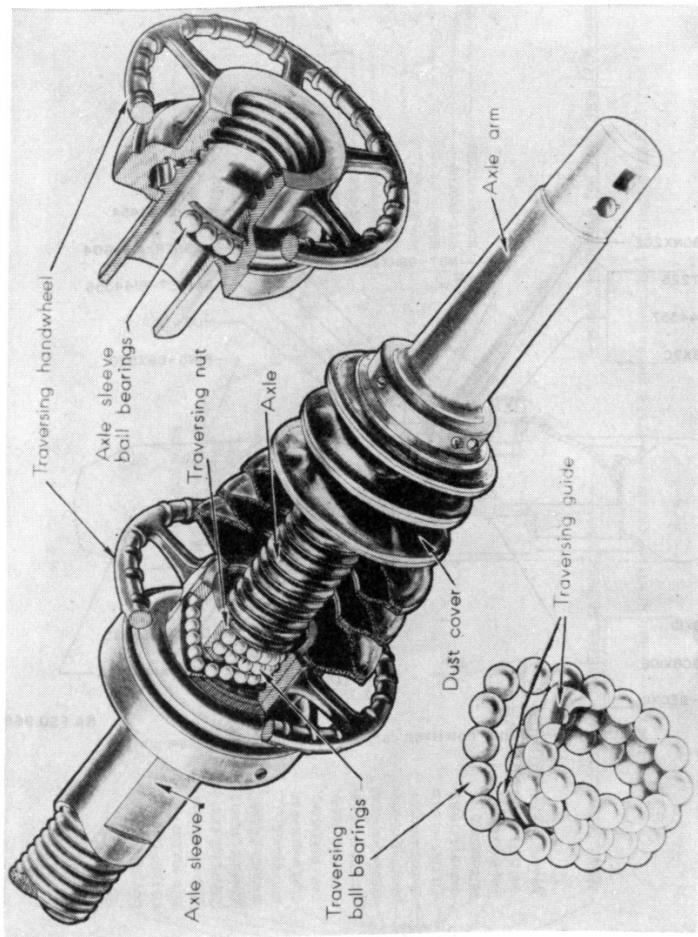


FIGURE 18.—75-mm pack howitzer carriage, M1—traversing handwheel mechanism.

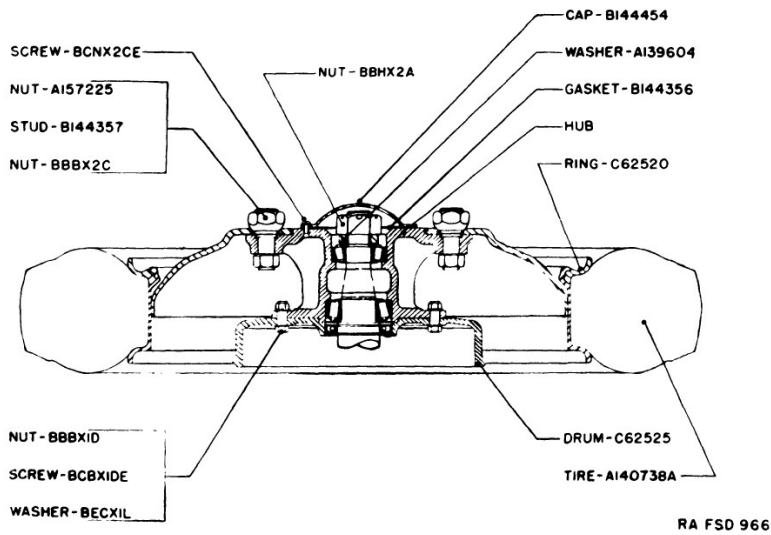


FIGURE 19.—75-mm howitzer carriages—wheel group assembly.

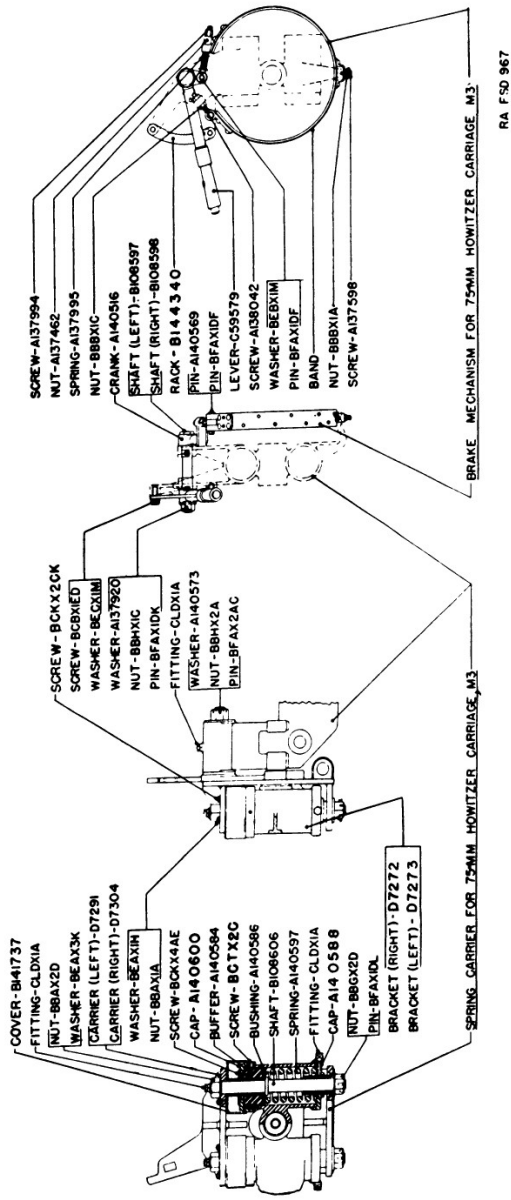


FIGURE 20.—75-mm howitzer carriages—brake mechanism and spring carrier.

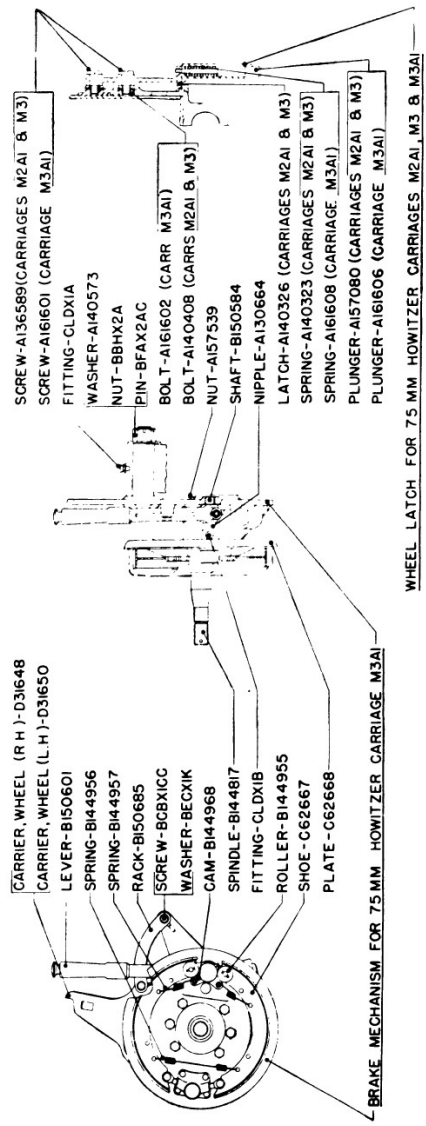


FIGURE 21.—75-mm howitzer carriages—brake mechanism, wheel carrier, and wheel latch.

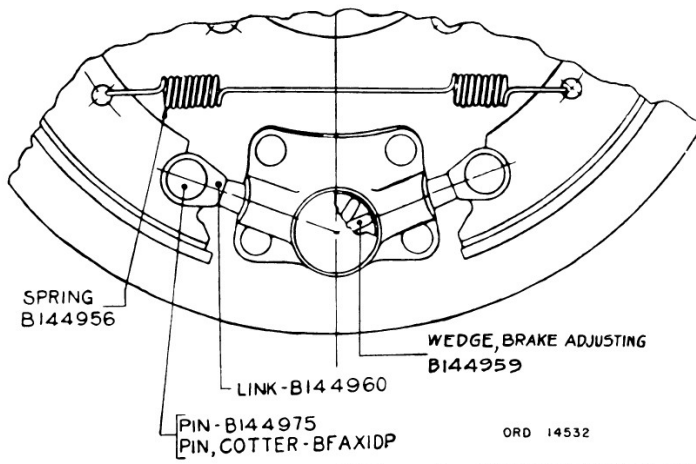


FIGURE 22.—75-mm howitzer carriage, M3A1—portion of brake mechanism showing adjusting wedge.

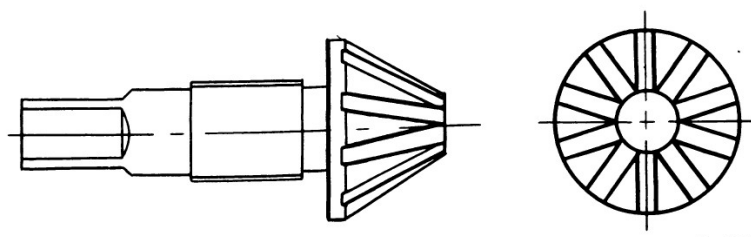


FIGURE 23.—Adjusting wedge, brake shoe.

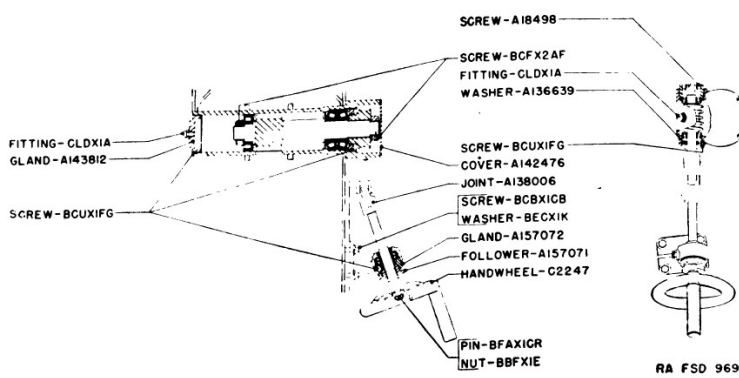


FIGURE 24.—75-mm howitzer carriages, M3 and M3A1—elevating mechanism.

CHAPTER 3

SIGHTING AND FIRE CONTROL EQUIPMENT

SECTION I

SIGHTING EQUIPMENT

72. Lamp, aiming post.—This is a combination of two lanterns, M2, with red lenses, one green lens, and two shields and two adapters.

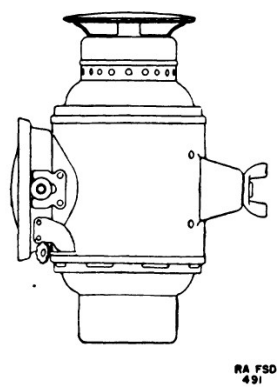


FIGURE 25.—Lantern, M2.

a. The lantern (fig. 25), is a small commercial lantern of the type formerly used as an automobile side lamp. It burns kerosene and delivers approximately 7 candlepower.

b. An adapter is provided which fits the mounting device on the rear of the lantern and clamps onto the aiming post.

c. The shield snaps around the rim of the lens and serves to eliminate unnecessary rays of light which may otherwise be observed by the enemy.

d. The lantern is operated in vertical position. The wick must be kept trimmed and the lens clean. The lantern will smoke if the wick is turned too high.

e. The various components of the lighting equipment should be kept in the chest when not in use.

73. Telescope, panoramic, M1, and mount, telescope, M3.— The standard components of the sighting system on the 75-mm howitzer, M1 (pack), are the M1 panoramic telescope and the M3 telescope mount. The telescope and mount (fig. 26) are used for aiming and laying for elevation. The mount automatically applies the corrections in azimuth and elevation for cant of the carriage. It is mounted in a socket on the left side of the cradle. It must be removed before traveling.

a. Description of telescope.—The panoramic telescope, M1, is a 3-power telescope with a rotating head and azimuth mechanism by which the line of sighting may be directed to any desired deflection. A knob at the top of the telescope (fig. 26) operates a movable prism permitting the line of sighting to be elevated or depressed through a limited angle as required to keep the aiming point within the field of view. The image viewed by the observer is erect. Both objective and eyepiece are of the fixed-focus type, designed for normal eyesight and for ranges ordinarily encountered. The eyepiece is rotatable about the vertical axis of the telescope to eliminate interference of the observer's head when backsighting, without effect on deflection indications or the line of sighting. The reticle contains a vertical and a horizontal cross line.

(1) *Telescope elevation.*—The telescope is bolted to the mount and positioned in the correct relation by machined locating surfaces. To set the telescope elevation to zero (prism to normal) the knob at the top is rotated until the coarse and fine index graduations on the uppermost part of the telescope coincide with zero position. This is the only setting that may be made on the telescope; there is no provision for reading other angles. At zero position the line of sighting of the telescope is perpendicular to the axis of the telescope.

(2) *Telescope azimuth scale.*—The azimuth scale is graduated in 100-mil steps, numbered progressively 0 to 32 in two consecutive semicircles. Zero readings indicate the line of sighting to be

directly forward, as in figure 26, or directly backward. The telescope is moved in deflection by means of the associated knob which has a throwout lever to permit disengagement, for rapid motion when required. Indications on the azimuth micrometer, which is graduated in 1-mil steps, supplement those on the azimuth scale.

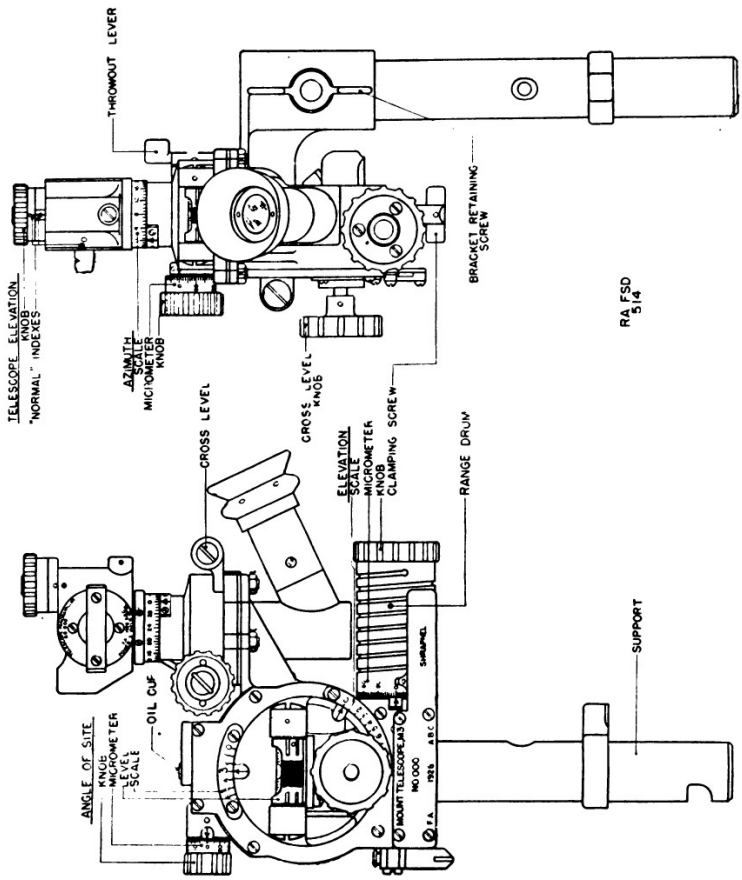


FIGURE 26.—Telescope mount, M3, with panoramic telescope, M1.

b. Description of telescope mount, M3.—The mount is supported on a central pivot which is alined to the bore of the piece. It includes a level and cross leveling mechanism, and angle of site and angle of elevation mechanisms. The angle of site and angle of elevation mechanisms introduce and add their respective elements of data. A range drum is included whereby range settings may be

made in lieu of angle of elevation settings. Range drums for different projectiles may be interchanged by removing the three flathead screws in the end of the elevating worm knob and withdrawing the knob and drum. Care is taken to disengage the pin of the pointer from the spiral slot in the drum. To replace the drum insert the pin of the pointer in the spiral slot and slide the drum into place. Bring the elevation scale and micrometer to zero and rotate the drum until the pointer indicates zero range simultaneously, then tighten the screws.

(1) *Cross level.*—The cross level mechanism consists of a cross level bubble and a worm and gear mechanism operated by the cross level knob for cross-leveling the mount. The centering of the cross level bubble indicates that angles of sight and angles of elevation set on the mount lie in a truly vertical plane.

(2) *Angle of site and angle of elevation.*—The leveling of the angle of site level while angle of site and angle of elevation are set on the respective scales and micrometers of the mount constitutes setting up a horizontal line from which the sum of the angle of site and angle of elevation is set in a plane. If the cross level bubble is also centered at the same time, a horizontal base plane is set up from which elevation and angle of site are set in a perpendicular vertical plane and in which deflection set on the telescope azimuth scale with the telescope elevation to normal is measured. The angle of site and cross level bubbles when centered also indicate the vertical axis of the telescope to be vertical. When the bubbles are leveled, angular indications are independent of carriage cant.

c. Operation.—(1) To place the telescope and mount in operation, insert the support of the mount in the sight bracket on the left side of the cradle. Turn the sight retaining shaft knob of the sight bracket counterclockwise to permit engagement with the hook on the lower end of the support. This knob returns by spring action to the locked position. Be certain that the projecting lug at the rear properly engages the mating parts and is held to the extreme right by the spring and plunger in the sight bracket. Clamp the mount in its upper position with the bracket retaining screw in the upper indentation of the support. Uncover the levels and release the elevation clamping screw.

(2) *Initial settings.*—(*a*) *Setting for direction.*

1. For direct laying set the deflection to the desired value, using the combined indications on the azimuth scale, 100-mil steps, and micrometer, 1-mil steps. Deflections to the left, trajectory displaced to left of line of sighting, are

indicated directly. For deflections to the right, values are subtracted from 3,200 and read directly or counted backward from the zero point. The battery commander normally performs all subtractions before giving the deflection setting. The azimuth worm may be disengaged by depressing the throwout lever for making large changes in deflection rapidly.

2. For indirect laying set the deflection on the azimuth scale and micrometer. Firing angle is the horizontal clockwise angle measured from the target to the aiming point, whose apex is at the piece. For values of firing angle greater than 3,200 mils, subtract 3,200 and make the setting with the rotating head directed to the left of the line of fire.

(*b*) *Setting for elevation.*

1. For laying the piece in elevation, set the desired angle of elevation in mils on the associated scale and micrometer, or set the desired range in yards on the range drum. In the latter case make sure that the ammunition in use is that specified on the range drum. Clamp the elevating mechanism of the telescope mount when the setting is complete. Set the angle of site and the telescope elevation to "normal."

2. For laying the piece in elevation any one of the following three combinations of data is applicable:

(a) Angle of site in mils; angle of elevation in mils.

(b) Angle of site in mils; range in yards, using only the ammunition specified on the range drum.

(c) Quadrant elevation in mils, set as angle of elevation, with angle of site set at "normal" (300 mils) since quadrant elevation includes necessary angle of site. Clamp the elevating mechanism of the telescope mount when the setting is completed. The telescope may be set to any convenient elevation to bring the aiming point into the field of view.

(3) *Operating procedure during firing.*—(*a*) Regardless of the laying method in use, operate the cross leveling mechanism so that the cross level bubble remains centered with respect to the graduation on its vial.

(*b*) For direct laying in direction, operate the traversing mecha-

nism of the piece so that the vertical cross line of the reticle falls on the target.

(*c*) For indirect laying in direction, operate the traversing mechanism of the piece so that the vertical cross line of the reticle falls on the aiming point. The eyepiece of the telescope may be swung around as required to avoid interference from the observer's head when backsighting.

(*d*) For direct laying elevation, elevate the piece, then depress it so that the horizontal cross line of the reticle falls on the target. Angle of site and telescope elevation must be set at "normal" and the position of the bubble of the angle of site level disregarded.

(*e*) For indirect laying in elevation, elevate the piece, then depress it so that the bubble of the angle of site level is centered with respect to the graduations on its vial. The telescope elevation may be set as desired to bring the aiming point into the field of view, the position of the horizontal cross line of the reticle to be disregarded.

(4) To prepare the instrument for traveling, cover the levels and clamp the mount at zero elevation as shown. Clamp the mount in its lower position, with the bracket retaining screw in the lower indentation of the support. Turn the sight retaining shaft knob of the sight bracket counterclockwise to release, then withdraw the mount and telescope as a unit and place it in the socket provided in the accessory chest, which has a retaining mechanism similar to that on the carriage.

(5) For operation in darkness, a window located a short distance ahead of the eyepiece permits illumination of the cross lines of the reticle, using an external source of light.

d. Tests and adjustments.—(1) *Angle of site and elevation scales.*—Micrometers and the range drum are clamped in place by a nut or screws in their respective knobs. The scales have slotted mounting holes to permit their alinement in the correct position.

(*a*) Set angle of elevation to zero. The associated scale and the micrometer should indicate zero simultaneously. If they do not, shift the micrometer or scale to give the required indication.

(*b*) With the above setting, zero range should also be indicated. If it is not, shift the range drum to give the required indication.

(*c*) Set angle of site to "normal" (300 mils). The associated scale and micrometer should indicate, respectively, "3" and "0" simultaneously. If they do not, shift the micrometer or scale to give the required indication.

(2) *Angle of site level.*—Level the piece transversely and longitudinally, jacking up a wheel if necessary. Cross level the telescope

mount. With elevation set at zero and angle of site set at "normal", the angle of site level bubble should be centered with respect to the graduations on its vial. If it is not, shift the angle of site or elevation micrometer and scale if necessary to indicate properly at the level position. Adjustment of the level vial is not permitted.

(3) *Bore sighting.*—With the piece level and the settings and adjustments made as outlined above, place the bore sights in position. Suspend the testing target vertically at a distance of about 50 yards so that axis of bore passes through the point on the target so marked. With telescope deflection and elevation set at zero and the mount in its upper position on the support, the aiming point should fall exactly at the intersection of the cross lines on the reticle. If not, the telescope and mount are not in correct adjustment.

(*a*) Failure to coincide laterally indicates that either the deflection indication of the telescope is incorrect or that alinement of the mount with respect to the bore of the piece, controlled by the round-point screw in the sight bracket, is incorrect. If a correction is required, the azimuth micrometer may be unclamped and slipped around to indicate properly. It is essential that the alinement of the pivot then be checked (see (4) below). If the azimuth scale and micrometer do not both indicate zero simultaneously the matter should be brought to the attention of qualified ordnance personnel.

(*b*) Failure to coincide vertically indicates either that the "normal" elevation indication of the telescope is incorrect or that the angle of site level is out of adjustment. If a correction is required, the telescope elevation micrometer may be unclamped and slipped around to indicate properly. Do not pull the knob out when making this adjustment, as the stop rings may become disarranged. If the "fine" and "coarse" indexes do not then both indicate zero simultaneously, the matter should be brought to the attention of qualified ordnance personnel.

(4) *Alinement of pivot and cross level.*—Make a setting of elevation near the maximum value and elevate the piece, complying otherwise with the conditions given for bore sighting. Failure of the vertical cross line to remain on the aiming mark indicates that either the cross level is out of adjustment or that the pivot of the mount is incorrectly alined with the bore of the piece. This should be brought to the attention of qualified ordnance personnel.

(*a*) *Unauthorized adjustment.*—Only the adjustment specifically authorized may be performed by the using arm. When necessity for further adjustment is indicated it is not sufficient to turn only the instrument in for repair, as adjustment of the lateral alinement

of the mount with the bore of the piece may be required. This adjustment is not to be performed by the using arm.

(*b*) Telescope mounts of this type are not interchangeable on different carriages. Alinement should be performed by qualified ordnance personnel.

c. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Avoid striking or bumping any part of the instrument, particularly denting or burring the locating surfaces of the mount or sight bracket.

(3) Stops are provided on the elevation, angle of site, and cross level mechanisms of the mount and the telescope elevating mechanism. Do not attempt to force the rotation of any of the knobs beyond these limits.

(4) Oil the principal bearing surfaces occasionally, using oil, lubricating, for aircraft instruments and machine guns, U. S. A. Spec. 2–27. An oil fitting is located on the top of the housing. The cross level worm gear segment also requires occasional oiling. Keep the sight retaining shaft, and the spring and plunger which position the sight laterally, well oiled, and the locating surfaces of the support and sight bracket lightly coated with grease, special, low temperature (Royco 6A). Keep the lubricant seeping from the moving parts wiped off to prevent the accumulation of dust and grit.

74. Telescope, panoramic, M1, and mount, telescope, M16.—This telescope and mount (fig. 27), furnished with each 75-mm howitzer and carriage, M2A1, M3, and M3A1, form sighting element for aiming the howitzer in direction. This mount is of the azimuth-compensating type, automatically applying the necessary azimuth correction for trunnion cant. It mounts in a socket in the sight bracket on the left-half side of the cradle of the howitzer. It is removed for traveling.

a. Description of telescope.—The panoramic telescope, M1, is described in paragraph 73*a*.

b. Description of mount, M16.—The housing of the mount, on which the telescope is mounted, is supported on a central pivot which is alined with the bore of the piece. The housing is also positioned longitudinally and transversely by knobs operating worm drives. Two levels are provided on the body. The cross level, when centered, indicates the "normal" or zero-deflection line of sighting of the telescope to lie in a vertical plane parallel to the bore of the piece. The angle of site level, when centered, indicates the shank of the telescope to be vertical. Hence, deflection indicated on the scale thereof is then measured in a truly horizontal plane.

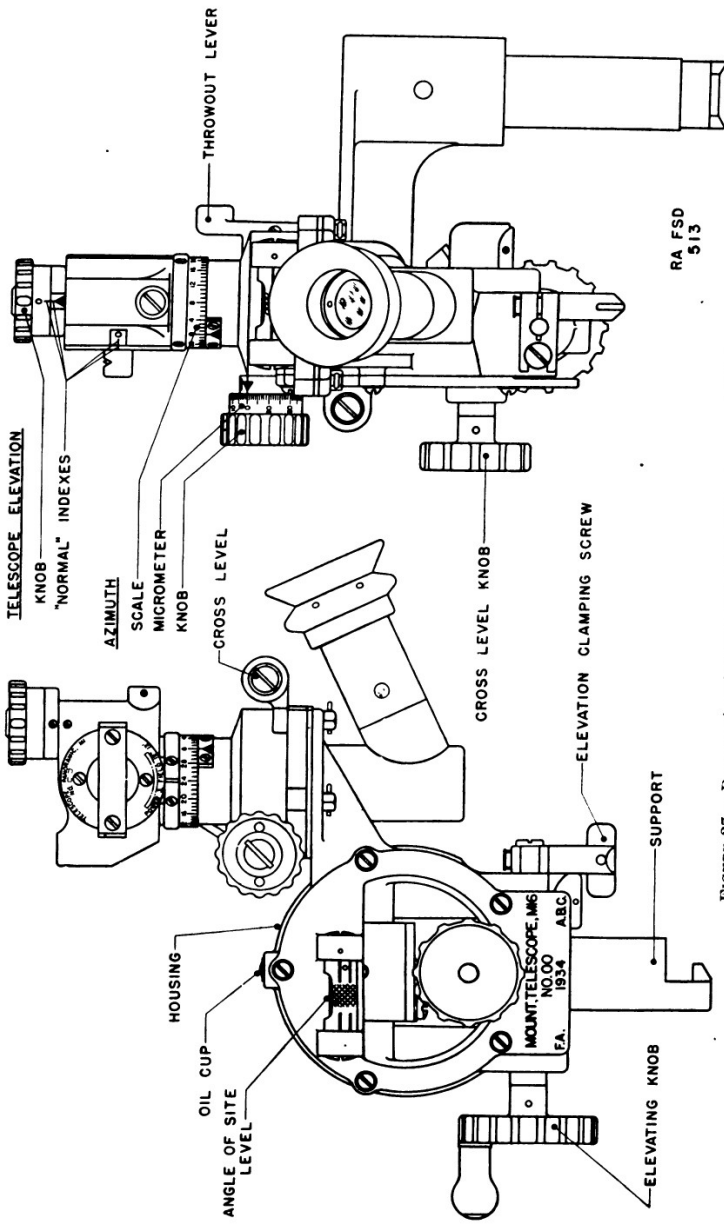


FIGURE 27.—Panoramic telescope, M1, with telescope mount, M16.

c. Operation.—(1) To place the telescope and mount in operation, remove them from the sighting equipment chest and insert the support of the mount in the left-hand sight bracket of the howitzer cradle. Turn the sight retaining shaft (lower) knob on the cradle clockwise to permit engagement with the hook at the lower end of the support. This knob returns by spring action to the locked position. By means of the sight clamping (upper) knob on the cradle, clamp the projecting lug firmly against the headless screw, properly locating the mount in azimuth. Uncover both levels and loosen the elevation clamping screw.

(2) Operating procedure during firing depends upon whether direct or indirect laying is to be employed, instructions for which are given separately.

(*a*) *Direct laying.*—In direct laying this telescope and mount are used to track the target in direction and introduce trajectory displacement.

1. Set the telescope in elevation to "normal" and leave in this position as long as direct laying is used.

2. Set the deflection to the desired value, using the combined indications on the azimuth scale (100-mil steps) and on the azimuth micrometer (1-mil steps). Deflection to the left (trajectory displaced to left of line of sighting) are indicated directly. For deflections to the right, values are subtracted from 3,200 and read directly, or counted backwards from the zero point. The battery commander normally performs all subtractions before giving the deflection setting. The azimuth worm may be disengaged for making large changes in deflection rapidly by depressing the throwout lever.

3. Operate the cross leveling knob of the telescope mount so that the bubble of the cross level is continuously centered with respect to the graduations on the vial as long as firing is continued. Operate the elevating knob of the telescope mount to keep the target within the field of view. Disregard the position of the angle of site level.

4. To complete the operation of laying for direction, traverse the piece so that the vertical cross line of the telescope reticle remains continuously on the target.

(*b*) *Indirect laying.*

1. Set the deflection or firing angle, using the combined indications on the azimuth scale (100-mil steps) and on the azimuth micrometer (1-mil steps). Firing angle is the

horizontal clockwise angle measured from the target to the aiming point whose apex is at the piece. In map firing a correction is usually applied to the firing angle for wind, drift, jump, etc., to obtain deflection. For values up to 3,200 mils it is numerically equal to the value indicated on the azimuth scale of the telescope, the rotating head being directed to the right of the line of fire. For values of firing angle greater than 3,200 mils, values are subtracted from 3,200 (usually by the battery commander) and settings made with the rotating head directed to the left of the line of fire. The azimuth worm may be disengaged for making large changes in azimuth by depressing the throwout lever.

2. Operate the longitudinal and cross leveling knobs of the telescope mount so that the bubbles of both levels are continuously centered with respect to the graduations on the vials as long as firing is continued.

3. Operate the traversing handwheel on the howitzer carriage so that the vertical cross line of the telescope reticle remains continuously on the aiming point. The telescope is elevated or depressed by the knob at the top to bring the aiming point within the field of view. It is not necessary to bring the aiming point exactly on the horizontal cross line. The piece is then properly pointed in direction for indirect laying.

(*c*) *Corrections.*—From time to time apply such corrections as may be required either by setting a new value of deflection or firing angle equal to the original value to which the desired correction has been algebraically added, or by turning the micrometer through the required number of mils in the desired direction. Applying positive corrections, or turning the micrometer toward the breech (increasing readings), displaces the trajectory toward the left.

(3) To prepare the instrument for traveling, cover the levels and clamp the mount in elevation in the position shown. Back off the sight clamping (upper) knob on the cradle and turn the sight retaining (lower) knob clockwise to release, then withdraw the mount and telescope as a unit and place it in the proper socket of the sighting equipment chest. This chest has studs of varying lengths extending from the lid to hold the various elements in place and care must be taken to place the equipment in proper position.

(4) For operation in darkness, a window located a short distance

ahead of the eyepiece permits illumination of the cross lines of the reticle, using an external light source.

d. Tests and adjustments.—(1) *Bore sighting.*—Level the piece transversely and longtiudinally, by jacking up one wheel if necessary. Place the bore sights in position and suspend the testing target vertically at a distance of about 50 yards so that the axis of the bore passes through the point on the target so marked. Place the telescope mount in operation, setting the telescope elevation at "normal" and the azimuth scale to zero. Level the bubbles. The line of sighting and the axis of the bore should then be parallel, and the aiming point on the target should appear exactly at the intersection of the cross lines on the reticle. If this is not the case, the telescope and mount are not in correct adjustment.

(*a*) Failure to coincide laterally indicates that either the azimuth indication of the telescope is incorrect, or that the alinement of the mount with respect to the bore of the piece, controlled by the headless screw in the sight bracket, is incorrect. If a correction is required the azimuth micrometer may be unclamped and slipped around to indicate properly. It is essential that the alinement of the pivot then be checked (see (2) below). If the azimuth scale and micrometer do not both indicate zero simultaneously the matter should be brought to the attention of qualified ordnance personnel.

(*b*) Failure to coincide vertically indicates that either the angle of site level is out of adjustment or that the "normal" indication of the telescope is incorrect. If a correction is required, the elevation micrometer ("fine" index) of the telescope may be unclamped and slipped around to indicate properly. Do not pull the knob out when making this adjustment as the stop rings may then become disarranged. If the "fine" and "coarse" indexes do not then both indicate zero simultaneously, the matter should be brought to the attention of qualified ordnance personnel.

(2) *Alinement of pivot and levels.*—(*a*) *Cross level.*—Elevate the piece to its maximum and center the bubble of the angle of site level. Failure of the vertical cross line to remain on the aiming mark or of the cross level bubble to remain centered indicates that either the cross level is out of adjustment or the pivot of the mount is incorrectly alined with the bore of the piece. If the vertical hair has moved either to the right or to the left, determine the error by turning the cross leveling knob by small trial movements until the vertical hair remains on its target while the piece is elevated and depressed. Note the position of the bubble. If it is not centered within one division, it should be repaired by the ordnance maintenance company. How-

ever, it may be used by setting the bubble in a position determined in the above test instead of in its true center.

(*b*) *Angle of site level.*—With 1,600 mils' deflection, lay the vertical cross hair on a plumb bob line and center the angle of site bubble. Rotate the elevating knob of the telescope so that the vertical cross hair moves along the plumb bob line. The vertical hair should not move either to the right or to the left. If the vertical hair moves, determine the error by moving the angle of site knob by trial adjustment until the vertical hair remains on the plumb bob line. Note the position of the bubble. If it is not centered within three divisions it should be repaired by the ordnance maintenance company. However, it may be used by setting the bubble in the same relative position determined in the above test instead of in its true center.

(3) Only the adjustments specifically authorized may be performed by the using arm. When necessity for further adjustment is indicated it is not sufficient to turn only the instrument in for repair, as adjustment of the lateral alinement of the mount with the bore of the piece may be required. This adjustment is not to be performed by the using arm.

(4) Telescope mounts of this type are not interchangeable on different carriages. Alinement should be performed by qualified ordnance personnel.

e. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Avoid striking or bumping any part of the instrument, particularly denting or burring the locating surfaces of the mount or sight bracket.

(3) Stops are provided on the elevating and cross leveling mechanisms of the mount and on the elevating mechanism of the telescope. Do not attempt to force the rotation of any of the knobs beyond these limits.

(4) The principal bearing surfaces should be oiled occasionally, neutral oil being used. An oil fitting is located on the top of the housing. The cross level worm gear segment also requires occasional oiling. Keep the sight retaining shaft and sight clamping screw well oiled and the locating surfaces of the support and sight bracket lightly coated with grease. Keep the lubricant seeping from the moving parts wiped off to prevent the accumulation of dust and grit.

75. Telescope, elbow, M4, and mount, telescope, M17.—This telescope and mount were formerly used on the 75-mm howitzer and carriage, M2, which has been converted to M2A1. The M2A1 uses the same sighting equipment as the 75-mm howitzer and carriage, M3 or M3A1.

76. Post, aiming, M1.—Two aiming posts are furnished with each 75-mm howitzer and carriage, M2A1, M3, or M3A1. Each aiming post (fig. 28), consists of two tubular sections, each approximately 4 feet long. The lower section has a metal point for embedding in the ground and the upper section is provided with a joint and catch fitting in the upper end of the lower section. The parts are painted with alternate 4-inch red and white bands. A canvas cover holding both sections is provided. Should it be necessary to drive the lower section into the ground, a wood block should be interposed or other means taken to insure that the surface mating with the upper part is not injured.

77. Quadrants, gunner's.—The gunner's quadrant is used in laying for elevation and for leveing the piece during bore sighting operations. The gunner's quadrant, M1, is intended for issue with all

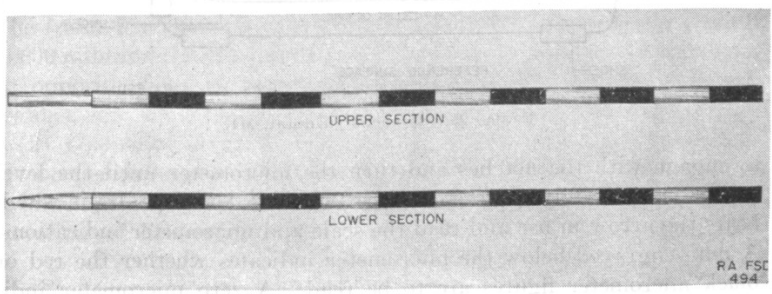


FIGURE 28.—Aiming post, M1.

75-mm howitzers. The gunner's quadrant, M1918, is issued as a substitute for the M1.

a. Gunner's quadrant, M1.—(1) *Description.*—This quadrant (fig. 29), includes a sector-shaped frame to which is pivoted an arm carrying a level. Notches on the frame engaging with a plunger in the arm permit rapid setting of the arm to the desired angle. The frame has two reference surfaces, one used for elevations from 0 to 800 mils and the other from 800 to 1,600 mils. Separate scale and micrometer indications on opposite sides of the quadrant are used for the two different regions.

(2) *Operation.*—(*a*) To measure the elevation of the piece place the proper reference surface of the quadrant on the leveling plates, parallel to the bore, with the associated arrow pointing in the direction of fire. Set the micrometer at zero. Disengage the plunger from the notches in the frame, lift the arm, and lower it slowly until the bubble is seen to pass through the central point. Allow the plunger

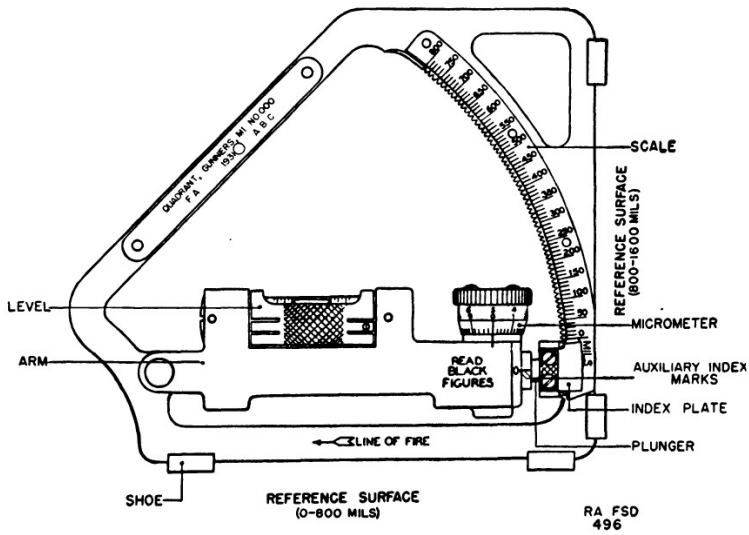


FIGURE 29.—Gunner's quadrant, M1.

to engage with the notches and turn the micrometer until the level bubble is accurately centered. Face the side of the quadrant which bears the arrow in use and read the scale and micrometer indications. A note engraved below the micrometer indicates whether the red or black micrometer figures are to be read. A zero micrometer indication is read as "0 mils" when the auxiliary indexes are matched, as in figure 29, and as "10 mils" when they are not matched. The elevation of the piece in mils is equal to the sum of the scale and micrometer readings. Remove the quadrant from the piece before firing.

(*b*) To measure depression angles, proceed as above, but with the arrow pointed in the reverse direction.

(*c*) To lay the piece to a given elevation set the scale and micrometer to the required angle and place the corresponding reference surface on the leveling plates of the piece. Elevate the piece, then depress it until the level bubble is centered.

(3) *Test and adjustment.*—No adjustment of the quadrant by the using arm is permitted. The zero indication may be verified by setting the quadrant to zero elevation, elevating or depressing the piece to center the bubble, then turning the quadrant end for end. If the bubble is not centered, determine the elevation or depression angle necessary to center it. One-half of this angle is the error and

a corresponding correction should be applied to all subsequent indications in the 0–800-mil region.

(4) *Care and preservation.*—(*a*) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(*b*) Exercise particular care to prevent burring, denting, or nicking of the reference surfaces and of the notched portion of the frame.

(*c*) When not in use, keep the quadrant in the chest provided, with the shoes forming the reference surfaces lightly greased.

b. Gunner's quadrant, M1918.—(1) *Description.*—This quadrant (fig. 30), includes a sector-shaped frame to which is pivoted an arm carrying a level. Notches on the frame engaging with a plunger in the arm permit rapid setting of the arm in 10-mil steps to the desired angle as indicated on the coarse scale. The arm is slightly curved and the level guide is arranged to be positioned along the arm to provide a fine indication supplementing that on the coarse scale. The frame has two reference surfaces, one used for elevations from 0 to 800 mils and the other from 800 to 1,600 mils. Separate indications on opposite sides of the quadrant are used for the two different regions.

(2) *Operation.*—(*a*) To measure the elevation of the piece, place the proper reference surface of the quadrant on the leveling plates, parallel to the bore, with the associated arrow pointing in the direction of fire. Clamp the level guide to indicate zero on the

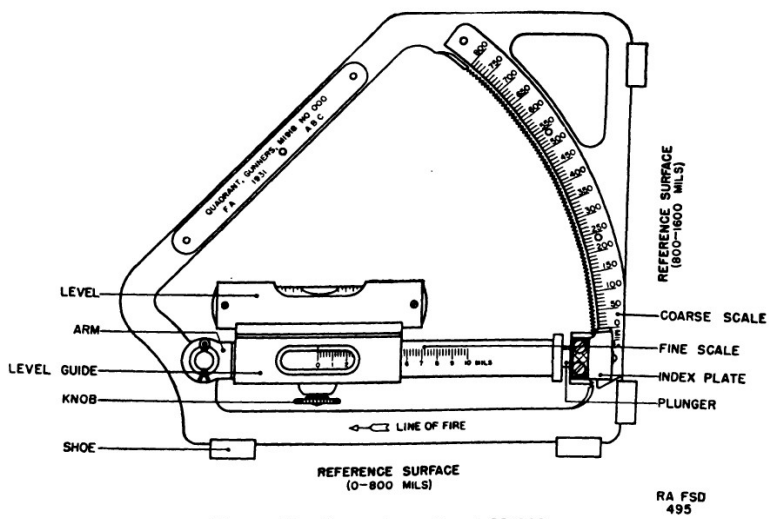


FIGURE 30.—Gunner's quadrant, M1918.

final scale. Disengage the plunger from the notches in the frame, lift the arm, and lower it slowly until the bubble is seen to pass through the central point. Allow the plunger to engage with the notches and slide the level guide along the arm until the level bubble is accurately centered. Face the side of the quadrant which bears the arrow in use and read the coarse and fine scales. The elevation of the piece in mils is equal to the sum of the coarse and fine scale readings.

(*b*) To measure depression angles, proceed as above, but with the arrow pointed in the reverse direction.

(*c*) To lay the piece to a given elevation, set the scale and micrometer to the required angle and place the corresponding reference surface on the leveling plates of the piece. Elevate the piece, then depress it until the level bubble is centered.

(3) *Test and adjustment.*—(*a*) No adjustment of the quadrant by the using arm is permitted.

(*b*) The zero indication may be verified by setting the quadrant to zero elevation, elevating or depressing the piece to center the bubble, then turning the quadrant end for end. If the bubble is not centered, determine the elevation or depression angle necessary to center it. One-half of this angle is the error and a corresponding correction should be applied to all subsequent indications in the 0–800-mil region.

(*c*) To test the accuracy of the index arm, set a reading of any multiple of 10 on the quadrant and place the sliding level at zero. Center the bubble by means of the elevating handwheel of the piece. Move the index arm one notch down, and slide the level to the opposite end of the scale. The bubble should remain centered. This makes the test of the quadrant complete, insofar as the battery may test the instrument.

(4) *Care and preservation.*—(*a*) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(*b*) Exercise particular care to prevent burring, denting, or nicking of the reference surfaces and of the notched portion of the frame.

(*c*) When not in use, keep the quadrant in the chest provided, with the shoes forming the reference surfaces lightly greased with Royco 6A.

78. Quadrant, range, M3, and telescope, elbow, M5.—This quadrant and telescope (figs. 31 and 32), are used for laying the howitzer, on carriages M2A1, M3, and M3A1, in elevation. The quadrant mounts in a socket in the sight bracket on the right side

of the cradle. It is removed for traveling. The telescope is mounted on the quadrant but is removed for traveling. When using direct laying, the angle of elevation is introduced by means of range graduations on the telescope reticle and angle of site is introduced directly.

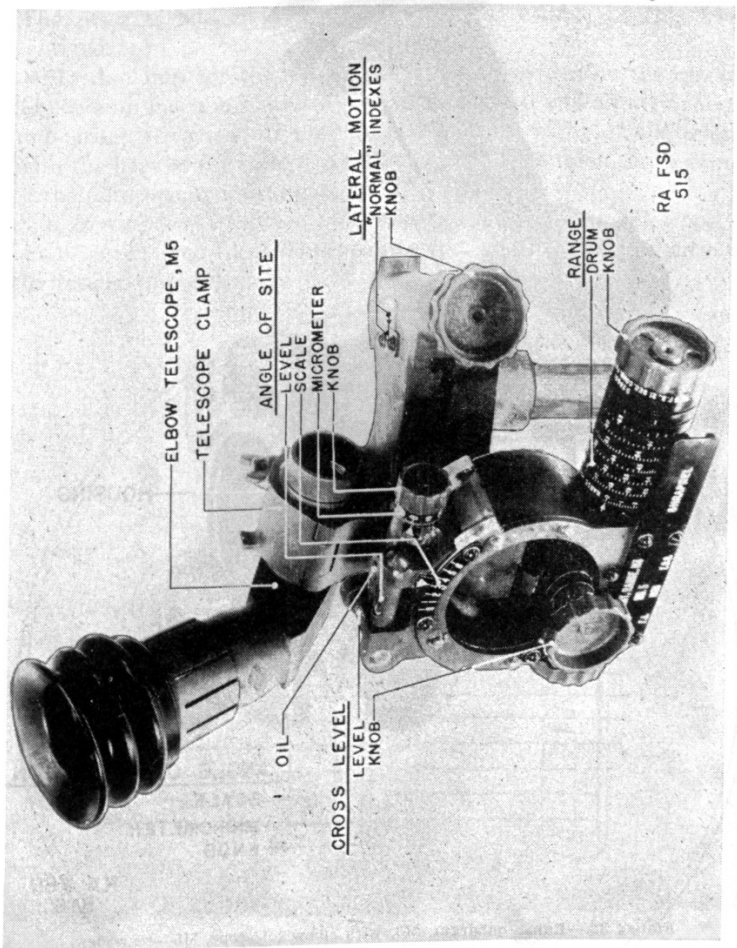


FIGURE 31.—Range quadrant, M3, with elbow telescope, M5—front view.

When using indirect laying, the elevation angle, or the corresponding range, and angle of site are set off on scales and automatically corrected for trunnion cant, the proper laying of the piece being indicated by the centering of the level bubbles.

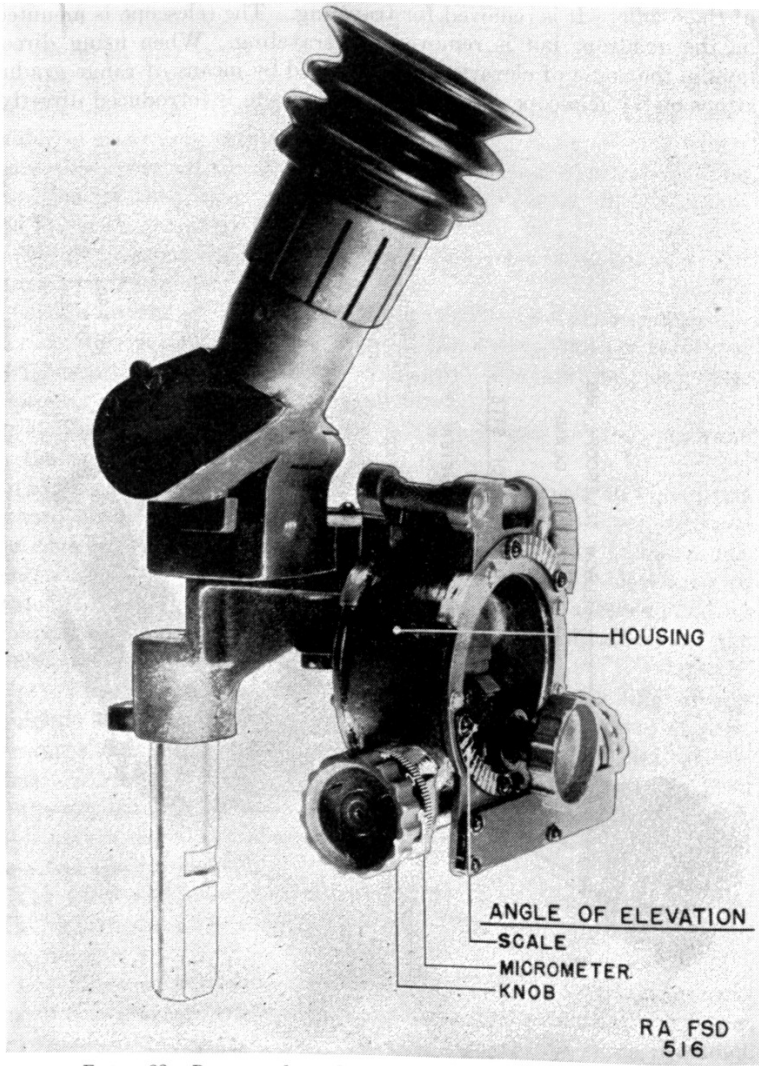


FIGURE 32.—Range quadrant, M3, with elbow telescope, M5—rear view.

a. Description of quadrant.—(1) The principal moving parts of the quadrant are supported on a central pivot which is alined with the bore of the piece. A cross leveling mechanism and level are provided so that angular indications are measured in a vertical plane, thus eliminating error due to cant of the trunnions.

(2) The angle of site and angle of elevation mechanisms introduce and add together their respective elements of data, and a range drum is included whereby range settings may be made in lieu of angle of elevation settings.

(3) The angle of site level provides a horizontal datum plane. The piece is laid in elevation so that the bubble of this level is centered.

(4) A clamp for the elbow telescope is provided on the quadrant. This clamp has a mechanism for lateral motion and a pair of indexes indicating alinement of the "normal" line of sight of the telescope with the bore of the piece. No correction for trunnion cant is applied to the telescope or its support.

b. Description of elbow telescope.—(1) The elbow telescope, M5, is a 3-power fixed-focus telescope provided with range graduations on the reticle (fig. 33).

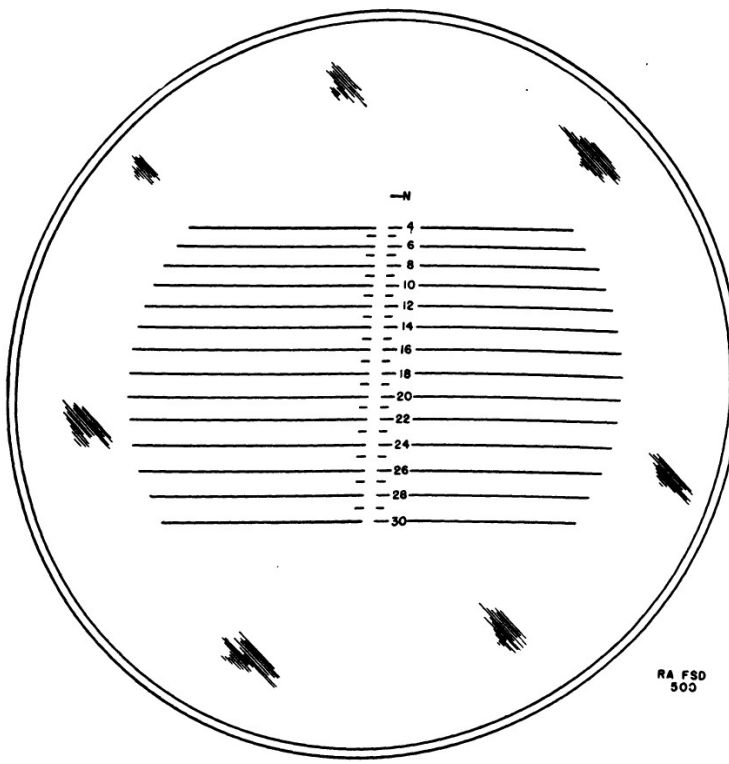


FIGURE 33.—Elbow telescope, M5, reticle.

(2) This reticle is graduated at 100-yard intervals up to 3,000 yards.

(3) The "normal" line of sighting, designated by "N" on the reticle is designed to be alined parallel to the bore of the piece. The geometrical axis of the telescope is depressed 65.8 mils, corresponding to 1,900 yards range, below the "normal" line of sight.

c. Operation.—(1) *To place quadrant and telescope in operation.*—Insert the mount support fully into the socket in the right sight bracket of the cradle. Turn the sight retaining shaft knob (the lower knob) clockwise to permit engagement with the projection on the support. This knob is returned by spring action to the locked position. By means of the sight clamping knob (the upper knob), clamp the projecting lug firmly against the headless screw, thus properly locating the quadrant in azimuth. Uncover both levels. Remove the elbow telescope from the chest and clamp it in its support. Be certain that the telescope is fully inserted, that the projecting lug fits the mating projection of the support, and that the wing nut is securely tightened. If it is known that direct laying will not be used, the elbow telescope need not be mounted.

(2) *Operating procedure for direct laying.*—(*a*) The elbow telescope, M5, is calibrated for ranges up to 3,000 yards, using only base charge plus 3 increments (zone 4).

(*b*) Using, if necessary, the open sight and the lateral motion of the telescope mounting, pick up the target and center it laterally within the field of view.

(*c*) Operate the elevating handwheel on the howitzer carriage, first elevating the piece, then depressing it until the target appears on the reticle graduation corresponding to its range, obtained from an external source. Numbers on the reticle correspond to hundreds of yards.

(*d*) Set the lateral motion of the elbow telescope mounting to its zero (indexes matched) position. Range graduations on the telescope are accurate only when indexes are matched and the target is centered laterally on the reticle. However, serious errors will not occur unless the offset is considerable. Failure of the target to be centered laterally within the field of view will ordinarily be found due to improper traversing of the howitzer carriage or to rapid travel of the target across the field of fire. A deflection lead will cause the target to be viewed off center in the field of view of the elbow telescope when the latter is set at normal deflection.

(*e*) Operation of leveling or cross leveling motions of the quadrant are not necessary when aiming the piece and no correction for trunnion cant is applied.

(3) *Operating procedure for indirect laying.*—(*a*) Any one of the following three combinations of data is applicable in making the initial settings.

1. Angle of site in mils; angle of elevation in mils.
2. Angle of site in mils; range in yards (using only the ammunition specified on the range drum).
3. Quadrant elevation in mils, set as angle of elevation with angle of site set at "normal" (300 mils), since quadrant elevation already includes any necessary angle of site.

(*b*) Having made the settings in accordance with the combination selected, cross level the quadrant and maintain it in that condition as long as firing is continued. Elevate the piece, then depress it until the angle of site level bubble remains centered with respect to the graduations on the vial. The piece is then properly laid in elevation.

(4) *To place in traveling position.*—(*a*) Cover the levels.

(*b*) Remove the elbow telescope and place it in the place provided in the sighting equipment chest.

(*c*) Back off the sight adjusting knob (upper knob), turn the sight retaining knob (lower knob) clockwise to unlock, and withdraw the quadrant.

(*d*) Place the quadrant in the proper socket of the sighting equipment chest. This chest has studs of varying lengths extending from the lid to hold the various elements in place. Care must be taken to place the equipment in its proper position.

d. Tests and adjustments.—(1) Micrometers and the range drum are clamped in place by a nut or screws in their respective knobs. The scales have slotted mounting holes to permit their alinement in correct position.

(*a*) Set angle of elevation to zero. The associated scale and the micrometer should indicate zero simultaneously. If they do not, shift the micrometer or scale to give the required indication.

(*b*) With the above setting, zero range should also be indicated. If not, shift the range drum to give the required indication.

(*c*) Set angle of site to "normal" (300 mils). The associated scale and micrometer should indicate, respectively, "3" and "0" simultaneously. If they do not, shift the micrometer or scale to give the required indication.

(2) Level the piece transversely and longitudinally. Cross level the range quadrant. With elevation set at zero and angle of site at "normal", the angle of site level bubble should be centered with respect to the graduations on its vial. If not, shift the angle of site

or elevation micrometer and, if necessary, scale to indicate properly at the new position. Adjustment of the level vial is not permitted.

(3) To verify the alinement of the pivot with the bore, and the position of the cross level, cross-level the quadrant with the bore and trunnion axes horizontal as in the preceding adjustments. Without disturbing the cross level setting, or the level condition of the cradle trunnions, set the angle of elevation, or range, to close to its maximum value and elevate the piece until the angle of site level bubble is central. The cross level bubble should remain central. If it does not, lack of lateral parallelism between the bore and the pivot axis, controlled by the headless screw in the sight bracket or incorrect adjustment of the cross level is indicated. Any discrepancy should be brought to the attention of qualified ordnance personnel.

(4) The elbow telescope is alined by bore sighting with the bore and trunnion axes leveled and the target in place, as described in paragraph 74*d*. Set the index on the lateral motion so that the arrows are matched when the aiming mark is laterally centered on the reticle. The aiming mark should fall in line with the "N" graduation on the reticle. If it does not, the condition should be brought to the attention of qualified ordnance personnel, as there is no provision for adjustment in a vertical direction.

(5) Only adjustments specifically authorized may be performed by the using arm. When necessity for further adjustment is indicated, it is not sufficient to turn only the instrument in for repair, as adjustment of the lateral alinement of the quadrant with the bore of the piece may be required and this adjustment is not to be performed by the using arm.

(6) Range quadrants of this type are not interchangeable with different carriages without alinement by qualified ordnance personnel.

e. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Striking or bumping any part of the instrument should be avoided, particularly denting or burring the locating surfaces of the quadrant, elbow telescope, or sight bracket.

(3) Stops are provided to limit the travel of the moving parts. Do not attempt to force the rotation of any of the knobs beyond these limits.

(4) Oil the principal bearing surfaces occasionally with oil, lubricating, for aircraft instruments and machine guns. An oil fitting is located on the top of the housing. The cross level worm gear segment and the worm gear segment of the lateral motion also require oil occasionally. Keep the sight retaining shaft and sight clamping

screw well oiled and the locating surfaces of the quadrant, sight bracket, and elbow telescope lightly coated with grease (Royco 6A). Keep the lubricant seeping from the moving parts wiped off to prevent accumulation of dust and grit.

79. Quadrant, range, M2.—This range quadrant was formerly used on the 75-mm howitzer and carriage, M2, which has now been converted to M2A1. It uses the same sighting equipment as the 75-mm howitzer and carriage, M3 and M3A1.

80. Sight, bore.—The bore sight is used to indicate the direction of the axis of the bore of the piece for alinement and verification of sights. Each bore sight is composed of a breech and muzzle element.

a. Description.—(1) The breech bore sight (fig. 34), is a disk which fits accurately in the chamber of the howitzer. The model of the howitzer for which it is to be used is engraved on the disk.

(2) The muzzle bore sight includes a cord, to be stretched tightly across the muzzle, vertically and horizontally in the score marks

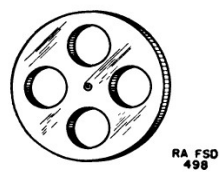


FIGURE 34.—Breech bore sight.

thereon, and a belt buckled around the muzzle to hold the cord in place.

b. Operation.—With the two elements in place, sight through the aperture in the breech bore sight. The direction of the axis is indicated by the cord intersection.

c. Care and preservation.—Handle the breech bore sight carefully to prevent nicks and burs. Wind the cord and belt compactly when not in use.

81. Sleeve, aiming post, M1.—Two of these sleeves (fig. 35) are furnished with each 75-mm pack howitzer and carriage, M1. Each sleeve fits over a lifting bar to permit use as aiming posts.

82. Targets, testing.—A testing target is used during the bore sighting of sights and subcaliber equipment. Four targets are provided with each weapon, except pack howitzers, with which only one target is provided. The aiming points corresponding to the axis of bore, subcaliber bore, and the lines of sight are plainly designated. It is essential that the proper aiming points be selected, and that the target be positioned vertically and in a vertical plane.

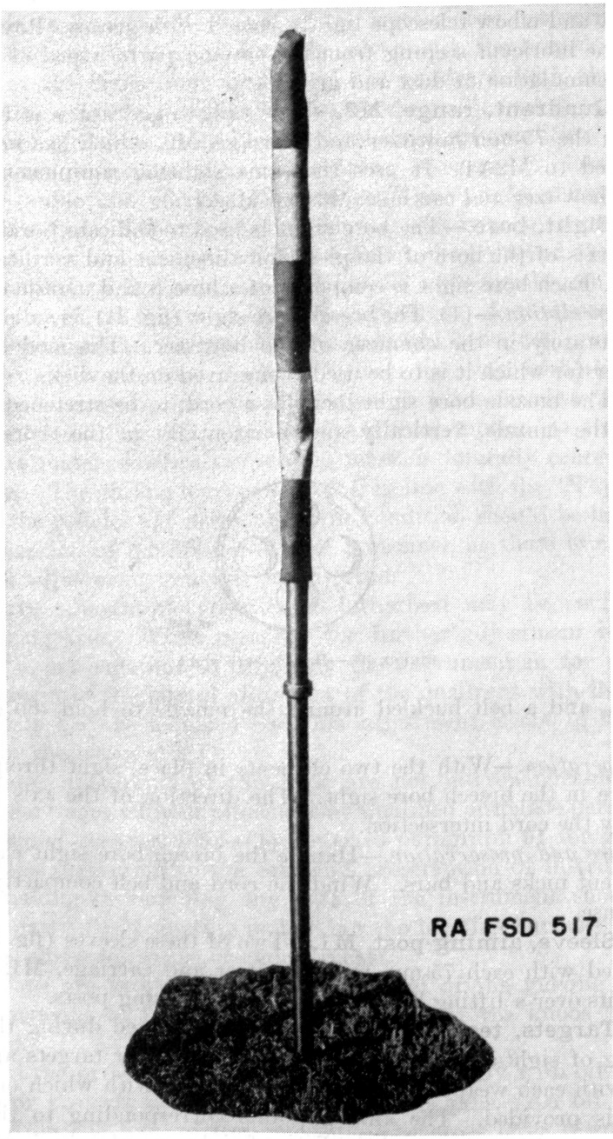


FIGURE 35.—Aiming post sleeve, M1.

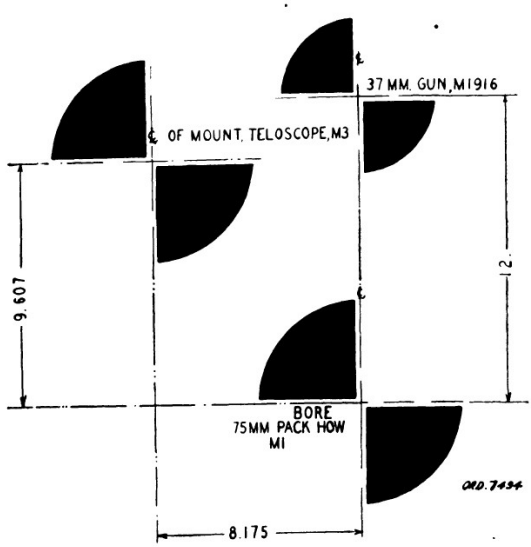


FIGURE 36.—Testing target, carriage, M1.

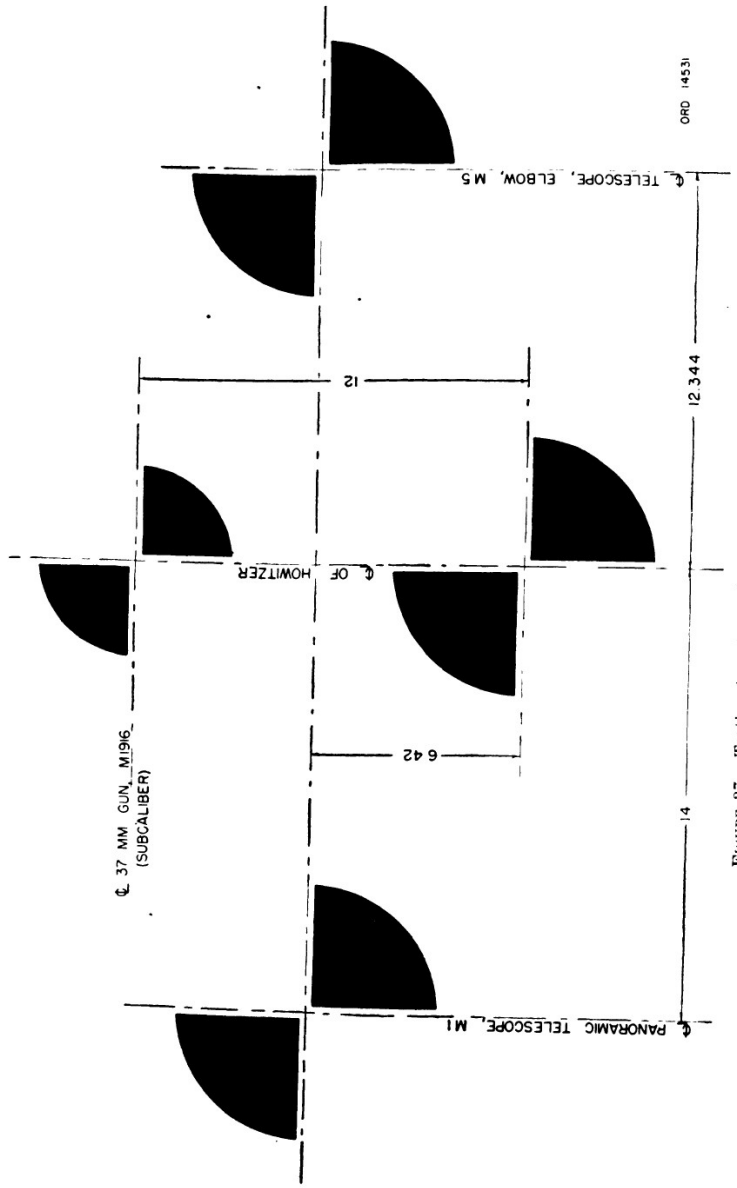


FIGURE 37.—Testing target, carriages, M2A1, M3, and M3A1.

SECTION II

FIRE CONTROL EQUIPMENT

83. Circles, aiming.—*a. General.*—These instruments are for measuring lateral and vertical angles and for general topographical work. The aiming circle, M1, is intended for issue with the 75-mm howitzer. However, aiming circles, M1916, M1916M1, and M1918, may be used as substitutes.

b. Aiming circle, M1.—(1) *Description.*—This instrument (fig. 38) is used for measuring angles in azimuth and site and for general topographical work.

It includes a 4-power telescope with a laterally and vertically graduated reticle, two levels, a declinator, elevating, orienting, and

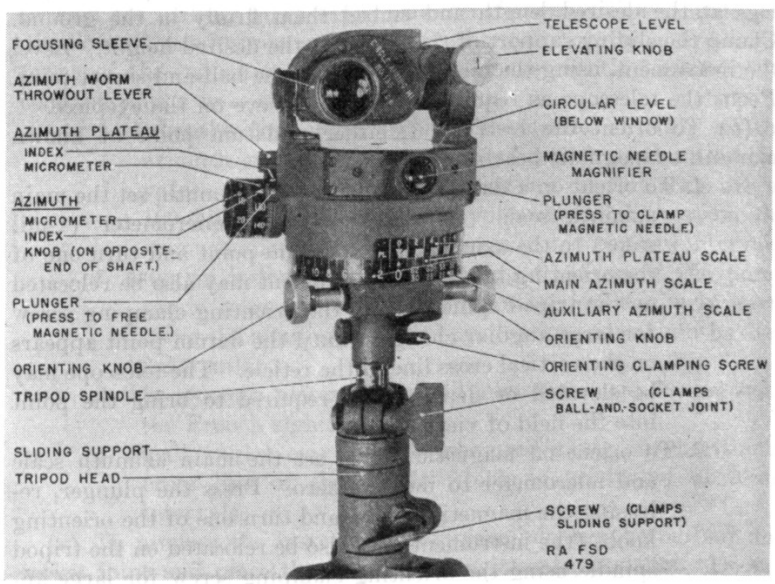


FIGURE 38.—Aiming circle, M1.

azimuth mechanisms, and azimuth scales and micrometers. Azimuth indications are in mils, numbered to correspond to the scale indications of other instruments commonly used with the aiming circle. For this purpose two separate azimuth scales with micrometers are provided—namely, the azimuth plateau scale and micrometer and the azimuth scale and micrometer. Azimuth plateau scale indications are read on the upper of the two lower horizontal-drum scales (fig. 38) and the inside micrometer and index. The outer azimuth micrometer is used when reading the lower main azimuth scale. No scale other than that on the reticle is provided for vertical angles. The instrument is furnished complete with tripod and carrying case.

(2) *Description of instrument light.*—All aiming circles, M1, are being equipped with the instrument light, M2, which includes a battery case connected by flexible cords to a reticle unit and a hand light. The battery case, containing one flashlight cell, is arranged to be clamped to a tripod leg and has a switch controlling both lamps. The reticle unit snaps in place in a dovetailed slot over the reticle illuminating window. The hand light is held in a spring clip on the battery case when not in use. The aiming circle carrying case is being modified to permit storage of the flashlight cell separately from the battery case.

(3) *Operation.*—(*a*) To set up the instrument, clamp the tripod legs at the desired length and embed them firmly in the ground. Clamp the sliding support of the tripod at the desired height. Level the instrument, using the circular level and the ball-and-socket joint. Focus the telescope as required, using the sleeve on the eyepiece.

(*b*) To orient the instrument, either a datum point of known azimuth or magnetic bearings may be used.

1. To orient on a datum point of known azimuth, set the main azimuth scale (100-mil steps) and micrometer (1-mil steps) to the azimuth of the datum point and turn one of the orienting knobs (the instrument may also be relocated on the tripod spindle using the orienting clamping screw for large angular changes) until the datum point appears on the vertical cross line of the reticle. The telescope may be elevated or depressed as required to bring the point into the field of view.

2. To orient on magnetic north, set the main azimuth scale and micrometer to indicate zero. Press the plunger, releasing the magnetic needle, and turn one of the orienting knobs (the instrument may also be relocated on the tripod spindle using the orienting clamping screw for large an-

gular changes) until the north-seeking (knife-edge) end of the magnetic needle appears approximately opposite an index behind the latter "N", at the front of the instrument. Then refine the setting so that the south-seeking (rectangular) end of the needle is centered in the reticle, viewed through the magnifier. The instrument will then indicate magnetic azimuths.

3. To orient on grid north, proceed as for magnetic north but set the azimuth to the magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. The instrument will then indicate grid azimuths.

4. When orientation by magnetic bearings has been completed, press the red plunger to clamp the magnetic needle.

(*c*) To read angle of site, rotate the elevating knob so that the bubble of the telescope level is centered. The angle of site of the object is then indicated by its position on the graduations at 5-mil intervals along the vertical cross line of the reticle. Angles of site thus measured are limited to ±85 mils. No other indicating means are provided.

(*d*) To read azimuth, bring the object on the vertical cross line of the reticle, using the azimuth knob. The throwout lever may be depressed for making large rapid azimuth changes. The azimuth indications of this instrument may be read either directly in mils or in terms of the indications of the "on" carriage sighting instruments commonly used in connection therewith.

1. Azimuths from 0 to 6,400 mils are read directly on the azimuth scales, using the main (upper) graduations for values above 3,200 mils. Indications on this scale are at 100-mil intervals and are supplemented by those on the azimuth micrometer, which is graduated at 1-mil intervals.

2. Angular indications corresponding to those of the panoramic telescope (0–3,200-mil scales) are similarly read, using the auxiliary (lower) graduations for azimuths over 3,200 mils.

3. The azimuth plateau scale and micrometer are for use with the French sight, M1901.

4. Small angles may also be measured along the horizontal cross line of the reticle which is graduated at 5-mil intervals.

(*e*) To prepare the instrument for traveling, loosen the ball and socket joint and place the instrument in its carrying case. Do not remove the instrument from the tripod.

(4) *Tests and adjustments.*—(*a*) The azimuth and plateau micrometers should read "0" and "100", respectively, when the azimuth scale indicates zero. Three screws in the end of the azimuth micrometer may be temporarily loosened for this adjustment.

(*b*) The telescope level should indicate the line of sight determined by the center of the reticle to be horizontal. This may be verified by sighting on a distant point at the same level as the telescope, the error, if any, being read on the reticle. No corrective adjustment by the using arm is permitted. A celluloid strip is provided on the front of the instrument, on which any correction should be recorded.

(*c*) To check the accuracy of the declinator (to declinate the instrument) set up the instrument at some point which is subject to a minimum of local magnetic attraction and from which several points can be seen and the grid (Y) azimuth of which can be determined from the map. Measure the magnetic azimuth to each of the points. Subtract the magnetic azimuths as measured by the instrument from the Y-azimuths (increased by 6,400, if necessary) as taken from the map for each object. The average of these differences will be the *declination constant* for that particular instrument. Record the value on the celluloid strip on the instrument. If the instrument is to be used in another locality, the declination constant again is determined for the new locality. No adjustment of the declinator by the using arm is permitted.

c. Aiming circles, M1916 and M1916MI.—These two types of aiming circles (fig. 39), are similar in construction except for minor design features.

(1) *Description.*—These instruments include a 4.2-power fixed-focus telescope with a laterally and vertically graduated reticle, a circular level, a declinator, elevating, orienting, angle of site, and azimuth mechanisms, and azimuth and elevation scales and micrometers. The instruments are furnished complete with tripods, stands, and two carrying cases.

(2) *Operation.*—(*a*) To set up the instruments, clamp the tripod legs at the desired length, embed them firmly in the ground, and tighten the leg clamping levers. Place the aiming circle on the mount, level by means of the ball-and-socket joint and circular level, and clamp the joint when the level bubble is centered. Swing the shutter over the telescope objective up so that the opening therein is in the direction of the line of sight.

(*b*) To orient the instrument, either a datum point of known azimuth or magnetic bearings may be used.

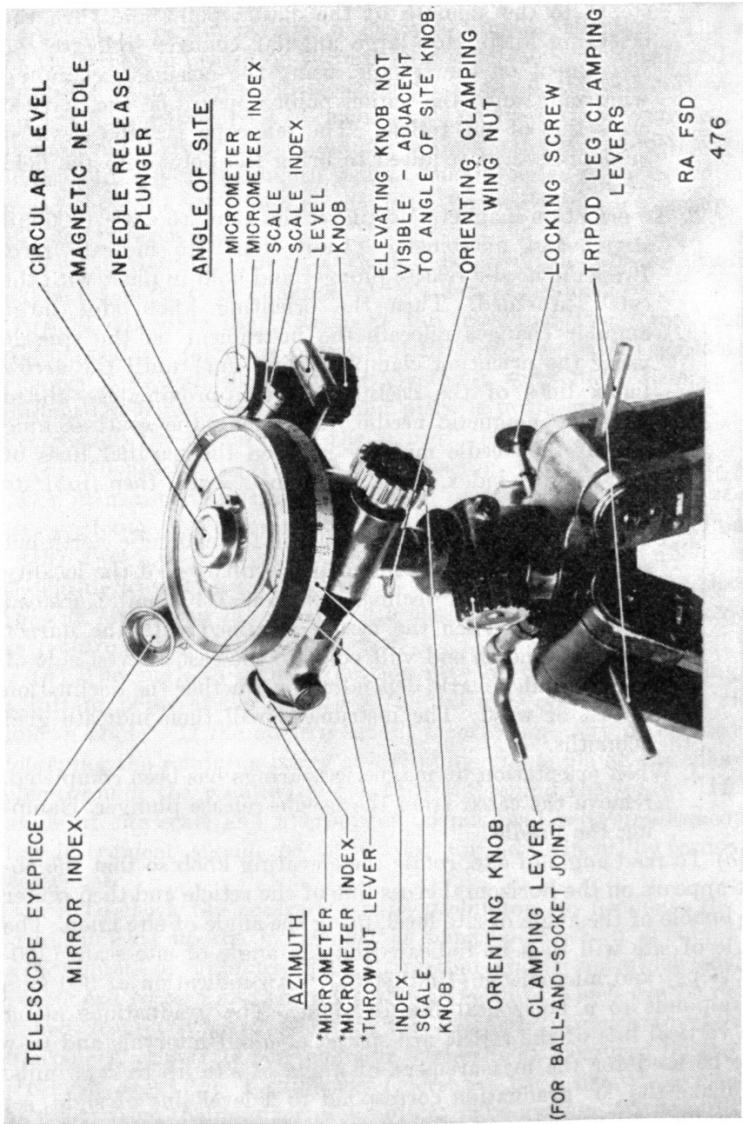


FIGURE 39.—Aiming circle, M1916. (Aiming circle, M1916MI, is similar in appearance but parts designated by an asterisk (*) are on the same end of the shaft as the knob.)

1. To orient on a datum point of known azimuth, set the azimuth scale (100-mil steps) and micrometer (1-mil steps) to the azimuth of the datum point and turn the orienting knob (for large angular changes, relocate the instrument on the spindle, using the orienting clamping wing nut) until the datum point appears on the vertical cross line of the reticle. The telescope may be elevated or depressed as required to bring the point into the field of view.

2. To orient on magnetic north, set the azimuth scale (100-mil steps) and micrometer (1-mil steps) to indicate zero. Press the needle release plunger and hold in place with the catch provided. Turn the orienting knob (for large angular changes relocate the instrument on the spindle using the orienting clamping wing nut) until the arrow index lines of the declinator are approximately alined with the magnetic needle, then bring the south-seeking end of the needle midway between the parallel lines of the mirror index. The instrument will then indicate magnetic azimuth.

3. To orient on grid north, proceed as for magnetic north but set the azimuth to the magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. When the needle is alined with the mirror index, the north end will point to the east or west side of the "N" index mark, depending on whether the declination is east or west. The instrument will then indicate grid azimuths.

4. When orientation by magnetic bearings has been completed, remove the catch from the needle release plunger, clamping the needle.

(*c*) To read angle of site, rotate the elevating knob so that the object appears on the horizontal cross line of the reticle and then center the bubble of the angle of site level, using the angle of site knob. The angle of site will then be indicated on the angle of site scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight. The graduations along the vertical line of the reticle are spaced at 5-mil intervals and may also be used for the measurement of angle of site up to ±85 mils. To make the "0" graduation correspond to a level line of sight, set the angle of site scale and micrometer to "normal" (300 mils) and elevate or depress the telescope to center the level bubble.

(*d*) To read azimuth, bring the object on the vertical cross line of the reticle, using the azimuth knob. The throwout lever may be depressed to permit making large rapid angular changes. The azimuth is then indicated on the azimuth scale (100-mil steps) and micrometer (1-mil steps). For azimuths in the 3,200–6,400-mil region an auxiliary (upper) set of graduations on the scale is provided, the indications thereon corresponding to those on panoramic telescopes with 0–3200, 0–3200 azimuth scales. Small angles may also be measured along the horizontal cross line of the reticle, which is graduated at 5-mil intervals.

(*e*) For use in darkness, a window is provided near the eyepiece of the telescope, to be illuminated by external means.

(*f*) To prepare the instrument for traveling, swing the shutter down over the telescope objective. Be sure the magnetic needle is clamped. Release the orienting clamping wing nut. Remove the aiming circle from the mount and place it in its carrying case. Do not remove the mount from the tripod.

(*g*) To use the instrument in connection with a plotting board, place it on the stand provided instead of on the tripod. The stand has a reference edge permitting use of the aiming circle as an alidade.

(3) *Tests and adjustments.*—(*a*) The azimuth scale and micrometer should indicate zero simultaneously. To make this adjustment, loosen the retaining screw in the end of the shaft, slip the micrometer around as required, then tighten the screw.

(*b*) The angle of sight indication may be verified by sighting on a distant point at the same level as the telescope or at some other known angle. If the error is small, a correction may be applied by loosening the retaining screw and slipping the angle of site micrometer through the required angle, then tightening the screw. If the angle of site scale and micrometer do not read zero simultaneously the instrument should be turned in for adjustment by ordnance personnel.

(*c*) To check the accuracy of the declinator (to declinate the instrument) set up the instrument at some point which is subject to a minimum of local magnetic attraction and from which several points can be seen and the grid (Y) azimuth of which can be determined from the map. Measure the magnetic azimuth to each of the points. Subtract the magnetic azimuths as measured by the instrument from the Y-azimuths (increased by 6,400, if necessary) as taken from the map for each object. The average of these differences will be the *declination constant* for that particular instrument. Record the value. If the instrument is to be used in another locality,

the declination constant again is determined for the new locality. No adjustment of the declinator by the using arm is permitted.

(*d*) The ball-and-socket joint of the mount should have a snug friction fit when the associated clamping lever is released. Excessive tightness or lost motion may be adjusted by means of the plug in the center of the bottom of the mount. This plug is locked by the retaining ring concentric therewith, which must be loosened for adjusting. Tighten the retaining ring securely when adjustment is completed.

d. Aiming circle, M1918 (French).—(1) *Description.*—This instrument (figs. 40 and 41), includes a 4-power telescope with a laterally and vertically graduated reticle, two levels, a declinator, elevating, orienting, and azimuth mechanisms, and azimuth scales and micrometers indicating both in mils and in "drum" and "plateau" settings of the French sight, M1901. No scale other than that on the reticle is provided for vertical angles. The instrument is furnished complete with tripod and carrying case.

(2) *Operation.*—(*a*) To set up the instrument, clamp the tripod legs at the desired length and embed them firmly in the ground. Clamp the sliding support of the tripod at the desired height by means of the clamping screw in the tripod head. Level the instrument, using the circular level and the ball-and-socket joint. Focus the telescope as required, using the focusing ring on the eyepiece.

(*b*) To orient the instrument, either a datum point of known azimuth or magnetic bearings may be used.

1. To orient on a datum point of known azimuth, set the azimuth scale (100-mil steps) and micrometer (1-mil steps) to the azimuth of the datum point and turn one of the orienting knobs (the instrument may also be relocated on the tripod spindle using the orienting clamping screw for large angular changes) until the datum point appears on the vertical cross line of the reticle. The telescope may be elevated or depressed as required to bring the point into the field of view.

2. To orient on magnetic north, set the azimuth scale and micrometer to indicate zero. Rotate the declinator locking lever to permit the magnetic needle to swing free. Turn one of the orienting knobs (the instrument may also be relocated on the tripod spindle using the orienting clamping screw for large angular changes) so that the south-seeking end of the magnetic needle is in exact alinement with the rear index of the declinator as viewed

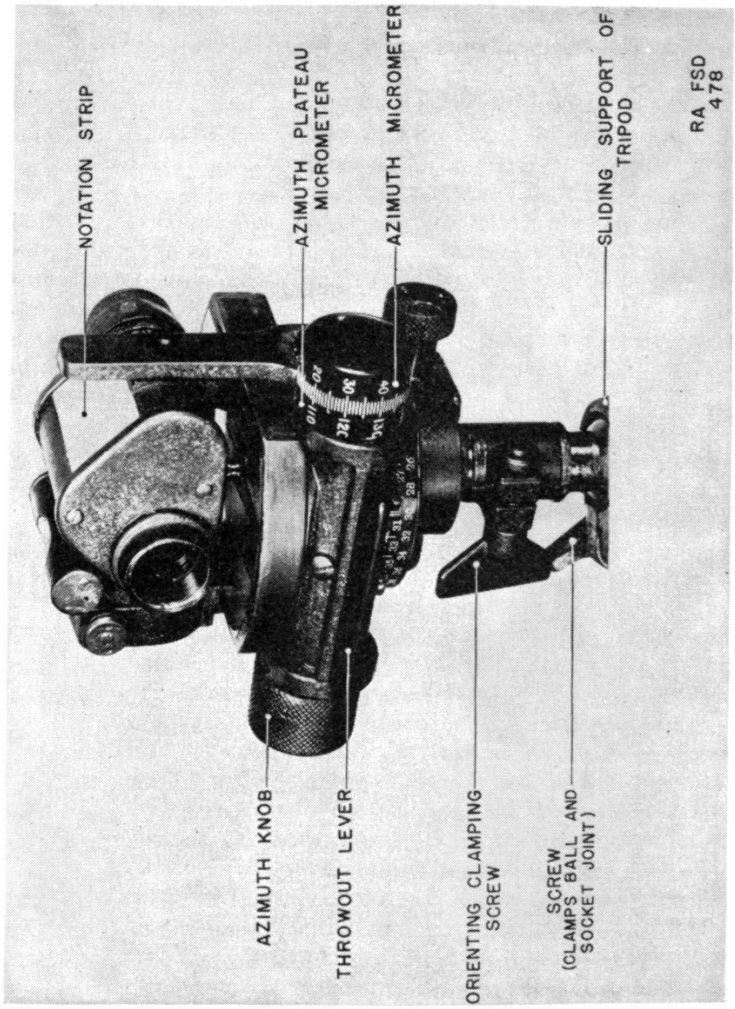


FIGURE 40.—Aiming circle, M1918 (French)—front view.

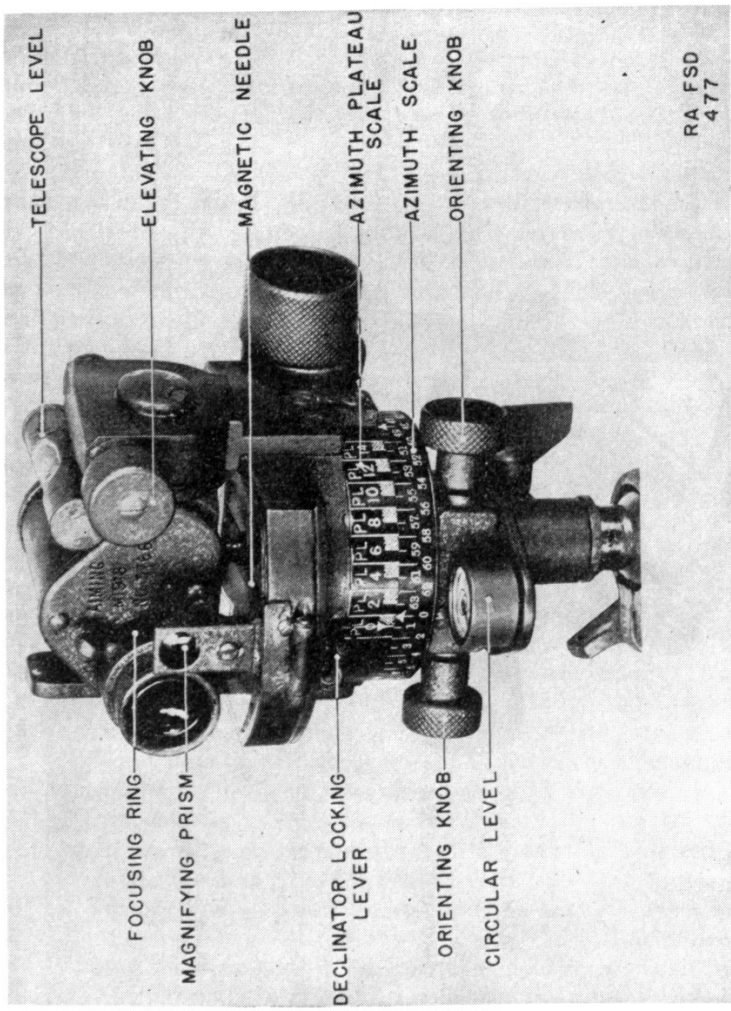


FIGURE 41.—Aiming circle, M1918 (French)—rear view.

through the magnifying prism. The instrument will then indicate magnetic azimuths.

3. To orient on grid north, proceed as for magnetic north but set the azimuth to the magnetic declination of the locality (subtracting west declinations from 6,400 mils) instead of to zero. The instrument will then indicate grid azimuth.

4. When orientation by magnetic bearings has been completed clamp the needle by means of the declinator locking lever.

(*c*) To read angle of site, rotate the elevating knob so that the bubble of the telescope level is centered. The angle of site of an object is then indicated by its position on the graduations at 5-mil intervals along the vertical cross line of the reticle. Angles of site thus measured are limited to ±100 mils. No other indicating means are provided.

(*d*) To read azimuth, bring the object on the vertical cross line of the reticle, using the azimuth knob. The throwout lever may be depressed for making large rapid azimuth changes.

1. The azimuth indication of this instrument may be read either directly in mils or in terms of the indications on the French sight, M1901. Azimuth in mils is read directly on the azimuth scale (100-mil steps) and micrometer (1-mil steps).

2. Indications corresponding to those on the French sight (four 0–1,600-mil quadrants graduated in 200-mil steps) are read on the azimuth plateau scale, read opposite one of the four index marks (at the 0, 16, 32, and 48 graduations of the azimuth scale). The even-numbered graduations only on the azimuth plateau scale are read. Supplementary indications are as read on the deflection scale ("drum") of the sight. When the index points into a clear space on the azimuth plateau scale, the supplementary indication is read on the azimuth micrometer (0–100 mils). When the index points into a cross-hatched space on that scale, the supplementary indication is read on the azimuth plateau micrometer. The two micrometers are read opposite different indexes. The azimuth plateau micrometer (upper) index bears cross hatching for ready identification.

3. Small angles may also be measured along the horizontal cross line of the reticle which is graduated at 5-mil intervals.

(*e*) To prepare the instrument for traveling, loosen the ball-and-socket joint and place the instrument in its carrying case. Do not remove the instrument from the tripod.

(3) *Tests and adjustments.*—(*a*) The azimuth and plateau micrometers should read "0" and "100", respectively, when the azimuth scale indicates zero. The screw in the end of the micrometer shaft may be loosened for this adjustment.

(*b*) The telescope level should indicate the line of sight determined by the center of the reticle to be horizontal. This may be verified by sighting on a distant point at the same level as the telescope, the error, if any, being read on the reticle. No corrective adjustment by the using arm is permitted. A celluloid notation strip is provided on the telescope, on which any correction should be recorded.

(*c*) To check the accuracy of the declinator (to declinate the instrument) set up the instrument at some point from which several points can be seen and the grid (Y) azimuths of which can be determined from the map. Measure the magnetic azimuth to each of the points. Subtract the magnetic azimuths (increased by 6,400 if necessary) as taken from the map for each object. The average of these differences will be the *declination constant* for that particular instrument. Record the value on the celluloid strip on the instrument. If the instrument is to be used in another locality, the declination constant again is determined for the new locality. No adjustment of the declinator by the using arm is permitted.

e. Care and preservation of aiming circles.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Exposed moving parts should be oiled occasionally with a small quantity of lubricating oil. Interior parts are not to be lubricated by the using arm. Keep access lubricant that seeps from the mechanism wiped off to prevent accumulation of dust and grit.

84. Compass, prismatic, M1918 (Sperry).—This instrument (fig. 42) is used for measuring angles of site, clinometer angles, and magnetic azimuths.

a. Description.—This instrument is furnished complete with a leather carrying case but without tripod. The instrument includes a compass dial (green) carrying a magnetic needle and azimuth scales, a weighted clinometer dial (white), and a sighting system whereby angular indications may be read while observing the object.

b. Operation.—(1) To measure angles of site, raise the leaf sight and the rear sight. Pull out the clinometer wedge knob to permit

free rotation of the clinometer dial. Focus the rear sight on the clinometer (white) dial, sliding the sight as required and clamping it in position with the rear sight knob. Hold the instrument with the dials in vertical plane, look through the niche in the rear sight, and elevate or depress the instrument until the object observed is in line with the horizontal central vane of the leaf sight. The angle of site, reflected in the rear sight prism, will also be visible in the center of the field of view. The angle of site scale (the outer scale on the clinometer dial) is graduated at 5-mil intervals and numbered at 100-mil intervals. The 50-mil points are also marked. A 300-mil indication corresponds to a level line of sight, as on the correspond-

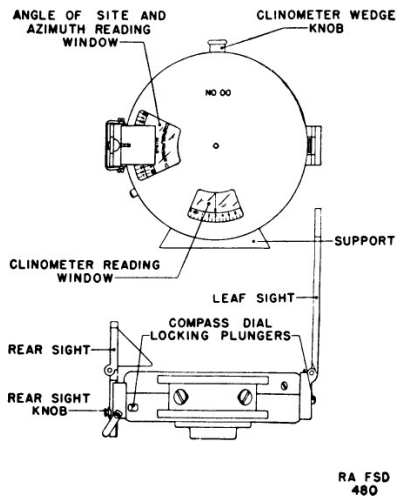


FIGURE 42.—Prismatic compass, M1918 (Sperry).

ing scales of range quadrants. The clinometer wedge knob may be partially depressed to damp out oscillations. It must not be depressed, however, when taking the reading.

(2) To measure azimuths, first operate the instrument in angle of site until the compass (green) dial is exposed at the rear sight by the cut-away portion of the clinometer (white) dial. Depress the clinometer wedge knob. Raise the leaf sight and the rear sight. Focus the rear sight on the compass (green) dial, sliding the sight as required and clamping it in position with the rear sight knob. Hold the instrument in the hand or support it on a convenient nonmagnetic body. Look through the niche in the rear sight and rotate the instrument in azimuth until the object observed is in line with the

vertical central vane of the leaf sight. The magnetic azimuth, reflected in the rear sight prism, will also be visible in the center of the field of view. The compass dial is graduated at 10-mil intervals and numbered at 100-mil intervals. Additional numbering is provided in the 3,200–6,400-mil half of the scale to correspond to the numbering on the azimuth scales of panoramic telescopes which are graduated 0–3,200 mils in this range. To damp out oscillations of the compass dial, depress gently one of the locking plungers. Plungers must not be in the depressed position when taking the azimuth reading.

(3) To use the instrument as a clinometer, pull out the clinometer wedge knob and stand the instrument, prism to the rear, on its support, on a straight portion of the piece which is parallel to the bore. The reading of the clinometer scale, read opposite an etched line on the clinometer reading window, is the elevation of the piece. The clinometer scale is graduated at 10-mil intervals and numbered at 100-mil intervals. A 300-mil reading indicates the bore of the piece to be level. The sights should not be raised when using the instrument only as a clinometer. The clinometer wedge knob may be partially depressed to damp out oscillations. It must not be depressed, however, when taking the reading.

(4) To prepare the instrument for traveling, push in the clinometer wedge knob (clamping the clinometer dial) and turn the leaf sight down (clamping the compass dial). Lower and fold back the rear sight, securing it in place with the catch. Place the instrument in its leather case.

c. Tests and adjustments.—Accuracy of the azimuth and angle of site indications may be checked by sighting on datum points of known azimuth and elevation. When placed on a flat level surface the clinometer should indicate 300. No adjustment by the using arm is permitted.

d. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) When not in use keep the leaf sight down, clamping the compass dial, and keep the clinometer wedge knob depressed, clamping the clinometer dial, thus preventing injury to, and excessive wear of their respective pivots.

(3) Observe particular care to prevent bending of the leaf sight parts.

(4) No lubrication of the instrument is required.

85. Finder, range, 1-meter base, M1916.—This instrument (figs. 43 and 44) is used primarily for measuring distance by triangulation. Indications of azimuth and angle of site are also provided.

a. Description.—The instrument includes an internal 1-meter base line, a 15-power optical system with two objectives and a common eyepiece of the coincidence type, and a scale on which the distance is indicated. It is furnished complete with mount and tripod. The necessary carrying cases and adjusting equipment are provided as accessories. The mount positions the line of sight of the range finder in elevation and azimuth and provides a hinge joint for placing the base line axis of the instrument in either a vertical or a horizontal position. Angle of site and azimuth scales and micrometers are provided on the mount.

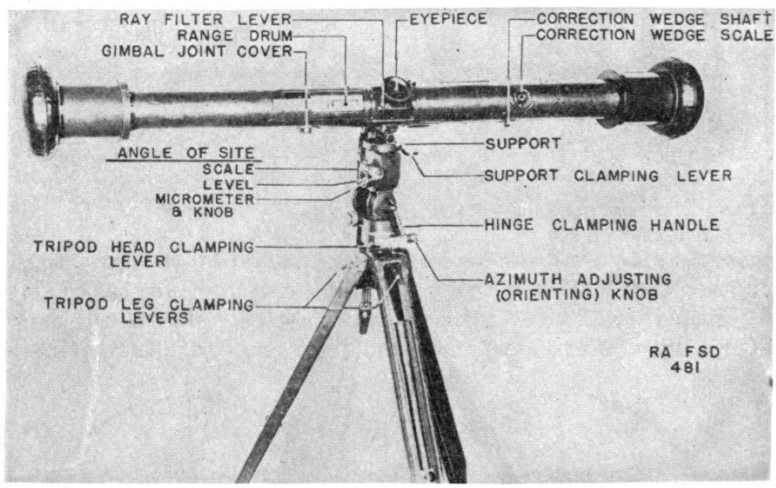


FIGURE 43.—Range finder, M1916, 1-meter base—rear view.

b. Operation.—(1) To set up the instrument, clamp the tripod legs securely at the desired length, embed them firmly in the ground, and tighten the leg clamping levers. It is necessary that the azimuth scale be in a substantially horizontal plane. Place the range finder on the mount and latch it in position. Position the longitudinal axis horizontally and clamp with the hinge clamping handle. Procedure for a vertical base line is described in (5) below.

(2) To prepare the optical system for use, rotate the end box sleeves, uncovering both windows. Set the ray filter lever to the proper position. No filter at all may be used, or the amber filter (for exceptionally bright daylight or reflection of sun over water) or the smoked filter (for observation near the sun or into direct rays of a searchlight) may be employed. Focus the eyepiece by rotating

the diopter scale to produce a clear image. If the operator knows the value for his own eye, the setting may be made directly on the scale.

(3) To orient the instrument, select a datum point of known azimuth. Set this value of azimuth on the azimuth scale and micrometer. Loosen the tripod head clamping lever and swing the instrument until the datum point appears near the vertical center line of the field of view, indicated by a short line in the lower field of view. Clamp the lever and refine the setting with the azimuth adjusting

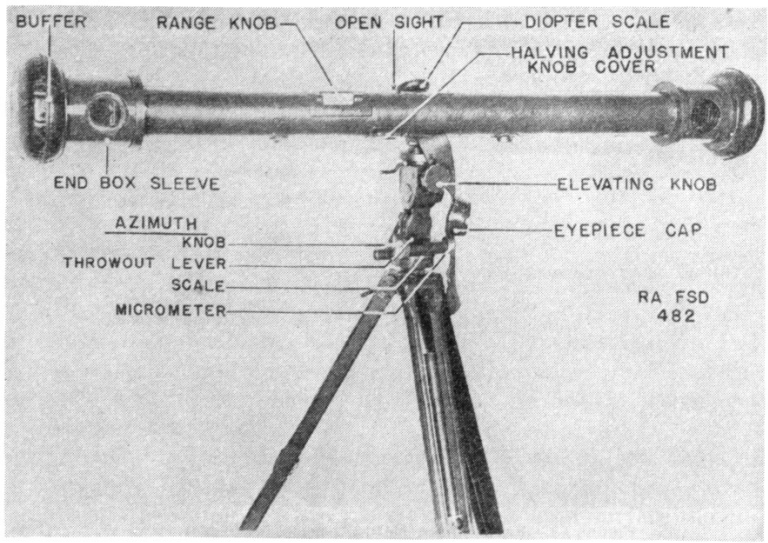


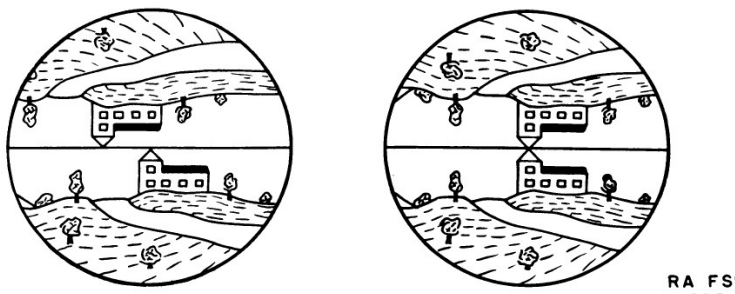
FIGURE 44.—Range finder, M1916, 1-meter base—front view.

(orienting) knob so that the point appears exactly on the vertical center line.

(4) To measure the range of an object, select a clearly defined part perpendicular, if possible, to the halving line. Move the instrument in azimuth and elevation as required to bring the part at the center of the field of view when in coincidence. On moving targets it is advisable to start with the target at the edge of the field of view so that it may be brought into coincidence as it crosses the field. An open sight is provided for picking up the target. For large angular displacements in azimuth, depress the throwout lever and turn the instrument as required. When first observed, the images will ordinarily not be in coincidence (fig. 45①). Turn the range,

knob until the images of the point selected appear in coincidence (fig. 45②). Read the range, in yards, on the range drum, opposite the sliding range pointer.

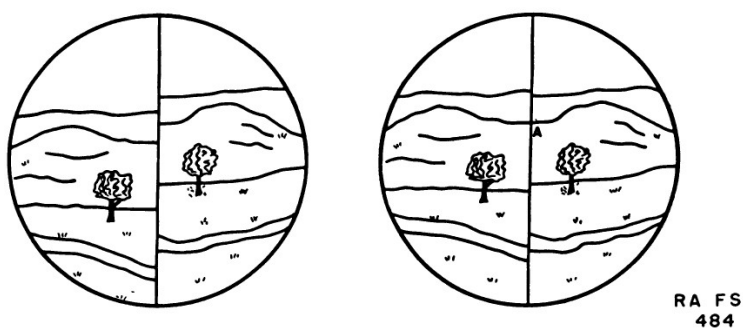
(5) To measure the range of horizontal objects, such as roads, trenches, crests of ridges, etc., which have no prominent vertical



① Not in coincidence. ② In coincidence.

FIGURE 45.—Range finder field of view—horizontal base.

parts, turn the instrument with the longitudinal axis vertical, temporarily loosening the hinge clamping handle for the purpose. The images when first observed will ordinarily not be in coincidence (fig. 46①). Turn the range knob until the image of the horizontal line



① Not in coincidence. ② In coincidence at A.

FIGURE 46.—Range finder field of view—Vertical base.

appears to continue across the halving line (as at A in fig. 46②). Lower the support clamping lever temporarily for any necessary motion in elevation (within the limits of ±40°).

(6) To read angle of site, center the level bubble, using the angle of site knob. The angle of site indication may then be read on the

associated scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight. Angle of site can be read only when using the instrument with the longitudinal axis horizontal.

(7) To read azimuth, the azimuth scale (100-mil steps) and micrometer (1-mil steps) furnish the necessary indications. It is essential that the plane of the azimuth scale be substantially level and that the object be at the center of the field of view for correct angular indications. Azimuth may be measured with the longitudinal axis either vertical or horizontal, but the instrument must be oriented separately for each position. Azimuths from 3,200 to 6,400 mils have an additional auxiliary scale reading from 0 to 3,200 mils for use with panoramic telescopes similarly graduated.

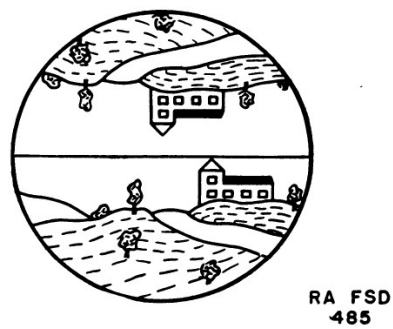


FIGURE 47.—Range finder field of view—incorrect halving.

(8) To prepare the instrument for traveling, cover the eyepiece, close the end box sleeves, and cover over the range drum. Remove the range finder from the mount and place in its case. Place the mount and tripod in its case, with the elevating knob toward the inside of the case. Do not remove the mount from the tripod. Remove the sight from the adjusting lath. Place the lath in the internal pocket of the tripod carrying case and the sight in the lid pocket. The latter pocket also contains the correction wedge key and a camel's-hair brush.

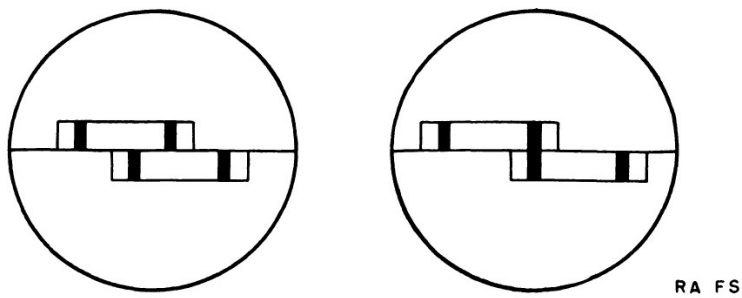
c. Tests and adjustments.—(1) *Halving line.*—Incorrect adjustment of the halving line is indicated by the failure of the corresponding points on the inverted and erect images to fall on the halving line (fig. 47). To correct the halving, slide back the cover exposing the halving adjustment knob and rotate the knob until the corresponding point of each image touches the halving line (as in figs. 45① and 45②). A sharply defined point at least 400 yards away must be

used for this adjustment. Return the cover to its original position when the adjustment is completed.

(2) *Range indications.*—(*a*) To test the instrument using a finite range, select a sharply defined object at a distance of 400 yards or more, the range of which is accurately known, and bring the object into coincidence in the center of the field of view (fig. 45②). If the range adjustment is correct, the known range should be indicated.

(*b*) To test using the moon or other celestial body (not the sun), proceed as for an object at finite range. Infinite range (00) should be indicated.

(*c*) To test the instrument by the infinity method, prepare the adjusting lath by inserting the sight. Place the adjusting lath in a horizontal position 125 yards or more from the instrument. Use



① Incorrect alinement. ② Correct alinement.

FIGURE 48.—Range adjustment—infinity method.

the sight on the lath to insure perpendicularity to the line of sight. Set the range drum to indicate infinite range. If the images appear alined as in (fig. 48②), the adjustment is correct. Misalinement, such as is shown in (fig. 48①), indicates the necessity for adjustment.

(*d*) To adjust the instrument in range, set at the known range or at infinity, depending on the method of test employed, and bring the images into correct relation, using the correction wedge key to turn the correction wedge shaft. Note the indication on the correction wedge scale, repeat several times, and set the scale to the average of the readings.

(*e*) It is essential that the adjusting lath, when used, be the one belonging with the instrument. The same serial number is provided on both.

(3) *Azimuth indications.*—Should the azimuth scale and micrometer fail to indicate zero simultaneously, the latter may be slipped

around as required, the clamping screw in the end being temporarily loosened.

(4) *Angle of site indications.*—Sight on a point at least 400 yards distant, at the same level as the range finder. The angle of site indication should be "normal" (300 mils). Corrections for small errors may be applied by slipping the angle of site micrometer through the required angle, the clamping screw in the end being temporarily loosened.

d. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) The gimbal joint cover is not to be removed by the using arm.

(3) Keep the cover over the halving adjustment knob closed except when making an adjustment.

(4) Do not point the range finder directly at the sun. This instrument contains a cemented prism which will be injured by such practice.

(5) Avoid striking or bumping the instrument at the ends when mounted, as the parts at the center will thereby be subjected to excessive stress.

(6) Exposed moving parts of the mount should be oiled occasionally, using oil, lubricating, for aircraft instruments and machine guns. Interior parts of the mount and range finder are not to be lubricated by the using arm. Keep excess lubricant that seeps from the mechanisms wiped off to prevent accumulation of dust and grit.

86. Glasses, field, type EE, 6-power.—The field glass, type EE, complete, consists of the field glass, neck strap, and carrying case.

a. Glasses, field.—(1) The field glass consists of two compact prismatic telescopes pivoted about a common hinge which permits adjustment for interpupillary distances. A scale, graduated every 2 millimeters from 56 to 74 permits the observer rapidly to set the telescopes to suit his eyes when spacing of his eyes is known. The eyepiece can be focused independently for each eye by screwing in or out. Each is provided with a diopter scale for rapid setting when the observer knows the correction for his eye.

(2) The left telescope is fitted with a glass reticle upon which are etched a vertical mil scale, a horizontal mil scale, and stadia graduated similarly to the sight leaf graduation on the service rifle.

b. Use.—The field glass is used for observations and the measurement of small horizontal and vertical angles in mils. The vertical stadia scale (inverted sight leaf) is used to pick up auxilary aiming marks in direct laying and to determine troop safety for overhead fire. Note that this reticle is graduated for caliber .30, M1906, ammu-

nition only. A newer type reticle does not have the leaf graduations and therefore does not pertain to any particular type of ammunition.

c. Preliminary adjustments; interpupillary distance.—To adjust the glass so that the eyepieces are the same distance apart as the pupils of the observer's eyes, point the glass at the sky and open or close the hinged joint until the field of view ceases to be two overlapping circles and appears to be one sharply defined circle. Note the reading on the scale, which indicates the spacing of the observer's eyes. The similar setting of any other field glass will then accommodate his eyes.

d. Focus of the eyepiece.—Look through the glasses, both eyes open, at an object several hundred yards away. Place the hand over the front of one telescope and screw the eyepiece of the other in or out until the object is sharply defined. Repeat this operation for the other eye, then note the reading on the diopter scales. The similar setting of any other field glass will accommodate the eyes.

e. Operation.—(1) In using the glass it should be held in both hands and pressed lightly to the eyes so as to keep the relation with the eyes constant without transmitting tremors from the body. The bent thumbs should fit into the outer edges of the eyes sockets in such a manner as to prevent light from entering in rear of the eyepieces. When possible, it is best to use a rest for the glass or elbows.

(2) The mil scales are seen when looking through the glass, and by superimposing them upon the required objects the horizontal and vertical angles may be read between these objects.

f. Care.—The field glass is a rugged, serviceable instrument, but should not be abused or roughly handled.

87. Setter, fuze, bracket, M1916A2.—This fuze setter (fig. 49) mounts on the 75-mm. howitzer carriages, M2A1, M3, and M3A1. It is used for setting the 21-second powder train fuze, M1907M. It is furnished completed with a canvas cover and metal anchor.

a. Operation.—(1) Check to see that the range ring corresponds to the matériel and ammunition in use. This information is engraved on the range ring.

(2) Using the crank, set the desired value of range opposite the range index. By means of the corrector knob set the desired value of correction opposite the correction index. A setting of "30" corresponds to zero corrector.

(3) Insert the round, fuze foremost, into the setter without regard to the relative position of fuze pins and setter parts. With the round pressed firmly into the setter, rotate the round manually in a clockwise direction until a stop is encountered.

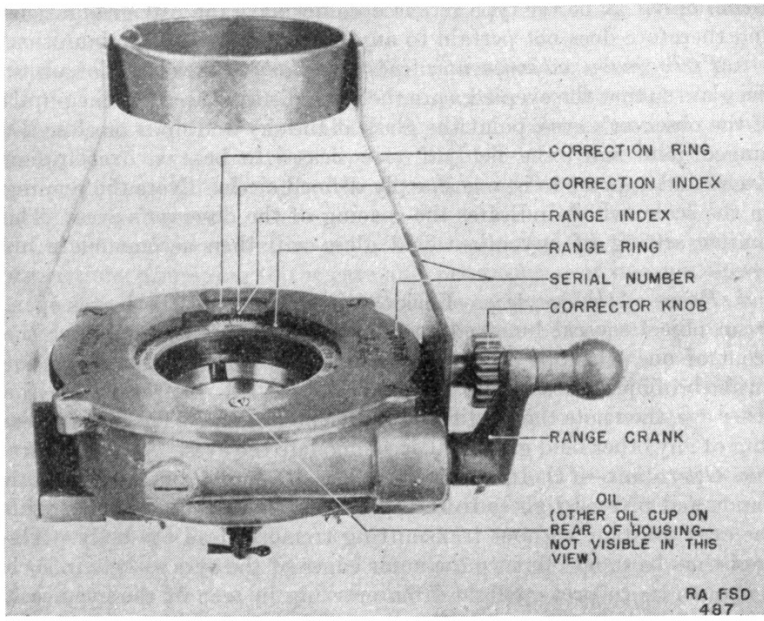


FIGURE 49.—Bracket fuze setter, M1916A2 (without anchor).

(4) Leave the round in the setter until ready for use. Range or corrector may be changed with the round in place, the round then being again turned clockwise as in the original setting operation. Remove the round when ready for use, being careful not to change the fuze setting.

(5) To set a fuze to "safe", set the range at "S", the correction at "30", and proceed as for other settings.

b. Tests and adjustments.—The accuracy of a particular fuze setter may be verified by comparing the values of range indicated on the range scale with those actually set on the fuze. The procedure is as follows: Set corrector 30 and an arbitrary range on the fuze setter, and set a fuze. The time set on the fuze should agree with the firing-table time of flight for the particular range. Using several ranges, determine the average error. A false corrector may be applied to reduce the error. The only adjustments permitted the using arm are as follows:

(1) To eliminate looseness in either worm gear, loosen the set screw and, with a teat wrench, turn the adjusting plug clockwise.

Retighten the set screw. The range crank should not fall of its own weight.

(2) To eliminate end play in either worm shaft, remove the crank handle or knob by driving out the tapered pin, loosen the set screw, and tighten the bearing cap with a teat wrench. Retighten the set screw. Replace the handle or knob.

c. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Oil the mechanism occasionally through the two oil cups provided. Set range to zero when oiling.

(3) Rotate the round only in a clockwise direction. Incorrect settings and loosening of the fuze may result from failure to do so.

(4) Should the setter become clogged with sand or dirt so as to affect its operation, it is to be turned over to qualified ordnance personnel for cleaning.

(5) When not in use, protect the setter with its canvas cover.

88. Setter, fuze, hand, M1912A4.—This fuze setter (fig. 50) is provided with the carriage, M1. It is a small, portable device for setting the 21-second fuze, M1907M. It is furnished complete with

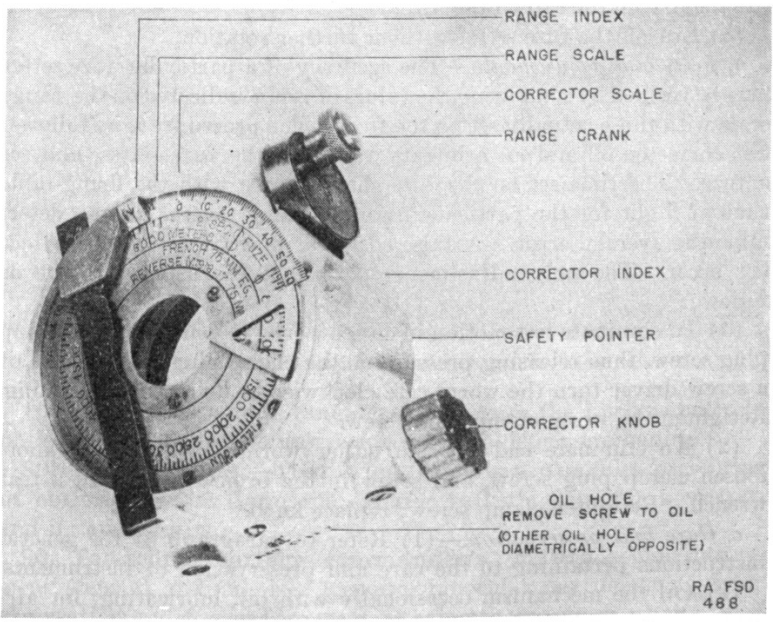


FIGURE 50.—Hand fuze setter, M1912, as formerly manufactured with ranges in meters. (Hand fuze setter, M1912A4, is similar in appearance but has a range scale graduated in yards and designated "75-mm pack howitzer, M1—shrapnel, M37.")

a leather carrying case. The range scale is graduated for shrapnel, although this ammunition is no longer used with the 75-mm howitzer. Although the fuze setter is not used for service ammunition it serves to simulate actual procedure with the M54 fuze and appropriate fuze setter, etc.

a. Operation.—(1) Check to see that the range scale corresponds to the matériel and ammunition in use. This information is engraved on the range scale.

(2) Push the range index to its outermost position, as shown in figure 50. Other positions of the index, originally intended for zone fire, are no longer used.

(3) Pull out the knob of the range crank and turn the crank until the desired range is indicated. By means of the corrector knob, set any desired corrector on the correction scale. Zero correction corresponds to "30" on the scale.

(4) Place the fuze setter over the point of the fuze and rotate the setter in a clockwise direction (as indicated by the arrow) until a stop is encountered, indicating completion of the setting operation. Verify the completion by noting that the safety pointer falls opposite the line on the cap on the fuze.

(5) Lift off the fuze setter without further rotation.

b. Tests and adjustments.—The accuracy of a particular fuze setter may be verified by comparing the values of range indicated on the range scale with those actually set on the fuze. The procedure is as follows: Set corrector 30 and an arbitrary range on the fuze setter, and set a fuze. The time set on the fuze should agree with the firing-table time of flight for the particular range. Using several ranges, determine the average error. A false corrector may be applied to reduce the error. The only adjustments permitted the using arm are as follows:

(1) To eliminate lost motion in either worm, loosen the worm clamp plug screw, thus releasing pressure on the clamp plug. By means of a screw driver turn the worm case clockwise in its eccentric bushing. Retighten the worm clamp plug screw.

(2) To eliminate end play in either worm shaft, remove knob, loosen clamp plug screw, and screw in the bronze plug with a teat wrench. Retighten clamp screw; replace knob.

c. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Oil the mechanism occasionally with oil, lubricating, for aircraft instruments and machine guns, through the two oil holes in the side of the case. The using arm may remove the screws for oiling. They are to be replaced immediately thereafter.

(3) Turn the fuze setter in a clockwise direction only. Incorrect settings and loosening of the fuze may result from failure to follow this procedure.

(4) Keep the fuze setter in its carrying case when not in use.

(5) Do not lay or drop the setter on the ground. Setters which become clogged with dirt so as to be inoperable are to be turned in for repair by ordnance personnel.

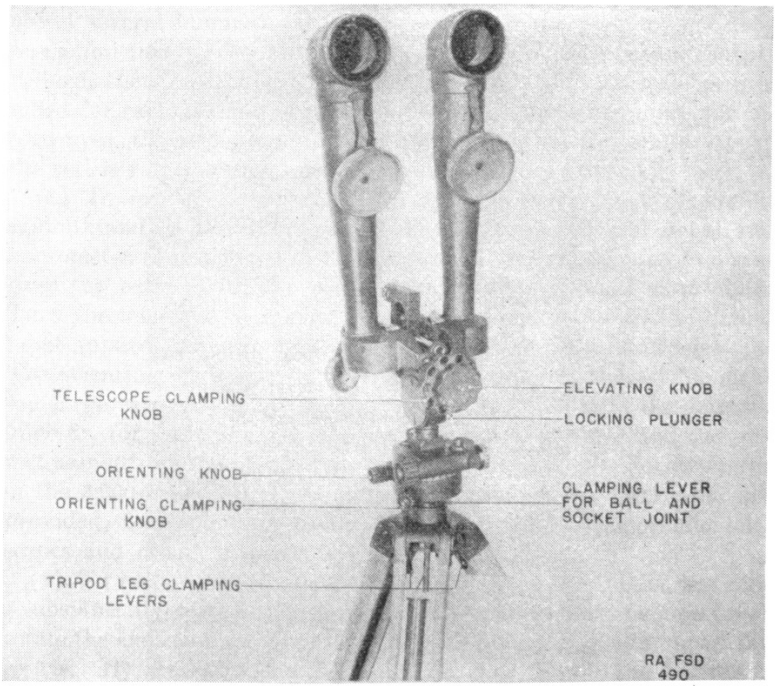


FIGURE 51.—Battery commander's telescope, M1915—front view.

(6) When turning the range crank, be sure the knob is entirely pulled out to prevent excessive wear on the detent mechanism.

89. Table, Firing.—The Firing Table is a pamphlet presenting in uniform tabular form the exterior ballistic data for a weapon and its ammunition.

90. Telescope, battery commander's, M1915.—This instrument (figs. 51 and 52), is a 10-power binocular instrument used for observation and for measurement of azimuth and angle of site.

a. Description.—The instrument complete includes a binocular telescope, mount, tripod, and, as accessories, the necessary carrying

cases, storage chest, and cleaning brushes. The telescopes are arranged so that they may be positioned vertically, as shown, or swung down horizontally.

b. Operation.—(1) To set up the instrument, remove the tripod and mount from the tripod carrying case, clamp the tripod legs at the desired length, embed them firmly in the ground, and tighten the leg clamping levers. Remove the telescope from its carrying case and place it on the vertical spindle extending from the mount, de-

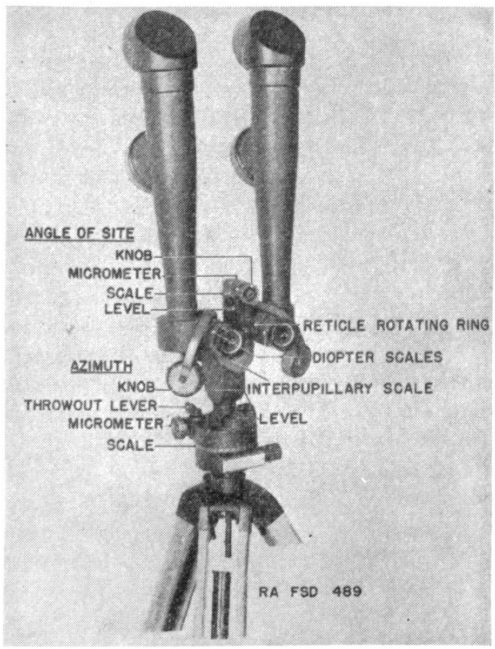


FIGURE 52.—Battery commander's telescope, M1915—rear view.

pressing the locking plunger and turning the telescope until the mating surfaces of telescope and mount engage properly, then releasing the plunger. Level the mount, using the circular level and the ball-and-socket joint at the bottom of the mount, and clamp with the lever when the level bubble is centered.

(2) To prepare the telescope, remove the caps from the eyepiece and objectives. If required, place the sunshades over the objectives and the amber filters over the eyelenses. Sunshades and filters are carried in compartments of the telescope case. Release the telescope

clamping knob and turn the telescopes to the vertical or horizontal position as required, at the same time setting the proper interpupillary distance in millimeters on the associated scale, and clamp in place. If the interpupillary distance for the observer is not known it may be found by observing the sky and moving the eyepieces apart or together until the field of view changes from two overlapping circles to one sharply defined circle. Focus each eyepiece independently, looking through the telescope with both eyes open at an object several hundred yards away, covering the front of one telescope and turning the diopter scale until the object appears sharply defined, then repeating for the other eye. A diopter scale is provided for each eye and if the observer remembers the values for his own eyes, the settings may be made directly on the scales. Turn the reticle rotating ring until the reticle appears erect.

(3) To orient the instrument, select a datum point of known azimuth and set this value on the azimuth scale (100-mil steps) and micrometer (1-mil steps). The throwout lever may be used to disengage the worm drive for making large rapid changes in azimuth. Turn the telescope by means of the orienting knob until the datum point appears at the center of the reticle of the right-hand telescope. The orienting clamping knob may be temporarily released for making large rapid angular changes. Thereafter, use only the azimuth knob or, for large changes, the azimuth throwout lever and the correct azimuth of the point observed will be indicated. For azimuths in the 3,200–6,400 mil region additional numbers (0–3,200 mils) are provided, corresponding to the azimuth scales on panoramic telescopes and other instruments.

(4) To read angle of site, swing the angle of site mechanism into a substantially vertical plane. Direct the telescope on the object and rotate the elevating knob until the object appears at the center of the reticle. By means of the angle of site knob, center the bubble of the angle of site level in its vial. The angle of site is then read on the angle of site scale (100-mil steps) and micrometer (1-mil steps). An indication of 300 mils corresponds to a horizontal line of sight.

(5) Angular indications on the reticle. The horizontal axis of the reticle is graduated at 5-mil intervals for 30 mils on each side of the center. The two short lines above the horizontal line are spaced 3 mils apart.

(6) To prepare the instrument for traveling, remove the sunshades and filters, if used, and place them in the pockets of the telescope carrying case. Cover the objectives and eyepieces. With the telescope shanks in a vertical position, press the locking plunger and

lift the telescope from the mount. Loosen the telescope clamping knob and swing the elevating mechanism against the right- or left-hand telescope. The instrument will then fit snugly into the blocking of the case. Do not remove the mount from the tripod. Tripod leg clamping levers should not protrude.

c. Tests and adjustments.—(1) The azimuth micrometer and azimuth scale should read zero simultaneously. The screw in the end of the micrometer may be temporarily loosened to permit slipping the micrometer to the desired position.

(2) The angle of site mechanism may be checked by observing a datum point of known angle of site. Small errors may be corrected by temporarily loosening the screw in the end of the knob and slipping the micrometer and knob to the correct position. Should the angle of site scale and micrometer then fail to indicate "3" and "0", respectively, simultaneously, the instrument should be turned in for adjustment by authorized ordnance personnel.

(3) The ball-and-socket joint of the mount should have a snug friction fit when the associated clamping lever is released. Excessive tightness or lost motion may be adjusted by means of the plug in the center of the bottom of the mount. This plug is locked by the retaining ring concentric therewith, which must be loosened for adjusting. Tighten the retaining ring securely when adjustment is completed.

d. Care and preservation.—(1) Refer to paragraph 91 for general instructions pertaining to the care and preservation of instruments.

(2) Exposed moving parts should be oiled occasionally with a small quantity of oil, lubricating, for aircraft instruments and machine guns (U. S. A. Spec. No. 2-27). Interior parts are not to be lubricated by the using arm. Keep excess lubricant that seeps from the mechanism wiped off to prevent accumulation of dust and grit.

91. General care and preservation of fire control equipment.—*a. General.*—(1) The instructions given hereunder supplement instructions pertaining to individual instruments included in preceding paragraphs.

(2) Fire control and sighting instruments are, in general, rugged and suited for the purposes for which designed. They will not, however, stand rough handling or abuse, and inaccuracy or malfunctioning will result from such mistreatment.

(3) Disassembly and assembly by the using arm is permitted only to the extent authorized in the paragraphs dealing with the individual instruments. Unnecessary turning of screws or other parts not incident to the use of the instrument is expressly forbidden.

(4) Keep the instruments as dry as possible. Do not put an instrument in its carrying case when wet.

(5) When not in use, keep the instruments in the carrying cases provided, or in the condition indicated for traveling.

(6) Any instruments which indicate incorrectly or fail to function properly after the authorized tests and adjustments have been made are to be turned in for repair by ordnance personnel. Adjustments other than those expressly authorized in the paragraphs dealing with the individual instruments are not to be performed by the using arm.

(7) No painting of fire control equipment by the using arm is permitted.

(8) Many worm drives have throwout mechanisms to permit rapid motion through large angles. When using these mechanisms, it is essential that the throwout lever be fully depressed to prevent injury to the worm and gear teeth.

(9) When using a tripod with adjustable legs, be certain that the legs are clamped tightly to prevent possibility of collapse.

(10) When setting up tripods on sloping terrain, place two legs on the downhill side to provide maximum stability.

b. Leather articles.—Care and preservation of leather articles are covered in AR 30–3040.

c. Optical parts.—(1) To obtain satisfactory vision, it is necessary that the exposed surfaces of the lenses and other parts be kept clean and dry. Corrosion and etching of the surface of the glass, which greatly interfere with the good optical qualities of the instrument, can be prevented or greatly retarded by keeping the glass clean and dry.

(2) Under no conditions will polishing liquids, pastes, or abrasives be used for polishing lenses and windows.

(3) For wiping optical parts use only paper specially intended for cleaning optical glass (U. S. A. Spec. No. 19–40). Use of cleaning cloths in the field is not permitted. To remove dust, brush the glass lightly with a clean camel's-hair brush and rap the brush against a hard body in order to knock out the small particles of dust that cling to the hairs. Repeat this operation until all dust is removed. With some instruments an additional brush with coarse bristles is provided for cleaning mechanical parts. It is essential that each brush be used only for the purpose intended.

(4) Exercise particular care to keep optical parts free from oil and grease. Do not wipe the lenses of windows with the fingers. To remove oil or grease from optical surfaces, apply ethyl alcohol

(U. S. A. Spec. No. 4–1018) with a clean camel's-hair brush and rub gently with clean lens paper. If alcohol is not available, breathe heavily on the glass and wipe off with clean lens paper. Repeat this operation several times until clean.

(5) Moisture due to condensation may collect on the optical parts of the instrument when the temperature of the parts is lower than that of the surrounding air. This moisture, if not excessive, can be removed by placing the instrument in a warm place. Heat from strongly concentrated sources should not be applied directly, as it may cause unequal expansion of parts resulting in breakage of optical parts or inaccuracies in observation.

d. Lubricants authorized for use in the paragraphs dealing with the individual instruments are covered by the following specifications:

Oil, lubricating, for aircraft instruments and machine guns.	U. S. Army Specification No. 2–27.
Grease, special, low temperature (Royco 6A).	Commercial.

CHAPTER 4

AMMUNITION

92. General.—*a.* Ammunition for the 75-mm pack howitzers, M1A1 and M1, is issued fuzed in the form of "fixed" and "semifixed" complete rounds. A complete round includes all of the ammunition components used in a cannon to fire one round.

b. Fixed ammunition.—In fixed ammunition, the cartridge case, which contains the propelling charge and primer, is crimped rigidly to the projectile. The fixed complete round is loaded into the cannon as a unit.

c. Semifixed ammunition.—Semifixed ammunition differs from fixed ammunition in that the projectile is a free fit in the cartridge case and the propellant is divided into increments. Thus, the projectile may be removed in the field and the propelling charge adjusted for the desired zone of fire. As in the case of fixed ammunition, the complete round is loaded into the cannon as a unit.

93. Classification.—Dependent upon the kind of filler, projectiles may be classified as explosive, chemical, or inert. Explosive projectiles comprise high explosive and practice projectiles and shrapnel. High explosive projectiles contain a high explosive bursting charge, whereas shrapnel and practice projectiles contain a relatively small

quantity of low explosive filler. The modern shrapnel is a projectile designed to carry a large number of spherical shot to a distance from the gun and there discharge them over an extended area. The low explosive filler for practice projectiles is intended solely as a spotting charge and for some purposes may be omitted. Chemical projectiles comprise those containing a chemical filler; that is, a chemical agent which produces either a toxic or an irritating physiological effect, a screening smoke, incendiary action, or a combination of these. Inert projectiles contain no explosive.

94. Firing Tables.—FT 75-I-3 is used for all ammunition, 75-mm pack howitzers, M1 and M1A1.

95. Identification.—To identify completely an ammunition lot, it is necessary to state in full the kind of ammunition, the ammunition lot number, and the manufacturer's name. This information plus other essential information such as weight zone and muzzle velocity may be obtained from the painting and marking of the round and the accompanying data card. (See figs. 53, 54, and 55 and the following paragraphs.)

96. Mark or model.—To identify a particular design, a model designation is assigned. The model designation becomes an essential part of the nomenclature and is included in the marking on the item. Prior to July 1, 1925, it was the practice to assign mark numbers, the word "Mark" being abbreviated "Mk.", which was followed by a roman numeral; for example, SHELL, H.E., Mk. I. The first modification of a model was indicated by the addition of MI, the second by MII, etc. Thus, Mk. IMII would indicate the second modification of an item originally designated Mk. I. The present system of model designation consists of the letter M followed by an arabic numeral. Modifications are indicated by adding the letter A and appropriate arabic numeral. Thus, M9A1 indicates the first modification of an item for which the original model designation was M9.

97. Ammunition lot number.—When ammunition is manufactured, an ammunition lot number, which becomes an essential part of the marking, is assigned in accordance with pertinent specifications. This lot number is stamped or marked on each loaded complete round, on all packing containers, and on the accompanying ammunition data card. It is required for purposes of record, including reports on condition, functioning, and accidents, in which ammunition is involved. To provide for uniform functioning, all of

the rounds in any one lot of fixed or semifixed ammunition consists of:

Projectiles of one lot number (one type and one weight zone).
Fuzes of one lot number.
Primers of one lot number.
Propellent powder of one lot number.

Therefore, to obtain the greatest accuracy, successive rounds should be from the same ammunition lot whenever practicable.

98. Ammunition data card.—A 5- by 8-inch card, known as an ammunition data card, is packed in each packing box with the ammunition or, in the case of bundle packing, with the round in each fiber container. When required, assembling and firing instructions are printed on the reverse side of the card.

99. Painting and marking.—*a. Painting.*—Projectiles are painted to prevent rust and, by means of the color, to provide a ready means of identification as to type. The color scheme is as follows:

High explosive	Yellow; marking in black.
Chemical	Gray; one green band indicates nonpersistent gas; two green bands, persistent gas; one yellow band, smoke. Marking on the projectiles is in the same color as the band.
Shrapnel	Red; marking in black.
Practice	Blue; marking in white. (Projectile may be inert or may contain a live fuze and spotting charge of black powder.)
Dummy or drill (inert)	Black; marking in white.

b. Marking.—For purpose of identification the following is marked on each round of fixed and semifixed ammunition.

(1) *On the projectile.*

Caliber and type of cannon in which fired.
Kind of filler, for example, "TNT", "CN GAS", etc.
Mark or model of projectile.
Weight zone marking.
Lot number of loaded projectile. Ordinarily the projectile lot number is not required after the complete round has been assembled, hence, it is stenciled below the rotating band, in which position it is covered by the neck of the cartridge case.

(2) *On the cartridge case.*—Recently changes have been made in the marking on the cartridge cases. The new marking, which is being used on ammunition of new manufacture, is shown compared with the old marking in tables I and II below.

TABLE I.—*On the body of the cartridge case—marking in black unless otherwise indicated*

Old marking	New marking
"FLASHLESS" when propelling charge is of flashless (FNH) powder.	Omitted.
Initials of powder manufacturer, symbol of powder, and lot number.	Omitted.
Caliber, type, and model of cannon in which fired.	Omitted.
MV and muzzle velocity of full charge, in feet per second, inclosed in black rectangle.	Omitted.

TABLE II.—*On the base of the cartridge case—marking in black unless otherwise indicated*

Old marking	New marking
Ammunition lot number (in older lots, stamped in the metal).	Ammunition lot number and initials of loader.
"FLASHLESS" when propelling charge is flashless (FNH) powder.	Omitted.
Model of projectile. If chemical, the kind of filler is also indicated.	Model of projectile.
One diametral stripe to indicate full service charge.	Omitted.
Caliber and model of cartridge case, type and model of cannon in which fired (stamped in the metal).	Caliber and model of cartridge case (stamped in the metal).
Cartridge case lot number and initials of cartridge case manufacturer (stamped in the metal).	Cartridge case lot number, initials, or symbol of cartridge case manufacturer, and year of manufacture (stamped in the metal).

100. Weight zone markings.—Because it is not practicable to manufacture high explosive or chemical projectiles within the narrow weight limits required for the desired accuracy of fire, projectiles

are grouped into weight zones in order that the appropriate ballistic corrections indicated by firing tables may be applied. The weight zone of the projectile is marked thereon by means of black crosses, one, two, or three, dependent upon the weight of the projectile. A weight zone lighter than one cross is indicated by L. Two crosses indicate "normal" weight.

101. Care, handling, and preservation.—*a.* Ammunition is packed to withstand conditions ordinarily encountered in the field. Complete rounds are packed in individual, moisture-resistant, metal or fiber containers and then in a wooden packing box, or bundle. Nevertheless, since explosives are adversely affected by moisture and high temperature, due consideration should be given to the following:

(1) Do not break moisture-resistant seal until ammunition is to be used.

(2) Protect the ammunition, particularly fuzes, from high temperatures, including the direct rays of the sun. More uniform firing is obtained if the rounds are at the same temperature.

b. Do not attempt to disassemble any fuze.

c. Explosive ammunition, including components containing explosives, must be handled with appropriate care at all times. The explosive elements in primers and fuzes are particularly sensitive to undue shock and high temperature.

d. Before loading, the complete round should be free of foreign matter—sand, mud, grease, etc. If it gets wet or dirty, wipe it off at once.

e. Do not remove protection or safety devices from fuzes until just before use.

f. Components of rounds prepared for firing but not fired will be returned to their original packings and appropriately marked. Such components will be used first in subsequent firings, in order that stocks of opened packings may be kept at a minimum.

102. Authorized rounds.—The 75-mm pack howitzers, M1A1 and M1, being chambered alike, fire the same ammunition. The ammunition authorized for use therein is listed below; see also figures 53, 54, and 55. It will be noted that the designation completely identifies the ammunition as to type and model of the projectile and the fuze, and caliber of cannon in which the round is fired. To the nomenclature of ammunition which is issued fuzed, shrapnel excepted, a suffixed statement such as "w/PDF M48" indicates the type and model of fuze assembled thereto.

AMMUNITION FOR 75-MM PACK HOWITZERS, M1A1 AND M1

Nomenclature	Prescribed fuzes		Approximate weight of projectile as fired (pounds)
	Model	Action	
Service ammunition			
Shell, semifixed, H. E., M48, w/PDF [1] M48, 75-mm pack howitzer, M1A1 and M1.	M48	SQ [2]-Del [3]	14. 60
Shell, semifixed, H. E., M48, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.	M54	SQ-Time	14. 60
Shell, semifixed, H. E., M41, w/PDF M48, 75-mm pack howitzer, M1A1 and M1.	M48	SQ-Del	13. 82
Shell, semifixed, H. E., M41, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.	M54	SQ-Time	13. 82
Shell, semifixed, H. E., M41A1, w/PDF M48, 75-mm pack howitzer, M1A1 and M1.	M48	SQ-Del	13. 76
Shell, semifixed, H. E., M41A1, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.	M54	SQ-Time	13. 76
Drill ammunition			
Cartridge, drill, M2A1, 75-mm pack howitzer, M1A1 and M1.	M1907	Inert	
Cartridge, drill, M2A2, 75-mm pack howitzer, M1A1 and M1.	M1907M	Inert	
Blank ammunition			
Ammunition, blank (1-lb. charge) 75-mm guns, M1897–16–17 and 75-mm pack howitzer, M1A1 and M1.	None.		
Ammunition, blank (double pellet charge), 75-mm guns, M1897–16–17 and 75-mm pack howitzer, M1A1 [4] and M1.	None.		
Subcaliber ammunition			
Shell, fixed, practice, Mk. II 37-mm gun, M1916.	M38A1E1	BP [5]	1. 23
Shell, fixed, L. E., Mk. I, 37-mm gun, M1916.	Mk. I & II	BP	1. 097
Shell, fixed, sand loaded, Mk. I, 100 percent service charge, 37-mm gun, M1916.	None.		

[1] Point detonating fuze.
[2] Superquick.
[3] Delay.
[4] Double pellet (13.8 oz.) for use in lieu of 1-pound charge.
[5] Base percussion fuze.

103. Propelling charges.—The charges for the 75-mm pack howitzers are of the base and increment type. They consist of a base section and three increments, permitting four zones of fire. When it is desired to use other than the full charge, the projectile is removed from the cartridge case, the required number of increments removed, and the connecting twine broken. The projectile is then replaced in the cartridge case. Unused increments are destroyed under the direct supervision of the battery executive. The arrangement of the charges in the complete round is shown in figure 54.

104. Fuzes.—*a. General.*—A fuze is a mechanical device used with a projectile to explode it at the time and under the circumstances desired.

NOTE.—No attempt will be made to disassemble any fuze.

b. Types.—(1) Fuzes may be classified into two principal types—namely, those which function by time action a certain number of seconds after firing, and those which function as a result of impact of the projectile with a resistant object such as earth, water, or structural material.

(2) Further subdivision of the impact types is dependent upon quickness of action, classifications being superquick, nondelay, short delay, and long delay.

(3) Dependent upon the manner of arming, certain fuzes are considered to be "boresafe" as distinct from those which are not boresafe. A boresafe fuze (detonator-safe) fuze is one in which the explosive train is so interrupted that prior to firing and while the projectile is still in the bore of the cannon, premature action of the bursting charge is prevented should any of the more sensitive elements, primer and/or detonator, malfunction.

c. Boresafe and nonboresafe fuzes.—Those classified as boresafe and nonboresafe are as follows:

Nonboresafe	Boresafe
Fuze, combination, 21-second, M1907M [1]	Fuze, P. D., M48.[1] Fuze, P. D., M54.[1]

[1] Assembled to fixed or semifixed round. Not issued separately for use in the field.

105. Fuze, P. D., M48.—*a. Description.*—This fuze, shown in figure 53, is a combination superquick and short delay type and is issued assembled to the shell. The fuze contains two actions, superquick and delay. On the side of the fuze, near the base, is a slotted "setting sleeve" and two registration lines, one parallel to the

axis of the fuze, the other at right angles thereto. The line parallel to the axis is marked "S. Q." and the other "DELAY." To set the fuze, the setting sleeve is turned so that the slot is alined with "S. Q." or "DELAY", whichever is required. The setting may be made or changed with a screw driver or other similar instrument any time before firing, even in the dark, by noting the position of the slot: parallel to the fuze axis for "S. Q." at right angles thereto for "DELAY." It should be noted that with this fuze, even though set superquick the delay action will operate should the superquick action fail to function.

b. Preparation for firing.—Prior to firing, it is only necessary to set the fuze, and this only when delay action is required—when shipped, the fuze is set superquick. In order to obtain the desired type of fuze action in any one ammunition lot or zone of projectile weights, the M48 and M54 fuzes may be interchanged. The stake (a punch mark which prevents unscrewing of the fuze in transportation) is safely broken by inserting the fuze wrench in the slots of the fuze, holding the projectile firmly, and striking the end of the wrench with a hammer. The fuze then may be unscrewed by hand. The fuze wrench should be used to insure a tight fit when installing the fuze; staking is unnecessary.

106. Fuze, time and superquick, M54.—*a. Description.*—This standard fuze, shown in figure 54, is a combination superquick-time type and is issued assembled to the shell. A safety pin extends through the fuze to secure the time plunger during shipment. The fuze contains two actions, superquick and time. The superquick action is always operative and will function on impact unless prior functioning has been caused by time action. Therefore, to set the fuze for superquick action, it is required that the time action is set either at safe (S) or for a time longer than expected time of flight The time train ring, graduated for 25 seconds, is similar to that of other powder time train fuzes. The fuze is set for time by means of a fuze setter. When the fuze is set at less than 0.4 second, the safety disk, a safety feature of the fuze, covers the body pellet and prevents its ignition by the graduated ring time train.

b. Preparation for firing.—Prior to firing, the safety pin must be withdrawn from the fuze. If superquick action is required, the graduated time ring is set safe (S) or for a time greater than the expected time of flight.

NOTE.—The fuze, as shipped, is set safe. If time action is required, the graduated time train ring is set for the required time of burning by means of a fuze setter.

107. Packing.—Rounds of 75-mm pack howitzer ammunition are packed in individual metal or fiber containers, in wooden boxes containing four rounds, or in special bundle packings of three rounds. While the weights of the individual rounds vary somewhat, depending upon type and model, the following data are considered representative for estimated weight and volume requirements:

	Weight (pounds)	Volume (cubic feet)
Complete round without packing material	18	
3 rounds in bundle packing	67	0. 9
4 rounds in wooden packing box	104	1. 5

The over-all dimensions of the packings are:

3-round bundle, 24¼ by 8.10 by 7.57 inches.
4-round box, 28¼ by 9 1⁄16 by 9 1⁄16 inches.

Bundles for oversea shipment are crated.

108. Subcaliber ammunition.—*a. General.*—The shell, fixed, practice, Mk. II, with fuze, practice, M38, 37-mm gun, M1916, is authorized for use in the gun, 37-mm, M1916, when used for subcaliber purposes with the howitzer, 75-mm, M1 and M1A1. This ammunition is issued in the form of fixed, complete rounds. The projectile is fitted with a base fuze and contains a low explosive filler of black powder. When used for target practice purposes the low explosive filler serves as a spotting charge. The complete round is shown in figure 55, and may be identified by the marking indicated thereon.

b. Packing.—Two standard packings of 60 rounds each are provided: one, a wooden box with metal liner for oversea shipments, the other a wooden box without metal liner for domestic shipments. Data for these packings are as follows:

	Weight (pounds)	Volume (cubic feet)
Complete round without packing material	1. 62	
Oversea shipments:		
Box with metal liner (60 rounds)	128	1. 99
Over-all dimensions of box, 23 5⁄16 by 13 5⁄16 by 11 1⁄16 inches.		
Domestic shipments:		
Box without metal liner (60 rounds)	115	1. 60
Over-all dimensions of box, 21½ by 12 1⁄16 by 10 5⁄32 inches.		

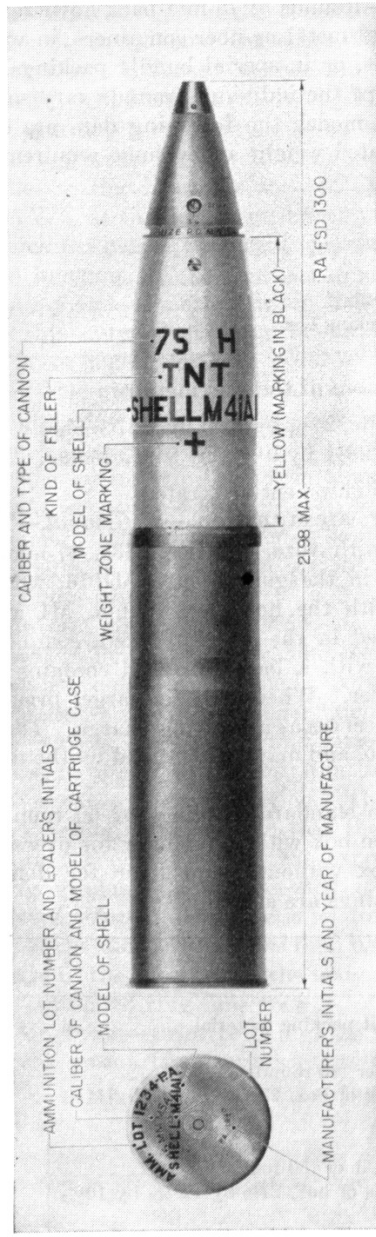


FIGURE 53.—Shell, semifixed, H. E., M41A1, w/fuze, P. D., M48, 75-mm pack howitzer, M1 and M1A1.

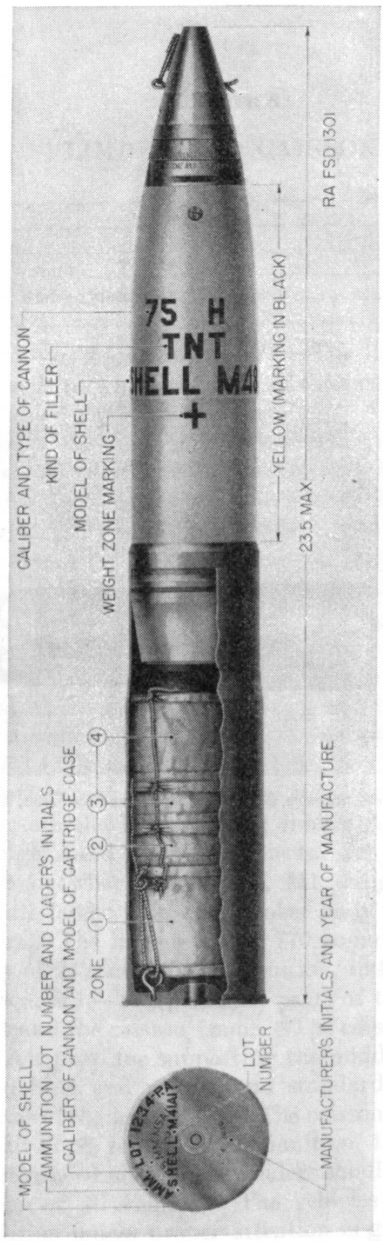


FIGURE 54.—Shell, semifixed, H. E., M48, w/fuze, P. D., M54, 75-mm pack howitzer, M1 and M1A1.

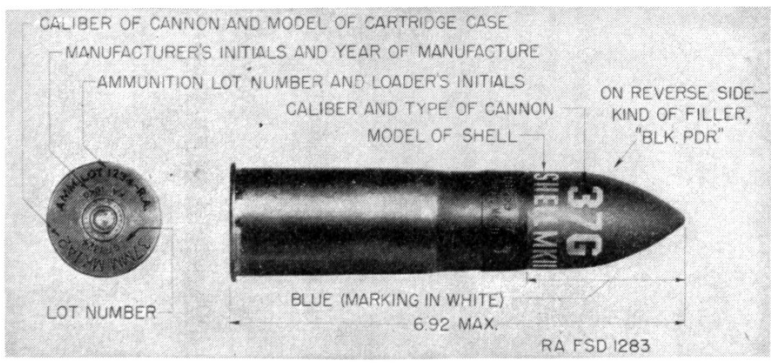


FIGURE 55.—Shell, fixed, practice, Mk. II, w/fuze, practice, M38, 37-mm gun, 1916.

CHAPTER 5

LIMBER AND CAISSON

109. General.—*a. Light limber, M2.*—The light limber, M2, is a two-wheeled vehicle to which the trail of the carriage is connected to form a four-wheeled vehicle when traveling. Attachments are provided on the outside of the chest for carrying certain small implements. This vehicle is designed especially for high speed travel and is equipped with pneumatic-tired automobile disk and rim type wheels, mounted on anti-friction bearings. (See fig. 56.)

b. Light caisson, M1.—The light caisson, M1, is a two-wheeled vehicle built primarily to carry ammunition. Attachments are provided on the outside of the chest for carrying various tools and accessories. This vehicle is designed especially for high speed travel and is equipped with pneumatic-tired automobile disk and rim type wheels, mounted on anti-friction bearings, and standard automobile brakes similar to those on the howitzer carriages. (See figs. 22 and 23.)

110. Description.—*a. Light limber, M2.*—The principal parts of the light limber are the limber chest; limber frame; limber body; and axle and high speed hubs and wheels. In addition the limber is fitted with a drawbar; doubletree, M1; singletree, M1; pintle, M7A1, with pintle latch; pole, M1; limber body springs; neck yoke, M1, and snubbers. The limber weighs 770 pounds and, when loaded with its capacity of 22 rounds of ammunition, 1,245 pounds.

b. Light caisson, M1.—The principal parts of the light caisson are the caisson chest and the caisson frame. The caisson is also equipped with pintle, M7A1, prop for supporting the middle rail, lunette, M6, axle, high speed hubs and wheels, and standard automobile brakes operated by means of the hand lever. The caisson weighs 860 pounds, and, with its load of 52 rounds of ammunition, 1,965 pounds.

111. Inspection.—Battery commanders should make frequent detailed inspections of all vehicles. The vehicles cannot be kept in serviceable condition unless proper attention is given to cleaning, to

lubrication, and to loose or broken parts. Special attention should be given to sliding and bearing surfaces. These, together with screw threads and exterior parts, must be kept free from dirt and other foreign matter. Extra precautions should be observed regarding the foregoing, particularly when proceeding with disassembling and assembling operations.

112. Disassembly and assembly.—*a.* Incidents of wear, breakage, and inspecting make necessary the occasional disassembly of various parts of the limber and caisson. This work comes under two headings, that which may be performed by the battery personnel and that which is performed by ordnance personnel. The battery personnel may, in general, do such dismounting as is required for the assembling of parts indicated in Standard Nomenclature List No. C-29. Such work should be done in the manner prescribed. Any difficulty which cannot be overcome should be brought to the attention of ordnance personnel.

b. These vehicles are so designed that any disassembling or assembling operations that may be performed by the battery personnel involve the use of standard or miscellaneous hardware and common hand tools and, therefore, may be performed readily without detailed instructions.

113. Care, maintenance, and adjustment.—*a. General.*—Care and maintenance of these vehicles and attachments consist mainly in cleaning and oiling where necessary, and tightening or properly adjusting bolts, nuts, and such parts as may be assembled by hand or with use of common hand tools.

b. Brake mechanism.—Brake levers must not be released by a kick or blow. When brake bands slip and fail to lock the wheels, they may be worn or merely greasy. Wash the lining surfaces thoroughly with dry cleaning solvent and adjust. No dressing of any kind is to be put on the linings. When linings are worn beyond further service, which will be when no further adjustment is practicable or when the copper rivets attaching them to the bands become loose, the band must be relined. Report to ordnance officer.

c. To adjust brakes.—The braking effect should be the same for both wheels. It should be possible to skid the wheels and to secure proper release of the brake bands when the brake lever is operated. The correct procedure for adjusting the brakes is as follows:

(1) Jack up one or both wheels.

(2) Set hand brake lever at the full released position.

(3) Tighten one of the brake-shoe adjusting wedges until a drag is felt on the wheel. Then back off just enough so that the brake does

not drag. Follow the same procedure with the other wheel. Brakes must be cold when making this adjustment.

(4) Apply the brakes. The hand brake lever should not go beyond the center of the ratchet. If it does, adjust the linkage leading to both brake cams by loosening the jam nuts and tightening the rod ends equally.

(5) Remove the jack (or jacks).

(6) Road test the brakes to determine that the brake effect is the same on both wheels.

114. Lubrication.—*a. General.*—(1) The life of the vehicle depends to a great extent on proper lubrication. Particular attention should be given to the sliding and bearing surfaces, oil cups, oil holes, openings, or exposed surfaces providing means for lubricating the various bearing parts.

(2) Care should be taken when cleaning oil and grease compartments to insure the complete removal of all residue and sediment. Be certain that no dirt or other foreign matter drops into any of the lubricating passages or on the bearing surfaces.

(3) Oil passages which become clogged should be cleaned with a piece of wire. Wood should not be used for this purpose, as splinters are apt to break off and clog the passages.

(4) Should an oiler stick in its seat and prevent the passage of oil, it can be loosened by means of a piece of wire pushed through the hole, care being taken not to damage the valve.

(5) No lubricants other than those issued will be used. Lubricants will be used only in the prescribed manner.

b. Specific.—(1) The limber and caisson wheel bearings will be cleaned and packed with wheel bearing lubricant No. 2 every 6 months.

(2) Lubricate daily all hand brake moving parts with engine oil SAE 10W for temperatures below 32° F. and engine oil SAE 20 for temperatures above 32° F.

(3) Lubricate spring shackle bearings monthly with chassis lubricant No. 0.

(4) All other sliding surfaces should be cleaned and lubricated daily with engine oil SAE 10W for temperatures below 32° F. and engine oil SAE 20 for temperatures above 32° F.

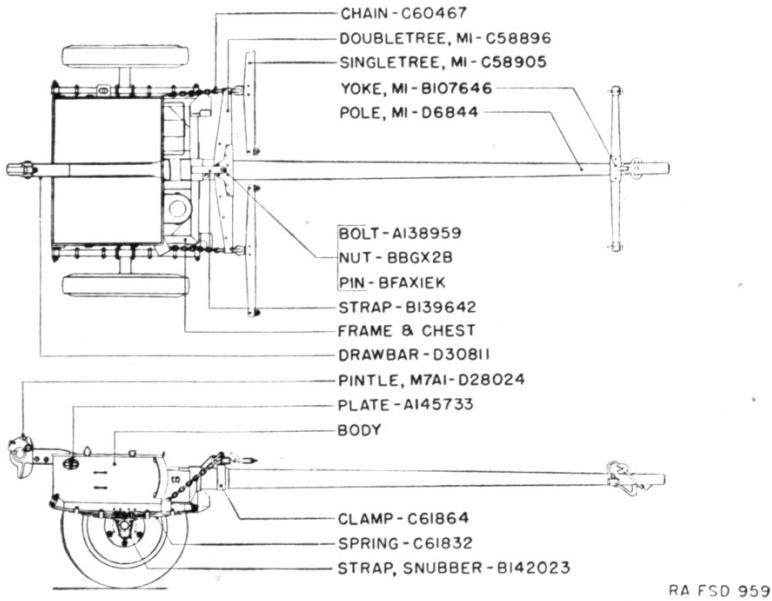


FIGURE 56.—Light limber, M2—plan view and right elevation.

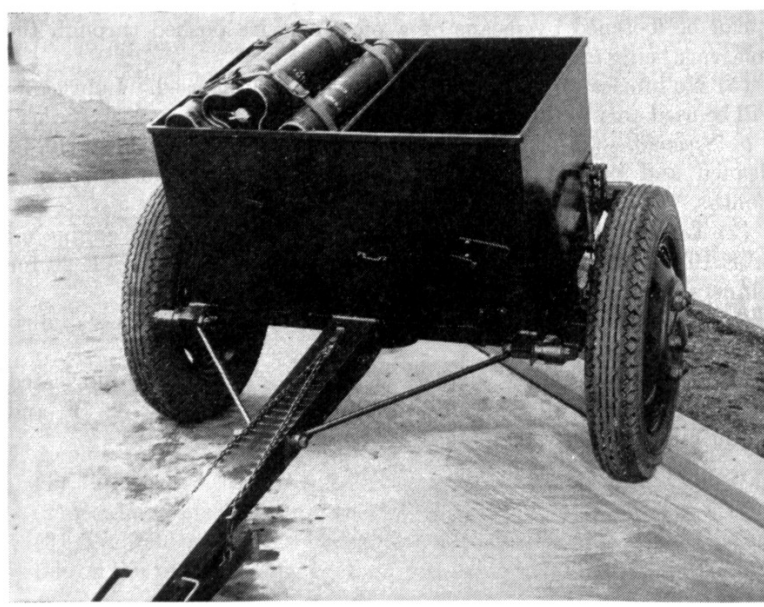


FIGURE 57.—Light caisson, M1. ORD 10291

CHAPTER 6

SPARE PARTS AND ACCESSORIES

115. Spare parts.—*a. General.*—Parts become unserviceable through breakage or through wear resulting from continuous usage. For this reason certain parts are provided for replacement purposes. These parts are divided into two groups—namely, spare parts and basic spare parts. The using arm has no concern with basic spare parts. Except in an emergency basic spare parts are issued only to ordnance maintenance companies. The assembly of basic spare parts usually requires special tools or special knowledge of assembly. Parts should be kept clean and lightly oiled to prevent rust.

b. Spare parts.—These are extra parts provided with the matériel for replacement of those most likely to fail, and are for use by the using arm in making minor repairs. Sets of spare parts should be complete at all times as far as possible. The allowances of spare parts are prescribed in pertinent standard nomenclature lists.

116. Accessories.—*a. General.*—Accessories include the tools and equipment required for such disassembling and assembling as the using arm may do, and for the cleaning and preservation of the equipment. They also include covers, containers, tool rolls, etc., necessary for storage and protection when the equipment is not in use, or when traveling. Accessories should not be used for purposes other than as prescribed, and when not in use should be stored in the places or receptacles provided. There are a number of accessories, the names or general characteristics of which indicate their uses or application. Therefore, detailed descriptions or methods of use are not outlined herein. However, accessories embodying special features or having special uses are described and their uses outlined.

b. Accessories for 75-mm pack howitzer and pack howitzer carriage, M1.—Only the most important accessories are given here. For a complete list, see SNL C-20.

(1) *Bar, lifting, M2.*—The lifting bar, M2, is composed of a pipe body with two collars spaced equidistant from the center. The bar is for lifting the matériel when disassembling for loading on pack and when unloading and assembling for action.

(2) *Book, artillery gun.*—The gun book (O. O. Form 5825) is used for the purpose of keeping an accurate record of the matériel. It must always remain with the matériel regardless of where it may be

sent. The book is divided as follows: Record of assignments, company commander's daily gun record, inspector's record of examination, as well as forms to be filled out in case of premature explosions. This book should be in the possession of the organization at all times, and it is the responsibility of the organization commander as to the completeness of the record and as to the book's whereabouts. It must also contain date of issuance of the matériel, to and by whom issued, and place where issued. If a new howitzer is installed on the carriage, all data in the old book with reference to sights, carriage, etc., must be copied into the new gun book before the old book is relinquished.

NOTE.—Data pertaining to record of assignments must be removed and destroyed prior to entering combat.

(3) *Brush, bore, M9.*—The bore brush, M9, is used for cleaning the bore.

(4) *Carrier, oil can, M1.*—The oil can carrier, M1, is composed of two leather tubes with straps interposed between to hold them together. The purpose of the carrier is to hold the oil cans, M4, for pack transport.

(5) *Chests.*—Chests vary in size acording to use. They are usually made of steel and are provided for the storage and protection of equipment, cleaning material and small stores, and miscellaneous spare parts.

(6) *Cover, muzzle, M1.*—The muzzle cover is made of leather and used when the matériel is not in use. It is held in place by a billet with buckle and a thong.

(7) *Filler, oil screw, M3.*—The oil screw filler is a high pressure hand pump used to replenish the recoil mechanism with oil. The oil screw filler is fitted with an adapter by the means of which the nozzle is screwed into the filling hole. The oil is forced into the recoil mechanism by means of a screw plunger. Extreme care must be used in order that the threaded nozzle of the filler does not break or the threads become distorted. The handle should be centered and both hands used to assure an even stroke.

(8) *Handspike, M3.*—The handspike is a steel tube with a socket welded 7 inches from the tapered end. The purpose of the handspike is to traverse the howitzer by moving the trail. The handspike socket is also used to turn the cam latch in engaging or disengaging the top sleigh to or from the bottom sleigh.

(9) *Lanyard, M8 and M9.*—The lanyards are made of sash cord with a handle at one end and a means of attachment to the firing mechanism at the other. The lanyard, M9, is longer than the M8 and has a pulley with a hook assembled between the ends. Lanyard,

M9, is issued in time of peace only while the M8 lanyard is the standard for normal fire. The pulley of the M9 lanyard is hooked to the trail and forms a support for the lanyard to prevent sagging or becoming entangled.

(10) *Release, oil.*—The oil release is a 5-inch plug-shaped device with a hollow center. It is threaded on one end and screwed into the filling and drain plug hole and releases the valve for draining the reserve oil from the recoil mechanism.

(11) *Sleeve, aiming post, M1.*—This sleeve is made of heavy canvas and painted with alternate red and white stripes. It is fitted over the lifting bars which together are used as aiming posts.

(12) *Sponge and staff.*—The sponge and staff is for the purpose of swabbing the breech chamber of the howitzer during firing. The sponge consists of a piece of carpet sewed to a wooden cylinder which slips over a bronze head. The head is bored for use in ramming out a shell when it is desired to remove the shell without firing it. The two-sectioned wooden staff is attached to the head by means of a male coupling.

(13) *Tool, locking.*—The locking tool is made of ½-inch round stock threaded at one end and knurled at the other. The purpose of the tool is to retain the equilibrator in its assembled unit when making adjustments to the equilibrator trunnion pins or when removing or replacing the equilibrator in its bearing on the carriage.

(14) *Wrench, fuze, M7.*—This is a standard wrench used to tighten the fuze in the projectile before firing, and for interchanging fuzes. It may also be used for setting the time element of some fuzes. The screw driver portion of this wrench is also used to set the setting sleeve of the fuze as described in paragraph 105*a*.

c. Accessories for pack transport.—(1) *General.*—(*a*) Pack load accessories are provided to transport the matériel either on the Phillips cargo type pack saddle, or the aparejo in the following component loads: ammunition; howitzer tube; bottom sleigh and recoil mechanism; cradle and top sleigh; front trail; rear trail and axle; wheels and breechblock; fire control instruments; and pioneer antiaircraft. Information as to the distribution of these component loads and accessories, as well as the equipment of other supply services, and data pertaining to the pay loads will be found in Standard Nomenclature List No. C-20.

(*b*) The details of the use, method of loading, balancing, etc., of pack loads, as well as the securing of the loads, are covered in pertinent field manuals. Therefore, only a short, concise description of the accessories and their care and preservation will be given herein.

(2) *Arch, front trail, rear.*—This is composed of the pack arch, M2, and an adapter having a flat top. The adapter has lugs which fit into cut-outs of the pack arch, and is held in position by headless pins secured by cotter pins. The arch is used for pack transport of the front trail.

(3) *Arch, howitzer tube, front or rear.*—This arch is composed of the pack arch, M2, and an adapter having a curved surface into which either the muzzle or breech end of the howitzer tube may be placed. Each adapter has a wire rope which holds the tube in place. These adapters are held securely to the pack arch, M2, by headless pins secured by cotter pins.

(4) *Arch, pack, M2.*—The pack arch, M2, is malleable iron casting with a flat top. Two of these pack arches may be bolted directly to the framework of the Phillips cargo type pack saddle. They may also be used with the aparejo. In the latter case they are stapled to the aparejo and have two pack frame sides, M1, hinged thereto.

(5) *Bar, ammunition.*—The ammunition bar is made of flat steel bent to form a wide U and having inclined lugs welded in the corners. It is attached to the aparejo for transporting the ammunition box hanger, M4.

(6) *Cincha.*—The cinchas provided are made of olive-drab cotton duck and have a leather strap attached to either or both ends to secure the cincha and prevent the pack load from slipping. Cincha, M7, however, has, in place of the leather straps, a 6-foot length of rope spliced as a loop on one end and a 14-foot length spliced into the adjustable loop at the other end.

(7) *Cover, breech, M1.*—The breech cover is made of leather with a sheepskin lining and two leather thongs for holding it in place over the breech ring. It is used for protection of the howitzer breech when the howitzer is disassembled for pack transport.

(8) *Cover, tube, M1.*—The tube cover is fitted over the muzzle end of the tube for pack transport. It is made of leather with a sheepskin lining, and two chapes and billets which are buckled together to hold the cover in place.

(9) *Filler.*—Thick and thin steel fillers having hooks to fit into the cut-outs of the pack arch are provided for use when the conformation of a particular animal brings the load too low. The fillers are placed between the pack arch, M2, and the load.

(10) *Frame, ammunition, M4.*—The frame, composed of rear, center, and front braces held together by longitudinal bars, is secured to the pack saddle. The three extension bars are adjustable to suit the bundled ammunition.

(11) *Frame, breech mechanism, M1.*—The frame is a malleable iron casting with a wire rope hooking assembly attached which holds the breech mechanism in position when transported.

(12) *Frame, instrument, M3.*—This frame is composed of the frame body, various braces and supports, and adjustable stops. It is used to carry items of fire control equipment.

(13) *Frame, pack, M1912.*—This pack frame is used for aparejo transport of the forge, supply, and command post pack loads. It consists of two pack frame sides, M1, assembled to arches, X10A, to which four strap loop clevises and straps are attached.

(14) *Hanger, ammunition M4.*—The hanger, M4, is a U-bolt which fits around the ammunition box. A hook is slipped over the two ends and secured by lock washers and wing nuts. Two hangers are required for each box. When assembled, the outside of the hooks should measure 13⅝ inches apart for the Phillips cargo type pack saddle and 16½ inches for the aparejo.

(15) *Hanger, automatic rifle, M1.*—The hanger is constructed to carry the automatic rifle and a chest of ammunition. The ammunition chest is carried above the rifle and is held in the hanger by straps equipped with quick-release devices. The hanger is mounted on the off-side.

(16) *Hangers, instrument, M3 and M4.*—The two instrument hangers hang from the instrument frame, M3, the M3 hanger on the off-side and the M4 hanger on the near side. The hanger, M3, carries the two aiming circles and the range finder in their respective cases. The hanger, M4, carries the various tripods in their respective cases. The straps holding the equipmet of both hangers are equipped with quick release devices.

(17) *Hangers, wheel, M3A1 and M4A1.*—These hangers transport the wheels of the pack howitzer carriage. Hanger, M3A1, is used with the Phillips cargo type pack saddle and hanger, M4A1, with the aparejo.

(18) *Pad, hay, M1.*—The hay pad is a canvas pad stuffed with hay and used with animals having prominent hip bones. They are placed under the ammunition boxes when transported on the aparejo.

(19) *Side, pack frame, M1.*—When the aparejo is used, two pack frame sides, M1, are necessary on certain of the loads—namely, ammunition, howitzer tube, cradle and top sleigh, bottom sleigh and recoil mechanism, front trail, rear trail and axle, wheels and breech-block, fire control, pioneer antiaircraft, and wire. It consists of two upright braces and two crossbars with riveted wooden blocks. Hinged hooks are attached to the tops of the braces by which the pack frame sides may be assembled to the front and rear arches.

d. Accessories for 75-mm pack howitzer and howitzer carriage, M2A1, M3, and M3A1.—The major accessories only are listed. For a complete list of accessories, see SNL C-26.

(1) *Bolt, assembling, equilibrator.*—The bolt is 22 inches long, threaded at one end and knurled at the other. The purpose of the bolt is to retain the equilibrator in its assembled unit when making adjustments to the equilibrator trunnion pins or when removing or replacing the equilibrator in its bearing on the carriage.

(2) *Book, artillery gun.*—This book is described in *b*(2) above.

(3) *Brush, bore. M9.*—The bore brush, M9, is used for cleaning the bore.

(4) *Chests.*—See *b*(5) above.

(5) *Filler, oil screw, M3.*—The oil screw filler is described in *b*(7) above.

(6) *Handspike.*—The handspike is a steel tube with a socket welded 7 inches from the tapered end. The purposes of this handspike are to traverse the howitzer by moving the trail and to turn the cam latch in engaging or disengaging the top sleigh to or from the bottom sleigh.

(7) *Lanyard, M8.*—The lanyard, M8, is described in *b*(9) above.

(8) *Puller, gear.*—The gear puller is for the purpose of removing the elevating and traversing worm wheels which have been assembled on the shafts.

(9) *Release, oil.*—The oil release is described in *b*(10) above.

(10) *Sponge and staff.*—The sponge and staff is described in *b*(12) above.

(11) *Wrench, fuze, M7.*—The fuze wrench, M1, is described in *b*(14) above.

e. Accessories for light caisson, M1, and light limber, M2.—The uses and purposes of these accessories are apparent from their designations. They consist of the ax, hatchet, pick mattock, shovel, canvas watering bucket, paulin, kerosene lantern, and straps of various lengths.

CHAPTER 7

SUBCALIBER EQUIPMENT

117. General.—*a.* Subcaliber equipment is issued to provide a means for a greater amount of training with small caliber ammunition than would be obtained by the use of regular 75-mm ammunition. Although the handling and loading, as well as the range obtained, differ from those of the regular pieces, the results obtained in elevating, traversing, sighting, etc., are adequate for instructional purposes.

b. The 37-mm gun, M1916, with its recoil mechanism is used for subcaliber firing. The subcaliber gun with recoil mechanism is firmly affixed to the matériel by means of a specially constructed mount.

118. Description and operation of mount.—The 37-mm subcaliber mount, M5, is composed of a number of steel angles and plates, welded into a frame. The frame is retained upon the howitzer by four hooks formed to slide under the lugs of the bottom sleigh.

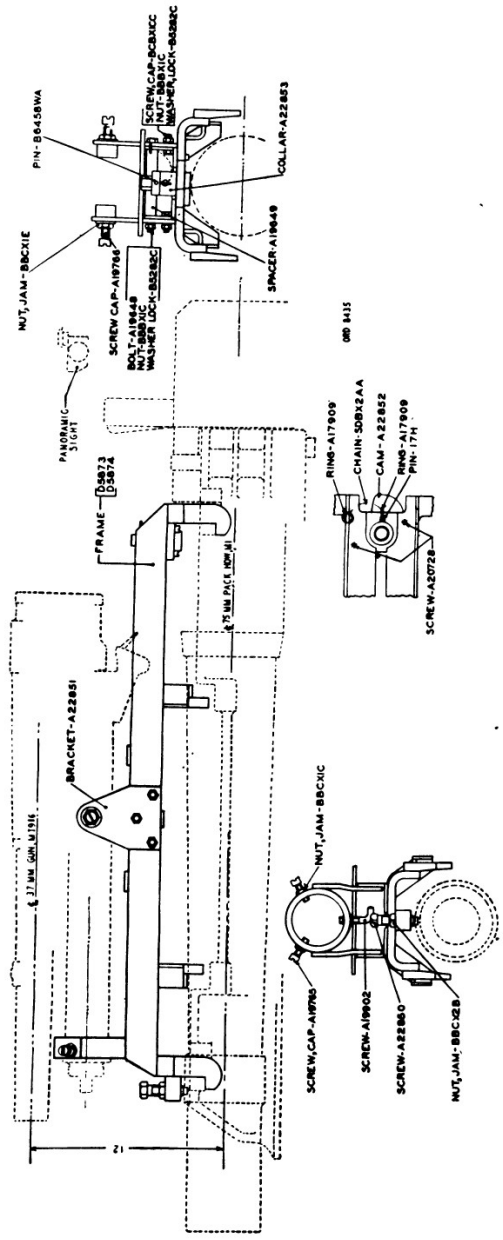
a. The rear end of the frame is equipped with a cam, the purpose of which is to force the frame forward to the full engagement of the hooks and lock it in this position.

b. At the front an adjusting screw is provided for the purpose of raising the front end of the frame until the hooks are in full contact with the lugs of the bottom sleigh.

c. Trunnion brackets are bolted to each side of the frame which support the trunnions of the 37-mm gun cradle.

d. The collar welded on the upright pieces at the front of the frame encircles the recoil cylinder of the 37-mm gun cradle. Three adjusting screws are provided in the collar to hold the cradle in position and to facilitate adjustment for parallelism of the bore of the 37-mm gun with that of the pack howitzer.

119. Assembly and disassembly.—*a.* To assemble the 37-mm subcaliber mount to the howitzer, it is necessary to remove the top sleigh from the howitzer.



PICTURE 58.—Mount, subcaliber, 37-mm, M1916.

b. Place the 37-mm subcaliber mount on top of the howitzer, guiding the hooks of the frame under the lugs of the bottom sleigh.

(1) Turn the locking cam clockwise 90°, forcing the frame into the full locked position and with the adjusting screw raise the frame at the front until the hooks of the frame come to a bearing on the lugs of the bottom sleigh.

(2) Remove the trunnion brackets from the frame and place them on the trunnions of the 37-mm gun cradle.

(3) Lift the 37-mm gun and cradle on the mount, guiding the recoil cylinder through the collar at the front of the frame. Bolt the trunnion brackets in place.

(4) Center the recoil cylinder in the collar by the three adjusting screws. In making this adjustment no strain should be exerted on the screws. Tighten the adjusting screws in the trunnion, centering the cradle in the frame.

120. Bore sighting.—*a.* As the 37-mm gun is to be laid with the regular sighting and maneuvering mechanism of the howitzer, the bore of the guns should be parallel. To secure proper alinement when the 75-mm howitzer carriage is in firing position, bore sights are set in the subcaliber gun as well as in the pack howitzer.

b. Verification of the sights having been accomplished, the following procedure should be observed in bore sighting the 37-mm gun:

(1) Place the bore sights in the 37-mm gun and bore sight on the testing target.

(2) All adjustments of the 37-mm gun upon the testing target are made by the three adjusting screws in the collar that encircles the recoil cylinder and those in the trunnion brackets.

(3) When the proper adjustments have been made set the jam nuts up tight. Ordnance Field Service Modification Work Order No. A7–W5 provides for modification of the cylinder of the recoil mechanism when used for subcaliber purposes. A steel band is to be applied. Without this the pressure of the screws is liable to distort the cylinder, in which case the gun fails to return to the full battery position. When mounted, the axis of the subcaliber gun is 12 inches directly above the axis of the howitzer tube.

121. Care and preservation.—Repairs to the 37-mm subcaliber mount, M5, will be minor in nature and will involve only the removal of burs when necessary and the replacement of parts. When the subcaliber mounts are disassembled all screws, nuts, and lock washers should be assembled in their proper places.

122. Spare parts and accessories.—*a. Spare parts.*—The spare parts issued with the subcaliber equipment are those which are liable

to fail and which may readily be replaced by the using arms. These parts are specified in Standard Nomenclature Lists Nos. C-20 and C-26. (See appendix.)

b. Accessories.—The accessories provided for the subcaliber weapon are those required for the cleaning and preserving as well as for keeping a complete record of the equipment. They include a gun book, cartridge extractor, cleaning brush, oil gun, rammer, tool roll, etc.

CHAPTER 8

MATERIAL AFFECTED BY GAS

123. Protection and cleaning of material affected by gas.—*a. Protection against phosgene, chlorine, etc.*—(1) For material which is in constant danger of gas attacks, whether from gas clouds or gas shells, care should be taken to keep all bright parts of the guns, carriages, mountings, and accessories well coated with oil.

(2) It must not be forgotten that practically all fabrics and materials such as wool, cotton, rubber, and oilcloth can be penetrated by mustard gas if sufficient time is given. The mustard gas is absorbed by these materials and penetrates them by a slow process of diffusion. In general, it may be said that the greater the length of time allowed for penetration the greater the danger in wearing these articles. For instance, rubber boots which have been worn in an area shelled heavily with mustard gas may be a grave danger to men who wear them several days after the bombardment. Fabrics thoroughly impregnated with linseed oil will resist penetration by mustard gas for over an hour, but after this time these articles are dangerous because the mustard gas dissolves in the linseed oil and they must be destroyed.

(3) Sights and all instruments should also be covered with oil and protected with covers when not in actual use, care being taken that the oil does not come in contact with any glass or find its way into the interior of the instruments.

(4) All uncapped fuzes or fuzes which have been removed from their containers should be wiped over with oil as soon as possible and protected with a cover.

b. Cleaning.—All bright parts of weapons, carriages, and other vehicles, together with all accessories and spare parts exposed to the gas, must be cleaned and wiped dry as soon as possible after the attack, and in any case within 24 hours, after which they should be thoroughly coated afresh with oil. The same applies to the whole of the ammunition still in the battery position. Ammunition which for any reason has not been oiled must be cleaned and oiled. It is desirable to expend it as soon as possible.

c. Disinfection of material.—The following measures should be taken for the removal of mustard gas from various materials and

equipment (guns, projectiles, cases, wood, metals, rope, etc.) which have come in contact with mustard gas. For all of the operations indicated below the gas mask and protective clothing, including protective shoes and gloves, must be worn.

(1) Commence by freeing the objects of dirt, lumps of earth, and liquid with wooden spatulas, rags, etc., which will be buried immediately after this operation. They must not be burned.

(2) Sprinkle a continuous layer of calcium hypochlorite, which is preferred if available, or else dry chloride of lime over the parts that lend themselves to this treatment. In the statements hereafter calcium hypochlorite is specified but dry chloride of lime may be substituted in the event that calcium hypochlorite is not available. After 2 hours, or better after 6 hours if practicable, wash off the layer of calcium hypochlorite and rinse thoroughly. It is imperative that all the calcium hypochlorite be removed in order to prevent the deterioration resulting from the prolonged action of the calcium hypochlorite. In the case of ammunition it is imperative to prevent particles of calcium hypochlorite from being introduced into the bore of the piece.

(3) Whitewash soiled parts which do not lend themselves to sprinkling with dry powder with a thick paste of calcium hypochlorite made from three volumes of calcium hypochlorite and one volume of water. After 2 hours, or preferably 6 hours, wash off the calcium hypochlorite.

(4) The delicate parts of the apparatus, such as breech mechanism, sighting apparatus, glasses, etc., which would be injured by calcium hypochlorite, should be cleaned by dry polishing with rags. After this operation the rags should be buried.

(5) If there are large quantities of water at hand, in place of calcium hypochlorite use water. The water should be warm, but not boiling and large quantities should be used. This cannot be done in the case of greasy articles, where only calcium hypochlorite should be used.

(6) When it is not necessary immediately to use contaminated material, or when one has not the above means at his disposal, it may be considered that the handling of the material or apparatus is not dangerous after 6 or 8 days.

d. Transportation of material affected by gas.—The removal will be effected by automotive units whenever possible. If horse transport must be used, the route will be carefully reconnoitered in order to avoid contaminated ground. The material will be decontaminated as thoroughly as possible before its removal.

APPENDIX

LIST OF REFERENCES

1. Standard Nomenclature Lists.

Ammunition, fixed, all types, for pack, light, and medium field artillery	SNL R–1.
Ammunition instructional material for pack, light, and medium field artillery	SNL R–6.
Blank ammunition for pack, light, and medium field artillery	SNL R–5.
Caisson, light, M1; limber, light, M2	SNL C–29.
Howitzer and carriage, pack, 75-mm, M1	SNL C–20.
Howitzer and carriage, 75-mm, M2, M3, and M3A1	SNL C–26.
Major items of small arms, automatic gun, trench mortar, and field artillery sighting equipment and fire-control instruments	SNL F–1.
Material, cleaning and preserving, and tools and equipment used therewith	SNL K–1.
Mount, telescope, M3; telescope, panoramic, M1	SNL F–106.
Mount, telescope, M17; Quadrant, range, M2, Telescope, elbow, M4; Mount, telescope, M16; Quadrant, range, M3	SNL F–169.
Service fuzes and primers for pack, light, and medium field artillery	SNL R–3.
Setter, fuze, bracket, M1916A2, with anchor	SNL F–11.
Setter, fuze, hand, M1912A4	SNL F–126.
Telescope, elbow, M5	SNL F–169.

Current Standard Nomenclature Lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index" (OPSI).

2. Firing Tables.

Gun, subcaliber, M1916, 37-mm:

Shell, fixed, L. E., Mk. I, 37-mm gun, M1916. — FT 37–H–2.

Howitzer, pack, 75-mm, M1 and M1A1:

Shell, semifixed, H. E., M48, w/PDF M48, 75-mm pack howitzer, M1A1 and M1.
Shell, semifixed, H. E., M48, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.
Shell, semifixed, H. E., M41, w/PDF M48, 75-mm pack howitzer, M1A1 and M1.
Shell, semifixed, H. E., M41, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.
Shell, semifixed, H. E., M41A1, w/PDF M48, 75-mm pack howitzer, M1A1 and M1.
Shell, semifixed, H. E., M41A1, w/PDF M54, 75-mm pack howitzer, M1A1 and M1.
— FT 75–I–3.

Current firing tables are as tabulated here. An up-to-date list of firing tables is maintained in SNL F–69.

3. Technical Manuals.

Ammunition, general	TM 9–900 (now published as TR 1370–A).
Cleaning and preserving materials	TM 9–850 (now published as TR 1395–A).
Ordnance maintenance, 75-mm howitzer and carriages.	TM 9–1320.

4. Field Manuals.

Service of the piece, 75-mm howitzer, horse and truck-drawn.	FM 6–70.
Pack Artillery	FM 6–110.

5. Artillery Gun Book.

Artillery Gun Book	O.O. Form 5825.

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(For explanation of symbols, see FM 21–6.)

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