TECHNICAL BULLETIN

EXERCISING OF RECOIL MECHANISMS AND EQUILIBRATORS

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NO. 9-1000-234-13

Washington, DC 15 September 1993

EXERCISING OF RECOIL MECHANISMS AND EQUILIBRATORS

DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE, DISTRIBUTION IS UNLIMITED

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to Commander, US Army Armament, Munitions and Chemical Command, ATTN: AKSMC-MAS, Rock Island, IL 61299-6000. A reply will be furnished to you.

*This bulletin supersedes TB 9-1000-234-30, 1 February 1985.

CHAPTER 1
INTRODUCTION

1-1. Purpose. This bulletin provides instructions and guidance on methods of exercising all types of recoil mechanisms and equilibrators, mounted on weapons or unmounted, on weapons not fired for prolonged periods, in the field, in storage, or at a manufacturer or overhaul facility.

1-2. Scope.

a. The instructions in this publication are applicable to operator, organizational, direct support, general support, and depot maintenance personnel responsible for exercising recoil mechanisms and equilibrators.

b. This publication provides periodic preventive maintenance that is not covered in pertinent weapon manuals, and specific methods for exercising each type of hydropneumatic recoil mechanism, hydrospring recoil mechanism, and equilibrator.

c. Only the particular recoil mechanisms listed in table 1-1 do not require exercising.

Table 1-1. RECOIL MECHANISMS WHICH DO NOT REQUIRE EXERCISING

RECOIL MECHANISM MODEL NUMBER	WEAPON SYSTEM
M1A8	HOWITZER, PACK: 75-MM, M116
M2A4 M2A5	*HOWITZER, LIGHT-TOWED: 105-mm, Ml 01 and M101AI
M6Al M6A2 M6B2	*HOWITZER, MEDIUM, TOWED: 155-mm, M114
M37 M37A1	HOWITZER, LIGHT, TOWED: 105-mm, M102
M45	**HOWITZER, MEDIUM, TOWED: 155-mm, M198

*M101, M101A1, and M114 Howitzers with other recoil mechanisms will require exercising.
**U.S. Marine Corps (USMC) Howitzers are to be exercised.

1-3. General Exercising Procedures.

a. General. Exercising is the moving of rods and pistons in the recoil mechanism to reestablish a fluid film between the packings, seals, and sliding surfaces. It prevents drying of seals and corrosion of rod surface at the packing. Variations of exercising methods may be used, depending on availability of equipment. The exercising method selected must not be performed in such a way as to be injurious to the weapon and thereby cause future malfunctions. Deficiencies noted will be recorded on appropriate forms in accordance with DA PAM 738-750.

b. Exercising Frequency. Hydropneumatic and hydrospring recoil mechanism and pneumatic and hydropneumatic equilibrators must be inspected and exercised at least every 180 days. There are two configurations of Ml1 9A1 recuperators currently in use, refer to TM 9-1015-252-10 for differences between "old" and "new". The "old" recuperator (NSN 3040-01-340-4823) must be exercised every 30 days, while the 1tnewn one, referred to as the Low Temperature Recuperator (LTR), (NSN 1015-01-3625288) must be exercised every 90 days to maintain them in a serviceable condition when not in use. This

applies to all mounted or unmounted, serviceable or unserviceable recoil mechanisms and equilibrators in the field or in storage, as indicated below:

(1) On serviceable weapons in the field which will not be fired for prolonged periods. A prolonged period is 180 days for all weapons except the Towed Howitzer M119A1. Those M119A1 Howitzers with the Folds recuperator must be exercised every 30 days, and those with the “new” LTR recuperator must be exercised every 90 days. Armored Reconnaissance Airborne Assault Vehicle M551 and M551A1 and Self-Propelled Howitzer M110A2, which must be exercised every 90 days when in administrative storage and every 30 days when in the hands of using units.

(2) On weapons in all types and classes of storage, in storage at manufacturer's, or in storage at overhaul facilities.

(3) On serviceable unmounted recoil mechanisms and equilibrators in the field or in storage.

c. Exercising Procedures (General).

CAUTION

The recoil mechanism may be seriously and permanently damaged if the extension of the piston rod reaches the point at which metal-to-metal contact between the recoiling and non recoiling parts occur. The distance of the piston rod extension where this occurs is given in table 2-1 in the winches distance rod NOT to be extended" column. Never extend the piston rod the distance given in this column. If the metal-to-metal contact distance of any weapon is unknown, do not exceed the distance given as "maximum recoil’ in the pertinent technical manual.

NEVER attempt to exercise recoil mechanisms on combat vehicle by placing cannon muzzle against an immovable object and driving the vehicle forward to create a moving force.

(1) The recoil piston rod must be extended a sufficient distance to leave a film of fluid between the packings and respective sliding surfaces. Move the recoil piston rod back and forth three times to make sure a satisfactory film of fluid is reestablished under the packings. Refer to tables 2-1 and 2-2 for the distance the piston rod should be moved on the various weapons for all methods of exercising, except when exercising with the oil pump M3 (paragraphs 2-1g and 2-2b).

(2) The initial procedure in the exercising process is to remove discolorations on the piston rod caused by the stuffing box packing. The cleaning must be done when the piston rod is extended the first time, as follows: retain the piston rod in the extended position and use an oiled crocus cloth, worked in a longitudinal direction, to remove discolorations from rod. Under no circumstances will discolorations be removed with abrasives other than crocus cloth. With the piston rod still extended, remove the recoil cylinder head (respirator) and clean the exposed part of the cylinder, where the recoil piston normally rests, with a fine lint-free cloth dampened with dry cleaning solvent.

NOTE

If the recoil mechanism is of the type where the recoil cylinder is independent of the counterrecoil assembly (for example, recoil mechanisms use with 8inch howitzer MI 15 and 155-mm howitzer M114 Series), the counterrecoil cylinder head will be removed instead of the recoil cylinder head. Remove any grit or chips from critical surfaces to prevent damage by further exercising. Apply a thin coat of automotive and artillery grease (GM) to the exposed surfaces of the piston rod, and a thin coat of preservative general purpose lubricating oil (PL-S) to the cylinder wall where the packing normally rests. Take special care to prevent fingerprints being left on highly machined surfaces. Replace the cylinder head and finish exercising.

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d. Exercising Procedures With Power Winch.

(1) Use a rope or cable of sufficient strength and length to pull the cannon out-of-battery. The size rope needed is 1 1/2 inch; the size steel cable needed is 7/8 inch. Secure one end of the rope or cable to a 4 by 4 by 24 inch piece of wood, and install the rope or cable through the cannon bore (figures 1-1, 1-2, and 1-3). Adjust the cannon elevation so that the rope or cable installed through the bore and connected to a winch will not rub the rifling. To prevent the rope from being damaged, it should be bent over a sleeve instead of a small diameter hook or cable. Select a winch with the necessary capacity for the amount of pull required. If a winch of the necessary capacity is not available, a block and tackle may be used with the winch, or independently, to increase the pulling force. If a steel cable is used, protect the lands and grooves with strips of wood. Be careful that the material used for securing the rope or cable at the muzzle end will not slip and damage the bore.

WARNING

Keep the winch cable as short as possible. The shorter the cable, the safer the operators are from danger of broken cable. Use of a winch with a power-reverse is the best way to prevent excess unreeling and snarling of the cable.

(2) A steel bar with a reinforced disk head to press against the muzzle may be constructed for use in the bore instead of a rope or cable, when a sufficient number of weapons are to be exercised to warrant it. Wrap the bar with cloth to keep it from damaging the lands. This steel bar has the following advantages:

(a) It can be inserted quickly and easily through the bore.

(b) Dragging a hook over the lands of the rifling becomes unnecessary.

(c) The bar may have an eye on the end, to which the winch hook can be connected easily.

(d) The danger of a broken cable damaging the bore is eliminated.

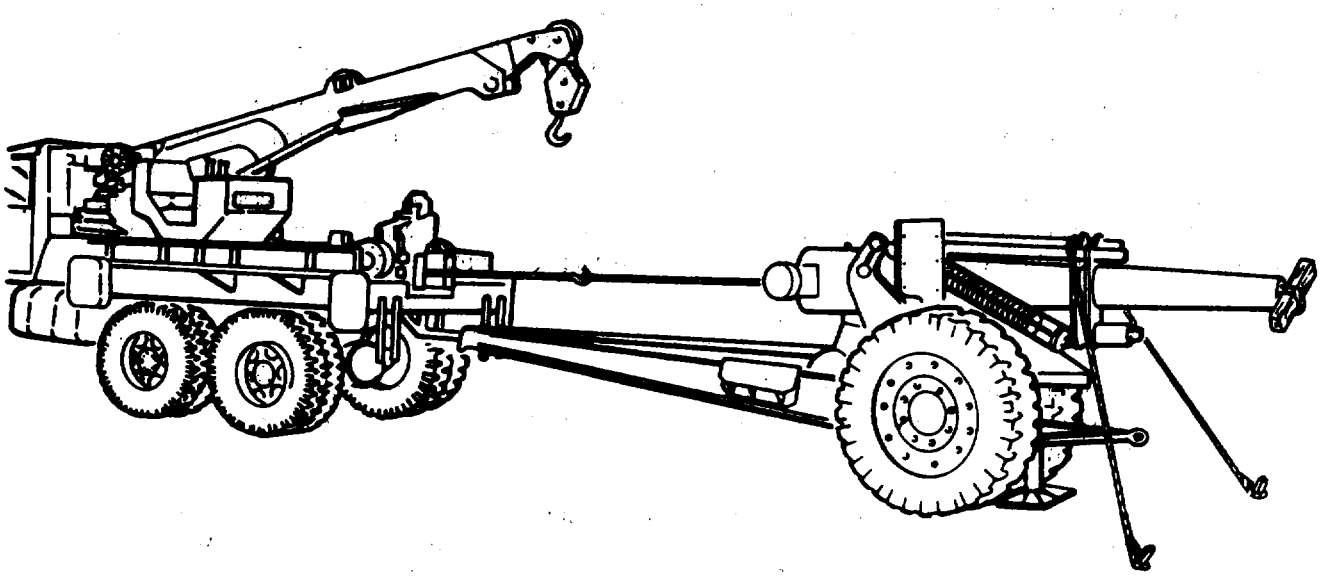

Figure 1-1. Exercising Recoil Mechanism of Towed Artillery in Traveling Position by using Winch on Wrecker Trick

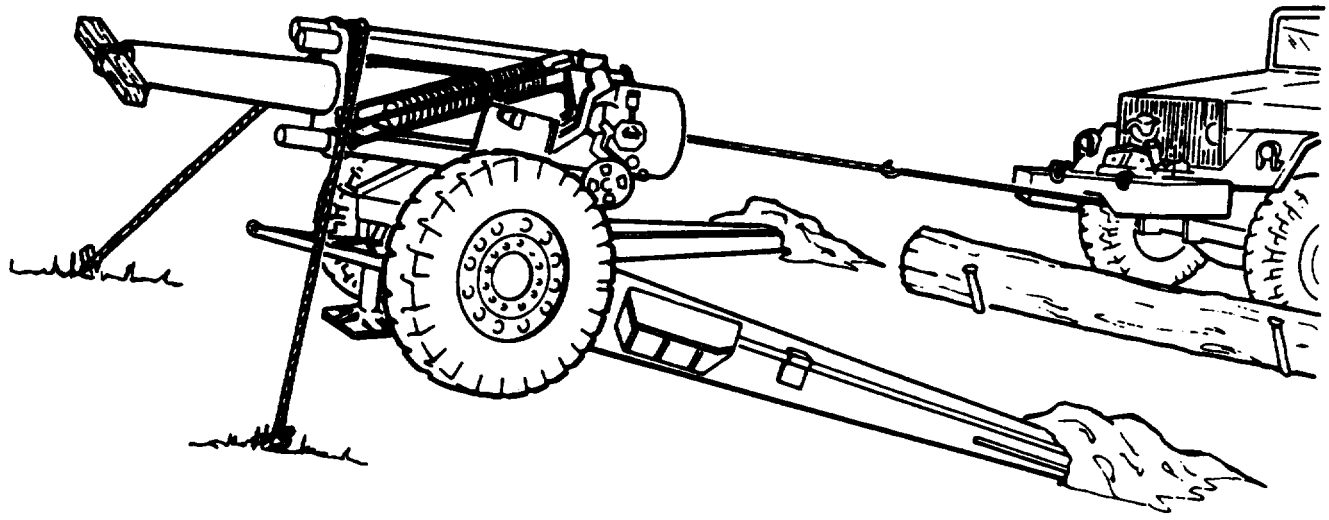

Figure 1-2. Exercising Recoil Mechanism of Towed Artillery with Trails Spread and Spades Dug In by using Winch on Heavy Truck or Tractor

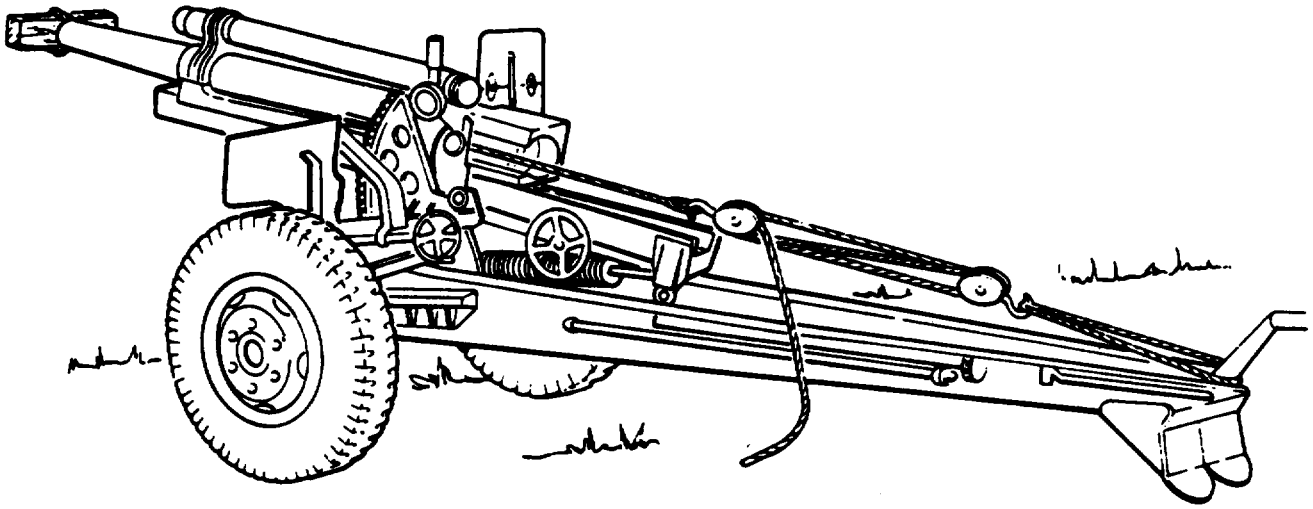

Figure 1-3. Exercising Recoil Mechanism of Towed Artillery with Trails in Traveling

e. Lubrication of Recoil Pistons. During the process of exercising, when the cannon is out-off battery the last time, block the cannon with a 2 by 4 piece of wood about 8 inches long to prevent it from returning to battery. Coat the exposed surfaces of the recoil piston rod or cannon tube lightly with GAA. Remove the block and allow gun to return to battery.

f. Preservation. When exercising has been completed, return preservation to original condition in accordance with SB 740-98-1.

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CHAPTER 2
EXERCISING PROCEDURES

2-1. Exercising Hydropneumatic Recoil Mechanism.

a. General

(1) Prior to exercising, an inspection shall be made to make certain that recoil mechanisms contain the correct amount as well as the right type of hydraulic fluid, in accordance with pertinent lubrication order.

(2) To make certain that the floating piston will be moved sufficiently and to determine the condition of the hydraulic fluid, the recoil fluid reserve shall be drained and reestablished before exercising.

(3) Exercising procedures pertinent to specific weapons are prescribed in table 2-1.

b. Firing Weapon. Firing the weapon (tables 2-1 and 2-2) exercises the recoil mechanism. It is one of the best methods, but is not always practicable.

CAUTION

This method is not to be used on the 8-inch howitzer M115 or larger similar carriages when in traveling position with the lumber, as the powerful forces needed to pull the cannon out-of-battery might buckle the limber.

c. Winch-Weapon In Traveling Position. Certain field artillery weapons (table 2-1) may be exercised in traveling position by connecting the weapon to a wrecking truck with a suitable winch (figure 1-1). Refer to paragraph 1-3d.

d. Winch-Weapon with Trails Spread/Spades Dug In. Certain field artillery guns (table 2-1) set up with the trails spread and spades dug in and self-propelled weapons anchored in place utilizing parking brakes or blocking may be exercised by using a sufficiently strong winch on a heavy truck or tractor to pull the cannon rearward (figure 1-2). The cannon must be positioned at an elevation angle that will permit a straight pull with the winch. Anchor the truck or tractor if the required pull is too great for the weight of the truck or tractor. Stake or weight the carriage down, if necessary. Refer to paragraph 1-3d for instructions on the use of a power winch.

e. Block and Tackle-Weapon in Traveling Position/Direct Pull Against Spades. A block and tackle may be used to exercise a weapon (table 2-1) with the trails in traveling position (figure 1-3). The block and tackle may be anchored to the trail spades and to a rope or cable through the cannon. The cannon is pulled to the rear to exercise the recoil mechanism. Refer to paragraph 1-3d.

f. Block and Tackle-Weapon in Firing Position/Direct Pull Against Spades. For Ml 19AI Howitzer, refer to TM 91015-252-10 to place weapon in firing position and TM9-1015-252-20&P to exercise recoil mechanism.

g. Power Winch. Recoil mechanisms on self-propelled weapons listed in table 2-1 may be exercised using a power winch. See paragraph 1-3d.

h. Oil Pump M3 (Howitzers, excluding M109 Series and M110A2).

(1) Place cannon at approximately zero mils

(2) Clean accumulated dust and dirt from around the filling plug in the recoil mechanism.

(3) Assemble purge pipe to the liquid releasing tool. Remove filling plug from recoil mechanism.

Make sure the valve in purge pipe is closed and install liquid releasing tool with purge pipe into filing hole.

CAUTION

Do not permit cannon to slide more than one foot out-of-battery since self-elvation may result if cannon slides beyond this point

(4) Elevate the howitzer sufficiently to allow cannon to slide out-of as additional fluid as released. Open the valve allowing the fluid to drain into container. Close the valve. emit the cannon to slide out of battery one foot, then close the valve. It may be necessary to use a pry bar to start the cannon to recoil.

(5) Level the cannon and remove the liquid releasing tool.

(6) Filter the fluid drained from the recoil mechanism into the oil pump M3 if it is considered suitable for reuse. Install the proper fluid filling plug adapter into the filling hole and loosely attach the oil hose and oil pump. Operate the pump slowly until the line is purged of air and tighten all connections. Continue pumping until the cannon returns to battery and fluid reserve is established.

NOTE

Make certain the oil pump is not allowed to become empty during operation to avoid pumping air into the system.

(7) To exercise the floating piston pump, add 50 strokes into the recoil mechanism for the 105-mm howitzer M101 and M101A1. Add 100 strokes for the 155-mm howitzer M114 series and for the 8-inch howitzer M115.

(8) Repeat the above procedure two more times, the establish the correct fluid reserve according to the pertinent technical manual.

(9) Close the trails and return the weapon to its original condition.

i. Movement of Cannon Battery to Retracting Position/Retracted to Battery Position (Howitzer M110A2 Only).

(1) Movement of the cannon from the battery position to the retracted position or from the retracted position to the battery position as outlined in TM 9-2350-304 10 will exercise the recoil rod piston, conterrecoil rod piston, and related stuffing boxes; however, this method will not exercise the floating piston in recuperator cylinder.

(2) In the event the pistons and stuffing boxes of the recoil and counterrecoil rods are exercised by movement of the cannon, with the control handle in the retract or return position, the following methods can be used to exercise the floating piston and establish the correct reserve in the recuperator cylinder:

(a) Use of the hand operated hydraulic pump:

1. Return weapon to battery position and place retractor control valve handle in HOLD position.

2. Close the accumulator shut-off valve.

3. Place retractor valve handle in RETURN position and hold.

4. Use hand pump until index pin starts to move. (Hand pump is double action so movement of handle in one direction is one stroke).

5. Count the strokes until pin has been fully extended (0.20 inch).

Table 2-1. Exercising Procedures for Hydropneunmatic Recoil Mechanisms

(For exceptions to exercising, see table 1-1 on page 1-1)

Weapon System	Method Paragraph References											Inches distance rod to be extended	Inches distance rod NOT to be extended
	2-1b	2-1c	2-1d	2-1e	2-1f	2-1g	2-1h	2-1i	2-1j	2-2d	2-2e		
HOWITZER, HEAVY, SELF-PROPELLED: 8-Inch, M110A2	X									X	X	16	73
HOWITZER, HEAVY TOWED: 8-Inch, M115	X		X				X					*16	*73
HOWITZER, LIGHT TOWED: 105-mm, M101 AND M101A1	X	X	X	X			X					*26	*44.89
HOWITZER, MEDIUM SELF-PROPELLED: 155-mm, M109 Series	X				X					X	X	12-14	Not applicable
HOWITZER,MEDIUM TOWED: 155-mm, M114 Series	X	X	X		X							*16	*73
HOWITZER, LIGHT, TOWED: 105-MM, M119A1	X		X	X							X	20-24	24
HOWITZER, MEDIUM TOWED: 155mm, M198	X								X			14	

*Not applicable when using oil pump M3 (para 2-1h).

** This extended distance will make metal-to-metal contact causing damage.

6. By applying the strokes counted in extending the pin three times, the correct reserve of oil is placed in the recuperator.

7. Place the retracting valve handle in the normal HOLD position.

8. Open the accumulator shut-off valve.

(b) Use of vehicle engine and engine-driven pump:

1. Start vehicle engine.

2. Place power take-off and pump switch to ON.

3. Place retractor valve handle in RETURN position.

4. After weapon has returned to battery, watch the oil index pin to see if it moves out. If pin fails to move out before the automatic clutch disengages pump (caused by pressure in system reaching 2400 psi and pressure switch opening), it means the pressure in recuperator is higher than motor driven pump (primary source). Place and hold switch in the OVERRIDE position; this will bypass the pressure switch and start electric drive pump.

5. Watch the oil index pin. When it starts to move out, count the time interval required to move pin from IN to OUT (fully extended). Now continue to hold OVERRIDE switch for a period of time twice as long as it is required to move pin out This will establish reserve of oil.

6. Place retractor valve handle in normal HOLD position.

7. Turn off power take-off and pump switch.

8. Stop vehicle engine.

NOTE

The 8-inch howitzer can be filled with reserve oil without using the OVERRIDE switch because of the lower pressure required in the recuperator.

(c) Use of fully charged batteries or a slave unit with the 8-inch howitzer in retracted position:

1. Turn on master switch in driver's compartment.

2. Place electric motor driven pump switch to ON position.

3. Place retractor valve handle in RETURN position.

4. After weapon has returned to battery position and the 1600-2400 psi pressure switch has automatically stopped the electric pump, and the oil index pin is still recessed in the IN position, place and hold switch in the OVERRIDE position.

5. Watch the oil index pin. When it starts to move OUT, count the time interval required to bring pin to the OUT position (fully extended -0.20 inch from face).

6. Continue to OVERRIDE pressure switch for a period of time twice as long as in step (5) above. This will establish an oil reserve in recuperator.

7. Place retractor valve handle in the normal-HOLD position.

8. Release OVERRIDE switch and it will return to the OFF position.

NOTE

The 8-inch howitzer can be fined with reserve oil without using the OVERRIDE switch because of the lower pressure required in the recuperator.

j. M198 Howitzer (USMC only) Recoil Exerciser/Hydraulic Ram.

(1) Elevate or depress cannon tube to approximately zero mils.

(2) Assemble hydraulic ram support assembly on cannon tube.

(3) Connect the hydraulic ram support assembly to the cradle assembly with attaching hardware.

(4) Block out replenisher indicator rod by installing the replenisher indicator rod clamp on the indicator rod guard.

(5) Connect hydraulic hose to the hydraulic ram support assembly and to either the hand or electric operated hydraulic pump.

(6) Operate pump until the hydraulic ram is extended approximately 14 inches.

(7) Release hydraulic pressure, allowing the M45 recoil mechanism to return to battery.

(8) Repeat steps 6 and 7 two more times.

(9) Remove hydraulic ram support assembly and attaching parts from the cannon and cradle assembly.

(10) Remove the replenisher indicator rod clamp from the indicator rod guard.

(11) Return howitzer to the respective travel lock position prior to exercising the recoil mechanism.

2-2. Exercising Hydrospring Recoil Mechanisms.

a. General.

(1) When exercising hydrospring recoil mechanisms with the oil pump M3, the replenisher is disconnected from the recoil cylinder or cradle and must be exercised independently as outlined in para 2-2b below. Recoil Mechanisms cannot be exercised through the replenisher when using oil pump M3.

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(2) Prior to exercising, an inspection should be made to make certain that recoil mechanisms contain the correct amount as well as the right type of hydraulic fluid, in accordance with the pertinent lubrication order.

(3) Exercising procedures pertinent to specific weapons are prescribed in table 2-2.

(4) After exercising the recoil mechanism stencil the date on the cannon tube using 1-inch letters. Stencil should read "Exercised month-day-year."

b. Oil Pump M3 (Single or Double Type Recoil Mechanisms).

(1) On certain types of replenishers (Table 2-2), remove hydraulic fluid from replenisher cylinder.

(2) Remove replenisher hose from recoil cylinder or cradle.

(3) Install plug or cap to seal replenisher hose hole.

(4) Level cannon and remove plug from rear of recoil cylinder.

(5) Attach hose from oil pump M3 to recoil cylinder.

(6) Mark the cannon tube 8 inches from gun shield.

(7) Using oil as specified in the lubrication order for weapon being exercised, operate the oil pump and hydraulically force the gun 8 inches out-of-battery, as marked on the gun tube.

Table 2-2. Exercising Procedures for Hydrospring Recoil Mechanisms

Weapon System	Method Paragraph references							Inches distance rod to be extended
	2-1b	2-2b	2-2c	2-2d	2-2e	2-2f	2-2g	
ARMORED RECONNAISSANCE/ AIRBORNE ASSAULT VEHICLE: FULL-TRACKED, 152-MM, M551/M551A	X				X	X		6-8
TANK, COMBAT, FULL-TRACKED: 90-mm gun, M48 SERIES	X	X	X	X	X			6-8
TANK, COMBAT, FULL-TRACKED: 105-mm gun, M60 SERIES and M48A5	X	X	X	X	X			6-8
VEHICLE, COMBAT ENGINEER, FULL-TRACKED: M728	X	X	X	X		X		6-8
TANK, COMBAT FULL-TRACKED: 105-mm, gun, Ml ABRAMS	X	X		X	X		X	6-8
TANK, COMBAT FULL-TRACKED: 120-mm, gun, M1A1 ABRAMS	X	X		X	X		X	6-8
TANK, COMB3AT FULL-TRACKED: 120-mm, gun, M1A2 ABRAMS	X	X		X	X		X	6-8

(8) Release valve on oil pump and allow cannon to move back into battery.

(9) Repeat operation at least three times to ensure that recoil slide area and seals are lubricated.

(10) Apply GAA as specified in paragraph 1-3e.

(11) Remove 2 by 4 and proceed as in step (8) above.

(12) Remove plug or cap and attach replenishment hose by one or two threads.

(13) Fill replenisher, bleeding out any air in replenisher hose.

(14) Tighten replenisher hose and recheck for proper amount of oil as specified in the pertinent technical manual.

c. Replenisher.

(1) Replenisher may be exercised with either oil pump M3 or an 8 ounce filler gun.

(2) Drain fluid from replenisher into a clean container.

(3) Attach oil pump hose loosely into filter plug hole. Force air out of hose, tighten hose, and pump fluid into replenisher. Fill replenisher until indicator tape shows smooth edges.

(4) Drain replenisher until the proper reading is showing on the indicator tape.

(5) Using an oil spray gun, spray petroleum base hydraulic fluid (MII-H-46170 FRH) to the inner surface of replenisher cylinder. This is accomplished by placing the nozzle of gun into each hole alongside indicator tape and alongside tape through the center hole. This procedure should be repeated each time cannon is exercised.

NOTE

The replenisher is exercised independently, but in conjunction with exercising the recoil mechanism. The recoil mechanism cannot be exercised through the replenisher.

d. Hydraulic Jack. Position vehicle (tables 2-1 and 2-2) so that hydraulic jack can be placed between protected cannon muzzle and a vertical, solid, immovable object.

CAUTION

Ensure that cannon bore is square with object, and jack is placed parallel with bore and at right angle to the side or flat face of the object.

Make sure traversing and elevating controls are locked in place before operating jack to move weapon out-of-battery.

Repeat movement at least three times. Lubricate as specified in paragraph 1-3e.

e. Wrecker M62, M543A2, M816, M977, or M98E1 HEMTT and Improvised Exercising Bracket. When exercising a number of combat vehicle recoil mechanisms, an improvised exercising bracket (figures 2-1, 2-2, and 2-3) can be fabricated to save time and effort. With this exercising device, any number of combat vehicles (tables 2-1 and 2-2) can be exercised by using the wrecker boom (figures 2-3 and 2-4) and exercise recoil mechanism as outlined below.

CAUTION

Ensure that turret lock Is engaged and vehicle master switch if off.

Ensure that wrecker boom and gun tubes are horizontally and laterally squared to prevent damage to the tube, turret and other components.

Operators should be in both vehicles to keep brakes fully applied to prevent movement of either vehicle while tube is being pushed out of battery.

(1) Using black paint, stencil a 1 inch by 6 Inch stripe on cannon tube 6 to 8 inches from the gun shield.

(2) With the improvised bracket attached to the wrecker boom as shown in figures 2-4 and 2-5, extend boom until distance prescribed in tables 2-1 and 2-2 "Inches-distance to be extended" column, is reached. Retract boom and allow gun to return to the in-battery position.

NOTE

On M551/M551A1 vehicles only, the recoil mechanism must be at precharged pressure. Hand pump (see TM 9-2350-230-10) will be used if gun-launcher fails to return to in-battery position.

(3) Repeat operation a minimum of three times to insure recoil slide area and seals are lubricated. For M551/M55A1 vehicles, repeat operation a minimum of ten times. See paragraph 1-3b for frequency of exercising recoil mechanisms.

(4) Lubricate other areas according to the procedures outlined in paragraph 1-3e.

f. Exercise of 152-mm Gun/Launcher Armored Reconnaissance/Airborne Assault Vehicle M551 and M551A1. When conditions (lack of space, etc.) deny conventional use of wrecker, an improvised harness may be fabricated and used as follows:

NOTE

Two men required.

(1) Obtain chain hoist, 1/2 ton capacity or equivalent.

(2) Obtain two gun shield lifting eye bolts.

(3) Fabricate or locally obtain two eye bolts 5/8 inch in diameter, eye opening 2 1/2 to 3 inches, and shaft length 4 to 4 1/2 inches. Appropriate washers and nuts are also required.

(4) Fabricate or locally obtain two steel rings 5/8 inch in diameter and 3 1/2 to 4 inches in circumference.

(5) Fabricate gun muzzle attachment (figure 2-6) as follows:

(a) Utilizing oak or similar hard wood block 12 inches long, 8 inches wide, and 4 inches thick, remove approximately 1 inch of wood from one side except for a centered disk approximately 5 inches in diameter and 1inch high.

(b) Drill holes to accommodate eye bolts (step (3) above) at each end and centered approximately 2 inches from end of block. Insert eye bolts with bolt eye on side with raised deck.

(6) Insert eye bolts to gun shield.

(7) Utilize two suitable lengths of rope, chain, cable with a 1/2 ton capacity and attach the end of one to the eye bolt in the gun shield and the end of the other to an eye bolt of the improvised muzzle block (step (5) above). Thread a steel ring (step (4) above) through each length, attach opposite end of respective eye boll (gun shield or muzzle block). Adjust length so chain hoist can be attached to steel ring. Provide adequate length to rope, chain, etc., on gun shield eye bolts to avoid damage to transmitter cover (figure 2-7).

CAUTION

Make sure traversing and elevating controls are locked in place before using the chain hoist.

Make sure gun launcher is at zero elevation. Gun may slide completely out-of-battery if elevated.

(8) One man operates the chain hoist and the other, from within the vehicle, opens the manual relief valve on the side of the reservoir releasing gun mount precharge pressure. The chain hoist is utilized to back the gun launcher out-of-battery for a distance of 6 to 8 inches. The chain hoist is then released, the manual relief valve closed, and the pump handle actuated until the gun launcher is returned to full battery position. This procedure is repeated at least 10 times. Upon completion, the recoil system should be left in full precharge pressurized condition.

g. Exercise of 105-mm/120-mm Gun (M1/M1A1/M1A2 Series Tank Only). The Gun Mount Exerciser is another method for exercising the recoil mechanisms for the M1/M1A1/M1A2 Series Tank. Refer to the applicable manual for operation of the Gun Mount Exerciser. (TM 9-2350-255-20-2-4 for M Tank, TM 9-2350264-20-2-4 for M1A1 Tank, and TM 9-2350-288-20-2-4 for M1A2 Tank).

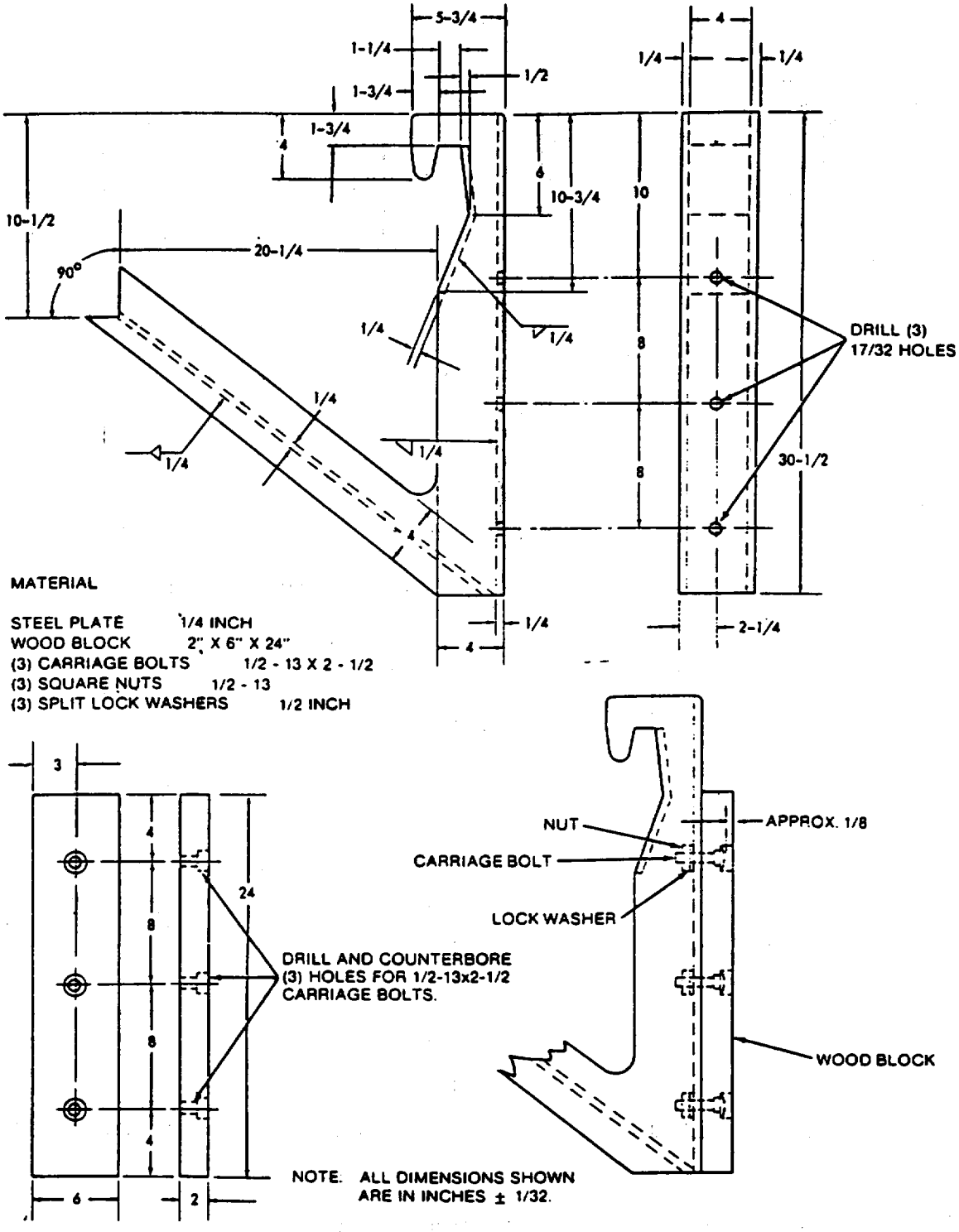


Figure 2-1. Dimensional Drawing for Fabricating Improvised Recoil Mechanism Exercising Bracket (M62 Wrecker)

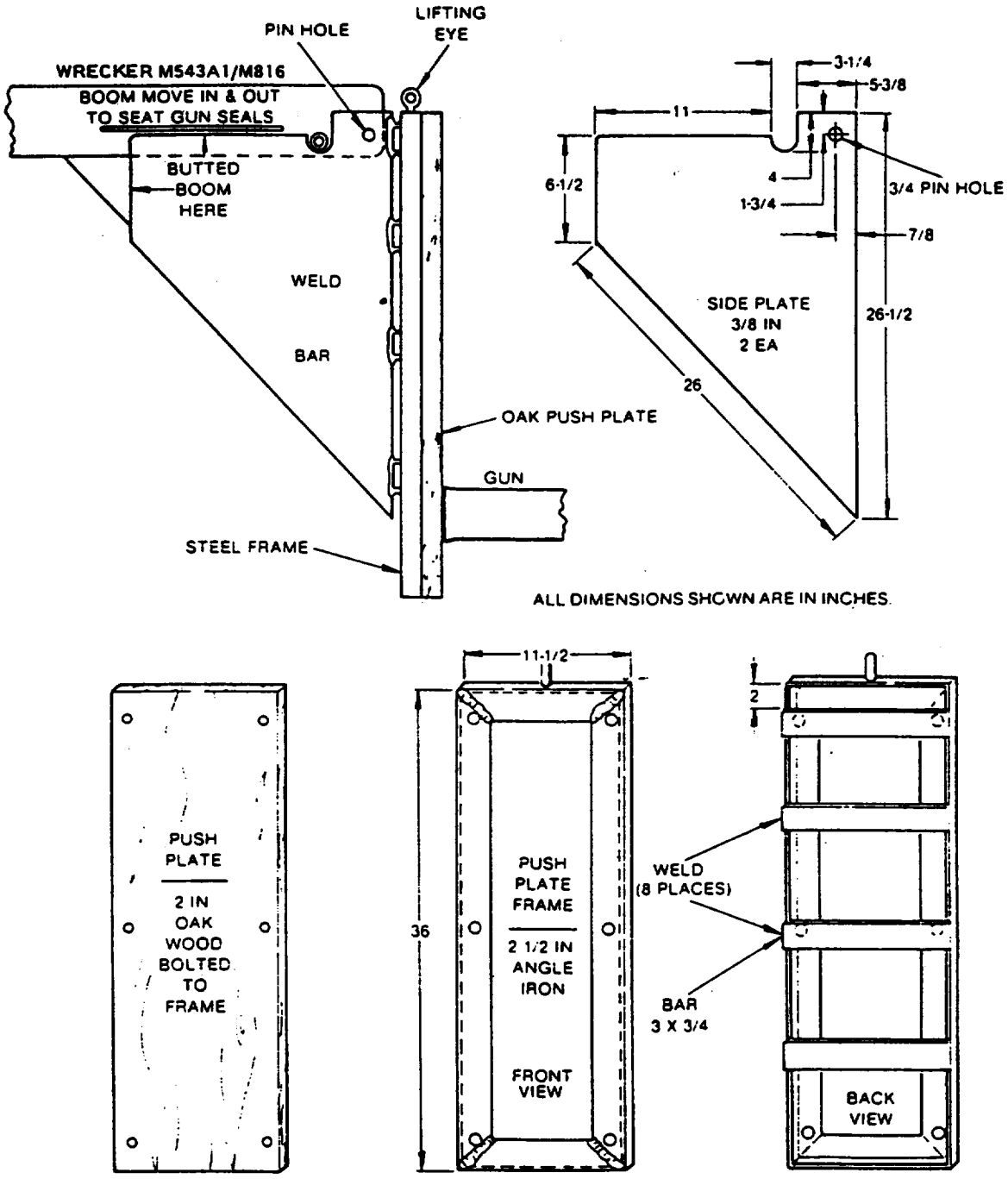
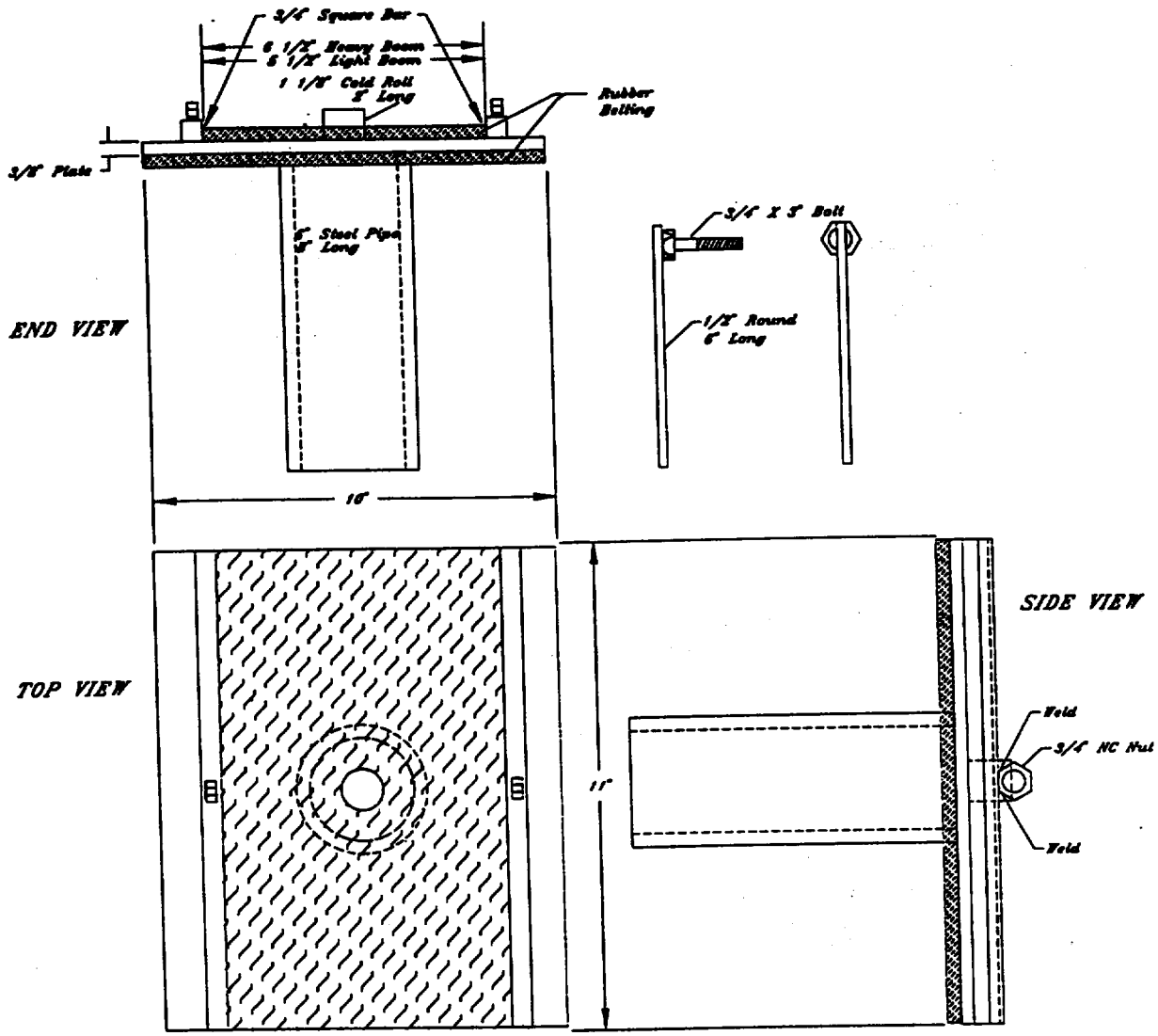


Figure 2-2. Dimensional Drawing for Fabricating Improvised Recoil Mechanism Exercising Bracket for Wreckers M543A2/M816



MATERIAL – LOW ALLOY STEEL		RUBBER BELTING	1/4 INCH TO 1/2 INCH
STEEL PLATE	3/8 INCH	SQUARE BAR	3/4 INCH
COLD ROLL	1 1/8 INCH	STEEL PIPE	6 INCH

Rubber belting is cut to fit between 3/4" square bars on boom side and cut to fit around pipe on tube side.

Figure 2-3. Dimensional Drawing for Fabricating Improvised Recoil Mechanism Exercising Bracket of M977 or M98E1 HEMTT

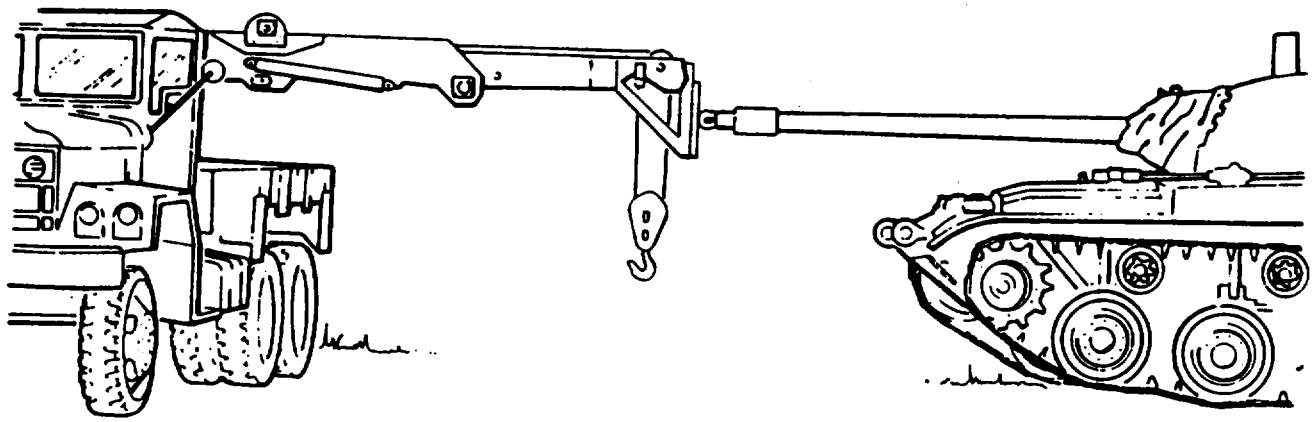


Figure 2-4. Exercising Recoil Mechanism of Combat Vehicle with Wrecker and Improvised Exercising Bracket (M62 Wrecker Shown)

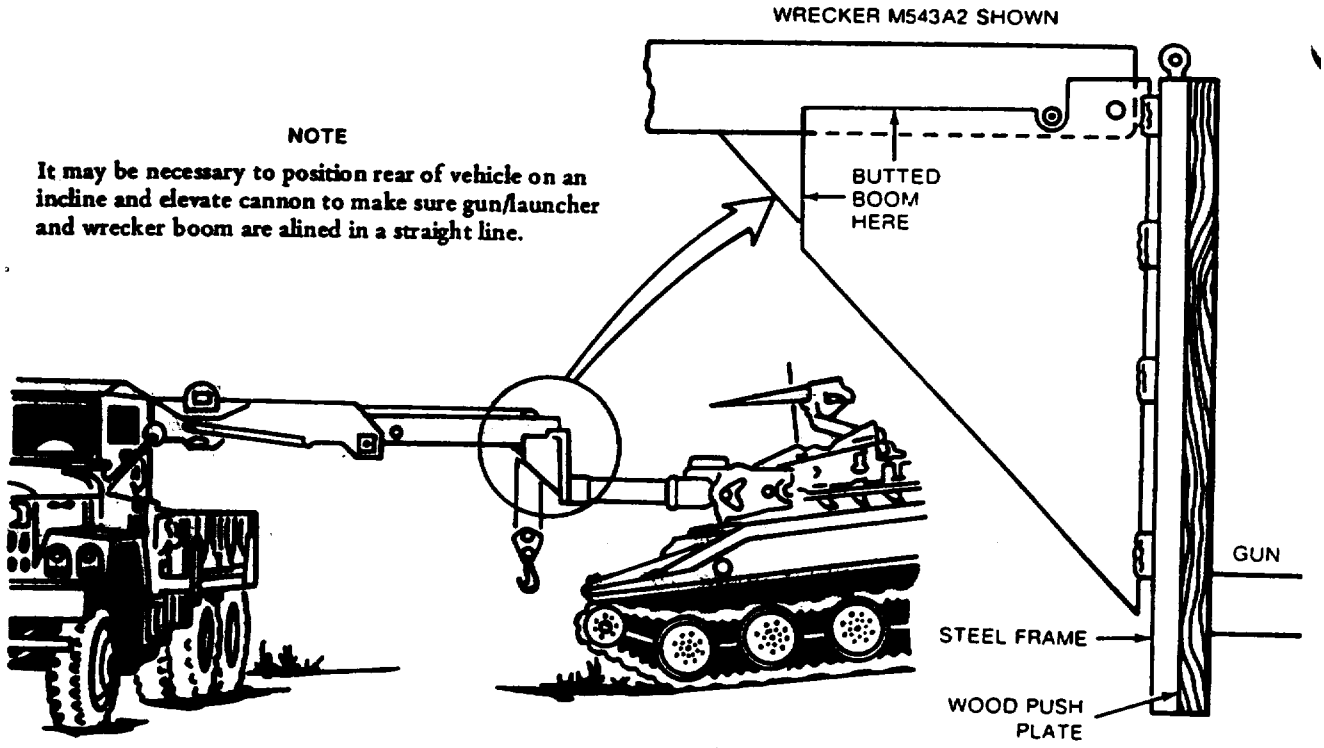


Figure 2-5. Exercising M551/M551A1 with Wrecker (M543A2 Wrecker Shown)

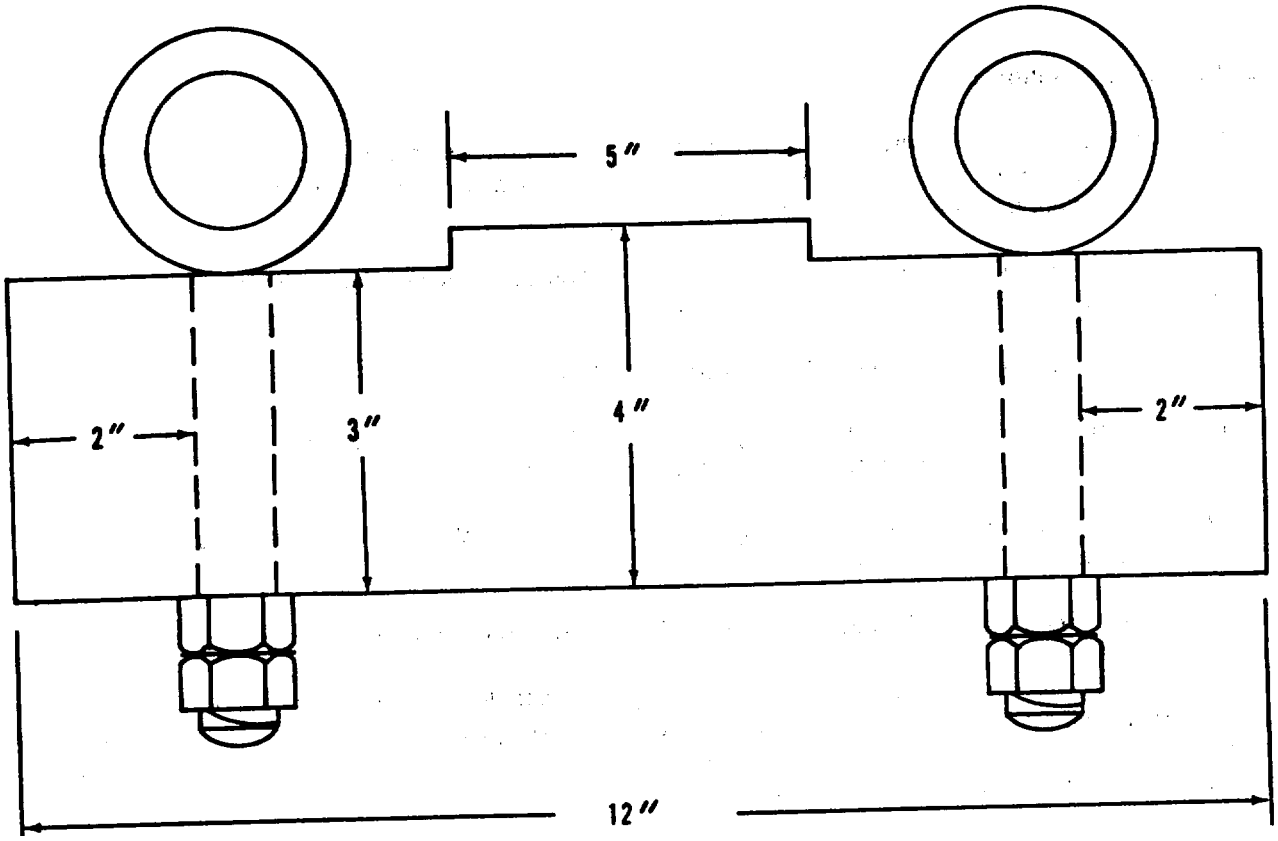


Figure 2-6. Dimensional Drawing for Fabricating Gun Muzzle Attachment

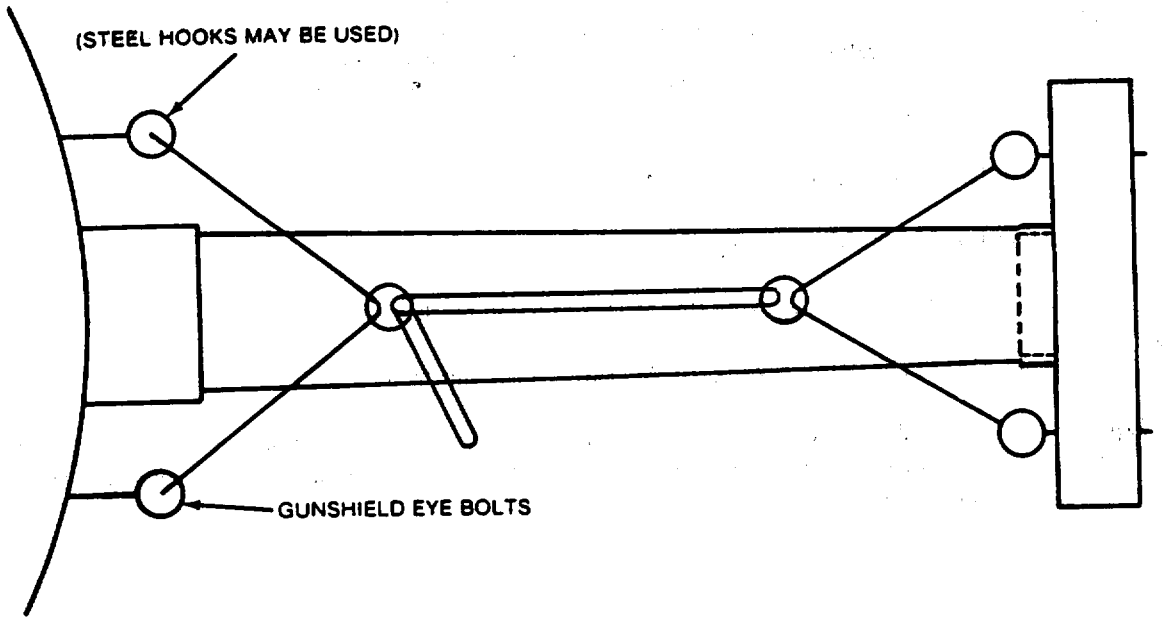


Figure 2-7. Exercising Using Chain Hoist

2-3. Exercising Equilibrators.

a. General. Pneumatic and hydropneumatic equilibrators must be exercised periodically for reasons given in paragraph 1-3. Proper exercising of equilibrators at least every six months, as outlined in paragraph 2-3b below, is essential to maintain them in serviceable condition.

b. Angled Equilibrators. To exercise equilibrators mounted on a carriage or vehicle, elevate and depress the cannon at least three times.

c. Equilibrated Elevating Cylinders (Howitzer M109 Series).

(1) To exercise the equilibrated elevating cylinders on the howitzer M109 series, activate the cab hydraulic system and elevate and depress the cannon through its full range at least three times.

(2) If it is not practical to activate the cab hydraulic system, use the elevation hand pump and elevate and depress the cannon through its full range at least once.

2-4. Exercising Unmounted Hydropneumatic Recoil Mechanisms and Equilibrators In Storage.

a. General. The procedures given in the preceding paragraphs apply to hydropneumatic type recoil mechanisms or equilibrators in storage. When exercising has been completed, restore proper preservatives in accordance with MIL-P-14232 and pertinent Packaging and Data Sheets. Record the date of exercising on a tag and attach to recoil mechanism or equilibrator.

b. Unmounted Hydropneumatic Recoil Mechanisms. If the hydropneumatic recoil mechanism is of the independent type and unmounted, it will be necessary to exercise the recoil cylinder assembly and counterrecoil assembly separately. The force required to exercise the recoil cylinder assembly is only that force necessary to overcome friction. Extension of 6 inches will be enough for the recoil cylinder and counterrecoil assembly. An adapter may be improvised for extending and retracting the recoil piston by a direct pull or a jacking process. The counter recoil assembly will return to a retracted position on its own volition due to nitrogen pressure. Recoil mechanisms may also be exercised with 7 1/2 horsepower portable gymnasticator (RIA drawing E7113950) and pertinent adapters as follows:

Adapter D7123504 (RIA drawing (for M1 series recoil mechanisms)

Adapter D7123508 (RIA drawing (for M2 series recoil mechanisms)

Adapter D7123510 (RIA drawing (for M6 series recoil mechanisms)

Adapter D7123512 (RIA drawing (for M4 series recoil mechanisms)

c. Equilibrators. Equilibrators in storage may or may not contain high nitrogen pressure. Equilibrators may be exercised by anchoring one end to the floor or wall and pulling the other end with a suitable power source. Extend the equilibrators 8 inches.

2-5. Exercising Recoil Mechanisms and Equilibrators Under Extreme Climatic Conditions.

a. The extreme temperatures of the arctic's and tropics will affect the rate of corrosive action.

b. The heat of the tropics will lower the viscosity of the hydraulic fluid, thereby causing the film of fluid between the packings and sliding surfaces to dry out more quickly. Consequently, more frequent exercising will be required to maintain the necessary film of fluid. An increase of 18'F has been found to approximately double the rate of corrosion due to chemical reaction.

c. The freezing temperatures of the artics will also affect the efficiency of the fluid seal and packings.

d. It is impractical to prescribe the increased frequency at which recoil mechanisms should be exercised in various climates. On hydropneumatic systems under extreme climatic conditions, special inspections must be made of the surfaces of the recoil piston rod and cylinder on which the stuffing and piston packings rest when in battery position. This inspection should be made while the recoil mechanism is being exercised, in accordance with instructions in paragraph 1-3c. The frequency of exercising should be increased in accordance with the findings of the above inspections.

APPENDIX A
REFERENCES

A-1. Technical Manuals and Supply Bulletins. The technical manuals and supply bulletin which follow are applicable to this bulletin.

SB 740-98-1	Storage Servicieability Standard: Tracked Vehicles, Wheeled Vehicles, and Component Parts
TM 9-1015-252-10	Operator's Manual for Howitzer, Light, Towed: 105-mm M119A1 (1015-01-308-1872)
TM 9-1015-252-20&P	Unit Maintenance Manual Including Repair Parts and Special Tools List for Howitzer, Light, Towed: 105-mm M119A1 (1015-01-308-1872)
TM 9-2350-217-20N	Organizational Maintenance Manual: Howitzer, Medium, Self-Propelled, 155-mm M109 (2350-00-440-8811), M109A1 (2350-00-485-9662) and M109A3 (2350-01-031-8851)
TM 9-2350-230-10	Operator's Manual (Crew) for Armored Reconnaissance/Airborne Assault Vehicle, Full-Tracked, 152-mm Gun/Launcher M551 (2350-00-873-5408) and M551A1 (2350-00-140-5151)
TM 9-2350-255-20-2-4	Unit Maintenance Manual Volume 4 of 4 Tank, Combat, Full-Tracked: 105-mm Gun, Ml (2350-01-061-2445)
TM 9-2350-264-20-2-4	Unit Maintenance Manual Volume 4 of 4 Tank, Combat, Full-Tracked: 120-mm Gun, M1A1 (2350-01-087-1095) General Abrams Turret
TM 9-2350-303-20	Organizational Maintenance Manual for Howitzer, Medium, Self-Propelled, 155-mm M109A2 (2350-01-031-0586)
TM 9-2350-304-10	Operator's Manual for Howitzer, Heavy, Self-Propelled: 8-Inch, M110A2 (2350-01-041-4590)
TM 9-2350-288-20-2-4	Unit Maintenance Manual Volume 4 of 4 Tank, Combat, Full-Tracked: 120-mm Gun, M1A2 (2350-01-328-5964) General Abrams Turret

A-2. Other Publications. The following publications are related to information contained in this bulletin.

MIL-P-14232	Parts, Equipment and Tools for the Packaging and Packing of Army Material
DA Pam 738-750	The Army Maintenance Management Systems (TAMMS)

A-3. RIA Drawings. The following drawings are related to information contained in this bulletin.

E7113950	7 1/2 Horsepower Portable Gymnasticator
D7123504	Adapter for Ml series Recoil Mechanisms
D7123508	Adapter for M2 series Recoil Mechanisms
D7123510	Adapter for M6 series Recoil Mechanisms
D7123512	Adapter for M4 series Recoil Mechanisms

*U.S. G.P.O.:1993-746-045:80037

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'VEIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

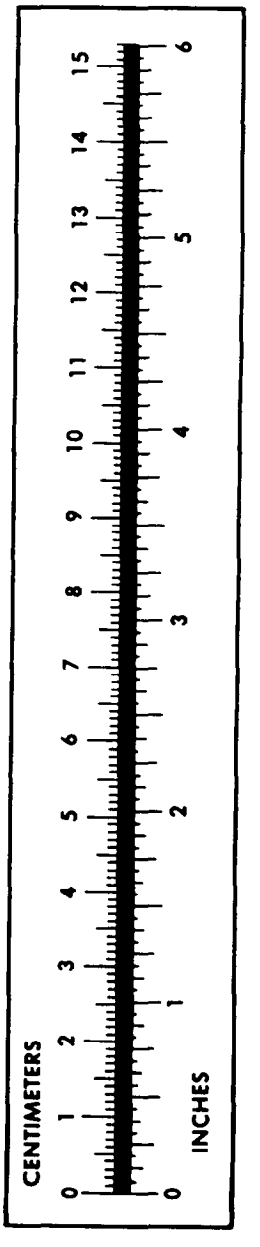
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
ers	Gallons	0.264
ms	Ounces	0.035
ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
lometers per Liter	Miles per Gallon	2.354
meters per Hour	Miles per Hour	0.621



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