

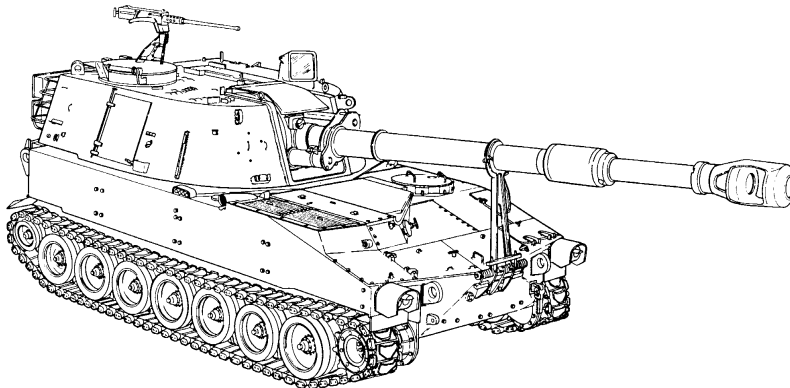
**TM 9-2350-311-10**

Supersedes TM 9-2350-311-10  
and LO 9-2350-311-12, dated  
June 1986, and all changes

**DEPARTMENT OF THE ARMY  
TECHNICAL MANUAL**

**OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED,  
155MM**

**M109A2 (2350-01-031-0586)(EIC:3EZ)  
M109A3 (2350-01-031-8851)(EIC:3E2)  
M109A4 (2350-01-277-5770)(EIC:3E8)  
M109A5 (2350-01-281-1719)(EIC:3E7)**



**DESCRIPTION AND USE OF  
OPERATOR'S CONTROLS  
AND INDICATORS 2-2**

**PREVENTIVE MAINTENANCE  
CHECKS AND SERVICES (PMCS) 2-16**

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**EXPENDABLE AND DURABLE  
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**DISTRIBUTION: To be distributed in accordance with the Initial Distribution Number (IDN)  
371238 requirements for the TM 9-2350-311-10.**

**HEADQUARTERS, DEPARTMENT OF THE ARMY**



**WARNING****CARBON MONOXIDE POISONING CAN BE DEADLY**

Carbon monoxide is a colorless, odorless, deadly poisonous gas, which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, apparent drowsiness, coma, permanent brain damage, or even death from severe exposure.

Carbon monoxide occurs in the exhaust fumes of fuel-burning heaters and internal-combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. The following precautions must be observed to ensure the safety of personnel whenever the personnel heater, main engine, or auxiliary engine of any vehicle is operated for maintenance purposes or tactical use.

Do not operate heater or engine of vehicle in an enclosed area unless it is adequately ventilated.

Do not idle engine for long periods without maintaining adequate ventilation in personnel compartments.

Do not drive any vehicle with inspection plates, cover plates, or engine compartment doors removed unless necessary for maintenance purposes.

Be alert at all times during vehicle operation for exhaust odors and exposure symptoms. If either is present, immediately ventilate personnel compartments. If symptoms persist, remove affected personnel from vehicle and treat as follows: expose to fresh air; keep warm; do not permit physical exercise; and if necessary, administer artificial respiration.

**THE BEST DEFENSE AGAINST CARBON MONOXIDE  
POISONING IS ADEQUATE VENTILATION.**



**RADIATION HAZARD**



**TRITIUM GAS (H<sub>3</sub>)**

**Rules and Regulations**

This item contains radioactive material. Control of this radioactive material is mandated by federal law. Immediately report any suspected lost or damaged items to your Radiation Protection Officer. If your Radiation Protection Officer can not be reached contact the TACOM-ACALA Safety Office.

Copies of the following rules and regulations are maintained at HQ, TACOM ACALA, Rock Island, IL 61299-7630. Copies may be requested or information obtained by contacting the ACALA Radiological Protection Officer (RPO), DSN 793-2965/2995/2962, Commercial (309) 782-2965/2995/2962. After duty hours, contact the staff duty officer through the operator at DSN 793-6001, Commercial (309) 782-6001.

1. 10 CFR Part 19 - Notices, Instructions and Report to Workers; Inspections.
2. 10 CFR Part 20 - Standards for Protection Against Radiation.
3. 10 CFR Part 21 - Reporting of Defects and Noncompliance.
4. NRC license, license conditions, and license application.

**Safety Precautions**

The radioactive material used in the M1A1 collimator and the M140 alinement device is tritium gas (H<sub>3</sub>) sealed in pyrex tubes. These sources illuminate the instrumentation for night operations. Tampering with or removing the source in the field is prohibited by Federal Law. They pose no significant hazard when intact. However, if an M1A1 collimator or an M140 alinement device is discovered to be broken, damaged, or defective, the following procedures will be followed:

1. Evacuate to a safe distance upwind and cordon off immediate area around device.
2. Immediately notify the installation Radiation Protection Officer (RPO) and the Installation Safety Officer (SO).
3. All personnel will stand fast at the safe area until released by the RPO or the SO.
4. Follow the RPO's instruction for decontamination so as to avoid excess spread of tritium contamination.
5. Personnel exposed to tritium will notify medical personnel.

**WARNING****RADIATION HAZARD****TRITIUM GAS (H<sub>3</sub>)****Rules and Regulations (Cont)****Identification**

Radioactive self-luminous sources are identified by means of radioactive warning labels (as above). These labels should not be defaced or removed, and should be replaced immediately when necessary. Refer to the local RPO or the ACALA RPO for instructions on handling, storage, or disposal.

**Storage**

When radioactively illuminated instruments are defective, notify unit maintenance. These items must be placed in a plastic bag (item 6, Appx D) and packaged in the shipping container. Spare equipment must be stored in the shipping container, as received, until installed on the weapon. Storage of these items is recommended to be in an outdoor shed-type storage or unoccupied building.

**WARNING**

- DO NOT chamber ammunition until immediately before firing. Ammunition left too long in a hot weapon may result in hazardous conditions to personnel. Fire or remove ammunition within five minutes of chambering. See Hot Cannon Tube Misfire/Checkfire Procedure, paragraph 2-15.
- Never insert primer in primer vent unless breechblock assembly is closed and locked. ignition of propelling charge with breechblock not fully closed presents a critical hazard to crew.
- Firing mechanism lever should be positioned before primer is inserted in primer vent. Don't force primer into primer chamber. Forcing primer could prematurely ignite powder charge causing the howitzer to recoil resulting in serious injury to the crew.
- If major work has been done by direct or general support, fire first round using the 50 foot lanyard to prevent injury. In addition, each new issue, overhaul, or inspect and repair vehicle received should be fired using the 50 foot lanyard for the first round.
- The firing of a field artillery round without a fuze or with an unauthorized fuze is strictly prohibited. Only authorized fuzes will be used with the authorized projectiles and propelling charges to prevent death or injury from an inbore or premature explosion.
- Stand clear of breech to avoid injury from cannon recoil.
- All doors and hatches should be closed when firing the M203 family of charges to prevent injury.
- The ventilation blower switch must be turned to INTAKE during firing (para 2-17.3) to ensure adequate fresh air supply for personnel.
- Refer to TM 9-1300-206, Ammunition and Explosives Standards, for correct procedures involving the use of ammunition for storing and handling ammunition.

**WARNING****CHEMICAL AGENT RESISTANT COATING (CARC) PAINT**

CARC paint contains isocyanate, a constituent that can cause respiratory effects during and after the application of the material. During the application of CARC paint, coughing, shortness of breath, pain on respiration, increased sputum, and chest tightness may occur. CARC paint also produces itching and reddening of the skin, a burning sensation of the throat and nose, and watering of the eyes.

An allergic reaction may occur after initial exposure (ranging from a few days to a few months later), producing asthmatic symptoms including coughing, wheezing, tightness in the chest, or shortness of breath.

The following precautions must be observed to ensure the safety of personnel when CARC paint is applied.

- For brush/roller painting in confined spaces, an airline respirator is required, unless an air sampling shows exposure to be below standards. If the air sampling is below standards, either chemical cartridge or airline respirators are required.
- Spot painters applying CARC paint by brush or roller must wear clothing and gloves affording full coverage.
- Do not use water, alcohol, or amine based solvents to thin or remove CARC paints. Use of these solvents with CARC paints can produce chemical reactions resulting in nausea, disease, burns, or severe illness to personnel.
- Do not use paint solvents to remove paint/coating from your skin.
- Mix paint/coating in a well ventilated mixing room or spraying area away from open flames. Personnel mixing paint/coating should wear eye protection.
- Use paint/coating with adequate ventilation.
- Unusable CARC mixtures maybe considered hazardous waste and may require disposal in accordance with federal, state, DOD, and DA hazardous waste regulations. Consult the installation environmental office for proper disposal guidance. Mixed CARC has a flashpoint of approximately 38° F (3° C) due to the incorporation of solvents and is highly flammable.





TM 9-2350-311-10

C5

HEADQUARTERS

DEPARTMENT OF THE ARMY

WASHINGTON, D.C., 15 JULY 2004

**CHANGE  
NO. 5**

**OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED, 155MM  
M109A2 (2350-01-031-0586) (EIC: 3EZ)  
M109A3 (2350-01-031-8851) (EIC: 3E2)  
M109A4 (2350-01-277-5770) (EIC: 3E8)  
M109A5 (2350-01-281-1719) (EIC: 3E7)**

TM 9-2350-311-10, 23 November 1994, is changed as follows:

1. The purpose of this change is to update TM 9-2350-311-10.
2. New or changed material is indicated by a vertical bar in the outside margin of text changes and by a hand symbol beside illustration changes.
3. Remove the old page and insert the new page as indicated below:

Remove Pages

A through C/(D blank)

1-21 and 1-22

3-49 and 3-50

5-11 and 5-12

5-12.1 and 5-12.2

5-17 and 5-18

5-27 and 5-28

None

5-29 and 5-30

None

5-65 and 5-66

B-3 thru B-14

Insert Pages

A through C/(D blank)

1-21 and 1-22

3-49 and 3-50

5-11 and 5-12

5-12.1 and 5-12.2

5-17 and 5-18

5-27/(5-27.0 blank)

5-27.1 and 5-28

5-29 and 5-30

5-30.1/(5-30.2 blank)

5-65 and 5-66

B-3 thru B-14

4. File this change in front of the publication.

Distribution Statement A: Approved for public release; distribution is unlimited.

By Order of the Secretary of the Army:

Official:



JOEL B. HUDSON

*Administrative Assistant to the  
Secretary of the Army*

0418203

PETER J. SCHOOMAKER  
*General, United States Army  
Chief of Staff*

DISTRIBUTION: To be distributed in accordance with the Initial Distribution Number (IDN) 371238, requirements for TM 9-2350-311-10

TM 9-2350-311-10

C4

HEADQUARTERS

DEPARTMENT OF THE ARMY

WASHINGTON, D.C., 15 JANUARY 2002

**CHANGE  
NO.4**

**OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED, 155MM  
M109A2 (2350-01-031-0586) (EIC: 3EZ)  
M109A3 (2350-01-031-8851) (EIC: 3E2)  
M109A4 (2350-01-277-5770) (EIC: 3E8)  
M109A5 (2350-01-281-1719) (EIC: 3E7)**

TM 9-2350-311-10, 23 November 1994, is changed as follows:

1. The purpose of this change is to update TM 9-2350-311-10.
2. New or changed material is indicated by a vertical bar in the outside margin of text changes and by a hand symbol beside illustration changes.
3. Remove the old page and insert the new page as indicated below:

Remove Pages

e and f

A through C/(D blank)

1-21 and 1-22

2-229 and 2-230

2-233 through 2-236

3-49 and 3-50

5-1 through 5-30

5-35 and 5-36

None

5-43 through 5-48

5-51 and 5-52

5-63 and 5-64

None

5-65 through 5-70

5-73 and 5-74

5-77 and 5-78

None

Insert Pages

e and f

A through C/(D blank)

1-21 and 1-22

2-229 and 2-230

2-233 through 2-236

3-49 and 3-50

5-1 through 5-30

5-35 and 5-36

5-40.1 and 5-40.2

5-43 through 5-48

5-51 and 5-52

5-63 and 5-64

5-64.1 through 5-64.4

5-65 through 5-70

5-73 and 5-74

5-77 and 5-78

5-78.1 and 5-78.2

4. File this change in front of the publication.

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By Order of the Secretary of the Army:

Official:



JOEL B. HUDSON

*Administrative Assistant to the  
Secretary of the Army*

0133202

ERIC K. SHINSEKI  
*General, United States Army  
Chief of Staff*

DISTRIBUTION: To be distributed in accordance with IDN 371238 requirements for TM 9-2350-311-10.

CHANGE

NO. 3

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, D.C., 10 January 2000

OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED,  
155MM

M109A2 (2350-01-031-0586) (EIC: 3EZ)

M109A3 (2350-01-031-8851) (EIC: 3E2)

M109A4 (2350-01-277-5770) (EIC: 3E8)

M109A5 (2350-01-281-1719) (EIC: 3E7)

TM 9-2350-311-10, 23 November 1994, is changed as follows:

1. Remove old pages and insert new pages as indicated below.
2. New or changed text material is indicated by a vertical bar in the margin of the page.
3. Added or revised illustrations are indicated by a pointing hand or a vertical bar.

Remove pages	Insert pages
i and ii	i and ii
1-9 and 1-10	1-9 and 1-10
2-11 and 2-12	2-11 and 2-12
2-43 and 2-44	2-43 and 2-44
2-53 and 2-54	2-53 and 2-54
2-54.1 through 2-54.4	2-54.1 through 2-54.4
2-55 and 2-56	2-55 and 2-56
2-73 and 2-74	2-73 and 2-74
2-91 and 2-92	2-91 and 2-92
2-99 and 2-100	2-99 and 2-100
2-121 and 2-122	2-121 and 2-122
2-141 and 2-142	2-141 and 2-142
2-203 and 2-204	2-203 and 2-204
2-245 through 2-252	2-245 through 2-252
2-255 and 2-256	2-255 and 2-256
3-53 and 3-54	3-53 and 3-54
3-71 and 3-72	3-71 and 3-72
3-97 and 3-98	3-97 and 3-98
5-89 and 5-90	5-89 and 5-90
B-11 and B-12	B-11 and B-12
E-3 through E-6	E-3 through E-6

Remove pages

E-9 and E-10

G-7 and G-8

G-15 and G-16

G-21 through G-24

G-29 and G-30

G-35 and G-36

Insert pages

E-9 and E-10

G-7 and G-8

G-15 and G-16

G-21 through G-24

G-29 and G-30

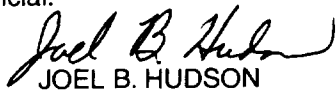
G-35 and G-36

File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army

DENNIS J. REIMER  
General, United States Army  
Chief of Staff

Official:

  
JOEL B. HUDSON

Administrative Assistant to the  
Secretary of the Army

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CHANGE

NO. 2

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON D.C., 31 JULY 1998

OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED,  
155MM  
M109A2 (2350-01-031-0586) (EIC: 3EZ)  
M109A3 (2350-01-031-8851) (EIC: 3E2)  
M109A4 (2350-01-277-5770) (EIC: 3E8)  
M109A5 (2350-01-281-1719) (EIC: 3E7)

TM 9-2350-311-10, 23 November 1994, is changed as follows:

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3. Added or revised illustrations are indicated by a pointing hand or a vertical bar.

Remove pages	Insert pages
a and b	a and b
e and f	e and f
i and ii	i and ii
1-1 through 1-4	1-1 through 1-4
1-11 through 1-16	1-11 through 1-16
1-21 and 1-22	1-21 and 1-22
1-33 and 1-34	1-33 and 1-34
1-39 and 1-40	1-39 and 1-40
2-5 through 2-8	2-5 through 2-8
2-17 and 2-18	2-17 and 2-18
2-21 through 2-24	2-21/(2-22 blank)
2-25 and 2-26	2-25 and 2-26
2-31 through 2-34	2-31 through 2-34
2-37 through 2-40	2-37 through 2-40
2-43 and 2-44	2-43 and 2-44
None	2-54.1 through 2-54.4
2-55 and 2-56	2-55 and 2-56
2-59 and 2-60	2-59 and 2-60
None	2-60.1 /(2-60.2 blank)
2-61 through 2-66	2-61 through 2-66
2-71 and 2-72	2-71 and 2-72

Remove pages

2-77 through 2-80  
2-83 through 2-86  
None  
2-87 and 2-88  
2-93 and 2-94  
2-113 through 2-116  
2-119 and 2-120  
2-123 and 2-124  
None  
2-125 through 2-128  
2-139 and 2-140  
2-147 and 2-148  
2-153 and 2-154  
2-169 and 2-170  
2-189 and 2-190  
2-193 through 2-200  
2-217 and 2-218  
2-221 and 2-222  
2-245 through 2-248  
2-251 and 2-252  
2-255 through 2-258  
None  
2-291/(2-292 blank)  
3-3 and 3-4  
3-21 and 3-22  
3-31 through 3-36  
3-39 and 3-40  
3-51 through 3-58  
None  
3-71 through 3-74  
3-83 and 3-84  
4-1 and 4-2  
5-5 and 5-6  
5-11 and 5-12  
None  
5-15 and 5-16  
5-25 through 5-28

Insert pages

2-77 through 2-80  
2-83 through 2-86  
2-86.1 and 2-86.2  
2-87 and 2-88  
2-93 and 2-94  
2-113 through 2-116  
2-119 and 2-120  
2-123 and 2-124  
2-124.1/(2-124.2 blank)  
2-125 through 2-128  
2-139 and 2-140  
2-147 and 2-148  
2-153 and 2-154  
2-169 and 2-170  
2-189 and 2-190  
2-193 through 2-200  
2-217 and 2-218  
2-221 and 2-222  
2-245 through 2-248  
2-251 and 2-252  
2-255 through 2-258  
2-268.1 through 2-268.5/(2-268.6 blank)  
2-291/(2-292 blank)  
3-3 and 3-4  
3-21 and 3-22  
3-31 through 3-36  
3-39 and 3-40  
3-51 through 3-58  
3-58.1 through 3-58.3/(3-58.4 blank)  
3-71 through 3-74  
3-83 and 3-84  
4-1 and 4-2  
5-5 and 5-6  
5-11 and 5-12  
5-12.1/(5-12.2 blank)  
5-15 and 5-16  
5-25 through 5-28

Remove pages

5-33 and 5-34  
5-51 through 5-56  
A-1 through A-4  
B-9 and B-10  
C-1 and C-2  
D-1 through D-4  
E-1 and E-2  
E-5 and E-6  
F-5 through F-7/(F-8 blank)  
G-1 and G-2  
G-7 and G-8  
G-15 through G-18  
None  
G-23 through G-28  
G-31 through G-34  
G-37 through G-40  
Index 1 through Index 14

Insert pages

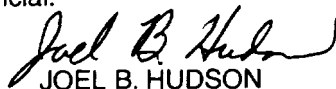
5-33 and 5-34  
5-51 through 5-56  
A-1 through A-4  
B-9 and B-10  
C-1 and C-2  
D-1 through D-5/(D-6 blank)  
E-1 and E-2  
E-5 and E-6  
F-5 through F-9/(F-10 blank)  
G-1 and G-2  
G-7 and G-8  
G-15 through G-18  
G-18.1 and G-18.2  
G-23 through G-28  
G-31 through G-34  
G-37 through G-40  
Index 1 through Index 14

File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

DENNIS J. REIMER  
General, United States Army  
Chief of Staff

Official:



JOEL B. HUDSON

Administrative Assistant to the  
*Secretary of the Army*  
04957

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CHANGE

NO. 1

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington D.C., 1 February 1996

OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED,  
155MM

M109A2 (2350-01-031-0586) (EIC: 3EZ)

M109A3 (2350-01-031-8851) (EIC: 3E2)

M109A4 (2350-01-277-5770) (EIC: 3E8)

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2. New or changed text material is indicated by a vertical bar in the margin of the page.

Remove pages	Insert pages
a through d	a through d
1-3 and 1-4	1-3 and 1-4
2-51 through 2-54	2-51 through 2-54
2-139 and 2-140	2-139 and 2-140
2-147 and 2-148	2-147 and 2-148
2-155 and 2-156	2-155 and 2-156
2-161 and 2-162	2-161 and 2-162
2-167 and 2-168	2-167 and 2-168
2-177 through 2-180	2-177 through 2-180
2-183 through 2-186	2-183 through 2-186
2-215 and 2-216	2-215 and 2-216
2-219 and 2-220	2-219 and 2-220
3-37 through 3-40	3-37 through 3-40

File this change sheet in front of the publication for reference purposes.

**By Order of the Secretary of the Army:**

**DENNIS J. REIMER**  
*General, United States Army*  
*Chief of Staff*

Official:

*Yvonne M. Harrison*

**YVONNE M. HARRISON**  
*Administrative Assistant to the*  
*Secretary of the Army*  
01181

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INSERT LATEST CHANGED PAGES.  
DESTROY SUPERSEDED PAGES

**LIST OF EFFECTIVE PAGES**

Note: The portion of the text affected by the changes is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Date of issue for original and changed pages are:

Original	0	23 November 1994
Change	1	1 February 1996
Change	2	31 July 1998
Change	3	10 January 2000
Change	4	15 January 2002

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 731, CONSISTING OF THE FOLLOWING:

Page No.	*Change No.	Page No.	*Change No.	Page No.	*Change No.
Cover	0	2-17 – 2-18	2	2-80 – 2-82	0
Blank	0	2-19 – 2-20	0	2-83 – 2-86	2
Change 4 Errata Added (2)	1	2-21	2	2-86.1 – 2-86.2	2
Change 3 Errata Added (4)	1	2-22 blank	2	2-87	2
Change 2 Errata Added (4)	1	2-23 – 2-24	0	2-88 – 2-90	0
Change 1 Errata Added (2)	1	2-25 – 2-26	2	2-91 – 2-92	3
a	0	2-27 – 2-30	0	2-93	2
b	2	2-31	2	2-94 – 2-99	0
c	1	2-32 – 2-33	0	2-100	3
d	0	2-34	2	2-101 – 2-112	0
e	4	2-35 – 2-36	0	2-113	2
f	2	2-37	2	2-114	0
g	0	2-38	0	2-115	2
h blank	0	2-39	2	2-116 – 2-118	0
A – C	4	2-40 – 2-42	0	2-119 – 2-120	2
D blank	4	2-43	3	2-121	3
i	3	2-44 – 2-51	0	2-122	0
ii - v	0	2-52 – 2-53	1	2-123 – 2-124.1	2
1-0 – 1-1	0	2-54	3	2-124.2 blank	2
1-2 – 1-3	2	2-54.1	3	2-125	2
1-4 – 1-9	0	2-54.2	2	2-126	0
1-10	3	2-54.3	3	2-127	2
1-11 – 1-15	2	2-54.4	2	2-128 – 2-138	0
1-16 – 1-20	0	2-55	2	2-139	1
1-21 – 1-22	4	2-56	3	2-140	2
1-23 – 1-32	0	2-57 – 2-58	0	2-141	3
1-33	2	2-59 – 2-60	2	2-142 – 2-146	0
1-34 – 1-38	0	2-60.1 – 2-60.2	2	2-147	1
1-39	2	2-61 – 2-64	2	2-148	2
1-40 – 1-46	0	2-65	0	2-149 – 2-152	0
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2-8	2	2-73	0	2-157 – 2-161	0
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2-234	0	5-12.2 blank	4	E-10	3
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G-45	0				
G-46 blank	0				
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TECHNICAL MANUAL

No. 9-2350-311-10



HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, D.C., 23 November 1994

**OPERATOR'S MANUAL  
FOR  
HOWITZER, MEDIUM, SELF-PROPELLED,  
155MM**

**M109A2 (2350-01-031-0586) (EIC: 3EZ)**

**M109A3 (2350-01-031-8851) (EIC: 3E2)**

**M109A4 (2350-01-277-5770) (EIC: 3E8)**

**M109A5 (2350-01-281-1719) (EIC: 3E7)**

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028-2 (Recommended Changes to Equipment Technical Publications), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is <http://aeps.ria.army.mil>. If you need a password, scroll down and click on "ACCESS REQUEST FORM". The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or email your letter, DA Form 2028, or DA Form 2028-2 direct to: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-LC-CIP-WT, Rock Island, IL 61299-7630. The email address is [amsta-ac-nml@ria.army.mil](mailto:amsta-ac-nml@ria.army.mil). The fax number is DSN 793-0726 or Commercial (309) 782-0726.

DISTRIBUTION. To be distributed in accordance with the Initial Distribution Number (IDN) 371238 requirements for TM 9-2350-311-10.

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\*This manual supersedes TM 9-2350-311-10 and LO 9-2350-311-12, dated June 1986, and all changes.

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## HOW TO USE THIS MANUAL

### This manual consists of:

1. Instructions for use by the crew in operating and maintaining the M109A2/M109A3/M109A4/M109A5, 155MM, Self-Propelled, Medium, Howitzer.
2. Location, description, and basic operation characteristics of the M109A2/M109A3/M109A4/M109A5 howitzer major components.
3. Procedures to:
  - a. Operate the M109A2/M109A3/M109A4/M109A5 howitzer and components.
  - b. Perform for firing.
  - c. Perform preventive maintenance on systems/components.
  - d. Perform troubleshooting of malfunctioning systems/components (isolation of malfunction causes).
  - e. Remove, repair, and install cab system/components.
4. Appendixes for detailed listings of:
  - Appendix A. References applicable to M109A2/M109A3/M109A4/M109A5 howitzer, including supply manuals, forms, and other M109A2/M109A3/M109A4/M109A5 publications.
  - Appendix B. List of components and support items that are supplied with the vehicle for operational maintenance.
  - Appendix C. List of items required to support vehicle during operation.
  - Appendix D. List of expendable and durable items needed to operate and maintain this vehicle.
  - Appendix E. Illustrates stowage and sign guides which mark the place where equipment should be stowed when not in use.
  - Appendix F. Provides information for loading on-vehicle equipment.
  - Appendix G. Instructs crew on lubrication, including correct intervals and lubricants.

HOW TO USE THIS MANUAL — CONTINUED

**Indexing**

Five major indexing procedures are used in this manual to help operators locate information rapidly.

1. Cover Index: Lists sections of text and page number. Includes index mark which lines up with index marks on the actual page of reference.

Example: Description and Use of Operator's Controls and Indicators . . . . . 2-2

2. Table of Contents.
3. Chapter and section indexes listing data/information covered within the chapter and section.
4. Malfunction Index identifies system malfunction and provides paragraph references for specific troubleshooting procedures or maintenance action.
5. Index: Alphabetical listing of information.

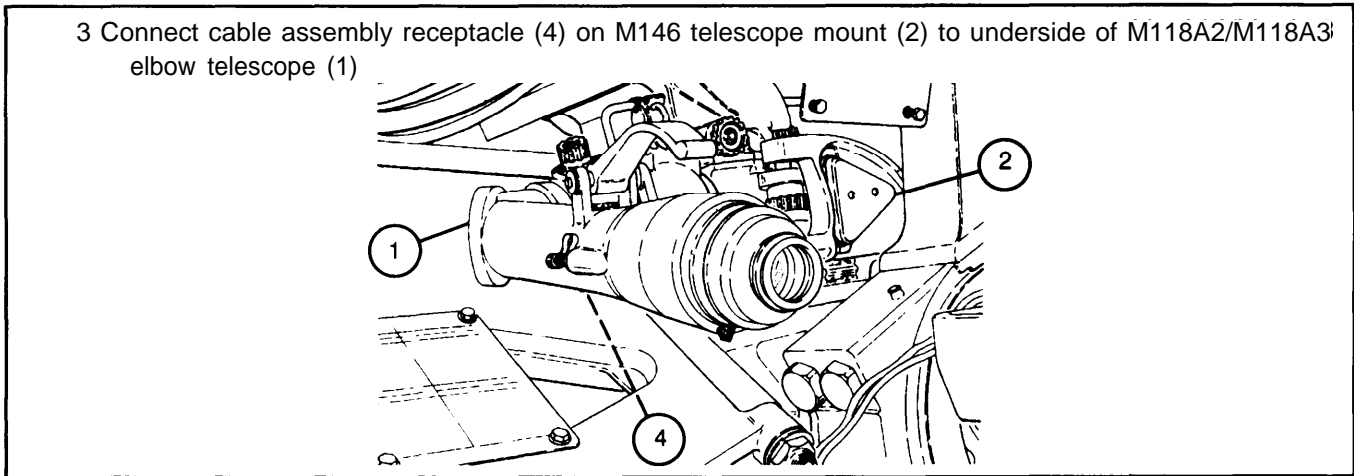
**Operation/Maintenance Text and Illustrations (Chapters 2 through 6)**

1. Procedures are to be performed in the sequence shown in the text and illustrations. Step 1 must be performed before Step 2. Procedure A must be performed before Procedure B, and so on.
2. Parts of the system/components are identified in text by callout numbers in parentheses.

Example: Remove two cap screws (1) and two lockwashers (2).

3. Parts/components are identified on illustrations with callout numbers keyed to the callouts in the text. Visible parts are identified by a solid line from the callout to the illustration. Hidden parts are indicated by a dashed line. See Sample A below.

SAMPLE A



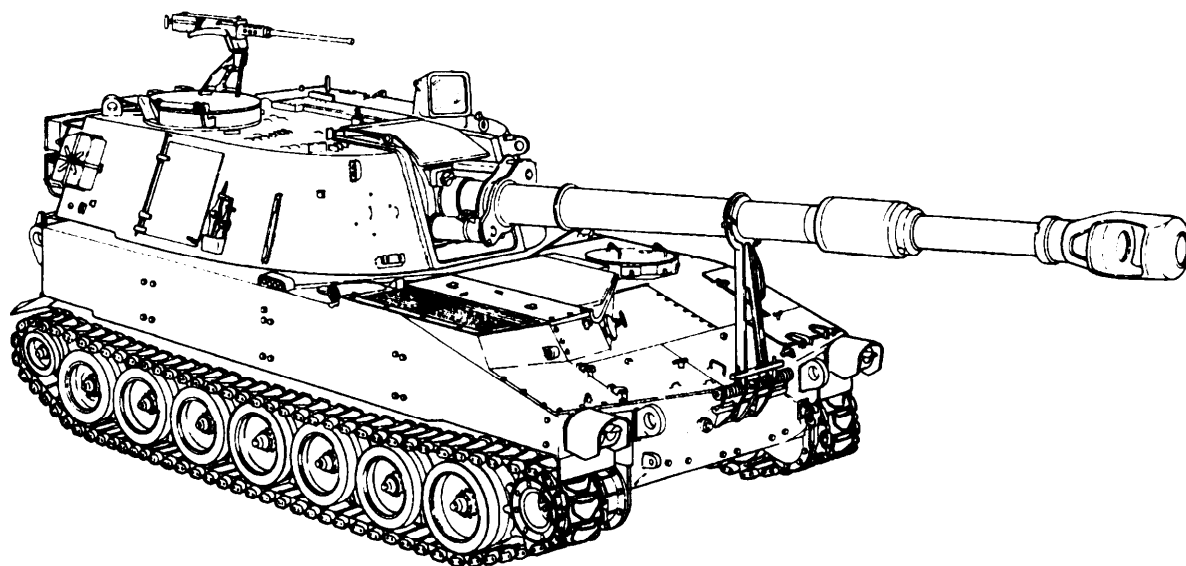
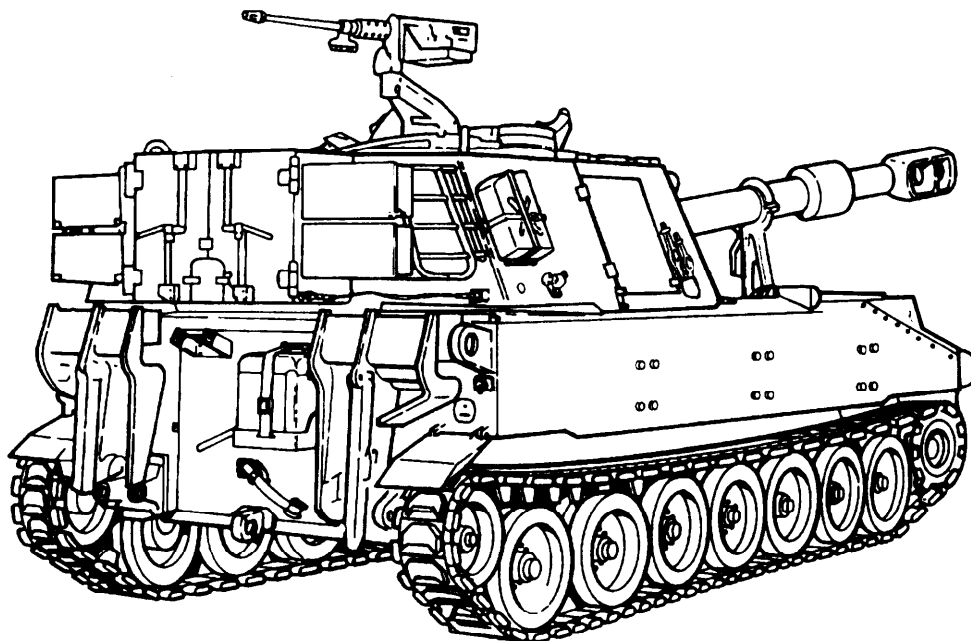
4. Throughout this manual the words WARNING and CAUTION will appear. There is a reason for every one of them.

A warning is used to alert the user of hazardous operating and maintenance procedures, practices, conditions, statements, etc., that may result in injury or death of personnel if not strictly observed. Warnings are preceded by the following symbol:



A caution is used to alert the user of hazardous operating or maintenance procedures, practices, conditions, statements, etc., that may result in damage to or destruction of equipment or mission effectiveness if not strictly observed. Cautions are preceded by the following symbol:





M109A2/M109A3/M109A4/M109A5



## CHAPTER 1 INTRODUCTION

### Section I. GENERAL INFORMATION

#### 1 - 1 SCOPE

- a. Type of Manual: Operator's
- b. Model Number and Equipment Name: M109A2/M109A3/M109A4/M109A5 Howitzer, Medium, Self-Propelled, 155MM.
- c. Purpose of Equipment: The howitzer is a vehicle that provides armored combat support. It allows firing through its primary armament, M185 or M284 155MM cannon assembly, and its secondary armament, M2 heavy barrel caliber 50 machine gun.
- d. Special Inclusions in the Manual: Section IV. of Chapter 1 outlines section drill procedures to be practiced for performance improvement. Appendix F provides on-vehicle loading plans.

#### 1 - 2 MAINTENANCE FORMS AND PROCEDURES

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in the Maintenance Management Update.

#### 1 - 3 AMMUNITION

##### 1-3.1 Injury/Damage

Accidents involving injury to personnel or damage to material will be reported in accordance with AR 385-40. Explosives and ammunition malfunctions will be reported in accordance with AR 75-1.

##### 1-3.2 Safety, Care, and Handling

For safety, care, and handling of ammunition, refer to paragraph 2-15 and to Chapters 5 and 6.

#### **1-4 CORROSION PREVENTION AND CONTROL (CPC)**

Corrosion Prevention and Control (CPC) of Army materiel is a continuing concern. It is important that any corrosion problems with the howitzer be reported so that the problem can be corrected and improvements can be made to prevent the problem in the future.

While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials, such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem.

If a corrosion problem is identified, it can be reported using SF 368, Product Quality Deficiency Report. Use of keywords such as "corrosion," "rust," "deterioration," or "cracking," will ensure that the information is identified as a CPC problem.

The form should be submitted to:

Commander  
U.S. Army Armament Research, Development and Engineering Center  
ATTN: AMSTA-AR-QAW-A (R)/Customer Feedback Center  
Rock Island, IL 61299-7300

#### **1-5 DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE**

Refer to TM 750-244-6 for procedures on how to destroy the M109 self-propelled howitzer. You will find procedures for destruction of munitions in TM 43-0002-33 (improved conventional munitions). Procedures for destruction of chemical munitions are outlined in TM 3-250.

Below are some general guidelines to follow in destruction of equipment to prevent enemy use.

Destruction of the vehicle, armament, and equipment when subject to capture or abandonment in a combat zone, will be undertaken only when the unit commander decides such action is necessary in accordance with orders of, or policy established by, the Army commander.

In general, destruction of essential parts, followed by burning, will usually be sufficient to render the vehicle, armaments, and equipment useless. Time is usually critical.

Materiel must be damaged so that it cannot be restored to usable condition by either repair or cannibalization. If a lack of time or personnel prevents destruction of all parts, give priority to destruction of parts hardest to replace. It is important that the same parts be destroyed on all units to prevent construction of one complete unit from several damaged ones.

All items of sighting and fire control instruments and equipment, especially telescopes, gunner's quadrants, and binoculars, are costly and difficult to replace. They should be conserved whenever possible. If you cannot carry them with you, destroy them by smashing with your sledgehammer, pick, or mattock. Throw the pieces in all directions.

When time is short, a method of destroying the equipment with materials at hand is as follows:

Retrieve or smash sighting and fire control equipment.

**1-5 DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE - CONTINUED**

Load cannon with projectile and full powder charge. Attach a 50 foot (15.2 m) or longer lanyard to firing mechanism. Disconnect recoil cylinder lines and fire the weapon.

Take a sledgehammer and bend the end of the counter recoil buffer rod.

A second method is to close the breechblock and toss several thermite grenades down the cannon tube. Elevate the cannon tube so that the grenades will fall against the breechblock. This will melt the breech and the powder chamber, causing them to fuse together.

**1-6 REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATION (EIR)**

If your howitzer needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: Commander, U.S. Army Armament Research, Development and Engineering Center, ATTN: AMSTA-AR-QAW-A (R)/Customer Feedback Center, Rock Island, IL 61299-7300. We will send you a reply.

**1-7 WARRANTY INFORMATION**

The M109 howitzer series is no longer warranted.

**1-8 NOMENCLATURE CROSS-REFERENCE LIST**

Nomenclature in this manual was chosen in accordance with the terms used for provisioning as they appear in the Repair Parts and Special Tools Lists (RPSTL). A few tools and cab components however are referred to by names more common than those in the RPSTL. In many cases the more common name is a shorter name for the same component.

**Manual Nomenclature**

**Official Nomenclature**

Cab ammunition rack assembly

Projectile stowage rack assembly

Canister rack propellant

Bracket assembly

Cannon tube

Tube assembly

Combat override switch

Override switch assembly

Dipstick

Gage rod

Hex key

Socket head screw key

Howitzer

155MM, medium, self-propelled howitzer, M109A2/M109A3/M109A4/M109A5

Lockwire

Safety wire, nonelectrical wire

M1A1 collimator

Infinity aiming reference collimator M1A1

**1-8 NOMENCLATURE CROSS-REFERENCE LIST — CONTINUED**

**Manual Nomenclature**

M178 mount  
 M182 mount  
 Projectile rack  
 Rheostat  
 Torque key

**Official Nomenclature**

Howitzer M178 mount  
 Howitzer M182 mount  
 Hull rear ammunition rack  
 Resistor, variable  
 Machine key

**1-9 LIST OF ABBREVIATIONS**

AAL	Additional Authorization List	CTA	Common Table of Allowances
ADAM	Area Denial Artillery Munition	CW	Clockwise
AG	Assistant Gunner	D	Delay
AOAP	Army Oil Analysis Program	DA	Department of the Army
APU	Auxiliary Power Unit	DAP	Distant Aiming Point
ASL	Authorized Stockage List	DOD	Department of Defense
ASP	Ammunition Supply Point	DS	Direct Support
ATC	Ammunition Team Chief	DS2	Decontaminating Solution No. 2
AVD	Ammunition Vehicle Driver	EFC	Equivalent Full Charge
BCS	Battery Computer System	EIR	Equipment Improvement Recommendation
BII	Basic Issue Items	EOD	Explosive Ordnance Disposal
°C	Degrees Celsius	ET	Electronic Time
CAM	Chemical Agent Monitor	°F	Degrees Fahrenheit
CARC	Chemical Agent Resistant Coating	FDC	Fire Direction Center
CASP	Chemical Ammunition Supply Point	FM	Field Manual
CAT	Carrier Ammunition Tracked, 7 Ton M992 (FAASV)	G	Gunner
CCW	Counterclockwise	GS	General Support
CLGP	Cannon Launched Guided Projectile	HD	Howitzer Driver
CLP	Cleaner, Lubricant, Preservative	HE	High Explosive
CM	Centimeter	HEAT	High Explosive Anti-Tank
COEI	Components of End Item	HERA	High Explosive Rocket Assisted
CPC	Corrosion Prevention Control	ICM	Improved Conventional Munitions
CS	Chief of Section	KG	Kilogram
		KM	Kilometer

**1-9 LIST OF ABBREVIATIONS — CONTINUED**

KMPH	Kilometers Per Hour	PLL	Prescribed Load List
L	Liter	PMCS	Preventive Maintenance Checks and Services
LCD	Liquid Crystal Display	PROX	Proximity
LED	Light Emitting Diode	PSI	Pounds Per Square Inch
LHR	Low Heat Rejection	RAAM	Remote Anti-Armor Mine
LPRS	Loose Projectile Restraint System	RAP	Rocket Assisted Projectile
M	Meter	RDS	Rounds
MAX	Maximum	RPM	Revolutions Per Minute
MIN	Minimum	RPO	Radiation Protection Officer
MM	Millimeter	SF	Standard Form
MOPP	Mission-Oriented Protective Posture	SINCGARS	Single Channel Ground and Airborne Radio
MPH	Miles Per Hour	SOP	Standing Operating Procedures
MT	Mechanical Time	SP	Self-Propelled
MTOE	Modified Table of Allowances and Equipment	SQ	Super Quick
MTSQ	Mechanical Time Super Quick	TOE	Table of Organization and Equipment
NATO	North Atlantic Treaty Organization	V	Volts
NBC	Nuclear, Biological, and Chemical	VAC	Volts Alternating Current
NCO	Non-Commissioned Officer	VDC	Volts Direct Current
NRC	Nuclear Regulatory Commission	VT	Variable Time
PD	Point Detonating	WP	White Phosphorous

**Section II. EQUIPMENT DESCRIPTION****1-10 EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES**

The medium, self-propelled howitzer is a full-tracked, armored combat support, internally loaded, air transportable, vehicle powered by an eight cylinder, diesel engine. The vehicle carries a crew of six: howitzer driver, chief of section, two cannoneers, gunner, and assistant gunner.

The primary armament on M109A2/M109A3/M109A4 howitzers includes a 155MMM185 cannon assembly and M178 mount, with firing accomplished by an M35 firing mechanism which uses cartridge type primers. The primary armament on M109A5 howitzers includes a 155MMM284 cannon assembly and M182 mount, with firing accomplished by an M49 firing mechanism. The secondary armament is a caliber 50 machine gun.

The hull and cab assemblies protect the crew and equipment against small arms fire. The vehicle is divided into three sections: driver's compartment, engine compartment, and fighting compartment.

M109A4/M109A5 howitzers contain nuclear, biological, and chemical (NBC) equipment that allows the crew to operate the howitzer in an NBC environment.

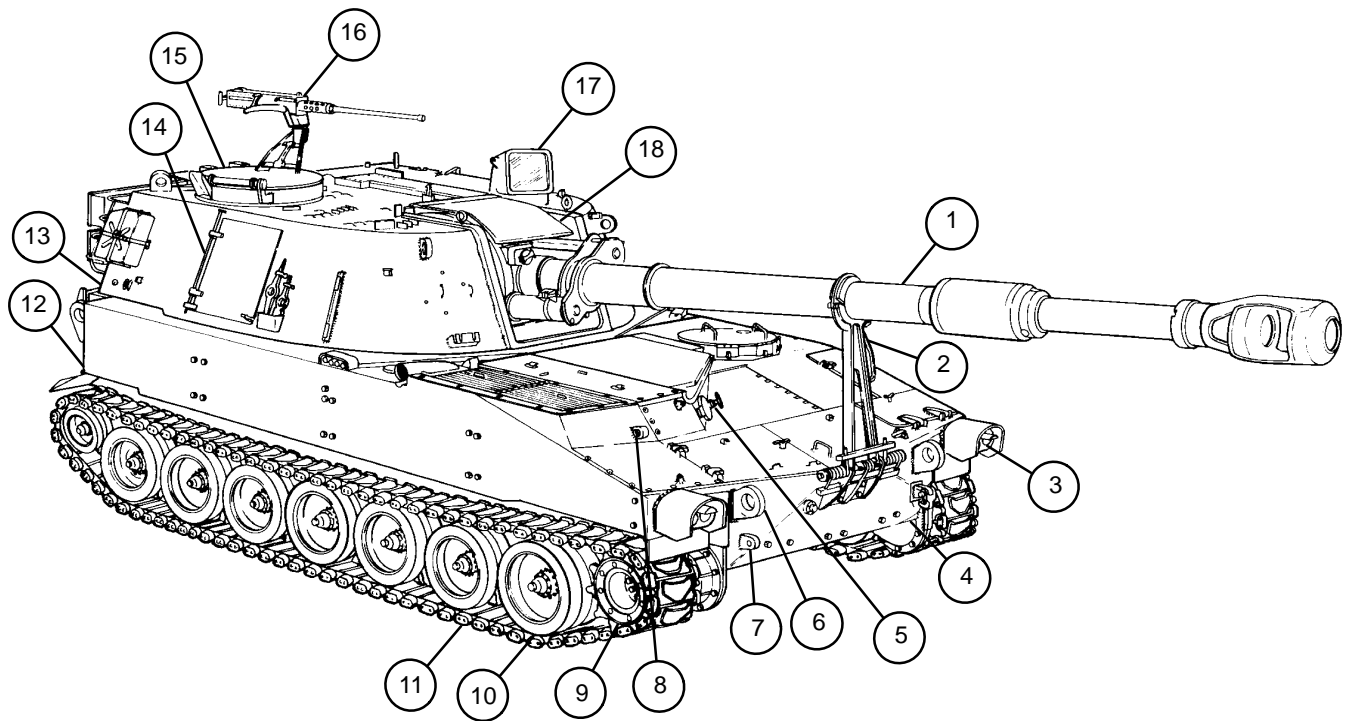
## 1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

### 1-11.1 Location and Description of Major External Components

- |    |                                     |  |
|----|-------------------------------------|--|
| 1  | CANNON AND HOWITZER ASSEMBLY        | The mount and howitzer assembly consists of a 155MM cannon assembly which is the primary armament for the M109 series howitzer. The M185 cannon assembly and M178 mount assembly are used on M109A2/M109A3/M109A4 howitzers. The M284 cannon assembly and M182 mount are used on M109A5 howitzers. |
| 2  | TRAVEL LOCK ASSEMBLY                | Locks cannon tube in place.  |
| 3  | HEADLIGHT                           | Two headlights provide light for night driving and blackout conditions.  |
| 4  | FINAL DRIVE DRAIN PLUG              | Two final drive drain plugs provide access for final drive filling or oil level check.   |
| 5  | ENGINE OIL LEVEL CHECK ACCESS DOOR  | Provides access for checking engine oil level.   |
| 6  | FRONT LIFTING EYE                   | Two front lifting eyes provide connection points for lifting howitzer.   |
| 7  | FRONT TOWING EYE                    | Two front towing eyes provide connection points for towing howitzer.   |
| 8  | BILGE PUMP OUTLET                   | Provides outlet for fluids during bilge pump operation.  |
| 9  | DRIVE SPROCKET AND HUB              | One drive sprocket mounted on hubs is located on each side of the vehicle and distributes power to track assembly.   |
| 10 | ROAD WHEELS                         | There are seven sets of road wheels on each side of vehicle located between the sprocket and idler wheels.   |
| 11 | TRACK ASSEMBLY                      | Consists of track shoes connected together by end connectors. Rotates to provide mobility to howitzer.   |
| 12 | HULL                                | Provides mobility for howitzer and crew.   |
| 13 | CAB                                 | Provides crew protection and is area where firing is controlled.   |
| 14 | CAB SIDE DOOR                       | Two cab side doors provide emergency exit.   |
| 15 | COMMANDER'S CUPOLA                  | Serves as mount and support for M2 machine gun, holds M27 periscope, and rotates manually 6400 mils.   |
| 16 | M2 CALIBER 50 MACHINE GUN           | A heavy barrel machine gun that fires manually. Refer to TM 9-1005-213-10 for more information.  |
| 17 | PANORAMIC TELESCOPE BALLISTIC COVER | Protects M117/M117A2 panoramic telescope against shock during firing and inclement weather.  |
| 18 | CAB WEATHER COVER                   | Protects upper gun rotor.  |

## 1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS — CONTINUED

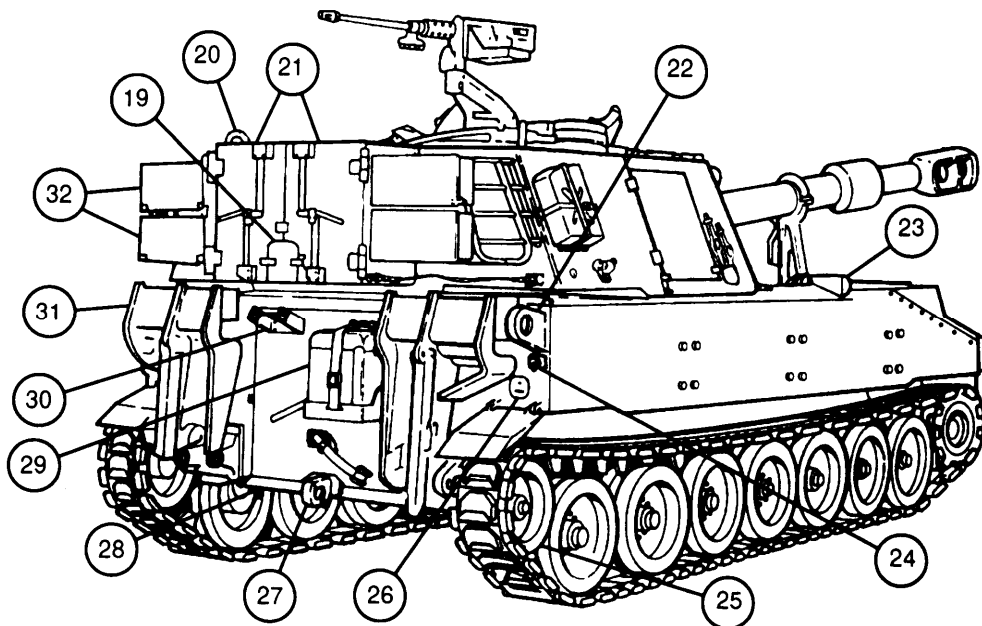
### 1-11.1 Location and Description of Major External Components — Continued



1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS — CONTINUED

1-11.1 Location and Description of Major External Components — Continued

- |    |   |   |
|----|---|---|
| 19 | PROJECTILE ACCESS DOOR                    | Allows projectiles to be passed into cab without opening bustle doors, providing greater security for crew.                             |
| 20 | CAB LIFTING EYE                           | Four cab lifting eyes provide connection points for lifting cab.  |
| 21 | BUSTLE DOOR                               | Two bustle doors allow projectiles to be passed into cab under normal operations.   |
| 22 | REAR LIFTING EYE                          | Two rear lifting eyes provide connection points for lifting howitzer.   |
| 23 | EXHAUST DEFLECTOR                         | Provides outlet for engine exhaust.   |
| 24 | EXTERNAL POWER RECEPTACLE (M109A4/M109A5) | NATO type power receptacle provides circuitry to receive power from an outside source.  |
| 25 | IDLER WHEELS                              | Two idler wheels on each side of vehicle maintain track tension.  |
| 26 | STOPLIGHT AND BLACKOUT LIGHT              | Two stoplight and blackout lights provide rear brake and tail-lights for night driving under normal and blackout (infrared) conditions. |
| 27 | TOWING PINTLE ASSEMBLY                    | Provides connecting point for towing operation.   |
| 28 | REAR HULL DOOR                            | Provides access to and from crew compartment.   |
| 29 | MI 3 DECONTAMINATION APPARATUS            | Contains all necessary material, including DS2, for personnel decontamination operations.   |
| 30 | REEL BRACKET                              | Holds communication wire reel.  |
| 31 | SPADE                                     | Two spades provide stability when firing.   |
| 32 | STOWAGE BOX                               | Four stowage boxes provide stowage for miscellaneous items.   |

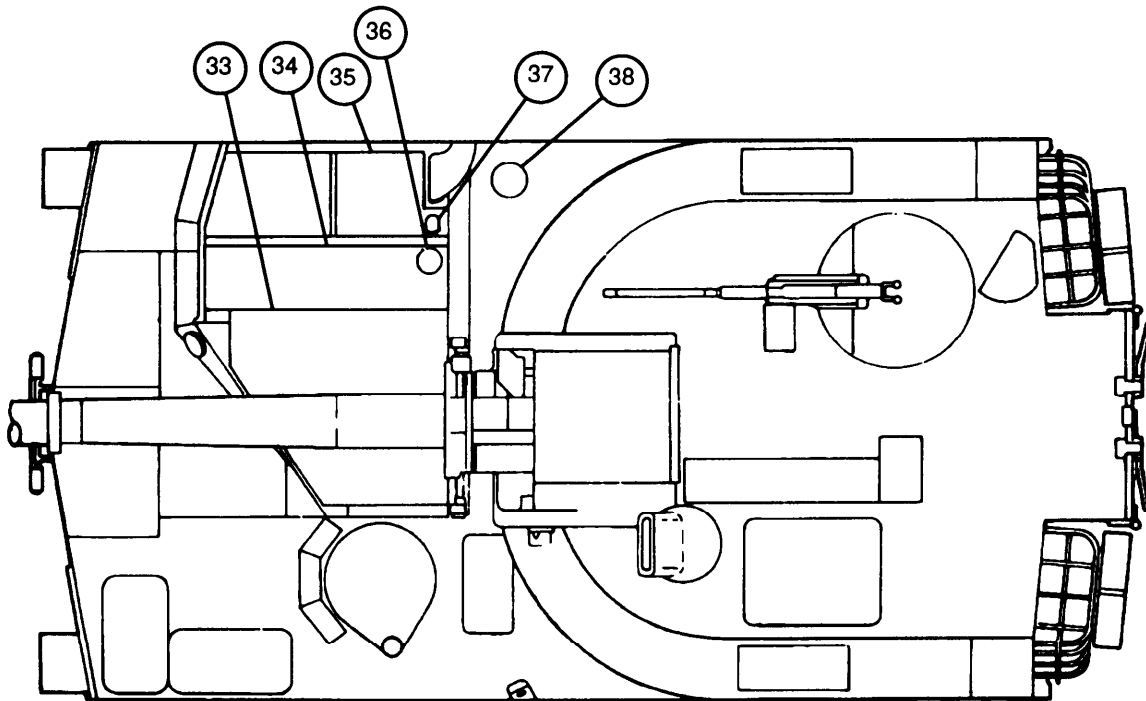




**1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS — CONTINUED**

**1-11.1 Location and Description of Major External Components — Continued**

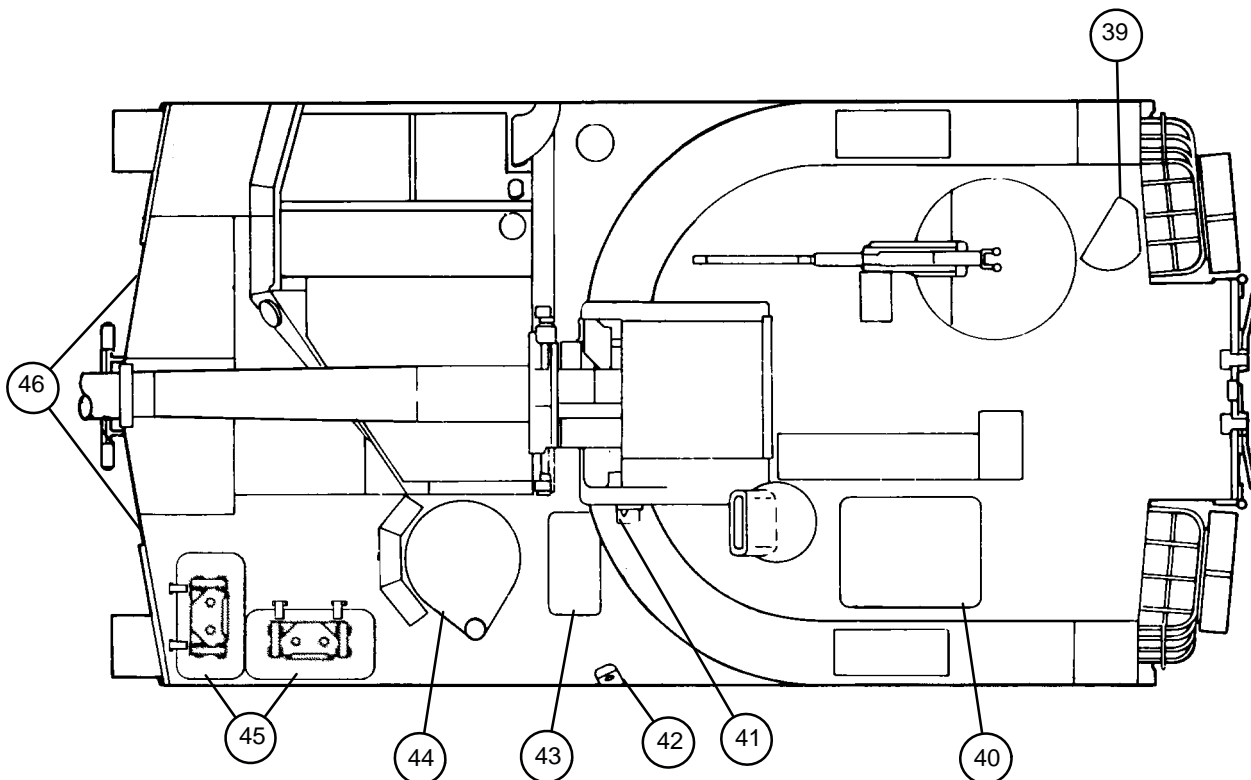
- |    |                                    |  |
|----|------------------------------------|--|
| 33 | AIR INTAKE GRILLE                  | Permits ventilation and access to engine.      |
| 34 | RADIATOR FAN ACCESS DOOR           | Permits access to radiator fans.               |
| 35 | EXHAUST GRILLE                     | Discharge location for engine cooling air.     |
| 36 | RADIATOR CAP ACCESS DOOR           | Provides access to engine radiator filler cap. |
| 37 | PERSONNEL HEATER EXHAUST DEFLECTOR | Outlet for personnel heater exhaust.           |
| 38 | FUEL TANK ACCESS DOOR              | Permits access for filling engine fuel tanks.  |



## 1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS — CONTINUED

### 1-11.1 Location and Description of Major External Components — Continued

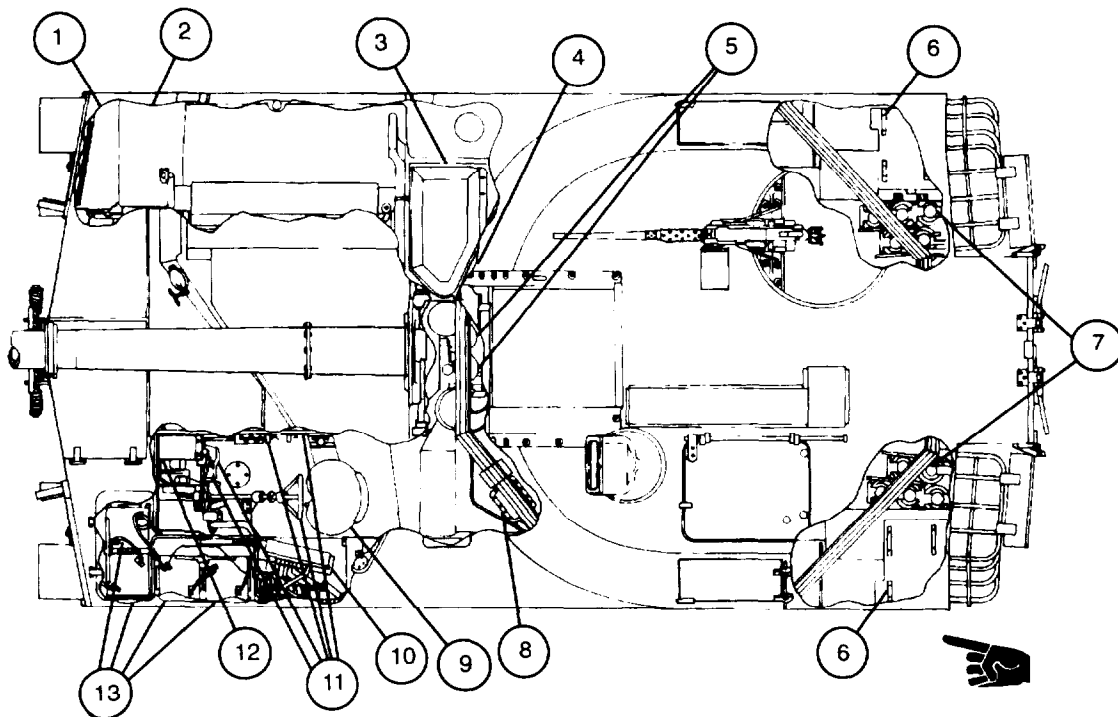
39 CAB ACCESS COVER	Permits access to power pack assembly.
40 GUNNER'S ESCAPE HATCH	Provides access to and from crew compartment.
41 M140 ALINEMENT DEVICE MOUNT	Serves as mount for M140 alinement device.
42 FIRE EXTINGUISHER HANDLE	Activates engine compartment fire extinguisher from outside the howitzer.
43 PERSONNEL AIR VENT VENTILATOR GRILLE	Provides personnel heater ventilation.
44 DRIVER'S HATCH COVER	Provides access to and from the driver's compartment.
45 BATTERY COMPARTMENT ACCESS DOORS	Two access doors provide access to vehicle batteries, and provide stowage for track shoes.
46 TRANSMISSION ACCESS DOORS	Two access doors provide access to transmission.



**1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED**

**1-11.2 Location and Description of Major Internal Hull Components**

- |    |   |   |
|----|---|---|
| 1  | COOLANT SURGE TANK                      | Has a capacity with the radiator of holding 22 gallons (83 l) of coolant.                           |
| 2  | FUEL TANK AND PUMPS                     | Allows fuel to be distributed to engine and stored.   |
| 3  | AIR CLEANER                             | Filters impurities from air before it reaches engine.   |
| 4  | PERSONNEL HEATER                        | Provides heated air to driver's and crew compartments.  |
| 5  | FIXED FIRE EXTINGUISHER                 | Two fixed fire extinguishers allow for extinguishing of fire in the engine compartment.             |
| 6  | CANISTER STOWAGE                        | Provides stowage of 21 to 22 mixed canisters on left and right sponson compartments and hull floor. |
| 7  | PROJECTILE RACKS                        | Provide stowage for 12 rounds on hull floor.  |
| 8  | ACCESSORY CONTROL BOX                   | Controls operation of personnel heater, ventilation fans, and lead filters.                         |
| 9  | DRIVER'S SEAT ASSEMBLY                  | Provides seating for driver.  |
| 10 | PORTABLE AND DRIVER'S INSTRUMENT PANELS | Provides driver with instruments and switches to operate vehicle.                                   |
| 11 | DRIVER'S CONTROLS                       | Provides driver with controls to operate the vehicle.   |
| 12 | M2A2 AIR PURIFIER (M109A4/M109A5)       | Provides filtered air to the M3 electrical heaters.   |
| 13 | BATTERY                                 | Four batteries are contained in vehicle.  |



1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED

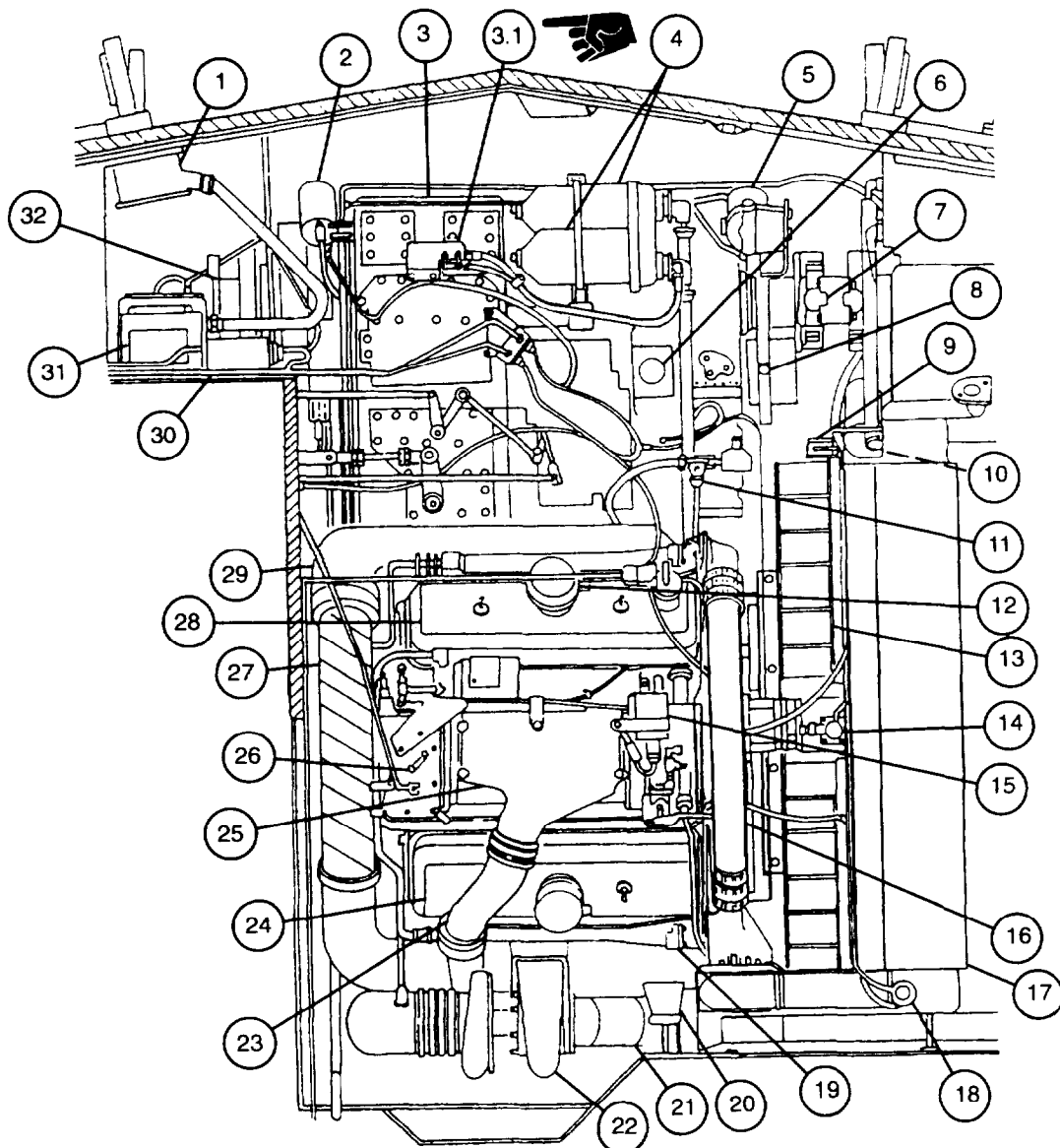
1-11.3 Location and Description of Powerplant and Drivetrain Components (Model 7083-7396)

1	RECTIFIER	Converts generator ac voltage to dc voltage.
2	SECONDARY FUEL FILTER	Provides additional filtering of fuel.
3	TRANSMISSION	Receives power from engine and delivers power to drive sprockets, universal joints, and final drives.
3.1	TRANSMISSION AND ENGINE OIL SAMPLING VALVES	Used for collecting oil samples for AOAP purposes.
4	ENGINE OIL FILTER	Two engine oil filters remove impurities from engine oil.
5	PRIMARY FUEL FILTER	Provides initial filtering of fuel.
6	TRANSMISSION DIPSTICK/FILLER CAP	Provides access for adding fluid and checking fluid level.
7	UNIVERSAL JOINT (RIGHT)	Receives transmission output power and transfers output to final drives.
8	TRANSMISSION BREATHER	Allows pressure to be vented from the transmission.
9	COOLANT AERATION DETECTOR	Activates low coolant indicator when radiator coolant level is low.
10	BILGE PUMP	Pumps fluids from engine compartment.
11	ENGINE OIL DIPSTICK	Used to determine engine oil level.
12	ENGINE OIL FILLER CAP	Permits access for adding engine oil.
13	RADIATOR FAN ASSEMBLY	Blows cooling air through radiator.
14	SURGE TANK PRESSURE RELIEF VALVE	Releases excess pressure that may build in the cooling system.
15	FLAME HEATER IGNITER	Located on the side of the engine intake air blower.
16	COOLANT CROSSOVER TUBE	Routes engine coolant between bypass and inlet thermostats.
17	RADIATOR	Cools engine coolant.
18	RADIATOR FILLER CAP	Provides access for adding engine coolant.
19	ENGINE COOLANT TEMPERATURE TRANSMITTER	Sensors engine coolant temperature for registering on gages of driver's portable instrument panel.
20	FIXED FIRE EXTINGUISHER NOZZLE	Directs fire extinguishing chemicals into engine compartment.
21	ENGINE EXHAUST OUTLET DUCT	Channels engine exhaust from engine.
22	TURBOCHARGER	Provides high pressure air to engine intake air blower.
23	ENGINE AIR INLET TUBE	Routes air to engine intake air blower.
24	CYLINDER HEAD ROCKER COVER (REAR)	Covers engine rockers.
25	ENGINE INTAKE AIR BLOWER	Provides constant volume of air to cylinders.
26	ENGINE SPEED GOVERNOR	Controls engine rpm.
27	EXHAUST CROSSOVER TUBE	Connects left and right exhaust manifolds to provide routing of exhaust gases.

**1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED**

**1-11.3 Location and Description of Powerplant and Drivetrain Components (Model 7083-7396)  
- Continued**

- |    |                                    |   |
|----|------------------------------------|---|
| 28 | CYLINDER HEAD ROCKER COVER (FRONT) | Covers engine rockers.  |
| 29 | RIGHT ENGINE EXHAUST MANIFOLD      | Routes engine exhaust from right side of engine.  |
| 30 | MASTER RELAY                       | Delivers 24 vdc (nominal) electrical power to operating systems when the MASTER switch is in ON position. |
| 31 | VOLTAGE REGULATOR                  | Controls electrical flow to vehicle operating system.   |
| 32 | UNIVERSAL JOINT (LEFT)             | Receives transmission output power and transfers output to final drives.                                  |



**1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED**

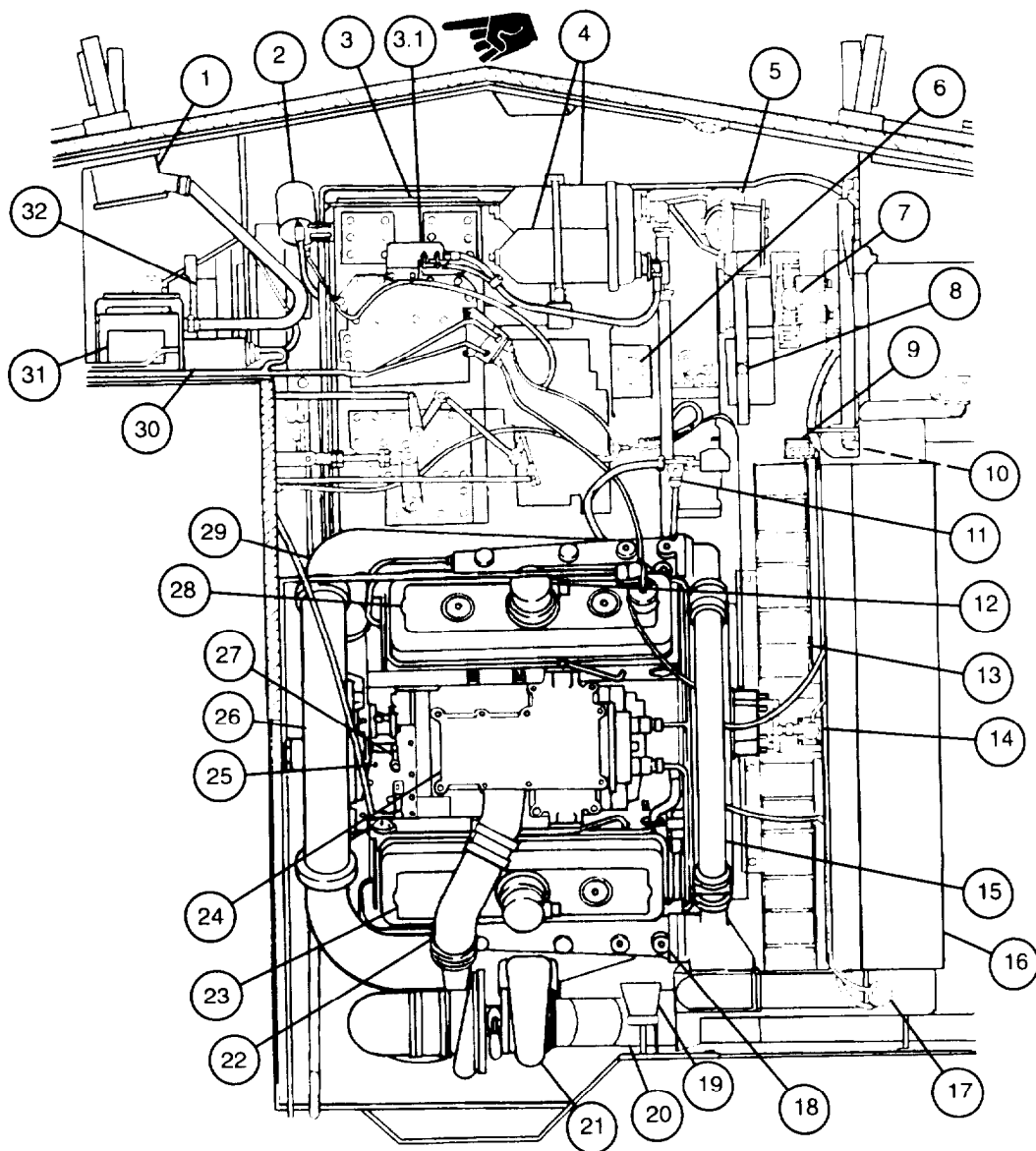
**1-11.4 Location and Description of Powerplant and Drivetrain Components (LHR Model 7083-7391)**

1 RECTIFIER	Converts generator ac voltage to dc voltage.
2 SECONDARY FUEL FILTER	Provides additional filtering of fuel.
3 TRANSMISSION	Receives power from engine and delivers power to drive sprockets, universal joints, and final drives.
3.1 TRANSMISSION AND ENGINE OIL SAMPLING VALVES	Used for collecting oil samples for AOAP purposes.
4 ENGINE OIL FILTER	Two engine oil filters remove impurities from engine oil.
5 PRIMARY FUEL FILTER	Provides initial filtering of fuel.
6 TRANSMISSION DIPSTICK/FILLER CAP	Provides access for adding fluid and checking fluid level.
7 UNIVERSAL JOINT (RIGHT)	Receives transmission output power and transfers output to final drives.
8 TRANSMISSION BREATHER	Allows pressure to be vented from the transmission.
9 COOLANT AERATION DETECTOR	Activates low coolant indicator when radiator coolant level is low.
10 BILGE PUMP	Pumps fluids from engine compartment.
11 ENGINE OIL LEVEL GAGE	Used to determine engine oil level.
12 ENGINE OIL FILLER CAP	Permits access for adding engine oil.
13 RADIATOR FAN ASSEMBLY	Blows cooling air through radiator.
14 SURGE TANK PRESSURE RELIEF VALVE	Releases excess pressure that may build in the cooling system.
15 COOLANT CROSSOVER TUBE	Routes engine coolant between bypass and inlet thermostats.
16 RADIATOR	Cools engine coolant.
17 RADIATOR FILLER CAP	Provides access for adding engine coolant.
18 ENGINE COOLANT TEMPERATURE TRANSMITTER	Sensors engine coolant temperature for registering on gages of driver's portable instrument panel.
19 FIXED FIRE EXTINGUISHER NOZZLE	Directs fire extinguishing chemicals into engine compartment.
20 ENGINE EXHAUST OUTLET DUCT	Channels engine exhaust from engine.
21 TURBOCHARGER	Provides high pressure air to engine intake air blower.
22 ENGINE AIR INLET TUBE	Routes air to engine intake air blower.
23 CYLINDER HEAD ROCKER COVER (REAR)	Covers engine rockers.
24 ENGINE INTAKE AIR BLOWER	Provides constant volume of air to cylinders.
25 ENGINE SPEED GOVERNOR	Controls engine rpm.
26 EXHAUST CROSSOVER TUBE	Connects left and right exhaust manifolds to provide routing of exhaust gases.
27 GLOW PLUG CONTROLLER	Provides power for heating glow plugs.

**1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED**

**1-11.4 Location and Description of Powerplant and Drivetrain Components (LHR Model 7083-7391)  
- Continued**

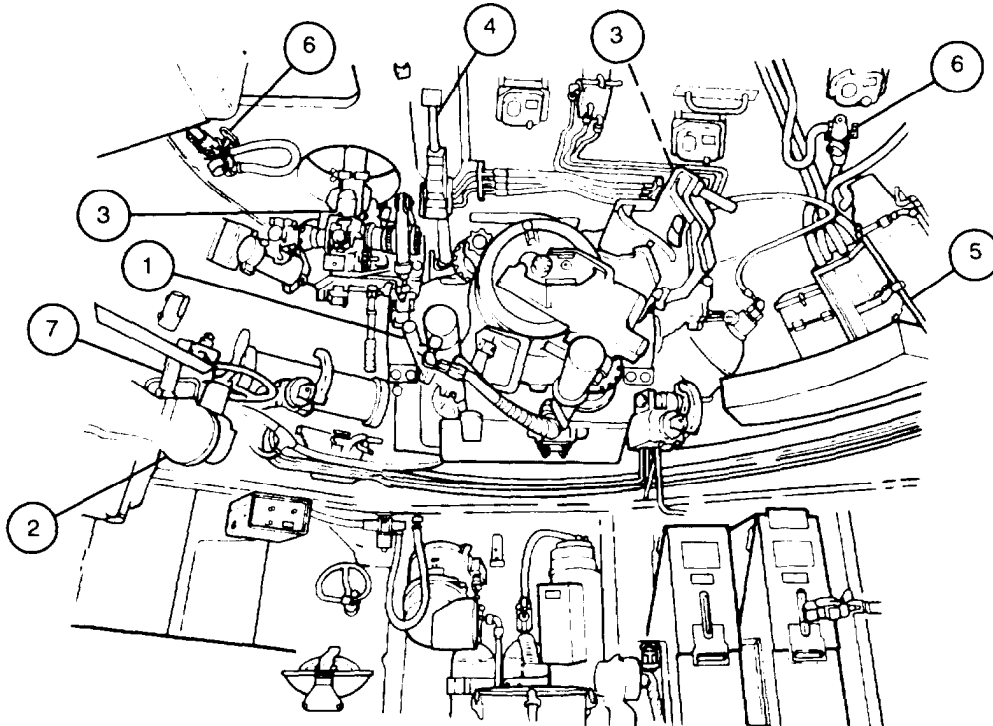
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|----|---------------------------------------|---|
| 28 | CYLINDER HEAD ROCKER COVER<br>(FRONT) | Covers engine rockers.  |
| 29 | RIGHT ENGINE EXHAUST MANIFOLD         | Routes engine exhaust from right side of engine.  |
| 30 | MASTER RELAY                          | Delivers 24 vdc (nominal) electrical power to operating systems when the MASTER switch is in ON position. |
| 31 | VOLTAGE REGULATOR                     | Controls electrical flow to vehicle operating system.   |
| 32 | UNIVERSAL JOINT (LEFT)                | Receives transmission output power and transfers output to final drives.                                  |



1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS - CONTINUED

1-11.5 Location and Description of Major Internal Cab Components

- |   |  |
|---|--|
| 1 RAMMER ASSEMBLY                       | Weapon mounted and hydraulically powered, with positive ram. Its two positions are stow and ram.                                   |
| 2 TRAVERSING MECHANISM                  | Allows the cab to traverse 6400 mils.  |
| 3 SIGHTING EQUIPMENT                    | Provides optical laying and boresighting of howitzer for both direct and indirect firing.  |
| 4 EQUILIBRATED ELEVATING CYLINDER       | Provides elevation and depression of cannon assembly. Also provides hydraulic balance to offset the weight of the cannon assembly. |
| 5 M2A2 AIR PURIFIER                     | Provides filtered air to the M3 electrical air heaters.  |
| 6 M3 ELECTRICAL AIR HEATER              | Three M3 electrical air heaters control temperature in each cab station for personal comfort.                                      |
| 7 GUNNER'S SELECTOR SWITCH BOX ASSEMBLY | Controls cab power, manual or power traversing, and elevation.   |

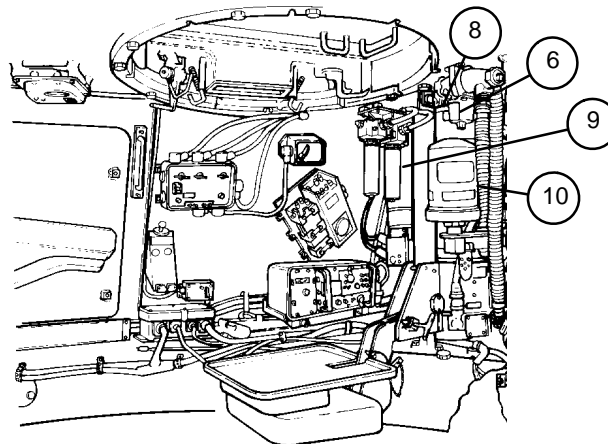




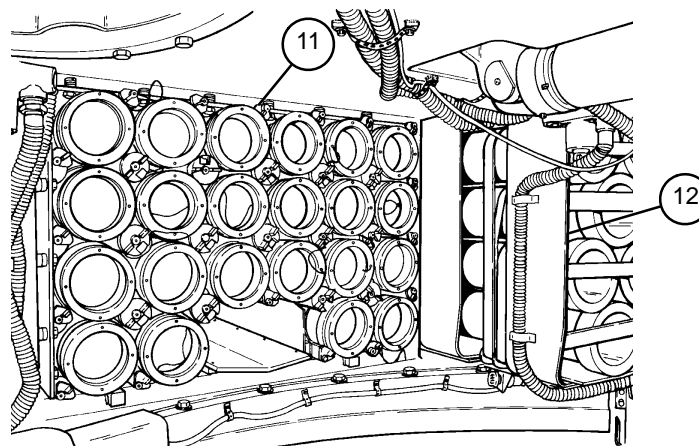
## 1-11 LOCATION AND DESCRIPTION OF MAJOR COMPONENTS — CONTINUED

### 1-11.5 Location and Description of Major Internal Cab Components — Continued

- |    |  |  |
|----|--|--|
| 8  | POWER PACK ASSEMBLY                                      | Provides hydraulic power to operate traversing, elevating, and rammer hydraulic systems. |
| 9  | EXTERNAL FILTER (M109A4/M109A5)                          | Two external filters hydraulically filter fluid.   |
| 10 | AIR LINE FILTER AND HYGROSCOPIC BREATHER (M109A4/M109A5) | Filter air and water from the hydraulic system.  |
| 11 | CAB AMMUNITION RACK ASSEMBLY                             | Provides stowage for 22 rounds of 155MM projectiles in cab rear bustle.                  |
| 12 | CANISTER RACK PROPELLANT                                 | Provides storage for up to 14 M4 canisters in left rear corner of cab.                   |



RIGHT REAR  
CAB INTERIOR



LEFT REAR  
CAB INTERIOR

## **1-12 DIFFERENCES BETWEEN MODELS**

### **NOTE**

When requesting support maintenance, properly identify the configuration of the vehicle on which work needs to be done in order to obtain the correct repair parts.

Unlike the M109A2 production model, the M109A3 is converted from an M109A1 model with a series of product improvement kits. Also some M109A2 and M109A3 howitzers have been converted to an M109A4 model with product improvement kits.

M109A5 models have been converted exclusively from M109A4 models. In addition to all M109A4 updates, the M109A5 model also modifies the M185 cannon assembly to an M284 cannon assembly and M178 mount to an M182 mount. Below are some differences important to operator/crew.

- a. Commander's cupola. On earlier design vehicles, the cupola can be opened from both the inside and outside. On later design vehicles, the cupola can be opened only from the inside. Some earlier design vehicles allow rotation of the cupola by loosening a ring lock, On later design vehicles, the cupola can be rotated by pulling out a latch and by placing the latch into one of ten notches to hold the cupola in position.
- b. Gunner's escape hatch. On later design vehicles, the gunner's escape hatch is opened by pushing a knob and turning a handle. On some early design vehicles, the gunner's escape hatch does not have a knob. To open hatch just turn the handle.
- c. Contact arm assemblies. Some M109A3 vehicles have three and some vehicles have five contact arm assemblies, AH M109A2/M109A4/M109A5 howitzers have five electrical contact arm assemblies.
- d. Machine gun mount, All M109A2 and some M109A3 howitzers require an arm adapter to lock the machine gun mount to the support assembly. M109A3 howitzers with the early machine gun mount design do not require the arm adapter,
- e. Protective shields, race ring. Some M109A3 howitzers do not have a turret shield behind the commander's seat.
- f. Commander's seat handle latch. Some early design vehicles have a short handle on the commander's seat assembly, and some vehicles have a long handle.
- g. Driver's instrument panel. Some vehicles have covers over the gages on the driver's instrument panel.
- h. NBC system. NBC system is provided on M109A4/M109A5 howitzers only. Driver and cannoneer no. 2 have an M2A2 air purifier and M3 electrical air heaters mounted in hull portion of vehicle. An M2A2 air purifier and four electrical air heaters are mounted in the cab for the rest of the crew members. NBC MOPP gear stowage is provided in new cannoneer seats and stowage boxes.
- i. Traversing mechanism and clutch valve. The traversing mechanism is operated with a hydraulic clutch in M109A4/M109A5 howitzers instead of an electric clutch as in M109A2/M109A3 howitzers, A clutch valve with an override lever is also provided in M109A4 models and M109A5 models for power traversing cab in the event of an electrical failure to the clutch valve solenoid.
- j. Power pack assembly. M109A4/M109A5 howitzers have two external hydraulic filters. M109A2/M109A3 howitzers have an internal hydraulic filter.

**1-12 DIFFERENCES BETWEEN MODELS — CONTINUED**

- k. Cab hydraulics. M109A4/M109A5 howitzers have a hydroscopic breather and an air line filter mounted to rear interior that provides added filtering of hydraulic fluid.
- l. Combat override switch. M109A4/M109A5 howitzers have a combat override switch mounted to back wall below chief of section's seat.
- m. NATO slave start receptacle. M109A4/M109A5 howitzers have a NATO slave start receptacle located in the driver's compartment. All M109A2/M109A3 howitzers have a NATO slave start receptacle located in the battery compartment.
- n. Air cleaner neutral safety switch. M109A4/M109A5 howitzers have a safety switch in the driver's compartment with a neutral position that prevents the air cleaner blowers from running continuously as in M109A2/M109A3 howitzers.
- o. Crew compartment subfloor drains. M109A4/M109A5 howitzers have 13 subfloor drains to provide drainage of DS2 (from NBC decontamination process) and drainage of excess water.
- p. External power receptacle. M109A4/M109A5 howitzers have external power receptacle located on the rear bulkhead.
- q. Mount. M109A2/M109A3/M109A4 howitzers have M178 mount. The M109A5 howitzers have M182 mount.
- r. Cannon assembly, howitzer. M109A2/M109A3/M109A4 howitzers have M185 cannon assembly. M109A5 howitzers have M284 cannon assembly. This configuration provides the M109A5 howitzer with extended range capability.
- s. Firing Mechanism. M109A2/M109A3/M109A4 howitzers use the M35 firing mechanism, M109A5 howitzers use the M49 firing mechanism.
- t. Torque key. M109A2/M109A3/M109A4 howitzers with the M178 mount assembly have torque keys with one keyway which measures approximately 31/32 inch (24.6 mm) and are held in place with ten cap screws and lockwashers. M109A5 howitzers with the M182 mount assembly have torque keys with two keyways which measure approximately 1-9/16 inches (3.97 cm) and are held in place with eight cap screws and lockwashers.
- u. Hull rear doors. Earlier versions of the howitzer have double doors, later versions have single doors.
- v. Personnel heater exhaust deflector. There is no personnel heater exhaust deflector on earlier versions of the howitzer. Later versions have exhaust deflectors mounted on the exhaust grille.
- w. Primary fuel filters. The primary fuel filters, in earlier versions of the howitzer, are positioned near the engine vibration damper and engine oil pan. Later versions have the primary fuel filters positioned near the oil filters, attached to the transmission.
- x. External telephone terminals. The M109A2/M109A3 telephone terminals are located on the hull rear bulkhead. The M109A4/M109A5 telephone terminals are located on the hull rear roof.
- y. Generator and charging system, The M109A2/M109A3 howitzers are equipped with a 100 ampere generator. The M109A4/M109A5 howitzers have a 180 ampere generator.

### 1-13 EQUIPMENT DATA

#### NOTE

Data shown apply to all models unless specified otherwise.

#### GENERAL

##### Weight:

Classification (empty) (approx) . . . . .	52,000lb (23,586 kg)
Combat loaded (approx) . . . . .	55,000lb (24,948 kg)

##### Dimensions:

Overall length . . . . .	359 in. (9.12 m)
Overall length (M109A5) . . . . .	361 in. (9.17 m)
Overall width . . . . .	124 in. (3.15 m)
Overall height (including machine gun) . . . . .	129.12 in. (3.28 m)
Ground clearance . . . . .	18 in. (46 cm)

##### Capacities:

Fuel tanks (diesel) . . . . .	135 gal. (511 l)
Engine crankcase . . . . .	9.5 gal. dry (36 l) 6.75 gal. (refill) (25.5 l)
Transmission . . . . .	22 gal. dry (83.3 l) 14 gal. (refill) (53 l)
Cooling system . . . . .	20.5 gal. dry (77.6 l) 14.5 gal. (refill) (54.9 l)

#### PERFORMANCES

High speed (max) . . . . .	35 mph (56.3 kmph)
Lowspeed (max) . . . . .	6 mph (10 kmph)
Reverse speed (max) . . . . .	7mph (11.3 kmph)
Cruising range (approx) . . . . .	217 miles (349 km)
Grade ascending ability (max) . . . . .	60%

**1-13 EQUIPMENT DATA — CONTINUED**

PERFORMANCES — CONTINUED

Grade descending ability (max)	60%
Trench crossing width (max)	72 in. (1.83 m)
Vertical wall (max)	21 in. (0.53 m)
Turn radius (min)	1 vehicle length
Fording depth	42 in. (1.07 m)

PRIMARY ARMAMENT (TWO CONFIGURATIONS)\*

Cannon assembly	M185 (M109A2/M109A3/M109A4) M284 (M109A5)
Cannon tube length	238 in. (6.05 m)(M185) 240 in. (6.09 m)(M284)
Cannon mount	M178 (M109A2/M109A3/M109A4) M182 (M109A5)
EFC value (M109A2/M109A3/M109A4)	(Zones 1-6) 0.25 (Zone 7) 0.75 (Zone 8) 1.00
EFC value (M109A5)	(Zone 1 (M231)) 0.05 (Zone 2 (M231)) 0.15 (Zone 3 (M232)) 0.10 (Zone 3G – 5G (3A1)) 0.05 (Zone 3W – 6W (M4A2)) 0.05 (Zone 4 (M232)) 0.25 (Zone 5 (M232)) 1.00 (Zone 7W (M4A2)) 0.15 (Zone 8/7R (M119A1/A2)) 0.25 (Zone 8R/8S (M203/A1)) 1.00

\* All data listed applies to both configurations unless specified otherwise.

## 1-13 EQUIPMENT DATA — CONTINUED

### PRIMARY ARMAMENT (TWO CONFIGURATIONS)\* — CONTINUED

Maximum range (M109A2/M109A3/M109A4)	(Zone 7) 14,600 m (Zone 8) 18,000 m (Zone 8 with RAP) 23,500 m
Maximum Range (M109A5)	(Zone 5 MACS) 22,000 m (Zone 5 MACS with RAP) 30,000 m (Zone 7) 18,000 m (Zone 8) 22,000 m (Zone 8 with RAP) 30,000 m
Maximum rate of fire	4 rds/min for 3 min
Sustained rate of fire	(Zones 1-7) 1 rd/min (Zone 8) 1 rd/min for 60 min 1 rd every 3 min thereafter

### SECONDARY ARMAMENT

Machine gun	Caliber 50, M2, heavy barrel
-------------	------------------------------

\* All data listed applies to both configurations unless specified otherwise.

## Section III. PRINCIPLES OF OPERATION

### 1-14 EQUIPMENT OPERATION AND DESCRIPTION

#### 1-14.1 Powerplant

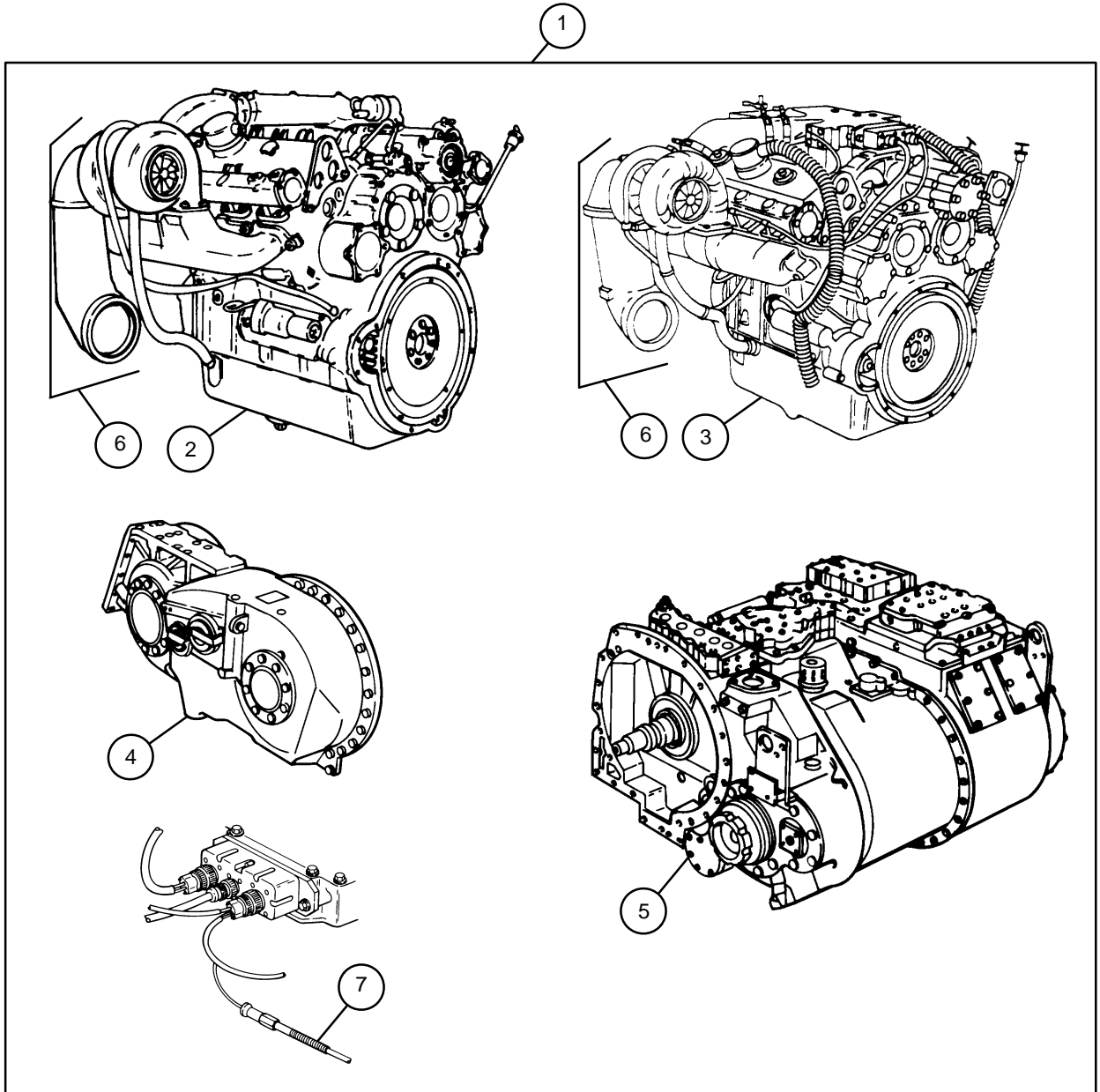
The flow diagram illustrates the transfer of power generated by the powerplant to the track assembly.

- a. POWERPLANT. The powerplant (1) can be removed from the vehicle as a complete unit that consists of an engine (Model 7083-7396) (2) or LHR engine (Model 7083-7391) (3), transfer assembly (4), and transmission (5).
- b. ENGINE (MODEL 7083-7396). Engine (Model 7083-7396) (2) is a liquid-cooled, two-stroke cycle, diesel-type, model 8V71T equipped with an exhaust-driven turbocharger (6). The engine develops 405 horsepower at 2300 rpm and delivers power to the transfer assembly (4).
- c. LHR ENGINE (MODEL 7083-7391). LHR Engine (Model 7083-7391) (3) is a liquid-cooled, two-stroke cycle, low heat rejection, diesel-type, model 8V71T equipped with an exhaust-driven turbocharger (6). The engine develops 440 horsepower at 2300 rpm, delivers power to the transfer assembly (4), and uses glow plugs (7).
- d. TRANSFER ASSEMBLY. The transfer assembly (4) receives power from the engine (2 or 3) and transfers that power to the transmission (5).

**1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED**

**1-14.1 Powerplant — Continued**

- e. TRANSMISSION. The transmission (5) is oil cooled and mechanically and hydraulically operated. It receives power from the engine (2 or 3) through a geared power transfer assembly (4). The transmission has seven gears – four forward, one neutral, and two reverse – and delivers power to the left and right drive sprockets through the output shaft, universal joints, and final drives. It also functions as the steering and braking mechanism.



## 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

### 1-14.2 Fuel System

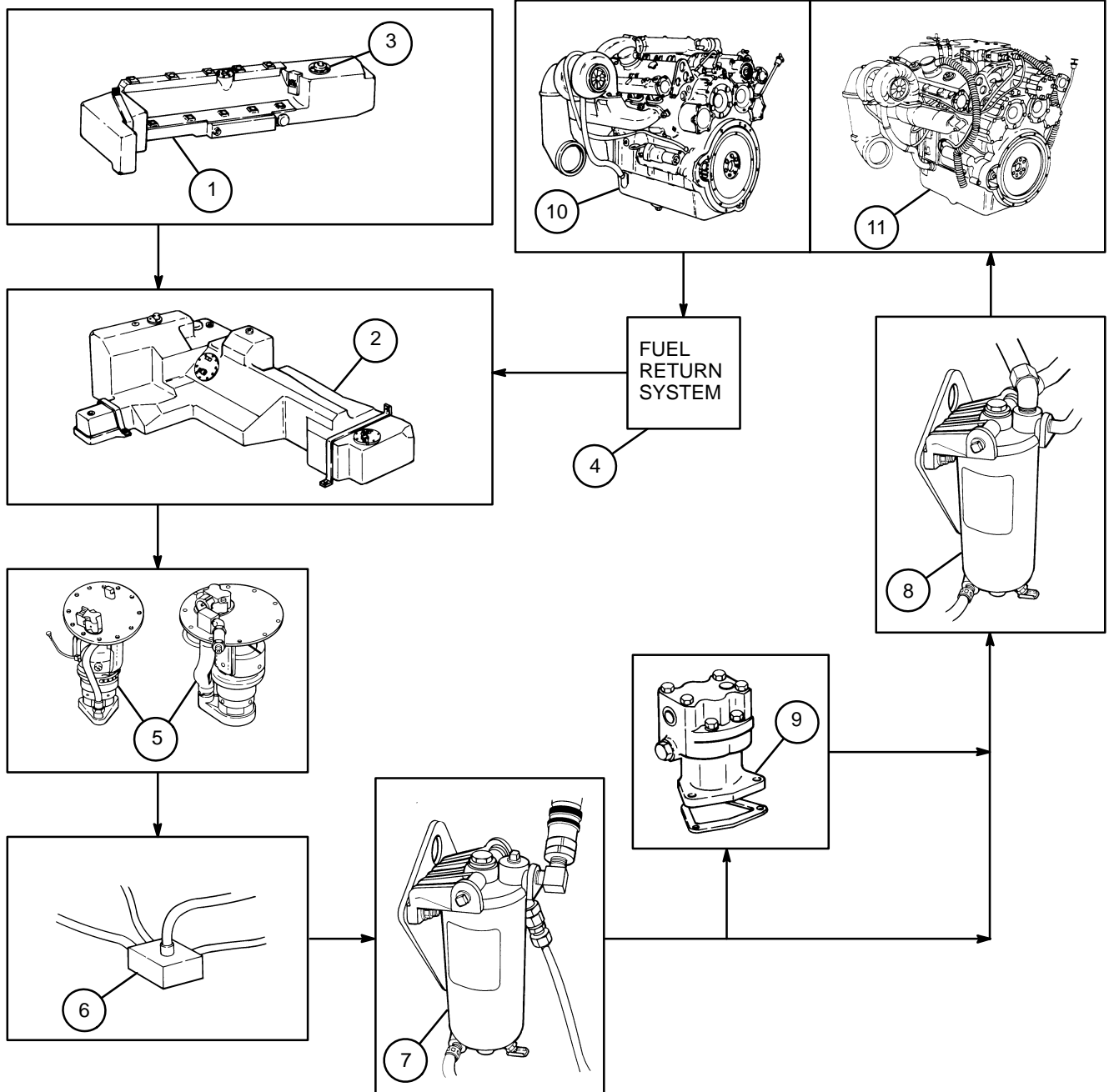
The fuel system flow diagram shows the interaction between the electrical system and fuel system to determine the flow of fuel.

- a. UPPER FUEL TANK. The upper fuel tank (1) provides additional fuel to the lower fuel tank (2). Filling of both fuel tanks takes place through the filler neck (3) of the upper fuel tank.
- b. LOWER FUEL TANK. The lower fuel tank (2) provides for fuel storage and for the return of unused fuel from the fuel return system (4).
- c. ELECTRIC FUEL PUMPS. The electric fuel pumps (5) are activated by the MASTER switch on the instrument panel (M109A2/M109A3) or by an oil pressure switch (M109A4/M109A5). These electric fuel pumps distribute fuel from the lower fuel tank (2) to the fuel distribution center (6). When engine is not operating, the electrical fuel pumps, activated by the fuel prime switch on the driver's fixed instrument panel, pumps fuel from the primary fuel filter (7) to the secondary fuel filter (8).
- d. FUEL DISTRIBUTION CENTER. The fuel distribution center (6) distributes fuel to the primary fuel filter (7).
- e. PRIMARY FUEL FILTER. The primary fuel filter (7) is the first filter from the upper fuel tank,
- f. ENGINE-DRIVEN FUEL PUMP. The engine-driven fuel pump (9) boosts fuel pressure and delivers fuel to the engine.
- g. SECONDARY FUEL FILTER. The secondary fuel filter (8) filters fuel a second time for additional impurities.
- h. ENGINE. The engine (Model 7083-7396) (10) or LHR engine (Model 7083-7391) (11) burns fuel,
- i. FUEL RETURN SYSTEM. The fuel return system (4) distributes excess fuel back to the lower fuel tank (2).



### 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

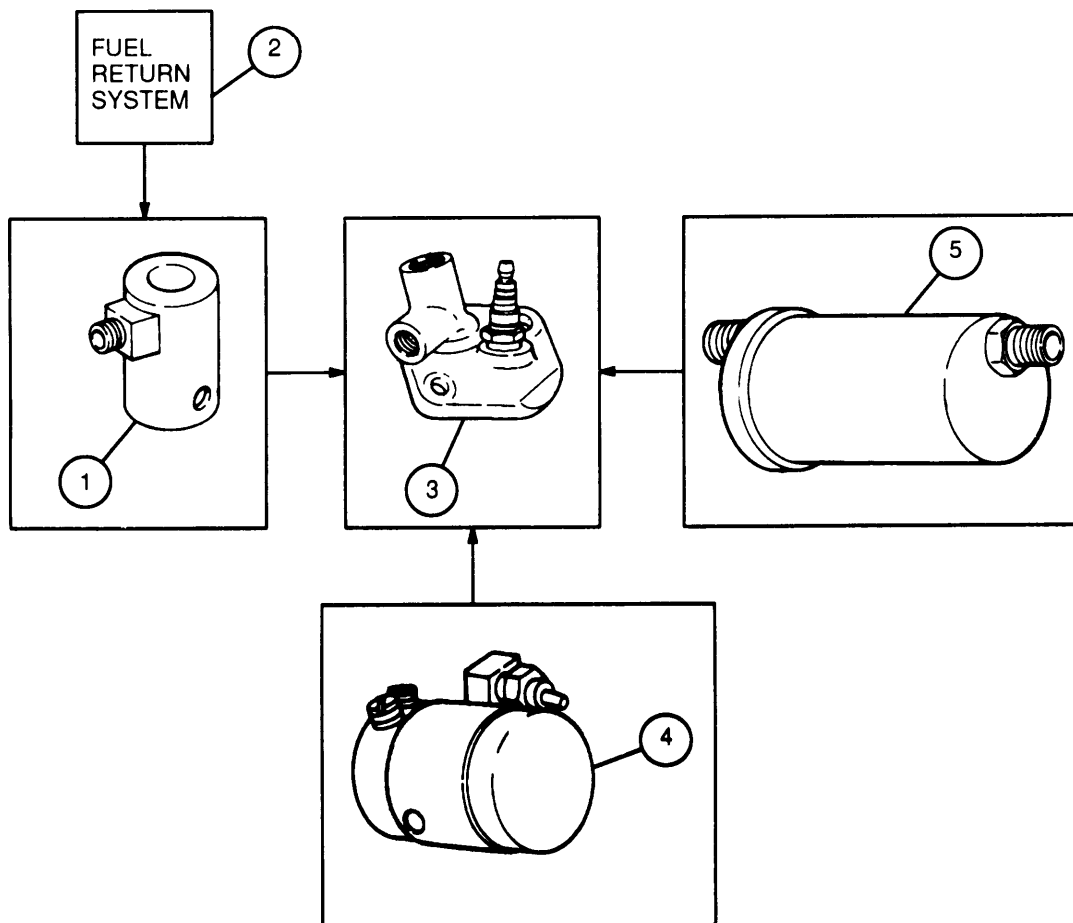
#### 1-14.2 Fuel System — Continued



1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

1-14.3 Flame Heater System (Engine Model 7083-7396)

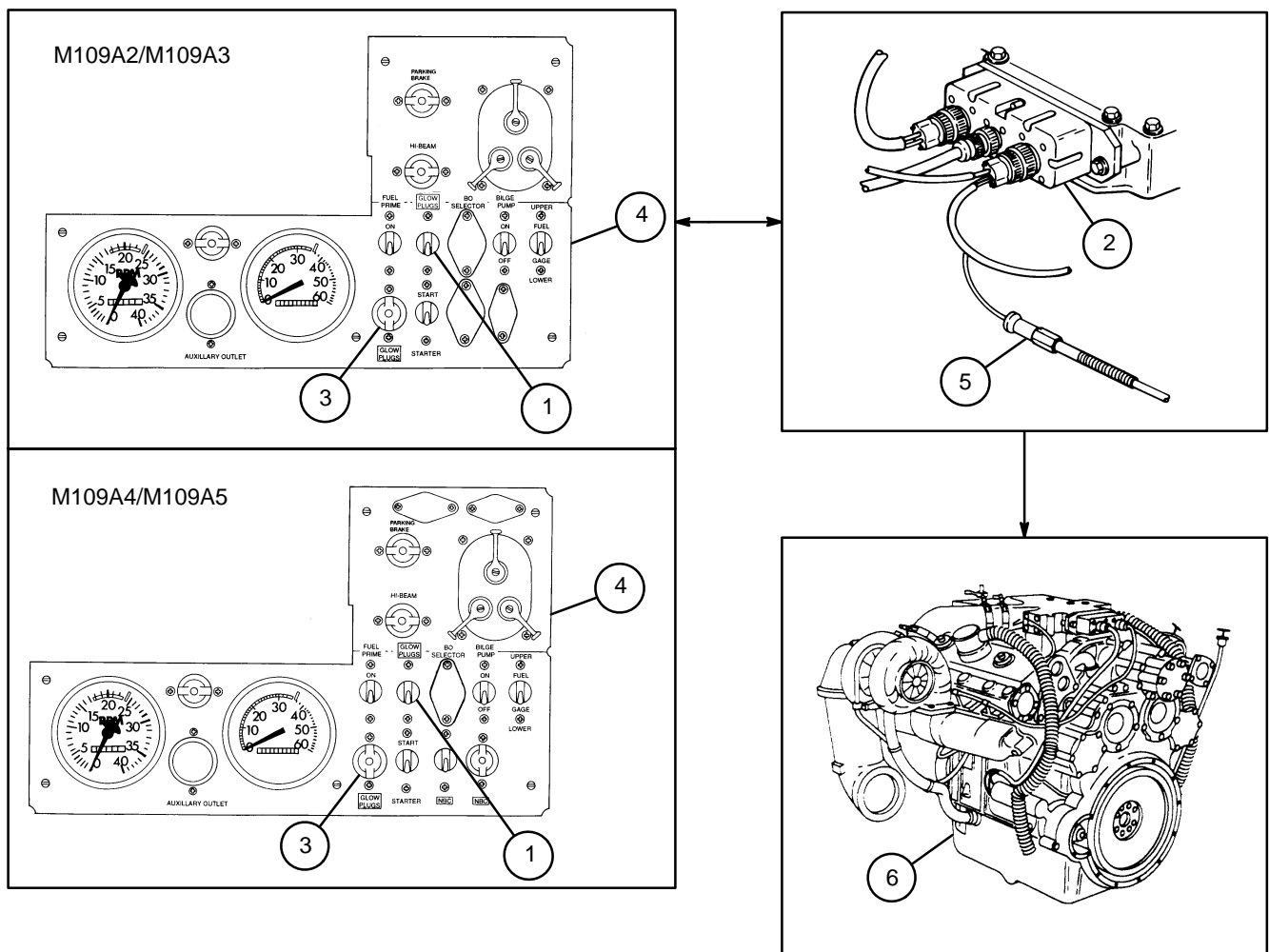
- a. **FLAME HEATER SOLENOID VALVE.** The flame heater solenoid valve (1) receives fuel from the fuel return system (2) and delivers this fuel to the flame heater box (3).
- b. **AIR MOTOR AND PUMP.** The air motor and pump (4) delivers air directly to the flame heater box (3).
- c. **FLAME HEATER IGNITER.** The flame heater igniter (5) provides electrical ignition of atomized fuel in the flame heater box (3).



## 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

### 1-14.4 Glow Plug System (LHR Engine Model 7083-7391)

- a. GLOW PLUGS SWITCH AND INDICATOR LIGHT. The GLOW PLUGS switch (1) activates the glow plug controller (2) and GLOW PLUGS indicator light (3) on driver's fixed instrument panel (4).
- b. GLOW PLUG CONTROLLER AND GLOW PLUGS. The glow plug controller (2) provides electric power to the glow plugs (5) and GLOW PLUGS indicator light (3). When activated, the GLOW PLUGS indicator light illuminates while glow plugs are heated. The GLOW PLUGS indicator light flashes when engine can be started.
- c. LHR ENGINE (MODEL 7083-7391). The LHR engine (Model 7083-7391) (6) contains glow plug controller (2) and eight glow plugs (5).



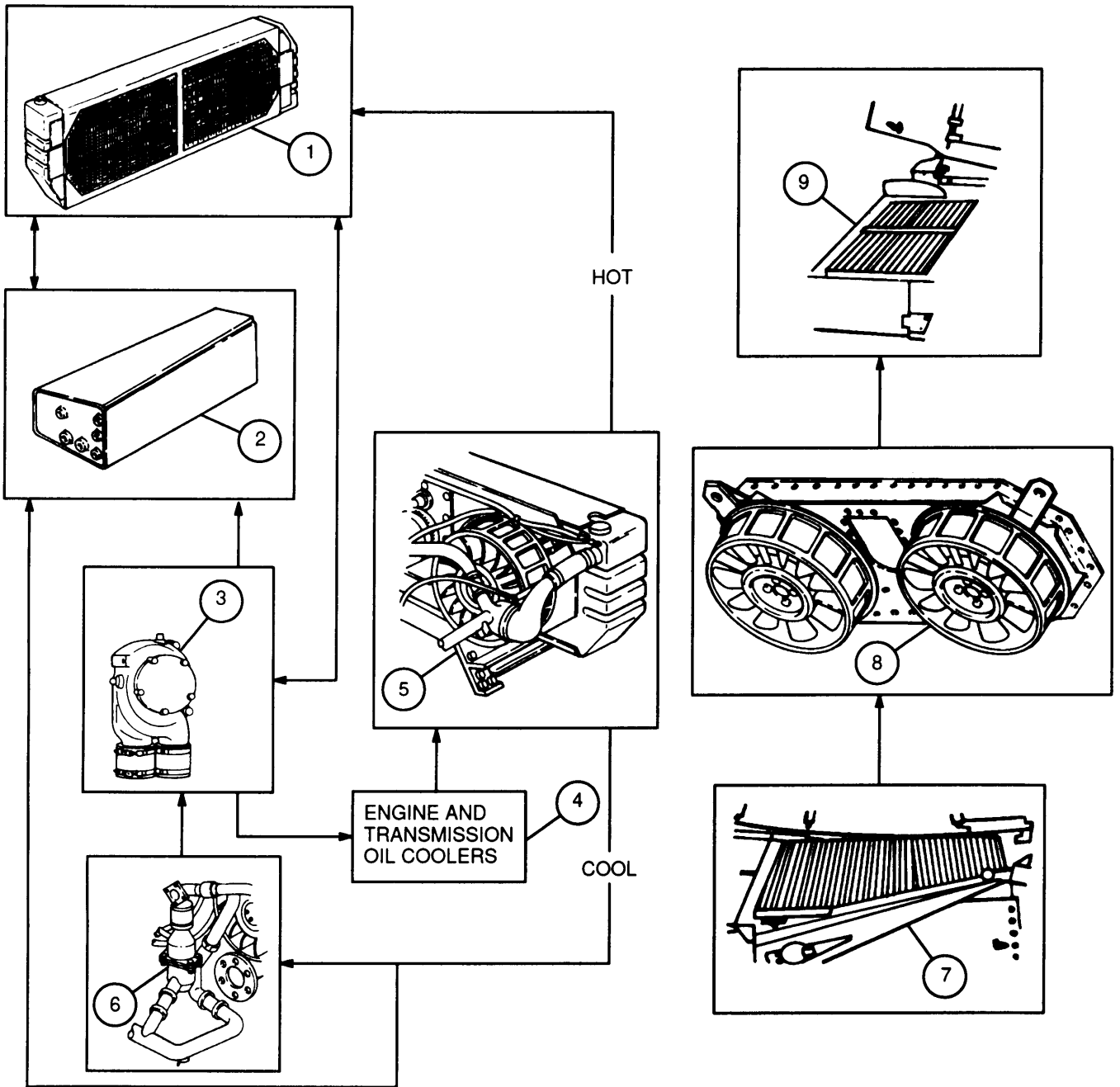
**1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED**

**1-14.5 Cooling System**

- a. **RADIATOR.** The radiator (1) cools the coolant flowing through it.
- b. **SURGE TANK.** The surge tank (2) allows for overflow from the radiator (1) in this closed cooling system.
- c. **ENGINE-DRIVEN COOLANT PUMP.** The engine-driven coolant pump (3) pulls coolant from the radiator (1) and distributes it to the engine and transmission oil coolers (4) and back to the radiator or surge tank (2).
- d. **ENGINE AND TRANSMISSION OIL COOLERS.** The engine and transmission oil coolers (4) cool the oil within the engine and transmission by surrounding the oil cooler tubes with coolant.
- e. **INLET THERMOSTAT.** The inlet thermostat (5) directs the flow of the coolant from the engine to different areas of the cooling system. If the engine is running hot enough to open the inlet thermostat, the coolant flow will be directed to the radiator (1) so it can be cooled. If the engine is running cool enough, the inlet thermostat will direct flow to the bypass thermostat (6) or surge tank (2).
- f. **BYPASS THERMOSTAT.** The bypass thermostat (6) allows inflow from the inlet thermostat (5) and cooling crossover tube and directs it back to the engine-driven coolant pump (3) and to the engine and transmission oil coolers (4).
- g. **AIR INTAKE GRILLE.** The air intake grille (7) allows air to be pulled into the engine compartment by the radiator fan assembly (8).
- h. **RADIATOR FAN ASSEMBLY.** The radiator fan assembly (8) pulls in air through the air intake grille (7) across the engine and pushes the air through the radiator (1) “honeycomb.” The air is then discharged through the exhaust grille (9).
- i. **EXHAUST GRILLE.** The exhaust grille (9) allows air circulated by the radiator fan assembly (8) through the radiator (1) and back out of the engine compartment.

1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

1-14.5 Cooling System — Continued



**1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED**

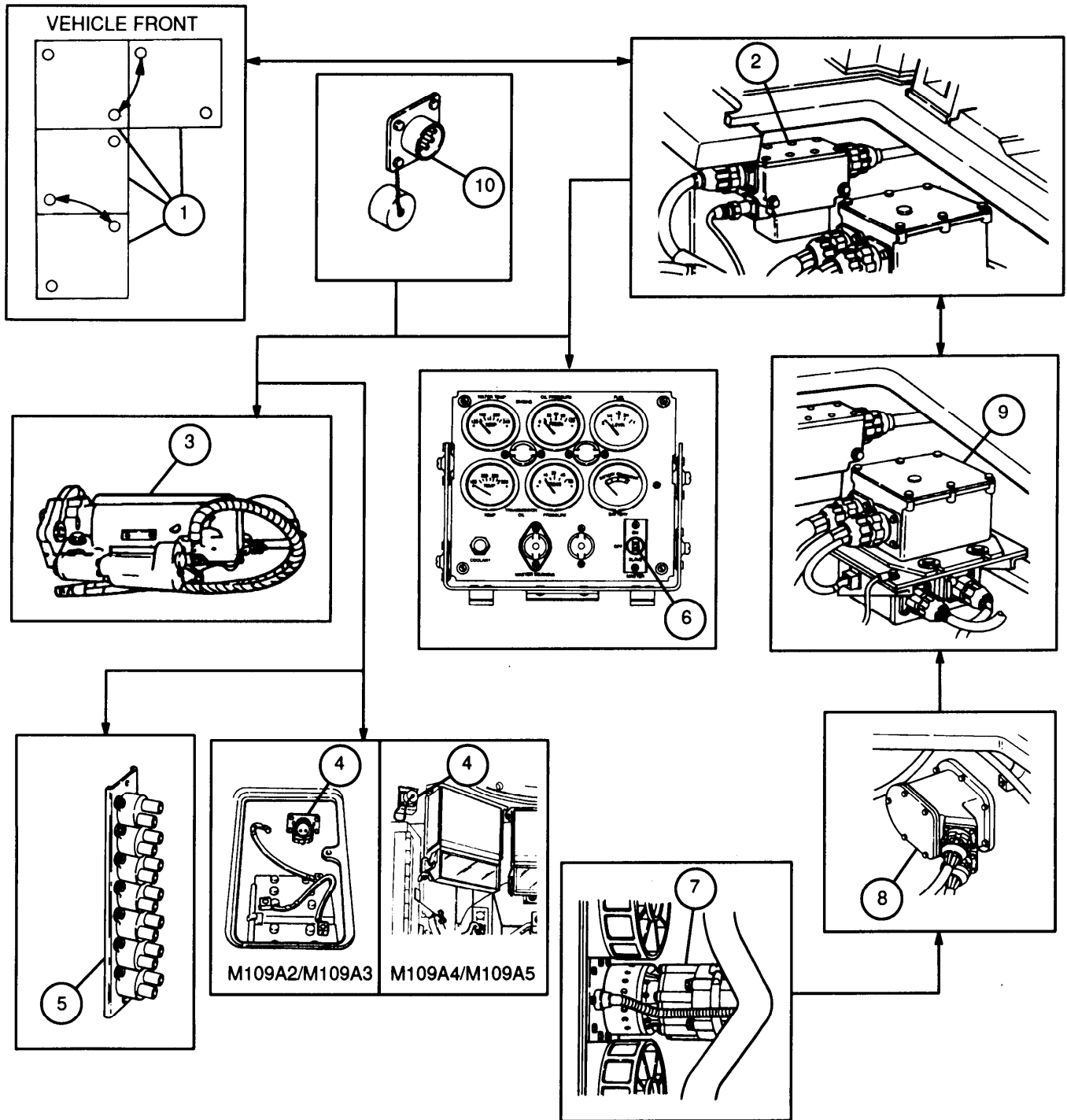
**1-14.6 Electrical System (Hull)**

**The electrical system consists of:**

- a. **BATTERIES.** There are four 12V batteries (1) connected in series and parallel to deliver 24 vdc (nominal) to the master relay (2).
- b. **MASTER RELAY.** The master relay (2) delivers power directly to the slip ring contact board, engine starter (3), slave start receptacle (4), and circuit breaker board (5).
- c. **MASTER SWITCH.** The MASTER switch (6), when activated, draws 24 vdc (nominal) from the batteries (1) through the master relay (2) to operate the electrical systems. With the MASTER switch in ON position, systems can be operated without running the engine.
- d. **GENERATOR.** The generator (7) is engine-driven and delivers 24 vac (nominal) to the rectifier (8).
- e. **RECTIFIER.** The rectifier (8) is a full-wave, bridge rectifier which converts the generator ac voltage to dc voltage and delivers it to the voltage regulator (9).
- f. **VOLTAGE REGULATOR.** The voltage regulator (9) controls the delivery of 24 vdc (nominal) to the vehicle operating systems through the master relay (2) and also acts as a recharger for the batteries (1) when the engine is operating.
- g. **EXTERNAL POWER RECEPTACLE.** The external power receptacle (10) provides vehicle auxiliary power from an external source.

1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

1-14.6 Electrical System (Hull) — Continued



**1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED**

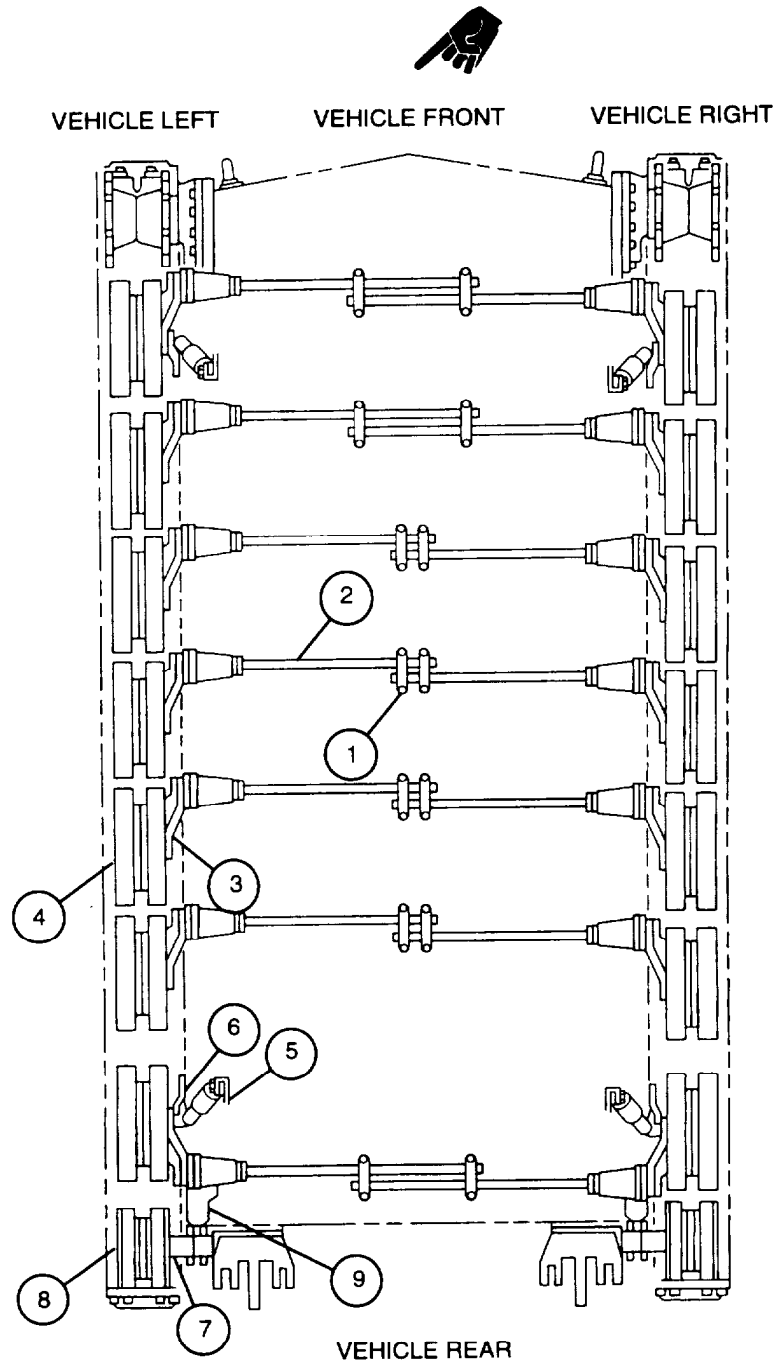
**1-14.7 Suspension System**

- a. **TORSION BAR ANCHORS.** The torsion bar anchors (1) secure the ends of the torsion bars (2). One anchor secures two torsion bars, one from the right and one from the left.
- b. **TORSION BARS.** The torsion bars (2) are secured at the anchor (1) and connected to the road wheel arm (3). The torsion bar acts like a spring for the road wheel.
- c. **ROAD WHEEL ARM.** The road wheel arm (3) is connected to the torsion bar (2) and provides a pivot point between the torsion bar and the road wheel (4).
- d. **ROAD WHEELS.** The road wheels (4) are suspended from the hull of the howitzer by road wheel arms (3). The road wheels have two wheel halves separated by a valley to allow track centerguides to pass between the halves.
- e. **SHOCK ABSORBERS.** The shock absorbers (5) handle differences in the terrain over which the vehicle operates. They are located on the front and back road wheels (4).
- f. **BUMP STOPS.** The bump stops (6) keep shock absorbers (5) from moving beyond their limits.
- g. **IDLER ARM ASSEMBLY AND TRACK ADJUSTER.** The idler arm assembly (7) consists of an idler arm with an idler wheel (8) attached, all rotating within the idler arm housing. The angle of the idler arm and wheel is determined by the length of the track adjuster (9). The track tension maybe increased or decreased by adding or removing grease (item 17, Appx D) to or from the track adjuster.



1-14 EQUIPMENT OPERATION AND DESCRIPTION - CONTINUED

1-14.7 Suspension System - Continued

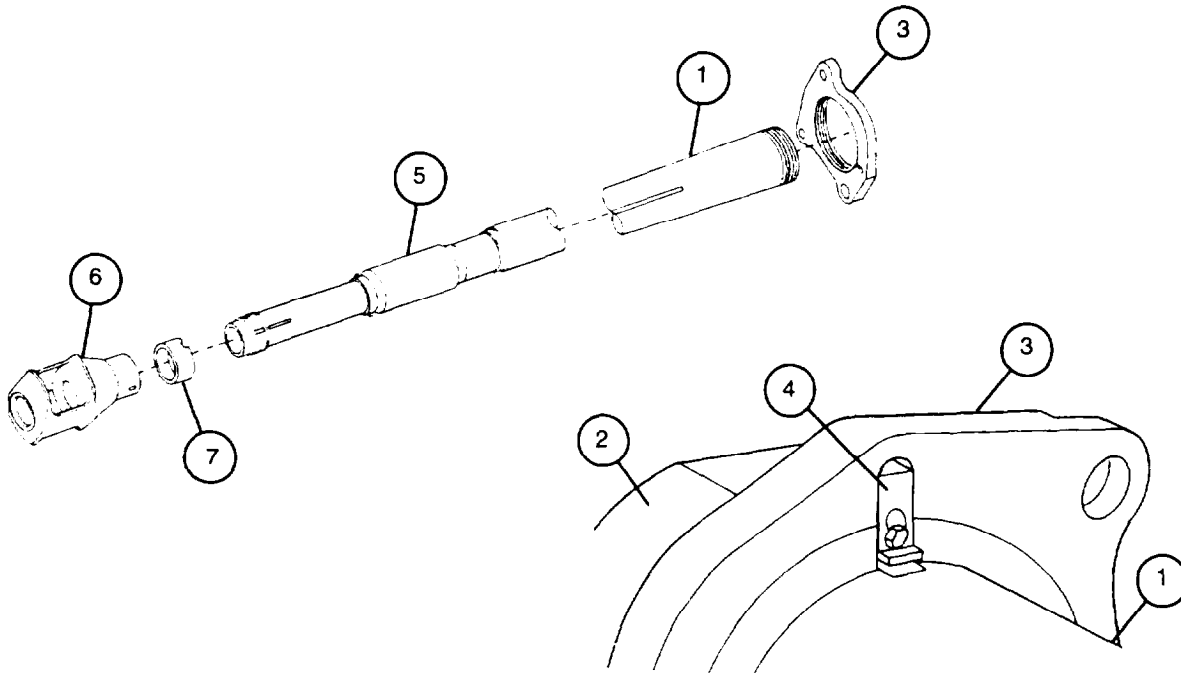


1-14 EQUIPMENT OPERATION AND DESCRIPTION - CONTINUED

1-14.8 Mount and Howitzer Assembly

a. Tube Assembly/Cannon Assembly

- 1 CANNON TUBE. The cannon tube (1) serves as the chamber for the projectile. Rifled bore ensures accurate projectile trajectory. Cannon tube mounts on inside of breech ring (2). Cannon tube locks inside breech ring band (3) by means of interrupted threads and breech ring key (4).
- 2 BREECH RING KEY. The breech ring key (4) holds cannon tube (1) in correct position on breech ring (2). The breech ring key prevents the cannon tube from turning and unlocking from interrupted threads.
- 3 BORE EVACUATOR. The bore evacuator (5) helps clear the cannon tube (1) of gases after firing, minimizing the contamination of the air within the cab.
- 4 MUZZLE BRAKE. The muzzle brake (6) reduces the force of recoil and forward flash, and deflects gases away from the cab.
- 5 THRUST COLLAR. The thrust collar (7) prevents the muzzle brake (6) from turning.

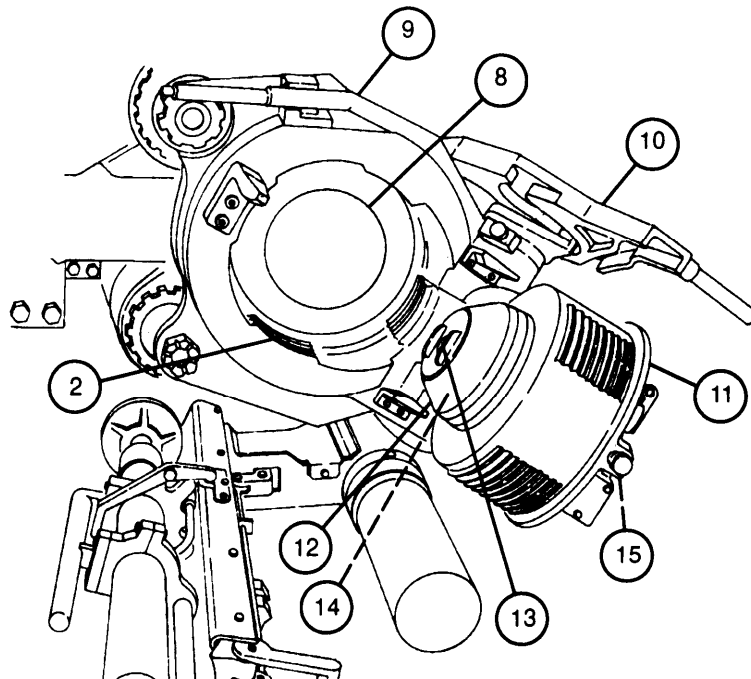


## 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

### 1-14.8 Mount and Howitzer Assembly — Continued

#### b. Breech Assembly

- 1 CHAMBER. The chamber (8) holds powder charge.
- 2 OPERATING HANDLE. The operating handle (9) is used to open the breech manually.
- 3 OPERATING CAM. The operating cam (10) permits automatic opening of the breech.
- 4 BREECHBLOCK ASSEMBLY. The breechblock (11) locks into place behind the chamber (8) holding the powder charge. On closing, the breechblock threads engage with the threads of the breech ring (2). When these threads are engaged, they lock the breechblock in place.
- 5 SPINDLE ASSEMBLY. The spindle assembly (12) seals the powder chamber to prevent escape of gases into the cab.
- 6 VENT HOLE. The vent hole (13) directs the primer blast against the base of the powder charge.
- 7 PRIMER CHAMBER. The primer chamber (14) holds the primer in place for firing.
- 8 FIRING GROUP BLOCK. The firing group block (15) slides over the primer and positions the M35 firing mechanism (on M185 cannon assembly) or M49 firing mechanism (on M284 cannon assembly) for firing.

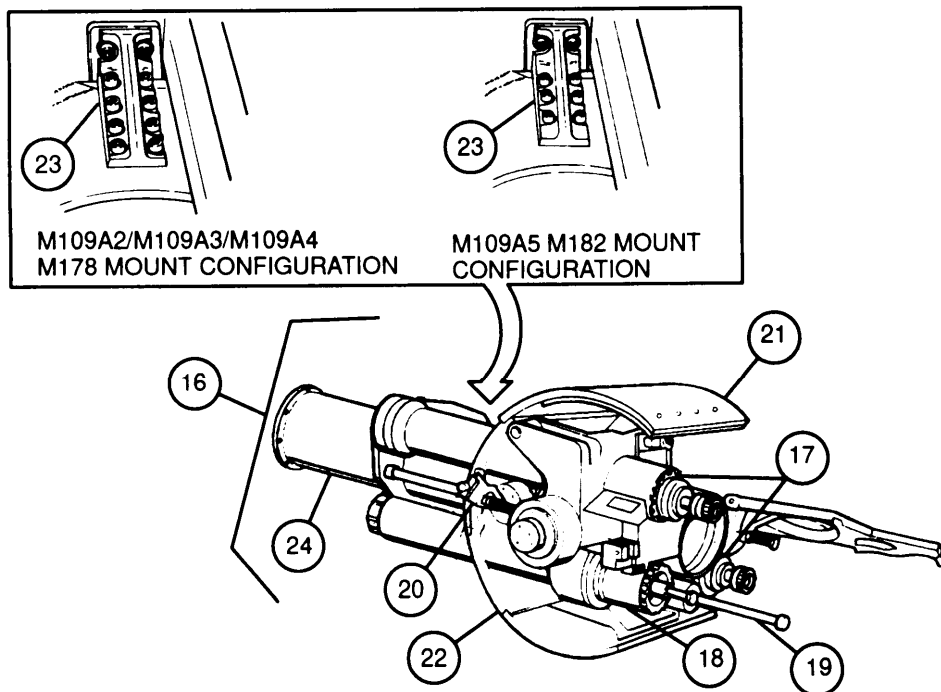


## 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

### 1-14.8 Mount and Howitzer Assembly — Continued

#### c. Mount Assembly

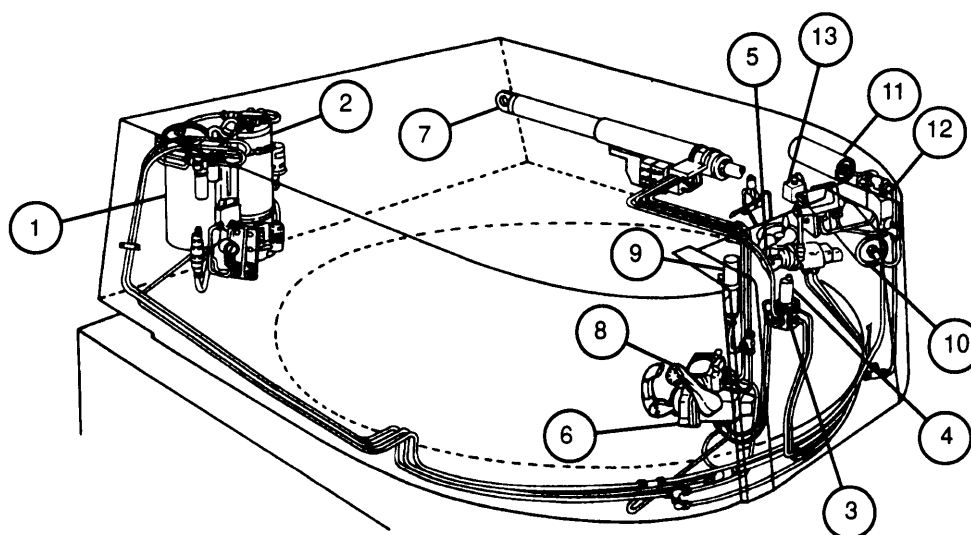
- 1 MOUNT. The mount (16) serves as a fulcrum for the elevation and depression of the cannon assembly.
- 2 VARIABLE RECOIL MECHANISM. The variable recoil mechanism (17) absorbs and reduces the recoil force of the cannon assembly.
- 3 RECUPERATOR. The recuperator (18) returns the cannon tube to battery after firing.
- 4 COUNTER RECOIL BUFFER ASSEMBLY. The counter recoil buffer assembly (19) absorbs shock; slows and cushions the cannon assembly as it returns to battery.
- 5 ACTUATOR. The actuator (20) adjusts recoil position depending on cannon elevation and allows longer recoil at low elevation and short recoil at high elevation.
- 6 UPPER GUN ROTOR. The upper gun rotor (21) protects the cab interior from outside elements that may come from above the cab.
- 7 LOWER GUN SHIELD. The lower gun shield (22) protects the cab interior from outside elements during high angle fire.
- 8 TORQUE KEY. The torque key (23) fits in the keyway of the cradle on the mount (16) to prevent the cannon tube from rotating.
- 9 DUST SHIELD. The dust shield (24) protects the variable recoil mechanism (17) from dirt and dust.



## 1-14 EQUIPMENT OPERATION AND DESCRIPTION — CONTINUED

### 1-14.9 Elevating System

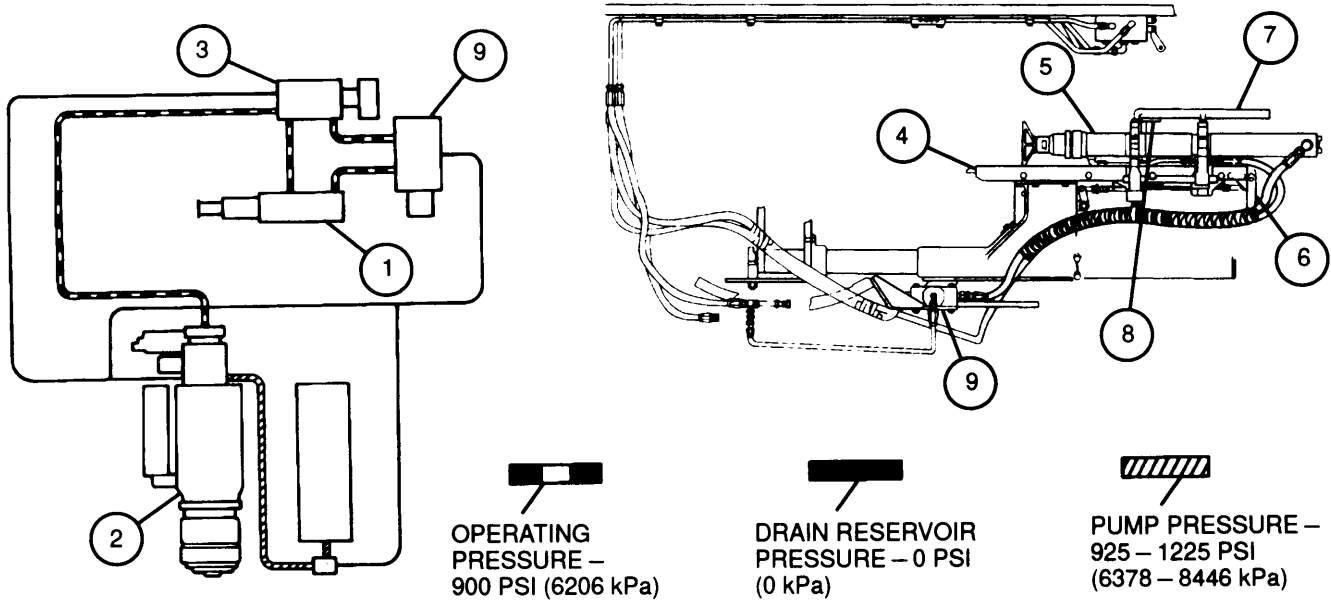
- a. MAIN ACCUMULATOR AND POWER PACK ASSEMBLY. The main accumulator (1) and power pack assembly (2) provide hydraulic power to cab components through a network of hydraulic lines and control valves.
- b. SELECTOR VALVE ASSEMBLY AND SOLENOID. The selector valve assembly (3) and solenoid (4) direct hydraulic flow from either the gunner's control assembly (5) or assistant gunner's control assembly (6) to the equilibrated elevating cylinder (7).
- c. GUNNER'S CONTROL ASSEMBLY. The gunner's control assembly (5) receives hydraulic power from power pack assembly (2) to elevate or depress the cannon and traverses cab left or right.
- d. ASSISTANT GUNNER'S CONTROL ASSEMBLY. The assistant gunner's control assembly (6) receives hydraulic power from the power pack assembly (2) to elevate or depress cannon.
- e. MANUAL ELEVATING HAND PUMP. The manual elevating hand pump (8) directs hydraulic flow to elevate and depress cannon manually.
- f. MANUAL ELEVATION ACCUMULATOR. The manual elevation accumulator (9) maintains hydraulic fluid in manual elevating hand pump (8) under minimum pressure to permit manual control of cannon elevation and depression.
- g. EQUILIBRATED ELEVATING CYLINDER. The equilibrated elevating cylinder (7) elevates, depresses, and balances cannon, as well as compensates for uneven distribution of weight of cannon tube. Other components of equilibration system are the primary accumulator assembly (10), secondary accumulator assembly (11), equilibration manifold assembly (12), and manual elevating hand pump (8).
- h. GUNNER'S SELECTOR SWITCH BOX ASSEMBLY. The gunner's selector switch box assembly (13) ELEVATION CONTROL switch allows either the gunner or assistant gunner to elevate the cab while the CAB POWER switch is to ON.



**1-14 EQUIPMENT OPERATION AND DESCRIPTION - CONTINUED**

**1-14.10 Rammer Hydraulic System**

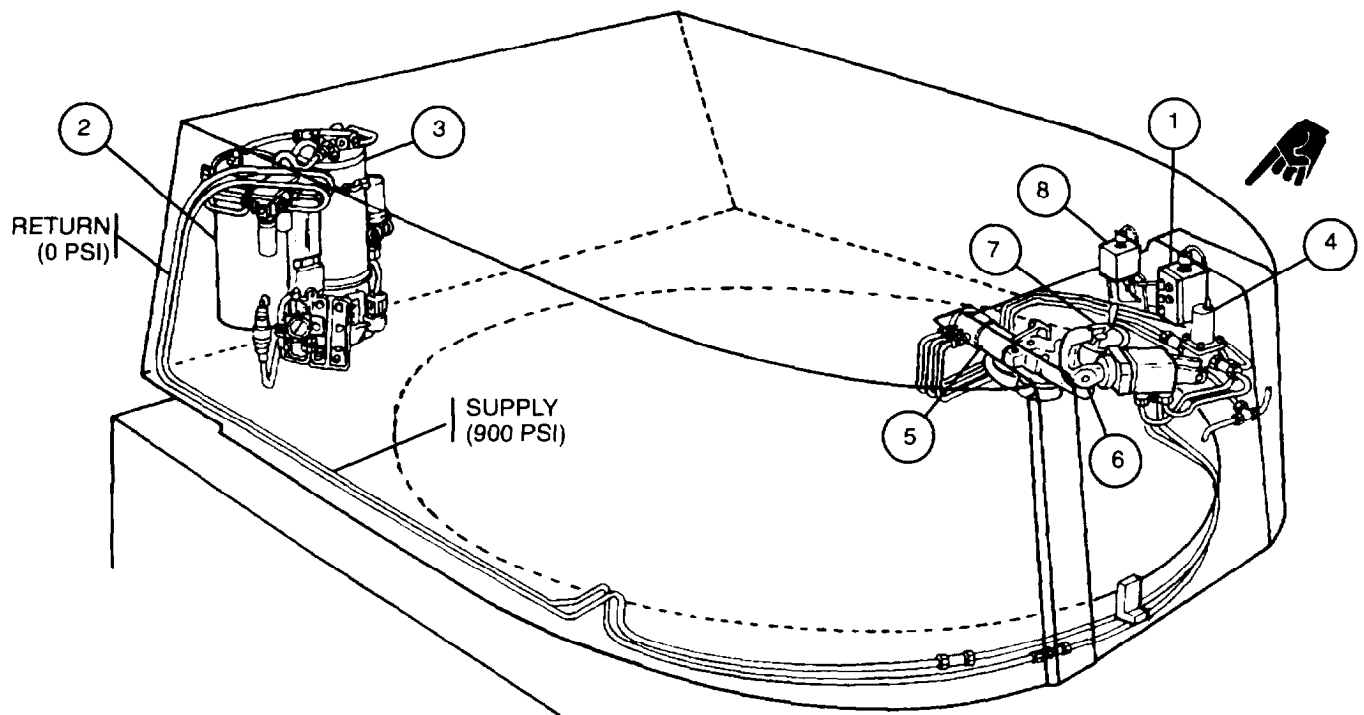
- a. **RAMMER ASSEMBLY.** The rammer assembly (1) is used for loading and ramming the projectile into the cannon tube. Hydraulic power from the power pack assembly (2) flows through the actuating valve (3) to the rammer cylinder which uses the pressure to ram the projectile into position.
- b. **ACTUATING VALVE.** The actuating valve (3) controls the inflow of hydraulic fluid for the ramming operation and outflow of hydraulic fluid for the retraction of the rammer assembly (1) after use.
- c. **TRAY ASSEMBLY.** The tray assembly (4) holds the projectile in position for ramming.
- d. **CYLINDER ASSEMBLY.** The cylinder assembly (5) contains the piston which rams the projectile into the chamber.
- e. **MAIN RELEASE HANDLE.** The main release handle (6) releases the locking mechanism so that the rammer assembly (1) may be moved into "RAM" position, and also back into "STOW" position.
- f. **HANDLE ASSEMBLY.** The handle assembly (7) provides a hand hold for rotating the rammer cylinder (5) into ramming position.
- g. **CYLINDER LATCH.** The cylinder latch (8) locks the rammer cylinder (5) into position on the tray assembly (4).
- h. **BLOCKING VALVE.** The blocking valve (9) prevents accidental ramming of rammer in stowed position.



**1-14 EQUIPMENT OPERATION AND DESCRIPTION - CONTINUED**

**1-14.11 Cab Traversing System**

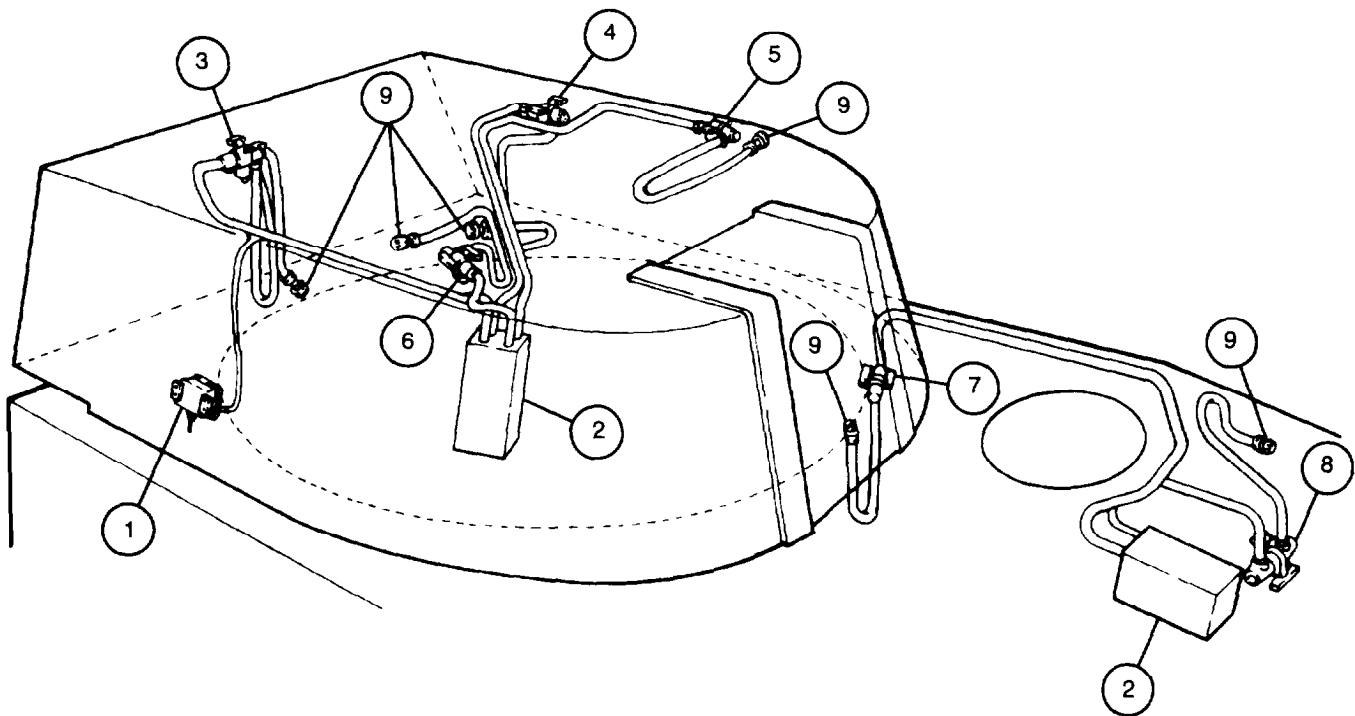
- a. GUNNER'S SELECTOR SWITCH BOX ASSEMBLY. The gunner's selector switch box assembly (1) TRAVERSE CONTROL switch allows either power or manual traverse of cab while the CAB POWER switch is to ON.
- b. MAIN ACCUMULATOR AND POWER PACK ASSEMBLY. The main accumulator (2) and power pack assembly (3) deliver hydraulic power to cab components through a network of lines and control valves.
- c. BY-PASS VALVE ASSEMBLY AND SOLENOID. The by-pass valve assembly and solenoid (4) direct hydraulic flow to allow manual or power traversing.
- d. TRAVERSING MECHANISM. The traversing mechanism (5) traverses the cab by hydraulic power or mechanical energy. Clutch mechanism controlled by gunner's selector switch box assembly (1) disengages manual gears and allows power traversing.
- e. GUNNER'S CONTROL ASSEMBLY. The gunner's control assembly (6) receives hydraulic power from the power pack assembly (3) and uses the power to either traverse the cab right and left, or elevate or depress the gun.
- f. MANUAL TRAVERSE HANDWHEEL. The manual traverse handwheel (7) allows manual traverse of cab.
- g. CLUTCH VALVE (M109A4/M109A5 ONLY). The clutch valve (8) allows power traversing in the event of electrical failure by activating the clutch valve manually.



## 1-14 EQUIPMENT OPERATION AND DESCRIPTION - CONTINUED

### 1-14.12 NBC System (M109A4/M109A5 Only)

- a. NBC CONTROL BOX ASSEMBLY. The NBC control box assembly (1) located at commander's station turns the NBC system on and off.
- b. M2A2 AIR PURIFIER. The M2A2 air purifier (2) pulls contaminated air through gas and particulate filters and distributes clean air through hoses to individual M3 electrical air heaters.
- c. M3 ELECTRICAL AIR HEATERS. The section chief's heater (3), cannoneer no.1's heater (4), gunner's heater (5), and assistant gunner's heater (6) located on the cab ceiling and cannoneer no. 2's heater (7) and driver's heater (8) located in the hull warm filtered air for individual comfort.
- d. ORIFICE CONNECTORS. The orifice connectors (9) attach purification system to M25A1 field protective masks.





## Section IV. SECTION DRILL

The purpose of section drill is to improve the performance of the howitzer section through execution of assigned tasks and cross training of howitzer section personnel.

Section drill must be conducted in silence, except for commands and reports. The howitzer section must be drilled until reaction to commands is quick, automatic, and correct.

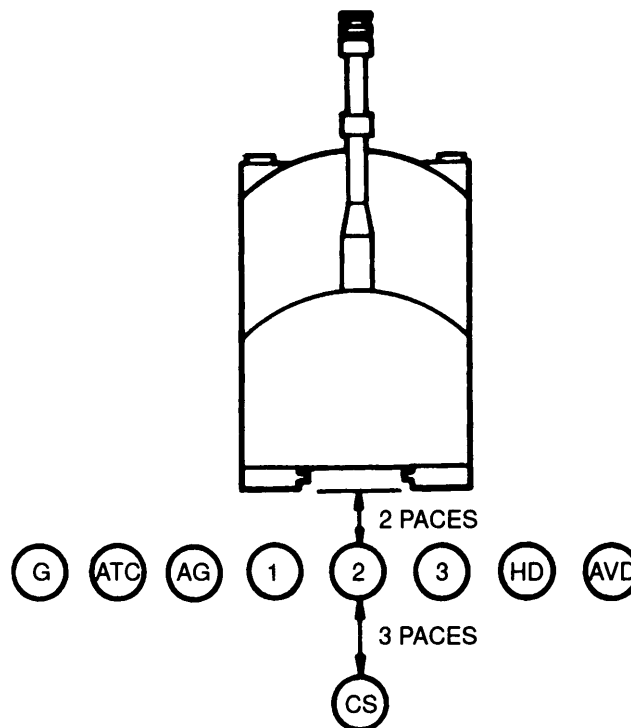
Battery officers will supervise the drill. Errors will be corrected immediately.

Duties should be rotated during training so that each howitzer section member can perform all duties within the howitzer section.

### 1-15 DRILL PROCEDURES

#### 1-15.1 Forming the Section

On the command of execution, the howitzer section forms a single rank, at close interval, centered on, and facing the chief of section at a distance of three paces. Numbered cannoneers form, in order, between the assistant gunner and the howitzer driver. The chief of section may indicate, in his preparatory command, the place and direction in which the section is to form.



FORMING THE SECTION AT REAR OF PIECE

## **1-15 DRILL PROCEDURES — CONTINUED**

### **1-15.1 Forming the Section — Continued**

- a. To Fall In. At the first formation of a drill or exercise, the caution “AS HOWITZER SECTION” precedes the first preparatory command. After the chief of section takes his post, either the execution command of “FALL IN” or the preparatory and execution commands of “IN FRONT (REAR) OF YOUR PIECE, FALL IN” is given. Howitzer crew members move at double time and format close interval, at attention, guiding on the gunner. The howitzer section vehicle driver is to the left of the howitzer driver.
- b. To Call Off. Once the section is formed, the command “CALL OFF” is given by the chief of section. All personnel, except the gunner, then execute eyes right. Each section member will then call off in sequence; for example, “GUNNER,” “AMMO TEAM CHIEF,” “ASSISTANT GUNNER,” “1,” “2,” “3,” “HOWITZER DRIVER,” “AMMO VEHICLE DRIVER.” Each soldier, except the gunner, turns his head smartly to the front as he calls out his designation.

### **1-15.2 Posting the Section**

To post the section the preparatory and execution commands are “CANNONEERS, POSTS.” The command is general and is applicable whether the section is in or out of ranks, at a halt, or marching. All movements are executed at double time and are terminated at the position of attention. The howitzer section moves to posts as shown in the following figures.

### **1-15.3 Changing Posts**

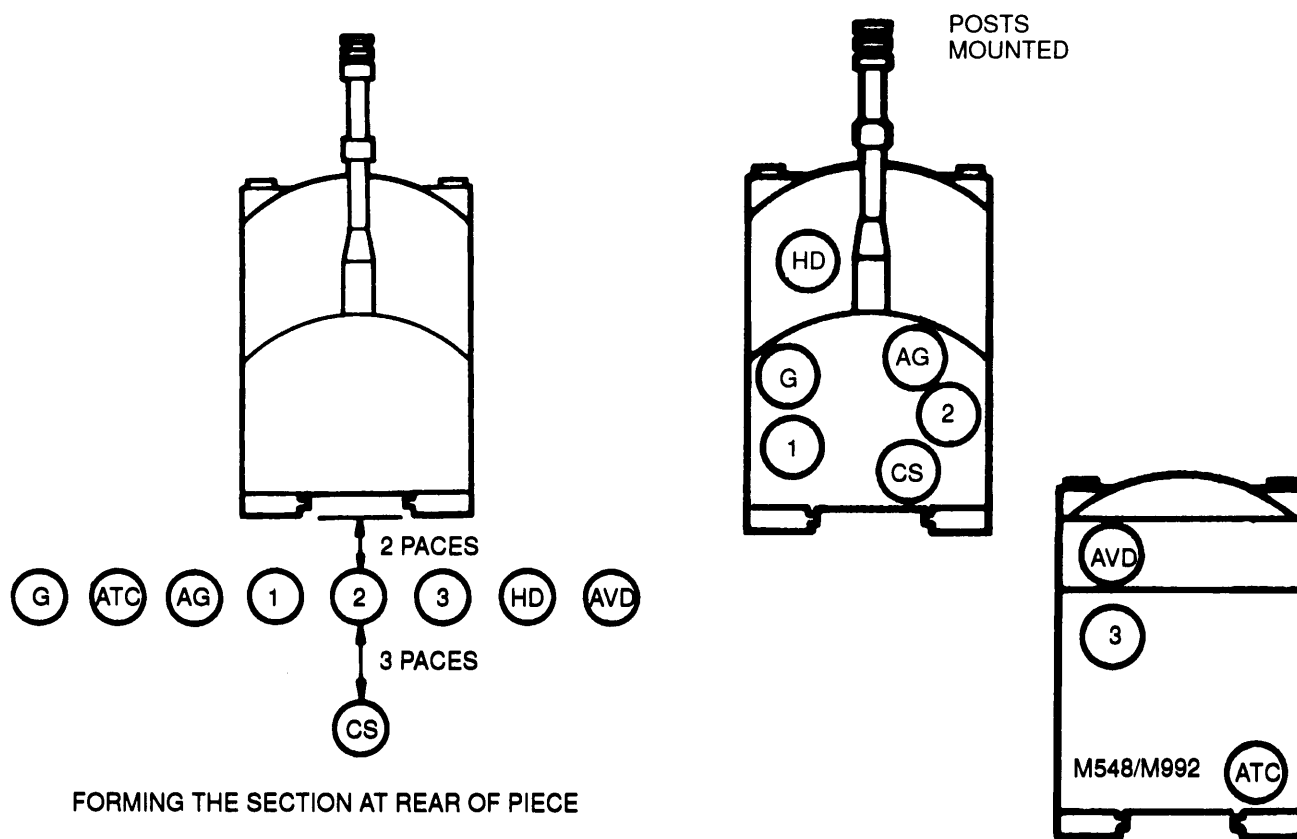
To acquaint howitzer section members with all duties, posts should be changed often. After forming the section, either of the following preparatory and execution commands are used; “CHANGE POSTS, MARCH” or “SECTION CHANGE POSTS, MARCH.”

- a. When the commands, “CHANGE POSTS, MARCH,” are used, the ammunition team chief, the assistant gunner, and numbered cannoneers except cannoneer no. 3 take two left steps, taking the position of the next higher numbered cannoneers. At the same time, cannoneer no. 3 moves at double time in rear of the rank to the post of the assistant gunner. All other members of the section stand fast.
- b. When the commands, “SECTION CHANGE POSTS, MARCH,” are used, all members of the section except the individual at the extreme left take two left steps. The excepted individual moves at double time in rear of the section and takes the post of the gunner.

## 1-15 DRILL PROCEDURES — CONTINUED

### 1-15.4 Mounting

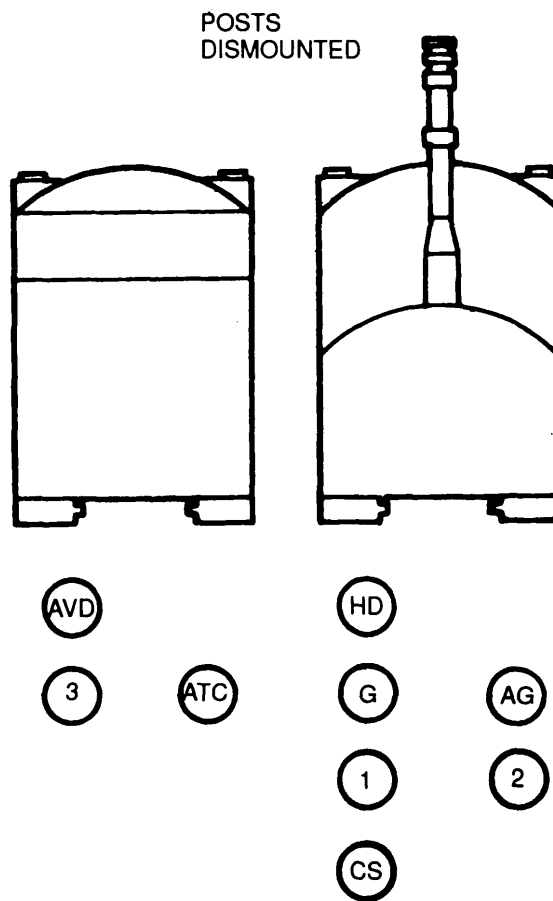
- a. At the preparatory command, "PREPARE TO MOUNT," all howitzer section members move at double time to their dismounted posts. At the command of execution, all personnel assume their mounted posts. The chief of section, driver, gunner, assistant gunner, and cannoneers no. 1 and no. 2 mount the howitzer. Likewise, at the command of execution, the driver of the ammunition vehicle, cannoneer no. 3, and team chief mount the ammunition vehicle. If any howitzer section member is not to mount, his designation is announced with the caution, "Stand fast," given between the preparatory command and the command of execution. For example, "PREPARE TO MOUNT, DRIVER STAND FAST, MOUNT."
- b. If the single command, "MOUNT" is used, the section will respond in the same manner as prescribed for the commands "PREPARE TO MOUNT, MOUNT."



## 1-15 DRILL PROCEDURES — CONTINUED

### 1-15.5 Dismounting

- a. At the preparatory command, "PREPARE TO DISMOUNT," the personnel mounted in the ammunition vehicle unlatch and open the doors (tailgate) of the vehicle and all howitzer section members assume positions from which they can dismount promptly. At the command of execution, they dismount and assume (at double time) their dismounted posts.
- b. If the single command, "DISMOUNT," is used, all howitzer section members will respond in the same manner as prescribed for the commands "PREPARE TO DISMOUNT, DISMOUNT."



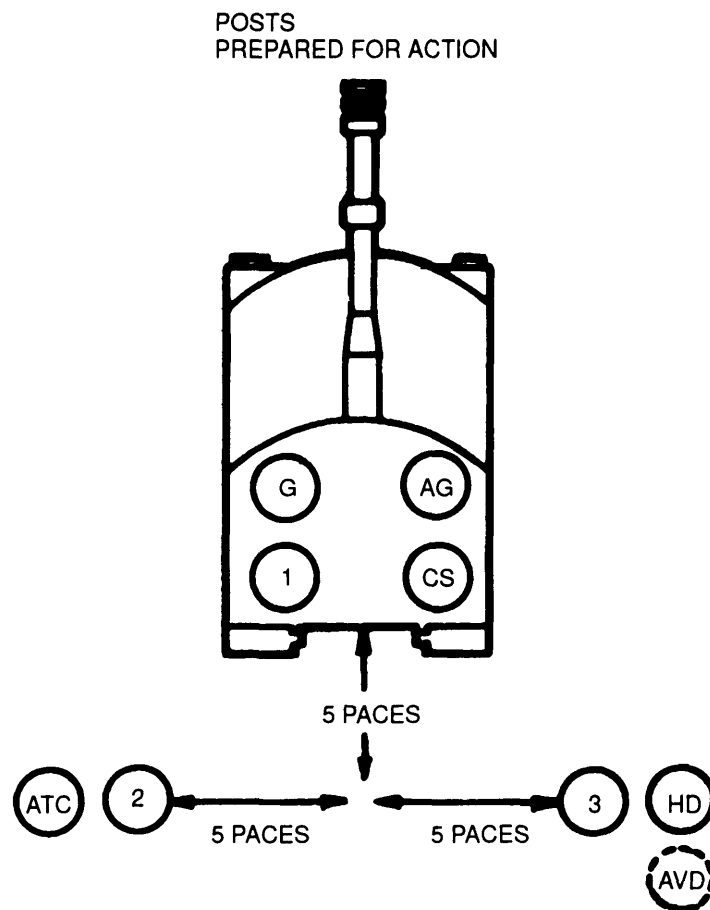
**1-15 DRILL PROCEDURES — CONTINUED**

**1-15.6 Preparing for Action**

At the single command, "PREPARE FOR ACTION," all howitzer section members, at double time, assume their prepare for action posts.

**1-15.7 Break Periods During Training or Firing**

- a. At Drill. When it is desired to give the howitzer section personnel a rest from drill or to relieve them temporarily from formation or post, the command "FALL OUT" is used. The command may be given at any time and means that howitzer section members are to remain in the drill area.
- b. When Firing. When firing has been temporarily suspended, and howitzer section members are to remain in the vicinity of the howitzer, the command "FALL OUT" is given. Howitzer section members must stand clear of the howitzer and any aiming aids within the emplacement area to ensure that settings remain undisturbed.



## 1-15 DRILL PROCEDURES — CONTINUED

### 1-15.8 Reduced Crew Drill

Howitzer section strength may be reduced to less than the prescribed TOE/MTOE strength due to illness, casualties, battery taskings, or the need to rest personnel. To meet the operational requirements of the howitzer section, the duties of the individuals of the section will be combined as shown below. The section chief will assign specific duties to crew members when the number of available personnel falls below the level show below. The reduced crew drill was developed under the Army Standardization Program and the duties as listed below are to be considered standard procedures.

#### 8-Man

CS

G

ATC

AG

#1

#2

#3/AVD

HD

#### 7-Man

CS

G

ATC

AG

#1

#2/#3/AVD

HD

#### 6-Man

CS

G

ATC

AG/HD

#1

#2/#3/AVD

## CHAPTER 2 OPERATING INSTRUCTIONS

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## Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS

### 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS

This section locates and describes the controls, indicators, and instruments used to operate the howitzer.

#### NOTE

In this manual, location descriptions of left and right side ALWAYS refer to the left and right side of the driver while in the driving position.

#### 2-1.1 Driver's Controls and Indicators

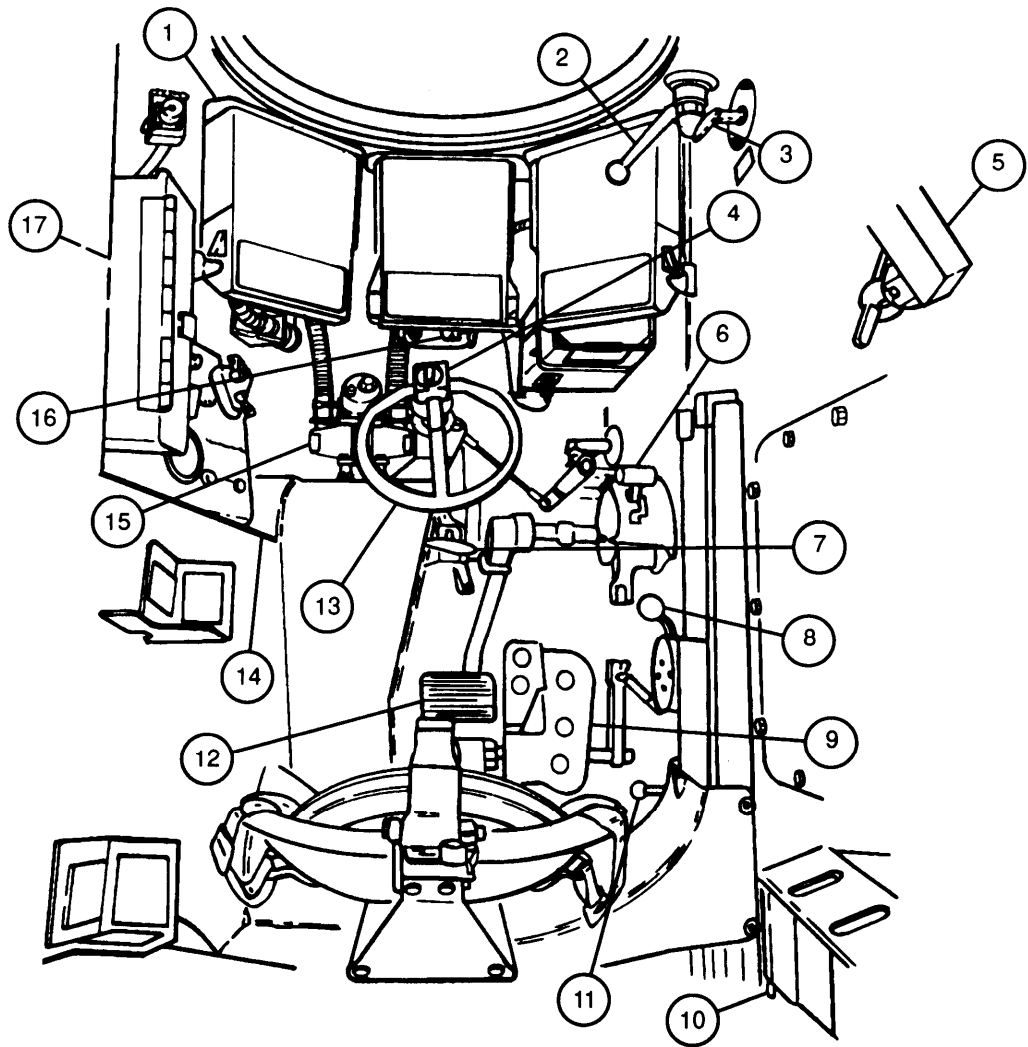
- |    |  |  |
|----|--|--|
| 1  | M42 DRIVER'S PERISCOPE                 | Three periscopes allow driver to see outside vehicle while driver's hatch is closed.   |
| 2  | HATCH LOCKING LEVER                    | Used to lock/unlock driver's hatch.  |
| 3  | FUEL SHUT OFF CONTROL ASSEMBLY HANDLE  | Used to stop fuel flow to engine.  |
| 4  | MASTER WARNING LIGHT                   | Illuminates when MASTER switch is in ON position and engine is not running.  |
| 5  | FIRE EXTINGUISHER HANDLE               | Activates fixed fire extinguishers.  |
| 6  | TRANSMISSION SHIFT CONTROL LEVER       | Used to select the speed range and the direction of the power output of the transmission.  |
| 7  | MANUAL CONTROL HANDLE                  | Used to engage parking brake.  |
| 8  | HAND THROTTLE CONTROL LEVER            | Another method of controlling the speed (rpm) of the engine. Pushing forward increases engine speed, while pulling back decreases engine speed.        |
| 9  | ACCELERATOR PEDAL                      | When depressed, speeds the engine allowing it to operate at greater rpm. When the accelerator pedal is released, engine rpm will return to idle speed. |
| 10 | DRIVER'S HEATER OUTLET DUCT            | Provides means of controlling flow of heated air into driver's compartment.  |
| 11 | DRIVER'S SEAT VERTICAL ADJUSTING LEVER | Used to vertically adjust driver's seat.   |
| 12 | BRAKE PEDAL                            | Used to apply brakes to slow or stop vehicle.  |
| 13 | STEERING WHEEL                         | Used to steer vehicle.   |
| 14 | DRIVER'S FIXED INSTRUMENT PANEL        | Panel having various switches and gages used by driver while operating vehicle.  |



**2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED**

**2-1.1 Driver's Controls and Indicators — Continued**

- |  |  |
|--|--|
| <p>15 M3 ELECTRICAL AIR HEATER<br/>(M109A4/M109A5)</p> <p>16 DOME LIGHT SWITCH</p> <p>17 PORTABLE INSTRUMENT PANEL</p> | <p>Two M3 electrical air heaters provide heated air to the driver and cannoneer no. 2 while operating in an NBC environment.</p> <p>Turns dome light assembly to ON or OFF.</p> <p>Used by driver when driver is in raised position.</p> |
|--|--|



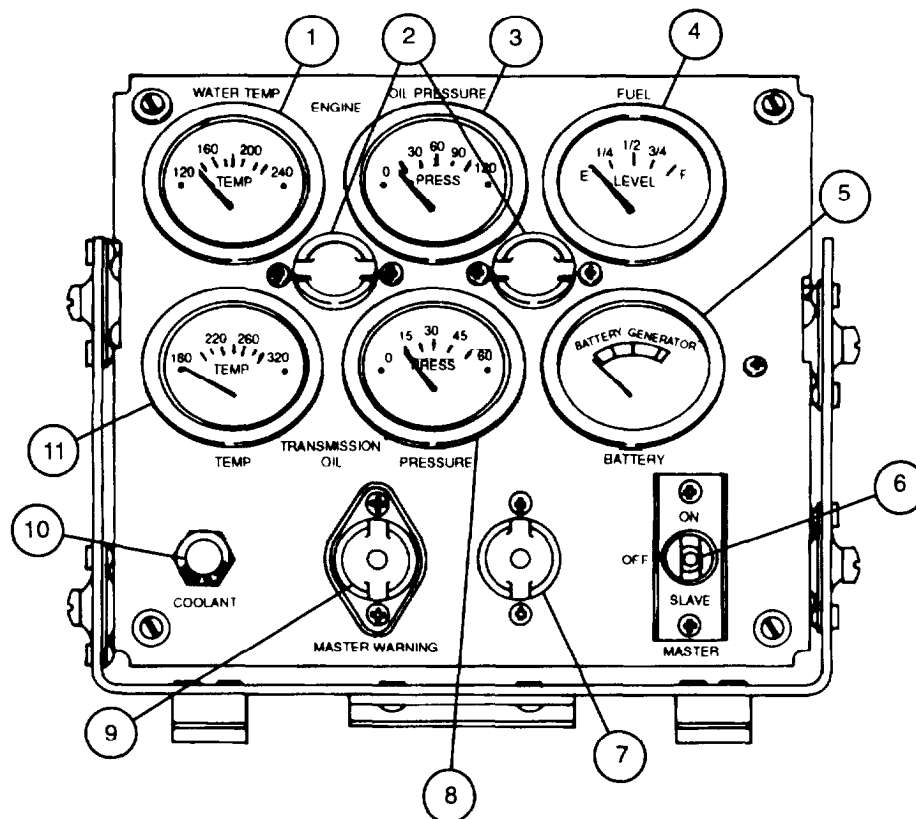
## 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

### 2-1.2 Portable Instrument Panel

1	WATER TEMP GAGE	Indicates engine water temperature.
2	INDICATOR LIGHTS	Illuminates portable instrument panel.
3	ENGINE OIL PRESSURE GAGE	Indicates engine oil pressure.
4	FUEL GAGE	Indicates fuel level.
5	BATTERY GAGE	Indicates battery condition.
6	MASTER SWITCH	Activates the vehicle electrical system.
7	MASTER SWITCH INDICATOR LIGHT	Illuminates when MASTER switch is in ON position.
8	TRANSMISSION OIL PRESSURE GAGE	Indicates transmission oil pressure.
9	MASTER WARNING INDICATOR LIGHT	Indicates critical engine operating conditions including transmission oil low pressure, transmission oil high temperature, engine coolant high temperature, and engine oil low temperature.
10	COOLANT INDICATOR LIGHT	Indicates low coolant.
11	TRANSMISSION OIL TEMP GAGE	Indicates transmission oil temperature.

2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS - CONTINUED

2-1.2 Portable Instrument Panel - Continued



**2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS - CONTINUED**

**2-1.3 Driver's Fixed Instrument Panels**

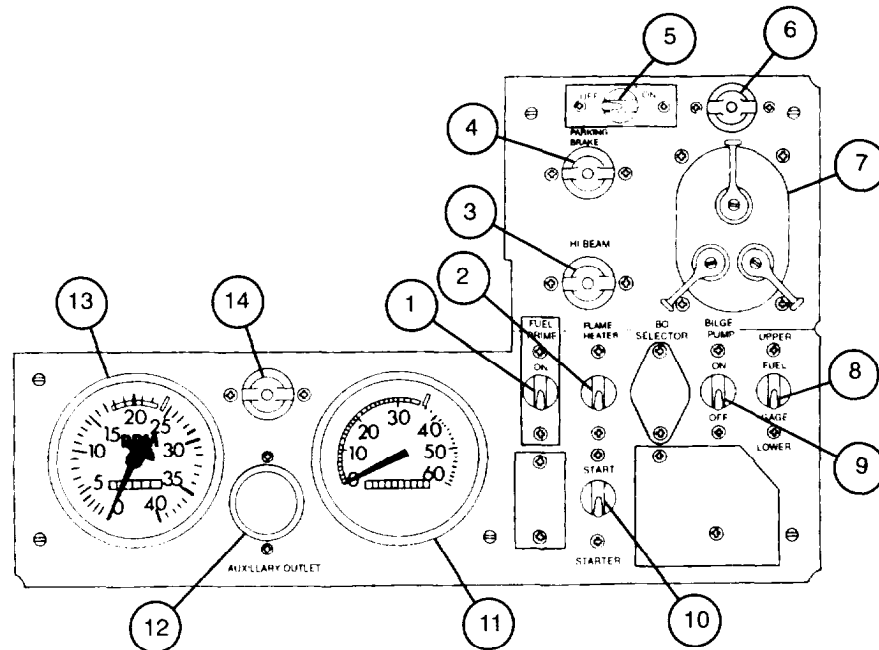
a. Driver's Fixed Instrument Panels for Engine Model 7083-7396

1	FUEL PRIME CONTROL SWITCH	Activates the fuel prime pump.
2	FLAME HEATER CONTROL SWITCH	Activates the flame heater.
3	HI-BEAM INDICATOR LIGHT	Lights when headlights are on high beam.
4	PARKING BRAKE INDICATOR LIGHT	Lights to indicate parking brake is set or not fully released.
5	NBC POWER SWITCH (M109A4/M109A5)	Powers the NBC system.
6	NBC INDICATOR LIGHT (M109A4/M109A5)	Lights to indicate NBC power switch is in the ON position and NBC system is activated.
7	DRIVING LIGHT CONTROL SWITCHES	Activate the driving lights.
8	FUEL GAGE CONTROL SWITCH	Activates the upper and lower fuel tank transmitters for FUEL gage readings.
9	BILGE PUMP CONTROL SWITCH	Activates the bilge pump.
10	STARTER CONTROL SWITCH	Activates the starter motor.
11	SPEEDOMETER	Indicates vehicle speed.
12	AUXILIARY OUTLET	Provides 24v power from electrical system to operate auxiliary electrical equipment.
13	TACHOMETER	Indicates engine rpm.
14	PANEL LIGHT	Lights instrument panel. Panel lights can be activated when driving control switch is in the "OFF" position.

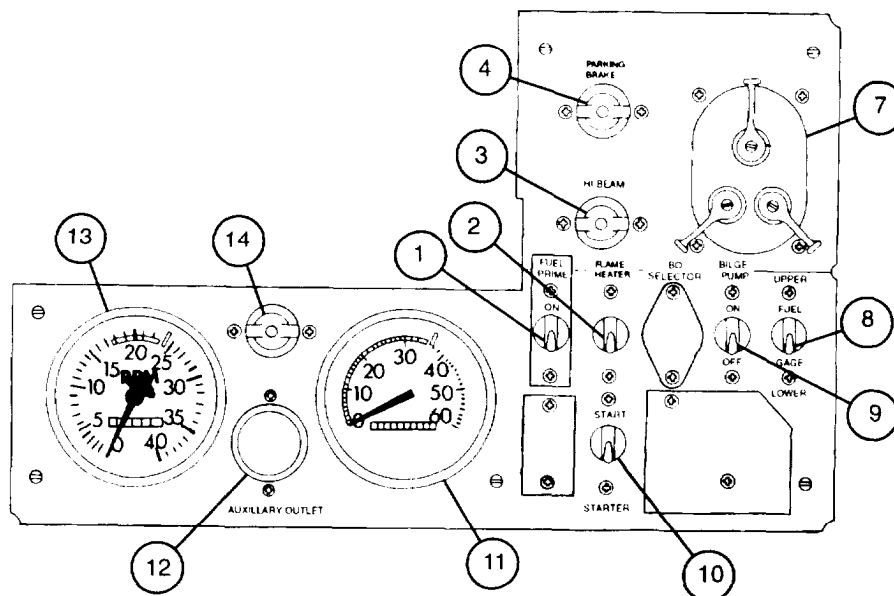
2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS - CONTINUED

2-1.3 Driver's Fixed Instrument Panels - Continued

a. Driver's Fixed Instrument Panels for Engine Model 7083-7396 - Continued



M109A4/M109A5 HOWITZERS



M109A2/M109A3 HOWITZERS

**2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS - CONTINUED**

**2-1.3 Driver's Fixed Instrument Panels - Continued**

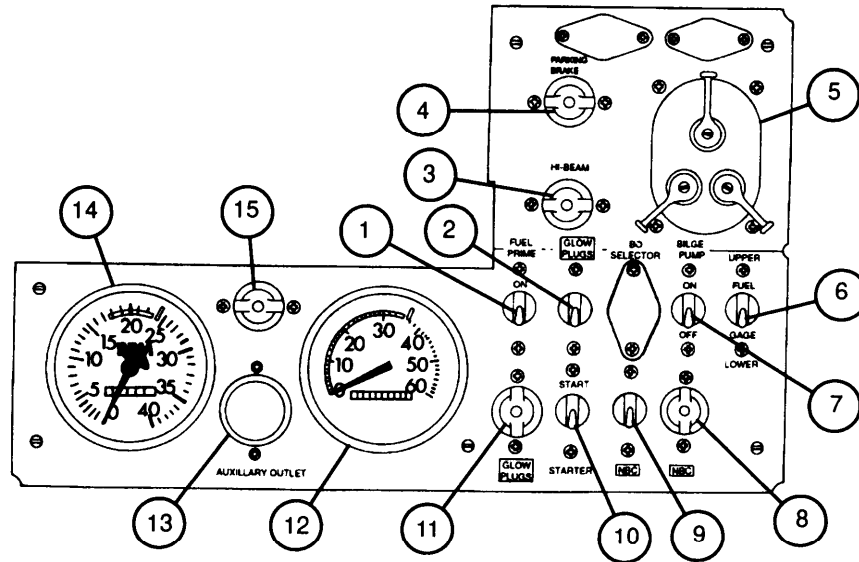
b. Driver's Fixed Instrument Panels for LHR Engine Model 7083-7391

1	FUEL PRIME CONTROL SWITCH	Activates the fuel prime pump.
2	GLOW PLUGS SWITCH	Lights GLOW PLUGS indicator light and controls the glow plug controller.
3	HI-BEAM INDICATOR LIGHT	Lights when headlights are on high.
4	PARKING BRAKE INDICATOR LIGHT	Lights to indicate brake is on or not fully released.
5	DRIVING LIGHT CONTROL SWITCHES	Activates the driving lights.
6	FUEL GAGE CONTROL SWITCH	Activates the upper and lower fuel tank transmitters for FUEL gage readings.
7	BILGE PUMP CONTROL SWITCH	Activates the bilge pump.
8	NBC INDICATOR LIGHT (M109A4/M109A5)	Lights when NBC power switch is in the ON position to indicate NBC system is activated.
9	NBC POWER SWITCH (M109A4/M109A5)	Powers the NBC system.
10	STARTER CONTROL SWITCH	Activates the starter motor.
11	GLOW PLUGS INDICATOR LIGHT	Lights to indicate GLOW PLUGS switch is in ON position and glow plugs system is activated.
12	SPEEDOMETER	Indicates vehicle speed.
13	AUXILIARY OUTLET	Provides 24v power from electrical system to operate auxiliary electrical equipment.
14	TACHOMETER	Indicates engine rpm.
15	PANEL LIGHT	Lights instrument panel. Panel lights can be activated when driving control switch is in the "OFF" position.

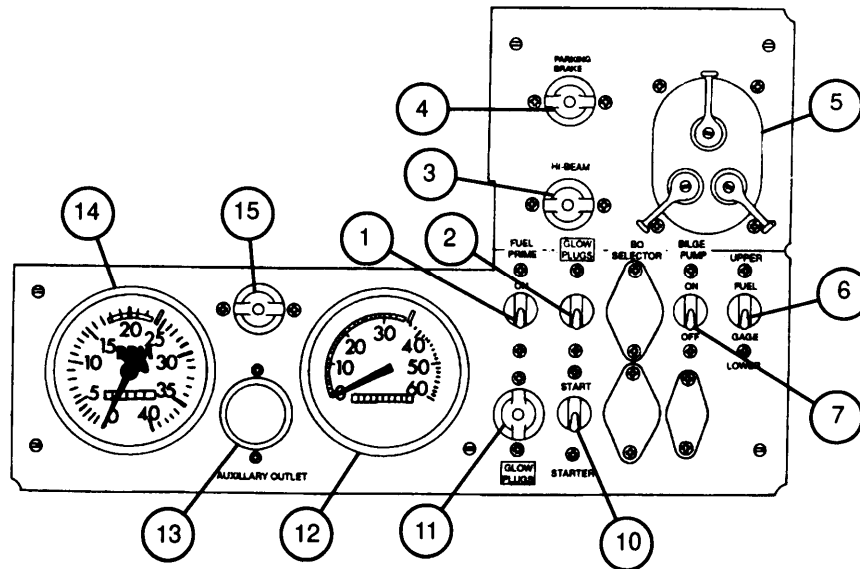
2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

2-1.3 Driver's Fixed Instrument Panels — Continued

b. Driver's Fixed Instrument Panels for LHR Engine Model 7083-7391 — Continued



M109A4/M109A5 HOWITZERS



M109A2/M109A3 HOWITZERS

## 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

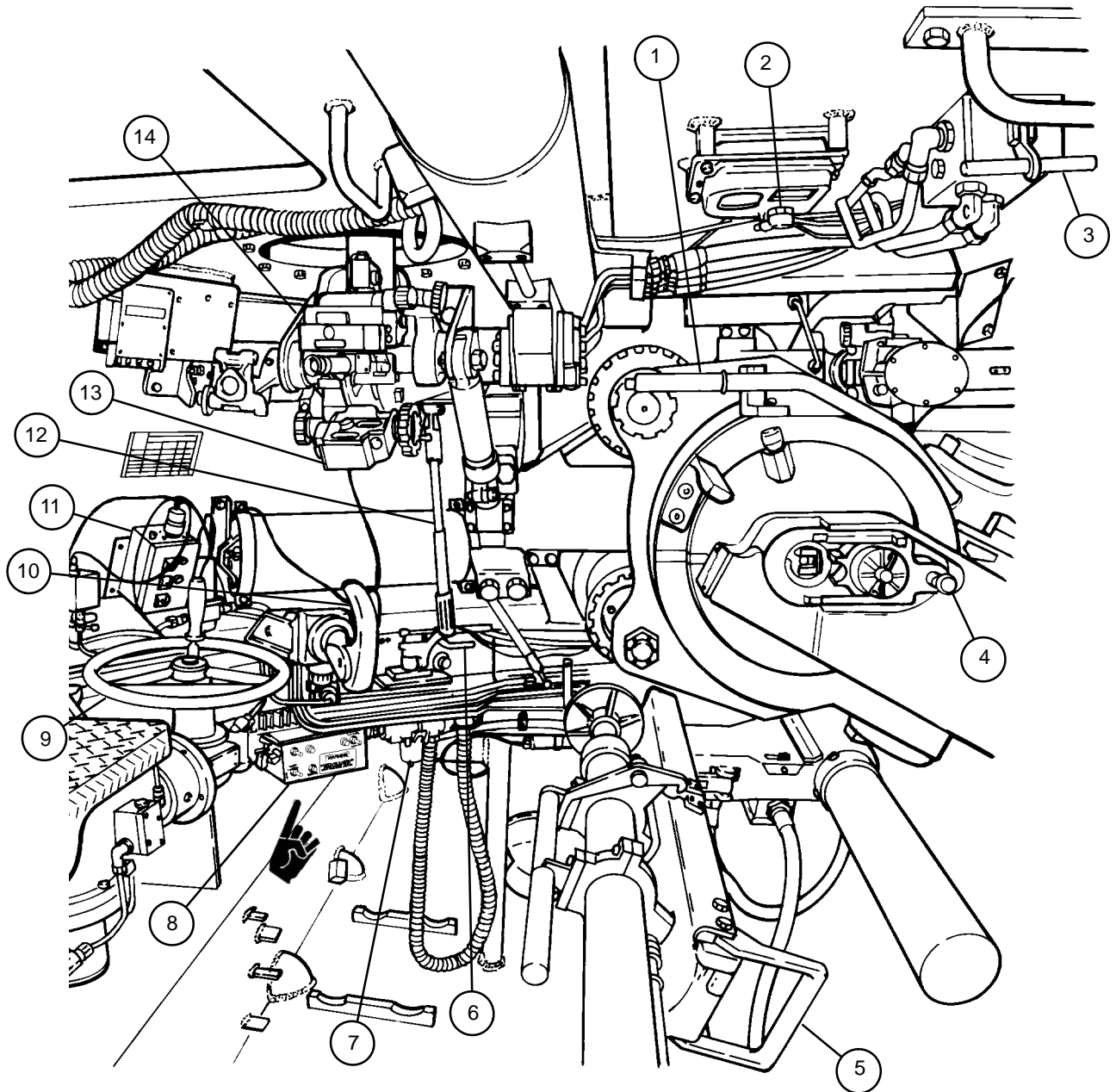
### 2-1.4 Crew Controls and Instruments

- |  |  |
|--|--|
| 1 OPERATING HANDLE (BREECH MECHANISM)      | Allows breech to be opened manually.   |
| 2 DOME LIGHT SWITCH                        | Turns dome light assembly on or off.   |
| 3 RAMMER ACTUATING VALVE CONTROL HANDLE    | Activates rammer actuating valve to operate rammer assembly.   |
| 4 FIRING MECHANISM MANUAL CONTROL LEVER    | Movement drives firing hammer into firing pin causing primer to ignite.  |
| 5 RAMMER HANDLE                            | Used to move rammer in and out of ramming position.  |
| 6 TURRET LOCK                              | Locks cab position to prevent cab traversing.  |
| 7 M3 ELECTRICAL AIR HEATER (M109A4/M109A5) | Four M3 electrical air heaters provide heated air to the gunner, cannoneer no. 1, section chief, and the assistant gunner while operating in an NBC environment.   |
| 8 ACCESSORY CONTROL BOX                    | Allows gunner to control cab ventilation and heating.  |
| 9 MANUAL TRAVERSE HANDWHEEL                | Permits manual traversing of cab.  |
| 10 GUNNER'S CONTROL ASSEMBLY HANDLE        | Allows gunner to elevate, depress, and traverse cannon assembly.   |
| 11 GUNNER'S SELECTOR SWITCH BOX ASSEMBLY   | Controls the electrical power to the cab with the CAB POWER switch, permits the selection of either power or manual traversing mode with the TRAVERSE CONTROL switch, and controls whether the gunner's or assistant gunner's control assembly will be permitted to elevate or depress the weapon with the ELEVATION CONTROL switch. |
| 12 EQUILIBRATION HANDPUMP ASSEMBLY         | Used to manually increase or decrease hydraulic fluid pressure.  |
| 13 M145/M145A1 TELESCOPE MOUNT             | Provides an adjustable base and support for the M117/M117A2 panoramic telescope.   |
| 14 M117/M117A2 PANORAMIC TELESCOPE         | Indirect fire instrument used in laying the weapon in azimuth.   |



## 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

### 2-1.4 Crew Controls and Instruments — Continued



LEFT FRONT CAB INTERIOR

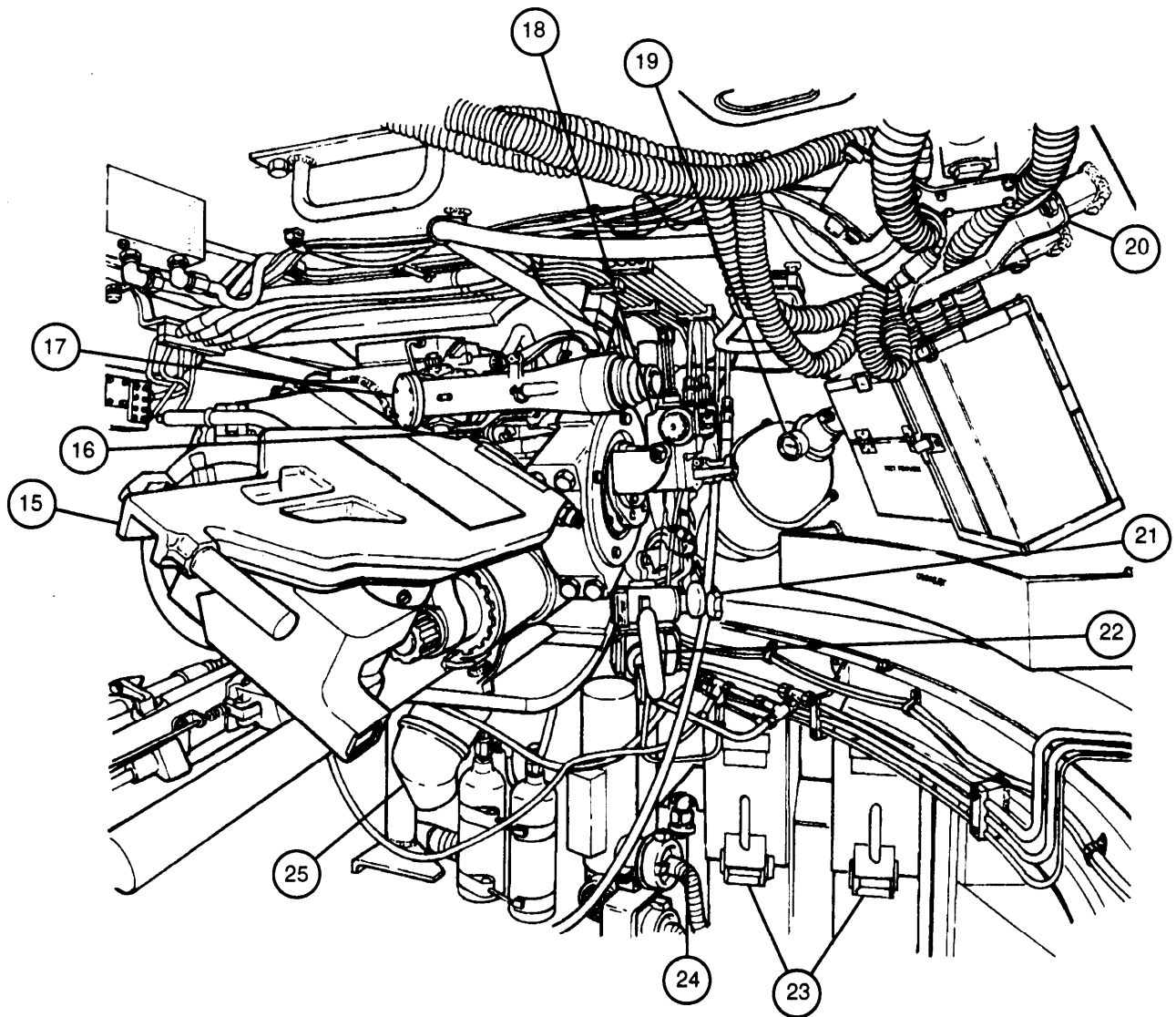
## 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

### 2-1.4 Crew Controls and Instruments — Continued

15	CAM ASSEMBLY	Holds breech in open position.
16	M146 TELESCOPE MOUNT	Provides an adjustable support for the M118A2/M118A3 elbow telescope.
17	M118A2/M118A3 ELBOW TELESCOPE	Direct fire instrument used for positioning the weapon in azimuth and elevation on targets visible from the weapon.
18	M15 ELEVATION QUADRANT	Provides the means for laying the weapon in elevation for indirect firing.
19	REPLENISHER ACCUMULATOR ASSEMBLY PRESSURE GAGE	Indicates hydraulic pressure.
20	COLLIMATOR STORAGE CONTAINER	Stores M1A1 collimator which is used for laying of the weapon.
21	HAND PUMP CRANK	Allows assistant gunner to manually elevate the cannon tube.
22	ASSISTANT GUNNER'S CONTROL ASSEMBLY HANDLE	Allows assistant gunner to elevate and depress the cannon tube.
23	AIR CLEANER LATCH	Opens door allowing access to filters.
24	AIR CLEANER INDICATOR	Alerts crew of air flow restriction in air cleaner.
25	PERSONNEL AIR VENTILATION BLOWER	Provides ventilation to crew compartment,

2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS - CONTINUED

2-1.4 Crew Controls and Instruments — Continued



RIGHT FRONT CAB INTERIOR

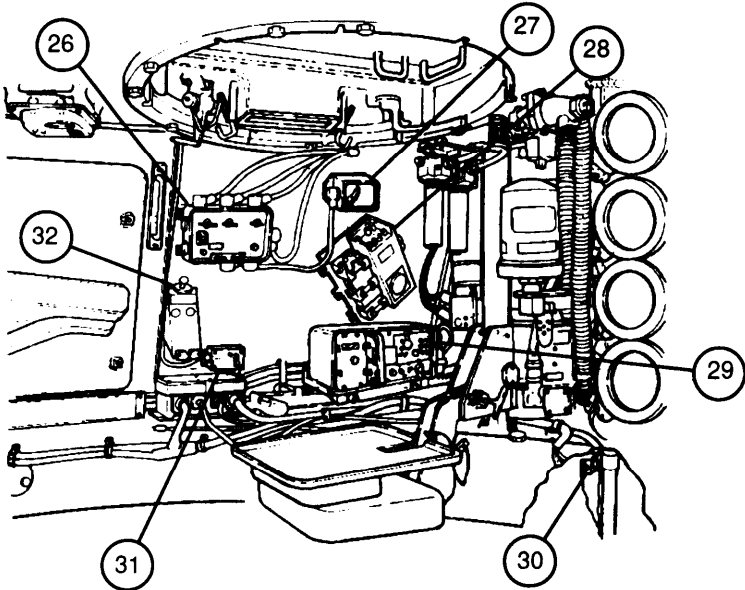
## 2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

### 2-1.4 Crew Controls and Instruments — Continued

- |    |  |  |
|----|--|--|
| 26 | AMPLIFIER AM-1780/VRC                                | Provides power and voice switching circuitry for vehicular inter-communications systems.   |
| 27 | COMMANDER'S CONTROL BOX C-2298/VRC                   | Provides operator attachment to vehicular system.  |
| 28 | AN/PRC-68 RADIO AND APPLIQUE OG-174                  | Provide two-way radio communication. Refer to TM 11-5820-882-10 for operation of AN/PRC-68 radio.  |
| 29 | CONTROL CASE C-10327/GYK-29                          | Refer to TM 11-7440-283-12-1 and TM 11-7440-283-12-2 for operation of the AN/GYK-29 battery computer system.                                     |
| 30 | COMBAT OVERRIDE SWITCH (M109A4/M109A5)               | Used to aid in starting the engine in emergency situations.  |
| 31 | NBC CONTROL BOX ASSEMBLY (M109A4/M109A5)             | Provides operational control of vehicular NBC equipment.   |
| 32 | DATA DISPLAY, GUN DIRECTION, OD-144(V)/GYK-29        | Refer to TM 11-7440-283-12-1 and TM 11-7440-283-12-2 for operation of the AN/GYK-29 battery computer system.                                     |
| 33 | DATA DISPLAY, DEFLECTION/ELEVATION (ID--2124/GYK-29) | Located on right front cab roof.<br>Refer to TM 11-7440-283-12-1 and TM 11-7440-283-12-2 for operation of the AN/GYK-29 battery computer system. |
| 34 | DATA DISPLAY, DEFLECTION/ELEVATION (ID-2124/GYK-29)  | Located on left front cab roof.<br>Refer to TM 11-7440-283-12-1 and TM 11-7440-283-12-2 for operation of the AN/GYK-29 battery computer system.  |

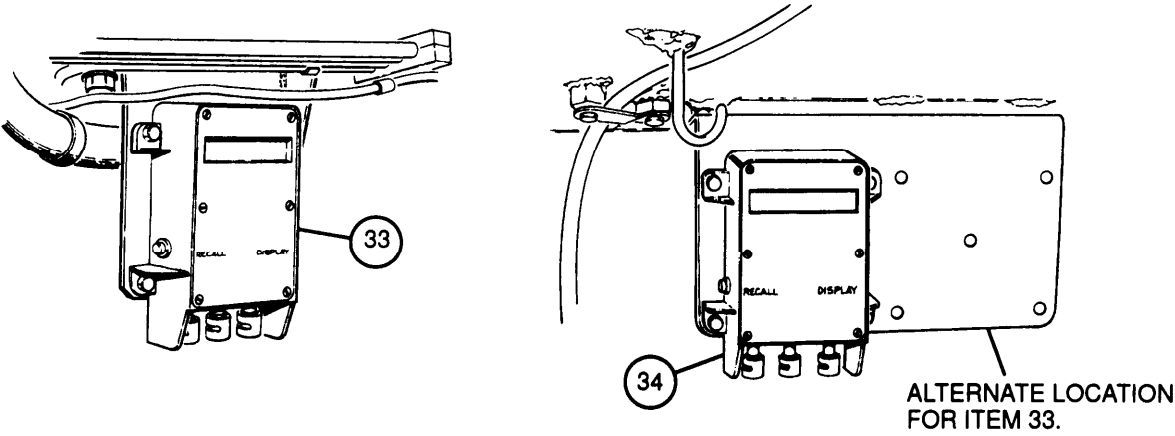
2-1 OPERATOR'S CONTROLS, INDICATORS, AND INSTRUMENTS — CONTINUED

2-1.4 Crew Controls and Instruments — Continued



NOTE

All components illustrated above are mounted on inside right rear cab wall.



## Section II. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

### 2-2 GENERAL

Preventive maintenance is the step-by-step caring, inspecting, and servicing of equipment to maintain it in good condition and to locate problems before extensive and time-consuming repairs or replacements are needed. Refer to DA PAM 738-750 for instructions on use of forms for preventive maintenance services.

<b>WARNING</b>
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Unusable CARC mixtures may be considered hazardous waste and may require disposal in accordance with federal, state, DOD, and DA hazardous waste regulations. Consult the installation environmental office for proper disposal guidance. Mixed CARC has a flashpoint of approximately 38° F (3° C) due to the incorporation of solvents and is highly flammable.

- a. Monthly touchup/spot painting. Painting at the operator level is limited to touchup/spot painting. CARC paint that has been opened must be used within 8 hours or it will deteriorate beyond use. Mix only what is needed for immediate use. Refer to TM 43-0139.
- b. Before you operate. Always keep in mind the WARNINGS, CAUTIONS and NOTES. Perform your before PMCS prior to the equipment leaving its containment area or performing its intended mission.
- c. While you operate. Always keep in mind the WARNINGS, CAUTIONS and NOTES. Perform your during PMCS when the equipment is being used in its intended mission.
- d. After you operate. Always keep in mind the WARNINGS, CAUTIONS, and NOTES. Perform your after PMCS when the equipment has been taken out of its mission mode or returned to its containment area.
- e. Weekly. Always keep in mind the WARNINGS, CAUTIONS, and NOTES. Perform your weekly PMCS once a week or if you are operating the item for the first time.
- f. Monthly. Always keep in mind the WARNINGS, CAUTIONS, and NOTES. Perform your monthly PMCS once a month.
- g. If your equipment fails to operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA PAM 738-750.

### 2-3 PMCS PROCEDURES

- a. The "Item No." column provides the number to be used by the mechanic when recording all faults found and actions taken on DA Form 2404, Equipment Inspection and Maintenance Worksheet. The item number on the DA Form 2404 must correspond to the item number of the preventive maintenance check.
- b. The "Interval" column provides the interval at which preventive maintenance checks and services are to be performed by crew. This is scheduled on DD Form 314 in accordance with DA PAM 738-750.

**2-3 PMCS PROCEDURES - CONTINUED****CAUTION**

- Do not direct a high pressure water hose or steam cleaner against the opening between the hull and doors or hatches or against exhaust grilles, mufflers, fuel cells, or other electrical components. Use of a high pressure water hose is only authorized on suspension components. Failure to heed this caution may result in damage to equipment.
  - After operation in water, mud, and loose sand, the vehicle should be cleaned and lubricated as soon as possible, without waiting for the next scheduled service.
- c. The "Item to Check/Service" column identifies specific items to be checked or serviced.
- d. The "Procedure" column tells how to do the required checks and services and which crewmember is responsible for the task. Carefully follow these instructions.
- e. The "Not Fully Mission Capable If" column explains when and why the equipment cannot be used.

**2-4 GENERAL CHECKS**

While performing PMCS, have tools available and check for the following:

- a. Loose bolts. A loose bolt can be difficult to spot without using a wrench. However, you can often identify loose bolts by observing loose or chipped paint around bolt head and bare metal or rust at its base. Tighten loose bolts and spot paint as required.
- b. Damaged welds. Damaged welds may be detected by observing rust or chipped paint where cracks occur.
- c. Frayed electrical wires and loose connectors. Check electrical wiring for cracks due to aging and exposed wires that could cause an electrical short. Tighten loose clamps and connectors.
- d. Frayed brake cables and loose linkages. Check brake cables for signs of excessive wear near middle of cable. Ensure throttle and steering linkages are properly secured.
- e. Corrosion. Check for signs of deterioration, rust, unusual cracking, softening, swelling, or breaking.

**2-5 LEAKAGE DEFINITIONS****CAUTION**

- Equipment operation is allowable with minor leakages (Class I or II). Of course, you must consider the fluid capacity in the item/system being checked/inspected. When in doubt, notify your supervisor. When operating with Class I or Class II leaks, continue to check fluid levels as required in your PMCS.
- Class III leaks should be reported to your supervisor or unit maintenance.

Leakage definitions for operator/crew PMCS shall be classified as follows:

- a. Class I. See page of fluid (as indicated by wetness or discoloration) not great enough to form drops.

**2-5 LEAKAGE DEFINITIONS - CONTINUED**

- b. Class II. Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.
- c. Class III. Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

**NOTE**

M182 only: Leakage of 1 ml (approximately 25 drops) is permissible at the seal interface to the variable recoil rods after five (5) rounds or 24 hours after firing.

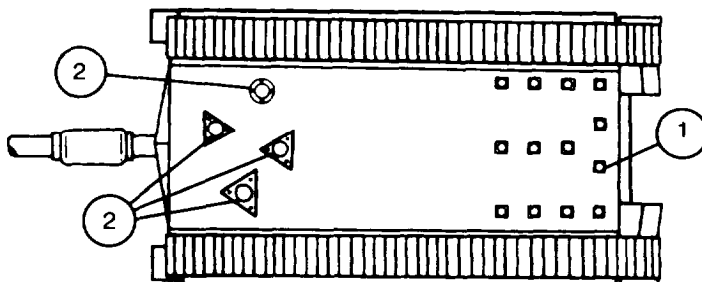
**2-6 DAMAGE DEFINITIONS**

Damage definitions are as follows:

- a. Blowby. Powder markings beyond a sealing surface.
- b. Burrs. A raised portion, restricting the entrance of a part, component, or assembly.
- c. Cracks. A narrow break or separation in material.
- d. Gouges. A groove or cavity in a sealing surface that cannot be repaired.
- e. Nicks. An indentation caused by object(s) striking the material.

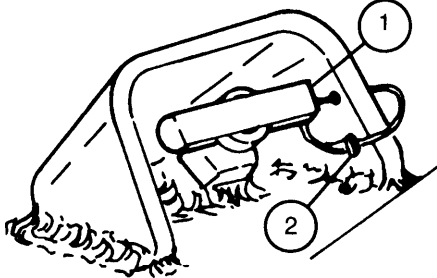
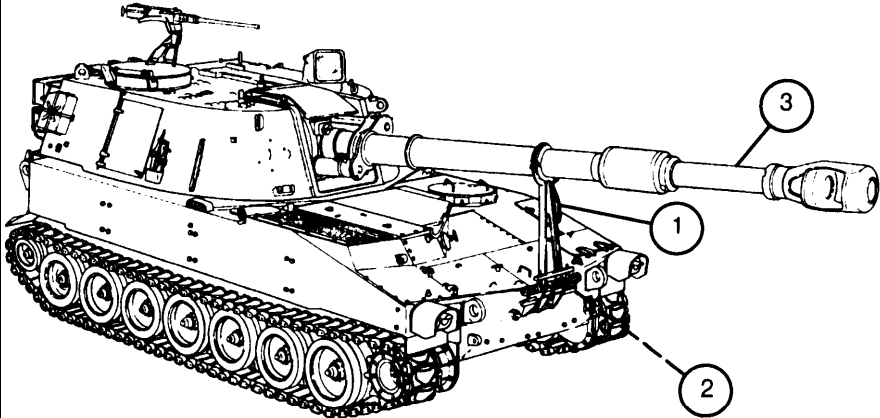
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
1	Before	Vehicle	<u>DRIVER</u> Walk around vehicle. Check for any obvious fluid leakage, missing items, or damage to equipment.	Any Class III oil, fuel, or coolant leak found.
2	Before	Subfloor Drain Plugs and Access Cover Plates	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px auto; width: fit-content;"> <b>CAUTION</b> </div> <p>Do not ford if any drain plugs are missing to prevent water damage to equipment.</p> <p>Check all drain plugs (1) and cover plates (2) for installation.</p>	Any drain plug (1) or cover plate (2) is missing.

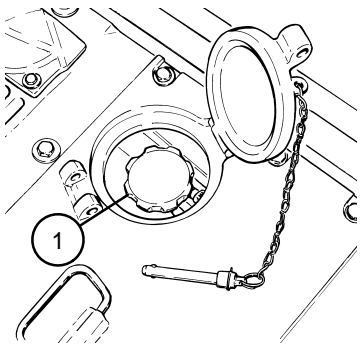
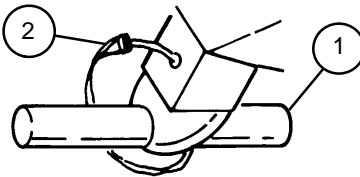




**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable if:
3	Before	External Fire Extinguisher	<p><u>DRIVER</u></p> <p>Check to ensure fire extinguisher handle (1) is properly seated and laced.</p> 	Wire seal (2) is broken, missing, or fire extinguisher handle (1) is pulled.
4	Before	Travel Lock Assembly	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"><b>WARNING</b></div> <p>Travel lock assembly is heavy. Use care when unlocking and close cap assembly before lowering travel lock assembly.</p> <p>Check to ensure travel lock assembly (1) is locked and lock pin (2) is secure.</p> 	Travel lock assembly (1) will not secure cannon tube (3) in place.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
5	Before	Radiator	<p><u>DRIVER</u></p> <p>Check coolant level in radiator. Add coolant as needed.</p> 	Any coolant leak exists or radiator cap (1) is missing.
6	Before	Driver's Compartment Fire Extinguisher Handle	<p><u>DRIVER</u></p> <p>Check to ensure fire extinguisher handle (1) is properly seated and laced with wire seal (2).</p> 	Wire seal (2) is broken, missing, or fire extinguisher handle (1) is pulled.
7	Before	Neutral Safety Switch	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>To prevent injury, make sure all personnel are a safe distance from vehicle.</p> <p>Make sure parking brake is engaged. Pull fuel shutoff control assembly out. Place vehicle in first gear. Attempt to start engine.</p>	Engine cranks. Notify unit maintenance.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

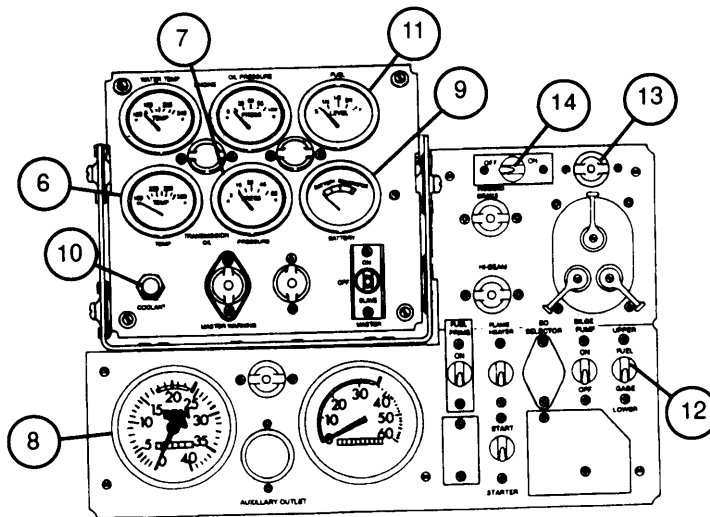
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
8	Before	Engine	<u>DRIVER</u>  <p style="text-align: center;"><b>NOTE</b></p> <p>The number of minutes required to warm up engine will vary depending on the climate. Start engine. Follow warm-up procedures.</p>	Engine will not start.
9			DELETED	
10			DELETED	

All data on pages 2-22 through 2-24 including illustrations, deleted.



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
9	Before	Driver's Fixed And Portable Instrument Panels (Engine Model 7083-7396) (Cont)	<p><b>DRIVER</b></p> <ul style="list-style-type: none"> <li>e. TRANSMISSION OIL TEMP gage (6) reads 220 to 240° F minimum, 300° F maximum.</li> <li>f. TRANSMISSION OIL PRESSURE gage (7) reads 10 psi to 45 psi (69 to 310 kPa) at fast idle.</li> <li>g. Tachometer (8) operates without unusual fluctuation or noise.</li> <li>h. BATTERY gage (9) is in green (charging) range.</li> <li>i. Press to test COOLANT indicator light (10) for proper operation.</li> </ul> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>Never run completely out of fuel. Injectors require full return flow for cooling.</p> <ul style="list-style-type: none"> <li>j. FUEL gage (11) indicates fuel quantity available in each fuel tank. Use FUEL GAGE control switch (12) to select fuel tank.</li> <li>k. NBC indicator light (13) lights when NBC power switch (14) (M109A4/M109A5) is turned to ON position.</li> </ul>	<p>TRANSMISSION OIL TEMP gage (6) does not read within limits.</p> <p>TRANSMISSION OIL PRESSURE gage (7) does not read within limits.</p> <p>BATTERY gage (9) is inoperative or does not read within limits.</p>

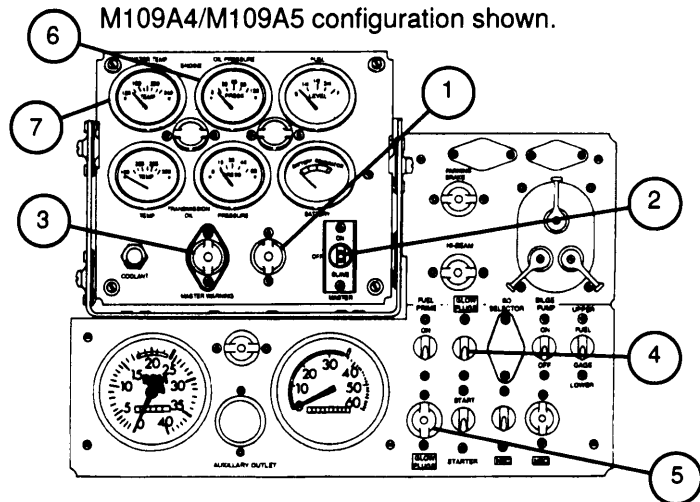


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

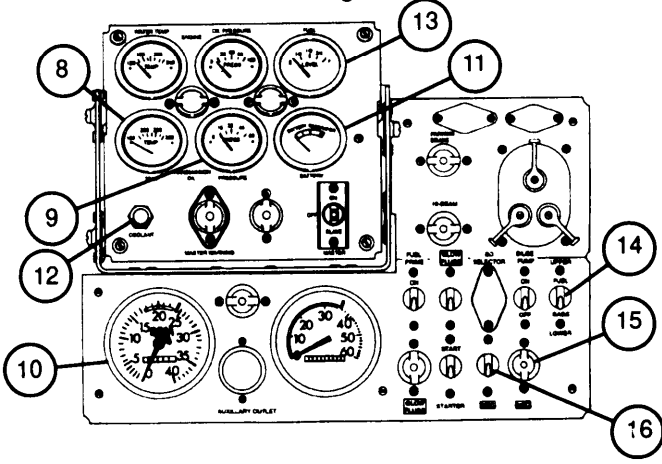
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
10	Before	Driver's Fixed And Portable Instrument Panels (LHR Engine Model 7083-7391)	<p><u>DRIVER</u></p> <p>Check the following:</p> <ol style="list-style-type: none"> <li>MASTER switch indicator light (1) is lit when MASTER switch (2) is in ON position.</li> <li>MASTER WARNING indicator light (3) isn't lit 15 seconds after engine starts.</li> <li>At temperatures above 50°F (10° C) the GLOW PLUGS indicator light (4) flashes light for one second when GLOW PLUGS switch (5) is turned to ON position. At temperatures below 50° F (10° C) the GLOW PLUGS indicator light (4) is lit for 35 seconds and flashes light for one minute when GLOW PLUGS switch (5) is turned to ON position.</li> </ol> <p style="text-align: center;"><b>NOTE</b></p> <p>Depending on climatic conditions, it may take several minutes to obtain these readings.</p> <ol style="list-style-type: none"> <li>ENGINE OIL PRESSURE gage (6) reads 30 to 70 psi (207 to 483 kPa) at fast idle.</li> <li>ENGINE WATER TEMP gage (7) reads 170° F minimum, 230° F maximum.</li> </ol>	<p>Operation is to occur in temperature below 40° F (5° C) and if GLOW PLUGS indicator light (4) remains lit.</p> <p>ENGINE WATER TEMP gage (7) or ENGINE OIL PRESSURE gage (6) is inoperative or does not read within limits.</p>

**NOTE**

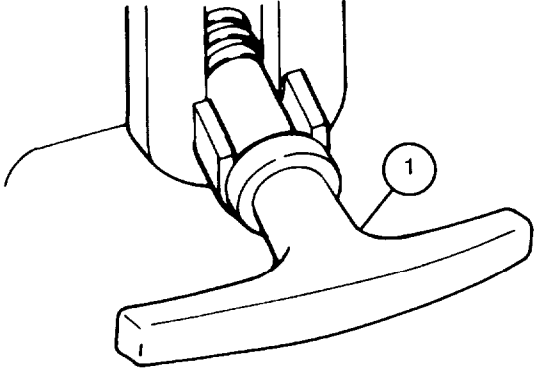
M109A4/M109A5 configuration shown.



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

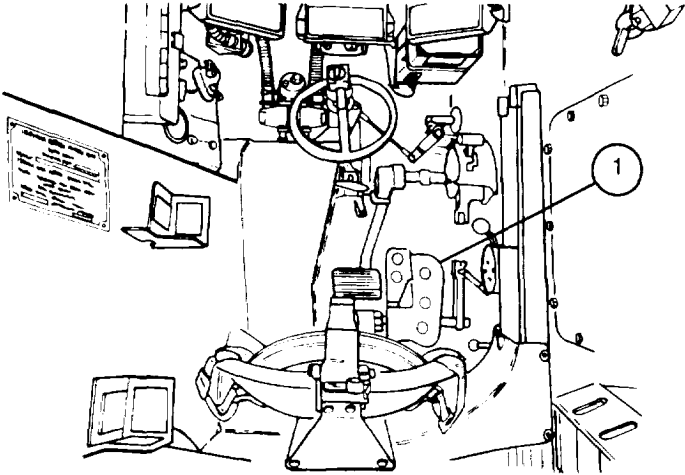
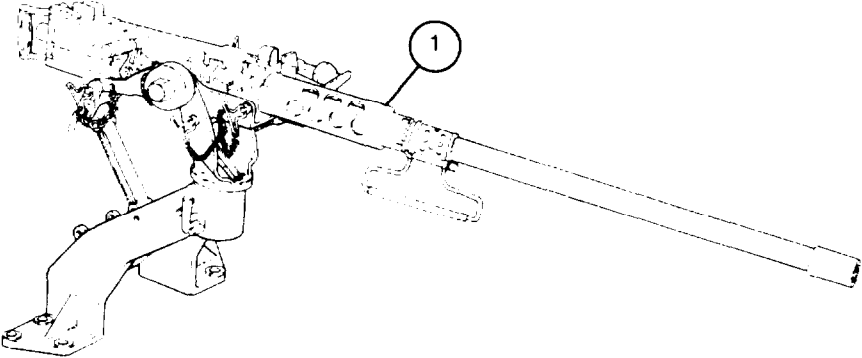
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
10	Before	Driver's Fixed And Portable Instrument Panels (LHR Engine Model 7083-7391) (Cont)	<p><b>DRIVER</b></p> <p>f. TRANSMISSION OIL TEMP gage (8) reads 220 to 240° F minimum, 300° F maximum.</p> <p>g. TRANSMISSION OIL PRESSURE gage (9) reads 10 psi to 45 psi (69 to 310 kPa) at fast idle.</p> <p>h. Tachometer (10) operates without unusual fluctuation or noise.</p> <p>i. BATTERY gage (11) is in green (charging) range.</p> <p>j. Press to test COOLANT indicator light (12) for proper operation.</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>Never run completely out of fuel. Injectors require full return flow for cooling.</p> <p>k. FUEL gage (13) indicates fuel quantity available in each fuel tank. Use FUEL GAGE control switch (14) to select fuel tank.</p> <p>l. NBC indicator light (15) lights when NBC power switch (16) (M109A4/M109A5) is turned to ON position.</p> <p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;">M109A4/M109A5 configuration shown.</p> 	<p>TRANSMISSION OIL TEMP gage (8) does not read within limits.</p> <p>TRANSMISSION OIL PRESSURE gage (9) does not read within limits.</p> <p>BATTERY gage (11) is inoperative or does not read within limits.</p>

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

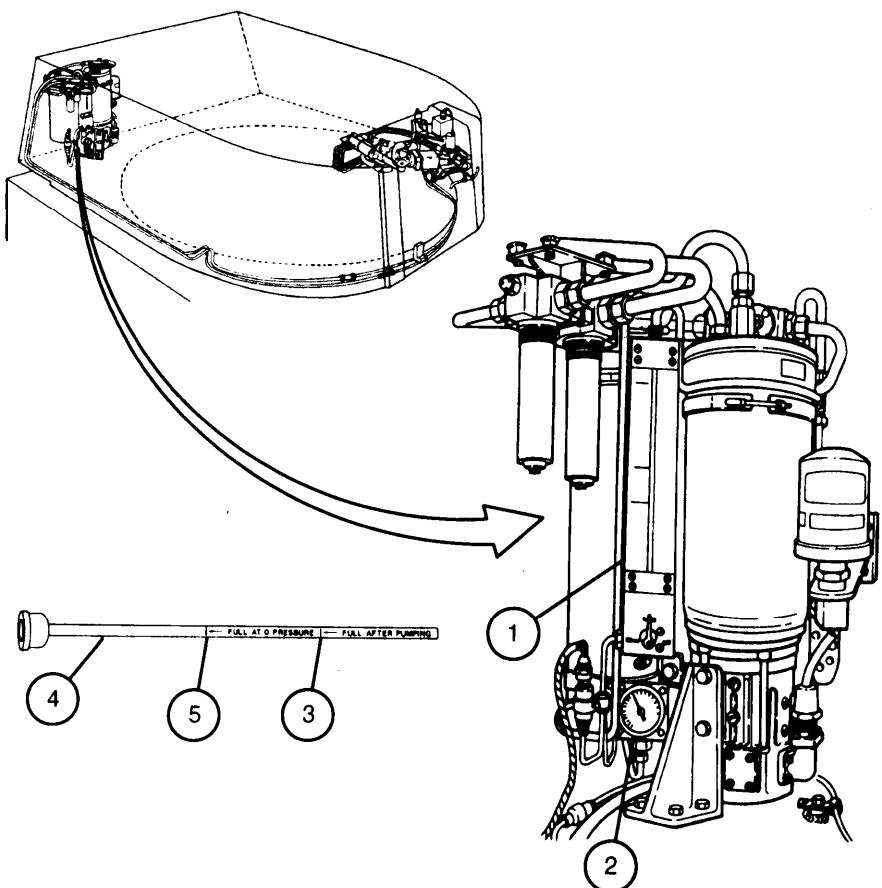
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember Procedure</u>	Not Fully Mission Capable If:
11	Before	Brakes	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>To prevent injury, make sure all personnel are a safe distance from vehicle.</p> <p>Move vehicle about 2 feet (0.61 m) and check brakes for proper operation.</p>	Brakes bind or do not stop vehicle. Brake pedal sticks.
12	Before	Parking Brakes	<p><u>DRIVER</u></p> <p>Check for proper operation of parking brake using manual control handle (1).</p> <div style="text-align: center; margin-top: 20px;">  </div>	Defective, inoperable, or out of adjustment braking exists. Parking brake does not hold.
13	Before	Steering Wheel	<p><u>DRIVER</u></p> <p>Turn steering wheel from left to right to check for binding or looseness.</p>	Any binding or looseness is evident.



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

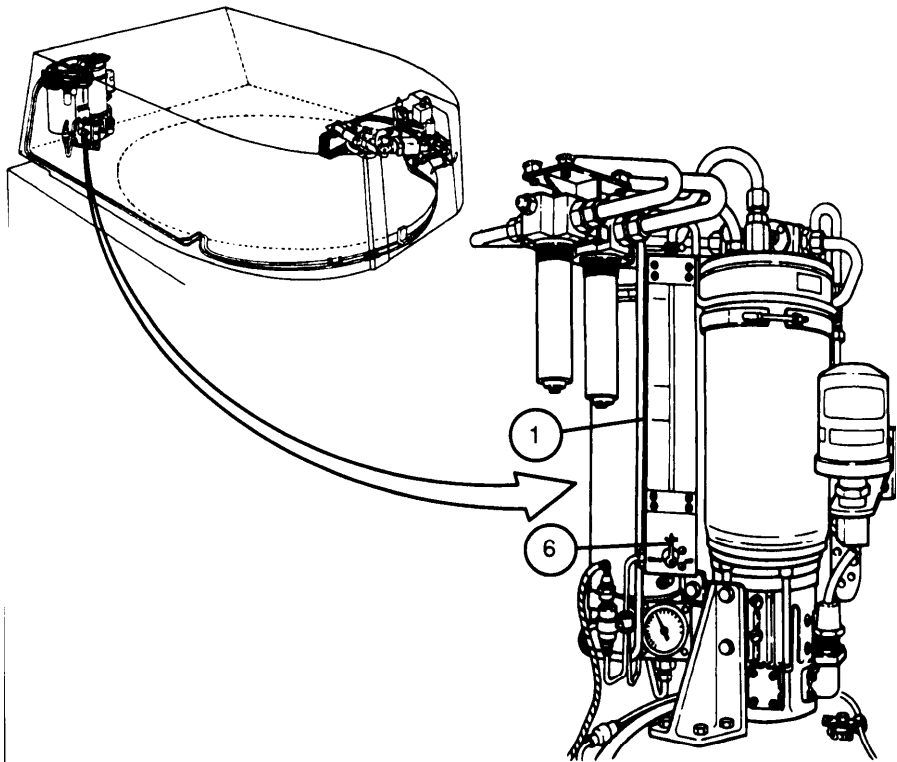
Item No.	Interval	Location Item to Check/ Service	<u>Crew-member</u> Procedure	Not Fully Mission Capable If:
13.1	Before	Accelerator Pedal	<p><u>DRIVER</u></p> <p>Check for missing or unserviceable accelerator pedal return spring by depressing accelerator pedal (1) and releasing.</p> 	<p>If accelerator pedal does not return to idle position after being depressed.</p>
14	Before	M2 Caliber .50 Machine Gun	<p><u>CHIEF OF SECTION</u></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>Removing machine gun mount support quick-release pins can cause violent closure of the machine gun mount support, which may injure personnel.</p> <p>Mount M2 machine gun (1) and perform function checks.</p> 	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
15	Before	Hydraulic Power Pack Reservoir	<p><u>CHIEF OF SECTION</u></p> <p>Before firing, check fluid level in sight gage (1). If pressure gage (2) reads between 925 and 1225 psi (6378 and 8446 kPa), the system is fully charged and fluid level should be at the FULL AFTER PUMPING mark (3) on power pack gage (4). Add hydraulic fluid (item 20, Appx D) to power pack reservoir, if needed, and check fluid level again on power pack gage. Hydraulic fluid should be up to FULL AT 0 PRESSURE mark (5). If power pack reservoir is over full, drain hydraulic fluid to proper level according to the following instructions:</p> 	

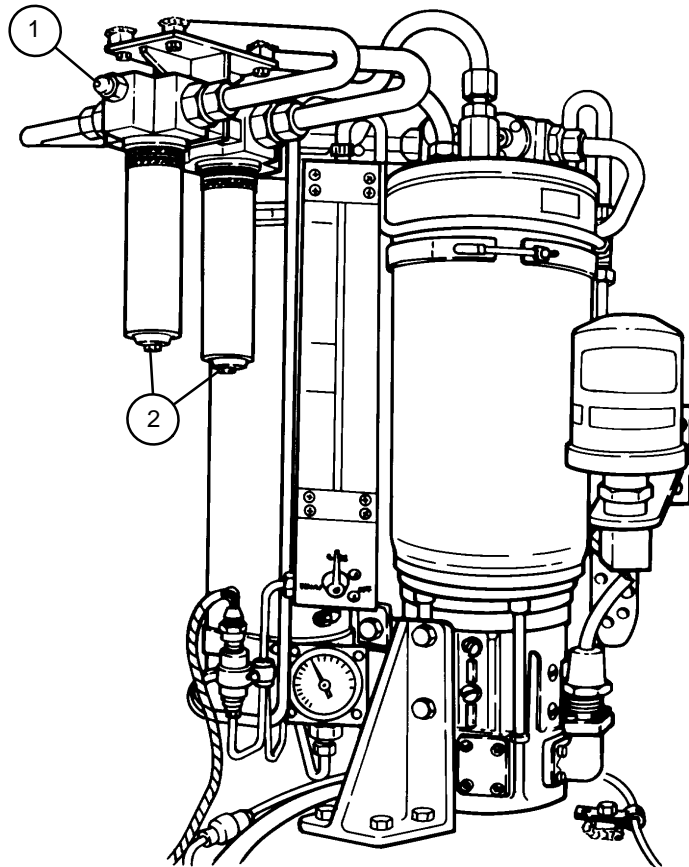
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
15	Before	Hydraulic Power Pack Reservoir (Cont)	<p><u>CHIEF OF SECTION</u></p> <ol style="list-style-type: none"> <li>a. Place utility pail under sight gage (1) drain.</li> <li>b. Turn pointer handle (6) at bottom of sight gage (1) to OFF position.</li> <li>c. Remove plug from elbow at bottom of sight gage (1).</li> <li>d. Turn pointer handle (6) at bottom of sight gage (1) to DRAIN position and drain hydraulic fluid.</li> <li>e. When oil level is correct turn pointer handle (6) to OFF position.</li> <li>f. Replace plug on elbow.</li> <li>g. Turn pointer handle (6) to GAGE position.</li> </ol> <p style="text-align: center;"><b>NOTE</b></p> <p>Dispose of hydraulic fluid in accordance with local regulations.</p> <ol style="list-style-type: none"> <li>h. Discard drained hydraulic fluid. Do not reuse.</li> </ol>	

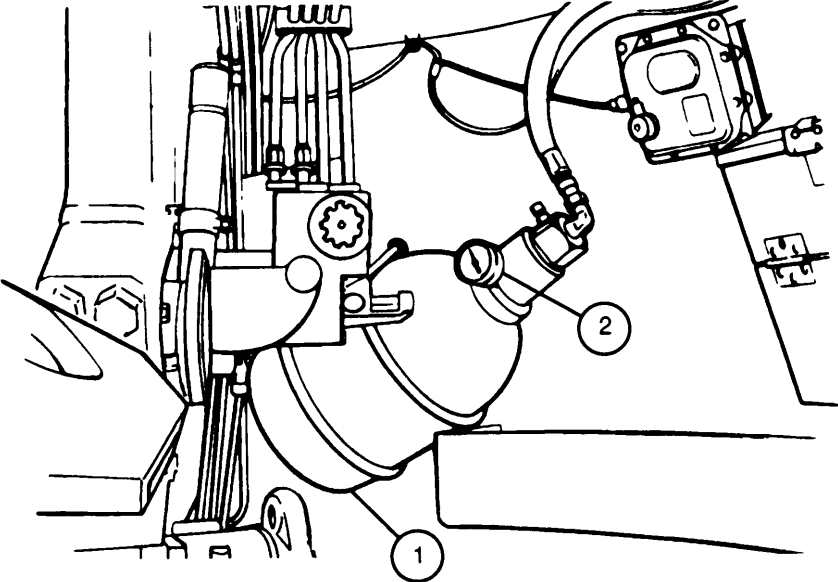


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
16	Before	Hydraulic Filter Assemblies (M109A4/M109A5)	<p><u>CHIEF OF SECTION</u></p> <p>Before firing, check bypass indicator (1) on hydraulic filter assembly (2). Filters are clean and functioning if red button is flush with bypass indicator. If red button is protruding from bypass indicator, hydraulic filter assemblies are dirty and hydraulic fluid is bypassing them.</p>	Hydraulic fluid is bypassing the hydraulic filter assemblies (2).

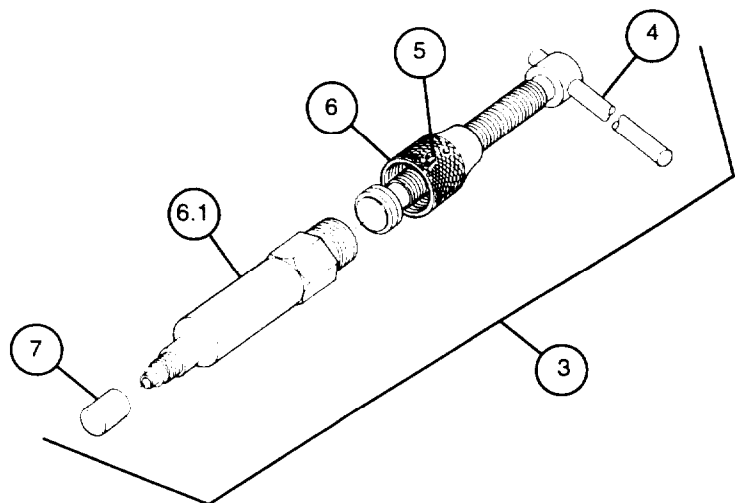


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Internal	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
17	Before	Replenisher accumulator Assembly Pressure	<p><u>CHIEF OF SECTION</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>To prevent damage to equipment, make sure M3 oil gun is loaded with hydraulic fluid (item 20, Appx D) and not lubricating oil.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Replenisher accumulator assembly (1) pressure gage (2) reading (before firing) should be 17 to 24 psi (117 to 165 kPa). Pressure may increase during normal firing due to heat expansion. Safe-to-fire range is 17 to 50 psi (117 to 344 kPa).</p> <p>During firing, be sure that replenisher accumulator assembly (1) pressure gage (2) shows a pressure of 17 to 50 psi (117 to 344 kPa). If pressure is lower or higher, add or bleed hydraulic fluid from replenisher accumulator assembly. When replenisher accumulator assembly pressure gage reading is low, add hydraulic fluid (item 20, Appx D) to the replenisher accumulator assembly as follows:</p> <ol style="list-style-type: none"> <li>a. Place cannon assembly at zero elevation.</li> </ol> <div style="text-align: center; margin-top: 20px;">  </div>	

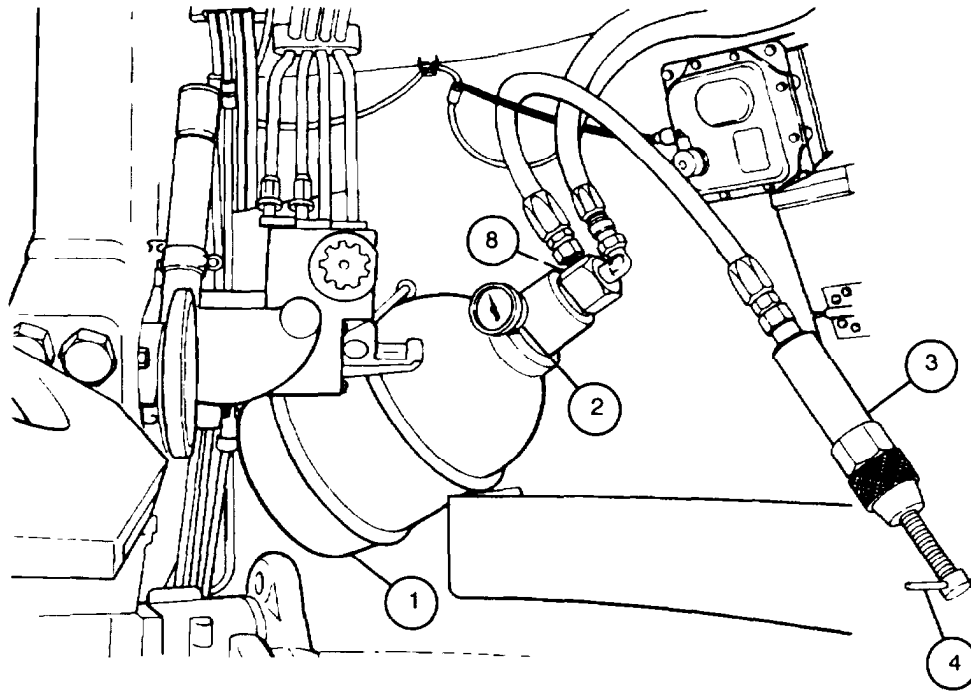
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
17	Before	Replenisher Accumulator Assembly Pressure (Cont)	<p><u>CHIEF OF SECTION</u></p> <p>b. Fill M3 oil gun (3) as follows:</p> <ol style="list-style-type: none"> <li>1. Turn handle (4) of M3 oil gun (3) counter-clockwise as far as it will go. Loosen locking screw (5) on head (6) of M3 oil gun.</li> <li>2. Unscrew and remove head (6) and handle (4) as a unit from body (6.1). Be sure cap (7) is on M3 oil gun (3).</li> </ol> <div style="border: 2px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>Do not clean body of M3 oil gun with solvent.</p> <ol style="list-style-type: none"> <li>3. Inspect inside of body (6.1) of M3 oil gun (3) for cleanliness and clean as necessary.</li> <li>4. With opening held upright and at an angle to reduce air entering body (6.1), fill body of M3 oil gun (3) with hydraulic fluid (item 20, Appx D).</li> <li>5. Install head (6) and handle (4) as a unit, and tighten locking screw (5).</li> <li>6. With nozzle end of M3 oil gun (3) held upright, remove cap (7) from nozzle and allow air to escape for a minute or two.</li> <li>7. Purge remaining air from M3 oil gun (3) by turning handle (4) until no more air bubbles appear at nozzle.</li> </ol>	



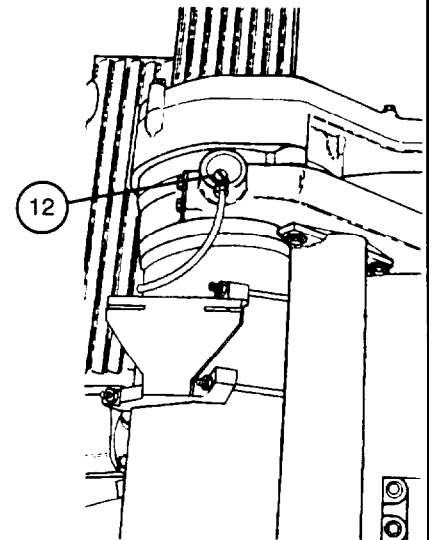
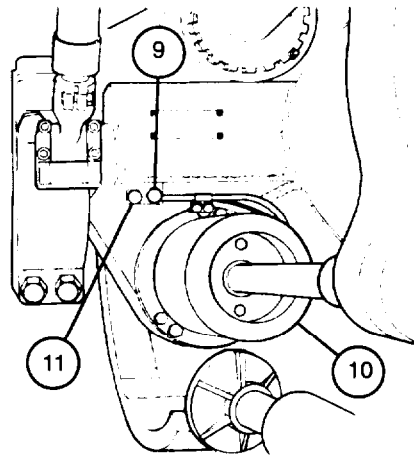
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
17	Before	Replenisher Accumulator Assembly Pressure (Cont)	<p><u>CHIEF OF SECTION</u></p> <p>c. Fill replenisher accumulator assembly (1) as follows:</p> <ol style="list-style-type: none"> <li>1. Using adapter, hose, and reducer, attach M3 oil gun (3) loosely to filling valve (8), turn handle (4) clockwise until clean liquid flows around filling valve. Tighten reducer to filling valve.</li> <li>2. Fill replenisher accumulator assembly (1) at filling valve (8) using M3 oil gun (3) until pressure gage (2) reads 17 to 24 psi (117 to 165 kPa).</li> </ol>	



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

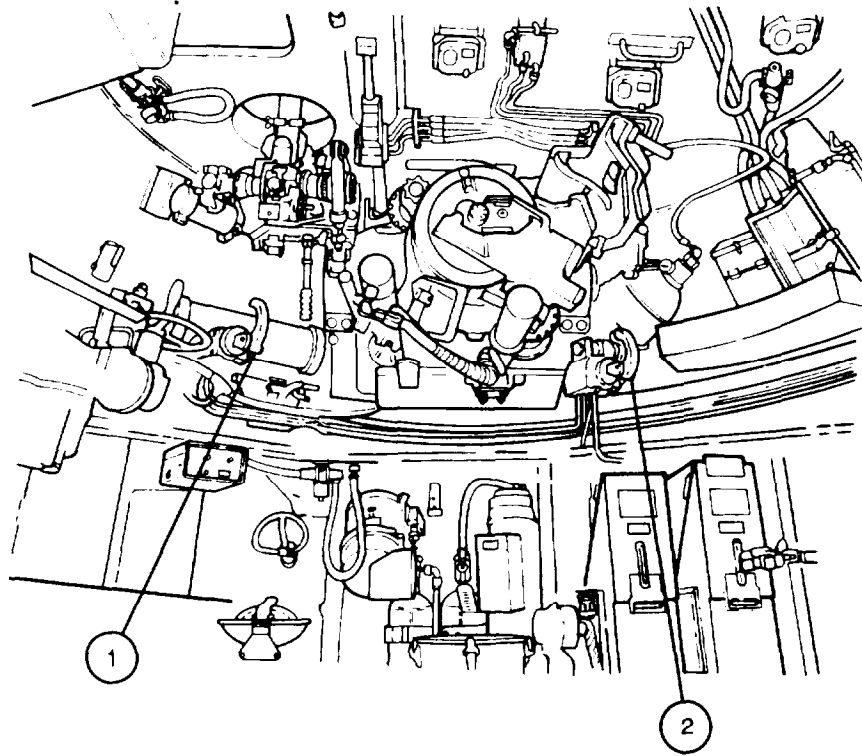
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
17	Before	Replenisher Accumulator Assembly Pressure (Cont)	<p><u>CHIEF OF SECTION</u></p> <ul style="list-style-type: none"> <li>d. Depress cannon assembly to maximum depression. Loosen right-hand bleeder plug (9) to bleed trapped air from rear of buffer assembly (10). When air-free fluid flows, tighten right-hand bleeder plug.</li> <li>e. Elevate cannon assembly to +50 mils. Loosen left-hand bleeder plug (11) to bleed trapped air from front of buffer assembly (10). When air-free fluid flows, tighten left-hand bleeder plug.</li> <li>f. Elevate cannon assembly to 180 mils; install hose and open bleeder valve (12). When air-free fluid flows from hose, tighten bleeder valve. Remove hose and stow in oddment tray.</li> <li>g. Check replenisher accumulator assembly (1) pressure gage (2) for 17 to 24 psi (117 to 165 kPa).</li> <li>h. If low, add hydraulic fluid (item 20, Appx D) to correct operating range. If overfilled, drain.</li> <li>i. Rebleed system until all air is bled from replenisher accumulator assembly (1) and mount. Check for fluid leaks.</li> </ul>	<p>Class III leak found.</p>



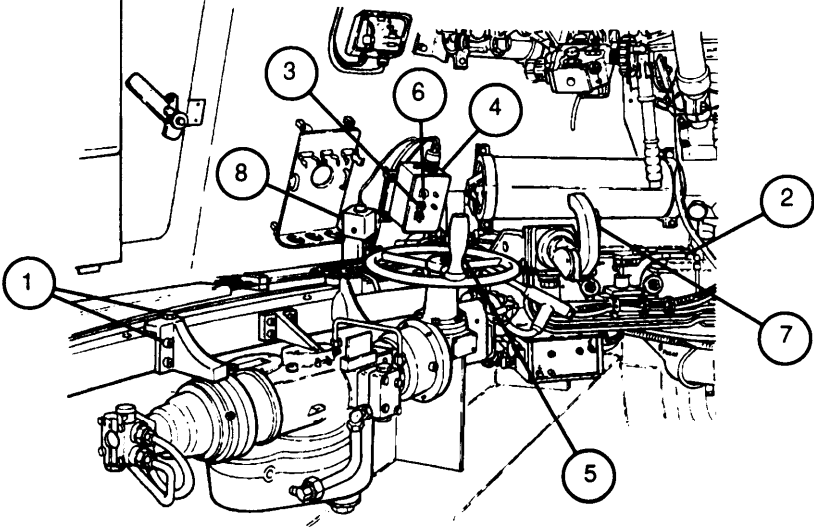


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
17.1	Before	Variable Recoil Assembly	<p><u>CHIEF OF SECTION</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>Before firing, there shall be no more than 1 ml (approximately 25 drops) of oil accumulation at any seal interface location and no evidence of seepage of hydraulic fluid from any of the hydraulic tubes, manifolds, hose connections, and fill bleeder valves.</p> <p>Check for oil accumulation at seal interface(s) and for any hydraulic leaks.</p>	
18	Before	Canon Equilibrator	<p><u>GUNNER AND ASSISTANT GUNNER</u></p> <div style="text-align: center; margin: 10px 0;"><b>NOTE</b></div> <p>Ensure that equilibrated elevation cylinder has been equilibrated.</p> <ol style="list-style-type: none"> <li>a. Unlock travel lock assembly, check power elevation operation at gunner's control assembly (1).</li> <li>b. Check manual and power elevation operation at assistant gunner's control (2).</li> </ol>	<p>Canon assembly will not elevate. Neither elevation method works.</p>

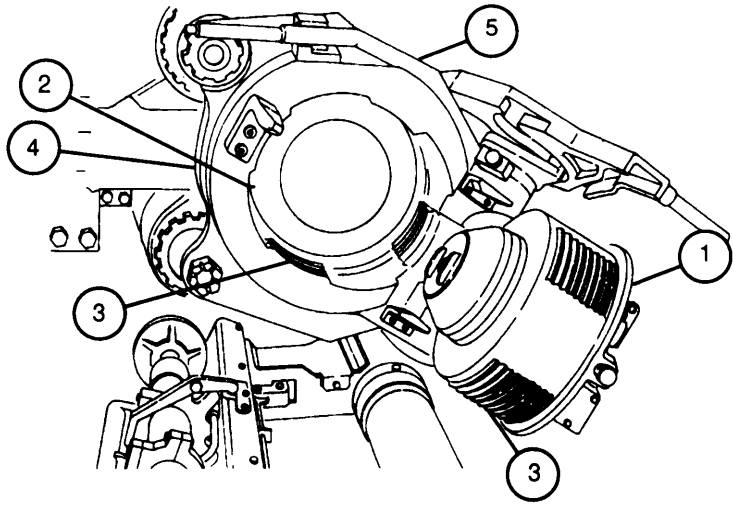


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
19	Before	Traversing Mechanism	<p><u>GUNNER</u></p> <p>a. Check to ensure mounting hardware (1) is not missing or loose.</p> <p>b. Manual Traverse Check:</p> <ol style="list-style-type: none"> <li>1. Place turret lock assembly (2) in UN-LOCKED position. Place TRAVERSE CONTROL switch (3) on gunner's selector switch box assembly (4) in the MANUAL position.</li> <li>2. Crank handwheel assembly (5) clockwise and counterclockwise to be sure cab traverses freely and smoothly.</li> </ol> <p>c. Power Traverse Check:</p> <p>Ensure turret lock assembly (2) is in UN-LOCKED position. Turn vehicle MASTER switch (not shown) and CAB POWER switch (6) to ON position. Place TRAVERSE CONTROL switch (3) on gunner's selector box assembly (4) in POWER position. Turn gunner's control assembly handle (7) to the left to check counterclockwise traversing and to the right to check clockwise traversing. If M109A4/M109A5 cab does not power traverse, pull up on override lever on clutch valve (8) and power traverse.</p> <p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;">Cover plate removed for clarity.</p> 	<p>Mounting hardware (1) is loose, missing or broken.</p> <p>Neither traverse method works.</p>

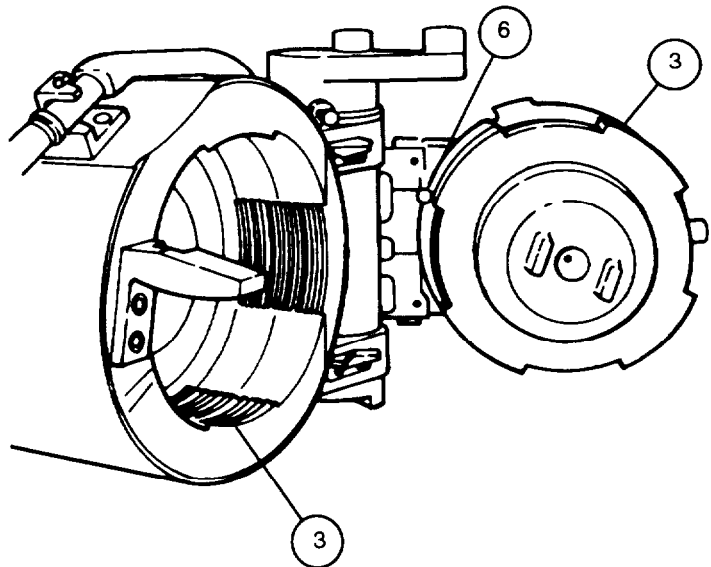
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
20	Before	Breechblock	<p>CANNONEER NO. 1</p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>WARNING</b></div> <ul style="list-style-type: none"> <li>• Never forget to put operating handle back to stow position. If left down while closing breechblock, it can cause serious injury to personnel. Make it a practice never to let go of handle until you return it to stowed position.</li> <li>• If breechblock is not closed completely, do not attempt firing, as it may result in death or injury to crew.</li> </ul> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>To prevent damage to follower assembly, firing mechanism must be in firing position before breechblock is opened manually.</p> <p>a. Before firing, open and close breechblock (1) to be sure it operates freely and smoothly and witness marks (2) aline. If breechblock or breech ring threads (3) are burred and prevent smooth operation, notify unit maintenance.</p>	<p>Breechblock (1) will not close completely (witness marks (2) on breech ring (4) do not aline with witness marks on breechblock). Operating handle (5) does not work or breech mechanism is seized.</p>

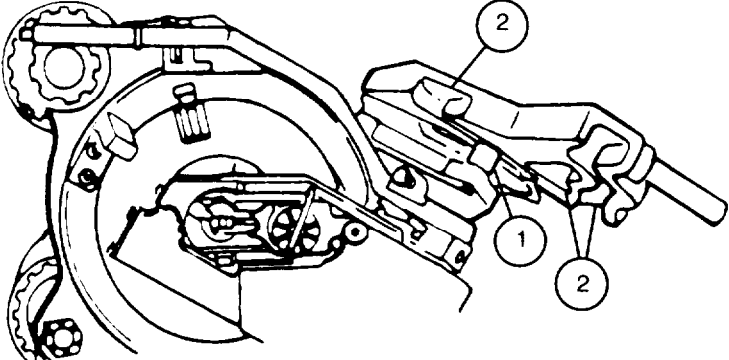
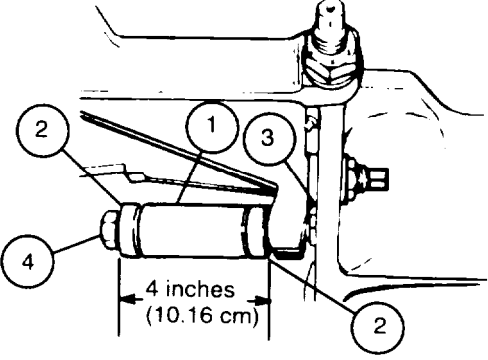


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
20	Before	Breechblock (Cont)	<p><u>CANNONEER NO. 1</u></p> <p>b. Lubricate breechblock and breech ring threads (3) with a light coating of CLP (item 8, Appx D).</p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"><b>CAUTION</b></div> <p>When weapon is not being fired or inspected, keep breechblock closed to prevent damage from tension on adjuster leaf springs.</p> <p>c. Inspect breechblock detent (6) for distortion and wear. If worn, notify unit maintenance.</p>	

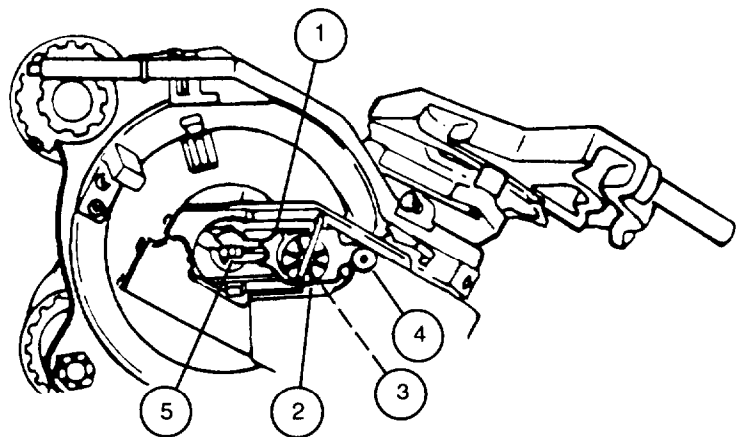


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

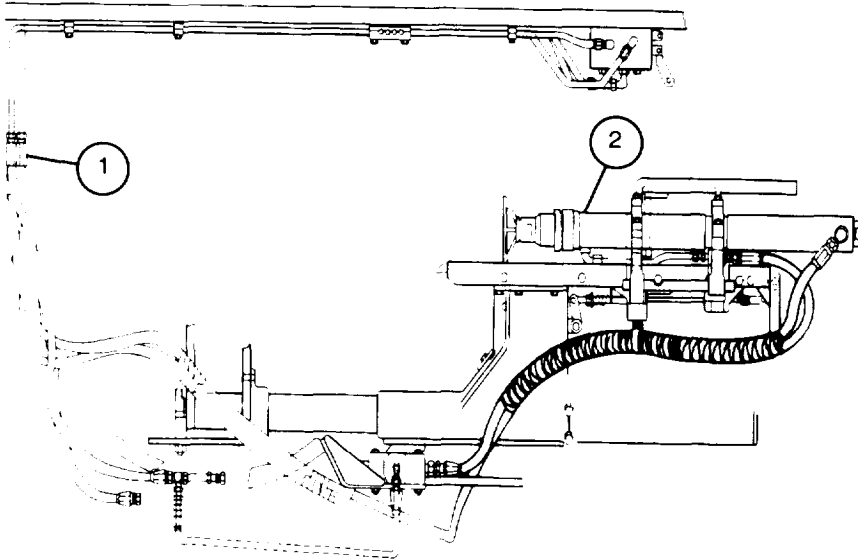
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember Procedure</u>	Not Fully Mission Capable If:
21	Before	Operating Cam And Rollers	<p><u>CANNONEER NO. 1</u></p> <p>a. Before firing, check rollers (1) and cam ways (2).</p> <p>b. Lubricate cam ways (2) daily with grease (item 17, Appx D) when cannon is fired.</p> 	Rollers (1) are broken.
22	Before	Damper Assembly	<p><u>CANNONEER NO. 1</u></p> <p>Inspect damper assembly (1) to ensure distance between spring cap ends (2) is 4 inches (10.16 cm). If not 4 inches (10.16 cm) in length, loosen hex nut (3) and adjust cap screw (4) until spring cap ends are 4 inches (10.16 cm) apart, then tighten hex nut against mount.</p> 	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
23	Before	Firing Mechanism, Firing Block Assembly, And Primer Chamber	<p><u>CANNONEER NO. 1</u></p> <p>a. With firing block assembly (1) in center position, push firing mechanism (2) into firing block assembly and rotate clockwise to remove. Remove lock pin and firing pin (3) and check to see if firing pin is damaged or broken.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>The M35 firing mechanism is used with the M109A2/M109A3/M109A4 M178 mount/M185 cannon assembly. The M49 firing mechanism is used with the M109A5 M182 mount/M284 cannon assembly.</p> <p>b. Replace firing pin (3) and firing mechanism (2). Place firing mechanism in firing position.</p> <p>c. Attach lanyard and check operation of firing mechanism with a steady pull on the lanyard. A click will be heard and firing mechanism (2) should recock.</p> <p>d. Check follower assembly (4) operation.</p> <p>e. Check primer chamber (5) for rust and powder fouling.</p> <p>f. Clean primer chamber (5) by inserting reamer assembly into primer chamber as far as it will go. Rotate briskly.</p> <p>g. Slide firing block assembly (1) back and forth to check for smooth movement. If firing block assembly binds, notify unit maintenance.</p>	<p>Firing mechanism (2) or follower assembly (4) is unserviceable or missing.</p> <p>Firing pin (3) is damaged or broken.</p>

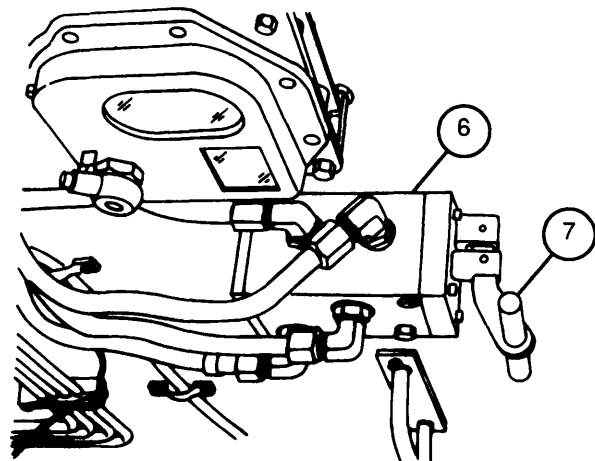
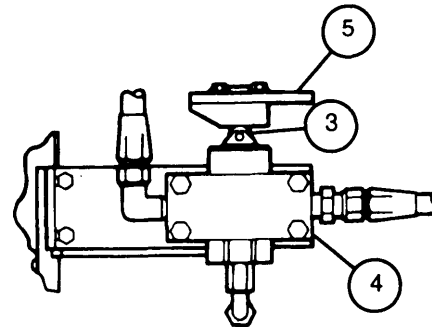


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
24	Before	Rammer Assembly	<p><u>CANNONEER NO. 1</u></p> <p>a. Before firing, check hoses, tubes, and connectors (1) for oil leaks.</p> <p>b. Check rammer assembly (2) for missing, loose, or broken components.</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <ul style="list-style-type: none"> <li>• When exercising rammer assembly, bring rammer to full extension slowly to avoid seal damage.</li> <li>• If the rammer assembly does not operate smoothly, or makes unusual noises, or jerking motions, notify unit maintenance and refer to para 2-12.5 for cannon hand ramming. Failure to observe this caution could result in short rounds and short rounds fall on friendly forces.</li> </ul> <div style="text-align: center; margin-top: 20px;">  <p>The diagram shows a side view of the rammer assembly. Callout 1 points to a hose or tube connection on the left side of the mechanism. Callout 2 points to the main rammer assembly, which includes a piston rod, a rammer head, and a flexible hose leading to the rear of the assembly.</p> </div>	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

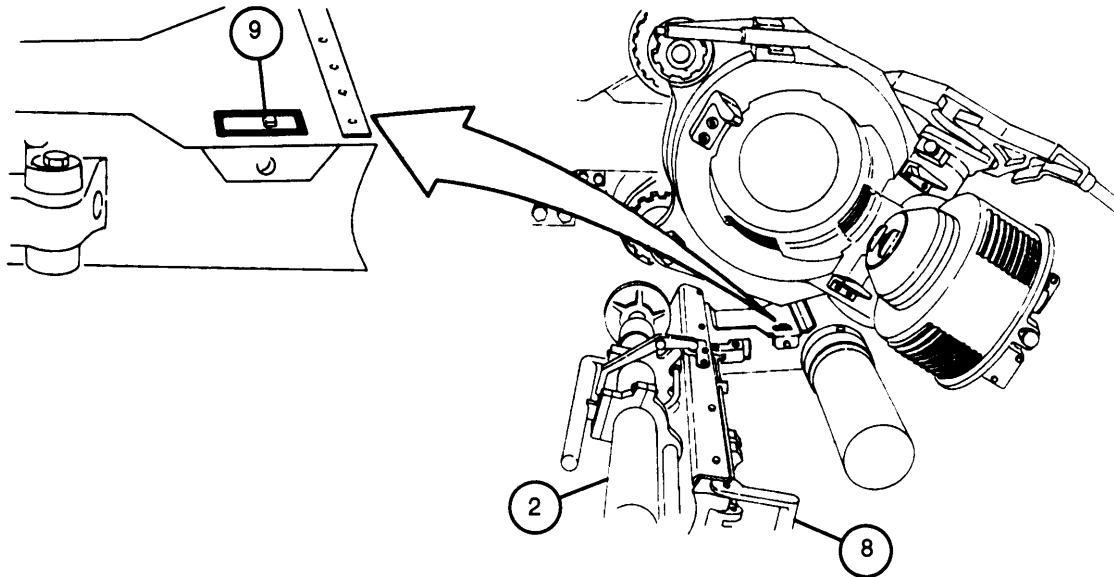
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
24	Before	Rammer Assembly (Cont)	<p><u>CANNONEER NO. 1</u></p> <p>c. Exercise rammer assembly (2) before firing according to the following instructions:</p> <ol style="list-style-type: none"> <li>1. Place rammer assembly (2) in ram position.</li> <li>2. Check to assure rammer assembly (2) locks in ram position and plunger and roller (3) on blocking check valve (4) is depressed by operating cam (5).</li> <li>3. Coat plunger and roller (3) lightly with grease (item 17, Appx D).</li> <li>4. SLOWLY depress actuating valve (6) control handle (7) and hold to extend rammer full stroke. Release control handle to bring rammer back to original position.</li> </ol>	





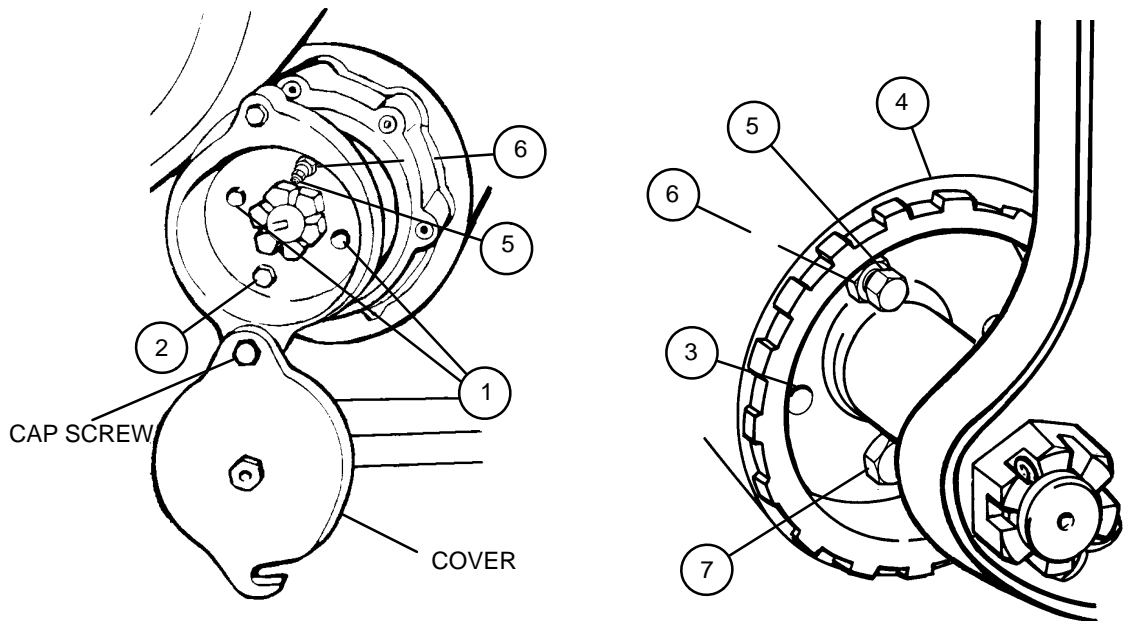
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
24	Before	Rammer Assembly (Cont)	<p><u>CANNONEER NO. 1</u></p> <p style="text-align: center;"><b>NOTE</b></p> <p>If rammer fails to ram, notify unit maintenance.</p> <p>d. Before firing, push main release handle (8) slowly forward to check that rammer assembly (2) latches securely in the stowed position (rammer safety pointer (9) in black band) before elevating or depressing howitzer.</p>	



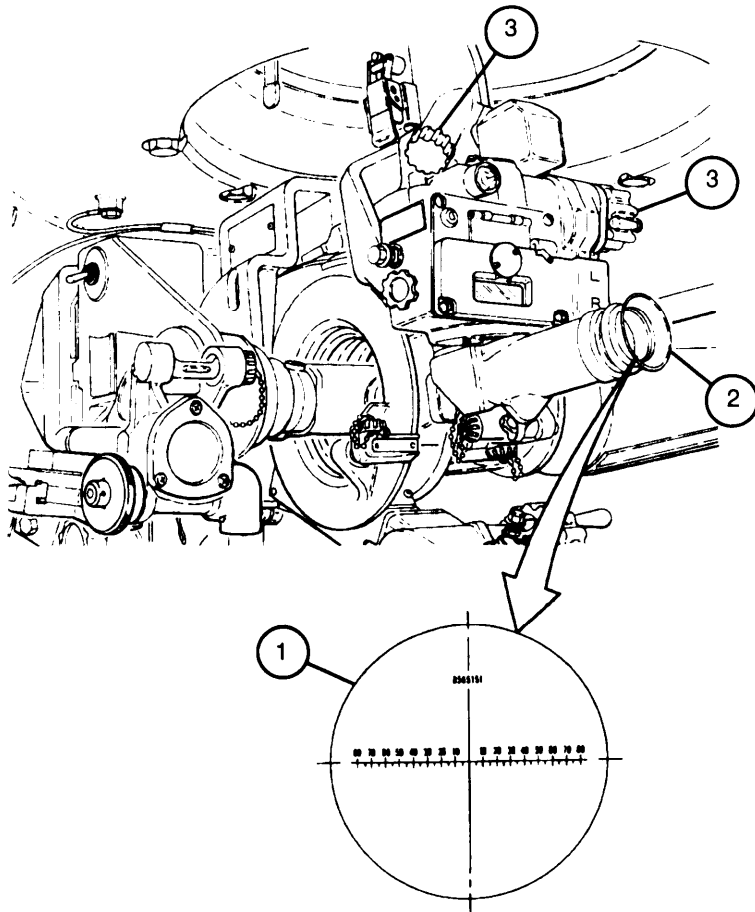
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
25	Before	Recuperator Assembly	<p><u>CHIEF OF SECTION</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>WARNING</b></div> <p>Do not attempt to remove drain plug completely. Hydraulic fluid in recuperator assembly is under high pressure and could cause injury.</p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <ul style="list-style-type: none"> <li>If drain plug is loosened for draining hydraulic fluid, check for leaks after tightening cover.</li> <li>To prevent damage to gasket or cover, loosen cap screws to stop pins before rotating cover.</li> </ul> <p>Before firing, check pins (1) in recuperator assembly (2) from outside of vehicle, and check pins (3) in recuperator head (4) from inside vehicle. Pins must extend from 1/4 to 3/4 inch (6.4 to 19.05 mm). If pins extend beyond 3/4 inch (19.05 mm), fill recuperator assembly (2) by removing valve cap (5) from valve (6). Fill M3 oil gun (item 17, Table 2-1) and add hydraulic fluid (item 20, Appx D) until pins extend 1/4 inch (6.4 mm). If pins extend less than 1/4 inch (6.4 mm), loosen drain plug (7) and drain hydraulic fluid until pins extend 1/4 inch (6.4 mm).</p>	<p>Pins (1 and 3) cannot be brought into specified range.</p>

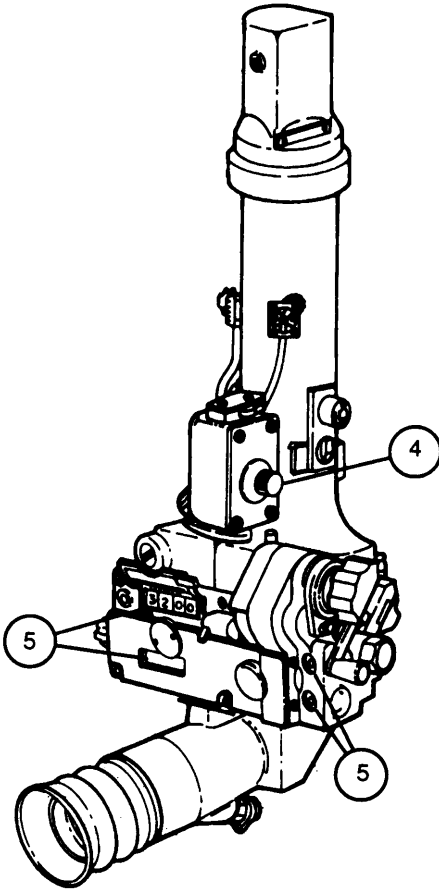


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
26	Before	M117/M117A2 Panoramic Telescope	<p><u>GUNNER</u></p> <ol style="list-style-type: none"> <li>a. Before firing, check field of view through reticle (1) for entrapped moisture, fungus, and optical defects. Make sure eyeshield (2) is free from deterioration, cuts, or tears.</li> <li>b. Check that all external surfaces of M117/M117A2 panoramic telescope are free of dents, cracks, rust, or corrosion.</li> <li>c. Check all knobs (3) for damage and freedom of movement.</li> </ol>	<p>Loose or defective parts prevent proper operation.</p> <p>Knobs do not turn.</p>

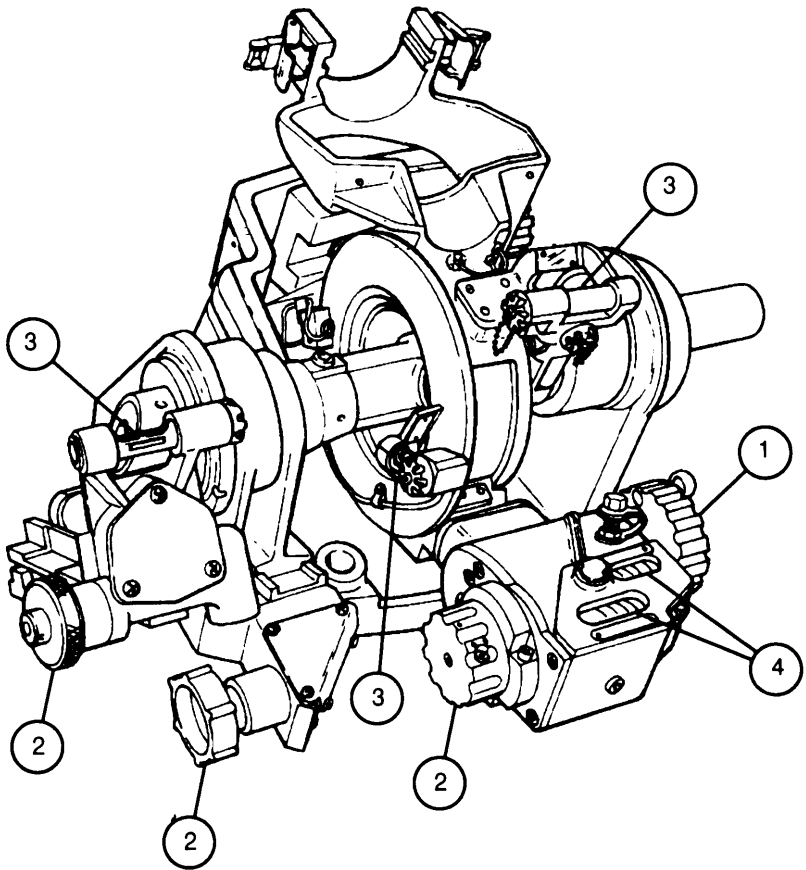


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
26	Before	M117/M117A2 Panoramic Telescope (Cent)	<p><u>GUNNER</u></p> <p>d. Check that variable resistor knob (4) moves freely and light goes from dim to bright and bright to dim.</p> <p>e. Check counters (5) to make sure viewing windows are not broken and numbers are legible and do not skip.</p> <p>f. Make sure mounting is secure.</p>  <p>The diagram shows a panoramic telescope with a cylindrical body and a lens at the bottom. Callout 4 points to a knob on the side of the upper section. Callout 5 points to two different locations: one on the side of the middle section and one on the side of the lower section near the lens.</p>	<p>Counters skip.</p> <p>Mounting is insecure.</p>

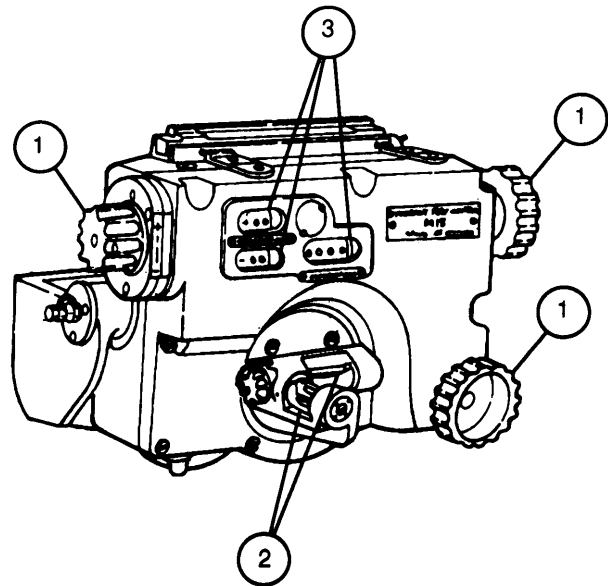
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
27	Before	M145/M145A1 Telescope Mount	<p><u>GUNNER</u></p> <p>Before firing, make sure elevation handwheel (1) and all knobs (2) are undamaged and move freely. Ensure level vials (3) are legible, that glass mirrors are not scratched, and vial covers move freely. Make sure LEDs illuminate vials. Inspect counters (4), making sure viewing windows are not broken and numbers move freely and read accurately. Make sure mounting is secure.</p>	<p>Knobs won't turn.</p> <p>Loose or defective parts prevent proper operation.</p> <p>Level vials are cracked, broken, or illegible.</p> <p>Counters skip.</p> <p>Mounting is insecure.</p>

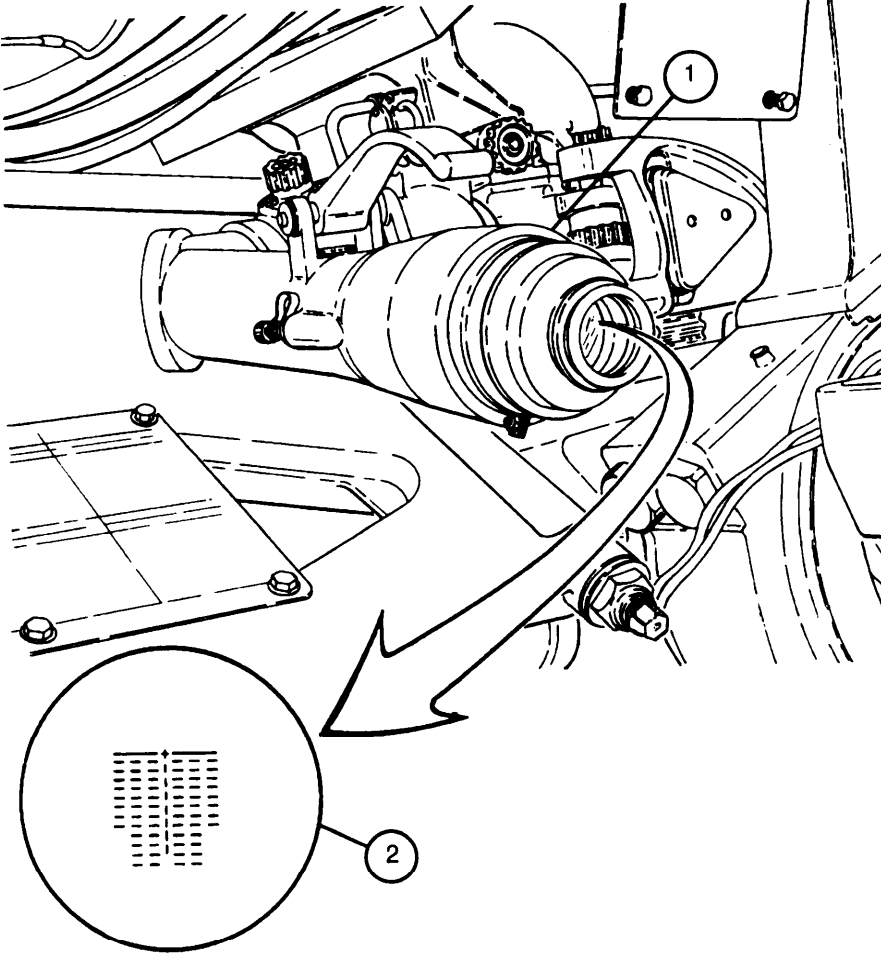


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
28	Before	M15 Elevation Quadrant	<p><u>ASSISTANT GUNNER</u></p> <p>a. Before firing, check all knobs and handwheels (1) for damage and verify freedom of movement. Ensure level vials (2) are legible and free of cracks or breaks.</p> <p>b. Check counters (3) to make sure viewing windows are not broken and numbers are legible, move freely, and do not skip.</p>	

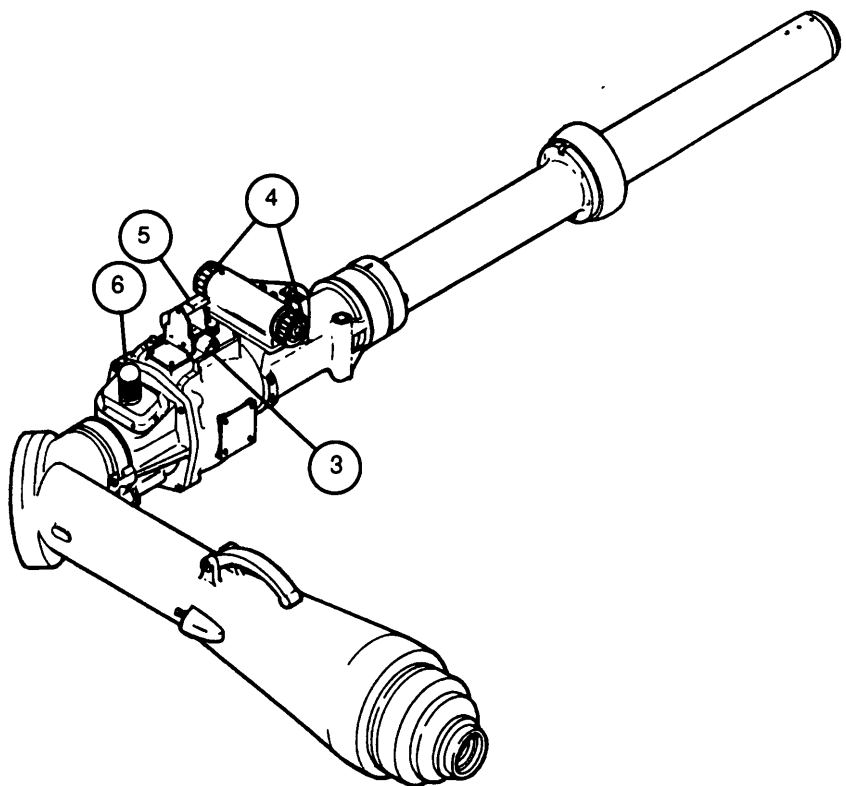


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
29	Before	M118A2/M118A3 Elbow Telescope M118 Series)	<p><u>ASSISTANT GUNNER</u></p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <b>CAUTION</b> </div> <p>In order to prevent damage to M118A2/ M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a hand- hold under any circumstances.</p> <p>a. Before firing, look through eyepiece (1) and check reticle (2) for entrapped moisture and op- tical defects.</p> 	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
29	Before	M118A2/M118A3 Elbow Telescope (M118 Series) (Cont)	<p><u>ASSISTANT GUNNER</u></p> <p>b. Check level vial (3), making sure it is legible and free of cracks or breaks. Check to see that knobs (4) move freely and level vial mirror (5) is not scratched. Ensure that variable resistor knob (6) moves freely and that light goes from dim to bright and from bright to dim.</p>	





**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Item	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
30	Before	M146 Telescope Mount	<p><u>ASSISTANT GUNNER</u></p> <p>a. Before firing, check that elevation bracket (1) slides freely. Check dial (2) for damage and verify freedom of movement. Check knobs (3) for damage and freedom of movement.</p>	

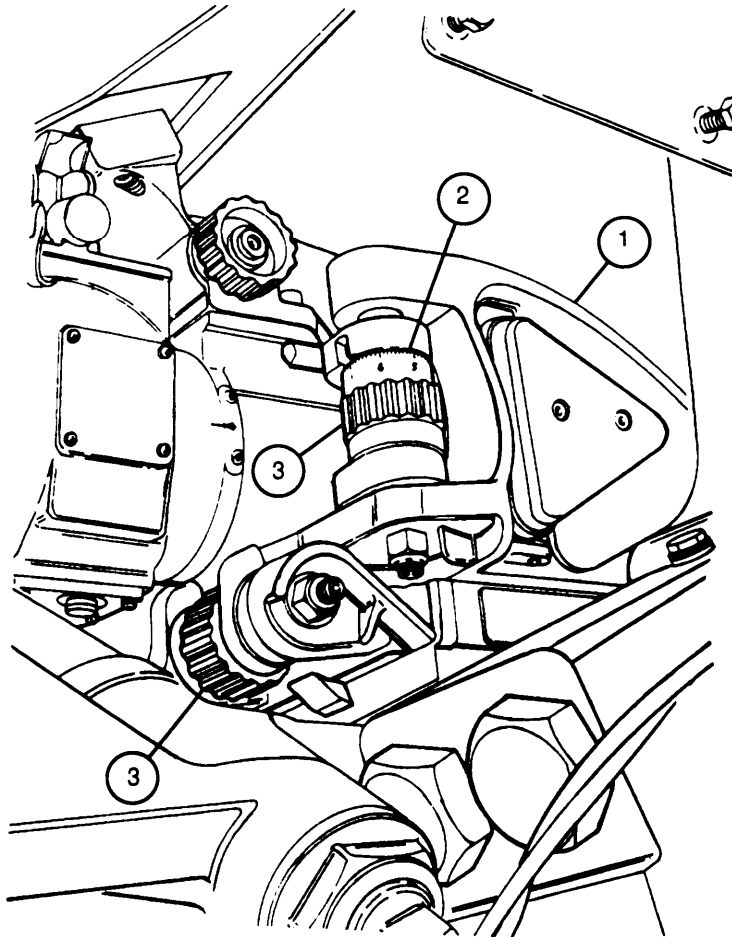


Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
30	Before	M146 Telescope Mount (Cont)	<p><b>ASSISTANT GUNNER</b></p> <p><b>NOTE</b></p> <p>Tapered pin (king pin) and cable assembly receptacle should be installed on M146 telescope mount whether or not M118A2/M118A3 elbow telescope is installed.</p> <p>b. Check cable assembly receptacle (4) of cable assembly (5) for damage.</p>	

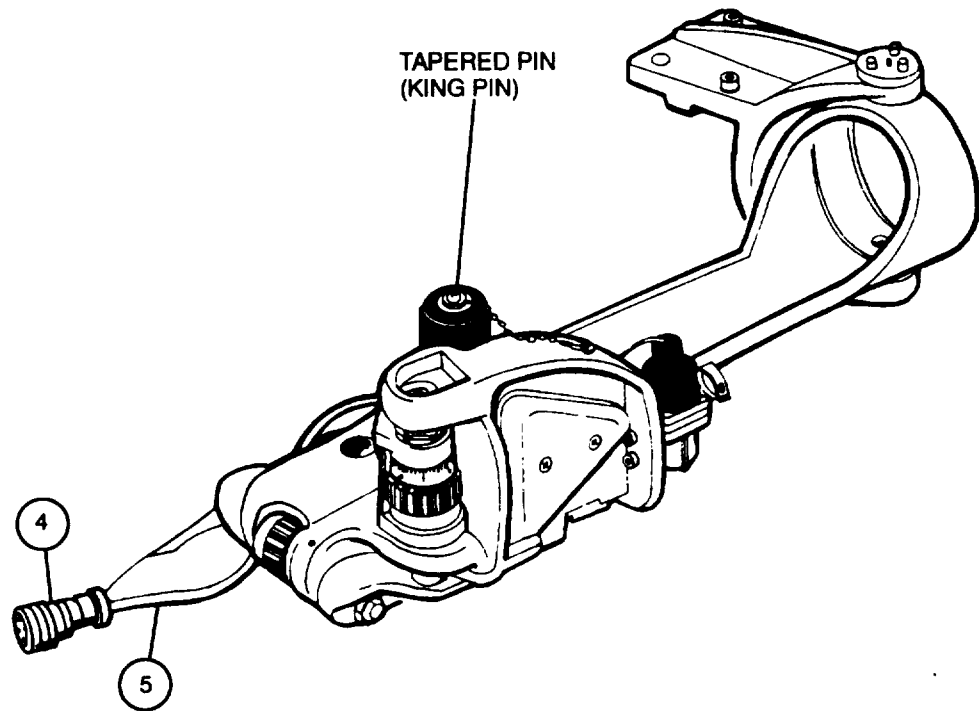


Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
31	Before	M1A1 Collimator	<u>CANNONEER NO. 1</u>	

**WARNING**



The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures listed on page b.

Before firing, check reticle (1) for correct alignment and illumination. Make sure cross level vial (2) is legible and free of cracks and breaks. Make sure clamping knobs (3) hold M1A1 collimator securely. Check adjustment knob (4) for freedom of movement.

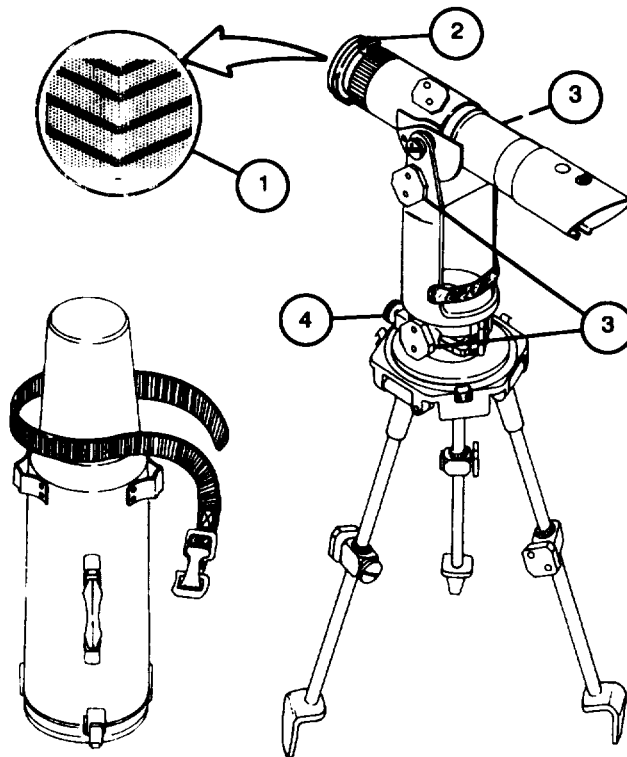

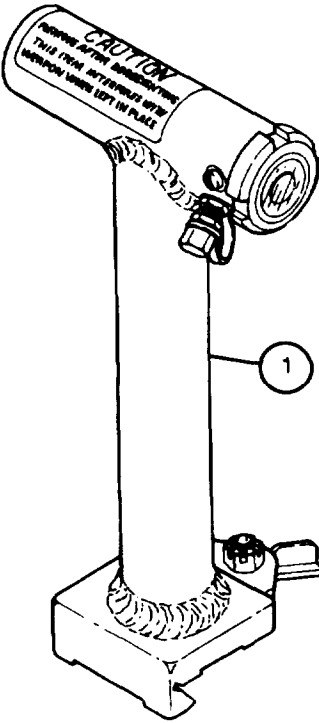
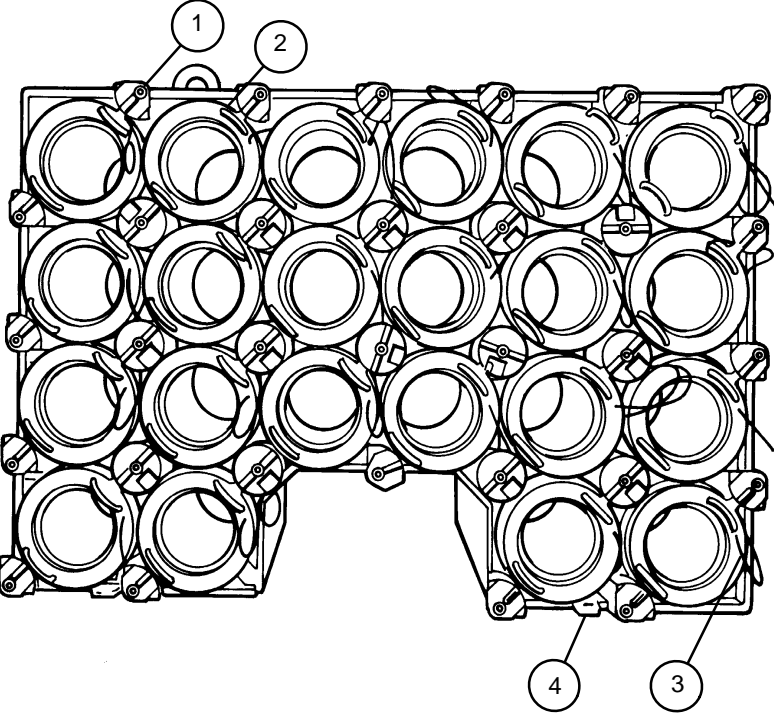


Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED

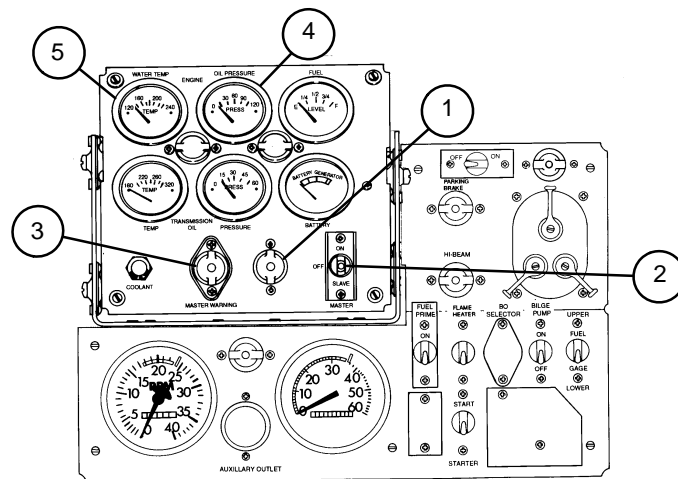
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
32	Before	M140 Alinement Device	CANNONEER NO. 4	
<div data-bbox="730 497 954 570" style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;"><b>WARNING</b></div> <div data-bbox="244 587 323 661" style="display: inline-block; vertical-align: middle; margin-right: 10px;">  </div> <div data-bbox="343 587 1438 661" style="display: inline-block; vertical-align: middle;"> <p>The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.</p> </div>				
			<p>Before firing, check M140 alinement device (1) for illumination.</p> <div data-bbox="905 917 1224 1640" style="text-align: center;">  </div>	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
33	Before	Cab Ammunition Rack Assembly	<p><u>CANNONEER NO. 1</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>WARNING</b></div> <p>If cab ammunition rack assembly has projectiles loaded, make sure locking caps and retainer assemblies are in place. Bustle doors must be closed and properly latched before moving vehicle.</p> <ol style="list-style-type: none"> <li>a. Before firing, make sure each locking cap (1) is rotated to hold its retainer assembly (2) in place.</li> <li>b. Check to see that each end of wire ropes (3) is securely attached to retainer and cab ammunition rack assembly (4).</li> </ol> 	
34	Before	DA FORM 2408-4	<p><u>CHIEF OF SECTION</u></p> <p>Check DA Form 2408-4 to ensure that cannon has been borescoped and recoil exercised within the last 180 days or EFC rounds have not exceeded 2650.</p>	<p>Not borescoped within last 180 days.</p>

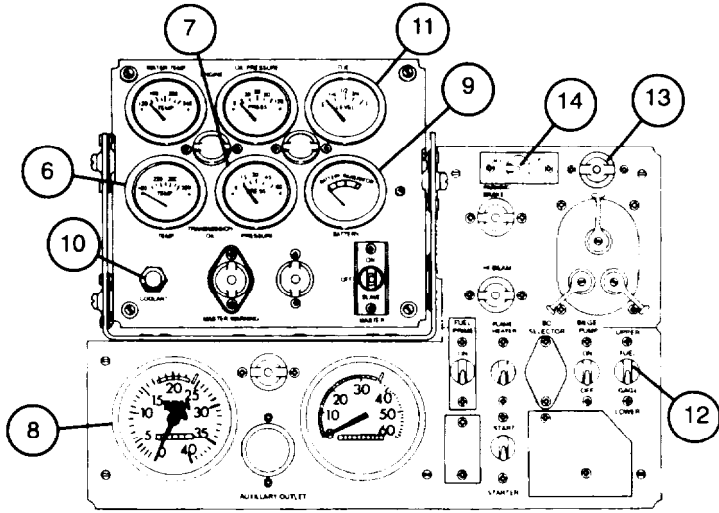
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
34.1	During	Driver's Fixed And Portable Instrument Panels (Engine Model 7083-7396)	<p><u>DRIVER</u></p> <p>Check the following:</p> <ol style="list-style-type: none"> <li>MASTER switch indicator light (1) is lit when MASTER switch (2) is in ON position.</li> <li>MASTER WARNING indicator light (3) is not lit 15 seconds after engine starts.</li> </ol> <p style="text-align: center;"><b>NOTE</b></p> <p>Depending on climatic conditions, it may take several minutes to obtain these readings.</p> <ol style="list-style-type: none"> <li>ENGINE OIL PRESSURE gage (4) reads: minimum of 5 psi (34 kPa) at idle (650 RPM) 30-50 psi (207-345 kPa) at 1800 RPM.</li> <li>ENGINE WATER TEMP gage (5) reads 170° F minimum, 230° F maximum.</li> </ol> <p style="text-align: center;"><b>NOTE</b></p> <p>M109A4/M109A5 configuration shown.</p>	<p>ENGINE WATER TEMP gage (5) or ENGINE OIL PRESSURE gage (4) is inoperative or does not read within limits.</p>



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
34.1	During	Driver's Fixed And Portable Instrument Panels (Engine Model 7083-7396) (Cont)	<p><u>DRIVER</u></p> <p>e. TRANSMISSION OIL TEMP gage (6) reads 220 to 240° F minimum, 300° F maximum.</p> <p>f. TRANSMISSION OIL PRESSURE gage (7) reads 10 psi to 45 psi (69 to 310 kPa) at fast idle.</p> <p>g. Tachometer (8) operates without unusual fluctuation or noise.</p> <p>h. BATTERY gage (9) is in green (charging) range.</p> <p>i. Press to test COOLANT indicator light (10) for proper operation.</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>Never run completely out of fuel. Injectors require full return flow for cooling.</p> <p>j. FUEL gage (11) indicates fuel quantity available in each fuel tank. Use FUEL GAGE control switch (12) to select fuel tank.</p> <p>k. NBC indicator light (13) lights when NBC power switch (14) (M109A4/M109A5) is turned to ON position.</p>	<p>TRANSMISSION OIL TEMP gage (6) does not read within limits.</p> <p>TRANSMISSION OIL PRESSURE gage (7) does not read within limits.</p> <p>BATTERY gage (9) is inoperative or does not read within limits.</p>

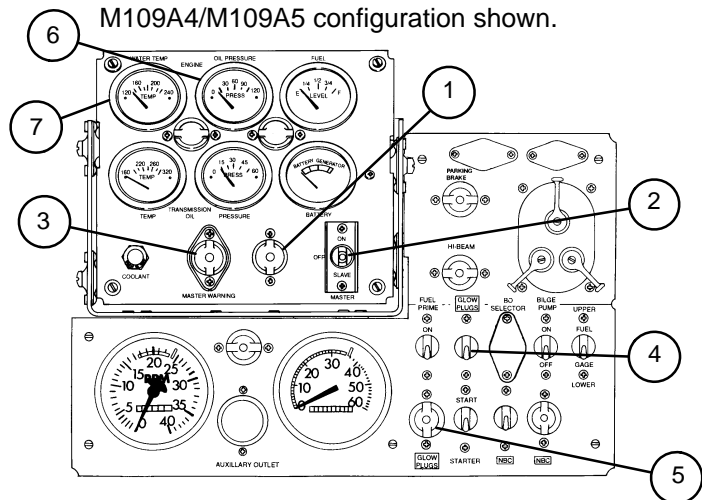


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
34.2	During	Driver's Fixed And Portable Instrument Panels (LHR Engine Model 7083-7391)	<p><u>DRIVER</u></p> <p>Check the following:</p> <ol style="list-style-type: none"> <li>MASTER switch indicator light (1) is lit when MASTER switch (2) is in ON position.</li> <li>MASTER WARNING indicator light (3) is not lit 15 seconds after engine starts.</li> <li>At temperatures above 50° F (10° C) the GLOW PLUGS indicator light (4) flashes light for one second when GLOW PLUGS switch (5) is turned to ON position.  At temperatures below 50° F (10° C) the GLOW PLUGS indicator light (4) is lit for 35 seconds and flashes light for one minute when GLOW PLUGS switch (5) is turned to ON position.</li> </ol> <p style="text-align: center;"><b>NOTE</b></p> <p>Depending on climatic conditions, it may take several minutes to obtain these readings.</p> <ol style="list-style-type: none"> <li>ENGINE OIL PRESSURE gage (6) reads: minimum of 5 psi (34 kPa) at idle (650 RPM) 30-50 psi (207-345 kPa) at 1800 RPM.</li> <li>ENGINE WATER TEMP gage (7) reads 170° F minimum, 230° F maximum.</li> </ol>	<p>Operation is to occur in temperature below 40° F (5° C) and if GLOW PLUGS indicator light (4) remains lit.</p> <p>ENGINE WATER TEMP gage (7) or ENGINE OIL PRESSURE gage (6) is inoperative or does not read within limits.</p>

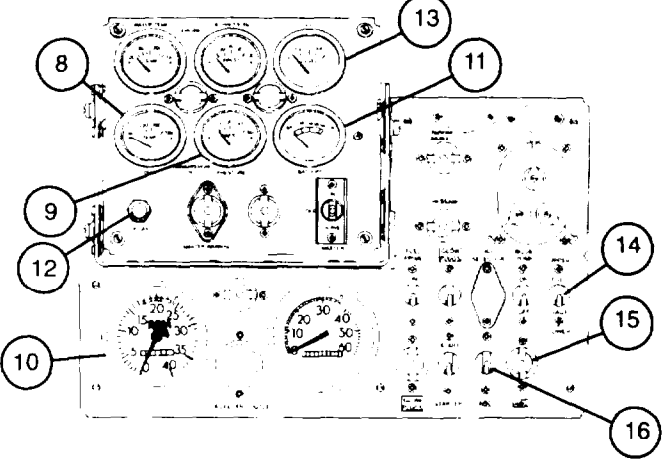
**NOTE**

M109A4/M109A5 configuration shown.



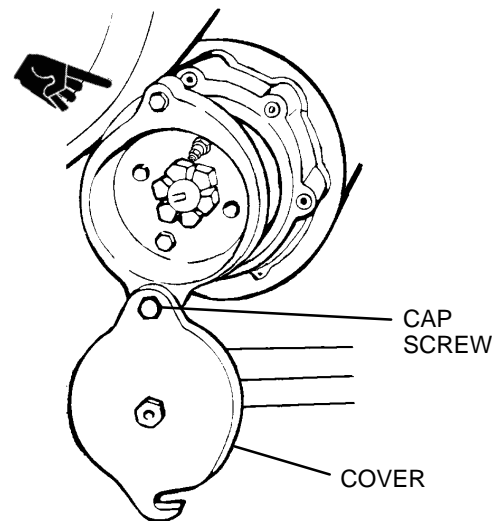
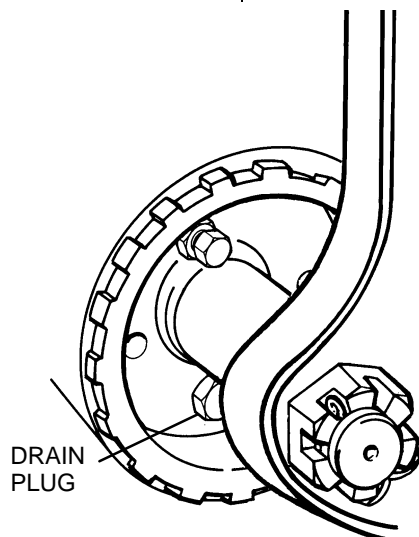


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
34.2	During	Driver's Fixed And Portable Instrument Panels (LHR Engine Model 7083-7391) (Cont)	<p><u>DRIVER</u></p> <p>f. TRANSMISSION OIL TEMP gage (8) reads 220 to 240° F minimum, 300° F maximum.</p> <p>g. TRANSMISSION OIL PRESSURE gage (9) reads 10 psi to 45 psi (69 to 310 kPa) at fast idle.</p> <p>h. Tachometer (10) operates without unusual fluctuation or noise.</p> <p>i. BATTERY gage (11) is in green (charging) range.</p> <p>j. Press to test COOLANT indicator light (12) for proper operation.</p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>Never run completely out of fuel. Injectors require full return flow for cooling.</p> <p>k. FUEL gage (13) indicates fuel quantity available in each fuel tank. Use FUEL GAGE control switch (14) to select fuel tank.</p> <p>l. NBC indicator light (15) lights when NBC power switch (16) (M109A4/M109A5) is turned to ON position.</p> <p style="text-align: center;"><b>NOTE</b> M109A4/M109A5 configuration shown.</p> 	<p>TRANSMISSION OIL TEMP gage (8) does not read within limits.</p> <p>TRANSMISSION OIL PRESSURE gage (9) does not read within limits.</p> <p>BATTERY gage (11) is inoperative or does not read within limits.</p>

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
35	During	Powerplant	<p><u>DRIVER</u></p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;"><b>CAUTION</b></div> <p>If you notice a shrill whine (above normal turbine whine), rubbing, vibrations, and/or a sudden increase in exhaust smoke, shut off engine and notify unit maintenance.</p> <p>Check for unusual noises or vibrations.</p>	Performance or function is inadequate or there are unusual noises or vibrations.
36	During	Recuperator Assembly	<p><u>CHIEF OF SECTION</u></p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;"><b>WARNING</b></div> <p>Do not attempt to remove drain plug completely. Hydraulic fluid in recuperator is under high pressure.</p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;"><b>CAUTION</b></div> <ul style="list-style-type: none"> <li>• If drain plug is loosened for draining fluid, check for leaks after tightening.</li> <li>• To prevent damage to gasket cover of cover, loosen cap screws to stop pins before rotating cover.</li> </ul>	

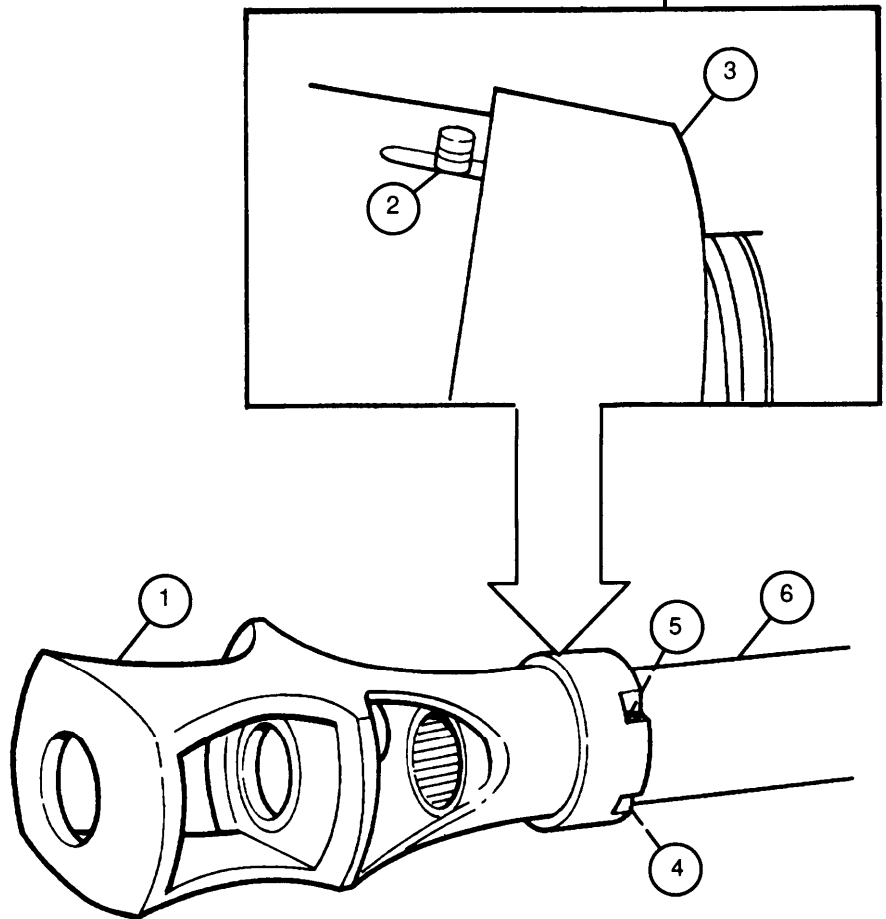


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
36	During	Recuperator Assembly (Cont)	<p><u>CHIEF OF SECTION</u></p> <p>a. After firing 100 rounds sustained fire, check pins (1) in recuperator assembly (2) from outside of vehicle and check pins (3) in recuperator head (4) from inside of vehicle. Pins must extend from 1/4 to 3/4 inch (6.4 to 19.05 mm).</p> <p>b. If pins are not extended within this range, bleed or fill recuperator assembly. If pins extend beyond 3/4 inch (19.05 mm), remove valve cap (5) from valve (6) and add hydraulic fluid (item 20, Appx D) until pins extend 1/4 inch (6.4 mm). If pins extend less than 1/4 inch (3.2 mm), loosen drain plug (7) and drain hydraulic fluid until pins extend 1/4 inch (6.4 mm).</p>	Pins (1 and 3) cannot be brought into specified range.
36.1	During	Variable Recoil Assembly	<p><u>CHIEF OF SECTION</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>During operation, there shall be no more than 1 ml (approximately 25 drops) of oil accumulation at any seal interface location. Immediately following this determination oil accumulations are to be wiped clean prior to an additional five (5) rounds.</p> <p>Check for oil accumulation at seal interface(s) and for any hydraulic leaks.</p>	

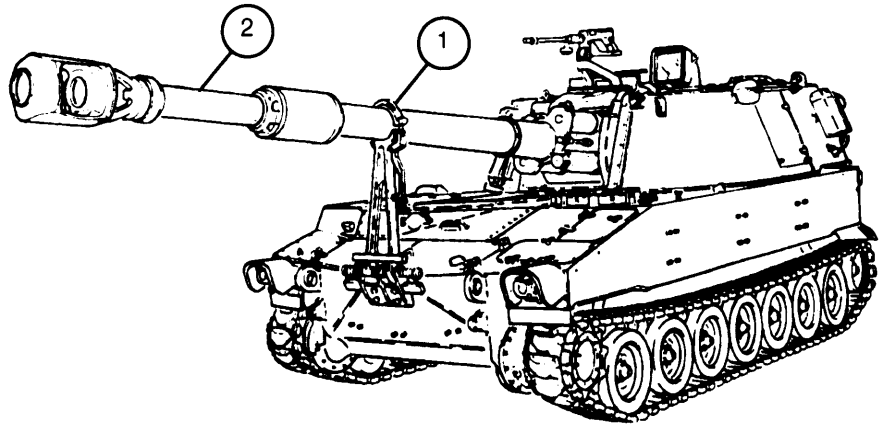
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
37	After	Cannon Tube And Muzzle Brake	<p><u>CHIEF OF SECTION</u></p> <p>a. After firing, check muzzle brake (1) for cracks.</p> <p>b. Ensure that muzzle brake key (2) is partly covered by thrust collar (3).</p> <p>c. Check setscrews (4 and 5) for tightness. Setscrew (4) is staked.</p> <p>d. Inspect cannon tube (6) for damage.</p>	<p>Any cracks in muzzle brake (1) are over 1 inch (2.54 cm) long.</p> <p>Muzzle brake key (2) is damaged or missing.</p> <p>Either setscrew (4 or 5) is missing.</p> <p>Any cracks in cannon tube (6).</p>



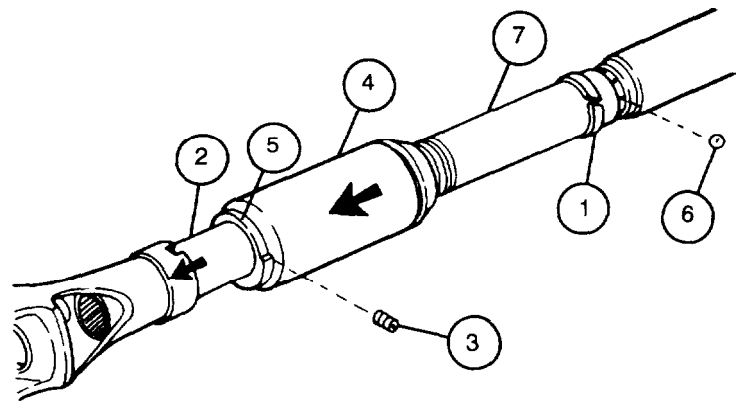
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
38	After	Travel Lock Assembly	<p><u>DRIVER</u></p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>Travel lock assembly is heavy, use care when locking to prevent injury and close cap assembly before raising travel lock assembly.</p> <p>Check travel lock assembly (1) for proper operation and missing or broken parts.</p>	<p>Travel lock assembly (1) will not lock cannon tube (2) in place.</p>



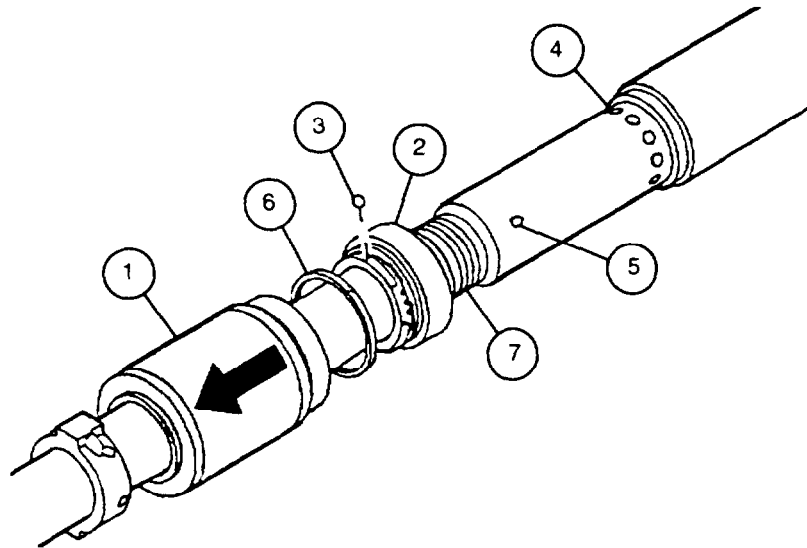
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
39	After	Bore Evacuator	<p><u>CHIEF OF SECTION</u></p> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• Some rotation of the bore evacuator is acceptable. However, if it rotates more than 1 inch (2.54 cm), check to ensure setscrew locks bearing ball. Notify unit maintenance if problem persists.</li> <li>• Do not fill metering holes with grease. Filling of the holes will decrease efficiency of the bore evacuator.</li> </ul> <p>Clean evacuation orifices and ensure that bottom setscrew (not shown) is staked.</p> <p>Inspect valve ring (1) for cracks or deformation.</p> <p>Clean cannon tube (2) threads.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Notify unit maintenance if valve ring is cracked or deformed, or if threads are burred or damaged.</p> <p>After firing, remove setscrew (3) from bore evacuator (4). Insert T-handle into setscrew hole. Turn T-handle to engage with threads. Continue turning to depress bearing ball and spring (not shown). Insert pry bar into hole (5). With bearing ball (not shown) depressed, unscrew bore evacuator and slide it forward. Slide valve ring (1) forward and 10 check balls (6) should fall out. Thoroughly clean check balls and three metering holes (7). Apply a light coat of grease (item 19, Appx D) or grease (item 18, Appx D) to bearing balls, valve ring, and unpainted cannon tube surfaces before reassembling.</p>	<p>Staked setscrew is missing.</p> <p>Valve ring (1) is broken.</p> <p>Three or more check balls are missing.</p>



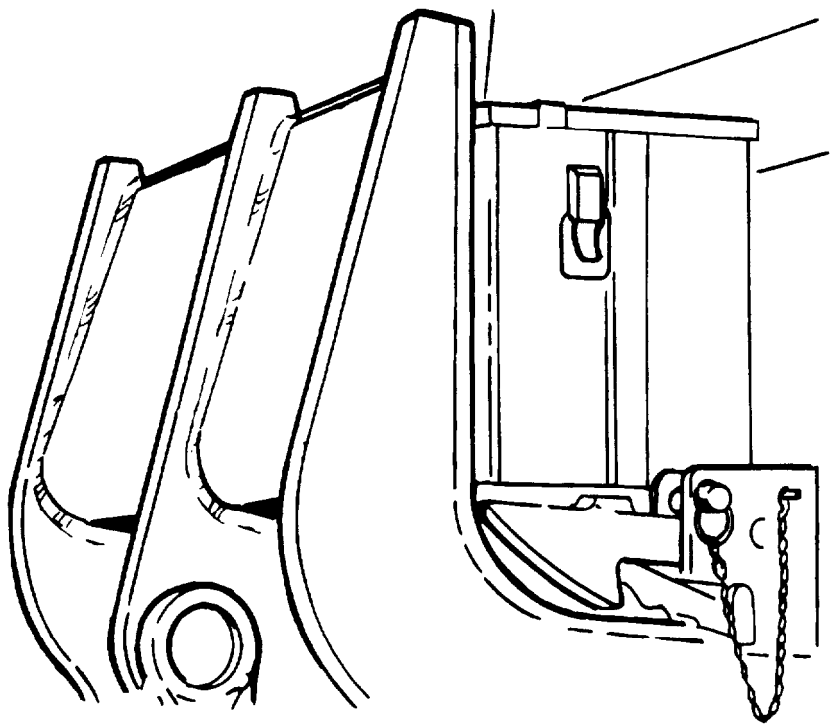
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
39.1	After	Bore Evacuator Assembly and Ball Valves	<p><b>CHIEF OF SECTION</b></p> <p>After firing, separate main reservoir (1) and pre-reservoir (2) of bore evacuator assembly (para 3-6.7.1). Muzzle brake need not be removed.</p> <p>Remove, clean, and lubricate nine evacuator ball valves (3), 10 evacuator orifices (4), and three metering holes (5). Ensure that bottom setscrew is staked.</p> <p>Clean and inspect ring valve (6) for cracks, breaks, or deformation.</p> <p>Clean tube and tube threads (7).</p> <p>Notify unit maintenance if ring valve is cracked, broken, or deformed, or if threads are burred or damaged.</p> <p>After installing setscrew in bore evacuator assembly, notify unit maintenance for torquing.</p> <p><b>NOTE</b></p> <p>Some rotation of the bore evacuator assembly is acceptable. However, if it rotates more than 1 inch, check ball lock spring and ball lock functioning. Notify unit maintenance if problem persists.</p>	<p>Ring valve is broken, cracked, or deformed.</p> <p>If three or more balls are missing.</p>



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
40	After	Cannon Tube	<p><u>CREW</u></p> <p>Clean and service cannon tube.</p>	
41	After	Spade	<p><u>CHIEF OF SECTION</u></p> <ol style="list-style-type: none"> <li>a. Check operation of spade latches in stowed position.</li> <li>b. Remove burrs from corners and spade face.</li> <li>c. Make certain all spade components are present, latches are secure, and that there are no broken weld joints.</li> </ol>	

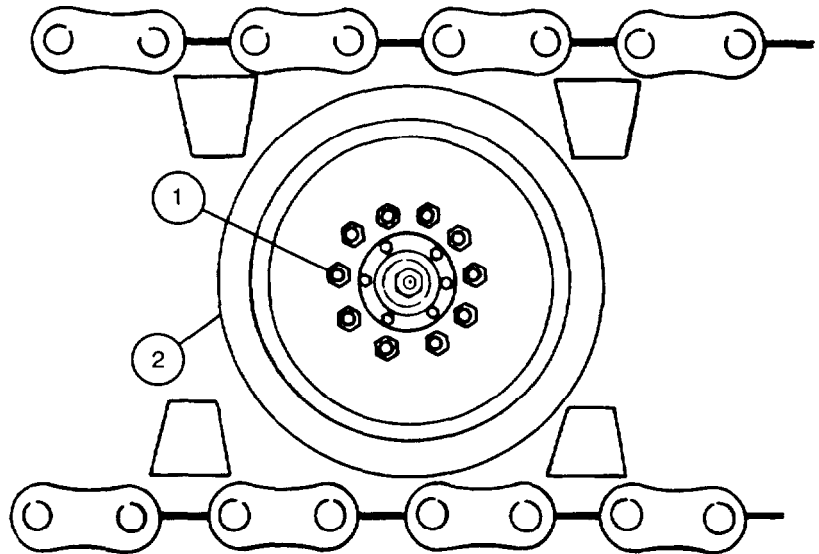






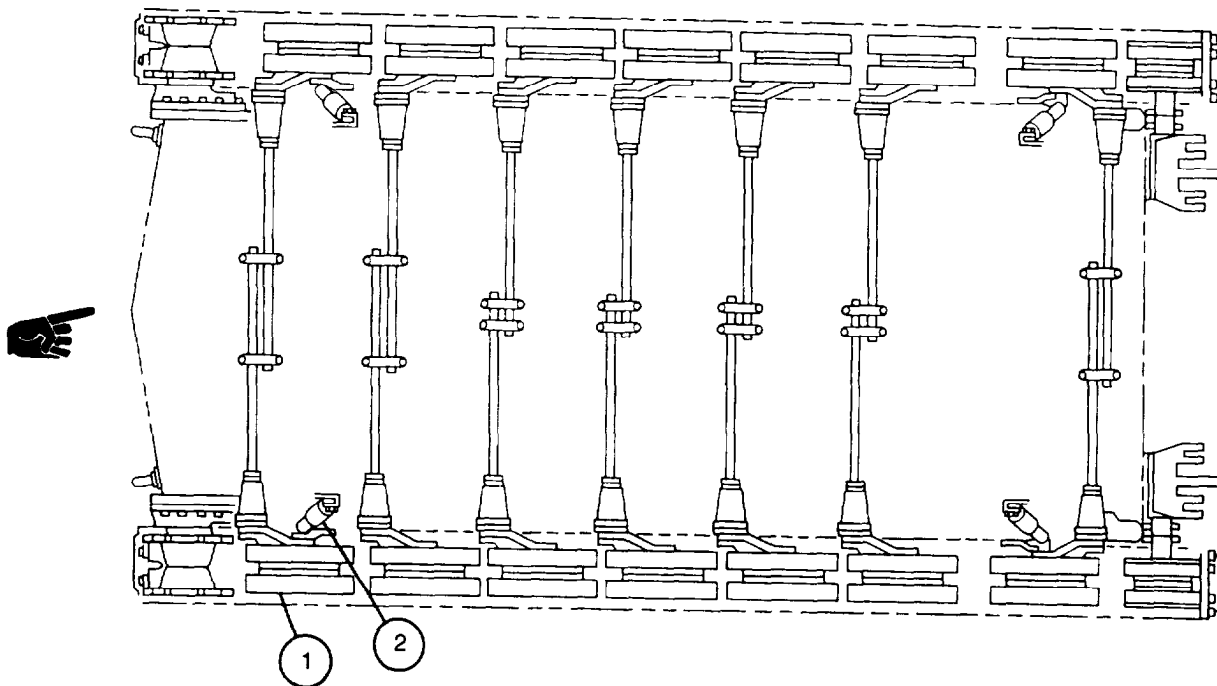
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
4 2	After	Road Wheels and Idler Wheels	<p><u>DRIVER</u></p> <p>a. Check to make sure lug nuts (1) are secure.</p> <p>b. Inspect for missing or separated rubber (2)</p> <p>c. Check for elongation of mounting bolt holes by inspecting for loose paint or bare metal around the lug nuts (1).</p>	<p>Missing, bent, or cracked road-wheel or idler wheel.</p> <p>Chunking across 50 percent or more of bonding surface.</p> <p>Mounting holes are elongated on any wheel.</p>

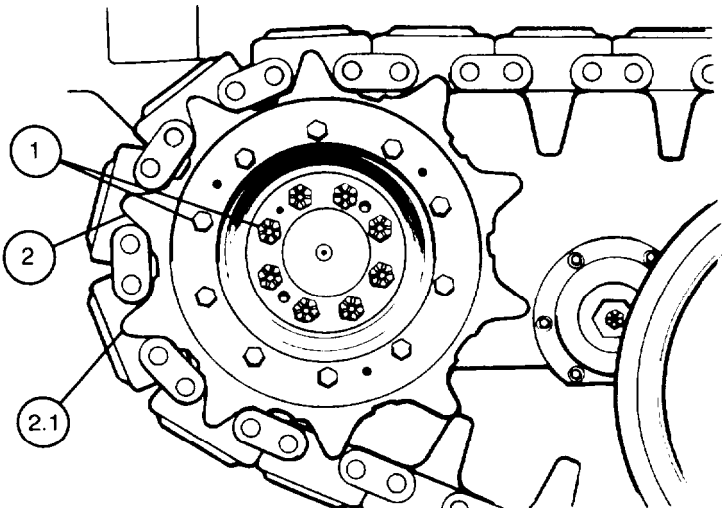
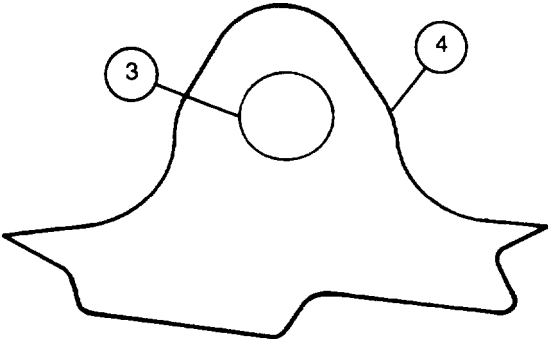


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

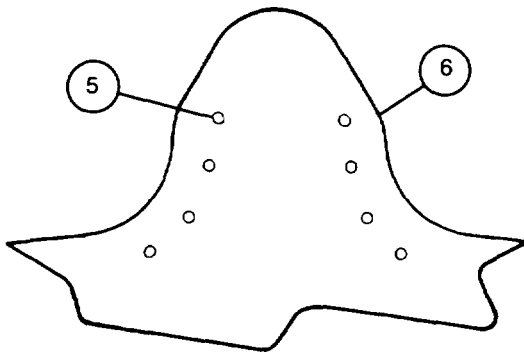
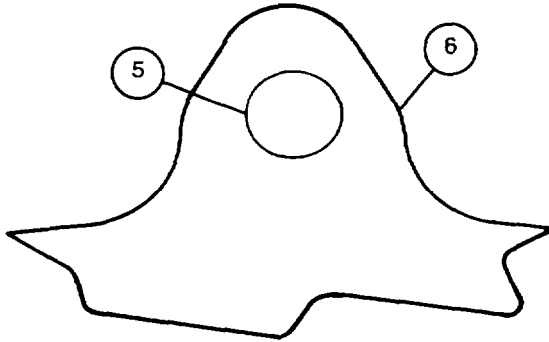
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Jot Fully Mission Capable If:
4 3	After	Wheel Hubs, Shock Absorbers	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>WARNING</b></div> <p>Wheel hubs may be hot after operation. Use care to prevent injury.</p> <p>a. Check for overheated wheel hubs (1). Immediately after operation, feel all wheel hubs cautiously for noticeable variation in temperature between components. An overheated hub indicates a maladjusted, inadequately lubricated, or damaged bearing.</p> <p>b. Feel the lower end of the shock absorbers (2) cautiously and check for variation of temperature between hull area and shock absorber. If shock absorber is operating properly, it should be warmer than the hull area around the shock absorber. If the shock is cold or overheating occurs, notify unit maintenance.</p>	



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

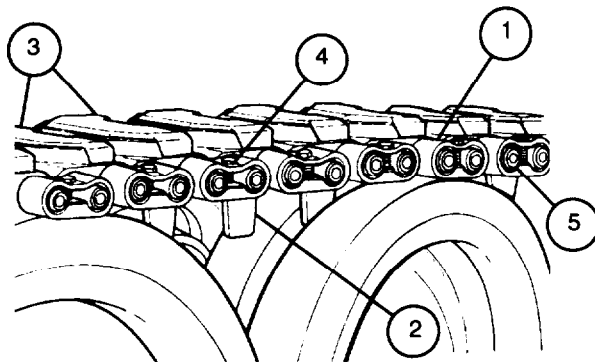
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
44	After	Final Drive Sprockets	<p><u>DRIVER</u></p> <p>a. Check for loose or missing nuts and bolts (1) on final drive sprocket (2). If any are loose or missing, notify unit maintenance. Check for cracked, broken, or missing sprocket teeth (2.1). If any are cracked, broken, or missing, notify unit maintenance.</p>  <p>b. The T-136 track has two types of final drive sprockets (2). Follow the procedures that match the type of final drive sprocket available.</p> <p>1. Visually check wear marks (3) on two teeth (4).</p> 	<p>Any nuts or bolts (1) are loose or missing. Any sprocket tooth (2.1) is cracked, broken or missing.</p> <p>Tooth (4) is worn to edge of wear mark (3).</p>

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

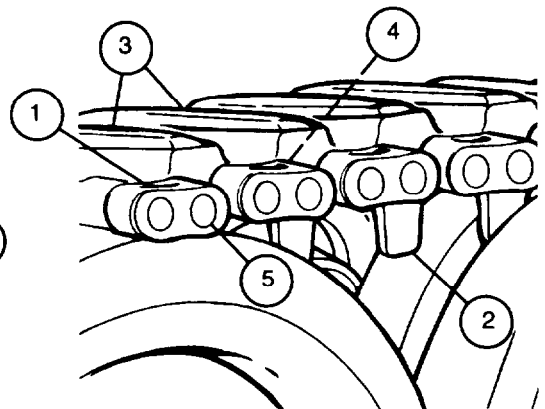
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Jot Fully Mission Capable If:
4 4	After	Final Drive Sprockets (Cont)	<p><u>DRIVER</u></p> <p>2. Visually check wear marks (5) on tooth (6). If wear mark disappears, notify unit maintenance.</p>  <p>c. Check T-154 track sprocket teeth for excessive wear. Visually check wear marks (5) on two teeth (6).</p> 	<p>Near mark (5) on final drive sprocket is not visible.</p> <p>One or more sprocket teeth are worn into edge of wear indicator.</p> <p>One or more sprocket teeth are showing excessive wear.</p>

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
45	After	Track Shoes, End Connector, Center Guides, Wedges, Bolts, and Bushings	<p><u>DRIVER</u></p> <p>a. Check for loose, damaged, or missing end connectors (1), center guides (2), track shoes (3), and wedges and bolts (4).</p> <p>b. Check track shoe (3) for damaged pins (5), missing pad nuts, and any unusual gaps between two adjacent track shoes which indicate worn bushings.</p> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• Worn bushings are very difficult to locate. Worn bushings will cause the pin to appear off-center. It may have protruding pin or track pad nut and unusual gaps between two adjacent track shoes.</li> <li>• Worn or missing track pads and track pad nuts must be replaced. Notify unit maintenance.</li> </ul> <p>c. Check track shoe (3) for damage. Report damaged track assembly to unit maintenance. Damage includes cracked or broken shoe body and chunked or missing road wheel rubber.</p>	<p>End connectors (1) are missing or cracked.</p> <p>Center guides (2) are missing.</p> <p>Any wedge or bolt (4) is missing.</p> <p>Any one track shoe (3) has worn bushings, protruding pin, or missing track pad nut.</p> <p>Any one bushing deemed unserviceable.</p> <p>Any track shoe (3) is bent, broken, or cracked.</p> <p>Any pin is bent, broken, or missing.</p> <p>Any one track shoe (3) body is bent, cracked, or broken.</p>

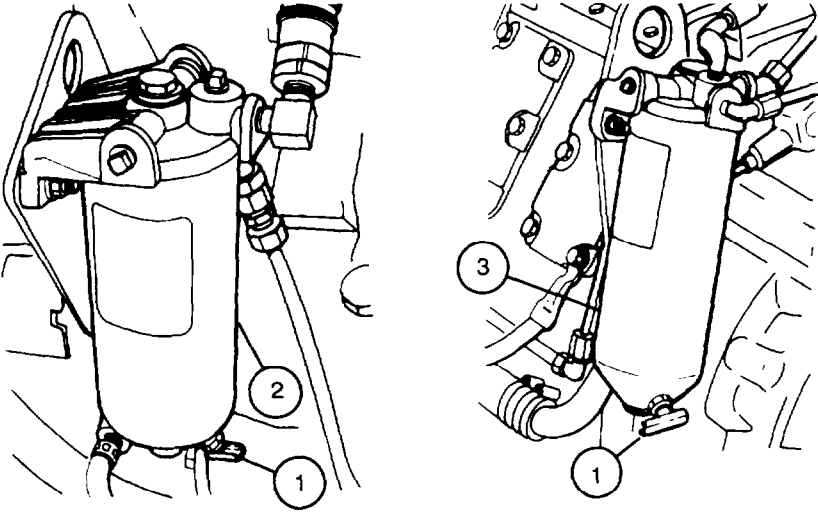
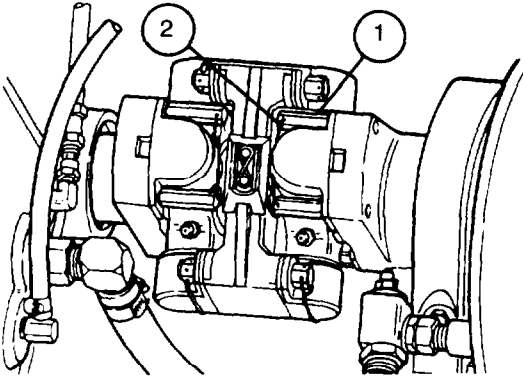


T-154 TRACK



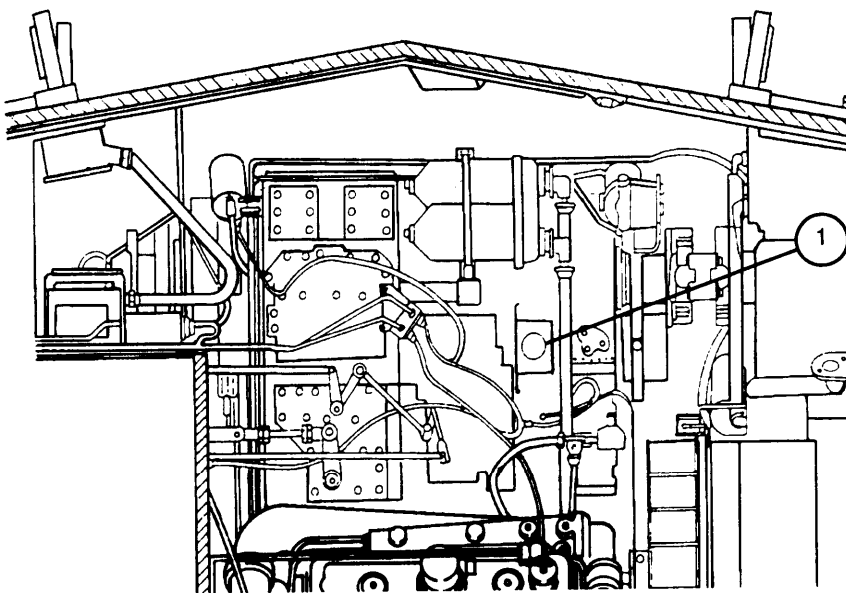
T-136 TRACK

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
46	After	Primary and Secondary Fuel Filters	<p><u>DRIVER</u></p> <p>Open bottom drain cocks (1) and drain water until clear fuel flows from primary fuel filter (2) and secondary fuel filter (3). Close drain cocks and turn on FUEL PRIME switch for 45 seconds before starting vehicle to purge fuel filters.</p> 	Any Class III leak is found.
47	After	Universal Joint (Both sides)	<p><u>DRIVER</u></p> <p>Open transmission access door. Check for loose, broken, or missing mounting screws (1). Check for missing or broken lockwire (2). Notify unit maintenance if these conditions exist.</p> 	Any universal joint screw is loose, broken or missing. Lockwires are missing or broken.

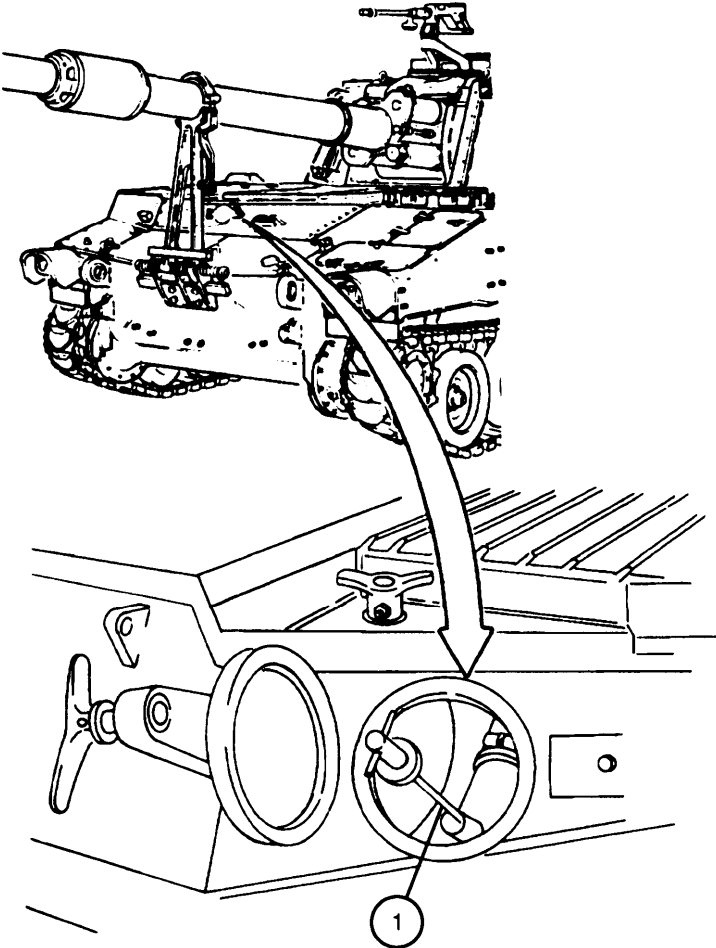
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
48	After	Transmission Oil Level	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>Powertrain assemblies must use lubricating oil (item 26, Appx D) while under warranty.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>New transmissions are delivered with preservative PE-10-1 oil. Until first scheduled oil change, maintain proper oil level by adding lubricating oil (item 27, Appx D) or lubricating oil (item 25, Appx D).</p> <p>Check transmission oil level. Level should be within the OPERATING RANGE area stamped on dipstick (1). Add or drain transmission oil as required with lubricating oil (item 27, Appx D).</p>	<p>No oil evident on dipstick.</p>



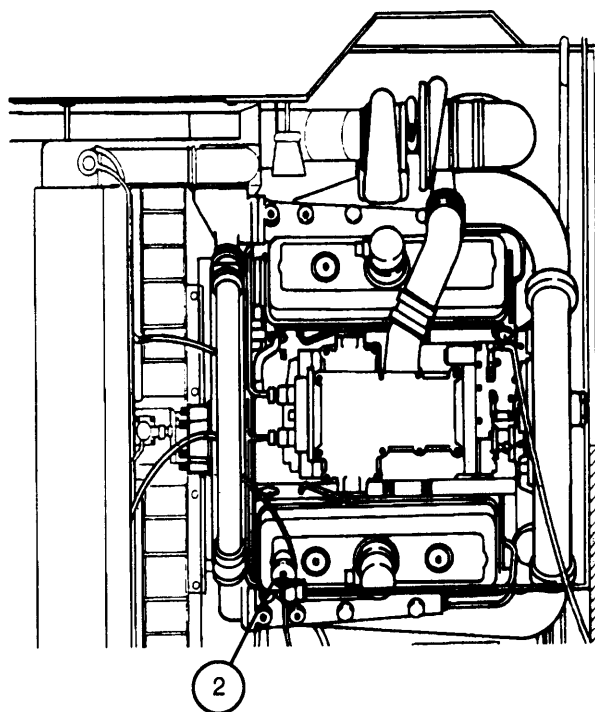


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

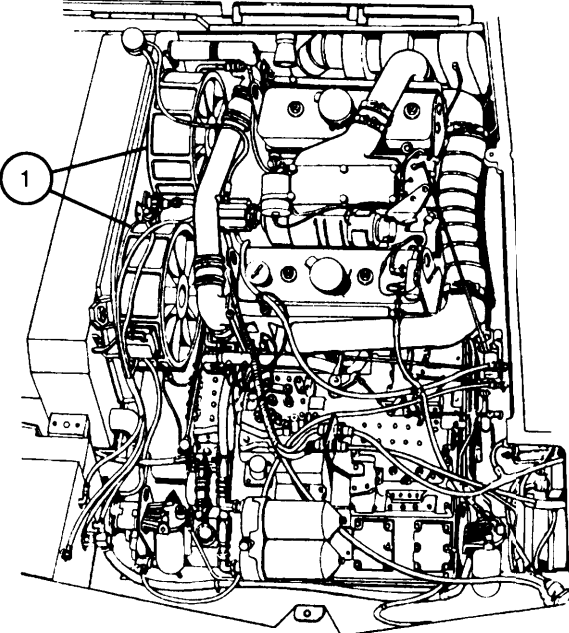
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
49	After	Engine Oil Level	<p><u>DRIVER</u></p> <p style="text-align: center;"><b>NOTE</b></p> <p>Perform engine oil level check with vehicle on level ground if possible.</p> <p>a. Engine oil level will take approximately 20 minutes to stabilize in engine crankcase. After 20 minutes, check engine oil level; it should be between L (low) and F (full) marks on engine oil level dipstick (1).</p> 	Engine oil level on engine oil level dipstick (1) is below L mark.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
4 9	After	Engine Oil Level (Cont)	<p><u>DRIVER</u></p> <p>b. Crankcase engine oil filler cap (2) is located in engine compartment. Add oil as required to bring level between L (low) and F (full) marks on engine oil level dipstick (1).</p>	

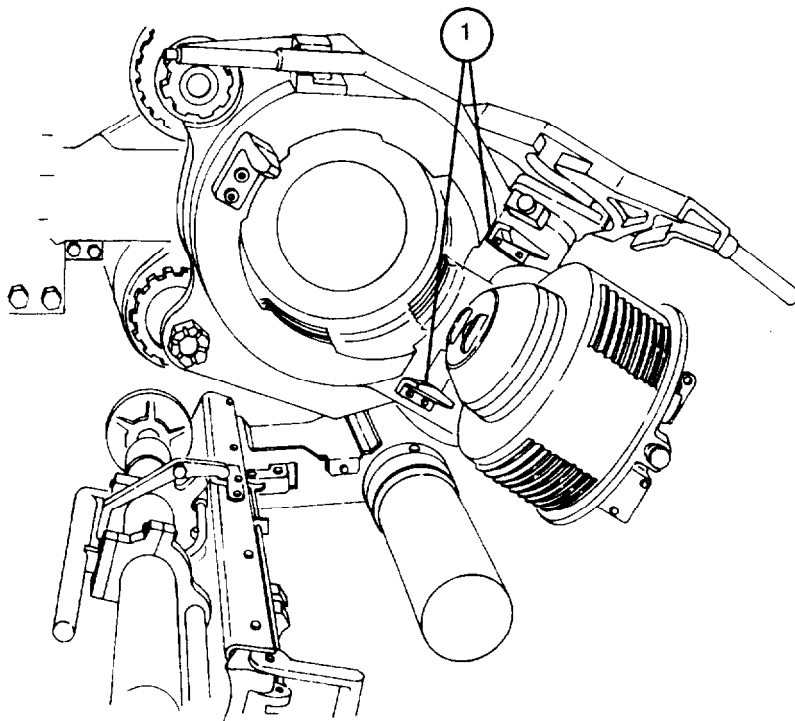


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
50	After	Fan (Radiator)	<p><u>DRIVER</u></p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>To prevent injury or death to personnel, keep hands and loose clothing away from fans when engine is running.</p> <ol style="list-style-type: none"> <li>a. Open air intake grille and transmission access doors.</li> <li>b. Check for coolant leaks and serviceability of hoses.</li> <li>c. Inspect fans (1) for missing or damaged impellers. Damage includes cracked, chipped, or broken impellers. If impellers are damaged, notify unit maintenance.</li> <li>d. Start engine, Check for oil leaks at fan drive. Check that both fans (1) are turning. If both fans are not turning, shut down engine and notify unit maintenance.</li> </ol> <div style="text-align: center; margin-top: 20px;">  </div>	<p>Class III leak is found.</p> <p>Fan (1) impellers are missing, cracked, chipped, or broken.</p> <p>Either fan (1) does not turn when engine is running.</p>
51	After	Torsion Bars	<p><u>DRIVER</u></p> <p>Check for broken torsion bars by prying up road wheel.</p>	<p>Any torsion bar is broken or missing.</p>

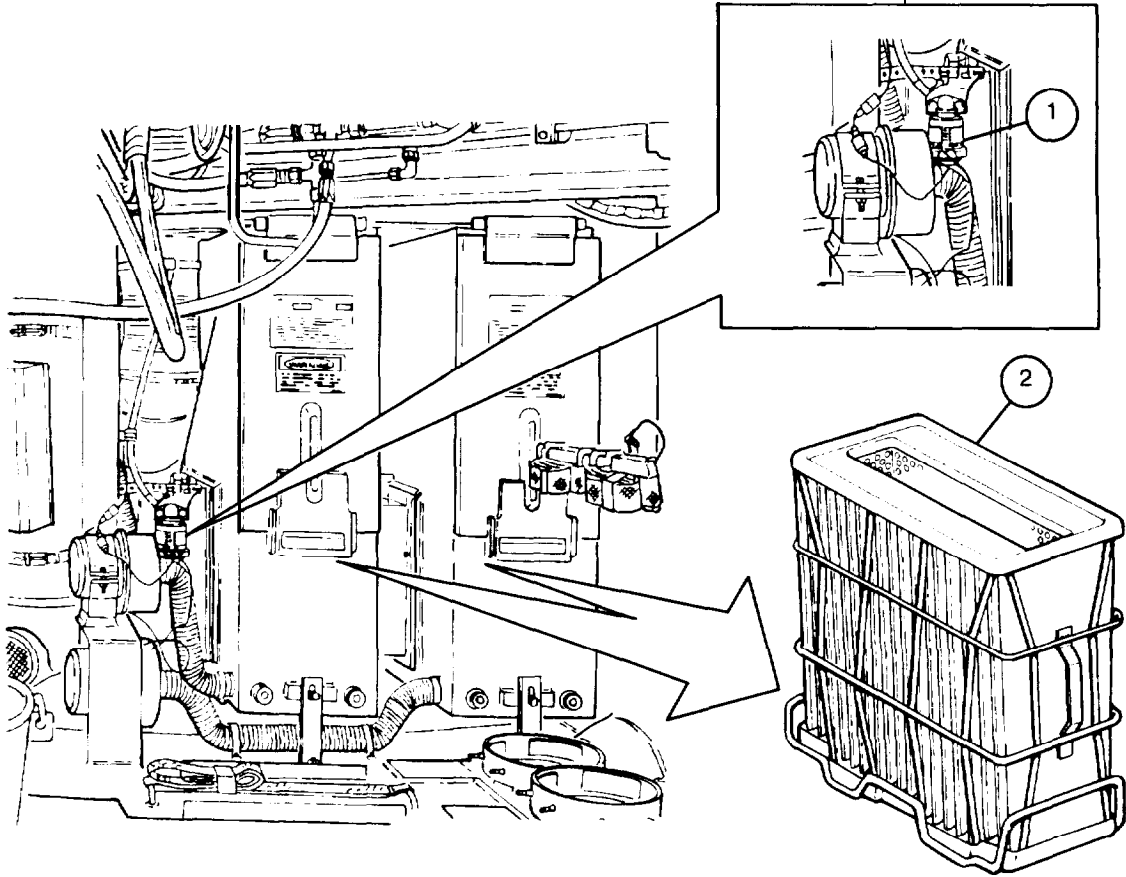
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
52	After	Spindle Assembly	<u>CANNONEER NO. 1</u>  Check and clean spindle assembly.	
53	After	Breech Ring Body Lugs	<u>CANNONEER NO. 1</u>  Visually inspect breech ring body lugs (1) for loose or missing setscrews.	Any setscrew is loose or missing.



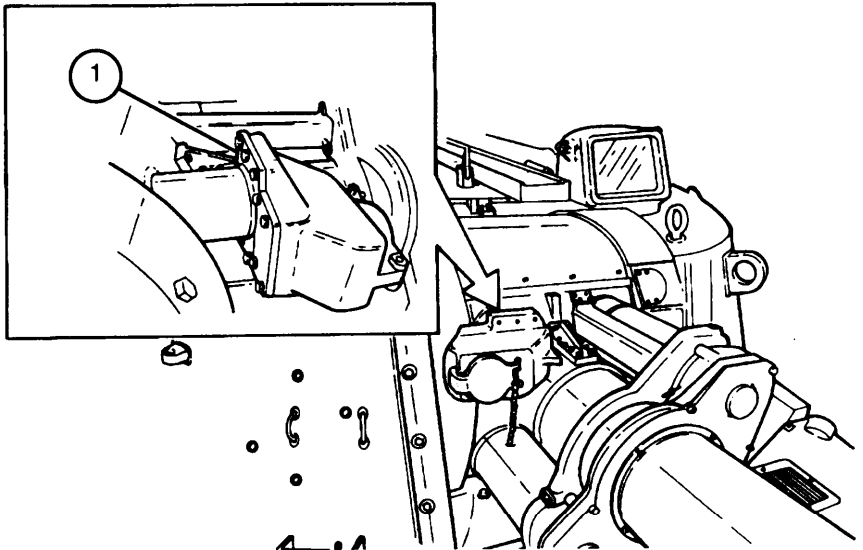
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
54	After	Air Cleaner Indicator	<p><u>DRIVER</u></p> <p style="text-align: center;"><b>NOTE</b></p> <p>Air cleaners should be checked daily in dusty conditions.</p> <p>a. Check air cleaner restriction indicator (1) for gage reading. If the air cleaner restriction indicator reads 20 to 24 in. H<sub>2</sub>O, clean the air cleaner filter packs (2) at the next service interval. If the air cleaner restriction indicator reads 25 in. H<sub>2</sub>O or greater, clean and service air cleaner filter packs. Blow air cleaner filters out with low pressure air and wash with warm water if needed. If washed, allow air cleaner filters to completely dry before reinstallation.</p> <p>b. Check air cleaner doors, seals, and hoses.</p>	<p>Any air cleaner filter, hose, or seal is missing or damaged.</p> <p>Doors do not seal properly.</p> <p>Any leakage of unfiltered air into intake system is evident.</p>

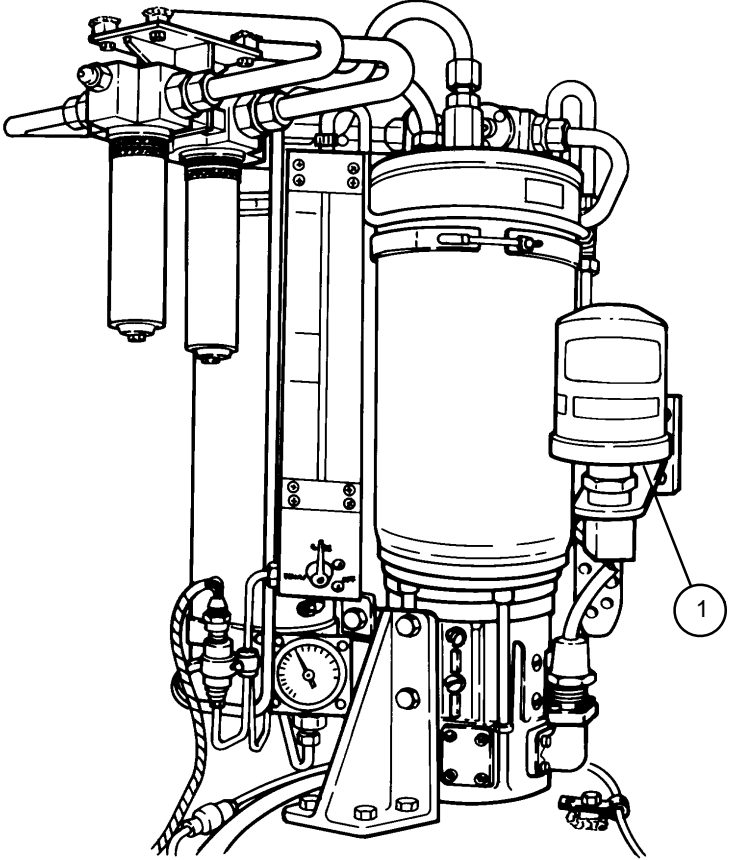


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
5 5	After	M42 Tank Periscope	<p><u>ASSISTANT GUNNER</u></p> <p>a. After firing, check M42 tank periscope (1) for moisture, fungus, dirt, or condensation within field of view.</p> <p>b. Clean window and close cover.</p>	

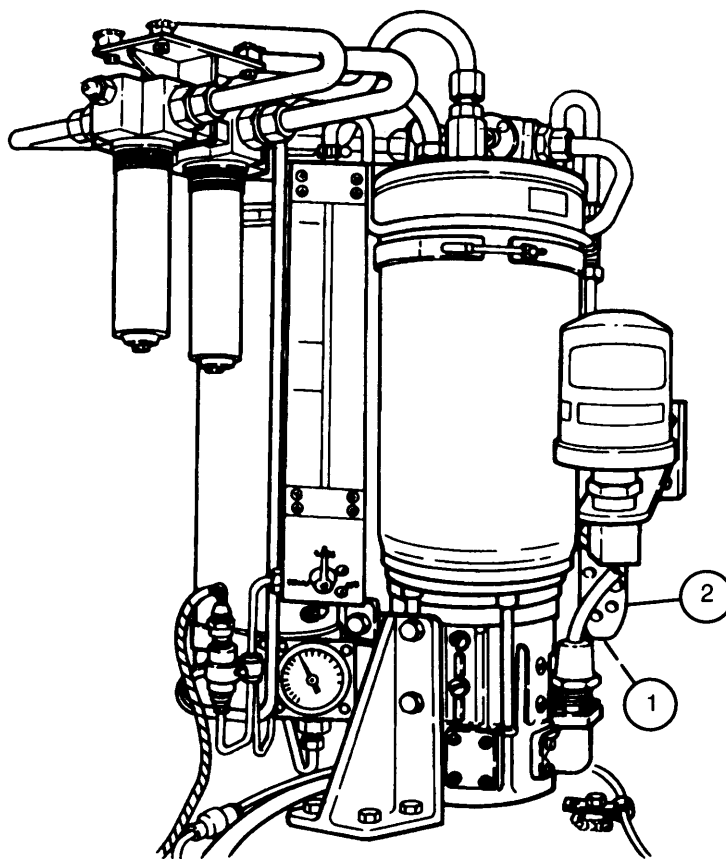


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
56	After	Hygroscopic Breather (M109A4/M109A5)	<p><u>CHIEF OF SECTION</u></p> <p>Check hygroscopic breather (1) color indicator. If color is blue or white, hygroscopic breather is functioning. If color is speckled pink or yellow, notify unit maintenance.</p> 	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

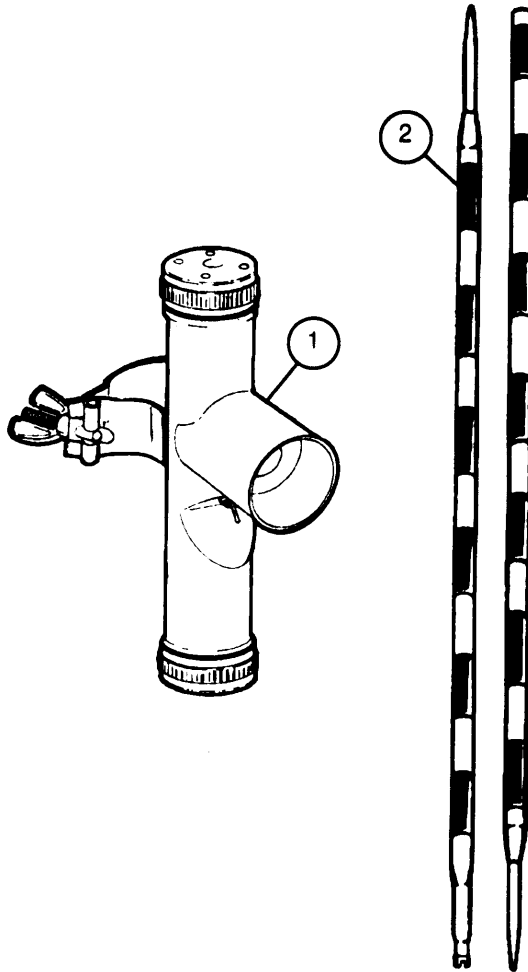
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
57	After	Air Line Filter (M109A4/M109A5)	Drain collected fluids in valve (1) on air line filter (2).	



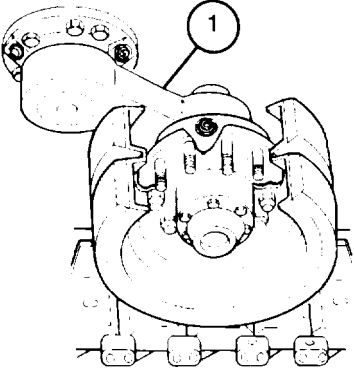
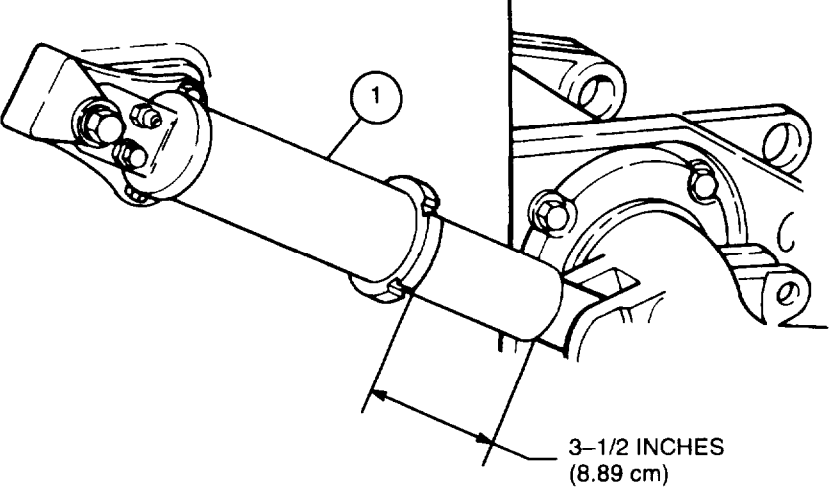


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
58	After	M14 Aiming Post Light and M1A2 Aiming Posts	<p><u>CANNONEER NO. 2</u></p> <p>a. After firing, check batteries of M14 aiming post light (1). Make sure light is operational.</p> <p>b. Check for damage to M1A2 aiming posts (2),</p> <p>c. Clean, remove, and stow batteries,</p>	

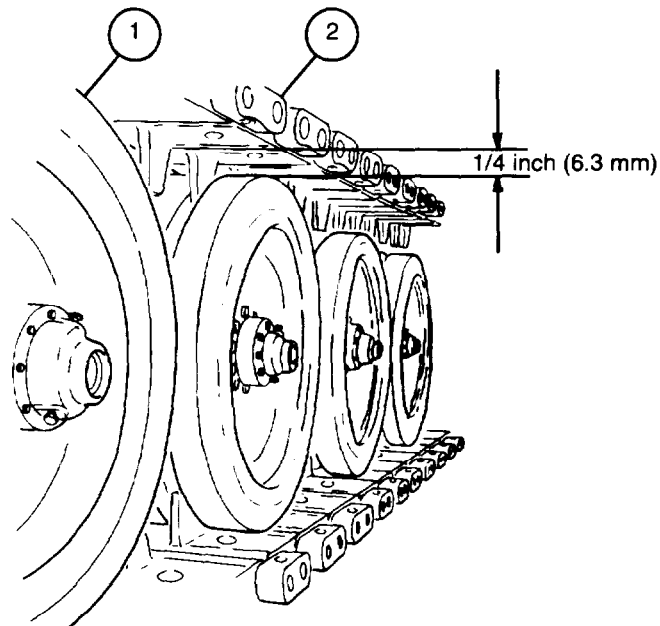


**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

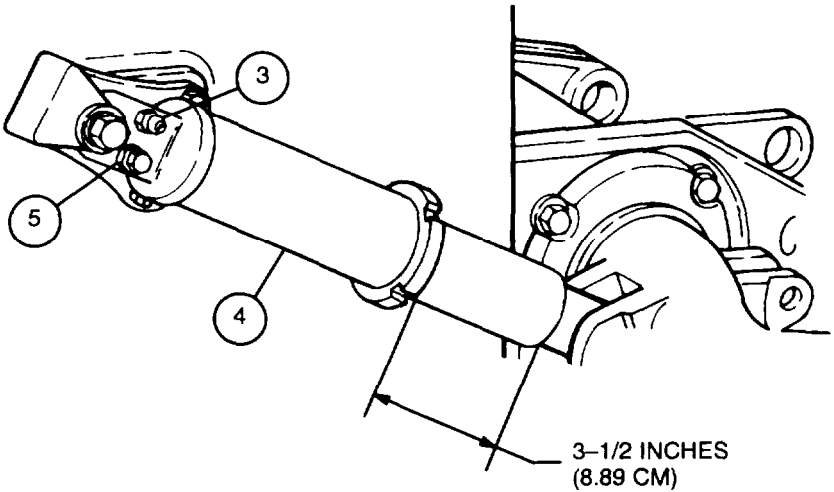
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
59	Weekly	Road Wheel Arms	<p><u>DRIVER</u></p> <p>Check for bent or broken road wheel arms (1).</p> 	Any road wheel arm (1) is bent or broken.
60	Weekly	Track Adjusters	<p><u>DRIVER</u></p> <p><b>NOTE</b></p> <p>When track adjuster has reached the maximum extended limit of 3-1/2 inches (8.89 cm), remove one track shoe assembly and readjust track tension.</p> <p>Check for bent or broken track adjusters (1).</p> 	Track adjuster (1) is bent, broken, or beyond maximum limits.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

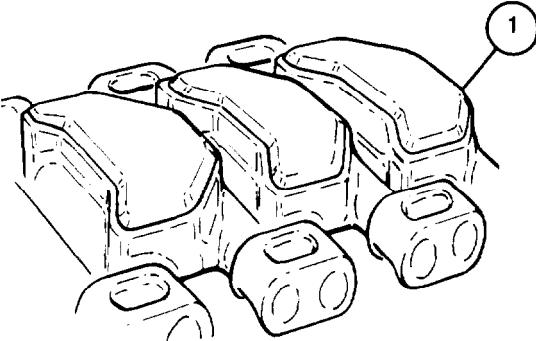
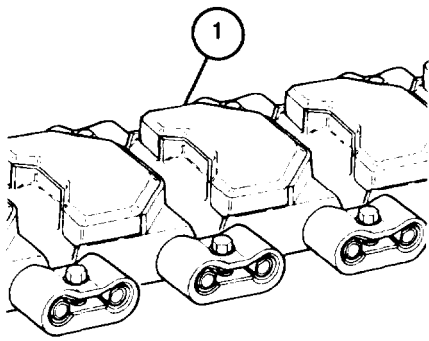
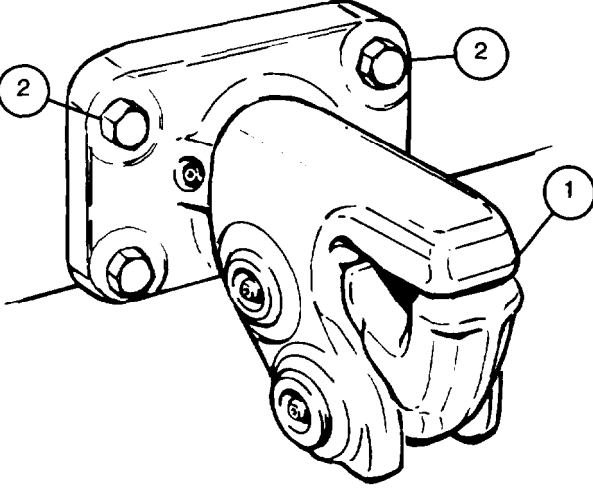
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
61	Weekly	Track Tension	<p><u>DRIVER</u></p> <p>Move vehicle back and forth several times on level ground. Stop by shifting transmission shift control to N and coasting to a stop. Turn off engine. Measure distance between top of the third road wheel (1) and the track (2). The distance should be 1/4 inch (6.3 mm). If not, adjust track tension.</p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p><b>CAUTION</b></p> </div> <p>When increasing track tension, do not let track adjuster extend beyond 3-1/2 inches (8.89 cm) to avoid track adjuster damage.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>When track adjuster has reached the maximum extended limit of 3-1/2 inches (8.89 cm), remove one track shoe and readjust track tension.</p> <p>To increase track tension, pump grease (item 17, Appx D) into clean lubrication fitting (3) on track adjuster (4) until correct tension is obtained.</p>	Track tension will not adjust.



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

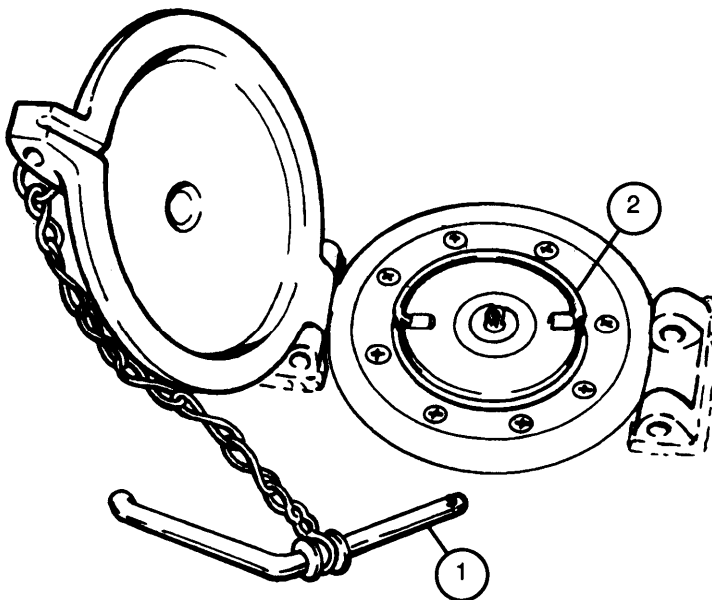
Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable if:
61	Weekly	Track Tension (Cont)	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>Lubricant is under high pressure. Loosen bleeder plug slowly to avoid injury to personnel.</p> <p>To decrease track tension, open bleeder plug (5) on track adjuster and reduce pressure until tension is released. Tighten bleeder plug and wipe away excess grease.</p> <div style="text-align: right; margin-top: 20px;">  </div>	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
62	Weekly	Track Pad Assemblies	<p><u>DRIVER</u></p> <p>Check to make sure all track pad assemblies (1) are present and not worn to the point where grouser (metal surface of track shoe) can damage road surface.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>T-136 TRACK ASSEMBLY</p> </div> <div style="text-align: center;">  <p>T-154 TRACK ASSEMBLY</p> </div> </div>	
63	Weekly	Towing Pintle	<p><u>DRIVER</u></p> <ol style="list-style-type: none"> <li>a. Check towing pintle (1) for proper operation.</li> <li>b. Inspect towing pintle (1) for loose mounting screws (2).</li> </ol> <div style="text-align: center;">  </div>	

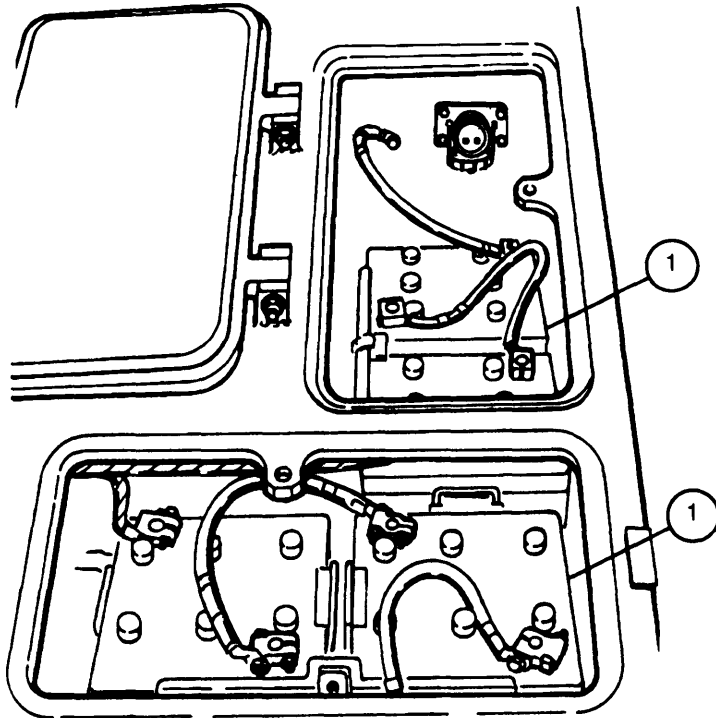
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
64	Weekly	External Power Receptacle (M109A4/M109A5)	<p><u>DRIVER</u></p> <p>Check serviceability of external power receptacle.</p>	
65	Weekly	Fuel Tank Access Door	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>CAUTION</b></div> <p>Remove any debris from around fuel tank access door to prevent equipment damage.</p> <ol style="list-style-type: none"> <li>a. Make sure locking pin and safety chain (1) are present and not broken.</li> <li>b. Remove fuel filler cap (2) and inspect fuel filler cap and gasket.</li> <li>c. Remove fuel filter screen, clean, and reinstall.</li> </ol>	



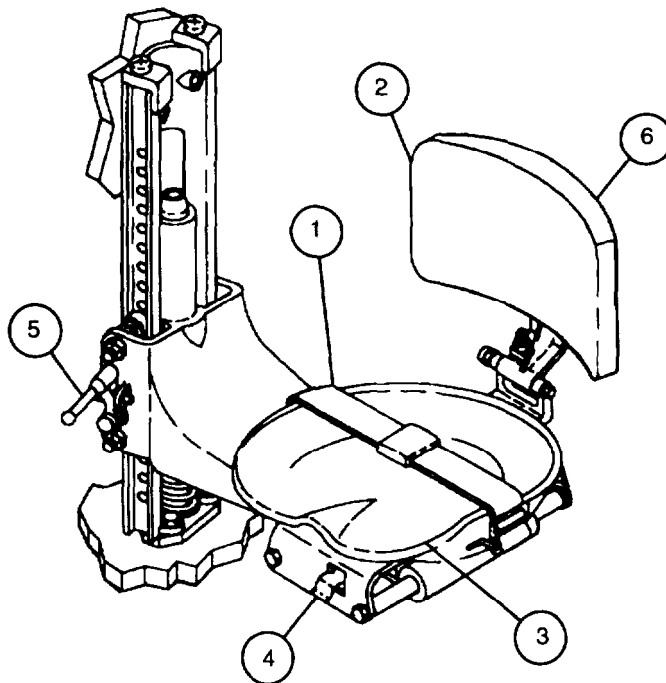
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER — CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
6 6	Weekly	Batteries	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p><b>WARNING</b></p> </div> <p>Lead-acid battery gases can explode. Do not smoke, have open flames, or make sparks around a battery, especially if the caps are off. If any gassing exists, notify unit maintenance since it can explode and cause injury to equipment and personnel.</p> <ol style="list-style-type: none"> <li>a. Check electrolyte level. Level should be above battery (1) cover plates. If low, fill to proper level with distilled water (item 13, Appx D).</li> <li>b. Check that battery (1) cable connections are tight and are not corroded. If loose or corroded, notify unit maintenance.</li> <li>c. Clean battery (1) caps and tighten. Coat battery lugs with light coat of grease (item 17, Appx D).</li> </ol>	<p>Any battery (1) is broken or cracked.</p> <p>Any battery (1) cable or terminal is loose.</p> <p>Batteries (1) will not start vehicle.</p>



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
67	Weekly	Lights	<p><u>DRIVER</u></p> <p>Check all lights for operation affecting serviceability.</p>	
68	Weekly	Bilge Pumps	<p><u>DRIVER</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"> <p><b>CAUTION</b></p> </div> <p>Do not run bilge pumps for more than 1 minute dry, or more than 15 minutes wet without starting engine to prevent equipment damage.</p> <p>Test operation of each bilge pump. If a bilge pump is dry, feel for airflow at air outlet when pump is running.</p>	
68.1	Weekly	Seats	<p><u>DRIVER</u></p> <p>Inspect seat belt (1), seat and backrest cushions (2 and 3) for deterioration. Make sure seat belt (1) buckle and end plate engage securely. Make sure seat adjustment levers (4 and 5) securely lock seat in all positions. Fold and unfold backrest (6) and check for binding. Check for loose or missing mounting hardware.</p>	

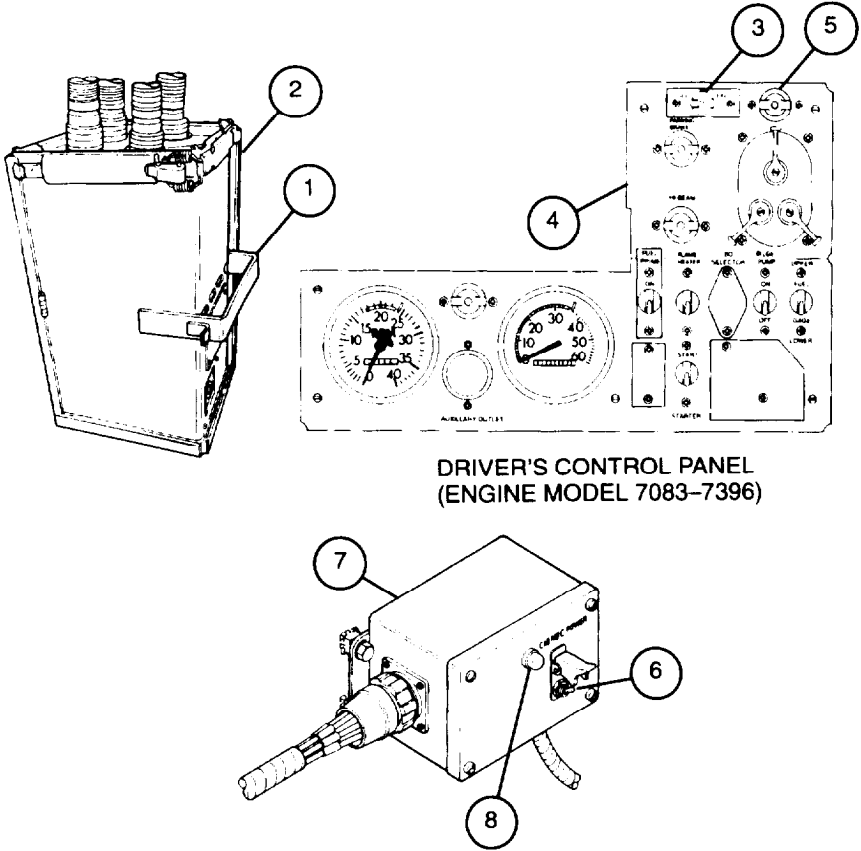




**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
69	Weekly	Driver's Hatch	<u>DRIVER</u> a. Check driver's hatch cover seal for tears or deterioration. b. Check for proper operation.	
70	Weekly	Winterization Heater Kit	<u>DRIVER</u>  <p style="text-align: center;"><b>NOTE</b></p> (Seasonal) Check only when operation is required. Check for proper operation. Inspect for any fuel or exhaust leakage and electrical shorts.	Any electrical short is found.  Any exhaust leak is found.  Any Class III fuel leak is found.
71	Weekly	Personnel Heater	<u>DRIVER</u>  <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"><b>WARNING</b></div> <ul style="list-style-type: none"> <li>• If the personnel heater operates improperly, fuel may overflow, causing danger of fire or explosion.</li> <li>• Be alert during personnel heater operation for exhaust odors or signs of exposure to carbon monoxide. Carbon monoxide can cause death. If present, shut off the personnel heater and ventilate the vehicle.</li> <li>• Explosive/flammable materials are a fire hazard. Do not store aerosol cans, solvents, fuel, etc., anywhere inside vehicle. Stow ammunition and powder in authorized stowage racks.</li> <li>• Fumes may accumulate in the ventilating air circuit or the personnel heater may be damaged by reverse burning if it is not operated for at least five minutes each time it is started.</li> </ul> <p>a. Operate personnel heater for at least five minutes each week. Be alert for signs of damage, loose fittings, loose connections, and fuel leaks; notify unit maintenance if any are found.</p> <p>b. Check crew/driver duct outlets for steady warm output. If there is no warm air output, shut off heater and notify unit maintenance.</p>	Loose fittings, loose connections, or fuel leak exists.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
72	Weekly	NBC System M 109A4/M109A5)	<p><u>CHIEF OF SECTION AND CREW</u></p> <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"><b>WARNING</b></div> <p>NBC contaminated filters must be handled using adequate precautions and must be disposed of by trained personnel.</p> <ol style="list-style-type: none"> <li>a. Open spring clip (1) on M2A2 air purifier (2). Turn NBC switch (3) on driver's fixed instrument panel (4) to ON position. Ensure NBC indicator light (5) lights. Place switch (6) on NBC control box assembly (7) to ON position. Ensure indicator light (8) lights.</li> <li>b. Inspect hoses for leaks, splits, and abrasions.</li> <li>c. Connect M25A1 masks to all six stations and check that air is entering all M25A1 masks.</li> </ol> <div style="text-align: center; margin-top: 20px;">  <p><b>DRIVER'S CONTROL PANEL (ENGINE MODEL 7083-7396)</b></p> </div>	

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

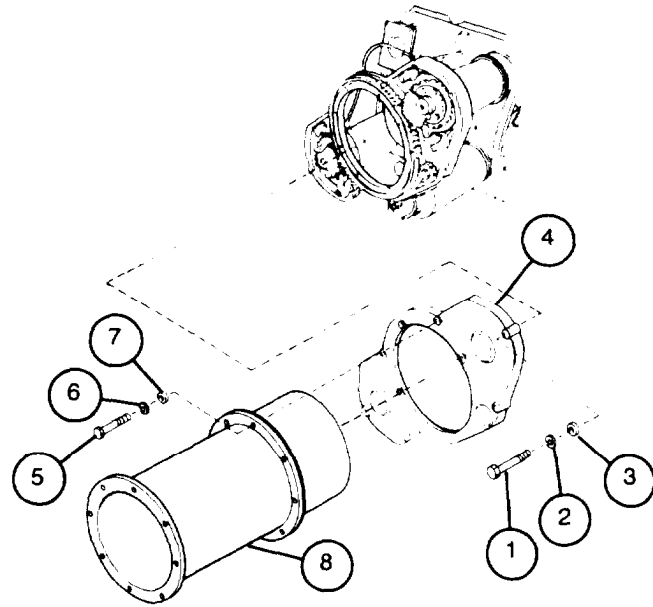
Item No.	Interval	Location Item to Check/ Service	<u>Crewmember</u> Procedure	Not Fully Mission Capable If:
72.1	Weekly	Ammunition Tie Down Strap	<p><u>CHIEF OF SECTION AND CREW</u></p> <p><b>NOTE</b></p> <p>Operation of vehicle with missing or damaged ammunition tie down strap may violate AR 385-55.</p> <p>Check tie down strap and buckle(s) for presence and damage.</p>	
73	Monthly	Bore Evacuator Setscrew	<p><u>CHIEF OF SECTION</u></p> <p><b>NOTE</b></p> <p>Setscrew is removable to provide access to release bearing ball.</p> <p>Inspect setscrew holding bearing ball and spring in place. This setscrew must be staked to prevent loosening which will cause bore evacuator to rotate. If this setscrew is not staked, notify unit maintenance.</p>	Setscrew is missing.

**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
73.1	Monthly	Muzzle Brake and Bore Evacuator Assembly Thrust Collar Setscrews	<p><b>CHIEF OF SECTION</b></p> <p>Inspect setscrew (1) holding the ball and spring in place. This setscrew must be staked to prevent loosening which will cause the bore evacuator and muzzle brake thrust collar to rotate. If this screw is not staked, notify unit maintenance.</p> <p><b>NOTE</b></p> <p>Setscrew (2) is removable to provide an access to release the ball lock. It should not be staked.</p> <div data-bbox="541 753 1384 1285" style="text-align: center;"> </div> <p>To inspect locking ball and spring, remove unstaked screw and insert screwdriver in hole. Push against lock ball to see if ball moves around freely. If ball moves freely and there's no resistance from spring, notify unit maintenance.</p> <p>Separate main reservoir (3) and prereservoir (4) (para 3-6.7.1). Clean and lubricate three metering orifices (5), nine evacuator ball valves (6), 10 evacuator holes (7), tube threads (8) and ring valve (9) (Appendix G).</p> <p><b>NOTE</b></p> <p>After installing setscrew (1) notify unit maintenance for torquing.</p>	<p>Staked setscrew is missing.</p> <p>Ring valve is broken, cracked, or deformed.</p> <p>If three or more balls are missing.</p>

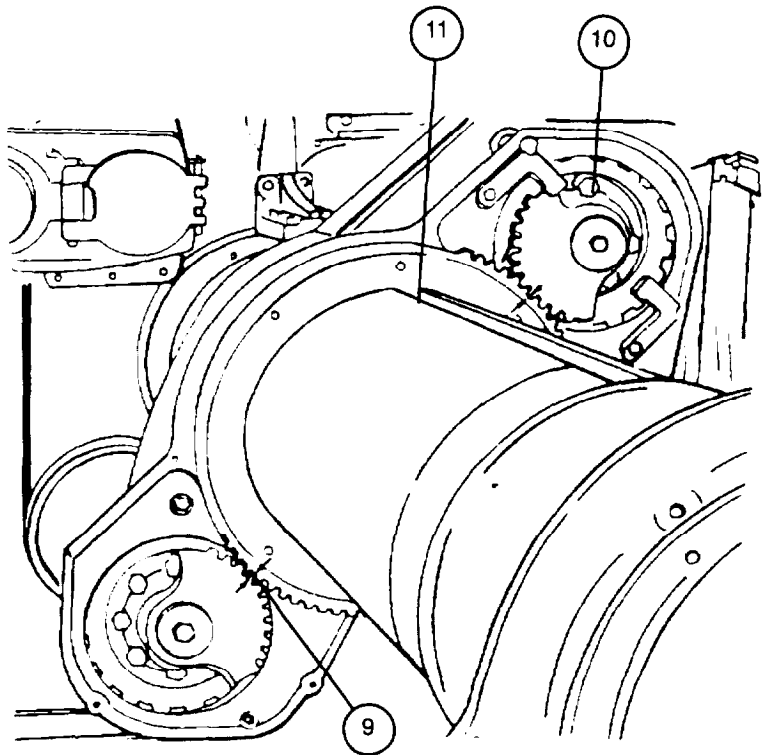
**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
74	Monthly	Traversing Mechanism Assembly	<p><u>GUNNER</u></p> <p>Position howitzer on a 5° slope or canted 90 mils, by using blocks under one side of the track assembly. When howitzer is canted, traverse in the direction of the low side in power and switch to manual traverse to check the traversing no-back bearing unit.</p>	
75	Quarterly	Variable Recoil Assembly	<p><u>CHIEF OF SECTION</u></p> <p>Inspect and service as follows:</p> <ol style="list-style-type: none"> <li>a. Remove six machine bolts (1), six lockwashers (2), and six flat washers (3) from variable recoil access cover (4).</li> <li>b. Remove four machine bolts (5), four lockwashers (6), and four flat washers (7) from dust shield (8).</li> </ol>	



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES FOR M109 SELF-PROPELLED HOWITZER**

Item No.	Interval	Location Item to Check/ Service	Crewmember Procedure	Not Fully Mission Capable If:
75	Quarterly	Variable Recoil Assembly (Cont)	<p><u>CHIEF OF SECTION</u></p> <p>c. Elevate cannon tube and check operation of variable recoil assembly components.</p> <p>d. Index arrows (9) should begin to separate between 600 mils and 800 mils. If arrows do not separate, notify unit maintenance.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>M109A2/M109A3/M109A4 M185 cannon assembly has one torque key groove. M109A5 M284 cannon assembly has two torque key grooves.</p> <p>e. Check for dirt/water accumulation and rust on sector gears (10) and torque key groove (11).</p> <p>f. Lubricate sector gears (10) and torque key groove (11) with grease (item 19, Appx D) or grease (item 18, Appx D) and replace dust shield (8) and variable recoil access cover (4).</p>	Arrows do not separate.



**Table 2-1. PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
FOR M109 SELF-PROPELLED HOWITZER - CONTINUED**

Item No.	Interval	Location Item to Check/ Service	<u>Crewmember Procedure</u>	Not Fully Mission Capable If:
76	*	Fire Control Instru- ments	<u>CHIEF OF SECTION AND CREW</u>  Perform fire control alinement tests and measure- ments.	Howitzer fails fire control aline- ment.

\*Fire control alinement tests are performed by the section crew members under the supervision of the battery executive officer, chief of firing battery, and artillery mechanic. These tests are performed at the discretion of the unit commander, Suggested intervals for these tests are as follows.

1. Once each year if the cannon is used for non-firing training.
2. Once every 3 months if the cannon is fired.
3. As soon as possible after extensive use.
4. Following accidents.
5. After traveling over extremely rough terrain.
6. When fire control mounts have been replaced.
7. When the cannon fires inaccurately for no apparent reason.
8. When the cannon tube is replaced.

## Section III. OPERATION UNDER USUAL CONDITIONS

### 2-7 GENERAL

This section contains instructions for operating the vehicle under usual conditions. Operating the vehicle under unusual conditions is covered in Section IV. of this chapter.

#### WARNING

- To prevent loss of control, drive carefully, especially if unfamiliar with vehicle.
- If you lose a track (break a track shoe or vehicle throws a track), extreme caution must be exercised in maintaining control. Immediately release accelerator and let the vehicle coast to a stop. Do not apply braking action, i.e., brake pedal, laterals, pivot or any type of steering controls. This causes the vehicle to pull to the active or good track and could result in a rollover. If it is absolutely necessary, apply braking action only and we stress only, if the vehicle is approaching a ravine, a cliff, or if you perceive the outcome to be catastrophic, probably resulting in fatalities. When rollover is imminent, all crew members should immediately withdraw inside the vehicle, tighten seat belts, and hold onto a secure fixture, until the vehicle comes to a complete stop.
- During vehicle operation, wear ear plugs to prevent ear damage from engine noise.
- To prevent injury to personnel, do not move vehicle unless the hatches and doors are secured and equipment is properly stowed.
- Be familiar with all driver's controls. The two stage accelerator is provided to compensate for variations in driver's seat height and in driver's physical characteristics. Do not mistake raised portion of accelerator for a brake. Death or injury could result from failure to heed this warning.
- When a track vehicle gets out of control and overturns, it is safer to stay in the vehicle than to try to get out while the vehicle is still moving. You may receive slight injuries from being thrown against metal parts; but if you try to leave the vehicle, it may roll over and crush you. Once the vehicle stops moving, get out as fast as possible because spilled fuel and oil may catch on fire. The first thing the driver should do in such an emergency is shut off the engine and turn off the MASTER switch to minimize the fire hazard.

#### CAUTION

- Never leave your vehicle unattended while engine is running.
- Transmission must be shifted manually to avoid damage to transmission.
- To prevent engine damage and overheating, set throttle control lever to run engine at 1000 to 1200 rpm on tachometer and run engine for a period of 5 minutes or until coolant temperature is 185° F or below, prior to shutdown.



## 2-7 GENERAL — CONTINUED

### CAUTION

- To prevent damage and overheating of engine and transmission when starting from a halt, begin with transmission in Range 1.
- To prevent transmission from overheating, do not hold howitzer on incline with transmission in gear.

## 2-8 ASSEMBLY AND PREPARATION FOR USE

Before operating a new vehicle, make sure unit maintenance has performed all service upon receipt procedures.

## 2-9 INITIAL ADJUSTMENTS AND CHECKS

### 2-9.1 Routine Checks

Check the controls before starting the vehicle and ensure all of the following conditions are met.

- 1 Before operation PMCS procedures have been performed (Table 2-1).

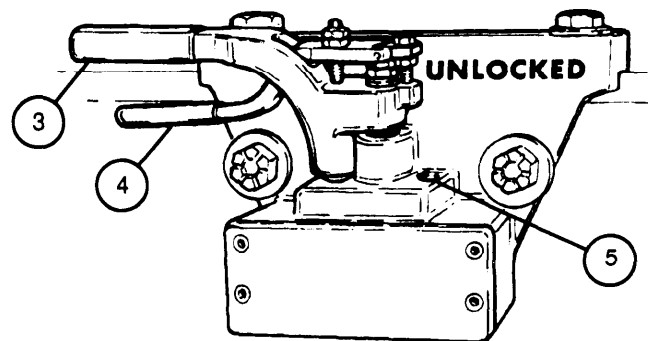
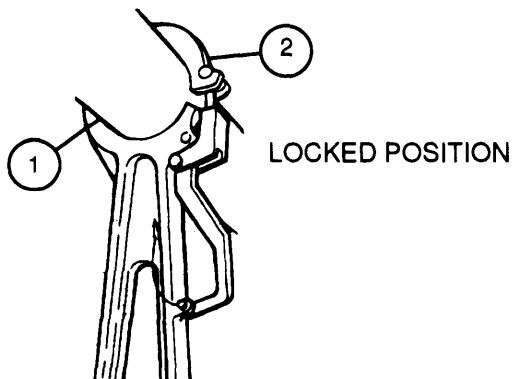
### CAUTION

Do not drive vehicle with cannon tube out of travel lock assembly. Operation with cannon tube out of travel lock assembly can cause serious vehicle damage.

- 2 Cannon tube (1) is positioned in travel lock assembly (2) and is locked in place

### NOTE

- When turret lock assembly covers word LOCKED, turret lock assembly is locked.
  - If turret lock assembly sticks in positioning hole, manually traverse cab slightly left or right to align lock teeth with cab ring teeth.
- 3 Secure turret lock assembly by squeezing manual control levers (3 and 4) together to rotate turret lock assembly over positioning hole (5).



## 2-9 INITIAL ADJUSTMENTS AND CHECKS — CONTINUED

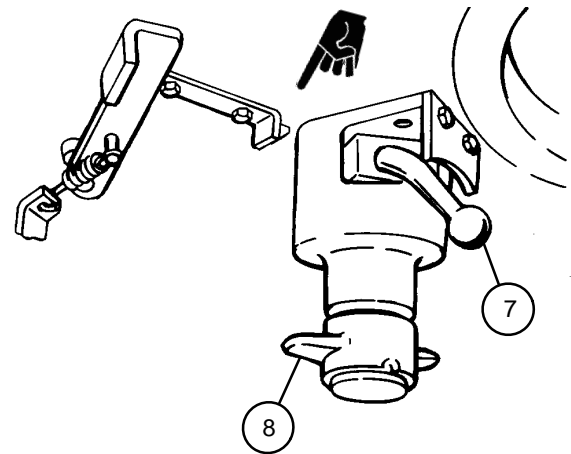
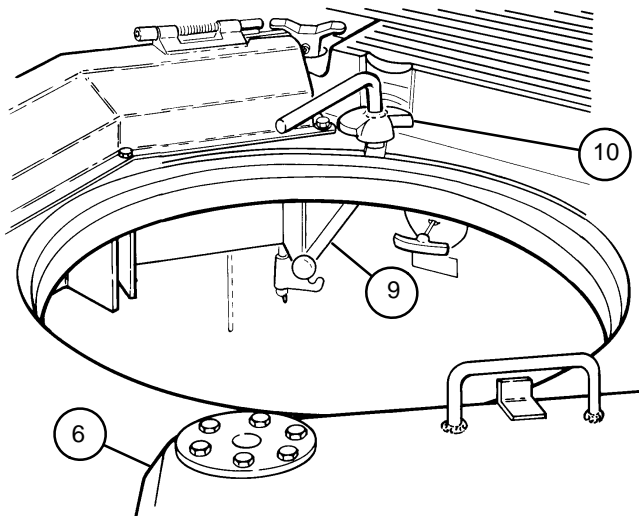
### 2-9.1 Routine Checks — Continued

- 4 TRAVERSE CONTROL switch is placed in MANUAL position.
- 5 All communication and accessory switches are turned off.

**WARNING**

Do not move vehicle if driver's hatch cover will not lock to avoid injury to personnel.

- 6 If driver's hatch cover (6) is open, pull down and rearward on elevating handle (7) and driver's hatch cover locks automatically. If driver's hatch cover is closed, tighten chuck (8) to lock driver's hatch cover. Move locking lever (9) rearward to lock locking cam (10).

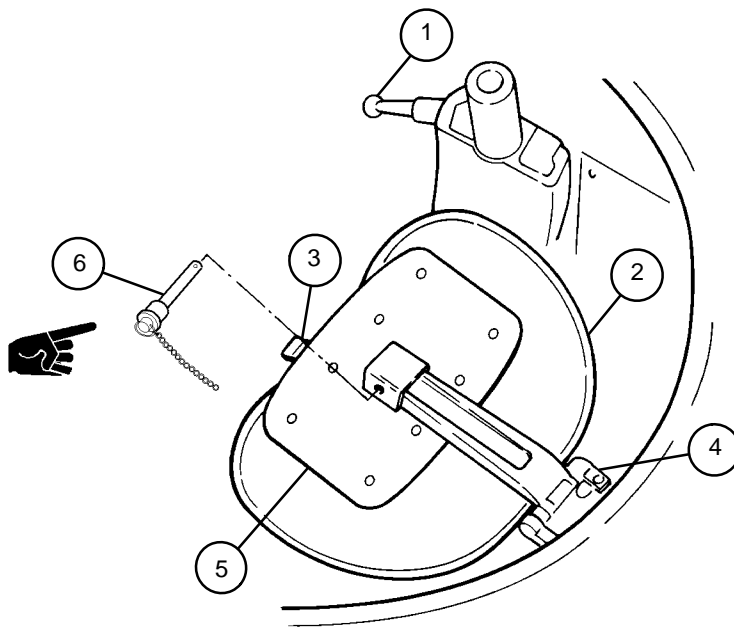


## 2-9 INITIAL ADJUSTMENTS AND CHECKS — CONTINUED

### 2-9.2 Adjustments

#### a. Adjusting Driver's Seat

- 1 Raise vertical adjusting lever (1) to adjust driver's seat (2) height. Release vertical adjusting lever to lock driver's seat in position.
- 2 Raise horizontal adjusting bar (3) to adjust driver's seat (2) forward and backward. Release horizontal adjusting bar to lock driver's seat in position.
- 3 Press pawl (4) to position backrest assembly (5) forward or backward. Release pawl to lock backrest assembly in position.
- 4 Remove quick release pin (6) to raise or lower backrest assembly (5) to desired height. Install quick release pin to lock backrest assembly in position.



**2-9 INITIAL ADJUSTMENTS AND CHECKS - CONTINUED****2-9.2 Adjustments - Continued****b. Adjusting Commander's Seat**

- 1 To unstow commander's seat:

**WARNING**

The commander's seat is heavy, use care when taking the commander's seat out of stowed position.

- (a) While supporting commander's seat, pull out on position pin (8).
  - (b) Lower commander's seat (9).
- 2 Pull manual control handle (10) to adjust height of commander's seat (9).

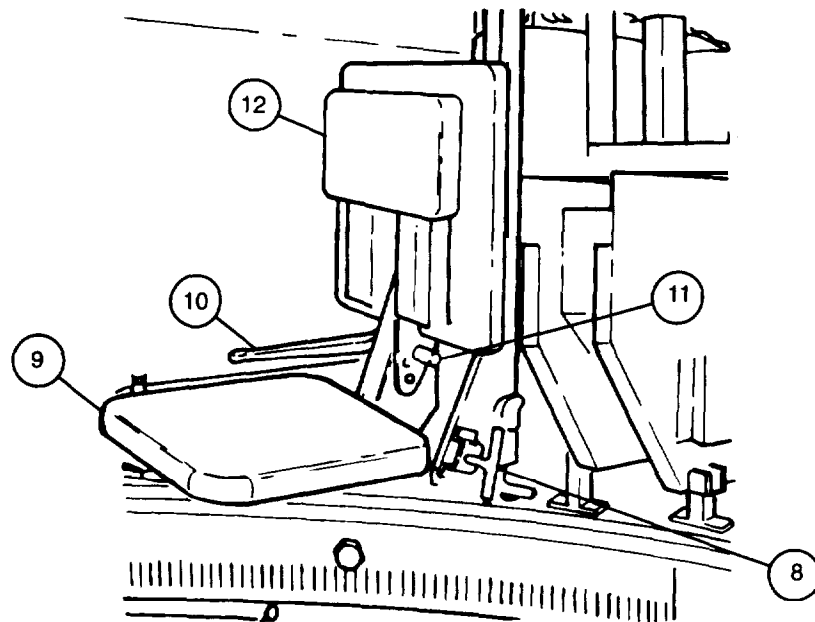
**NOTE**

Backrest is folded down to use as a platform when firing machine gun.

- 3 Remove quick release pin (11) to raise up backrest (12) and install quick release pin.
- 4 To stow commander's seat:
  - (a) If necessary remove quick release pin (11), fold down backrest (12) onto commander's seat (9) and install quick release pin.
  - (b) Push commander's seat (9) up and back, position pin (8) will then automatically lock commander's seat in position.

**NOTE**

Some vehicles have a shorter manual control handle than other vehicles.



## 2-9 INITIAL ADJUSTMENTS AND CHECKS - CONTINUED

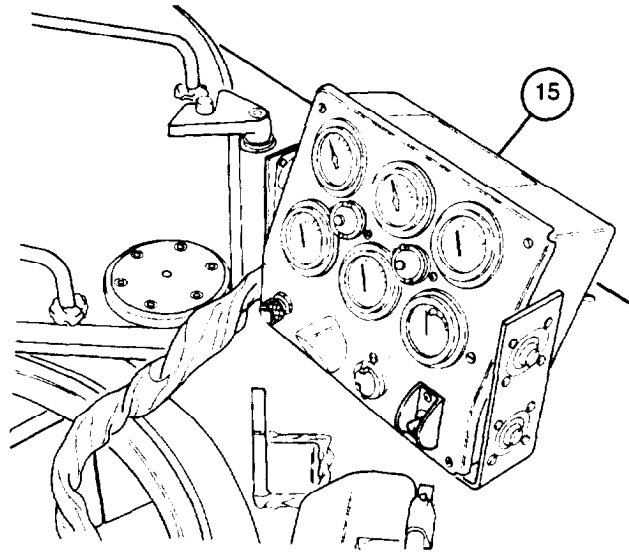
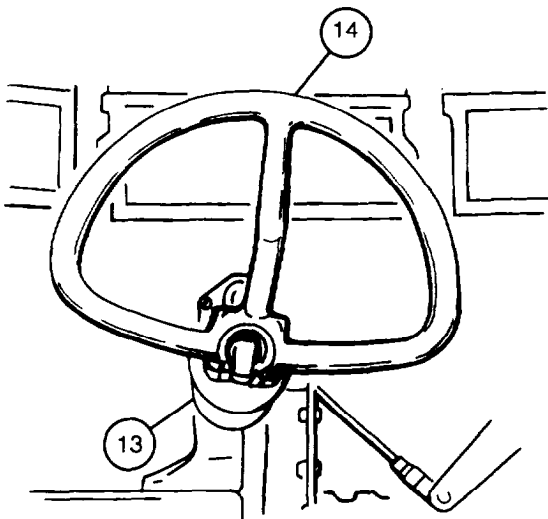
### 2-9.2 Adjustments - Continued

#### c. Adjusting Steering Wheel

#### NOTE

Raise steering wheel if driving with driver's hatch cover open and lower steering wheel if driving with driver's hatch cover closed.

- 1 Push in on sleeve bearing (13) and rotate steering wheel (14) up or down. Release sleeve bearing to lock steering wheel in position.
- 2 If driving with driver's seat in raised position, clip portable instrument panel (15) on hull.



## 2-10 OPERATING PROCEDURES

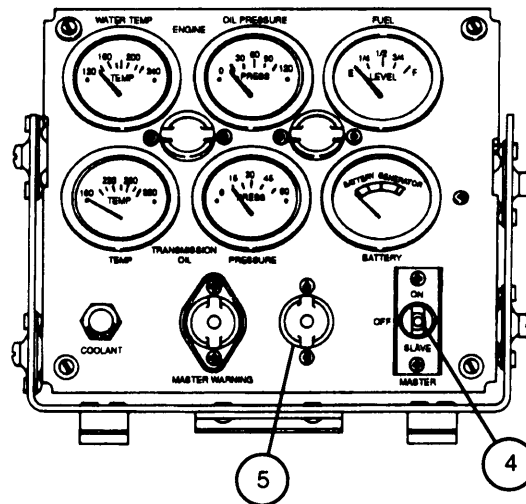
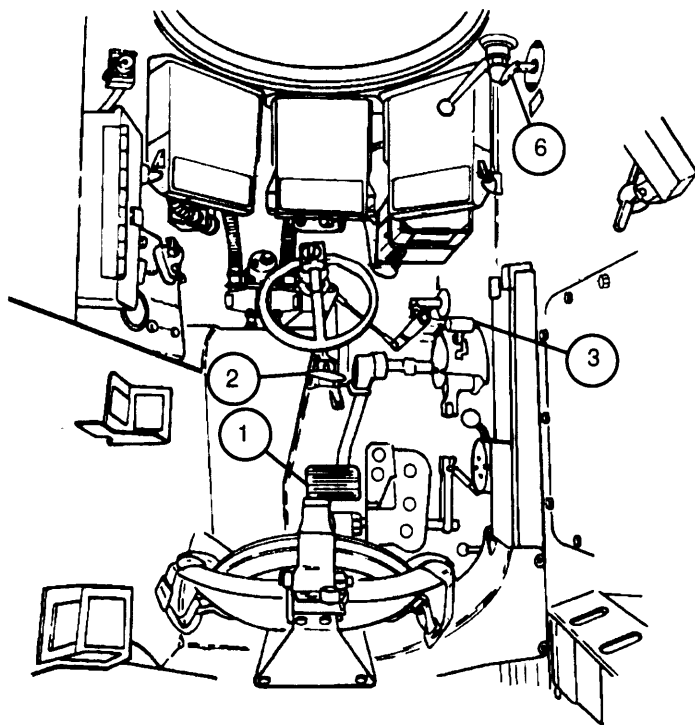
### 2-10.1 Starting Procedures

#### a. Starting Engine

**WARNING**

- Do not operate engine of vehicle in an enclosed area unless it is adequately ventilated.
- Do not leave driver's compartment, except during firing, with engine running. Personnel injury could result.

- 1 Press down on brake pedal (1), pull out and down on manual control handle (2) and then release manual control handle to set parking brake.
- 2 Shift transmission shift control lever (3) into N (neutral) position.
- 3 Turn MASTER switch (4) to ON. MASTER indicator light (5) will illuminate.
- 4 Pull out FUEL SHUT OFF control assembly handle (6) to off position before checking for hydrostatic lock.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.1 Starting Procedures — Continued

#### a. Starting Engine — Continued

**CAUTION**

Before starting engine, check for hydrostatic lock as indicated by engine starting to turn over with starter, then stopping or starter sounds as if straining when cranking engine. If hydrostatic lock is suspected, stop cranking immediately and notify unit maintenance.

- 5 Check for hydrostatic lock by intermittently actuating STARTER control switch (7).
- 6 Release FUEL SHUTOFF control assembly handle (6).
- 7 Place hand throttle control lever (8) in IDLE position.
- 8 If fuel filters have been drained, turn FUEL PRIME control switch (9) to ON, hold for 45 seconds, and then release.

**CAUTION**

- Do not operate starter over 30 seconds (on M109A2 and M109A3 vehicles this must be timed). If engine does not start, allow two minute cooling-off period before trying to start again. Four start attempts should be made before combat override switch (M109A4/M109A5) is used or unit maintenance is notified.
- Combat override switch (M109A4/M109A5) should be used in emergencies only, as determined by section chief. Excessive use of combat override switch could result in damage to starter or low battery voltage.

**NOTE**

- Refer to cold weather starting procedures when temperature is below 30° F (– 1° C) when using engine model 7083-7396 or 40° F (4° C) when using LHR engine model 7083-7391, or if engine will not start in moderately cold weather (para 2–20.4).

## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.1 Starting Procedures — Continued

#### a. Starting Engine — Continued

#### NOTE

The starter must be engaged after the time periods shown below. A starter protection device in the engine compartment of M109A4/M109A5 vehicles will disengage the starter automatically. For M109A2 and M109A3 vehicles, these periods must be timed as indicated:

After 30 seconds in temperatures above 50°F (10° C).

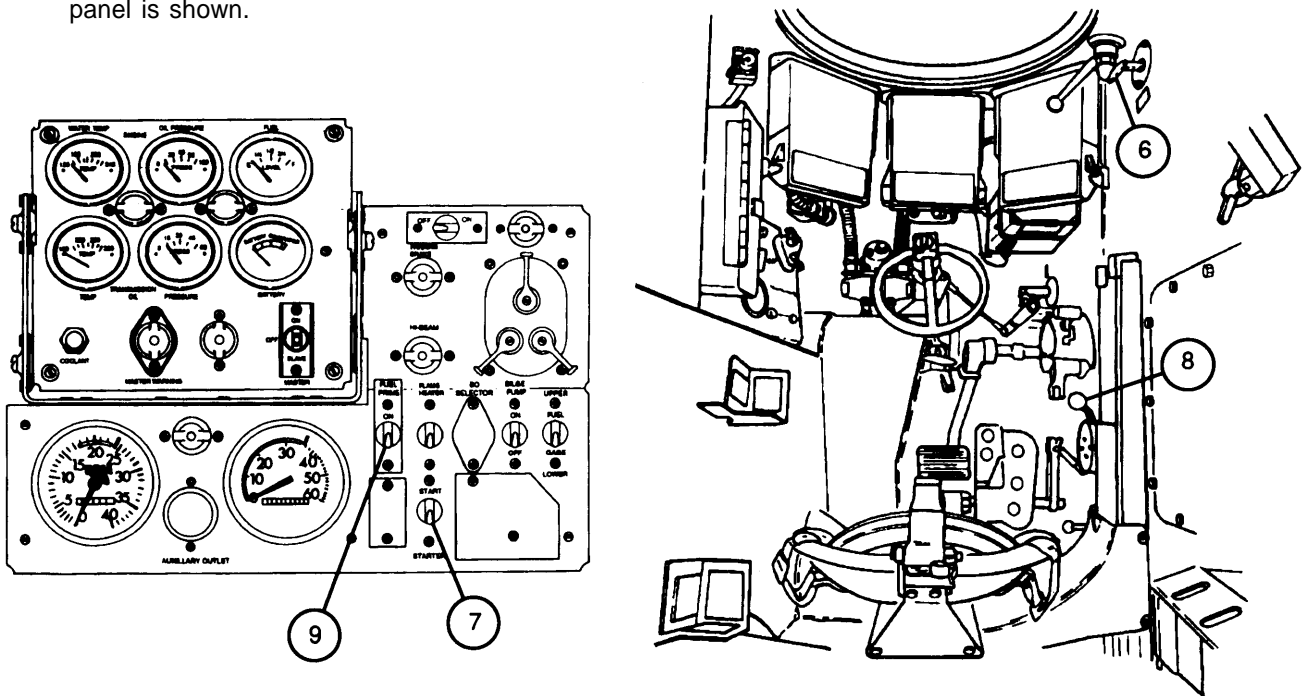
After 60 seconds in temperatures between 0 and 50° F (–17 and 10° C).

After 120 seconds in temperatures below 0°F(–17° C).

- 9 Push STARTER control switch (7) to START position and hold until engine starts. (Do not hold for more than 30 seconds except as noted above).

#### NOTE

M109A4/M109A5 howitzer engine model 7083-7396 fixed instrument panel is shown.





## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.1 Starting Procedures-Continued

#### a. Starting Engine — Continued

#### NOTE

The combat override switch (M109A4/M109A5) is located on the back bulkhead of the hull behind the section chief's station.

- 10 If engine in M109A4/M109A5 vehicle does not start after four attempts, engage both STARTER control switch (7) and combat override switch (10) as determined by the section chief. If engine still does not start, notify unit maintenance.

#### CAUTION

If you notice a shrill whine, above normal turbine whine, rubbing, unusual vibrations, or a sudden increase in exhaust smoke, shut off engine and notify unit maintenance.

- 11 With engine running, watch the ENGINE OIL PRESSURE gage (11). If engine oil pressure does not register within 15 seconds (approximately 5 to 30 psi (34 to 207 kPa) at idle of 650 to 750 rpm), immediately pull FUEL SHUTOFF control assembly handle (6) and stop engine. Notify unit maintenance.
- 12 Idle engine about two minutes. Adjust hand throttle control lever (8) and set to 1000 rpm (fast idle) on tachometer (12). Warm-up engine until WATER TEMP gage (13) reaches 170° F.
- 13 During engine warm up, perform portable instrument panel (14) checkout procedure (para 2-10.2).

#### b. Starting Disabled Vehicle

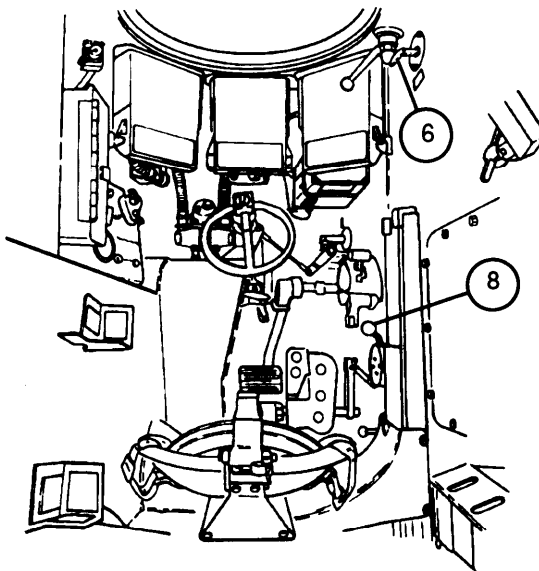
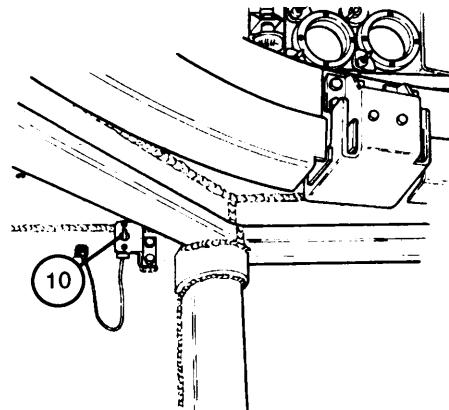
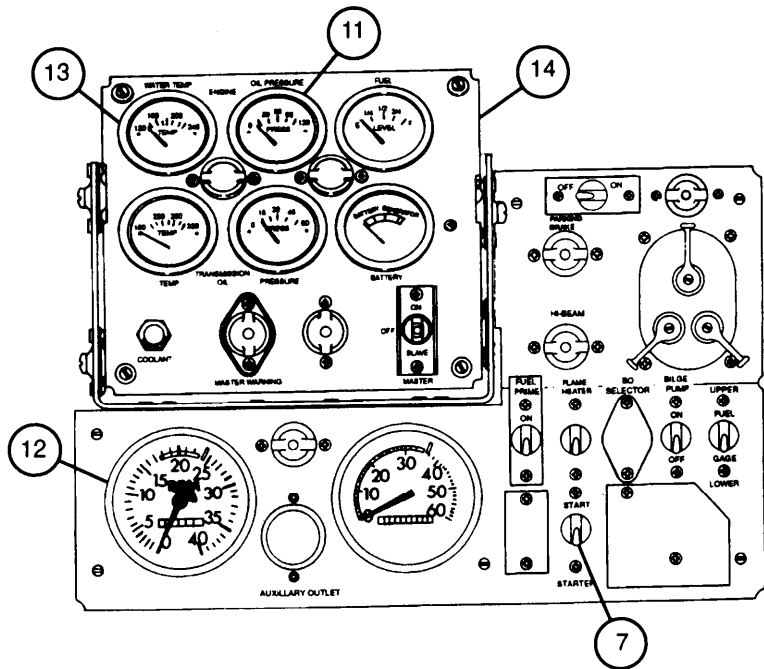
- 1 For slave starting, notify unit maintenance.
- 2 For tow starting, see paragraph 2-10.5.

2-10 OPERATING PROCEDURES — CONTINUED

2-10.1 Starting Procedures — Continued

NOTE

M109A4/M109A5 howitzer engine model 7083-7396 fixed instrument panel is shown.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.2 Portable Instrument Panel Checkout Procedures

#### a. MASTER WARNING Indicator Light

Ensure MASTER WARNING indicator light (1) goes out after the engine has run for 15 seconds. If MASTER WARNING indicator light illuminates during operation, shift transmission shift control lever (2) into N (neutral) and set hand throttle control lever (3) to run engine at 1000 to 1200 rpm and proceed as follows.

- 1 If either WATER TEMP gage (4) or TRANSMISSION OIL TEMP gage (5) reading is high and does not return to normal after 5 minutes, stop engine and check coolant level.
- 2 If either ENGINE OIL PRESSURE gage (6) or TRANSMISSION OIL PRESSURE gage (7) reading is low, stop engine and check oil level.
- 3 If MASTER WARNING indicator light (1) stays on, notify unit maintenance.

#### b. ENGINE OIL PRESSURE Gage

**CAUTION**

If oil pressure is below 5 psi at idle (650 RPM) or below 30 psi at 1800 RPM, shutdown engine and check oil level.

ENGINE OIL PRESSURE gage (6) normal range is minimum of 5 psi at idle (650 RPM) and 30-50 psi at 1800 RPM and 50-70 psi at 2100 RPM (Maximum of 70 psi).

#### c. TRANSMISSION OIL PRESSURE Gage

TRANSMISSION OIL PRESSURE gage (7) normal range is 18 to 45 psi at 1835 to 1900 rpm. (Minimum is 10 psi at 1000 rpm.)

#### d. Indicator Lights

Two indicator lights (8) illuminate portable instrument panel (9).

#### e. FUEL Gage

**NOTE**

Never run completely out of fuel. Injectors require full return flow for cooling.

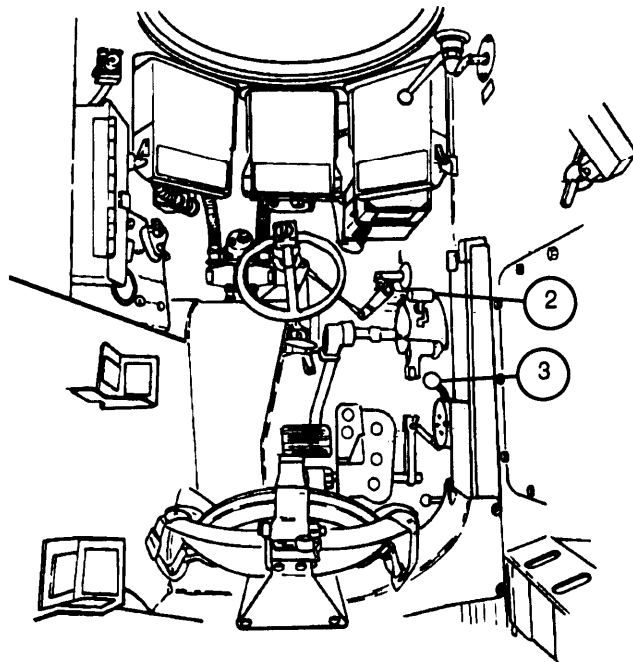
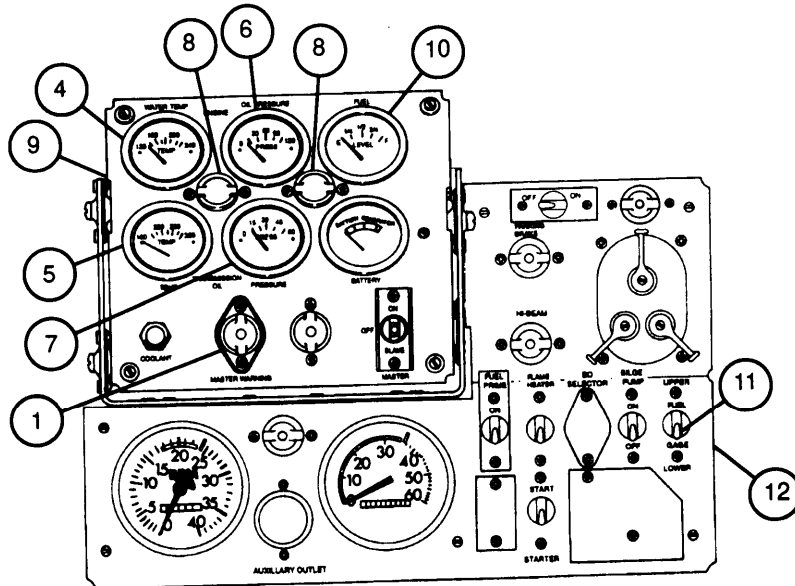
FUEL gage (10) indicates fuel quantity available in either fuel tank. FUEL gage control switch (11) located on fixed instrument panel (12) is used to select tank.

2-10 OPERATING PROCEDURES — CONTINUED

2-10.2 Portable Instrument Panel Checkout Procedures — Continued

NOTE

M109A4/M109A5 howitzer engine model 7083-7396 fixed instrument panel is shown.



**2-10 OPERATING PROCEDURES — CONTINUED**

**2-10.2 Portable Instrument Panel Checkout Procedures — Continued**

**f. BATTERY Gage**

If BATTERY gage (13) indicates subnormal charge or overcharge, notify unit maintenance.

**g. TRANSMISSION OIL TEMP Gage**

TRANSMISSION OIL TEMP gage (5) normal range is 220 to 240° F. (Maximum is 300° F.)

**h. WATER TEMP Gage**

WATER TEMP gage (4) normal range is 170 to 185° F. (Maximum is 230° F.)



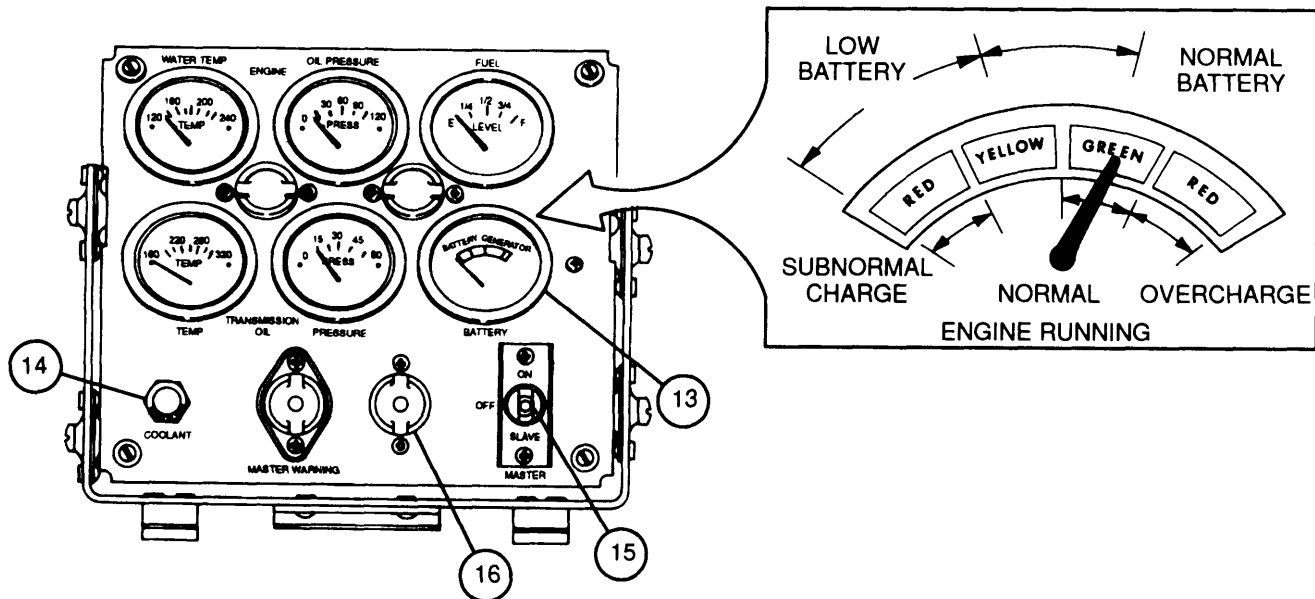
Do not remove radiator cap when engine is hot. Severe burns could result from failure to observe this warning.

**i. COOLANT Indicator Light**

COOLANT indicator light (14) indicates coolant level in cooling system. If low, shut engine down and check coolant level.

**j. MASTER Switch**

Move MASTER switch (15) to ON position to start engine. When MASTER switch is to ON, MASTER switch indicator light (16) is illuminated.



**2-10 OPERATING PROCEDURES — CONTINUED****2-10.3 Transmission Shift Control Lever****NOTE**

- The transmission is equipped with a shift inhibitor which will restrict movement of the transmission shift control lever and prevent downshifting of the transmission until vehicle speed drops within the correct operating limits of the desired gear range.
- Brake vehicle to prevent vehicle speed from over-running engine speed while downshifting.

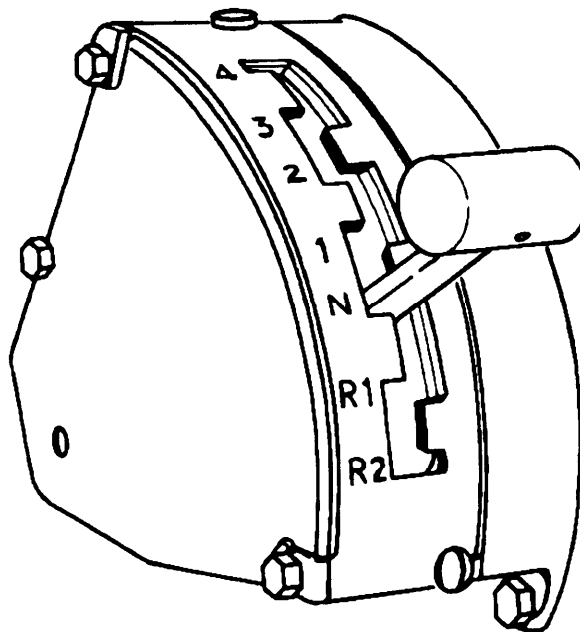
**a. N (Neutral)**

Use when:

**CAUTION**

Never descend an incline with transmission in neutral.

- 1 Stopped or parked.
- 2 Starting engine or shutting down engine.
- 3 Idling.



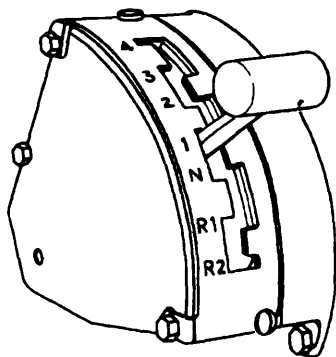
## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.3 Transmission Shift Control Lever — Continued

#### b. 1 (1st Gear)

Use when:

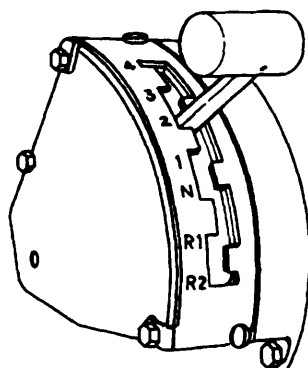
- 1 Setting vehicle in forward motion during field operation. Upshift to a higher gear when vehicle speed permits.
- 2 Ascending or descending steep grades and on soft, muddy, or rough terrain.
- 3 Making short forward radius turns. Short radius turns on hard surfaces should be initiated from a stand-still. (Maximum speed is 6 mph.)



#### c. 2 (2nd Gear)

Use when:

- 1 Towing heavy loads.
- 2 Ascending or descending steep grades and on extremely muddy or rough terrain.
- 3 Making short forward radius turns. (Maximum speed is 9 mph.)



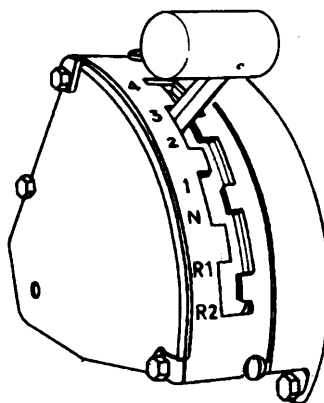
**2-10 OPERATING PROCEDURES — CONTINUED**

**2-10.3 Transmission Shift Control Lever — Continued**

**d. 3 (3rd Gear)**

Use when:

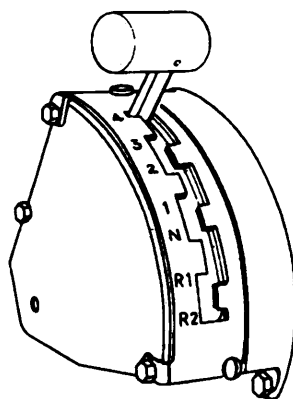
- 1 Operating on hard surfaced roads until sufficient vehicle speed (12 to 15 mph) permits shifting to 4 (4th gear) range.
- 2 Pulling heavy loads for sustained periods and for ascending or descending on long grades. (Maximum speed is 24 mph.)



**e. 4 (4th Gear)**

Use when:

Normal driving conditions are on firm, smooth, level ground. (Maximum speed is 35 mph.)





## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.3 Transmission Shift Control Lever — Continued

**WARNING**

Follow backing up procedures using two guides (para 2-10.4).

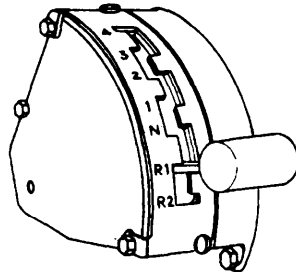
#### f. R1 (Reverse-Range 1)

Use when:

**CAUTION**

Never attempt to shift into R1 and R2 (reverse range: 1 and 2) unless the vehicle is at a dead stop and the engine is operating at idle rpm.

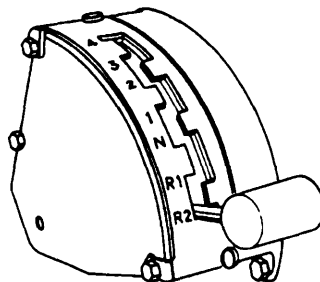
- 1 Backing up (para 2-10.4).
- 2 Making turns with heavy loads or on soft ground.
- 3 Ascending steep grades in rearward movement for maximum engine power. (Maximum speed is 5 mph.)



#### g. R2 (Reverse- Range 2)

Use when:

On level, hard surfaces when rearward movement for long distances is necessary. (Maximum speed is 7 mph.)



## 2-10 OPERATING PROCEDURES — CONTINUED

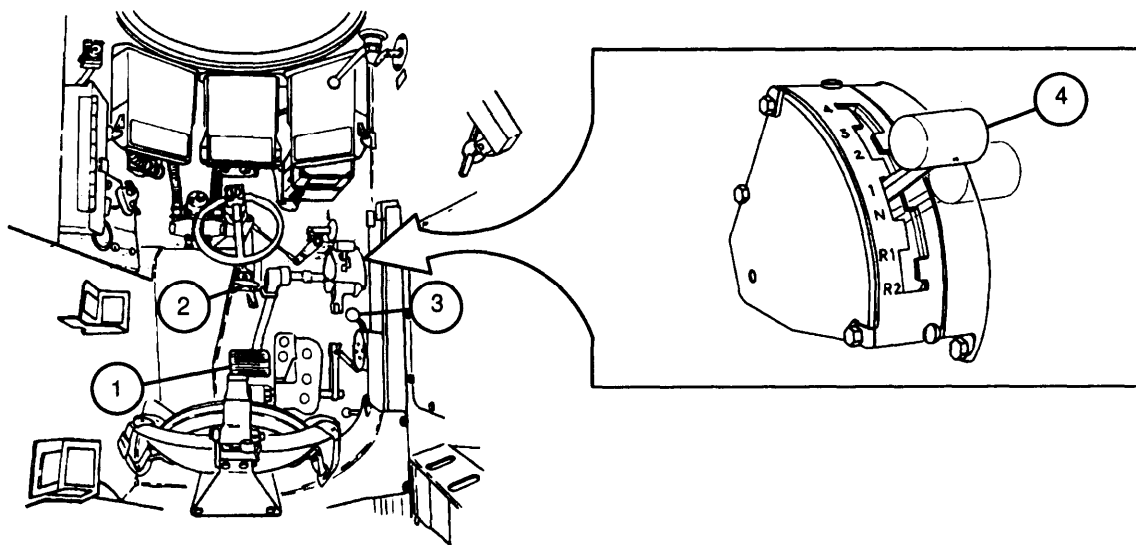
## 2-10.4 Driving

## a. Normal Driving Conditions

**WARNING**

- Drive carefully, especially if unfamiliar with vehicle. Avoid oversteering and speeding on hard pavement as it may result in loss of control.
- Secure covers, doors, and hatches (para 2-10.6) before moving vehicle. Lock driver's hatch cover in either open or closed position. Failure to follow warning could result in injury to personnel.
- If you lose a track (break a track shoe or vehicle throws a track), extreme caution must be exercised in maintaining control. Immediately release accelerator and let the vehicle coast to a stop. Do not apply braking action, i.e., brake pedal, laterals, pivot or any type of steering controls. This causes the vehicle to pull to the active or good track and could result in a rollover. If it is absolutely necessary, apply braking action only and we stress only, if the vehicle is approaching a ravine, a cliff, or if you perceive the outcome to be catastrophic, probably resulting in fatalities. When rollover is imminent, all crew members should immediately withdraw inside the vehicle, tighten seat belts, and hold onto a secure fixture, until the vehicle comes to a complete stop.

- 1 Press down on brake pedal (1). Lift up and push in manual control handle (2) to release parking brake.
- 2 With brake pedal (1) depressed and hand throttle control lever (3) in the idle position, shift transmission shift control lever (4) from N (neutral) to 1 (1st gear).



2-10 OPERATING PROCEDURES — CONTINUED

2-10.4 Driving — Continued

a. Normal Driving Conditions — Continued

- 3 Release brake pedal (1) and push down on accelerator pedal (5) to obtain desired vehicle speed. Shift transmission shift control lever (4) through intermediate ranges to desired speed range (para 2-1 0.3).
- 4 To turn your vehicle, turn steering wheel (6).

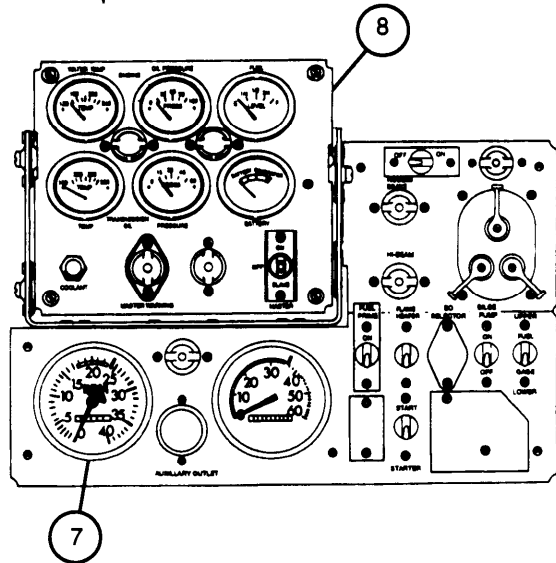
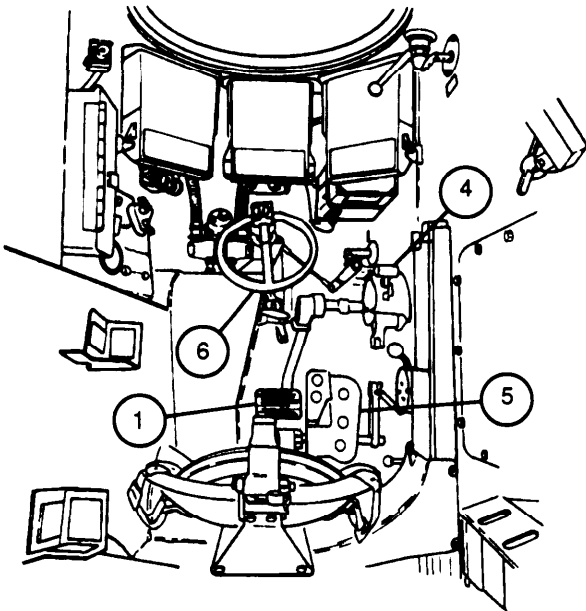
**CAUTION**

When engine rpm is less than 1725, shift to a lower range.

- 5 While driving, check your tachometer (7) and gages on portable instrument panel (8).
- 6 Perform "During" operation PMCS procedures (Table 2-1).

**NOTE**

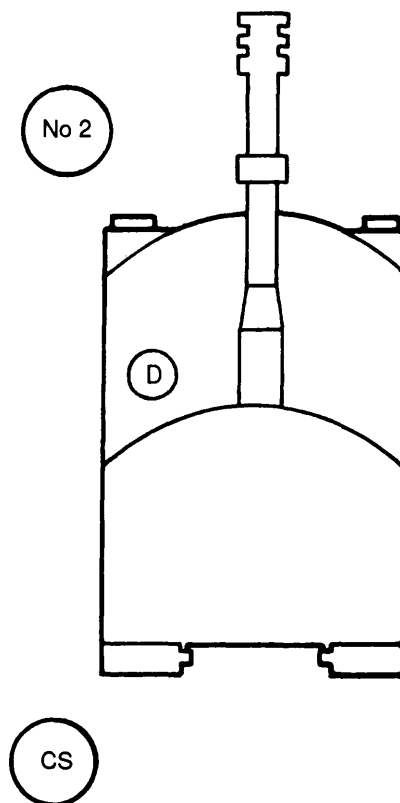
M109A4/M109A5 howitzer engine model 7083-7396 fixed instrument panel is shown.



**2-10 OPERATING PROCEDURES — CONTINUED****2-10.4 Driving — Continued****b. Backing the Howitzer****WARNING**

When backing the howitzer, two personnel must guide the driver to prevent accidental injury. Both guides stand to the left, a safe distance from the vehicle. Front left guide must be visible to the driver.

- 1 To prepare for backing the howitzer, driver (D) is seated at controls, looking to the left of the vehicle. Cannoneer no. 2 (No 2) stands to the left and front of the vehicle, visible to both the driver and chief of section (CS). The chief of section stands to the left and rear of the vehicle, visible to cannoneer no. 2.
- 2 Chief of section signals cannoneer no. 2 on direction and distances for safe back up. Cannoneer no. 2 relays signals to the driver.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.4 Driving — Continued

#### c. Crossing a Ditch, Shell Hole, or Trench

- 1 Press down on brake pedal (1) and shift transmission shift control lever (4) to 1 (1st gear).
- 2 As soon as the vehicle reaches the bottom and starts to climb, depress the accelerator pedal (5) for power needed to climb out of the ditch.

#### d. Going Over an Obstacle

**WARNING**

Approach an obstruction or obstacle head on when possible. Warn crew members to brace themselves. Secure hatches and doors.

- 1 As you approach an obstacle (21 inches (53.34 cm) maximum vertical height), release the accelerator pedal (5), press down on brake pedal (1), and shift transmission shift control lever (4) to 1 (1st gear).
- 2 Starting over the obstacle, apply full power. Release the accelerator pedal (5) on reaching the crest and permit vehicle to settle over it. Balance vehicle forward of crest so it begins to move down.
- 3 When front of tracks touch ground, add power and move on.

#### e. Starting Vehicle on an Upgrade

When the vehicle is headed uphill, depress brake pedal (1), place transmission shift control lever (4) in 1 (1st gear), increase engine speed, and release brake pedal.

#### f. Going Down Steep Grades

**CAUTION**

Do not use engine as a braking source for a long period of time. Transmission will overheat.

Using the service brakes too long will burn them out. Release and apply brakes occasionally to cool them off.

When going down a steep hill, shift transmission shift control lever (4) to 1 (1st gear). Apply the brake pedal (1) now and then to help slow down.

#### g. Turning in Sand

When turning in sand, shift transmission shift control lever (4) to 1 (1st gear) and make gradual turns. If sharp turns are made, the track may be thrown.

2-10 OPERATING PROCEDURES — CONTINUED

2-10.4 Driving — Continued

h. Stopping the Vehicle

- 1 Release accelerator pedal (5). Slowly depress brake pedal (1) until vehicle stops.
- 2 With brake pedal (1) depressed, move transmission shift control lever (4) into N (neutral). Pull out and down on manual control handle (2) to engage parking brake. Release brake pedal.

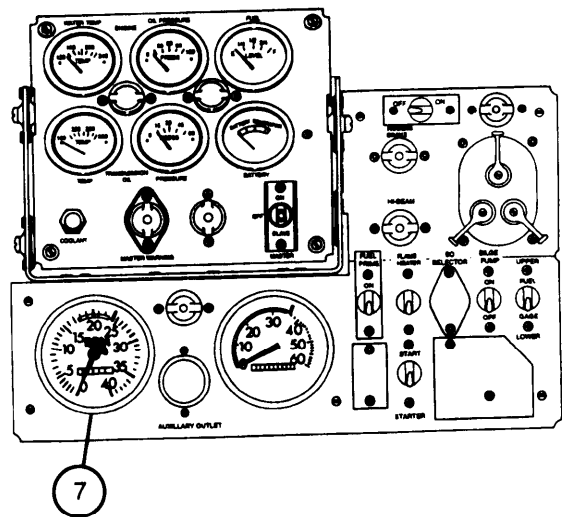
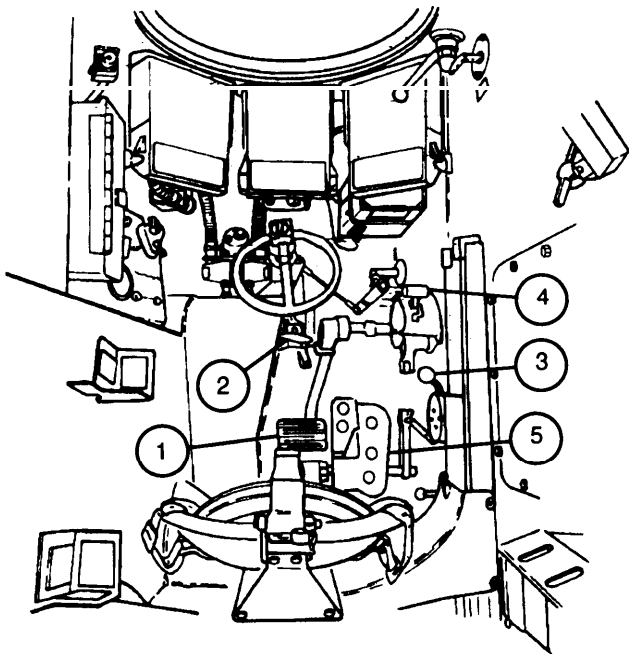
**CAUTION**

Failure to observe shutdown procedures may result in engine failure.

- 3 Set hand throttle control lever (3) to run engine at 1000 to 1200 rpm as indicated on tachometer (7). Run engine for a period of 5 minutes or until coolant temperature is 185° F or less.
- 4 Set hand throttle control lever (3) forward to return engine to normal idle (650 to 750 rpm).
- 5 Turn off all communication and accessory switches.

**NOTE**

M109A4/M109A5 howitzer engine model 7083-7396 fixed instrument panel is shown.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.4 Driving — Continued

#### h. Stopping the Vehicle — Continued

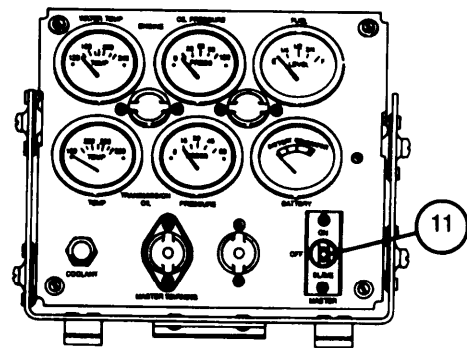
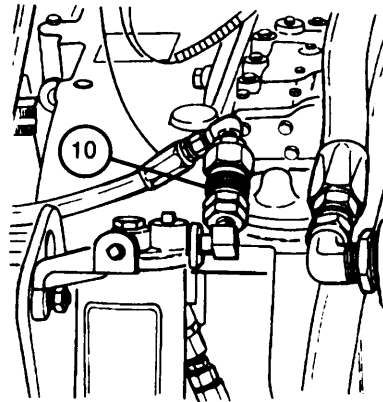
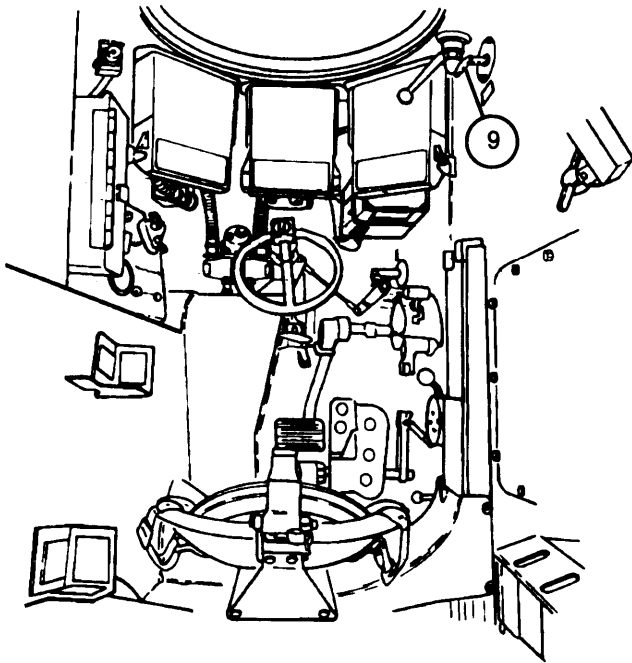
6 Pull out FUEL SHUTOFF control assembly handle (9) to stop engine. If engine doesn't stop, disconnect the main fuel inlet line at quick disconnect connection (10) in engine compartment. Notify unit maintenance.

7 Turn MASTER switch (11) to OFF.

#### NOTE

After daily operations fill the fuel tanks to prevent condensation. Use diesel fuel only.

8 Perform "After" operation PMCS procedures (Table 2-1).



## 2-10 OPERATING PROCEDURES - CONTINUED

### 2-10.5 Towing Operations

#### WARNING

- Vehicle engines must be shut off and brakes applied while tow cables are being connected or disconnected to prevent injury to personnel.
- An observer must be used to assist the driver when rigging the vehicle and during towing operations to prevent injury.

#### CAUTION

- To avoid damage, the howitzer is authorized to tow only one vehicle at a time and to tow only when another vehicle is disabled or when towing to start the engine.
- In an emergency, a vehicle can be towed for a short distance (not more than 1/4 mile (.40 km)) without disconnecting universal joints. Put transmission shift control lever in N (neutral) before starting towing operation. Do not tow disabled vehicle over 10 mph. Proceed being extra careful not to shift into gear accidentally.
- Vehicle must be towed backwards to keep the cannon from banging into the towing vehicle.
- Use a tow bar when towing another vehicle. When universal joints are disconnected, you can't steer or brake.
- Tow cables may be used to tow a disabled vehicle short distances on fairly level terrain only when brakes are operational. When towing a vehicle, there is a danger the towed vehicle will overrun the towing vehicle.
- Make sure tow cables are crossed to prevent damage to track.
- Towing pintle assembly must not be used to position or push vehicle sideways.



## 2-10 OPERATING PROCEDURES - CONTINUED

### 2-10.5 Towing Operations - Continued

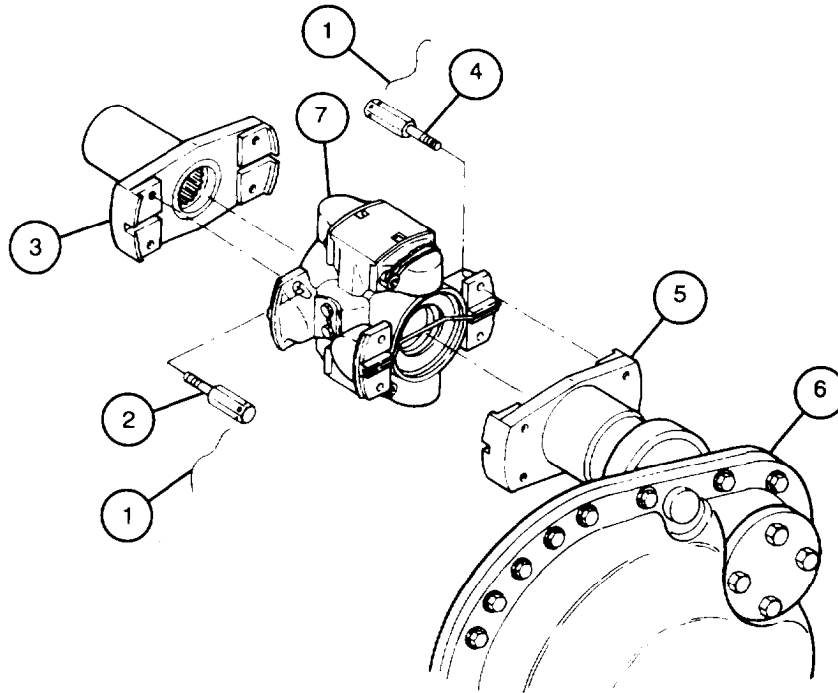
#### a. Disconnecting Universal Joints

- 1 Open right and left transmission access doors.

#### NOTE

If flange and adapter screws are inaccessible, place transmission shift control lever in N (neutral). Push or tow vehicle until universal joint rotates sufficiently to allow access to screws.

- 2 Remove lockwire (1).
- 3 Remove four screws (2) at flange assembly (3) and four screws (4) at adapter (5).
- 4 Slide flange assembly (3) toward final drive, and adapter (5) toward transmission (6). Lift out joint assembly (7).
- 5 Slide flange assembly (3) off final drive.
- 6 Check fluid level in final drive after reinstalling flange assembly and adapter (item 22, Appx G). Fluid can be lost with the flange assembly off.



**2-10 OPERATING PROCEDURES - CONTINUED**

**2-10.5 Towing Operations - Continued**

**b. Towing a Disabled Vehicle**

**WARNING**

When hooking or unhooking towbar from a disabled vehicle, set parking brake or chock tracks of disabled vehicle before hooking or unhooking towbar. If towed vehicle is not chocked, or parking brake not set, disabled vehicle may move, causing injury or death to personnel and/or damage to equipment.

**CAUTION**

- When a disabled vehicle is being towed, vehicles must be rear to rear to prevent damage to cannon of towed vehicle.
  - When towing, be sure to steer in a wide arc to avoid collision when turning.
- 1 Connect tow cables (8) or tow bar (9) to tow hooks of both vehicles.
  - 2 Shift transmission shift control lever (10) of towed vehicle into N (neutral) position.
  - 3 Push in manual control handle (11) to release parking brake of towed vehicle and signal observer.

**c. Towing Vehicle to Start Engine**

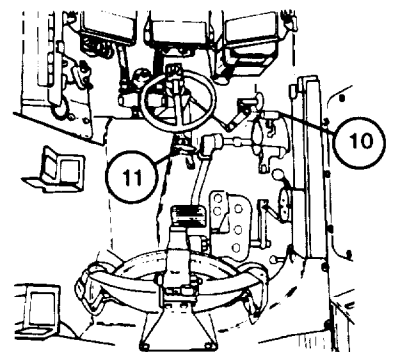
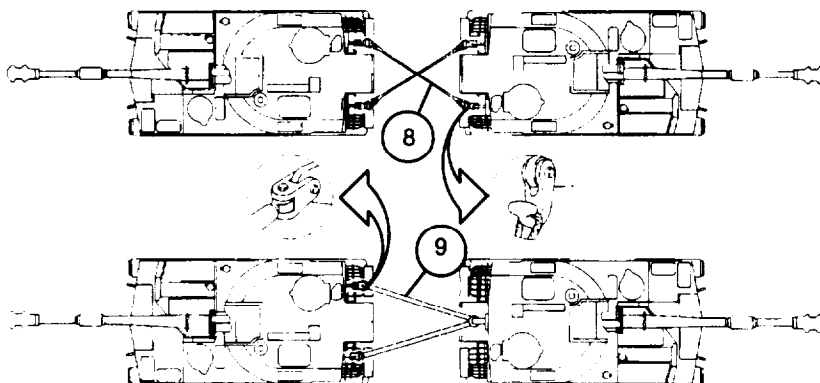
**WARNING**

- When hooking or unhooking towbar from a disabled vehicle, set parking brake or chock tracks of disabled vehicle before hooking or unhooking towbar. If towed vehicle is not chocked, or parking brake not set, disabled vehicle may move, causing injury or death to personnel and/or damage to equipment.
- Towing vehicle to start engine should be done on straight, smooth surface. Failure to do this may cause towed vehicle to lose control resulting in injury or death to personnel.

**CAUTION**

Use the following procedure only in case of emergency or as a last resort.

- 1 To start engine, traverse cab 180° to keep cannon tube from hitting the towing vehicle. Lower cannon assembly to mechanical limit stops.
- 2 Connect tow bar (9) or tow cables (8).



## 2-10 OPERATING PROCEDURES - CONTINUED

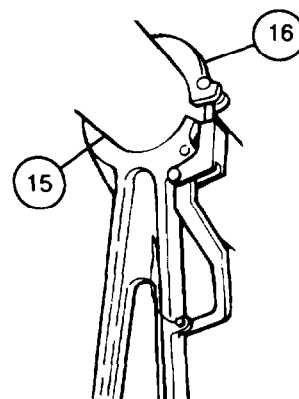
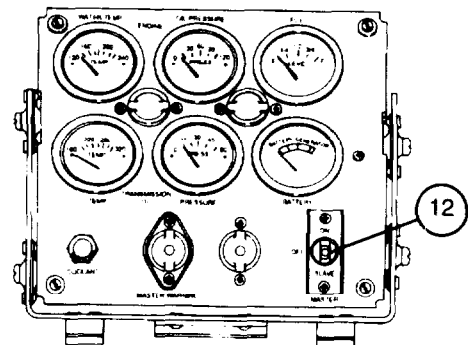
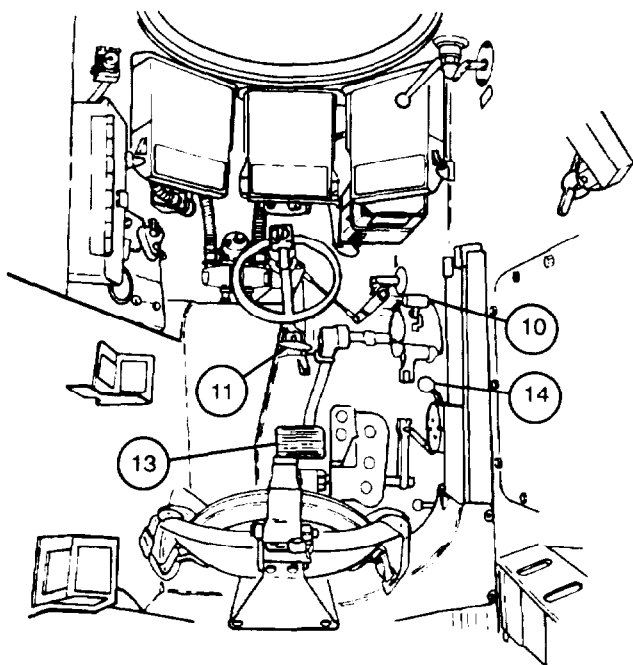
### 2-10.5 Towing Operations - Continued

#### c. Towing Vehicle to Start Engine - Continued

- 3 Shift transmission shift control lever (10) into 2 (2nd gear).
- 4 Turn vehicle MASTER switch (12) to ON
- 5 Depress brake pedal (13) and lift up and push in manual control handle (11) to release parking brake.

To avoid damage, never depress accelerator pedal on towed vehicle.

- 6 Tow vehicle in a straight line forward. Do not exceed 10 mph.
- 7 After engine starts, shift transmission shift control lever (10) to N (neutral) and adjust hand throttle control lever (14) to run engine at a fast idle (approximately 1000 rpm).
- 8 Disconnect towing vehicle.
- 9 Place cannon tube (15) in travel lock assembly (16).



**2-10 OPERATING PROCEDURES — CONTINUED**

**2-10.6 Operating Hull and Cab Doors and Hatches**

**WARNING**

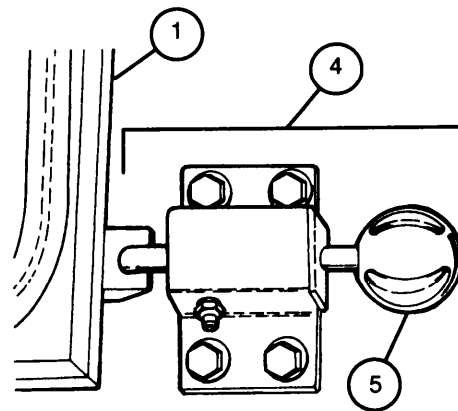
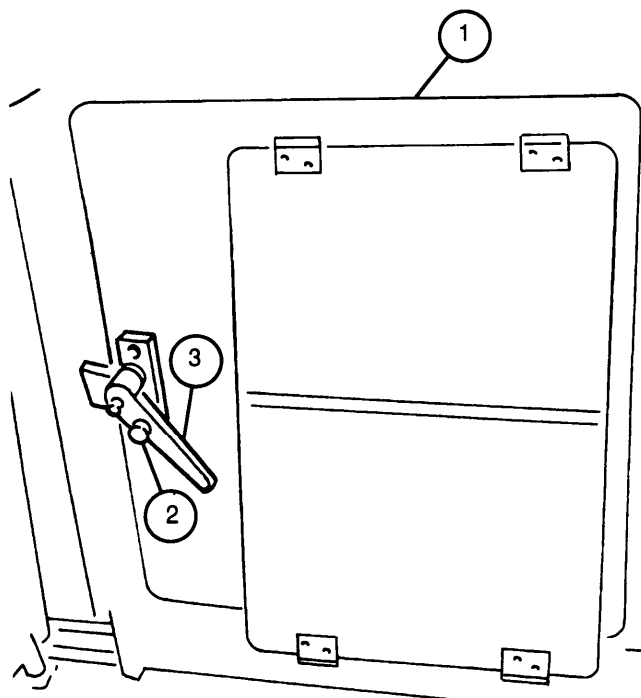
Make sure all latches are secured when operating with doors opened. Keep hands and arms out of openings when moving to prevent injury to personnel.

**a. Cab Side Doors (Left and Right)**

**WARNING**

To avoid injury, ensure all personnel are clear of the cab side doors before opening.

- 1 To open cab side door (1), push in knob (2) and pull up handle assembly (3) to release. Secure cab side door in open position with latch assembly (4) by pulling knob (5), moving cab side door behind latch assembly, and releasing knob.
- 2 To close cab side door (1), pull knob (5) on latch assembly (4) to release cab side door. Close cab side door and secure by pushing knob (2) and pulling down on handle assembly (3).



2-10 OPERATING PROCEDURES — CONTINUED

2-10.6 Operating Hull and Cab Doors and Hatches — Continued

b. Gunner's Escape Hatch

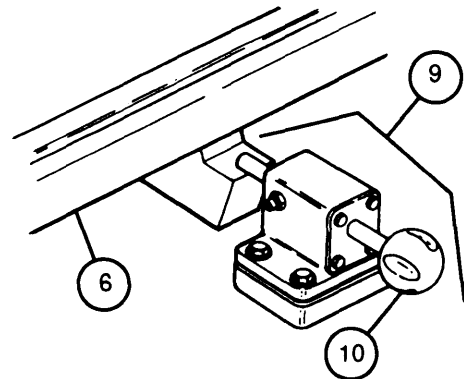
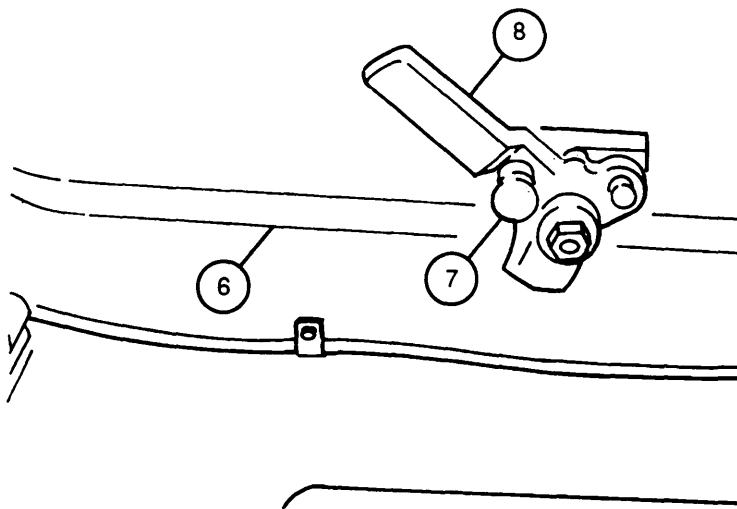
**WARNING**

To prevent injury to personnel, be extremely careful when opening gunner's escape hatch, so it does not slam shut.

**NOTE**

Gunner's escape hatches on some vehicles may not have a knob. Turn door handle left to open gunner's escape hatch.

- 1 To open gunner's escape hatch (6), push in knob (7) and turn door handle (8). Secure gunner's escape hatch in open position with latch assembly (9) by pulling knob (10), moving gunner's escape hatch behind latch assembly, and releasing knob.
- 2 To close gunner's escape hatch (6), pull knob (10) on latch assembly (9) to release gunner's escape hatch. Close gunner's escape hatch and secure by pushing knob (7) and turning door handle (8).

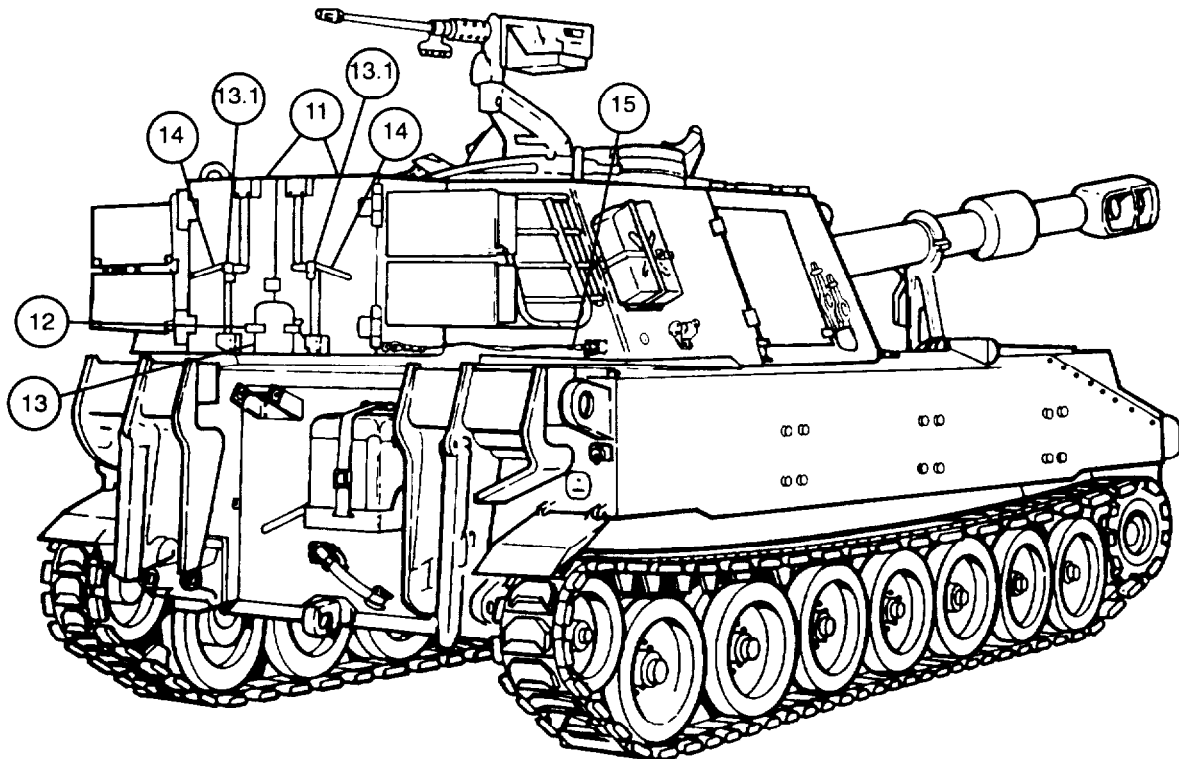


## 2-10 OPERATING PROCEDURES -CONTINUED

### 2-10.6 Operating Hull and Cab Doors and Hatches - Continued

#### c. Cab Bustle Doors

- 1 To open cab bustle doors (11), lift rim latch (12) and open projectile access door (13). Pull out on pin (13.1) then pull up on door handles (14) to release cab bustle doors. Secure cab bustle doors in open position with wire rope assembly (15).
- 2 To close cab bustle doors (11), release wire rope assembly (15). Close cab bustle door and secure by pulling down on door handles (14) and pushing in on pins (13.1). Close projectile access door (13), lift rim latch (12), and release when projectile access door is in position.



## 2-10 OPERATING PROCEDURES - CONTINUED

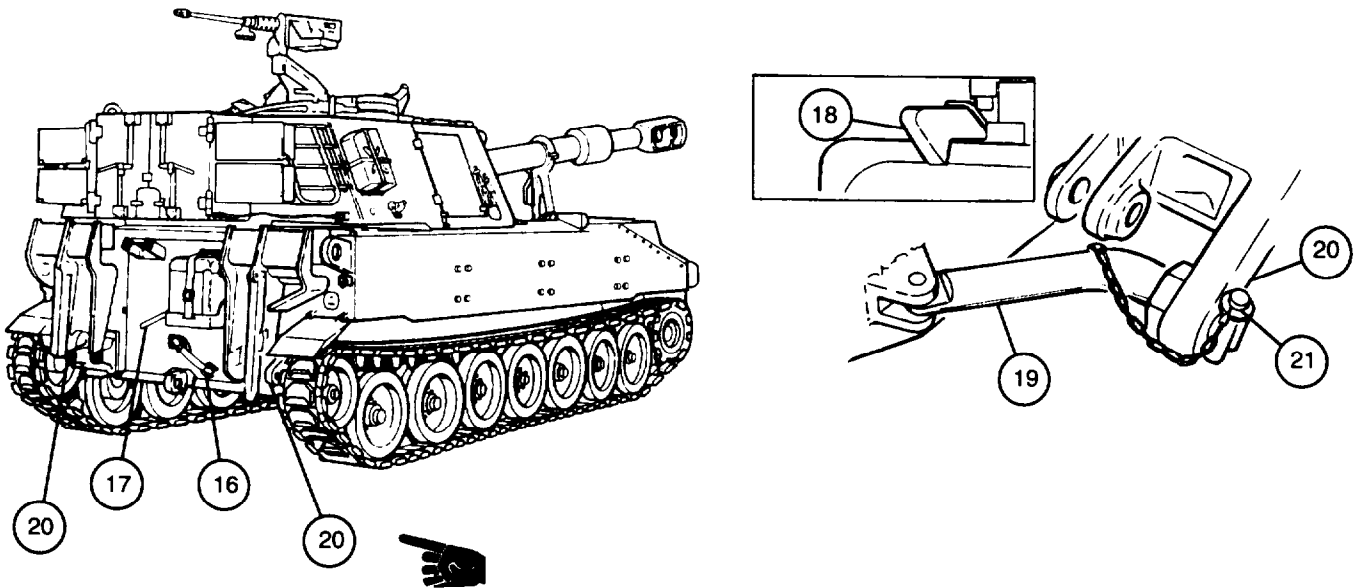
### 2-10.6 Operating Hull and Cab Doors and Hatches - Continued

#### d. Hull Rear Door

#### NOTE

- Some M109A3 vehicles have two hull rear doors.
- Hold-open latch is sufficient to hold hull rear door open, but when moving vehicle or firing howitzer with hull rear door open, place hold-open rod in tow lug and insert pin to hold in place.

- 1 To open hull rear door (16), lift door handle (17). Secure hull rear door in open position with hold-open latch (18) and hold-open rod (19). Secure hold-open rod in tow lug (20) with pin (21).
- 2 To close hull rear door (16), remove pin (21) from hold-open rod (19) and tow lug (20). Close hull rear door and pull down on door handle (17). Place hold-open rod in stowed position and secure with pin.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.6 Operating Hull and Cab Doors and Hatches — Continued

#### e. Driver's Hatch Cover

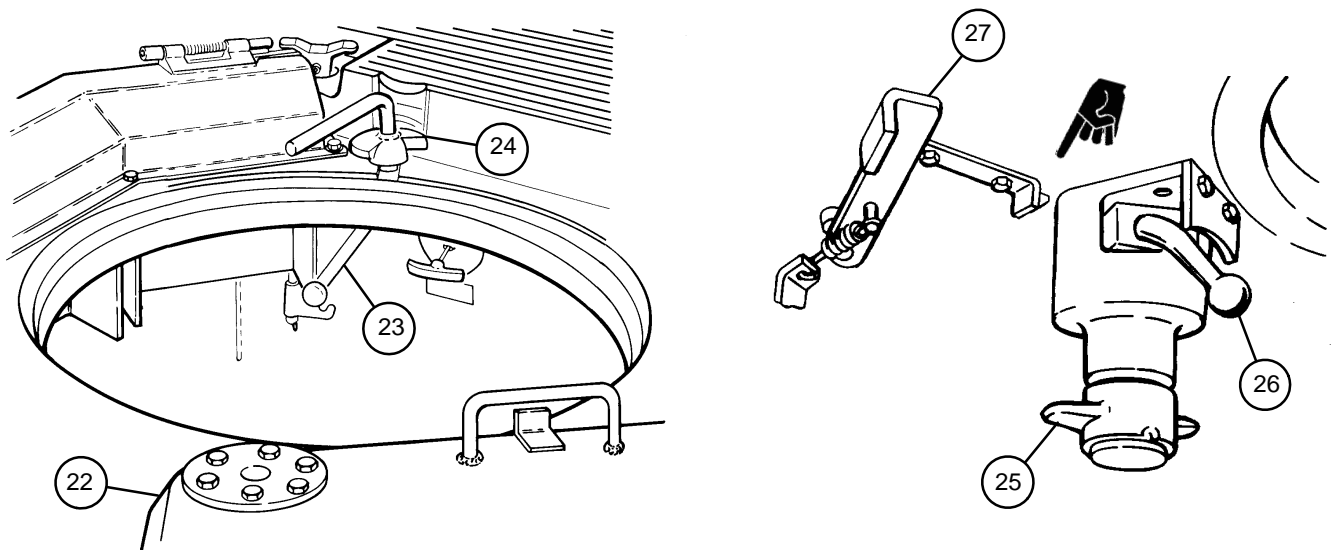
**WARNING**

Do not move vehicle if driver's hatch cover will not lock to avoid injury to personnel.

**NOTE**

Driver's hatch cover must be locked in either open or closed position.

- 1 To open driver's hatch cover (22), move locking lever (23) forward to release locking cam (24). Loosen chuck (25). Pull down and rearward on elevating handle (26) and driver's hatch cover locks automatically.
- 2 To close driver's hatch cover (22), move handle (27) forward. Pull down and forward on elevating handle (26). Tighten chuck (25) to lock driver's hatch cover. Move locking lever (23) rearward to lock locking cam (24).





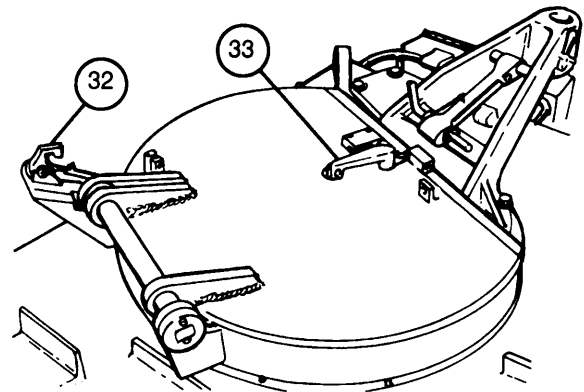
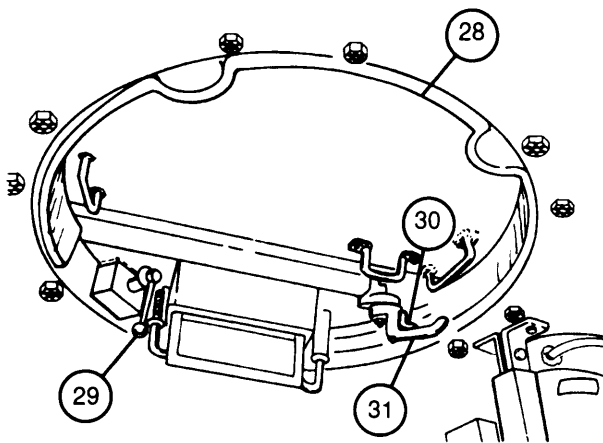
**2-10 OPERATING PROCEDURES — CONTINUED**

**2-10.6 Operating Hull and Cab Doors and Hatches — Continued**

**f. Commander's Cupola Cover**

1 Commander's cupola cover with outside latch handle is operated as follows.

- (a) To rotate commander's cupola cover (28) loosen screw assembly (29). Rotate commander's cupola cover and tighten screw assembly to hold in position.
- (b) To open commander's cupola cover (28) from inside, pull down on latch (30) and turn door handle assembly (31) to left to release. Secure commander's cupola cover in open position with manual control lever (32).
- (c) To open commander's cupola cover (28) from outside, use door handle (33).
- (d) To close commander's cupola cover (28), release manual control lever (32). Close commander's cupola cover and secure by turning door handle assembly (31) to right.



**2-10 OPERATING PROCEDURES -CONTINUED**

**2-10.6 Operating Hull and Cab Doors and Hatches - Continued**

**f. Commander's Cupola Cover - Continued**

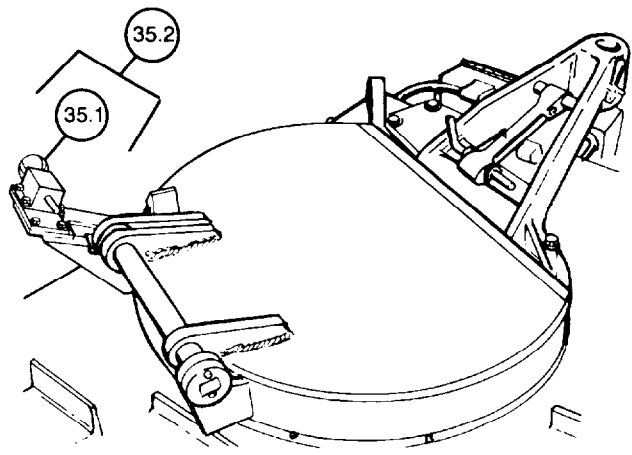
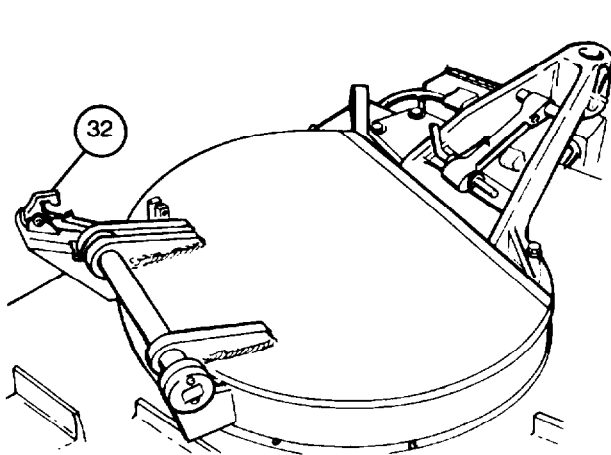
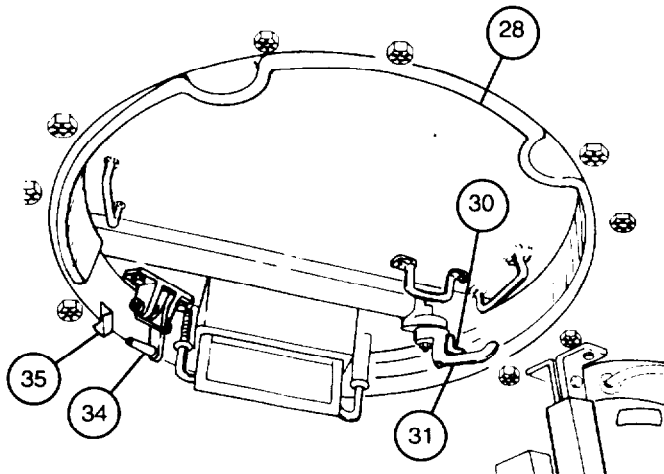
2 Commander's cupola without outside latch handle is operated as follows.

- (a) To rotate commander's cupola cover (28), pull out latch (34). Rotate commander's cupola cover and secure by releasing latch into one of the notches (35).
- (b) To open commander's cupola cover (28), pull down on latch (30) and turn door handle assembly (31) to left to release. Secure commander's cupola cover in open position with manual control lever (32).

**NOTE**

Step (c) pertains to hook latch assembly and step (d) pertains to knob latch assembly.

- (c) To close commander's cupola cover (28), release manual control lever (32). Close commander's cupola cover and secure by turning door handle assembly (31) to right.
- (d) To close commander's cupola cover (28), pull knob (35.1) on latch assembly (35.2). Close commander's cupola cover and secure by turning door handle assembly (31) to right.



## 2-10 OPERATING PROCEDURES - CONTINUED

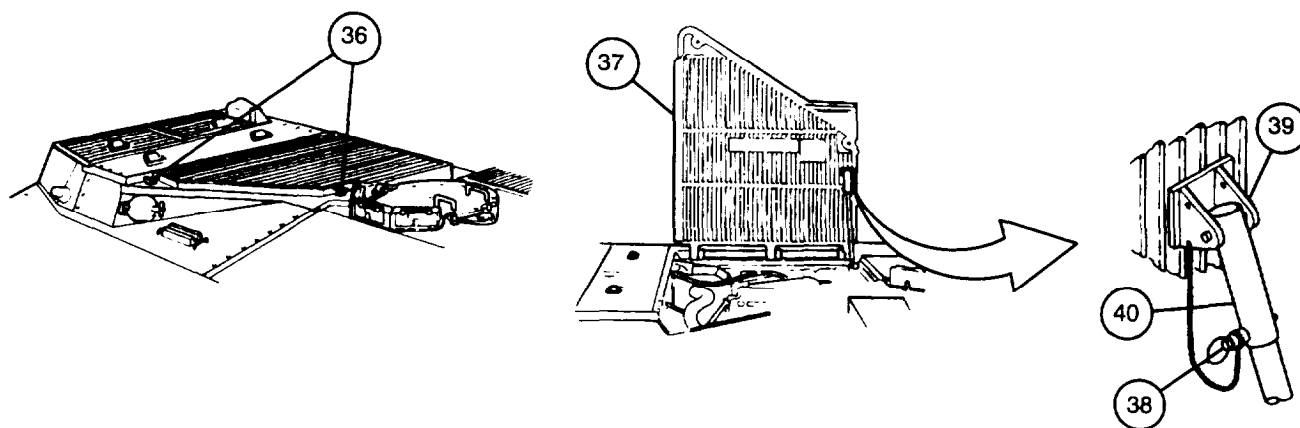
### 2-10.6 Operating Hull and Cab Doors and Hatches - Continued

#### g. Engine Air Intake Grille

**WARNING**

Be careful when handling the engine air intake grille and travel lock. Serious injury or death could occur if struck by either the grille or travel lock.

- 1 Release and elevate cannon tube and traverse cab 90° (para 2-10.8)
- 2 Unscrew two T-handles (36).
- 3 Open engine air intake grille (37) and secure in the open position by removing quick release pin (38) from bracket (39) and installing in support (40).
- 4 Lower travel lock assembly (para 2-10.8).
- 5 To close engine air intake grille (37), remove quick release pin (38) from support (40) and install in bracket (39).
- 6 Lower engine air intake grille (37) to closed position and secure with two T-handles (36).
- 7 Rotate cab 90°, so gun tube is facing forward. Raise travel lock assembly and lower cannon tube into travel lock. Secure cannon tube in travel lock.



2-10 OPERATING PROCEDURES -CONTINUED

2-10.7 Operating Miscellaneous Items

a. Bilge Pump

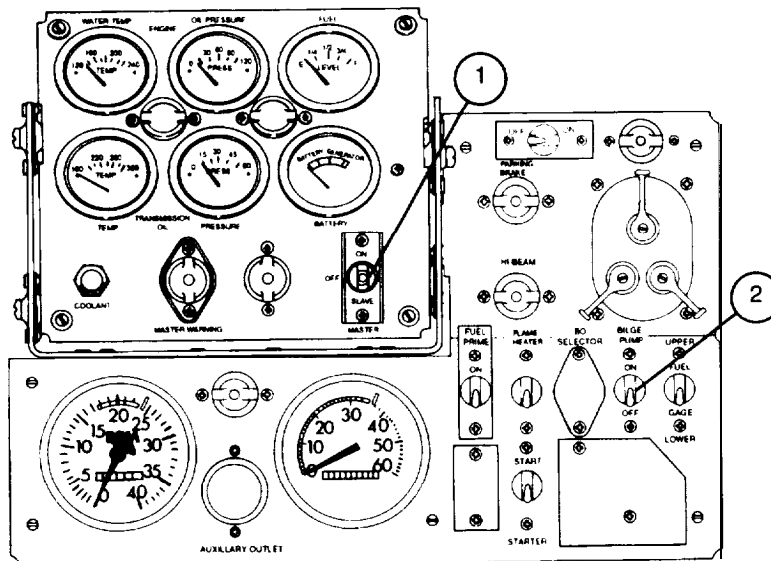
**CAUTION**

Do not operate bilge pump dry longer than 1 minute or wet for more than 15 minutes without engine running.

To drain water out of engine compartment, turn MASTER switch (1) to ON and turn BILGE PUMP control switch (2) to ON and hold.

**NOTE**

M109A4/M109A5 howitzer engine model 7083-7396 driver's fixed instrument panel is shown.



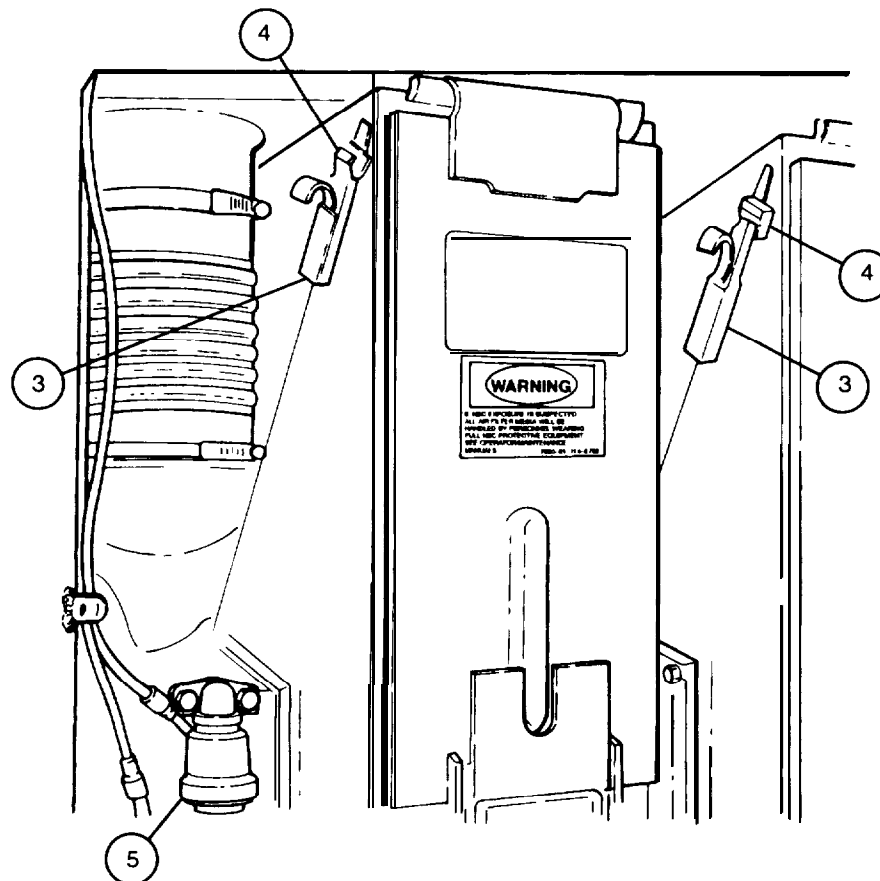


## 2-10 OPERATING PROCEDURES - CONTINUED

### 2-10.7 Operating Miscellaneous Items - Continued

#### b. Engine Air Cleaner

- 1 For summer position, when temperatures are over 40° F (4° C), leave locking handles (3) in holders.
- 2 For winter position, when temperatures are below 25° F (4° C), raise locking handles (3) and fasten on hooks (4).
- 3 For intermediate temperatures between 25 to 40° F (4 to 4° C), start engine with locking handles (3) in winter position. When engine reaches operating temperature, place locking handles in summer position.
- 4 An air cleaner indicator (5) is located alongside the left air cleaner. It reads less than 25 in. H<sub>2</sub>O when air cleaner is operating properly. When airflow is restricted, the gage reads 25 in. H<sub>2</sub>O or greater indicating that the air cleaner element should be serviced (para 3-5.4). The air cleaner indicator gage locks into position every 5 in. H<sub>2</sub>O. A reset button on the bottom of the air cleaner indicator gage must be pushed to zero the gage.



#### NOTE

Air cleaner shown in winter position.

2-10 OPERATING PROCEDURES - CONTINUED

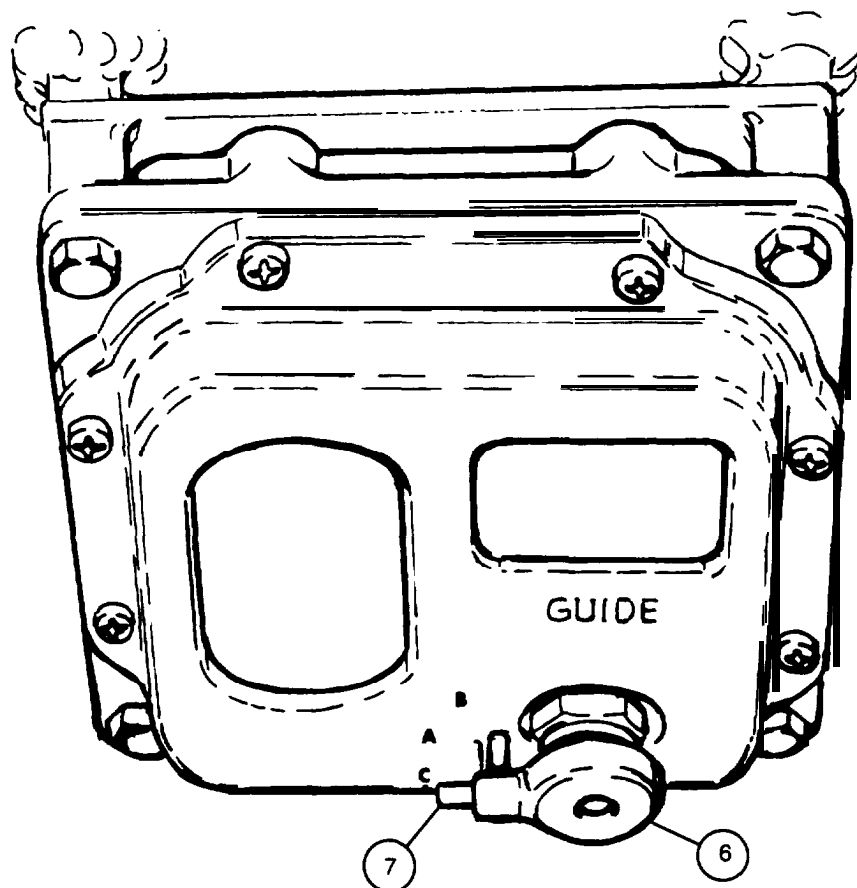
2-10.7 Operating Miscellaneous Items - Continued

c. Dome Light Assemblies

NOTE

Turn MASTER switch to ON to operate dome light assemblies.

- 1 Blue (blackout) light is on when knob (6) is turned fully clockwise (position B).
- 2 White light is on when push button (7) is pressed and knob (6) is turned counterclockwise past stop (position C).
- 3 Both lights are off when knob (6) is in center (position A).

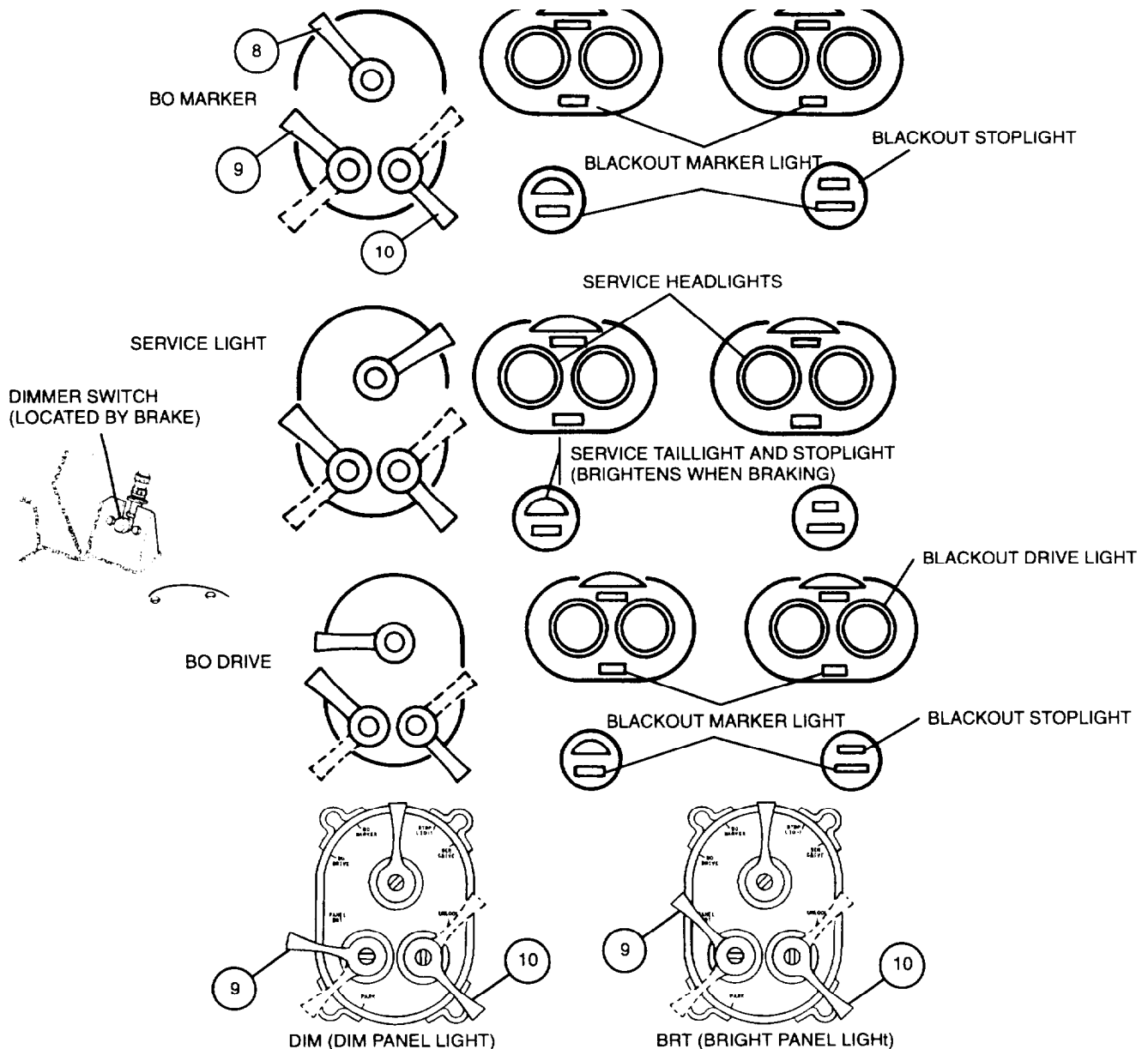


2-10 OPERATING PROCEDURES - CONTINUED

2-10.7 Operating Miscellaneous Items - Continued

d. Driving Light Control Switches

- 1 The illustrations below show which lights are turned on by the different positions of the main light switch (8). The instrument panel light switch (9) and safety switch (10) are also shown. To unlock main light switch, push up safety switch, then release after main light switch is in position.
- 2 To activate the panel lights, with the Driving Light Control switch in the OFF position, push safety switch (10) up and place instrument panel light switch (9) in BRT or DIM position. Release safety switch.





2-10 OPERATING PROCEDURES - CONTINUED

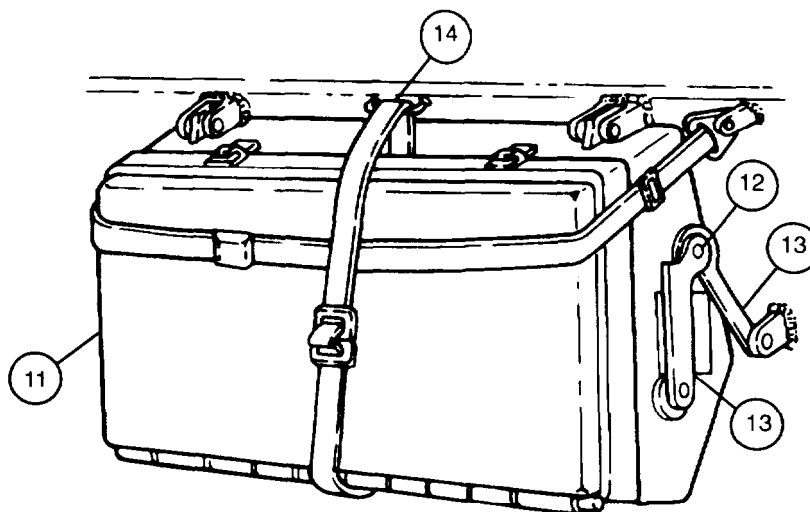
2-10.7 Operating Miscellaneous Items - Continued

e. Cannoneer's Seat Assemblies (M109A4/M109A5)

**NOTE**

Procedure is written for one cannoneer's seat assembly, although it applies to both.

- 1 To lower cannoneer's seat (11) to stowed position, push up in pin (12) area so two arms (13) fold and lower cannoneer's seat.
- 2 Attach strap (14) to floor so it is out of the way and secure during firing.
- 3 To raise cannoneer's seat (11) to traveling position, remove strap (14) and lift until two arms (13) lock in fully extended position. Push down in pin (12) area to lock arms. Strap attaches to floor and front of cannoneer's seat to prevent rattling and folding under.



**NOTE**

Cannoneer's seat is illustrated in stowed position.

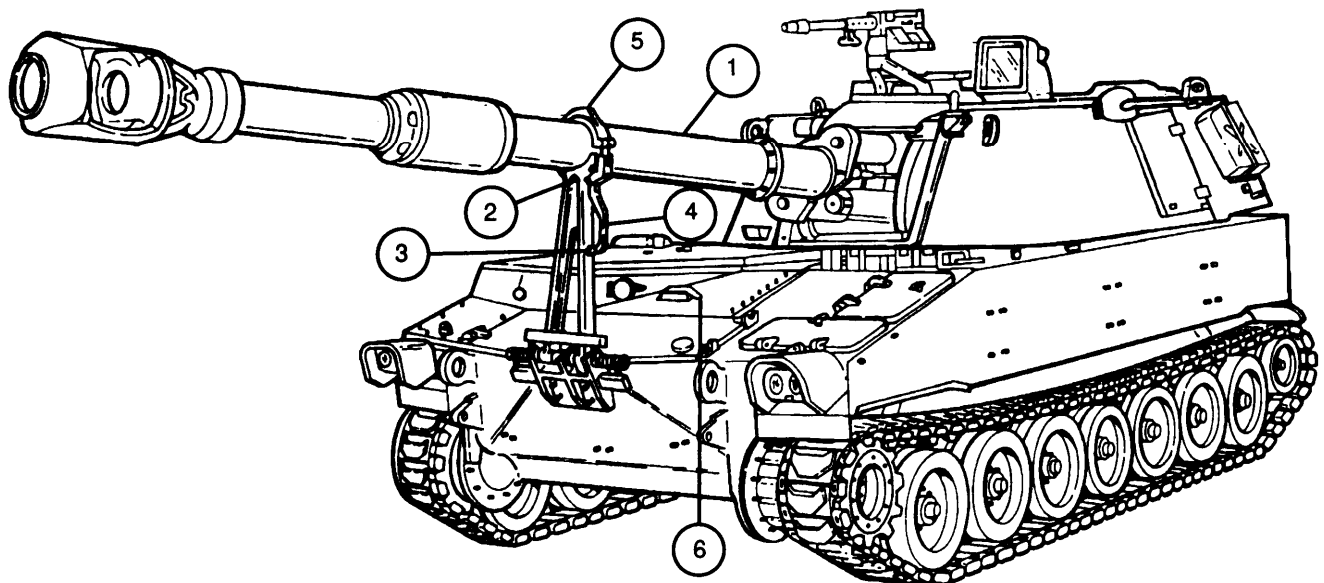
## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.8 Traversing and Elevating

#### a. Preparation

**WARNING**

- All personnel located outside the vehicle must be clear of hull while cab is being traversed to avoid injury.
  - Although the travel lock assembly is counterbalanced, it is heavy. Be careful when raising and lowering it to avoid injury.
- 1 Release cannon tube (1) from travel lock assembly (2) as follows.
    - (a) Remove pin assembly (3) and raise handle (4) vertically to release travel lock cap (5). Raise travel lock cap vertically until clear of cannon tube (1).
    - (b) Hold travel lock assembly (2) vertically until cannon tube (1) has been elevated to clear travel lock cradle rest.
    - (c) Close travel lock cap (5).
    - (d) Lower travel lock assembly (2) to stow position on engine compartment deck.
    - (e) Secure travel lock assembly (2) using hold-down strap (6).



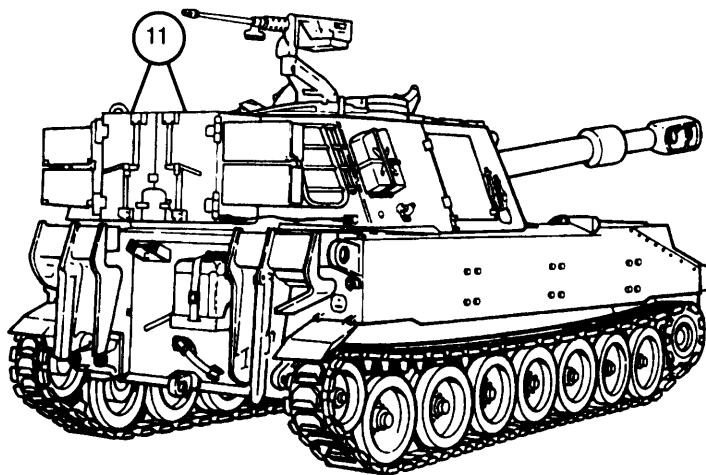
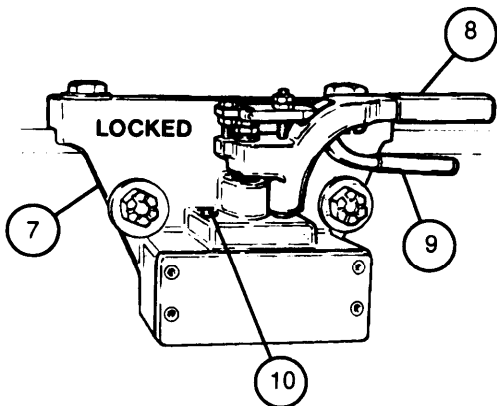
2-10 OPERATING PROCEDURES — CONTINUED

2-10.8 Traversing and Elevating — Continued

a. Preparation — Continued

NOTE

- Turret lock assembly is in unlocked position when UNLOCKED is covered.
  - If necessary for rotating turret lock assembly over positioning hole, manually traverse cab slightly left or right to aline lock teeth with cab ring teeth.
- 2 Release turret lock assembly (7) by squeezing manual control levers (8 and 9) together to rotate turret lock assembly over positioning hole (10).
  - 3 Close bustle doors (11) and secure loose bustle door latch assemblies.
  - 4 Alert crew when cab is going to be traversed.



2-10 OPERATING PROCEDURES — CONTINUED

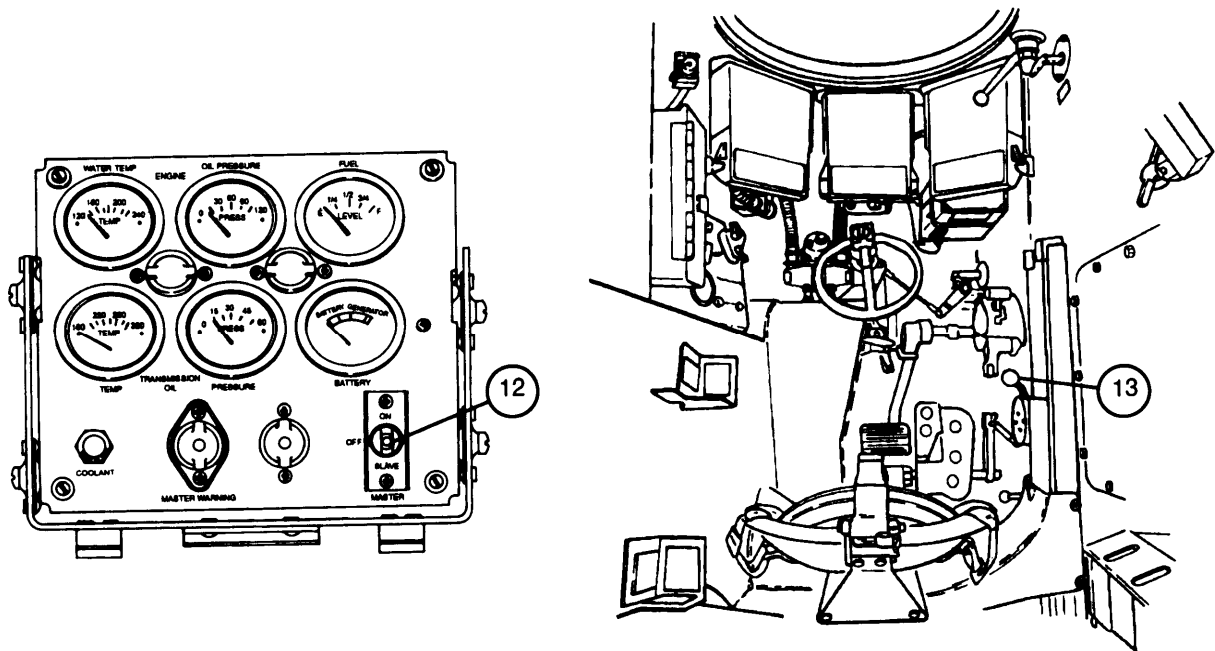
2-10.8 Traversing and Elevating — Continued

b. Power Traversing

**CAUTION**

Don't use power traverse if your vehicle is positioned with more than 90 mils cant.

- 1 Turn MASTER switch (12) to ON.
- 2 Start engine and set hand throttle control lever (13) at 1000 rpm to keep batteries charged.



## 2-10 OPERATING PROCEDURES — CONTINUED

### 2-10.8 Traversing and Elevating — Continued

#### b. Power Traversing — Continued

- 3 Turn CAB POWER switch (14) to ON. CAB POWER indicator light (15) should light.

<b>CAUTION</b>
----------------

If pressure exceeds 1400 psi with CAB POWER switch to ON, turn CAB POWER switch to OFF to prevent equipment damage and notify unit maintenance.

- 4 Ensure pressure gage (16) has normal pressure of 925 to 1225 psi (6378 to 8446 kPa) at 70° F (21 °C).
- 5 Turn TRAVERSE CONTROL switch (17) to POWER position. TRAVERSE CONTROL indicator light (18) should light.

#### NOTE

If electricity for clutch valve fails, loss of pressure to traversing mechanism occurs and cab cannot traverse normally. Perform step (6) on M109A4/M109A5 howitzers and notify unit maintenance.

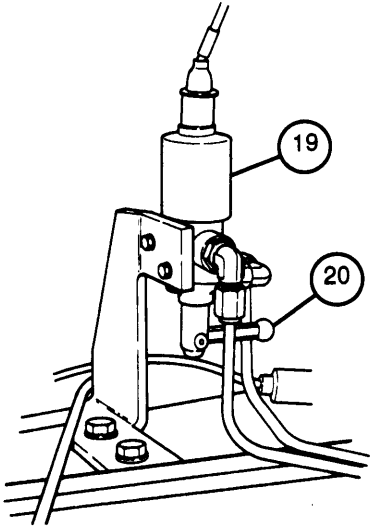
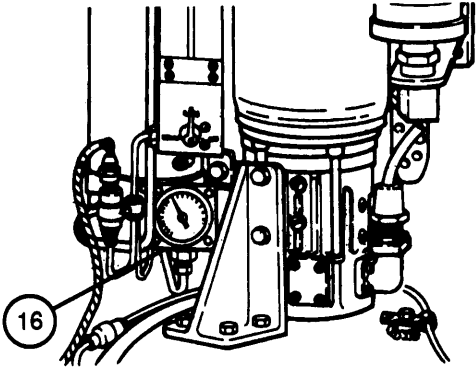
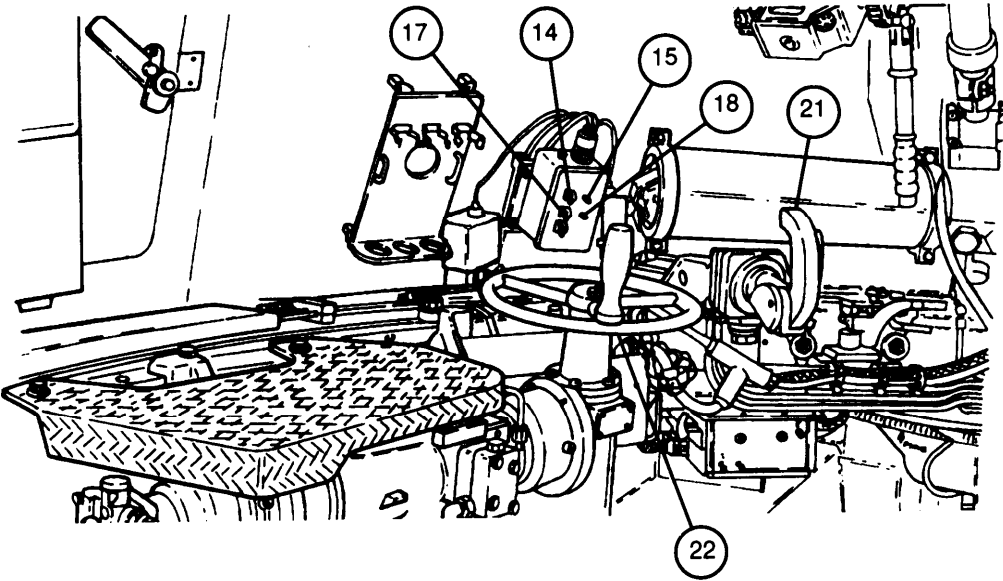
- 6 To overcome clutch valve (19) failure, pull up on override lever (20) on clutch valve and hold while traversing.
- 7 Turn gunner's control handle (21) right (to traverse right) or left (to traverse left).
- 8 To stop rotation, return gunner's control handle (21) slowly to center position and wait until cab stops.
- 9 Turn CAB POWER switch (14) to OFF and place TRAVERSE CONTROL switch (17) to MANUAL position.

#### c. Manual Traversing

- 1 Place TRAVERSE CONTROL switch (17) in MANUAL position.
- 2 Turn handwheel assembly (22) and cab will rotate in same direction as rotation.

2-10 OPERATING PROCEDURES — CONTINUED

2-10.8 Traversing and Elevating — Continued



2-10 OPERATING PROCEDURES — CONTINUED

2-10.8 Traversing and Elevating — Continued

d. Power Elevating

- 1 Turn MASTER switch (12) to ON.
- 2 Turn CAB POWER switch (14) to ON.

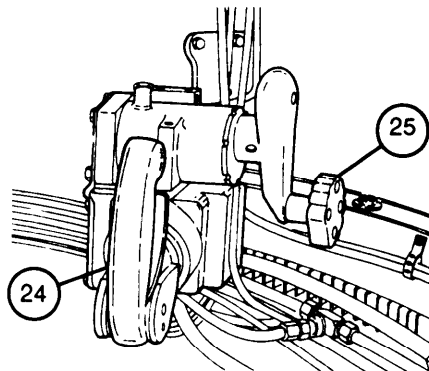
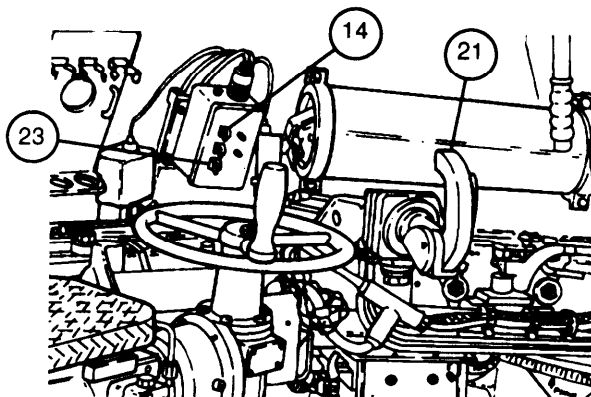
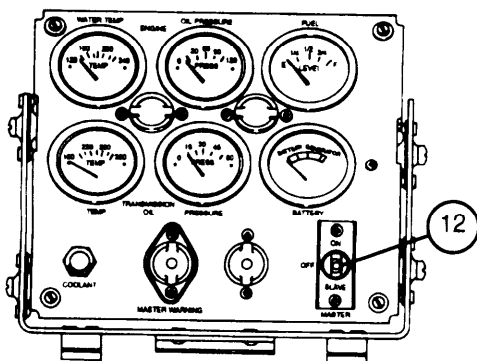
NOTE

If gunner is going to elevate, perform step 3; if assistant gunner is going to elevate, perform step 4.

- 3 Turn ELEVATION CONTROL switch (23) to GUNNER position. Pull gunner's control handle (21) to elevate or push to depress.
- 4 Turn ELEVATION CONTROL switch (23) to NO. 1 MAN position. Pull assistant gunner's control handle (24) to elevate or push to depress.

e. Manual Elevating

Manual elevating is done by assistant gunner turning handpump crank (25).



## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS

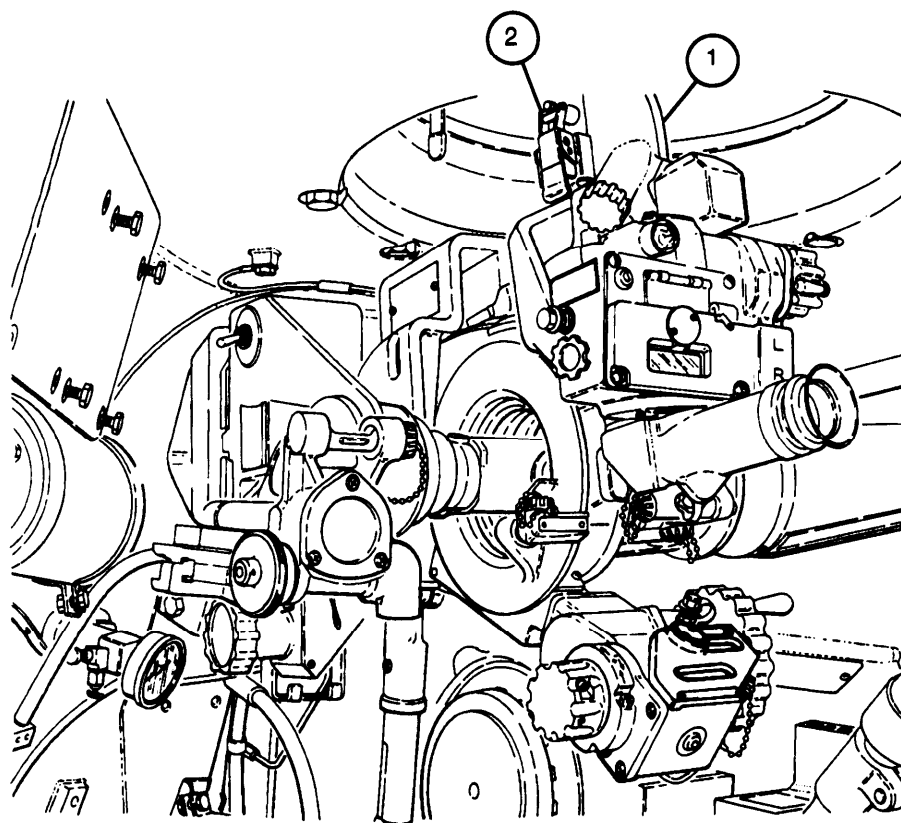
### 2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount

#### CAUTION

To avoid breaking electrical connections, install M117/M117A2 panoramic telescope straight up. Make sure that lenses and panoramic telescope ballistic cover window are clean.

#### a. Installation of M117/M117A2 Panoramic Telescope

Install M117/M117A2 panoramic telescope (1) and secure with two clamping catches (2).





## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS — CONTINUED

### 2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount — Continued

#### b. Description of M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount Components

- 1 Direct fire bar knob (3) allows deflection changes in 5 mil increments for direct fire.
- 2 Azimuth knob (4) sets azimuth counter (5) and reset counter (6) when turned and allows M117/M117A2 panoramic telescope (1) head to be rotated.
- 3 Cross-level mechanism knob (7) centers cross-level (8) when turned.
- 4 Gunner's aid knob (9) sets gunner's aid counters (10) when turned.
- 5 Gunner's aid counters (10) provide visual correction factor for individual weapon.
- 6 Boresight detent shaft (11) is used to change mil reading of azimuth counter (5) during boresighting.
- 7 Pitch level (12) is used for leveling.
- 8 Cross-level (8) is used for leveling.
- 9 Elevation handwheel (13) sets elevation counter (14) when turned.
- 10 Elevation counter (14) shows quadrant.
- 11 Correction counter (15) registers correction value for individual weapon in mils.
- 12 Correction knob (16) sets correction counter (15) when turned.
- 13 Pitch knob (17) centers pitch level (12) when turned.
- 14 Level (18) is used for leveling.
- 15 Quadrant support assembly knob (19) centers quadrant support assembly level (20) when turned.
- 16 Quadrant support assembly level (20) is used for leveling.
- 17 Toggle switch (21) turns on lamps when pushed up.
- 18 Reset knob (22) resets the reset counter (6) when pushed in and turned.
- 19 Reset counter (3200 mil) (6) registers azimuth travel in mils.
- 20 Azimuth counter (6400 mil) (5) registers azimuth travel in mils.
- 21 Door release (23) opens azimuth counter (5) access door when moved to the right.

**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

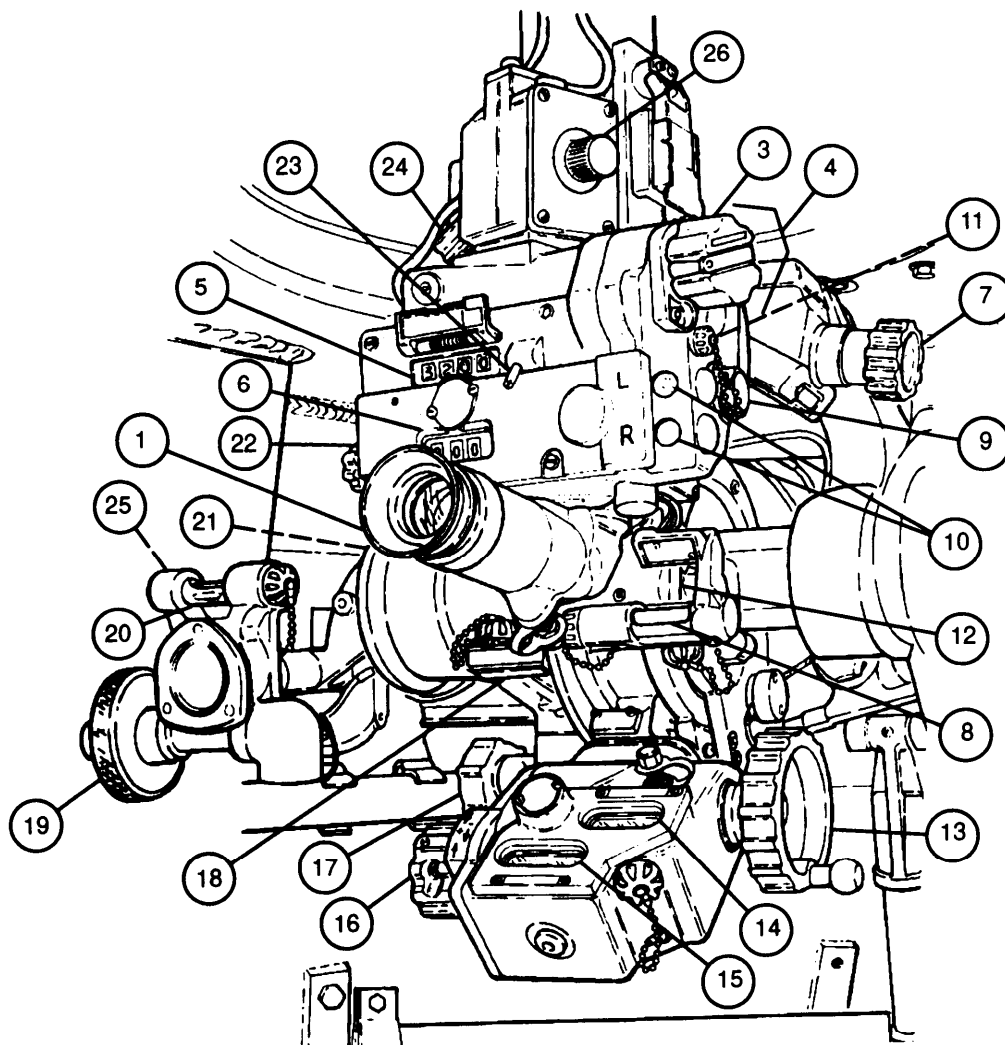
**2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount — Continued**

**b. Description of M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount Components  
— Continued**

22 Elevation knob (24) adjusts reticle up or down 300 mils when turned.

23 Quadrant seat (25) allows M1A1 gunner's quadrant to be positioned for fine elevation adjustment.

24 Variable resistor knob (26) varies amount of light for reticle pattern when turned.



## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS — CONTINUED

### 2-11.1 M117/M17A2 Panoramic Telescope and M145/M145A1 Telescope Mount — Continued

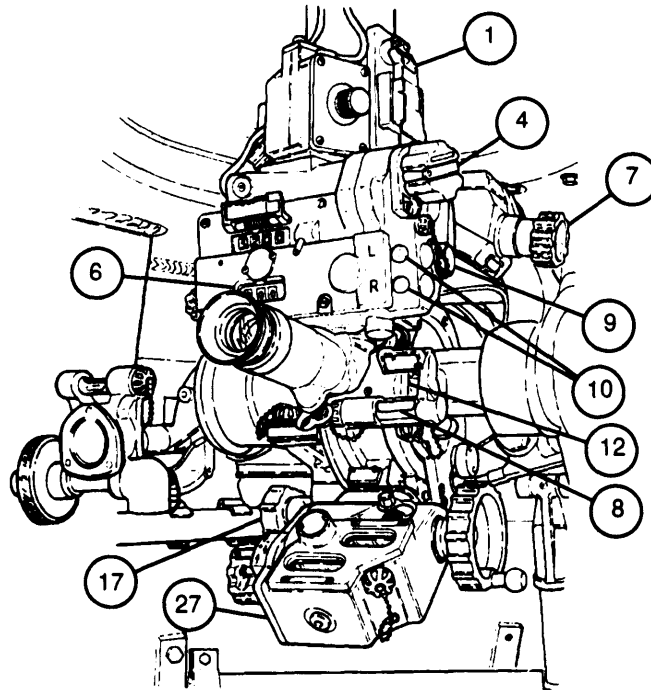
#### c. Operation of M117/M117A2 Panoramic Telescope

##### NOTE

- The following steps are required to ensure correct announced deflection is set on M117/M117A2 panoramic telescope.

- Steps 1 through 4 are to be performed by the gunner prior to firing the weapon.

- 1 Turn gunner's aid knob (9) to place correction factor obtained from Fire Direction Center (FDC) for individual weapon to either L or R window of gunner's aid counters (10).
- 2 Turn azimuth knob (4) until 3200 or announced deflection appears on reset counter (6).
- 3 Traverse cannon tube until proper sight picture is obtained on aiming point (para 2-1 2.6).
- 4 Turn cross-level mechanism knob (7) and pitch knob (17) on M145/M145A1 telescope mount (27) to center cross-level (8) and pitch level (12). Recheck sight picture and adjust if necessary.



## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS - CONTINUED

### 2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount - Continued

#### d. Quick Alinement of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device

**WARNING**

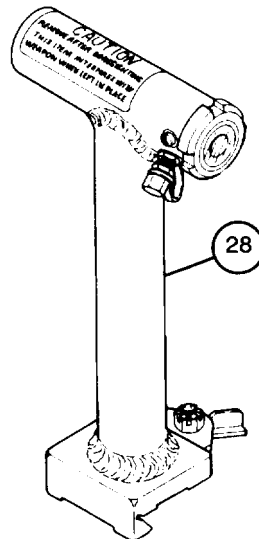


The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

**NOTE**

- To assure the M140 alinement device is in collimation and can be used for quick alinement procedure, the fire control instruments must first be boresighted using either distant aiming point method or test target method (para 2-12.2). Paragraph 2-12.2 also provides procedures for checking the M140 alinement device while boresighting on the test target.
- M140 alinement device is used to aline M117/M117A2 panoramic telescope with cannon tube.
- Parallax occurs when panoramic telescope ballistic cover is not perpendicular to line of sight of M117/M117A2 panoramic telescope. To eliminate this refraction problem, keep panoramic telescope ballistic cover perpendicular to line of sight of M140 alinement device and M117/M117A2 panoramic telescope during boresighting.

- 1 Gunner removes M140 alinement device (28) from stowage and hands it to driver.



**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
- CONTINUED**

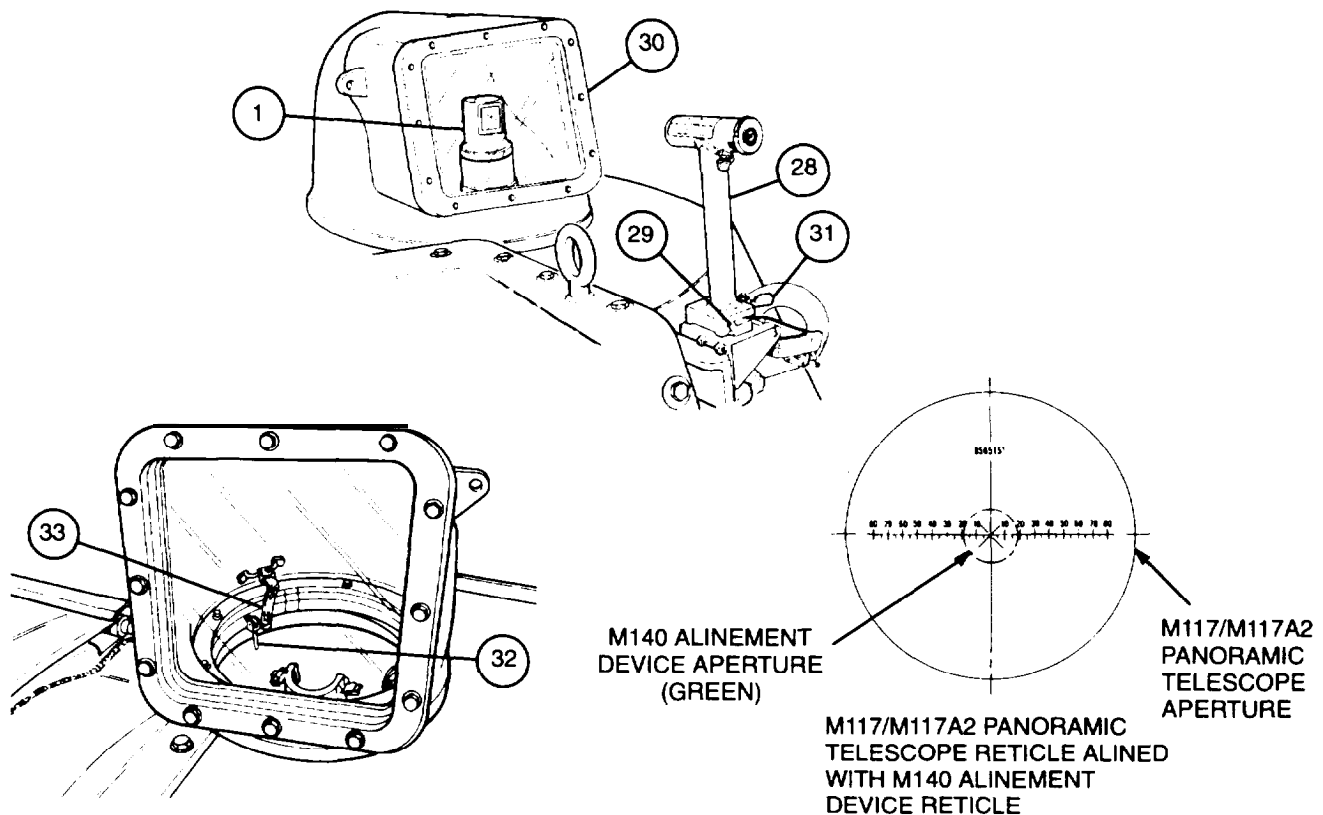
**2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount - Continued**

**d. Quick Alinement of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device  
- Continued**

**NOTE**

Ensure mounting surfaces are clean and free of burrs. If dovetail door wedge has burrs, notify unit maintenance.

- 2 Driver slips M140 alinement device (28) onto dovetail door wedge (29) in front of panoramic telescope ballistic cover (30) and secures in position by turning clamping catch (31). Ensure M140 alinement device is securely latched.
- 3 To rotate panoramic telescope ballistic cover (30), release brakes using rod end clevis assemblies (32) inside cab and rotate by holding webbing straps (33).
- 4 Sighting through M117/M117A2 panoramic telescope (1) eyepiece at M140 alinement device (28) line up apertures as shown. At this setting, M117/M117 panoramic telescope is in close alinement with cannon tube.
- 5 Driver should release clamping catch (31) and remove M140 alinement device (28) from dovetail door wedge (29) and hand it to gunner for stowage.

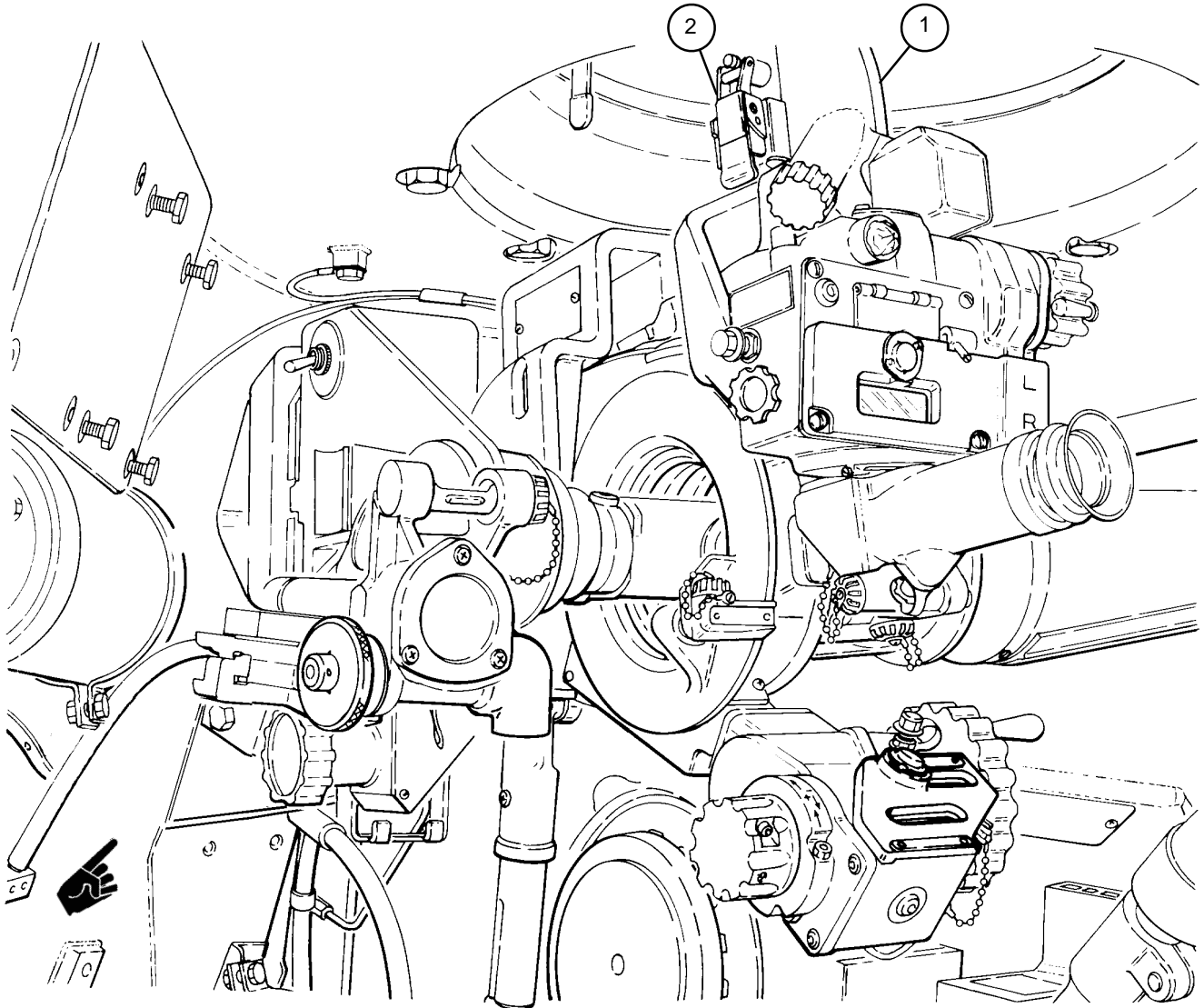


**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-11.1 M117/M117A2 Panoramic Telescope and M145/M145A1 Telescope Mount — Continued**

**e. Removal of M117/M117A2 Panoramic Telescope**

Release two clamping catches (2) and remove M117/M117A2 panoramic telescope (1).



## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS — CONTINUED

### 2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount

#### a. Installation of M118A2/M118A3 Elbow Telescope

When installing M118A2/M118A3 elbow telescope, make sure electrical connector is not lying on top of mount.

#### NOTE

Before installing M118A2/M118A3 elbow telescope, clean forward lens and eyepiece lens using lens paper (item 33, Appx D).

- 1 Slide M118A2/M118A3 elbow telescope (1) into M146 telescope mount (2). Support M118A2/M118A3 elbow telescope.

**WARNING**

M118A2/M118A3 elbow telescope weighs 55 pounds (24.9 kg). Failure to install kingpin will result in injury to personnel and damage to M118A2/M118A3 elbow telescope when cannon tube is elevated.

- 2 Install kingpin (3) and tighten by rotating clockwise,
- 3 Connect cable assembly receptacle (4) on M146 telescope mount (2) to underside of M118A2/M118A3 elbow telescope (1).

#### b. Description of M118A2/M118A3 Elbow Telescope and M146 Telescope Mount Components

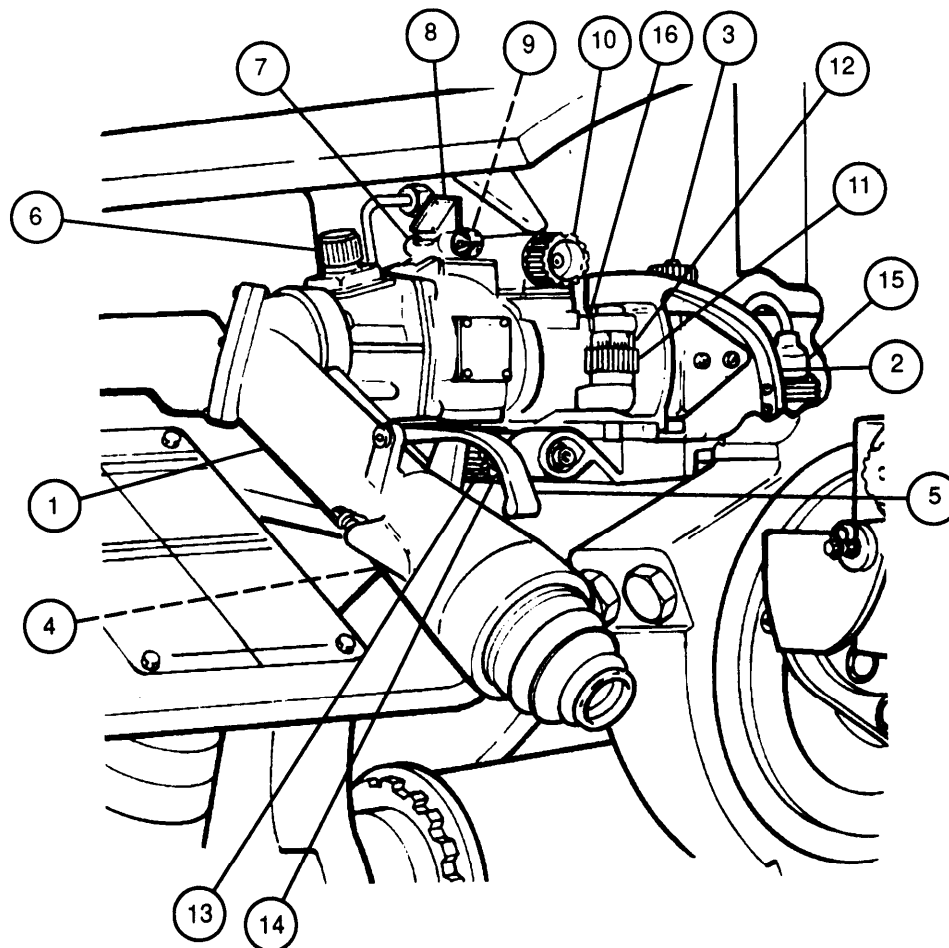
- 1 Lock-release lever (5) locks the M118A2/M118A3 elbow telescope (1) in any position at any desired angle.
- 2 Variable resistor knob (6) varies amount of light for reticle pattern when turned.
- 3 Level vial (7) is used by the gunner to cross-level the cant corrector whenever it is in canted position.
- 4 Level assembly mirror (8) is provided for easy viewing of the level vial (7).
- 5 Wormshaft assembly knobs (9 and 10) are used in conjunction with the level assembly to correct cant.
- 6 Elevation knob (11) adjusts the M118A2/M118A3 elbow telescope (1) up or down 8 mils when turned.
- 7 Elevation dial (12) registers elevation corrections in mils.

**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-1 1.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount — Continued**

**b. Description of M118A2/M118A3 Elbow Telescope and M146 Telescope Mount Components  
— Continued**

- 8 Deflection knob (13) allows deflection changes in 8 mil increments when turned.
- 9 Deflection scale dial (14) registers deflection corrections in mils.
- 10 Cable assembly (15) supplies 24v dc power from the vehicle supply to the M118A2/M118A3 elbow telescope (1) for reticle and level vial illumination.
- 11 Elevation slide (16) supports the M118A2/M118A3 elbow telescope (1) in elevation.
- 12 Kingpin (3) allows mounting of the M118A2/M118A3 elbow telescope (1) to the M146 telescope mount (2).



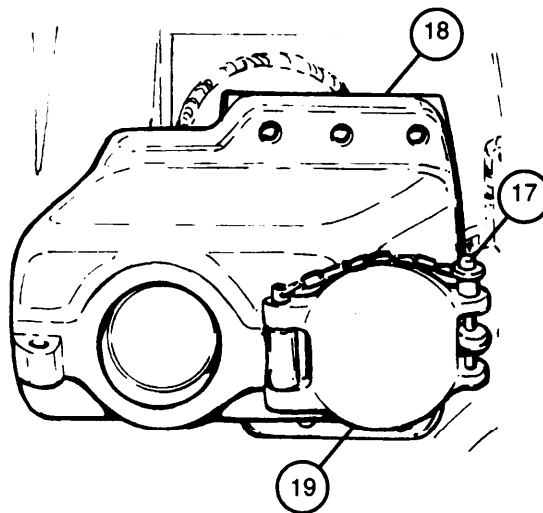
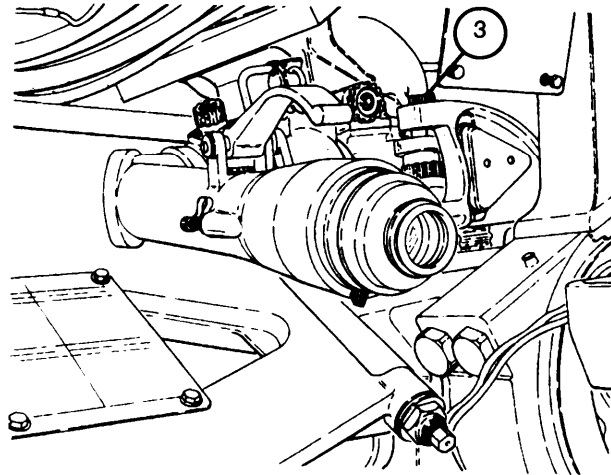


**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount — Continued**

**c. Operation of M118A2/M118A3 Elbow Telescope and M146 Telescope Mount**

- 1 Be sure kingpin (3) is tight.
- 2 Remove quick-release pin (17) and M42 tank periscope (18) cover door (19). Lock cover door in open position with quick-release pin.



**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-11.2 M118A2/M118A3 Elbow Telescope and M148 Telescope Mount — Continued**

**c. Operation of M118A2/M118A3 Elbow Telescope and M148 Telescope Mount — Continued**

**NOTE**

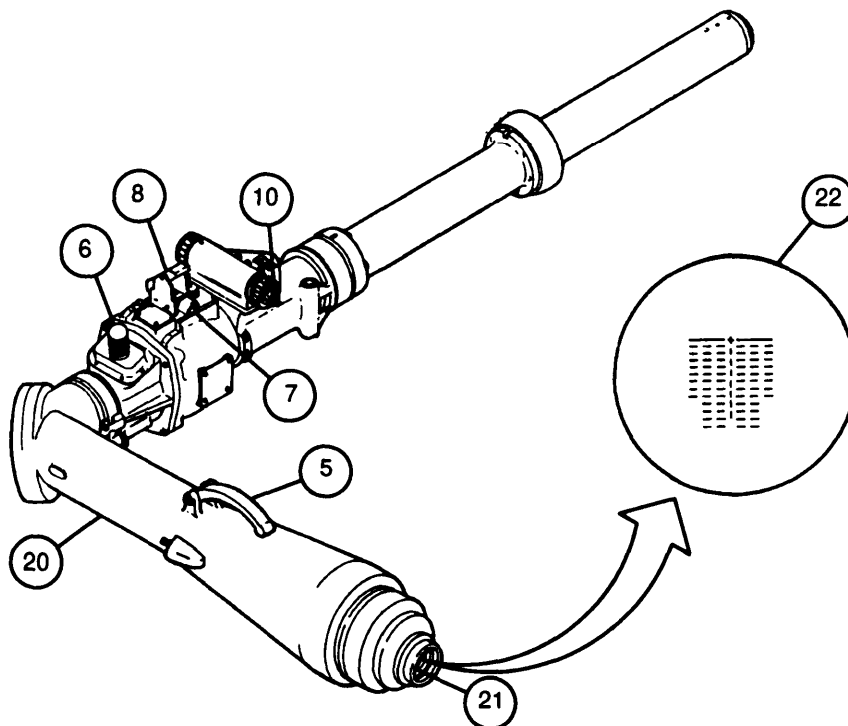
Eyepiece arm will automatically lock within 50 mils.

- 3 Depress lock-release lever (5) to adjust eyepiece arm (20).

**NOTE**

The field of view may look tilted because reticle and target will only appear level when angle of eyepiece and elevation angle coincide exactly. The apparent tilt does not affect accuracy and may be lessened by moving eyepiece arm.

- 4 Look through eyepiece (21) and turn variable resistor knob (6) to adjust reticle (22) illumination.
- 5 Level assembly mirror (8) is used to view level vial (7).
- 6 Turn wormshaft assembly knob (10) until bubble is centered in level vial (7).



**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount — Continued**

**c. Operation of M118A2/M118A3 Elbow Telescope and M146 Telescope Mount — Continued**

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

**NOTE**

Red index line and arrow located on side below wormshaft assembly knob serve as a direction reference only and will be aligned only when instrument and vehicle are both level.

M118A2/M118A3 elbow telescope does not have a reticle selection lever. It has only one reticle in a fixed position.

- 7 Enter boresight corrections by adjusting elevation knob (11) and deflection knob (13) on M146 telescope mount (2) while reading proper value on elevation dial (12) and deflection scale dial (14).
- 8 Locate and place target on appropriate range line of reticle (22) by traversing and elevating weapon (para 2–10.8).

**NOTE**

Always check to see that bubble is centered in level vial every time weapon is elevated or traversed.

- 9 Turn wormshaft assembly knob (10) to center bubble in level vial (7).
- 10 Repeat steps 8 and 9 until target is properly aligned and bubble in level vial (7) is centered.

**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
- CONTINUED**

**2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount - Continued**

**d. Quick Alinement of M118A2/M118A3 Elbow Telescope Using the M140 Alinement Device**

**WARNING**

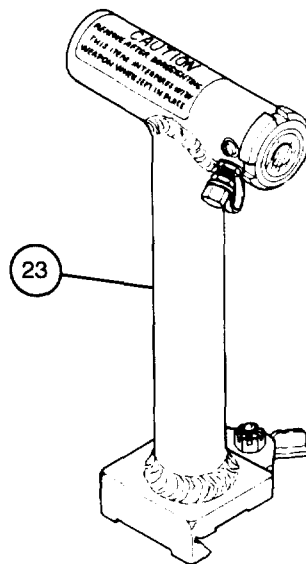


The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

**NOTE**

- To assure the M140 alinement device is in collimation and can be used for quick alinement procedure, the fire control instruments must first be boresighted using either distant aiming point method or test target method (para 2-12.2). Paragraph 2-12.2 also provides procedures for checking the M140 alinement device while boresighting on the test target.
- M140 alinement device is used to aline M118A2/M118A3 elbow telescope with cannon tube.

1 Gunner removes M140 alinement device (23) from stowage and hands it to driver.



2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
- CONTINUED

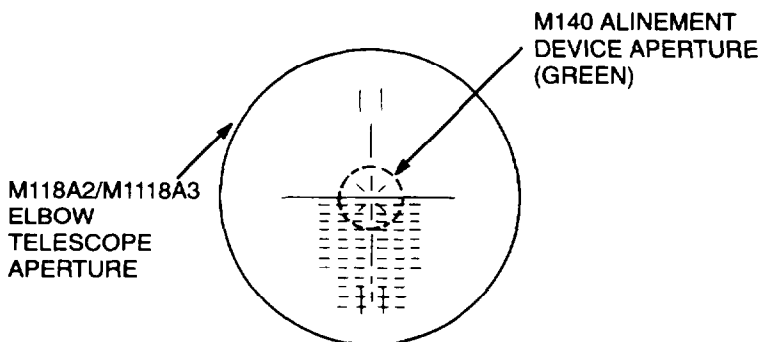
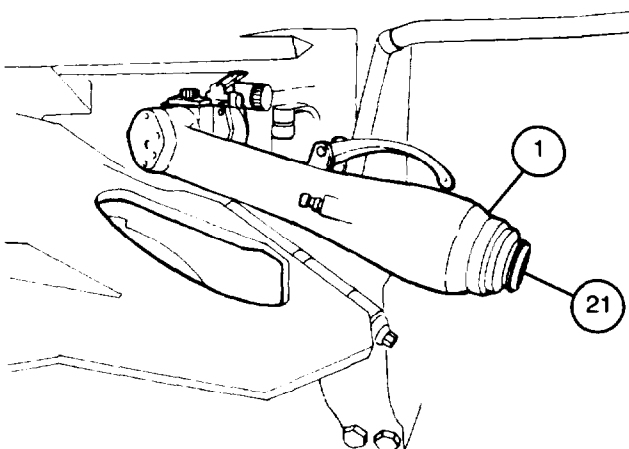
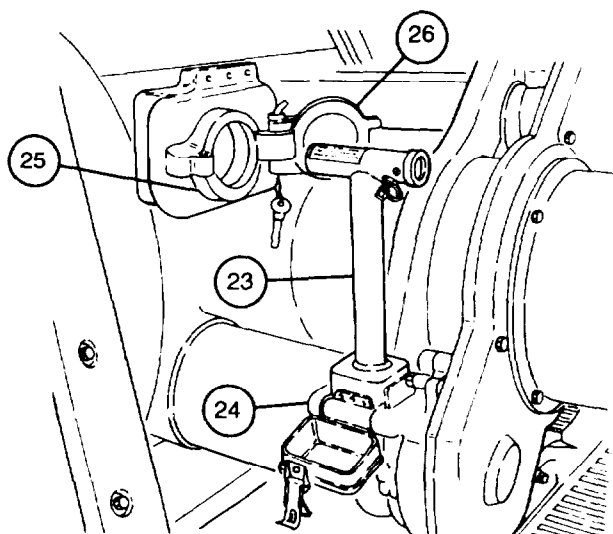
2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount - Continued

d. Quick Alinement of M118A2/M118A3 Elbow Telescope Using the M140 Alinement Device - Continued

NOTE

Ensure mounting surfaces are clean and free of burrs. If dovetail door wedge has burrs, notify unit maintenance.

- 2 Driver slips M140 alinement device (23) onto dovetail door wedge (24) in front of M42 tank periscope (25) cover door (26).
- 3 Sighting through M118A2/M118A3 elbow telescope (1) eyepiece (21) at M140 alinement device (23), line up apertures as shown. At this setting, M118A2/M118A3 elbow telescope is in close alinement with cannon tube.
- 4 Driver removes M140 alinement device (23) from dovetail door wedge (24) and hands it to gunner for stowage.



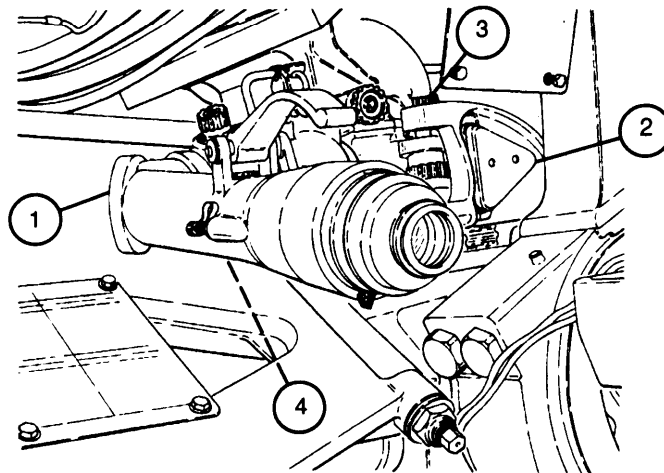
M118A2/M118A3 ELBOW TELESCOPE RETICLE ALINED WITH M140 ALINEMENT DEVICE RETICLE

**2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED**

**2-11.2 M118A2/M118A3 Elbow Telescope and M146 Telescope Mount — Continued**

**e. Removal of M118A2/M118A3 Elbow Telescope**

- 1 Disconnect cable assembly receptacle (4) on underside of M118A2/M118A3 elbow telescope (1).
- 2 Support M118A2/M118A3 elbow telescope (1) to prevent it from sliding out of M146 telescope mount (2).
- 3 Remove kingpin (3) by turning counterclockwise.
- 4 Slide M118A2/M118A3 elbow telescope (1) out of M146 telescope mount (2).



## 2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS — CONTINUED

### 2-11.3 M15 Elevation Quadrant

#### a. Description of the M15 Elevation Quadrant

- 1 Correction knob (1) sets correction counter plus window (2) or minus window (3) when turned.
- 2 Correction counter plus window (2) or minus window (3) registers correction factor for individual weapon.
- 3 Elevation knob (4) sets elevation counter (5) when turned.
- 4 Elevation counter (5) shows mils of gun elevation.
- 5 Cross-level knob (6) centers cross-level (7) bubble when turned.
- 6 Cross-level (7) is used for leveling.
- 7 Elevation level (8) is used for leveling.
- 8 Toggle switch (9) turns on lamp when pushed up.
- 9 M15 elevation quadrant seat (10) is a bar permanently mounted on top of the housing for seating the M1A1 gunner's quadrant.

#### b. Operating Procedures

##### NOTE

- M15 elevation quadrant is used along with M117/M117A2 panoramic telescope in laying weapon. If desired, functions of M15 elevation quadrant can be done using M145/M145A1 telescope mount.
  - The following steps must be done to ensure correct announced quadrant is set on M15 elevation quadrant and will be performed by assistant gunner.
- 1 Turn correction knob (1) on M15 elevation quadrant (11) to place correction factor for individual weapon in either correction counter plus window (2) or minus window (3).
  - 2 Turn elevation knob (4) to put quadrant value commanded by Fire Direction Center (FDC) in elevation counter (5).
  - 3 Elevate or depress weapon to center elevation level (8) bubble.

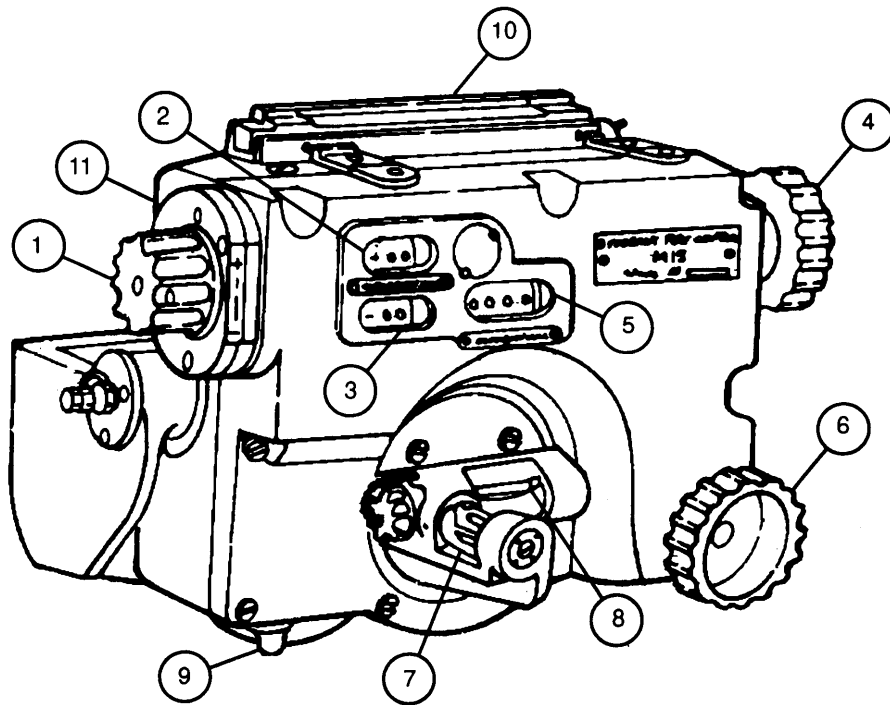
##### NOTE

Use M1A1 gunner's quadrant on M15 elevation quadrant for fine elevation adjustments. Bubble must be centered in cross-level using cross-level knob each time weapon is elevated, depressed, or traversed.

- 4 Turn cross-level knob (6) to center cross-level (7) bubble.

2-11 OPERATION OF FIRE CONTROL EQUIPMENT UNDER NORMAL CONDITIONS  
— CONTINUED

2-11.3 M15 Elevation Quadrant — Continued





## 2-12 \*PREPARATION FOR FIRING

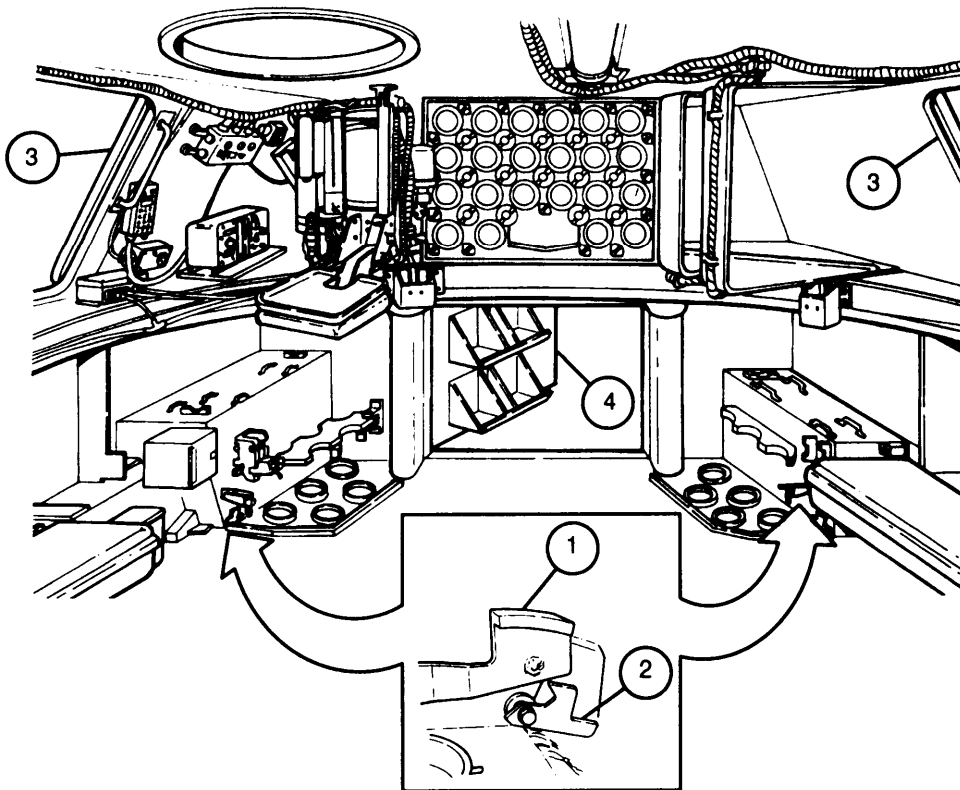
### 2-12.1 Pre-Firing Emplacement

#### a. Emplacing Howitzer

- 1 Chief of section commands "PREPARE FOR ACTION" and supervises work of all crew members during emplacement.

#### NOTE

- Spades must be used when firing off of loose, sandy, or muddy soils. Spades need not be used when firing off of hard surfaces. Battery commander or platoon leader must decide if spades are to be deployed.
  - Once emplaced, howitzer can be fired in any direction. However, it is recommended that vehicle be moved off spades before firing to left or right side of vehicle.
- 2 Assistant gunner depresses right spade pedal (1), locks it with the latch (2), and opens right cab side door (3). Gunner depresses left spade pedal, locks it with the latch, and opens left cab side door.
  - 3 Cannoneer no. 1 opens hull rear door (4), dismounts, and holds hull rear door open. Chief of section and cannoneer no. 2 dismount. Cannoneer no. 1 closes hull rear door.



\* Standardized procedures for preparation for firing are identified with an asterisk (\*) preceding the title.

## 2-12 PREPARATION FOR FIRING - CONTINUED

### 2-12.1 Pre-Firing Emplacement - Continued

#### a. Emplacing Howitzer - Continued

Ensure vehicles equipped with shackles on the spade bracket have the shackles up to prevent damage to equipment.

#### NOTE

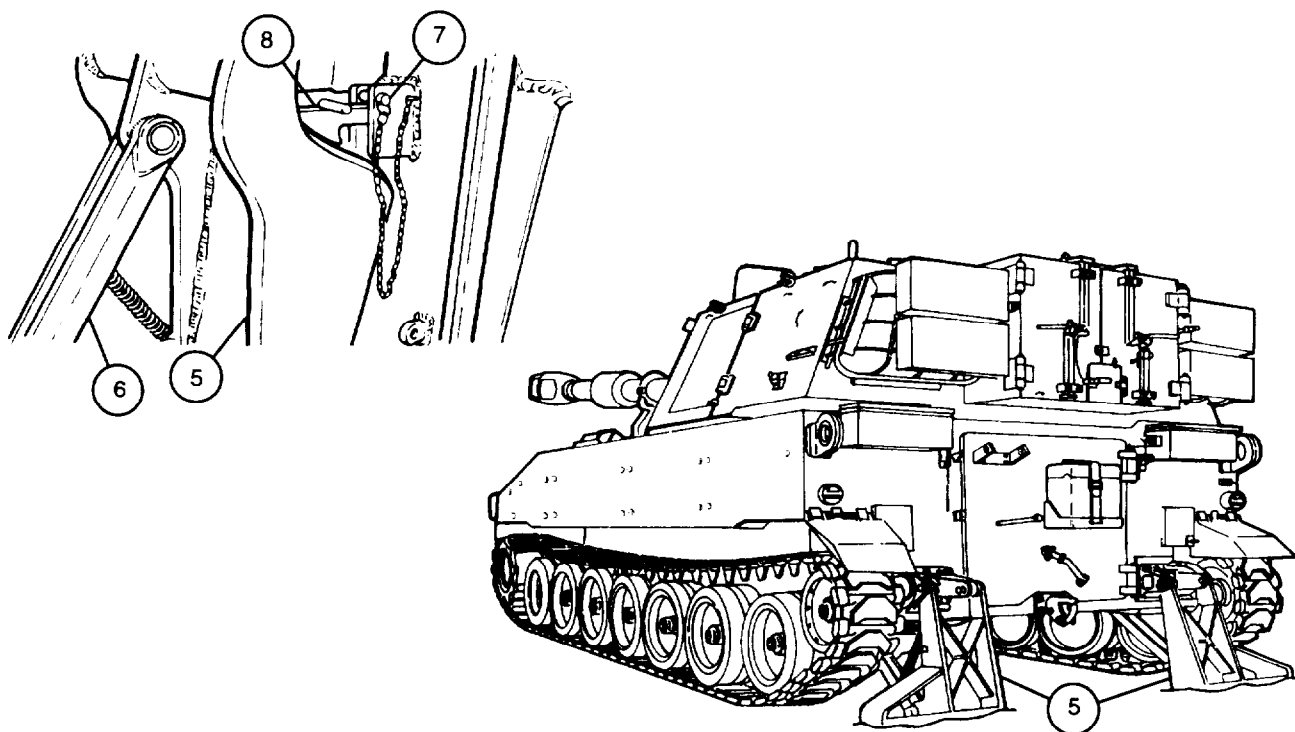
Cannoneer no. 1 releases left spade while cannoneer no. 2 releases right spade.

- 4 To release spade (5), cannoneer pulls strut (6) loose from spade, removes pin assembly (7), releases latch (8), and lowers spade to ground.

#### WARNING

When backing vehicle for emplacement or for any other reason, two personnel must guide driver.

- 5 Standing to rear and left of howitzer, the chief of section signals cannoneer no. 2 on safe backing direction and distance. Cannoneer no. 2, standing to left front of vehicle, relays backing directions to driver until spades (5) are emplaced.

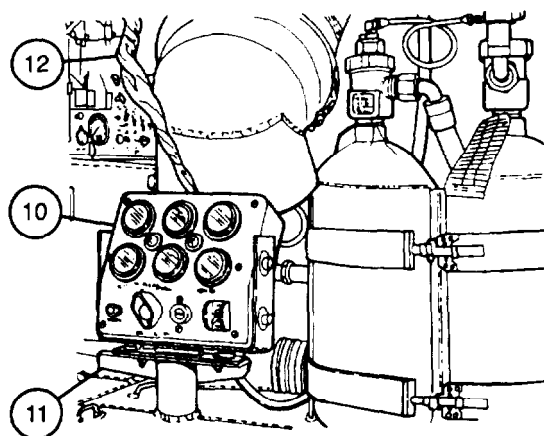
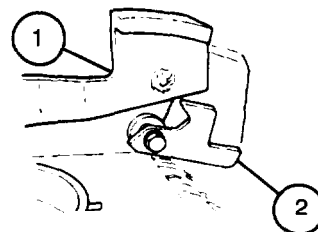
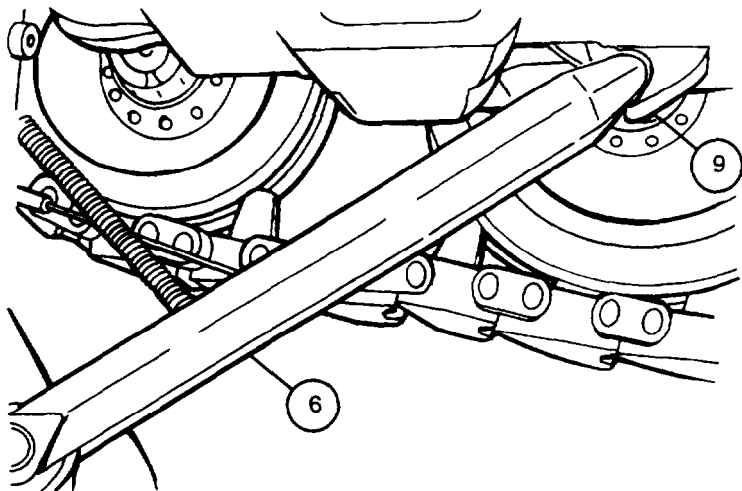


## 2-12 PREPARATION FOR FIRING - CONTINUED

### 2-12.1 Pre-Firing Emplacement - Continued

#### a. Emplacing Howitzer - Continued

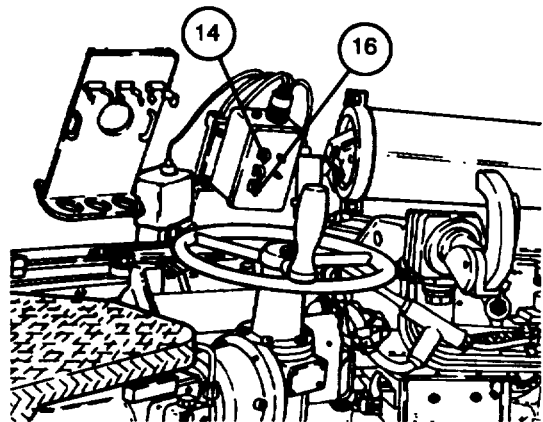
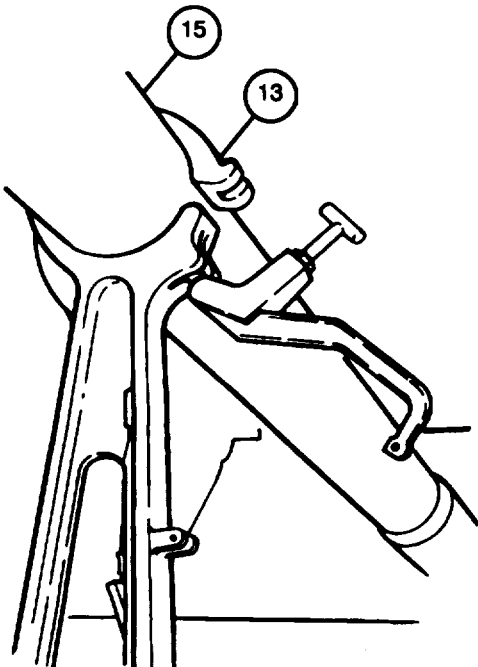
- 6 Chief of section checks struts (6) to ensure they are in socket (9).
- 7 Gunner depresses left spade pedal (1) latch (2) and assistant gunner depresses right spade pedal latch to lock struts.
- 8 Driver, when directed by chief of section, locks howitzer brakes and follows prescribed shutdown procedures (para 2-10.4).
- 9 Driver passes portable instrument panel (10) to gunner who secures portable instrument panel in bracket (11) provided. Gunner stows wiring harness (12) in hooks over driver's passageway.



**2-12 PREPARATION FOR FIRING — CONTINUED****2-12.1 Pre-Firing Emplacement — Continued****a. Emplacing Howitzer — Continued****WARNING**

Travel lock assembly is heavy. Close travel lock cap before lowering travel lock assembly and be careful when lowering to avoid injury.

- 10 Driver disengages travel lock assembly (13) (para 2-10.8) and commands gunner to elevate.
- 11 On driver's command, gunner turns CAB POWER switch (14) to ON and elevates cannon tube (15). Driver lowers and secures travel lock assembly (13) (para 2-10.8), gunner depresses cannon tube and turns ELEVATION CONTROL switch (16) to NO. 1 MAN position.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### a. Emplacing Howitzer — Continued

**WARNING**

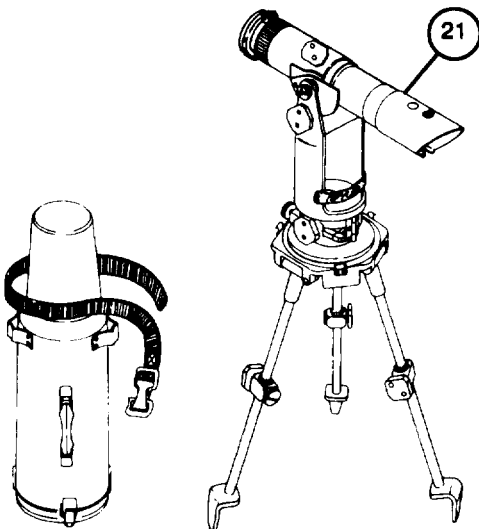
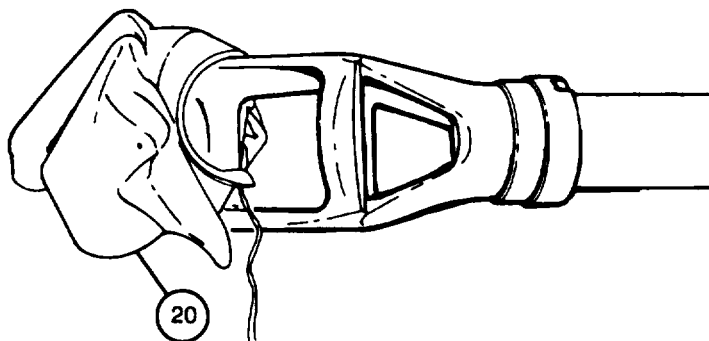
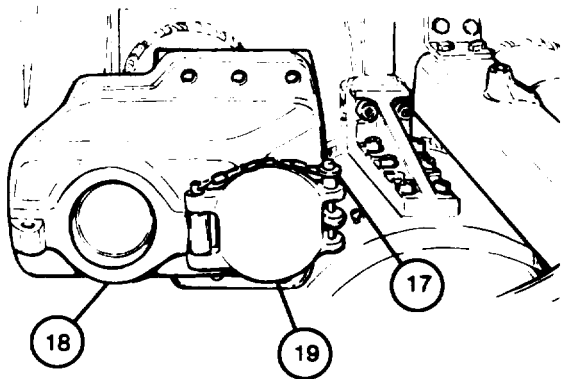


The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

12 Driver removes quick release pin (17), opens M42 tank periscope (18) cover door (19), and locks cover door in open position with quick release pin.

13 Cannoneer no. 2 removes muzzle brake cover (20).

14 Assistant gunner removes M1A1 collimator (21) and hands it to cannoneer no. 3 to emplace at left front of howitzer.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

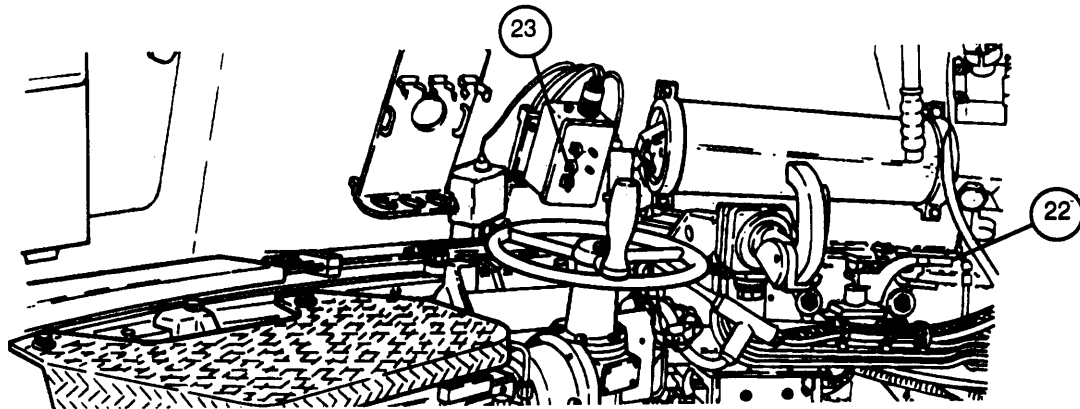
#### a. Emplacing Howitzer — Continued

- 15 Gunner releases turret lock assembly (22) and turns TRAVERSE CONTROL switch (23) to POWER or MANUAL position as desired.
- 16 Driver removes M1A2 aiming posts and cleaning artillery staff sections and passes them to cannoneers no. 2 and 3.
- 17 Assistant gunner checks functioning of elevation system (para 2-10.8).
- 18 Cannoneer no. 1 performs pre-fire checks on rammer and breech (para 2-12.4). Cannoneer no. 1 removes 3 foot or longer lanyard and vent cleaning tool from oddment tray.

#### NOTE

Unless otherwise directed, skip steps 19, 20, and 21 if ammunition vehicle is used.

- 19 Cannoneers no. 2 and 3 spread tarpaulins as directed by chief of section.
- 20 Cannoneers no. 2 and 3 unload and unpack fuze boxes. Cannoneer no. 2 gets fuze setters.
- 21 Cannoneers no. 2 and 3 and ammunition team chief (ATC) unload and place ammunition as directed by chief of section.
- 22 Cannoneer no. 1 gets swab and bucket of water and fastens bucket to floor.
- 23 Cannoneer no. 1 then gets primers and places them in the primer belt.



## 2-12 PREPARATION FOR FIRING — CONTINUED

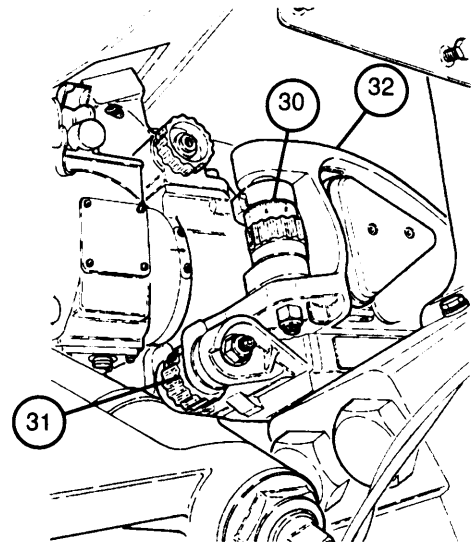
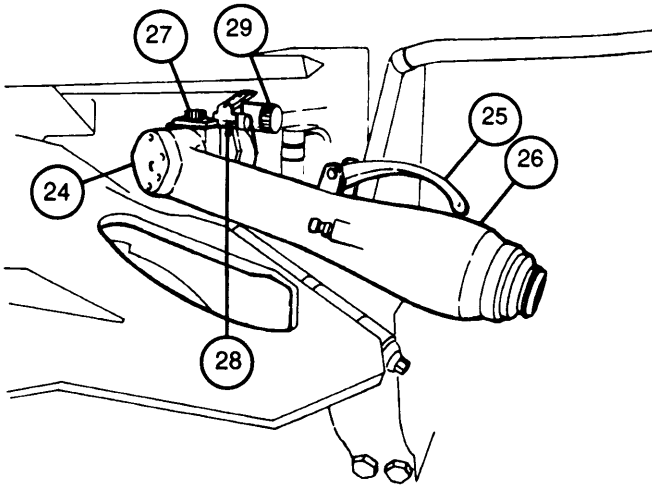
### 2-12.1 Pre-Firing Emplacement — Continued

#### a. Emplacing Howitzer — Continued

**CAUTION**

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

- 24 Assistant gunner checks M118A2/M118A3 elbow telescope (24) as follows.
  - (a) Depress lock-release lever (25) to adjust eyepiece arm (26) to a convenient viewing angle.
  - (b) Adjust variable resistor knob (27) for reticle illumination.
  - (c) Center level vial (28) by turning red wormshaft assembly knob (29).
  - (d) Verify that elevation dial (30) and deflection scale dial (31) on M146 telescope mount (32) are set 4 to center scale.
- 25 Chief of section conducts pre-fire checks (para 2-12.4) and verifies howitzer is prepared for action, and reports "SIR, NUMBER (SO AND SO) IN ORDER" or reports any defects section cannot correct.



## 2-12 PREPARATION FOR FIRING — CONTINUED

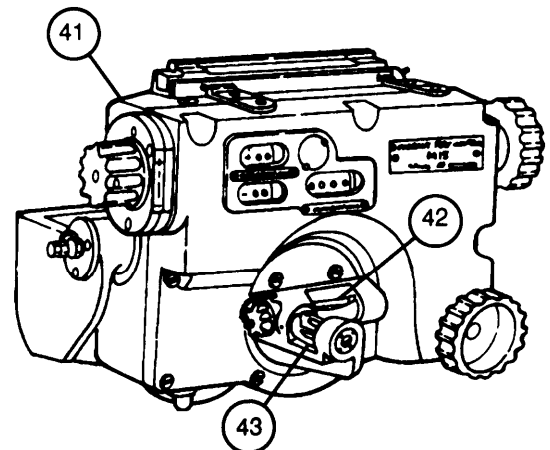
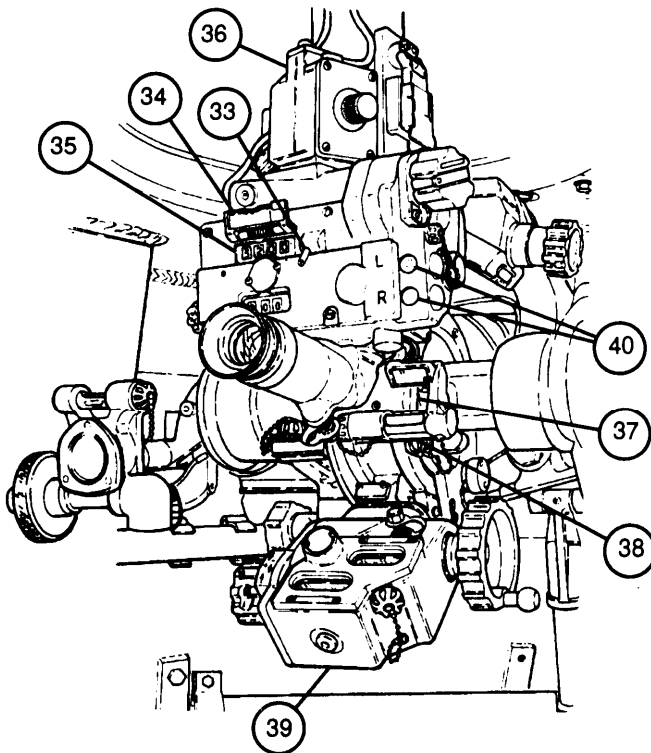
### 2-12.1 Pre-Firing Emplacement — Continued

#### b. Laying the Howitzer Using the M2/M2A2 Aiming Circle

#### NOTE

Gunner uses M117/M117A2 panoramic telescope to lay howitzer for direction.

- 1 Upon gunnery sergeant's command, "BATTERY ADJUST AIMING POINT THIS INSTRUMENT," gunner uses door release (33) to lift access door (34) covering azimuth counter (35) on M117/M117A2 panoramic telescope (36).
- 2 Gunner ensures bubbles in pitch level (37) and cross-level (38) on M145/M145A1 telescope mount (39) are centered and gunner's aid counters (40) are set at ZERO.
- 3 Assistant gunner sets 300 mils on M15 elevation quadrant (41), then depresses or elevates cannon tube (not shown) until elevation level (42) bubble centers. Ensure that elevation level and cross-level (43) bubbles are centered throughout laying process.





## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

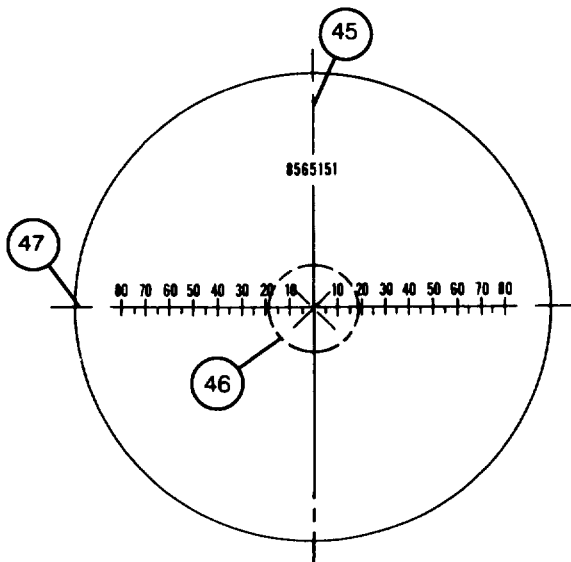
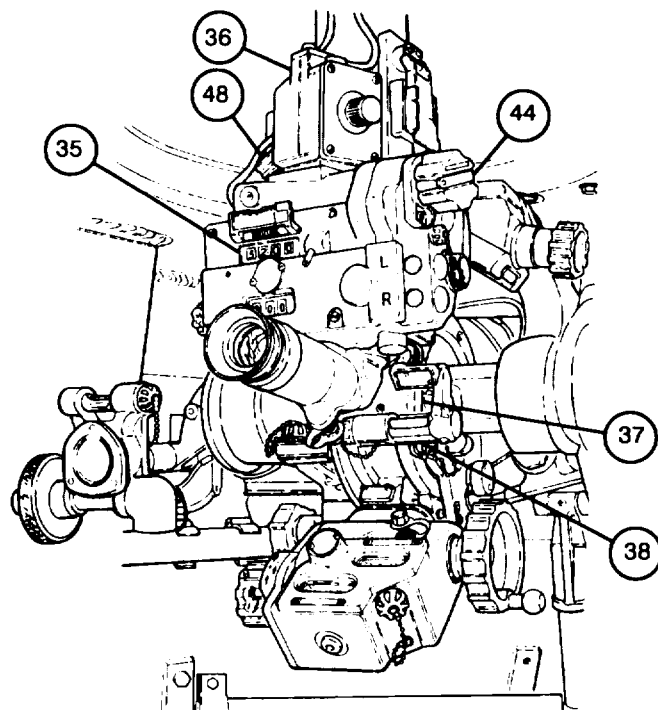
#### b. Laying the Howitzer Using the M2/M2A2 Aiming Circle — Continued

- 4 Sighting through M117/M117A2 panoramic telescope (36), gunner rotates head by turning azimuth knob (44) until vertical crosshair (45) is centered on lens of M2/M2A2 aiming circle (46). Horizontal crosshair (47) alignment is obtained by turning elevation knob (48).
- 5 When M117/M117A2 panoramic telescope (36) crosshairs (45 and 47) are alined on M2/M2A2 aiming circle (46) and all bubbles are level, gunner announces to gunnery sergeant, "NUMBER (SO AND SO), AIMING POINT IDENTIFIED."
- 6 Gunnery sergeant determines azimuth reading to howitzer and announces, "NUMBER (SO AND SO), DEFLECTION (SO MUCH)."
- 7 Upon announcement of deflection, gunner repeats deflection by announcing "NUMBER (SO AND SO), DEFLECTION (SO MUCH)," and rotates azimuth knob (44) until announced deflection appears on azimuth counter (35).
- 8 Operating traversing mechanism assembly and sighting through M117/M117A2 panoramic telescope (36), gunner traverses weapon until crosshairs (45 and 47) are centered on reflector of M2/M2A2 aiming circle (46), ensuring that pitch level (37) and cross-level (38) bubbles are centered.
- 9 Gunner announces to the gunnery sergeant, "NUMBER (SO AND SO), READY FOR RECHECK."
- 10 Gunnery sergeant determines a new azimuth reading to howitzer and announces, "NUMBER (SO AND SO), DEFLECTION (SO MUCH)."
- 11 Upon announcement of new deflection, gunner repeats deflection and difference between new deflection reading and reading on azimuth counter (35) to gunnery sergeant by saying, "NUMBER (SO AND SO), DEFLECTION (SO MUCH), (SO MANY), MILS."
- 12 Gunner then rotates azimuth knob (44) until new deflection appears on azimuth counter (35).
- 13 Operating traversing mechanism assembly and sighting through M117/M117A2 panoramic telescope (36), gunner traverses the weapon until crosshairs (45 and 47) are centered on reflector of M2/M2A2 aiming circle (46) with pitch level (37) and cross-level (38) bubbles centered.
- 14 Gunner and gunnery sergeant repeat recheck steps 9 through 13 until difference between azimuth reading to M117/M117A2 panoramic telescope (36) and reading on azimuth counter (35) is zero mils. Gunnery sergeant then announces, "NUMBER (SO AND SO) IS LAID."
- 15 Upon the command, "LAID," gunner records value appearing on azimuth counter (35). The cannon tube is now oriented for direction and will not be moved until an aiming point is established.

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### b. Laying the Howitzer Using the M2/M2A2 Aiming Circle — Continued



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### c. Emplacing Infinity Aiming Reference M1A1 Collimator

**WARNING**



The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

**NOTE**

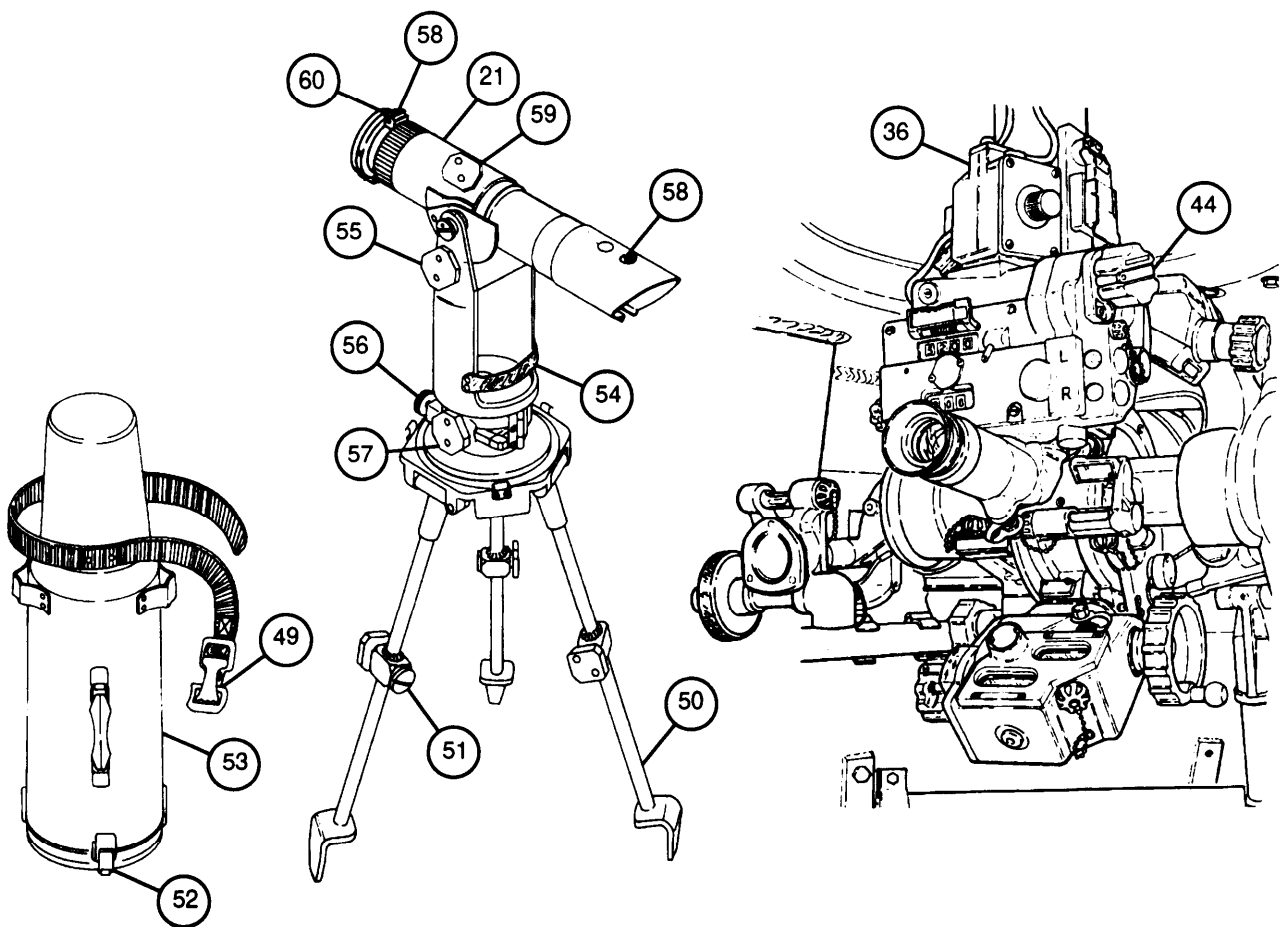
- The M1A1 collimator is emplaced during the laying operation. Alinement of the M1A1 collimator is done after the laying operation is complete.
  - The M1A1 collimator should be emplaced in a concealed position. Placing M1A1 collimator between 2400 and 2800 mils will minimize displacement. Emplacement distance away from weapon will vary due to type of terrain encountered, but must be within a minimum of 4.37 yards (4 m) and a maximum of 16.4 yards (15 m). Optimum distance is between 5 and 13 yards (5 and 12 m). M1A1 collimator should not be emplaced more than 4.37 yards (4 m) above or below M117/M117A2 panoramic telescope.
  - M1A1 collimator has a self-luminous radioactive light source (see warning above).
- 1 Under directions from gunner, the M1A1 collimator (21) is emplaced by cannoneer no. 3 as follows.
- (a) Unfasten strap (49) which retains tripod legs (50).
  - (b) Extend tripod legs (50) as necessary. Lock by tightening locking knob (51).
  - (c) Rotate tripod legs (50) to down position and set each tripod leg firmly into ground with one tripod leg pointed toward M117/M117A2 panoramic telescope (36).
  - (d) Release three latches (52) that retain cover (53) and remove cover from tripod. Place cover underneath M1A1 collimator (21) with closed end pointing to muzzle brake of weapon.
  - (e) Unfasten strap (54). Loosen elevation adjustment clamping knob (55) and rotate M1A1 collimator (21) to a horizontal position. Tighten elevation adjustment clamping knob.

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### c. Emplacing Infinity Aiming Reference M1A1 Collimator — Continued

- (f) Ensure azimuth adjustment is in center of the traversing capabilities by operating the azimuth adjustment knob (56).
  - (g) Loosen azimuth adjustment clamping knob (57). Sighting down front and rear sights (58), rough lay M1A1 collimator (21) on M117/M117A2 panoramic telescope (36) objective lens. Tighten azimuth adjustment clamping knob. Adjust M1A1 collimator elevation as required and tighten elevation adjustment clamping knob (55).
  - (h) Loosen cross-level clamping knob (59). Rotate M1A1 collimator (21) until bubble in cross-level vial (60) is centered. Tighten cross-level clamping knob.
- 2 Sighting through M117/M117A2 panoramic telescope (36), gunner rotates azimuth knob (44) until M1A1 collimator (21) is sighted.

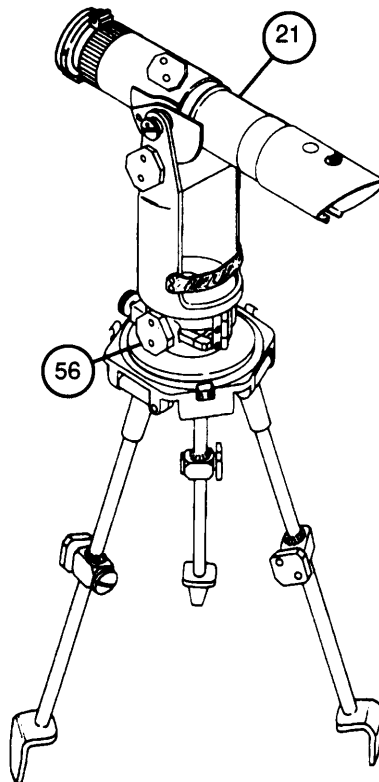


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### c. Emplacing Infinity Aiming Reference M1A1 Collimator — Continued

- 3 The gunner directs emplacement of M1A1 collimator (21) by extending his left hand above his head through gunner's escape hatch and having cannoneer no. 3 move as directed by following hand movements.
  - (a) Moving hand (left or right) represents movement of M1A1 collimator (21) left or right.
  - (b) Clenched fist means stop.
  - (c) Up and down movement represents emplace.
  - (d) Tapping top of vehicle and moving hand (left or right) represents movement of top of M1A1 collimator (21).
  - (e) Hand waved in a circular motion means for cannoneer no. 3 to return.

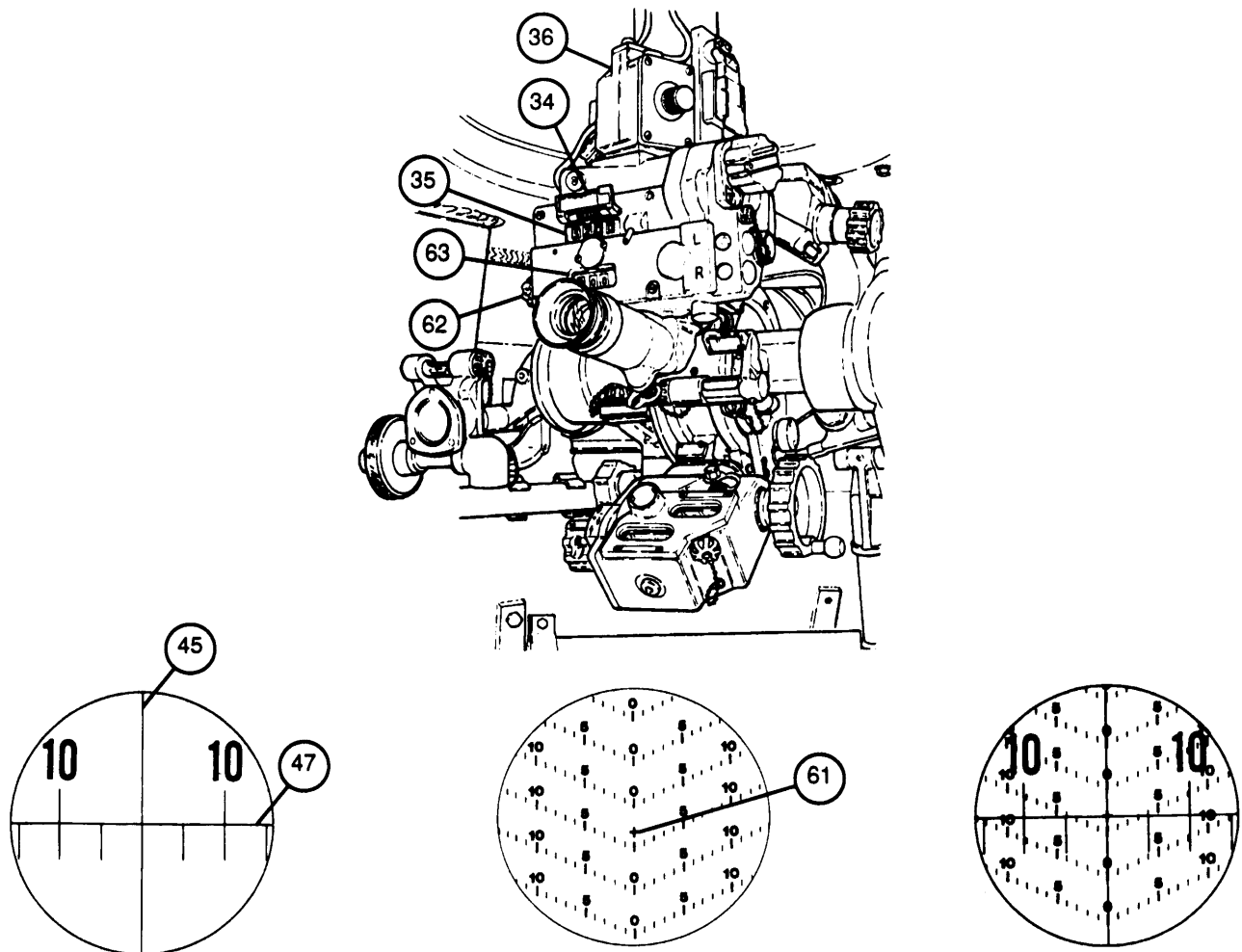


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### c. Emplacing Infinity Aiming Reference M1A1 Collimator — Continued

- 4 Sighting through M117/M117A2 panoramic telescope (36), gunner commands cannoneer no. 3 to rotate M1A1 collimator (21) azimuth adjustment knob (56) until M117/M117A2 panoramic telescope crosshairs (45 and 47) are centered with M1A1 collimator reticle crosshairs (61), as shown. Gunner then motions cannoneer no. 3 in.
- 5 Gunner then records value appearing on his azimuth counter (35) and closes access door (34).
- 6 Gunner rotates reset knob (62) on M117/M117A2 panoramic telescope (36) until 3200 appears on reset counter (63).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.1 Pre-Firing Emplacement — Continued

#### d. Emplacing M1A2 Aiming Posts

##### NOTE

M1A2 aiming posts are alternate aiming reference for M109 series howitzers and are emplaced, time permitting, immediately following emplacement of M1A1 collimator.

- 1 With howitzer laid on initial azimuth of fire, gunner checks the following,
  - (a) Pitch level (37) and cross-level (38) bubbles on M145/M145A1 telescope mount (39) are centered.
  - (b) Gunner's aid counters (40) on M117/M117A2 panoramic telescope (36) are set at zero.
- 2 Cannoneer no. 3 emplaces M1A2 aiming posts (64) as follows.
  - (a) Remove M1A2 aiming posts (64) from fire control cover (65) and assemble two sections for far M1A2 aiming post.

##### NOTE

Unit SOP should state which M14 aiming post light to use on near M1A2 aiming post and which to use on far M1A1 aiming post and instructions for M1A2 aiming post emplacement.

- (b) At night, install M14 aiming post lights (66) on M1A2 aiming posts (64).
- 3 Cannoneer no. 3 runs out approximately 55 yards (50 m) with both M1A2 aiming posts (64) and sticks near post (short post) in ground. Cannoneer no. 3 continues an additional 55 yards (50 m), stops and faces gunner, and emplaces far post (long post) alined with body, Cannoneer no. 3 returns to near M1A2 aiming post and positions it by observing hand signals of gunner.

##### NOTE

At night, step 4 can be used with a flashlight in an ON and OFF mode. An alternate method for gunner if the gunner's escape hatch is closed, is to use left cab side door. This limits location of M1A2 aiming post emplacement, though.

- 4 Sighting through M117/M117A2 panoramic telescope (36), gunner positions M1A2 aiming posts (64) by extending his left hand above his head through gunner's escape hatch and having cannoneer no. 3 move as directed by following hand movements.
  - (a) Moving hand (left or right) represents movement of M1A2 aiming post right or left.
  - (b) Clenched fist means stop.
  - (c) Up and down movement represents emplace.

2-12 PREPARATION FOR FIRING — CONTINUED

2-12.1 Pre-Firing Emplacement — Continued

d. Emplacing M1A2 Aiming Posts — Continued

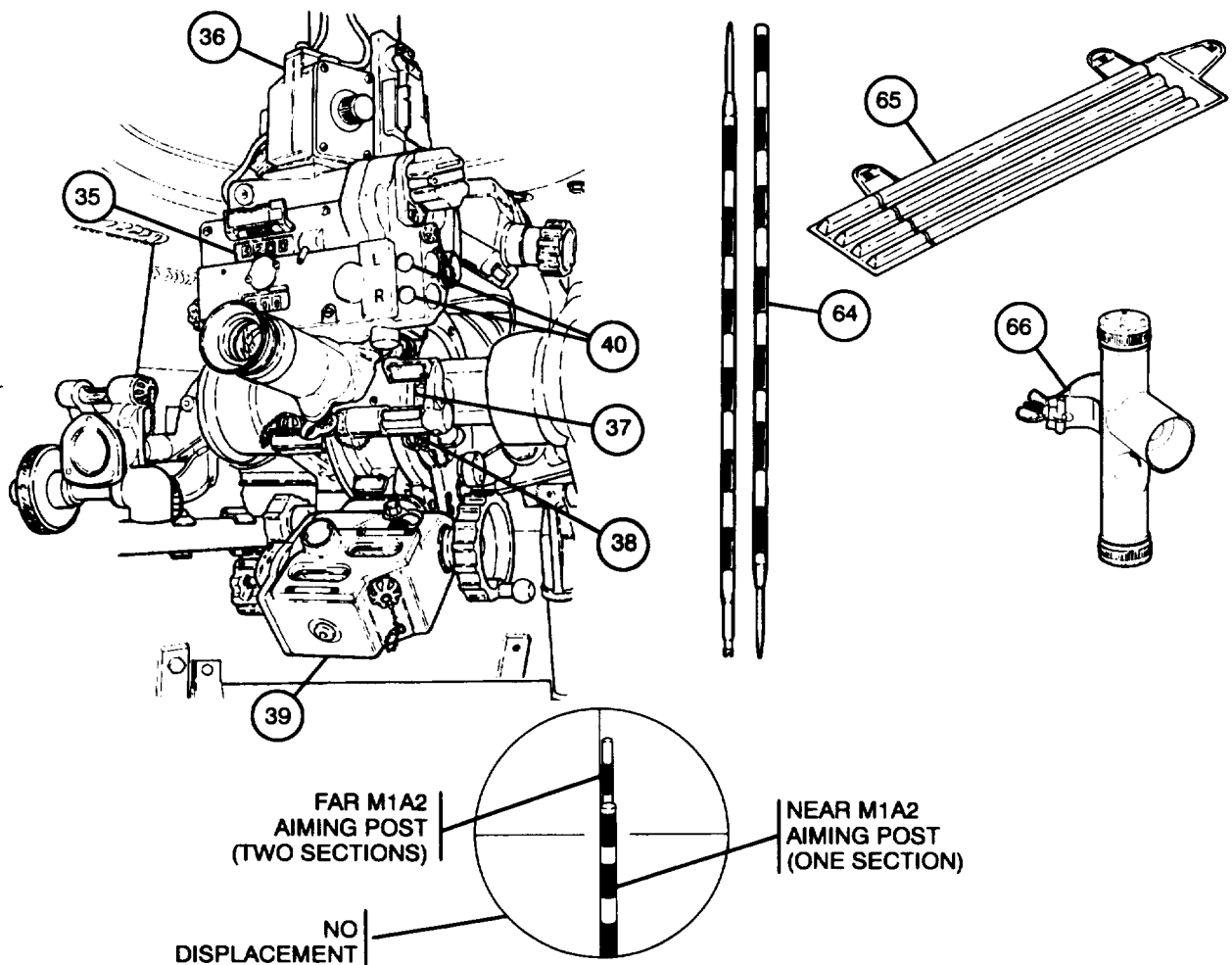
- (d) Tapping top of vehicle and moving hand (left or right) represents movement of top of M1A2 aiming post (64).
- (e) Hand waved in a circular motion means for cannoneer no. 3 to return.

**WARNING**



The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

- 5 After M1A2 aiming posts (64) are emplaced, M117/M117A2 panoramic telescope (36) sight picture should be as illustrated (no displacement). Gunner then records value indicated on azimuth counter (35) and returns to sight picture on M1A1 collimator (not shown).





## 2-12 PREPARATION FOR FIRING — CONTINUED

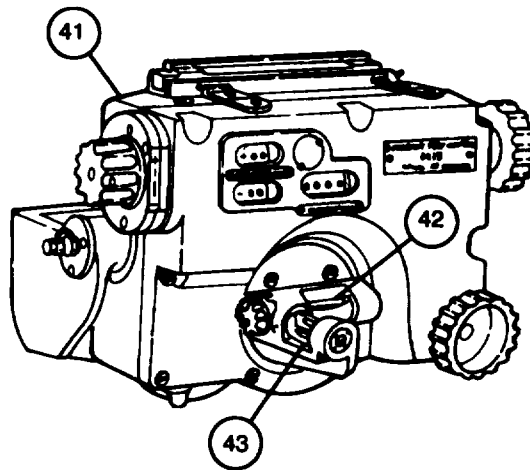
### 2-12.1 Pre-Firing Emplacement — Continued

#### e. Measuring Site to Crest

#### NOTE

Ensure aiming points are established.

- 1 Chief of section selects highest crest in his sector of fire.
- 2 Chief of section sights along the bottom part of cannon tube.
- 3 Chief of section directs gunner to traverse and assistant gunner to elevate cannon tube until bottom of cannon tube just clears crest.
- 4 Chief of section directs assistant gunner to level cross-level (43) and elevation level (42) bubbles of M15 elevation quadrant (41).
- 5 Chief of section reads quadrant off of M15 elevation quadrant (41) scale, records this reading, and estimates range to crest (M1A1 gunner's quadrant may also be used).

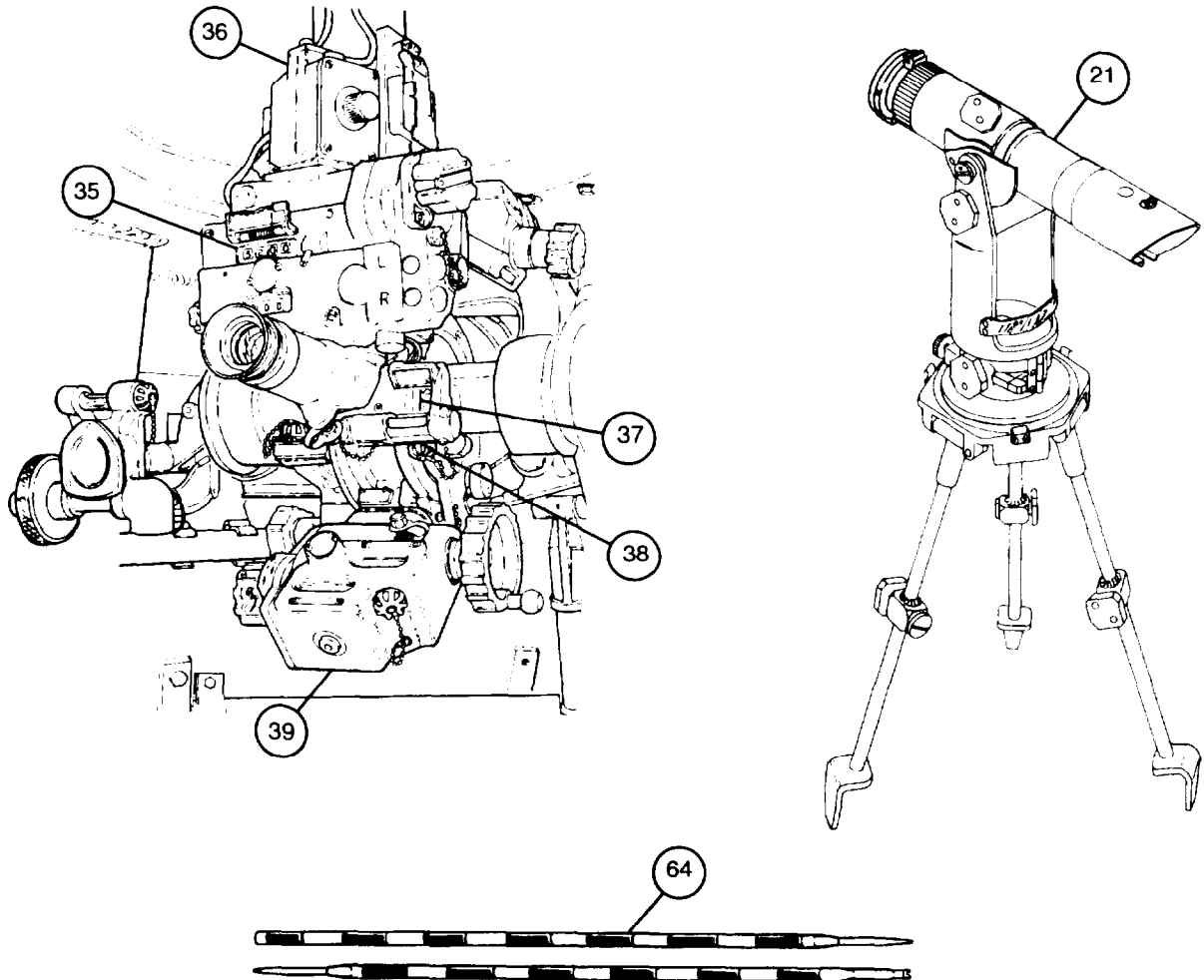


2-12 PREPARATION FOR FIRING - CONTINUED

2-12.1 Pre-Firing Emplacement - Continued

e. Measuring Site to Crest - Continued

- 6 Chief of section reports quadrant and estimated range to executive officer, "SIR, NUMBER (SO AND SO) SITE TO CREST (SO MUCH) AT (SO MUCH) RANGE."
- 7 Chief of section may have gunner measure and record deflection to crest, if desired.
- 8 To measure deflection, gunner levels cross-level (38) and pitch level (37) of M145/M145A1 telescope mount (39), turns head of M117/M117A2 panoramic telescope (36) to M1A1 collimator (21) or M1A2 aiming post (64) and records deflection from azimuth counter (35).

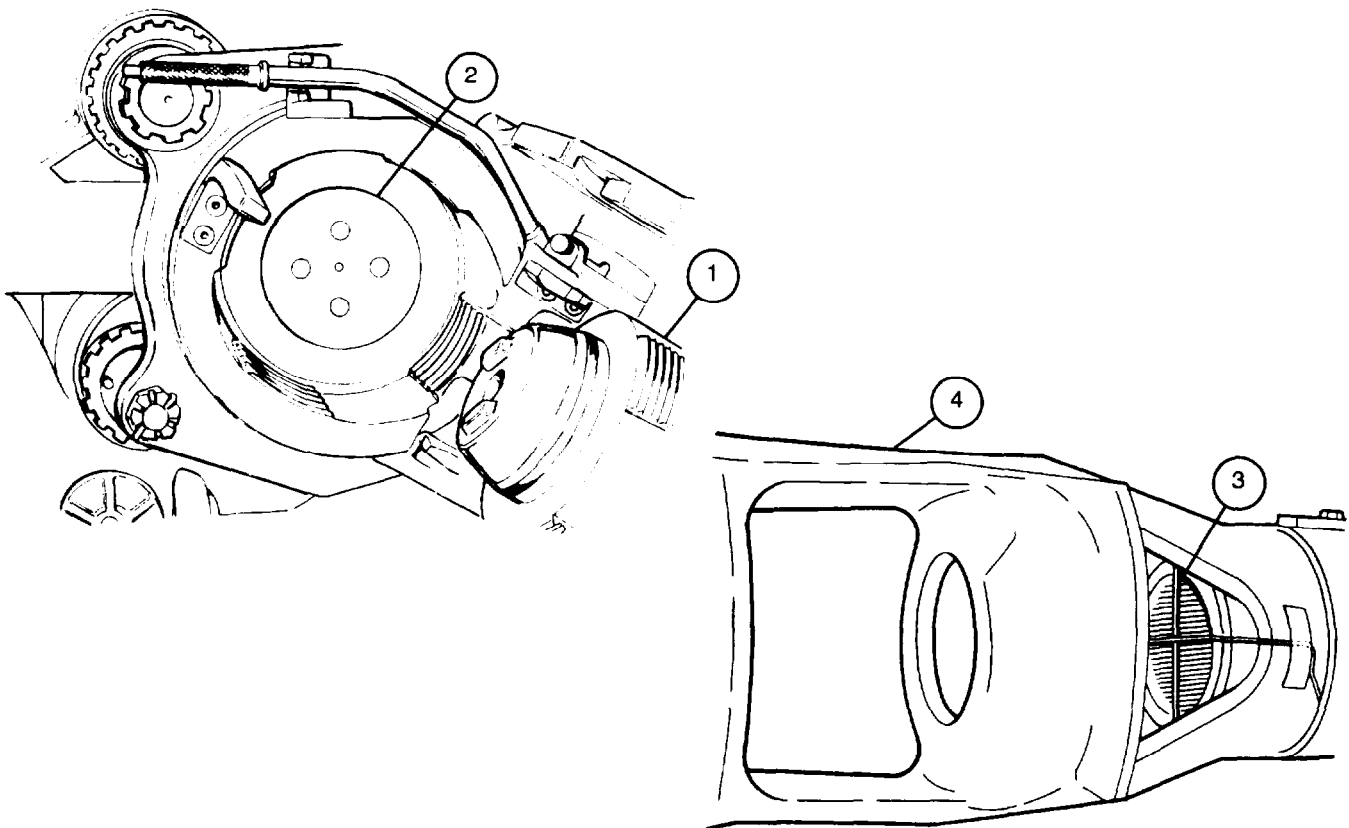


## 2-12 PREPARATION FOR FIRING - CONTINUED

### 2-12.2 Boresighting

#### a. Preliminary Procedure

- 1 Make sure howitzer cant is no more than 90 mils.
  - (a) Observe howitzer and determine which side is higher.
  - (b) Place M1A1 gunner's quadrant on breech ring cross-level seats with the direction of fire indicator pointing toward high side of howitzer.
  - (c) Place cross-level arm on zero and ensure micrometer knob indicates zero. Move cross-level arm in increments of 10 mils until bubble moves to the opposite end of vial.
  - (d) Move cross-level arm back down one 10 mil increment, and use the micrometer knob to level bubble.
  - (e) Observe reading on M1A1 gunner's quadrant.
  - (f) If cant is greater than 90 mils, howitzer must be moved to more level ground.
- 2 Open breechblock (1) and install breech bore sight (2).
- 3 Fasten crosshairs (3) to muzzle brake (4) at witness marks.
- 4 Ensure M117/M117A2 panoramic telescope and M118A2/M118A3 elbow telescope are installed (para 2-11.1 and 2-11.2).

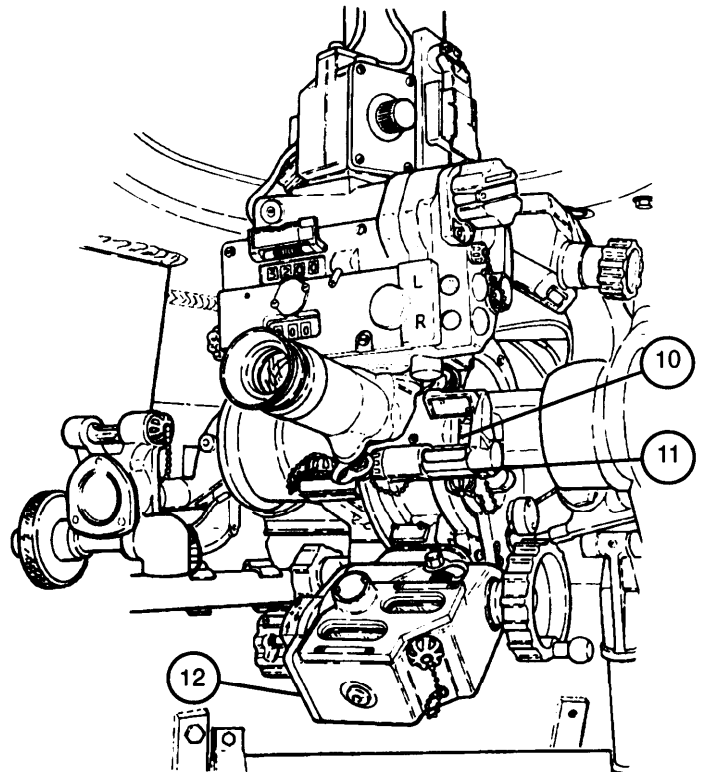
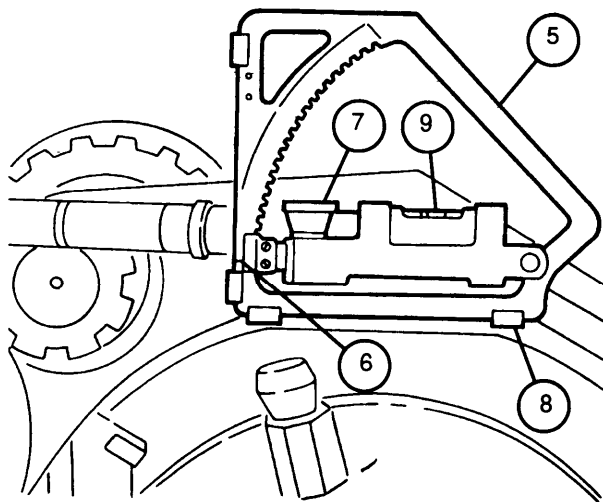


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### a. Preliminary Procedure — Continued

- 5 Use M1A1 gunner's quadrant (5) that has been checked by micrometer test and end-for-end test (para 3-7.2). Level gun trunnions as follows.
  - (a) Set index arm (6) and micrometer knob (7) to zero.
  - (b) Set M1A1 gunner's quadrant (5) with end-for-end correction applied on cross-level seats (8) on breech ring.
  - (c) Traverse howitzer until bubble (9) centers (test target method only).
- 6 Set cannon tube at zero elevation (para 3-7.5).
- 7 Center bubbles in pitch level (10) and cross-level (11) of M145/M145A1 telescope mount (12).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### b. Test Target Method

**WARNING**

The test target method of boresighting must be used to check M140 alinement device. Failure of M140 alinement device reticle to align with reticles of M117/M117A2 panoramic telescope and M118A2/M118A3 elbow telescope could result in projectiles landing outside target area. Injury or death of friendly forces can result from firing with misaligned fire control equipment.

- 1 Perform all preliminary procedures (para 2-12.2a.).
- 2 Prepare test target (13) as follows:
  - (a) Fasten test target (13) to a stand (14) for stability.
  - (b) Prior to boresighting in dark, drill a 1/16 inch (1.59 mm) hole through center of each aiming diagram (15). Cover holes with a piece of cloth. At night, hold a flashlight to the boresight, against the cloth.

**NOTE**

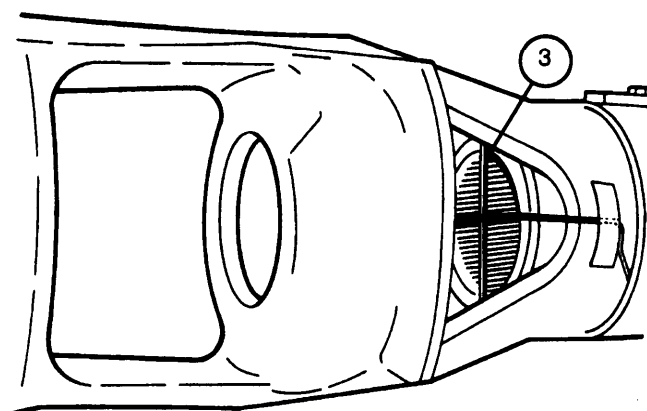
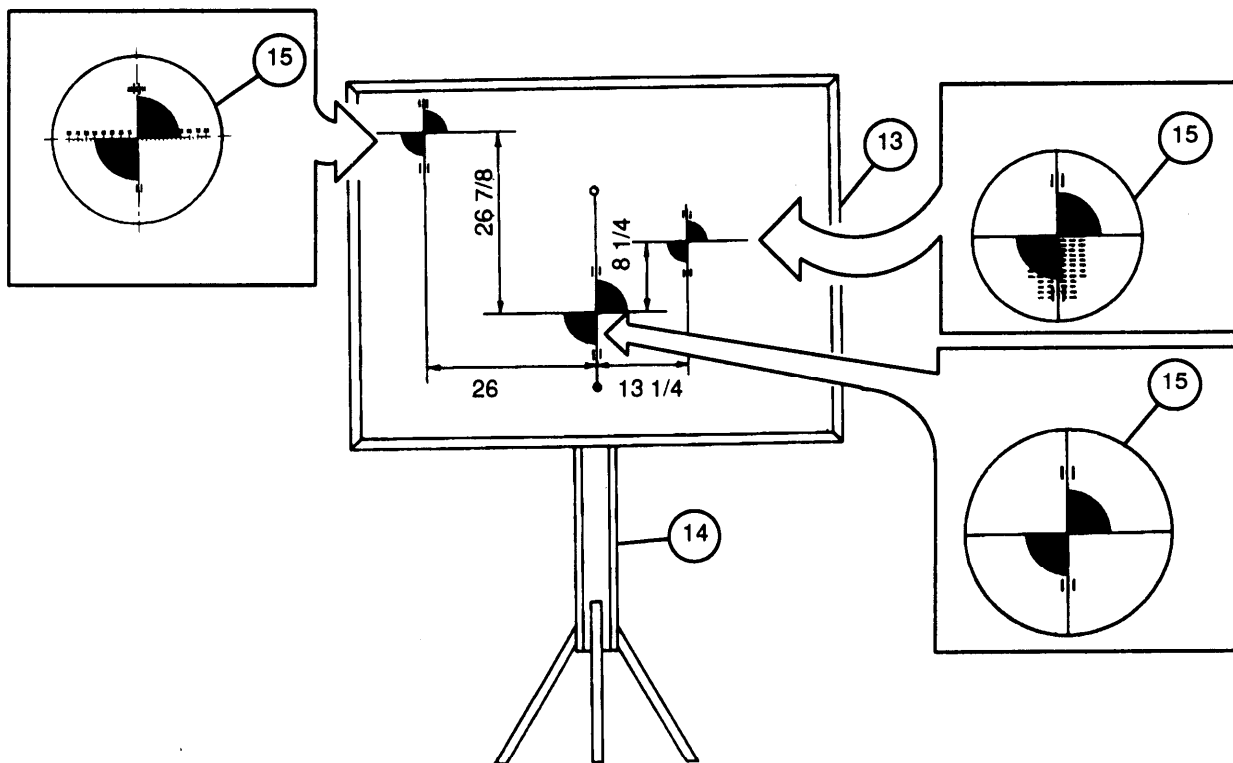
Measurements do not appear on test target. They are shown in case it is necessary to make a test target.

- 3 Locate test target (13) 55 yards (50 m) in front of howitzer.
- 4 Without moving cannon tube, align center of aiming diagram (15) with muzzle crosshairs (3).

2-12 PREPARATION FOR FIRING — CONTINUED

2-12.2 Boresighting — Continued

b. Test Target Method — Continued



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### b. Test Target Method — Continued

#### NOTE

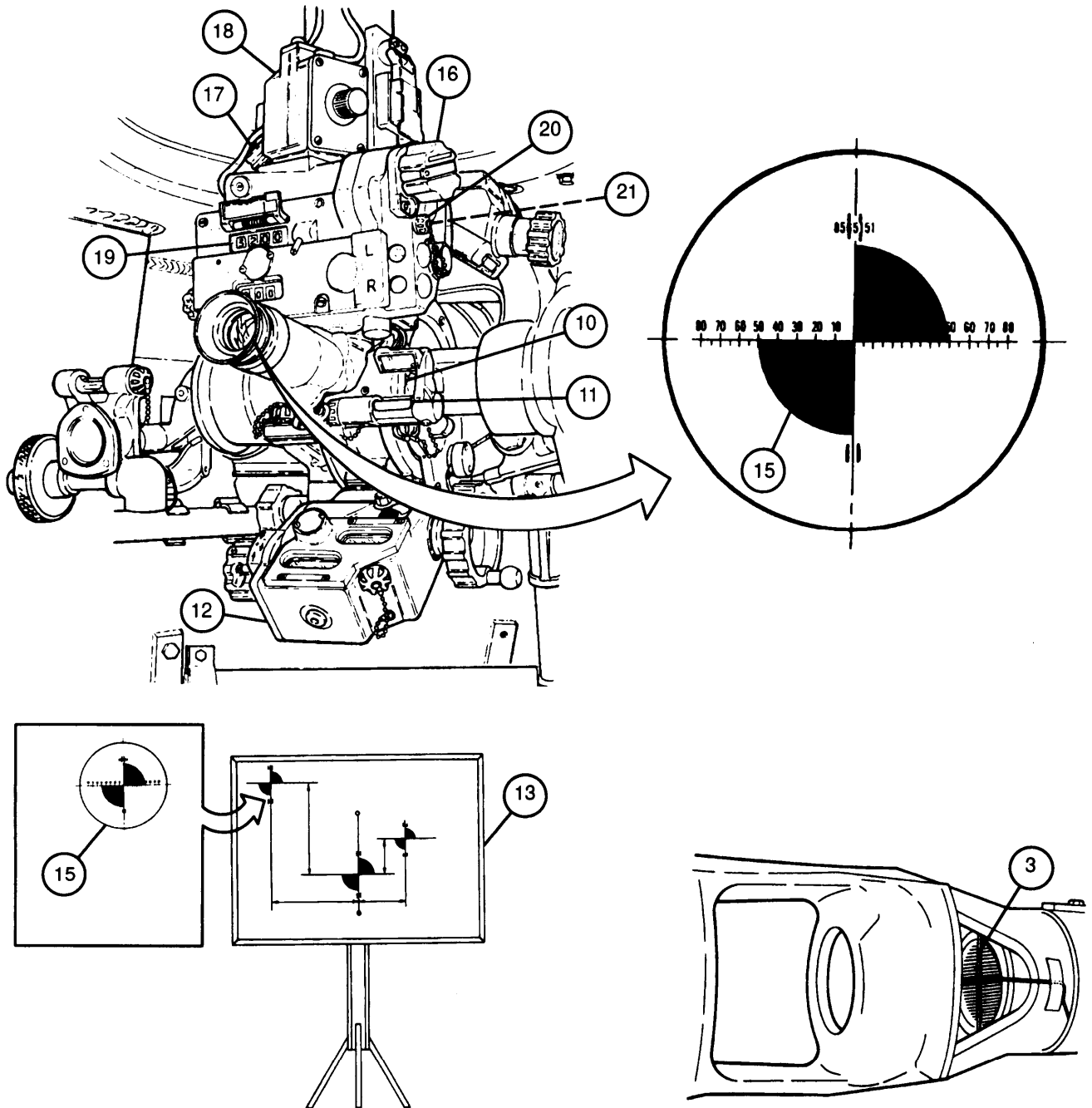
- Keep the panoramic telescope ballistic cover perpendicular to line of sight. After aligning the reticles, panoramic telescope ballistic cover may be rotated away from perpendicular and then returned to it. If reticles are within  $\pm 0.5$  mil tolerance correct positioning has been established. If reticles are separated by more than  $\pm 0.5$  mil displacement, panoramic telescope ballistic cover needs to be moved a bit more toward perpendicular.
- When viewing through M117/M117A2 panoramic telescope, parallax may occur if panoramic telescope ballistic cover is rotated. Panoramic telescope ballistic cover must be kept perpendicular to line of sight to keep parallax at a minimum.

- 5 Adjust azimuth knob (16) and elevation knob (17) on M117/M117A2 panoramic telescope (18) to lay reticle precisely on left aiming diagram (15) on test target (13).
- 6 Check that muzzle crosshairs (3) are still centered on aiming diagram (15).
- 7 Check cross-level (11) and pitch level (10) to be sure M145/M145A1 telescope mount (12) is level.
- 8 Azimuth counter (19) should read 3200 mils. If it does not, remove cover (20) from boresight detent shaft (21). Insert small screwdriver and depress boresight detent shaft. Turn boresight detent shaft until 3200 mils appears in azimuth counter. Recheck sight picture to be sure M117/M117A2 panoramic telescope (18) is still in boresight.

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### b. Test Target Method — Continued





## 2-12 PREPARATION FOR FIRING — CONTINUED

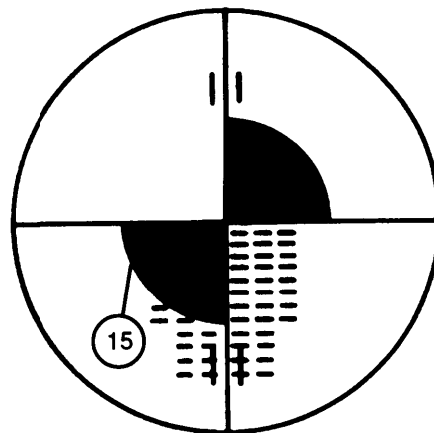
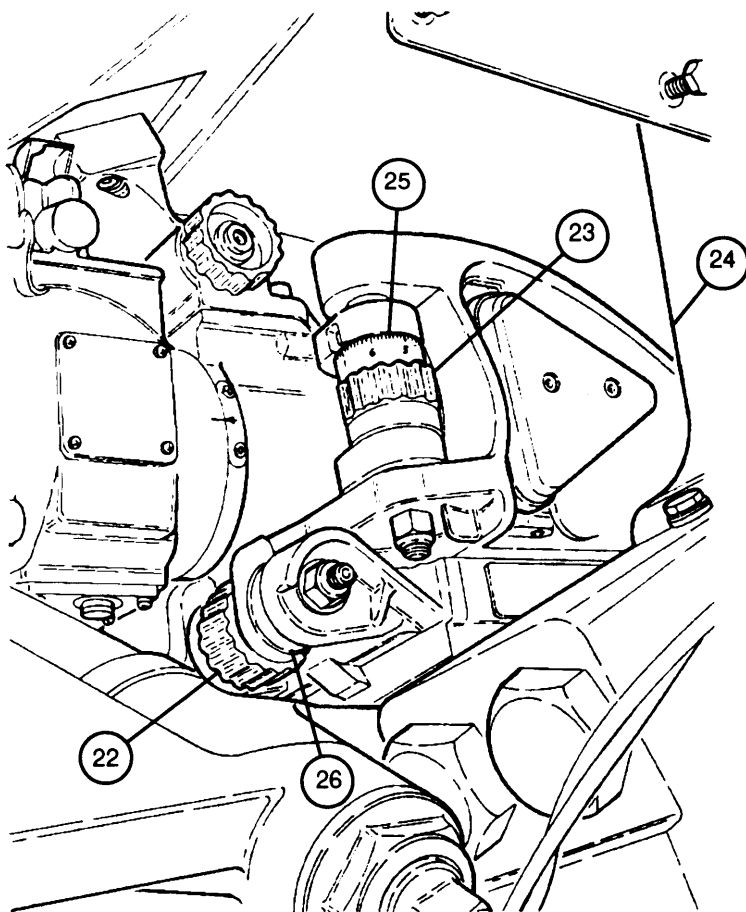
### 2-12.2 Boresighting — Continued

#### b. Test Target Method — Continued

**CAUTION**

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

- 9 Rotate deflection knob (22) and elevation knob (23) on M146 telescope mount (24) to lay reticle on right hand butterfly of aiming diagram (15).
- 10 Set M146 telescope mount (24) elevation dial (25) and deflection scale dial (26) to elevation 4, azimuth 4. Be careful not to move deflection knob (22) or elevation knob (23) when setting elevation dial and deflection scale dial.
- 11 Howitzer is now boresighted.



M118A2/M118A3 ELBOW  
TELESCOPE RETICLE  
LAID ON AIMING DIAGRAM  
BUTTERFLY

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### c. Checking M140 Alinement Device While Boresighting on Test Target

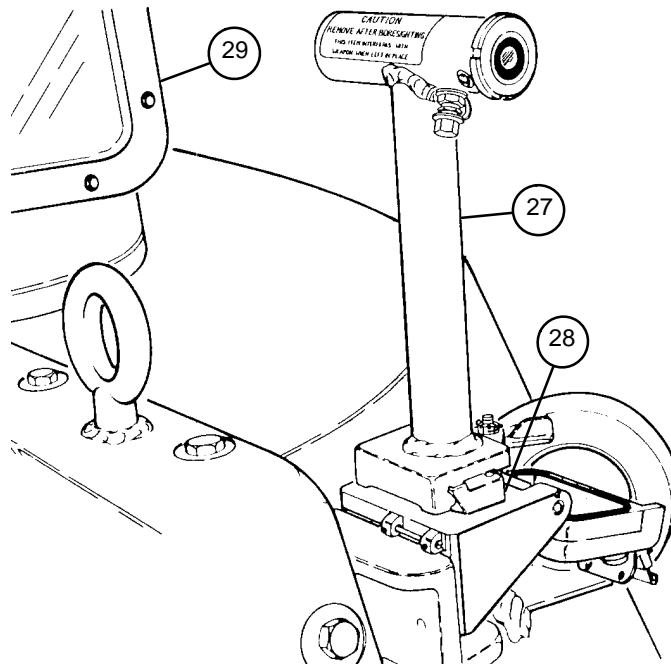
- 1 Level gun trunnions (para 3-7.3).
- 2 Aline cannon tube, M117/M117A2 panoramic telescope, and M118A2/M118A3 elbow telescope on test target (para 2-12.2b.).

**WARNING**



The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

- 3 Install M140 alinement device (27) on dovetail door wedge (28) in front of panoramic telescope ballistic cover (29).

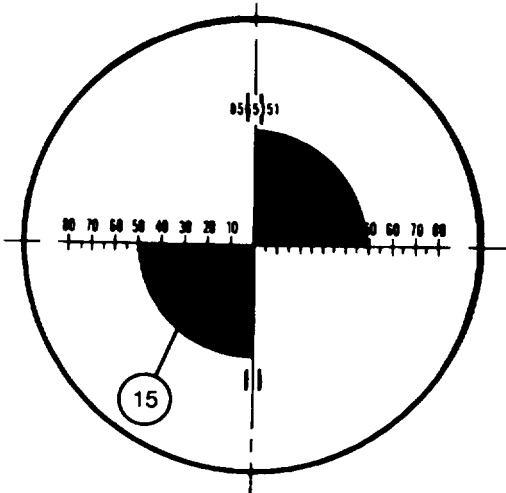
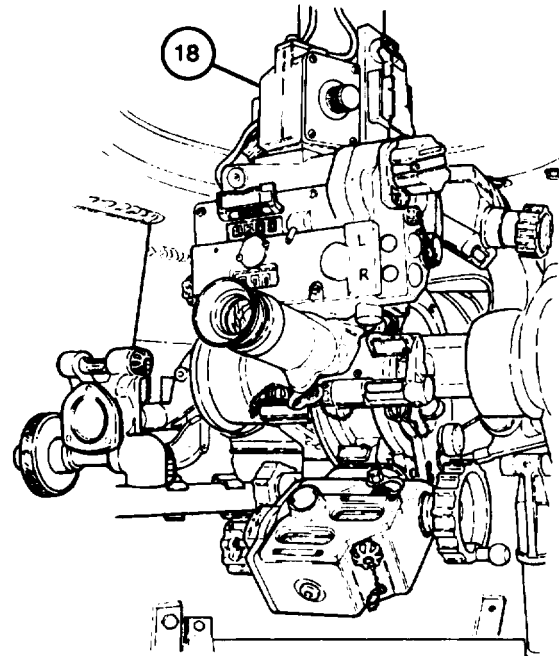
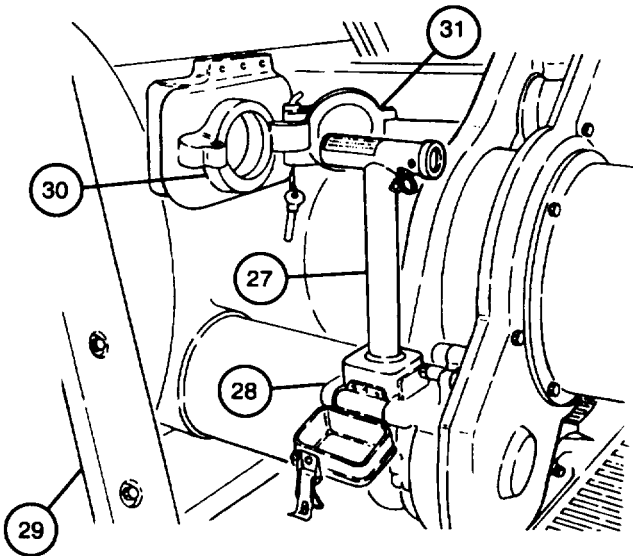


2-12 PREPARATION FOR FIRING — CONTINUED

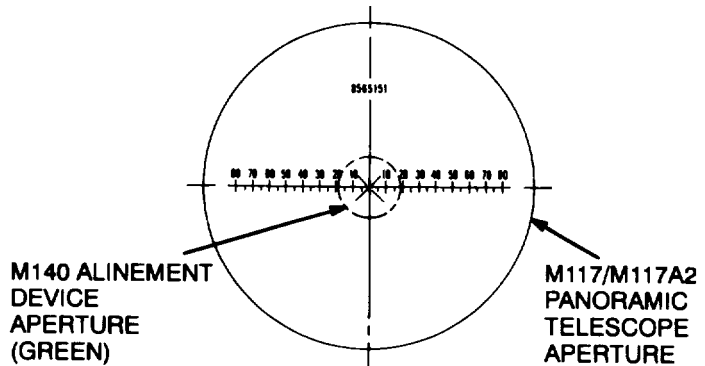
2-12.2 Boresighting — Continued

c. Checking M140 Alinement Device While Boresighting on Test Target — Continued

- 4 Check alinement of M140 alinement device (27) reticle against reticle of M117/M117A2 panoramic telescope (18) laid on left hand butterfly aiming diagram (15) of test target. Reticles should aline within 0.5 mil.
- 5 Remove M140 alinement device (27) from in front of panoramic telescope ballistic cover (29) and install on dovetail door wedge (28) in front of M42 tank periscope (30) cover door (31).



M117/M117A2 PANORAMIC TELESCOPE RETICLE LAID ON AIMING DIAGRAM BUTTERFLY



M140 ALINEMENT DEVICE APERTURE (GREEN)

M117/M117A2 PANORAMIC TELESCOPE APERTURE

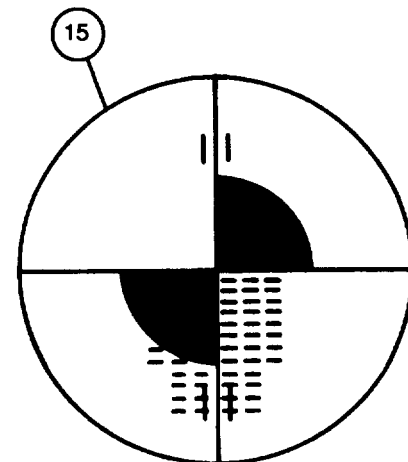
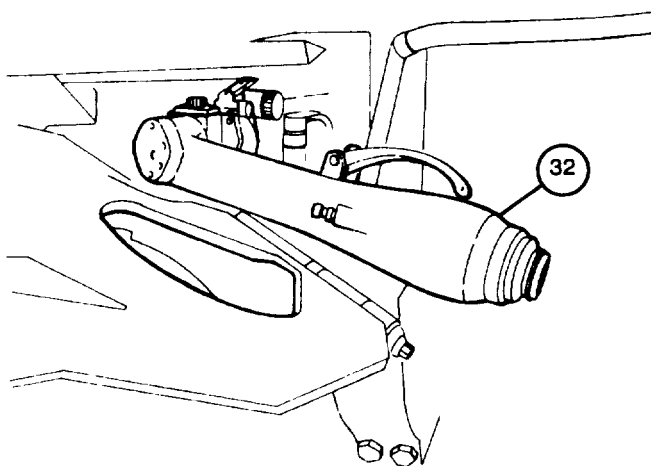
M117/M117A2 PANORAMIC TELESCOPE RETICLE ALINED WITH M140 ALINEMENT DEVICE RETICLE

**2-12 PREPARATION FOR FIRING — CONTINUED**

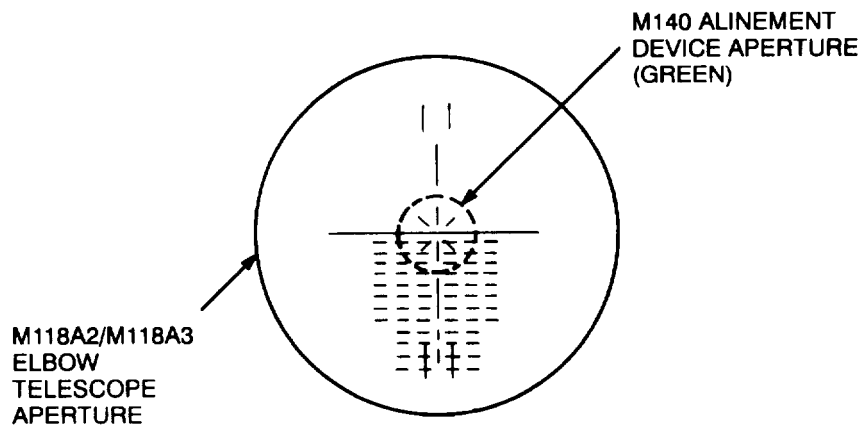
**2-12.2 Boresighting — Continued**

**c. Checking M140 Alinement Device While Boresighting on Test Target — Continued**

- 6 Check alinement of M140 alinement device (27) reticle against reticle of M118A2/M118A3 elbow telescope (32) laid on right hand butterfly aiming diagram (15) of test target. Reticles should align within 0.5 mil.
- 7 If M140 alinement device (27) does not aline with M118A2/M118A3 elbow telescope (32) or M117/M117A2 panoramic telescope (18) reticles, notify unit maintenance.



M118A2/M118A3 ELBOW TELESCOPE RETICLE LAID ON AIMING DIAGRAM BUTTERFLY



M118A2/M118A3 ELBOW TELESCOPE RETICLE ALINED WITH M140 ALINEMENT DEVICE RETICLE

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### d. Checking Boresight of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device

**WARNING**



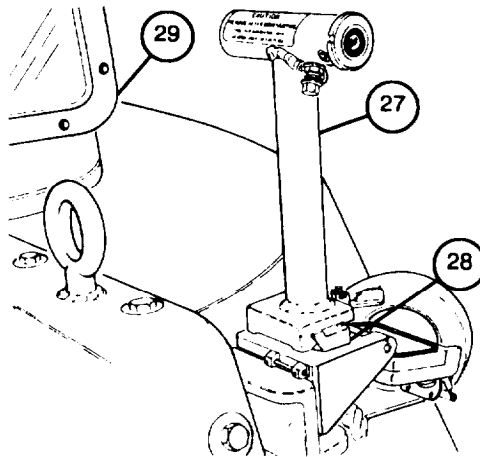
The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

- 1 Inspect mating surfaces of M140 alinement device (27) and dovetail door wedge (28) for burrs. Wipe mating surfaces clean. If dovetail door wedge has burrs, notify unit maintenance.
- 2 Install M140 alinement device (27) on dovetail door wedge (28).

**NOTE**

M117/M117A2 panoramic telescope parallax may occur between M117/M117A2 panoramic telescope and M140 alinement device. This may happen as panoramic telescope ballistic cover is rotated away from perpendicular to line of sight of M117/M117A2 panoramic telescope. Panoramic telescope ballistic cover should be kept perpendicular to M140 alinement device during boresighting to minimize this problem. Tolerance is  $\pm 0.5$  mil.

- 3 Position panoramic telescope ballistic cover (29) perpendicular to M140 alinement device (27) to eliminate error that may be induced by light refraction through glass.



## 2-12 PREPARATION FOR FIRING — CONTINUED

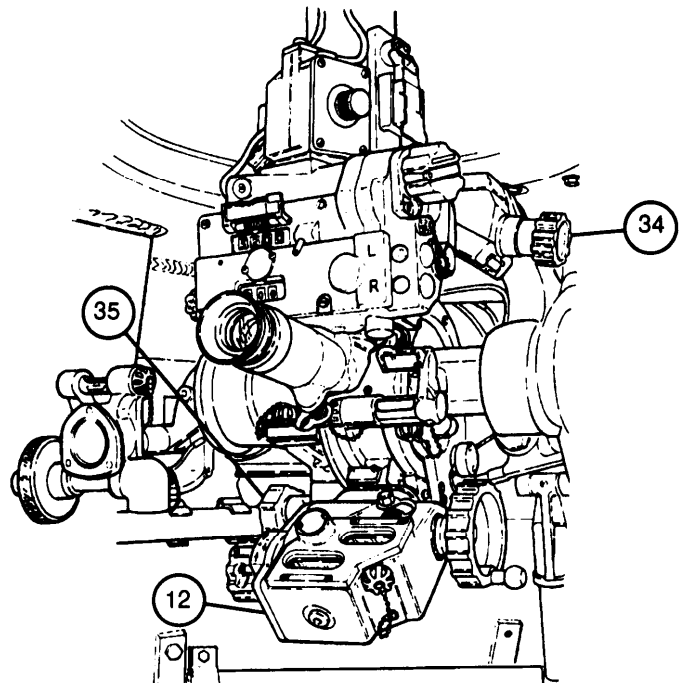
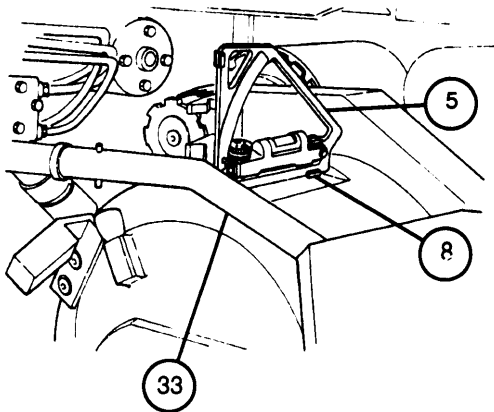
### 2-12.2 Boresighting — Continued

#### d. Checking Boresight of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device — Continued

**WARNING**

The breechblock must be opened and the operating handle left unlocked. To prevent injury to personnel, be careful not to lift up on operating cam before securing operating handle after leveling cannon tube.

- 4 Unlatch operating handle (33) enough to place M1A1 gunner's quadrant (5).
- 5 Depressor elevate cannon tube to 0 mils using M1A1 gunner's quadrant (5) on elevation seats (8) of breech. Make sure cannon tube and M1A1 gunner's quadrant corrections are added when depressing or elevating cannon tube (para 3-7.5).
- 6 Aline scribed lines on cross-level mechanism knob (34) and pitch level knob (35) of M145/M145A1 telescope mount (12) (para 3-7.7).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### d. Checking Boresight of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device — Continued

- 7 To ensure M117/M117A2 panoramic telescope (18), M145/M145A1 telescope mount (12), and M140 alinement device (27) are properly alined, the following additional check should be made.
  - (a) Rotate pitch level knob (35) and cross-level mechanism knob (34) of M145/M145A1 telescope mount (12) in a clockwise direction.
  - (b) Positions of pitch level knob (35) and cross-level mechanism knob (34) will be correct when upper end of gear sector driven by pitch level knob and right end cross-level mechanism knob are in “nearest to flush position” with respect to adjacent casting.
  - (c) If M145/M145A1 telescope mount (12) is not in correct alinement, there will be excessive cutoff when viewing M140 alinement device (27) through M117/M117A2 panoramic telescope (18).
- 8 Aline M117/M117A2 panoramic telescope (18) reticle crosshairs with M140 alinement device (27) using M117/M117A2 panoramic telescope azimuth knob (16) and elevation knob (17).
- 9 With M117/M117A2 panoramic telescope (18) reticle alined with M140 alinement device (27), pitch level knob (35) and cross-level mechanism knob (34) scribed lines alined, azimuth counter (19) should read 3200 mils.
- 10 If azimuth counter (19) reading is 3200 mils  $\pm$  0.5 mil, weapon is boresighted. If not, conduct M140 alinement device (27) comparison tests (para 2-12.2f.). If, after verifying accuracy of the M140 alinement device, the M117/M117A2 panoramic telescope (18) azimuth counter (19) exceeds  $\pm$  0.5-mil tolerance, boresighting must be conducted using test target method (para 2-12.2b.) or distant aiming point (DAP) method (para 2-12.2g.) before the weapon can be fired.

#### NOTE

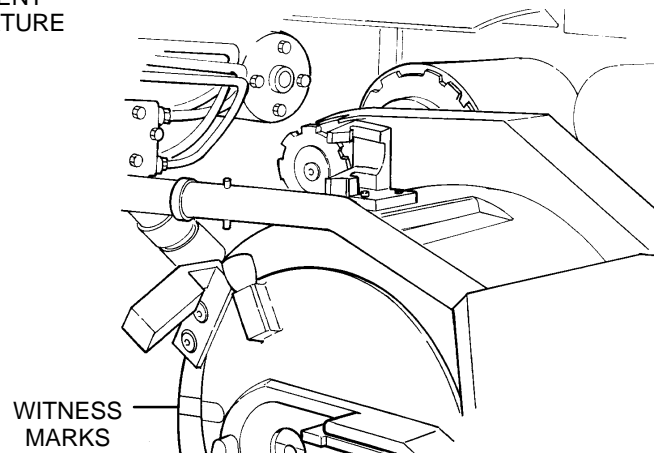
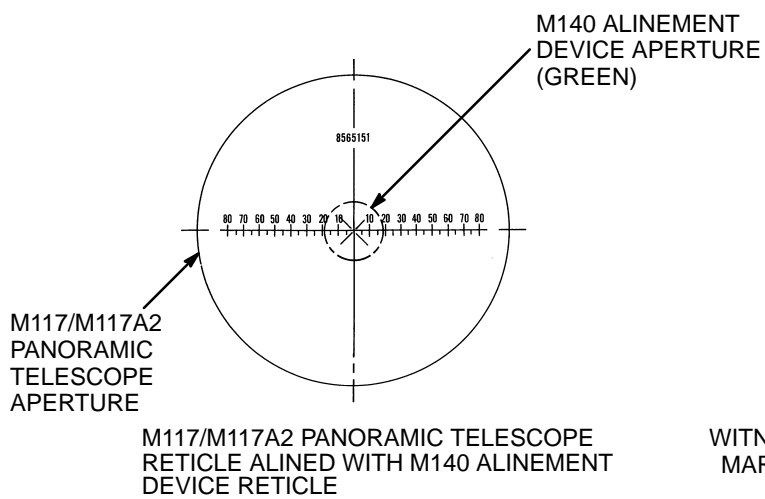
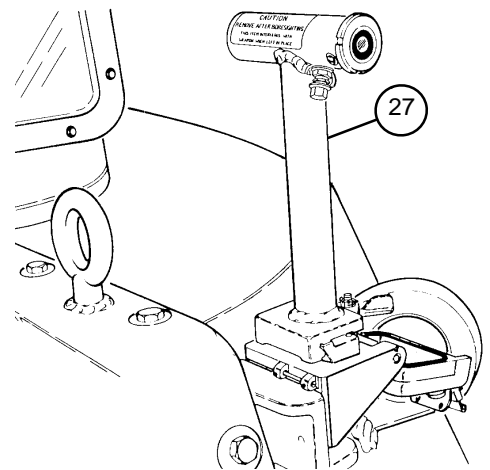
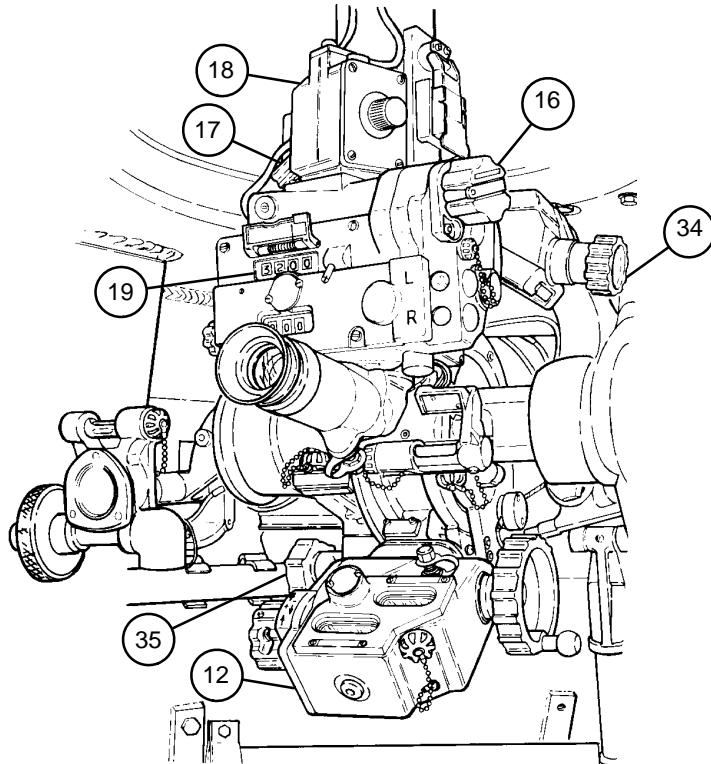
Breech is completely closed when witness marks on breech ring and breechblock aline.

- 11 If necessary, open breech and close completely.

**2-12 PREPARATION FOR FIRING — CONTINUED**

**2-12.2 Boresighting — Continued**

**d. Checking Boresight of M117/M117A2 Panoramic Telescope Using the M140 Alinement Device — Continued**





## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

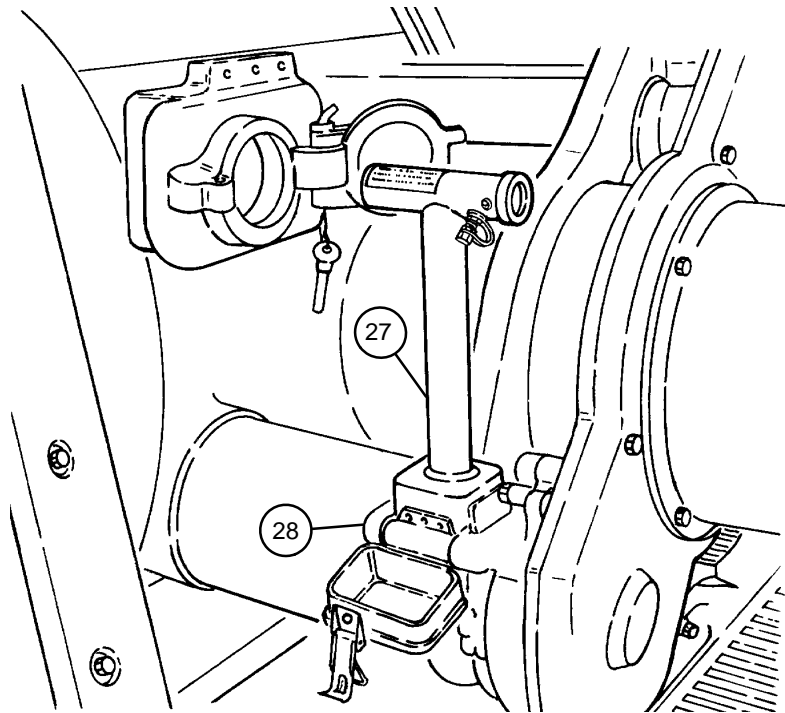
#### e. Checking Boresight of the M118A2/M118A3 Elbow Telescope Using the M140 Alinement Device

**WARNING**



The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

- 1 Inspect mating surfaces of M140 alinement device (27) and dovetail door wedge (28) for burrs. Wipe mating surfaces clean. If dovetail door wedge has burrs, notify unit maintenance.
- 2 Install M140 alinement device (27) on dovetail door wedge (28).



**2-12 PREPARATION FOR FIRING — CONTINUED**

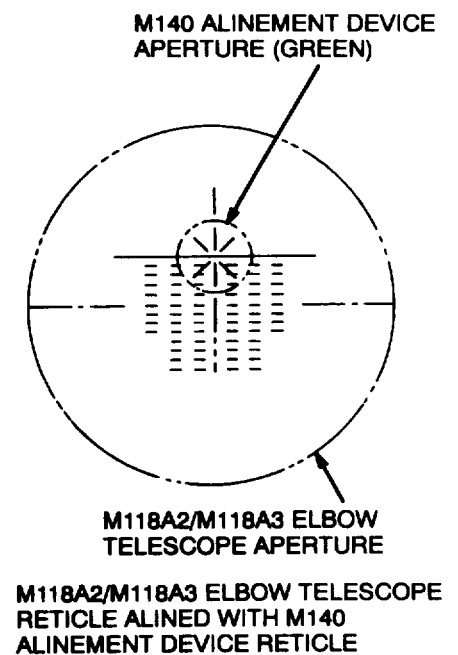
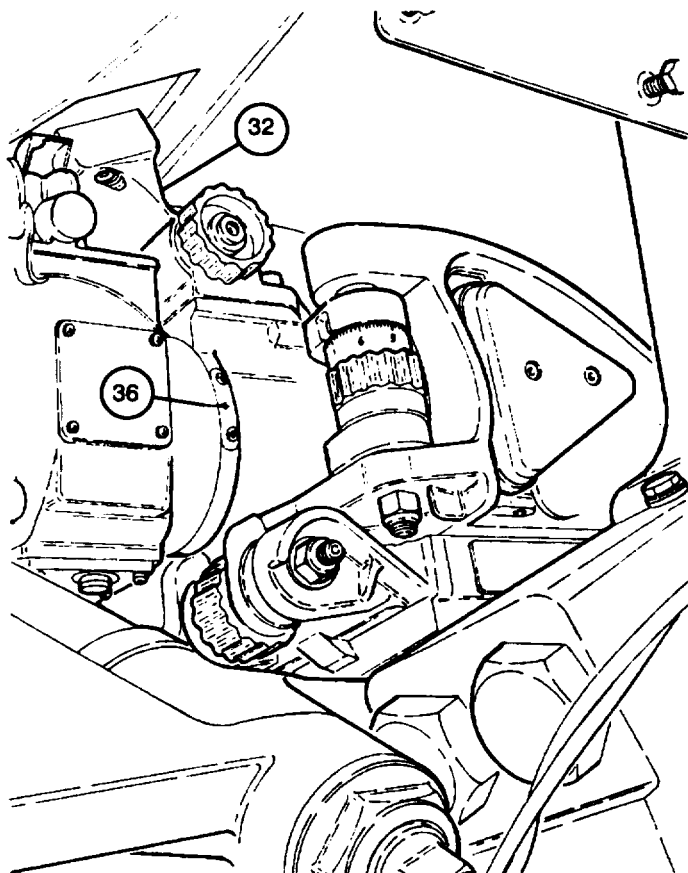
**2-12.2 Boresighting — Continued**

**e. Checking Boresight of the M118A2/M118A3 Elbow Telescope Using the M140 Alinement Device — Continued**

**NOTE**

Always check to see that bubble is centered in level vial of M118A2/M118A3 elbow telescope every time you elevate or traverse.

- 3 Aline cant correction scribe lines (36) and sight through M118A2/M118A3 elbow telescope (32). Boresight crosshairs of M118A2/M118A3 elbow telescope should be in alinement with M140 alinement device (27).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### e. Checking Boresight of the M118A2/M118A3 Elbow Telescope Using the M140 Alinement Device — Continued

##### NOTE

If alinement of M140 alinement device and M118A2/M118A3 elbow telescope is not obtained, a comparison test must be performed (para 2-12.2f.).

- 4 If after verifying accuracy of the M140 alinement device (27), alinement is not obtained, boresighting must be conducted using test target method (para 2-12.2b.) or distant aiming point method (para 2-12.2g.)

##### CAUTION

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

#### f. Comparison Test of the M140 Alinement Device

##### WARNING



The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

##### NOTE

- Comparison test of M140 alinement device is performed to identify any device that has been bent or damaged due to accident or mishandling. Reference to azimuth counters pertains to M117/M117A2 panoramic telescope only.
- When viewing through M117/M117A2 panoramic telescope, parallax may occur if panoramic telescope ballistic cover is rotated. Panoramic telescope ballistic cover must be kept perpendicular to line of sight to keep parallax at a minimum.

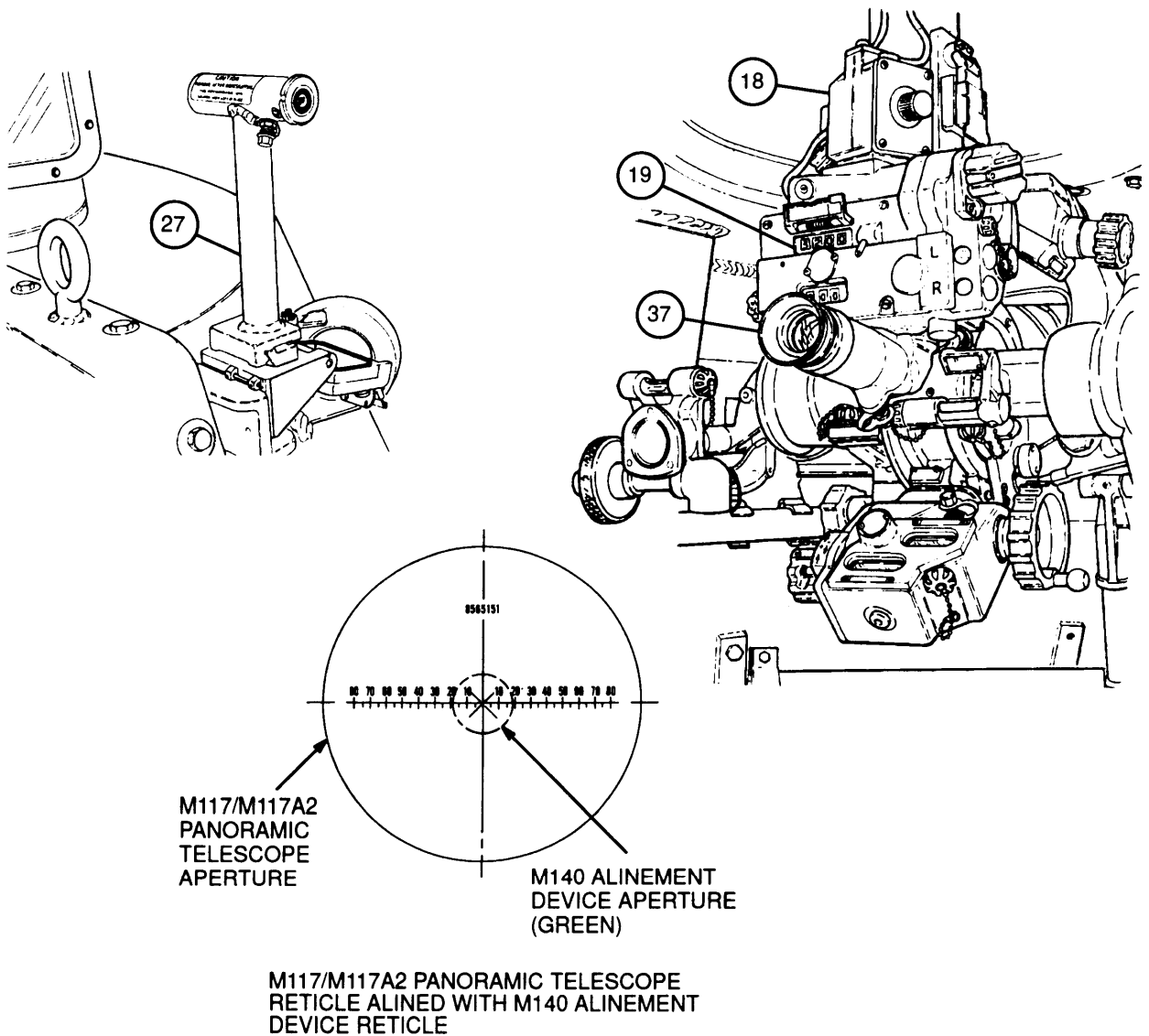
- 1 Check boresight using M140 alinement device (27).

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### f. Comparison Test of the M140 Alinement Device — Continued

- 2 Install a second M140 alinement device (27). Without moving position of M117/M117A2 panoramic telescope (18), view through eyepiece (37). If M117/M117A2 panoramic telescope reticle and M140 alinement device reticle align, you have verified accuracy of M140 alinement device.
- 3 If M117/M117A2 panoramic telescope (18) reticle and second M140 alinement device (27) reticle do not align, or if azimuth counter (19) reading is not correct after reticles are alined, one of two M140 alinement devices is unserviceable.



## 2-12 PREPARATION FOR FIRING — CONTINUED

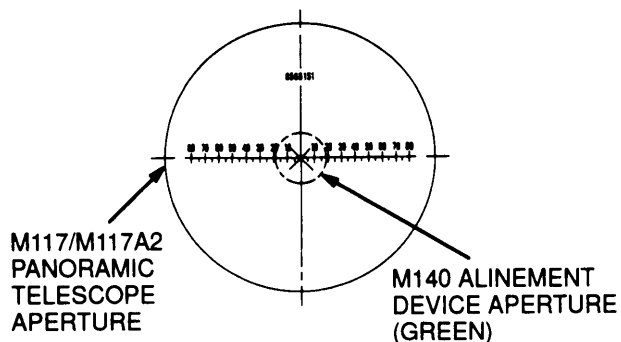
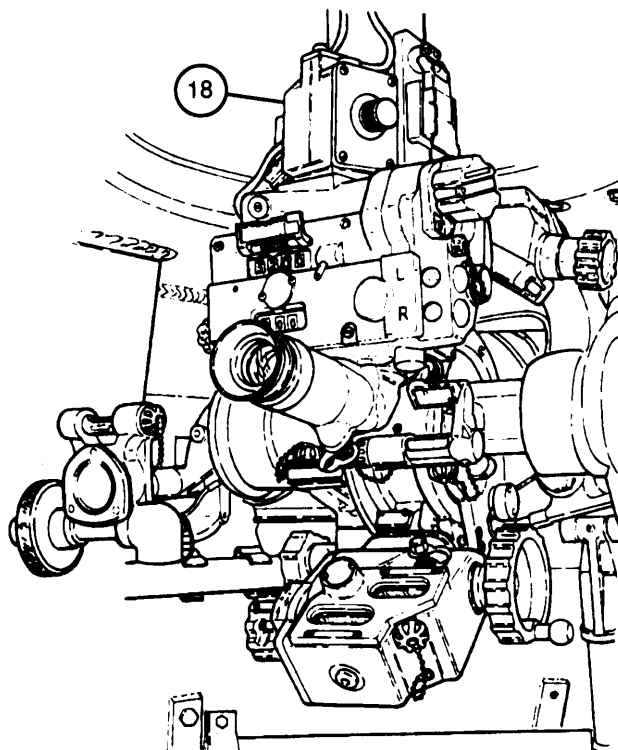
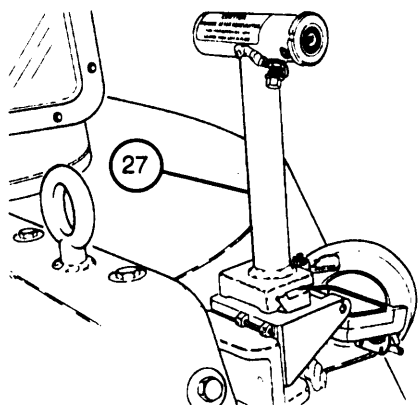
### 2-12.2 Boresighting — Continued

#### f. Comparison Test of the M140 Alinement Device — Continued

##### NOTE

Correct azimuth reading is 3200 mils.

- 4 To determine which M140 alinement device (27) is unserviceable, obtain a third M140 alinement device and check boresight of weapon again.
- 5 Without changing azimuth reading, install each of the other two M140 alinement devices (27). The M140 alinement device on which reticles will not align with M117/M117A2 panoramic telescope (18) reticle is defective. Turn in defective M140 alinement device to unit maintenance for repair.



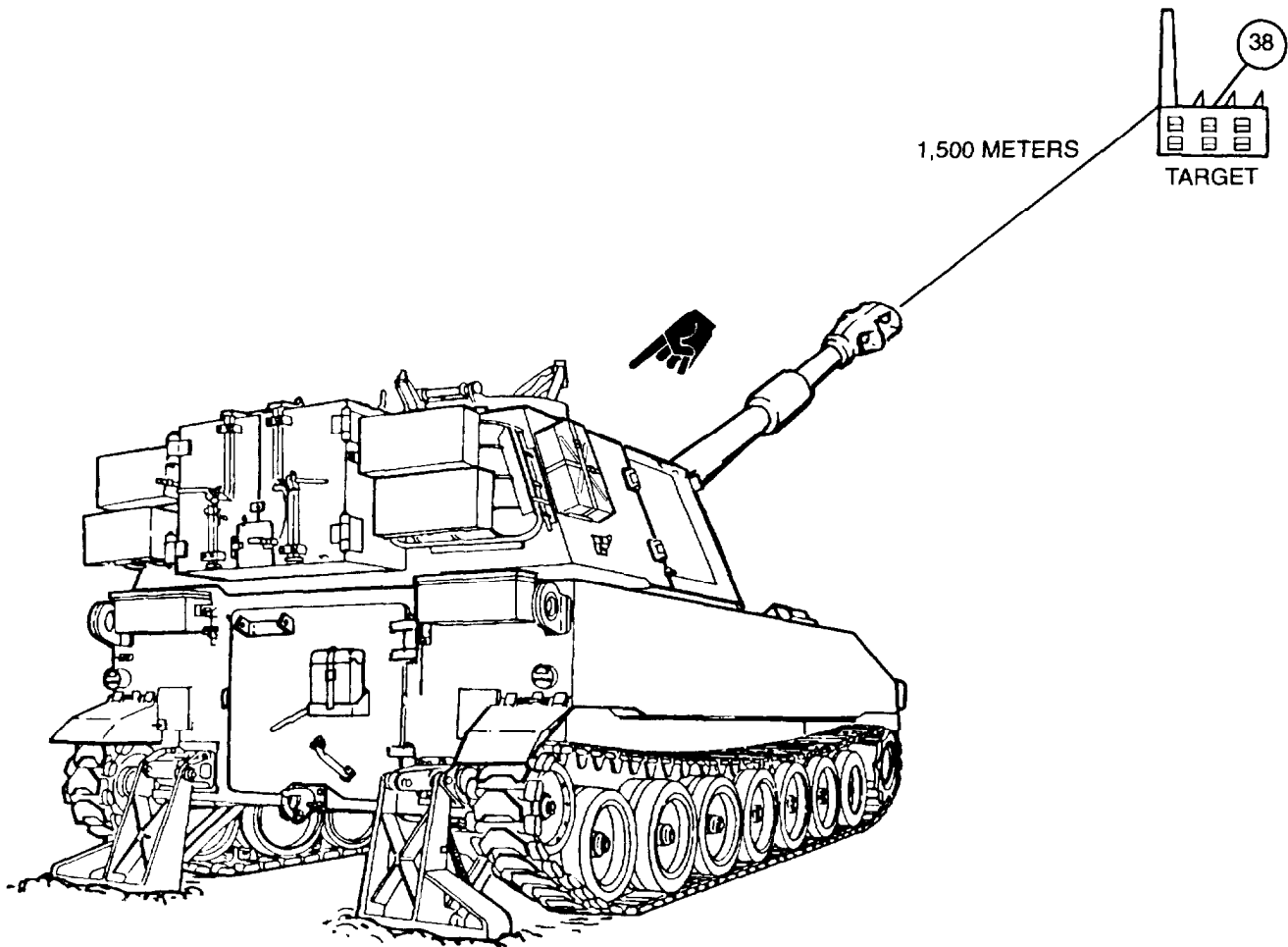
M117/M117A2 PANORAMIC TELESCOPE  
RETICLE ALINED WITH M140 ALINEMENT  
DEVICE RETICLE

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### g. Boresighting — Distant Aiming Point Method

- 1 Perform all preliminary procedures (para 2-12.2a.).
- 2 Select a sharply defined distant aiming point (38) which is at least 1640.4 yards (1500 m) from the weapon.



## 2-12 PREPARATION FOR FIRING — CONTINUED

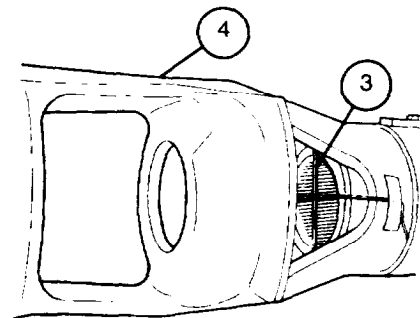
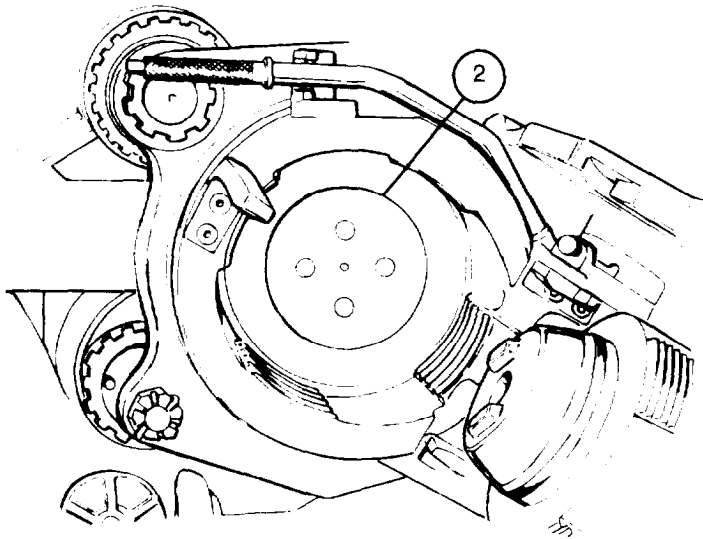
### 2-12.2 Boresighting — Continued

#### g. Boresighting — Distant Aiming Point Method — Continued

##### NOTE

Either the breech bore sight or the firing pin hole may be used as a rear sighting guide during boresighting.

- 3 Look through the center hole of the breech bore sight (2) or through firing pin hole as applicable, and elevate and traverse the cannon tube until the muzzle brake (4) boresight crosshairs (3) are on the upper left-hand corner of the distant aiming point (38).
- 4 Center bubbles of cross-level (11) and pitch level (12) by turning cross-level mechanism knob (34) and pitch level knob (35).
- 5 Rotate azimuth knob (16) and elevation knob (17) on M117/M117A2 panoramic telescope (18) to lay reticle on left edge of distant aiming point (38).
- 6 Check that muzzle brake (4) crosshairs (3) are still on the upper left-hand corner of distant aiming point (38).
- 7 Azimuth counter (19) should read 3200 mils. If it doesn't, remove cover (20) from boresight detent shaft (21) insert small screwdriver and depress boresight detent shaft. Turn until 3200 mils appears in azimuth counter. Recheck sight picture to be sure M117/M117A2 panoramic telescope (18) is still in boresight.

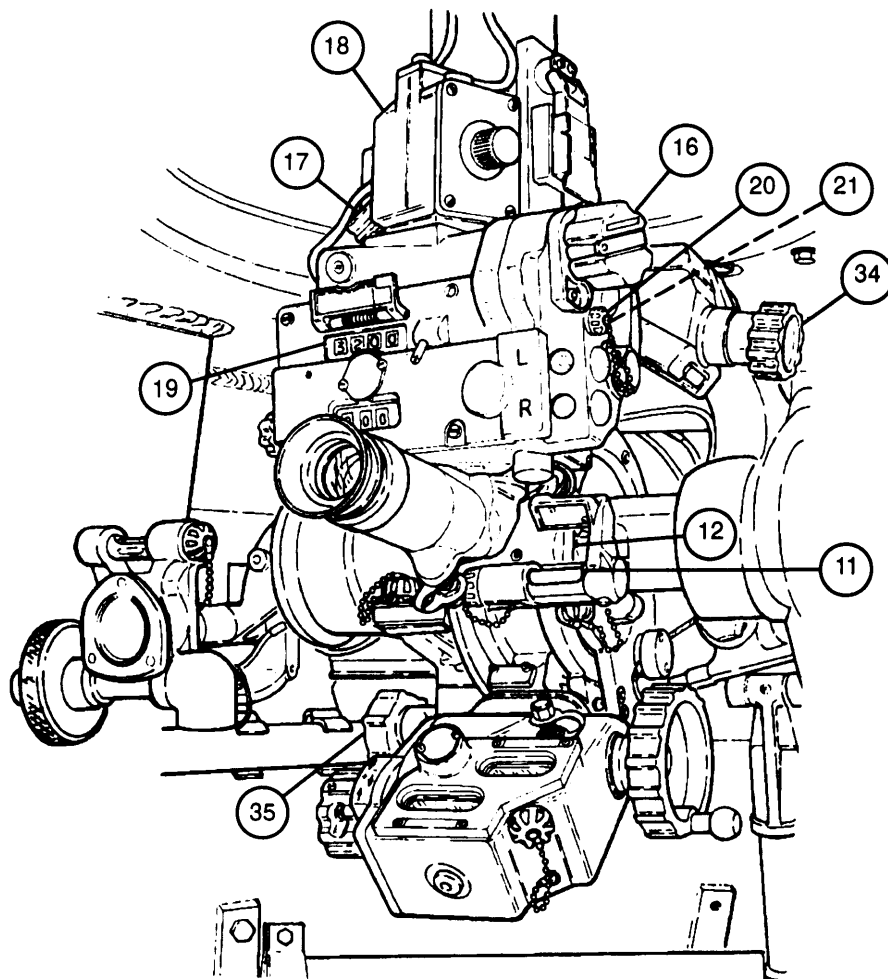
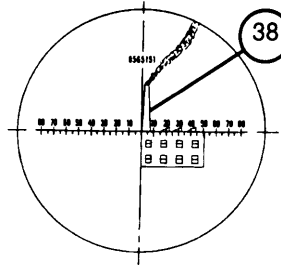


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### g. Boresighting — Distant Aiming Point Method — Continued

M117/M117A2 PANORAMIC  
TELESCOPE PATTERN





## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.2 Boresighting — Continued

#### g. Boresighting — Distant Aiming Point Method — Continued

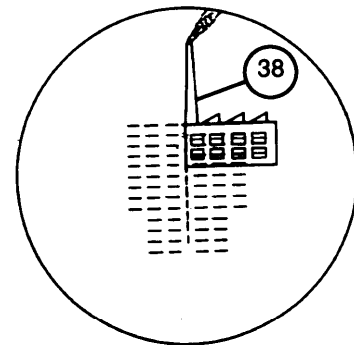
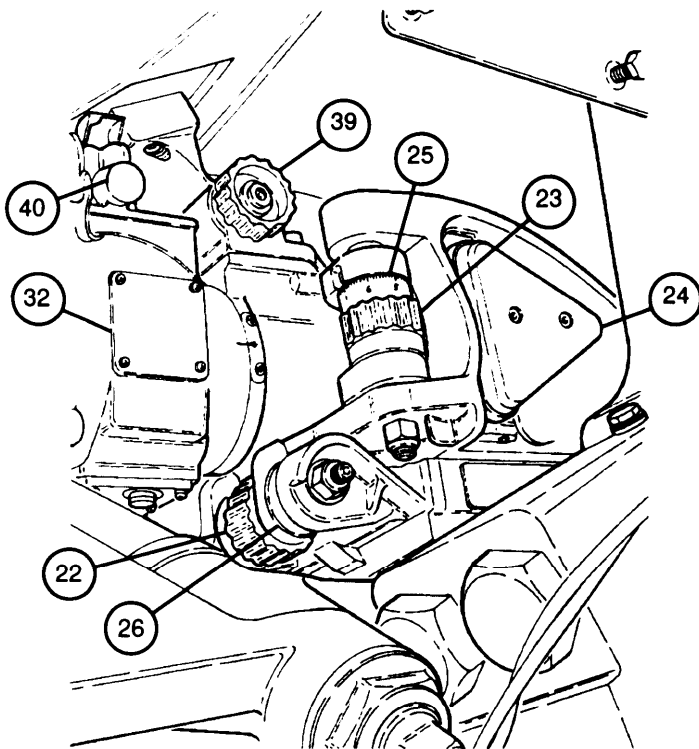
#### NOTE

Make sure you have done steps 1 through 3.

#### CAUTION

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

- 8 Turn wormshaft assembly knob (39) to center bubble in level vial (40). Rotate deflection knob (22) and elevation knob (23) to lay M118A2/M118A3 elbow telescope (32) reticle on the upper left-hand corner of distant aiming point (38).
- 9 Without moving deflection knob (22) and elevation knob (23), set M146 telescope mount (24) elevation dial (25) and deflection scale dial (26) to elevation 4, azimuth 4. Check to be sure sight picture did not move when elevation dial and deflection scale dial were set to 4.
- 10 Weapon is now boresighted.



M118A2/M118A3 ELBOW  
TELESCOPE RETICLE

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.3 Standard Angle Method

#### a. Determining the Standard Angle

**NOTE**

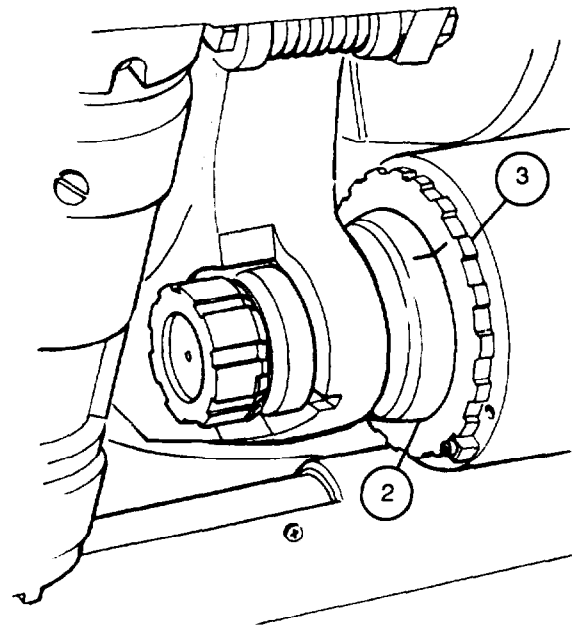
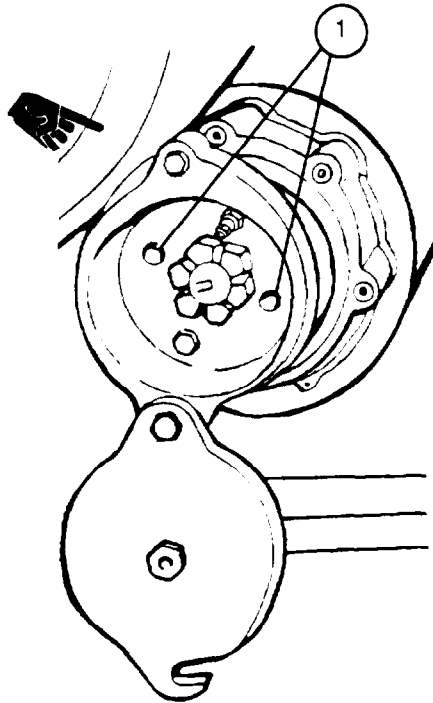
When performing fire control alignment tests and measurements, ensure the gun trunnions are leveled using the plumbline method (para 3-7.3) and that the M1451M145A1 telescope mount is scribed (para 3-7.9).

- 1 Perform fire control alignment tests and measurements (para 3-7).
- 2 Inspect recuperator assembly pins (1) to ensure that the recoil system contains the proper amount of hydraulic fluid (item 12, Appx G).

**NOTE**

The scribe line at the junction of the variable recoil cylinder and the machine bushing verifies that the recoiling and non-recoiling parts of the howitzer have the same relationship as when the standard angle was determined during fire control alignment tests.

- 3 Scribe a line at the junction of the variable recoil cylinder (2) and the machine bushing (3).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.3 Standard Angle Method — Continued

#### a. Determining the Standard Angle — Continued

##### NOTE

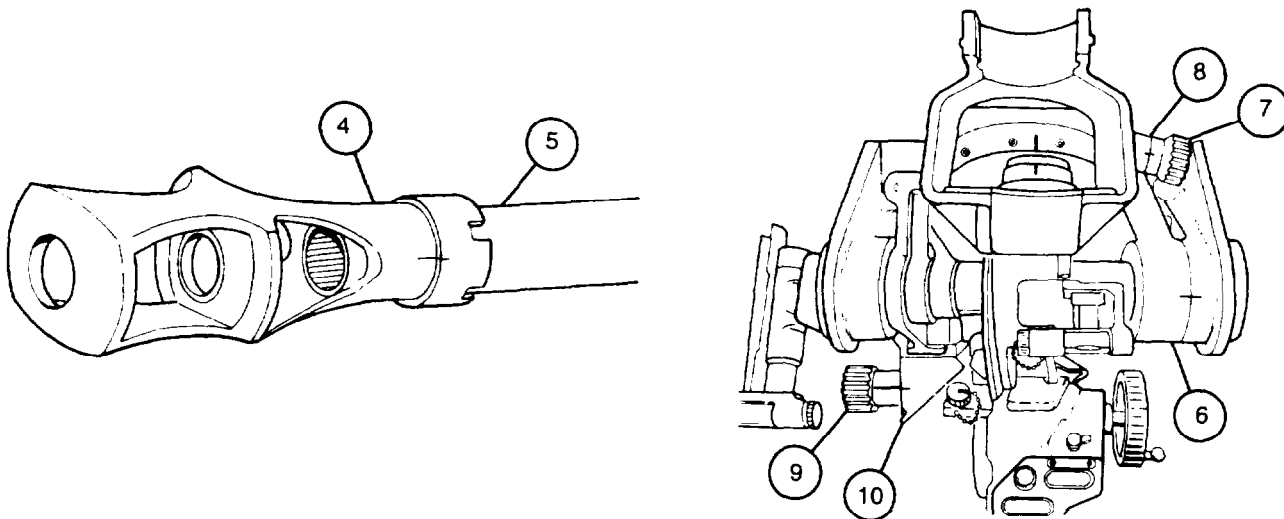
- The scribe line at the junction of the muzzle brake and cannon tube verifies that the muzzle brake has not shifted. Therefore, the standard angle should remain unchanged.
- Scribe lines must be aligned when installing the muzzle brake after maintenance. If the scribe lines don't match, fire control alignment tests must be performed, new scribe lines made, and new standard angle determined.

- 4 Scribe a line at the junction of the muzzle brake (4) and the cannon tube (5).

##### NOTE

- Aligning the scribe lines on cross-level mechanism knob and the cross-level mechanism and the scribe lines on pitch level knob and bracket serves as the coarse alignment indices for these two mounts.
- The marks placed on the M145/M145A1 telescope mount cross-level knob and pitch level knob serve as the fine indices for conducting the standard angle test.

- 5 Rotate the M145/M145A1 telescope mount (6) cross-level mechanism knob (7) until scribe lines on cross-level mechanism knob and cross-level mechanism (8) align.
- 6 Rotate the M145/M145A1 telescope mount (6) pitch level knob (9) until scribe lines on pitch level knob and bracket (10) align.



## 2-12 PREPARATION FOR FIRING — CONTINUED

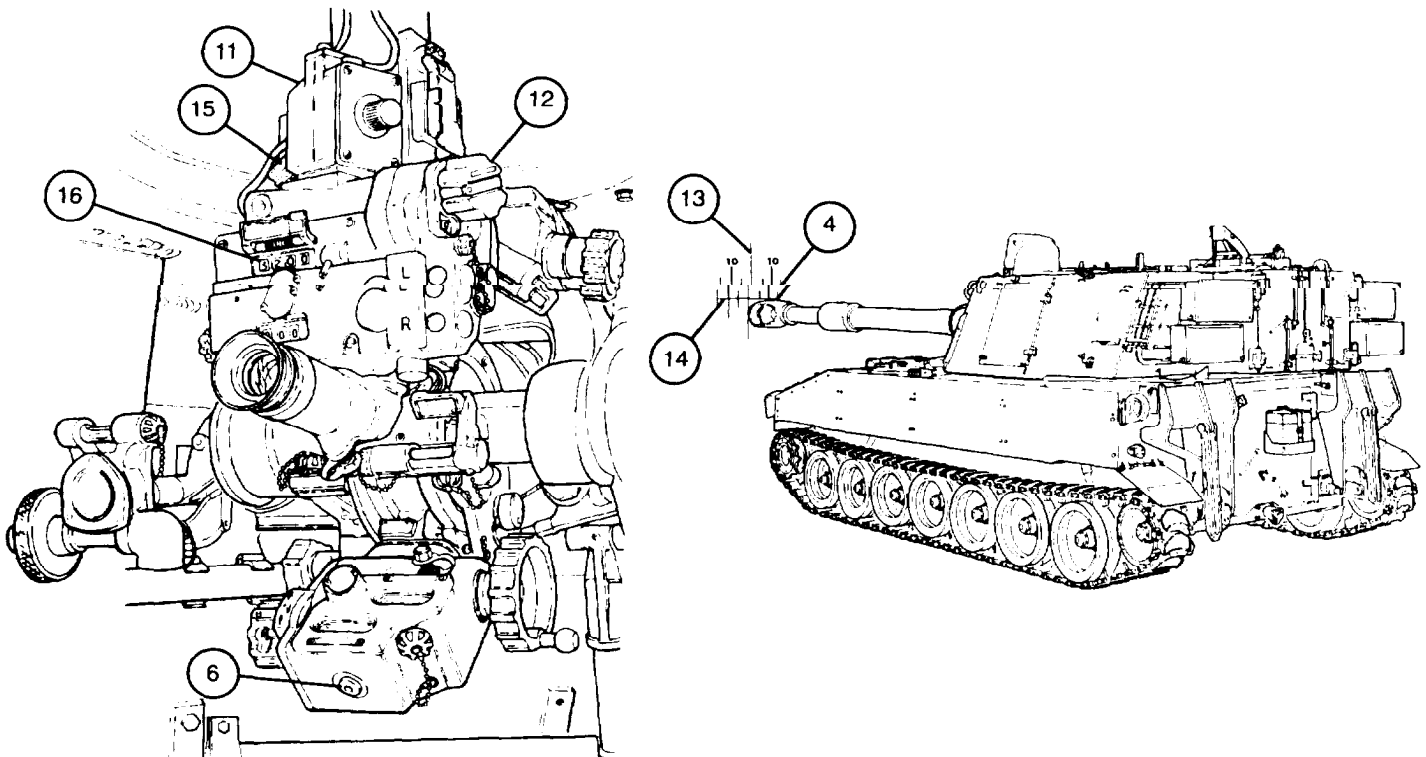
### 2-12.3 Standard Angle Method — Continued

#### a. Determining the Standard Angle — Continued

- 7 Boresight using the test target method (para 2-12.2).

#### NOTE

- A parallax shield can be made to prevent eye movement in two ways. One is to use a dust cap with a hole in the center. The second way is to use a small opening marked off with strips of tape.
  - Final movement of the azimuth knob when making any setting should be in a clockwise direction.
- 8 Using a parallax shield, turn the M117/M117A2 panoramic telescope (11) azimuth knob (12) to align the vertical hairline (13) of the M117/M117A2 panoramic telescope on the farthest, left edge of the muzzle brake (4). Align the horizontal hairline (14) of the M117/M117A2 panoramic telescope on the top edge of the muzzle brake by turning the elevation knob (15).
  - 9 Record the reading from the M117/M117A2 panoramic telescope (11) azimuth counter (16) to the nearest 1/4 mil. This is the standard angle of deflection for this M145/M145A1 telescope mount (6), M117/M117A2 panoramic telescope, and howitzer.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.3 Standard Angle Method — Continued

#### b. Boresighting Using the Standard Angle Method (Field Situation)

##### NOTE

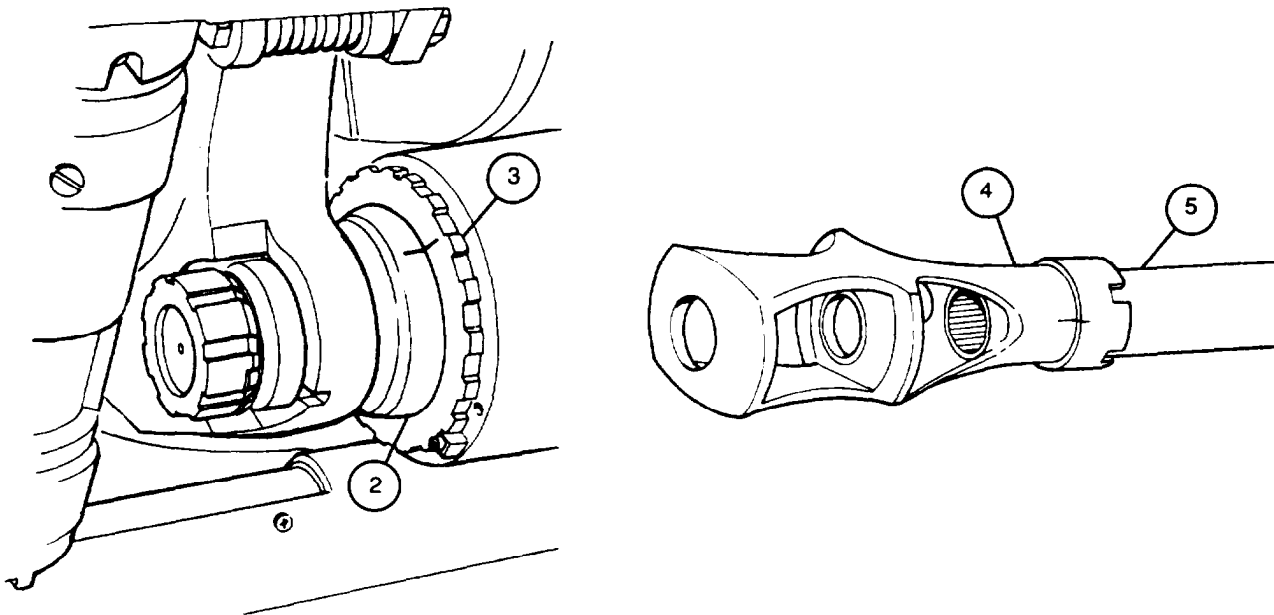
Although boresighting using the standard angle method is acceptable, boresighting using the distant aiming point method or test target method (para 2-12.2) should be accomplished as soon as is feasible.

- 1 Ensure gun trunnions have 90 mils cant or less.

##### NOTE

The standard angle method of boresighting is accurate only to the extent that the relationship between recoiling and non-recoiling parts remains constant. The distance from the M117/M117A2 panoramic telescope to the muzzle brake remains the same, so the angle from the M117/M117A2 panoramic telescope to the muzzle brake should not change.

- 2 Ensure scribe lines on variable recoil cylinder (2) and machine bushing (3) align.
- 3 Ensure scribe lines on muzzle brake (4) and cannon tube (5) align.
- 4 Place the cannon tube (5) at 0 mils using the M1A1 gunner's quadrant.

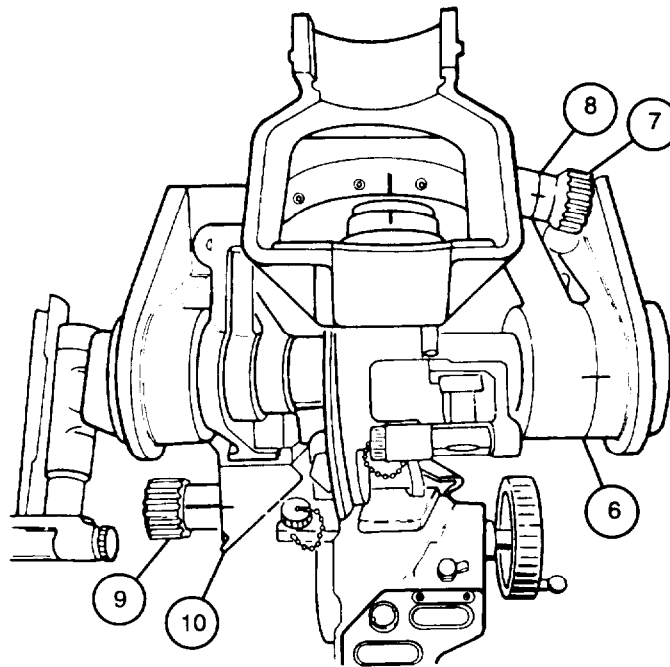


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.3 Standard Angle Method — Continued

#### b. Boresighting Using the Standard Angle Method (Field Situation) — Continued

- 5 Rotate the M145/M145A1 telescope mount (6) cross-level mechanism knob (7) until the scribe lines on cross-level mechanism knob and cross-level mechanism (8) align.
- 6 Rotate the M145/M145A1 telescope mount (6) pitch level knob (9) until scribe lines on pitch level knob and bracket (10) align.
- 7 Repeat steps 5 and 6, rotating the pitch level knob (9) and cross-level mechanism knob (7) in a clockwise direction until alinement is achieved.



## 2-12 PREPARATION FOR FIRING — CONTINUED

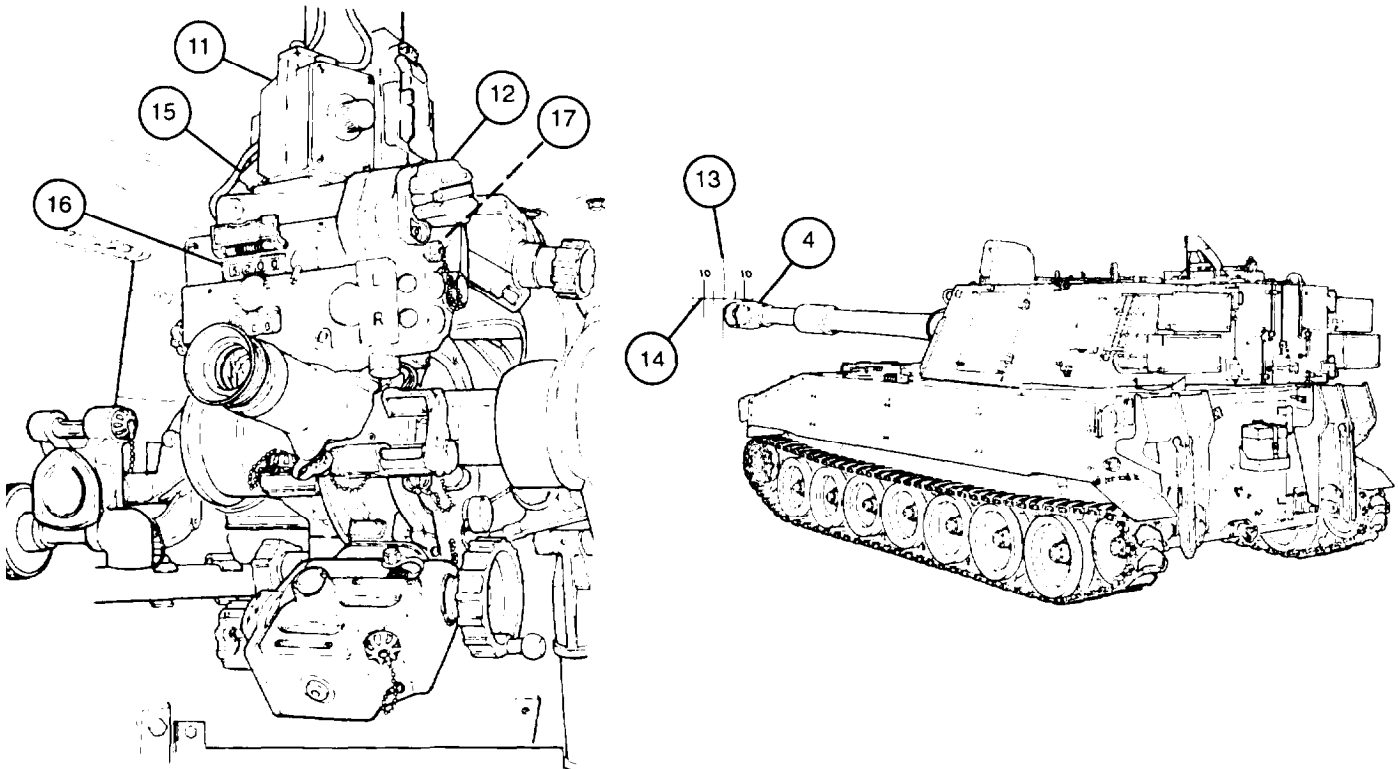
### 2-12.3 Standard Angle Method — Continued

#### b. Boresighting Using the Standard Angle Method (Field Situation) — Continued

##### NOTE

A parallax shield can be made to prevent eye movement in two ways. One is to use a dust cap with a hole in the center. The second is to use a small opening marked off with strips of tape.

- 8 Using a parallax shield, turn the M117/M117A2 panoramic telescope (11) azimuth knob (12) to align the vertical hairline (13) of the M117/M117A2 panoramic telescope on the farthest left edge of the muzzle brake (4). Aline horizontal hairline (14) of the M117/M117A2 panoramic telescope on the top edge of the muzzle brake by turning the M117/M117A2 panoramic telescope elevation knob (15).
- 9 Note the reading on the M117/M117A2 panoramic telescope (11) azimuth counter (16). If the reading equals the standard angle of deflection, the howitzer is boresighted. If the reading does not equal the standard angle of deflection, go to step 10.
- 10 Using a screwdriver, depress the boresight detent shaft (17) and adjust the azimuth counter (16) until it displays the standard angle of deflection. Repeat step 8. The weapon is now boresighted.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.4 Pre-Fire Checks

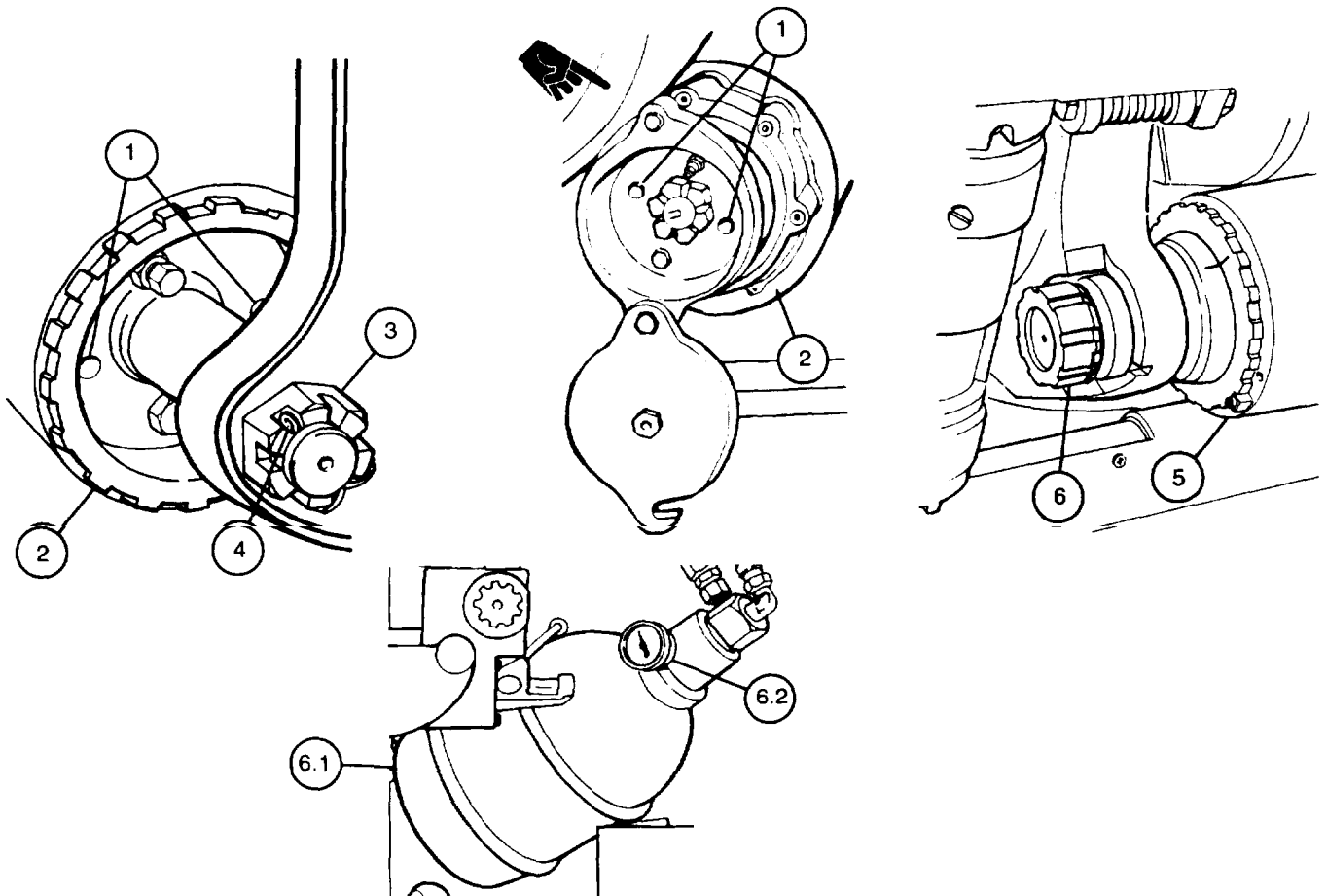
#### a. Recoil System

- 1 Pins (1) on recuperator assembly (2) must not extend more than 3/4 inch (19.05 mm) or less than 1/8 inch (3.2 mm).
- 2 Recuperator assembly (2) slotted nut (3) and cotter pin (4) must be properly installed.
- 3 Variable recoil assembly (5) round nut (6) must be properly installed.

#### NOTE

Due to heat expansion, pressure may increase during normal firing. Safe to fire range is 17 to 50 psi (117 to 345 kPa).

- 4 Check replenisher accumulator assembly (6.1) pressure gage (6.2) for 17 to 24 psi (117 to 165 kPa).





## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.4 Pre-Fire Checks — Continued

#### b. Cannon Tube

- 1 Cannon tube (7) must be dry and clear with no visible damage or foreign matter present.

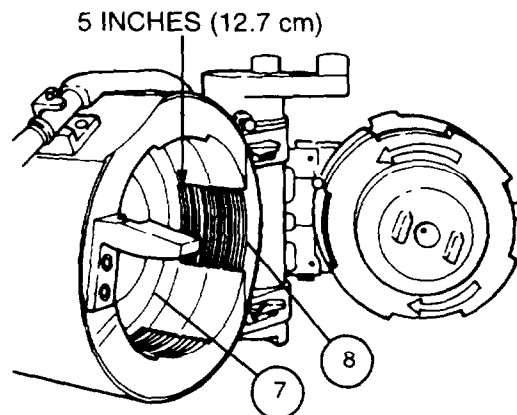
**WARNING**

- If cannon is new or retubed, check the following before initial firing. If either step 2 or step 3 is not right, do not fire. The cannon may blow up, causing severe injury or death to personnel. Notify unit maintenance.
- If major work has been done by direct support or general support maintenance, fire first round using 50 foot lanyard to prevent injury.
- Do not fire without follower assembly. This will result in injury to personnel and damage to equipment.
- High intensity hearing protection is required. Decibel levels from firing exceed safe levels for human hearing. Failure to wear hearing protection could result in hearing impairment.
- The ventilation blower VENTILATOR BLOWER INTAKE switch must be turned to INTAKE during firing (para 2-17.3).

**CAUTION**

After a new M284 cannon assembly or a new torque key has been installed, a zone 6 charge must be fired to mate the torque key and the cannon tube. Failure to follow this procedure could result in equipment damage.

- 2 Rear face of cannon tube (7) must be flush with forward shoulder of breech ring (8).
- 3 Measure distance from rear face of cannon tube (7) to rear of breech ring (8). Distance cannot be more than five inches (12.7 cm).



## 2-12 PREPARATION FOR FIRING — CONTINUED

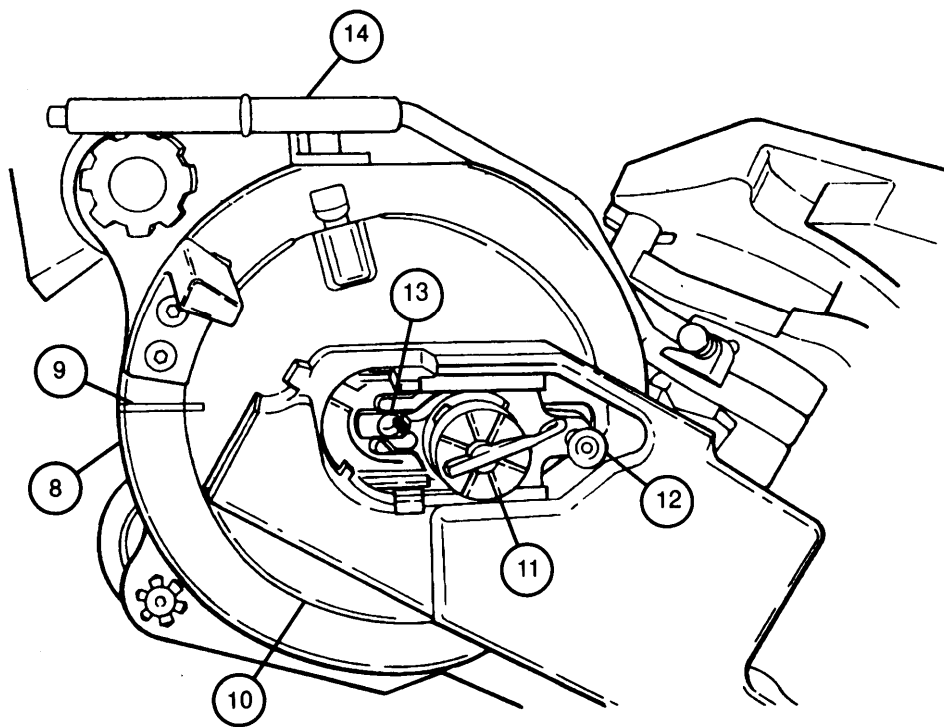
### 2-12.4 Pre-Fire Checks — Continued

#### c. Breech

- 1 Witness marks (9) on breech ring (8) and breechblock (10) must align when breechblock is closed.
- 2 Firing mechanism (11) and block assembly (12) must be working properly.
- 3 Primer chamber (13) must be clean and operating handle (14) securely latched forward.

#### d. Rammer Assembly

Perform rammer reliability checks (para 3-6.3).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 \*Loading the 155MM Cannon

**WARNING**

All crew members must be familiar with misfire procedures in paragraph 2-15 before loading howitzer for firing.

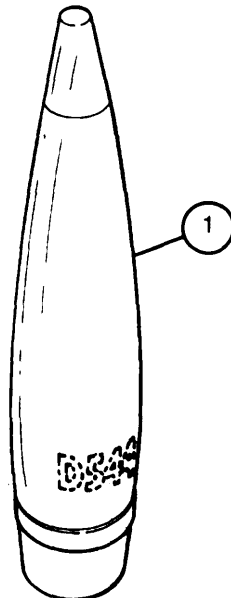
#### a. Loading

- 1 When a fire mission is announced, chief of section indicates aiming point reference to gunner (M1A1 collimator, DAP, or M1A2 aiming posts) and repeats fire mission to the crew.

**WARNING**

Dirt or grease left on projectile rotating band could cause failure of projectile to seat properly on ramming. Firing an unseated projectile could cause an inbore explosion, resulting in injury or death to personnel.

- 2 Cannoneer no. 3 verifies, cleans, and inspects the projectile to be fired. Cannoneer no. 3 removes grommet, examines rotating band (1) to see that it is free from dirt and burrs, and then stands projectile in an upright position for fuzing. For preparation of M712 or M823 projectiles (copperhead) refer to paragraph 5-14.



\*Standardized procedures for firing drills are identified with an asterisk (\*) preceding the title.

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

#### a. Loading — Continued

**WARNING**

- Do not load or fire artillery ammunition without authorized fuze. Firing of such rounds without fuzes or with an unauthorized fuze could result in inbore premature and other hazardous conditions causing serious injury or death to personnel.
  - Do not load or fire round if fuze is not fully seated; it could cause severe injury or death to personnel.
- 3 Cannoneer no. 2 removes lifting plug and inspects fuze well for rust, dirt, or leaking filler. Cannoneer no. 2 removes supplementary charges, if required, fuzes projectile (para 5-5), and sets fuze for desired fuze action (i.e. SQ, D, or time). When directed, cannoneer no. 3 reads and announces time set on fuze.

**CAUTION**

Be careful when placing ammunition in hull to prevent damage to rotating band.

- 4 Cannoneer no. 3 then passes projectile to cannoneer no. 1 inside howitzer.
- 5 Ammo vehicle driver, assisted by howitzer driver, prepares propelling charge (para 5-12). When propelling charge is prepared, driver then hands propelling charge, igniter pad first, to cannoneer no. 1.
- 6 The ammunition team chief acts as radio/telephone operator.

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

#### a. Loading — Continued

**WARNING**

Never forget to put operating handle back to stowed position. If left down while closing breechblock, it can cause serious injury to personnel. Make it a practice never to let go of operating handle until you return it to stowed position.

**CAUTION**

Lock pin should be in closed position before opening breechblock.

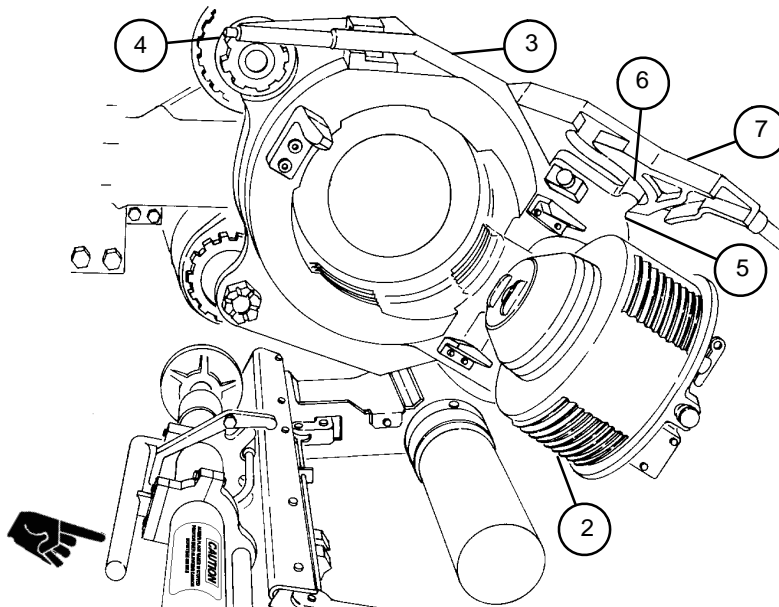
- 7 Cannoneer no. 1 opens breechblock (2) (first round only) by depressing operating handle (3) detent plunger (4) and pulling operating handle rearward until operating crank assembly (5) roller (6) is engaged in operating cam (7). Cannoneer no. 1 then returns operating handle to stowed position (forward).

**NOTE**

During combat emergency missions the cannon tube may be loaded between -53 mils and +756 mils to meet operational requirements.

**CAUTION**

- Always place rammer in stowed position when elevating cannon more than 800 mils to avoid damaging rammer.
  - If rammer is left in ramming position when elevating above 800 mils, the rammer will strike the floor and bend the rammer support shaft.
- 8 Assistant gunner ensures that cannon tube is at loading elevation (+300 to +400 mils).



## 2-12 PREPARATION FOR FIRING — CONTINUED

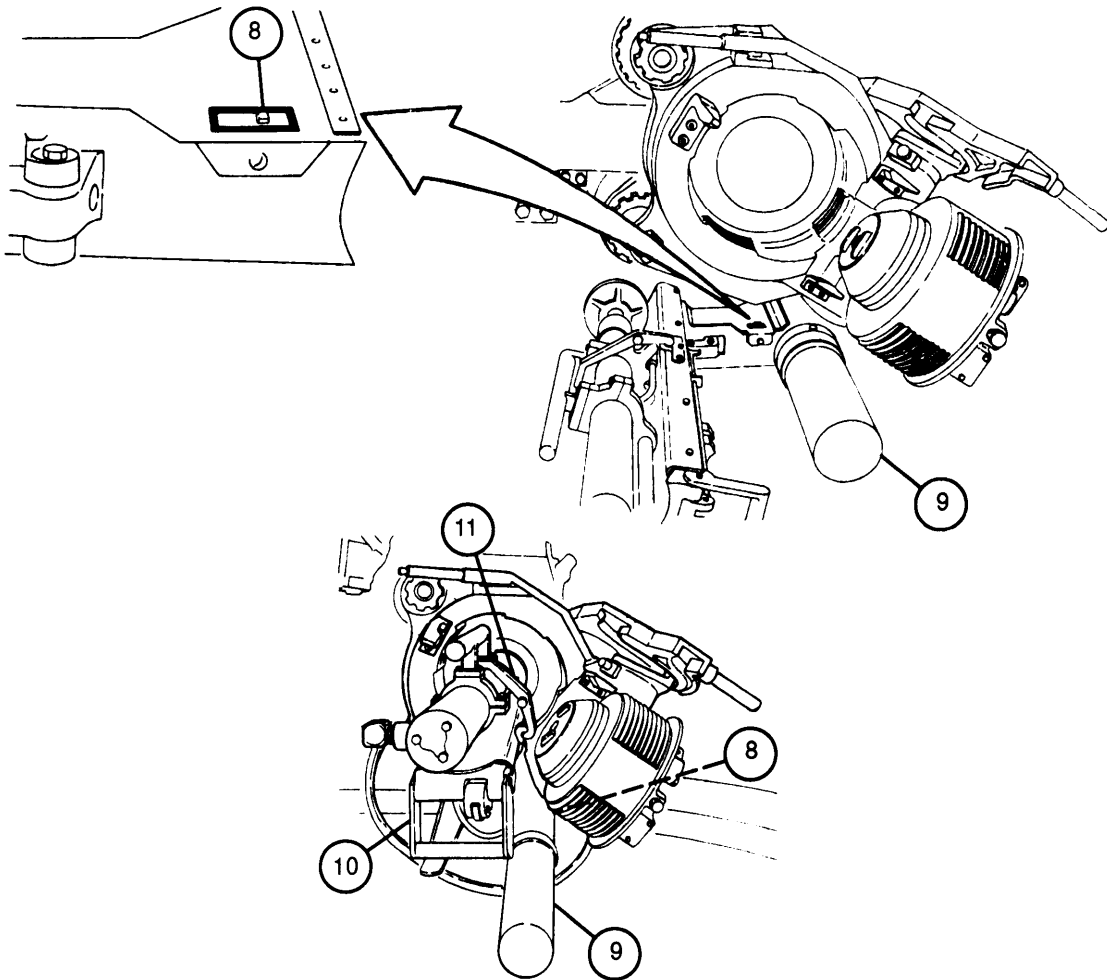
### 2-12.5 Loading the 155MM Cannon — Continued

#### b. Power Ramming

#### NOTE

If rammer is not working, see paragraph 2-12.5c. for hand ramming instructions.

- 1 Check rammer safety pointer (8). It should be in black position indicating that rammer assembly (9) is properly stowed and latched,
- 2 Cannoneer no. 1 pulls main release handle (10) and slides rammer assembly (9) back to rear stop. Rammer safety pointer (8) should now be in red position.
- 3 Cannoneer no. 1 places his left hand on rammer handle (11) and swings rammer assembly (9) up and forward until latched. Rammer safety pointer (8) returns to black position.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

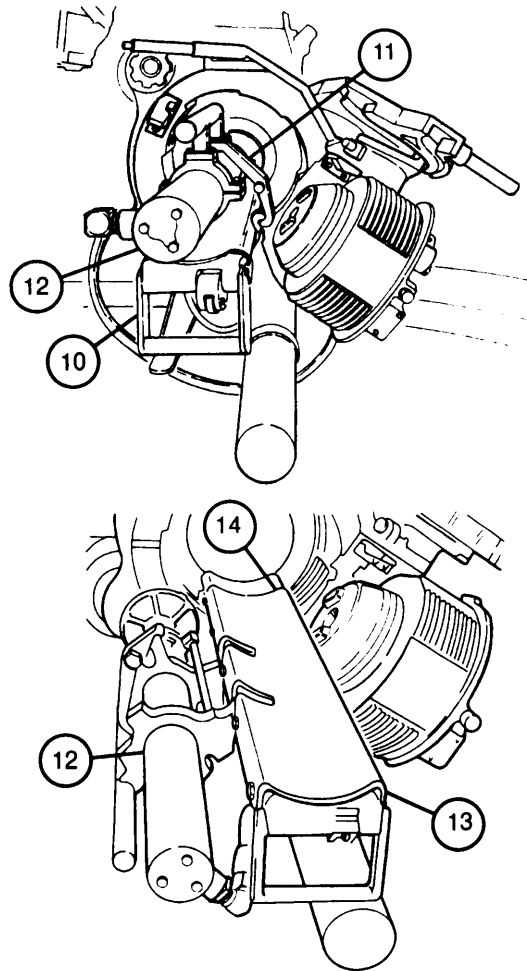
#### b. Power Ramming — Continued

- 4 Without touching the main release handle (10), cannoneer no. 1 pulls on the rammer handle (11) to unlatch and rotate the cylinder assembly (12) to the side.

**CAUTION**

Be careful not to accidentally push control lever on rammer assembly actuating valve of cab while rammer assembly is in unlatched/loading position.

- 5 Cannoneer no. 1 then places projectile on tray (13) and pushes projectile forward until rear of projectile is just beyond line (14).



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

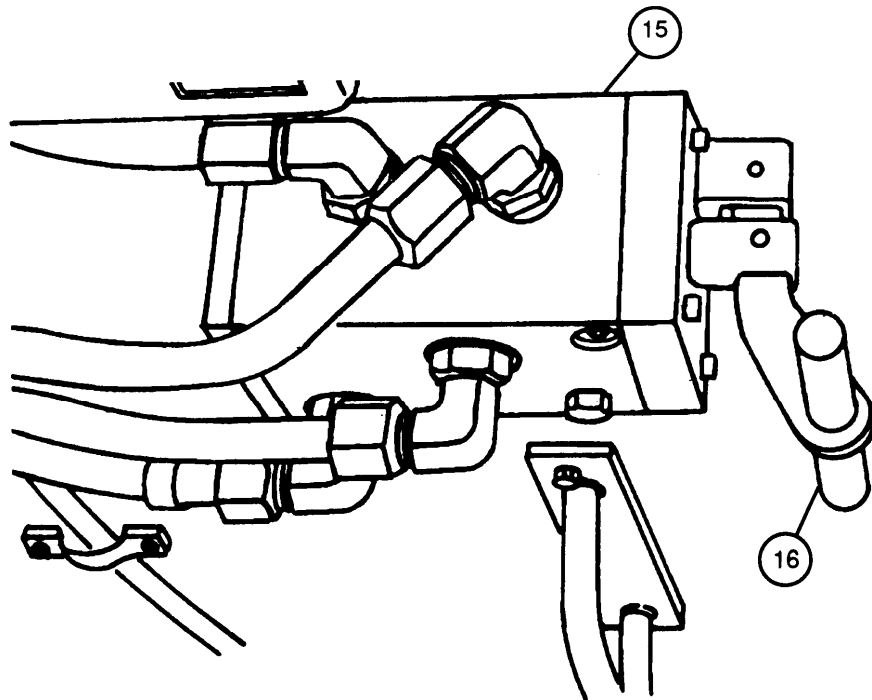
#### b. Power Ramming — Continued

6 Hearing last digit of quadrant reading, cannoneer no. 1 rotates cylinder assembly (12) up to latch position to keep projectile from falling back until last digit of quadrant, display of quadrant, or chief of section signals to ram.

**WARNING**

- Before actuating control lever on rammer assembly actuating valve, be sure power pack assembly pressure gage indicates at least 925 psi (6378 kPa) for proper seating of projectiles. Improperly seated projectile can cause short rounds and injury to personnel.
- Be sure to hold actuating valve forward for a full four seconds to properly seat projectile. Improperly seated projectiles cause short rounds and injury to personnel.

7 Cannoneer no. 1 reaches up to actuating valve (15) on cab ceiling, pushes control lever (16) forward, and holds control lever for 4 seconds to allow full extension of cylinder assembly (12) rod and proper seating of projectile. After projectile is seated, cannoneer no. 1 releases control lever.





## 2-12 PREPARATION FOR FIRING — CONTINUED

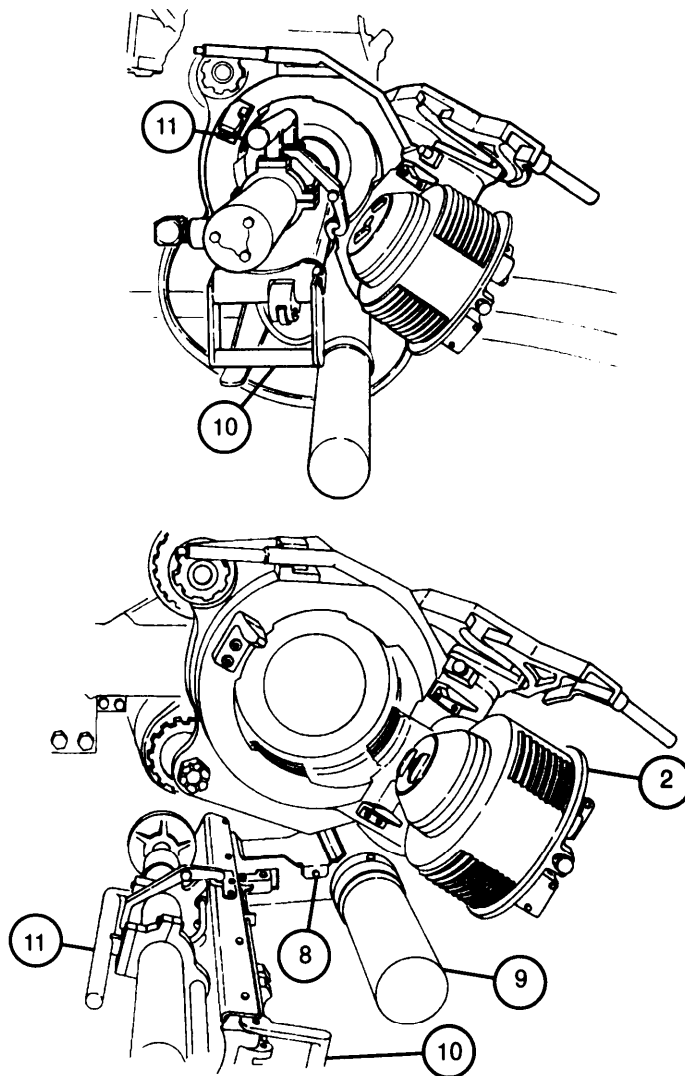
### 2-12.5 Loading the 155MM Cannon — Continued

#### b. Power Ramming — Continued

**CAUTION**

Do not let rammer assembly fall to stowage bracket. Dropping rammer can cause tray bracket to crack.

8 Cannoneer no. 1 places right hand on main release handle (10), left hand on rammer handle (11), and pulls rammer assembly (9) fully to rear. Cannoneer no. 1 rotates loader-rammer counterclockwise and pushes rammer assembly forward to stowed position, making sure rammer safety pointer (8) is in the black position.



**2-1 2 PREPARATION FOR FIRING — CONTINUED**

**2-12.5 Loading the 155MM Cannon — Continued**

**b. Power Ramming — Continued**

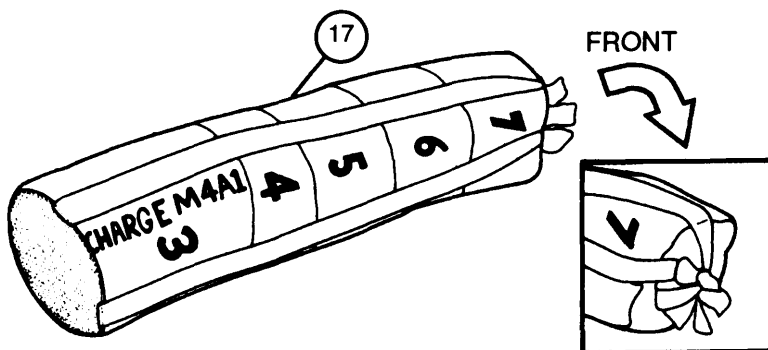
**WARNING**

- Never load a propelling charge into propellant chamber by increments. Only fully assembled charges will be used. Critical malfunction could result causing injury to personnel.
- Do not assemble M3 series green bag propelling charges with M4 series white bag propelling charges. Critical malfunction could result causing injury to personnel.
- When inserting propelling charge, check that igniter (red) end is towards breechblock. If propelling charge is not properly loaded, a misfire may result causing injury to personnel.

**NOTE**

Don't put propelling charge in until just before firing. Temperature variation will affect performance of propelling charge.

9 Cannoneer no. 1 receives propelling charge (17) from HD, loads propelling charge into propellant chamber with igniter (red) end toward breechblock (2) so that it is 3 inches (7.62 cm) inside rear of propellant chamber or in groove in propellant chamber, and announces, "1 SEE RED."



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-1 2.5 Loading the 155MM Cannon — Continued

#### b. Power Ramming — Continued

**WARNING**

To prevent injury to personnel, stand clear of breechblock. Do not close breechblock unless red igniter pad is visible.

- 10 Cannoneer no. 1 commands "CLOSE" and lifts operating cam (7).
- 11 After breechblock (2) is closed, cannoneer no. 1 ensures that witness marks (18 and 19) are alined. If witness marks are not alined, do the following.
  - (a) Release operating handle (3) and push in clutch pin (20).
  - (b) Hold clutch pin (20) in and push forward on operating handle (3). this should rotate breechblock (2) closed.

**WARNING**

- if breechlock does not lock, do not load primer to prevent injury to personnel. Report unsafe condition to supervising officer and unit maintenance, then unload cannon assembly (para 2-14).
- NEVER insert primer in primer chamber unless breechblock assembly is closed and locked. Ignition of propelling charge with breechblock not fully closed presents a critical hazard to crew.
- Don't force primer into primer chamber, Forcing primer could prematurely ignite powder charge causing the howitzer to recoil resulting in serious injury to the crew.

**NOTE**

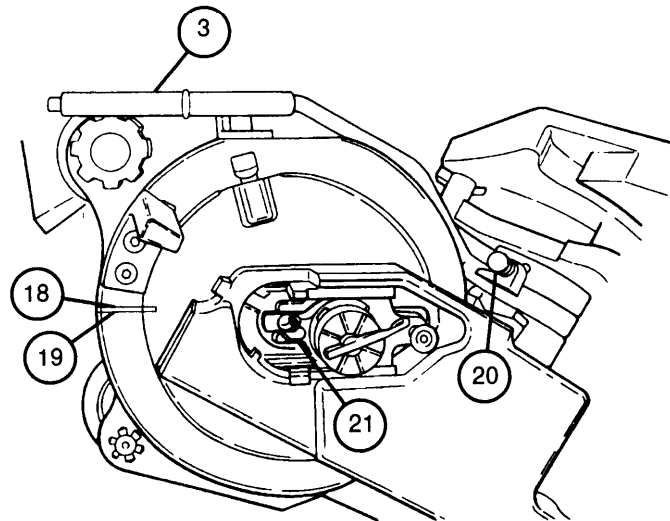
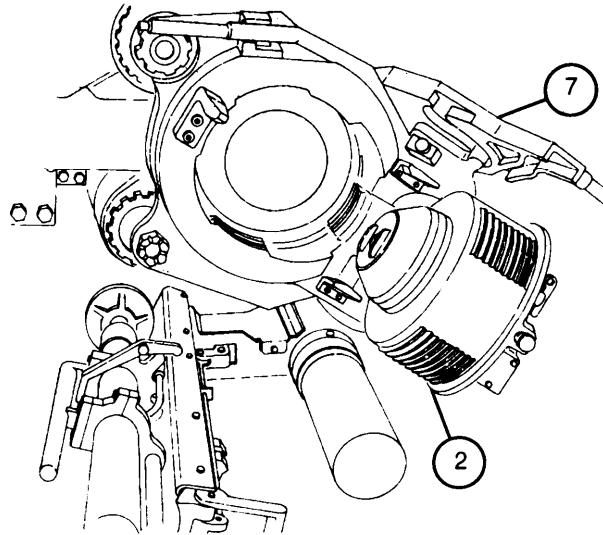
Use only M82 primer in cannon assembly (para 5-2.4).

- 12 Cannoneer no. 1 inserts primer (21) into primer chamber, If primer will not go in, primer chamber is probably dirty. Clean primer chamber and vent hole by inserting reamer assembly into chamber as far as it will go and rotating briskly. After primer is inserted, cannoneer no. 1 announces, "PRIMED."

**2-12 PREPARATION FOR FIRING — CONTINUED**

**2-1 2.5 Loading the 155MM Cannon — Continued**

**b. Power Ramming — Continued**



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

#### b. Power Ramming — Continued

**WARNING**

Do not fire without follower assembly. This will result in injury to personnel and damage to equipment.

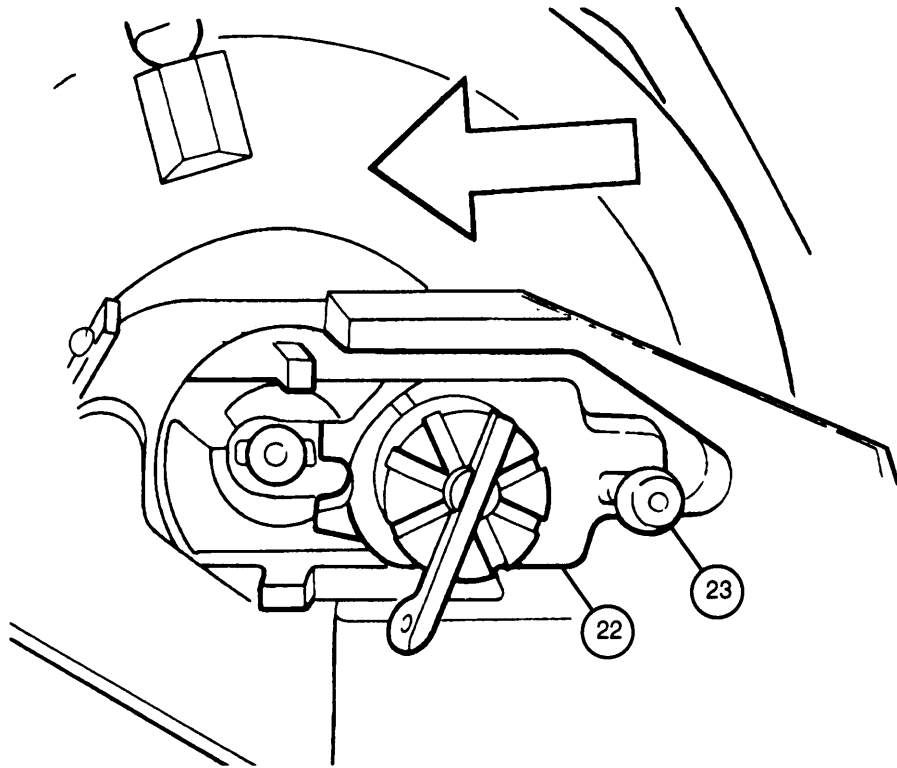
**CAUTION**

Be sure firing group block is all the way left. If it isn't, a misfire will result. Do not hook lanyard to firing mechanism until cannon tube is elevated.

**NOTE**

Make sure flanged head of primer is firmly seated against cartridge extractor.

- 13 Cannoneer no. 1, with left hand, palm out, back of hand toward breech, slides firing group block (22) to the left by pulling on follower assembly knob (23).

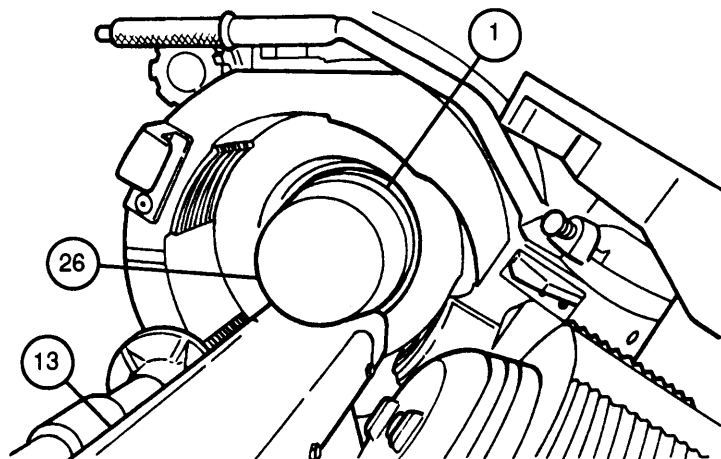
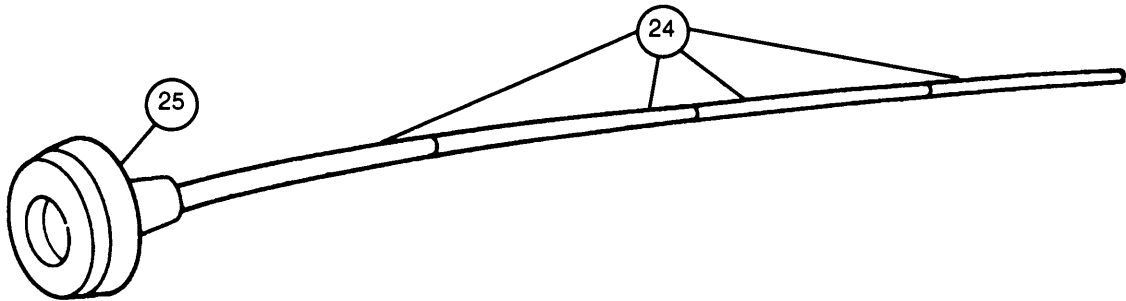


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.5 Loading the 155MM Cannon — Continued

#### c. Hand Ramming

- 1 Cannoneers no. 2 and 3 assemble four rammer staff cleaning sections (24) with artillery loading rammer (25) on the end.
- 2 The assistant gunner elevates cannon tube to approximately 265 mils or convenient elevation to permit hand ramming through hull rear door.
- 3 Cannoneer no. 1 places tray (13) in position.
- 4 Cannoneer no. 1 places projectile (26) on tray (13) and pushes the projectile forward by hand until the rotating band (1) is just forward of tray.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-1 2.5 Loading the 155MM Cannon — continued

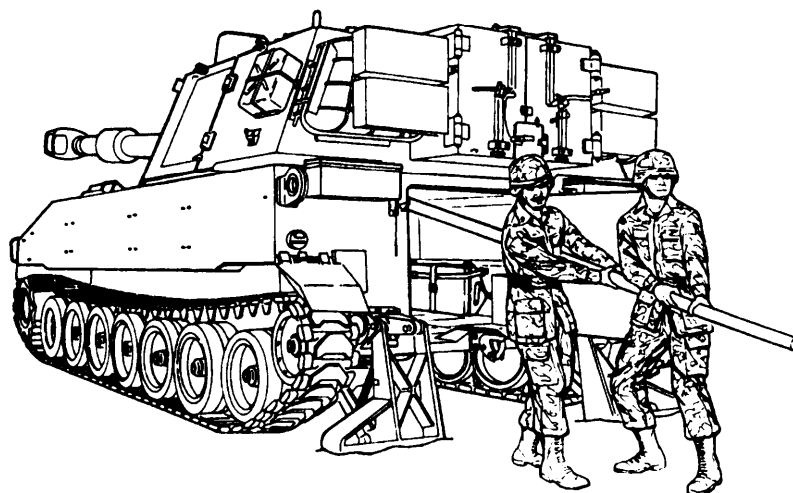
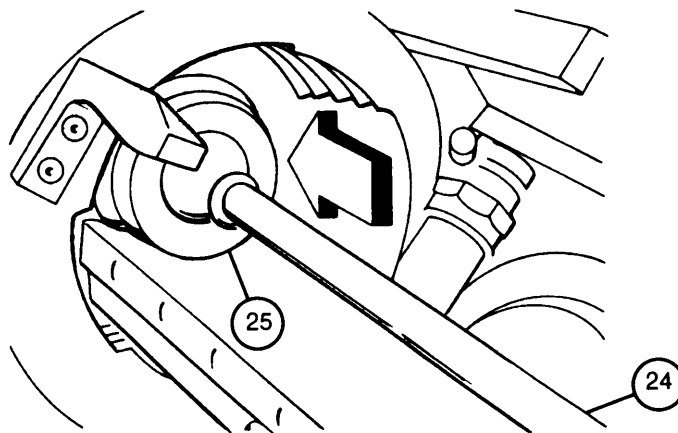
#### c. Hand Ramming — Continued

5 Cannoneers no. 2 and 3 place the staff cleaning section (24) with artillery loading rammer (25) attached through the rear hull door and position it against the base of the projectile.

#### NOTE

When operating in “buttoned-up” environment (hull doors closed), or when the M992FAASV is mated to the howitzer, cannoneer no. 1 uses one-and-one-half staff cleaning sections.

6 Cannoneers no. 2 and 3 position hands and bodies as illustrated below. On the command “RAM,” together they push the projectile as hard as possible to seat it in the cannon tube.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission

#### NOTE

Laying howitzer for direction and quadrant during indirect fire missions is the duty of gunner and assistant gunner, respectively. These operations are normally done at same time.

#### a. Laying for Direction Using M1A1 Collimator

#### WARNING



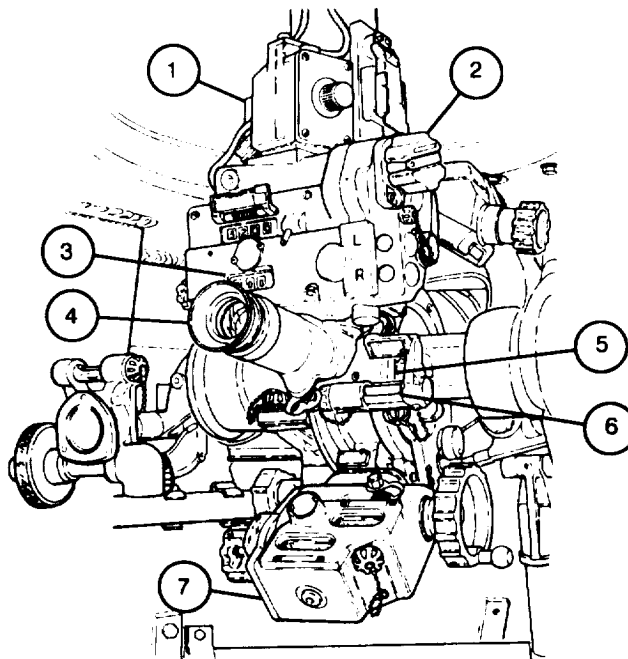
The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

- 1 Upon announcement or data display of "DEFLECTION (SO MUCH)," gunner rotates M117/M117A2 panoramic telescope (1) azimuth knob (2) until announced deflection appears in reset counter (3). Gunner then reads setting to chief of section.
- 2 Sighting through M117/M117A2 panoramic telescope (1) eyepiece (4), gunner traverses howitzer until a proper sight picture on aiming point is achieved.

#### NOTE

Each time howitzer is traversed or cannon tube is elevated or depressed, gunner must repeat steps 2 and 3 before alining M117/M117A2 panoramic telescope on any aiming reference point.

- 3 Gunner centers pitch level (5) and cross-level (6) on M145/M145A1 telescope mount (7).





2-12 PREPARATION FOR FIRING — CONTINUED

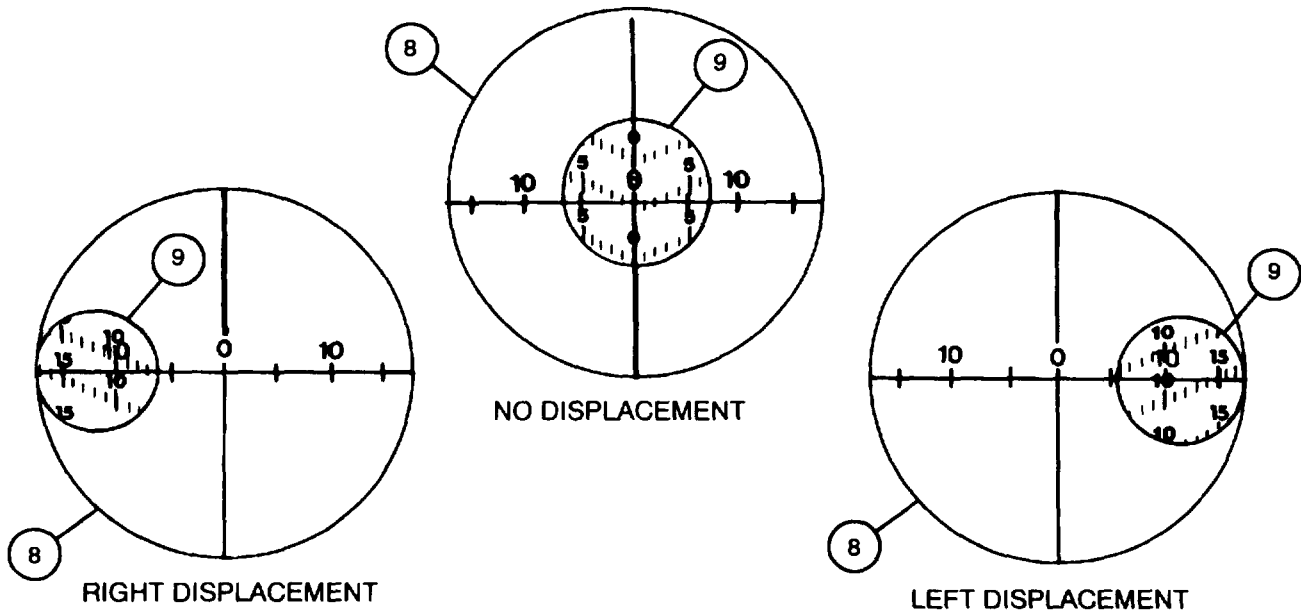
2-12.6 Laying For Direction and Quadrant During indirect Fire Mission — Continued

a. Laying for Direction Using M1A1 Collimator — Continued

NOTE

If there is no weapon displacement, gunner's sight picture should appear centered as shown.

- 4 To correct for weapon displacement, gunner must match M117/M117A2 panoramic telescope reticle (8) with M1A1 collimator reticle (9). Numbers in M1A1 collimator reticle indicate 5-mil increments. Individual mils are indicated by short lines in V format of pattern. For example, if gunner sees 10 and 15 in M1A1 collimator and reticle pattern slopes upward from right to left, weapon has experienced right displacement. To compensate for this displacement, gunner matches left portion of M117/M117A2 panoramic telescope reticle with M1A1 collimator as shown.
- 5 If gunner sees 10 and 15 in M1A1 collimator and pattern slopes upward from left to right, weapon has experienced left displacement. To compensate for this displacement, gunner matches the right portion of M117/M117A2 panoramic telescope reticle (8) with M1A1 collimator reticle (9), as shown.

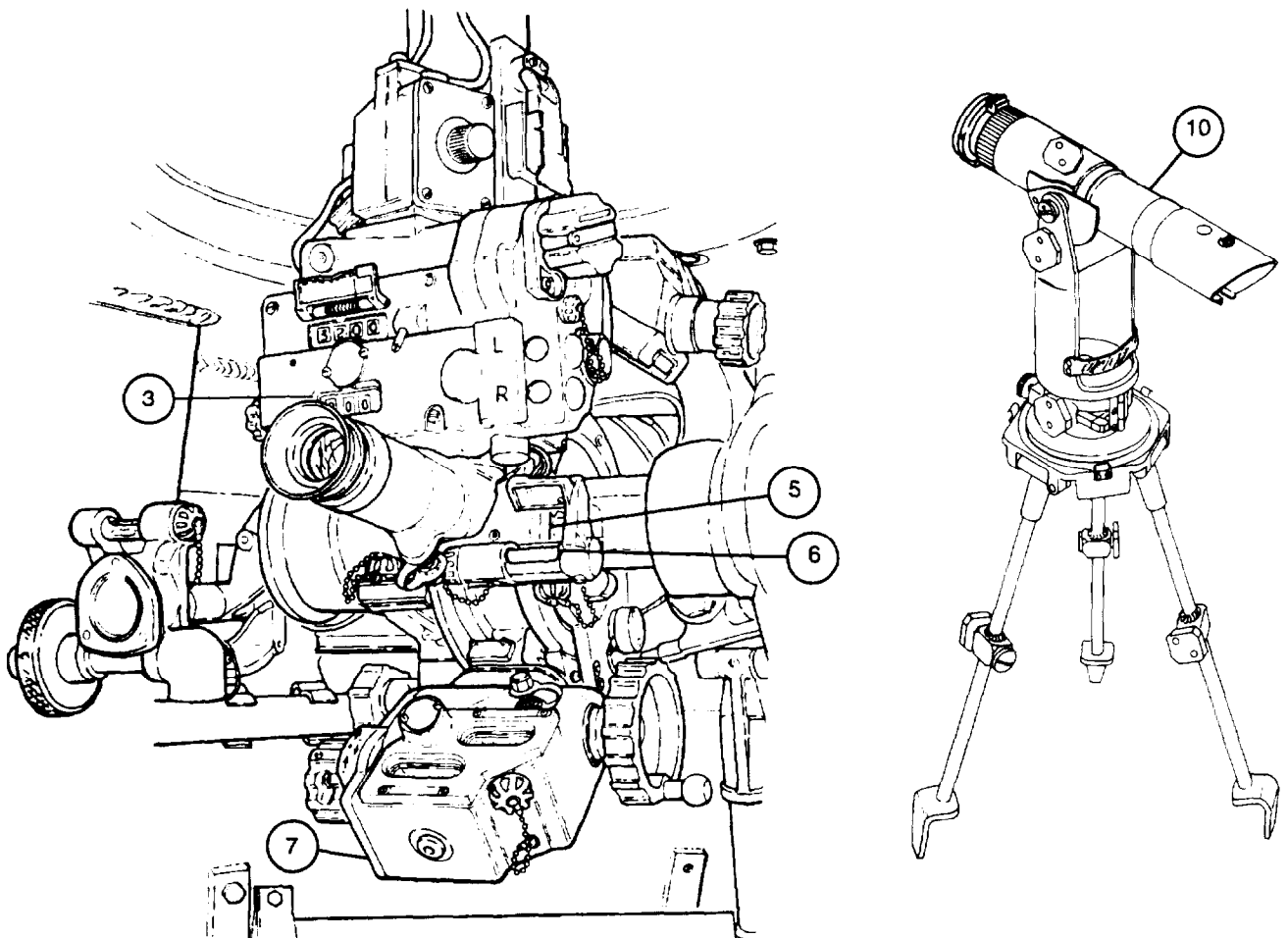


## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

#### a. Laying for Direction Using MI AI Collimator — Continued

- 6 After assistant gunner lays the cannon for quadrant and announces to "SET," gunner verifies that announced deflection appears on reset counter (3). M145/M145A1 telescope mount (7) pitch level (5) and cross-level (6) bubbles are centered, and a proper sight picture is on M1A1 collimator (10). Gunner then announces "READY."



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

#### b. Laying for Direction Using M1A2 Aiming Posts

##### NOTE

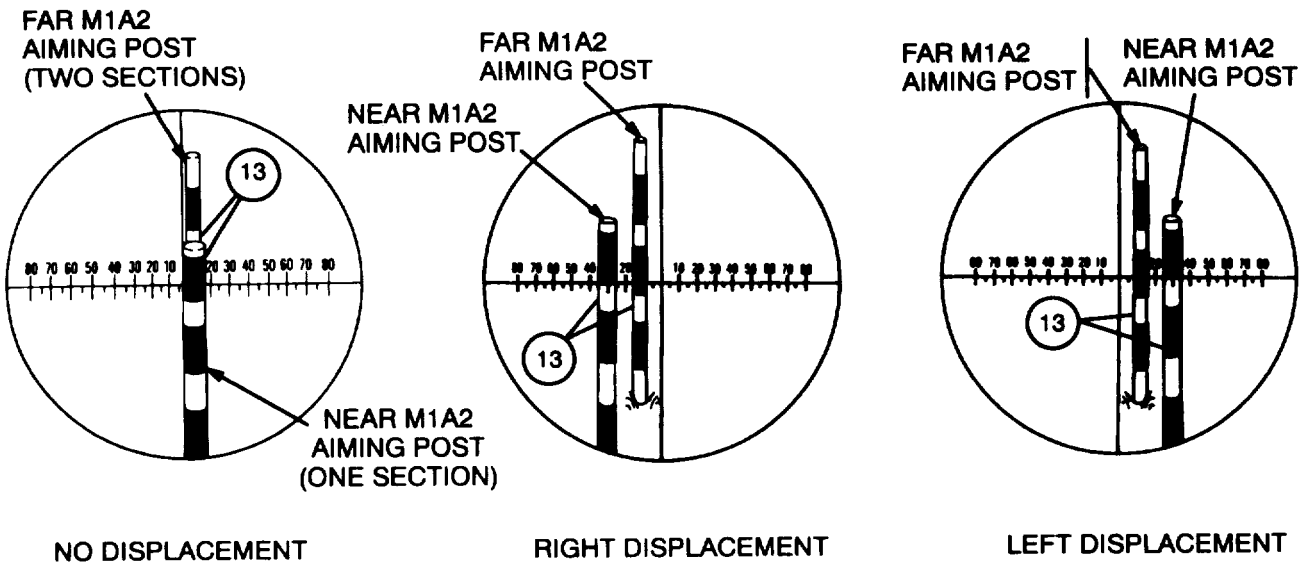
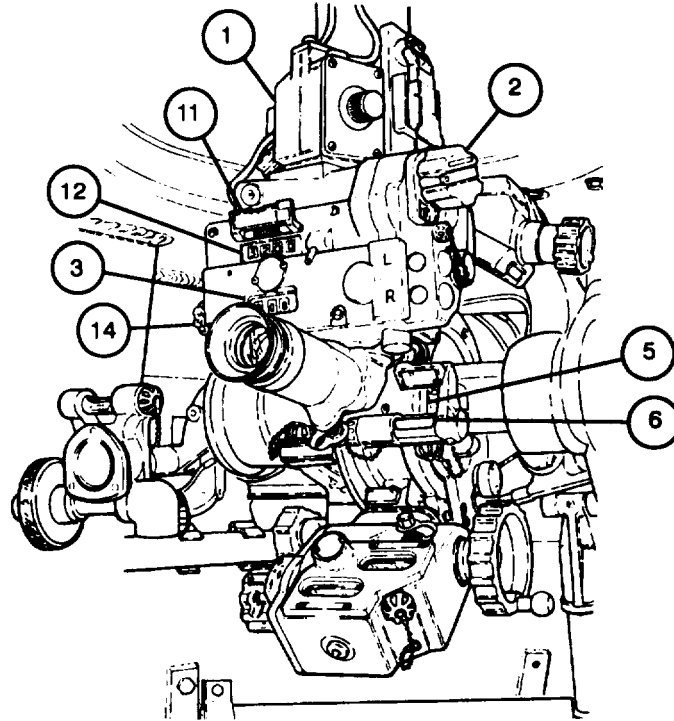
During rapid traverse operations, or if the gunner informs the section chief that the M1A1 collimator isn't working, an alternate aiming point may be used. If the M1A2 aiming posts are used as primary aiming point, omit steps 1 and 2 below.

- 1 Gunner opens access door (11) that covers M117/M117A2 panoramic telescope (1) azimuth counter (12). Gunner rotates azimuth knob (2) until azimuth, on which M1A2 aiming posts (13) were originally emplaced, appears on azimuth counter. Gunner rotates and centers panoramic telescope ballistic cover (not shown) on M117/M117A2 panoramic telescope line of sight.
- 2 Gunner rotates reset knob (14) until 3200 appears on reset counter (3). The section chief verifies the aiming post deflection on true azimuth scale before the gunner closes access door (11), covering azimuth counter (12).
- 3 Upon announcement or data display of "DEFLECTION (SO MUCH)," gunner rotates azimuth knob (2) until announced deflection appears on reset counter (3). Gunner then reads setting to chief of section.
- 4 Sighting through M117/M117A2 panoramic telescope (1), gunner operates traverse control handle until a proper sight picture on M1A2 aiming posts (13) appears. If there is no weapon displacement, gunner's sight picture on M1A2 aiming posts should appear as shown.
- 5 To correct for weapon displacement, gunner must compensate so that far M1A2 aiming post (13) appears exactly halfway between near M1A2 aiming post and M117/M117A2 panoramic telescope (1) vertical hairline. If the gunner sees near M1A2 aiming post to right of far M1A2 aiming post, weapon has experienced left displacement. To compensate, gunner traverses weapon until far M1A2 aiming post is exactly halfway between near M1A2 aiming post and M117/M117A2 panoramic telescope vertical hairlines, as shown.
- 6 If gunner sees that near M1A2 aiming post (13) is to left of far M1A2 aiming post, weapon has experienced right displacement. To compensate, gunner traverses weapon until far M1A2 aiming post is exactly halfway between near M1A2 aiming post and M117/M117A2 panoramic telescope (1) vertical hairlines as shown.
- 7 After assistant gunner lays cannon for elevation and announces "SET," gunner verifies that announced deflection appears on reset counter (3), pitch level (5) and cross-level (6) bubbles are centered, and proper sight picture is obtained on M1A2 aiming posts (13). Gunner announces "READY"

2-12 PREPARATION FOR FIRING — CONTINUED

2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

b. Laying for Direction Using M1A2 Aiming Posts — Continued



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

#### c. Switching Aiming Points

**WARNING**



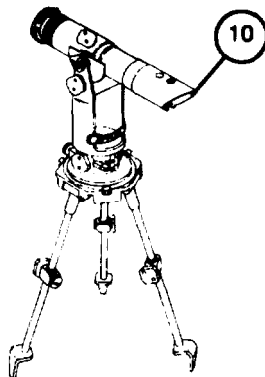
The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

In the event that a gunner needs to switch aiming points any time after he has established one (i.e. switch from the M1A1 collimator (10) to the M1A2 aiming posts (13), or switch from the M1A2 aiming posts to the DAP method), the following steps will place the gunner on his new aiming point.

**NOTE**

If in a fire mission, follow steps 1 through 6. Otherwise, follow steps 1 and 2. These steps will place the gunner on his new aiming point.

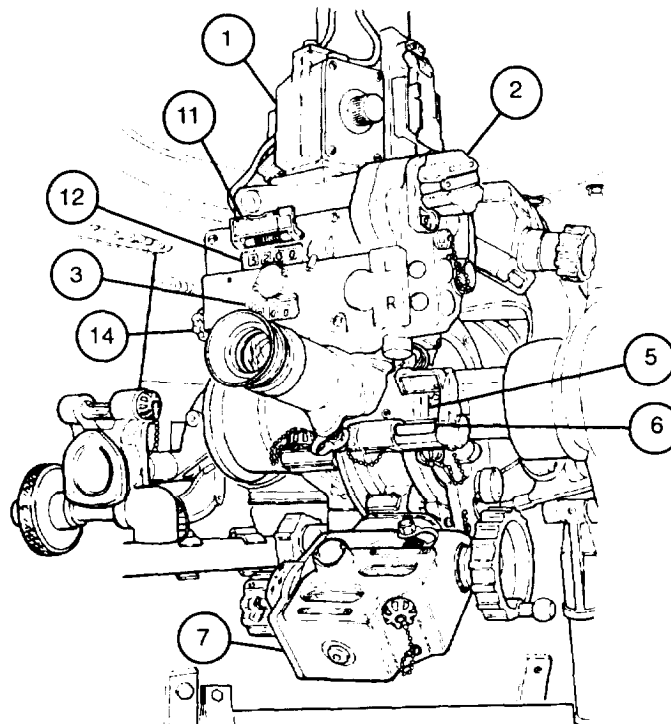
- 1 The gunner opens the access door (11) that covers M117/M117A2 panoramic telescope (1) azimuth counter (12). The gunner then turns the azimuth knob (2) until the azimuth counter shows the value from the gunner's reference card for the aiming point being used.
- 2 The gunner closes access door (11) and rotates reset knob (14) on the M117/M117A2 panoramic telescope (1) until 3200 appears on reset counter (3).
- 3 The gunner sets the deflection given in the fire mission on the azimuth counter (12) using the azimuth knob (2).
- 4 The gunner centers the pitch level (5) and cross level (6) bubbles on the M145/M145A1 telescope mount (7) and reads the setting to the chief of section.
- 5 The gunner takes up proper sight picture on the new aiming point and verifies that both pitch level (5) and cross level (6) bubbles are centered.
- 6 Fire according to the fire command.



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

#### c. Switching Aiming Points — Continued



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.6 Laying For Direction and Quadrant During Indirect Fire Mission — Continued

#### d. Laying for Elevation Using M15 Elevation Quadrant

##### NOTE

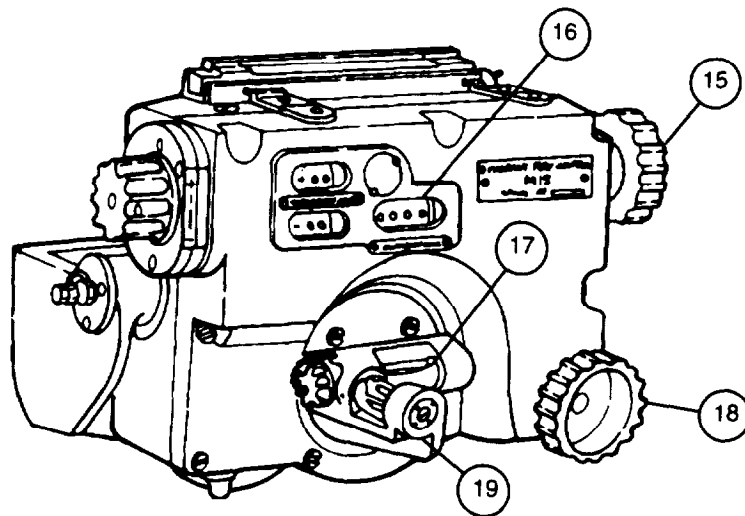
M15 elevation quadrant is shown removed for clarity.

- 1 Upon announcement or data display of "QUADRANT (SO MUCH)," assistant gunner rotates elevation knob (15) until announced quadrant appears on elevation counter (16). Assistant gunner then reads setting to chief of section.

##### NOTE

Each time cab is traversed or cannon is elevated or depressed, assistant gunner must repeat steps 2 and 3.

- 2 Assistant gunner elevates or depresses cannon until elevation level (17) bubble centers,
- 3 Assistant gunner turns cross-level knob (18) to center cross-level (19) bubble.
- 4 After gunner has traversed howitzer, assistant gunner verifies that cross-level (19) and elevation level (17) bubbles are centered, and the announced or displayed quadrant appears on elevation counter (16). Assistant gunner then announces, "SET."



## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.7 Direct Fire Procedures

#### a. General

**WARNING**

Direct fire on targets located closer than 875 yards (800 m) from the howitzer will be fired on during combat situations only. Lethal fragments can travel up to 656 yards (600 m) from point of burst causing injury to personnel.

Direct fire is used against either stationary or moving targets at close range (normally less than 2,187 yards (2,000 m)). The section will usually fire the HE projectile and highest authorized charge. Either fuze quick, delay, or time maybe used. Fuze quick is best against close-in targets.

There are three direct fire techniques:

- Two man/two sight
- Two man/one sight
- One man/one sight

The two man/two sight technique is the primary means of direct fire. One man/one sight is least effective. All three techniques will be covered in the following pages. The next steps apply to all three direct fire techniques.

- 1 All numbered cannoneers perform the same duties in direct fire as they do during indirect fire missions.

**WARNING**

Driver's hatch cover must be closed to guard against pressure from cannon blast.

- 2 Driver must be in driver's compartment with engine operating and ready to move howitzer, if necessary.

#### b. Two Man/Two Sight System

**NOTE**

When command to engage in direct fire is given, chief of section is in complete control and directs firing of this section.

- 1 Chief of section first identifies designated target. If target consists of several weapons, chief of section selects target that is the greatest threat to position.



2-12 PREPARATION FOR FIRING — CONTINUED

2-12.7 Direct Fire Procedures — Continued

b. Two Man/Two Sight System — Continued

NOTE

- . Fire at will means to keep firing until target is destroyed or another command is given.
- . Chief of section will estimate range if no accurate range data is available.
- Use lead chart mounted in commander's cupola (shown below) for initial lead. An additional lead chart is mounted on left wall of cab for gunner's reference as required.
- . Assistant gunner will use DIRECT FIRE RANGE PLATE to determine elevation based on announced range, charge, and projectile.

2 Chief of section gives fire command in the following order:

ELEMENT

- Target (identify and locate)
- Projectile, charge, and fuze
- Lead
- Range
- Method of fire

EXAMPLE

- “Target, left front”
- “Shell HE, charge 7, fuze quick
- “Lead right (left) 10”
- “Range 800”
- “Fire at will”

DIRECT FIRE MOVING TARGET LEAD			
TARGET SPEED (MPH)	TARGET DIRECTION OF TRAVEL LEAD IN MILS (m)		
	←	×	↑
5	5 m	5 m	0 m
10	10 m	5 m	0 m
15	15 m	10 m	0 m
20	20 m	15 m	0 m
25	20 m	15 m	0 m
30	30 m	20 m	0 m

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
M107 HE PROJECTILE M119A1 PC (WB)			
RANGE (METERS)	ELEV (MILS)		
400	—	4	
600	—	7	
800	—	9	
1000	—	11	
1200	—	14	
1400	—	16	
M107 HE PROJECTILE M4A2 PC (WB)			
RANGE (METERS)	ELEV (MILS)		
400	—	6	
600	—	10	
800	—	13	
1000	—	16	
1200	—	20	
1400	—	24	
PLATE DIRECT FIRE P/N 11785314			

M109A2/M109A3/M109A4  
M185 CANNON CONFIGURATION

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
M549A1 RAP		M107 HE PROJECTILE	
ROCKET OFF		M119A1 PC WB	
M203 SERIES PC RB		M119A2 PC RB	
RANGE METERS	ELEV MILS	RANGE METERS	ELEV MILS
400	3	400	4
600	5	600	7
800	6	800	9
1000	8	1000	11
1200	9	1200	14
1400	11	1400	16
L15 HE PROJECTILE M107 HE PROJECTILE		M203 SERIES PC RE M4A2 PC WB	
RANGE METERS	ELEV MILS	RANGE METERS	ELEV MILS
400		400	6
600		600	10
800		800	13
1000		1000	16
1200		1200	20
1400		1400	23
PLATE DIRECT FIRE P/N 12910859			

M109A5  
M284 CANNON CONFIGURATION

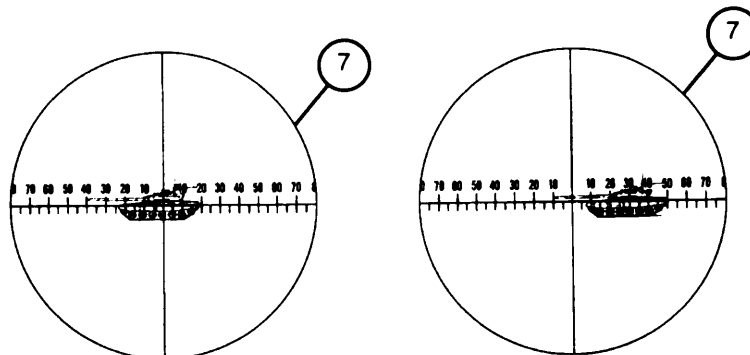
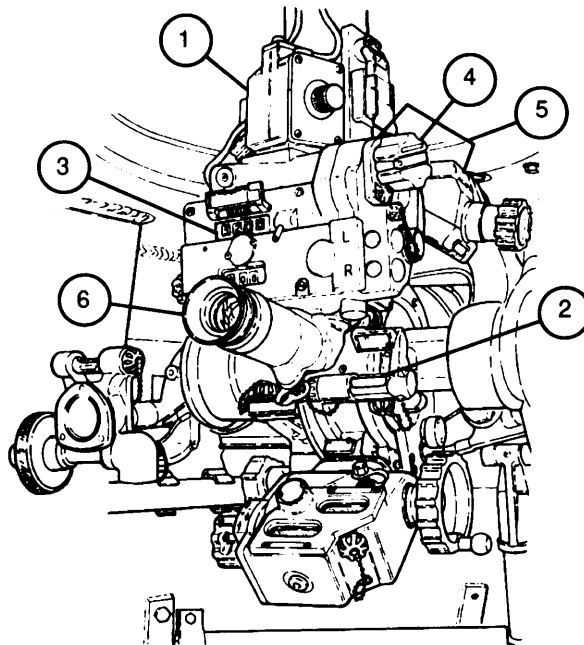
**2-12 PREPARATION FOR FIRING — CONTINUED**

**2-12.7 Direct Fire Procedures — Continued**

**b. Two Man/Two Sight System — Continued**

3 Gunner centers M117/M117A2 panoramic telescope (1) cross-level (2) bubble, sets azimuth counter (3) to 3200, and turns direct fire bar knob (4) of azimuth knob (5) to direct position to engage 5.0 mils per click sight mechanism.

4 If central laying is used, gunner places announced lead on azimuth counter (3), sights through eyepiece (6) and traverses cannon tube until vertical hairline of M117/M117A2 panoramic telescope reticle (7) centers on the target. If reticle method is used, gunner places vertical hairline left or right of target, the number of mils lead announced by chief of section.



**CENTRAL LAYING**

**RETICLE METHOD**

## 2-12 PREPARATION FOR FIRING — CONTINUED

### 2-12.7 Direct Fire Procedures — Continued

#### b. Two Man/Two Sight System — Continued

**CAUTION**

In order to prevent damage to M118A2/M118A3 elbow telescope, stow against upper stop when not in use. Do not use as a handhold under any circumstances.

- 5 The assistant gunner checks the level vial (8) level assembly mirror (9) on the M118A2/M118A3 elbow telescope (10) to check position of level vial bubble and adjusts for cant with wormshaft assembly knob (11) to center bubble in level vial.
- 6 For M118A2/M118A3 elbow telescope (10), the assistant gunner checks the DIRECT FIRE RANGE PLATE (12) mounted on the breech operating cam, sights through the M118A2/M118A3 elbow telescope, and elevates or depresses the cannon tube until the appropriate mil scale line (actual or interpolated) passes through the center of mass of the target (13).
- 7 Assistant gunner announces “SET” when correct picture has been established and continues to announce “SET” as long as correct picture is laid on target (13).
- 8 Gunner tracks target by traversing cannon tube and commands “FIRE” after assistant gunner calls “SET.” Gunner and assistant gunner continue to track and fire on target until it is destroyed, or a subsequent fire command is given by chief of section.
- 9 Chief of section gives subsequent fire commands based on observed effects, and changes range, lead, or both as necessary.

ELEMENT

EXAMPLE

Change in lead  
Change in range

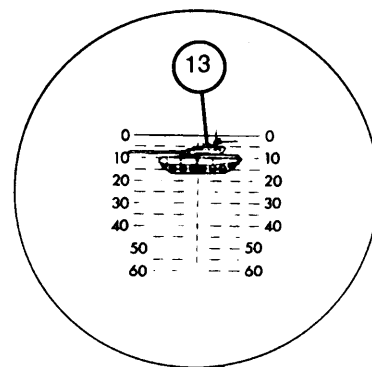
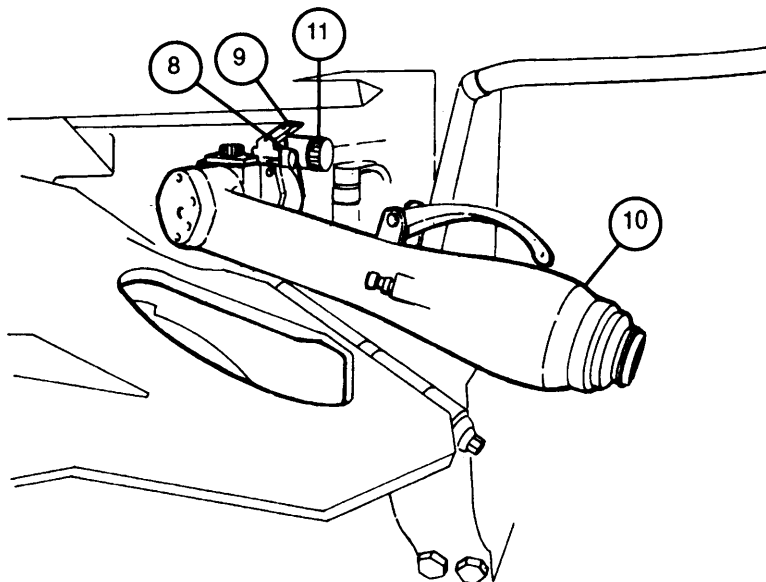
“RIGHT (or LEFT) 5”  
“ADD (or DROP) 100”

Gunner turns azimuth knob (5) in 5 mil (1 click) increments to set lead changes. Assistant gunner elevates or depresses cannon tube until appropriate range line is centered on target (13) center of mass.

2-12 PREPARATION FOR FIRING — CONTINUED

2-12.7 Direct Fire Procedures — Continued

b. Two Man/Two Sight System — Continued



M118A2/M118A3  
ELBOW TELESCOPE  
APERTURE

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
		M107 HE PROJECTILE	
		M119A1 PC (WB)	
	RANGE (METERS)	ELEV (MILS)	
	400	4	
	600	7	
	800	9	
	1000	11	
	1200	14	
	1400	16	
		M107 HE PROJECTILE	
		M4A2 PC (WB)	
	RANGE (METERS)	ELEV (MILS)	
	400	6	
	600	10	
	800	13	
	1000	16	
	1200	20	
	1400	24	
PLATE DIRECT FIRE P/N 11785314			

M109A2/M109A3/M109A4  
M185 CANNON CONFIGURATION

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
M549A1 RAP		M107 HE PROJECTILE	
ROCKET OFF		M119A1 PC WB	
M203 SERIES PC RB		M119A2 PC RB	
	RANGE METERS	ELEV MILS	
	400	3	4
	600	5	7
	800	6	9
	1000	8	11
	1200	9	14
	1400	11	16
		L15 HE PROJECTILE M107 HE PROJECTILE	
		M203 SERIES PC RE M4A2 PC WB	
	RANGE METERS	ELEV MILS	
	400		6
	600		10
	800		13
	1000		16
	1200		20
	1400		23
PLATE DIRECT FIRE P/N 12910859			

M109A5  
M284 CANNON CONFIGURATION

2-12 PREPARATION FOR FIRING — CONTINUED

2-12.7 Direct Fire Procedures — Continued

c. Two Man/One Sight System



The primary means of direct fire will be the two man/two sight method, The two man/one sight or one man/one sight system should only be used when the target and the howitzer are at the same elevation with no mask (site to crest) obstacles in between. Firing at targets above or below the howitzer position requires adjustments to the quadrants listed on the range chart. Adjustments must be computed by the Fire Direction Center (FDC) in accordance with FM 6-40.

- 1 Duties of chief of section are the same as for two man/two sight system, except that when giving fire command, chief of section announces quadrant instead of range. The DIRECT FIRE RANGE PLATE (12) located on the operating cam has all the information on direct fire.
- 2 The duties of gunner are same as for two man/two sight system.

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
		M107 HE PROJECTILE	
		M119A1 PC (WB)	
	RANGE (METERS)	ELEV (MILS)	
	400	— 4	
	600	— 7	
	800	— 9	
	1000	— 11	
	1200	— 14	
	1400	— 16	
		M107 HE PROJECTILE	
		M4A2 PC (WB)	
	RANGE (METERS)	ELEV (MILS)	
	400	— 6	
	600	— 10	
	800	— 13	
	1000	— 16	
	1200	— 20	
	1400	— 24	
PLATE DIRECT FIRE P/N 11785314			

M109A2/M109A3/M109A4  
M185 CANNON CONFIGURATION

DIRECT FIRE RANGE PLATE 155MM HOWITZER			
M549A1 RAP		M107 HE PROJECTILE	
ROCKET OFF		M119A1 PC WB	
M203 SERIES PC RB		M119A2 PC RB	
	RANGE METERS	ELEV MILS	
	400	3	400 4
	600	5	600 7
	800	6	800 9
	1000	8	1000 11
	1200	9	1200 14
	1400	11	1400 16
L15 HE PROJECTILE		M107 HE PROJECTILE	
M203 SERIES PC RE		M4A2 PC WB	
	RANGE METERS	ELEV MILS	
	400		6
	600		10
	800		13
	1000		16
	1200		20
	1400		23
PLATE DIRECT FIRE P/N 12910859			

M109A5  
M284 CANNON CONFIGURATION

## 2-12 PREPARATION FOR FIRING — CONTINUED

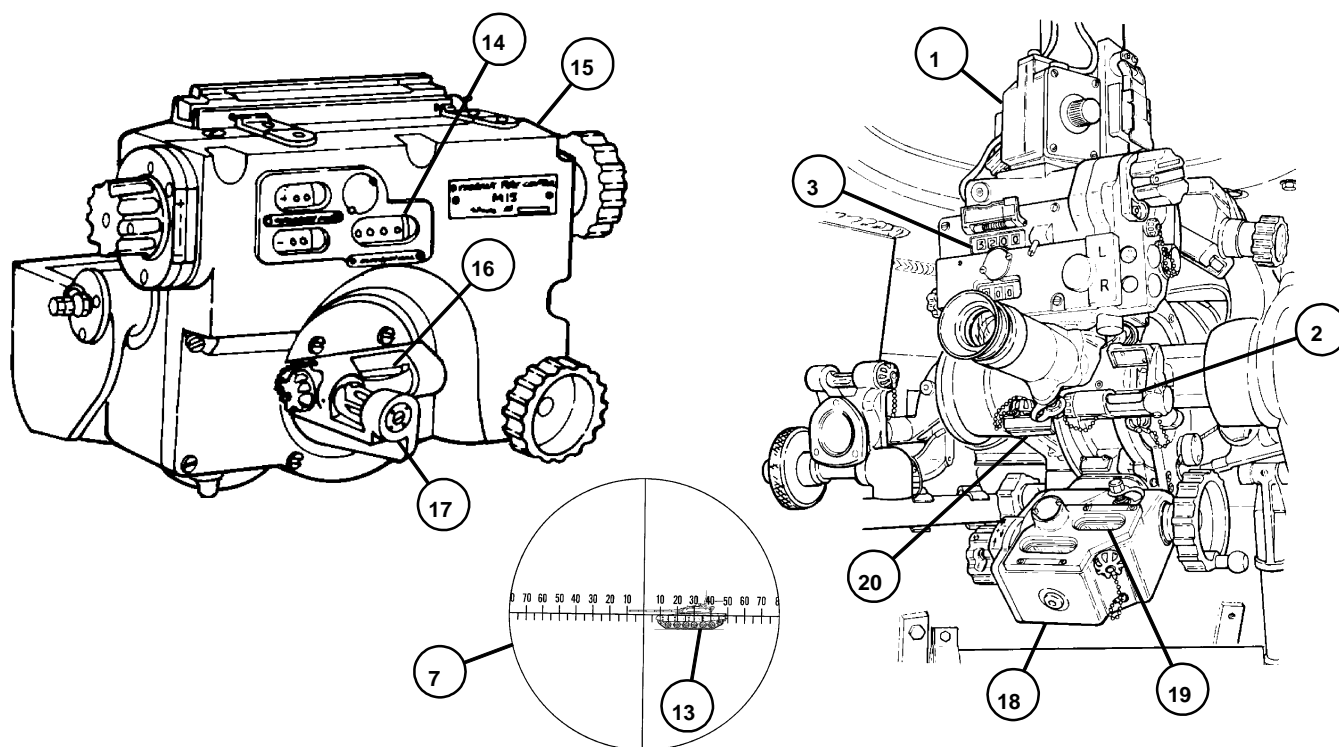
### 2-12.7 Direct Fire Procedures — Continued

#### c. Two Man/One Sight System — Continued

- 3 Assistant gunner sets announced quadrant on elevation counter (14) of M15 elevation quadrant (15). Assistant gunner then elevates or depresses cannon tube until elevation level (16) bubble is centered and centers cross-level (17) bubble. When bubbles are centered, assistant gunner announces "SET." Assistant gunner continues to elevate or depress cannon tube, keeping bubbles centered, until a change in fire commands is announced.

#### d. One Man/One Sight System

- 1 Duties of chief of section are same as for two man/one sight system, except that when giving fire command, chief of section announces quadrant instead of range.
- 2 Gunner lays for both deflection and elevation using M145/M145A1 telescope mount (18) and M117/M117A2 panoramic telescope (1). Gunner sets announced quadrant on elevation counter (19) and elevates or depresses cannon tube until elevation level (20) bubble is centered. Gunner then centers cross-level (2) bubble. With 3200 set on azimuth counter (3), gunner traverses cannon tube until crosshair of M117/M117A2 panoramic telescope reticle (7) pattern is on target (13) center of mass, or correct lead is established. When gunner establishes correct sight picture, he commands "FIRE." After firing, gunner continues to lay on target until it is destroyed or a subsequent fire command is issued.



<b>WARNING</b>
----------------

High intensity hearing protection required. Failure to wear hearing protection could result in hearing impairment. It is imperative that the following table be followed to ensure personnel do not accumulate more than 1000 points in a 24 hour period.

**NOTE**

- If hatches are closed, use blast overpressure and lead parameter and if hatches are open, use only blast overpressure parameter.
- Do not combine the total points of the two parameters. Each parameter has its own 1000 point limit.

BLAST OVERPRESSURE/LEAD HAZARD POINT RATING SYSTEM IF THE DRIVER IS NOT IN THE DRIVERS COMPARTMENT (1000 POINT LIMIT)									
PARAMETER	CONDITION	PROPELLING CHARGES							
		M3/M4	M119	M203	M231 Chg1	M231 Chg2	M232 Chg3	M232 Chg4	M232 Chg5
LEAD	HATCH CLOSED	2.3	12	22.2	NA	NA	NA	NA	NA
SINGLE HEARING PROTECTION	REAR & SIDE OPEN	6	37	P	1	1	71	P	P
	REAR ONLY OPEN	6	37	P	1	1	71	83	P
	HATCHES CLOSED	6	37	6	1	1	1	8	8

P=Prohibited

Note: Since the blast overpressure exceeds 1000 when firing the family of M203 and M232 charges with the hatches open, firing the M203 and M232 charges with the hatches open is prohibited.

**Example: To figure 1000 point limit of lead parameter**

25 M3/M4 Charges 25 x 2.3 = 58 points  
 25 M119 Charges 25 x 12 = 300 points  
 25 M203 Charges 25 x 22.2 = 555 points  
 913 points

**Example: To figure 1000 point limit of blast overpressure parameter**

25 M3/M4 Charges 25 x 6 = 150 points  
 22 M119 Charges 22 x 37 = 814 points  
 964 points

## 2-13 FIRING THE CANNON — CONTINUED

### Procedure — Continued

**WARNING**

To prevent injury during firing, use at least a 3 foot (0.91 m) lanyard.

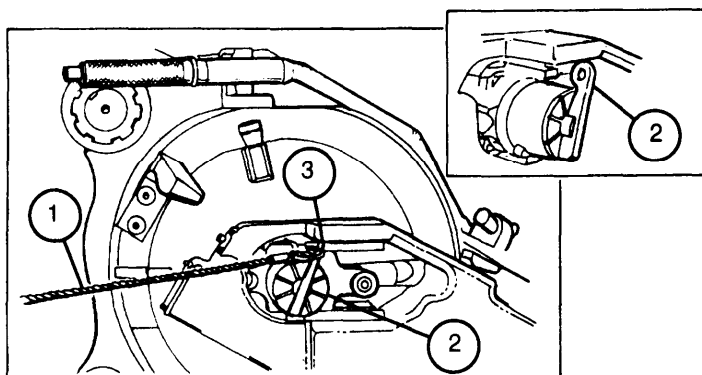
**NOTE**

- The howitzer is fired only upon verbal and/or hand signal from the chief of section.
  - The cannon assembly can be fired from either side. The firing mechanism assembly manual control lever can be rotated to any one of eight positions on the firing mechanism assembly. Push on eyelet end of manual control lever and rotate. The illustration shows manual control lever in correct position for firing from left side.
  - Cannon tube position (specifically elevation) should be rechecked prior to firing.
- 1 Chief of section verifies all personnel are in place and commands, "HOOK-UP," then "STAND-BY." After stand-by command, cannoneer no. 1 attaches 3 foot (0.91 m) or longer lanyard (1) to eyelet of firing mechanism assembly (2) manual control lever (3). Chief of section reports, "NUMBER (SO AND SO) READY" or presses ready button on gunner display unit. Chief of section then commands, "FIRE" by dropping arm or commands, "FIRE."
  - 2 At the command "FIRE," cannoneer no. 1 fires howitzer with a continuous pull on lanyard (1).

**WARNING**

Assure that water remaining in cannon tube after swabbing is kept to a minimum.

- 3 After cannon returns to battery position, cannoneer no. 1 swabs and inspects gas check seat, propellant chamber, and outside of spindle assembly. After looking through cannon tube and finding no obstructions, cannoneer no. 1 announces "BORE CLEAR."
- 4 If howitzer fails to fire, refer to paragraph 2-15.





## 2-13 FIRING THE CANNON — CONTINUED

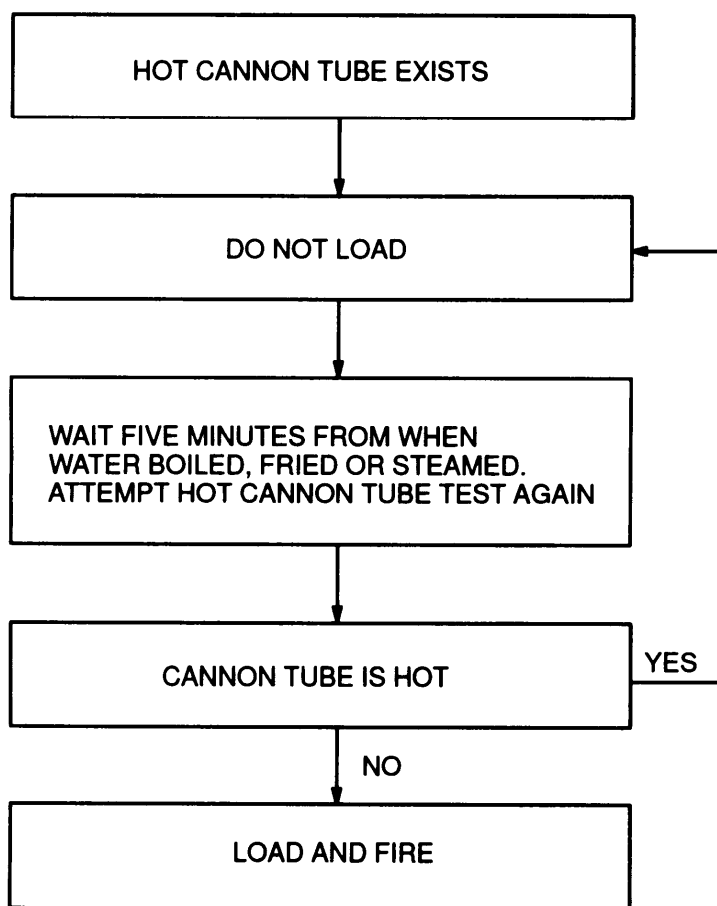
### Procedure — Continued

#### NOTE

In combat emergency, the commander will determine if hot cannon tube procedures will be followed.

- 5 Any cannon tube that has or has not exceeded the prescribed rate of fire, but does cause water from a wet swab to boil, fry, or steam off when placed just forward of gas check seat is a hot cannon tube. Follow procedures below.

#### HOT CANNON TUBE PROCEDURES DURING NORMAL FIRING OPERATIONS



## 2-14 UNLOADING THE 155MM CANNON

### Procedure

#### WARNING

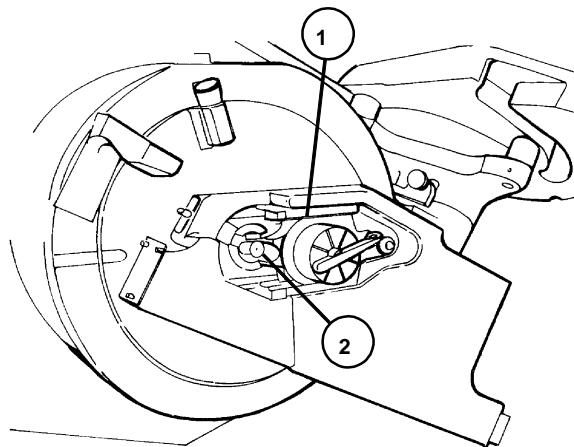
- Before attempting to unload cannon, see misfire/checkfire procedures (para 1-15) to prevent injury to personnel.
- Never stand directly behind the cannon when loading or unloading. Injury to personnel may result.

#### CAUTION

To avoid damaging M712 projectile, do not use unloading artillery rammer to unload M712 projectile. For unloading or extracting an M712 projectile, refer to paragraph NO TAG.

#### NOTE

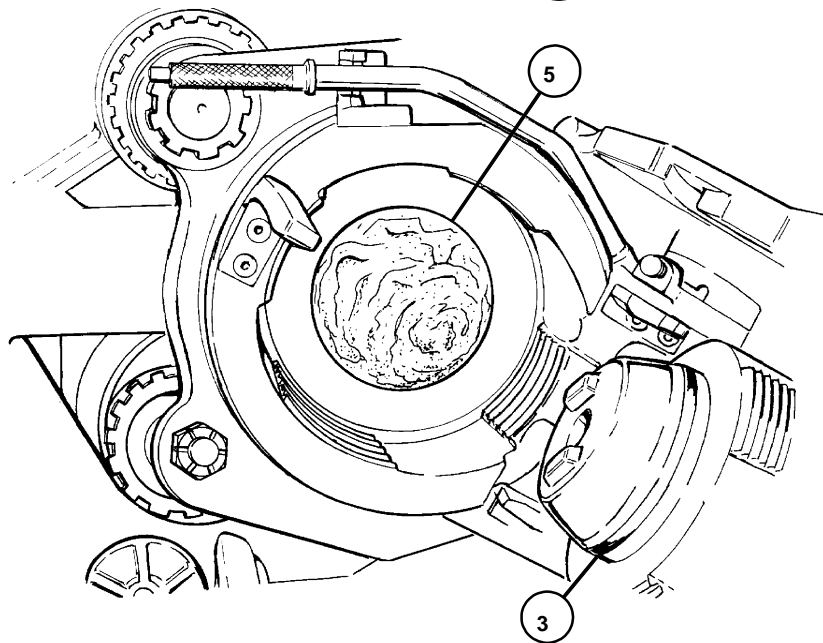
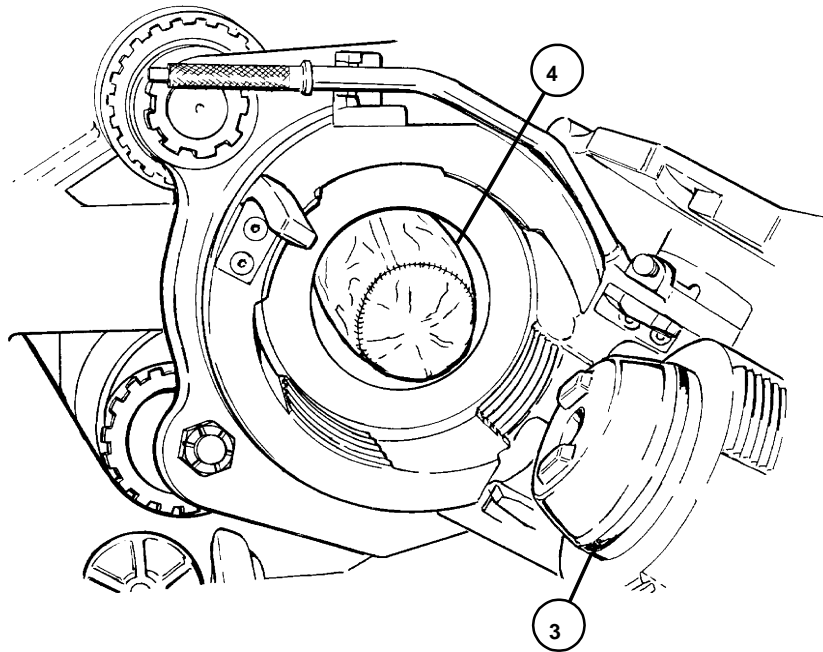
- A complete round, once loaded, should always be fired, in preference to being unloaded.
  - Unloading is supervised by an officer.
  - The command "UNLOAD" is given by an officer. An officer inspects unloading artillery rammer to ensure it is free from obstruction.
  - The following unloading procedures do not apply to the MACS propelling charge.
- 1 Cannoneer no. 1 slides firing group block (1) to right and removes primer (2).
  - 2 Assistant gunner depresses cannon to zero elevation.



## 2-14 UNLOADING THE 155MM CANNON — CONTINUED

### Procedure — Continued

- 3 Cannoneer no. 1 opens breechblock (3), removes propellant (4), and hands it to HD.
- 4 Cannoneer no. 1 places rags or other waste material in propellant chamber (5) and closes breechblock (3).



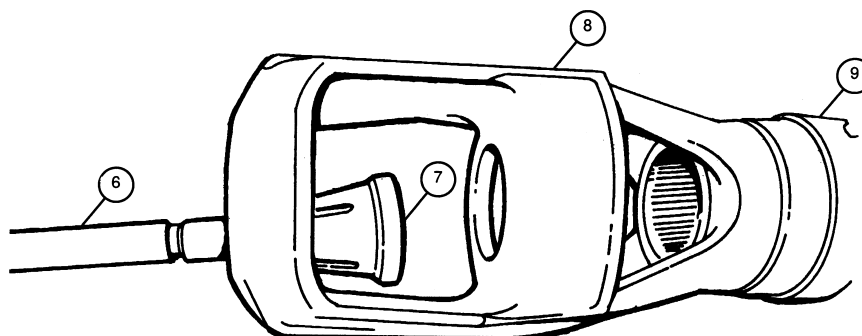
## 2-14 UNLOADING THE 155MM CANNON — CONTINUED

### Procedure — Continued

**WARNING**

Ensure that unloading artillery rammer is used to prevent injury to personnel.

- 5 Cannoneers no. 2 and 3, assemble seven cleaning staff sections (6) with unloading artillery rammer (7). They then insert unloading artillery rammer into muzzle brake (8) end of cannon tube (9), and push carefully until unloading artillery rammer head encircles fuze and is seated against projectile. Steadily increasing pressure is applied by tapping cleaning staff section with a wooden block until projectile is loose.
- 6 When projectile is loosened, cannoneers no. 2 and 3 suspend operation of rammer, while chief of section has breech opened by assistant gunner, and waste removed by cannoneer no. 1, who then places rammer tray (not shown) in position to receive projectile.
- 7 Cannoneers no. 2 and 3 steadily push projectile out of breech and onto rammer tray.
- 8 Projectile is then disposed of as directed.



#### 2-14.1 Unloading Procedures for MACS Propelling Charge Only

- 1 Slide firing mechanism block assembly left to eject primer, then slide firing mechanism block assembly right to firing position.
- 2 Open breech clock assembly.

**NOTE**

MACS increments must be removed one at a time.

- 3 Lift increment out of the swiss notch by using the thin black charge separator as a tool. Slide the separator along the side of the increment then under to lift it up and out of the swiss notch.
- 4 If MACS charge two or higher was loaded into the weapon then elevate the cannon as needed to get the increments to slide back into the swiss notch. Repeat step 3 above for each increment.
- 5 Follow instruction in previous section for unloading the projectile after MACS has been removed.

## 2-15 MISFIRE PROCEDURES

### 2-15.1 General

#### a. Precautions

Conditions described in this section are rarely encountered when authorized and properly maintained ammunition is fired in a properly maintained and operated weapon. However, to avoid injury to personnel and damage to equipment, it is important that all concerned understand the following.

- 1 What is involved when this weapon fails to fire.
- 2 What should be done when a failure to fire occurs.

**WARNING**

- Do not use charge 1 with howitzer to avoid injury to personnel.
- When the authorized rates of fire for the howitzer are exceeded, propelling charge cook-offs may occur within 1 minute after chambering causing injury to personnel.

**CAUTION**

When firing any combination of charge 8 and lower charges within the same sustained fire mission, charge 8 rates of fire apply to prevent premature equipment failure.

#### 3 Authorized Rates of Fire.

Maximum rate: 4 rds/min for three minutes

Sustained rate: Charge 2-7 - 1 rd/min  
Charge 8 - 1 rd/min for 60 minutes;  
1 rd/3 min thereafter

## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.1 General — Continued

#### b. Definitions

- 1 Checkfire. A checkfire is a command normally given by the executive officer, but in an emergency, may be given by anyone present who observes an unsafe act.
- 2 Cold cannon tube. Any cannon tube that has or has not exceeded rates of fire, and that does not cause water from a wet swab to boil, fry, or steam off when placed just forward of gas check seat.
- 3 Hot cannon tube. Any cannon tube that causes water from a wet swab to boil, fry, or steam off when placed just forward of gas check seat.
- 4 Cook-off. A cook-off is the functioning of the propelling charge when initiated by the heat of weapon.
- 5 Hangfire. A hangfire is a delay in the functioning of the primer, igniter, or propelling charge. This delay, though unpredictable, ranges from a fraction of a second to 10 minutes.
- 6 Misfire. A misfire exists when the weapon does not fire after an attempt to fire has been made. This failure may be due to failure of primer, igniter, propelling charge, or firing mechanism assembly to function wholly or in part. A misfire in itself is not dangerous. However, it cannot be immediately distinguished from a hangfire.

**WARNING**

Removal of the primer in a sticker situation is dangerous as it will be shooting rearward when released. The expelled primer may cause injury to personnel standing in its path of ricochet.

- 7 Sticker. A sticker is a projectile that is lodged in cannon tube after normal functioning of ignition train. Stickers may occur when firing at charge 2. When stickers occur, gases under high pressure are retained in chamber.

## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.1 General — Continued

#### c. Hot Cannon Tube Misfire/Checkfire Procedure – Charges 3 through 8

##### NOTE

If you get a failure-to-fire, follow YES/NO procedure below to clear weapon.

**WARNING**

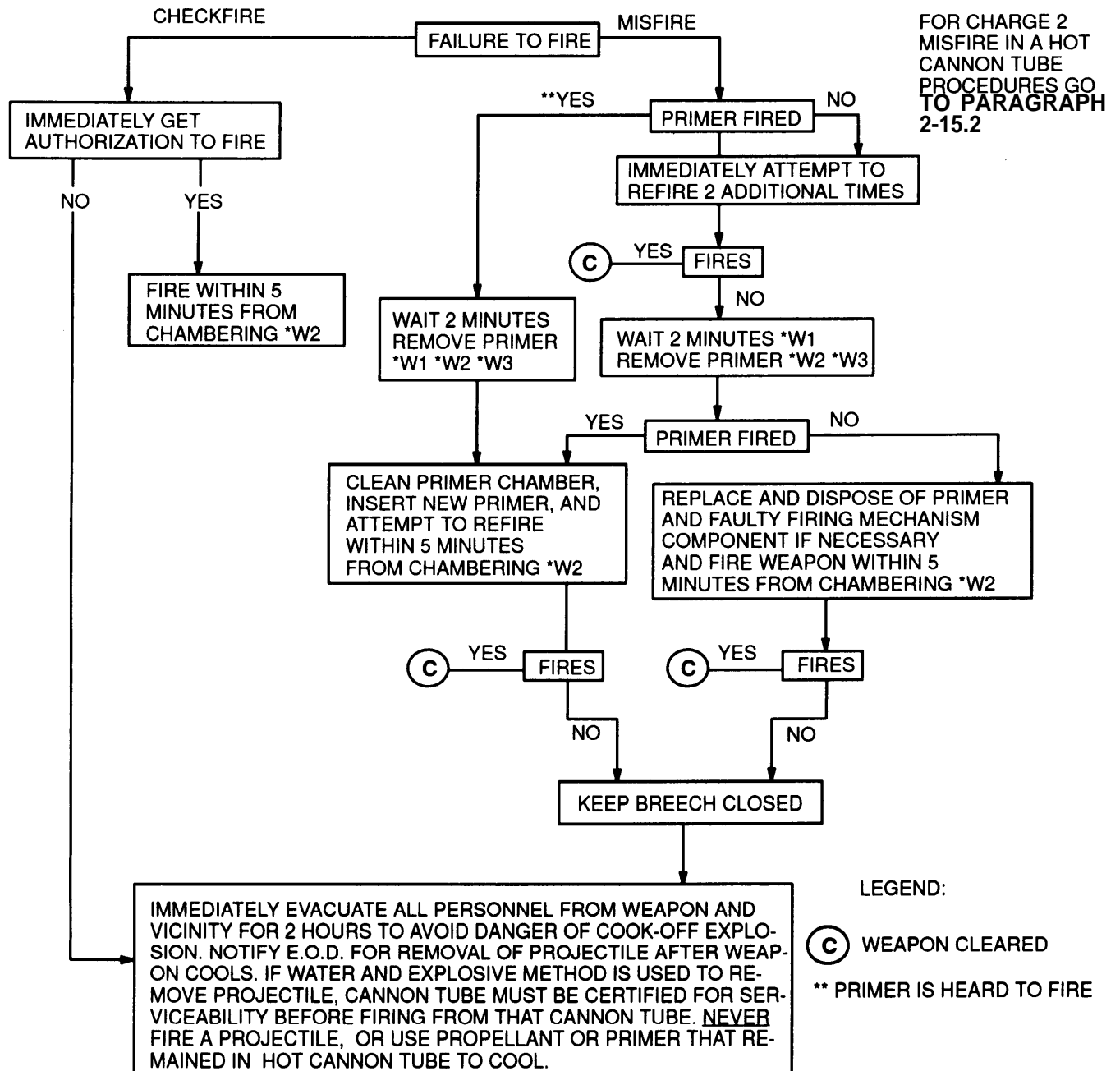
W1, W2, and W3 identify applicable warnings on flowchart. To prevent injury to personnel:

- W1      Keep weapon trained on target. Evacuate all personnel except CS and  
              cannoneer no. 1.
  
- W2      Stay clear of recoiling parts and don't put hand behind primer chamber.
  
- W3      The primer can be expelled rearward should there be a sticker.  
              If a sticker is suspected, follow charge 2 misfire in a hot cannon tube  
              procedures (para 2-15.2).

2-15 MISFIRE PROCEDURES — CONTINUED

2-15.1 General — Continued

c. Hot Cannon Tube Misfire/Checkfire Procedure – Charges 3 through 8 — Continued





## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.1 General — Continued

#### d. Cold Cannon Misfire/Checkfire Procedures - Charges 3 through 8

<b>WARNING</b>
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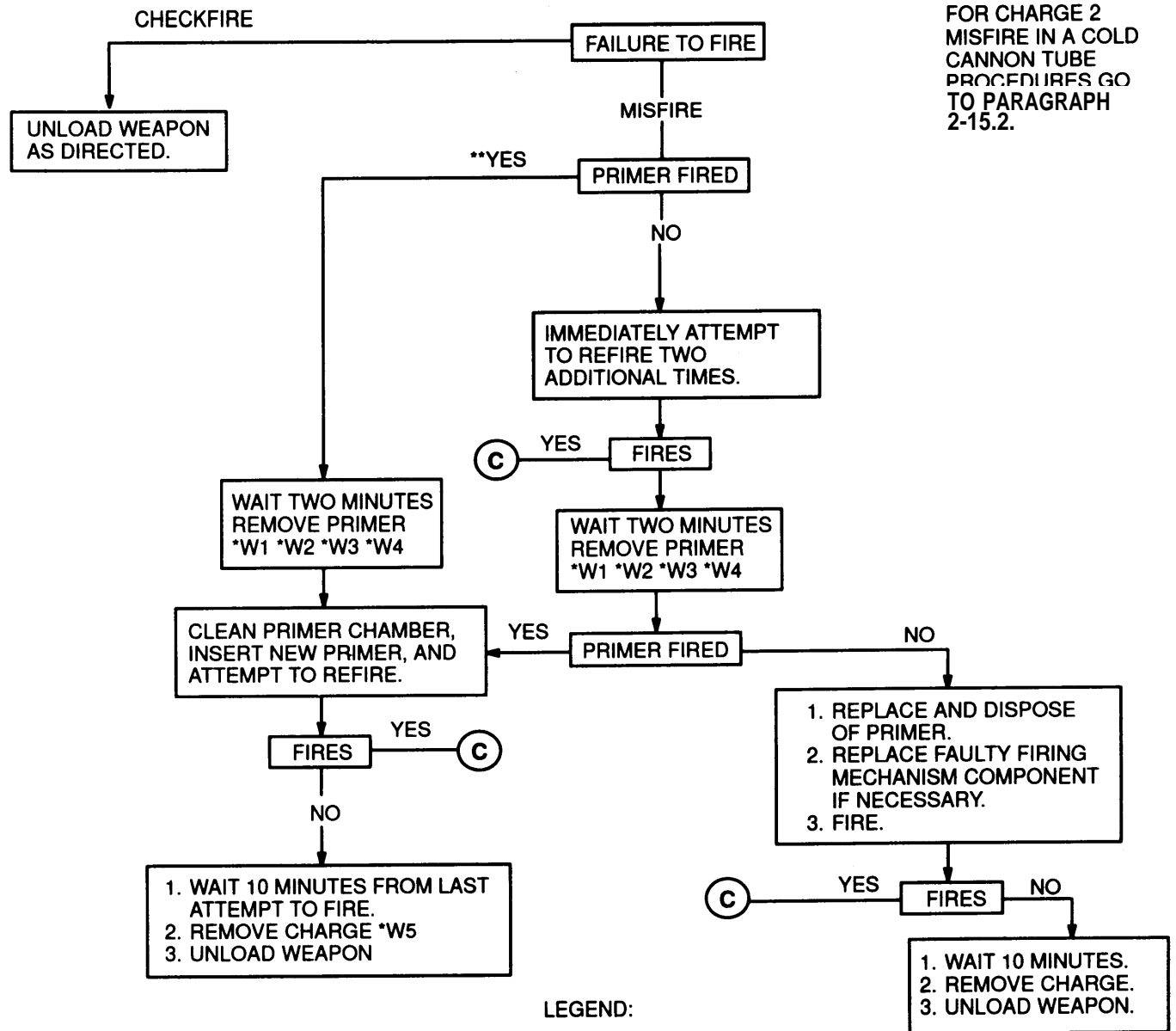
W1, W2, and W3 identify applicable warnings on flow chart. To prevent injury to personnel:

- W1      Weapon will be kept trained on target.
- W2      Personnel clear of muzzle and recoil path.
- W3      Stay clear of recoiling parts. Don't put hand behind primer chamber.
- W4      The primer can be expelled rearward should there be a sticker. If a sticker is suspected, follow charge 2 misfire in a cold cannon tube procedures (para 2-15.2).
- W5      When opening the breech to remove the powder charge and if smoke/sparks are coming from the chamber area, do not attempt to remove the charge or close the breech. Immediately evacuate the vehicle through the gunner's escape hatch, commander's cupola, or cab side doors, but not the hull rear door. Notify EOD.

2-15 MISFIRE PROCEDURES — CONTINUED

2-15.1 General — Continued

d. Cold Cannon Misfire/Checkfire Procedures - Charges 3 through 8 — Continued



FOR CHARGE 2 MISFIRE IN A COLD CANNON TUBE PROCEDURES GO TO PARAGRAPH 2-15.2.

LEGEND:

(C) WEAPON CLEARED

\*\* PRIMER IS HEARD TO FIRE

## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.2 Preventive and Corrective Measures When Howitzer Fails to Fire

#### a. Charge 2 Misfire in a Cold Cannon Tube

- 1 If a weapon fails to fire after one attempt to fire, immediately attempt to refire two more times.

**WARNING**

- Primer removal may expose cannoneer to the danger of a recoiling weapon if a hangfire condition exists.
- Stickers may infrequently occur when firing charge 2. When stickers occur, projectile lodges in cannon tube and hot gases under pressure are trapped in primer chamber. Removal of primer is dangerous as it will be expelled rearward when released. Expelled primer may cause injury to personnel standing in its path of ricochet.
- Stand clear of recoiling parts, exposing only hand and arm, when removing primer, before the end of safe wait period.
- Do not grasp lock pin, so that your hand is exposed to being hit by expelled primer.

- 2 If weapon still fails to fire:
  - (a) Wait 10 minutes.
  - (b) Open hull door.
  - (c) Position cannon tube so that primer can be expelled through hull rear door, should there be a sticker.
- 3 Stand to right side of breech. Grab follower assembly knob and pull outward until it is free to be opened. Keeping follower assembly knob out, firmly slide block assembly toward the open position until primer pops and gases are vented,
- 4 If a sticker occurs, refire at charge 4 or above with proper authority. If sticker cannot be fired at higher charge, notify EOD.

#### NOTE

No significant range loss is expected when firing sticker.

- 5 If a sticker is not involved, replace faulty component, and refire or clear weapon.

## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.2 Preventive and Corrective Measures When Howitzer Fails to Fire — Continued

#### b. Charge 2 Misfire in a Hot Cannon Tube

- 1 If weapon fails to fire after one attempt, immediately attempt to refire two more times.

**WARNING**

- Primer removal may expose cannoneer to danger of a recoiling weapon if a hangfire exists.
  - If a commander, in order to avoid prolonged loss of weapon, determines to fire projectile, it must be fired within 5 minutes of projectile cambering.
  - Stickers may infrequently occur when firing charge 2. When stickers occur, projectile lodges in cannon tube and hot gases under pressure are trapped in primer chamber. Removal of primer is dangerous, as it will be expelled rearward when released. Expelled primer may cause injury to personnel standing in path of ricochet.
  - Stand clear of recoiling parts, exposing only hand and arm when removing primer before end of safe wait period.
  - Do not grasp the lock pin, so that hand is exposed to being hit by expelled primer.
- 2 If weapon fails to fire, wait 2 minutes after last firing attempt.
  - 3 Evacuate extra personnel to a safe distance, open hull rear door, and position cannon tube so primer can be expelled through open hull rear door, should there be a sticker.
  - 4 Stand to right side of breech, Grab follower assembly knob and pull outward, until it is free to be opened. Keeping follower assembly knob out, firmly slide block assembly toward the open position until primer pops and gases are vented or primer is ejected normally.

**WARNING**

If sticker occurs, personnel should evacuate vehicle through cab side doors, gunner's escape hatch, or commander's cupola and notify EOD. Exiting through rear doors could cause injury.

- 5 Inspect primer if no pop-out occurs.

**WARNING**

If primer has fired, a hangfire condition continues so failure to observe hangfire procedures could cause injury to personnel and damage to equipment.

- 6 Immediately insert a new primer and refire.

## 2-15 MISFIRE PROCEDURES — CONTINUED

### 2-15.2 Preventive and Corrective Measures When Howitzer Fails to Fire — Continued

#### b. Charge 2 Misfire in a Hot Cannon Tube — Continued

**WARNING**

To avoid injury to personnel, do not open breech.

- 7 If weapon still fails to fire, evacuate personnel.
- 8 Wait 2 hours, then proceed as follows.
  - (a) Remove primer and propelling charge.
  - (b) Place waste in chamber.
  - (c) Close breech.
  - (d) Lock cannon in a traveling position.
  - (e) Carefully move weapon to remote location.

**WARNING**

To prevent injury to personnel, do not attempt to remove projectile.

- 9 Request EOD or unit maintenance personnel to remove projectile or to remove cannon with seated projectile. If EOD removes projectile using water and explosion charge method, DS/GS maintenance must be requested to certify condition and serviceability of cannon tube, prior to any further firing from cannon tube. Once projectile is removed, EOD is responsible for its evacuation and disposition.

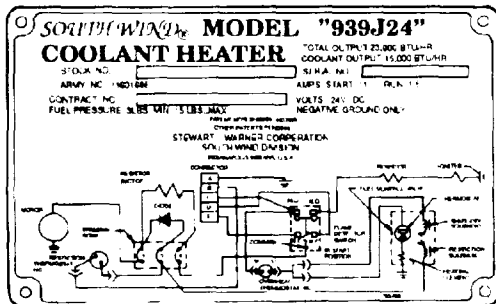
#### 2-15.3 Duds

**WARNING**

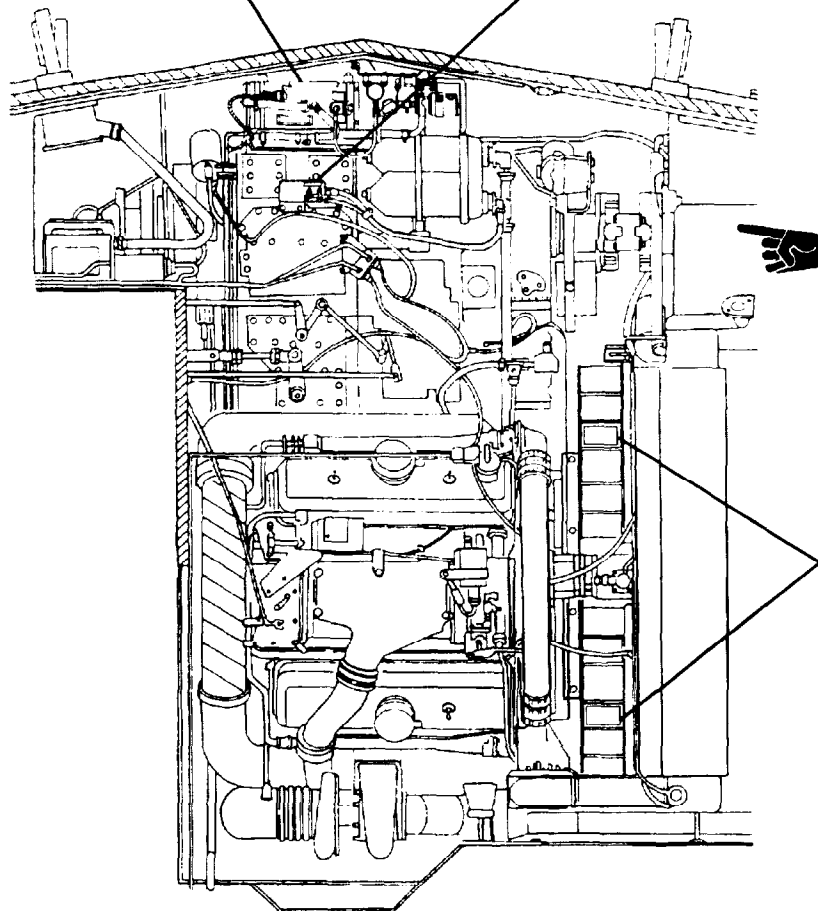
Do not touch, move, or otherwise handle duds. Their fuzes may be armed. Have duds destroyed in place by authorized personnel only,

## 2-16 DECALS AND INSTRUCTION PLATES

The following illustrations show locations of warnings, cautions, and instruction decals and plates applicable to the operation of the M109 series howitzer.

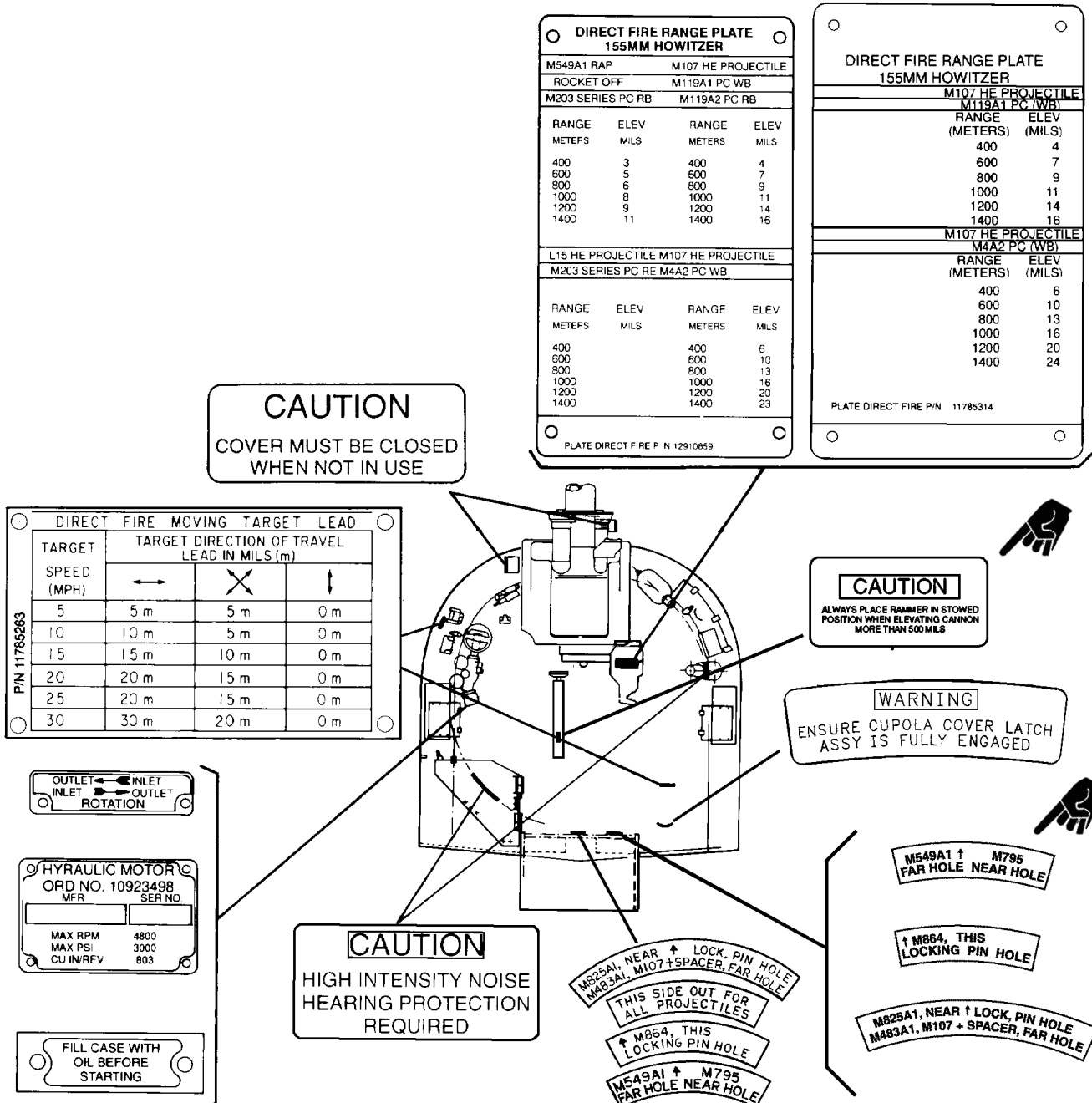


OIL SAMPLER  
TRANS ENGINE

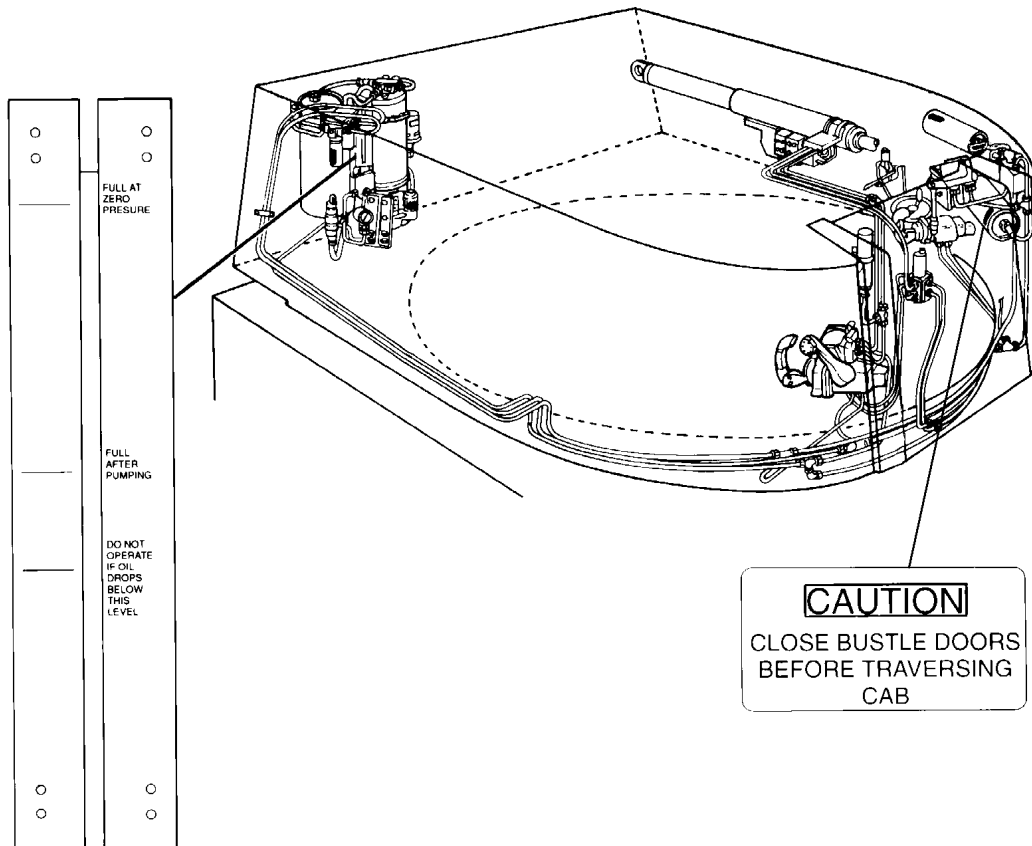


**WARNING**  
A PROTECTIVE FAN SCREEN MUST BE INSTALLED PRIOR TO DOING MAINTENANCE IN THE ENGINE COMPARTMENT WHEN ENGINE IS RUNNING OR WHEN RUNNING ENGINE IN GROUND HOP MODE. CONTACT WITH ROTATING FAN CAN CAUSE INJURY

2-16 DECALS AND INSTRUCTION PLATES — CONTINUED

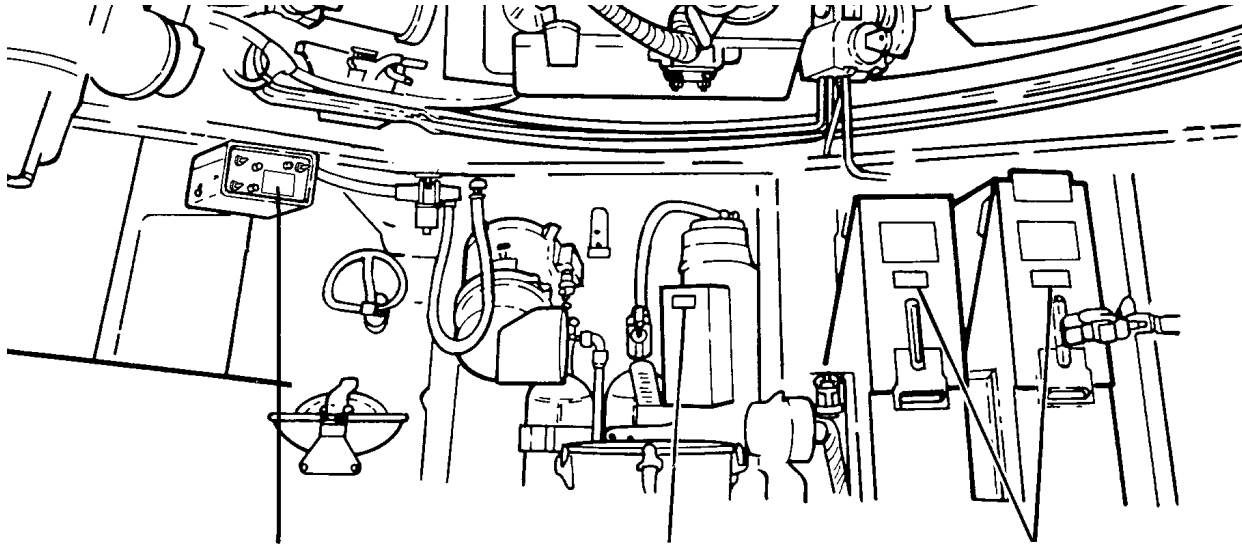


2-16 DECALS AND INSTRUCTION PLATES — CONTINUED





2-16 DECALS AND INSTRUCTION PLATES — CONTINUED



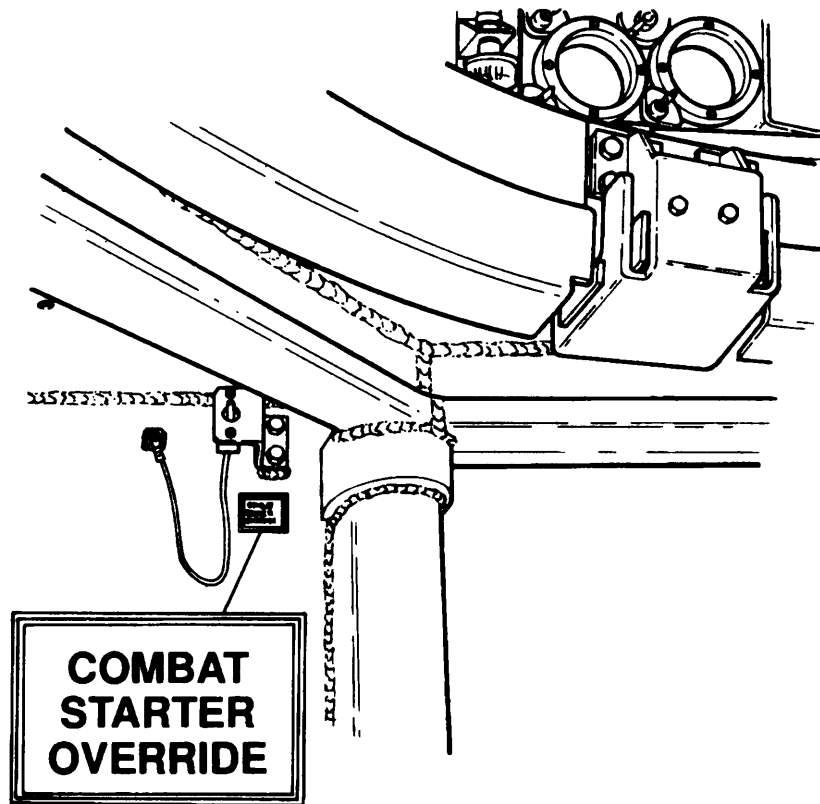
**WARNING**  
DO NOT PLACE FLAMMABLES  
OR EXPLOSIVES ON OR  
NEAR PERSONNEL HEATER



**WARNING**  
DO NOT PLACE  
FLAMMABLE OR  
EXPLOSIVES ON OR  
NEAR PERSONNEL HEATER

**WARNING**  
IF NBC EXPOSURE IS SUSPECTED,  
ALL AIR FILTER MEDIA WILL BE  
HANDLED BY PERSONNEL WEARING  
FULL NBC PROTECTIVE EQUIPMENT.  
SEE OPERATOR/MAINTENANCE  
MANUALS.  
7690-01-114-3702

2-16 DECALS AND INSTRUCTION PLATES — CONTINUED



## 2-17 OPERATING AUXILIARY EQUIPMENT

### 2-17.1 Personnel Heater (P/N 11669489-1 and 11669490-1)

#### a. Starting

**WARNING**

Do not place flammable materials or explosives on or near personnel heater. To prevent injury to personnel and damage to equipment, do not block or restrict the heater vent.

- 1 Turn MASTER switch (1) to ON.
- 2 Move HEATER SELECTOR switch (2) to LOW.

**CAUTION**

If recommended start times are exceeded, damage to the personnel heater can result by burning out ignitor or ignition control register. Step (2.1) and step (2.2) only apply to the Global heater. Steps (2.3) through step (4) only apply to the Hupp and Stewart-Warner heaters.

- 2.1 Push HEATER switch (2.1) to START and hold for four to seven seconds (no more than seven seconds, or Global heater will go into an automatic shutdown/diagnosis mode). If heater detects a fault it will automatically shutdown. If this occurs, notify Unit Maintenance.
- 2.2 Push HEATER switch (2.1) to RUN once heater starts.
- 2.3 Push HEATER switch (2.1) to START and hold. Set HEATER switch to RUN once heater starts
- 3 If personnel heater does not start within 2 minutes, move the HEATER switch (2.1) to OFF for 10 seconds, then immediately back to START and continue the attempt for an additional 1 minute.
- 4 If personnel heater has not started after performing step 3, move the HEATER switch (2.1) to OFF for 10 seconds, then immediately back to START, and make another 1 minute start attempt. This will make a total attempted start time of 4 minutes. If the personnel heater has not started by this time, notify unit maintenance.

**WARNING**

To prevent injury to personnel, the personnel heater must be operated for at least 5 minutes to clear the personnel heater of all excess fuel introduced during starting. Fumes may accumulate in the ventilating air circuit or the personnel heater may be damaged by reverse burning.

**NOTE**

The HEATER indicator light will illuminate when HEATER switch is in START or RUN position.

- 5 After the personnel heater starts, operate it on either HIGH or LOW heat by appropriate position of the HEAT SELECTOR switch (2).

## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.1 Personnel Heater (P/N 11669489-1 and 11669490-1) — Continued

#### b. Shut-Down

**WARNING**

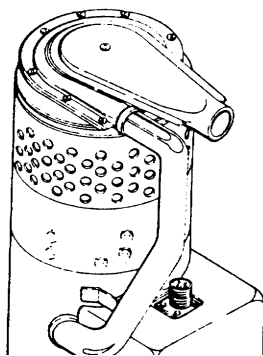
To prevent injury to personnel, do not use the MASTER switch to shut the personnel heater down. Fuel vapors will accumulate in the ventilating air circuit, and the personnel heater may also be damaged by reverse burning.

#### Shutting Down Hupp and Stewart Warner Heaters

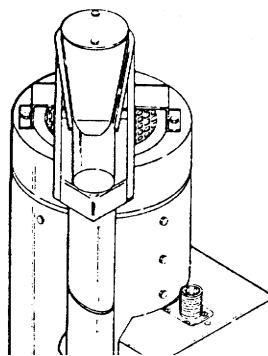
To stop personnel heater operation, move the HEATER switch (2.1) to the OFF position. The blower will continue to operate for approximately 3 minutes to allow the system to cool. If blower continues to operate or otherwise malfunctions, notify unit maintenance.

#### Shutting Down Global Heaters

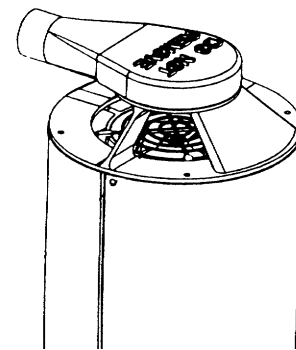
Move HEATER switch (2.1) to OFF position. Global heater will enter purge mode and after four minutes it will automatically shutdown.



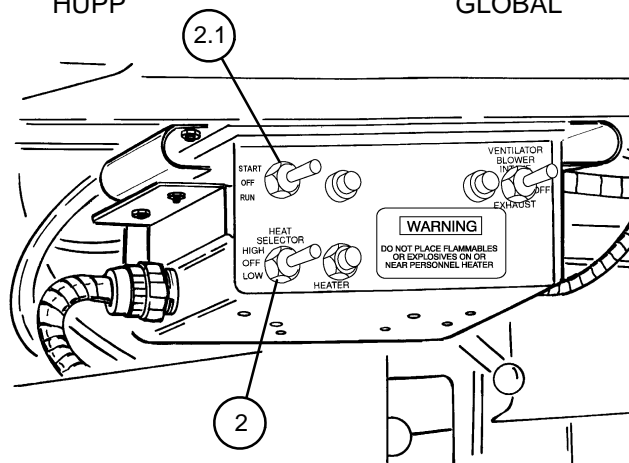
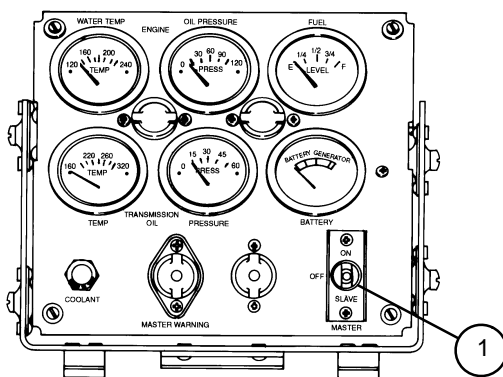
STEWART-WARNER



HUPP



GLOBAL



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.2 Radio and Intercommunication Equipment

#### a. General

Refer to TM 11-5830-340-12 for operation of intercommunication set AN/VIC-(V). Use of the set for intercom only is given below.

- For operating components of the intercommunication system, see TM 11-5830-340-12.



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.2 Radio and Intercommunication Equipment — Continued

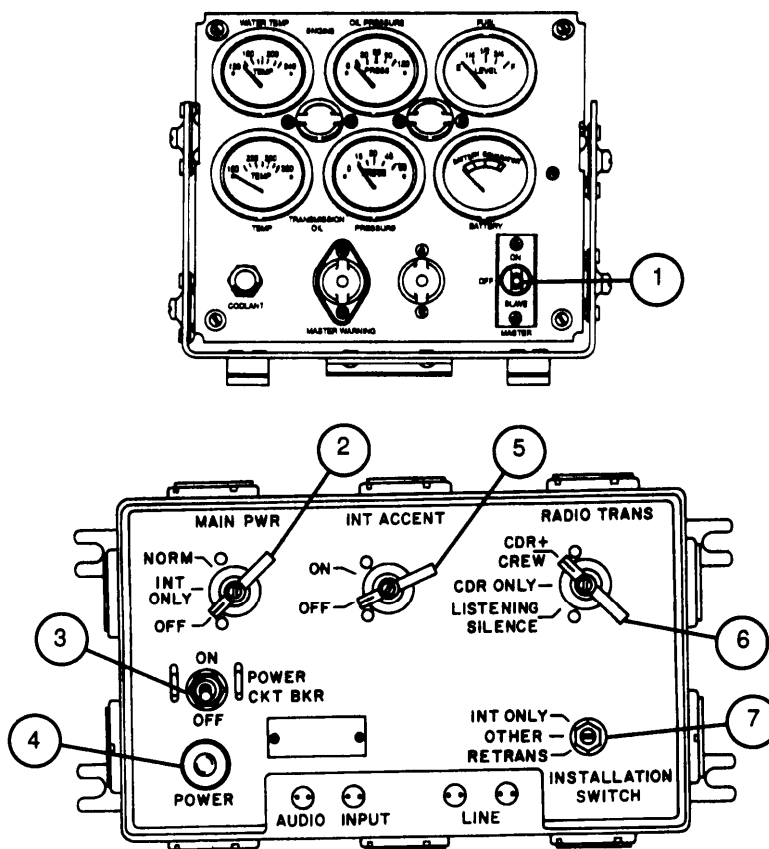
#### b. Amplifier AM 1780/VRC

- 1 The amplifier AM-1780/VRC is the master control for the intercommunication system. Nothing works until both vehicle MASTER switch and amplifier AM-1780/VRC are turned to ON.

**CAUTION**

Before starting vehicle engine, make certain MAIN PWR switch and amplifier AM-1780/VRC is set to OFF, Otherwise, engine start could damage amplifier AM-1780/VRC.

- 2 With vehicle MASTER switch (1) to ON, set MAIN PWR switch (2) to INT ONLY and POWER CKT BRK switch (3) to ON. POWER lamp (4) should illuminate.
- 3 Leave INT ACCENT switch (5) at OFF, RADIO TRANS switch (6) at LISTENING SILENCE, and INSTALLATION SWITCH (7) at INT ONLY.



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

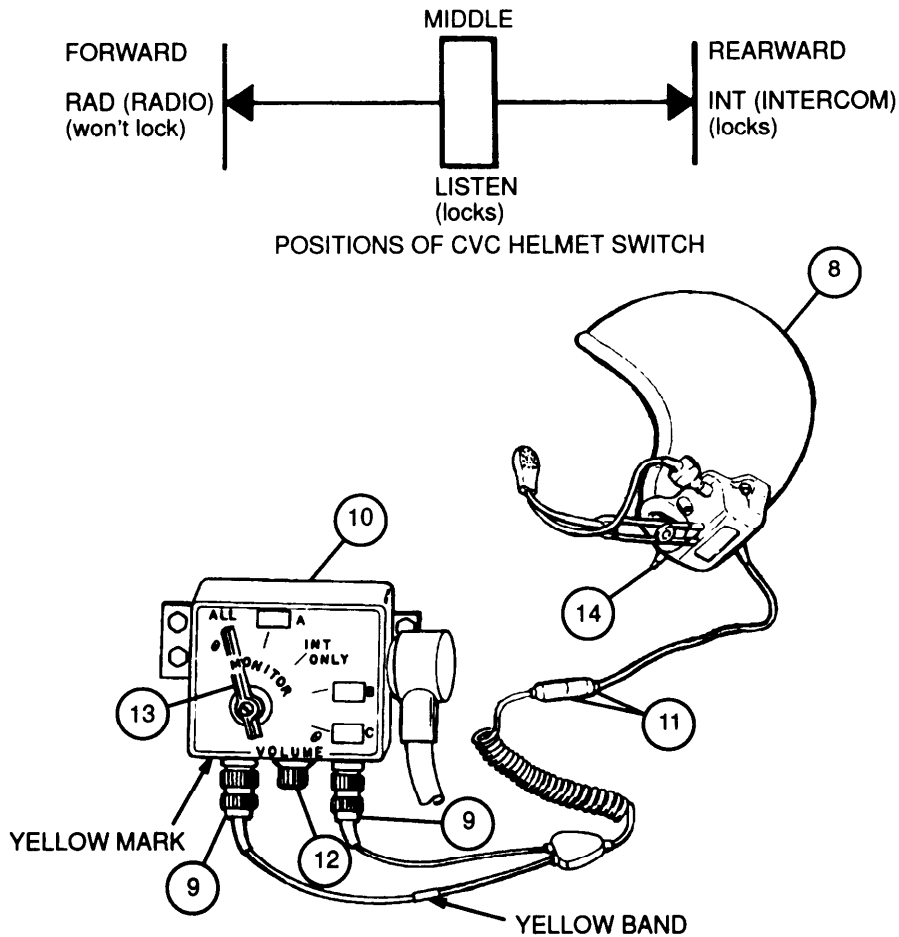
### 2-17.2 Radio and Intercommunication Equipment — Continued

#### c. Control Box C-2298/VRC

#### NOTE

Cable with yellow band (longer cable) connects to receptacle with yellow mark.

- 1 Connect CVC helmet (8) cable connectors (9) to control box C-2298/VRC (10) receptacles.
- 2 Check that bail-out connectors (11) are snapped in place.
- 3 During operation, adjust VOLUME knob (12) for best reception.
- 4 MONITOR switch (13) can be set A, ALL, or INT ONLY.
- 5 Talk to other crew members by pushing helmet switch (14) rearward. Set to middle position when done.



**2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED**

**2-17.2 Radio and intercommunication Equipment — Continued**

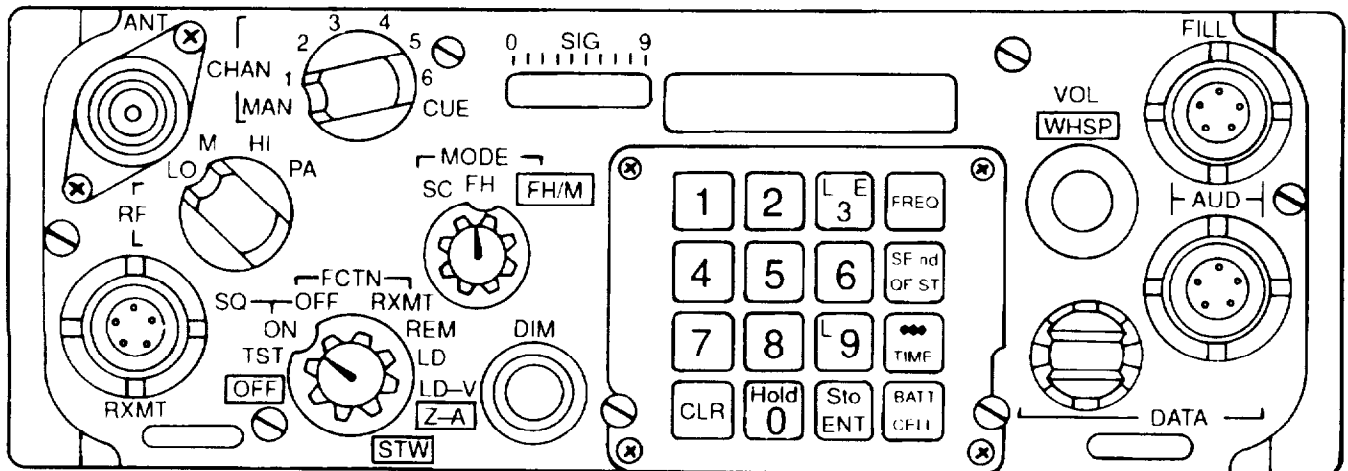
**d. Operation of Radio**

**NOTE**

Some vehicles may have SINGARS radio (TM 11-5820-890-10-1).

Complete operating instructions for the radio set ANNRC-89C are in TM 11-5820-890-10-1.

Complete operating instructions for the radio set AN/PRC-68 are in TM 11-5820-882-10.



AN/VRC-89C

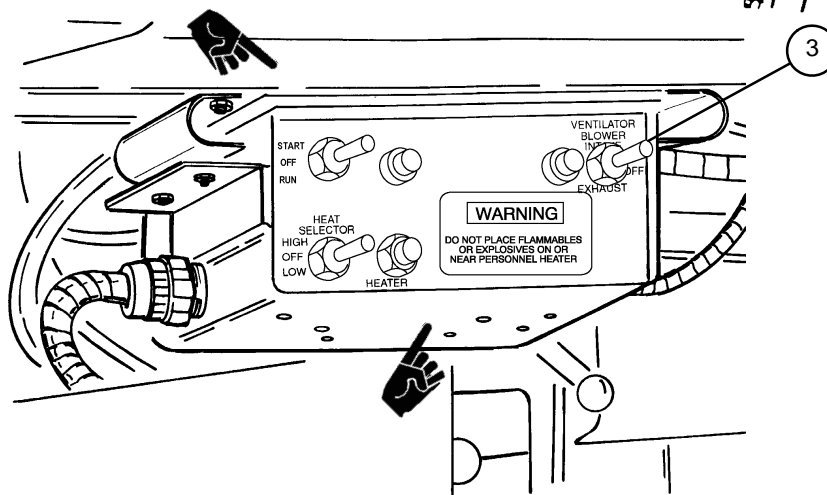
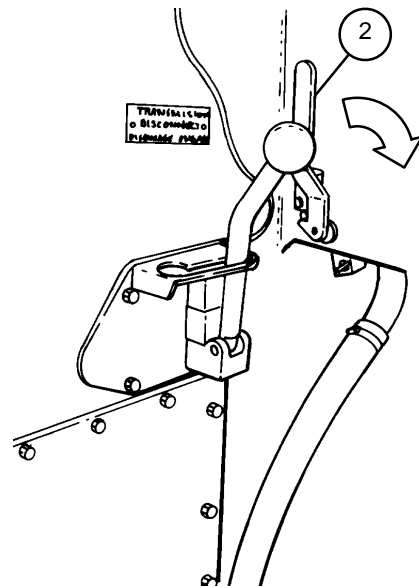
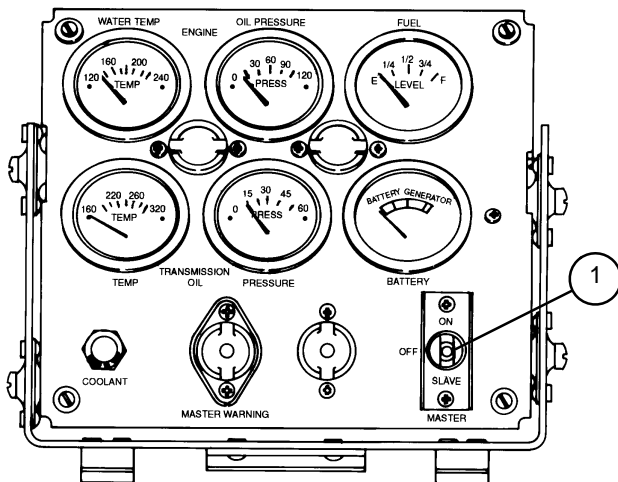


## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.3 Ventilation Blower

#### Operating Procedures

- 1 Turn MASTER switch (1) to ON.
- 2 To pull in fresh air, pull down air duct control handle (2) in driver's compartment. Turn VENTILATOR BLOWER INTAKE switch (3) to INTAKE.
- 3 To clear out smoke, pull down on air duct control handle (2) and turn VENTILATOR BLOWER INTAKE switch (3) to EXHAUST.



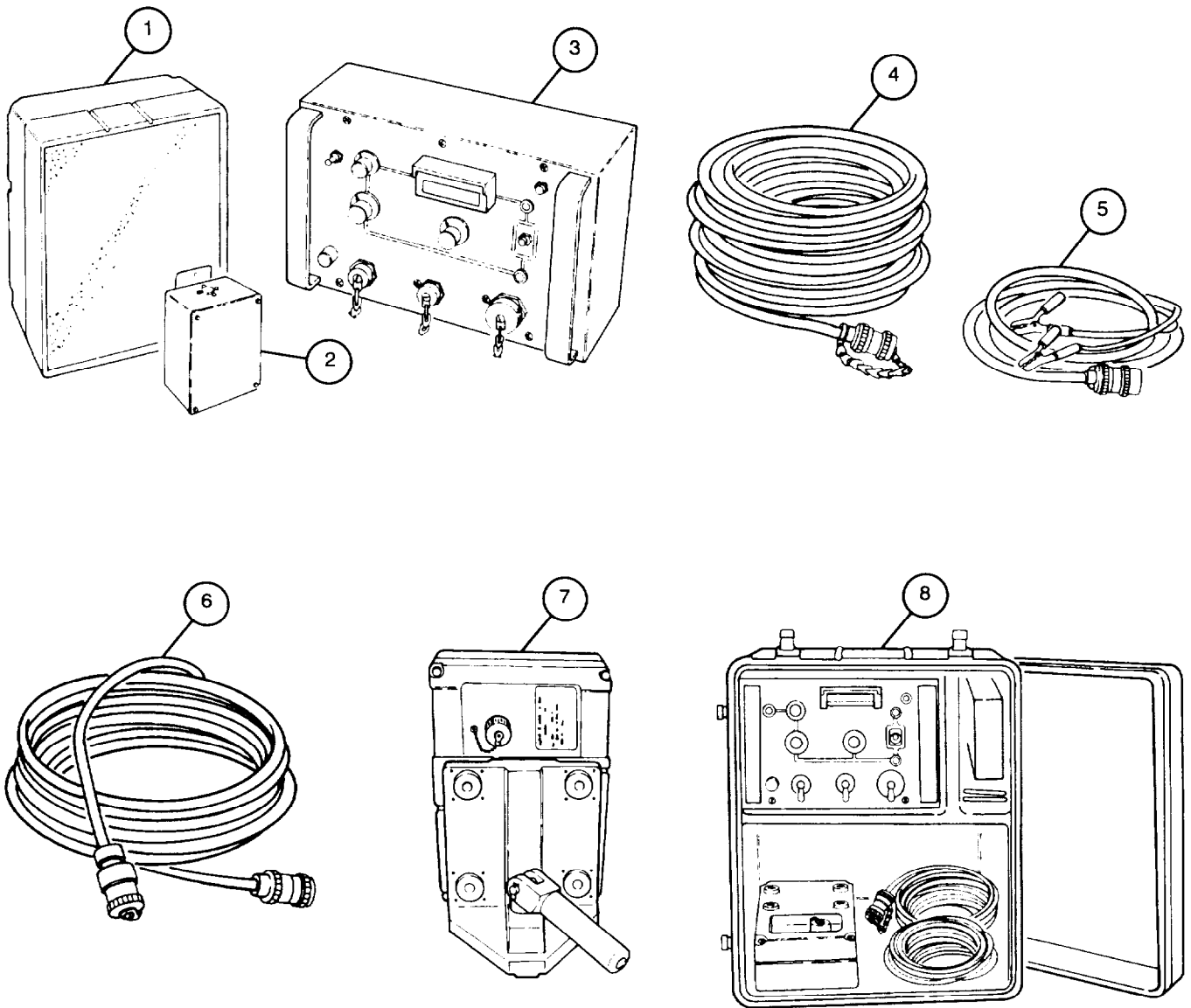
**2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED**

**2-17.4 M90 Radar Chronograph Equipment**

**a. General**

M90 radar chronograph equipment consists of the antenna unit (1), the system test unit (2) the data unit (3), a 50 meter cable (4) a 2 meter cable (5), a 30 meter antenna cable (6), and an antenna bracket assembly (7). When not in use, components are housed and transported in transport case (8).

Operating instructions are contained in TM 9-1290-359-14&P.

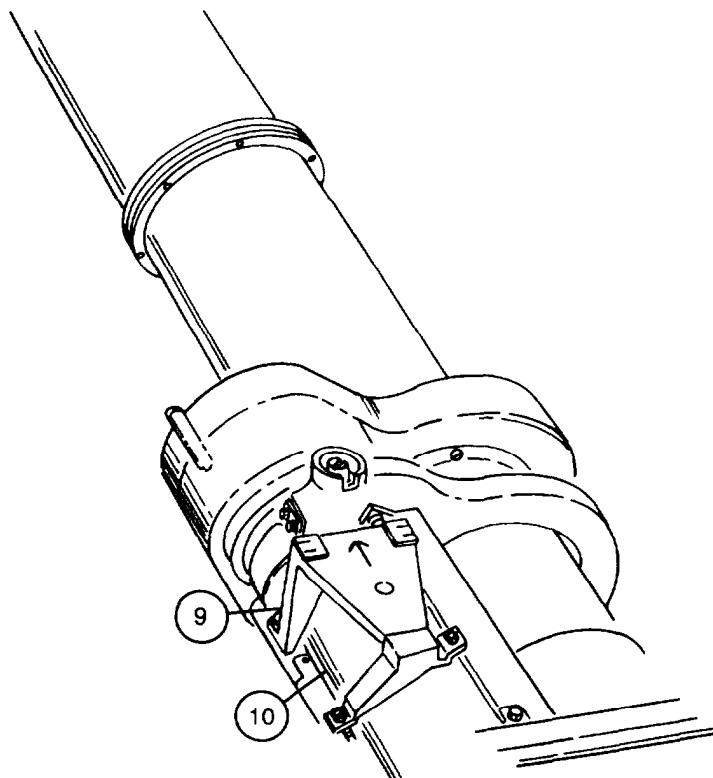


## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.4 M90 Radar Chronograph Equipment — Continued

#### b. Antenna Installation Bracket

The antenna installation kit (9) is mounted to the variable recoil cylinder (10).



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.5 Fire Extinguishers

#### a. Fixed Fire Extinguisher Handles

**WARNING**

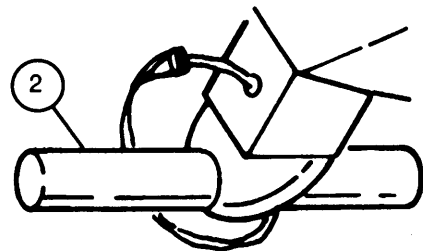
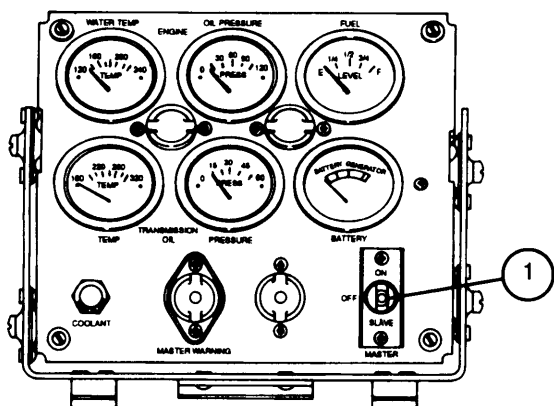
To avoid injury, turn off engine when extinguishing fires. The fire extinguisher doesn't work properly while the engine is running.

- 1 Stop vehicle. Shut off engine and turn MASTER switch (1) to OFF.

**WARNING**

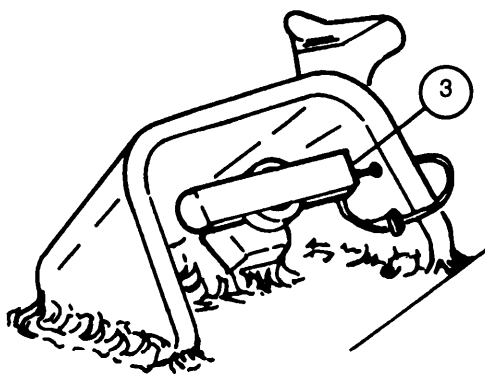
To avoid injury, all personnel must exit vehicle during fire extinguishing efforts.

- 2 Pull either internal fire extinguisher handle (2) or external fire extinguisher handle (3) to expel carbon dioxide into the engine compartment, forcing out the air and putting out the fire.



**NOTE**

Internal fire extinguisher handle is located to rear of driver's compartment.



**NOTE**

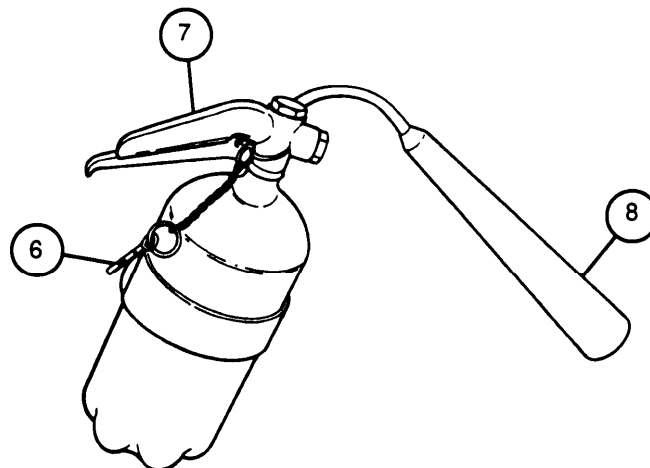
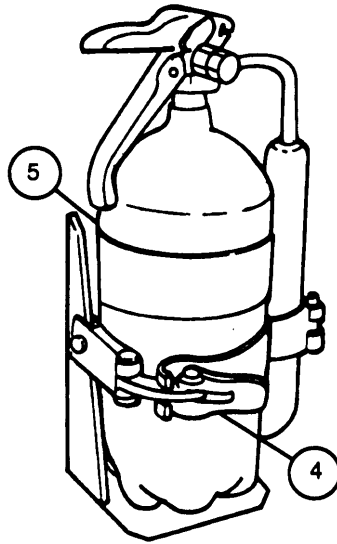
External fire extinguisher handle is located to left of driver's hatch cover.

## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.5 Fire Extinguishers — Continued

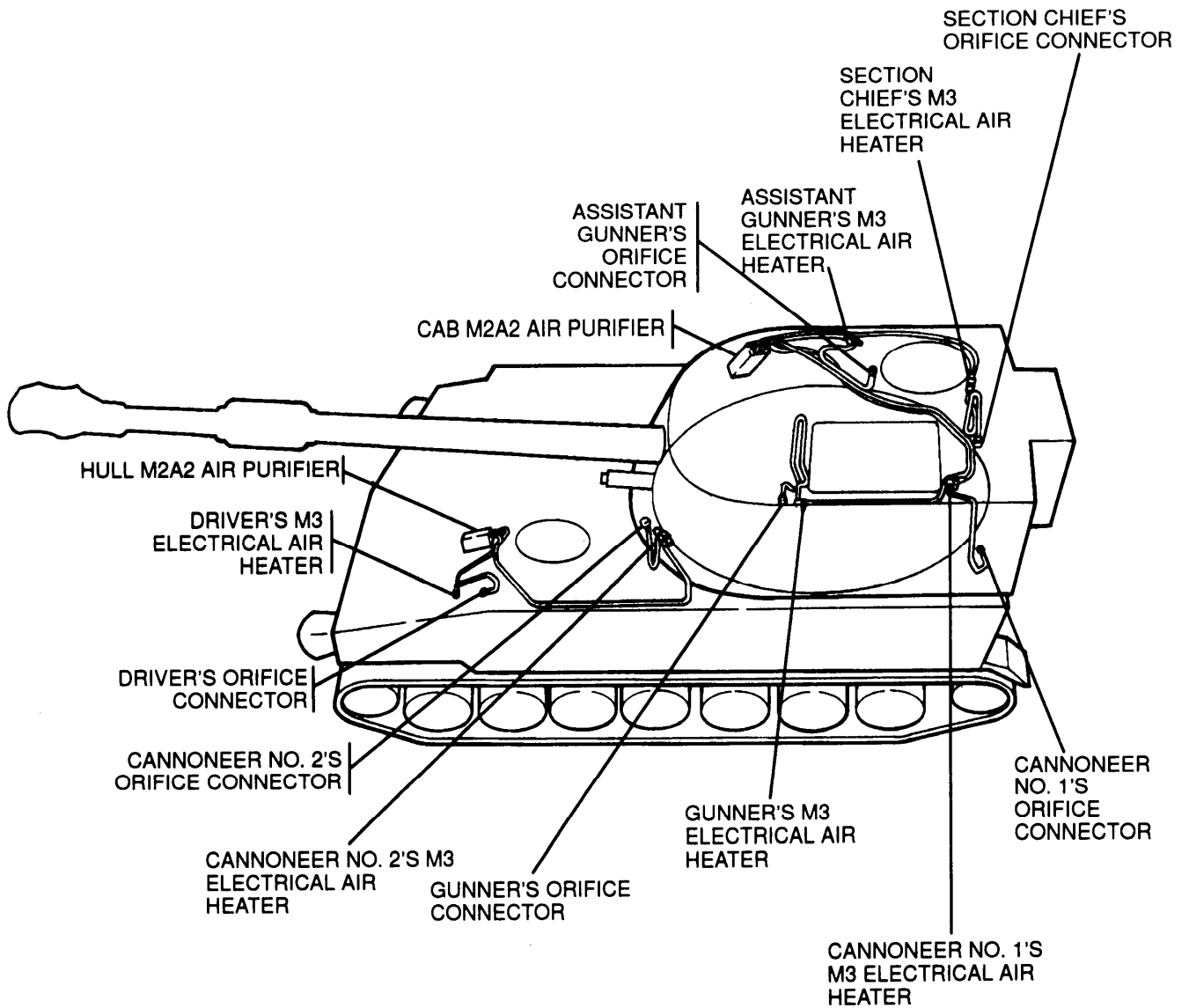
#### b. Portable Fire Extinguisher

- 1 Pull latch (4) to release arm assembly and remove fire extinguisher (5).
- 2 Break safety wire and remove safety pin (6).
- 3 Squeeze trigger (7) to operate.
- 4 Aim nozzle (8) at base of flames and direct discharge at the fire until it is extinguished.



2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.6 NBC Equipment (M109A4/M109A5 Howitzers)



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

#### a. General

The NBC equipment illustrated below is provided in M109A4/M109A5 howitzers. It is used against toxic gases in an NBC environment and during extremely dusty conditions to cleanse the air for the crew. Air is filtered through the M2A2 air purifiers, warmed in the M3 electrical air heater, and distributed through the hoses to the M25A1 masks. Hull NBC equipment consists of an M2A2 air purifier, an M3 electrical air heater in the driver's compartment, an M3 electrical air heater below the bearing/race ring assembly near the gunner's station, and connecting hoses. Cab NBC equipment consists of four M3 electrical air heaters on the cab roof, an M2A2 air purifier on the right cab wall, and connecting hoses. The cannoneers' seats and NBC stowage boxes mounted to back hull provide stowage for NBC MOPP gear.

#### WARNING

- Neither the M2A2 air purifiers nor the M25A1 masks will protect against carbon monoxide. They will only get rid of odors which would normally indicate the presence of carbon monoxide.
- When outside temperature is below 32° F (0° C), do not connect the M25A1 mask to orifice connector immediately or frostbite could result. Use the M25A1 mask only. Run M3 electrical air heaters 15 minutes to heat filtered air before using in cold weather.

#### CAUTION

- Use care when washing vehicle interior to ensure water does not enter M2A2 air purifiers. Water will damage the charcoal filters contained in the M2A2 air purifiers.
- If M10 canister on the M25A1 mask is being used for the first time or has been rough handled, hook M25A1 mask up to a hose, turn on NBC system, and ventilate M25A1 mask for an hour before using. Refer to TM 3-4240-280-10 for more detailed information about the M25A1 mask.

#### b. Operation of Hull NBC Equipment

#### NOTE

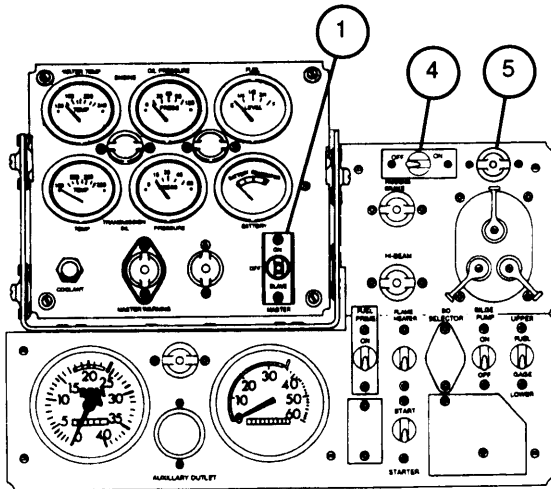
Unused outlet holes on M2A2 air purifier should be covered with caps without center holes. Caps with center holes are used during testing.

- 1 Turn MASTER switch (1) to ON.
- 2 Open spring clip (2) on hull M2A2 air purifier (3) to expose air inlet holes.
- 3 Turn NBC power switch (4) to ON and NBC indicator light (5) will illuminate.

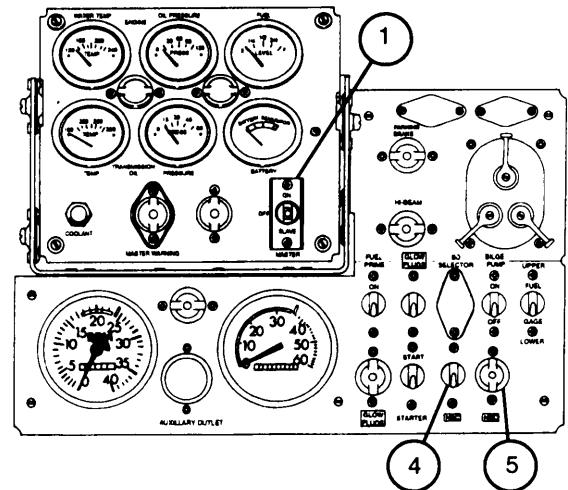
2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

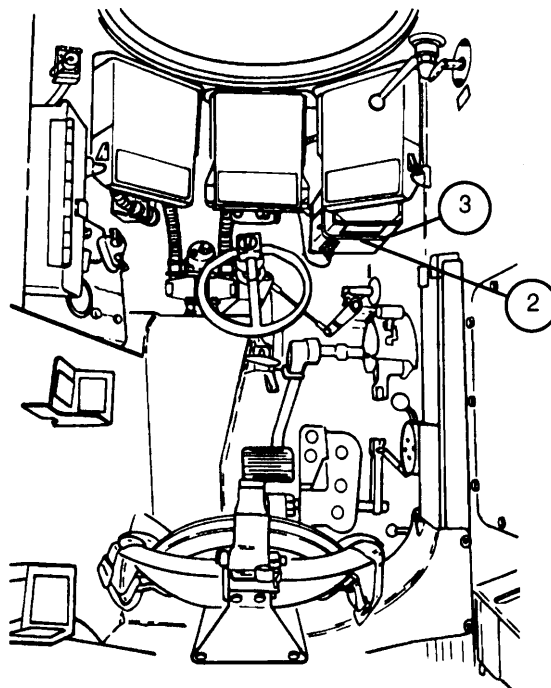
b. Operation of Hull NBC Equipment — Continued



Engine Model 7083-7396 Driver's Fixed Instrument Panel



LHR Engine Model 7083-7391 Driver's Fixed Instrument Panel





## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

#### b. Operation of Hull NBC Equipment — Continued

##### NOTE

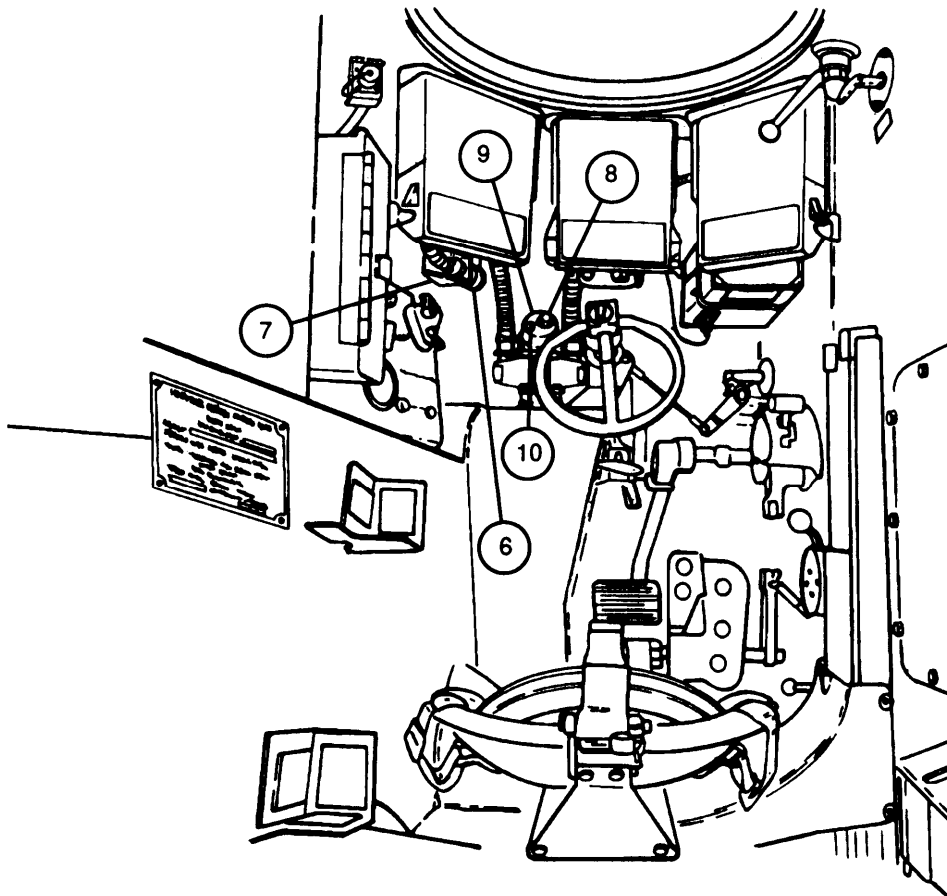
Illustration for steps 4 and 5 shows driver's station only, but procedures apply to both cannoneer no. 2's and the driver's station.

- 4 Pull orifice connector (6) from bracket (7) and connect to M25A1 mask (not shown).

##### NOTE

Indicator light on M3 electrical air heater will go off and on during operation as heating element adjusts to control air temperature.

- 5 Turn THERMOSTAT control knob (8) on M3 electrical air heater (9) to ON and incandescent lamp (10) will illuminate. Adjust air temperature for comfort.



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

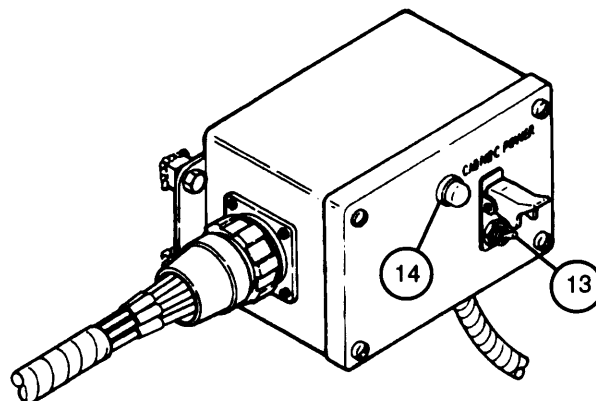
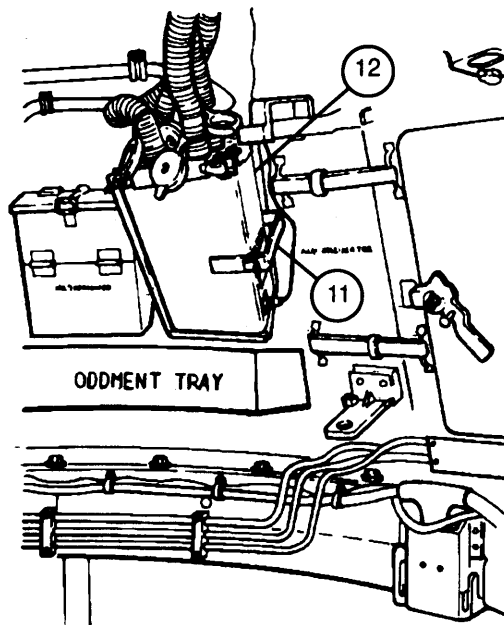
### 2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

#### c. Operation of Cab NBC Equipment

##### NOTE

Be sure MASTER switch is set to ON.

- 1 Open spring clip (11) on cab M2A2 air purifier (12) to expose air inlet holes.
- 2 Turn CAB NBC POWER switch (13) to ON and indicator light (14) will illuminate.



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

#### c. Operation of Cab NBC Equipment — Continued

##### NOTE

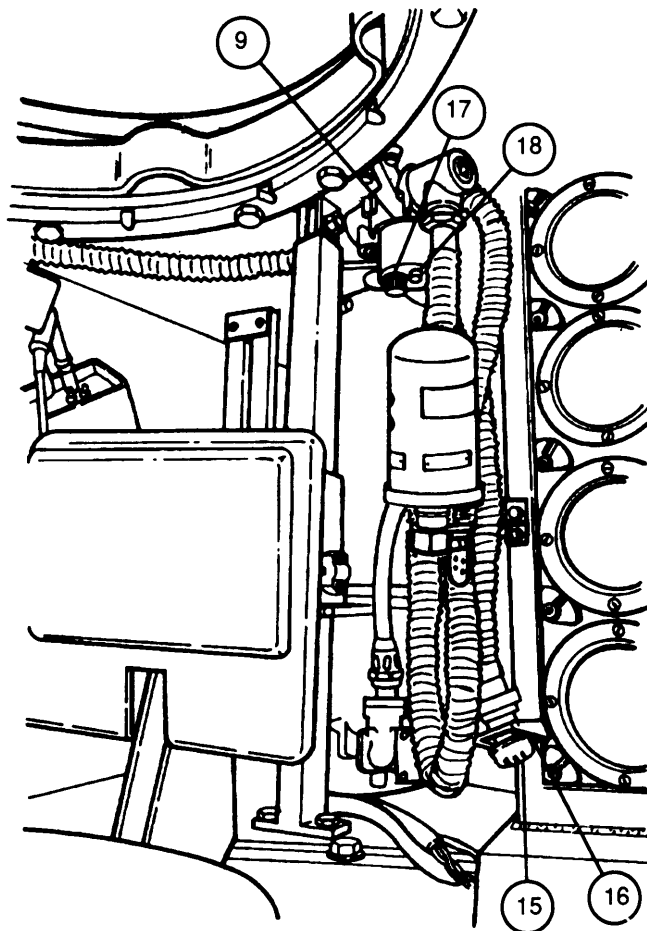
Illustration for steps 3 and 4 shows section chief station, but procedures apply to cannoneer no.1's, gunner's, assistant gunner's, and section chief's stations.

3 Pull orifice connector (15) from bracket (16) and connect to M25A1 mask (not shown).

##### NOTE

Indicator light on M3 electrical air heater will go off and on during operation as heating element adjusts to control air temperature.

4 Turn THERMOSTAT control knob (17) on M3 electrical air heater (9) to ON and incandescent lamp (18) will illuminate. Adjust air temperature for comfort.



## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.6 NBC Equipment (M109A4/M109A5 Howitzers) — Continued

#### d. NBC Filter Change Criteria

<b>WARNING</b>
----------------

NBC protective clothing and equipment are required for filter change. Crew members should not change filter elements. Filter element change requires coordination with an NBC qualified non-commissioned officer (NCO) or officer. Notify unit maintenance.

- 1 If the following conditions exist, notify unit maintenance to replace gas filter:
  - Physical damage
  - Filter becomes wet or clogged
  - Higher authority directs replacement of gas filter
  - Annual service time
  - At beginning of combat operation where use of blood agent (AC or CK) is expected
  - After every known blood agent attack
- 2 If the following conditions exist, notify unit maintenance to replace particulate filter:
  - Physical damage
  - When gas filters are changed
  - Particulate filter becomes clogged, causing insufficient air flow

## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.7 External Power Receptacle (M109A4/M109A5 Howitzers)

#### Operation

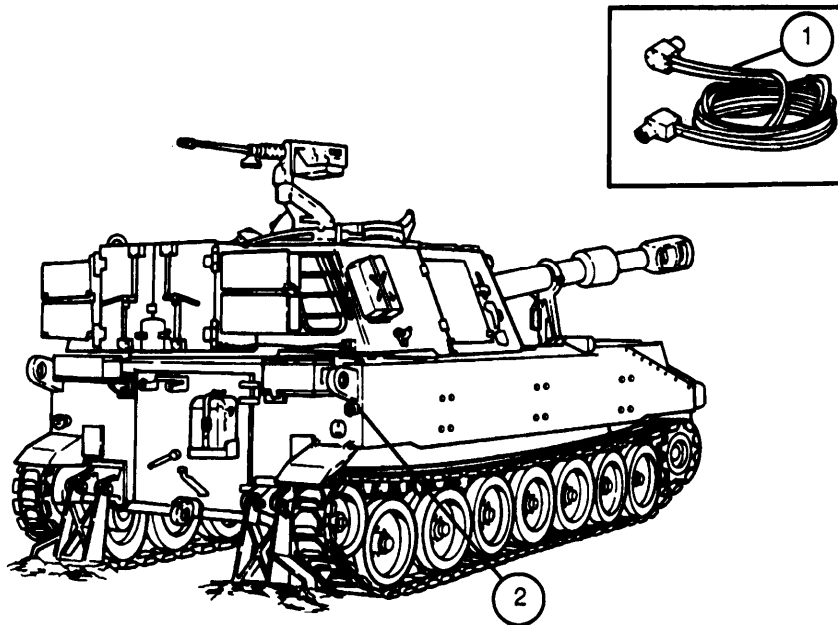
**WARNING**

Make sure all power is off before connecting or disconnecting cables to prevent electrical shock.

**CAUTION**

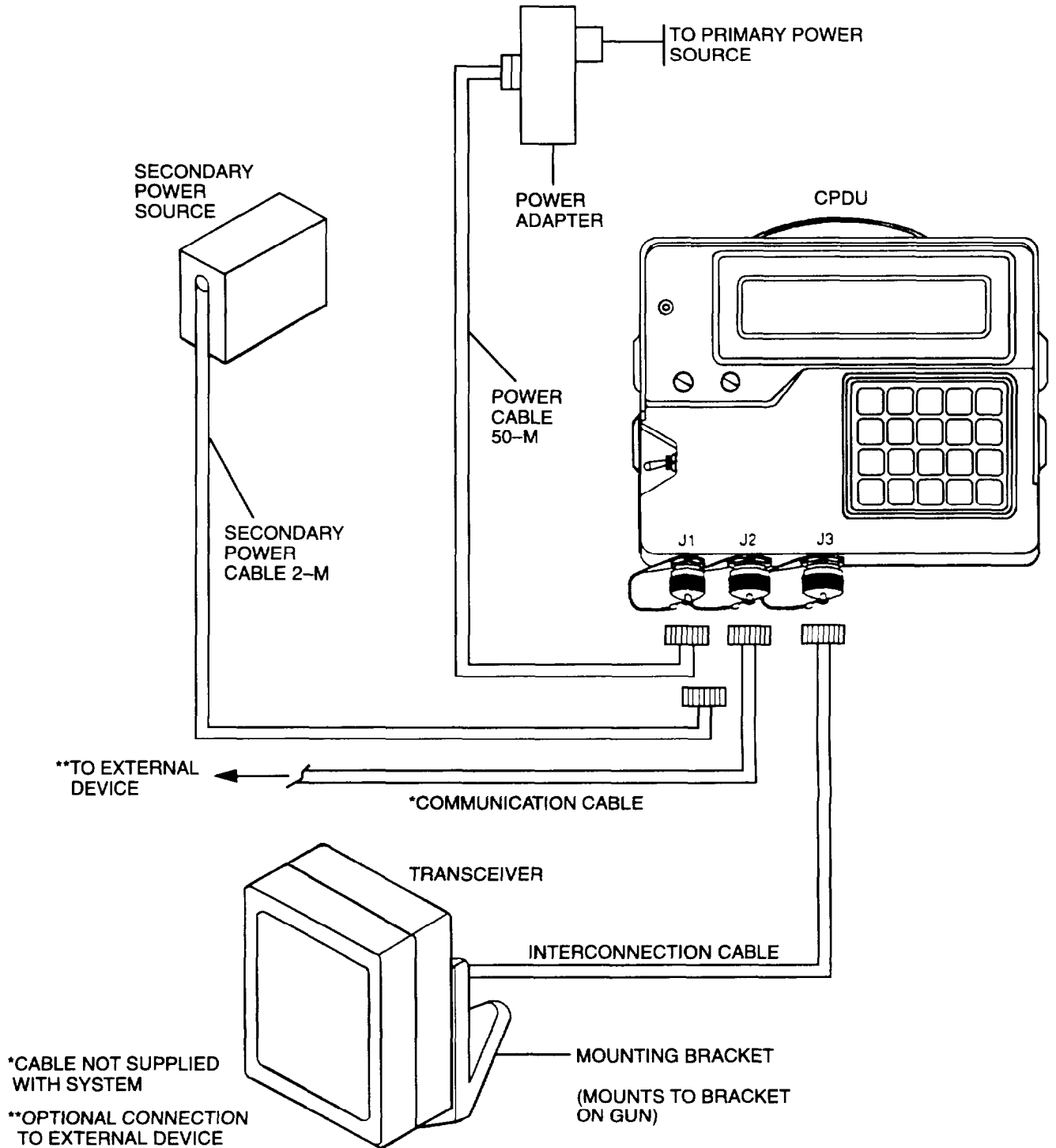
Do not slave start vehicle using external power receptacle. Damage to equipment will occur if caution is not observed.

- 1 Connect external power cable (1) to external power receptacle (2) on M109A4/M109A5 howitzers and to auxiliary power unit (APU),
- 2 Start APU in accordance with appropriate technical manual.
- 3 Check operation of electrical system in howitzer.
- 4 Stop APU in accordance with appropriate technical manual.
- 5 Remove external power cable (1) from APU and from external power receptacle (2) on M109A4/M109A5 howitzers.



2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.8 M94 MVS Interconnection



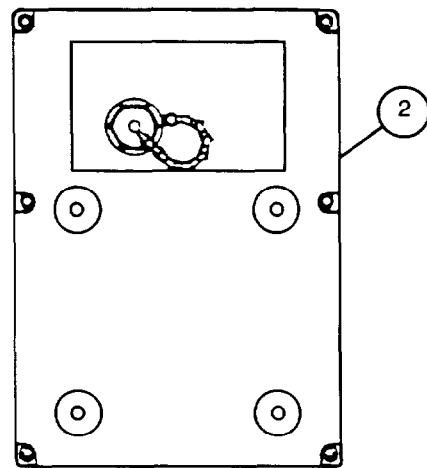
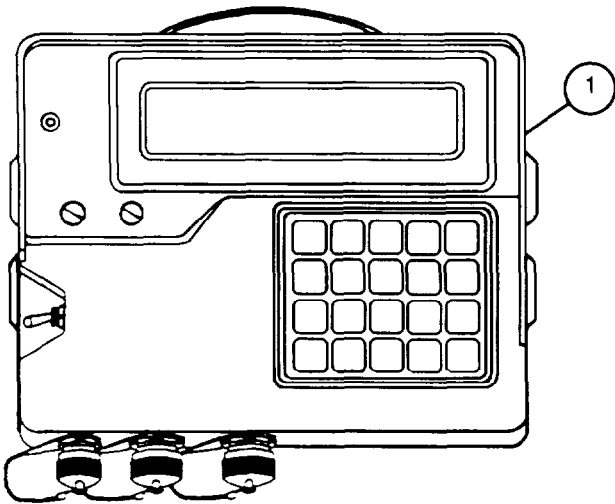
## 2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

### 2-17.8 M94 MVS interconnection — Continued

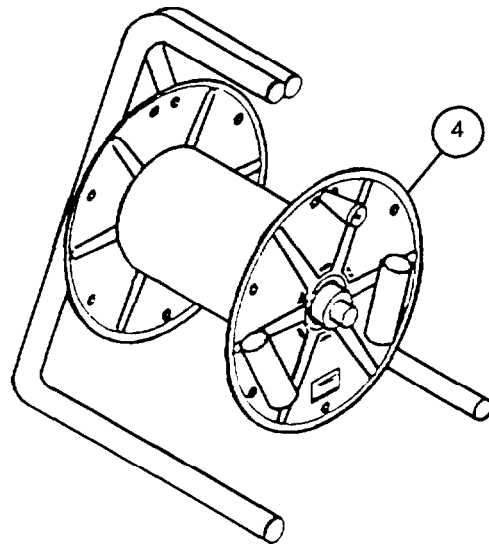
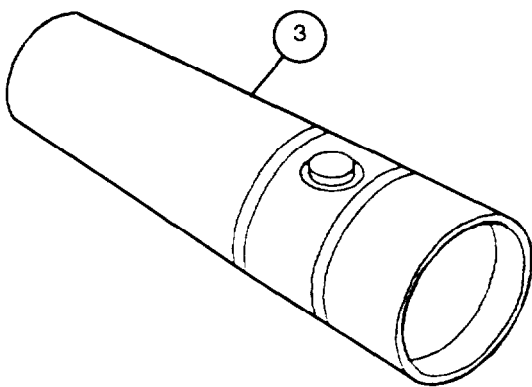
#### a. General

M94 MVS interconnection equipment consists of the control processor and display unit (1), the transceiver (2), a doppler simulator (3), two cable drums (4), the transceiver mounting bracket (5), a power adapter (6), the system transit case (7), and a secondary power source (8).

Operating instructions are contained in TM 9-1290-364-14&P.

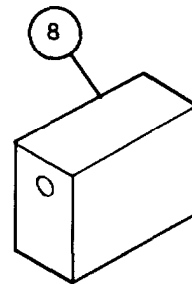
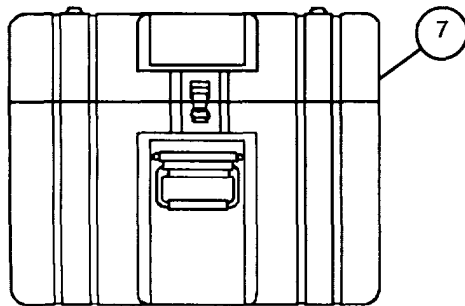
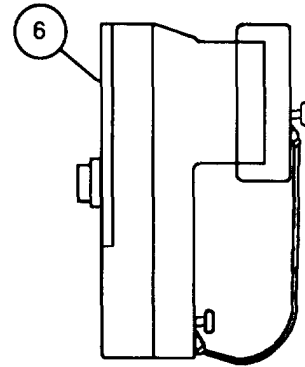
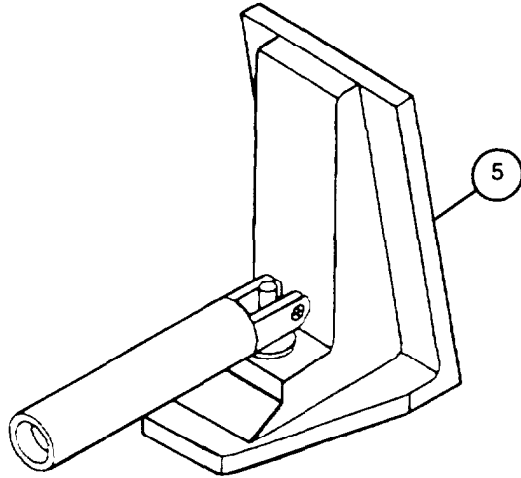


(REAR VIEW)



2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.8 M94 MVS Interconnection — Continued

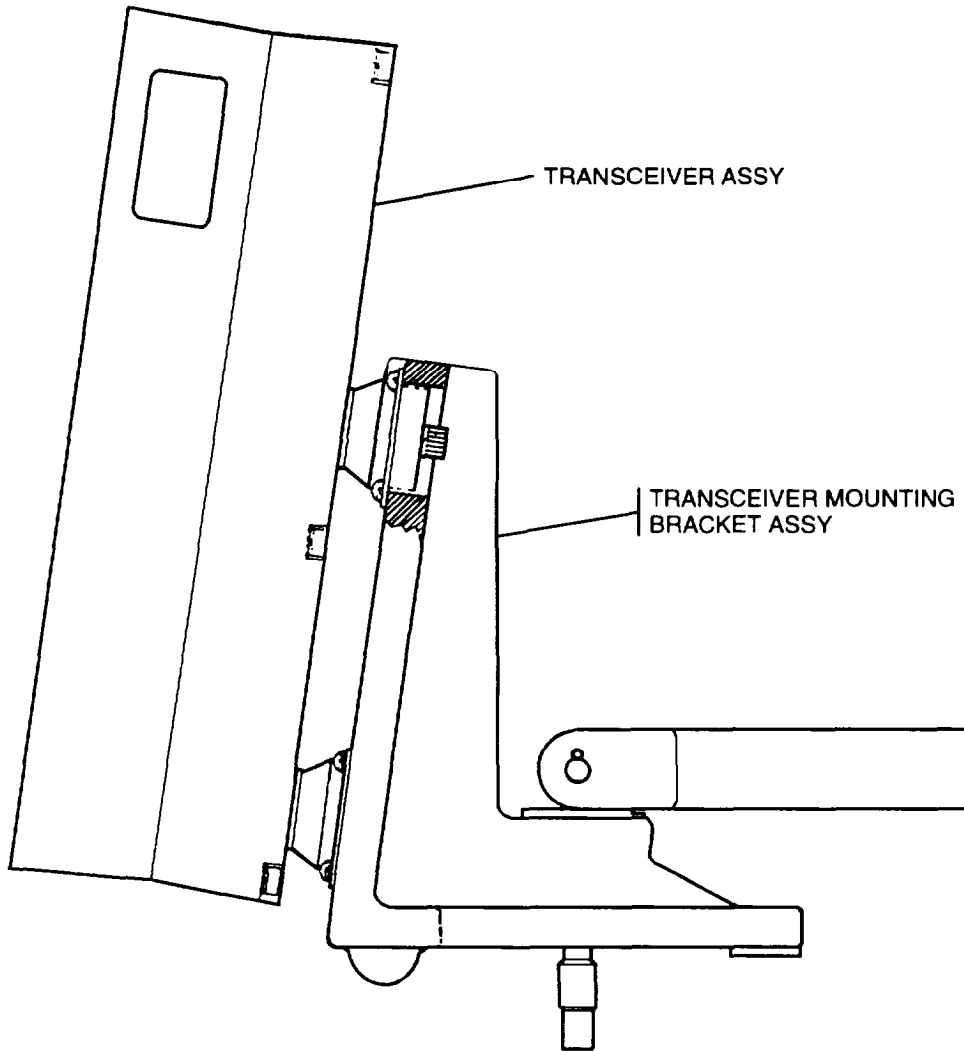




2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.8 M94 MVS Interconnection — Continued

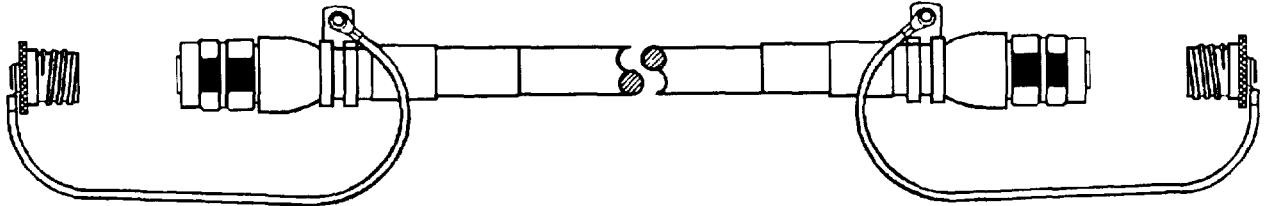
b. Transceiver and Bracket (Shown in Normal Operation)



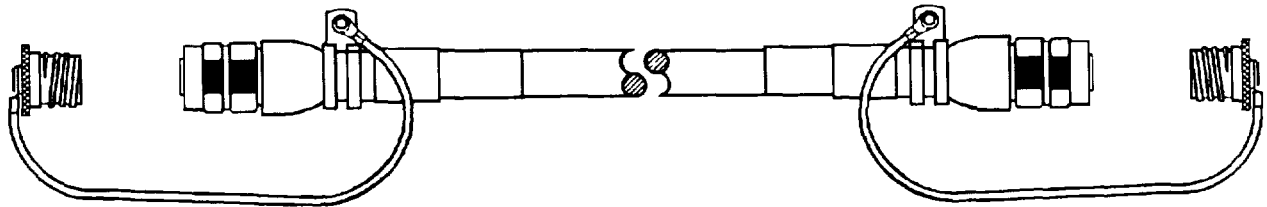
2-17 OPERATING AUXILIARY EQUIPMENT — CONTINUED

2-17.8 M94 MVS Interconnection — Continued

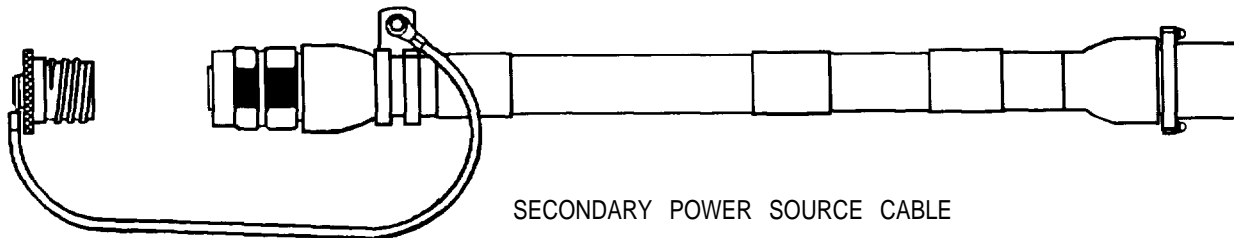
c. M94 MVS Interconnection Cables



INTERCONNECTION CABLE (30-METER)



POWER CABLE (50-METER)



SECONDARY POWER SOURCE CABLE



## 2-18 PREPARATION FOR MOVEMENT (\*MARCH ORDER)

### Procedure

- 1 March order and preparation of howitzer for travel is accomplished under supervision of chief of section. When movement is ordered, chief of section commands "MARCH ORDER."

<b>WARNING</b>
----------------

To prevent injury to personnel, projectiles and fuzes that have been rammed and then removed from cannon tube must not be reloaded and fired. They must be turned over to authorized personnel for destruction or demilitarization. Only an M712 projectile that has been rammed and extracted from a cold cannon tube may be reused.

- 2 Chief of section inspects chamber to see that howitzer is not loaded, supervises work of section, checks all ammunition not fired that has been prepared for firing before it is replaced in containers. Chief of section checks that powder increments prepared for firing are present in proper condition, are of same lot number as container, and are assembled in proper numeric order. Chief of section checks all time/proximity fuzes that have been set to see that they are reset to SAFE, and that eyebolt lifting plugs are replaced on all projectiles. Chief of section also checks that supplementary propelling charges that have been withdrawn are replaced and that grommets have been replaced on rotating bands of all projectiles not stored inside howitzer.
- 3 Gunner covers vials on M145/M145A1 telescope mount, and turns panoramic telescope ballistic cover to face rear of cab, and secures and locks it.
- 4 Assistant gunner covers vials on range quadrant.
- 5 Cannoneer no. 1 secures power rammer, closes breechblock, replaces unused primers in traveling compartment, secures swab and cleaning materials, and places vent and primer seat cleaning tools in oddment tray.
- 6 Cannoneer no. 2 places fuzes in containers and places them in stowage boxes.
- 7 Cannoneer no. 3 checks that projectiles are ready for loading, all fuzes are removed, and lifting plugs and grommets are replaced.
- 8 The ammunition team chief assists in reloading ammunition and section equipment. Ammunition team chief recovers, disassembles, and hands M1A2 aiming posts to driver for storage. Ammunition team chief secures communication equipment and replaces muzzle cover.
- 9 Driver disassembles and secures rammer cleaning staff sections, secures M1A2 aiming posts and other BII, and closes M42 periscope cover.

\* Standardized procedures for march orders are identified with an asterisk (\*) preceding the title.

## 2-18 PREPARATION FOR MOVEMENT (\*MARCH ORDER) — CONTINUED

### Procedure — Continued

- 10 Gunner assists driver in locking cannon tube in travel position, turns CAB POWER switch to OFF, locks turret lock, and closes left cab side door.

<b>WARNING</b>
----------------

To prevent accidental injury, two personnel must guide driver when backing up (para2-10.4).

- 11 Chief of section along with the assistance of the cannoneer no. 2 directs the driver to back against spades. When driver has backed against spades, gunner steps on left spade pedal, and assistant gunner steps on right spade pedal. The chief of section directs the driver to pull forward enough to permit the spades to be lifted into travel position.
- 12 Cannoneer no. 2 closes rear hull door.
- 13 Cannoneer no. 1 and 3 lift left spade into travel position, and cannoneer no. 1 replaces left spade pin assembly and secures left spade strut.
- 14 The ammunition team chief and cannoneer no. 2 lift right spade into travel position. Cannoneer no. 2 replaces right spade pin assembly, secures right strut, and opens rear hull door.
- 15 Cannoneer no. 1 checks left and right latches for complete engagement, secures left and right struts, and checks left and right pin assemblies and struts for security.
- 16 Cannoneer no. 2 and 3 fold and place tarpaulins in stowage racks.
- 17 Cannoneer no. 3 secures M1A1 collimator and hands it to assistant gunner, who stores it and closes right cab side door.
- 18 Assistant gunner verifies all section equipment is present and secure.
- 19 Entire section takes their post and cannoneer no. 1 closes rear hull door.
- 20 Chief of section verifies howitzer is prepared for traveling and reports "NUMBER (SO AND SO) IN ORDER" or reports any defect section cannot correct without delay.

## Section IV. OPERATION UNDER UNUSUAL CONDITIONS

### 2-19 GENERAL

#### NOTE

FM 21-17 contains important instructions on driver selection, training, and supervision.  
FM 21-306 gives driving instructions for operating your equipment under all conditions.

#### a. Vehicle

In addition to the normal PMCS, special care in cleaning and lubrication must be observed where extremes of temperature, humidity, and terrain conditions are present or anticipated.

#### b. General Lubrication of Armament

#### CAUTION

During lubrication of armament, be extremely cautious not to allow ice, snow, or water to mix with lubricants. Never use heavy or non-specified lubricants.

- 1 Refer to Appendix G for detailed lubrication instructions.
- 2 In temperatures below freezing, keep the howitzer's moving parts free from moisture.
- 3 During adverse conditions, lubricants should be changed more frequently to prevent damage to the equipment.

#### c. Primary Armament

When not in use, howitzer should be covered. Clean and lightly lubricate breech mechanism. Do not apply any lubrication to the firing pin. When cleaning, do not dilute or add antifreeze to CLP. Store cleaning solutions in a warm place, if available.

#### d. Secondary Armament

The unusual conditions procedures for secondary armament are the same as operation under usual conditions. Use CLP (item 8, Appx D) in cleaning and lubricating the M2 .50 caliber machine gun to ensure proper functioning.

#### e. Sighting and Fire Control Instruments

Where extremes of temperature, humidity, and other conditions cause panoramic telescope ballistic cover to fog over, treat window with anti-fogging kit (item 2, Appx D). These instruments should not be moved suddenly from cold to warm temperatures or vice versa, This may cause clouding of optics and rusting of internal parts.

## **2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER**

### **2-20.1 Driving in Ice and Snow Conditions**

The basic rules for driving during cold weather include all of the rules that apply under normal conditions. However, the necessity to adhere to these rules with the increased hazards of ice and snow is magnified. All drivers must be trained in proper winter driving weather operation as outlined below.

- 1 Never jam on brakes as this will cause the vehicle to skid and require more distance for stopping. The correct method for braking a vehicle on snow and ice is to release accelerator slowly and apply brakes with a feathering action.
- 2 Always adjust speed to road conditions and keep proper distance between vehicles (three to eleven times the distance may be required on snow and ice).
- 3 If the M2 .50 caliber machine gun begins to slide, slow down carefully without applying brakes and pull over to the side of the road until the condition can be corrected.

### **2-20.2 Operation in Extreme Heat, Humidity, or Salty Conditions**

When operating vehicle in extreme heat, humidity, or salty conditions, observe the following.

- 1 Don't park vehicle in the sun for long periods of time.
- 2 Do lubricate weapons more frequently because oil evaporates.
- 3 Do clean and lubricate the howitzer cannon bore and metal surfaces as often as needed.
- 4 Do apply light film of CLP (item 8, Appx D) on weapon and mount when not in use and keep covers in place.

### **2-20.3 Operation in Dusty/Sandy Areas**

When operating vehicle in dusty/sandy areas, observe the following.

- 1 Don't spin tracks while operating.
- 2 Do park vehicle under shelter. If none is available, cover vehicle with tarpaulins.
- 3 Do keep all armaments lubricated and covered when not in use.

## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold

#### NOTE

See FM 9-207 for description and operation of primary armament in extreme cold.

#### a. Winterization Kit

- 1 The winterization kit is installed by direct support maintenance. It is used in extreme cold temperatures between 0 to -65° F (-18 to -54° C) to prevent the coolant from freezing after vehicle has been shut down.
- 2 Both coolant level and fuel supply must be full.

#### NOTE

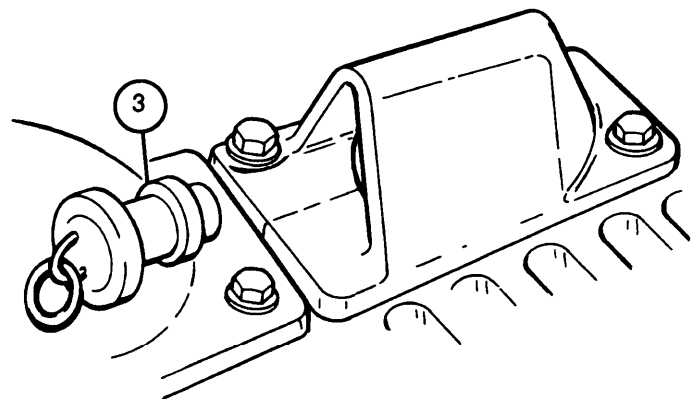
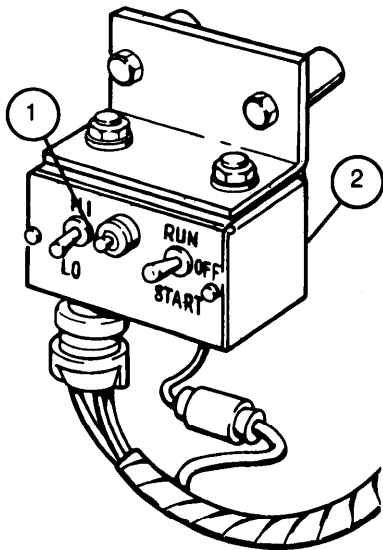
Coolant heater will operate with MASTER switch to either ON or OFF.

- 3 Depress press-to-test light (1) on heater control box (2) to check for electrical current.
- 4 Be sure engine coolant is at normal operating temperature. It may be necessary to start engine and bring coolant temperature up.

#### NOTE

Exhaust outlet plug is located on hull by engine exhaust.

- 5 Remove heater exhaust outlet plug (3).
- 6 Secure tarpaulins over air intake and exhaust grilles. Tarpaulins will help keep out the cold and retain heat from the winterization kit.





## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### b. Starting Coolant Heater

##### NOTE

After coolant heater starts, it will keep working as long as there is fuel, electric current, air, and a flow of engine coolant. Coolant heater will automatically stop if coolant temperature reaches 245° F.

- 1 Turn HI/LO switch (4) on heater control box (2) to HI.
- 2 Hold START/RUN/OFF switch (5) at START.
- 3 Press-to-test light (1) will illuminate, indicating coolant heater (6) is operating. Immediately move START/RUN/OFF switch (5) to RUN position without hesitating in the OFF position.
- 4 Set HI/LO switch (4) for desired rate of heat. If set at HI, coolant heater (6) will automatically go to low heat when coolant temperature reaches 190° F. If coolant temperature falls below 120° F, heat control will return to high. LOW position is suitable when coolant heater must burn for an extended period of time.

#### c. Stopping Coolant Heater

Place START/RUN/OFF switch (5) in OFF position. Coolant heater (6) will go to purge cycle. Fuel will shut off and burning will stop, when remaining fuel in coolant heater is exhausted. Blower will run at low speed until coolant heater is cool and then coolant heater will completely shut down.

#### d. Cold Weather Starting (Vehicles with Engine Model 7083-7396)

##### NOTE

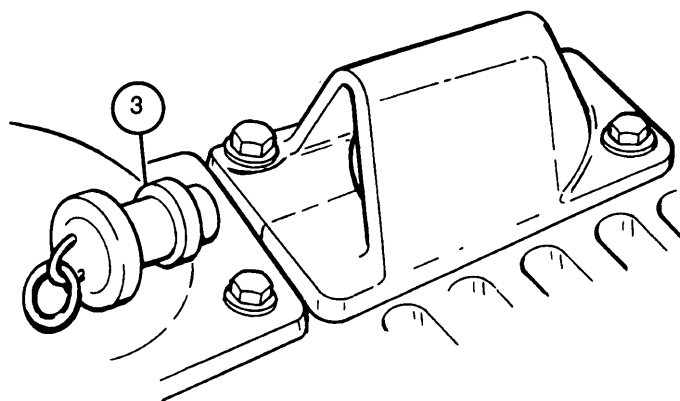
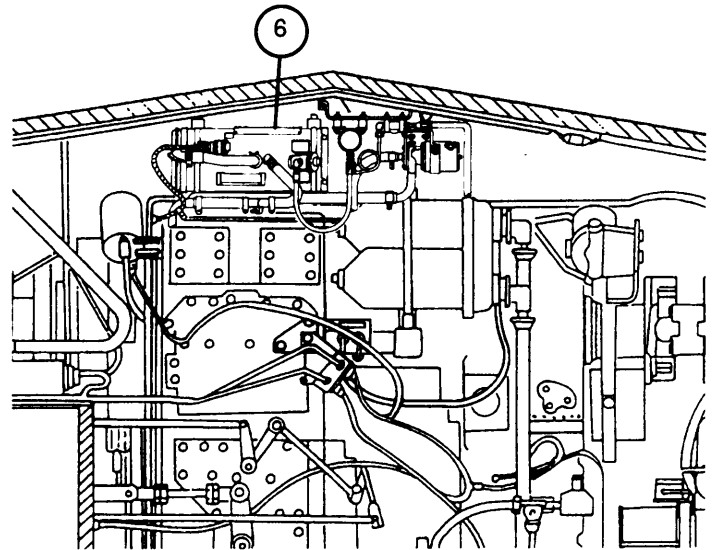
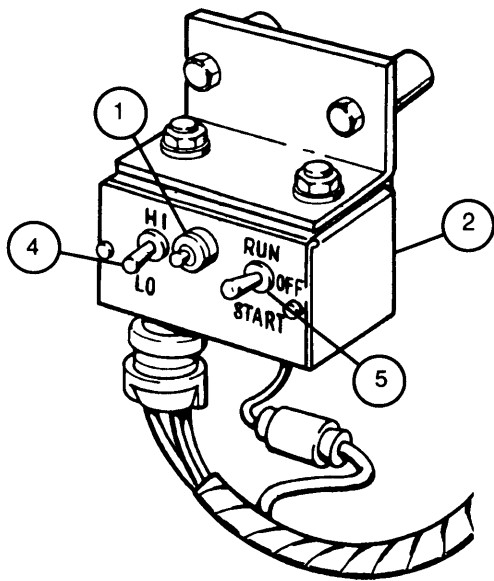
Cold weather starting procedures are to be used at 30° F (–1° C) and below. FLAME HEATER control switch and STARTER control switch must be activated at the same time.

- 1 If using winterization kit, stop coolant heater (6) before trying to start engine. Remove tarpaulins and roll into smallest tube form. Secure tarpaulins with webbing assemblies. Install exhaust outlet plug (3).
- 2 Charge batteries (especially after 24 hours of winterization kit operation).

## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### d. Cold Weather Starting (Vehicles with Engine Model 7083-7396) — Continued



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### d. Cold Weather Starting (Vehicles with Engine Model 7083-7396) — Continued

- 3 Depress brake pedal (7) and pull out and down on manual control handle (8) to engage parking brake.
- 4 Shift transmission shift control lever (9) into N (neutral) position.
- 5 Turn MASTER switch (10) to ON and MASTER switch indicator light (11) will illuminate.
- 6 Turn FUEL PRIME control switch (12) to ON and hold for 45 seconds, then release.

#### CAUTION

Do not engage STARTER control switch for more than 2 minutes at a time (for M109A2 and M109A3 models this must be timed; it is an automatic function in the M109A4 and M109A5 models). If engine speed does not reach 100 rpm after 15 seconds, release STARTER control switch and notify unit maintenance.

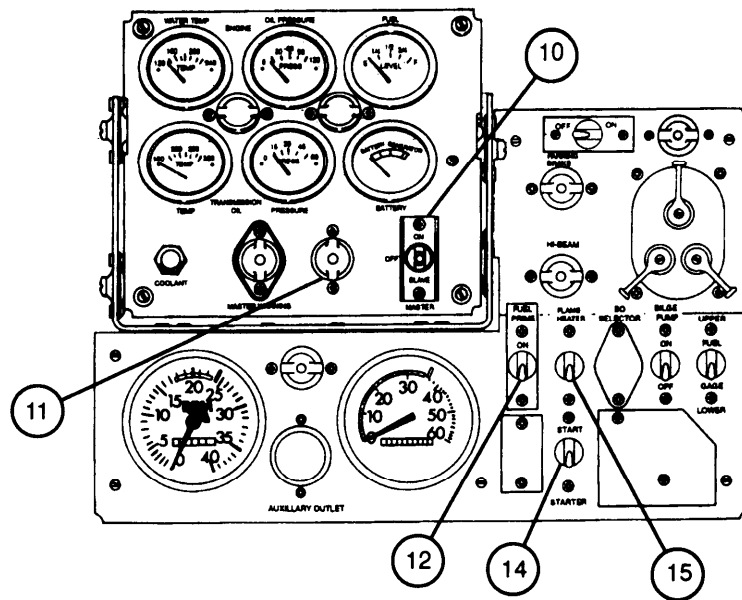
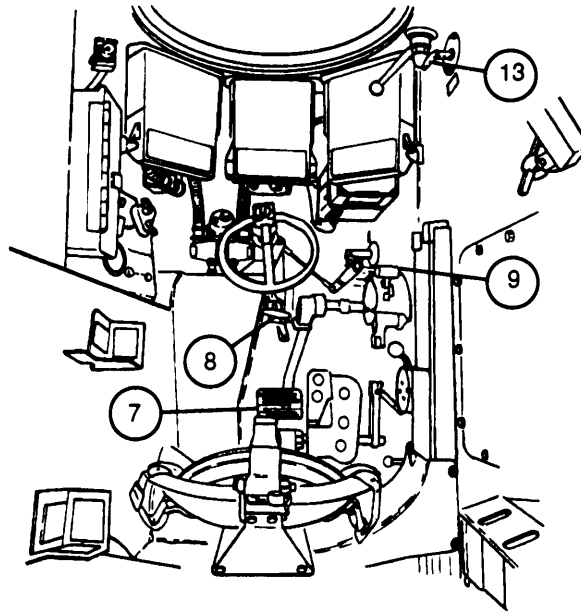
#### NOTE

- FLAME HEATER switch must be activated while starter is engaged.
  - M109A4 and M109A5 howitzers have a starter protection device in the engine compartment which will disengage starter automatically. The starter in all models must be disengaged after 60 seconds in temperatures between 0 and 50° F (–18 and 10° C) and after 120 seconds in temperatures below 0° F (–18° C). This will allow a 2 minute cooling off period between starting attempts. If engine (in M109A4 or M109A5) does not start using starter switch, proceed to step 8.
- 7 Pull FUEL SHUT OFF control assembly handle (13) out (off position) and hold. Engage STARTER control switch (14) and FLAME HEATER control switch (15), and crank engine for 15 seconds. Release FUEL SHUT OFF control assembly handle. Continue cranking engine and begin cycling FLAME HEATER control switch, on 1 second and off 1 second. When engine speed exceeds 300 rpm, release FLAME HEATER control switch. Continue to engage STARTER control switch until engine speed reaches 500 rpm.

2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

2-20.4 Operation in Extreme Cold — Continued

d. Cold Weather Starting (Vehicles with Engine Model 7083-7396) — Continued



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### d. Cold Weather Starting (Vehicles with Engine Model 7083-7396) — Continued

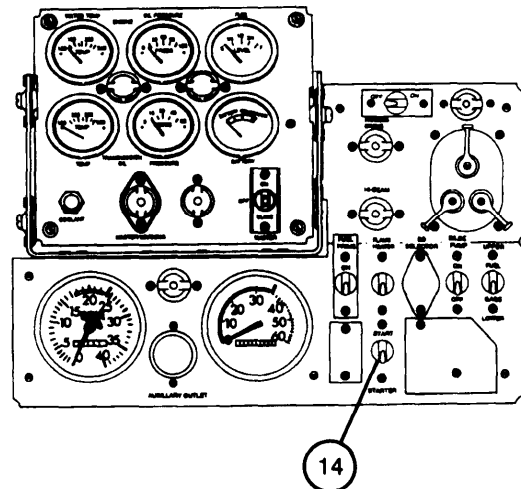
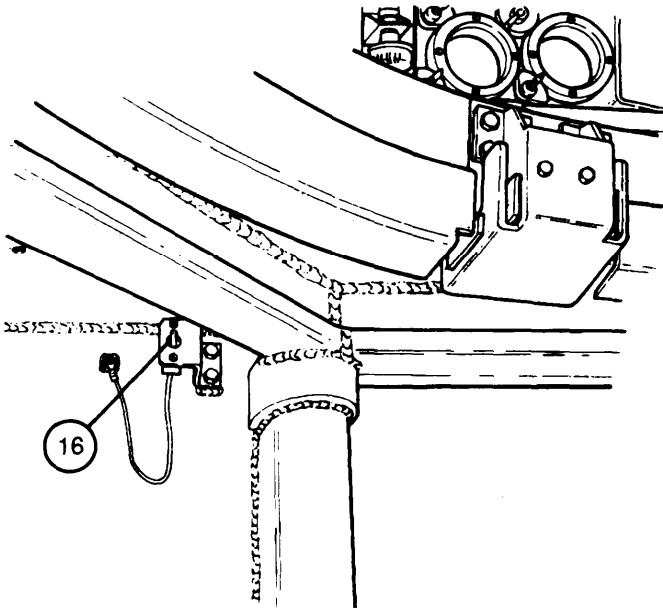
#### CAUTION

Combat override switch in M109A4 and M109A5 howitzers should be used in emergencies only, as determined by section chief. STARTER control switch must never be engaged for more than 2 minutes at a time. Do not make more than two attempts to start engine using combat override switch as damage to starter or low battery voltage may occur.

#### NOTE

- To assist in starting, hand throttle control lever setting may be increased 1/8 travel when engine speed exceeds 500 rpm.
- If engine does not start after 2 minutes of cranking, wait at least 2 minutes before trying to start again. If engine does not start after two tries, stop starting procedure and notify unit maintenance.
- If engine does not reach 100 rpm or more after 15 seconds, notify unit maintenance.

8 If engine in M109A4 or M109A5 howitzer does not start, repeat step 7 while engaging both STARTER control switch (14) and combat override switch (16). If engine does not start after two attempts, stop starting procedures and notify unit maintenance.

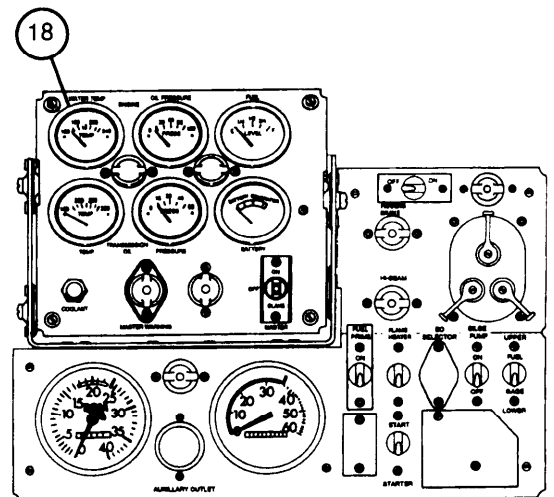
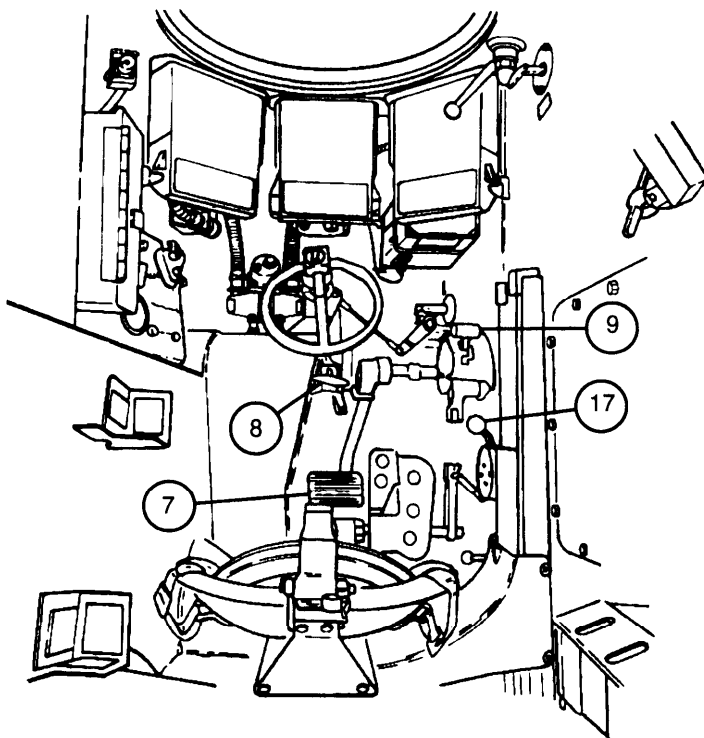


**2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED**

**2-20.4 Operation in Extreme Cold — Continued**

**d. Cold Weather Starting (Vehicles with Engine Model 7083-7396) — Continued**

- 9 With brakes still locked, shift transmission shift control lever (9) to 4 (4th gear) position and set hand throttle control lever (17) to run engine at 1200 rpm. When ENGINE WATER TEMP gage (18) indicates 120 to 140° F, shift into neutral and idle engine. (If transmission temperature approaches 300° F during warm-up, immediately shift to N (neutral), until temperature approaches normal range).
- 10 During warm-up, refer to portable instrument panel checkout procedure (para 2-10.2).
- 11 Press down on brake pedal (7) and lift up and push in on manual control handle (8) to release parking brake.
- 12 Shift transmission shift control lever (9) to 1 (1st gear position) and drive vehicle slowly 100 yards (91.4 m), being careful not to stall engine. This warms lubricants sufficiently for normal operation.



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

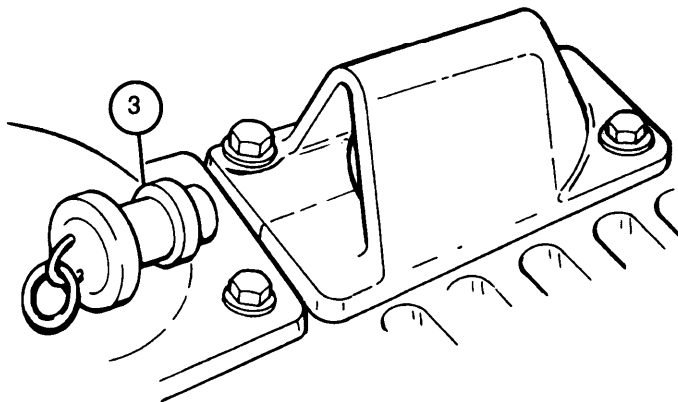
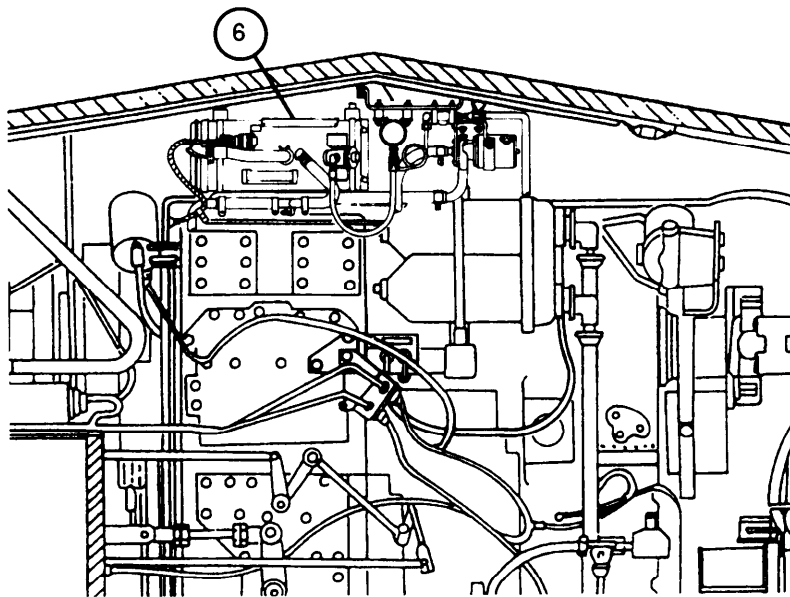
### 2-20.4 Operation in Extreme Cold — Continued

#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391)

##### NOTE

Cold weather starting procedures are to be used at 40° F (4° C) and below.

- 1 If using winterization kit, stop coolant heater (6) before trying to start engine. Remove tarpaulins and roll into smallest tube form. Secure tarpaulins with webbing assemblies. Install exhaust outlet plug (3).
- 2 Charge batteries (especially after 24 hours of winterization kit operation).



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

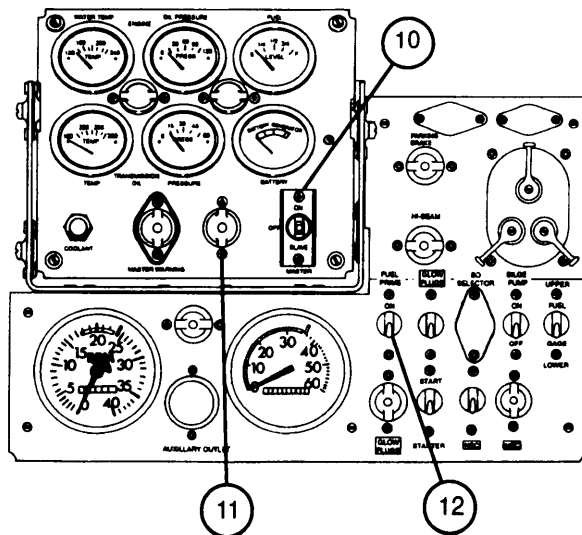
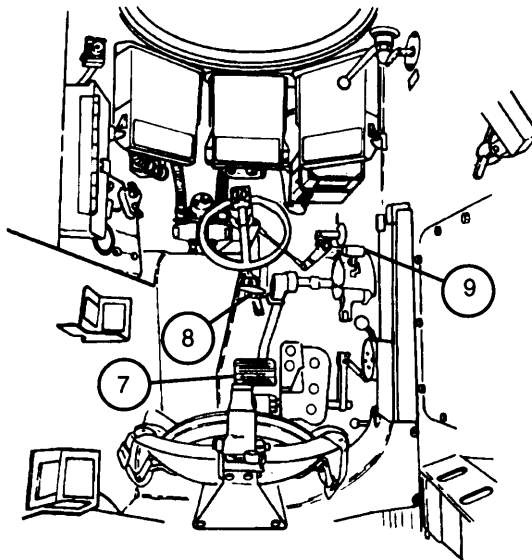
#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391) — Continued

3 Depress brake pedal (7) and pull out and down on manual control handle (8) to engage parking brake.

4 Shift transmission shift control lever (9) into N (neutral) position.

5 Turn MASTER switch (10) to ON and MASTER switch indicator light (11) will illuminate.

6 Turn FUEL PRIME control switch (12) to ON for 45 seconds and release.





## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391) — Continued

<b>CAUTION</b>
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Do not engage starter for more than 2 minutes at a time (for M109A2 and M109A3 models this must be timed; it is an automatic function in M109A4 and M109A5 models). If engine speed does not reach 100 rpm after 15 seconds, release STARTER control switch and notify unit maintenance.

#### NOTE

M109A4 and M109A5 howitzers have a starter protection device in the engine compartment which will disengage starter automatically. The starter in all models must be disengaged after 60 seconds in temperatures between 0 and 50° F (–18 and 10° C) and after 120 seconds in temperatures below 0° F (–18° C). This will allow a 2 minute cooling off period between starting attempts. If engine (in M109A4 or M109A5 howitzers) does not start using STARTER control switch, proceed to step 8.

- 7 Set hand throttle control lever (17) to full throttle position. Turn on GLOW PLUGS switch (19) and release. The GLOW PLUGS indicator light (20) will turn on and stay lit. After 35 seconds the GLOW PLUGS indicator light will flash on and off. Hold STARTER control switch (14) on for 2 or 3 seconds but not more than 5 seconds. Engine should start and increase in speed. When engine speed reaches 1500-1800 rpm, reduce throttle speed to 1200-1500 rpm to warm up engine.

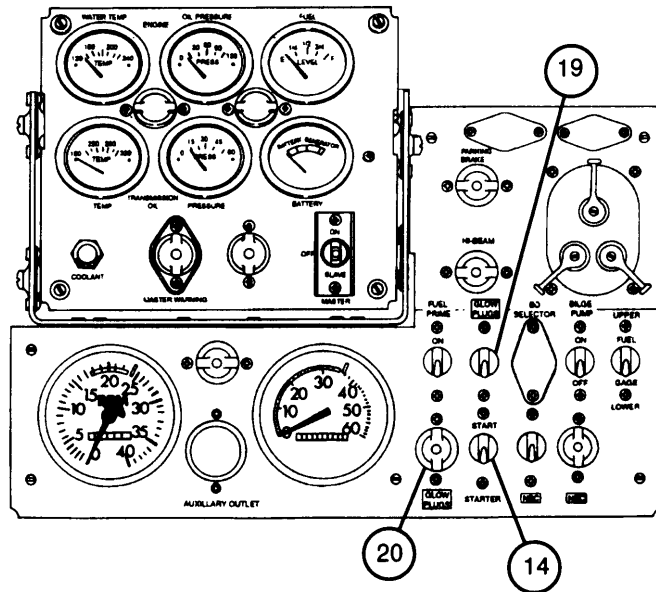
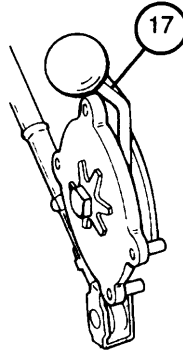
#### NOTE

- Attention should be focused upon the GLOW PLUGS indicator light during start-up. GLOW PLUGS are ON whether the GLOW PLUGS indicator light is lit continuously or flashing.
  - The GLOW PLUGS indicator light will not illuminate, or it will go out upon cranking the engine if voltage is insufficient.
  - When engine starter is engaged, GLOW PLUGS indicator light will stop flashing and stay on for 60 seconds after release of STARTER control switch.
  - If starter is not engaged within 60 seconds after GLOW PLUGS indicator light starts to flash, glow plugs and GLOW PLUGS indicator light will turn off.
  - Manual override of engine's glow plug controller is accomplished by continually holding GLOW PLUGS switch to on, as directed by chief of section.
- 8 If engine fails to start, wait 10 seconds and engage STARTER control switch (14). If the engine fails to start, or if the GLOW PLUGS indicator light (20) fails to illuminate after four attempts, manual override using the GLOW PLUGS switch (19) may be used as determined by the chief of section.

## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391) — Continued

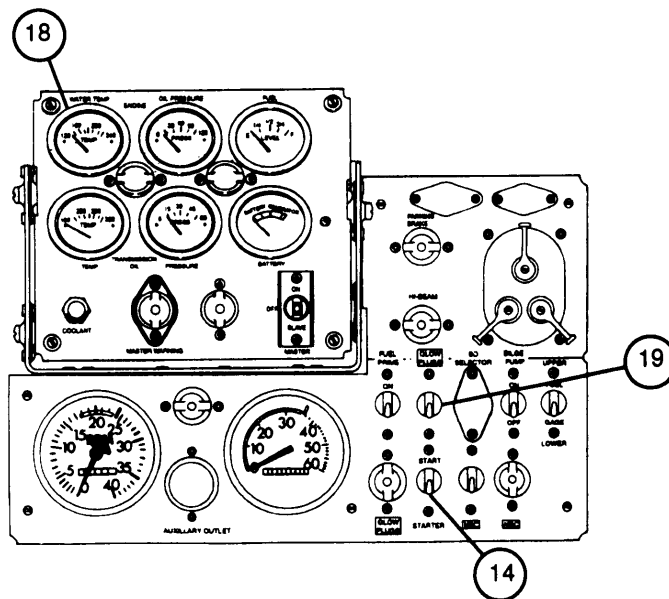


## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391) — Continued

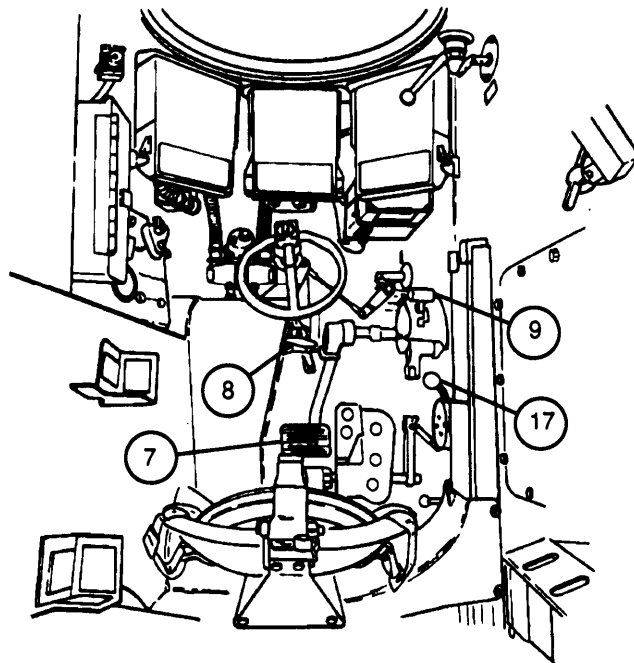
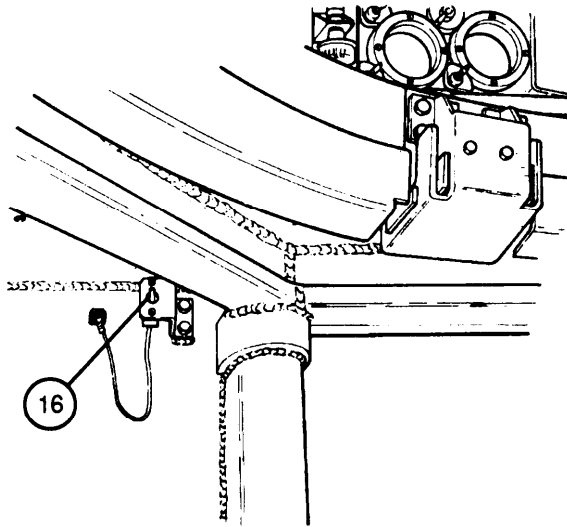
- 9 Manual override of the engine glow plug controller is accomplished by holding the GLOW PLUGS switch (19) for 35 seconds. Continue holding GLOW PLUGS switch and engage STARTER control switch (14). When engine starts, hold GLOW PLUGS switch on until engine speed reaches 1500 rpm. If engine fails to start after four attempts (M109A2/M109A3 howitzers) discontinue starting attempts and notify unit maintenance. For M109A4/M109A5 howitzers, proceed to step 10.
- 10 If engine in M109A4 or M109A5 howitzer does not start, repeat step 9 while engaging both STARTER control switch (14) and combat override switch (16). If engine does not start after two attempts, stop starting procedures and notify unit maintenance.
- 11 With brakes still locked, set hand throttle control lever (17) to run engine at 1200 rpm and shift transmission shift control lever (9) to 4 (4th gear) position. When engine WATER TEMP gage (18) indicates 120 to 140° F, shift into N (neutral) and idle engine. (If transmission temperature approaches 300° F during warm-up, immediately shift to N (neutral), until temperature approaches normal range).
- 12 During warm-up, refer to portable instrument panel checkout procedure (para 2–10.2).
- 13 Press down on brake pedal (7) and lift up and push in on manual control handle (8) to release parking brake.
- 14 Shift transmission shift control lever (9) to 1 (1st gear) position and drive vehicle slowly 100 yards (91.4 m), being careful not to stall engine. This warms lubricants sufficiently for normal operation.



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### e. Cold Weather Starting (Vehicles with LHR Engine Model 7083-7391) — Continued



## 2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED

### 2-20.4 Operation in Extreme Cold — Continued

#### f. Howitzer Cannon in Extreme Cold Weather

#### NOTE

Extreme cold weather temperatures between  $-20$  to  $-65^{\circ}$  F ( $-29$  to  $-54^{\circ}$  C) slows down extension of counter recoil to its maximum length for proper buffering action. Operate breech mechanism manually, observing the following instructions when firing first several rounds to warm buffer fluid to operating temperature.

- 1 Prepare weapon for firing before opening breech, loosen self-locking nut (21) on cam tension adjuster screw.
- 2 Manually open breech, load projectile and charge; close breech.

#### CAUTION

Use Zone 5 or below in cold weather to prevent malfunctions.

- 3 Before inserting primer, raise operating cam (22) until it clears roller (23) by  $1/16$  to  $1/8$  inch (1.59 to 3.18 mm) above rollers. Turn cradle cam stop (24) clockwise until clearance of  $1/16$  to  $1/8$  inch (1.59 to 3.18 mm) is maintained between operating cam and roller. Tighten self-locking nut (21).
- 4 Insert primer and continue standard firing procedures.
- 5 After weapon returns to battery, lift operating cam (22) and loosen self-locking nut (21). Turn cradle cam stop (24) counterclockwise until roller (23) engages in operating cam approximately  $3/16$  inch (4.8 mm), to permit operating cam and roller to hold breech open to reload weapon. Tighten self-locking nut.
- 6 Repeat steps 2 through 5 for each round fired, until buffer fluid is warmed to operating temperature. Buffer fluid can be warmed to operating temperature as follows:

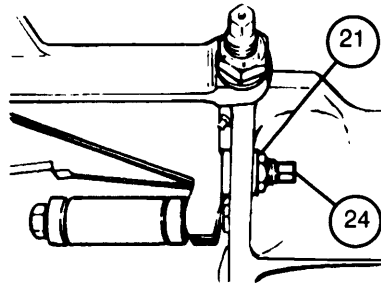
Temperature	No. of Rounds	Total Elapsed Time
$-20^{\circ}$ F ( $-29^{\circ}$ C)	4	9 minutes
$-30^{\circ}$ F ( $-34^{\circ}$ C)	5	12 minutes
$-40^{\circ}$ F ( $-40^{\circ}$ C)	6	15 minutes
$-50^{\circ}$ F ( $-46^{\circ}$ C)	7	21 minutes
$-60^{\circ}$ F ( $-51^{\circ}$ C)	8	24 minutes

- 7 After final "warm-up" round is fired, repeat step 5 to ensure proper clearance of at least  $3/16$  inch (4.8 mm) but not more than  $1/4$  inch (6.35 mm) between top of roller (23) at top of operating cam (22) path is maintained.

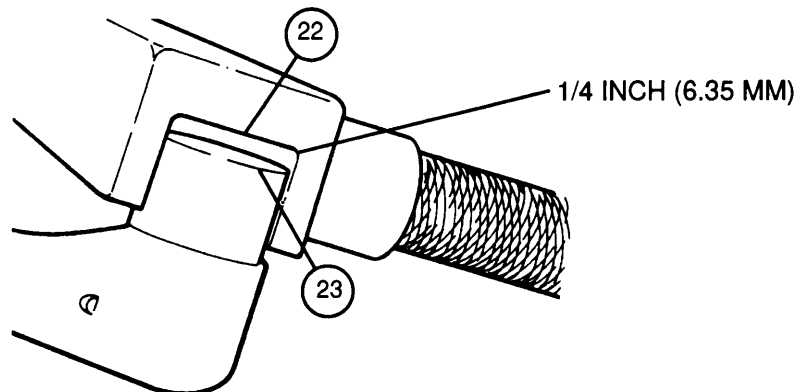
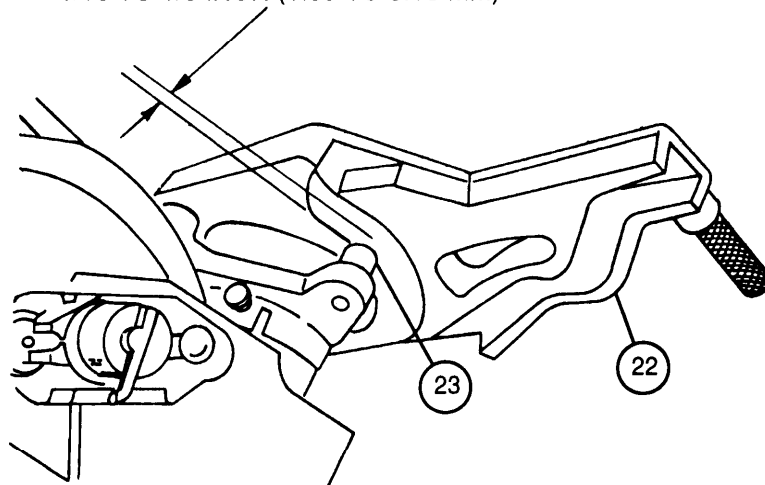
**2-20 OPERATION IN UNUSUAL ENVIRONMENT/WEATHER — CONTINUED**

**2-20.4 Operation in Extreme Cold — Continued**

**f. Howitzer Cannon in Extreme Cold Weather — Continued**



1/16 TO 1/8 INCH (1.59 TO 3.18 MM)



## 2-21 FORDING

The following procedures are for fording.

- 1 If time permits, add water to hull subfloor and check for leaks in hull plates and drain plugs of M109A4/M109A5 howitzers only. If leakage occurs, notify unit maintenance.
- 2 Assure hull plates are installed prior to fording operation. Do a lubrication on components exposed to water following the operation (Appendix G). Especially check wheel hub sight gages for water contamination.

## 2-22 EMERGENCY PROCEDURES — NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) DECONTAMINATION

### a. General

#### WARNING

- Keep M25A1 mask and Mission-Oriented Protective Posture (MOPP) gear on until the supervisor specifies "ALL CLEAR" in accordance with local procedures.
- The M13 Decontaminating Apparatus Kit contains DS2 decontaminating solution which is corrosive and gives off toxic fumes. Protective clothing and eye protection must be worn when handling DS2. It can severely burn the skin, cause blindness, or deteriorate the battledress and chemical protective overgarments. Do not use DS2 near an open flame, in confined spaces, or allow it to touch skin or clothing. Do not use M13 Decontaminating Apparatus Kit on the interior of the vehicle.
- When using any decontaminating spray, use care to avoid letting spray contact skin or clothing. it may cause personal injury.
- NBC contaminated gas and particulate filters must be handled using adequate precautions (FM 3-3) and must be disposed of in accordance with local procedures.
- The expended M13 Decontaminating Apparatus Kit components must be disposed of in a sealed container outside the vehicle in accordance with local procedures.
- During refueling and servicing operations, wear leather gloves (item 15, Appx D) over MOPP gloves to prevent injury due to deterioration of MOPP gloves from contact with petroleum products.

#### CAUTION

When using the DS2 decontaminating solution on the vehicle exterior, avoid spraying the vision blocks. It may damage electrical or optical components.

## 2-22 EMERGENCY PROCEDURES — NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) DECONTAMINATION — CONTINUED

### a. General-Continued

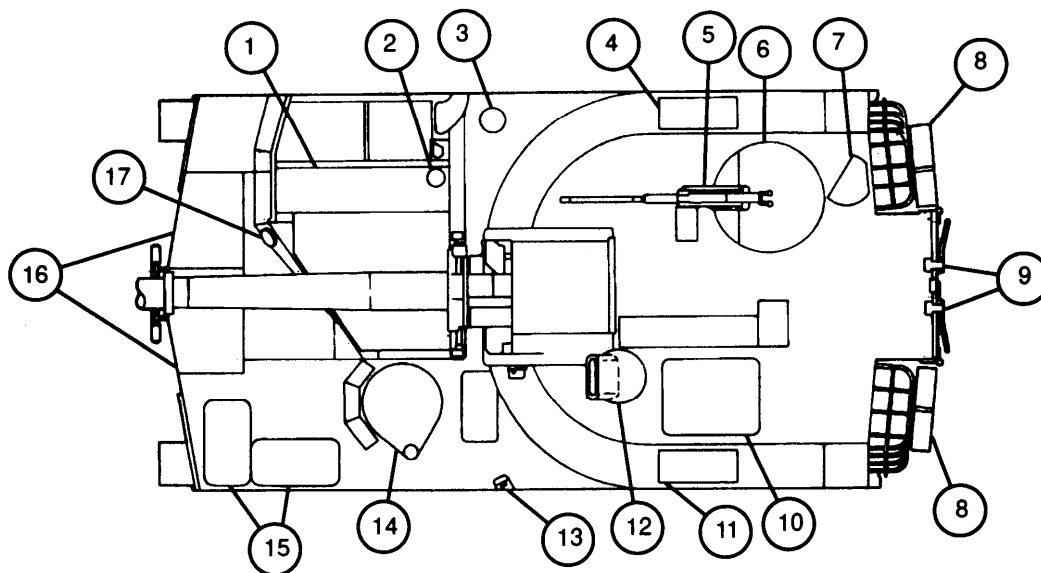
#### NOTE

- One M13 Decontaminating Apparatus Kit is carried on outside of vehicle rear door. Refer to TM 3-4230-214-12&P for detailed operation and maintenance of the M13 Decontaminating Apparatus Kit.
- The M258A1 Decontaminating Kit is to be used on the interior of the vehicle. Refer to TM 34230-216-10 for detailed operation and maintenance of the M28A1 Decontaminating Kit.

### b. External Decontamination

If outside of vehicle is contaminated during a chemical or biological attack, open and exit howitzer, and use M13 Decontaminating Apparatus Kit to spray the following areas:

- |                             |   |
|-----------------------------|---|
| 1. Radiator fan access door | 10. Gunner's escape hatch                         |
| 2. Radiator cap access door | 11. Left cab side door                            |
| 3. Fuel tank access door    | 12. Panoramic telescope ballistic cover           |
| 4. Right cab side door      | 13. Fire extinguisher handle and protective cover |
| 5. Caliber .50 machine gun  | 14. Driver's hatch cover                          |
| 6. Commander's cupola       | 15. Battery compartment access doors              |
| 7. Cab access cover         | 16. Transmission access doors                     |
| 8. Stowage boxes            | 17. Engine oil level check access door            |
| 9. Bustle doors             |   |





## 2-22 EMERGENCY PROCEDURES — NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) DECONTAMINATION — CONTINUED

### c. Internal Decontamination

**WARNING**

Do not use M258A1 Decontaminating Kit wipes on eyes, mouth, or open wounds. This may cause personal injury. Flush these areas with water.

**CAUTION**

Use the decontaminating kits as instructed on the kit or in the technical manual. Use several wipes if necessary. If a chemical agent monitor or other appropriate chemical agent detection device is not available, remain in full MOPP until safe levels are verified.

**NOTE**

- If monitoring is to be done with the Chemical Agent Monitor (CAM), use ONLY decontaminating wipe No. 2 prior to monitoring.
- After decontamination, clean all optical equipment, sights or periscopes with the appropriate lens cleaning fluid to remove residue from the wipes.

If inside of howitzer is contaminated during a chemical or biological attack, use the M258A1 Decontaminating Kit wipes on the following areas:

- Control handle, levers, and switches used to operate crew stations
- Steering and engine operating controls
- Fire control instruments and sights
- Weapons and weapon sights
- Seats and head rests
- Inside doors and hatches
- Radios

## **2-22 EMERGENCY PROCEDURES — NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) DECONTAMINATION — CONTINUED**

### **d. Chemical Agent Monitoring**

Use the Chemical Agent Monitor as directed in the accompanying instructions or refer to TM 3-6665-327-13&P for operating and maintenance instructions. If other chemical agent detection devices are used, follow accompanying instructions.

### **e. Complete Howitzer Decontamination**

When time permits, decontaminate complete howitzer (FM 3-5).



## CHAPTER 3 MAINTENANCE INSTRUCTIONS

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**Section I. LUBRICATION INSTRUCTIONS**

**3-1 LUBRICATION**

Lubrication instructions are in Appendix G of this manual. All lubrication instructions are mandatory.

**Section II. TROUBLESHOOTING PROCEDURES**

**3-2 INTRODUCTORY INFORMATION**

This table lists common malfunctions that you may find during the operation of the self-propelled howitzer or its components. Perform the tests, inspections, and corrective actions in the order they appear in the table.

This manual cannot list all the malfunctions that may occur, all the tests and inspections needed to find the faults, or all corrective actions needed to correct the fault. If the equipment malfunction is not listed or actions listed do not correct the fault, notify unit maintenance.

**NOTE**

Before using the troubleshooting table, be sure all applicable operating checks in Chapter 2 have been performed.

**3-3 MALFUNCTION INDEX**

The following Malfunction Index is to help locate the correct troubleshooting procedure quickly.

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Engine overheats . . . . .	3-6
<b>TRANSMISSION</b>	
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**3-3 MALFUNCTION INDEX — CONTINUED**

	Troubleshooting Procedures Page
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## 3-4 TROUBLESHOOTING

---

### MALFUNCTION

#### TEST OR INSPECTION

#### CORRECTIVE ACTION

---

### BATTERY

1. ENGINE CRANKS SLOWLY; ENGINE FAILS TO CRANK.

Step 1. Check position of MASTER switch.

Turn MASTER switch to ON.

Step 2. Check position of transmission shift control lever.

Place transmission shift control lever in the "N" position.

Step 3. Check to see if battery cables are loose, broken, or corroded.

Tighten loose battery cables (para 3-5.3). If battery cables are broken or corroded, notify unit maintenance.

Step 4. Check to see if BATTERY gage reads in normal range.

If BATTERY gage reads low, notify unit maintenance.

#### NOTE

During emergency conditions, attempt to tow-start vehicle (para 2-10.5). If the engine still won't start, notify unit maintenance.

2. BATTERIES DO NOT STAY CHARGED.

Check for excessive use of electrical systems when engine is not running.

Turn all electrical accessories off when not in use.

### MASTER RELAY

3. MASTER SWITCH INDICATOR LIGHT FAILS TO OPERATE.

Step 1. Check position of MASTER switch.

Turn MASTER switch to ON.

Step 2. Check to see if LED is burned out by replacing it with a spare. Apply silicone compound (item 10.1, Appx D) to base of LED before installing the LED.

If LED is burned out, discard. If problem persists, notify unit maintenance.

Step 3. Check for loose electrical leads.

If electrical leads are loose, notify unit maintenance.

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

##### TEST OR INSPECTION

##### CORRECTIVE ACTION

---

#### ENGINE

#### 4. ENGINE CRANKS BUT FAILS TO START.

Step 1. Check FUEL gage.

Fill as necessary (para 3-5.2).

Step 2. Check to see if fuel shut off control assembly handle is pulled out.

Push fuel shut off control assembly handle in completely.

Step 3. Check for blocked fuel lines.

Remove any blockage. Disconnect and straighten kinked or pinched fuel lines. If fuel lines continue to leak, notify unit maintenance.

Step 4. Check for sediment, water, or other evidence of contaminated fuel.

Drain primary and secondary fuel filters (para 3-5.2).

Step 5. Check for water and dirt in fuel tanks.

Remove dirt and water from fuel tanks (para 3-5.2).

#### NOTE

If improper fuel is suspected, notify unit maintenance.

#### 5. ENGINE DOES NOT ACCELERATE PROPERLY OR DOES NOT DEVELOP FULL POWER.

Step 1. Check for sediment, water, or other evidence of contaminated fuel.

Drain primary and secondary fuel filters (para 3-5.2).

Step 2. Check for fuel leaks.

Tighten fuel lines, fittings, and primary and secondary fuel filters.

Step 3. Check air cleaner indicator for evidence of restrictions in air cleaner filters.

If red, clean and service air cleaner filters (para 3-5.4).

Step 4. Check accelerator pedal for bends or binding.

Notify unit maintenance if bends or binding exists.

Step 5. Check accelerator pedal linkage for binding or damage.

Notify unit maintenance if binding or damage exists.



## 3-4 TROUBLESHOOTING — CONTINUED

---

### MALFUNCTION

#### TEST OR INSPECTION

#### CORRECTIVE ACTION

---

### ENGINE —CONTINUED

#### 6. ENGINE HAS LOW OR NO OIL PRESSURE.

Step 1. Check engine oil level.

If engine oil level is below L (low) mark, fill as necessary (item 1, Appx G).

Step 2. Check engine compartment for evidence of oil leaks.

Notify unit maintenance if oil leaks exist.

#### 7. ENGINE OVERHEATS.

Step 1. Check coolant level in radiator. Check for leaks in engine coolant tubes.

Fill radiator as necessary (para 3-5.1). If leaks are visible, notify unit maintenance.

Step 2. Check engine oil level.

If engine oil level is below L (low) mark, fill as necessary (item 1, Appx G).

Step 3. Check radiator cap for tight fit.

Tighten radiator cap. If replacement is necessary, notify unit maintenance.

Step 4. Check cooling fan for proper operation.

If defective, notify unit maintenance.

Step 5. Check radiator and grilles for blockage.

Remove blockage, if present.

Step 6. Check air cleaner indicator for evidence of restrictions in air cleaner filters.

If red, clean and service air cleaner filters (para 3-5.4).

Step 7. Check for prolonged period of idle at a low RPM.

If necessary, increase idle speed to 1000-1200 RPM (high idle).

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

##### TEST OR INSPECTION

##### CORRECTIVE ACTION

---

#### TRANSMISSION

##### 8. VEHICLE DOES NOT DRIVE; TRANSMISSION DOES NOT OPERATE IN ANY SHIFT POSITION.

Step 1. Check transmission oil level.

If low, fill as necessary (item 2, Appx G).

Step 2. Check for disconnected or broken universal joints.

If disconnected or broken, notify unit maintenance.

#### TRACKS AND SUSPENSION

##### 9. VEHICLE PULLS TO ONE SIDE WITH STEERING WHEEL IN CENTER POSITION.

Step 1. Check for mud or dirt buildup on tracks.

Clean tracks as necessary.

Step 2. Check track tension.

Adjust as necessary (para 3-5.5).

Step 3. Check final drive sprockets for even wear (Table 2-1).

If necessary, reverse sprockets. If excessive wear exists, notify unit maintenance.

##### 10. VEHICLE THROWS TRACK(S).

Step 1. Check for loose or worn track.

Adjust as necessary (para 3-5.5). If replacement is necessary, notify unit maintenance.

Step 2. Check for improper driving or operation of vehicle.

If necessary, modify driving or operation of vehicle. Do not make high speed turns.

#### PERSONNEL HEATER

##### 11. PERSONNEL HEATER FAILS TO OPERATE; PERSONNEL HEATER SMOKES OR BANGS UPON STARTING.

Check to see if you are starting personnel heater correctly (para 2-17.1).

If personnel heater still does not operate, notify unit maintenance.

##### 12. HEAT OUTPUT IS TOO LOW.

Check position of HEAT SELECTOR switch.

Place HEAT SELECTOR switch in HIGH position.

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

##### TEST OR INSPECTION

##### CORRECTIVE ACTION

---

#### BILGE PUMP

##### 13. BILGE PUMP FAILS TO OPERATE.

Step 1. Check position of BILGE PUMP control switch.

Move BILGE PUMP control switch to ON.

Step 2. Check position of MASTER switch.

Move MASTER switch to ON. If problem persists, notify unit maintenance.

#### BREECH

##### 14. BREECH DOES NOT CLOSE COMPLETELY.

<b>WARNING</b>
----------------

If breech is not closed completely, do not attempt firing, as it may result in death or injury to crew.

#### NOTE

Breech is completely closed when witness marks align.

Step 1. Check to see if breechblock or breech ring threads or components are dirty or burred.

Clean as required. If burrs are present, notify unit maintenance.

Step 2. Check for insufficient lubrication.

Lubricate as required (item 6, Appx G).

Step 3. Check outer edge of spindle assembly and gas check seat for residue or dirt buildup.

Swab areas clean (para 2-13).

Step 4. Check for deformation of the retaining rings and condition of obturator pad.

Disassemble and clean spindle assembly (para 3-6.8). If obturator pad is sliced, cracked, chipped, or damaged, notify unit maintenance for replacement.

Step 5. Check to see if breech mechanism components are damaged or worn.

Notify unit maintenance if components are damaged.

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

##### TEST OR INSPECTION

##### CORRECTIVE ACTION

---

#### CANNON

#### 15. JERKY RECOIL; EXCESSIVE RECOIL FORCE; EXCESSIVE RECOIL TRAVEL AT HIGH ANGLE OF FIRE.

Step 1. Check for air in variable recoil hydraulic system and buffer assembly.

Bleed variable recoil assembly and buffer assembly (item 11, Appx G).

Step 2. Check replenisher accumulator assembly level.

Fill as necessary (item 10, Appx G).

Step 3. Check to see if cradle sleeve bearings need lubrication.

If necessary, lubricate (item 32, Appx G).

Step 4. Check recuperator assembly pins.

If pins extend more than 3/4 inch (19.05 mm), add hydraulic fluid (item 12, Appx G). If fault continues, notify unit maintenance.

#### 16. PRIMER DOES NOT FIRE.

**WARNING**

Follow misfire instructions before opening breechblock (para 2–15).

Step 1. Check primer for firing pin dent.

Replace primer if dented (para 2–12.5).

Step 2. Check firing pin for mushrooming, breakage, or burrs.

#### NOTE

If firing pin is defective, replace on M109A5 howitzers or notify unit maintenance for replacement on M109A2/M109A3/M109A4 howitzers.

If defective, notify unit maintenance or replace firing pin (para 3-6.8).

Step 3. Check for bent, burred, or worn firing mechanism parts.

If necessary, notify unit maintenance to replace defective firing mechanism parts (para 3-6.8).

Step 4. Check nut on spindle assembly for cross-threading caused by carbon deposits.

Clean or replace nut on spindle assembly (para 3-6.8). If problem persists, notify unit maintenance.

## 3-4 TROUBLESHOOTING — CONTINUED

---

### MALFUNCTION

#### TEST OR INSPECTION

#### CORRECTIVE ACTION

---

### CANNON—CONTINUED

#### 17. PRIMER NOT EJECTED PROPERLY.

Step 1. Check to see if primer chamber is dirty or pitted.

Clean as necessary (para 2-12.5).

Step 2. Check to see if cartridge extractor is bent or broken.

Notify unit maintenance if defective.

#### 18. CAB FILLS WITH SMOKE OR GASES AFTER FIRING.

Step 1. Clean, lubricate, and inspect bore evacuator, bearing balls, orifices, and valve rings for serviceability (para 3-6.7).

Notify unit maintenance if defective parts are found.

Step 2. Check to see if retaining rings are properly installed (para 3-6.8).

Rotate so that splits in rear and front retaining rings are 180° apart.

Step 3. Visually check for worn obturator pad or deformed retaining rings.

#### NOTE

If obturator pad or retaining rings are defective, replace on M109A5 howitzers or notify unit maintenance for replacement on M109A2/M109A3/M109A4 howitzers.

If defective, remove spindle assembly (para 3-6.8) and notify unit maintenance or replace obturator pad or retaining rings.

#### 19. BORE EVACUATOR OR MUZZLE BRAKE THRUST COLLAR BECOMES LOOSE.

Step 1. Check for loose or missing setscrew that secures bearing bail and spring. This setscrew should be staked.

Notify unit maintenance if setscrew is missing or loose.

Step 2. Check functioning of bearing ball and spring.

Notify unit maintenance if bearing ball is stuck or spring appears broken.

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

#### TEST OR INSPECTION

#### CORRECTIVE ACTION

---

#### CAB TRAVERSING SYSTEM

##### 20. CAB WILL NOT TRAVERSE FREELY IN MANUAL MODE.

#### NOTE

All attempts to traverse should be made manually only.

Step 1. Check to see if travel lock and turret lock are fully released.

Release travel lock and turret lock (para 2–10.8).

Step 2. Check position of TRAVERSE CONTROL switch.

Turn TRAVERSE CONTROL switch to MANUAL position.

Step 3. Check vehicle interior and exterior for obstructions that may impede traversing.

Clear obstructions.

Step 4. Check for dirt, rust, or other obstructions on main drive gears or cab race ring gear.

Clean as necessary. If problem persists, notify unit maintenance.

##### 21. CAB WILL NOT TRAVERSE FREELY IN POWER MODE.

Step 1. Check to see if travel lock and turret lock are fully released.

Release travel lock and turret lock (para 2–10.8).

Step 2. Check positions of MASTER switch, CAB POWER switch, and TRAVERSE CONTROL switch.

Turn MASTER switch and CAB POWER switch to ON. Turn TRAVERSE CONTROL switch to POWER.

Step 3. Check oil level in traversing mechanism assembly.

Fill if oil level is low (item 46, Appx G).

Step 4. Check hydraulic pressure in accumulator assembly.

Correct hydraulic pressure is 925 to 1225 psi (6378 to 8446 kPa). If high or low, notify unit maintenance.

Step 5. Check for electrical failure of clutch valve in M109A4/M109A5 howitzer by pulling up on override lever while power traversing (para 2–10.8).

If cab traverses, the electrical solenoid in clutch valve is faulty, notify unit maintenance. Operate override lever and power traverse.

### 3-4 TROUBLESHOOTING — CONTINUED

---

#### MALFUNCTION

##### TEST OR INSPECTION

##### CORRECTIVE ACTION

---

#### CAB TRAVERSING SYSTEM—CONTINUED

##### 22. CAB CREEPS.

Step 1. Check positions of MASTER switch, CAB POWER switch, and TRAVERSE CONTROL switch.

Turn MASTER switch and CAB POWER switch to ON. Turn TRAVERSE CONTROL switch to POWER.

Step 2. Check for cant in excess of 89 mils.

Level vehicle if necessary. If problem persists, notify unit maintenance.

##### 23. TRAVERSING MECHANISM ASSEMBLY OVERHEATS.

Check oil level in traversing mechanism assembly.

Fill if oil level is low (item 46, Appx G). If oil level is not low, notify unit maintenance.

#### ELEVATING SYSTEM

##### 24. CANNON DOES NOT ELEVATE OR DEPRESS UNDER POWER OR MANUALLY, BUT HYDRAULIC PRESSURE IS NORMAL.

Step 1. Check to see if cannon tube is in travel lock.

If necessary, release travel lock.

Step 2. Check cannon equilibrators adjustment.

Adjust as necessary (para 3-6.2). If problem persists, notify unit maintenance.

##### 25. EFFORT REQUIRED TO ELEVATE CANNON IS GREATER OR LESS THAN EFFORT REQUIRED TO DEPRESS CANNON.

Check cannon equilibrators adjustment.

Adjust as necessary (para 3-6.2).

#### CAB HYDRAULIC SYSTEM

##### 26. POWER PACK OPERATES CONTINUOUSLY WHEN CAB POWER AND MASTER SWITCHES ARE ON.

Perform zero pressure check (para 3-6.4) on main accumulator assembly.

If pressure is below 500 psi or problem persists, notify unit maintenance.

### 3-4 TROUBLESHOOTING — CONTINUED

---

**MALFUNCTION****TEST OR INSPECTION****CORRECTIVE ACTION**

---

**RAMMER HYDRAULIC SYSTEM****27. RAMMER DOES NOT OPERATE PROPERLY.**

Check the hydraulic system for a malfunction. Perform reliability checks (para 3-6.3) to determine the malfunction.

If defective, notify unit maintenance.

**28. EFFORT REQUIRED TO MOVE RAMMER TO REAR STOP OR FORWARD STOWED POSITION.**

Check to see if rammer mounting bracket is properly adjusted (para 3-6.3).

Adjust as necessary (para 3-6.3).



### Section III. MAINTENANCE PROCEDURES

#### 3-5 HULL MAINTENANCE PROCEDURES

The following hull maintenance procedures are to be performed by the driver with the assistance of the crew.

##### 3-5.1 Engine Cooling System

###### a. Adding Coolant

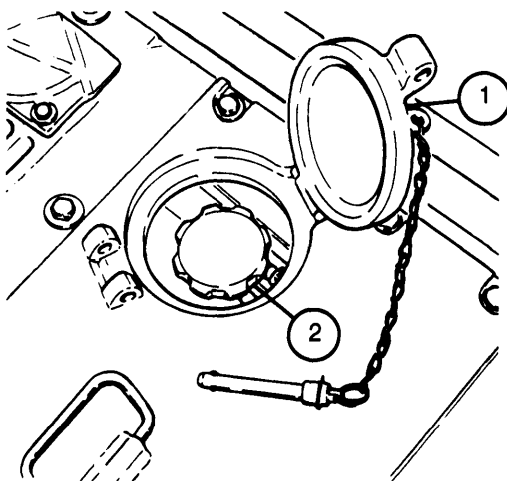
**WARNING**

NEVER remove radiator cap on an engine until it has cooled. Use a rag (item 35, Appx D), and remove radiator cap slowly to prevent serious injury to personnel.

**CAUTION**

Do not use methyl alcohol in engine cooling system. It may destroy non-metallic parts.

- 1 Lower the RPM below cruising speed on an overheated engine until temperature drops to operating range. If temperature continues to rise, shut down completely and allow 10 minutes for engine to cool before adding coolant.
- 2 Open radiator cap access door (1), and using a rag (item 35, Appx D), slowly unscrew radiator cap (2). When steam subsides, remove radiator cap.
- 3 Start engine and idle. Add antifreeze (item 3, 4, or 5 Appx D) to top of filler neck. Replace radiator cap (2).
- 4 Run engine for a minute longer to eliminate any air locks. Recheck coolant level and add antifreeze (item 3,4, or 5 Appx D), if necessary.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.1 Engine Cooling System — Continued

##### b. Faulty Cooling System

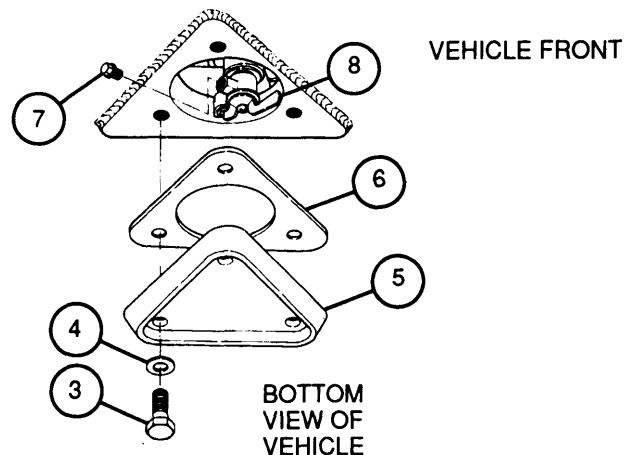
#### NOTE

Overheating is caused by a faulty cooling system or low coolant level. Proper maintenance of cooling system will help prevent overheating.

If radiator is clogged or dirty, notify unit maintenance.

##### c. Draining Coolant

- 1 Allow engine to cool down below 185° F.
- 2 Place vehicle on an incline, nose down, to facilitate coolant draining.
- 3 Remove three cap screws (3), three flat washers (4), and access cover (5) with gasket (6) from bottom of vehicle.
- 4 Use a container to catch fluids and remove plug (7).
- 5 Turn coolant drain valve (8) counterclockwise to drain.
- 6 Slowly remove radiator cap (2).
- 7 Close coolant drain valve (8), install plug (7), and refill coolant (para 3-5.1a.).
- 8 Install access cover (5) with gasket (6), three flat washers (4) and three cap screws (3).



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.1 Engine Cooling System — Continued

##### d. Coolant Temperature Ranges

Below -55° F(-48°C) . . . . .	Antifreeze, (Arctic type, full strength) (item 3, Appx D)
-55 to 32° F(-48° to 0°C) . . . . .	Antifreeze, (50% water mixture) (item 4 or 5, Appx D)
Above 32° F(0°C) . . . . .	Add corrosion inhibitor, see TB 750-651 (22-1/2 ounces (665.4 ml) per vehicle)

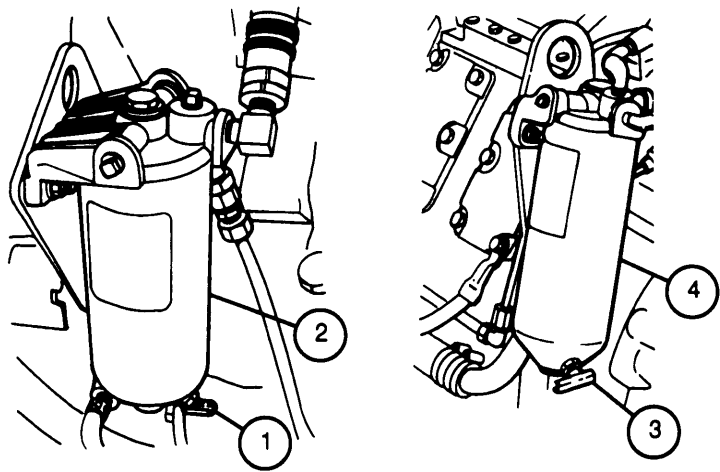
#### 3-5.2 Fuel System

##### a. Service



Diesel fuel is flammable. Do not smoke within 50 feet (15.2 m) of the vehicle while performing service operations to prevent serious injury to personnel.

- 1 Using a container to catch fuel, open drain cock (1) on primary fuel filter (2) and drain cock (3) on secondary fuel filter (4) to remove water and dirt.
- 2 When clear fuel is visible, close drain cocks (1 and 3).
- 3 After primary and secondary fuel filters (2 and 4) have been drained, purge air from fuel system by turning FUEL PRIME control switch to ON for 45 seconds prior to starting engine.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.2 Fuel System — Continued

##### a. Service — Continued

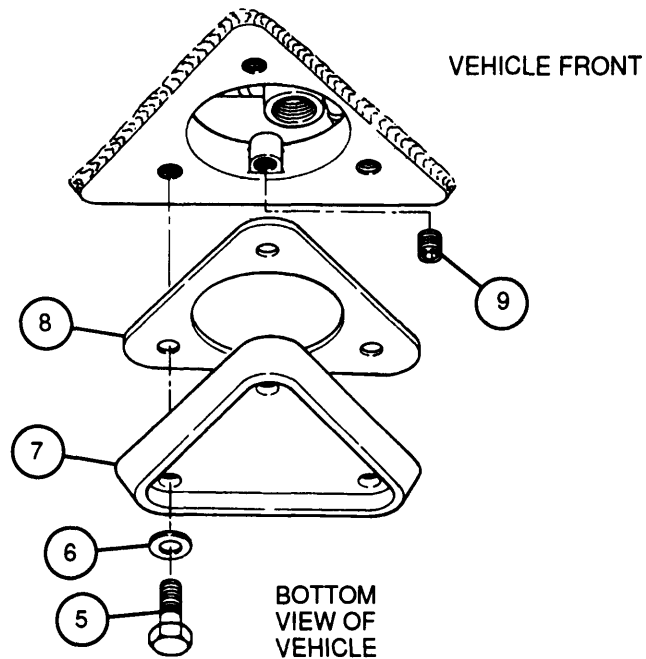
A fuel tank holds 135 gallons (511 l) of fuel. Before draining, provide a suitable container with capacity to hold the fuel to be drained.

**NOTE**

After operation, keep fuel tank full to minimize condensation.

- 4 When necessary, remove water and dirt from fuel tanks as follows:
  - (a) Remove three cap screws (5), three flat washers (6), and access cover (7) with gasket (8) from bottom of vehicle.
  - (b) Using a socket head screw key, remove plug (9).
  - (c) When clear fuel is visible, install plug (9).
  - (d) Install access cover (7) with gasket (8), three flat washers (6), and three cap screws (5).

**NOTE**  
Coolant drain valve removed for clarity.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.2 Fuel System — Continued

##### b. Refueling

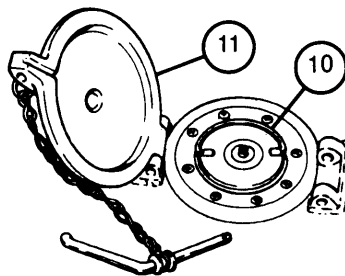
**WARNING**

Diesel fuel is flammable. Do not smoke within 50 feet (15.2 m) of the vehicle while refueling to prevent serious injury to personnel.

- 1 Shut off engine.
- 2 Before removing fuel filler cap (10), clean away debris.
- 3 Open fuel tank access door (11) and remove fuel filler cap (10) slowly.
- 4 Ground fuel hose nozzle to vehicle.

**NOTE**

- Do not lay hose across vehicle.
  - If vehicle will not be operated for more than 1 month, perform step 5. If not, skip to step 6.
  - Fuel additive in step 5 will not remove foreign matter from the fuel system, but will prohibit microbial growth on inner fuel tank surfaces.
  - Ensure fuel tank is at least half full prior to putting fuel additive into fuel tank.
- 5 Add 3.5 ounces (103.5 ml) of additive (item 1, Appx D) for each 100 gallons (378.5 l) of diesel fuel in fuel tank. Use 4.725 ounces (139.7 ml) for a full tank of fuel (135 gallons (511 l)).
  - 6 Fill to a level six inches (15.24 cm) below top of filler neck.
  - 7 Replace fuel filler cap (10) and close fuel tank access door (11).



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

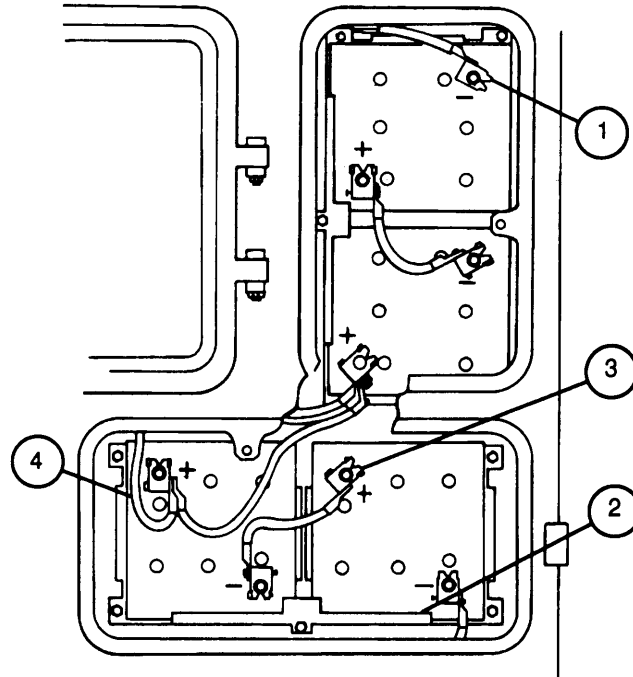
#### 3-5.3 Servicing Batteries

**WARNING**

- Lead-acid battery gases can explode. Do not smoke or allow sparks or open flames near batteries. Wear eye protection when checking batteries. Failure to follow this procedure could cause death or serious injury. If a battery is gassing, it can explode and cause injury to personnel.
- When working on batteries, remove all jewelry, dog tags, and metal items to avoid electrical shock and burns.

##### a. Loose Connections

- 1 Lugs (1) should be all the way down on the battery posts and tight (TM 9-6140-200-14).
- 2 Hold-down brackets (2) should be tight, but not so tight as to damage battery case.
- 3 If cap screw (3) threads are corroded, notify unit maintenance for replacement to ensure a tight hold.
- 4 Cables (4) and lugs (1) should be tight,



## 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

### 3-5.3 Servicing Batteries — Continued

#### b. Electrolyte Level

- 1 Clean off filler caps before removing. Do not allow dirt or foreign matter to get into battery cells.
- 2 Keep the vent holes in filler caps clear to allow gas to escape from cells.
- 3 Electrolyte level must not drop below the top of the battery plates, If this condition exists, fill battery to the level ring with distilled water (item 13, Appx D).

#### c. Corrosion

**WARNING**

Battery corrosion is an acid and will eat holes in clothing. Wash any acid off skin immediately to avoid the burning effects.

- 1 Corrosion tends to build upon the battery posts, lugs, and cables. This corrosion may damage cables and lugs. If corroded, notify unit maintenance.

**NOTE**

Make sure battery filler caps are tight and no cracks are visible in battery case.

- 2 Clean top of battery with a damp rag (item 35, Appx D) and wipe dry.

#### d. Unserviceable Batteries

**CAUTION**

Deep-cycling is a complete discharge of the batteries. This will lessen battery life and, in freezing weather, will burst the battery case. Avoid running the battery down.

If the batteries fail, notify unit maintenance.

### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.4 Maintenance of Air Cleaner

##### a. Removal

**WARNING**

If NBC exposure is suspected, all filter media will be handled by personnel wearing full NBC protective equipment.

**NOTE**

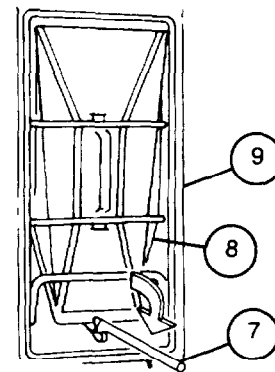
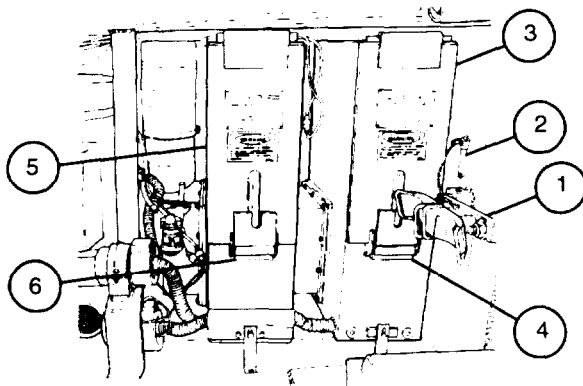
Depending on conditions, the air cleaner filter must be removed periodically for cleaning. Loss in engine power, an overheating engine, or excessive black exhaust may indicate need for more frequent cleaning. If air cleaner indicator shows red area, the air cleaner is restricted and air cleaner filters must be checked.

- 1 Shut off engine.
- 2 Remove hull ammunition rack (1) by disconnecting two quick-release pins (2) and lifting straight up.
- 3 Remove right access door (3) by pulling locking latch (4) down and lifting off right access door.

**CAUTION**

Do not pull left access door up so far that it causes binding and damage to left access door when removing.

- 4 Remove left access door (5) by pulling locking latch (6) down, pulling left access door up slightly, and sliding left access door off to right.
- 5 Pull locking levers (7) down.
- 6 Push air cleaner filter (8) in and pull out from air cleaner filter compartments (9).





### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.4 Maintenance of Air Cleaner — Continued

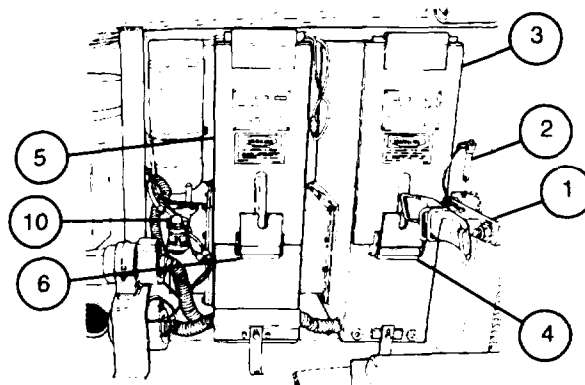
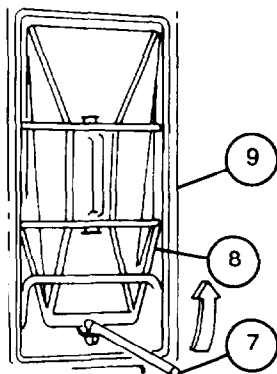
##### b. Cleaning

**WARNING**

- Wear eye protection. Particles released from air cleaner filters during cleaning could injure eyes.
  - Air cleaner filters will become contaminated when operating in an NBC environment. Contaminated air cleaner filters must be handled and disposed of in accordance with FM 3-3 and FM 3-4.
- 1 Clean air cleaner filters (8) with compressed air. (Emergency clean by tapping bottom or sides against flat surface. Do not strike open or sealing edge of air cleaner filters.)
  - 2 Clean air cleaner filter compartments (9).

##### c. Installation

- 1 Install air cleaner filters (8) by alining with outlet gaskets to assure proper sealing and secure locking levers (7).
- 2 Slide right and left access doors (3 and 5) on air cleaner and secure by pulling locking latches (4 and 6) down and then up.
- 3 Install hull ammunition rack (1) and secure with two quick-release pins (2).
- 4 Reset air cleaner indicator (10) by pushing up on reset button (located on bottom of cylinder).
- 5 Start engine. If indicator gage reads 25 in. H<sub>2</sub>O or greater, notify unit maintenance.

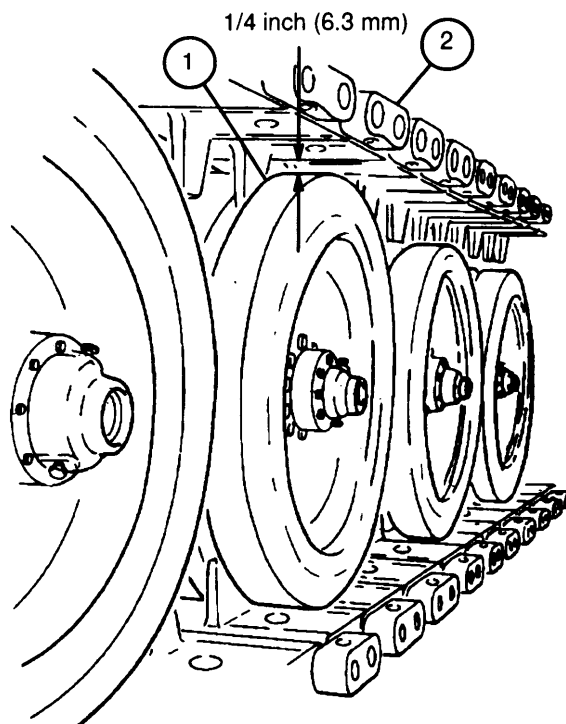


### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.5 Adjusting Track Tension

##### a. Checking Track Tension

- 1 Move vehicle forward and backward several times on level ground, stopping by shifting transmission shift control lever to "N" (neutral) and coasting to a stop without applying the brakes.
- 2 Turn off engine.
- 3 Measure the distance between top of the third road wheel (1) and the track (2). The distance should be 1/4 inch (6.3 mm). If not, adjust track tension.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.5 Adjusting Track Tension — Continued

##### b. Increasing Track Tension

**CAUTION**

When increasing track tension, do not let track adjuster extend beyond 3-1/2 inches (8.89 cm) or track adjuster damage may occur.

**NOTE**

- When track adjuster has reached the maximum extended limit of 3-1 /2 inches (8.89 cm), remove one track shoe and readjust track tension.
- If track sag cannot be taken up, decrease track tension; remove track shoe and adjust.

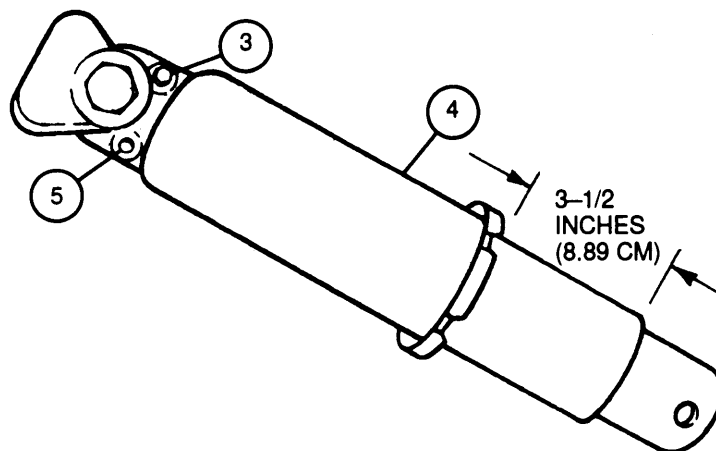
- 1 Clean fitting (3).
- 2 Pump grease (item 20, Appx G) into fitting (3) on track adjuster (4) until correct tension is obtained.

##### c. Decreasing Track Tension

**WARNING**

Lubricant is under high pressure. Loosen bleeder plug slowly to avoid injury to personnel.

Open bleeder plug (5) on track adjuster (4) and reduce pressure until tension is released. Tighten bleeder plug and wipe away excess grease.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

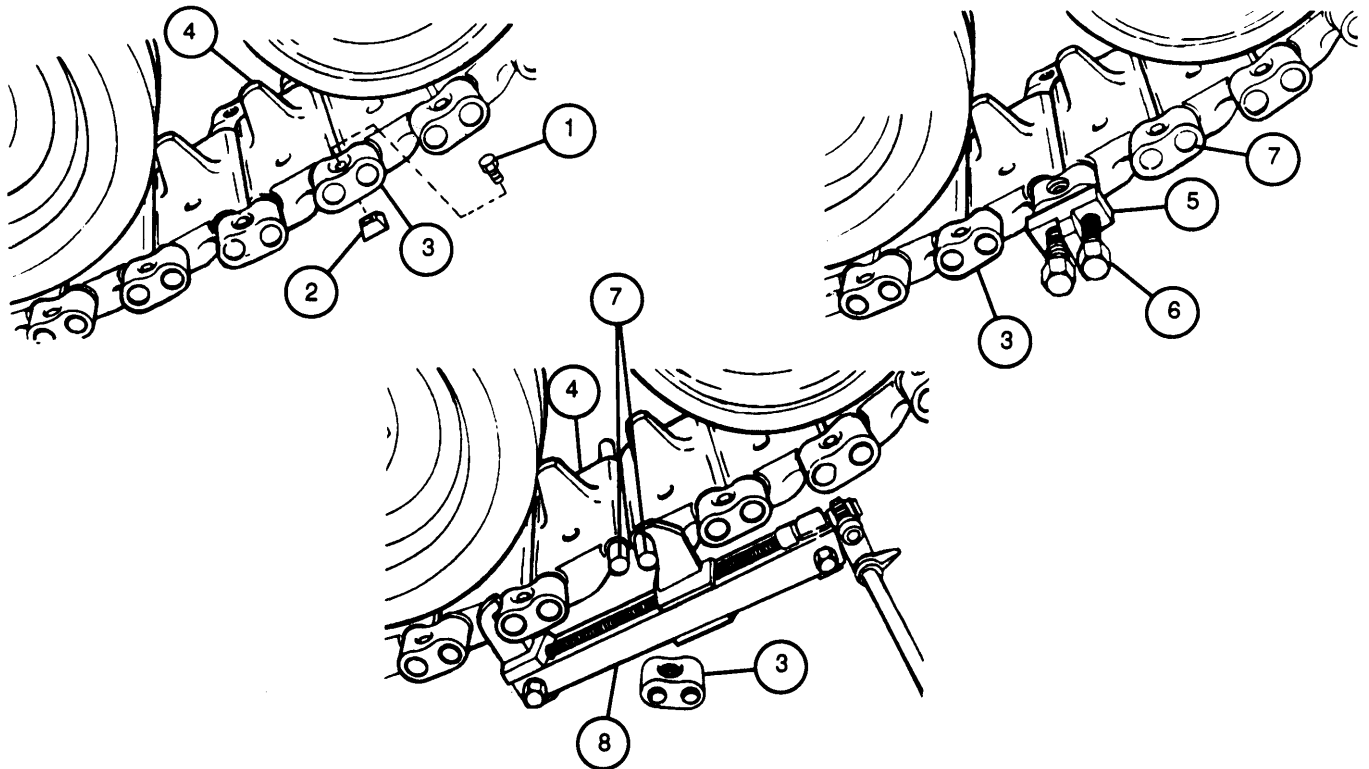
#### 3-5.6 Maintenance of T-136 Track

##### a. Removing Track Shoe

#### NOTE

Move vehicle so track shoe to be removed is off the ground, either between the road wheel and the idler wheel or between the drive sprocket and the front road wheel.

- 1 Decrease track tension (para 3-5.5).
- 2 Remove four bolts (1) and four retaining wedges (2) from four end connectors (3) of the track shoe (4) to be removed.
- 3 Install T-136 track connector puller (5) and tighten two screws (6) against ends of track link pins (7).
- 4 Move all four end connectors (3) out approximately 1 inch (2.54 cm), but do not remove.
- 5 Install track connector fixtures (8) on both sides of track shoe (4) being removed, engaging track link pins (7) on adjoining track shoes.
- 6 Remove four end connectors (3) and track shoe (4).



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.6 Maintenance of T-136 Track — Continued

##### b. Installing Track Shoe

- 1 With track connector fixtures (8) still installed, install track shoe (4) and four end connectors (3).
- 2 Install four retaining wedges (2) and four bolts (1) to four end connectors (3).
- 3 Notify unit maintenance to torque four bolts (1) to 90-100 lb-ft (122–136 N·m).
- 4 Remove track connector fixtures (8).
- 5 Adjust track tension (para 3-5.5).

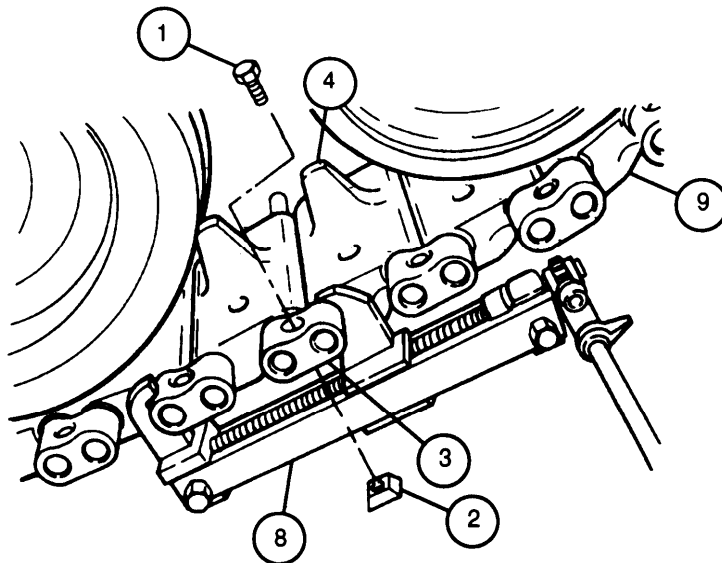
##### c. Disconnecting Track

- 1 Disconnect track (9) in same manner as replacing track shoe (4) (para 3-5.6a.), but only remove two end connectors (3) opposite each other.

**WARNING**

Track is heavy. Before removing track connector fixtures, support weight of track with crowbar to lower track to ground, preventing possible injury.

- 2 Remove track connector fixtures (8).
- 3 To connect track (9), refer to paragraph 3-5.6e.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.6 Maintenance of T-136 Track — Continued

##### d. Installing Track

**WARNING**

Both left and right tracks must match. When installing T-136 track on one side of vehicle, the other side must be T-136 track, otherwise control of vehicle could be lost causing injury.

**NOTE**

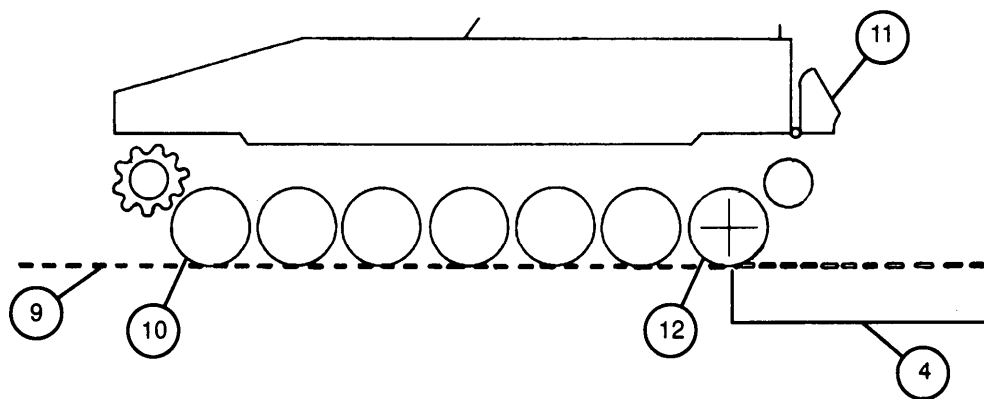
There are 79 track shoes per track.

- 1 Lay connected track (9) out in front of vehicle in a straight line, directly ahead of and touching the first road wheel (10).
- 2 Raise rear fender (11) to upper position.

**WARNING**

Use extreme care when moving vehicle on only one track. Drive slowly, moving only short distances. Carelessness can result in death or injury to personnel or damage to equipment.

- 3 Start engine and drive slowly onto track (9) until 11 track shoes (4) extend past centerline of last road wheel (12).
- 4 Stop engine. Apply parking brakes.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.6 Maintenance of T-136 Track — Continued

##### d. Installing Track — Continued

**WARNING**

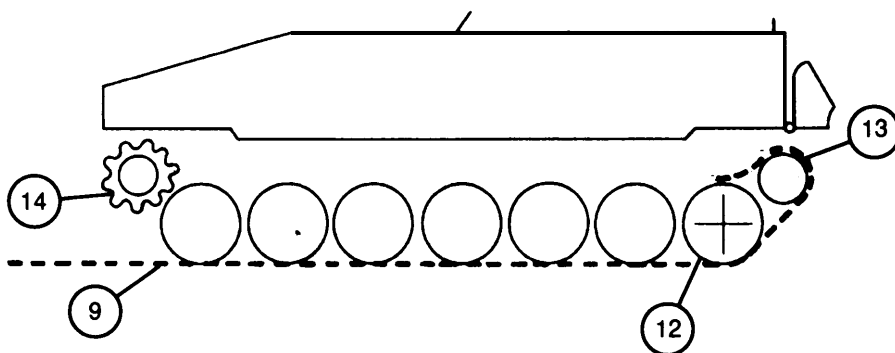
Personnel raising track with crowbar must stand to side of track. Do not allow personnel in front of track. Injury could result if track suddenly separates.

- 5 Lift track (9) with crowbar over idler wheel (13) until it rests on top of last road wheel (12).
- 6 Release parking brakes.

**CAUTION**

Raise end of track with crowbar to prevent damage from it getting caught between road wheels.

- 7 Start engine and shift transmission shift control lever to 1 (first gear) position. Drive forward slowly, steering in direction of track (9) being installed.
- 8 Stop when track (9) can be laid on drive sprocket (14).
- 9 Steer toward opposite track (9) and drive forward slowly.
- 10 Stop engine when track connector fixtures (8) can be connected to track link pins (7) on both ends of loose track (9).
- 11 Apply parking brakes.
- 12 To connect track, refer to paragraph 3-5.6e.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.6 Maintenance of T-136 Track — Continued

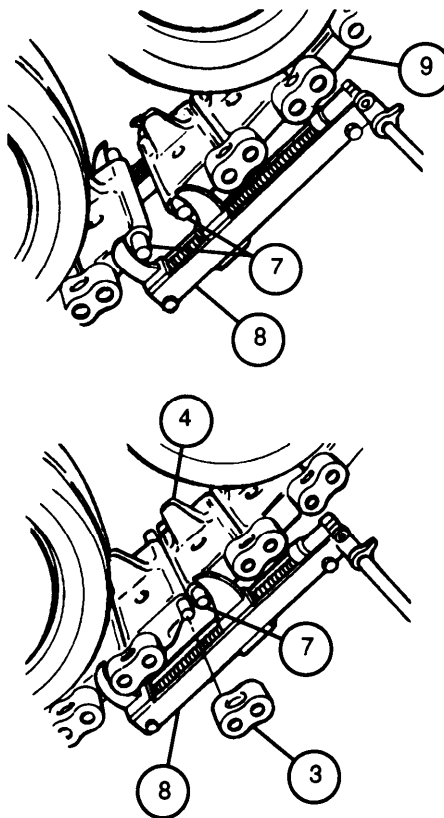
##### e. Connecting Track

- 1 Install a track connector fixture (8) over track link pins (7) on both sides of track (9).
- 2 Tighten track connector fixtures (8) evenly until track link pins (7) are close enough to permit track connector fixtures to fit over one track link pin and end connector (3) farthest from it.
- 3 Remove one track connector fixture (8) and reposition over one track link pin (7) and end connector (3) farthest from it. Tighten track connector fixture evenly until track link pins are close enough to install end connectors. Repeat this step for other track connector fixture.

#### NOTE

Do not attempt to install retaining wedges when installing end connectors.

- 4 Install end connectors (3) with raised edge toward track shoe (4) by tapping with hammer.
- 5 Remove track connector fixtures (8).





### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.6 Maintenance of T-136 Track — Continued

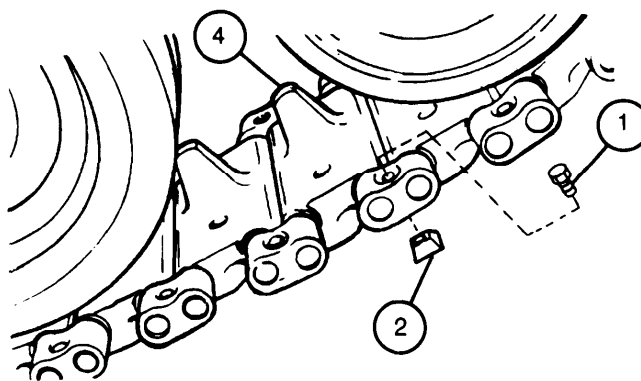
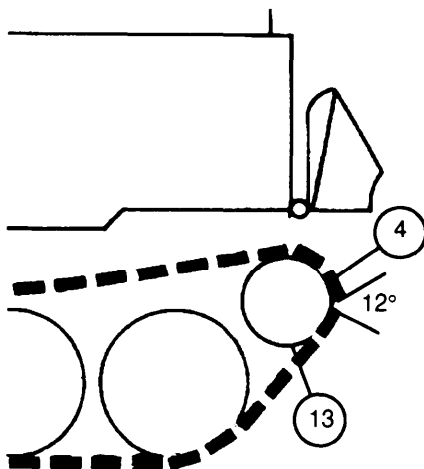
##### e. Connecting Track — Continued

- 6 Position vehicle so connecting point is positioned on idler wheel (13) where the track shoes (4) are bent at approximately a 12° angle.

**CAUTION**

Do not tighten bolts when track shoes form a straight line.

- 7 Install retaining wedges (2) and bolts (1).
- 8 Notify unit maintenance to torque bolts (1) to 90-100 lb-ft (122–136 N·m). Torque again after 50 miles (80 km).
- 9 Check track tension and adjust if necessary (para 3-5.5).



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.7 Maintenance of T-154 Track

##### a. Removing Track Shoe

**NOTE**

Ensure vehicle is parked so track shoe to be removed is off the ground, either between the road wheel and the idler wheel or between the drive sprocket and the front roadwheel.

Decrease track tension (para 3-5.5).

Remove four bolts (1) from four end connectors (2) holding track shoes (3) to be removed.

Install end connector puller (4) and tighten two screws (5) against ends of track link pins (6).

Move four end connectors (2) out approximately 1 inch (25.4 mm), but do not remove.

Install two track fixtures (7) across track shoe (3) being removed, engaging track link pins (6) on adjoining track shoes.



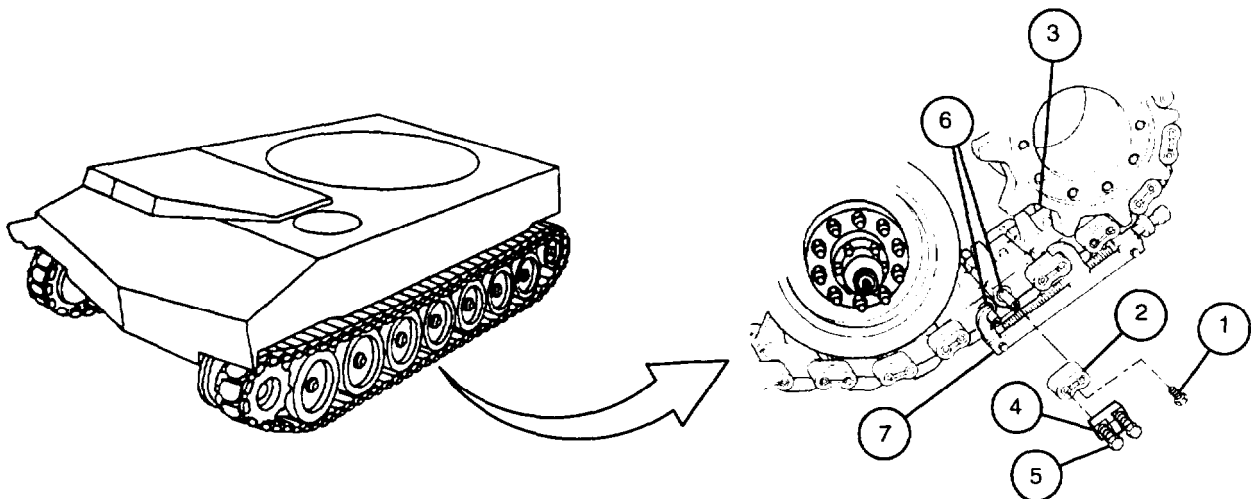
Track is heavy. Before removing track-connecting fixtures, support weight of track with crowbar to lower track to ground, to prevent possible injury.

Remove two end connectors (2) from track shoe (3) with end connector puller (4).

Support weight of track with crowbar.

Remove two track fixtures (7) and lower track to ground with crowbar.

Remove two remaining end connectors (3) from track shoe being removed.



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.7 Maintenance of T-154 Track — Continued

##### b. Installing Track Shoe

- 1 Position track shoe (3) on one end of disconnected track and secure with two end connectors (2).
- 2 Using a crowbar, raise track far enough to install two track fixtures (7).
- 3 Install two track fixtures (7) across track shoe being connected and tighten evenly until track link pins (6) are close enough to install two end connectors (2).
- 4 Connect track shoe with two end connectors (2) and remove two track fixtures (7).
- 5 Install two end connectors (2) on track shoe (3) by tapping with hammer until end connectors are flush with track link pins (6).

#### NOTE

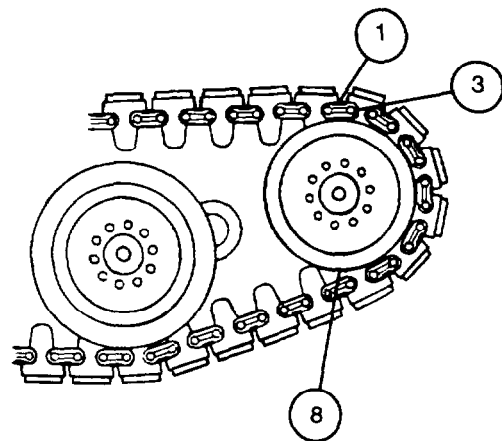
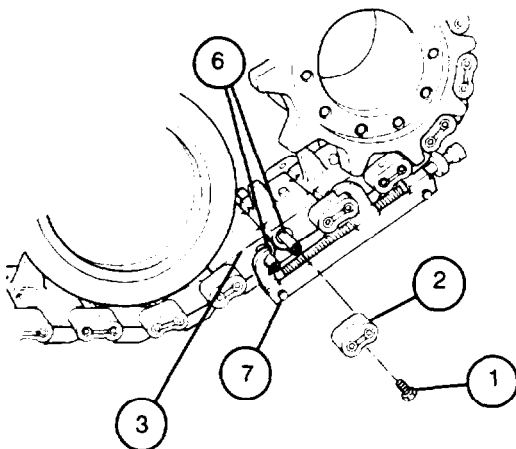
A lubricant is applied to end connector bolts at the manufacturer. Any end connector bolt torqued dry is incorrectly torqued (too LOW). If a bolt is removed and reinstalled, a new coating of lube must be applied. Any oil or grease is acceptable.

- 6 Install and tighten four bolts (1) in four end connectors (2).
- 7 Mark replaced end connectors (2).
- 8 Move track so that replaced end connector (2) is at the 12 o'clock position (top) of the idler wheel (8).

#### NOTE

Notify unit maintenance to torque replaced end connector bolts (1) to 380-420 lb-ft (515570 N·m) wet.

- 9 Adjust track tension (para 3-5.5).
- 10 Drive vehicle at a speed not to exceed 10 MPH for a short distance alternating right and left steers.
- 11 Stop vehicle and visually inspect the four end connectors (2) of the replaced track shoe (3). If any end connectors have shifted position, reposition and torque the four end connector bolts (1) (steps 7 and 8).



### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.7 Maintenance of T-154 Track — Continued

##### c. Disconnecting Track

- 1 Disconnect track in same manner as replacing track shoe (para 3-57a.), but remove only two connectors opposite each other.

**WARNING**

Track is heavy. Before removing track connecting fixtures, support weight of track with crowbar to lower track to ground, to prevent possible injury.

- 2 Before removing track fixtures, support weight of track with crowbar to lower track to ground.
- 3 To connect track, refer to paragraph 3-5.7e.

##### d. Installing Track

**WARNING**

Both left and right tracks must match. When installing T-154 track on one side of vehicle, the other side must be T-154 track, otherwise control of vehicle could be lost causing injury.

**NOTE**

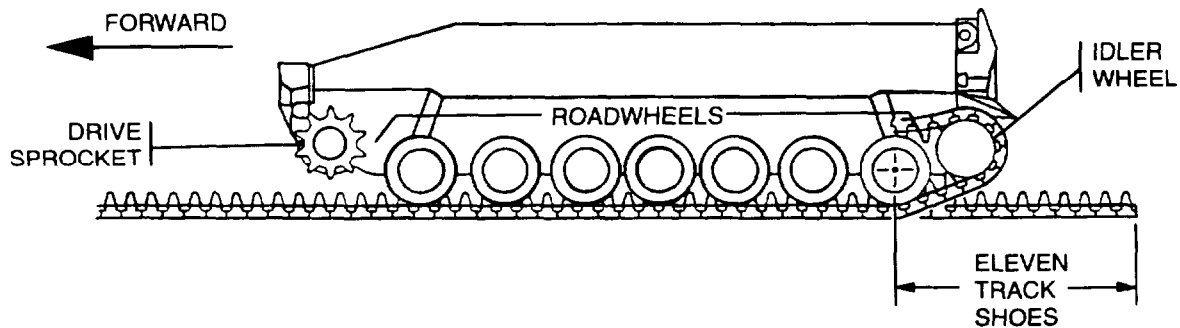
Rear fender must be in raised position to remove and install track over idler wheel.

- 1 Lay track out in front of vehicle in a straight line, directly ahead of and touching the first road wheel (80 shoes per track).

**WARNING**

Use extreme care when moving vehicle on only one track. Drive slowly, moving only short distances. Carelessness can result in death or injury to personnel or damage to equipment.

- 2 Start engine and drive slowly onto track to a point where enough track shoes to cover idler wheel extend past centerline of last roadwheel.



- 3 Stop engine and leave parking brake off.
- 4 Install stop blocks front and rear.

### 3-5 HULL MAINTENANCE PROCEDURES — CONTINUED

#### 3-5.7 Maintenance of T-154 Track — Continued

##### d. Installing Track — Continued

**WARNING**

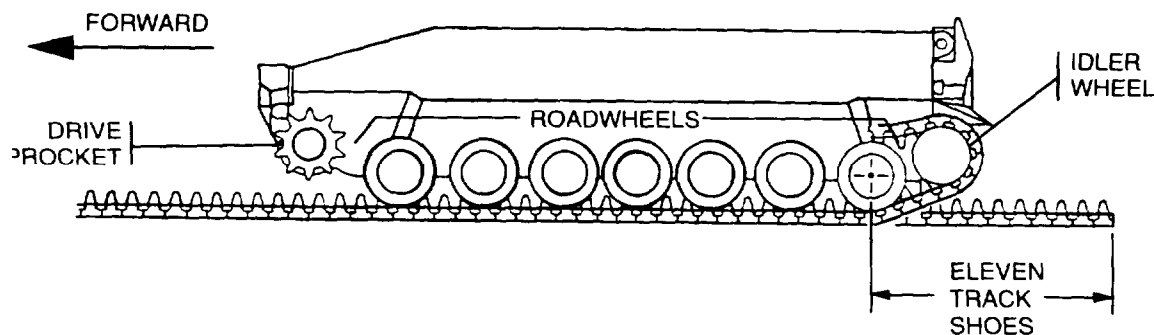
Personnel raising track with crowbar must stand to side of track. Do not allow personnel in front of track. Injury could result if track suddenly separates.

- 5 Place an end connector on end of the track, and with the use of track fixture handle, lift end of track over idler wheel until it rests on top of last roadwheel.
- 6 Remove stop blocks.

**CAUTION**

Raise end of track with crowbar to prevent damage from it getting caught between road wheels.

- 7 Start engine, place shift lever in forward (F-1), with steering turned in direction of removed track. Move vehicle forward slowly, allowing track to rest on roadwheels, lifting up on end of track to prevent it from getting caught between roadwheels.
- 8 Lay end of track on drive sprocket, turn steering wheel to opposite track and accelerate at low speed. This will clutch brake opposite track final drive, pulling track forward.
- 9 Stop engine when track fixtures can be connected to both ends of loose track and apply parking brake to hold sprocket in place. A crowbar may be used to pry down or up on loose track to install track fixtures. Install two fixtures over link pins one on inside and one on outside of track. Release brake. To connect track, refer to paragraph 3-5.7e.



##### e. Connecting Track

- 1 Tighten track fixtures (7) evenly until link pins (6) are close enough to install end connectors (2).
- 2 Connect track shoe with end connectors (2) and remove two track fixtures (7).
- 3 Reposition track fixtures (7), one at a time, and continue to tighten evenly until link pins (6) are close enough to install end connectors (2).

### 3-5 HULL MAINTENANCE PROCEDURES -CONTINUED

#### 3-5.7 Maintenance of T-154 Track — Continued

##### e. Connecting Track — Continued

- 4 Install end connectors (2) until end connectors are flush with track link pins (6) on track shoe (3) by tapping with hammer.

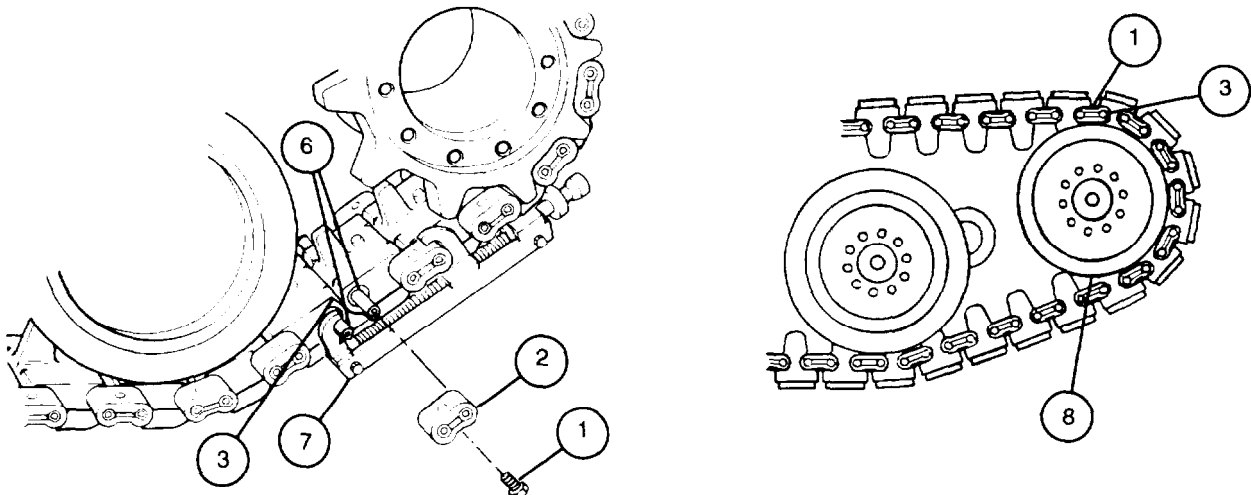
**NOTE**

A lubricant is applied to end connector bolts at the manufacturer. Any end connector bolt torqued dry is incorrectly torqued (too LOW). If a bolt is removed and reinstalled, a new coating of lube must be applied. Any oil or grease is acceptable.

- 5 Install end connector bolts (1) and tighten.
- 6 Mark replaced end connectors (2).
- 7 Move track so that end connectors (2) are at the 12 o'clock position (top) of idler wheel (8).

**NOTE**

Notify unit maintenance to torque end connector bolts (1) to 380-420 lb-ft (515-570 N•m).



- 8 Adjust track tension (para 3-5.5).

**CAUTION**

Hard pivot steers are unacceptable and may cause a track to be thrown.

- 9 Drive vehicle at a speed not to exceed 10 MPH for a short distance alternating right and left steers.
- 10 Stop vehicle and visually inspect for any end connectors (2) that may have shifted. If any end connectors have shifted, reposition. Tighten end connector bolts (1) (steps 6 and 7) that have been repositioned. Notify unit maintenance to torque bolts to 380-420 lb-ft (515-570 N•m) wet.

## 3-6 ARMAMENT AND CAB MAINTENANCE

### 3-6.1 Maintenance of Sighting and Fire Control Equipment

#### a. Inspection

Whenever inaccuracies, maladjustments, or other conditions affecting the serviceability are evident, the equipment should be referred to unit maintenance.

Check instruments for completeness and appearance. Painted surfaces should be free of wear, scratches, or chipped or loose paint. All graduations, lettering, and indexes must be clear and distinct. There must not be evidence of corrosion on any part.

There must be no dirt, smears, stains, scratches, digs, condensation, fungus growth, chips, fractures, or cement separations visible through optics.

#### b. Care

Rough or careless handling can cause inaccuracy of the sighting and fire control instruments.

The following points will keep your equipment in working order:

- 1 Don't force rotation of any knob beyond its stop limit.

**WARNING**

Don't point an optical instrument directly at the sun without using a filter. The heat of focused rays may damage eyes and optical elements.

- 2 Keep instruments as dry as possible. If wet, dry before stowing in carrying case. Condensation may collect on optical parts when temperature of parts is lower than surrounding air. Moisture can be removed by placing instruments in a warm, but not hot place. Heat can cause unequal expansion of parts, resulting in damaged optics.

**CAUTION**

- To prevent damage to components, under no circumstances should polishing liquids, pastes, or abrasives be used for polishing lenses and windows.
  - For wiping optical parts, use lens paper (item 33, Appx D) especially intended for cleaning optical glass. To prevent damage to components, don't use silicone treated paper that is used for eyeglasses.
- 3 Keep optical parts free of oil and grease. Don't touch lenses or windows with fingers. To remove oil or grease from optical surfaces, apply optical lens cleaning compound (item 9, Appx D). If cleaning compound is not available, and temperature is above freezing, breathe heavily upon glass and wipe off with clean lens paper (item 33, Appx D).

**3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED**

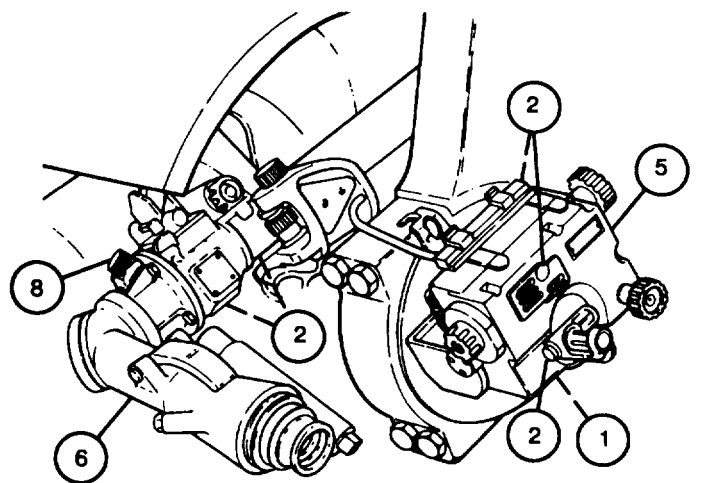
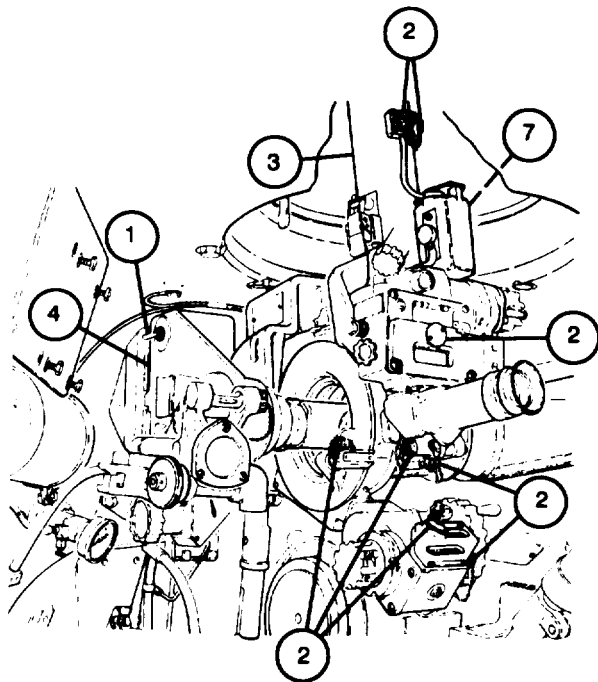
**3-6.1 Maintenance of Sighting and Fire Control Equipment — Continued**

**b. Care — Continued**

- 4 In below-freezing weather, optical surfaces should be cleaned with lens paper (item 33, Appx D) moistened with optical lens cleaning compound (item 9, Appx D). If cleaning compound is not available, use dry lens paper, Don't breathe on lens. Wipe gently to avoid scratching or removing the lens coating. FM 9-207 contains cold-weather maintenance instructions on fire-control material.

**c. Instrument Light**

- 1 Operate switches (1) to check operation of LEDs (2) on M117/M117A2 panoramic telescope (3), M145/M145A1 telescope mount (4), M15 elevation quadrant (5), and M118A2/M118A3 elbow telescope (6).
- 2 Check brightness of reticle LEDs with variable resistor knobs (7 and 8).
- 3 Inspect electrical leads and connections for damaged or frayed insulation. Properly connector stow as required.





3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

3-6.1 Maintenance of Sighting and Fire Control Equipment — Continued

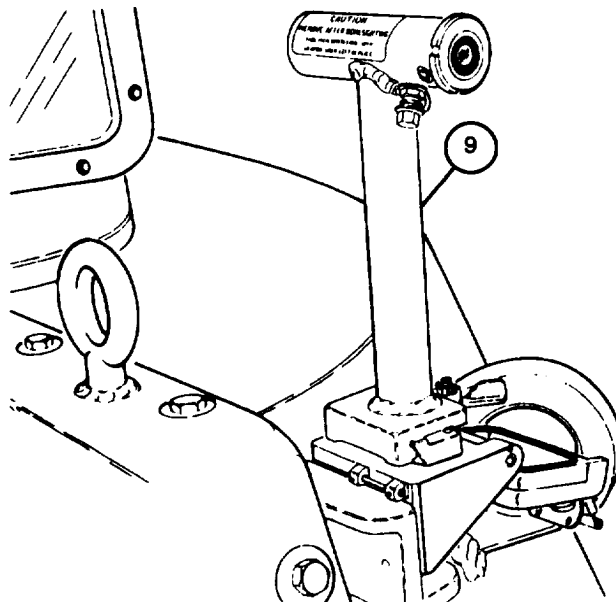
d. M140 Alinement Device

**WARNING**



The M140 alinement device is radioactively illuminated. Check for loss of luminescence, breakage, damage, or defects. If present, follow the procedures on page b.

In a low light environment, check M140 alinement device (9) for illumination. If illumination is weak, notify local Radiation Protection Officer.



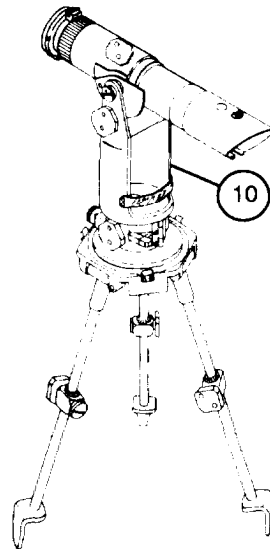
**3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED****3-6.1 Maintenance of Sighting and Fire Control Equipment — Continued****e. M1A1 Collimator****WARNING**

The M1A1 collimator is radioactively illuminated. Check for presence of illumination and damage. If discovered broken, damaged, or defective, follow the procedures on page b.

**CAUTION**

The M1A1 collimator has an airtight seal. Breaking seal by removing any part will expose internal mechanism to moisture and may eventually impair operation of instrument.

- 1 Follow maintenance instructions of sighting and fire control for inspection and care of M1A1 collimator (10) (para 3-6.1a. and 3-6.1b.)
- 2 Notify unit maintenance for correction of unserviceable components.



## 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

### 3-6.1 Maintenance of Sighting and Fire Control Equipment — Continued

#### f. Cleaning Glass on Fire Control Equipment

Using lint-free cloth (item 10, Appx D) and optical lens cleaning compound (item 9, Appx D), clean glass on eyepieces and counter windows on all fire control equipment. Clean glass on panoramic telescope ballistic cover.

### 3-6.2 Cannon Equilibrator

#### Adjustment

#### CAUTION

With the MASTER switch and CAB POWER switch to ON, the equilibrator valve open (turned left), and the system drain valve open, the complete power pack assembly will be pumped dry. Equilibrating hydraulic fluid comes from the power pack assembly. To prevent damage to equipment, do not operate the system with low fluid levels.

#### NOTE

Variations in temperatures can affect elevating or depressing of the cannon tube. The cannon equilibrator, which counterbalances the weight of the cannon tube, must be adjusted if more effort is required to elevate than depress or vice-versa.

- 1 Using M1A1 gunner's quadrant or M15 elevation quadrant, set cannon tube elevation at + 266 mils.
- 2 Using the elevating hand pump (1), elevate and depress the cannon tube to determine if it is as easy to elevate as it is to depress.
- 3 If no difference is detected, no adjustment is required.

#### NOTE

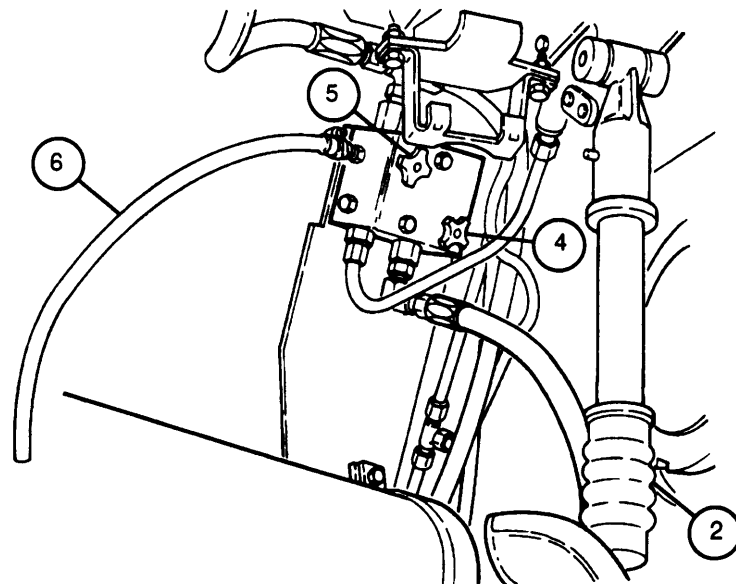
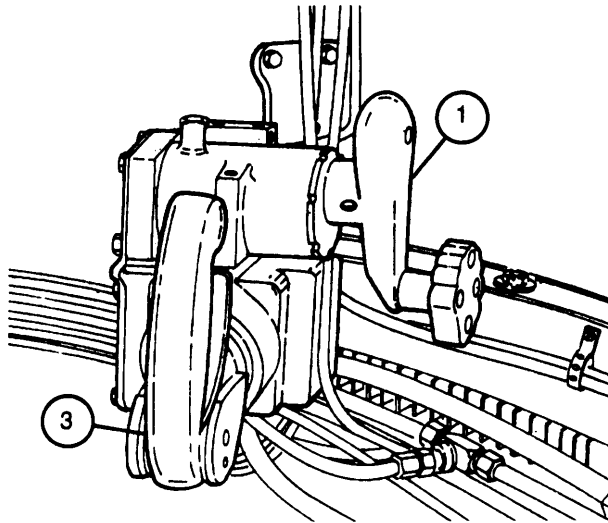
If possible use two personnel to perform task in step 4 to reduce time required.

- 4 If cannon tube is harder to elevate than depress, use equilibrator hand pump (2) and assistant gunner's control handle (3) simultaneously to get cannon to maximum elevation. With cannon at maximum elevation and CAB POWER switch to ON, open equilibrator valve (white knob) (4) to allow system to equalize (approximately 15 seconds). Close equilibrator valve (white knob) and repeat steps 1, 2, and 3.
- 5 If cannon tube is harder to depress than elevate, slowly open system drain valve (red knob) (5). Place a clean container under drain tube (6) and bleed off a small quantity of hydraulic fluid,
- 6 Repeat step 2 and adjust system with steps 4 or 5 until no difference is detected.

### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.2 Cannon Equilibrator — Continued

##### Adjustment — Continued



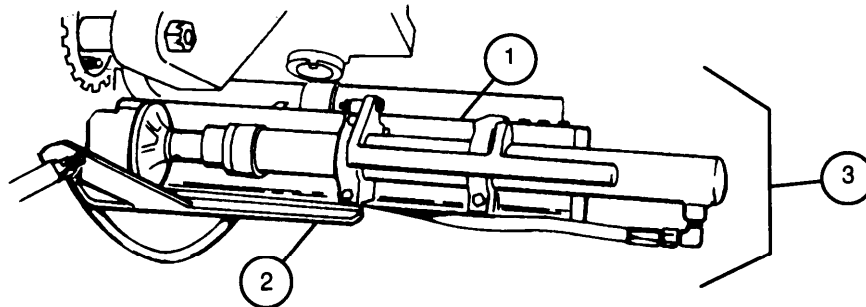
### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.3 Rammer Assembly

##### a. Adjustment

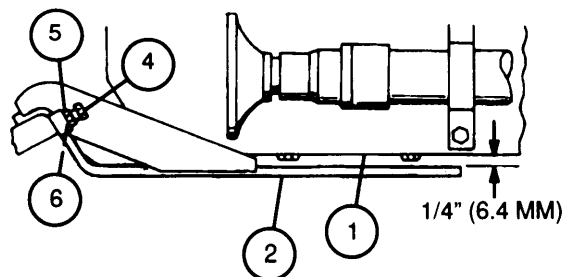
Do not spot paint bridge clamp or plunger as it could cause damage to equipment. Lubricate rammer blocking valve plunger and roller (item 13, Appx G).

- 1 If tray (1) contacts rammer mounting bracket (2) refer to steps 2 and 3 to adjust position of rammer mounting bracket.
- 2 With rammer assembly (3) in stowed position, adjust two cap screws (4) to provide a clearance of approximately 1/4 inch (6.4 mm) between tray (1) and rammer mounting bracket (2).
- 3 Securely lock cap screws (4) in position with two hex nuts (5) and lockwire (6).



**NOTE**

RAMMER ASSEMBLY IS SHOWN IN RAM POSITION.

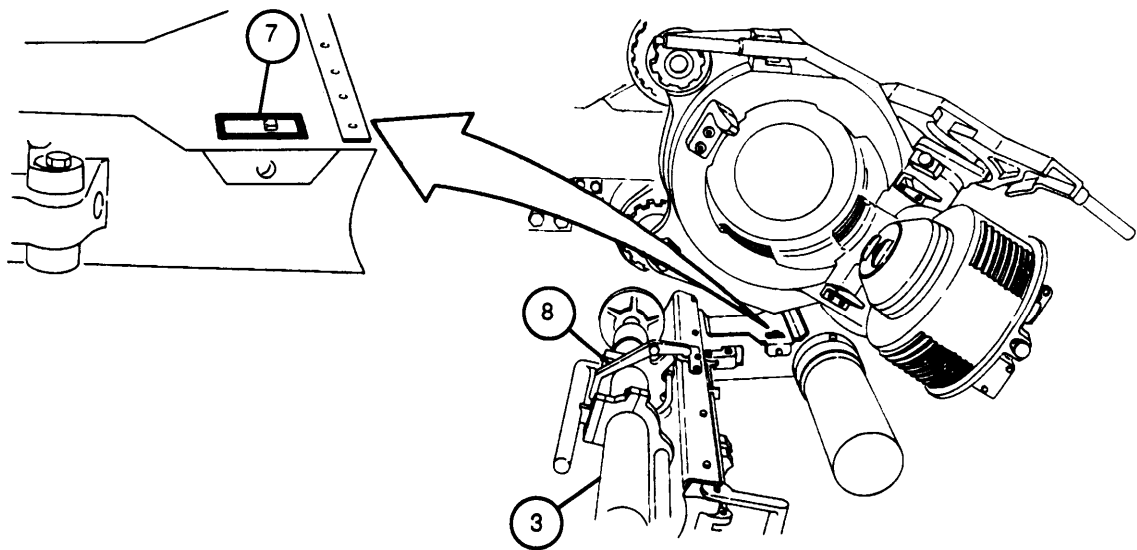


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.3 Rammer Assembly — Continued

##### b. Rammer Reliability Checks

- 1 With rammer assembly (3) in stowed position, check to assure that rammer safety pointer (7) is in the black position.
- 2 Be sure that latch (8) will latch.
- 3 Place rammer assembly (3) in ram position.



**NOTE**

RAMMER ASSEMBLY IS SHOWN IN STOWED POSITION.

### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.3 Rammer Assembly — Continued

##### b. Rammer Reliability Checks — Continued

**WARNING**

Improperly rammed projectiles can cause short rounds and short rounds fall on friendly forces causing serious injury or death.

**CAUTION**

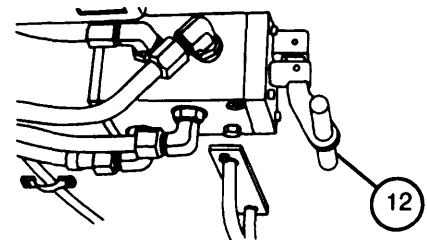
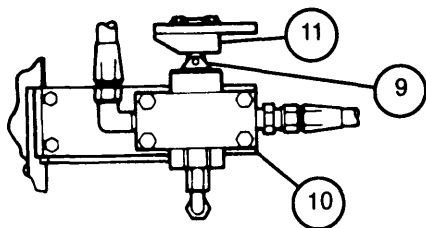
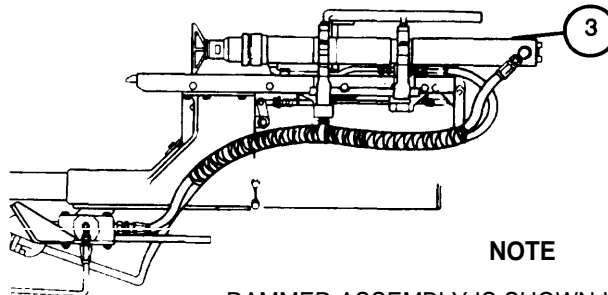
When exercising rammer assembly, bring the rammer assembly to full extension slowly to avoid seal damage.

- 4 Check to assure rammer assembly (3) locks in ram position and plunger (9) on blocking check valve (10) is depressed by bridge clamp (11).
- 5 Slowly depress control handle (12) and hold to extend rammer assembly (3) to full stroke. Release control handle to bring rammer assembly back to original position.

**CAUTION**

If rammer assembly fails to ram, does not operate smoothly, makes unusual noises, or jerking motions, discontinue use of the rammer assembly to prevent damage to equipment and notify unit maintenance.

- 6 Return rammer assembly (3) to stowed position.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.4 Zero Pressure Check and Checking, Filling, and Draining Power Pack

##### Procedure

The zero pressure check should be performed by unit maintenance personnel or when troubleshooting the cab hydraulic system. The zero pressure check is not performed by the crew as a part of daily or pre-fire preventive maintenance checks. However, in the event no unit maintenance personnel are available, then it would become the responsibility of the chief of section and the crew.

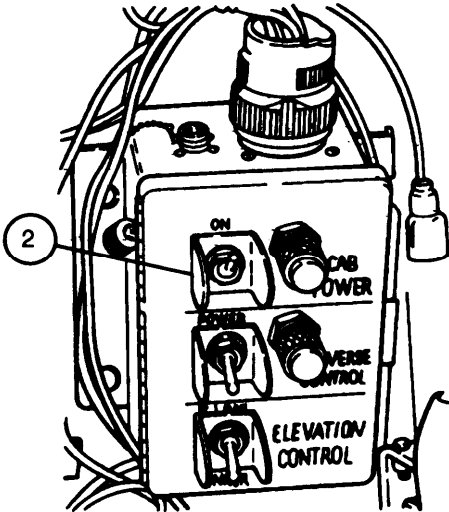
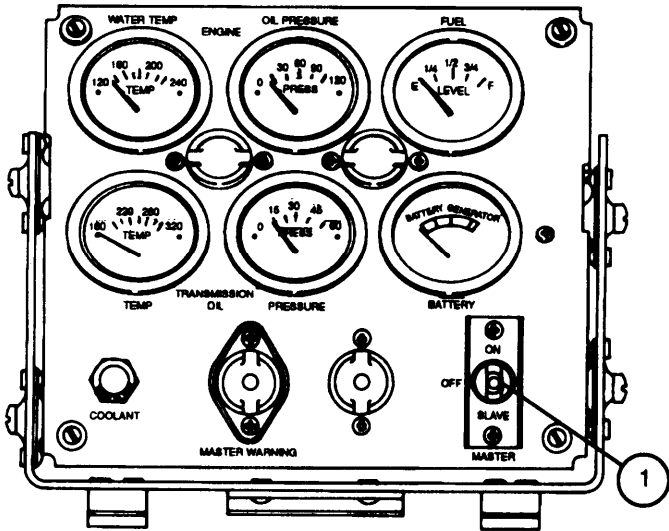
The zero pressure check indicates the amount of precharged nitrogen in the main accumulator assembly and if there is enough hydraulic fluid in the power pack assembly.

It maybe necessary to perform a zero pressure check if the cab traversing, elevation, and rammer systems function sluggishly or unusually after the before-operation and maintenance checks have been performed.

##### NOTE

Don't perform the following procedure unless instructed by chief of section.

- 1 Position weapon on level ground if possible.
- 2 Turn MASTER switch (1) and CAB POWER switch (2) to ON to charge system.





## 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

### 3-6.4 Zero Pressure Check and Checking, Filling, and Draining Power Pack — Continued

#### Procedure — Continued

- 3 Observe pressure gage (3). Normal operating pressure range is 925 to 1225 psi (6378 to 8446 kPa).
- 4 Turn CAB POWER switch (2) and MASTER switch (1) to OFF.

#### NOTE

Turret lock is in LOCKED position when word LOCKED is covered.

- 5 Move turret lock (4) to LOCKED position or place cannon tube in travel lock.
- 6 Turn TRAVERSE CONTROL switch (5) to MANUAL position.
- 7 Disconnect wire 645 (6) at quick disconnect (7) near pressure gage (3).
- 8 Turn MASTER switch (1) and CAB POWER switch (2) to ON.

#### NOTE

Perform steps 9 and 10 simultaneously.

- 9 Move gunner's control handle (8) to left or right.

#### NOTE

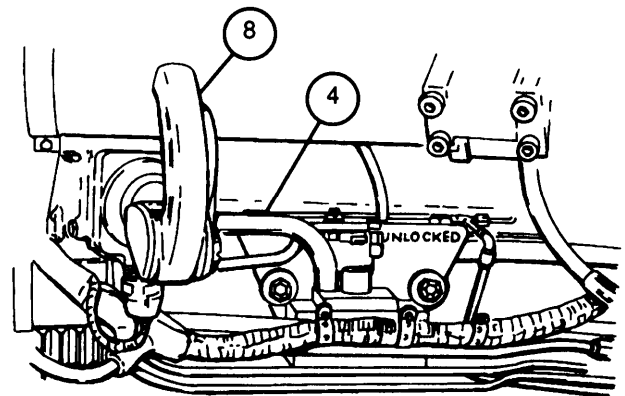
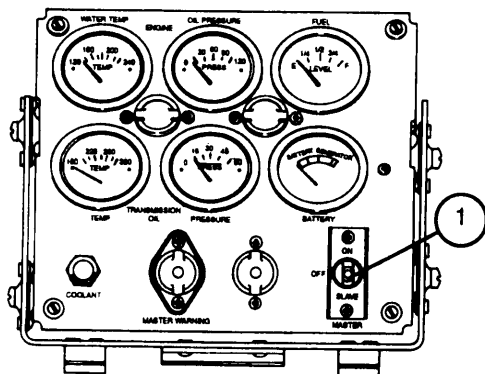
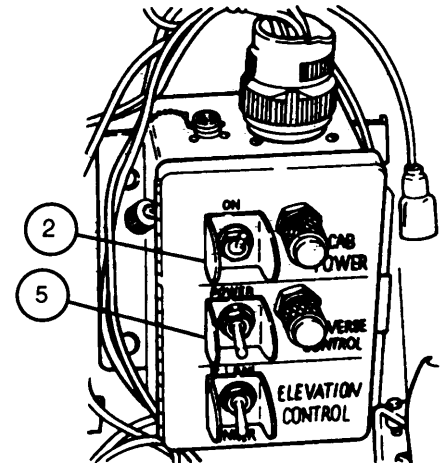
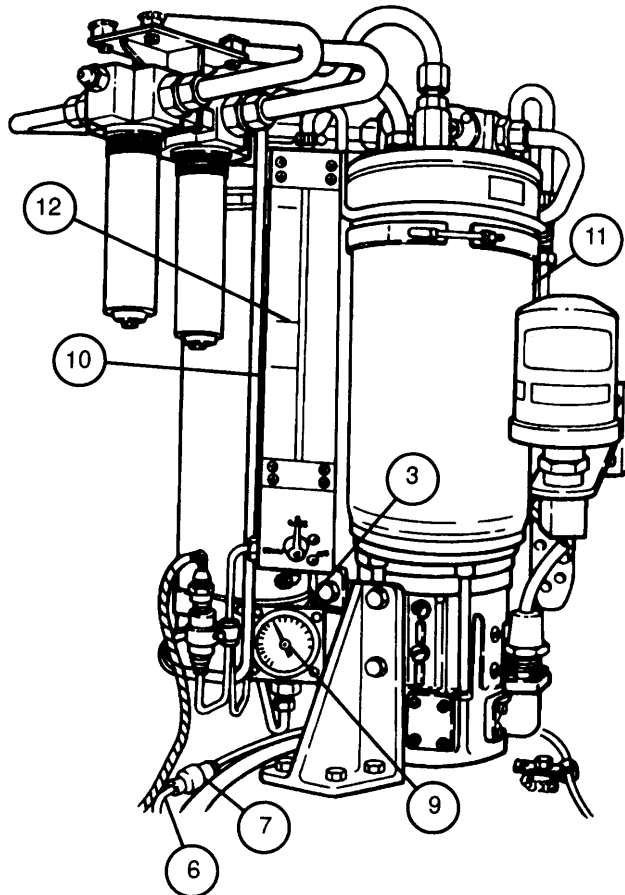
- If main accumulator nitrogen pressure is below 500 psi (3448 kPa), notify unit maintenance.
- Normal precharged nitrogen pressure varies with temperature changes.

- 10 Watch pressure gage (3) needle (9) as it drops from operating pressure until it flutters, then drops sharply to 0 psi (0 kPa). The reading at which the pressure gage needle fluttered is the amount of precharged nitrogen in the main accumulator. Normal precharged nitrogen pressure in the main accumulator will be 500 to 550 psi (3448 to 3792 kPa) at 70° F (21° C).
- 11 Turn CAB POWER switch (2) and MASTER switch (1) to OFF position.
- 12 Observe sight gage (10) on power pack assembly (11). Fluid appearing in gage should be level with FULL AT ZERO PRESSURE mark (12).
- 13 Check and fill power pack assembly (11) (item 4, Appx G) as required.

### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.4 Zero Pressure Check and Checking, Filling, and Draining Power Pack — Continued

##### Procedure — Continued



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

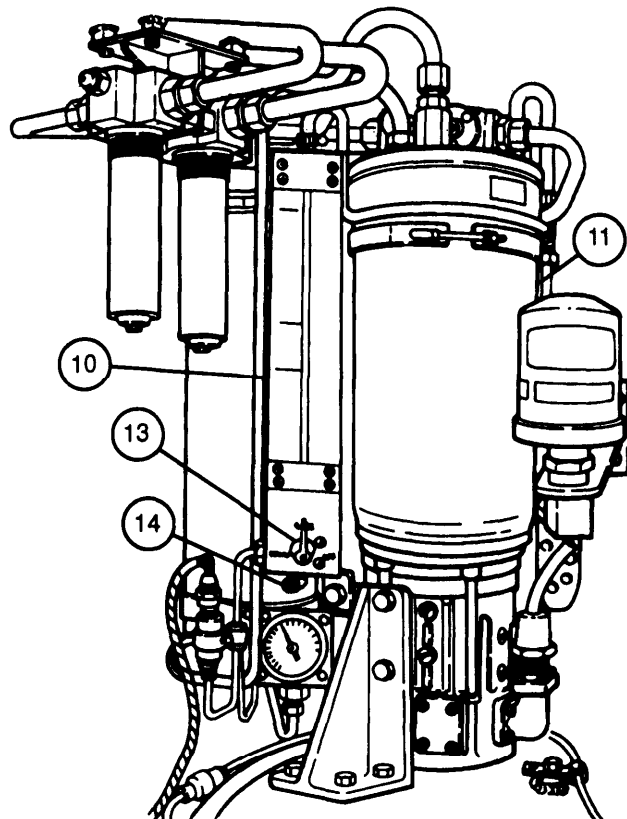
#### 3-6.4 Zero Pressure Check and Checking, Filling, and Draining Power Pack — Continued Procedure — Continued

- 14 If power pack assembly (11) reservoir is overfilled, drain hydraulic fluid to proper level.
  - (a) Turn pointer handle (13) at bottom of sight gage (10) to OFF.
  - (b) Place a container below plug (14).
  - (c) Loosen plug (14) at sight gage (10).

#### NOTE

Dispose of drained hydraulic fluid in accordance with local regulations. Do not reuse.

- (d) Turn pointer handle (13) at bottom of sight gage (10) to DRAIN and collect excess hydraulic fluid in container.
- (e) When hydraulic fluid level is correct, turn pointer handle (13) to OFF.
- (f) Turn pointer handle (13) to GAGE position and tighten plug (14).

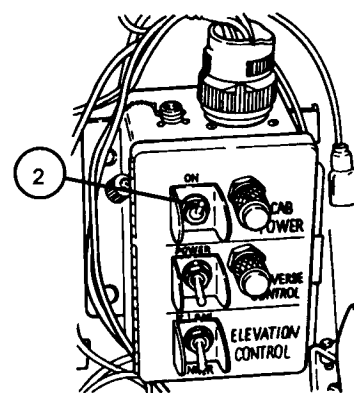
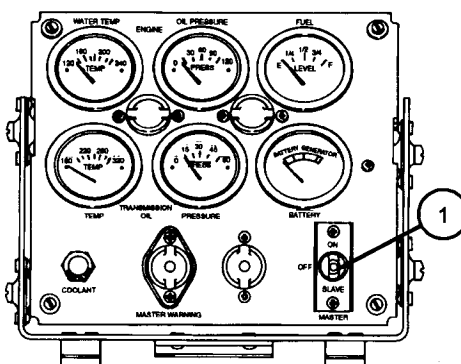
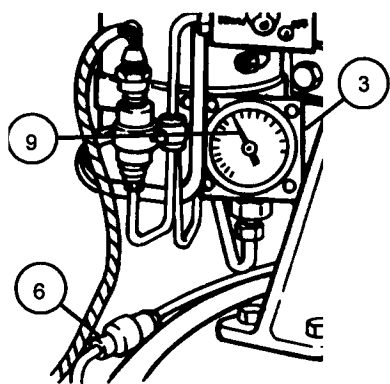
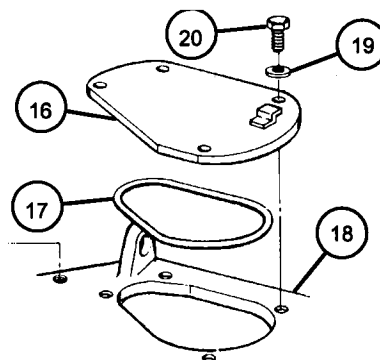
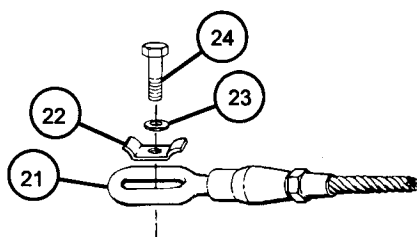
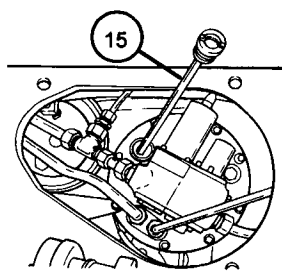


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.4 Zero Pressure Check and Checking, Filling, and Draining Power Pack — Continued

##### Procedure — Continued

- 15 Install power pack gage (15).
- 16 Install access cover (16) with gasket (17) on cab roof (18) and secure with four flat washers (19) and four cap screws (20).
- 17 Secure tow cable (21) to cab roof (18) with towing cable strap (22), flat washer (23), and cap screw (24).
- 18 Reconnect wire 645 (6).
- 19 Turn MASTER switch (1) and CAB POWER switch (2) to ON to charge the main hydraulic system.
- 20 The pressure gage (3) needle (9) will move from zero and stop between 1175 and 1275 psi (8102 and 8791 kPa).
- 21 If nitrogen pressure is low, use manual operation only. Notify unit maintenance as soon as possible.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.5 Estimating Remaining Round Life of Cannon Tubes

Cannon tubes must be inspected and borescoped within 180 days prior to initial firing and within each 180 day interval when utilized for continuous or recurring firing. Notify unit maintenance for borescoping (TM 9-1000-202-14).

**WARNING**

Do not fire beyond cannon tube life.

**NOTE**

- Condemnation of the cannon tube is based on fatigue life in Equivalent Full Charge (EFC) rounds or wear life (pullover gauge measurement), whichever occurs first.
- Breech assemblies which have been modified from the M185 cannon assembly to the M284 cannon assembly may have EFC condemnation criteria stamped on the breech assembly and DA Form 2408-4.

The method for determining remaining life for cannon tubes is to convert rounds fired to Equivalent Full Charge (EFC) rounds. Convert to EFC rounds and enter in Weapon Record Data DA Form 2408-4 in accordance with DA Pam 738-750. Since the condemnation criteria as listed in the table below is based on EFC rounds fired, the zone for each round fired must be entered on DA Form 2408-4, and the total rounds fired by zone must be carried forward to the new data card upon closeout in accordance with DA Pam 738-750.

Condemnation Criteria for Cannon Tube and Breech Assembly			
Model No.	EFC Life of Cannon Tube	EFC Factor	Breech Assembly Life
M185	6375 rds	Zone 1-6 = 0.25 Zone 7 = 0.75 Zone 8 = 1.00	Original and two retubings
M284	2650 rds	Zone 1 (M231) = 0.05 Zone 2 (M231) = 0.15 Zone 3 (M232) = 0.10 Zone 4 (M232) = 0.25 Zone 5 (M232) = 1.00 Zone 3G-5G (3A1) = 0.05 Zone 3W-6W (M4A2) = 0.05 Zone 7W (M4A2) = 0.15 Zone 8/7R (M119A1/A2) = 0.25 Zone 8R/8S (M203/A1) = 1.00	Original with one retubing

### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.6 Replenisher Accumulator Assembly

##### a. Filling M3 Oil Gun

**CAUTION**

To prevent damage to equipment, make sure M3 oil gun is filled with hydraulic fluid per Appendix G and not lubricating oil.

Turn handle (1) of M3 oil gun (2) counterclockwise as far as it will go. Loosen locking screw (3) on head (4) of M3 oil gun.

Unscrew and remove head (4) and handle (1) as a unit from body (4.1). Be sure cap (5) is on M3 oil gun (2).

**CAUTION**

Do not clean body of M3 oil gun with solvent.

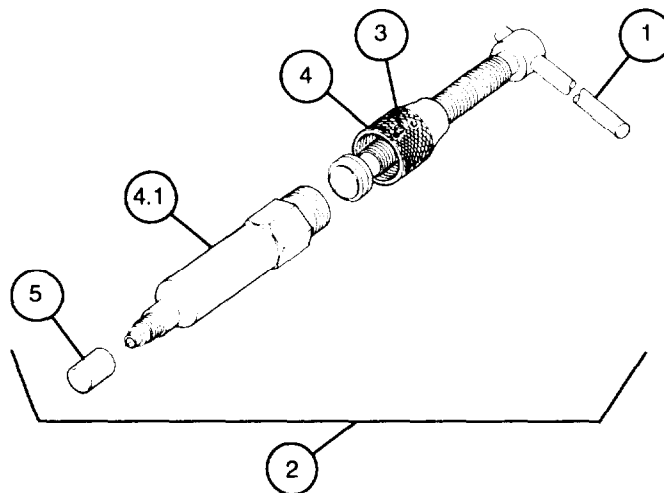
Inspect inside of body (4.1) of M3 oil gun (2) for cleanliness and clean as necessary.

With opening held upright and at an angle to reduce air entering body (4.1), fill body of M3 oil gun (2) with hydraulic fluid (item 20, Appx D).

Install head (4) and handle (1) as a unit, and tighten locking screw (3).

With nozzle end of M3 oil gun (2) held upright, remove cap (5) from nozzle and allow air to escape for a minute or two.

Purge remaining air from M3 oil gun (2) by turning handle (1) until no more air bubbles appear at nozzle.

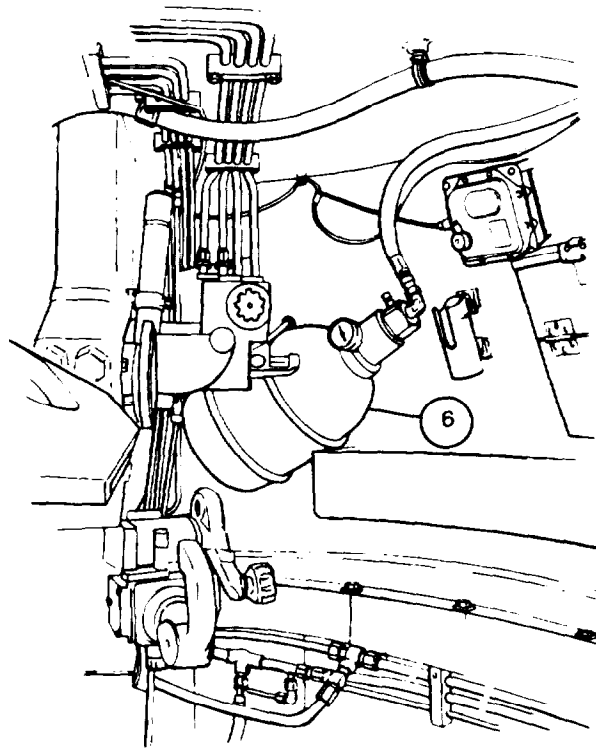


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.6 Replenisher Accumulator Assembly — Continued

##### b. Servicing

- 1 Check and fill replenisher accumulator assembly (6) (item 10, Appx G).
- 2 Bleed recoil system (item 11, Appx G).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-8.7 Muzzle Brake and Bore Evacuator (11578385)

##### a. Removal

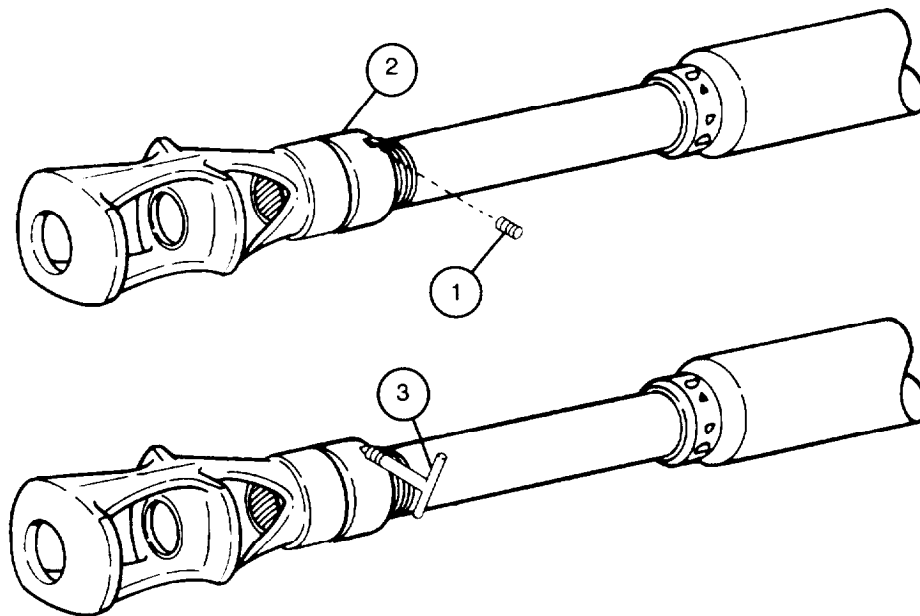
##### NOTE

- Visually inspect muzzle brake. If any cracks exceed 1 inch (2.54 cm) in length, muzzle brake is unserviceable. Notify unit maintenance for replacement.
- There are two setscrews in the thrust collar. One is staked in place and should not be removed. It holds the bearing ball and spring in place. The second setscrew is not staked. Removal of this one allows access to release the bearing ball.

Remove setscrew (1) from thrust collar (2).

##### NOTE

- If T-handle is not available, a screwdriver can be used to depress bearing ball.
  - If bearing ball is stuck or spring appears broken, notify unit maintenance.
- 2 Insert T-handle (3) into setscrew (1) hole. Turn T-handle to engage with threads. Continue turning to depress bearing ball and spring (not shown).





### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### ■ 3-8.7 Muzzle Brake and Bore Evacuator (11578385) — Continued

##### a. Removal — Continued

- 3 With bearing ball depressed, screw thrust collar (2) rearward to uncover machine key (4).
- 4 Remove machine key (4) from muzzle brake (5) and cannon tube (6).

**WARNING**

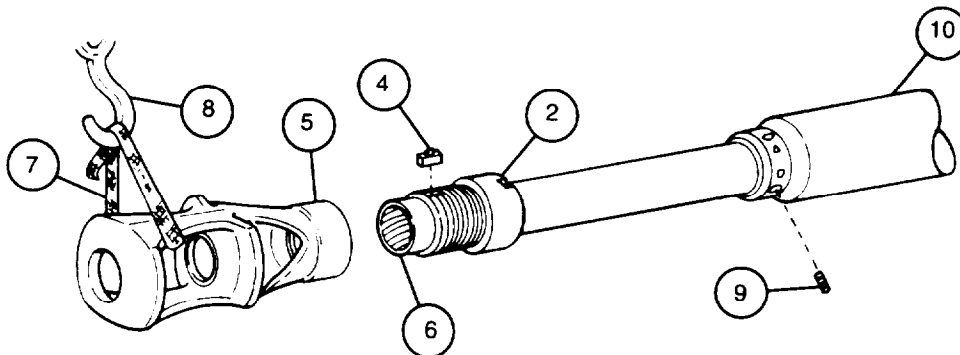
Muzzle brake weighs approximately 350 pounds (159 kg). Use caution to avoid injury to personnel.

- 5 Unscrew muzzle brake (5) until threads on muzzle brake just clear threads on cannon tube (6). Attach sling (7) and hoist (8) to muzzle brake and remove muzzle brake from cannon tube.

#### NOTE

There are two setscrews at the muzzle brake end of the bore evacuator. One setscrew is staked in place and should not be removed. It holds the bearing ball and spring in place. The second setscrew is not staked. Removal of this one will allow release of the bearing ball.

- 6 Remove thrust collar (2) from cannon tube (6), and remove setscrew (9) from bore evacuator (10).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.7 Muzzle Brake and Bore Evacuator (11578385) — Continued

##### a. Removal — Continued

Bore evacuator weighs approximately 210 pounds (95 kg). Use caution to avoid injury to personnel.

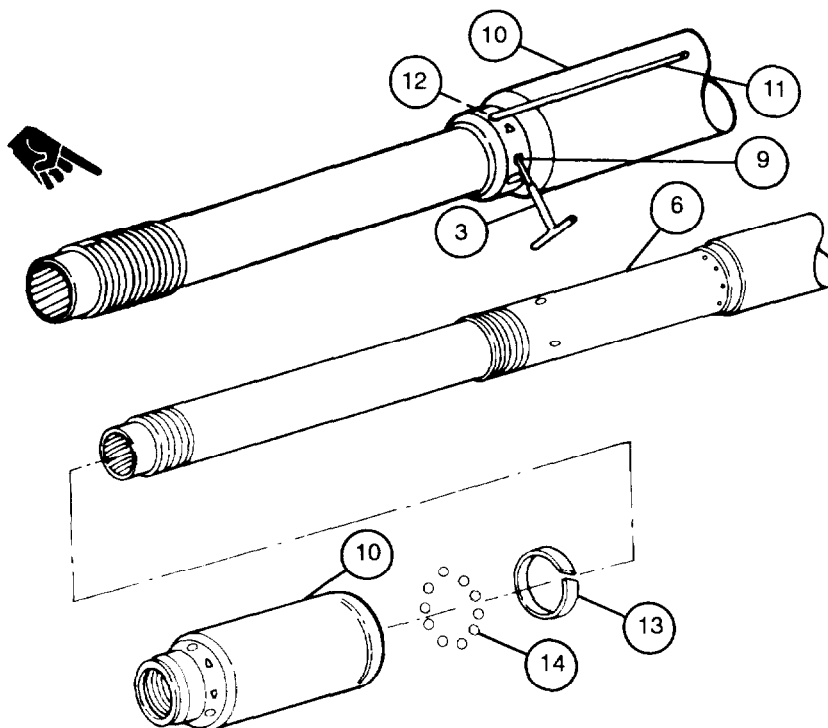
#### NOTE

- If T-handle is not available, a screwdriver can be used to depress bearing ball.
  - If bearing ball is stuck or spring appears broken, notify unit maintenance
- 7 Insert T-handle (3) into setscrew (9) hole. Turn T-handle to engage with threads. Continue turning to depress bearing ball and spring (not shown).
  - 8 Insert pry bar (11) into hole (12). With bearing ball (not shown) depressed, unscrew bore evacuator (10) and slide it forward to remove from cannon tube (6).

#### NOTE

Use rag (item 35, Appx D) to catch ten check balls when sliding valve ring forward.

- 9 Slide valve ring (13) forward and remove from cannon tube (6) along with 10 check balls (14).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### ■ 3-6.7 Muzzle Brake and Bore Evacuator (11578385) — Continued

##### b. installation

**WARNING**

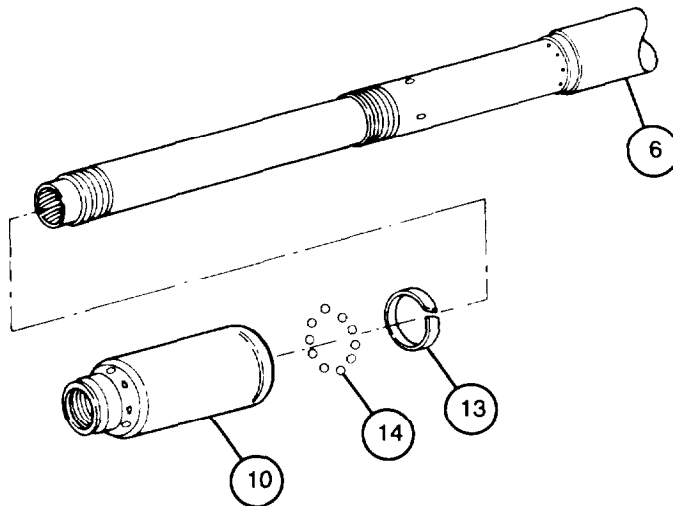
Bore evacuator weighs approximately 210 pounds (95 kg). Use caution to avoid injury to personnel.

- 1 Before installing bore evacuator (10), clean and lubricate (item 14, Appx G).

**NOTE**

- Never replace check balls with standard bearing balls.
- Valve ring should be replaced if cracked or deformed. Notify unit maintenance for replacement.

- 2 Install ten check balls (14) and slide valve ring (13) rearward.
- 3 Slide bore evacuator (10) rearward on cannon tube (6) and screw bore evacuator into position.



### 3-6 ARMAMENT AND CAB MAINTENANCE - CONTINUED

#### 3-6.7 Muzzle Brake and Bore Evacuator (11578385) - Continued

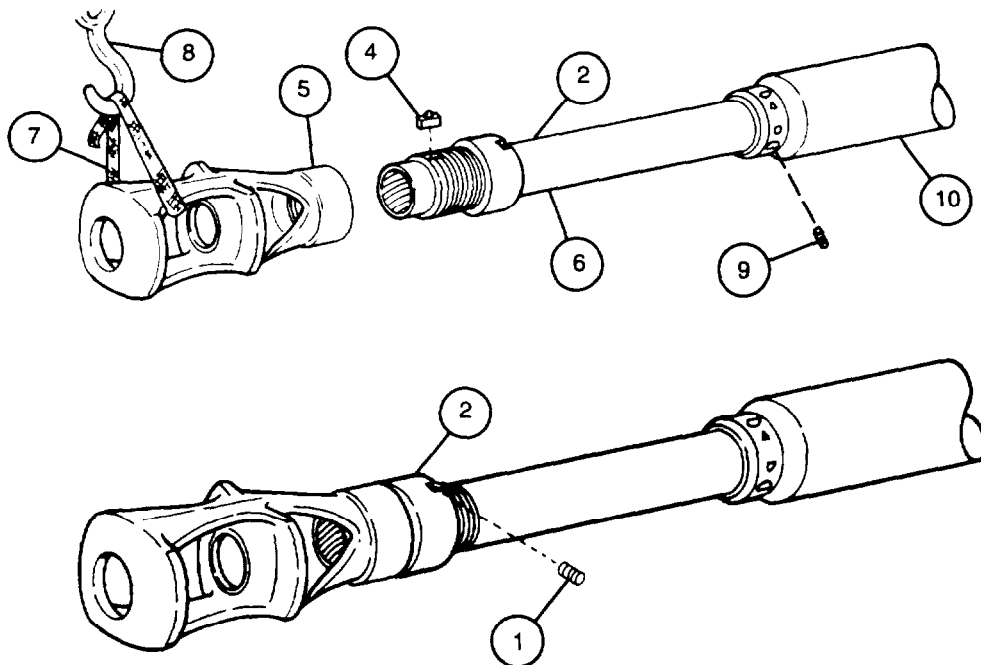
##### b. Installation - Continued

- 4 Install setscrew (9) on forward end of bore evacuator (10).
- 5 Notify unit maintenance to torque setscrew (9) to 30-35 ft-lb (4147 N.m).
- 6 Install thrust collar (2) rearward and screw on far enough to allow insertion of machine key (4) when muzzle brake (5) is installed.

**WARNING**

Muzzle brake weighs approximately 350 pounds (159 kg). Use caution to avoid injury to personnel.

- 7 Before installing muzzle brake (5) clean and lubricate (item 30, Appx G).
- 8 Using sling (7) and hoist (8) raise muzzle brake (5) to cannon tube (6). Screw muzzle brake on threads, and aline keyway in muzzle brake to keyway on cannon tube.
- 9 Insert machine key (4) in aligned keyways.
- 10 Screw thrust collar (2) in place.
- 11 Install setscrew (1).
- 12 Notify unit maintenance to torque setscrew (1) to 30-35 ft-lb (4147 N.m).



### 3-6 ARMAMENT AND CAB MAINTENANCE - CONTINUED

#### 3-6.7.1 Muzzle Brake and Bore Evacuator (11580776)

##### a. Removal

- 1 Remove muzzle brake (para 3-6.7).
- 2 Remove muzzle brake thrust collar (1) from cannon tube (2).

**WARNING**

Bore evacuator assembly weighs approximately 200 pounds. Use caution to avoid injury to personnel.

**CAUTION**

The bore evacuator assembly must be cleaned daily after firing.

**NOTE**

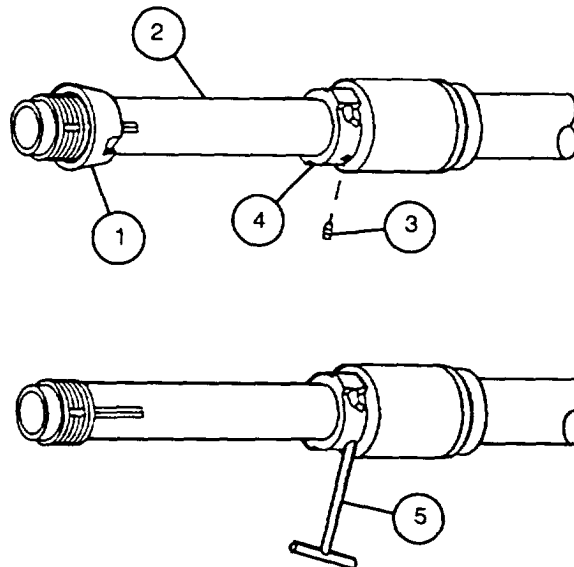
There are two setscrews at the muzzle end of the bore evacuator assembly. One is staked in place and should not be removed. It holds the ball lock and spring in place. The second screw is not staked. Removal of this screw will allow release of the ball lock device.

- 3 Remove setscrew (3) from bore evacuator thrust collar assembly (4).

**NOTE**

If ball is stuck or spring appears broken, notify unit maintenance.

- 4 Insert T-handle (5) into setscrew hole. Turn T-handle to engage with threads. Continue turning to depress ball and spring. If T-handle is not available, a screwdriver can be used to depress ball.



### 3-6 ARMAMENT AND CAB MAINTENANCE—CONTINUED

#### 3-6.7.1 Muzzle Brake and Bore Evacuator (11580776)—Continued

##### a. Removal—Continued

- 5 Insert pry bar (6) into hole (7) and, with ball depressed, unscrew bore evacuator assembly thrust collar (4) and remove.

**CAUTION**

- Ensure main reservoir is centered when moving over gun tube threads to prevent damage or dislodging preformed packings from grooves of reservoir.
  - Significant amount of moisture might have accumulated in the main reservoir.
- 6 Using sling and hoist pull main reservoir (8) forward.

**NOTE**

It may be necessary to use wooden block and hammer to tap reservoir toward muzzle brake end for removal.

- 7 Remove prereservoir (9).

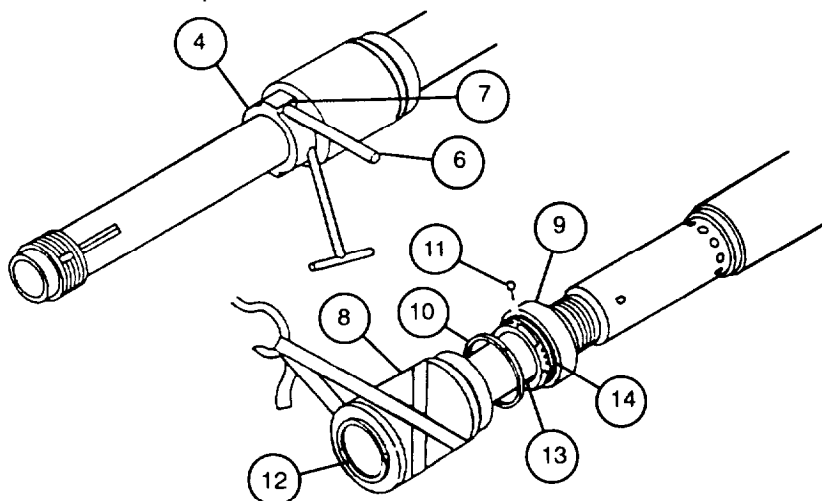
**WARNING**

Upon visual inspection replace ring valve or valve balls if the valve balls appear non-spherical or severely deformed or cracked, or if one or more balls are missing or if valve ring is cracked. Failure to comply with this requirement could result in failure of the ring valve and thus flashback. Notify unit maintenance for replacement.

**NOTE**

Use rag (item 35, Appx D) to catch nine valve balls when sliding valve ring forward.

- 8 Remove ring valve (10) and nine valve balls (11) from prereservoir (9).
- 9 Inspect preformed packings (12, 13, and 14) on main reservoir (8) and prereservoir (9) for damage. Notify unit maintenance for replacement.



### 3-6 ARMAMENT AND CAB MAINTENANCE - CONTINUED

#### 3-6.7.1 Muzzle Brake and Bore Evacuator (11580776) - Continued

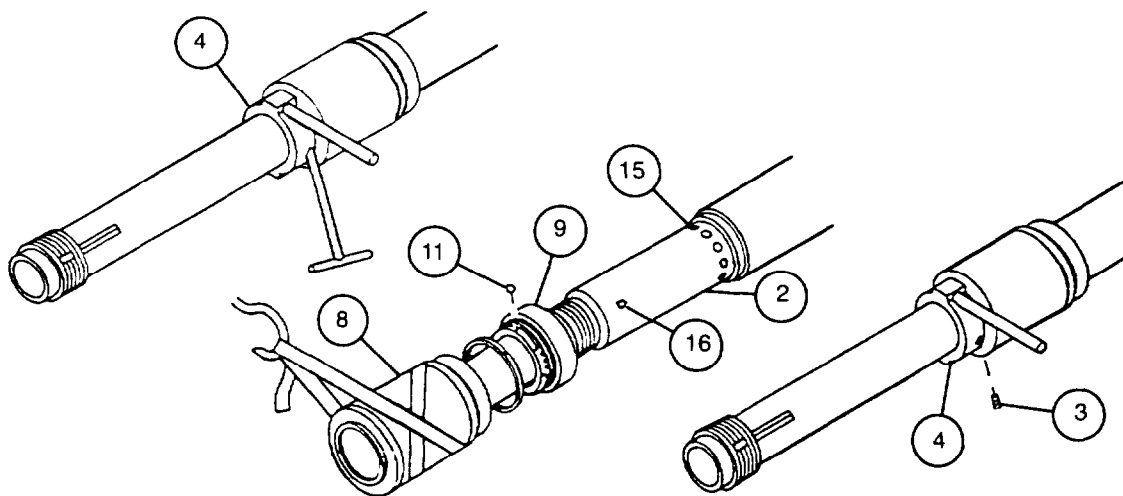
##### b. Installation

- 1 Before installing main reservoir (8) and preservoir (9) thoroughly clean and lubricate inside of main reservoir and preresevoir. Clean unpainted tube surface (2), nine evacuator ball valves (11), 10 evacuator orifices (15) and three metering holes (16). Refer to Appendix G.

##### NOTE

The preservoir and main reservoir should be concentric with center of tube when installing to prevent disengaging preformed packing from groove when sliding over threads. Apply a thick coating of grease (item 18, Appx D) over threads to prevent damage to preformed packing before installing reservoirs.

- 2 Install preresevoir (9) on cannon tube (2).
- 3 Using a sling and hoist, slide main reservoir (8) onto preresevoir (9).
- 4 Screw bore evacuator assembly thrust collar (4) back into position.
- 5 Install setscrew (3). Notify unit maintenance to torque setscrew 30-35 ft-lb (41-47 N•m)
- 6 Install thrust collar and muzzle brake (para 3-6.7).



### 3-6 ARMAMENT AND CAB MAINTENANCE - CONTINUED

#### 3-6.8 Breech Mechanism

##### a. Disassembly

#### NOTE

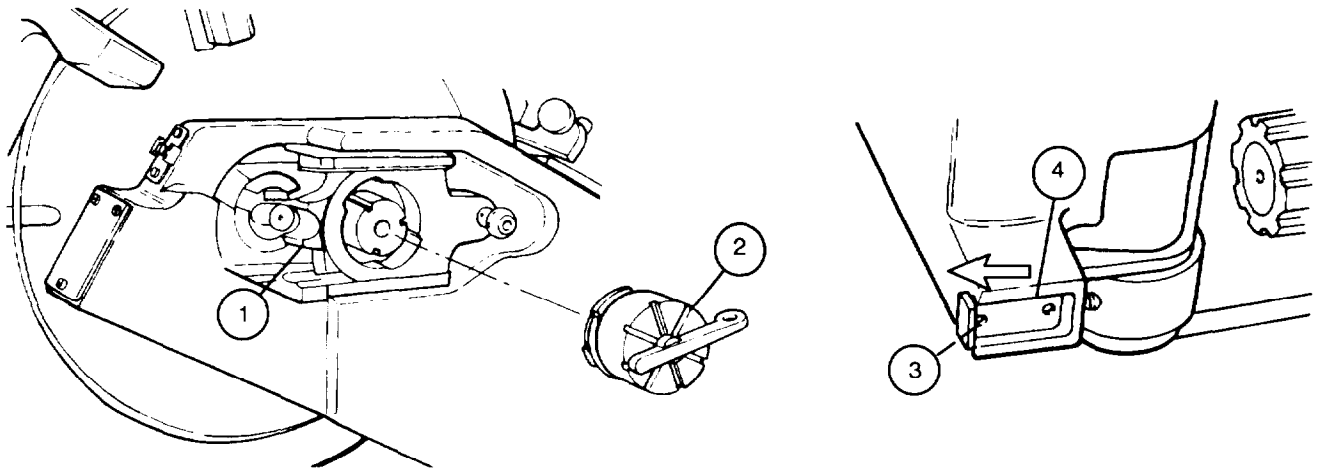
While disassembling breech mechanism, ensure that cam is not raised against M118A2/M118A3 elbow telescope.

- 1 With firing group block (1) in center position, push firing mechanism (2) into firing group block and rotate clockwise to remove.

#### WARNING

Only remove rack springs when breechblock is in closed position. Rack springs are under heavy pressure and could cause injury to personnel. Under no circumstances will removal of rack springs be attempted with breechblock open.

- 2 Depress plunger (3) with punch and slide rack plate (4) rearward until rack plate disengages from plunger.







### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly—Continued

**NOTE**

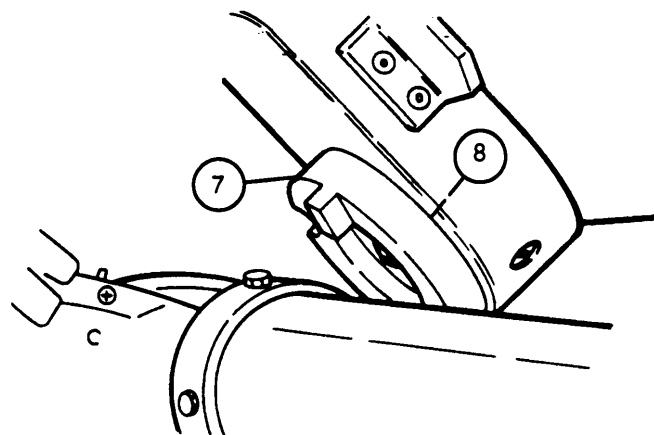
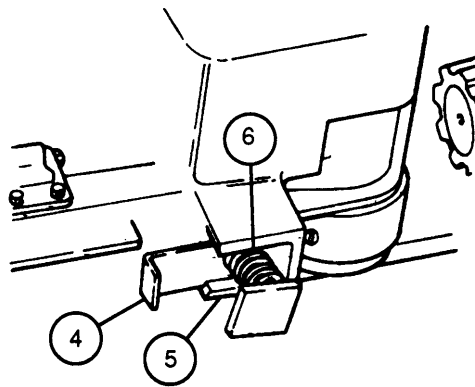
Use clean rag (item 35, Appx D) to catch stop plate and rack springs.

- 3 With breechblock closed, drive rack plate (4) rearward with hammer. Stop plate (5) and rack springs (6) will now pop out.

**NOTE**

Adjuster may have lugs for an adjustable wrench or holes for a spanner wrench.

- 4 Release pre-load on closing spring using adjustable wrench or spanner wrench. Apply clockwise pressure on adjuster (7) and depress adjuster plunger (8). Rotate adjuster slowly counterclockwise until all torque has been relieved.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

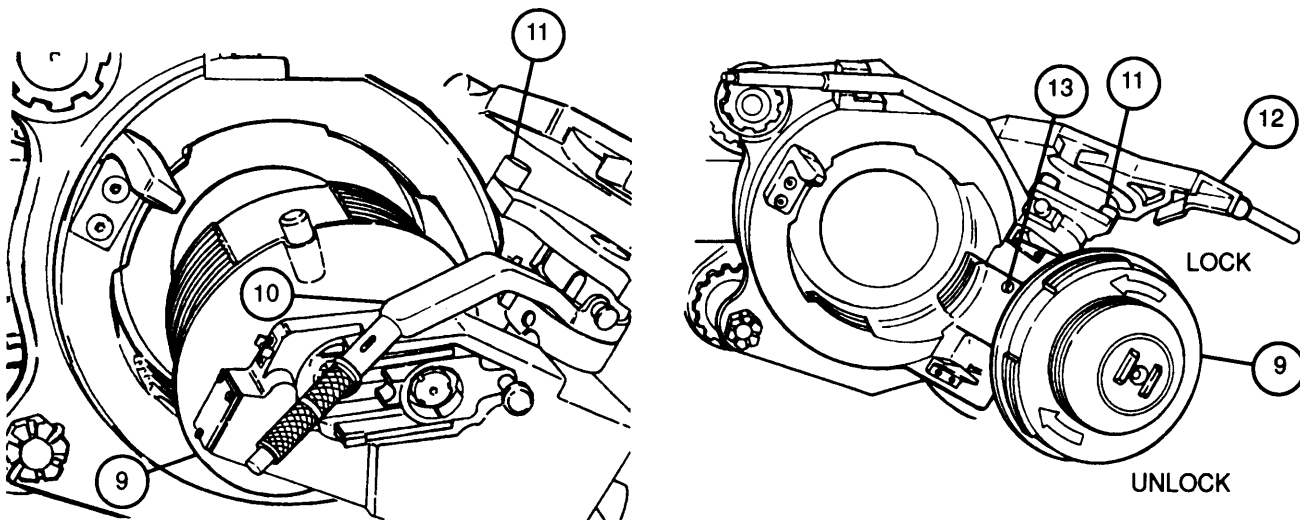
##### a. Disassembly — Continued

**CAUTION**

- Never attempt to disassemble the breech mechanism with breech partially or fully closed.
  - Since all spring tension has been released, be extra careful when opening breechblock. Use operating handle and support breechblock as it is being opened. Otherwise, breechblock will slam open and carrier assembly may be damaged.
- 5 With one individual supporting breechblock (9) and another individual slowly using operating handle (10), open breechblock until rollers (11) are eased into operating cam (12) path. Return operating handle to stowed position.
  - 6 While supporting breechblock (9), raise operating cam (12) slightly until rollers (11) have cleared operating cam path. Rotate breechblock to UNLOCKED position.
  - 7 While holding operating cam (12) slightly upward, depress detent (13) using punch and rotate breechblock (9) to LOCKED position.

**NOTE**

- It is not necessary to remove the plunger assembly from the cannon assembly if only the spindle assembly has to be removed for inspection or replacement.
- Perform step 8 for the M109A2/M109A3/M109A4 M185 cannon assembly if only the nut and spindle assembly are to be removed. If housing and firing group block are to be removed, go to step 11.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

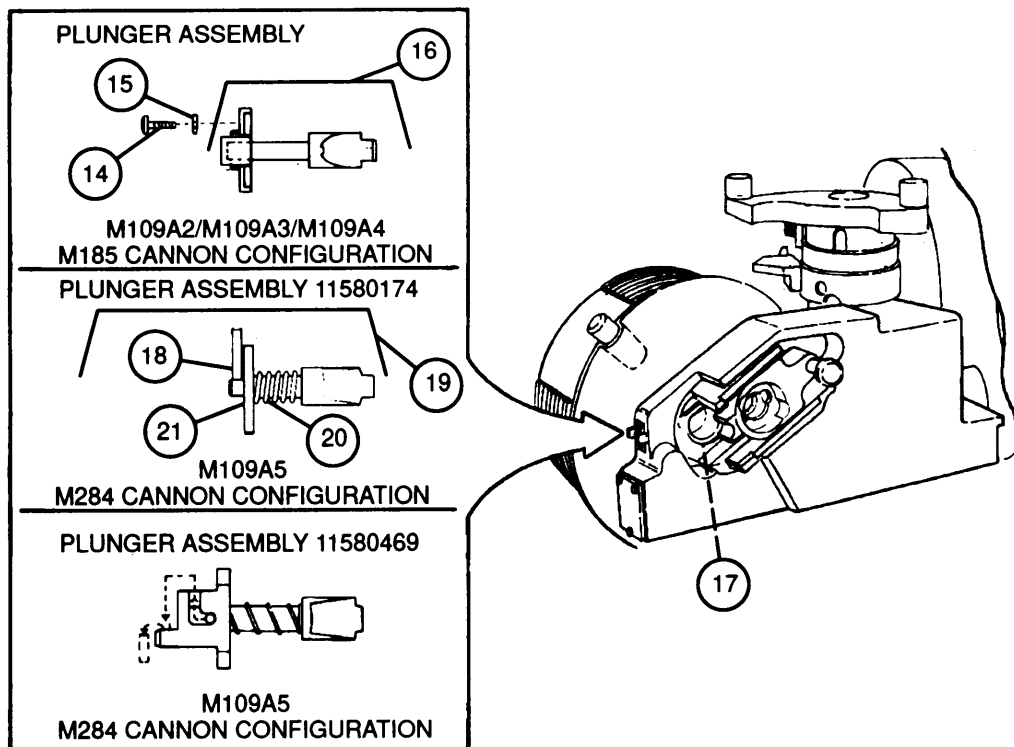
##### a. Disassembly — Continued

8 Remove two cap screws (14), two lockwashers (15), and plunger assembly (16) until it clears nut (17).  
Go to step 13.

#### NOTE

- When plunger assembly 11580174 is lifted out and locked in place, the tip of the plunger will provide some support in holding the housing and firing group block in place while the spindle assembly is removed.
- The M109A5 M284 cannon assembly has two configurations for the plunger assembly.
- Perform steps 9 and 10 for the M109A5 M284 cannon assembly containing plunger assembly 11580174 if only the nut and spindle assembly are to be removed. If housing and firing group block are to be removed, go to step 11.

9 Grasp spring pin (18) located on top of plunger assembly (19). Pull outward against spring (20) until slot in plunger assembly lines up with cam plate (21).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly — Continued

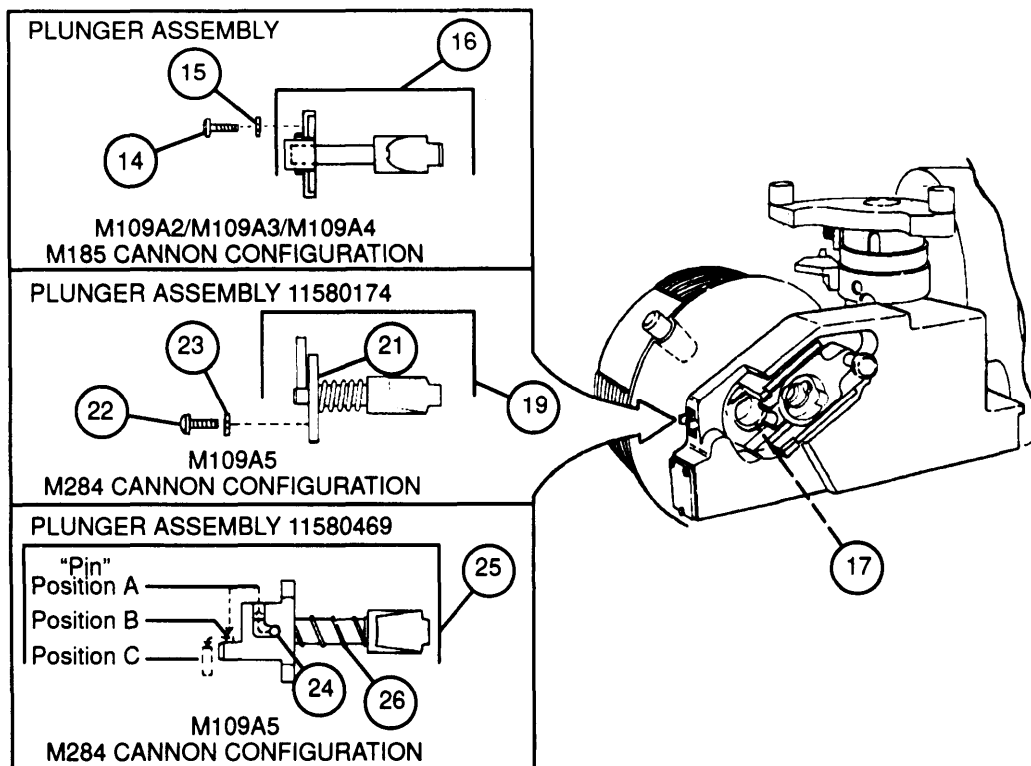
10 Rotate plunger assembly (19) to lock with cam plate (21). Plunger assembly is now held in place and disengaged from nut (17). Go to step 13.

11 Remove two cap screws (14 or 22), two lockwashers (15 or 23) and plunger assembly (16 or 19). Go to step 13.

#### NOTE

- Perform step 12 for M109A5 M284 cannon assembly containing plunger assembly 11580469.
- When the plunger assembly is pulled out and locked in position B, the nut and spindle assembly can be removed without the housing and firing group block. Position C allows the removal of all components.
- If the plunger assembly cannot be pulled out easily, a screwdriver or pry tool can be inserted between the plunger tip and nut. Applying leverage will free plunger assembly.

12 Move pin (24) located on top of plunger assembly (25), against spring (26) from position A to position B or C.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

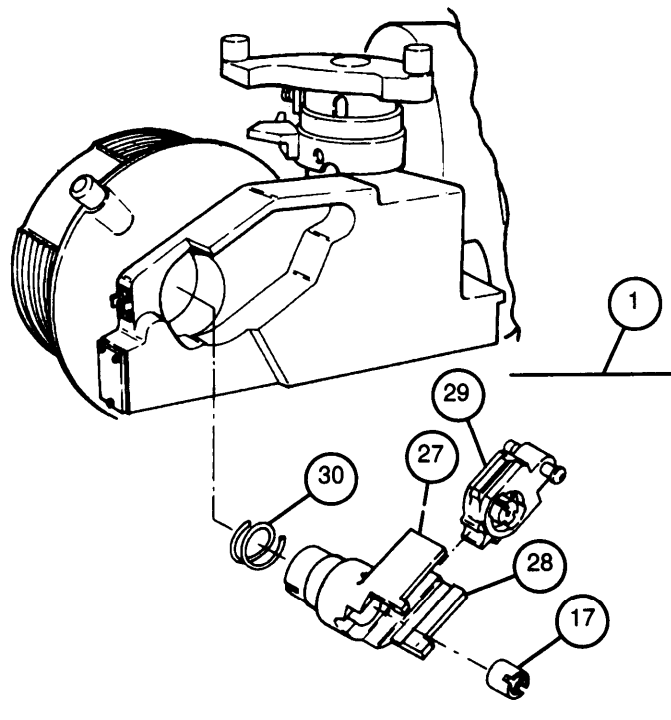
#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly — Continued

- 13 Slide firing group block (1) to extreme right hand position.

#### NOTE

- Cartridge extractor is located inside firing group block.
  - Some howitzers may have different configurations of housing.
- 14 Partially withdraw nut (17) by moving cartridge extractor (27) away from nut. Support firing group block (1) and housing (28). Using spanner wrench, remove nut.
- 15 If completely disassembling breech mechanism, remove block assembly (29), housing (28), and spring (30).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly — Continued

- 16 Remove spindle assembly (31) from breechblock (9). Push on spindle (32) as necessary.
- 17 Remove the following from spindle (32): washer bearing (33), rear retaining ring (34), inner retaining ring (35), obturator pad (36), and front retaining ring (37).

**CAUTION**

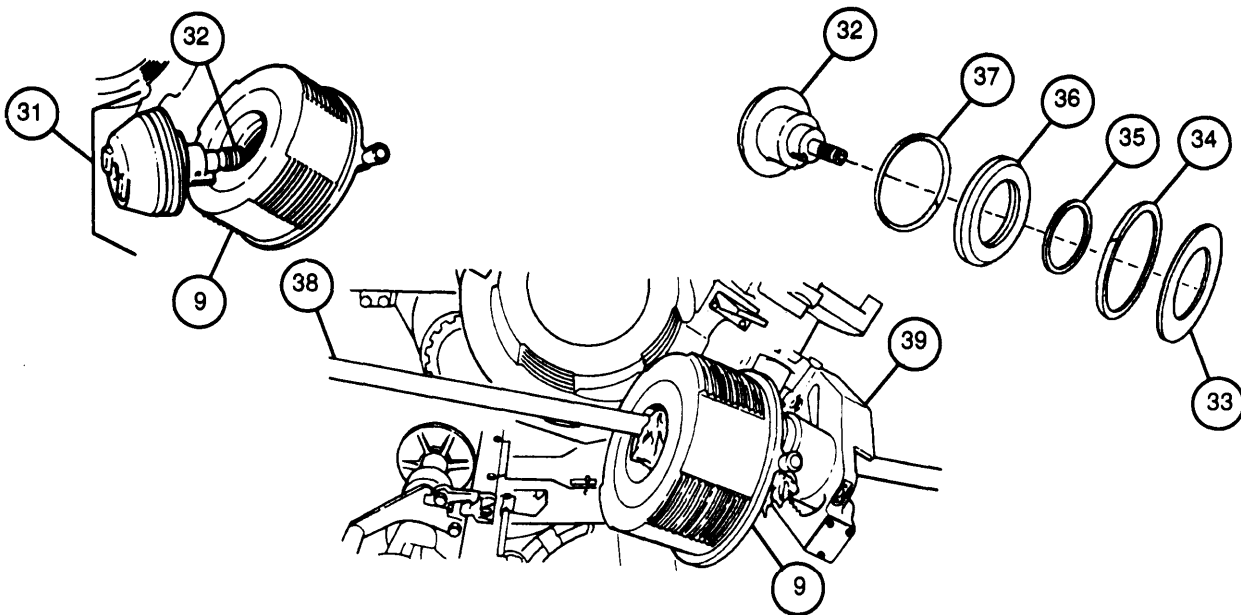
Do not apply oil or cleaning solvent to obturator pad to prevent damage to obturator pad.

- 18 Clean obturator pad (36) with soap (item 12, Appx D) and water. Dry with clean rags (item 35, Appx D). Go to 3-6.8b. for inspection of spindle assembly parts.

**WARNING**

The breechblock weighs approximately 125 pounds (57 kg). It takes two personnel to remove the breechblock to prevent injury to personnel.

- 19 Wrap cleaning staff section (38) with rags (item 35, Appx D) to protect carrier assembly (39) and breechblock (9). Insert cleaning staff section through breechblock and carrier assembly.
- 20 While supporting cleaning staff section (38) at both ends, lift and slide breechblock (9) off carrier assembly (39).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

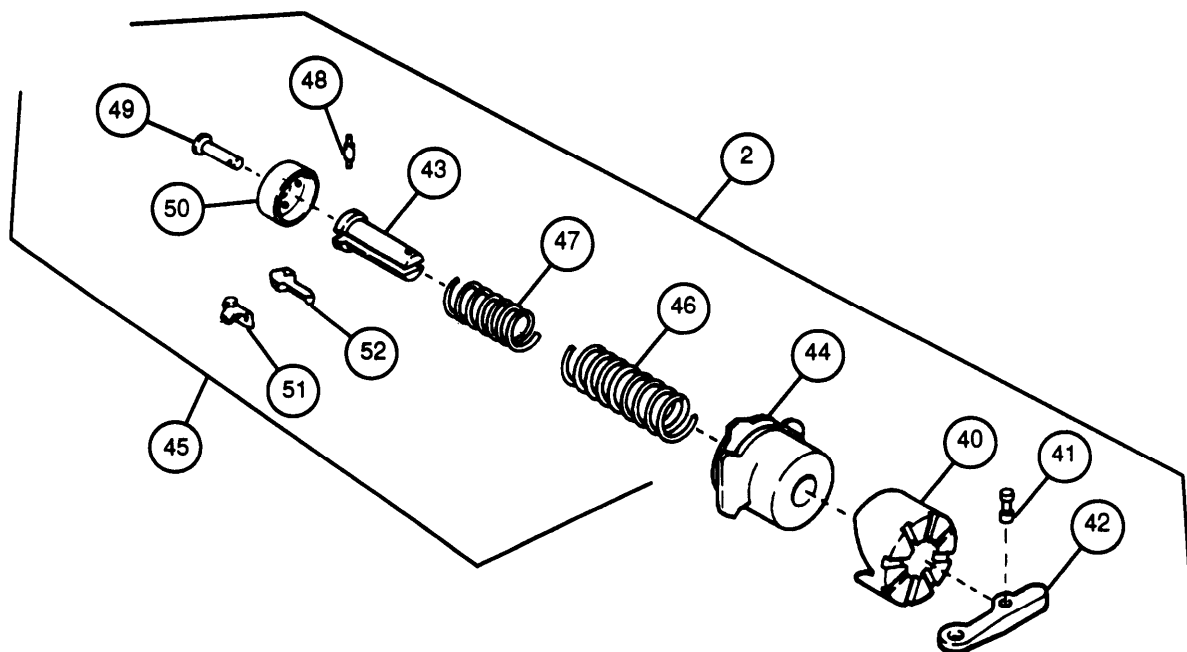
#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly—Continued

#### NOTE

Step 21 is for the M35 firing mechanism on the M109A2/M109A3/M109A4 M185 cannon assembly.

- 21 Disassemble M35 firing mechanism.
  - (a) Place firing mechanism (2) on solid surface.
  - (b) Depress follower (40) until grooved pin (41) can be removed from manual control lever (42) and rod end clevis (43).
  - (c) Separate follower (40) and case (44) from sear group (45).
  - (d) Remove two springs (46 and 47).
  - (e) Remove grooved pin (48) from rod end clevis (43) and separate firing hammer (49), hammer guide cup (50), firing spring (51), and sear (52).





### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-8.8 Breech Mechanism — Continued

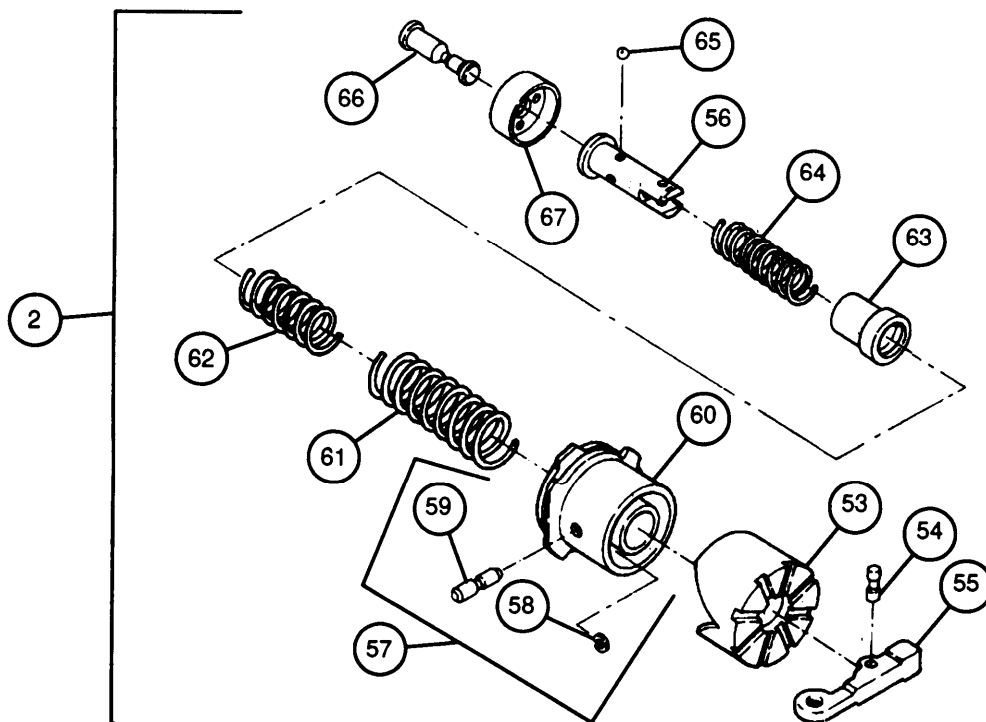
##### a. Disassembly — Continued

#### NOTE

Step 22 is for M49 firing mechanism on the M109A5 M284 cannon assembly.

22 Disassemble M49 firing mechanism.

- (a) Place firing mechanism (2) on solid surface.
- (b) Place M34 fuze setter over follower (53) and depress until grooved pin (54) can be removed from manual control lever (55) and hammer guide yoke (56). Remove grooved pin and manual control lever.
- (c) Raise and remove M34 fuze setter, follower (53), and case assembly (57).
- (d) Remove two retaining rings (58) and two grooved pins (59) from case (60) if damaged.
- (e) Remove two springs (61 and 62), sleeve bushing (63), and spring (64).
- (f) Separate hammer guide yoke (56), three bearing balls (65), firing hammer (66), and access cover (67).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

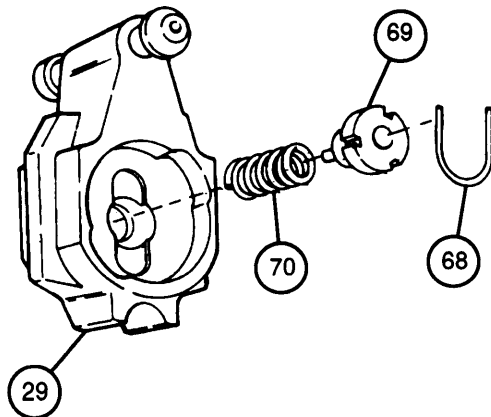
#### 3-6.8 Breech Mechanism — Continued

##### a. Disassembly — Continued

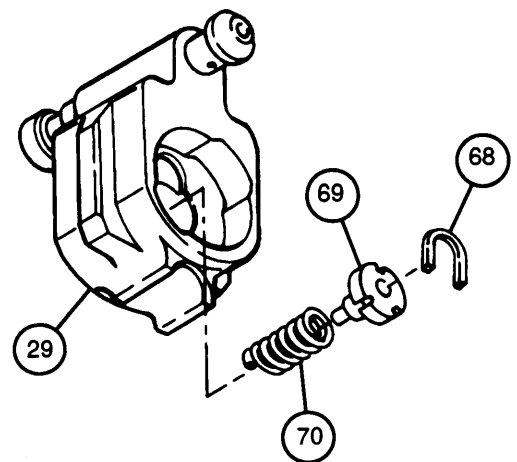
**WARNING**

- The follower group has a safety interlock, which keeps the block assembly from moving to the firing position until breechblock is fully closed. The follower must be in good working condition and properly assembled to make sure safety interlock works to avoid injury.
- The firing pin is under pressure and will spring out when removed. Hold firing pin during disassembly to prevent injury.

23 Remove lock pin (68), firing pin (69), and spring (70) from block assembly (29).



M109A2/M109A3/M109A4  
M185 CANNON CONFIGURATION



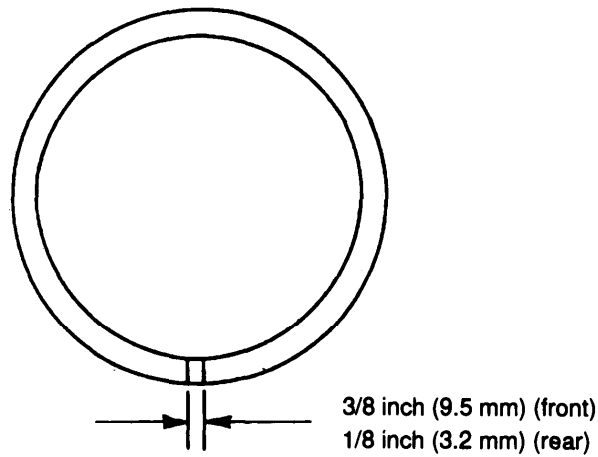
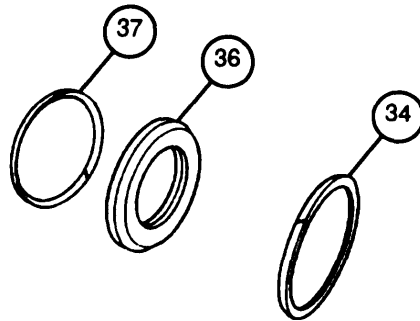
M109A5  
M284 CANNON CONFIGURATION

### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism —Continued

##### b. inspection of Spindle Assembly Components

- 1 Inspect obturator pad (36) for evidence of leakage past sealing surfaces. Replace obturator pad if sliced, cracked, chipped, or damaged.
- 2 Inspect retaining rings (34 and 37) for deformed shape as determined by the following.
  - (a) Maximum allowable circular spread for front retaining ring (37) is 3/8 inch (9.5 mm). The maximum allowable circular spread for the rear retaining ring (34) is 1/8 inch (3.2 mm).

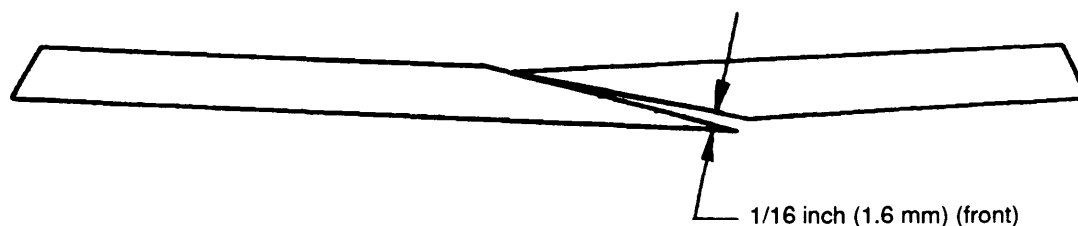


**3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED**

**3-6.8 Breech Mechanism —Continued**

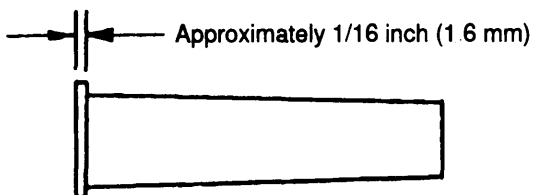
b. Inspection of Spindle Assembly Components — Continued

- (b) Maximum allowable gap at split of front retaining ring (37) is 1/16 inch (1.6 mm). No gap is allowed for rear retaining ring (34).



**NOTE**

The lip of the M82 primer case measures approximately 1/16 inch (1.6 mm).

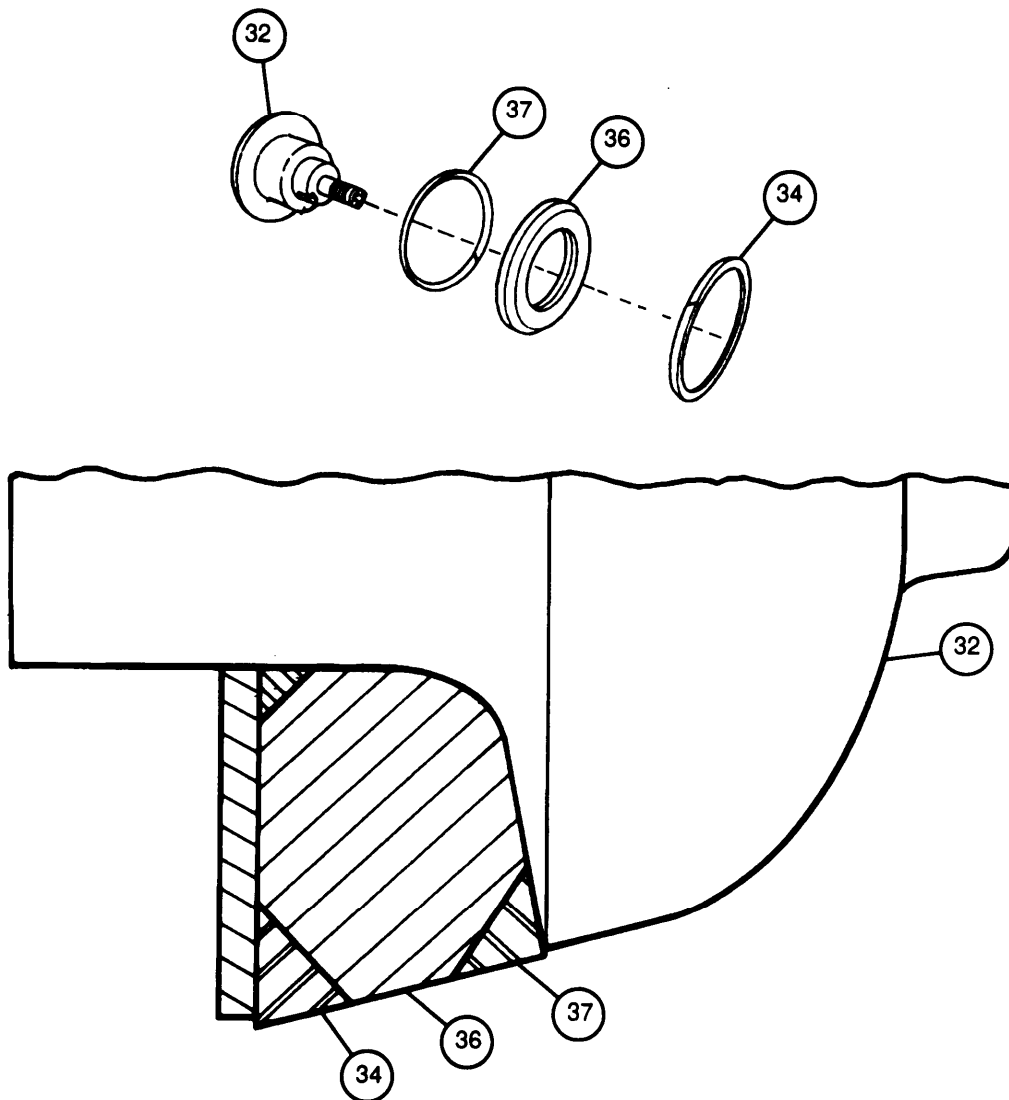


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism —Continued

##### b. inspection of Spindle Assembly Components — Continued

- 3 Gouges in surface between obturator pad (36) and retaining rings (34 and 37) mating surfaces are normal and will not hinder operation, unless gouging is over 50% of obturator pad.
- 4 If there is evidence of leakage past breech ring assembly, replace obturator pad (36).
- 5 Inspect spindle (32) and retaining rings (34 and 37) for burrs or cracks. If burrs or cracks are present, notify unit maintenance.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

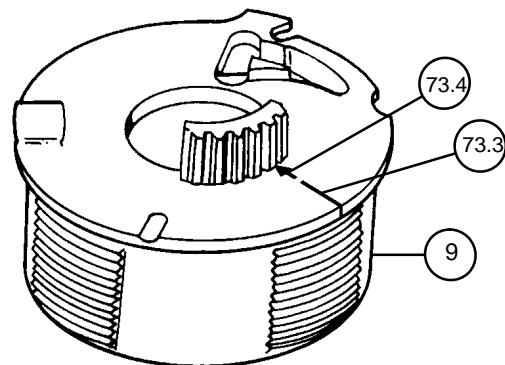
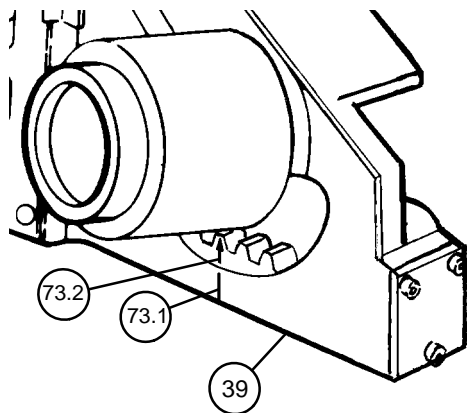
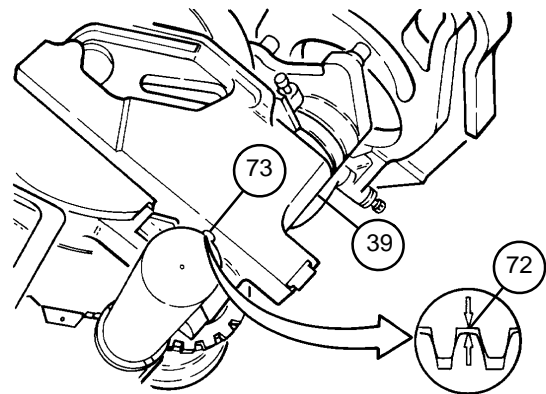
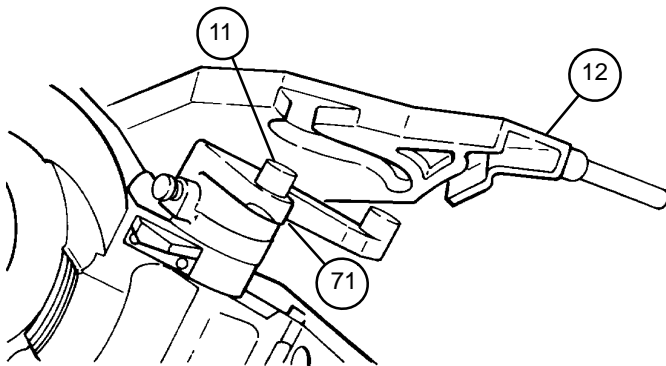
#### 3-6.8 Breech Mechanism — Continued

##### c. Assembly

**WARNING**

The breechblock weighs approximately 125 pounds (57 kg). It takes two personnel to install the breechblock to prevent injury to personnel.

- 1 Slightly raise operating cam (12) enough to clear rollers (11) from operating cam path. Rotate operating crank assembly (71) to move gear rack and sector gear timing marks (72) to the center of the inspection hole (73) in the carrier assembly (39). Scribe a line (73.1) from gear rack timing mark (73.2) onto carrier assembly (39), insure line extends completely down and onto outer edge of carrier assembly. Slowly lower operating cam to rest on rollers.
- 1.1 Scribe a line (73.3) from timing mark (73.4) onto breechblock (9), insure line extends completely down and onto outer edge of breechblock.

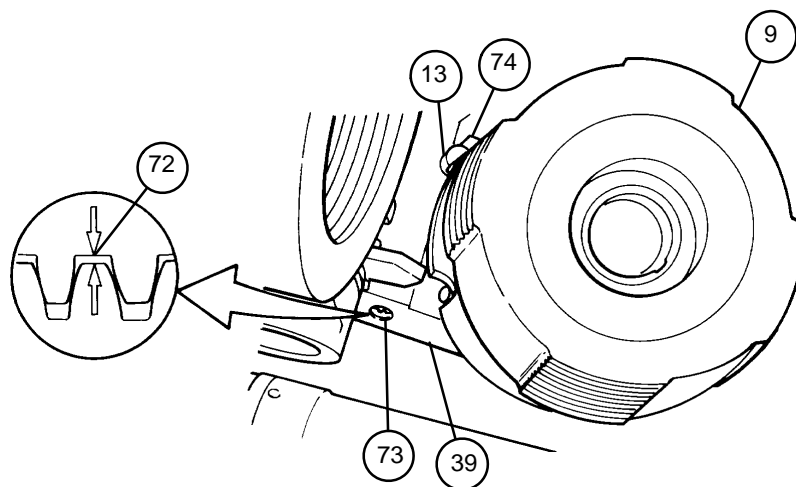
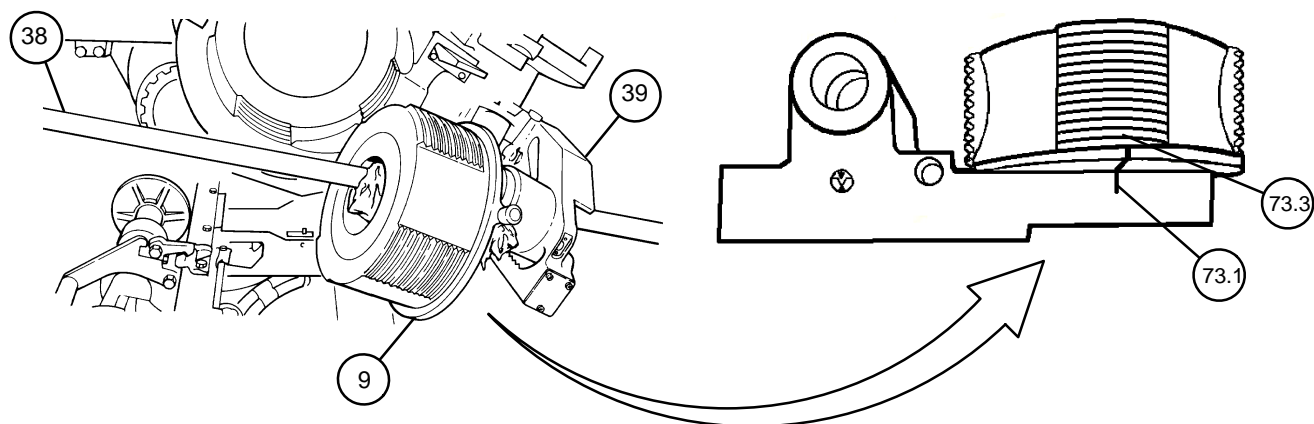


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### c. Assembly — Continued

- 2 Wrap cleaning staff section (38) with rags (item 35, Appx D) and insert through breechblock (9).
- 3 With carrier assembly (39) in fully open position, lift breechblock (9) and insert one end of cleaning staff section (38) into carrier assembly.
- 4 While alining scribed lines (73.3) and (73.1), slide breechblock (9) down cleaning staff section (38) onto carrier assembly (39). Remove cleaning staff section from breechblock and carrier assembly.
- 5 With carrier assembly (39) in fully open position, aline closing lug (74) with detent (13). With gear rack and sector gear timing marks (72) alined in the center of the inspection hole (73), slide breechblock (9) completely onto carrier assembly. Recheck timing marks.



### 3-6 ARMAMENT AND CAB MAINTENANCE -CONTINUED

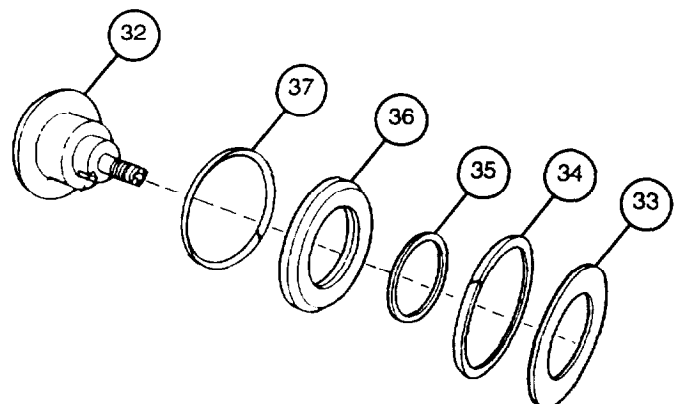
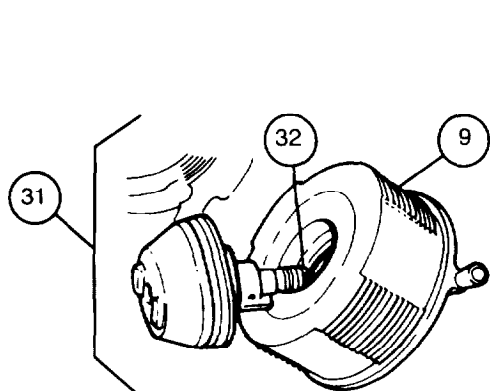
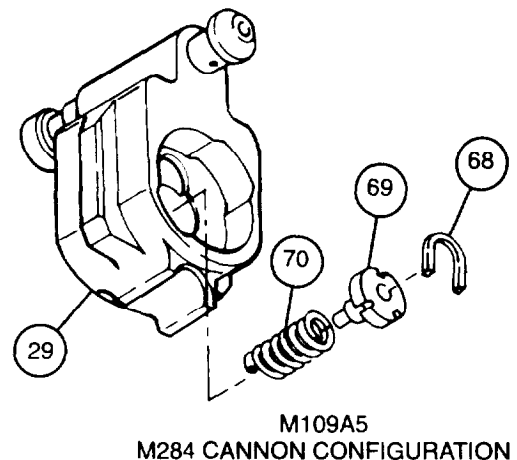
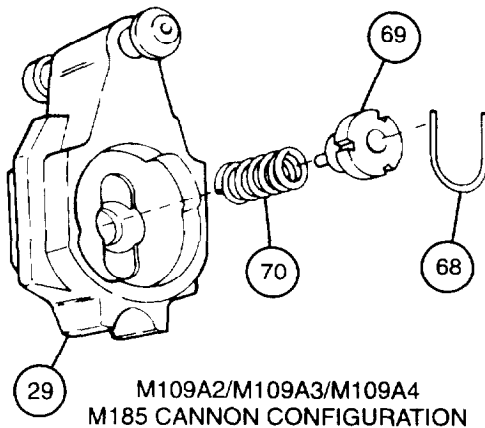
#### 3-8.8 Breech Mechanism—Continued

##### c. Assembly—Continued

**WARNING**

The follower group has a safety interlock which keeps the block from moving to the firing position until breechblock is fully closed. The follower must be in good working condition and properly assembled in firing mechanism to make sure safety works to avoid injury.

- 6 Install spring (70), firing pin (69), and lock pin (68) on block assembly (29).
- 7 Install the following on spindle (32): front retaining ring (37), obturator pad (36), inner retaining ring (35), rear retaining ring (34), and washer bearing (33). Make sure that retaining rings are alined 180° apart as shown.
- 8 Install spindle assembly (31) in breechblock (9).





### 3-6 ARMAMENT AND CAB MAINTENANCE - CONTINUED

#### 3-6.8 Breech Mechanism - Continued

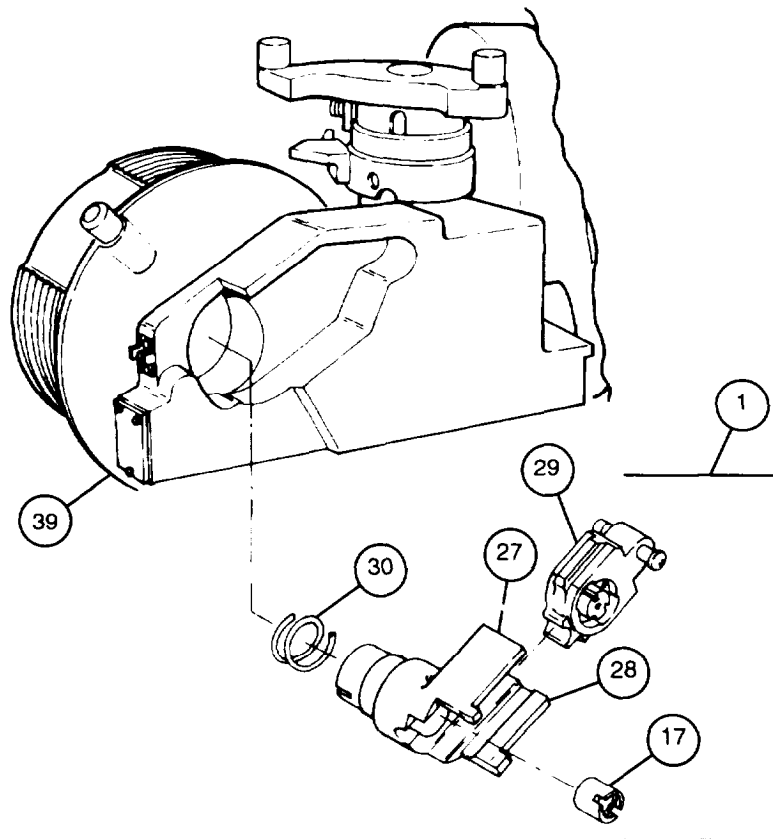
##### c. Assembly - Continued

- 9 If removed, install spring (30), housing (28), and block assembly (29) in carrier assembly (39).
- 10 Support housing (28) and firing group block (1). Install nut (17) using spanner wrench.

#### NOTE

- Cartridge extractor is located inside firing group block.
- Some howitzers may have different configurations of housing.

- 11 Position cartridge extractor (27) over nut (17).



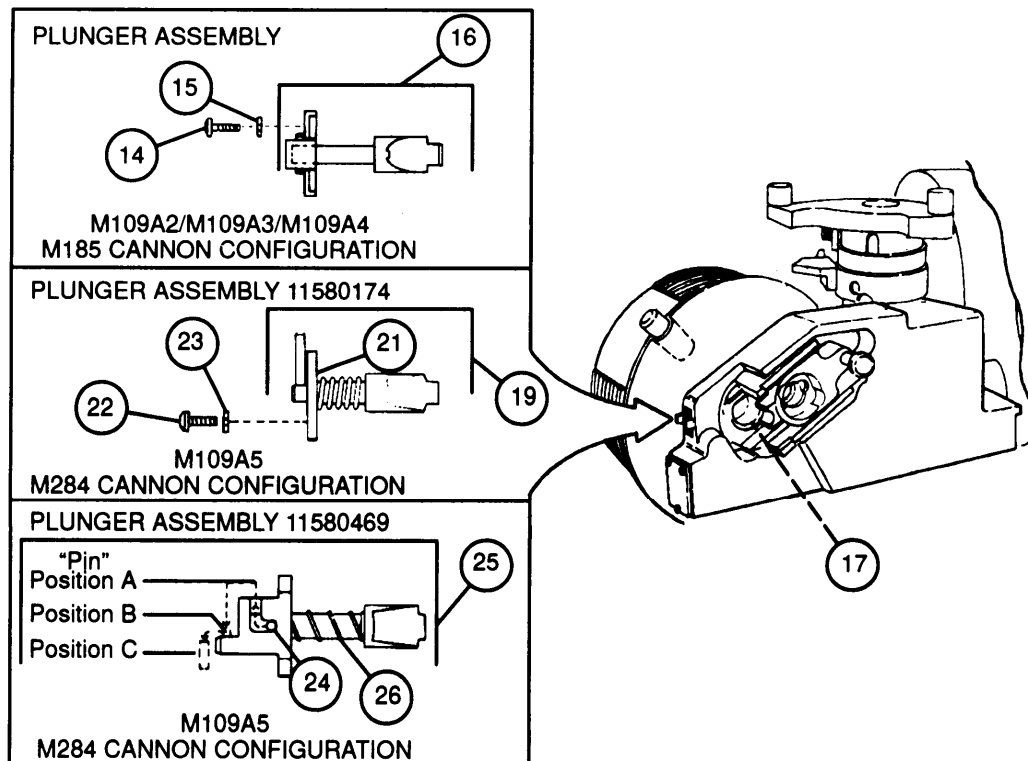
### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### c. Assembly — Continued

**NOTE**

- Perform step 12 for the M109A2/M109A3/M109A4 M185 cannon assembly or for the M109A5 M284 cannon assembly if the housing and firing block were removed.
  - Perform step 13 for the M109A5 M284 cannon assembly with plunger assembly 11580174 if only the spindle assembly was removed.
  - Perform step 14 for the M109A5 M284 cannon assembly with plunger assembly 11580469.
- 12 Install plunger assembly (16 or 19) and secure with two new lockwashers (15 or 23) and two cap screws (14 or 22). Be sure plunger tip seats in narrow slot of nut (17).
  - 13 Rotate plunger assembly (19) to release from cam plate (21). Be sure plunger assembly tip seats in narrow slot of nut (17).
  - 14 Rotate pin (24) from position B or C to position A to seat plunger assembly (25) tip in narrow slot of nut (17).

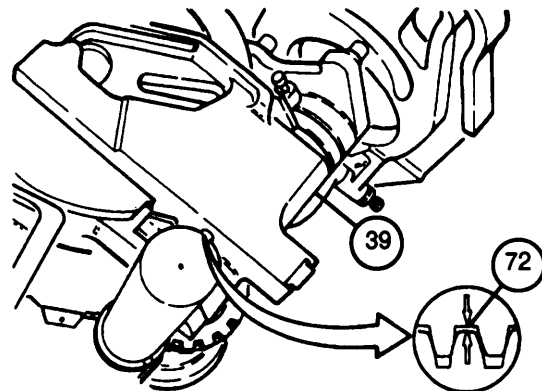
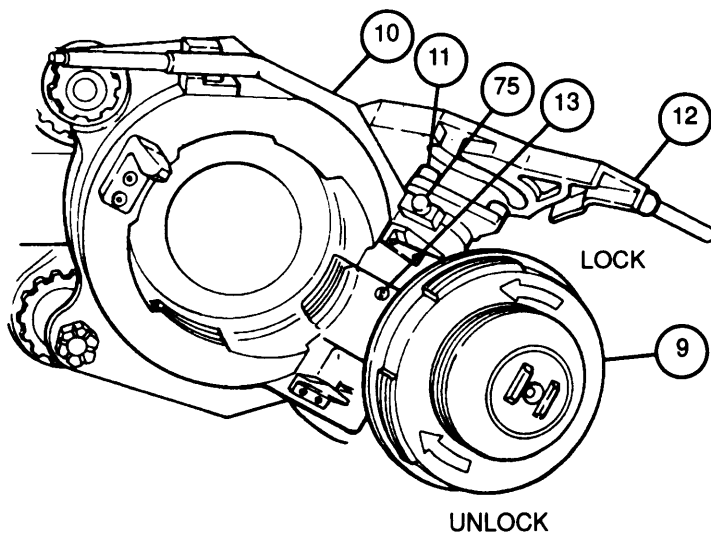


### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

##### c. Assembly — Continued

- 15 Slightly raise operating cam (12) to clear rollers (11).
- 16 Depress detent (13) with punch.
- 17 Rotate breechblock (9) to UNLOCKED position.
- 18 Pull carrier assembly (39) until rollers (11) align with operating cam (12) path and slowly lower operating cam into rollers.
- 19 Engage clutch pin (75). Raise operating cam (12) enough to clear rollers (11).
- 20 Close breechblock (9), using one soldier to move operating handle (10) to CLOSED position and the other to support the breechblock. If timing marks (72) are not aligned, the breechblock is out of time. Repeat steps 1 through 5.



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism —Continued

##### c. Assembly — Continued

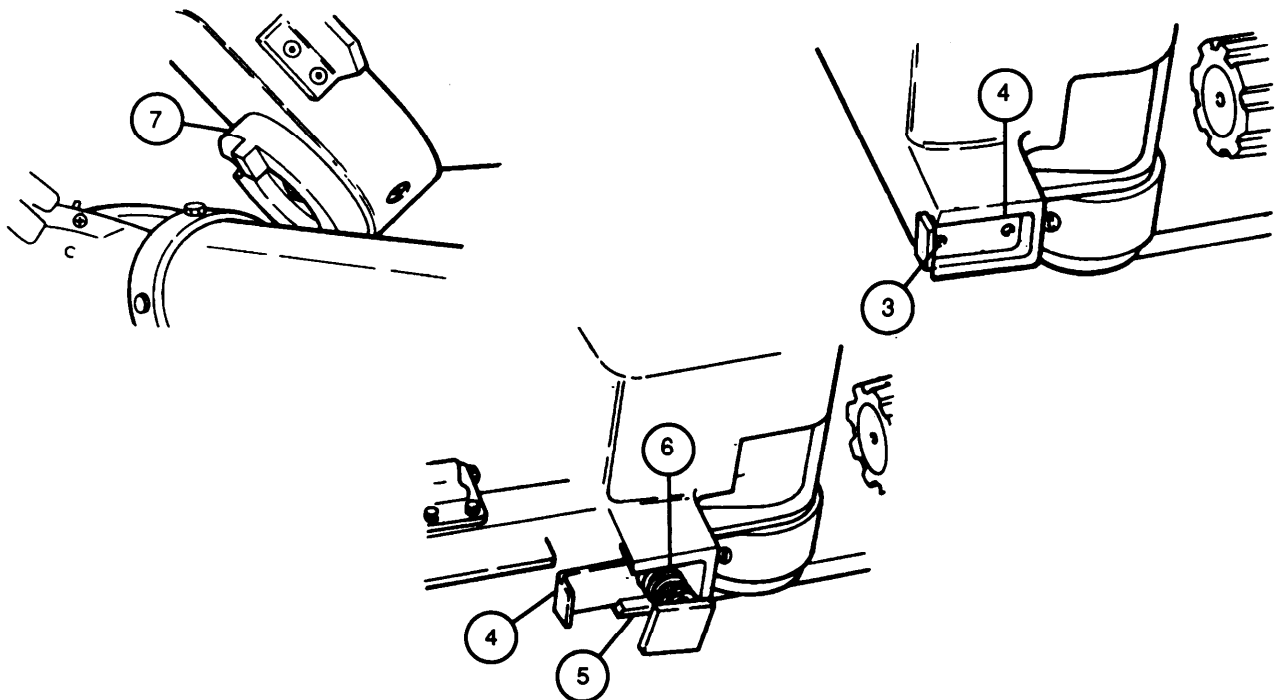
#### NOTE

Adjuster may have lugs for an adjustable wrench or holes for a spanner wrench.

- 21 Apply pre-load tension on breech mechanism closing springs. Use adjustable wrench or spanner wrench installed in holes of adjuster (7). The three notches in the adjuster provide the three graduations of adjustment. Do not apply more pre-load than is necessary to close breechblock (9) securely. Use of the final (third) notch reduces life of the leaf springs and should be used only if necessary.

#### NOTE

- Step 22 requires two people.
  - If stop plate has an arrow on it, be sure it points to muzzle brake end.
- 22 Depress plunger (3) with punch, and apply pressure to stop plate (5) and rack springs (6) with wood hammer handle. Slide rack plate (4) over stop plate.
- 23 Slide rack plate (4) forward until rear hole of rack plate engages plunger (3).



### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-6.8 Breech Mechanism — Continued

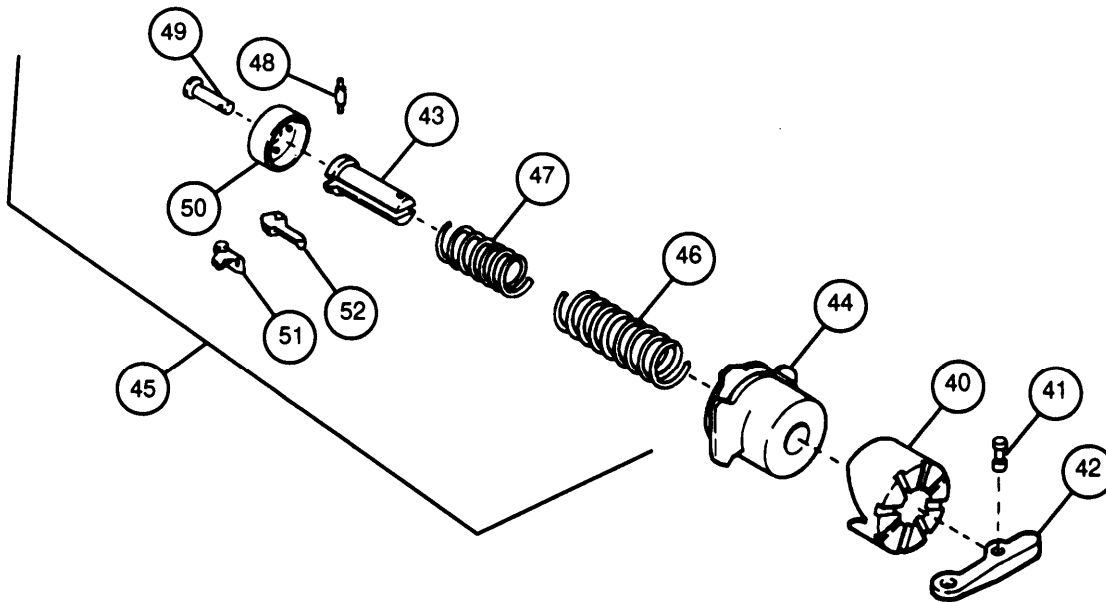
##### c. Assembly — Continued

#### NOTE

Step 24 applies to M35 firing mechanism on M109A2/M109A3/M109A4 M185 cannon assembly.

24 Assemble M35 firing mechanism.

- (a) Assemble sear (52) and firing spring (51).
- (b) Aline hole in rod end clevis (43) with hole in hammer guide cup (50). Install firing hammer (49) into hammer guide cup and rod end clevis.
- (c) Install sear (52) and firing spring (51) using grooved pin (48) on rod end clevis (43).
- (d) Install two springs (47 and 46) on rod end clevis (43).
- (e) Install case (44) and follower (40) on sear group (45).
- (f) Depress follower (40).
- (g) Install pin (41) in manual control lever (42) and rod end clevis (43).



**3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED****3-6.8 Breech Mechanism — Continued****c. Assembly — Continued****NOTE**

Step 25 applies to M49 firing mechanism on M109A5 M284 cannon assembly.

25 Assemble M49 firing mechanism.

- (a) Install firing hammer (66) in access cover (67).
- (b) Install hammer guide yoke (56) on firing hammer (66) so groove in firing hammer lines up with holes in hammer guide yoke.

**NOTE**

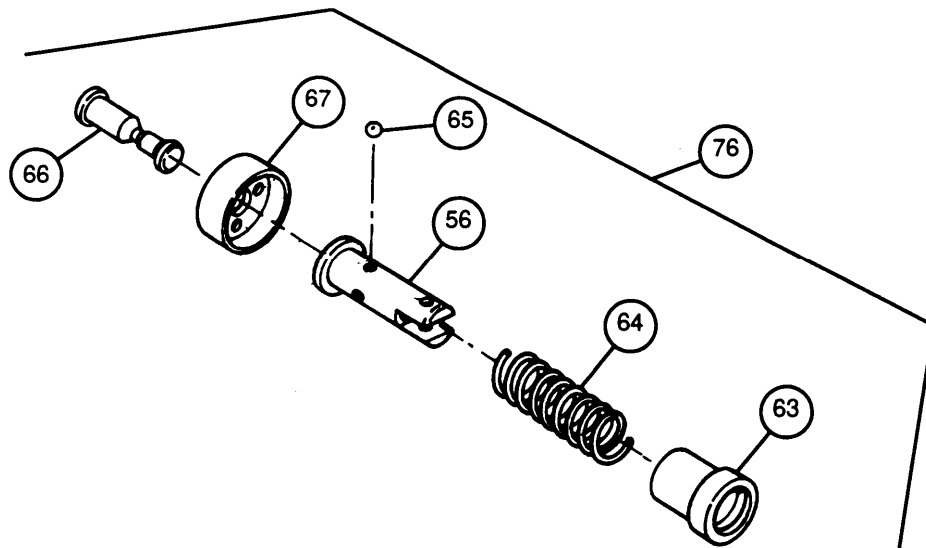
Apply grease (item 17, Appx D) to holes in hammer guide yoke prior to installing bearing balls.

- (c) Install spring (64) and sleeve bushing (63) on hammer guide yoke (56) and install three bearing balls (65) into hammer guide yoke holes between spring coils. Slide sleeve bushing against spring until spring is fully compressed against access cover (67).
- (d) Pull firing hammer (66) from hammer guide yoke (56) until sleeve bushing (63) locks in place.

**NOTE**

Use a 1-1/8 inch (2.86 cm) socket and M34 fuze setter to complete assembly.

- (e) Set yoke and hammer group (76) on socket so firing hammer (66) hangs freely,



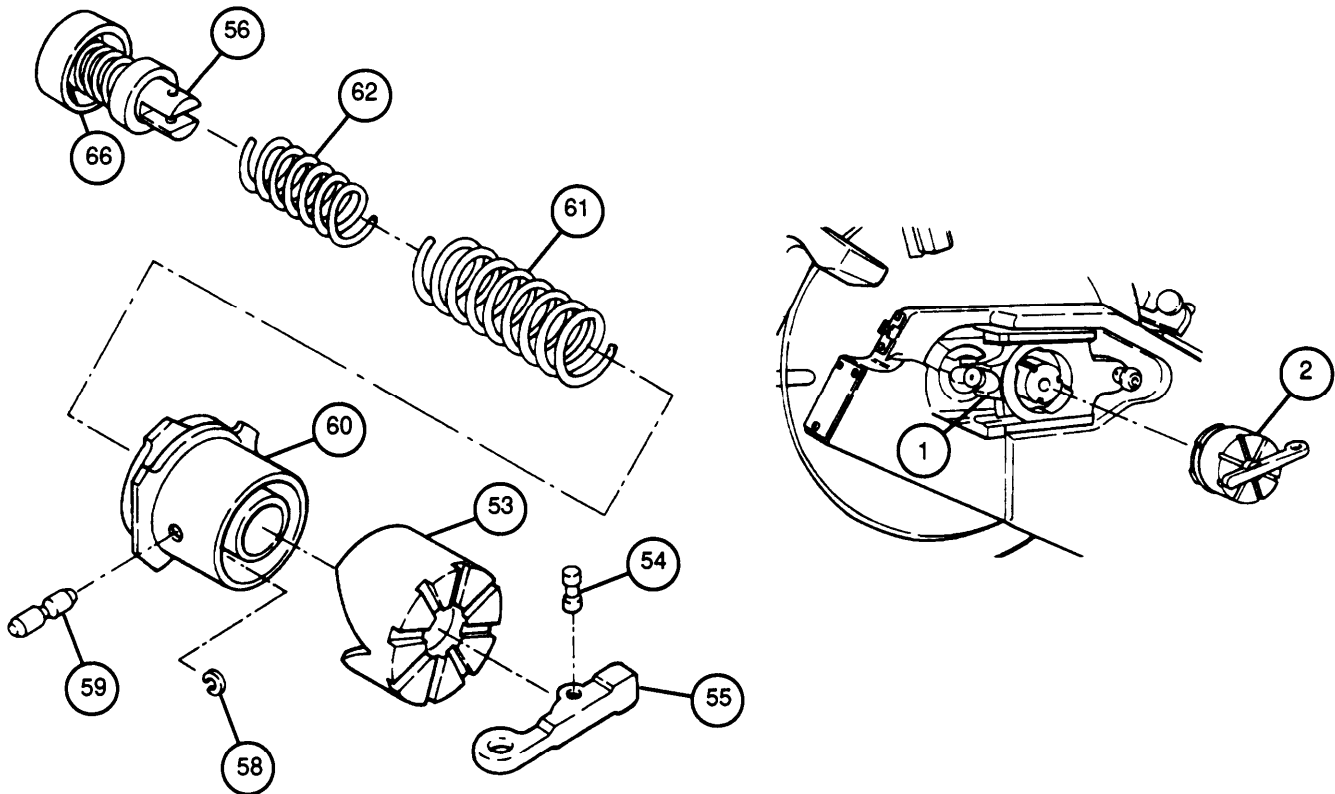
### 3-6 ARMAMENT AND CAB MAINTENANCE — CONTINUED

#### 3-8.8 Breech Mechanism — Continued

##### c. Assembly — Continued

- (f) Assemble two grooved pins (59) and two retaining rings (58) in case (60), if disassembled.
- (g) Install two springs (62 and 61) over hammer guide yoke (56).
- (h) Install assembled case (60) over springs (62 and 61).
- (i) Install follower (53) over assembled case (60) alining pins with cutouts of follower.
- (j) Using M34 fuzesetter, compress two springs (62 and 61) and follower (53) over hammer guide yoke (56) until manual control lever (55) can be inserted into hammer guide yoke.
- (k) Install grooved pin (54) in manual control lever (55) and hammer guide yoke (56).
- (l) Depress firing hammer (66) against solid flat surface to seat firing mechanism (2).

26 With firing group block (1) in center position, insert firing mechanism (2) and rotate counterclockwise.



## 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS

### 3-7.1 General

#### a. Intervals

Fire control alinement tests are performed by the section crew members under the supervision of the battery executive officer, chief of firing battery, and artillery mechanic. These tests are performed at the discretion of the unit commander. Suggested intervals for these tests are as follows.

- 1 Once each year if the cannon is used for non-firing training.
- 2 Once every 3 months if the cannon is fired.
- 3 As soon as possible after extensive use.
- 4 Following accidents.
- 5 After traveling over extremely rough terrain.
- 6 When fire control mounts have been replaced.
- 7 When the cannon fires inaccurately for no apparent reason.
- 8 When the cannon tube is replaced.

#### b. Equipment Required for Fire Control Alinement Tests

Equipment necessary for performing the fire control alinement tests is as follows.

- 1 Three 10-ton jacks.
- 2 A cord at least 22 feet (67 m) long with an object that weighs at least 1/2 pound (0.23 kg) tied to the end.
- 3 Muzzle crosshairs.
- 4 Breech boresight disc.
- 5 M1A1 gunner's quadrant.
- 6 Test target.
- 7 Three to five gallon (18.91) container of waste oil or water.
- 8 Three inch (7.62 cm) screwdriver for boresighting M117/M117A2 panoramic telescope.
- 9 Cannon tube leveling fixture (bar) when required.



## 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

### 3-7.1 General —Continued

#### c. Preparation for Fire Control Alinement Tests

- 1 Emplace the weapon on as firm and level ground as is possible. Use hard stand if one is available.
- 2 Check the M15 elevation quadrant, the M117/M117A2 panoramic telescope, and the M145/M145A1 telescope mount for looseness or other obvious defects. Make sure M117/M117A2 panoramic telescope is securely mounted using both latches. Make sure M140 alinement device is securely mounted in front of panoramic telescope ballistic cover.
- 3 Inspect the M1A1 gunner's quadrant shoes for dirt or burrs. If necessary, clean the shoes with a wiping rag (item 35, Appx D). If burrs are present, notify unit maintenance.
- 4 Perform M1A1 gunner's quadrant tests (para 3-7.2).
- 5 Level the gun trunnions (para 3-7.3).
- 6 Zero the cannon tube.
- 7 If necessary check the stability of the cannon assembly (cannon tube drop).
  - (a) Using the M1A1 gunner's quadrant, place cannon tube at + 266 mils.
  - (b) Turn CAB POWER switch to OFF and wait 1 hour.
  - (c) Cannon tube should not have moved more than 3.0 mils. If greater movement is found, notify unit maintenance.
  - (d) Repeat steps (b) and (c) placing cannon tube at+ 600 mils.
  - (e) Boresight the weapon (para 2-12.2).

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS—CONTINUED

#### 3-7.2 M1A1 Gunner's Quadrant Tests

##### a. Micrometer Test

- 1 Inspect the elevation seats (1) on breech ring for dirt or burrs. If necessary, clean with a wiping rag (item 35, Appx D). If burrs are present, notify unit maintenance.
- 2 Set index arm (2) of M1A1 gunner's quadrant (3) at plus 10.
- 3 Set the micrometer knob (4) at zero.

**WARNING**

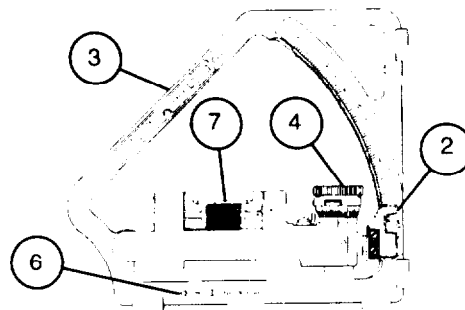
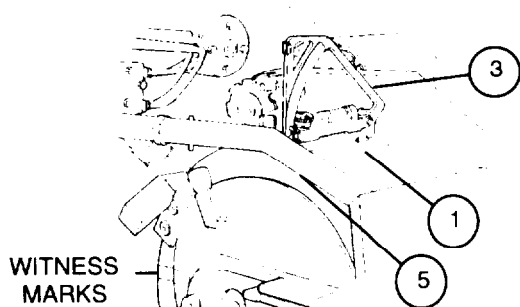
The breechblock must be open and the operating handle left unlocked. To prevent injury to personnel, be careful not to lift up on operating cam before securing operating handle after leveling cannon tube.

- 4 Unlatch operating handle (5) enough to place M1A1 gunner's quadrant (3).
- 5 Position M1A1 gunner's quadrant (3) on breech with LINE OF FIRE arrow (6) pointing toward muzzle.
- 6 Depress or elevate cannon tube to center bubble (7).
- 7 Set index arm (2) at zero.
- 8 Set micrometer knob (4) at 10.
- 9 Position M1A1 gunner's quadrant (3) on breech with LINE OF FIRE arrow (6) pointing toward muzzle.
- 10 Bubble (7) should center. If bubble centers, micrometer test is complete. Proceed to end-for-end test (para 3-7.2b.). If bubble does not center, the micrometer is in error and should be turned in to unit maintenance for repair.

#### NOTE

Breech is completely closed when witness marks on breech ring and breechblock aline.

- 11 If necessary, open breech and close completely.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS - CONTINUED

#### 3-7.2 M1A1 Gunner's Quadrant Tests - Continued

##### b. End-For-End Test

#### NOTE

In tolerance is  $\pm 0.4$ . Anything greater is not acceptable.

- 1 Inspect the elevation seats (1) on breech ring for dirt or burrs. If necessary, clean with a wiping rag (item 35, Appx D). If burrs are present, notify unit maintenance.
- 2 Set index arm (2) and micrometer knob (4) of M1 A1 gunner's quadrant (3) at zero.

**WARNING**

The breechblock must be slightly open and the operating handle left unlocked. To prevent injury to personnel, be careful not to lift up on operating cam before securing operating handle after leveling cannon tube.

- 3 Unlatch operating handle (5) enough to place M1A1 gunner's quadrant (3).
- 4 Position M1A1 gunner's quadrant (3) on breech with LINE OF FIRE arrow (6) pointing toward muzzle brake.
- 5 Depress or elevate cannon tube to center bubble (7).
- 6 Reverse direction of M1 A1 gunner's quadrant (3).
- 7 Bubble (7) should center. If bubble centers, end-for-end test is complete. If bubble does not center, go to step 8.
- 8 Center bubble (7) using micrometer knob (4). If bubble centers, go to step 9. If bubble does not center, go to step 15.
- 9 Read the black figures. Divide micrometer reading by 2 to determine correction factor (Example:  $0.4 \div 2 = 0.2$ ; so 0.2 is correction factor).
- 10 Place correction factor on micrometer knob (4).
- 11 Position M1A1 gunner's quadrant (3) with LINE OF FIRE arrow (6) pointing toward muzzle brake.
- 12 Depress or elevate cannon tube to center bubble (7).
- 13 Reverse direction of M1 A1 gunner's quadrant (3).

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.2 M1A1 Gunner's Quadrant Tests — Continued

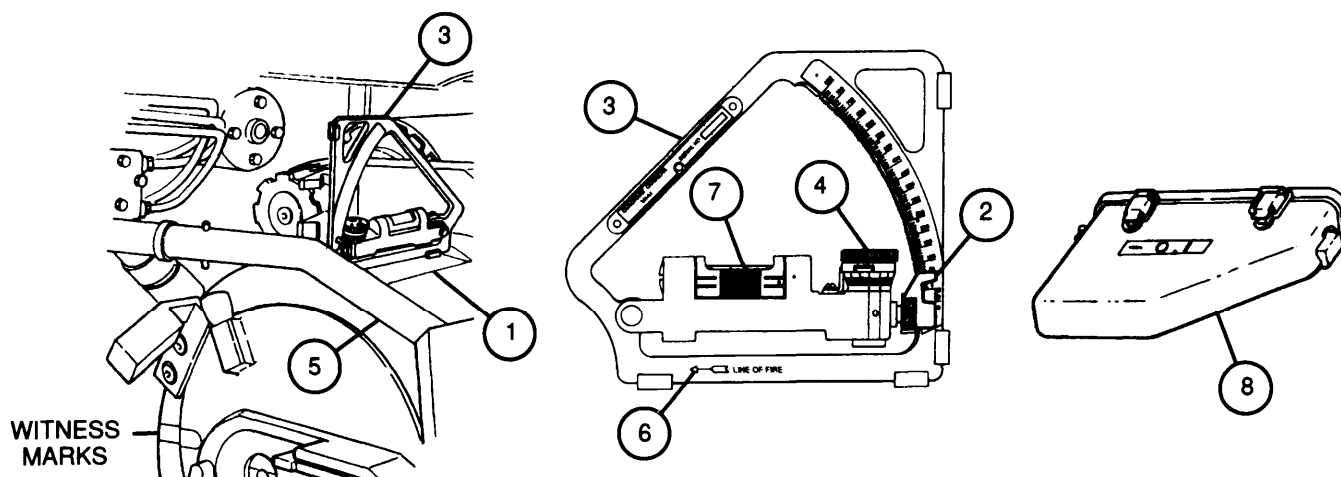
##### b. End-For-End Test — Continued

- 14 Bubble (7) should center. If bubble centers, end-for-end test is complete. Record end-for-end correction. If bubble does not center, go to step 15.
- 15 Set index arm (2) at minus 10.
- 16 Center bubble (7) with micrometer knob (4).
- 17 Add micrometer reading to 10.0.
- 18 Divide step 17 answer by 2. This is your trial correction. An example  $\frac{19.8}{2} = 9.9$
- 19 Place answer on micrometer knob (4).
- 20 Position M1A1 gunner's quadrant (3) with LINE OF FIRE arrow (6) pointing toward muzzle brake.
- 21 Depress or elevate cannon tube to center bubble (7).
- 22 Reverse direction of M1A1 gunner's quadrant (3).
- 23 Bubble (7) should center. If bubble centers, go to step 24. If bubble does not center, go back to step 15.
- 24 Subtract micrometer reading from 10. Since this is a negative correction (step 14) a minus sign must be placed in front of the correction factor.
- 25 Record negative end-for-end correction on case (8).

**NOTE**

Breech is completely closed when witness marks on breech ring and breechblock align.

- 26 If necessary, open breech and close completely.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

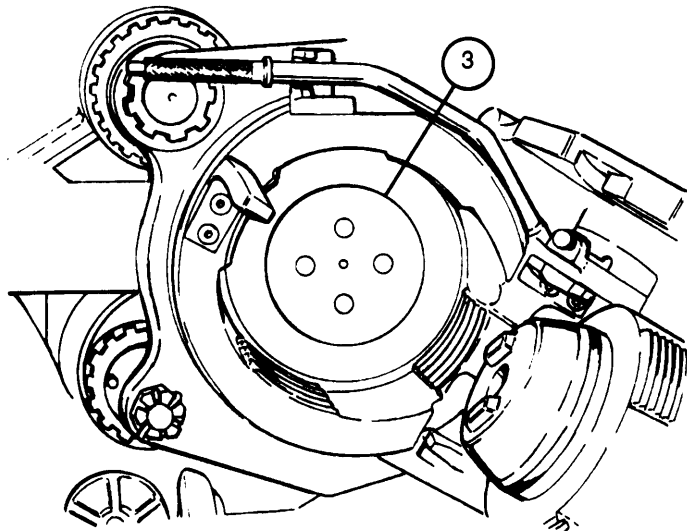
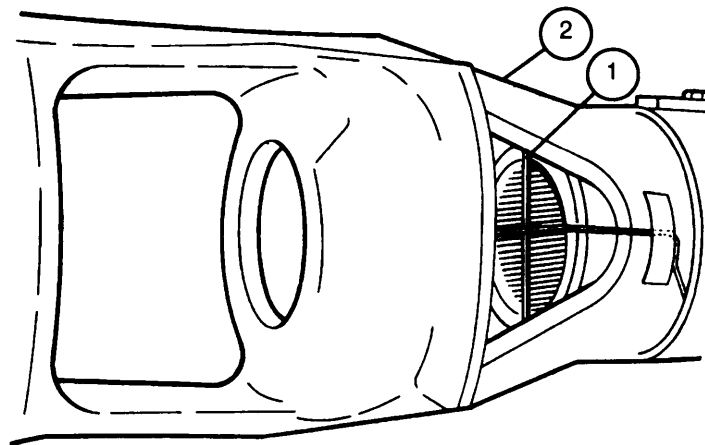
#### 3-7.3 Leveling Gun Trunnions

##### NOTE

Gun trunnions must be leveled to ensure the fire control equipment mounts are parallel with the cannon tube. There are two ways to level gun trunnions: plumbline method and scribed lines method.

##### a . Plumbline Method

- 1 Attach crosshairs (1) made of fibrous twine (item 39, Appx D) at witness marks on muzzle brake (2).
- 2 Install breech bore sight (3) or remove firing pin and use firing pin hole for rear sight instead of breech bore sight.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.3 Leveling Gun Trunnions — Continued

##### a. Plumblines Method — Continued

3 Suspend plumblines (4) with weight (5) attached at a location where there is little or no wind. The plumblines must be high enough (22 feet (6.7 m)) to elevate cannon tube (6) to 600 mils.

4 Place weight (5) in waste oil or water.

5 Position weapon so that cannon tube (6) is within 12 inches (30.48 cm) of the plumblines (4).

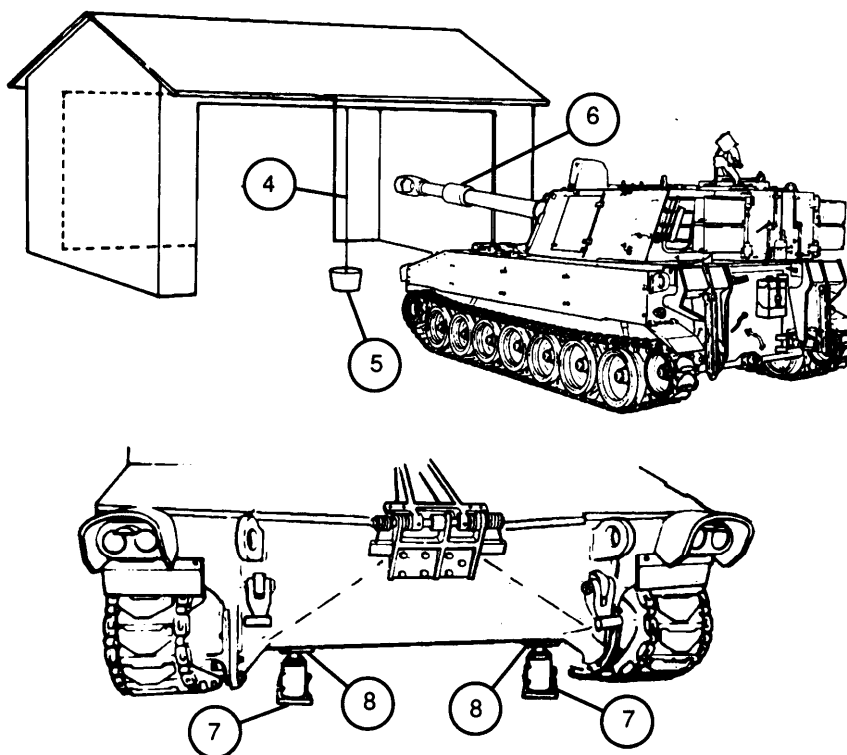
#### NOTE

Use jacks with capacity of 10 tons or better. Ensure hydraulic jacks do not leak so test will be accurate.

#### NOTE

An alternate method to steps 6 and 7 is to place one jack under center front of vehicle and two jacks under left and right rear sides of vehicle.

6 Install two jacks (7) on the left and right front sides under 1 inch (2.54 cm) pads (8). Raise jacks until they support a load.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

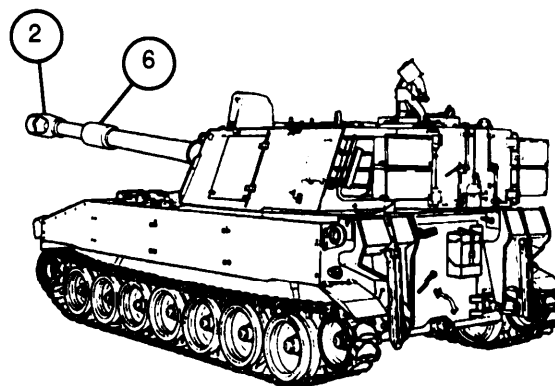
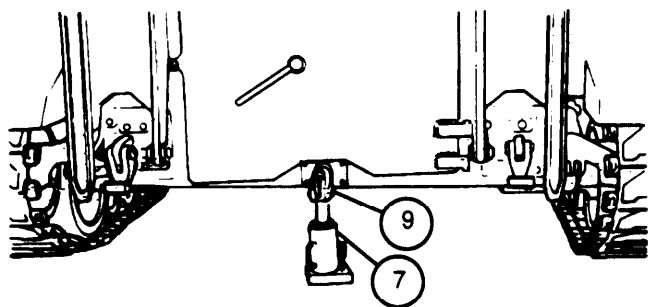
#### 3-7.3 Leveling Gun Trunnions — Continued

##### a. Plumblines Method — Continued

#### NOTE

Use wooden block (item 40, Appx D) at least 1 inch (2.54 cm) thick between jack and towing pintle assembly.

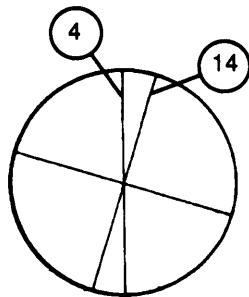
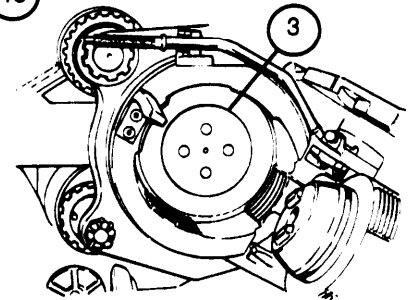
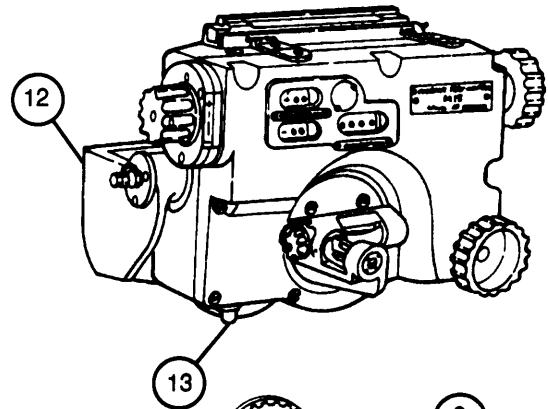
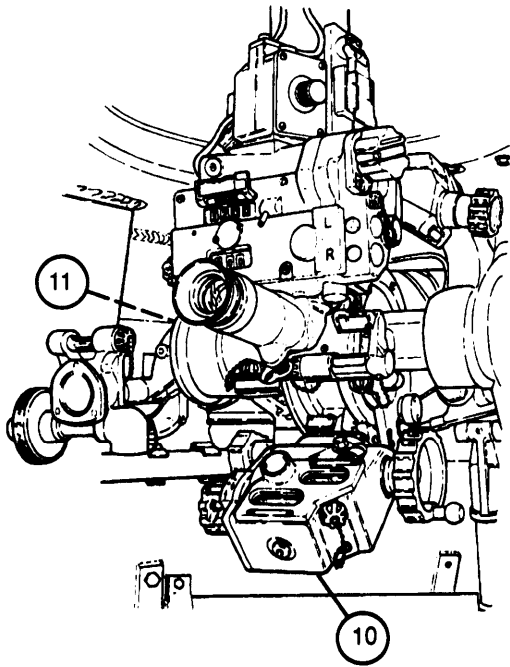
- 7 Install jack (7) in center rear of vehicle with rear edge of jack pad under towing pintle assembly (9).
- 8 Release cannon tube (6) from travel lock and position turret lock in UNLOCKED position (para 2-10.8).
- 9 Turn on M145/M145A1 telescope mount (10) lights with toggle switch (11) and M15 elevation quadrant (12) lights with toggle switch (13).
- 10 Manually position the cannon tube (6) at approximately zero elevation.
- 11 Look through the breech bore sight (3) and have someone manually traverse the cannon tube until the vertical crosshair (14) on the muzzle brake (2) is alined next to the plumbline (4). If traversing more than 100 mils left or right is necessary, reposition the weapon or the plumbline.
- 12 If alinement looks like A, right front or right rear jacks (7) need to be jacked up until there is proper alinement like B.
- 13 If alinement looks like C, left front or left rear jacks (7) need to be jacked up until there is proper alinement like B.



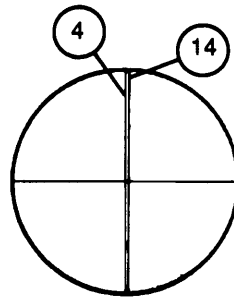
### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.3 Leveling Gun Trunnions — Continued

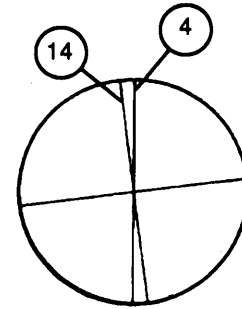
##### a. Plumblines Method — Continued



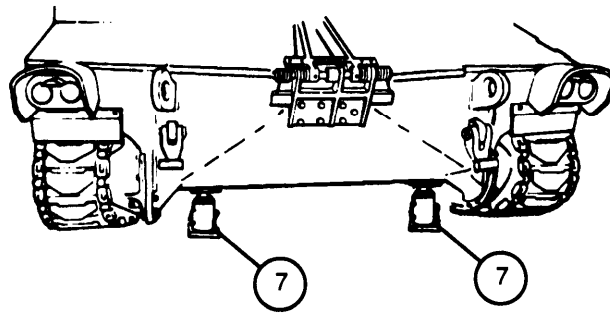
A



B



C



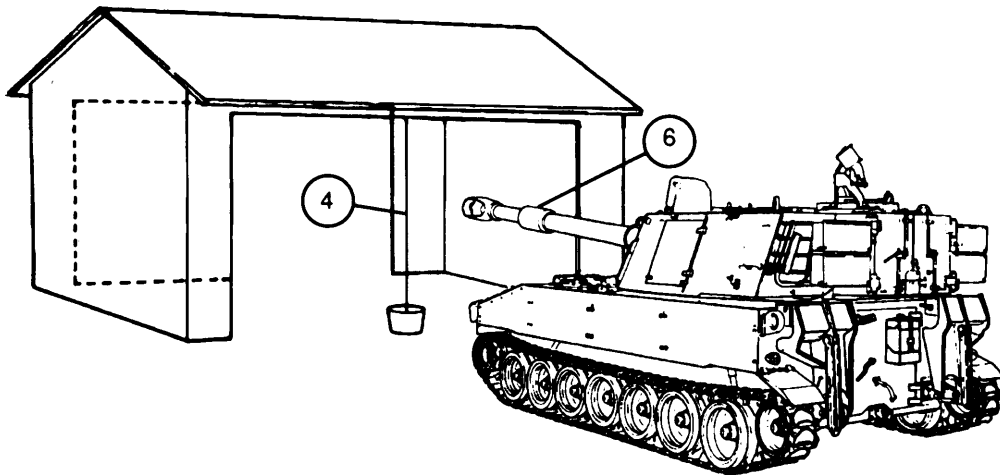
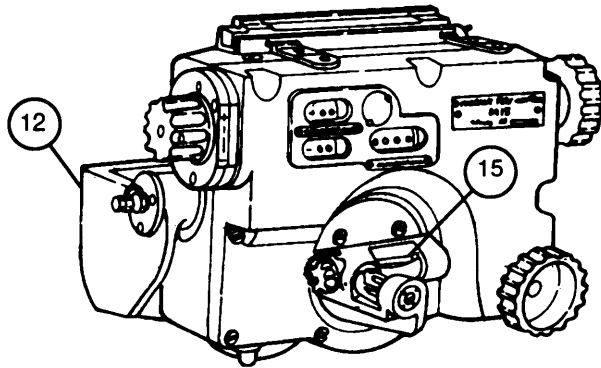


### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.3 Leveling Gun Trunnions — Continued

##### a. Plumblines Method-Continued

14 Set off 100 mils on M15 elevation quadrant (12) and elevate the cannon tube (6) manually until the elevation bubble (15) centers.

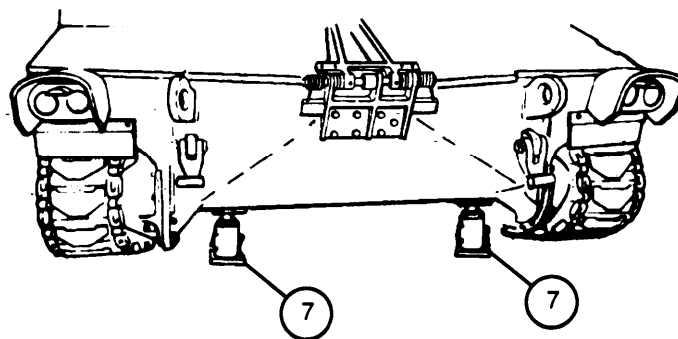
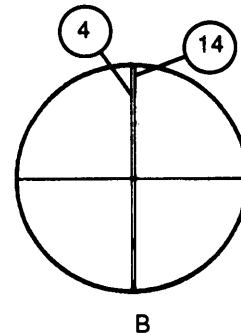
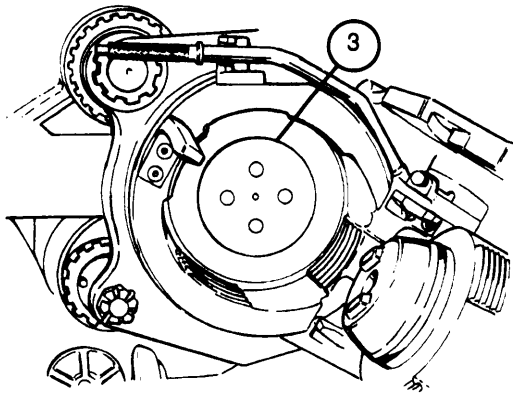


### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.3 Leveling Gun Trunnions — Continued

##### a. Plumblines Method-Continued

- 15 Look through the breech bore sight (3) and check for proper alinement like B. Correct as required (steps 12 or 13).
- 16 Continue to elevate cannon tube (6) manually in 100 mil increments up to 600 mils, while observing plumblines (4). Jack the weapon as required to keep vertical crosshair (14) parallel to plumblines.
- 17 Slowly depress cannon tube (6) to zero mils while observing plumblines (4). The crosshair should track the plumblines. If it does, the gun trunnions are level. If it does not track, repeat steps 14 through 17 until the proper alinement like B is obtained without moving the jacks (7). If plumblines cannot be tracked, notify unit maintenance.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

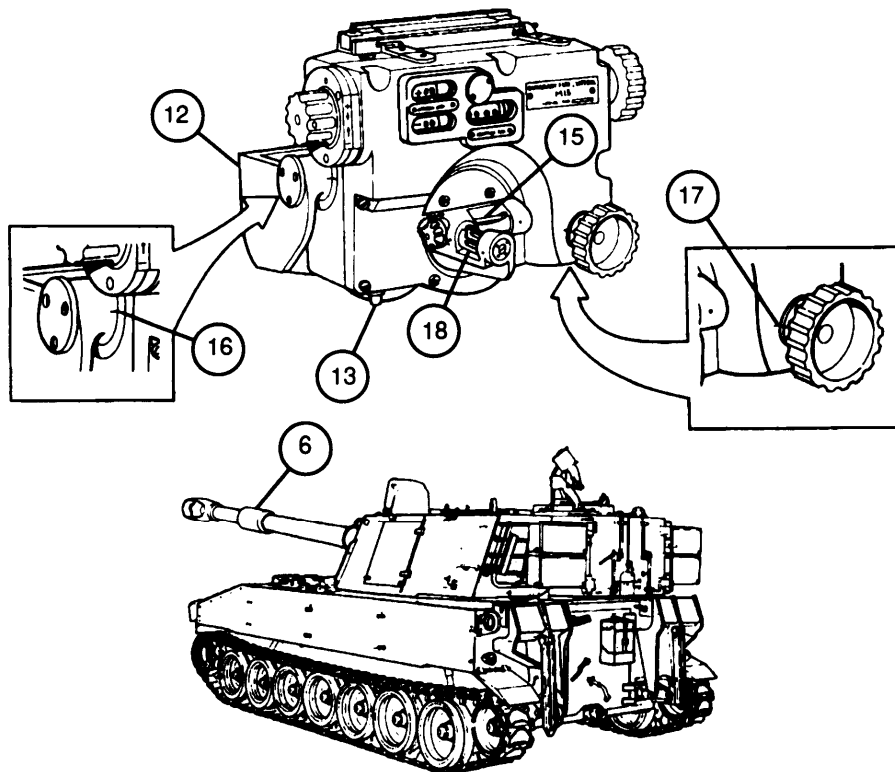
#### 3-7.3 Leveling Gun Trunnions — Continued

##### b. Scribed Lines Method

#### NOTE

This procedure applies only to weapons with M15 elevation quadrants that have been previously scribed (para 3-7.8).

- 1 Position the weapon on as firm and level ground as is possible or hardstand if one is available.
- 2 Turn on M15 elevation quadrant (12) lights with toggle switch (13) and carefully aline scribe lines (16) and (17).
- 3 Set zero mils on M15 elevation quadrant (12) and level the elevation bubble (15) by elevating or depressing the cannon tube (6).
- 4 Manually and slowly traverse the cannon tube (6) (either direction) while someone watches the cross-level bubble (18). Stop traversing when the cross-level bubble centers. Manually elevate or depress the cannon tube until the elevation bubble (15) centers. Recheck the cross level bubble. If cross-level bubble remained exactly centered, the gun trunnions are level. If not, traverse until the cross-level bubble is centered. The gun trunnions are now level.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.4 Boresighting the Weapon

Boresight using the test target method (para 2-12.2).

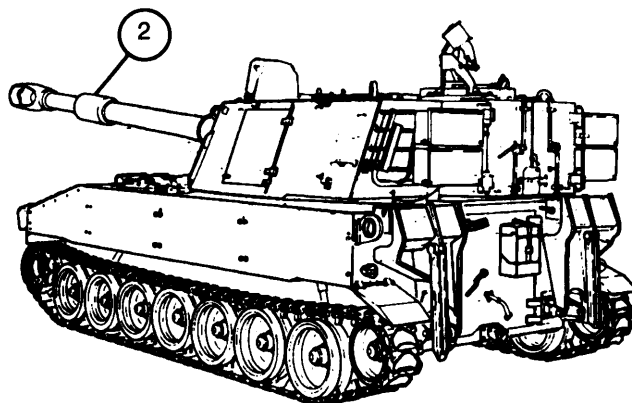
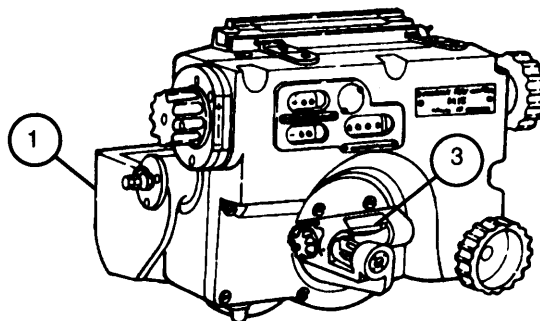
#### 3-7.5 Leveling the Cannon Tube

##### a. Leveling the Cannon Tube Using the Cannon Tube Leveling Fixture (if Required)

#### NOTE

- Use of cannon tube leveling fixture is required if cannon tube does not have quadrant seats on muzzle brake end of cannon tube.
- Recheck gun trunnions. They must be perfectly level for this test.

1 Set zero on the M15 elevation quadrant (1). Elevate or depress the cannon tube (2) until the elevation bubble (3) centers.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

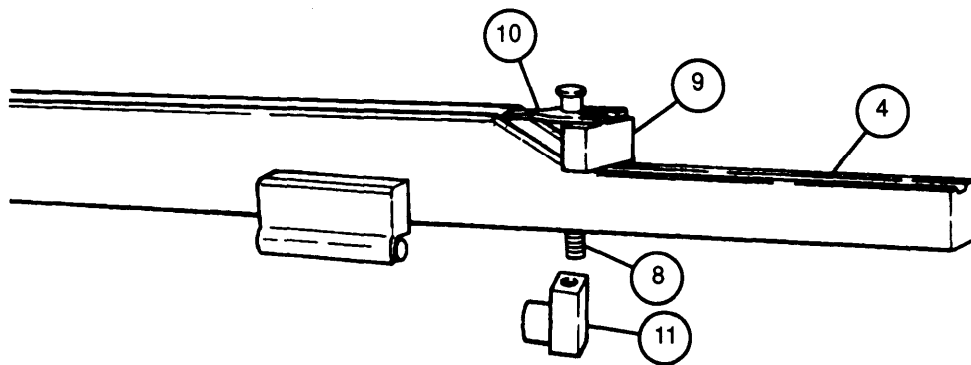
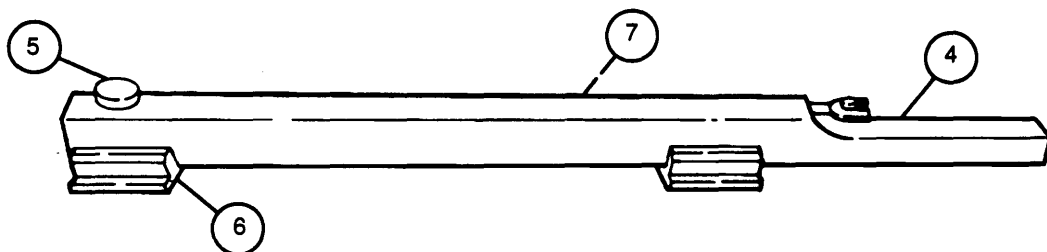
#### 3-7.5 Leveling the Cannon Tube — Continued

##### a. Leveling the Cannon Tube Using the Cannon Tube Leveling Fixture (If Required) — Continued

2 On the cannon tube leveling fixture (4), remove the screw (5) from the movable shoe (6) and move the shoe over the 155MM mark (7).

3 Replace and tighten screw (5).

4 Loosen screw (8) and insert cross-level vial (9) under holder (10) on cannon tube leveling fixture (4). Tighten screw, then screw the magnet base stop (11) onto the screw as it protrudes through the cannon tube leveling fixture from the holder. Tighten magnet base stop securely.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

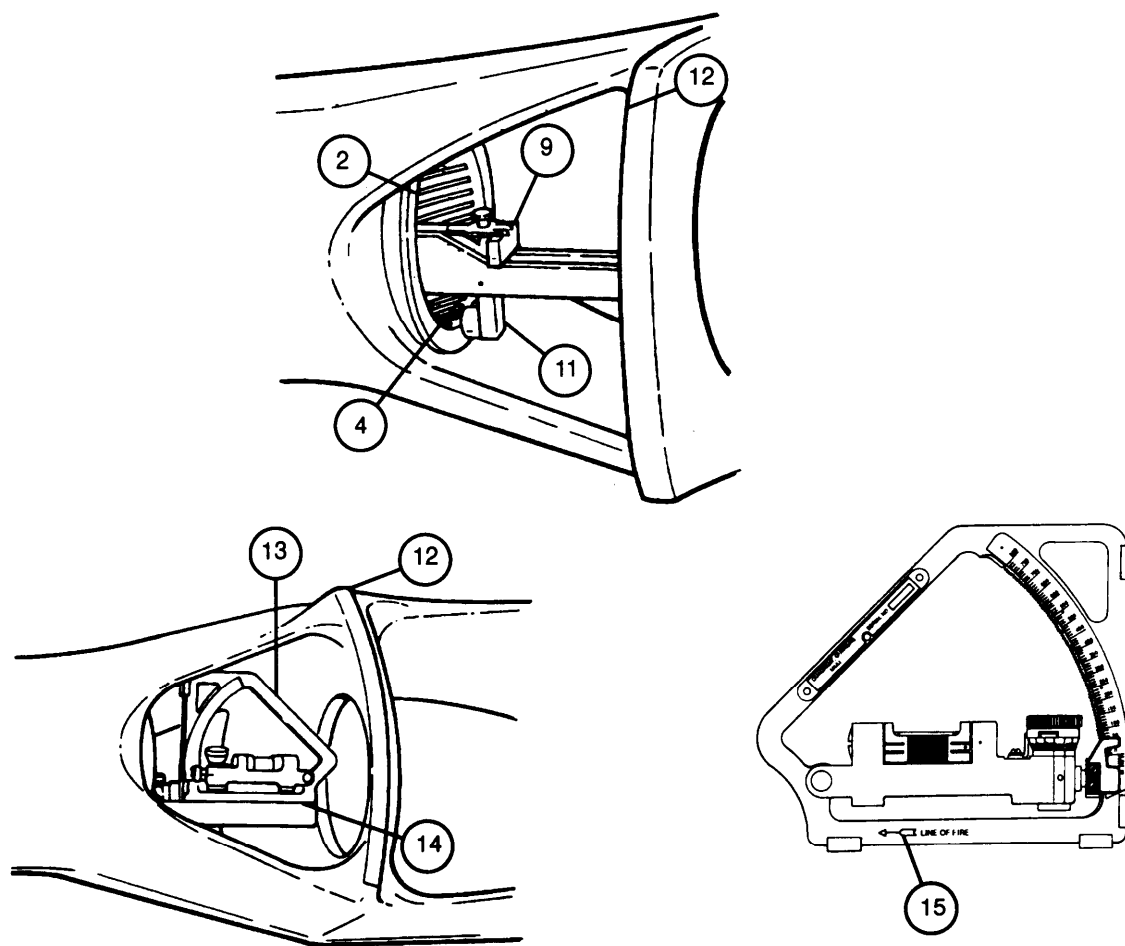
#### 3-7.5 Leveling the Cannon Tube— Continued

##### a. Leveling the Cannon Tube Using the Cannon Tube Leveling Fixture (If Required) — Continued

5 Be sure cannon tube (2) is dry and clean. Insert the cannon tube leveling fixture (4) into muzzle brake (12) end of the cannon tube to the point at which the magnet base stop (11) contacts the face of the cannon tube. Be sure the magnet base stop is flush with the cannon tube.

6 Rotate the cannon tube leveling fixture (4) until the cross-level vial (9) bubble centers.

7 Place a pre-tested M1A1 gunner's quadrant (13) set at 0 (with corrections applied if applicable) in the groove (14) of the cannon tube leveling fixture (4) with LINE OF FIRE arrow (15) pointing to muzzle brake (12) end.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

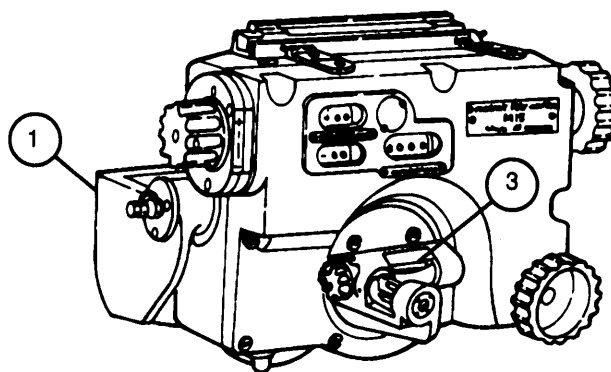
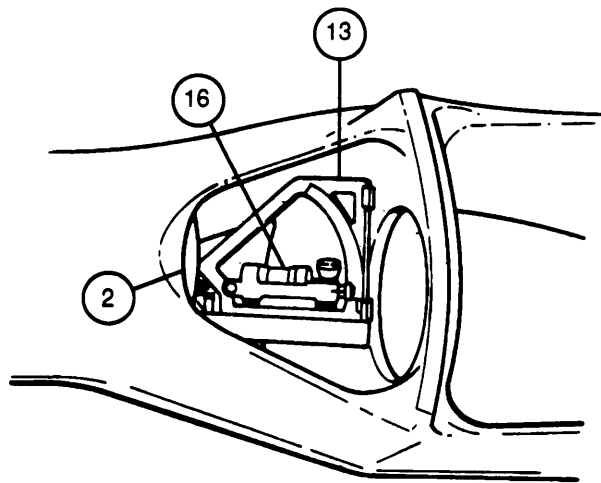
#### 3-7.5 Leveling the Cannon Tube — Continued

##### a. Leveling the Cannon Tube Using the Cannon Tube Leveling Fixture (If Required) — Continued

8 Elevate or depress the cannon tube (2) until the M1A1 gunner's quadrant (13) bubble (16) is centered.

9 Reverse the M1A1 gunner's quadrant (13). The bubble (16) should center again.

10 Check to see if M15 elevation quadrant (1) elevation bubble (3) is still centered. If adjustment to center elevation bubble is more than  $\pm 0.5$  mil, notify unit maintenance.



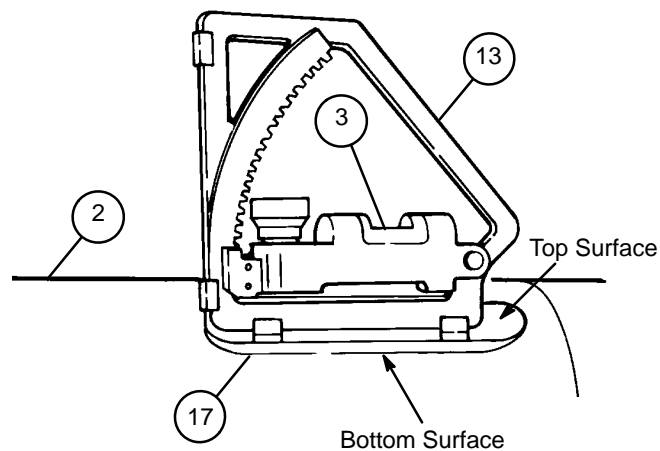
### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.5 Leveling the Cannon Tube — Continued

##### b. Leveling the Cannon Tube Using the M1A1 Gunner's Quadrant

#### NOTE

- Top surfaces of cannon tube quadrant seat must be free of paint prior to being used for taking readings with M1A1 gunner's quadrant.
  - The cannon has quadrant seats on the top muzzle brake end of the cannon tube and on the top of the breech ring. The embedded correction (the difference between muzzle and breech elevation) is measured rather than being stamped on the breech. Breechblocks that have stamped embedded corrections should be disregarded during cannon tube leveling test.
- 1 Place a tested M1A1 gunner's quadrant (13) on the top surface of cannon tube quadrant seat (17). Apply only the M1A1 gunner's quadrant correction, if any, and center the elevation bubble (3) by manually elevating or depressing the cannon tube (2). The cannon tube is now at 0 mils.





### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.5 Leveling the Cannon Tube — Continued

##### b. Leveling the Cannon Tube Using the M1A1 Gunner's Quadrant — Continued

**WARNING**

The breechblock must be open and the operating handle left unlocked. To prevent injury to personnel, be careful not to lift up on operating cam before securing operating handle after leveling cannon tube.

- 2 Unlatch operating handle (18) enough to place M1A1 gunner's quadrant (13).
- 3 Move M1A1 gunner's quadrant (13) to elevation seats (19) on breech ring and center the elevation bubble (3) by moving micrometer knob (20). The difference between 0 mils at muzzle brake end and the reading taken at breech ring is the measured correction.
- 4 Add M1A1 gunner's quadrant (13) correction and measured corrections. For example:

M1A1 gunner's quadrant correction	- 0.4
Measured correction	<u>+ 1.9</u>
Place on M1A1 gunner's quadrant	+ 1.5

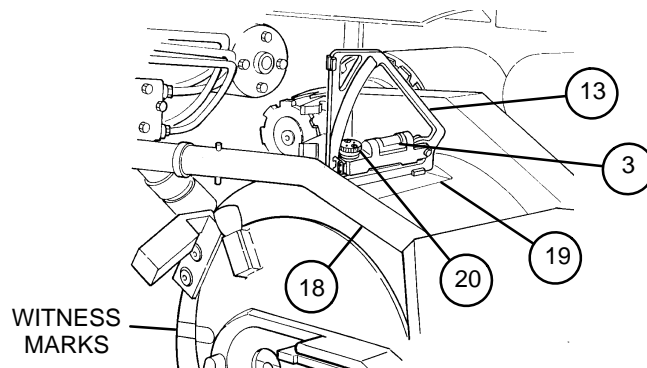
**NOTE**

- Failure to compensate for measure correction will result in misalignment on weapon being checked.
  - The measured correction shall be determined again when a breech is retubed.
- 5 Record the measured correction in the remarks column on DA Form 2408-4. Refer to the measured correction when making elevation settings with the M1A1 gunner's quadrant (13).

**NOTE**

Breech is completely closed when witness marks on breech ring and breechblock aline.

- 6 If necessary, open breech and close completely.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

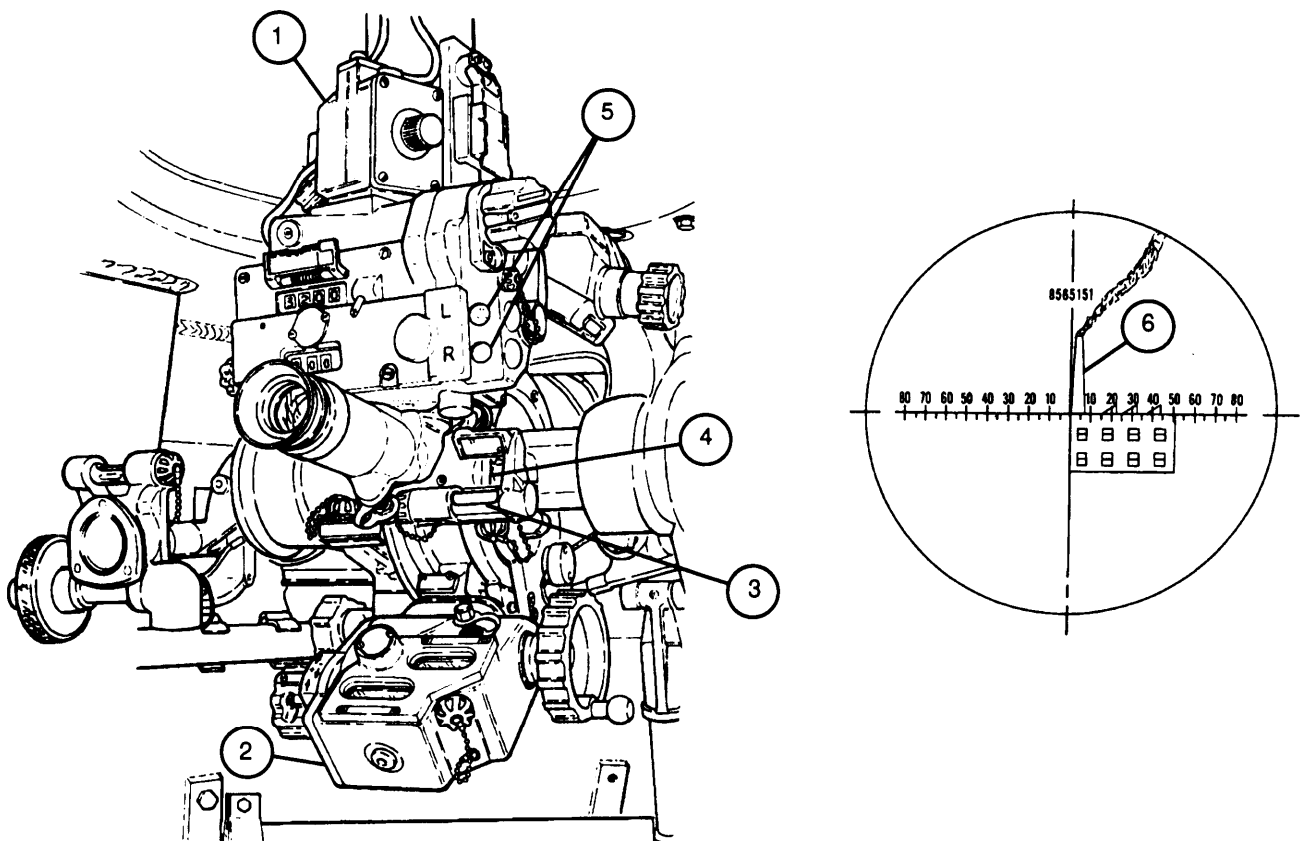
#### 3-7.6 M117/M117A2 Panoramic Telescope Reliability Testing

##### a. Testing Reliability of Deflections

- 1 Install M117/M117A2 panoramic telescope (1) in M145/M145A1 telescope mount (2) (para 2-11.1).
- 2 Center the cross-level (3) and pitch level (4) bubbles of the M145/M145A1 telescope mount (2).
- 3 Set the gunner's aid counter (5) to 0.

#### NOTE

- To prevent eye movement, a parallax shield can be made in two ways. One is to use a dust cap with a pin hole in the center. The second way is to use a small opening marked off with strips of tape.
  - If reference point is less than 55 yards (50 m) away, you must use a parallax shield.
- 4 Sight on a reference point (6) at least 55 yards (50 m) away.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.6 M117/M117A2 Panoramic Telescope Reliability Testing — Continued

##### a. Testing Reliability of Defections — Continued

5 Record the reading on the azimuth counter (7). Reset the reset counter (8) to 3200.

##### NOTE

If you pass the reference point on the second revolution in step 4, rotate the M117/M117A2 panoramic telescope at least 50 mils in the opposite direction (counterclockwise) and reapproach the reference point from left to right. This is done to eliminate induced backlash.

6 Turn the azimuth knob (9) in a clockwise direction until you have rotated the M117/M117A2 panoramic telescope (1) through two complete revolutions of the head and returned to the reference point (6).

##### NOTE

If recorded readings do not appear in steps 7, 8, and 9, the M117/M117A2 telescope is out of adjustment and should be reported to unit maintenance.

7 The reading on the azimuth counter (7) should be the same as that recorded at the start of the test within  $\pm 1$  mil. If not, notify unit maintenance.

8 The reading on the reset counter (8) should be  $6000 \pm 1$  mil. If not, notify unit maintenance.

9 The reading on the gunner's aid counters (5) should still be at 0. If not, notify unit maintenance.

##### b. Testing Reliability of Special Corrections

1 Center the cross-level (3) and pitch level (4) bubbles of the M145/M145A1 telescope mount (2).

##### NOTE

- A parallax shield can be made to prevent eye movement in two ways. One is to use a dust cap with a pin hole in the center. The second way is to use a small opening marked off with strips of tape.

- If the reference point is less than 55 yards (50 m) away, use a parallax shield.

2 Look through the eyepiece (10) and sight on a reference point (6) at least 55 yards (50 m) away.

3 Record the reading on the azimuth counter (7). Reset the reset counter (8) to 3200.

4 Turn the gunner's aid knob (11) to insert 10 mils into the left gunner's aid counter (5).

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.6 M17/M117A2 Panoramic Telescope Reliability Testing — Continued

##### b. Testing Reliability of Special Corrections — Continued

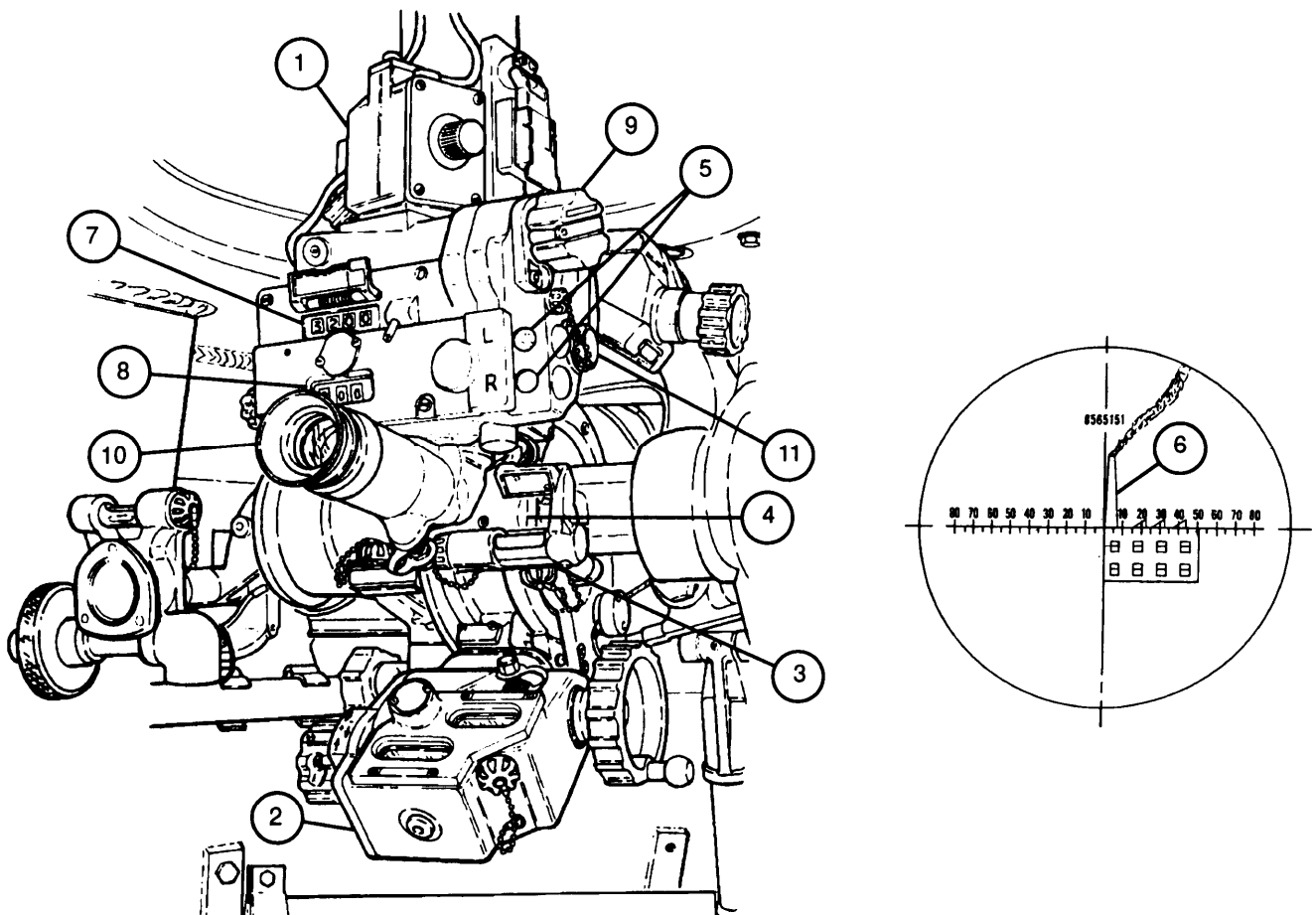
5 Now check the following:

- (a) The line of sight must be on the reference point (6).
- (b) The reading on the azimuth counter (7) should not change by more than 1/4 mil.
- (c) The reset counter (8) should be changed by 10 mils.

6 Repeat the steps in 4 and 5 for 20, 30, and 40 mils.

7 Repeat the steps in 4, 5, and 6 above using the right gunner's aid counter (5) instead of the left.

8 If checks are not as stated in 5 (a), (b), and (c) above, the M117/M117A2 panoramic telescope (1) is out of adjustment and should be reported to unit maintenance.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.7 Testing the M145/M145A1 Telescope Mount (Azimuth Walk-Off)

**NOTE**

Gun trunnions must be perfectly level before conducting the azimuth walk-off test.

- 1 Level the gun trunnions (para 3-7.3).

**NOTE**

If the azimuth walk-off test is being performed independently, install M117/M117A2 panoramic telescope in M145/M145A1 telescope mount, and depress cannon tube to zero mils before doing step 2.

- 2 Center the cross-level (1) and pitch level (2) bubbles of the M145/M145A1 telescope mount (3).

**NOTE**

- A parallax shield can be made to prevent movement in two ways. One is to use a dust cap with a hole in the center. The second is to use a small opening marked off with strips of tape.
- If the reference point is less than 55 yards (50 m) away, use a parallax shield.

- 3 Turn the azimuth knob (4) to place the vertical reticle of the M117/M117A2 panoramic telescope (5) on any stationary reference point (6), at any deflection. Be sure to approach the reference point from left to right. Record the reading on the azimuth counter (7) to the nearest 1/4 mil.

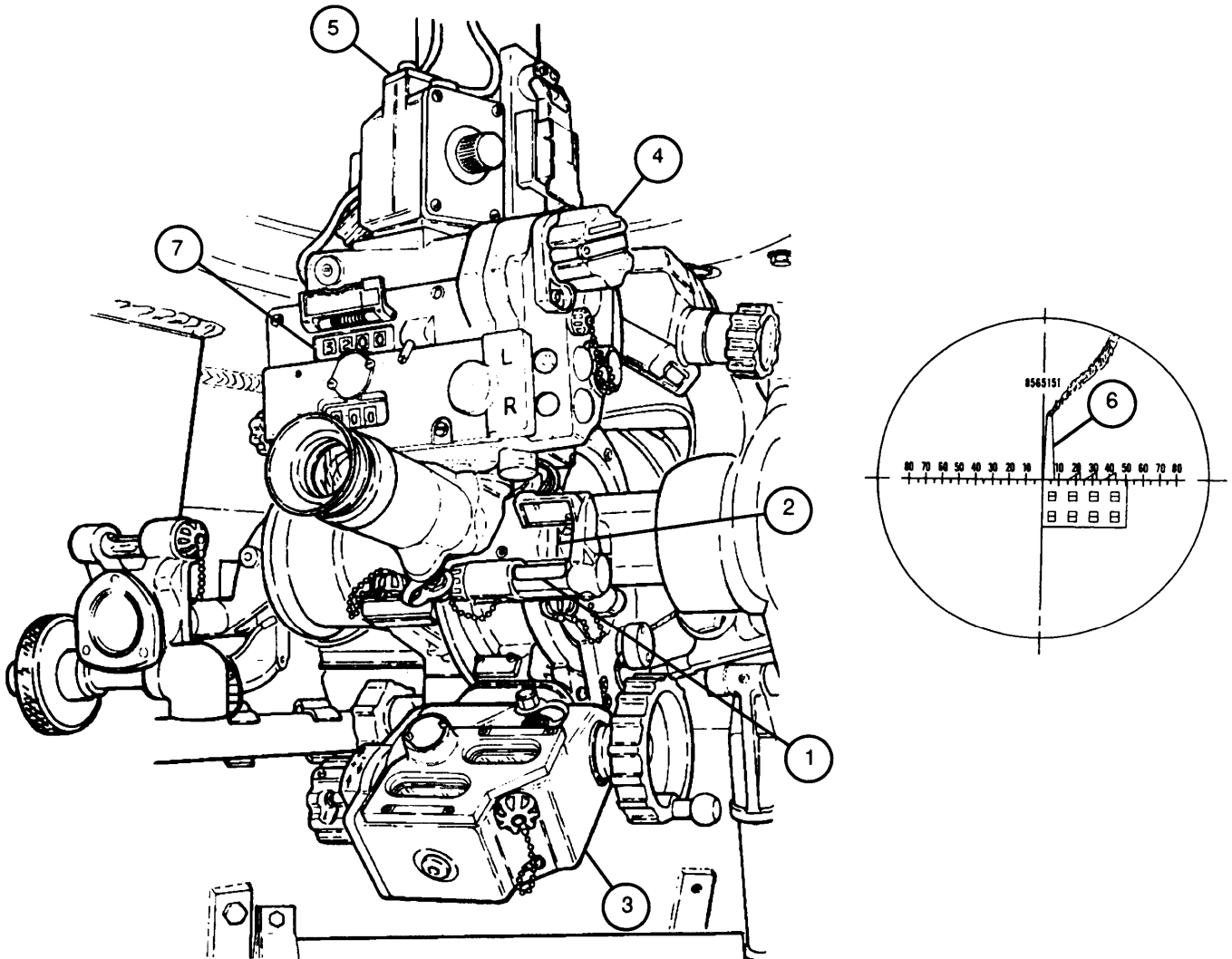
**NOTE**

Be careful not to traverse the cannon tube.

- 4 Elevate the cannon tube to 400 mils. Center the cross-level (1) and pitch level (2) bubbles and turn the azimuth knob (4) to realign the vertical reticle on the same stationary reference point (6). Make sure you approach the reference point from left to right. The reading on the azimuth counter (7) must be within  $\pm 1.0$  mil of the reading taken in step 3. If not, notify unit maintenance.
- 5 Elevate the cannon tube to 900 mils. Center cross-level (1) and pitch level (2) bubbles and realign the vertical reticle as in step 3 on the same stationary reference point (6). Approach the reference point from left to right. The reading on the azimuth counter (7) must be within  $\pm 2$  mils of the reading taken in step 3. If not, notify unit maintenance.

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.7 Testing the M145/M145A1 Telescope Mount (Azimuth Walk-Off) — Continued



## 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

### 3-7.8 Testing and Scribing M15 Elevation Quadrant

#### a. Testing

#### NOTE

- If M15 elevation quadrant is already scribed, proceed to field verification of scribe lines (para 3-7.11).
- The M15 elevation quadrant is scribed so that the crew may accurately level the gun trunnions without using the plumbline.

- 1 Level the gun trunnions (para 3-7.3).
- 2 Turn the elevation knob (1) to place the elevation counter (2) on zero.
- 3 Turn the correction knob (3) to place the correction counters (4) on zero.
- 4 Turn the cross-level knob (5) to center cross-level (6) bubble.
- 5 Manually elevate or depress the cannon tube until the elevation level (7) bubble centers and the cannon tube is at zero elevation. The elevation counter (2) and the correction counters (4) should still read zero. Relevel cross level (6) if necessary.
- 6 Set the elevation counter (2) to 600 mils while watching the cross-level (6) bubble and slowly elevate the cannon tube to 600 mils. During elevation movement, the bubble must not move over 2 graduation marks from the center of the cross-level. If it does, the M15 elevation quadrant (8) may be defective; notify unit maintenance.
- 7 Set the elevation counter (2) to zero mils and depress the cannon tube to zero mils. Again observe the cross-level (6) bubble. It must not move over 2 graduation marks on the cross-level.
- 8 When the cannon tube is at zero elevation, carefully recenter the cross-level (6) bubble, if necessary.
- 9 If bubble in cross-level (6) does not center, repeat steps 4 through 8. If it still does not center, notify unit maintenance.

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

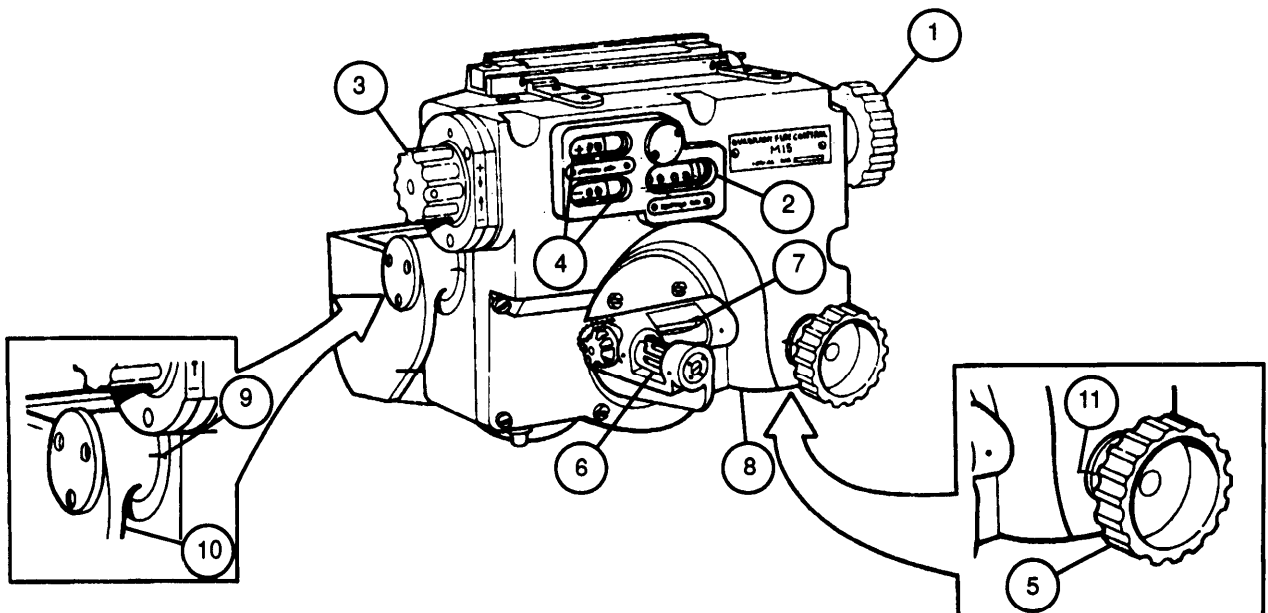
#### 3-7.8 Testing and Scribing M15 Elevation Quadrant — Continued

##### b. Scribing

#### NOTE

Use a sharp instrument and cut two scribe lines on the M15 elevation quadrant. Use a straight edge when possible to be sure the lines are even with each other.

- 1 Scribe one line (9) from the range quadrant mounting bracket pivot stud (10) to the front side of the M15 elevation quadrant (8).
- 2 Scribe the second line (11) from the cross-level knob (5) to the side of the M15 elevation quadrant (8).
- 3 Paint these scribe lines (9 and 11) with a paint that contrasts with the color of the M15 elevation quadrant (8), so that they can be easily seen.
- 4 Wipe off the excess paint and let it dry.

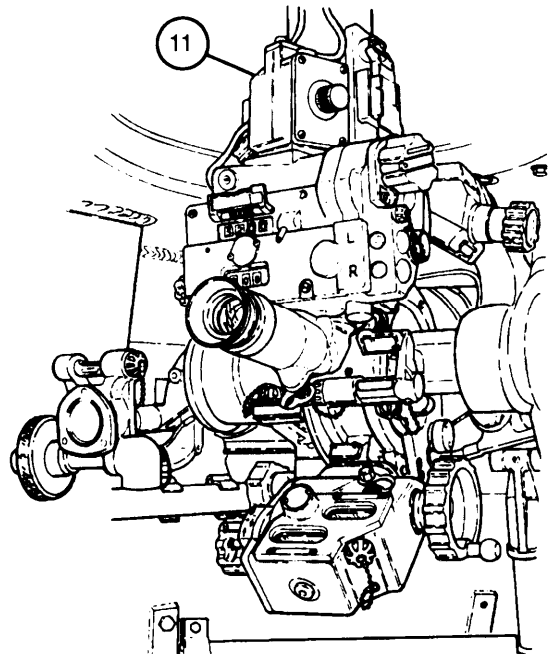
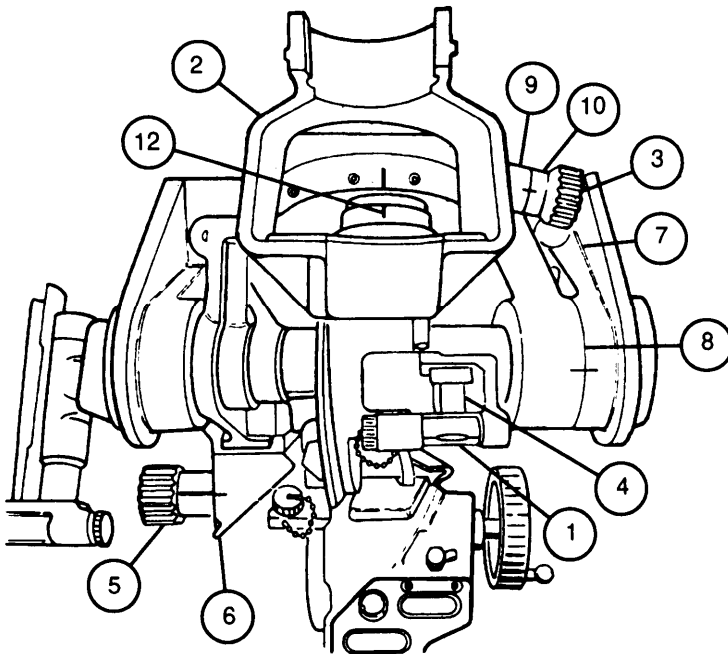




### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.9 Testing and Scribing the M145/M145A1 Telescope Mount

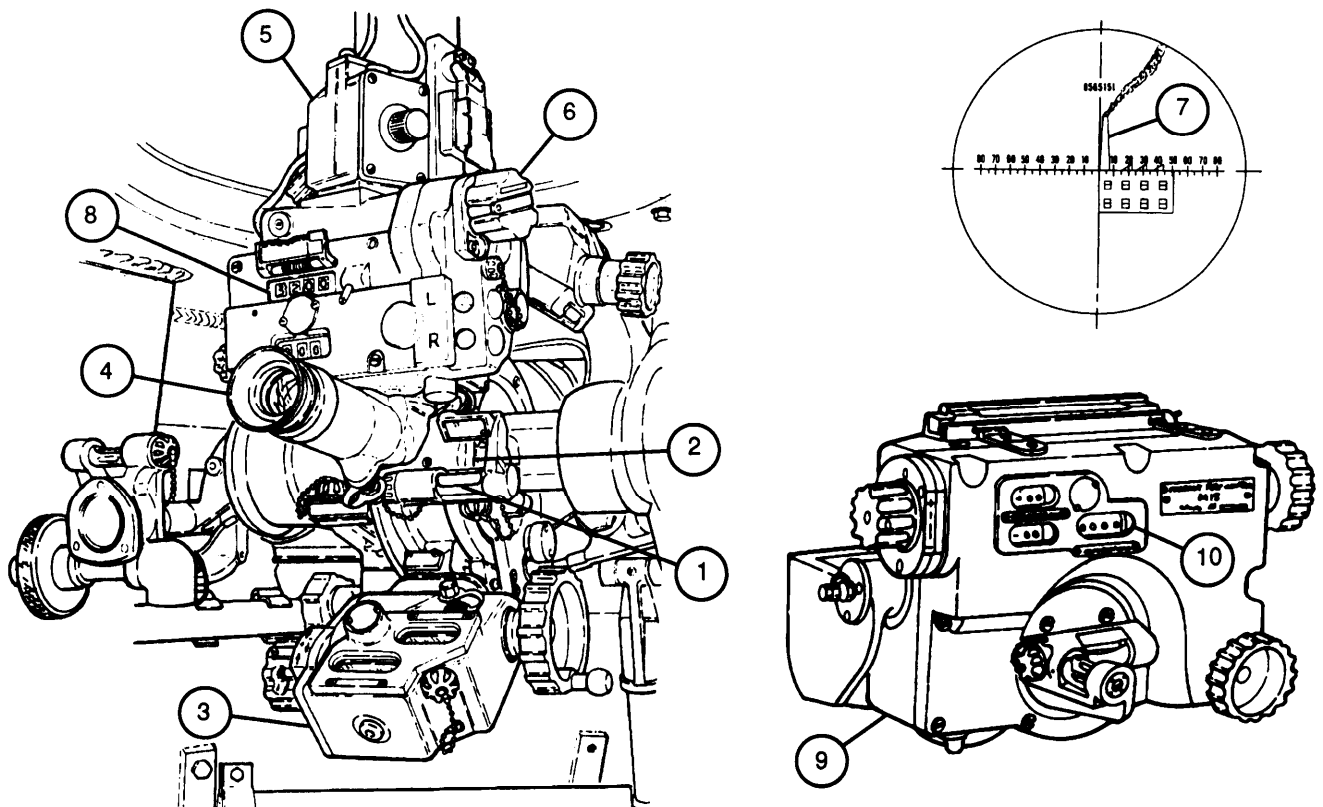
- 1 Level the gun trunnions (para 3-7.3).
- 2 Zero the cannon tube using tested M1A1 gunner's quadrant (para 3-7.5).
- 3 Center cross-level (1) bubble of the M145/M145A1 telescope mount (2) by turning cross-level mechanism knob (3).
- 4 Center pitch level (4) bubble by turning the pitch level knob (5).
- 5 Scribe one line from pitch level knob (5) to bracket (6).
- 6 Scribe another line across from bracket (7) to rocker (8).
- 7 Aline scribe lines on cross-level mechanism knob (3) and cross-level mechanism (9) by loosening two screws on cross-level mechanism knob and slipping indicator (10) to scribe line on cross-level mechanism, retighten two screws on cross-level mechanism knob.
  - (a) Remove M117/M117A2 panoramic telescope (11).
  - (b) Scribe line from cross-level mechanism (9) to body (12) and install M117/M117A2 panoramic telescope (11).



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.10 Scribe Verification Using the M145/M145A1 Telescope Mount Check

- 1 With the howitzer still on the jacks, place the cannon tube at zero elevation. Be sure the M15 elevation quadrant scribe lines are still matched (para 3-7.8).
- 2 Center the cross-level (1) and pitch level (2) bubbles of the M145/M145A1 telescope mount (3).
- 3 Look through the eyepiece (4) on the M117/M117A2 panoramic telescope (5) and turn the azimuth knob (6) to rotate the M117/M117A2 panoramic telescope. Choose a well-defined reference point (7), moving the head of the M117/M117A2 panoramic telescope from left to right when choosing the reference point.
- 4 Record the reading that is on the azimuth counter (8).
- 5 Set the M15 elevation quadrant (9) elevation counter (10) to 900 mils and elevate the cannon tube to 900 mils.
- 6 With the cannon tube at 900 mils elevation, center bubble in cross-level (1) on the M145/M145A1 telescope mount (3).



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

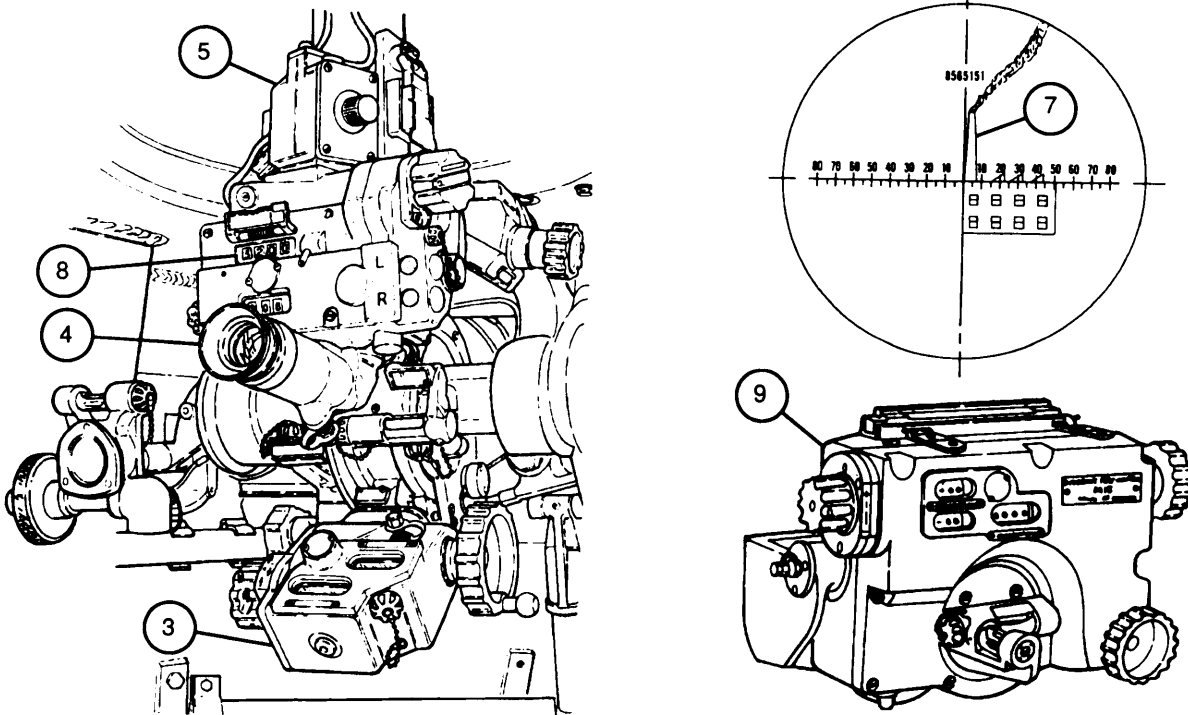
#### 3-7.10 Scribe Verification Using the M145/M145A1 Telescope Mount Check — Continued

- 7 Look through the eyepiece (4) on the M117/M117A2 panoramic telescope (5) again and find the same reference point (7). Be sure to move the head of the M117/M117A2 panoramic telescope from left to right. If the sight is off to the right of the reference point, turn the head of the M117/M117A2 panoramic telescope at least 50 mils in the opposite direction and reapproach the reference point from left to right to eliminate any induced backlash.
- 8 Record the reading that is on the azimuth counter (8).

**NOTE**

The difference between the two readings taken on the azimuth counter (steps 4 and 8) should not be over  $\pm 1$  mil. If it is, notify unit maintenance to check the M145/M145A1 telescope mount. However, for purposes of this test, the  $\pm 1$  mil tolerance is not critical.

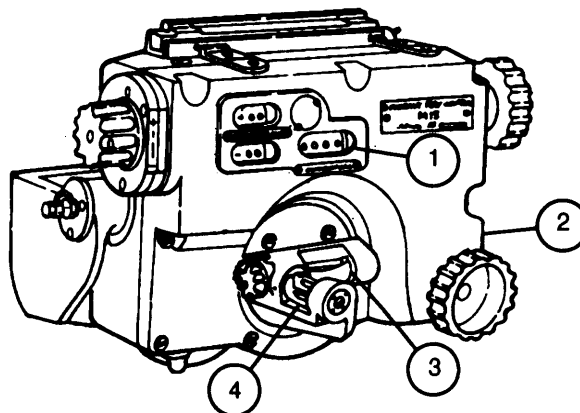
- 9 The difference in the readings on the azimuth counter (8) at zero mil (step 4) and 900 mils elevation (step 8) is the amount of error in the M145/M145A1 telescope mount (3).
- 10 Record the amount of error in the M145/M145A1 telescope mount (3). It will be needed later. The accuracy of the scribe lines on the M15 elevation quadrant (9) are now verified.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS - CONTINUED

#### 3-7.11 Field Verification of Scribe Lines On the M15 Elevation Quadrant

- 1 Emplace howitzer in firing position with spades emplaced.
- 2 Set the elevation counter (1) on the M15 elevation quadrant (2) to zero and then manually elevate or depress the cannon tube until the elevation level (3) bubble is centered.
- 3 Carefully aline the scribed lines on the M15 elevation quadrant (para 3-7.8).
- 4 Slowly traverse the cannon tube manually as someone watches the elevation level (3) bubble and the cross-level (4) bubble. If the elevation level goes off center, recenter it by elevating or depressing the cannon tube. (As traversing continues, it may be necessary to repeat the raising and lowering of the cannon tube to keep the elevation level bubble centered.)
- 5 At some point in the 6400 mil traverse, the cross-level (4) bubble will center. It is very important that the bubble in the cross-level vial is centered exactly.
- 6 When elevation level (3) bubble and the cross-level (4) bubble are centered, the gun trunnions are level.
- 7 Repeat steps 3 through 8 of scribe verification using M145/M145A1 telescope mount check (para 3-7.10) and record the differences between the two readings.
- 8 Compare the M145/M145A1 telescope mount error from step 7 with the M145/M145A1 telescope mount error recorded while the howitzer was still on the jacks (para 3-7.10). The difference between the two M145/M145A1 telescope mount error readings must not be more than  $\pm 1$  mil. If the difference is greater than  $\pm 1$  mil, go through the entire procedure again to ensure there were no mistakes made and no steps overlooked. Then, if the difference between M145/M145A1 telescope mount error reading in the two tests is still greater than  $\pm 1$  mil, notify unit maintenance.
- 9 If the readings are within  $\pm 1$  mil tolerance, the gun trunnions can be leveled and M145/M145A1 telescope mount check can be performed in the field by use of the scribe lines on the M15 elevation quadrant.



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

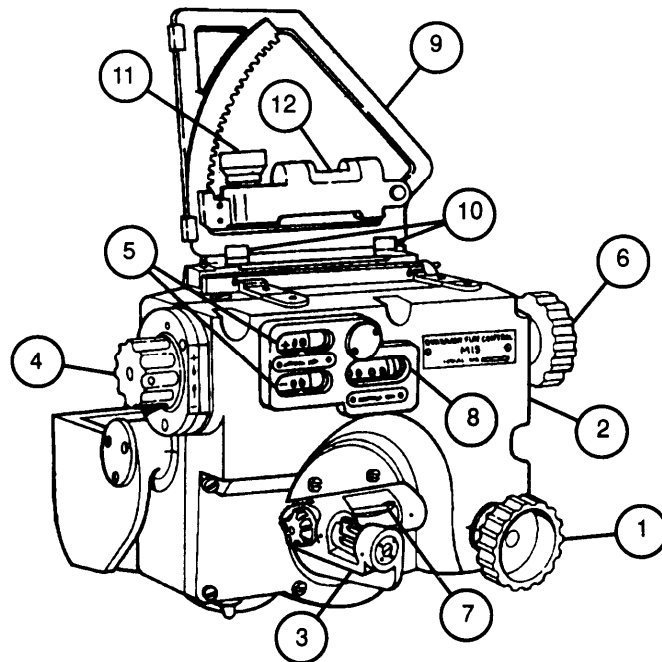
#### 3-7.12 Testing the M15 Elevation Quadrant and Auxiliary Quadrant (On M145/M145A1 Telescope Mount)

##### NOTE

Before doing this test you must level the gun trunnions. Zero the cannon tube.

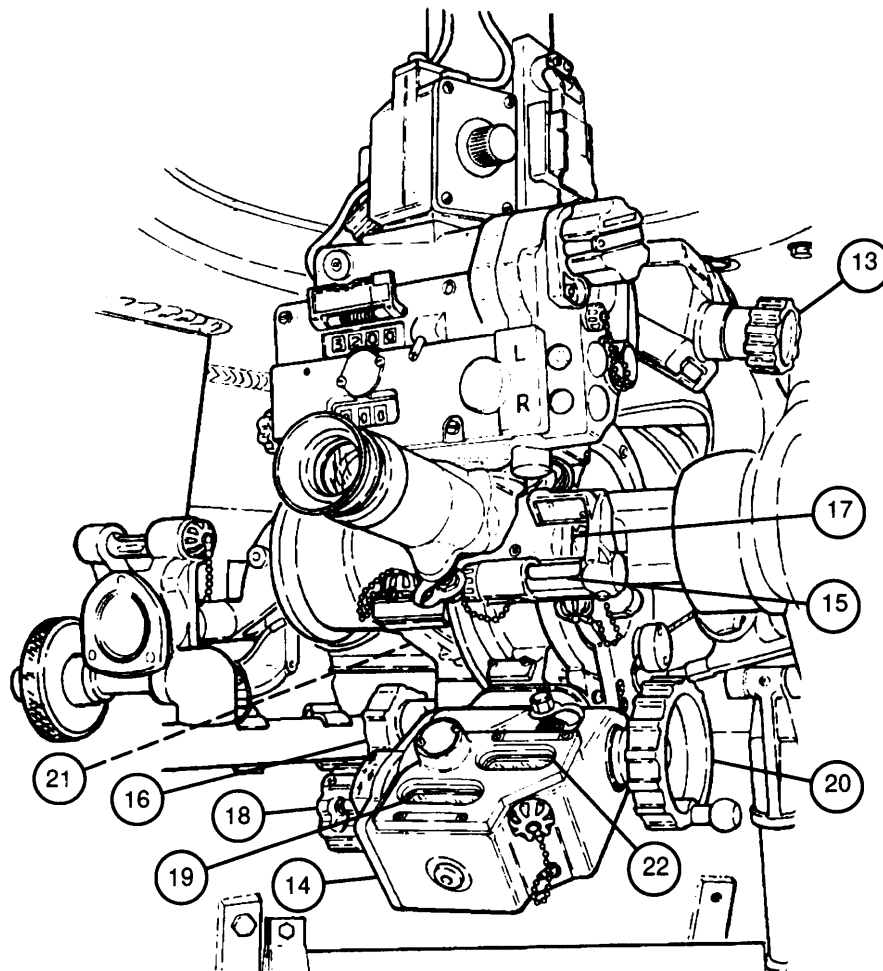
- 1 Turn cross-level knob (1) on M15 elevation quadrant (2) until cross-level (3) bubble is centered.
- 2 Turn correction knob (4) on M15 elevation quadrant (2) and zero correction counters (5).
- 3 Turn the elevation knob (6) on M15 elevation quadrant (2) and center bubble in the elevation level (7).
- 4 Check elevation counter (8) reading. The reading should be less than 9999 (- 1 mil elevation) and no more than 0001 (+1 mil elevation). If reading is not within tolerances, notify unit maintenance.
- 5 Place M1A1 gunner's quadrant (9) on M15 elevation quadrant (2) seats (10). Apply the M1A1 gunner's quadrant correction factor, if any, but do not apply embedded correction.
- 6 Turn the micrometer knob (11) on M1A1 gunner's quadrant (9) to center the bubble (12). The value of the M1A1 gunner's quadrant should not change more than 0.5 mil. If the value changes more than 0.5 mil, notify unit maintenance.

Example: M1A1 gunner's quadrant correction is -0.4. The value on the M1A1 gunner's quadrant should be between -0.9 and +0.1.



**3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS - CONTINUED****3-7.12 Testing the M15 Elevation Quadrant and Auxiliary Quadrant (On M145/M145A1 Telescope Mount) — Continued**

- 7 Turn the cross-level mechanism knob (13) on the M145/M145A1 telescope mount (14) and center cross-level (15) bubble. Turn pitch-level knob (16) and center pitch-level (17) bubble.
- 8 Turn correction knob (18) and zero the correction counter (19).
- 9 Turn elevation handwheel (20) and center elevation level (21) bubble.
- 10 Check reading on elevation counter (22). It should read no less than 9999 (-1 mil elevation) and no more than 0001 (+1 mil elevation).



### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENTS — CONTINUED

#### 3-7.12 Testing the M15 Elevation Quadrant and Auxiliary Quadrant (On M145/M145A1 Telescope Mount) — Continued

- 11 Zero correction counters (5) and elevation counter (8) on the M15 elevation quadrant (2) and center the cross-level (3) bubble.
- 12 Using the M15 elevation quadrant (2), elevate or depress the cannon tube to zero mils elevation.
- 13 Set the M1A1 gunner's quadrant (9) on M15 elevation quadrant (2) seats (10). Turn micrometer knob (11) and center bubble (12). Record the value on the M1A1 gunner's quadrant.
- 14 Turn correction knob (18) on the M145/M145A1 telescope mount (14) to place a + 5 mil reading on the correction counter (19). Check the reading on the elevation counter (22). It should have changed by 5 mils. If it doesn't, notify unit maintenance.
- 15 Turn the elevation handwheel (20) on the M145/M145A1 telescope mount (14) until elevation counter (22) reads 0.
- 16 Elevate or depress cannon tube until elevation level (21) bubble centers.
- 17 Place + 5 mil and value recorded in step 13 on the M1A1 gunner's quadrant (9). Set the M1A1 gunner's quadrant back on the M15 elevation quadrant (2). The M1A1 gunner's quadrant bubble (12) should center. If it does not, notify unit maintenance.
- 18 Now, zero all counters. Repeat steps 12 through 17, only this time, use a value of – 5 mils. If the M1A1 gunner's quadrant (9) bubble (12) does not center, the correction counters (5) are inaccurate. Notify unit maintenance.
- 19 Remove the – 5 mils from the M1A1 gunner's quadrant (9).
- 20 Using the M15 elevation quadrant (2), zero the cannon tube.
- 21 Set the M1A1 gunner's quadrant (9) on the M15 elevation quadrant (2) seats (10). Level the bubble (12) on the M1A1 gunner's quadrant using the micrometer knob (11), then record the value on the M1A1 gunner's quadrant.

### 3-7 FIRE CONTROL ALINEMENT TESTS AND MEASUREMENT - CONTINUED

#### 3-7.12 Testing the M15 Elevation Quadrant and Auxiliary Quadrant (On M145/M145A1 Telescope Mount) — Continued

**NOTE**

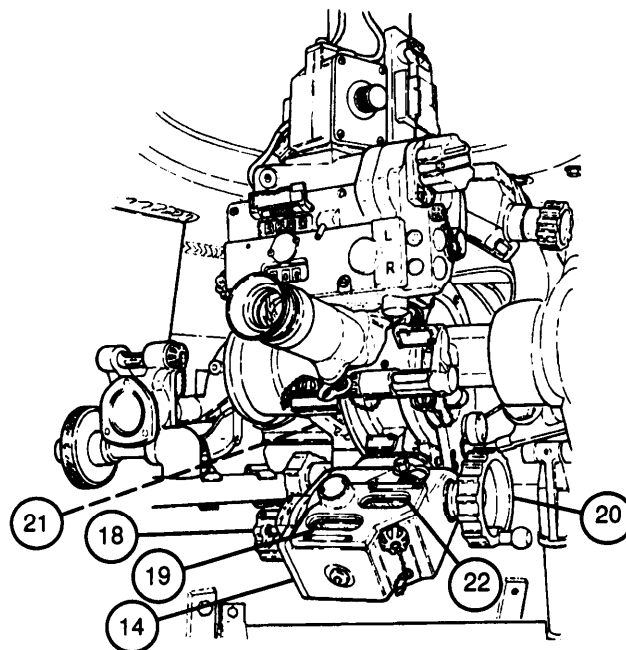
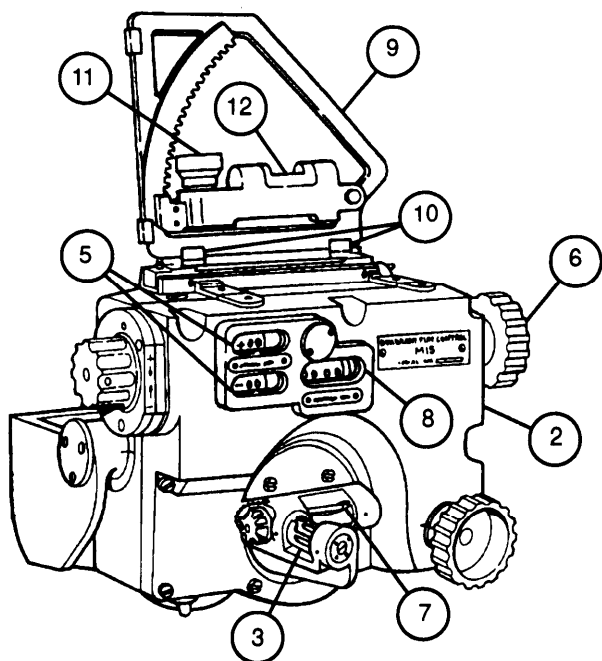
When checking the M15 elevation quadrant at 400 and 800 mils elevation (as in step 22), also check the M145/M145A1 telescope mount elevation counter. It should read 400 mils and  $800 \pm 1$  mil at those elevations.

- 22 Using the M15 elevation quadrant (2), elevate the cannon tube from 0 mils to 400 mils and then to 800 mils. At each elevation, place the elevation counter (8) reading (400, then 800) plus the value recorded in step 21 on the M1A1 gunner's quadrant (9) and set the M1A1 gunner's quadrant on the M15 elevation quadrant (2) seats (10).

Example:

Elevations placed on elevation counter	400.0	800.0
Value measured in step 21 at zero elevation	+0.7	+ 0.7
Values placed on gunner's quadrant	400.7	800.7

The bubble (12) in the M1A1 gunner's quadrant (9) should center. If the bubble centers, the test is complete. If the bubble doesn't center, center it by turning the micrometer knob (11). After centering the M1A1 gunner's quadrant, read the value now on the elevation counter (8). It should not have changed more than  $\pm 0.5$  mils from the original reading. If it does, the M15 elevation quadrant (2) is in error and must be turned into unit maintenance.







## CHAPTER 4 MAINTENANCE OF AUXILIARY EQUIPMENT

### 4-1 GENERAL

Information on maintenance of the auxiliary equipment listed is provided in the following technical manuals:

M2 .50 caliber machine gun	TM 9-1005-213-10
M90 radar chronograph	TM 9-1290-359-14&P
M94 MVS interconnection	TM 9-1290-364-14&P
Intercommunications set	TM 11-5830-340-12
SINCGARS	TM 11-5820-890-10-1

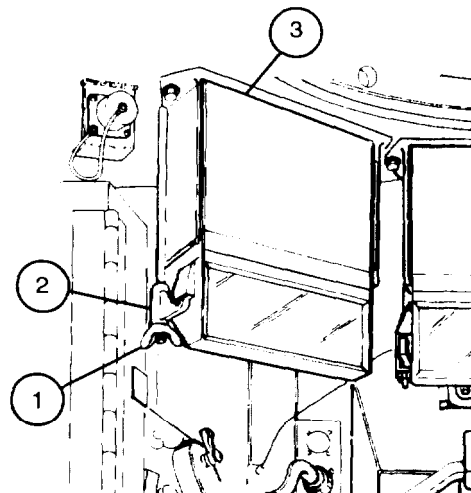
### 4-2 M45 DRIVER'S PERISCOPE

#### a. Removal

- 1 Loosen two wingnuts (1) to release two supports (2).
- 2 Remove M45 driver's periscope (3).

#### b. Installation

- 1 Install M45 driver's periscope (3) in two supports (2).
- 2 Secure two supports (2) by tightening two wingnuts (1).



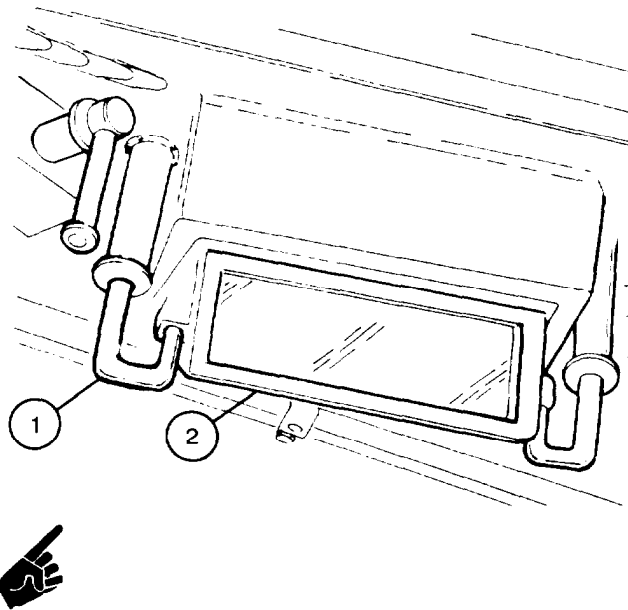
### 4-3 M27 COMMANDER'S PERISCOPE

#### a. Removal

- 1 Pull and turn two support hooks (1).
- 2 Remove M27 commander's periscope (2).

#### b. Installation

- 1 Install M27 commander's periscope (2).
- 2 Secure M27 commander's periscope (2) with two support hooks (1).



## 4-4 M2 CALIBER .50 MACHINE GUN AND MOUNT

### WARNING

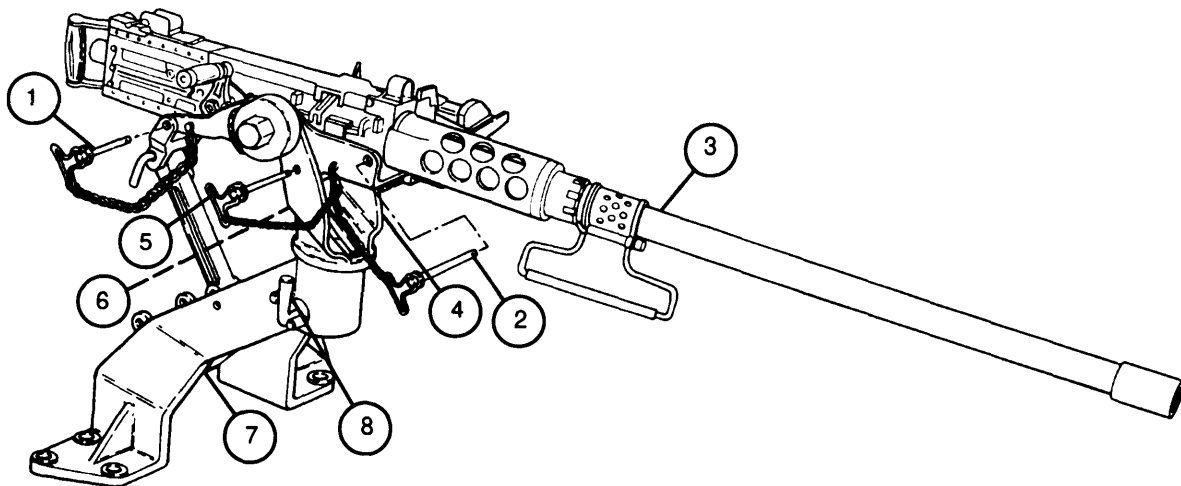
Do not remove rear pin assembly if M2 caliber .50 machine gun is not installed in mount. Serious injury to personnel could result.

#### a. Removal

- 1 Remove rear pin assembly (1), front pin assembly (2), and M2 caliber .50 machine gun (3) from mount (4).
- 2 Remove travel lock pin assembly (5) from travel lock (6). Secure travel lock pin assembly to mount support (7).
- 3 Rotate manual control lever (8) so manual control lever handle points down and remove mount (4) from mount support (7).

#### b. Installation

- 1 Install mount (4) into mount support (7). Rotate manual control lever (8) so manual control lever handle points up.
- 2 Remove travel lock pin assembly (5) from mount support (7) and install into travel lock (6).
- 3 Install M2 caliber .50 machine gun (3) in mount (4). Install front pin assembly (2) and rear pin assembly (1).





## CHAPTER 5

### U.S. AMMUNITION

#### Section I. GENERAL

##### 5-1 GENERAL

Ammunition for the 155MM howitzer cannon is the separate-loading type. The loading of each complete round into the howitzer cannon requires three separate operations: loading the fuzed projectile, the propelling charge, and the primer.

These components are shipped separately; therefore, the cannon crew must know how to store, unpack, inspect, prepare, and load each complete round every time the weapon is fired. The chief of section supervises duties of the crew during loading. The chief of section must also see that the cannoneers and driver are cross-trained in the specific duties of the care, handling, unpacking, inspection, preparation, and loading of the ammunition components in order to sustain a 24-hour operation or to operate with a reduced crew.

It is planned that future ammunition for all new 155MM weapons will be interchangeable. This will enable projectiles and propelling charges of one NATO nation to be fired from the 155MM weapons of all others. Current items of interchangeability are contained in Chapter 6.

For maintenance of ammunition, see Section III of this chapter.

<b>WARNING</b>
----------------

Until safety and reliability testing is completed, the use of ammunition other than prescribed in this manual is prohibited.

Refer to paragraph 5-13 for information about the Loose Projectile Restraint System (LPRS), which is a divider rack for securing loose unfuzed projectiles for transportation with field artillery companion vehicles. This does not pertain to the M992.

## 5-2 AUTHORIZED MUNITIONS

### 5-2.1 Authorized Projectiles

**WARNING**

- Unauthorized assembly and use of projectiles and propelling charges are extremely dangerous. Make sure projectiles are marked 155 H (not G).
- Only those items listed are authorized. Firing of unauthorized propelling charge, projectile, or fuze combinations can result in critical malfunctions.
- Charge 1 (M3 series green bag (GB)) will not be fired in the M109A2/M109A3/M109A4 M185 or M109A5 M284 cannon assembly. Charge 2 (GB charge) may be used with any M100 series projectile, M449 projectile, M804/M804A1 projectile, and the M485 projectile, however, stickers may occasionally occur. All other projectiles, except the M795, use minimum charge 3 (GB) or charge 3 (white bag (WB)) charge and higher. M795 uses minimum charge 3 (GB) or charge 4 (WB). Firing below these charges may result in stickers.

Important information is stenciled on each projectile. New and old projectile colorings and markings are listed in Table 5-1, 155MM Ammunition for M109 Howitzers. Various markings are identified below. Knowing the color coding and the meaning of the markings will aid in the rapid selection of the required projectile when firing.

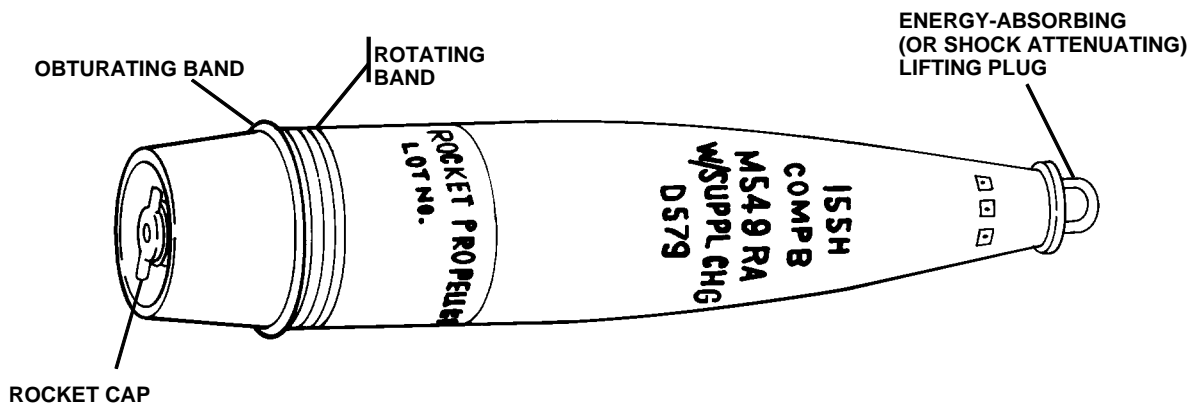
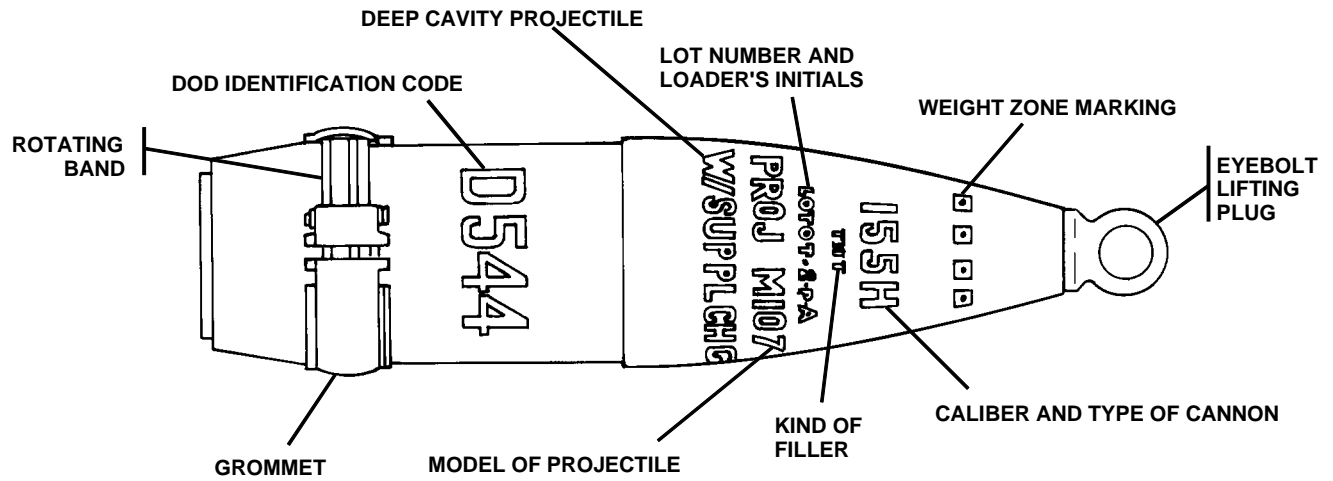
Projectile and fuze combinations for authorized rounds are given in Table 5-1, 155MM Ammunition for M109 Howitzers. Authorized projectile propelling charge combinations are given in Table 5-2, Authorized Projectile/Propelling Charge Combinations for M109A2/M109A3/M109A4 M185 and M109A5 M284 Cannon Assemblies (155MM).

Projectiles of current manufacture, with deep fuze cavities and supplementary charges of TNT, are suitable for use with the long intrusion (M728 or M514 series) or the short intrusion (M732) proximity fuzes. The supplementary charge must be removed when the long intrusion proximity fuze is used; it must remain in place whenever any other authorized fuze is used.

Deep-cavity projectiles are identified by the words, W/SUPPL CHG, marked on the projectile. Weight zones are indicated on projectiles by one or more squares of the same color as the markings. Four squares indicate standard or normal weight for which no weight corrections are necessary when computing firing data. There may also be punch marks in center of squares for night identification of weight zones by touch.

5-2 AUTHORIZED MUNITIONS — CONTINUED

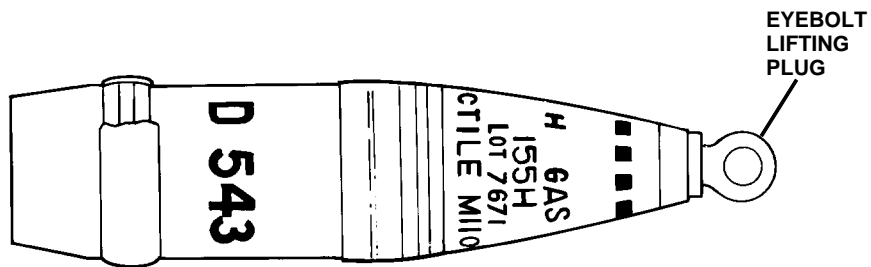
5-2.1 Authorized Projectiles — Continued





**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS**

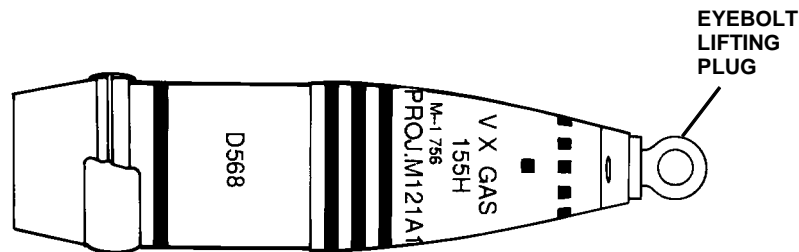
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M110, agent, H or HD, with burster	Toxic (filled w/ mustard gas (H) or distilled mustard gas (HD))	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"><b>WARNING</b></div> <p>Since the burster in H or HD ammunition is loaded with tetrytol, do not store or fire at temperatures exceeding 125° F (52° C). Temperatures above 125° F (52° C) will cause the tetrytol to melt and/or seep, causing premature functioning.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>Renovated or newly manufactured (past 1976) projectiles will be marked with one green band and if burstered, one yellow band.</p> <p>New manufacture:</p> <ul style="list-style-type: none"> <li>• Blue-grey w/ 2/green, 1/yellow bands</li> <li>• Green marking</li> </ul> <p>Old manufacture:</p> <ul style="list-style-type: none"> <li>• Gray w/ 2/green bands</li> <li>• Green marking</li> </ul> <p>Weight: 93 pounds (42.18 kg)</p>	M557/M572 PD, M739 series PD, M564 MTSQ, M582 series MTSQ, M767 Series ET M782 MOFA	For toxic effect on personnel or for contaminating habitable areas



**M110 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

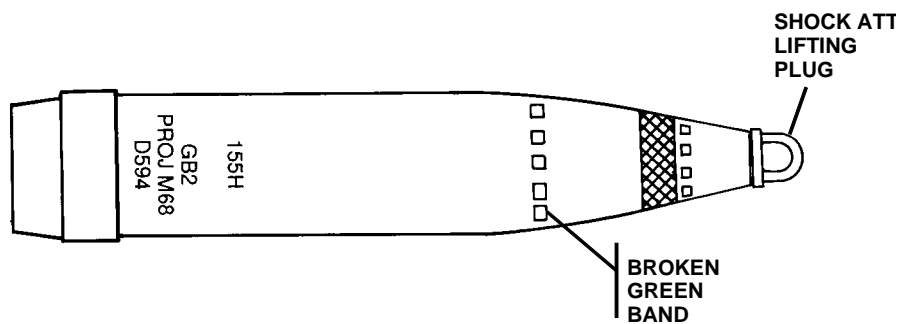
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M121A1, agent GB (non-persistent) or VX (persistent), with burster	Gas	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"> <b>WARNING</b> </div> <p>The M121 projectile is no longer authorized. A few M121 (basic model) projectiles with tetrytol bursters may remain in some stock piles and should not be used, as inbore explosions may result.</p> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• M728 and M732 fuzes are fired with "VX" projectile in combat emergency only.</li> <li>• M728 fuze requires removal of the supplementary charge to make room for the long intrusion fuze.</li> <li>• For renovated or newly manufactured projectiles (past 1976), see TM 43-0001-28.</li> </ul> <p>New manufacture:</p> <ul style="list-style-type: none"> <li>• Gray w/ 3/green, 1/yellow bands</li> <li>• Green marking</li> </ul> <p>Old manufacture:</p> <ul style="list-style-type: none"> <li>• Gray w/ GB1/green, VX 2/green bands</li> <li>• Green marking</li> </ul> <p>Weight: 100 pounds (45.36 kg)</p>	M557/M572 PD, M739 series PD, M728 PROX, M732 series PROX, M782 MOFA	For toxic effect on personnel or contamination of habitable areas.



**M121A1 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

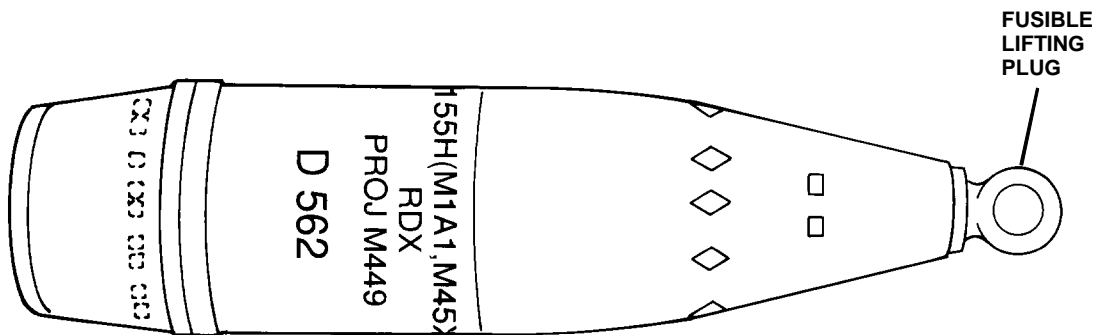
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M687, agent GB2 with burster	Binary	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M687 is a binary projectile which requires assembly of the M20 canister prior to firing. The M20 canister is a separate issue item.</li> <li>• The M687 is assembled at the chemical ammunition supply point (CASP) in accordance with TM 3-1320-242-10 and will have a visible broken green band. If a rubber sleeve covers the broken green band, assembly of the M20 canister has not been accomplished and the projectile should not be fired.</li> </ul>	M557/M572 PD M739 series PD M782 MOFA	For toxic effect on personnel



**M687 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M449 series, HE, ICM	High-explosive, improved conventional munitions (ICM)	<p style="text-align: center;"><b>NOTE</b></p> <p>The cargo consists of 60 M43 grenades which are ejected in flight. The fuze having been set to function at a predetermined time, initiates the expulsion charge ejecting the entire cargo from the rear of the projectile. The projectile spins centrifugally and dispenses the grenades from the projectile line-of-flight. Upon impact with the target area, an expulsion charge is initiated which propels a high explosive filled sphere upward 4 to 6 feet (1.22 to 1.83 m) above the impact area. The elevated sphere is detonated sending high-velocity fragments in a spherical pattern.</p> <p>New manufacture:</p> <ul style="list-style-type: none"> <li>• Olive drab w/ row of yellow diamonds between nose and bourrelet of projectile</li> <li>• Yellow marking</li> </ul> <p>Old manufacture:</p> <ul style="list-style-type: none"> <li>• Olive drab w/ no bands</li> <li>• Yellow marking</li> </ul> <p>Weight: 95 pounds (43.09 kg)</p>	M565 MT, M577 series MTSQ, M762 series ET	For use primarily against personnel



**M449 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

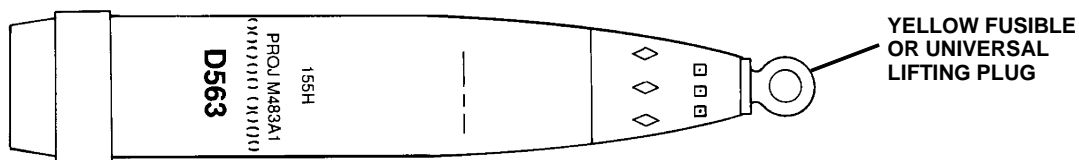
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M483A1, HE, DP, ICM				

**NOTE**

- The M483A1 projectile may be fired with or without an obturating band. If the obturating band is broken, remove and discard it. If it is dislodged, remove or reposition it.
- The M483A1 projectile consists of a steel body with aluminum base and ogive containing an expelling charge and 88 shaped-charge grenades.
- The M483A1 projectile can be used in the fire-for-effect mode or the registration mode.
- In the fire-for-effect mode, the expelling charge ejects the 88 grenades from the projectile during flight and they actuate on ground or target impact. A shaped charged jet is expelled downward while the body bursts into a large number of high velocity fragments.
- The jet is capable of penetrating approximately 2.75 inches (6.99 cm) of homogeneous armor plate. Antipersonnel effects are obtained by fragmentation of the body.
- In the self-registration mode, the expelling charge is removed, a projectile spotting charge is attached to the time fuze and installed into the projectile. Functioning of the fuze detonates the entire projectile over the target, permitting observation of the projectile as it functions in relation to the target. The spotting charge will cause the projectile to detonate all 88 grenades inside the projectile, causing high fragmentation in the same manner as a standard high-explosive projectile.
- The M483A1 projectile may be used for self-registration (as a spotting round) by replacing the expulsion charge assembly with a projectile spotting charge added to the M577 series or M762 series fuze.

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M483A1, HE, DP, ICM — continued	High—explosive, dual purpose, ICM, base—ejection type	Olive drab w/ row of yellow diamonds between nose and bourrelet of projectile Yellow marking Weight: 103 pounds (46.72 kg)	M577 series MTSQ M762 Series ET	For personnel and light materiel targets



**M483A1 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M864, HE, DP extended range, ICM		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>WARNING</b> </div>		

- A 5000-meter safety zone is required short of the target because of the possibility of the base burner assembly non-ignition.
- The M864 projectile is not to be fired if the obturator is missing or broken because it may result in a short round. If the band is displaced and can be repositioned and remain in the groove, the projectile can be fired.
- For M864 projectiles marked with three solid white circles 120° apart on the ogive (above the weight zone markings) avoid hazards resulting from gaps at the base to body joint and from separation of the base from the body in the M864 projectile by following these safety procedures:
  - Projectiles are to remain palletized as long as possible prior to use.
  - Do not transport projectiles as loose cargo.
  - Do not fire projectiles received without grommets or with evidence of dents, flattenings, or gouges to the lifting plug, grommet, rotating band, and boatail area.
  - Do not fire projectiles which have been dropped loose from supply vehicles or SP howitzers.
  - Any base separations should be handled by EOD personnel.
- A gap at the base to body joint of the projectile may lead to hot propellant gases entering the round during firing and causing an inbore premature. Gaps are not detectable with a visual examination due to the presence of the obturator over the base to body joint. In addition, a separation of the base from the body of the projectile will expose M42 and M46 grenades. Arming could occur and result in injury and/or death.

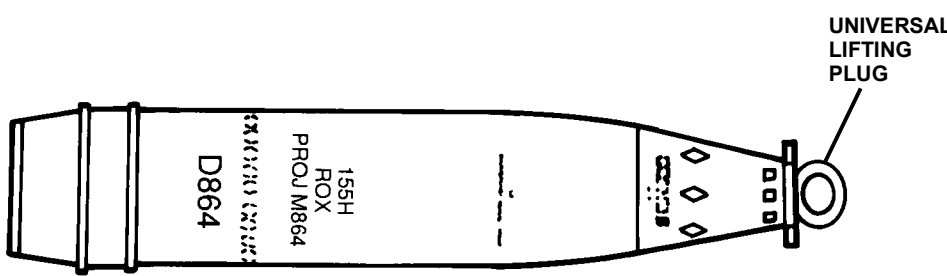
**NOTE**

- The M864 is for extended range only. Use the M483A1 projectile through the M119A2 charge (zone 7) where applicable. The M864 shall be fired to achieve ranges beyond the capabilities of the M483A1 projectile or when the M483A1 projectile is not available.
- For stowage of M864 projectiles, see para F-5.

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
<p>M864, HE, DP extended range, ICM — continued</p>	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M864 projectile is modeled after the M483A1 projectile with the addition of a base burner unit at the projectile's base. The propellant in the base burner ignites upon firing of the projectile, producing gases, which reduce the drag on the projectile and extend its range.</li> <li>• The expulsion charge contains 105 grams of M10 propellant. There are 72 shaped-charge grenades: 48 are M42 grenades and 24 are M46 grenades.</li> <li>• The M864 projectile can be used in the fire-for-effect mode or the registration mode. See the M483A1 description for mode differences.</li> <li>• The M864 projectile may be used for self-registration (as a spotting round) by replacing the expulsion charge assembly with a projectile spotting charge added to the M577 series or M762 fuze.</li> <li>• The M864 projectile is for extended range only and will be fired to achieve ranges beyond the capabilities of the M483A1 projectile or when the M483A1 projectile is not available.</li> </ul>			
	<p>High-explosive, dual purpose ICM, base ejection type, extended range</p>	<p>Olive drab, row of yellow diamonds between nose and bourrelet of projectile Yellow marking Weight: 102 pounds (46.27 kg)</p>	<p>M577 series MTSQ M762 series ET</p>	<p>For use against personnel and light materiel targets</p>

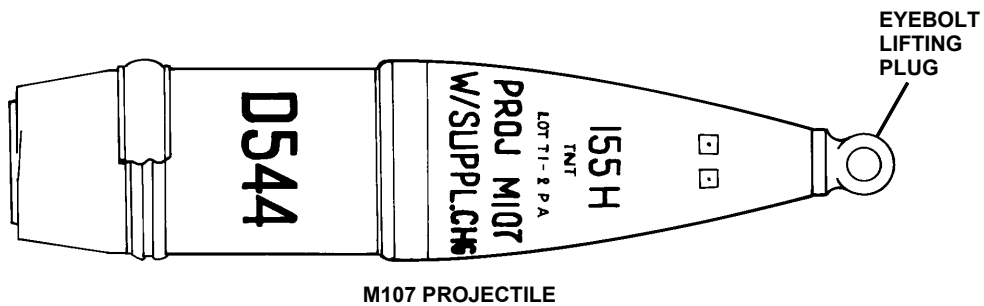


**M864 PROJECTILE**



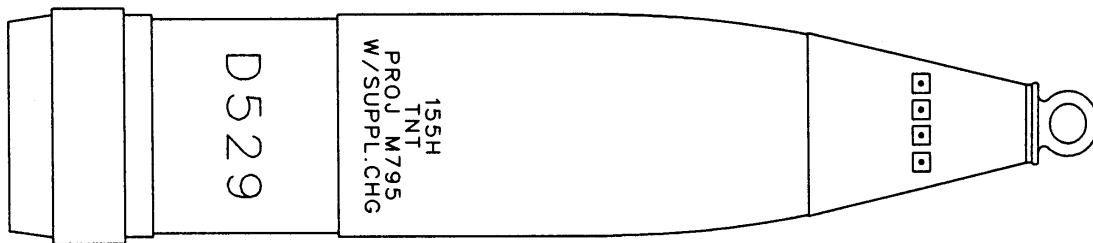
**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M107, HE	<p>High-explosive, deep or shallow cavity</p>	<p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• M728 and M514 series fuzes require removal of the supplementary charge to make room for the long intrusion fuze.</li> <li>• M107 projectile consists of a steel case loaded with TNT or composition B.</li> <li>• Refer to the description of the MK399 MOD 1 fuze in paragraph 5-2.2a for expected performance against MOUT targets.</li> </ul> <p>New manufacture:</p> <ul style="list-style-type: none"> <li>• Olive drab w/ no bands</li> <li>• Yellow marking</li> </ul> <p>Old manufacture:</p> <ul style="list-style-type: none"> <li>• Olive drab w/ no bands</li> <li>• Yellow marking</li> </ul>	<p>Normal cavity:</p> <p>M399 MOD 1, M557/M572 PD, M739 series PD, M564 MTSQ, M582 series MTSQ, M732 series, M767 ET</p> <p>Deep cavity:</p> <p>M399 MOD 1, M557/M572 PD, M739 series PD, M564 MTSQ, M582 series MTSQ, M728 PROX, M514 series PROX, M767 series ET, M782 MOFA</p>	<p>For blast, fragmentation, and mining</p>



**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M795, HE	<p>High-explosive, shallow cavity</p>	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"><b>WARNING</b></div> <p>The M795 projectile will not be fired at charge 3 (white bag (WB)). Firing below these charges may result in stickers.</p> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M795 is similar to the M483A1 externally, except that it is two inches shorter.</li> <li>• The M795 consists of 23.8 pounds of TNT explosive loaded into a 78.1 pound body assembly. A welded rotating band encircles the high fragmentation steel HF-1 body near its base.</li> <li>• Refer to the description of the MK399 MOD 1 fuze in paragraph 5-2.2a for expected performance against MOUT targets.</li> </ul> <ul style="list-style-type: none"> <li>• Olive drab</li> <li>• Yellow marking</li> </ul>	<p>M577 PD M739 Series PD M582 Series MTSQ M732 Series PROX M767 Series ET M782 MOFA MK399 MOD1</p>	<p>For personnel and light materiel targets</p>

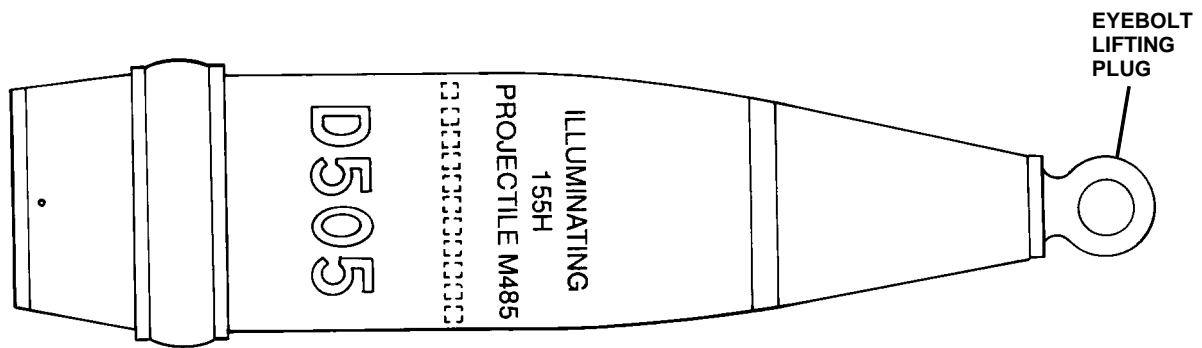


**M795 PROJECTILE**



**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

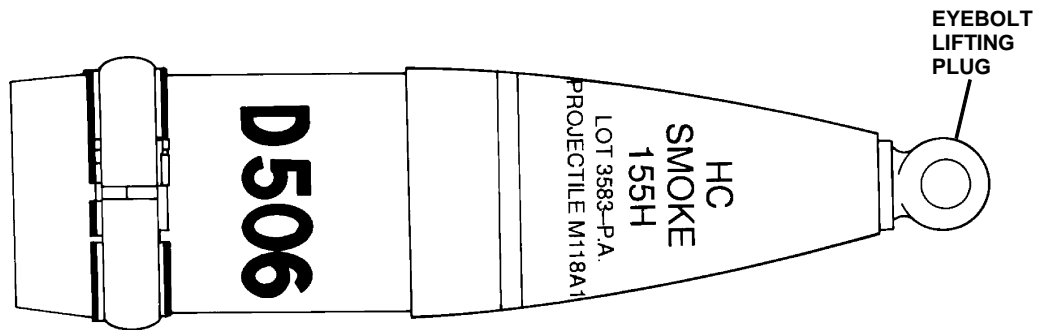
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M485A1, M485A2, illuminating	Illuminating	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"><b>WARNING</b></div> <p>The M485A1 and M485A2 projectiles can be fired with charge 2 (M3 green bag (GB)) through charge 8 (M119 series charges) inclusive. These projectiles are not reliable when fired at charges 6, 7, and 8 with fuze settings of 10 seconds or less.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>The M485A1 and M485A2 projectiles have a hollow steel body containing a primary expelling charge, a canister assembly, and a drogue parachute. The canister contains a secondary expelling charge, a delay holder, a light producing chemical, and the main parachute.</p>	M565 MT, M577 series MTSQ, M762 series ET	For battlefield illumination



**M485A1/M485A2 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M116, M116B1, HC (smoke), BE	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M116 and M116B1 projectiles are issued with a filler of HC (white) chemical smoke mixture.</li> <li>• The M116 and M116B1 projectiles contain four smoke canisters.</li> </ul> <p>Base-ejection, HC chemical (smoke)</p>	<p>New manufacture:</p> <ul style="list-style-type: none"> <li>• Light green w/ no bands</li> <li>• Black marking</li> </ul> <p>Old manufacture:</p> <ul style="list-style-type: none"> <li>• Gray w/ 1/yellow band</li> <li>• Yellow marking</li> </ul> <p>Weight: 86 pounds (39 kg)</p>	M501 series MTSQ	For screening, spotting, and signalling
M116A1, HC (smoke), BE	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M116A1 projectile is similar to the M116/M116B1 projectiles.</li> <li>• The M116A1 projectile has improved M1 and M2 HC (white) smoke canisters.</li> </ul> <p>Base-ejection, HC chemical (smoke)</p>	<p style="text-align: center;"><b>NOTE</b></p> <p>Light green w/ no bands Black marking</p>	M565 MT, M577 series MTSQ, M762 series ET	For screening, spotting, and signaling



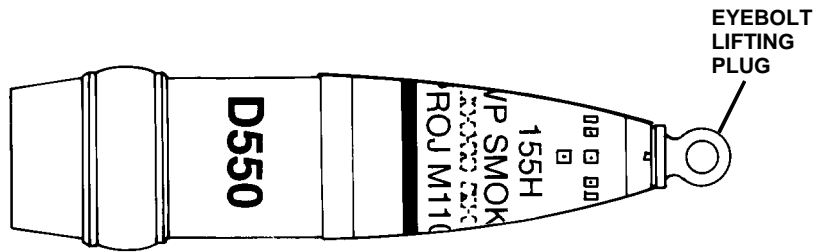
M116, M116B1 (M116E1), M116A1 PROJECTILE

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

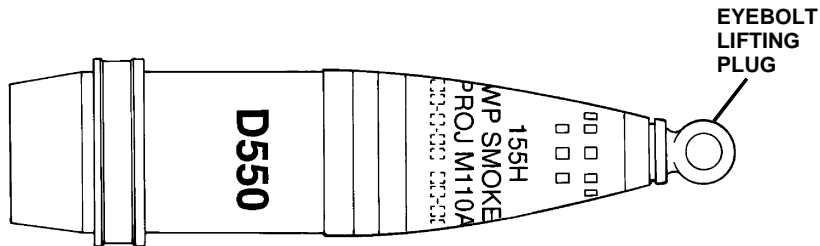
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M110, M110E1, M110A1 (M110E2), M110A2 (M110E3)		<div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px auto; width: fit-content;"> <b>WARNING</b> </div> <ul style="list-style-type: none"> <li>The filler in white phosphorus (WP) smoke projectiles melts at 111.4° F (44.1° C) and creates voids inside the projectile. The WP projectile must be stored base down so that any voids are in the nose of the projectile. Do not fire WP projectiles which are known to have been stored in other than base down position. Firing of such projectiles could contribute to inbore explosions or close-in premature malfunctions.</li> <li>Since the burster in the M110 and M110E1 projectiles is loaded with tetrytol, do not store or fire at temperature exceeding 125° F (52° C). Temperatures above 125° F (52° C) will cause the tetrytol to melt and/or seep, causing premature functioning. Prior to firing, inspect fuze well cup for dents in bottom surface. If dents are found and/or fuze is hard to seat, do not use round.</li> </ul> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>The M110 and M110E1 projectiles are similar to the M110 gas projectile and have the same ballistic characteristics as the M107 HE projectile.</li> <li>The M110A1 (M110E2) and M110A2 (M110E3) projectiles are similar to the M110 and M110E1 projectiles except that the burster is loaded with composition B5.</li> <li>The M110A1 (M110E2) and M110A2 (M110E3) projectiles may be stored and transported at temperatures up to 145° F (63° C). Inspection of the fuze well cup is required before firing.</li> </ul>		

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M110, M110E1, M110A1 (M110E2), M110A2 (M110E3) — continued	Smoke (WP)	New manufacture: <ul style="list-style-type: none"> <li>• Light green w/ 1/yellow band</li> <li>• Red marking</li> </ul> Old manufacture: <ul style="list-style-type: none"> <li>• Gray w/ 1/yellow band</li> <li>• Yellow marking</li> </ul> Weight: 98 pounds (44.45 kg)	M557/M572 PD, M739 series PD, M582 series MTSQ, M767 series ET, M782 MOFA	For primarily producing screening smoke. Also have a slight burning effect.



M110 AND M110E1 PROJECTILE



M110A1 (M110E2) AND M110A2 (M110E3) PROJECTILE

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M825, M825A1	Smoke (WP)	<div style="border: 1px solid black; padding: 2px; text-align: center; margin-bottom: 10px;"><b>WARNING</b></div> <ul style="list-style-type: none"> <li>White phosphorus (WP) impregnated felt wedges from the M825/M825A1 are not totally consumed when the WP burns. When the unburned felt wedges are crushed or moved, residual WP will re-ignite, posing a burn hazard. Personnel should not contact or move the unburned felt wedges.</li> <li>The M825/M825A1 projectile is not to be fired if the obturator is missing or broken because it may result in a short round. If the band is displaced and can be repositioned and remain in the groove, the projectile can be fired.</li> </ul> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>The M825/M825A1 projectile consists of a modified M483A1 projectile carrier with a payload of white phosphorus impregnated felt wedges. In-flight fuze functioning ejects a canister. A burster inside the canister scatters burning wedges over the target area producing obscuring smoke.</li> <li>The M825A1 projectile contains an improved payload and a new base which have corrected the M825 projectile flight instability. The restrictions imposed on the M825 projectile do not apply to the M825A1 projectile.</li> </ul> <p><u>M825:</u> Light green w/ 1/yellow band Red marking</p> <p><u>M825A1:</u> Similar to M825 and a red band near top of projectile.</p>	M577 series MTSQ, M762 series ET	For producing screening smoke

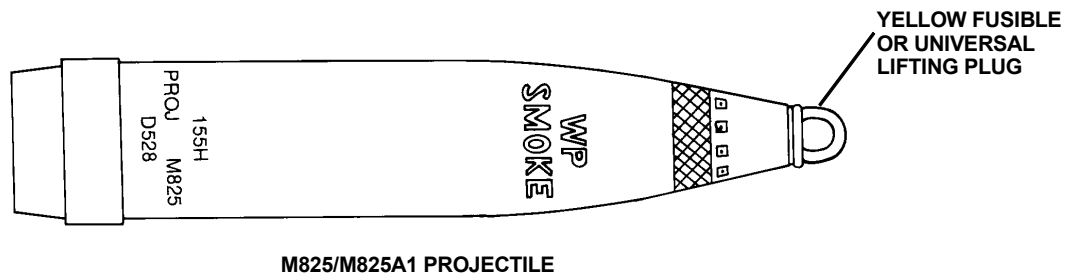
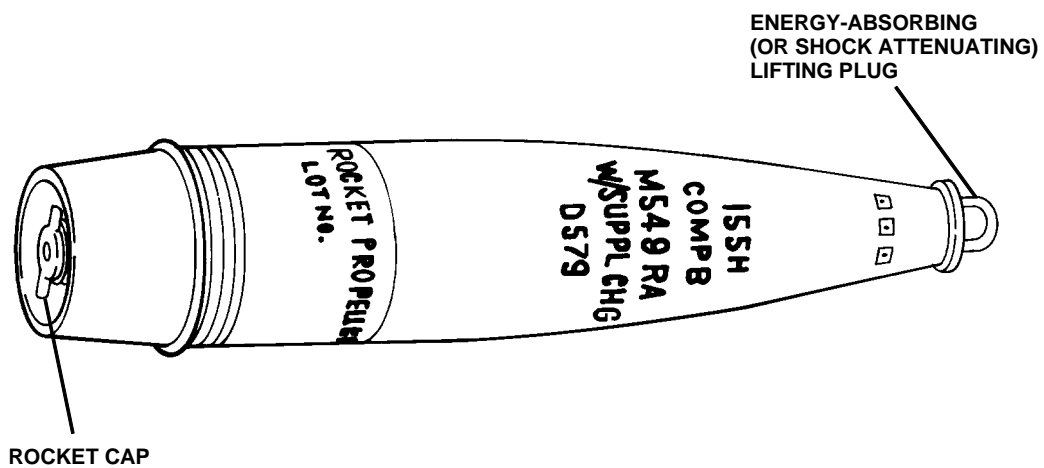




Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED				
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M549, M549A1, HERA		<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>WARNING</b> </div>		
	<ul style="list-style-type: none"> <li>• The M549 and M549A1 projectiles should not be fired in the rocket off mode. The rocket cap must be removed prior to firing.</li> <li>• The M549 and M549A1 projectiles are not to be fired if the obturator is missing or broken as rotating band failure and short round may result. If the band is displaced and can be repositioned and remain in the groove, the projectile can be fired. The basic M119 charge is not to be used with the M549 and M549A1 projectiles as its use will result in rocket motor ignition failure, causing loss of range (short rounds). Use M119A1 or M119A2 charges.</li> <li>• A 6000-meter safety zone is required short of the target because of the possibility of rocket motor nonignition.</li> <li>• The M549 projectile may not be fired with the M203 propelling charge. The M549A1 projectile may be fired with the M203 propelling charge.</li> </ul> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The protective rocket motor cap must be removed from the projectile before firing to increase the range over that attainable ballistically.</li> <li>• The M549 projectile differs from the M549A1 projectile only in the type of explosive filler. The M549 projectile is loaded with composition B and the M549A1 projectile is loaded with TNT.</li> <li>• The M549 and M549A1 projectiles have the energy-absorbing or shock attenuating lifting plug designed to protect the projectile fuze area against accidental damage. The new plug has an oversized 3-3/4 inches (9.53 cm) flange. If this lifting plug is broken at the neck area, the threaded portion of the plug will remain in the projectile and the projectile cannot be fuzed. No attempt should be made to extract any portion of a broken plug from a projectile. The projectile is not to be used and should be returned to battalion ammunition section.</li> <li>• The M549/M549A1 projectile may break-up upon impact with urban structures and bunkers rendering it an ineffective penetrator of these targets.</li> <li>• Refer to the description of the MK399 MOD 1 fuze in paragraph 5-2.2a for expected performance against MOUT targets.</li> </ul>			

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M549, M549A1, HERA — continued	High-explosive, rocket assisted	Olive drab w/ no bands Yellow marking	M557/M572 PD, M739 series PD, M582 series MTSQ, M767 series ET M782 MOFA MK399 MOD 1	For target engagement over extended range

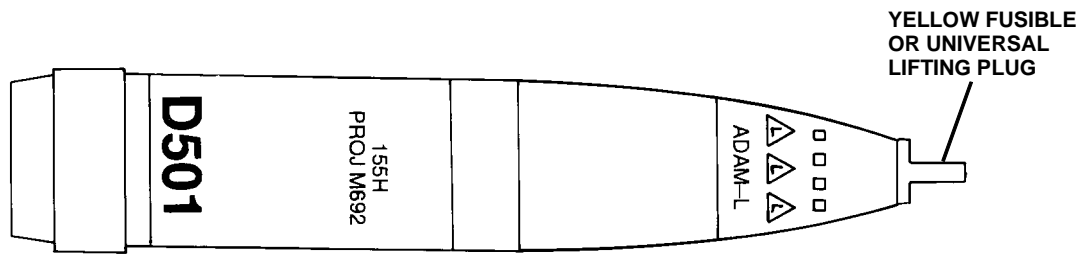


M549/M549A1 PROJECTILE

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M692, HE (ADAM)	High-explosive, area denial artillery ammunition (ADAM), base-ejection type	Olive drab w/ yellow triangles between the nose and bourrelet of projectile with letter L or "ADAM-L" painted inside the triangle Yellow marking	M577 series MTSQ, M762 series ET	For emplacement of antipersonnel mines

**NOTE**  
"ADAM-L" marking on later production projectiles indicates a long self-destruct time of the antipersonnel mine submunitions.



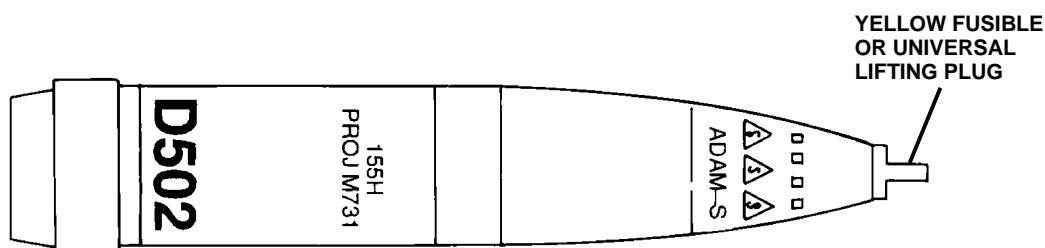
**M692 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M731, HE (ADAM)	High-explosive, area denial artillery munition (ADAM), base-ejection type	Olive drab w/ yellow triangles between the nose and bourrelet of projectile with letter S painted inside the triangle Yellow marking	M577 series MTSQ, M762 series ET	For emplacement of antipersonnel mines

**NOTE**

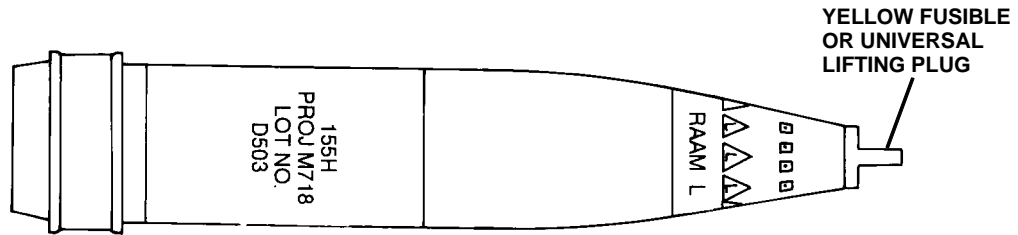
The M731 projectile is the same as the M692 projectile in appearance and function except for the letter S marking that indicates a shorter self-destruct time of the mine submunitions.



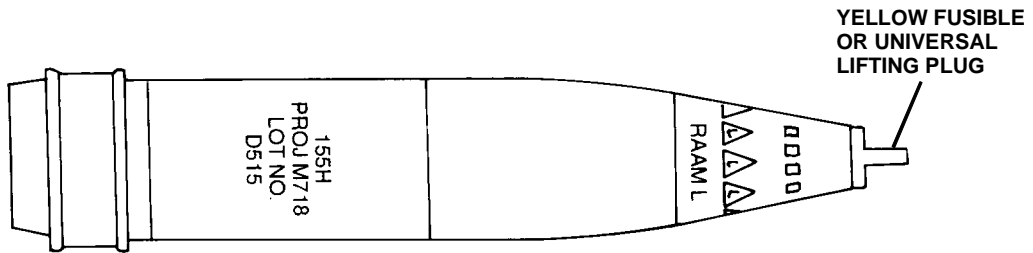
**M731 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M718, M718A1, AT (RAAM)	<p><b>NOTE</b></p> <p>The M718A1 projectile contains internal changes to the submunition and has a new DODIC (D515), but is handled and fired the same as the M718 projectile.</p> <p>Remote anti-armor mine (RAAM), base-ejection type</p>	<p>Olive drab w/ yellow triangles between the nose and bourrelet of projectile with letter L painted inside the triangle</p> <p>Yellow marking</p>	<p>M577 series MTSQ, M762 series ET</p>	<p>Used to deliver nine high-explosive anti-tank mines in front of enemy armored force to deny or delay access to a particular area for a specific time period</p>



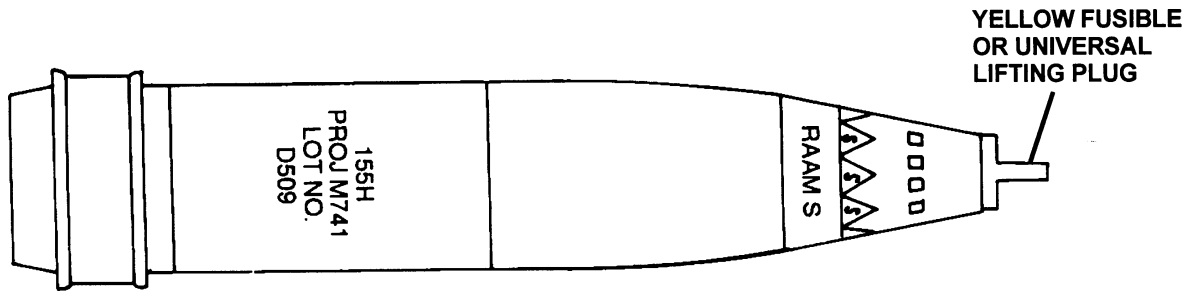
M718 PROJECTILE



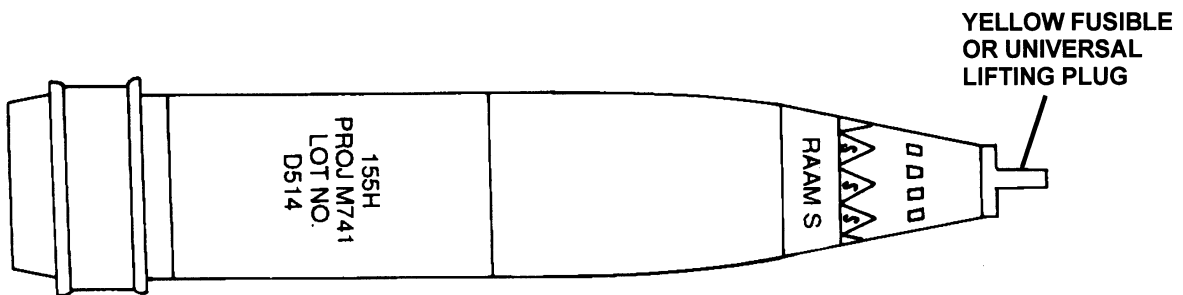
M718A1 PROJECTILE

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M741, M741A1, AT (RAAM)	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>The M741 and M741A1 projectiles are the same as the M718 and M718A1 projectiles except the letter S marking indicates a shorter self-destruct time.</li> <li>The M741A1 projectile contains internal changes to the submunition and has a new DODIC (D514), but is handled and fired the same as the M741 projectile.</li> </ul>			Used to deliver high-explosive anti-tank mines in front of enemy armored force to deny or delay access to a particular area for a specific time period
Remote anti-armor mine (RAAM), base-ejection type	Olive drab w/ yellow triangles between the nose and bourrelet of projectiles with letter S painted inside the triangle Yellow marking	M577 series MTSQ, 762 series ET		



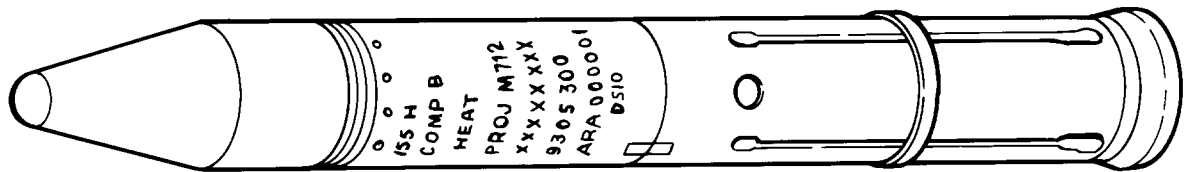
**M741 PROJECTILE**



**M741A1 PROJECTILE**

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

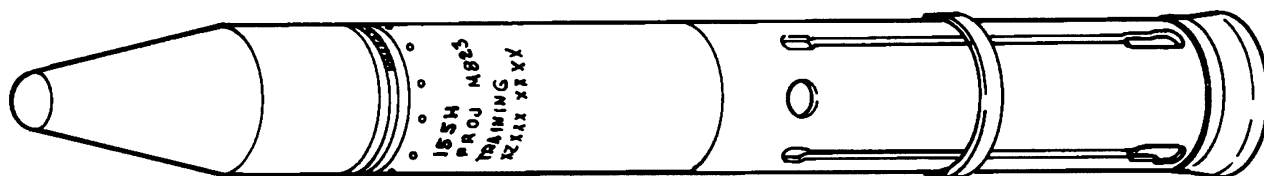
Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M712, HEAT (Copperhead)	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M712 projectile is loaded with 14.75 pounds (6.69 kg) of composition B.</li> <li>• The M712 projectile is guided to its target by a laser beam directed on the target from the laser designator and has five time and code switches set by the crew prior to firing.</li> <li>• For additional details on use of the M712 projectile, see section III.</li> </ul> <p>Cannon launched guided projectile (CLGP), high-explosive antitank (HEAT)</p>	<p>Black Yellow marking Weight: 138 pounds (62.59 kg) Length: 54 inches (137.16 cm)</p>	<p>The war head section of the M712 projectile contains its own M740 base-detonating fuze</p>	<p>For engaging armored vehicles and emplacements</p>



M712 PROJECTILE

**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M823, Training (Copperhead)	Training	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"><b>WARNING</b></div> <p>The M823 projectile must not be fired. Such firing can be a hazard to personnel forward of the weapon.</p> <p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M823 projectile simulates the M712 projectile in weight, center of gravity, and external appearance. It contains code and time switches which are set to simulate prefiring activity by the crew. It is shipped and stored in the same type container as the M712.</li> <li>• For additional details on use of the M823 projectile, see section III.</li> </ul>		For training crew to handle and set M712 projectile



**M823 PROJECTILE**



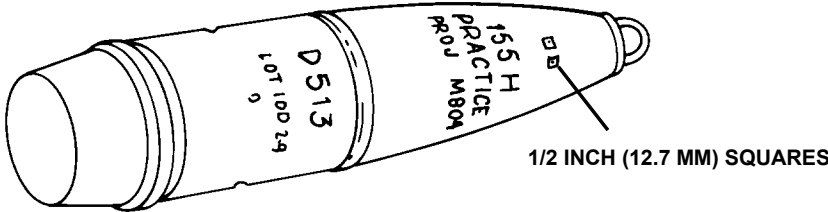
**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M804, M804A1 Training	<p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M804 and M804A1 projectiles are similar in weight and external configuration to the M107 HE projectile.</li> <li>• M804 and M804A1 projectiles are handled and fired the same way. However, the M804 projectile contains a small smoke canister in the fuze well which provides flash and smoke for visual determination of functioning. The M804 projectile body has four body vent holes, 90° apart, which serve to disperse smoke on functioning. The M804A1 projectile does not contain any holes and has a large smoke canister.</li> <li>• The M732 fuze cannot be used with the M804A1 projectile.</li> </ul>			
	Training	<p>M804: Blue w/ 1/brown band White marking</p> <p>M804A1: Blue w/ 1/yellow band White marking</p>	<p>M557/M572 PD, M739 series PD, M564 MTSQ, M582 series MTSQ, M732 series (M804 only), M767 series ET, M782 MOFA</p>	<p>Used in training without the blast and fragmentation which accompany functioning of an M107 HE projectile</p>

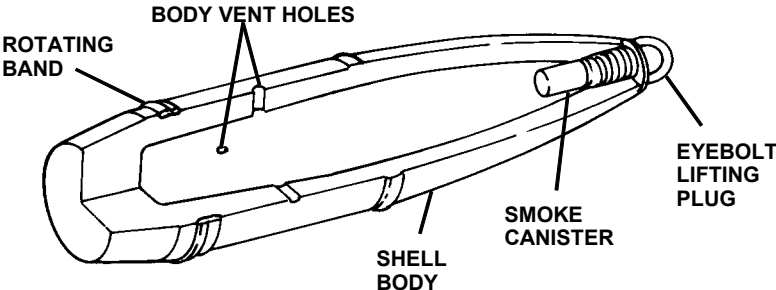
**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M804, M804A1 Training — continued				

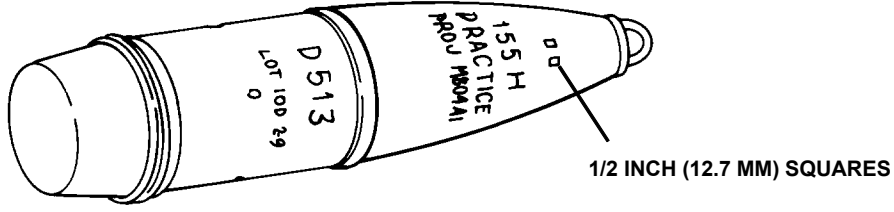
  



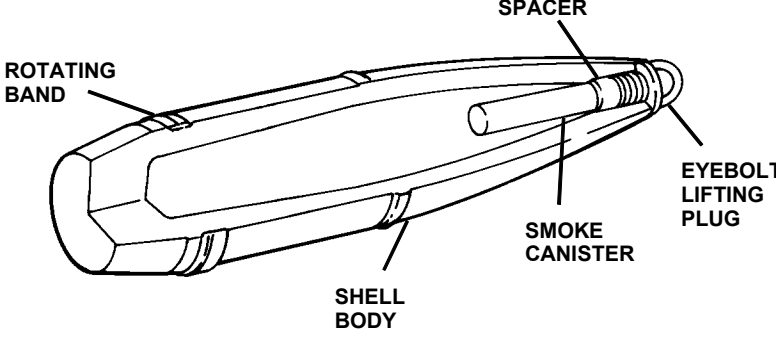
1/2 INCH (12.7 MM) SQUARES



M804 PROJECTILE



1/2 INCH (12.7 MM) SQUARES

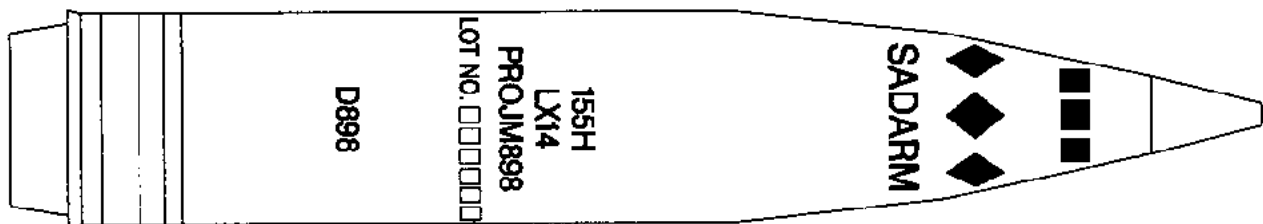


M804A1 PROJECTILE



**Table 5-1. 155MM AMMUNITION FOR M109 HOWITZERS - CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M898 (SADARM Basic)	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>• The M898 projectile has millimeter-wave radar and infrared sensors to locate targets and provide countermeasure resistance.</li> <li>• The warhead is an explosively formed penetrator designed for top-attack of self-propelled artillery and armored combat vehicles. SADARM will defeat all know armor with the same anti-armor effectiveness as the M483A1 DPICM with 80 percent fewer projectiles.</li> </ul>			For top-attack of self-propelled artillery and armored combat vehicles.
	Fire-and-forget top-attack, counterfire munition.	Olive drab w/yellow markings  Weight: 103.5 lbs (46.99 kg) w/fuze  Submunitions (2) footprint radius: Basic: 75m	M577A1*	



\* Firing Limitation: M577A1 fuze must be marked "M898 SADARM Compatible".

Table 5-2. AUTHORIZED PROJECTILE/PROPELLING CHARGE COMBINATIONS FOR M109A2/M109A3/ M109A4 M185 AND M109A5 M284 CANNON ASSEMBLIES <sup>(1)</sup> (155MM)																			
Projectiles	Propelling Charges																		
	(Green Bag) M3A1 Charges					(White Bag) M4 and M4A2 Charges					M119A1 Chg 8	(Red Bag) M119A2 Chg 7 <sup>(2)</sup>	M203 and M203A1 Chg 8 <sup>(3)</sup>	M231 Chg <sup>(9)</sup>		M232 Charge <sup>(9)</sup>			
	1	2	3	4	5	3	4	5	6	7				1	2	3	4	5	
M110, AGENT, H OR HD	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	Firing Limitations: M110 agent burster loaded with tetrytol cannot be stored or fired at temperatures exceeding 125° F (52° C).
M121A1, AGENT, GB OR VX	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	
M687, AGENT, GB2	NO	NO	X	X	X	X	X	X	X	X	X	X	X	NO	NO	X	X	X	Firing Limitations: Firing below charge 3 may result in stickers.
M449 SERIES, HE, ICM	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	
M483A1, HE, ICM	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	Firing Limitations: Firing below charge 3 may result in stickers.
M864 HE, ICM, EXTENDED RANGE	NO	NO	NO	NO	NO	NO	NO	NO	NO	X	X	X	X	NO	NO	X	X	X	Firing Limitations: Firing below charge 3 may result in stickers. <sup>(4)</sup>
M107, HE	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	
M795, HE	NO	NO	NO	NO	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
M485A1, M485A2, ILLUMINATING	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	Firing Limitations: M485A1 and M485A2 projectiles are not reliable when fired at charges 6, 7, and 8 with fuze settings of 10 seconds or less.
M116, M116B1, SMOKE, BE, HC	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	
M116A1, SMOKE, BE, HC	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	
M825 WP SMOKE	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	NO	NO	NO	NO	NO	Firing Limitations: Firing below charge 3 may result in stickers. <sup>(7)</sup>
M825A1 WP SMOKE	NO	NO	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Firing Limitations: Firing below charge 3 may result in stickers. <sup>(7)</sup>
M110 (M110E1), M110A1	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO	Firing Limitations: M110 (M110E1) burster loaded with tetrytol cannot be stored at temperatures exceeding 125° F (52° C).
(M110E2), M110A2 (M110E3), WP SMOKE																			
M898 (SADARM)	NO	NO	X	X	X	NO	X	X	X	X	X	X	X	X	X	X	X	X	Firing Limitations: M577A1 fuze must be marked "M898 SADARM Compatible".

Table 5-2. AUTHORIZED PROJECTILE/PROPELLING CHARGE COMBINATIONS FOR M109A2/M109A3/ M109A4 M185 AND M109A5 M284 CANNON ASSEMBLIES <sup>(1)</sup> (155MM)																		
Projectiles	Propelling Charges																	
	(Green Bag) M3A1 Charges					(White Bag) M4 and M4A2 Charges					M119A1 Chg 8	(Red Bag) M119A2 Chg 7 <sup>(2)</sup>	M203 and M203A1 Chg 8 <sup>(3)</sup>	M231 Chg <sup>(9)</sup>		M232 Charge <sup>(9)</sup>		
	1	2	3	4	5	3	4	5	6	7				1	2	3	4	5
M549, M549A1 <sup>(8)</sup> , HERA Firing Limitations: Rocket on firing only.	NO	NO	NO	NO	NO	NO	NO	NO	NO	X	X	X	X	NO	NO	X	X	X
M692, M731, HE Firing Limitations: Firing below charge 3 may result in stickers.	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO
M718, M718A1, M741, M741A1, AT Firing Limitations: Firing below charge 3 may result in stickers.	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO
M712, HEAT (COPPERHEAD)	NO	NO	NO	X	X	NO	X	X	X	X	X	X	NO	NO	X	X	X	NO
M804, M804A1 TRAINING	NO	NO	X	X	X	X	X	X	X	X	X	X	NO	X	X	X	X	NO

**NOTE**

- (1) Primer M82 is the only authorized primer to be used in the M109A2/M109A3/M109A4 M185 or M109A5 M284 cannon assemblies.
- (2) The M119A2 charge 7 (Red Bag) is equivalent to the M119A1 charge 8. Refer to firing tables for small differences in velocity which affect range.
- (3) The M203/M203A1 charges are to be fired in the M109A5 M284 cannon only.
- (4) The M864 will be fired with the M203 series charge only in the M109A5 M284 cannon. The M864 will be fired to achieve ranges beyond the capabilities of the M483A1 projectile or when the M483A1 is not available. M203 series charge 8 is not equivalent to M119A1 charge 8.
- (5) M116 and M116B1 restricted from overhead fire with zone 7 of M4A1/M4A2 charges due to possible base plate separation, creating downrange safety hazard.
- (6) M825 projectiles (manufactured Jan 85 - May 86) fired at temperatures above 110° F (43° C) (WP liquified) have resulted in flight instability and short rounds. This instability does not occur below 110° F (43° C) (WP solid). This restriction does not apply to M825A1 projectile.
- (7) M825 projectiles are restricted to firing below 950 mils elevation with the M203 series charge. Firing of this combination at elevations exceeding 950 mils may result in short rounds. This restriction does not apply to M825A1 projectile.
- (8) Do not fire the M549/M549A1 projectiles if the obturating band is missing or broken. If band is displaced and can be repositioned and remain in the groove, the projectile can be fired. The M549A1 projectile can be fired with the M203 series charge and M232 charge 5 but the M549 projectile must never be fired with the M203 series charge or M232 charge 5.
- (9) Do not load or fire M231 charges with M232 charges. Critical malfunction could result. M231 and M232 are authorized for the M284 cannon only.

## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.2 Authorized Fuzes

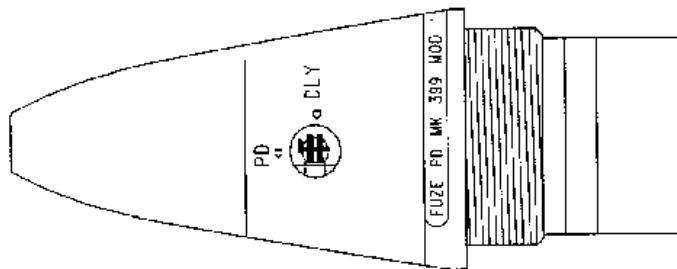


The firing of a field artillery round without a fuze or with an unauthorized fuze is strictly prohibited as an inbore explosion may result.

Paragraph 5-2.2 describes some of the fuzes to be used with this weapon. For additional information and more detailed descriptions and functioning of the authorized fuzes, see TM 43-0001-28.

#### a. MK399 MOD 1 (Mout) Point Detonating Fuze

The MK399 fuze (1) is primarily for use against urban structures (bunkers, buildings, etc.). The fuze has a setscrew that can be turned by a flathead screwdriver or M18 fuze wrench to select PD (point detonating) or DLY (delay) function. When set to PD, the fuze functions superquick which is useful for spotting purposes. When set to DLY, the fuze penetrates the target to function the projectile inside the target. The fuze is assembled with a booster pellet and set to PD for shipping. This fuze is rain sensitive.



**MK399 MOD 1 Summary Matrix of Expected Performance Against MOUT Targets**

Obliquity Angle →	Wood Frame				Single Brick				Triple Brick				Reinforced Concrete			
	0°	30°	45°	60°	0°	30°	45°	60°	0°	30°	45°	60°	0°	30°	45°	60°
155mm M107/M795 low zone	M <sup>1</sup>	M <sup>1</sup>	M <sup>1</sup>	M <sup>1</sup>	G	G	G	G	G	G	M <sup>3</sup>	M <sup>3</sup>	G	G	M <sup>3</sup>	M <sup>3</sup>
155mm M107/M795 mid zone	G	G	G	G	G	G	G	G	G	G	M <sup>3</sup>	M <sup>3</sup>	G	G	M <sup>3</sup>	M <sup>3</sup>
155mm M107/795 high zone	G	G	G	G	G	G	G	G	M <sup>2</sup>	M <sup>2</sup>	G	G	M <sup>2</sup>	M <sup>2</sup>	G	G
155mm M549/A1	G	G	G	G	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>	P <sup>1</sup>

G = good
M = marginal
P = poor, not recommended

**NOTES:**

Always be prepared to use multiple rounds to defeat targets

Obliquity angle of 0° = perpendicular to target wall

M<sup>1</sup> - for lighter wood frame construction, at low zone, insufficient impact force may result in duds

M<sup>2</sup> - perpendicular and near perpendicular impacts against harder targets at high zone can result in functions on the wall before penetration

M<sup>3</sup> - at low and mid zones, impact angles at and beyond 45° can result in duds

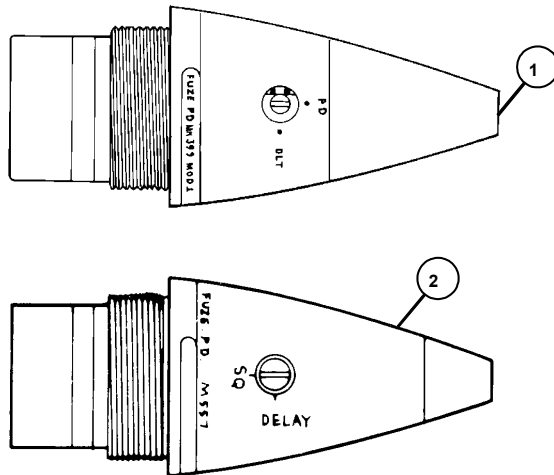
P<sup>1</sup> - RAP rounds not recommended against MOUT targets, projectile may break-up upon impact.

## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.2 Authorized Fuzes

#### b. M557 or M572 Point Detonating Fuze

The M557 and M572 fuzes (2) have selective superquick delay setscrews. The fuzes are packed set for superquick and have a booster attached. Premature functioning can occur when fuzes are fired in heavy precipitation: i.e., rainfall, sleet, snow, or hail. These fuzes can be set to SQ (superquick) or DELAY action by turning the setscrew. The M572 fuze is identical to the M557 fuze with the exception of epoxy under the steel ogive. The M572 fuze is handled, set, and fired the same as the M557 fuze.







**5-2 AUTHORIZED MUNITIONS — CONTINUED**

**5-2.2 Authorized Fuzes — Continued**

**c. M739 or M739A1 Point Detonating Fuze**

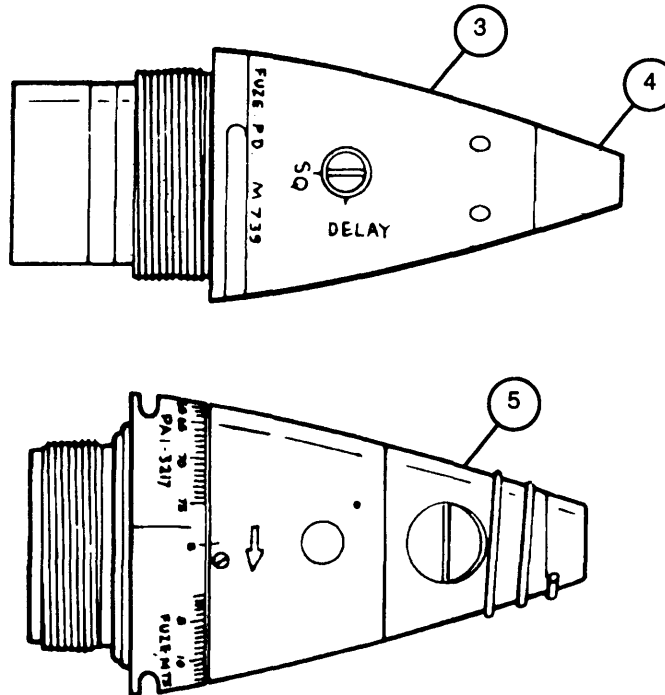
The M739 and M739A1 fuzes (3) are the latest improved version of the selective impact fuze. These fuzes have a solid aluminum ogival body with a threaded base. The fuze contains a rain-insensitive fuze head (4) that allows firing in heavy rain without premature fuze functioning of the round of ammunition. These fuzes can be set for SQ (superquick) or DELAY action by turning the setscrew. The M739A1 fuze contains a new impact delay module which provides more effective functioning in the DELAY mode. In addition to the stamped markings, the M739A1 fuze features anodized green for positive identification of fuze model.

**d. M501 or M501A1 Mechanical Time and Superquick Fuze**

**WARNING**

Dropping or rough handling of a projectile assembled with M501/M501A1 MTSQ fuze may result in fuze functioning and expulsion of projectile base plate and contents. When handling projectiles assembled with this fuze, exercise extreme care to protect the fuze from impact. Keep pull wire on fuze in place until immediately prior to firing.

The M501 or M501A1 fuze (5) has settings for time action (2 to 75 seconds) and an impact element for superquick action. It is used only with the M116 and M116B1 smoke projectiles.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

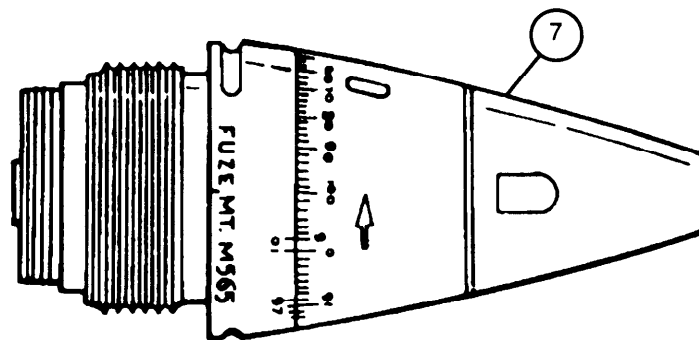
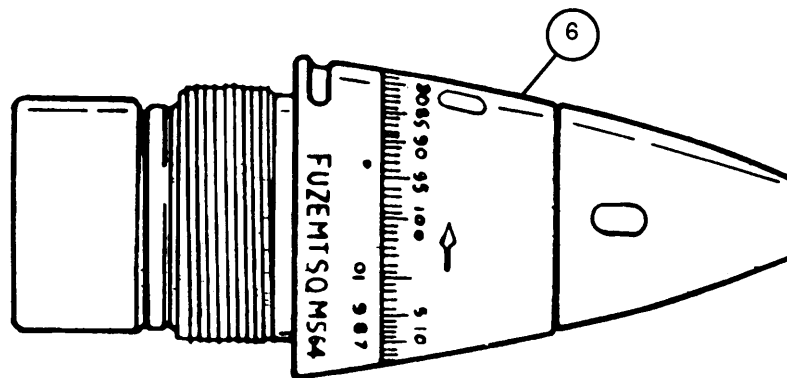
### 5-2.2 Authorized Fuzes — Continued

#### e. M564 Mechanical Time and Superquick Fuze

The M564 fuze (6) is an improvement over the older MTSQ fuzes, in that it provides a longer timing mechanism (100 seconds) for functioning at longer ranges. The date of manufacture is stamped on the fuze body before the lot number. Fuzes manufactured through 1969 must be set on 90 seconds if superquick (impact) action is desired. Setting of these fuzes between S and 2 seconds may result in functioning after approximately 2 seconds. Fuzes manufactured since 1970 may be set as shipped on S for superquick (impact) functioning. Premature functioning of the fuze may occur downrange if the fuze is fired in heavy precipitation; i.e., rainfall, sleet, snow, or hail.

#### f. M565 Mechanical Time Fuze

The M565 fuze (7) mechanical time (MT) fuze is similar to the M564 fuze (6) except that the M565 fuze does not contain the point detonating assembly or the booster assembly. The M565 fuze can be set from 2 to 100 seconds. Like the M564 fuze, the M565 fuze has a vernier scale to assure a setting accuracy of 0.1 seconds. The M565 fuze is used with base-ejection projectiles only.



## 5-2 AUTHORIZED MUNITIONS - CONTINUED

### 5-2.2 Authorized Fuzes - Continued

#### g. M728 and M514 Series Variable Time Proximity Fuze

**WARNING**

The M728 and M514 series fuzes are not to be used with the M203 and M203A1 propelling charge.

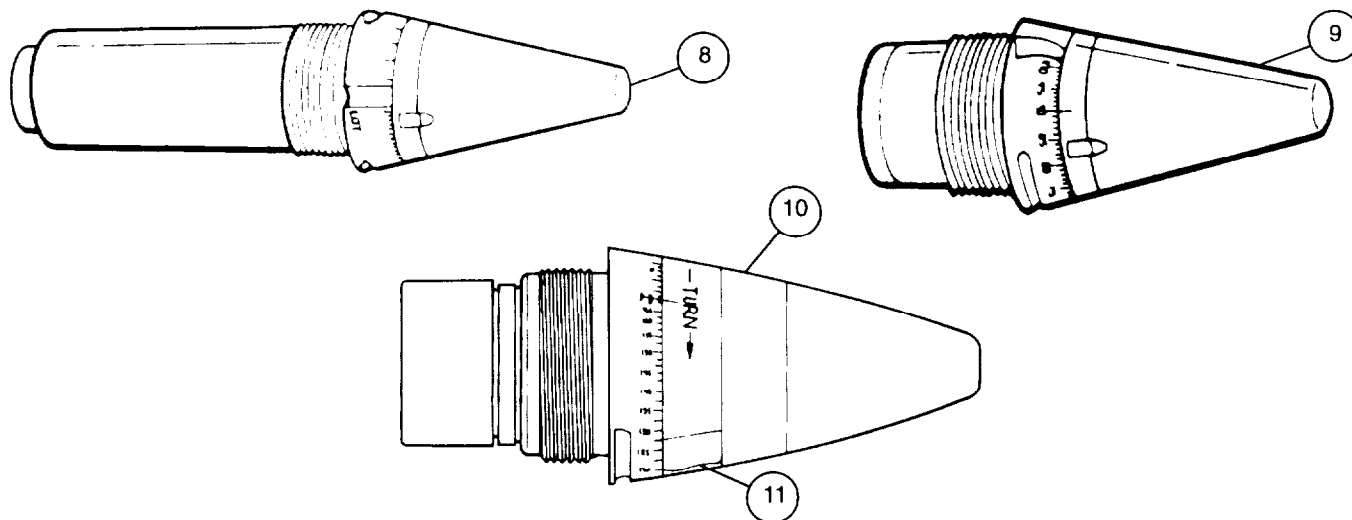
The M728 and M514 series fuzes (8) are long intrusion proximity variable time (VT) fuzes used with deep cavity projectiles and are essentially self-powered radio and transmitting units. The fuzes can be set from 5 to 100 seconds. The nose of the M728 fuze has been painted black to reduce static electricity.

#### h. M732 Series

**NOTE**

The PD setting of the M732 series VT fuzes, when fired into soft impact areas, will produce less lethality than the superquick setting of the M739 series PD fuze.

The M732 fuze (9) and M732A2 fuze (10) are proximity variable time (VT), short-intrusion fuzes of the same overall length as the standard impact or mechanical time fuze. The supplementary charge must be left in the fuze well for proper functioning of the M732 series fuze. The M732 series fuze has a time ring that can be set from 5 to 150 seconds. The M732A2 fuze can be set from 4 to 156 seconds. Time settings are used to arm these fuzes 3 to 5 seconds prior to set time for proximity function. The fuzes can also function PD as an option or proximity mode back-up and are always armed for PD at 400 calibers. The M732A2 was especially designed for compatibility with rocket-assisted rounds. The M732A2 is set by simultaneously depressing two pushbuttons (11) and rotating the setting ring to the desired position. When the two pushbuttons are released, the setting ring is locked into position.

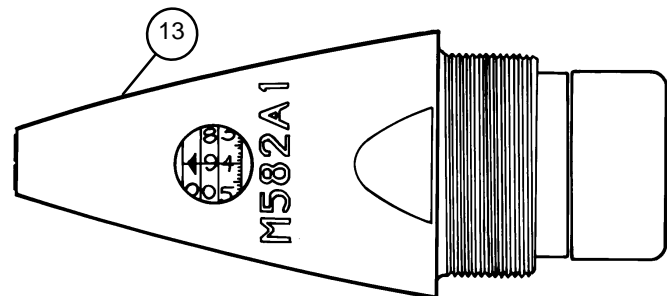
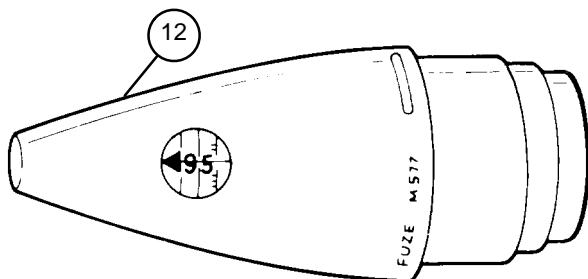


## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.2 Authorized Fuzes — Continued

#### i. M577 Series and M582 Series Mechanical Time and Superquick Fuzes

- 1 The M577 series fuze (12) and M582 series fuze (13) have a 200 second mechanical time mechanism with three movable digital dials similar to a speedometer. Each fuze has a window through which the dials are viewed. The dials permit setting of the fuze to the nearest tenth of a second. The M577A1 and M582A1 fuzes contain a different mechanism for point detonating action. Externally the major difference is the configuration of the wrench slots. The M577A1 and M582A1 fuzes are handled, set, and fired the same as the basic models. Early manufactured basic and A1 fuzes have black paint finished ogives, while the later produced A1 fuze has a gold (chromite finish) color ogive.
- 2 The dial closest to the M577 series fuze (12) and M582 series fuze (13) nose indicates the time in hundreds of seconds. (The triangle (▴) position is a nontime setting). The second dial indicates time in ten second intervals. The third dial indicates the nearest second and also tenths of seconds by using the scale on the right edge of the dial.
- 3 The M582 series fuze (13) is fitted with a booster and is used with burster type projectiles. The M577 series fuze does not contain a booster and is used with base-ejection projectiles. In order to minimize identification problems, current production of the M582A1 fuzes contain a white stencil “M582A1” below the window of the fuze body.
- 4 The M577 series fuze (12) can be used with a special spotting charge when firing the M483A1 or M864 projectile in the self-registration mode (para 5-4).
- 5 If M577 series fuze (12) and M582 series fuze (13) are set for time and the timing mechanism fails, the fuze may or may not function on impact.
- 6 The M577 series fuze (12) and M582 series fuze (13) can be set with the M35 fuze setter or a flat-tip screwdriver. The time-setting key is located on the end of the fuze nose. The desired time is set under the hairline. Detailed setting instructions are outlined in paragraph 5-6.
- 7 The M577 series fuze (12) and M582 series fuze (13) are not sensitive to rain.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

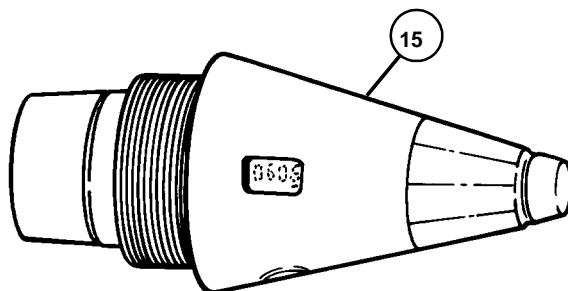
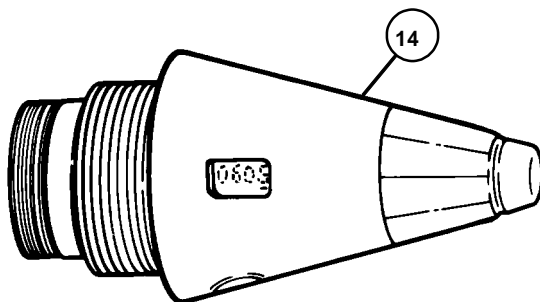
### 5-2.2 Authorized Fuzes — Continued

#### j. M762 and M767 Series Electronic Time (ET) Fuze

#### NOTE

Once activated, the M762 and M767 series fuzes cannot be turned off. Therefore, the fuzes have approximately 15 days service life before the battery runs down and the LCD goes blank.

- 1 The M762 series fuze (14) and M767 series fuze (15) are powered by a reserve lithium battery. The battery is activated manually by rotating the ogive or remotely via inductive auto-set fire controls or a portable handheld inductive fuze auto-setter. An electronic subassembly contains integrated circuits that provide controls and logic for 199.9 seconds electronic timing and transmit a fire pulse signal for time function. A liquid crystal display (LCD) provides a visual readout of the fuze setting, as follows:
  - (a) The column closest to the base end indicates time in hundreds of seconds (the triangle (◄) position is a nontime setting). The M762A1/M767A1 will have a blank space, a Ø or 1.
  - (b) The second column away from base end indicates time in tens of seconds.
  - (c) The third column away from base end indicates time in seconds.
  - (d) The fourth column (closest to nose end) indicates time in tenths of seconds.

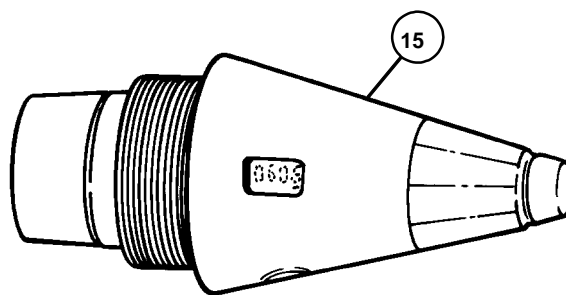
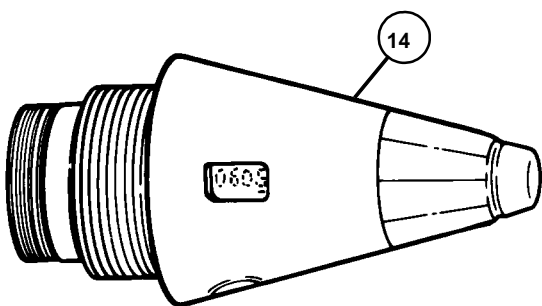


## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.2 Authorized Fuzes — Continued

#### j. M762 and M767 Series Electronic Time (ET) Fuze — Continued

- 2 The M762 series fuze (14) and M767 series fuze (15) contain an electromechanical safe and arming mechanism (S&A). When set for time function, the S&A provides overhead safety by arming at 50 milliseconds before set time. For this reason, if the fuze impacts before a time setting expires, there will be no point detonating (PD) back-up function. For PD setting, the S&A arms the fuze at 0.45 seconds in flight. Upon impact, a crush switch assembly (contained in the ogive) senses the impact and transmits a fire signal for PD action.
- 3 The M762 series fuze (14) and M767 series fuze (15) can be set either by hand (rotating ogive) and depressing selector and cocking button or remotely by a weapon equipped with auto-set fire control system. Detailed setting instructions are outlined in paragraph 5-6. The settings can be changed as many times as required for the duration of the activated life of the battery.
- 4 The M762 fuze (14) and M767 fuze (15) bodies are anodized gold. The rear portion of the ogive is coated with a gold phosphate finish. The forward portion of the ogive is brown plastic for the basic fuzes and black plastic for the M762A1 and M767A1 fuzes. The nose cap is unpainted bronze for the basic fuzes and stainless steel for the M762A1/M767A1.
- 5 The M762 series fuze (14) does not contain a booster and is used with base-ejection projectiles. The M767 series fuze (15) is fitted with a booster for firing with burster type and high explosive projectiles.
- 6 The M762 series fuze (14) can be used with a special spotting charge when firing the M483A1 and M864 projectiles in the self-registration mode (para 5-4).
- 7 If the M762 series fuze (14) and M767 series fuze (15) fail in the time mode, there is no PD backup function.
- 8 The M762 series fuze (14) and M767 series fuze (15) are not sensitive to rain.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.3 Authorized Propelling Charges

**WARNING**

Some propelling charges may have an MK2A4 primer packed inside the container. This primer is not authorized for firing in M109A2/M109A3/M109A4 M185 or M109A5 M284 cannon assembly.

#### a. M3A1 Propelling Charge

The M3A1 propelling charge (1) is a green bag charge divided into a base and four increments for firing in charges 1 through 5. It has a flash reducer pad (2) assembled in front of the base charge with similar 1 ounce (28.30 g) pads assembled in front of increments 4 and 5. The increment bags are tied together by cloth straps. A clean-burning igniter charge in a red cloth bag is sewn to the rear of the base section.

#### b. M3 Propelling Charge

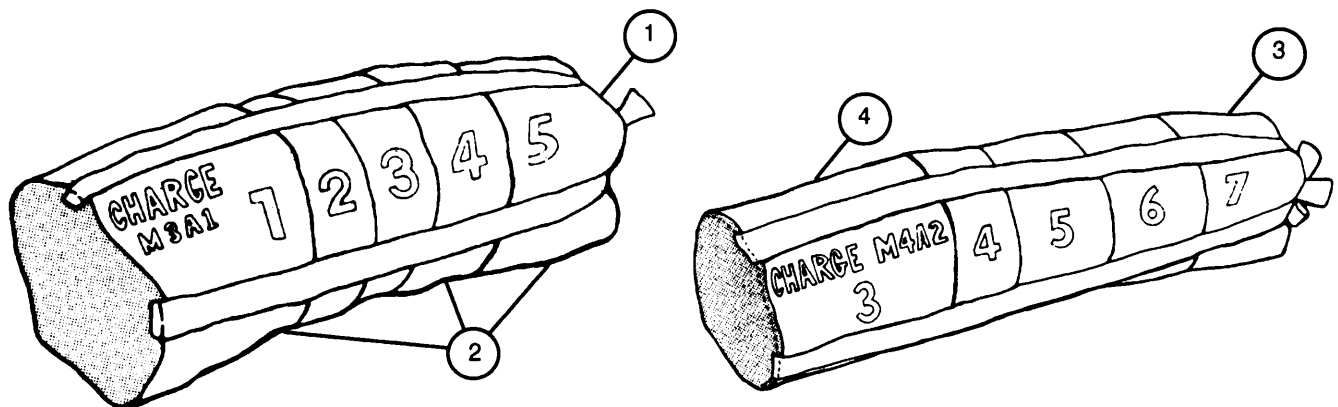
The M3 propelling charge is a green bag charge similar to the M3A1 propelling charge (1), except it is not assembled with flash reducer pads and black powder is used in the igniter pad.

#### c. M4A2 Propelling Charge

The M4A2 propelling charge (3) is a white bag charge consisting of a base charge and four increments for firing in charges 3 through 7. The increments are tied together by cloth straps. A clean-burning igniter charge in a red cloth bag is sewn to the rear of the base section. It has a flash reducer pad (4) assembled in front of the base charge.

#### d. M4A1 Propelling Charge

The M4A1 propelling charge is identical to the M4A2 propelling charge (3), except that it does not contain a flash reducer, and the base igniter contains black powder instead of a clean-burning igniter charge. The M2 flash reducer may be used with this charge and is a separate item of issue (para 5-2.5).





## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.3 Authorized Propelling Charges — Continued

#### e. M119A1 Propelling Charge

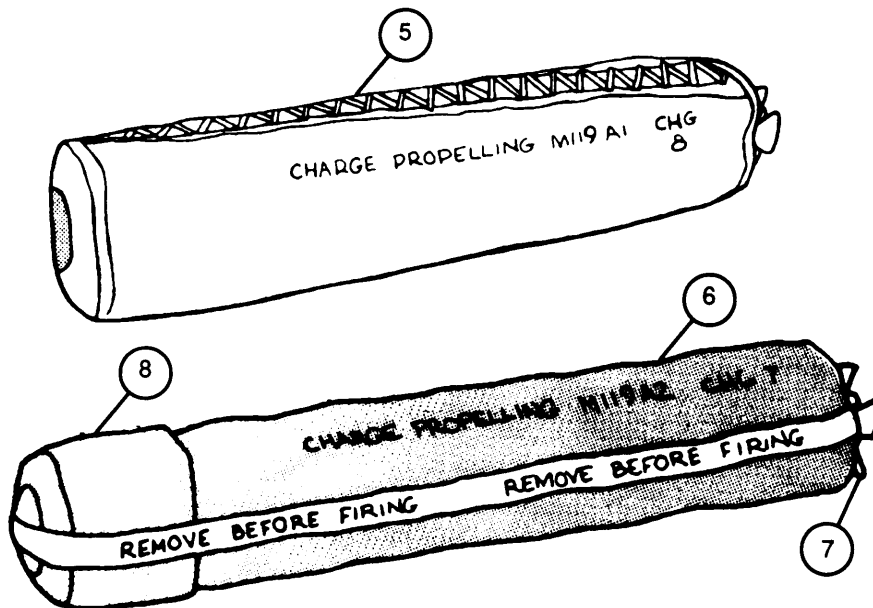
**WARNING**

A central igniter core in M119A1 propelling charges extends through the center of the propelling charge for its entire length. The M119A1 propelling charges must be stored and transported in a horizontal position so that any possibility of damage to the core in the form of cracks or splits is eliminated.

The M119A1 propelling charge (5) is a single charge 8 with a flash reducer that allows firing of the M119A1 propelling charge with the M549 and M549A1 projectiles. A pull strap on the M119A1 propelling charge provides removal from the metal container. This pull strap must be removed from the M119A1 propelling charge before loading into the cannon tube.

#### f. M119A2 Propelling Charge

The M119A2 propelling charge (6) differs in appearance from the M119A1 propelling charge (5) in that it has no lacing jacket and the forward end (7) of the M119A2 propelling charge is white and the remainder is red. It is a base ignited charge 7 with an igniter pad sewn on the base and a flash reducer which lines the side of the M119A2 propelling charge. Like the M119A1 propelling charge, it can be fired with the M549 and M549A1 projectiles. The igniter protector cap (8) and tie strap must be removed prior to firing the M119A2 propelling charge. The M119A2 propelling charge 7 is equivalent to the M119A1 propelling charge 8.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.3 Authorized Propelling Charges — Continued

#### g. M203 Propelling Charge

**WARNING**

Use M203 propelling charge in M109A5 howitzers as they are equipped with M284 cannons assemblies.

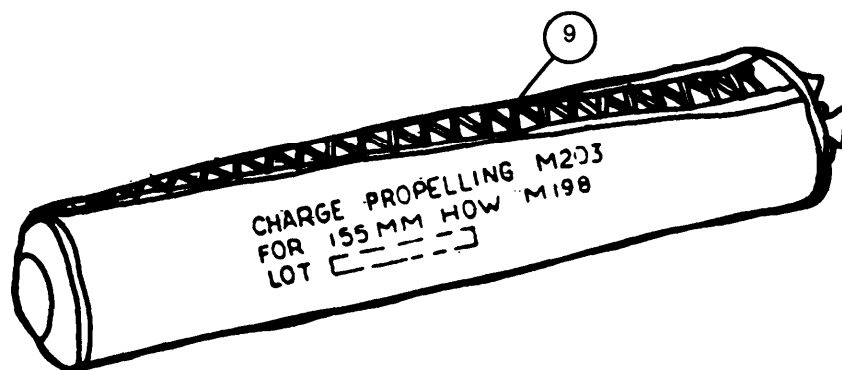
**NOTE**

Early production of M203 propelling charges are marked charge 8S (i.e., super) Later production M203 propelling charges are marked charge 8. The propelling charges are ballistically equivalent and should be identified as charge 8 red bag.

**WARNING**

A central igniter core in M203 propelling charges extends through the center of the propelling charge for its entire length. The M203 propelling charges must be stored and transported in a horizontal position so that any possibility of damage to the core in the form of cracks or splits is eliminated.

The M203 propelling charge (9) is a charge 8 propelling charge developed for extended range in 155MM howitzer M109A5 M284 cannon assemblies. This red bag charge consists of one increment with an igniter bag sewn on its base, a central core igniter extending through the center of the propelling charge, and a flash reducer in front of the propelling charge. The entire length of the M203 propelling charge is encased in a tight-fitting lacing jacket for added strength and stability.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

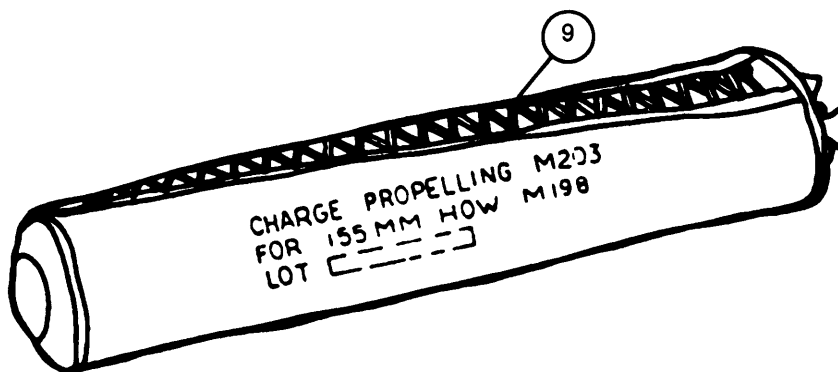
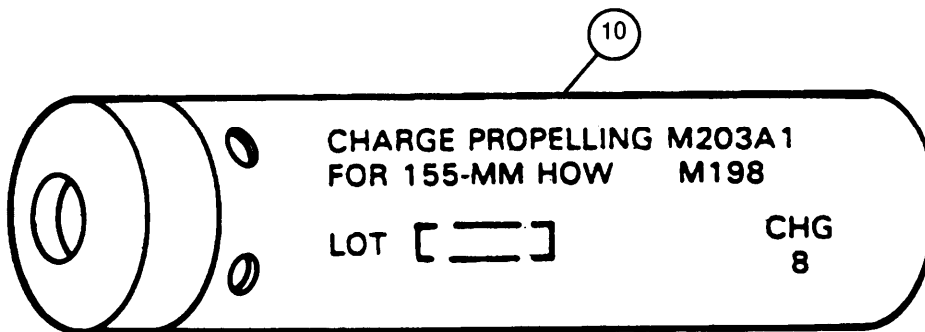
### 5-2.3 Authorized Propelling Charges — Continued

#### h. M203A1 Propelling Charge

**WARNING**

Use M203A1 propelling charge in M109A5 howitzers as they are equipped with M284 cannon assemblies.

The M203A1 propelling charge (10), like the M203 propelling charge (9), is a charge 8 propelling charge developed for extended range in 155MM howitzer M109A5 M284 cannon assemblies. The M203A1 propelling charge consists of one increment of stick propellant and a base igniter pad encased in a full length rigid combustible cartridge case. The M203A1 propelling charge also contains a wear reducing additive and a lead foil decoppering agent. The M203A1 propelling charge 8 is ballistically equivalent to the M203 red bag propelling charge 8.

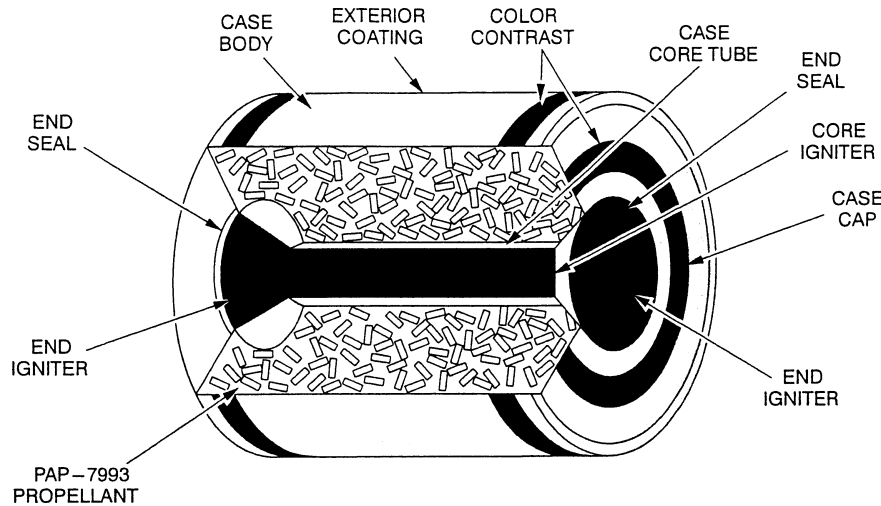


**5-2 AUTHORIZED MUNITIONS — CONTINUED**

**5-2.3 Authorized Propelling Charges — Continued**

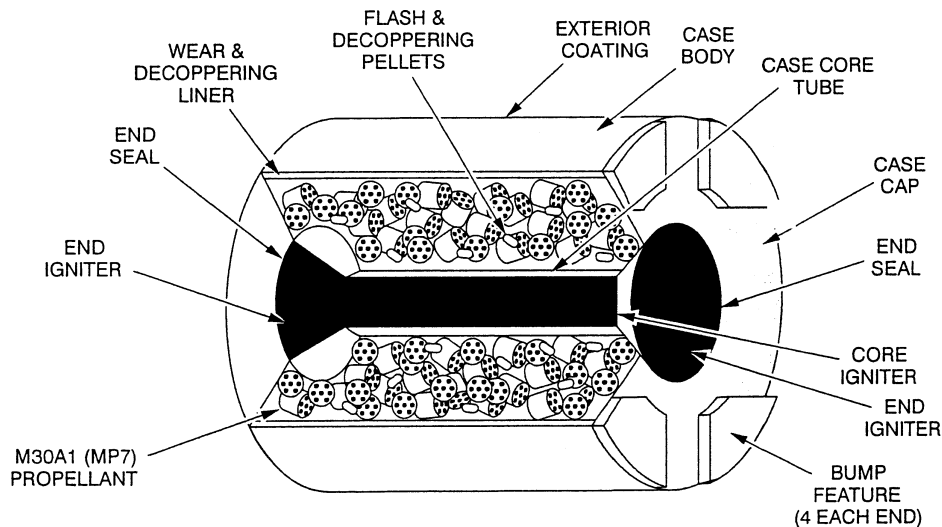
**i. M231 Propelling Charge**

The M231 propelling charge is comprised of a green-colored, coated, nitrocellulose-based combustible case with black markings and black bands. This charge is bi-directional (can be loaded in either direction). The M231 is fired in increments of 1 or 2 for charges 1 and 2.



**j. M232 Propelling Charge**

The M232 propelling charge is comprised of a tan-colored, coated, nitrocellulose-based combustible case with black markings. This charge is bi-directional (can be loaded in either direction). Each end has four raised 1/8-inch bumps. The M232 is fired in increments of 3 through 5 for charges 3 through 5.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.3 Authorized Propelling Charges — Continued

#### k. Fuzes Artillery, Multi-Option (MOFA): M782

These fuzes are intended for use with fragmentation (HE loaded) and burster-type projectiles. They are automatically remote set prior to launch via an inductive communication link. There are four functional modes on these fuzes: point detonation (PD), delay (DLY), variable time (VT), and time (TIME). An electronic subassembly containing integrated circuits provides control and logic for 199.9 seconds electronic timing, and transmits a fire pulse signal for time and proximity functions. The mission data transferred from the M1155 Portable Inductive Artillery Fuze Setter (PIAFS) to the fuze is confirmed by the setter and is displayed on a Liquid Crystal Display (LCD) module found on the setter. The readout provided for the fuze setting is as follows:

#### Fuze Menu

→M762	DM-52
M767	DM-74
M782	*MORE*
C32	*QUIT*

#### Fuze Setting Menu

FUZE: M782  
 MODE: VT  
 TIME: 187 sec  
 SET FUZE

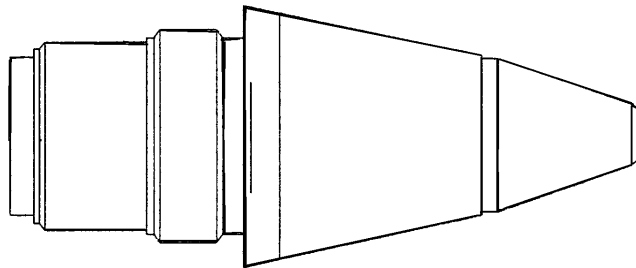
#### Mode Menu

TIME  
 VT  
 DELAY  
 PD

#### Time Menu

100.0 sec

MULTI- OPTION FUZE ARTILLERY (MOFA), M782



MOFA utilizes a standard M739 Safety and Arming (S&A) mechanism that is housed in a retaining cup just below the detonator block. Both setback and spin locks are used to prevent accidental arming of the S&A prior to firing. This S&A mechanism provides a safe separation distance of at least 400 calibers of projectile travel when fired.

These fuzes are set remotely by a weapon equipped with auto-set fire control system or by a Portable Inductive Artillery Fuze Setter (PIAFS) M1155 (TM 9-1290-210-12&P). The setting can be changed as many times as required.

This fuze is not sensitive to rain.

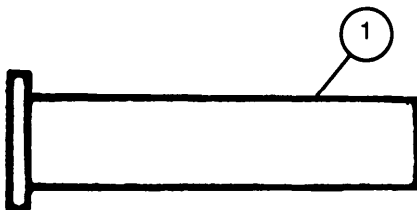
## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.4 M82 Primer

**WARNING**

The M82 primer is the only primer authorized for firing in the M109A2/M109A3/M109A4 M185 and M109A5 M284 cannon assemblies. Do not fire the MK2A4 primer in these cannon assemblies as it may cause misfires or equipment damage.

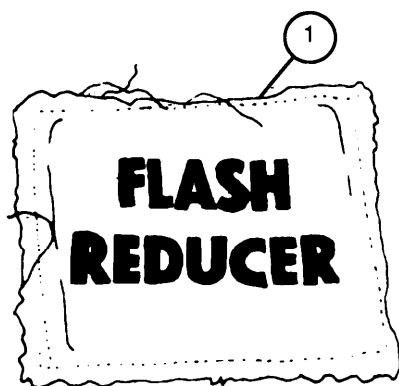
The M82 primer (1), which is loaded separately from the projectile, is inserted into the primer chamber. When the cannon is fired, the firing pin strikes the primer which in turn ignites the propelling charge that moves the projectile forward.



## 5-2 AUTHORIZED MUNITIONS — CONTINUED

### 5-2.5 M2 (T2) Flash Reducer

The M2 flash reducer (1) pads serve to limit breech flashback, as well as muzzle brake flash and blast overpressure. The M2 flash reducer consists of a red cotton cloth bag, 4 inches (10.16 cm) square, containing black powder and potassium sulfate or potassium nitrate. The M2 flash reducer, which is a separate item of issue, may be used with M4A1 propelling charge if additional flash reduction is desired. In preparing an M4A1 white bag propelling charge for firing, one flash reducer is added in front of the base charge and one in front of each increment used.



## Section II. PREPARATION FOR FIRING

### 5-3 GENERAL

**WARNING**

To prevent projectile malfunction and possible bodily injury, ensure that projectile upper temperature limit stays below 125° F (52° C). Shade projectiles when weather is expected to be hot, i.e., the outside temperature is expected to exceed 100° F (38° C) during the day.

#### a. Temperature Limits

Unless otherwise specified, observe the following limits when firing.

- 1 Lower limit is -40° F (-40° C).
- 2 Upper limit is 125° F (52° C).

#### b. Temperature Check Procedures for Modular Artillery Charge System (MACS), M231 and M232

**NOTE**

Temperature will be taken using the standard issue M1A1 powder thermometer. The operating temperature of MACS is -50°F through +120°F.

- 1 Lift the edge of the red seal on either end of the increment and peel the seal back.

**WARNING**

Do not jab the round end igniter bag with thermometer or any other object that may be used to break through the edge of the red seal. Black powder is impact sensitive and forceful impact of the bag may cause an accidental ignition.

**NOTE**

Do not puncture the combustible case since this makes the increment defective.

- 2 Lift the edge of the igniter bag and insert the powder thermometer under the cloth igniter bag and down along the inside of the center core.
- 3 The thermometer must stay in the increment until the temperature stabilizes.

#### c. Packing and Unpacking Ammunition Components

Retain packing materials for repackaging, as required.

**WARNING**

The M82 primer is the only authorized primer to be used in the M109A2/M109A3/M109A4 M185 and M109A5 M284 cannon assemblies. Do not use the MK2A4 primer in these cannon tubes. The propellant may not ignite.

- 1 The M3 series propelling charges are packed two per metal container, with or without the MK2A4 primer. The M4A1, M4A2, M119A1, M119A2, M203, and M203A1 propelling charges are packed one per metal container.
- 2 The M231 is packed with four increments (two per extraction sleeve) in each metal container and the M232 is packed five per metal container. Increments in extraction sleeves that are not full will be combined to reduce the number of partially loaded containers. These increments will be repacked into their correct type of extraction sleeve and the repacked sleeves returned to their correct container (correct type and lot number) using the following procedure:
  - (a) Place one of the end cushions into the end of the extraction sleeve and lock in place using the velcro strap.



### 5-3 GENERAL — CONTINUED

#### c. Packing and Unpacking Ammunition Components — Continued

- (b) Slide the correct amount of charges (two for the M231 and five for the M232) into the open end of the extraction sleeve.
- (c) Slide the separators between the charges, making sure they slide all the way in. The bumps on the M232 must be aligned for the separators to slide all the way in.
- (d) Place second cushion into the open end of the sleeve and lock in place using the second Velcro strap.
- (e) Slide extraction sleeve with charges into the container and close.
- (f) Mark partially loaded containers so that they are not turned in as empty.

3 The M82 primer is packed one per waterproof bag. Primers are ready for firing when unpacked and should be protected from blows that might cause accidental functioning.

4 The M2 (T2) flash reducer is packed 200 per metal container (four containers, 800 flash reducers per wooden box).

5 Fuzes are generally packed in metal boxes. The metal boxes are then packed in wooden boxes.

6 Refer to paragraph 5-15 for Unpacking and Inspection procedures for the M712 copperhead (HEAT) and M823 training (copperhead) projectiles.

#### d. Procedures

Inspect ammunition components and verify item identification.

**WARNING**

Inspect your ammunition. Failure to accomplish required inspections can result in unnecessary ammunition malfunctions, which could cause bodily injury.

**CAUTION**

Do not use axes, crowbars, etc., which may damage ammunition or packaging.

- 1 Unpack and inspect ammunition as outlined in paragraph 5-15.
- 2 Return all defective ammunition to ammunition supply point.

### 5-4 PREPARATION FOR FIRING

Preparation for firing the four components of a complete round of 155MM ammunition requires efficient teamwork among the crew. They must quickly and accurately select, unpack, inspect, and prepare the correct primer, propellant, projectile, and fuze from the fire commands received by the howitzer section. The chief of section must thoroughly cross-train the entire crew so that any crewman can perform any or all of the duties required of other crew members.

#### a. M82 Primer

Do not open this moisture protective bag until ready to use the M82 primer.

#### b. Propelling Charges

Propelling charges come packed in hermetically sealed metal containers. There is one complete propelling charge in each container of the M4 series, M119 series, and M203 series. The M3 series green bag propelling charges are packed with two complete propelling charges in each metal container. Check the following when preparing the propellant for firing.

- 1 Select the right propelling charge announced in the fire command.
- 2 Unpack the propelling charge from the metal container and inspect for torn cloth, loose powder grains, or discoloration of the cloth bags.

## 5-4 PREPARATION FOR FIRING— CONTINUED

### b. Propelling Charges — Continued

- 3 For M203A1 propelling charge only, pull pull-straps until the buttons on the base igniter assembly clear the mouth of the container. Grasp charge around the buttons and pull charge out of the container supporting it along its length to avoid dropping the charge. Do not fire propelling charges that have severely crushed or distorted cases and/or contain missing or broken propellant.
- 4 Remove the igniter cap and inspect the red igniter pad. The pad should not be torn or wet. The igniter powder grains are highly hygroscopic (will absorb moisture) and could stick together, causing misfires. The igniter powder grains should move freely inside the pad to show that they are not stuck together. Unserviceable charges should be set aside for disposal by authorized personnel.
- 5 Check the smell of the powder charge and its container. There should not be a sour, acid smell as this indicates the charge became wet. There should be a sweet ether-like smell, indicating that the charge is fresh.
- 6 Remove any excess powder increments (those increments with a higher number than called for in the fire command), and retighten the tie straps so that all powder increments are secure, with the highest numbered charge (per fire command) on top.
- 7 Place the unused powder increments in a secure container and dispose of them later by burning under the supervision of an officer.

### c. Modular Artillery Charges System (MACS)

The MACS propelling charges are combustible case type charges that are packed in hermetically sealed metal containers. The M231 MACS is packed with four modules (two per extraction sleeve) in each metal container. The M232 MACS is packed with five modules in each metal container. Check for the following when preparing the propellant for firing:

- 1 Select the right charge announced in the fire command.
- 2 Unpack the charges from the metal container by pulling on the velcro strap to remove the sleeve with the MACS enclosed from the container. Remove separator assembly by pulling on the connecting strap. Open the velcro strap and remove end cushions from either end of the sleeves. Push the needed amount of MACS from the opposite end of the sleeve through the now open end of the sleeve. Charges that are severely crushed, distorted, or broken are not to be fired.
- 3 Check the red mylar seals on the end of the charges. If the seal is torn, punctured or missing, inspect the igniter bag. The pad should not be torn or wet. The igniter powder grains are highly hygroscopic (will absorb moisture): the grains will stick together, which could cause misfires. The igniter powder grains should move freely inside the pad to show that they are not stuck together.
- 4 Unused MACS charges are repacked for later use.

### d. Projectiles

Projectiles for these howitzers normally come packed 8 to the pallet, with top and bottom of the wooden pallets banded together. (For preparation of M712 (copperhead) projectile, see section III. of this chapter.) Each projectile has a lifting plug and a grommet attached for protection during shipping and handling activities. See paragraph 5-13 for the Loose Projectile Restraint System (LPRS), which is an optional system for securing loose unfuzed projectiles for transportation.

#### NOTE

These procedures apply to all projectiles, except for the M483A1 and M864 projectiles when used in the self-registration mode.

- 1 Preparation of projectiles. Cannoneer selects the right projectile announced in the fire commands and prepares it for firing as follows.
  - (a) Inspects and cleans projectile.

## 5-4 PREPARATION FOR FIRING — CONTINUED

### d. Projectiles — Continued

- (1) Verifies that the projectile is the type designated by the fire commands.

#### NOTE

A projectile with a burred rotating band will be put aside until the burrs can be removed with a file.

- (2) Removes grommet and examines rotating band to ensure that it is free from all dirt and burrs.
- (3) Cannoneer removes lifting plug and gasket and examines the fuze well for leaks or damage to the filler. If any high-explosive filler residue clings to the threads of the fuze well, the round is rejected and another one is used to complete the fire mission.

#### WARNING

Dirt or grease left on the projectile rotating band could cause failure of the projectile to seat properly in the forcing cone. Firing of an unseated projectile could result in inbore explosion causing injury or death to personnel.

#### NOTE

Any sand, dirt, oil, or grease left on the projectile will cause wear, scratches, or gouges in the bore.

- (4) Cannoneer examines the entire projectile for defects and checks to see that the projectile is not damaged or corroded and is free of dirt, grease, sand, and oil. Slight rust on the projectile is acceptable.
- (b) Cannoneer holds the projectile upright for fuzing and fuze setting.
- (1) If required, cannoneer holds the projectile firmly while another cannoneer fuzes the projectile and sets the fuze.
  - (2) When directed, cannoneer reads and announces the time set on the fuze.

#### WARNING

Care must be exercised in placing the ammunition in the hull to prevent damage to the rotating band or fuze and bodily harm to the ammunition handler.

- (c) Cannoneer carries fuzed projectile to the howitzer and places it where it will be convenient for loading.

### e. Special Preparation of the M483A1 and M864 Projectiles for Use in the Self-Registration Mode

When the command for use of the M483A1 or M864 ICM projectile includes the self-registration mode, the expulsion charge inside the nose of the projectile must be removed and a projectile spotting charge threaded on the fuze as follows.

- 1 Remove the fusible or universal lifting plug (1) with attached gasket. When lifting plug is removed, the compressed coiled pull-wire (2) on the bagged expulsion charge assembly (3) will expand and protrude beyond the fuze well of the projectile ogive. If the projectile is assembled with the cylindrical plastic expulsion charge assembly (4), the tab (5) will pop up.

## 5-4 PREPARATION FOR FIRING — CONTINUED

### e. Special Preparation of the M483A1 and M864 Projectiles for Use in the Self-Registration Mode — Continued

- 2 Remove the expulsion charge assembly (3 or 4) by grasping and firmly pulling the pull-wire (2) or tab (5). Set expulsion charge assembly aside for disposition. Visually inspect the fuze well (6) for loose grains of propellant or other foreign material. Remove any loose material.

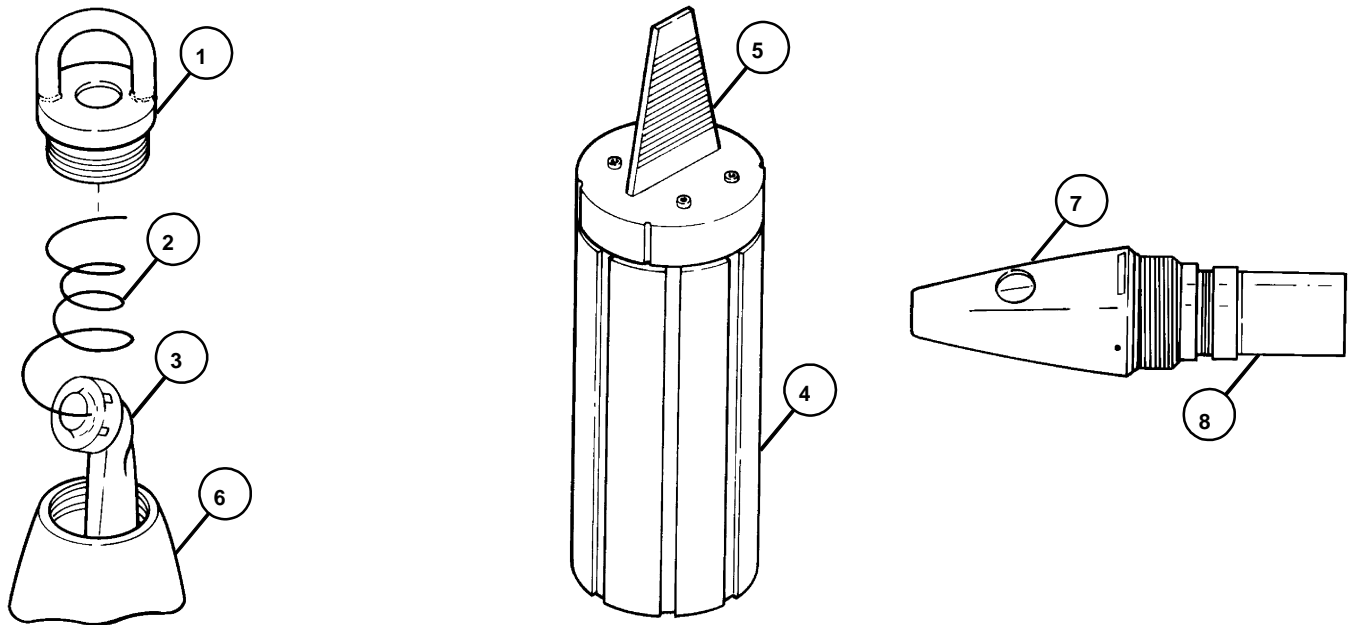
**WARNING**

When screwing the projectile spotting charge onto rear of the M577 series fuze or M762 series fuze, ensure that shoulder of projectile spotting charge is seated squarely against shoulder of fuze. An improperly seated charge could cause a malfunction.

**CAUTION**

When assembling projectile spotting charge to fuze, exercise care to avoid damaging threads. If binding occurs, consider charge unserviceable and report it for disposition. If binding has occurred, reinspect fuze to assure it is still serviceable.

- 3 Obtain an M577 series fuze or an M762 series fuze (7) and a projectile spotting charge (8).
- 4 If firing the M483A1 or M864 projectile in the self-registration mode, screw the projectile spotting charge (8) handtight on the M577 series fuze or the M762 fuze (7) (left-hand thread).



## 5-5 FUZES

### a. General

There are four basic types of fuzes: impact, mechanical time, electronic time, and proximity variable time (VT) fuzes. On command, "FUZE," cannoneer no. 2 must select the right fuze, unpack, inspect, install it in the projectile, and set it as commanded (TIME, SUPERQUICK, DELAY).

### b. Removal of Lifting Plug

**WARNING**

- Do not use the M549/M549A1 projectile if the lifting plug has been broken to prevent injury to personnel. Do not attempt to extract any portion of the lifting plug from the fuze well of the projectile. Return projectile to the ammunition supply point.
  - Do not use a projectile with explosive on the threads or evidence of explosive powder seepage. It could cause detonation of the projectile, if fired, resulting in possible bodily injury.
- 1 Remove lifting plug (1) and inspect the spacer (2) beneath the lifting plug.
  - 2 Inspect cavity and projectile threads for damage. Remove loose material from cavity. If any high explosive is found stuck to the threaded portion of the projectile throat, do not fire.

### c. Supplementary Charge

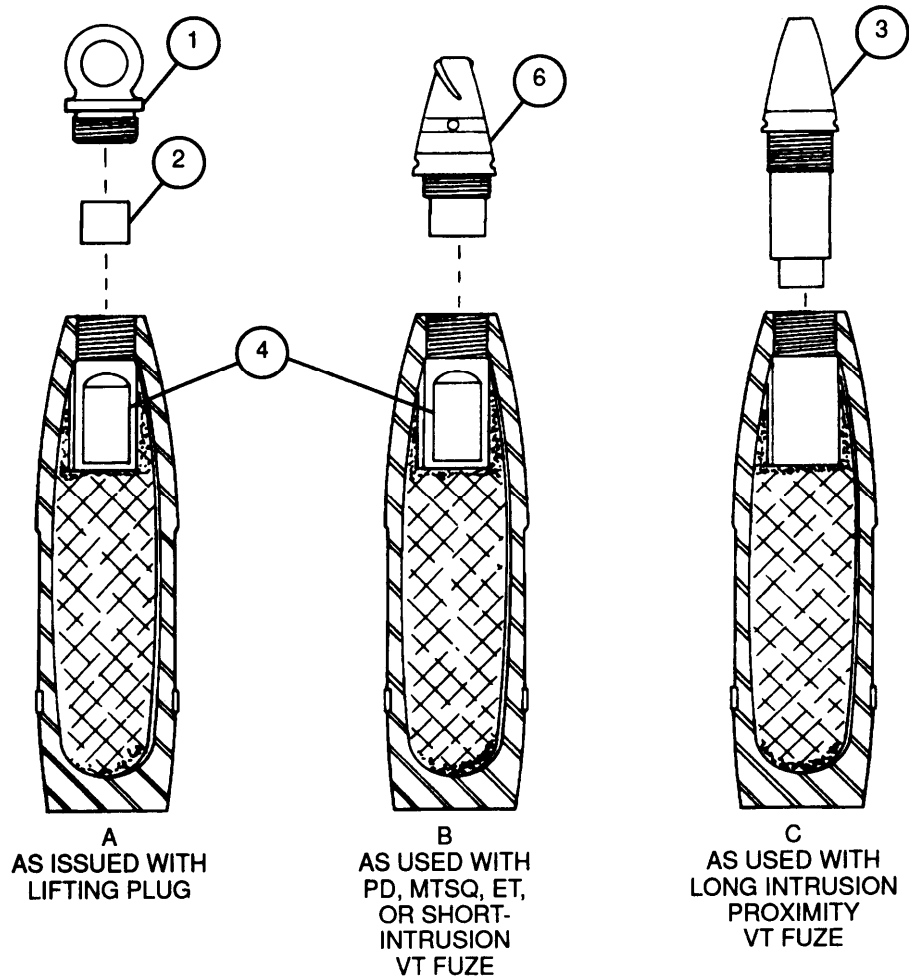
**WARNING**

- Do not fire point–detonating (PD), mechanical time and superquick (MTSQ), electronic time (ET), or the short–intrusion variable time (VT) fuzes in a deep–cavity projectile without the supplementary charge as an inbore premature may result.
- Do not attempt to remove supplementary charge by any means other than the lifting loop. Use of screwdrivers or other tools to remove the charge by force is dangerous.

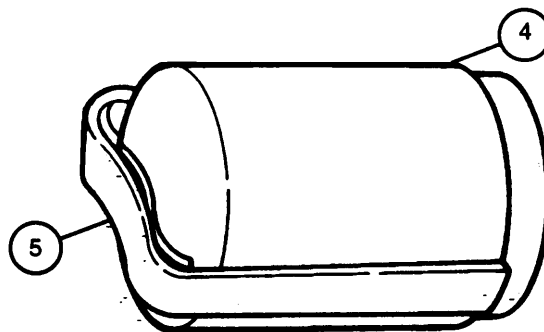
For the long–intrusion proximity fuze (3) firings, remove supplementary charge (4) by means of its lifting loop (5). If the supplementary charge cannot be removed by its lifting loop, either fire with a short–intrusion VT, PD, ET, or MTSQ fuze (6) or dispose of the round.

5-6 FUZES — CONTINUED

c. Supplementary Charge — Continued



TYPICAL DEEP-CAVITY PROJECTILES



## 5-5 FUZES — CONTINUED

### d. Fuze Assembly

The following procedures apply to all fuzes. See step 2 for special instructions for the M577 series fuze.

- 1 Assembly of fuze to projectile.

**WARNING**

Rounds fired without a fuze or with improperly seated fuzes may result in premature functioning,

- (a) Screw fuze (6) in by hand. If binding occurs, inspect fuze cavity and threads of both fuze and projectile. Reject whichever is at fault.

**WARNING**

When tightening fuze to projectile, do not hammer on fuze-setter wrench or use extension handle on fuze-setter wrench. Do not stake fuze to projectile under any circumstances. Shocks transmitted to fuzes during assembly may cause a malfunction resulting in injury to personnel.

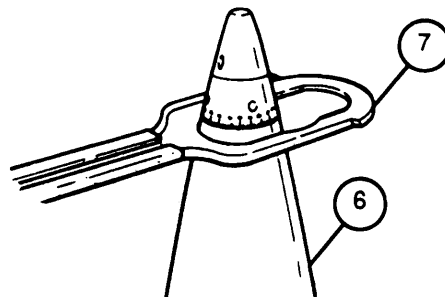
**CAUTION**

Always be sure that the supplementary charge is in the deep cavity projectile before adding fuze-booster combination or projectile will not detonate properly.

**NOTE**

For long intrusion proximity fuzes with a gap between the fuze shoulder and projectile, either replace the supplementary charge and fire with impact PD, MTSQ, ET, or short-intrusion VT fuze, or dispose of round.

- (b) After assembling fuze (6) by hand, back fuze off 1/4 turn. Another cannoneer holds projectile to ensure cannoneer no. 2 can firmly seat fuze. Using M1 8 fuze-setter wrench (7), tighten fuze to projectile with a sharp snap of the M18 fuze-setter wrench so that the fuze shoulder is seated firmly against the projectile nose.



## 5-5 FUZES — CONTINUED

### d. Fuze Assembly — Continued

**WARNING**

When screwing the projectile spotting charge onto the rear of the M577 series fuze, ensure that the shoulder of the projectile spotting charge is seated squarely against the shoulder of the fuze. An improperly seated charge could cause a malfunction causing possible bodily injury.

**CAUTION**

When assembling the projectile spotting charge to a fuze, be careful not to damage threads. If binding occurs, consider the charge unserviceable and report it for disposition. If binding has occurred, reinspect the fuze to ensure it is still serviceable.

- 2 Special preparation for the M577 series fuze includes inspecting the fuze setting. The fuze will be considered unserviceable if the fuze setting is not between • 93.5 and • 95.5, the fuze shows signs of damage, or the window is blackened or sooty inside.

## 5-6 FUZE SETTING

The following procedures apply to all authorized fuzes. Fuze-setting tools and procedures are listed in Table 5-2.

<b>Table 5-3. Fuze, Fuze-Setting Tools, and Procedures</b>											
Fuze										SETTER	PROCEDURE # / PARAGRAPH
PD				MT	MTSQ			PROX	ET		
MOFA	MK399	M557 M572	M739 SERIES	M565	M564	M501 SERIES	M577 SERIES/ M582 SERIES	M732 SERIES M728 M514 SERIES	M762 SERIES M767 SERIES		
	X	X	X							Fuze- setter, wrench, M18	1/0-4a.
						X				M27	2/0-4b.
								X		M27	3/0-4c.
				X	X					M34	4/0-4d.
							X			M35	5/0-4e.
X									X	None	6/0-4f.



## 5-6 FUZE SETTING — CONTINUED

### a. Procedure Number 1, MK399, M557, M572, or M739 Series Fuzes

#### NOTE

Point–detonating (PD) fuzes, with superquick (SQ) or delay functioning are shipped for SQ action. The MK399 fuze is shipped set on the DLY (DELAY) mark.

- 1 If superquick action is desired, check the setting to make sure it is set at SQ.
- 2 To set fuzes for delay action, use screwdriver end of the M18 fuze–setter wrench (1) or similar tool and turn slot (2) 1/4 turn to align with index mark indicating DELAY (or DLY on MK399 fuze).

### b. Procedure Number 2, M501 Series Fuze

#### WARNING

Exercise extreme care when handling an M501 series fuzed projectile to prevent injury to personnel. Manhandling or dropping could cause the M501 series fuze to function, expelling the base plate, and contents. When handling a projectile assembled with the M501 series fuze, exercise extreme care to protect the M501 series fuze from impact. Keep pull wire on M501 series fuze in place until immediately prior to firing.

#### CAUTION

To avoid malfunction, do not use M501 series fuzes with cocked or loose lower caps. Mark such M501 series fuzes “defective” and return to ammunition supply point.

#### NOTE

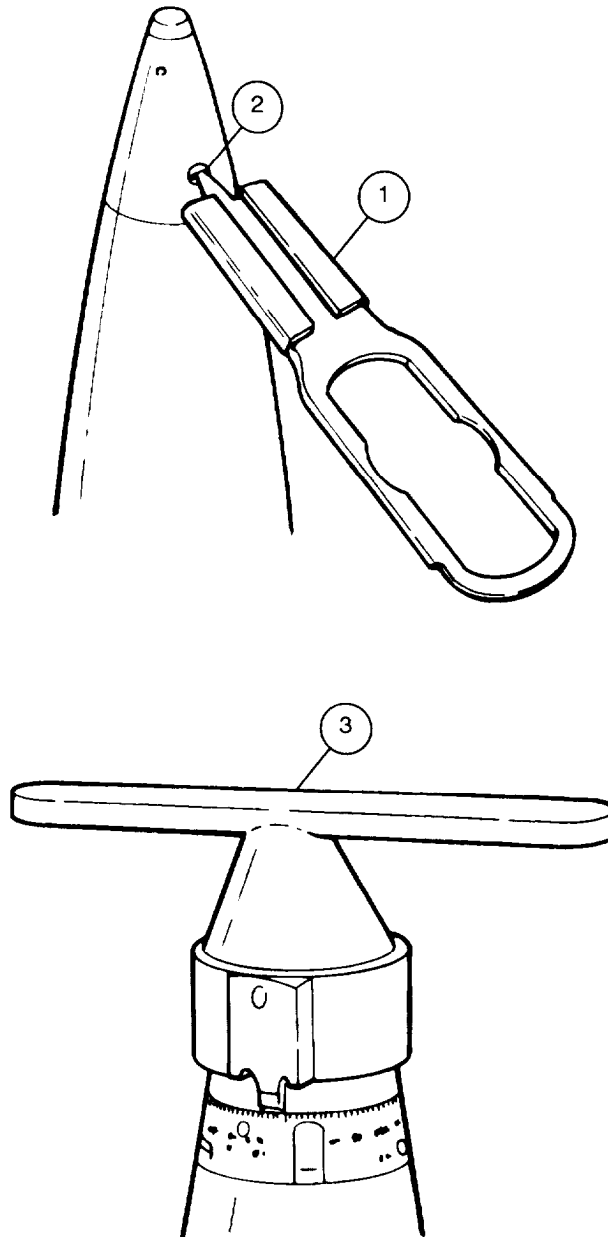
The M501 series fuzes are shipped with the index mark on the lower cap aligned with the S engraved on the base.

- 1 Time setting.
  - (a) Check fuzes for cocked or loose lower caps.
  - (b) To remove safety wire before setting, pull end of safety wire from hole in lower cap, sliding safety wire off end of M501 series fuze.
  - (c) With M27 fuze setter (3), set M501 series fuze by rotating lower cap to desired time in counterclockwise direction or in the direction of the arrow marked on lower cap. The M501 series fuze is properly set when the index mark on the lower cap is aligned with desired time, in seconds, engraved on the base.
  - (d) If the round is not fired after the M501 series fuze is set, reset the M501 series fuze to safe (S) position and place the safety wire in its proper position.

## 5-6 FUZE SETTING -CONTINUED

### b. Procedure Number 2, M501 Series Fuze - Continued

- 2 Impact setting. Impact functioning of the M501 series MTSQ fuze may be obtained by leaving the S (shipping mark) alined with the index mark on the base. The safety wire must be removed (pull free end of safety wire off and out of hole) before firing or setting the M501 series fuze.



## 5-6 FUZE SETTING - CONTINUED

### ■ c. Procedure Number 3, M732 Series, M728, and M514 Series Proximity VT Fuzes

#### CAUTION

■ For M732 series, M728, and M514 series fuzes, plastic nose cones rotate with index mark. Damage to the plastic cone will produce duds. However, since there is no backlash, fuze setting can be accomplished or changed one or more full turns without harmful effect. If counterclockwise rotation is used, be sure that the fuze has not come loose from the projectile.

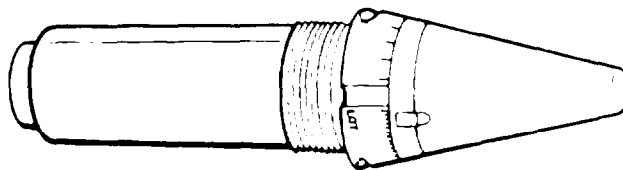
#### NOTE

- M728 and M514 series fuzes are shipped with the index mark on the nose cone set at 10 seconds. The M732 series fuzes are shipped set on the PD mark.
- Do not attempt to set the fuze until just before firing.

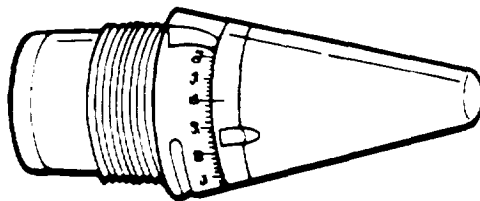
- 1 These fuzes are set when index line at base of nose cone is aligned with time, in seconds, engraved on base of fuze.

#### NOTE

Rotation of the M732 series fuze nose cone has been experienced at top zones (not a safety hazard). If this occurs when M732 series fuze is set on time for proximity function, PD function might occur instead. In such instances, set the M732 series fuze to a time of 10 seconds less than the time of flight for proximity function. If this occurs when the M732 series fuze is set on PD mark, proximity functioning may occur instead of impact functioning. In such instances, set the M732 series fuze to a time equal to time of flight plus 10 seconds for impact function.



M728 OR M514 SERIES FUZE



M732 SERIES FUZE

## 5-6 FUZE SETTING - CONTINUED

### c. Procedure Number 3, M732 Series, M728, and M514 Series Proximity VT Fuzes - Continued

- 2 To set the M732 series, M728, and M514 series fuzes for proximity action, rotate nose cone with the M27 fuze setter, normally in a clockwise direction while looking down on the nose of the fuze, until the index mark coincides with the announced time. The fuze setting can be changed one or more times with no harmful effects.
- 3 For impact functioning set the M728 and M514 series fuze to 90 seconds and M732 series fuze on PD mark using the M27 fuze setter.
- 4 The M732A2 fuze is set manually by aligning the index mark on the movable aluminum setting ring (4) to the desired setting as marked on the fuze sleeve.
- 5 To set the M732A2 fuze for proximity function, simultaneously depress the two locking pushbuttons on the setting ring and rotate the setting ring to align the index mark on the desired time setting. After pushbuttons are released, the setting will be locked in place. This procedure may be repeated as necessary.
- 6 For impact functioning of the M732A2 fuze, align the index mark with the PD mark on the fuze sleeve.

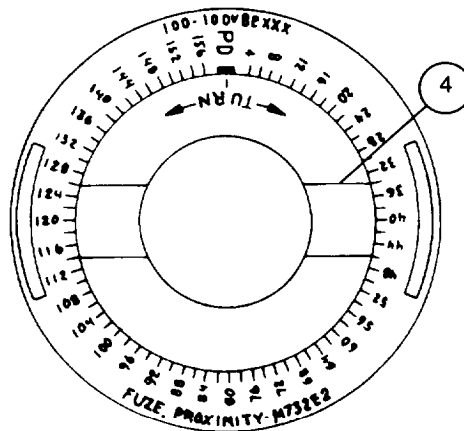
**WARNING**

Do not fire projectile unless fuze is fully seated. Inbore explosion may result, leading to injury or death of personnel.

**NOTE**

Firing the M728 series fuze above charge 7 may result in excessive impact (PD) duds.

- 7 Firing temperature limits for M728 and M732 series proximity fuzes are -40 to 140°F (-40 to 60°C).



## 5-6 FUZE SETTING - CONTINUED

### d. Procedure Number 4, M564 and M565 Fuzes

The following procedures include instructions for setting the fuze for superquick (impact) action and airburst (time) and for meeting safety requirements. If the M564 fuze is to be fired for superquick action (impact) only, first check the year of manufacture stamped on the fuze body, then follow instructions below, as appropriate.

**WARNING**

To avoid accidental functioning of PD element in M564 fuze, do not drop, roll, or strike the M564 fuze under any circumstances (packaged, unpackaged, or assembled to the projectile).

#### NOTE

Do not attempt to set M564 fuzes until just before firing.

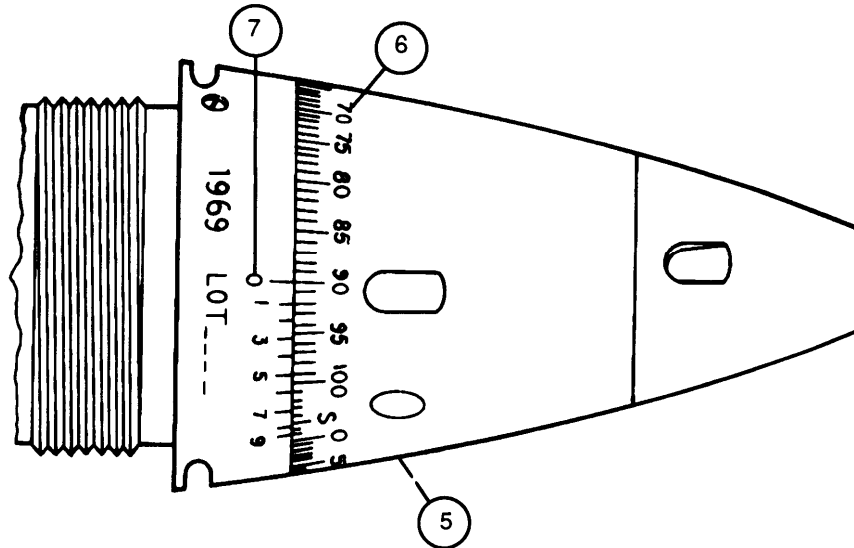
- 1 Setting M564 fuze for superquick (impact) action.

#### NOTE

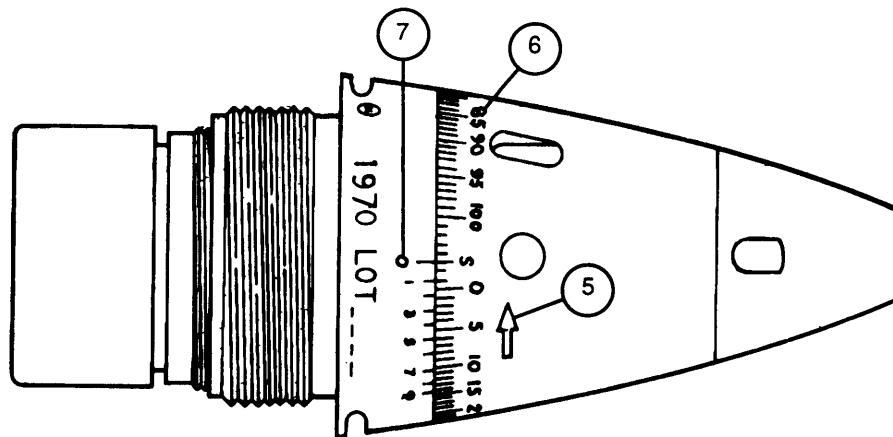
- M564 fuzes manufactured before January 1970 must be set on 90.0 seconds if superquick action (impact) is desired. M564 fuzes manufactured from January 1970 on, should be left set on "S" for superquick action. The year of manufacture is stamped on the M564 fuze body. These fuzes are shipped with the "S" on the lower cap scale alined with the "0" on the vernier scale.
  - The numbers on the vernier scale represent tenths of a second and the numbers on the lower cap scale represent whole seconds. When setting the fuze, always rotate the lower cap scale.
- (a) For M564 fuzes manufactured prior to January 1970, use M34 fuze setter to rotate the lower cap in the direction of the arrow (5) (clockwise) from shipping "S" position until the 90-second position on the lower cap scale (6) is alined with the "0" on the vernier scale (7).
  - (b) For M564 fuzes manufactured in January 1970 and later, set the M564 fuze on "S" as shipped for superquick action. Always be sure the "S" on the lower cap scale (6) is alined with the "0" on the vernier scale (7).

5-6 FUZE SETTING — CONTINUED

d. Procedure Number 4, M564 and M565 Fuzes — Continued



MANUFACTURED PRIOR TO JANUARY 1970



MANUFACTURED IN JANUARY 1970 AND LATER

## 5-6 FUZE SETTING — CONTINUED

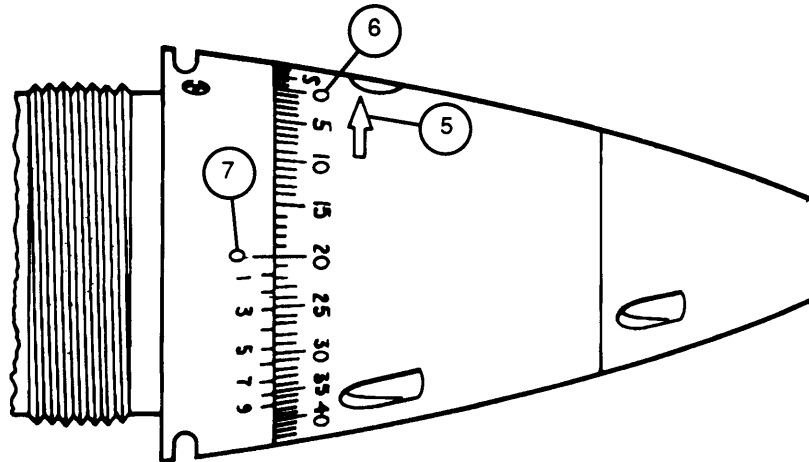
### d. Procedure Number 4, M564 and M565 Fuzes — Continued

2 Setting M564 and M565 fuzes for airburst (time).

**WARNING**

Incorrect settings of MT and MTSQ fuzes can and have resulted in downrange premature malfunctions. The safety of personnel located downrange of a weapon firing MT and MTSQ fuzes (between the weapon and intended target) is in the hands of the gun crew personnel assigned the job of setting the fuzes.

- (a) To set the M564 and M565 fuzes for a whole-second time setting use the M34 fuze setter to rotate the lower cap in the direction of the arrow (5) (clockwise), until the desired whole number of seconds (e.g., 20.0 seconds) on the lower cap scale (6) is aligned with the "0" mark engraved on the vernier scale (7).



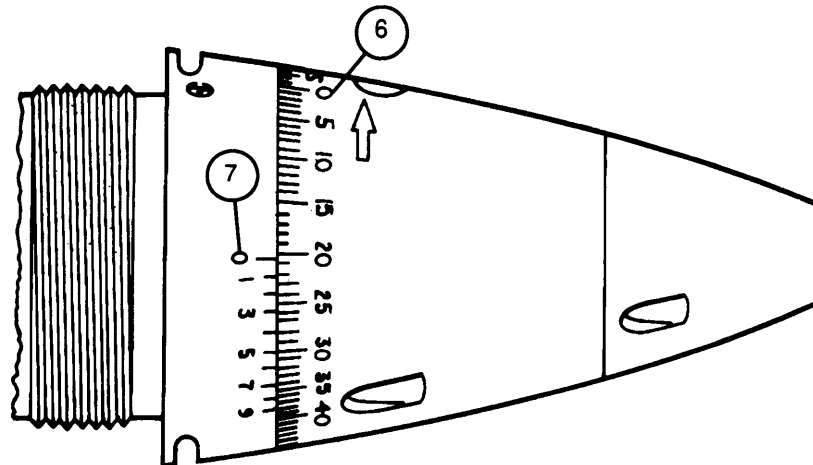
## 5-6 FUZE SETTING — CONTINUED

### d. Procedure Number 4, M564 and M565 Fuzes — Continued

#### NOTE

The whole-second fuze setting is always indicated by the position of the "0" on the vernier scale. Each vertical mark on the lower cap scale (moveable portion of the fuze) represents one whole second of time. For other than whole-second settings, the "0" on the vernier scale (non-moveable portion of the fuze) must always be to the right of the whole-second portion of the desired fuze setting and between the whole-second portion of the desired fuze setting and the next one whole-second vertical mark. For example, for a setting of 20.5 seconds, the "0" on the vernier scale is to the right of the 20-second mark and midway between the 20 and 21-second marks on the lower cap scale.

- (b) To set the M564 and M565 fuzes for a tenth of a whole second (e.g., 20.5 seconds), use the M34 fuze setter to set the fuze for the whole seconds on the lower cap scale (6) (in this case the whole is 20 seconds). Next find the desired tenth of a second mark on the vernier scale (7). Continue to slightly rotate the lower cap in the direction of the arrow until the adjacent upper right graduation on the lower cap scale is aligned with the desired tenth of a second mark on the vernier scale. (The 0.5-second mark is now aligned with the 30-second mark on the lower cap scale.)





## 5-6 FUZE SETTING — CONTINUED

### d. Procedure Number 4, M564 and M565 Fuzes — Continued

#### NOTE

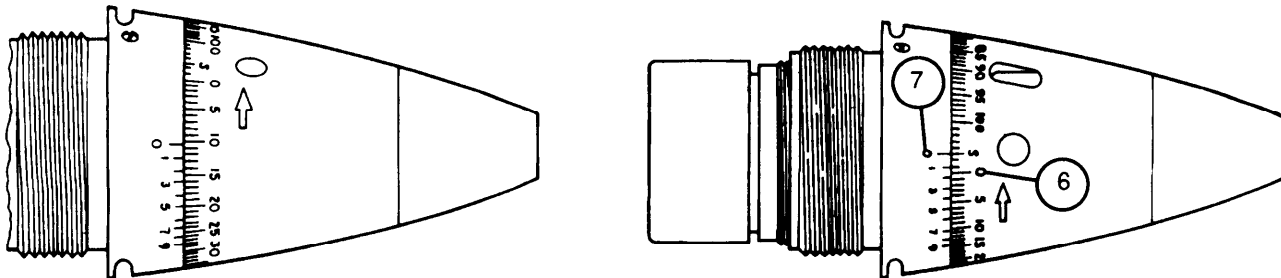
- Alining the 20-second mark on lower cap scale with the 0.5-second mark on the vernier scale is an incorrect setting for a 20.5-second fuze setting. Set in this manner, the fuze is actually set to function at 10.5 seconds, causing the fuze to function earlier than desired.

- Do not attempt to set the fuze until just before firing.

3 Resetting fuze. If the setting is missed, use the M34 fuze setter and turn the lower cap in the opposite direction (counterclockwise) 2 or 3 seconds below the desired setting. Then rotate the lower cap in the direction of the arrow (clockwise) and set the fuze on the correct time. Always make the final setting from low to high numbers.

4 Fuzes not fired. If prepared for firing but not fired, reset the fuze, using M34 fuze setter, by turning the lower cap in the direction of the arrow (clockwise) until the "S" mark on the fuze lower cap scale (6) is in line with the "0" mark on the vernier scale (7).

5 Fuzes fired in heavy precipitation. If M564 fuzes are fired in heavy precipitation (rain, sleet, snow, or hail), occasional downrange premature functioning may occur. The precipitation necessary to cause malfunctioning is comparable to a heavy downpour which occurs during a summer thundershower. The premature rate will vary with the charge fired and the density of the precipitation.



EXAMPLE OF INCORRECT SETTING  
OF 20.5 SECONDS

**5-6 FUZE SETTING — CONTINUED**

**e. Procedure Number 5, M577 and M582 Series Fuzes**

The slotted setting key on the nose of the fuze is used for setting the fuze in the following steps.

- 1 Press the open end of M35 fuze setter (8) against the setting key.
- 2 Turn the knob handle of the M35 fuze setter (8) counterclockwise, as viewed from the nose end, until the M35 fuze setter blade engages fuze-setting key slot. The hairline in the window is used for all settings.

**NOTE**

The M577 or M582 series fuze is set to desired time by rotating the M35 fuze setter in a counterclockwise direction. To return to shipping and storage setting, the M35 fuze setter must be rotated in a clockwise direction.

**NOTE**

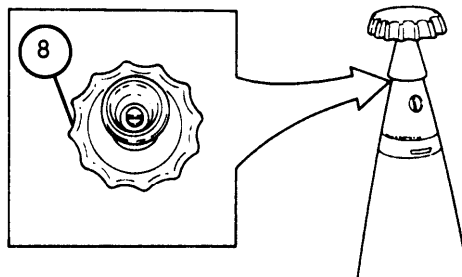
Direction of setting or resetting M577 series or M582 series fuze is as follows.

<u>COUNTERCLOCKWISE</u>	<u>CLOCKWISE</u>
SHIPPING AND STORAGE	
SETTING (◀ 93.5 TO ▶ 95.5) .....	1/4 TURN
PD SETTING (▶ 98.0) .....	1/4 TURN
001 SECONDS .....	1/4 TURN
200 SECONDS .....	20 TURNS

**CAUTION**

Do not attempt to set M577 or M582 series fuzes below ▶ 93.5 when setting them in the clockwise direction or above 200 seconds when setting them in the counterclockwise direction. The settings of 000 and/or 200 are not authorized service settings.

- 3 When setting the M577 or M582 series fuze for PD action (superquick), start with shipping and storage setting (safe) (▶ 93.5 to ▶ 95.5), then turn counterclockwise to ▶ 98.0 under the hairline window for PD action.



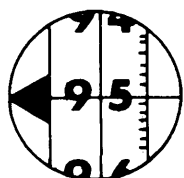
## 5-6 FUZE SETTING — CONTINUED

### e. Procedure Number 5, M577 and M582 Series Fuzes — Continued

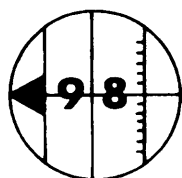
- 4 To set the M577 or M582 series fuze for mechanical time action, turn the M35 fuze setter (8) counterclockwise from safe setting (◀ 93.5 to ▶ 95.5) past PD (▶ 98.0), until the triangle (▶) moves off the hairline. This action occurs near a 000 setting. Continue to turn M35 fuze setter counterclockwise until desired time appears under the hairline. Maintain a very light turning force against the M35 fuze setter while reading the setting. The A-F sequence is illustrated for settings of 8.7, 25.5, and 107.4.
- 5 To set a lower time on M577 or M582 series fuze already set, reseal M35 fuze setter (8) and turn clockwise (numbers get smaller) to a setting at least one second lower than the required setting (for example, at least 24.5 for 25.5). Reverse direction to counterclockwise (numbers get larger) and set required time under the hairline.
- 6 To return M577 or M582 series fuze to the shipping and storage (safe) setting, turn the M35 fuze setter (8) clockwise (numbers get smaller) until 000 is passed, and continue to turn until M35 fuze setter stops turning freely. This point should be past the PD setting (▶ 98.0) and between ▶ 95.5 and ▶ 93.5. Notice that the triangle has reappeared in the window. Do not apply excessive force on the M35 fuze

M582 series fuze to the reusable fuze container. The M577 or M582 series fuze is considered unserviceable after being out of the container for more than 30 days.

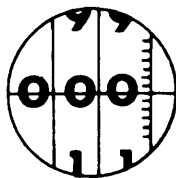
- 7 For special preparation of M577 series fuze, inspect the M577 fuze setting. The M577 series fuze will be considered unserviceable if the setting is not between ▶ 93.5 and ▶ 95.5, it shows signs of damage, or the window is blackened or sooty inside.
- 8 Firing temperature limits for M577 series and M582 series MTSQ fuzes are -35 to 145° F (-37 to 63° C).



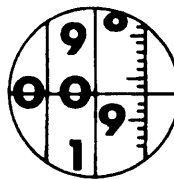
A STORE (SAFE)



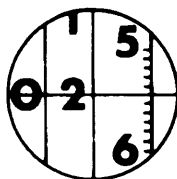
B PD



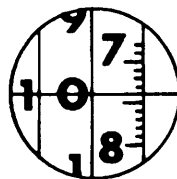
C 000.0



D 8.7

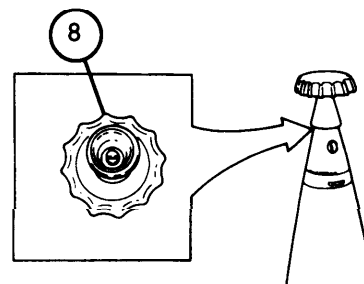


E 25.5



F 107.4

FUZE SETTING SEQUENCE FOR M577 OR M582 SERIES FUZE



## 5-6 FUZE SETTING — CONTINUED

### f. Procedure Number 6, M762 and M767 Series Fuzes

The M762 or M767 series fuzes can be set either by hand or remotely by a weapon equipped with auto-set fire control system, as follows.

#### CAUTION

Do not activate M762 or M767 series fuzes unless they will be fired before 15 days elapse. Once activated, M762 or M767 series fuzes have a service life of approximately 15 days, before the battery runs down. Check if LCD is active to determine if M762 or M767 series fuze is still settleable.

#### 1 Setting by hand.

#### CAUTION

If, after steps (a) and (b) are completed, the LCD display is blank or shows other displays than indicated, the M762 or M767 series fuze is considered unserviceable and should not be fired.

#### NOTE

The M762 or M767 series fuze ogive will rotate only clockwise (as viewed from nose end). If a desired digit was passed, continue rotating clockwise until the desired digit appears again. The M762A1/M767A1 fuze ogive can be rotated bi-directionally to provide quicker manual setting.

- (a) Rotate ogive clockwise at least one quarter revolution to activate the battery. The liquid crystal display (LCD) window will display • 88.8 indicating that all segments are operating as a visual safety check.
- (b) Depress the thumb operated cocking and selector button to clear the LCD display. The LCD window will display - - - -, ensuring that no segments are stuck.
- (c) Depress the thumb operated cocking and selector button a second time; the LCD window will display 000.0. The cursor under the zero in the hundreds of seconds column indicates that this column is ready to be set.

#### NOTE

The hundreds of seconds column can display 0, 1 or • while the tens of seconds, seconds, and tenths of seconds columns each can display 0 through 9.

- (d) Each column is set independently. Depress and release the thumb operated cock and selector button as required to move the cursor to the desired column. At the desired column, keep the thumb operated cock and selector button depressed and rotate the ogive to select the desired digit or •. Release the thumb operated cock and selector button and depress again to move cursor to the next column to continue setting.
- (e) For PD, set the M762 or M767 fuze to • 98.0. Any other setting with • would result in a dud.
- (f) For the M762A1 or M767A1 fuzes, place the cursor in the hundreds digit and rotated the ogive until the    (underline) is selected. At this point the fuze will be set to point detonating setting and the display will be “\_ Pd”.

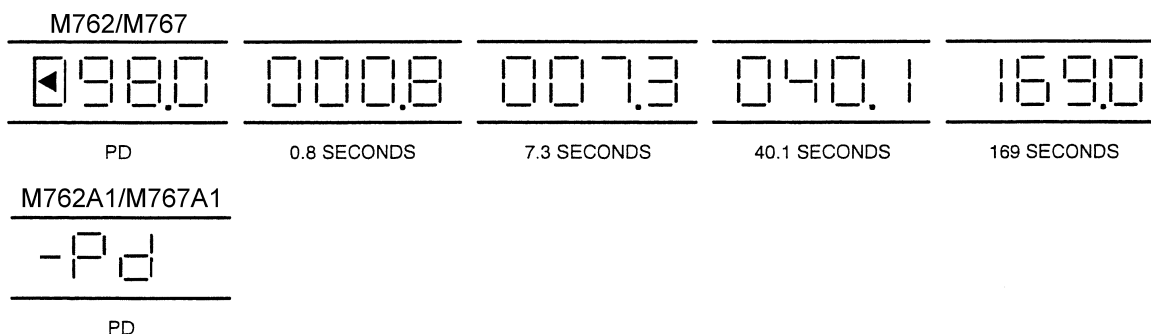
## 5-6 FUZE SETTING — CONTINUED

### f. Procedure Number 6, M762 and M767 Series Fuzes — Continued

- (g) Examples of fuze settings are shown below.
- (h) When fuze setting is completed and thumb operated cock and selector button is released, the ogive can be rotated without changing the fuze setting.
- (i) The settings can be changed as many times as required for the duration of the activated life of the battery.

2 Auto-setting is accomplished via an inductive data link between the M762 or M767 fuze and a weapon equipped with an auto-set fire control system. The desired fuze setting is inputted in the setter console and the transmit button is depressed. The M762 or M767 series fuzes will be remotely activated and set, and the console will display the actual fuze setting as a safety feature.

- 3 To return the M762 or M767 series fuzes to the shipping and storage configuration, reset the M762 or M767 fuze to • 88.8. These fuzes should be segregated and used first in subsequent firings.
- 4 Firing temperature limits for M762 and M767 series ET fuzes are -25 to 110° F (-32 to 43° C).



### g. Procedure Number 7, M782 Fuze

This fuze can only be set inductively by a weapon equipped with auto-set fire control system or the Portable Inductive Artillery Fuze Setter (PIAFS) M1155 (TM 9-1290-210-12&P).

- 1 Setting for point detonating (PD) mode using PIAFS M1155

#### NOTE

When the setter is first initialized it displays the Fuze Menu, afterwards it remembers where it was last and displays the Fuze Setting Menu and the last fuze set.

- (a) Press the ENTER button to turn on the setter

#### Fuze Setting Menu

```

→FUZE:  M782
MODE:   TIME
TIME:   187 sec
SET FUZE
    
```

- (b) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor (arrow ( → ) to the left of the items in the menu) to indicate FUZE, then press the ENTER button.

#### Fuze Menu

```

→M762  DM-52
M767   DM-74
M782   *MORE*
C32    *QUIT*
    
```

**g. Procedure Number 7, M782 Fuze — Continued**

- (c) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor ( → ) indicate M782, then press the ENTER button. The fuze setting menu appears with the cursor pointing to the MODE line.

**Fuze Setting Menu**

```

FUZE:  M782
→MODE:  TIME
TIME:   187 sec
SET FUZE

```

- (d) Press the ENTER button. The MODE menu for the M782 appears.

**Mode Menu**

```

→TIME
VT
DELAY
PD

```

- (e) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor ( → ) to indicate PD, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the SET FUZE line.

**Fuze Setting Menu**

```

FUZE:  M782
MODE:  PD
→SET FUZE

```

- (f) Place setter on the fuze and press the ENTER button. The setter will attempt to set the fuze. After the "WAIT" message is briefly displayed either the "FUZE SET OK" message will be displayed which means that the fuze has been set, or the "FAILED" message will be displayed. If "FAILED" appears, try setting another fuze. If both fuzes do not accept the setting, replace the fuze setter and try setting the fuzes.

**2 Setting for delay (DLY) mode using PIAFS M1155****NOTE**

When the setter is first initialized it displays the Fuze Menu, afterwards it remembers where it was last and displays the Fuze Setting Menu and the last fuze set.

- (a) Press the ENTER button to turn on the setter

**Fuze Setting Menu**

```

→FUZE:  M782
MODE:  TIME
TIME:   187 sec
SET FUZE

```

- (b) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor ( → ) to the left of the items in the menu) to indicate FUZE, then press the ENTER button.

**Fuze Menu**

```

→M762  DM-52
M767  DM-74
M782  *MORE*
C32   *QUIT*

```

- (c) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor ( → ) indicate M782, then press the ENTER button. The fuze setting menu appears with the cursor pointing to the MODE line.

**Fuze Setting Menu**

```

FUZE:  M762
→MODE:  TIME
TIME:   187 sec
SET FUZE

```

**g. Procedure Number 7, M782 Fuze — Continued**

- (d) Press the ENTER button. The MODE menu for the M782 appears.

**Mode Menu**

→TIME  
VT  
DELAY  
PD

- (e) Press the right ( ↑ ) or left ( ↓ ) buttons to move the cursor ( → ) to indicate DELAY, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the SET FUZE line.

**Fuze Setting Menu**

FUZE: M782  
MODE: DELAY  
→SET FUZE

3 Setting for variable time (VT) mode using PIAFS M1155

**NOTE**

When the setter is first initialized it displays the Fuze Menu, afterwards it remembers where it was last and displays the Fuze Setting Menu and the last fuze set.

- (a) Press the ENTER button to turn on the setter

**Fuze Setting Menu**

→FUZE: M782  
MODE: TIME  
TIME: 187 sec  
SET FUZE

- (b) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate FUZE, then press the ENTER button. The Fuze Menu appears.

**Fuze Menu**

→M762 DM-52  
M767 DM-74  
M782 \*MORE\*  
C32 \*QUIT\*

- (c) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate M782, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the MODE line.

**Fuze Setting Menu**

→FUZE: M782  
MODE: TIME  
TIME: 187 sec  
SET FUZE

- (d) Press the ENTER button. The Mode Menu for the M782 appears.

**Mode Menu**

→TIME  
VT  
DELAY  
PD

- (e) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate PRX, then press the ENTER button. The Time Menu appears with a line ( \_ ) cursor under the hundreds place.

**Time Menu**

100.0 sec

**g. Procedure Number 7, M782 Fuze — Continued**

- (a) Press the right ( ↑ ) or left ( ↓ ) button to toggle between 0 and 1 for the hundreds digit, then press the ENTER button. The cursor ( \_ ) will move to the tens place.

**Time Menu**

000.0 sec

- (b) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the ones digit, then press the ENTER button. The cursor ( \_ ) will move to the ones place.

**Time Menu**

030.0 sec

- (c) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the ones digit, then press the ENTER button. The cursor ( \_ ) will move to the tenths place.

**Time Menu**

035.0 sec

- (d) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the tenths digit, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the TIME line (showing the set time).

**Fuze Setting Menu**

FUZE: M782

MODE: TIME

→TIME: 35.2 sec

SET FUZE

- (e) Press the left ( ↓ ) button to move the cursor ( → ) to indicate SET FUZE. Place setter on the fuze and press the ENTER button. The setter will attempt to set the fuze. After the "WAIT" message is briefly displayed either the "FUZE SET OK" message will be displayed which means the fuze has been set, or the "FAILED" message will be displayed. If "FAILED" appears, try setting another fuze. If both fuzes do not accept the setting, replace the fuze setter and try setting the fuzes.

**4 Setting for TIME (TIME) mode using PIAFS M1155****NOTE**

When the setter is first initialized it displays the Fuze Menu, afterwards it remembers where it was last and displays the Fuze Setting Menu and the last fuze set.

- (a) Press the ENTER button to turn on the setter

**Fuze Setting Menu**

→FUZE: M782

MODE: TIME

TIME: 187 sec

SET FUZE

- (b) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate FUZE, then press the ENTER button. The Fuze Menu appears.

**Fuze Menu**

→M762 DM-52

M767 DM-74

M782 \*MORE\*

C32 \*QUIT\*

- (c) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate M782, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the MODE line.

**Fuze Setting Menu**

→FUZE: M782

MODE: TIME

TIME: 187 sec

SET FUZE



**g. Procedure Number 7, M782 Fuze — Continued**

- (d) Press the ENTER button. The Mode Menu for the M782 appears.

**Mode Menu**

→TIME  
VT  
DELAY  
PD

- (e) Press the right ( ↑ ) or left ( ↓ ) button to move the cursor ( → ) to indicate TIME, then press the ENTER button. The Time Menu appears with a line ( \_ ) cursor under the hundreds place.

**Time Menu**

100.0 sec

- (f) Press the right ( ↑ ) or left ( ↓ ) button to toggle between 0 and 1 for the hundreds digit, then press the ENTER button. The cursor ( \_ ) will move to the tens place.

**Time Menu**

000.0 sec

- (g) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the ones digit, then press the ENTER button. The cursor ( \_ ) will move to the ones place.

**Time Menu**

030.0 sec

- (h) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the ones digit, then press the ENTER button. The cursor ( \_ ) will move to the tenths place.

**Time Menu**

035.0 sec

- (i) Press the right ( ↑ ) or left ( ↓ ) button to choose a number between 0 and 9 for the tenths digit, then press the ENTER button. The Fuze Setting Menu appears with the cursor pointing to the TIME line (showing the set time).

**Fuze Setting Menu**

FUZE: M782  
MODE: TIME  
→TIME: 35.2 sec  
SET FUZE

- (j) Press the left ( ↓ ) button to move the cursor ( → ) to indicate SET FUZE. Place setter on the fuze and press the ENTER button. The setter will attempt to set the fuze. After the "WAIT" message is briefly displayed either the "FUZE SET OK" message will be displayed which means the fuze has been set, or the "FAILED" message will be displayed. . If "FAILED" appears, try setting another fuze. If both fuzes do not accept the setting, replace the fuze setter and try setting the fuzes.

5 Auto-setting is accomplished via an inductive data link between the fuze and a weapon equipped with an auto-set fire control system. The desired fuze setting is inputted into the setter console then transmitted. The fuze will be remotely activated and set, and the console will display the actual fuze setting as a safety feature.

6 Firing temperature for the M782 is -45°F to +145°F (-43°C to +63°C).

## 5-7 PROPELLING CHARGE PREPARATION

**WARNING**

Under no circumstances will green bag and white bag charges be assembled together for firing. Critical malfunction could result causing personnel injury and equipment damage.

### a. M3 Series and M4 Series Propelling Charges

M4A2 and M4A1 white bag charges can be expected to perform within design limits at charges 5 through 7. However, large dispersions may result when these charges are fired at charges 3 and 4. It is recommended that M3A1 or M3 green bag charges be used instead of white bag charges at charge 3 and 4. If green bag charges are not available, white bag charges may be used, although range dispersions may result.

- 1 If required, remove excess increments from charge and retighten excess straps by twisting and securing ends under straps.

#### NOTE

Use of the M2 flash reducer to reduce muzzle flash is optional, except when TB 9-1300-385 series restricts a specific propelling charge lot to use only with flash reducer. The M4A2 propelling charge has a flash reducer assembled in front of the base charge (increment number 3) at the time of manufacture and does not require use of the M2 flash reducer.

- 2 In preparing the M4A1 white bag charge, one M2 flash reducer should be added in front of each increment used. The charge must be untied and the proper number of M2 flash reducers inserted (i.e., one flash reducer added in front of the base charge and each increment used). The charge is then retied with two interlapping square knots.

### b. M119A1 Propelling Charges

The M119A1 propelling charge is a one–increment, charge 8 white bag propelling charge and is shipped ready for firing. After unpacking and inspecting, the only preparation required is removal of the igniter protector cap and the pull scrap.

### c. M119A2 Propelling Charge

The M119A2 propelling charge is a one–increment charge 7 red bag propelling charge, and is shipped ready for firing. This charge is not used in lieu of charge 7, M4 series white bag. It has almost the same muzzle velocity as the M119A1 white bag charge 8. After unpacking and inspection, the only preparation required is removal of the igniter protector cap and its separate tie strap.

### d. M203 and M203A1 Propelling Charge

**WARNING**

The M203 series propelling charge is for use only in M284 cannons. Use in any other configuration may cause equipment damage and possible personal injury.

The M203 series propelling charge is a one–increment charge 8 propelling charge. After unpacking and inspecting, the only preparation required is removing the igniter protector cap.

### e. Propelling Charge, M231 or M232 (MACS)

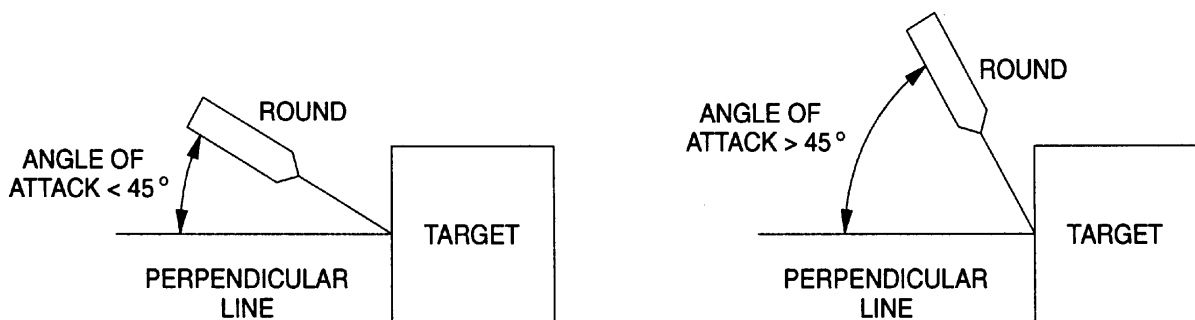
The M231 contains four charges (two per extraction sleeve) in each metal container and the M232 contains five charges per metal container. There is no other preparation needed after unpacking and inspecting the MACS.

## 5-8 LOADING AND FIRING

The chief-of-section must ensure that the following duties and actions are accomplished by the crew on each and every round loaded and fired from the cannon tube.

**WARNING**

- Observe all precautions in AR 385-63, FM 6-40, and FM 6-50, particularly limitations regarding overhead fire in training and combat to prevent injury to personnel.
- Do not load or fire artillery ammunition without the authorized fuze to prevent death or injury to personnel. Firing of such rounds without fuzes or with an unauthorized fuze could result in inbore prematures and other hazardous conditions.
- Do not load or fire round if the fuze is not fully seated to prevent death or injury to personnel.
- Firing the M557, M572, and M564 fuzes during heavy precipitation (heavy rainfall, sleet, snow, or hail) may result in occasional downrange prematures causing injury to personnel. The amount of precipitation necessary to cause functioning is comparable to the heavy downpour which occurs during a summer thunderstorm.
- Do not fire M110 series WP projectiles which are known to have been stored in other than the base down position. Firing of such projectiles could contribute to inbore prematures or close-in premature malfunctions resulting in death or injury to personnel.
- Do not fire proximity-fuzed ammunition at targets closer than 765.53 yards (750 m) to friendly troops to prevent injury to personnel.
- Firing the M100 series, M485, or M804/M804A1 projectiles at charge 2 may occasionally result in stickers causing death or injury to personnel.
- Do not fire the M483A1, M692, M731, M718, M718A1, M741, M741A1, M825, M687, or M864 projectiles below charge 3. Firing below charge 3 may result in stickers causing death or injury to personnel.
- MK399 MOD 1 fuzes set in the delay mode perform more effectively if the angle of attack (angle between the round and the perpendicular of the target) is less than 45 degrees. Angles of attack higher than 45 degrees will result in decreased effectiveness and increase the likelihood of unexploded ordnance in the battlefield.
- If a projectile fired with MK399 MOD 1 fuze impacts a substantial object, a high order detonation may occur even if the object is within the 400 caliber minimum firing distance, which could result in damage to the weapon and/or death or serious injury to unprotected crew members.



**5-8 LOADING AND FIRING — CONTINUED**

- Do not fire the M549/M549A1, M864, and M825/M825A1 projectiles if obturating band is missing or broken. Separation of the projectile and rocket motor may occur causing injury to personnel. If the obturating band is displaced and can be repositioned and remain in the groove, the projectile can be fired.
- Do not assemble M3 series green bag charges with M4 series white bag charges. Critical malfunction could result causing injury to personnel.
- Do not load or fire M231 charges with M232 charges. Critical malfunction could result. Do not load or fire more than two M231 charges or less than three M232 charges.
- Firing a round with an obstruction in the cannon tube can cause inbore premature detonation causing death or injury to personnel.
- Do not fire an M864 projectile if the outer weather seal is damaged (torn, punctured, or peeling) to the extent that moisture can enter the base burner assembly. A loss in range (short round) may result and short rounds fall on friendly forces. Return projectile to ammunition supply point (ASP).
- For M864 projectiles marked with three solid white circles 120° apart located on the ogive (above the weight zone markings) observe the following warnings to prevent injury to personnel.

Do not fire the M864 projectile if it has been dropped or if it shows evidence of denting, flattening, or gouging to the lifting plug, grommet, rotating band, or boattail area.

If during handling and/or loading, the M864 projectile base separates, call EOD personnel.

Do not fire the M864 projectile if the obturating band is missing or broken because it may result in a short round. If the obturating band is displaced and can be repositioned and remain in the groove, the M864 projectile can be fired.

Do not fire the M864 projectile if it has been delivered without the grommet.

- 1 Make sure round is clean and fuze is present and fully seated.
- 2 Make sure there are no obstructions in the cannon tube.
- 3 Check cannon firing mechanism to see that primer expended in previous firing has been removed.
- 4 Remove grommet from projectile.

<b>WARNING</b>
----------------

- Never load a propelling charge into the chamber by increments. Only the fully assembled charges will be used. Critical malfunction could result causing injury to personnel.
- Dirt or grease left on the projectile rotating band could cause failure of the projectile to seat properly in the forcing cone on ramming. Firing an unseated projectile could cause inbore explosion resulting in injury or death to personnel.

**NOTE**

If firing the M549/M549A1 projectile, remove the rocket motor-off cap from the base of the projectile by turning in the direction of the arrow (clockwise). The M549/M549A1 projectile is authorized for rocket-on firings only.

- 5 Load fuzed projectile into cannon and ram it solidly through the firing chamber into the forcing cone so it will not fall back on the propelling charge. Round must remain wedged into the forcing cone at all angles of elevation.

## 5-8 LOADING AND FIRING — CONTINUED

- 6 Remove the igniter protective cap from propelling charge and load propelling charge into cannon chamber with igniter end (red bag) toward the breechblock assembly.

**WARNING**

Never close the breechblock assembly unless you can see the red igniter pad on the base of the propelling charge. Misfires, hangfires, erratic performance, or other critical malfunctions could result causing injury to personnel.

- 7 Close and lock the breechblock assembly.

**WARNING**

Never insert primer in primer chamber unless breechblock assembly is closed and locked. Ignition of the propelling charge with breechblock assembly not fully closed presents a critical hazard to the crew.

- 8 Insert primer and move firing mechanism block assembly to firing position and fire on command of the chief of section.

## 5-9 AFTER FIRING

The following must be accomplished after firing.

- 1 Make sure breechblock assembly is in the fully open position.
- 2 Wipe face of spindle assembly after each round and swab the propellant chamber, making sure that all burning fragments of powder charge are removed from propellant chamber. Look through the cannon tube. If the cannon tube is clear, announce "BORE CLEAR."
- 3 All ammunition fired must be recorded by charge number, type, and total number of each fired, and entered on DA Form 2408-4.

## 5-10 AMMUNITION PREPARED FOR FIRING BUT NOT FIRED

### a. General Instructions

**WARNING**

The projectiles and fuzes that have been rammed and then removed from the tube will not be reloaded or fired, with the exception of M712 copperhead projectiles extracted from a cold cannon tube. Put these aside for turn-in (para 5-20).

- 1 Using applicable fuze setter and procedure (para 5-6), reset the fuzes of the projectiles prepared for firing but not rammed. Reset time fuzes to safe; reset VT fuzes to initial setting at which they were shipped; reset point detonating fuzes to SQ or PD. M762/M767 series ET fuzes that have been activated and not fired should be reset to •88.8, segregated, and used first in subsequent firings. When the battery runs down on an activated M762/M767 series fuze, the LCD goes blank. These fuzes are unserviceable, and should be packed separately, marked unserviceable, and turned in to the ammunition supply point (ASP). To determine if an M762/M767 series fuze has been activated and run down, gently attempt to turn the ogive clockwise by hand without depressing the selector button. If the ogive turns easily, the fuze has been activated. An M762/M767 series fuze that has not been activated should resist the applied torque. Replace safety wires on those fuzes furnished with them.
- 2 Disassemble fuze from projectile and repack in original packing. When a long intrusion proximity fuze is removed from projectile, replace supplementary charge in projectile before assembling spacer and the correct type of lifting plug.

#### NOTE

Be sure the correct type of lifting plug is used (e.g., energy-absorbing or shock attenuating lifting plugs for M549 series projectiles, yellow fusible or universal lifting plugs for M483A1 series projectiles, and standard eyebolt lifting plugs for other projectiles).

- 3 Replace grommet over rotating band.
- 4 Restore propelling charges to original condition. Make sure all zones (increments) are present, tied, in proper order, in good condition, of the proper lot number, and that igniter caps are replaced.

## 5-10 AMMUNITION PREPARED FOR FIRING BUT NOT FIRED — CONTINUED

### a. General Instructions — Continued

- 5 Replace fuzes, primers, and flash reducers in original packing.
- 6 Make sure the lot number of the ammunition corresponds with the lot number on the container.
- 7 If rocket cap was removed from the M549/M549A1 HERA projectile, replace cap and tighten handtight.
- 8 Return all projectiles to shaded and protected storage, regardless of weather.

### b. Special Instructions for the M712 Projectile

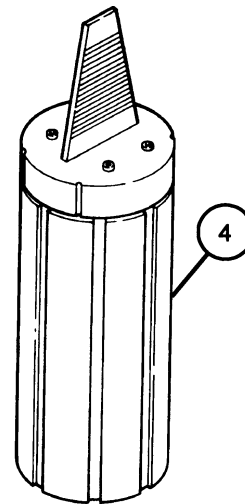
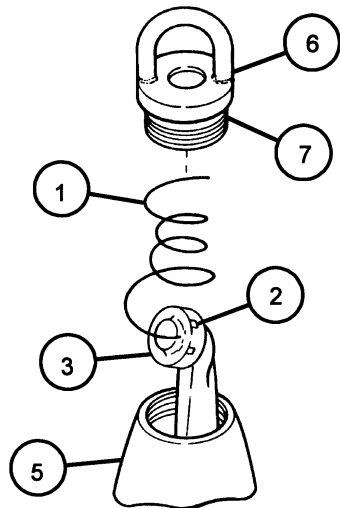
See paragraph 5-20 for special instructions for the M712 projectile.

### c. Special Instructions for the M483A1 and M864 ICM Projectiles

**WARNING**

Use no other lifting plug except the fusible or universal plug removed from this projectile, because it is designed for safe release of pressure inside the projectile in case of a fire during storage or shipping actions.

- 1 Wind the pull-wire (1) under four tabs (2) on the cover of the bagged expulsion charge assembly (3) (1–1/2 turns for proper engagement).
- 2 Place bagged expulsion charge assembly (3) or cylindrical plastic expulsion charge assembly (4) into projectile fuze well (5).
- 3 Reinstall fusible or universal lifting plug (6) with attached gasket (7).



Section III. **MAINTENANCE****5-11 AMMUNITION CARE AND HANDLING****a. Handling****WARNING**

- Keep fire and flammable materials out of the ammunition areas. DO NOT SMOKE in the vicinity of ammunition. Serious injury or death may occur.
  - Shield all ammunition from high temperatures (e.g., direct rays of the sun). When outside temperature is expected to reach 100° F (38° C), failure to shade could result in damage to materiel and the loss of life.
- 1 Do not expose ammunition and components containing explosives to extreme temperatures. Do not expose to direct sunlight, flame, or other sources of heat.
  - 2 Do not expose unpacked propelling charges and fuzes to rain, excessive humidity, or ground moisture.
  - 3 Prevent rough handling of projectiles and fuzes. Do not strike projectiles together and do not offload ammunition by dropping projectile on top of projectile.
  - 4 Protect fuzes, primers, and flash reducers at all times from foreign matter and impact. A drop of 4 feet (1.20 m) may cause the electrolyte vial in a VT fuze battery to break, thus causing a dud.
  - 5 Do not disassemble fuzes.

**b. Care**

- 1 Ammunition is packed to withstand conditions ordinarily encountered in the field. Keep packing boxes from becoming broken or damaged.
- 2 Since ammunition is impaired by moisture, frost, extreme temperatures, and foreign matter (mud, oil, etc.), observe the following.
  - (a) Do not break the moisture-resistant seal on the container until ammunition is to be used.
  - (b) Shield all ammunition from high temperatures (e.g., the direct rays of the sun). When covering projectiles to provide this shield, cover with tarpaulin keeping 18 inches (45.7 cm) air space over and 6 inches (15.2 cm) of air space on sides, This will ensure free air flow necessary to keep the projectiles cooler in hot weather.
  - (c) Refer to paragraph 5-23 for information regarding maintenance of the M712 copperhead projectile.



## 5-12 MAINTENANCE

**WARNING**

Alteration of loaded ammunition or components is prohibited. Unauthorized modification of ammunition could cause critical malfunction resulting in injury to personnel.

**NOTE**

Proper performance of ammunition maintenance procedures when ammunition is received by using units assures that ammunition on hand is kept ready for use.

### a. General

**NOTE**

Do not open sealed boxes or containers unless defective ammunition is suspected.

- 1 Inspect ammunition packaging daily. Open boxes or containers that show evidence of contamination or deterioration and inspect ammunition.
- 2 Preparations of M712 copperhead projectiles for firing are found in section IV. of this chapter, as well as care, maintenance, inspection, unpackaging, and repackaging of the M712 projectile.
- 3 Inspect unpackaged ammunition and explosive components daily.
- 4 Wipe off wet or dirty ammunition at once, Remove light corrosion. Do not polish ammunition to make it look better.
- 5 Consider ammunition unserviceable if it has severe rust or propellant contamination, particularly moisture. Do not use except in emergency.
- 6 When repackaging ammunition, put it back in original container. If other packing material must be used, the old marking should be transferred to the new containers.
- 7 See paragraph 5-13 for the Loose Projectile Restraint System (LPRS), which is an optional system for securing loose unfuzed projectiles for transportation.

### b. Projectiles

- 1 Visually inspect projectiles for the following defects.
  - (a) Distorted, out of round, or damaged body.
  - (b) Dirt or other foreign material.
  - (c) Seepage of explosive filler.
  - (d) Rust through projectile baseplate.

## 5-12 MAINTENANCE — CONTINUED

### b. Projectiles — Continued

- 2 Clean dirt or foreign material from projectile by wiping with a damp rag (item 35, Appx D).
- 3 Return defective projectiles to ammunition supply point (ASP).
- 4 Inspect the M549/M549A1 projectile for the following.
  - (a) Missing or broken obturating bands. The M549/M549A1 projectile cannot be used if the obturating band is broken or missing. Return M549/M549A1 projectile to the supply point.
  - (b) Broken energy-absorbing or shock attenuating lifting plugs. When the lifting plug is broken, the threaded area will remain in the M549/M549A1 projectile. Do not attempt to extract any portion of the broken plug. Return the M549/M549A1 projectile to the supply point.
- 5 The M483A1 projectile can be used if the obturating band is missing or broken. Remove and discard broken obturating bands.
- 6 Inspect the M864 projectile for the following.
  - (a) Missing or broken obturating bands. Do not fire the M864 projectile if the obturating band is broken or missing as rotating band failure and short rounds may result. Return M864 projectile to the supply point. If the band is displaced and can be repositioned and remain in the groove, the M864 projectile can be fired.
  - (b) Damaged (torn, punctured, or peeling) weather seal. The M864 projectile cannot be used if the weather seal is damaged. Return M864 projectile to the supply point.
  - (c) Gaps at the base to body joint. If a separation of base from the body exists, refer to the safety precautions on M864 projectile in Table 5-1.
- 7 Inspect specially marked M864 projectiles (three solid white circles located on the ogive) for the following.
  - (a) M864 projectiles that have not been palletized or have been transported as loose cargo. These conditions can cause gaps or separation at the base to body joint resulting in a hazard. Return the M864 projectile to the supply point.
  - (b) Projectiles showing denting, flattening, or gouging to the lifting plug, grommet, rotating band, or boatail area. These conditions can cause gaps or separation at the base to body joint resulting in a hazard. Return the M864 projectile to the supply point.
- 8 The M825/M825A1 cannot be fired if the obturator is missing or broken because it may result in a short round. If the band is displaced and can be repositioned and remain in the groove, the projectile can be fired.

## 5-12 MAINTENANCE — CONTINUED

### c. M3 Series and M4 Series Propelling Charges

- 1 Visually inspect M3 series and M4 series propelling charges for the following defects.
  - (a) Loose tie straps, allowing separation of the charge into increments.
  - (b) Missing increment, extra increment, or incorrect sequencing (order) of increments.
  - (c) Increment bags torn or damaged to the extent that black powder or propellant spills out.
  - (d) Wet propelling charge.
  - (e) Missing or damaged red igniter pad on base of charge.
- 2 Charges requiring retying may be retied as follows.
  - (a) Assemble increments in correct order.
  - (b) Tie the four tie straps over top of charge.
- 3 Return all defective charges to the ammunition supply point (ASP).

### d. M119 Series, M203 Series, and M231 and M232 Propelling Charges

- 1 Visually inspect M119 series, M203 series, and M231 and M232 propelling charges for the following defects.
  - (a) Missing flash reducer. (Flash reducer is sewn into sides of charge bag on M119A2 propelling charge.)
  - (b) Charge bag ripped or damaged to the extent that propellant can escape.
  - (c) Black powder leaking from base igniter pad.
  - (d) Base igniter pad not centered with respect to outer diameter of charge, both ends for the M231 and M232 charges.
  - (e) Evidence of broken or damaged central igniter tube (M119A1, M203, M231 and M232 only).
  - (f) Combustible case for M231 and M232 charges with a cut or puncture through case wall.
  - (g) Combustible case for M231 and M232 charges with uneven cap (crooked, tilted, or slanted).
  - (h) Combustible case for M231 and M232 charges that cannot be replaced into its sleeve due to exterior damage.
  - (i) Tie straps not tight over forward end of charge.
  - (j) Lacing jacket not secure on propelling charge (M119A1 and M203 only).
  - (k) Cord missing or broken on lacing jacket (M119A1 and M203 only).
  - (l) Crushed or distorted cases or missing/broken propellant in M203A1 charges.
- 2 If tie straps are loose, retighten the straps at the forward end of the propelling charge.
- 3 Return all defective propelling charges to the ammunition supply point (ASP).

## 5-12 MAINTENANCE — CONTINUED

### e. Fuzes

- 1 Inspect fuzes for the following defects.
  - (a) Damage to body or threads.
  - (b) Loose components.
- 2 Return defective fuzes to ammunition supply point (ASP).

### f. Ammunition or Components of Ammunition Prepared for Firing, But Not Rammed

- 1 Return such ammunition to the original condition and packing. Mark appropriately, and use first in subsequent firings to keep stocks of open packings to a minimum.
- 2 Reassemble the supplementary charge and the correct type of lifting plug (with gasket and spacer) to the projectile to restore to its original condition. Return fuzes to original condition. Return fuzes to original packing. In reassembling the components, make certain the supplementary charge is properly inserted (felt pad end innermost).
- 3 Remove the projectile spotting charge from the M577 series or M762 fuze and replace the expulsion charge assembly and fusible or universal lifting plug with gasket to the M483A1 or M864 projectiles. Replace rocket cap on M549 and M549A1 projectiles.
- 4 Reassemble propelling charges prepared for firing and not used. Replace in original containers as follows.
  - (a) If increment was removed, reinstall and retie.
  - (b) Replace igniter protective cap.
  - (c) Repack charge in container (igniter end first), and close and secure container.
  - (d) Mark container appropriately and use charge first in subsequent firings.

### g. Unserviceable Ammunition

- 1 Conspicuously mark unserviceable ammunition or explosive components "UNSERVICEABLE," and return to ammunition supply personnel for disposition.
- 2 Repackage ammunition components in original containers. If original container is unsuitable, use available package material and transfer all markings. All layers of packing must be conspicuously marked "UNSERVICEABLE."

## 5-12 MAINTENANCE — CONTINUED

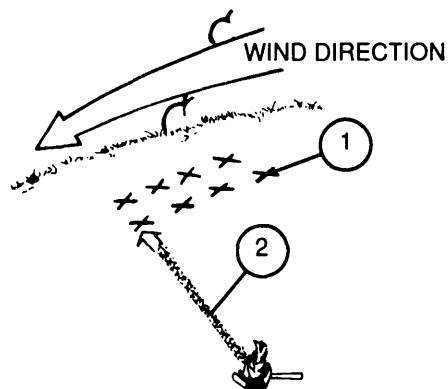
### h. Excess Explosive Components

- 1 Pack supplementary charges removed from projectiles prior to assembling long intrusion proximity fuzes in containers from which these proximity fuzes were removed.
- 2 Properly mark containers and return to ammunition supply personnel for disposition.

**WARNING**

Never bring excess powder increments back to the howitzer or ammunition carrier. Severe burns to personnel may result from accidental ignition of excess powder increments.

- 3 Destroy any unused powder increments or expelling charges left over after round has been fired by performing the following steps.
  - (a) Locate proper burning area. Area should be 200 feet (60.96 m) from any combustible material.
  - (b) Ensure proper firefighting equipment and personnel are present.
  - (c) Lay out powder increments (1) stacked one high, parallel to wind direction in 12-inch (30.48-cm) wide column.
  - (d) Lay out an igniter trail (2) at the downwind end of the line of powder increments (1) by opening one powder bag and making a trail of powder at 90° to the powder increments. The igniter trail should be approximately 16.40 feet (5 m) long and 2 inches (5.08 cm) wide.
  - (e) Light the end of the igniter trail (2), then move away from the powder increments(1).
  - (f) While powder increments (1) are burning, be alert for sparks or burning fragments caught by the wind.



## 5-12 MAINTENANCE — CONTINUED

### h. Excess Explosive Components — Continued

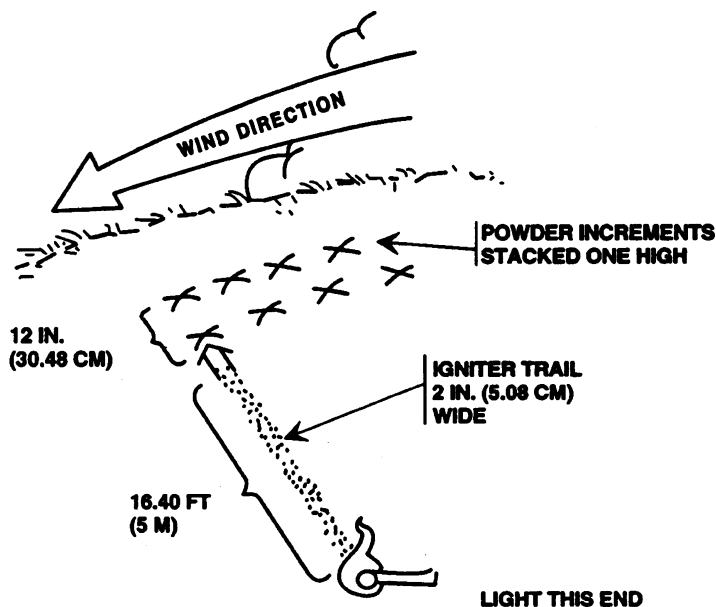
#### NOTE

Be sure ashes are completely burned.

- (g) When powder is through burning, be sure all flames are extinguished and no smoldering ashes remain.

### i. Destroying MACS Charge Increments

- 1 Locate proper burning area. Area should be 164 feet (50 meters) from any combustible material.
- 2 Ensure proper firefighting equipment and personnel are present.
- 3 Prepare MACS propelling charge increments for field destruction:
  - (a) Peel off both red Mylar covers, exposing igniter end bags.
  - (b) Remove igniter bags from charge increment (locate ribbon tying bags together and cut, taking care not to cut into bags).
  - (c) Use one charge increment to make igniter trail. If one increment is cracked, break it open and use propellant to make igniter trail.
  - (d) If no charge increments are cracked, roll one charge increment on the ground, exerting a downward pressure on the joint of the case base and case body. This should break the joint and the exposed propellant can be poured out and used to make the igniter trail.
- 4 Lay out MACS propelling charge increments parallel to wind direction in 12-inch (30.48 centimeters) wide column (columns of two increments) and lay the removed igniter bag components among the increments.
- 5 Lay out an igniter trail at the downwind end of the line of increments by either breaking open one increment or by using a cracked or broken increment and making a trail of propellant at 90 degrees to the increments. The igniter trail should be approximately 16.40 feet (5 meters) long and 2 inches (5.08 centimeters) wide.



## 5-12 MAINTENANCE — CONTINUED

### i. Destroying MACS Charge Increments — Continued

- 6 Light the end of the igniter trail, then move away from the MACS propelling charge increments.
- 7 While increments are burning, be alert for sparks or burning fragments caught by the wind.
- 8 When increments are through burning, be sure all flames are extinguished and no smoldering ashes remain. Be sure ashes are completely burned.

## 5-13 STORAGE

### a. Temperature Limits

**WARNING**

- Ammunition exposed directly to sunlight, or in unventilated containers, enclosures, shelters, freight cars, closed vehicles, and similar structures exposed to direct sunlight may reach temperatures exceeding upper storage limits. Avoid exposure of ammunition components to direct sunlight. Do not store ammunition assembled with tetrytol-loaded bursters (i.e., 155 mm projectiles: M110 WP (smoke) projectiles and M110 (H or HD) persistent projectiles) at temperatures exceeding 125° F (52° C).
  - Do not store ammunition under trees or near tall buildings that attract lightning. When ammunition must be stored in the open, select a storage site free of power lines, electric cables, and flammable materials. Sites should not be adjacent to reservoirs, water mains, etc. Do not store ammunition near a large concentration of personnel to prevent injury.
- 1 Except as otherwise specified, observe the following limits.
    - (a) Lower limit is -80° F (-62° C) for a period of not more than 3 days.
    - (b) Upper limit is 160° F (71° C) for a period of not more than 4 hours per day.
  - 2 Store or transport M110 series and M825 projectiles containing WP at a temperature below the melting point (111.4° F (44° C)) of the WP filler. If this is not practicable, store or transport such projectiles on their bases so that, should the WP filler melt, it will resolidify with the void in the nose of the M110 series projectile. This restriction does not apply to the M825A1 WP projectiles.
  - 3 Protect proximity fuzes and proximity rounds from long exposure to high humidity. Store M728 series fuze in temperatures between -65 to 145° F (-54 to 63° C) and M732 series fuze in temperatures between -60 to 160° F (-51 to 71° C).

### b. Sites

Store ammunition in the firing area so that it is protected against accidental explosions. Sites should be level and well drained.

### c. Provisions

#### NOTE

A hardstand of blacktop or gravel and sand is preferable to excessive use of dunnage.

- 1 Use heavy, well supported dunnage to keep bottom tier of stack off the ground and to prevent it from sinking into the ground.
- 2 Allow at least 6 inches (15.24 cm) of space beneath the pile for air circulation. Dig trenches to prevent water from flowing under pile.
- 3 Provide nonflammable covers (e.g., tarpaulin) for all ammunition. Maintain air space of approximately 18 inches (45.72 cm) between cover and ammunition. Keep cover at least 6 inches (15.24 cm) from pile on ends and sides to permit circulation of air.

## 5-13 STORAGE — CONTINUED

### c. Provisions — Continued

- 4 Store M110 series and M825 WP projectile nose up. This restriction does not apply to the new M825A1 WP projectiles.
- 5 Store ammunition and primer containers with top side up. Labels or marking on boxes and containers indicate which side should be up.

### d. Loose Projectile Restraint System (LPRS)

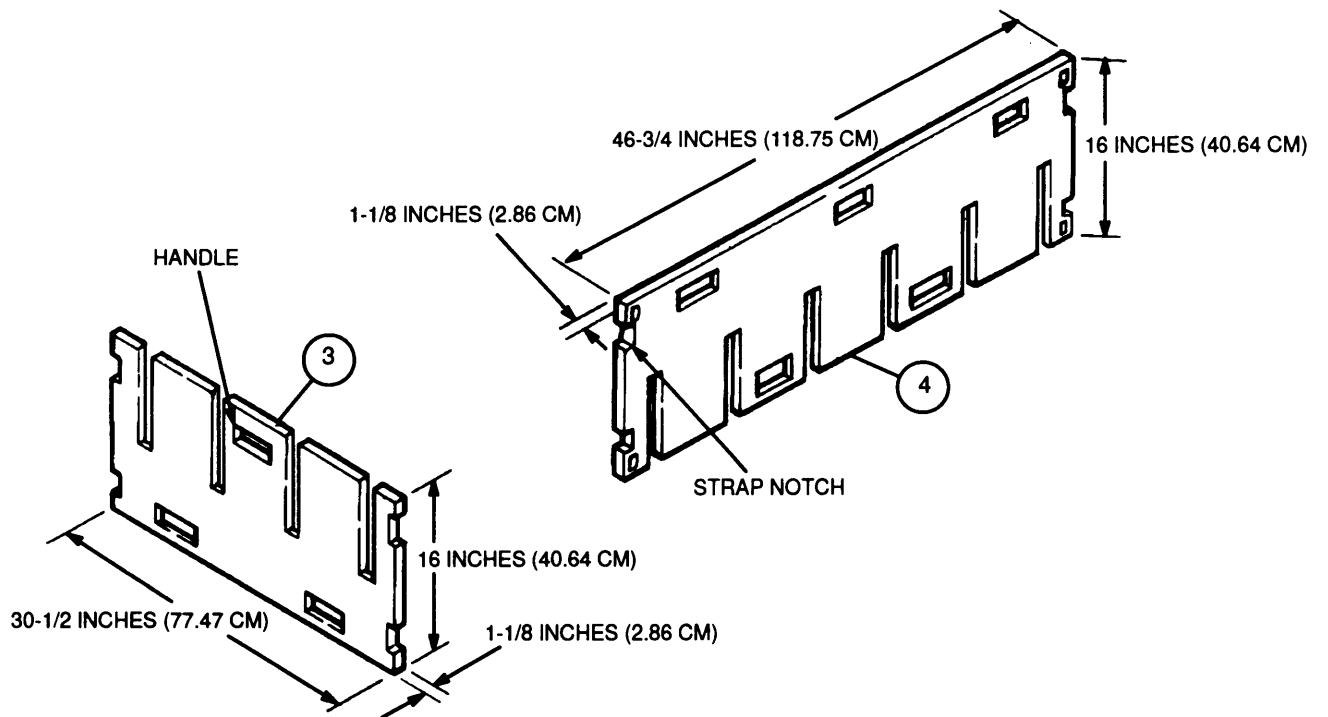
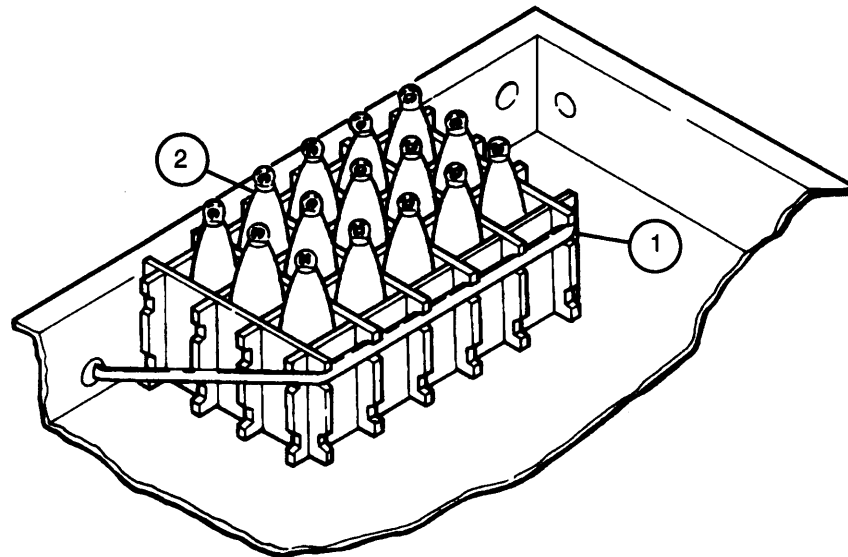
- 1 Use of the LPRS is optional, and the components are:
  - Panel, Long, LPRS, 155MM (item 31, Appx D)
  - Panel, Short, LPRS, 155MM (item 32, Appx D)
  - Rack Assembly, 15 Round, LPRS, 155MM (item 34, Appx D)
  - Strap, Webbing, 1.75 Inch W. (item 36, Appx D)
  - Strap, Webbing, Tie Down, Cargo, Aircraft (item 37, Appx D)
  - Nylon, 1.719 Inch W. (item 30, Appx D)
- 2 The LPRS (1) is a divider rack that provides a fast, simple method of securing “loose” unfuzed projectiles (2) for transportation with field artillery companion vehicles. The divider rack restrains projectiles from excessive longitudinal and lateral movement and from contact with other projectiles. The divider rack is easily assembled as shown below, using a quantity of short dividers (3) and/or long plastic dividers (4) that fit together. Projectiles are then placed vertically in the divider rack, with the base of each projectile resting on the floor of the vehicle. The assembly is then secured to the sidewall of the vehicle by means of cargo tiedown straps. After use, the rack may be disassembled and stored for reuse.





### 5-13 STORAGE — CONTINUED

#### d. Loose Projectile Restraint System (LPRS) — Continued



## Section IV. CANNON-LAUNCHED M712 COPPERHEAD PROJECTILE AND M823 COPPERHEAD TRAINING PROJECTILE

### 5-14 DESCRIPTION

#### a. M712 Projectile

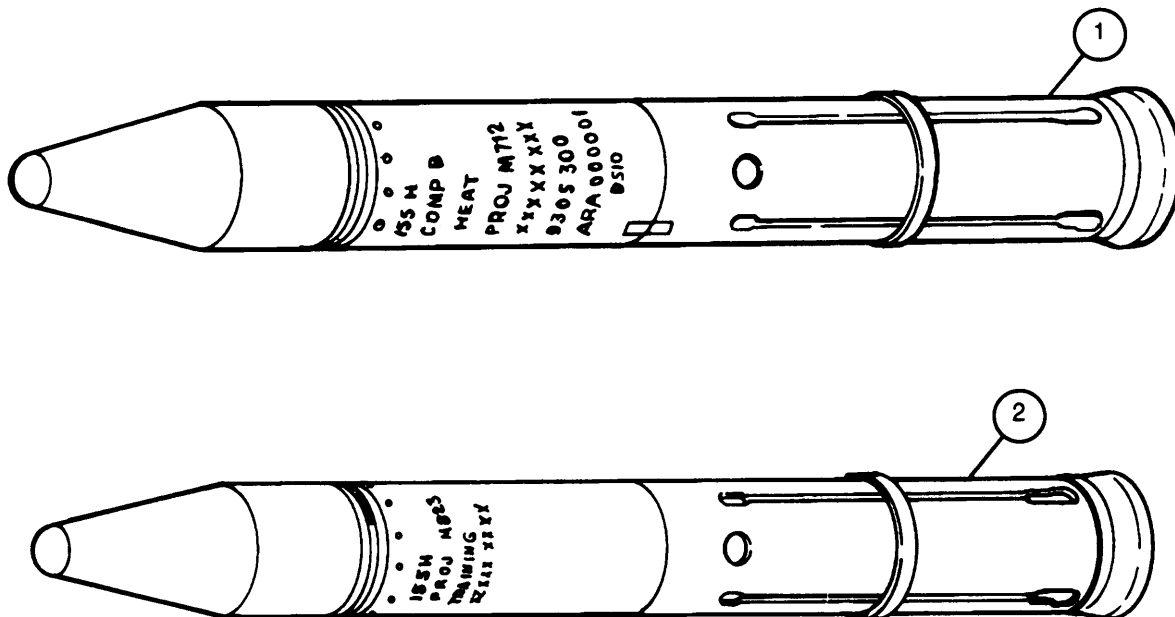
Cannon-launched, guided M712 projectile (1) is a terminally guided system launched from the howitzer into a ballistic trajectory. During flight, the target is illuminated by a laser beam from a laser designator. An onboard computer continuously refines the terminal trajectory and provides guidance to the control surfaces, causing the round to home in on stationary or moving hard-point targets. The M712 projectile is fired in the same manner as conventional projectiles.

**WARNING**

The M823 training projectile must not be fired. Such firing could be a hazard to personnel forward of the weapon.

#### b. M823 Projectile

The training round for the M712 projectile (1) is the M823 projectile (2). The M823 training projectile is designed to train 155 mm howitzer weapon crews in the handling and setting of the M712 projectile. It simulates the M712 projectile in weight, center of gravity, and external appearance. It contains code and time switches which are set to simulate prefiring activity by the crew; however, it does not have the wings or fins. It is shipped and stored in the same type of container as the M712 projectile.



## 5-15 UNPACKING AND INSPECTION

### a. Unpacking the M712 Projectile

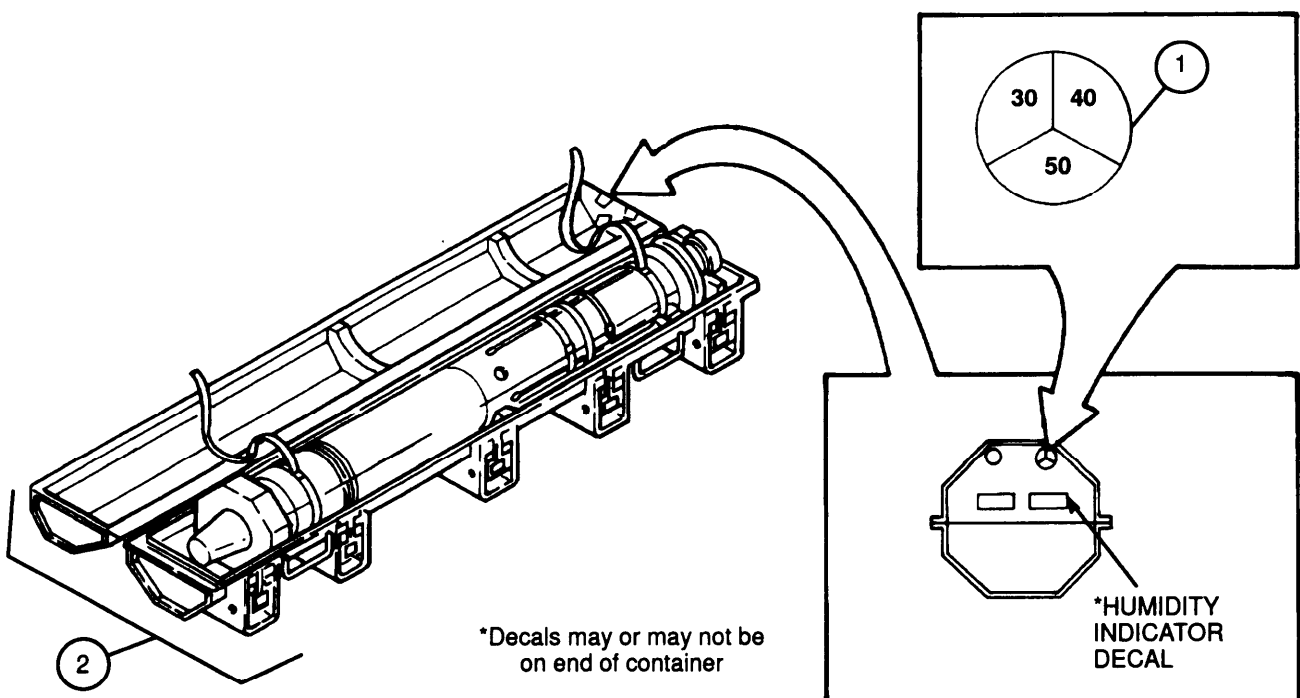
**WARNING**

If exuded composition B is observed on the projectile or in the container during the unpacking and inspection operations, move the projectile to a safe area and notify EOD for disposal.

**NOTE**

- Unless the unpacked projectile is to be fired immediately, it must be protected from the elements (by means of protective bag). Do not let an unpacked M712 projectile sit out unprotected.
- These procedures apply only to the M712 projectile.
- The M823 training projectile has a humidity indicator that resembles the one on the M712 projectile, but says "DUMMY CARD" on its face.

- 1 A humidity indicator (1) is located in aft end of the container (2). The humidity indicator is the pie-sector type.



## 5-15 UNPACKING AND INSPECTION — CONTINUED

### a. Unpacking the M712 Projectile — Continued

**CAUTION**

Before removing the round from container, make a quick visual inspection of the projectile for obvious damage or other condition that would prevent use. If projectile appears not usable, replace lid and return to battalion ammunition section.

- 2 Open only those containers (2) whose humidity indicator (1) shows under 40 percent relative humidity (40 percent spot must be colored blue, 30 percent spot maybe blue or pink), and only when a fire mission is planned or anticipated. If the 40 percent humidity spot is pink, turn complete item in to battalion ammunition section.
- 3 Keep all packing materials in the container (2). A protective bag is provided inside each container. When mission requirements dictate a need, the M712 projectile (3) may be removed from the shipping and storage container and placed in the protective bag. The protective bag will protect the round against direct effects of water, sunlight, dirt, and debris. However, it will not protect the round from the elements for more than 30 days at a time. Repackage unfired projectiles within 30 days and turn into battalion ammunition section. The howitzer may be driven with two M712 projectiles, in protective bags, stowed in the crew compartment on the right side (para 5-21). All other M712 projectiles to be moved must be (repackaged in their containers and transported in ammunition carrier vehicles.
- 4 Unpackage the M712 projectile (3) from its container (2) as follows:

**NOTE**

There is one wire on center latch assembly of each side of the container.

- (a) Break metallic seal wire (if still present) located on center latch assembly, using screwdriver or equivalent tool.
- (b) Depress manual relief valve (4).
- (c) Release all ten latches (5) by starting at one end and opening corresponding left and right side latches. Pull latch all the way up to release T-bolts (6). Then push latch with T-bolts all the way down.
- (d) Separate cover (7) from body (8) of container (2) and place upside down on ground, alongside the body.
- (e) Partially pull torquing rod (9) from rear end of tension mechanism.
- (f) Use torquing rod (9) to release the tension by turning counterclockwise, then spin tension mechanism by hand until it stops.

**5-15 UNPACKING AND INSPECTION — CONTINUED**

**a. Unpacking the M712 Projectile — Continued**

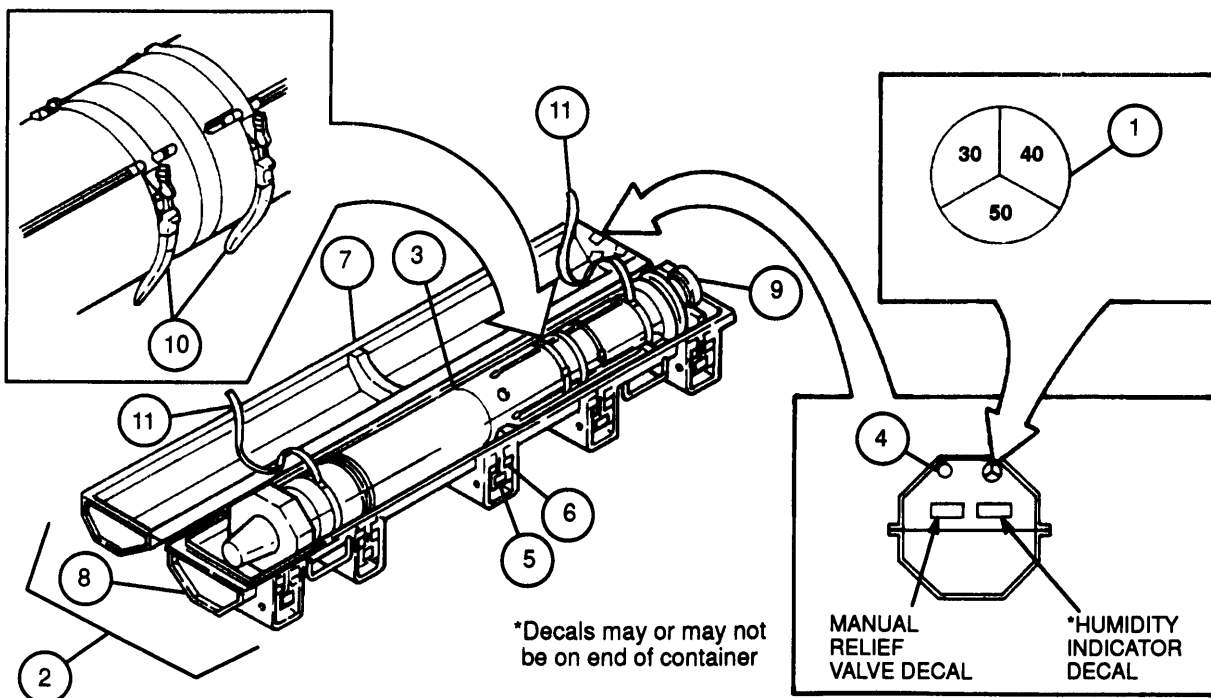
**CAUTION**

Do not let the M712 projectile touch the ground or lie in water. Water, dirt, or other materials entering M712 projectile through wing/fin slots may cause M712 projectile to fail during flight. Do not touch or grasp ogive when handling and loading M712 projectile.

**NOTE**

If projectile is to be stored inside the howitzer, skip step (g).

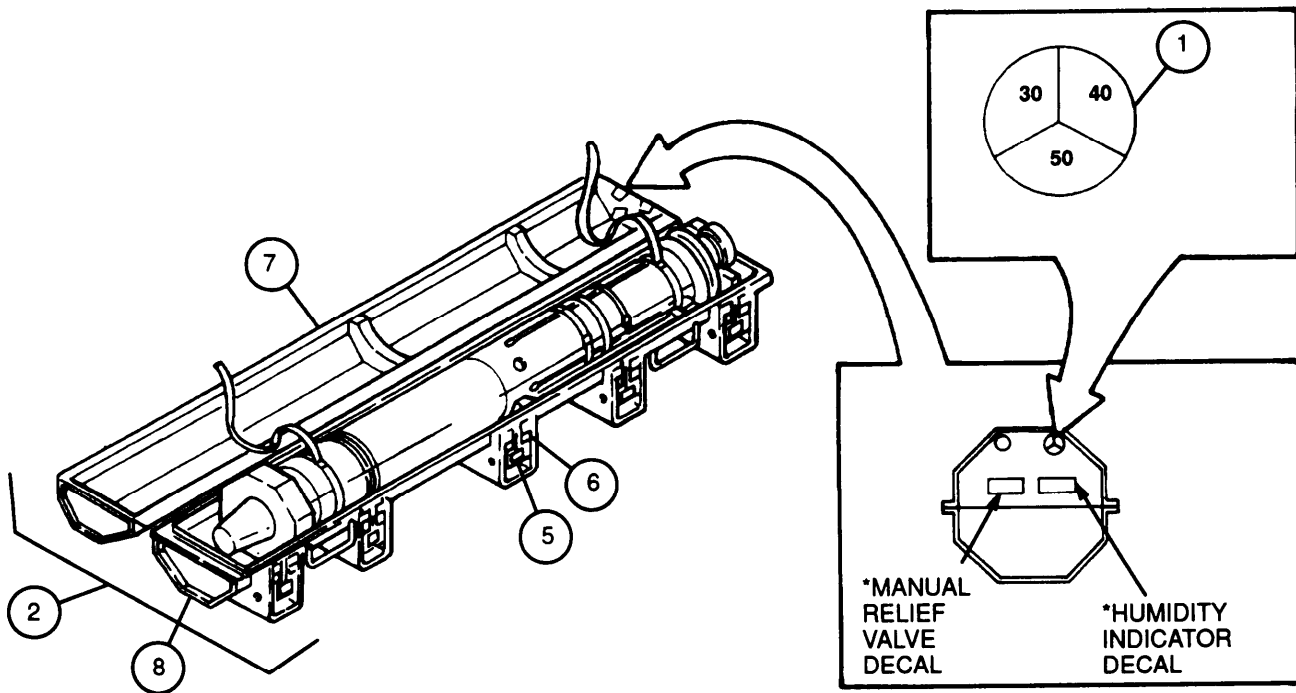
- (g) Open stainless steel fin and wing preload bands (10). Remove and place in cover (7) of container (2).
- (h) Carefully remove M712 projectile (3) from container (2) by lifting it up and to the rear using lifting straps (11) provided on the M712 projectile.
- (i) Place the M712 projectile (3) on a clean surface free of dirt or water. M712 projectile maybe placed on a tarpaulin or may be put down across the top of the open container (2). The M712 projectile should be shielded from direct sunlight, rain, dirt, and other debris.
- (j) Remove lifting straps (11) and place them in the container (2).



## 5-15 UNPACKING AND INSPECTION — CONTINUED

### a. Unpacking the M712 Projectile — Continued

- (k) Spin tension mechanism several turns clockwise by hand to avoid interference of torquing rod (9) with cover (7) when container (2) is closed.
- (l) Replace cover (7) on body (8) of container (2).
- (m) Starting on the end opposite the humidity indicator (1), straddle container (2), place T-bolts (6) in cover (7) recesses, and close corresponding left and right side latches (5) at the same time in pairs, until all ten latches are closed.
- (n) Keep the container (2) and all packing materials for reuse or return complete container to battalion ammunition section. Covers (7) and bodies (8) of containers form a set. Do not separate or mix covers and bodies.



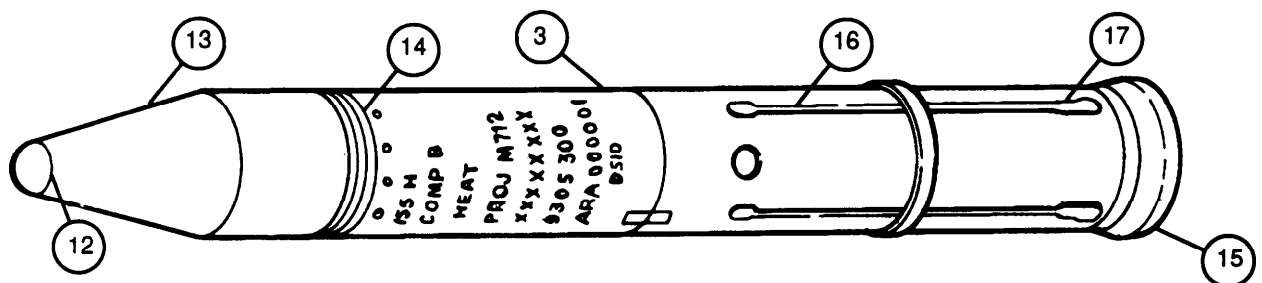
\*Decals may or may not be on end of container

## 5-15 UNPACKING AND INSPECTION — CONTINUED

### b. Inspection of M712 Projectile

Perform the following inspections immediately after the M712 projectile (3) is unpacked from its container (not shown). If an M712 projectile is found to be unserviceable as a result of damage or other defects as described below, repack the M712 projectile in its original container and return to battalion ammunition section. Attach a marking tag (item 38, Appx D) describing the defects.

- 1 Inspect the window (12) area of the nose cone (13) to make sure that it is clean and that there are no cracks, fogging, indications of moisture on the inside of the window, or other damage. Clean a dirty window using a clean rag (item 35, Appx D) or tissue. Reject an M712 projectile (3) as unserviceable for any of the following reasons.
  - (a) Window (12) cannot be properly cleaned.
  - (b) Window (12) shows signs of fogging or has moisture on the inside.
  - (c) Window (12) is cracked, broken, or badly gouged.
  
- 2 Inspect code and time switches (14) for dirt. Numbers and index marks must be legible. Remove dirt using a clean rag (item 35, Appx D). Reject an M712 projectile (3) as unserviceable for any of the following reasons.
  - (a) Missing or broken code and time switch (14) dials.
  - (b) Code and time switch (14) dials cannot be properly cleaned to make numbers and index marks legible.
  - (c) Code and time switches (14) cannot be rotated freely when the firing codes are being set into the M712 projectile (3). Turn code and time switches, using a screwdriver or the tang end of the MI 8 fuze-setter wrench, to check that code and time switches turn. A click should occur at each number.
  
- 3 Reject an M712 projectile (3) as unserviceable if the obturator(15) has a crack or large gouge.
  
- 4 Inspect wing slots (16) and fin slots (17) to make sure there is no dirt, debris, or other foreign matter in the wing and fin slots. If debris is found, attempt to clean out the wing and fin slots. Reject as unserviceable if foreign material cannot be removed.





## 5-15 UNPACKING AND INSPECTION — CONTINUED

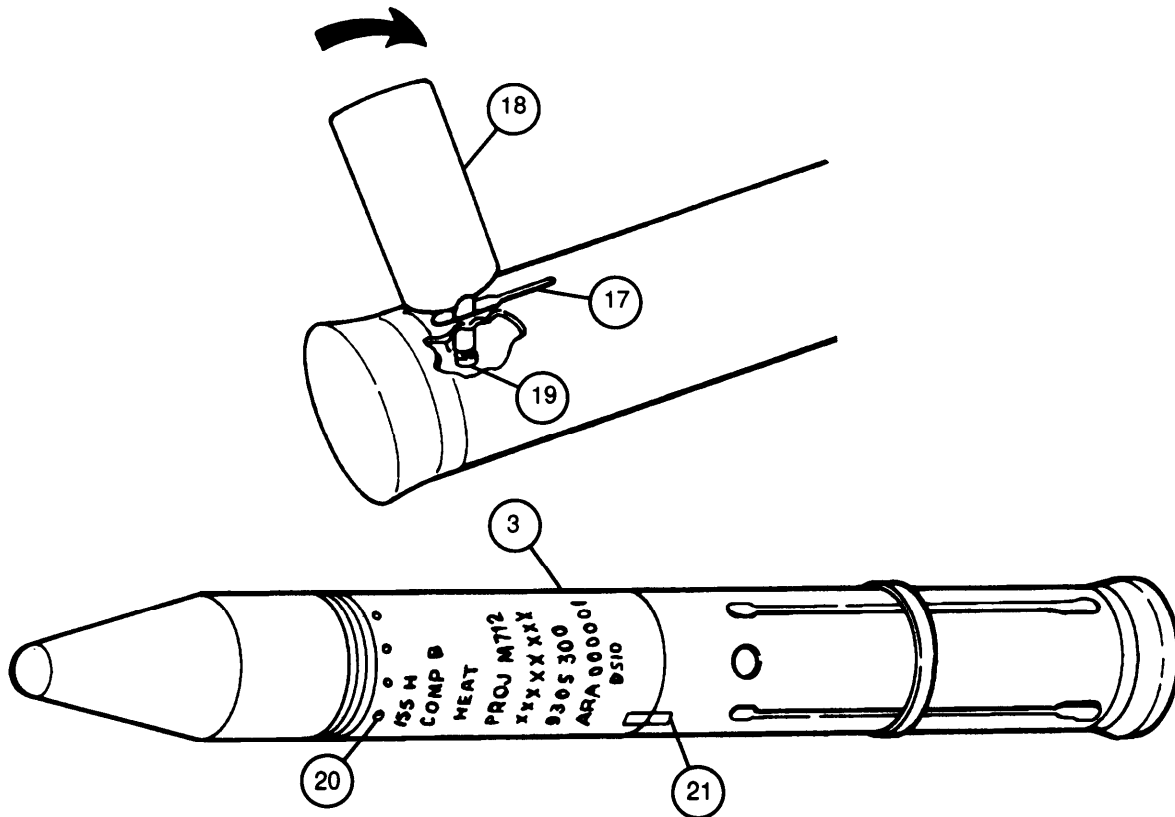
### b. Inspection of M712 Projectile — Continued

5 Inspect fins (18) to make sure that they are not in extended position. If they are, perform either steps (a) or (b) below to relatch fins. Reject an M712 projectile (3) as unserviceable if fins cannot be related.

(a) If fin (18) is only part way out, gently push fin back into its slot until it locks in place.

(b) If fin is locked in extended position, insert a small screwdriver, knife blade, or similar tool into fin slot (17) as shown below. Depress locking pin (19) with the tool and push fin (18) forward at the same time to lock fin in retracted position.

6 Inspect the overall M712 projectile (3) to make sure that there is no caked-on dirt, excessive corrosion, loose or missing items such as splice screws (20) or access covers (21), or other damage. Remove dirt, minor corrosion, and foreign matter using a lint free cloth (item 10, Appx D) or tissue. Inspect for loose or missing splice screws. If any splice screw or access cover screw is loose, attempt to make it finger tight, turning by hand. Reject an M712 projectile as unserviceable if there is excessive corrosion or screw missing on access cover. Minor corrosion, minor gouges, burrs on metal projectile body, and/or missing splice screw(s) are acceptable. Screws slightly above flush are acceptable after tightening.

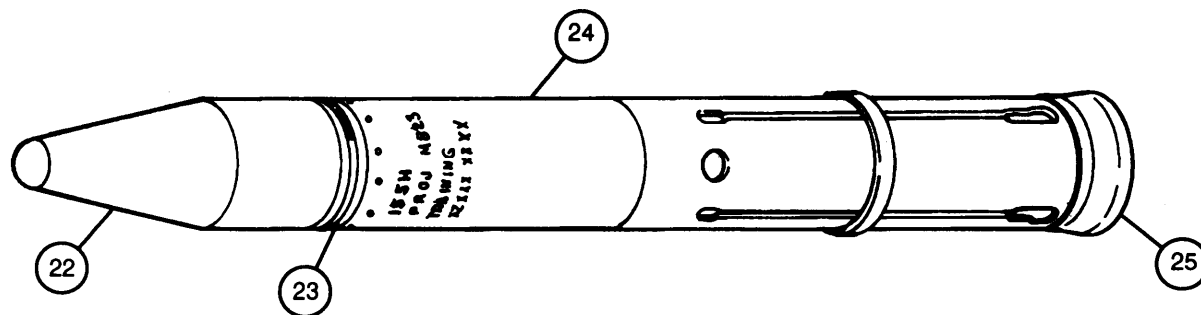


## 5-15 UNPACKING AND INSPECTION — CONTINUED

### c. Inspection of M823 Projectile

Since the M823 projectile will be reused many times, it will be rejected only for the following reasons.

- 1 Nose cone (22) is cracked or broken.
- 2 One or more code and time switches (23) cannot be rotated or will not stay set to a number.
- 3 Severe damage to M823 projectile (24) body which could prevent it from being rammed or extracted, and cause damage to the interior of the tube.
- 4 Badly damaged or worn obturator (25) which results in failback.
- 5 Damaged base which prevents proper extraction.



## 5-16 PREPARATION FOR FIRING

### a. M823 Projectile

For training purposes, the M823 training projectile will be used instead of the M712 projectile. All operational procedures which apply to the M712 projectile also apply to the M823 projectile. However, no live propelling charges are to be used with the M823 training projectile.

### b. M712 Projectile

**WARNING**

- Cannon tube forcing cone must be free of oil and grease before ramming. Oil or grease may permit projectile fallback, causing possible injury to personnel.
- After extracting an M712 projectile from a hot cannon tube, clean the forcing cone of melted plastic. Failure to do so may result in projectile fallback causing possible injury to personnel. Cleaning may be accomplished by firing another type projectile, if mission requirements permits, or firing a propelling charge alone.

- 1 Unpack and inspect the M712 projectile or M823 projectile (para 5-15).
- 2 Make sure that the projectile extractor is set up and ready for use (para 5-18).
- 3 After unpacking the M712 projectile (1), the Fire Direction Center (FDC) will announce the code switch (2) and time switch (3) setting in the fire command in the same place as they usually send "lime" for Time or VT fuzes. This setting will always have five numbers. Code and time switches will be set from left to right as seen when facing the nose of the projectile from the base of the round. Code and time switches are circular dials that can be rotated clockwise or counterclockwise as many times as required without damage. The appropriate number on the code and time switches must be centered on the scribe line. Set the code and time switches using a screwdriver or the tang end of the M18 fuze-setter wrench as follows.

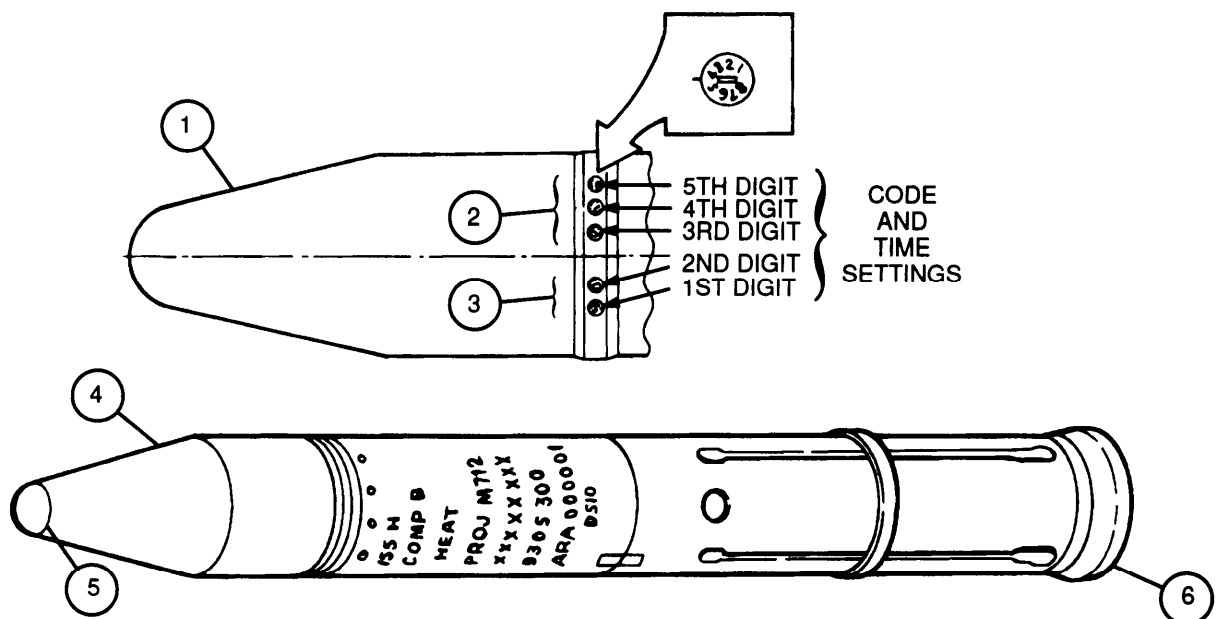
**NOTE**

- Be sure to set code and time switches in correct sequence. Always set first switch on left (looking from base of projectile toward nose) first, then the next switch to the right, etc., until all five switches have been set.
  - A noticeable click should occur at each number on the code and time switch. This click may be heard and/or felt.
- (a) Rotate code switch (2) and time switch (3) at least one complete turn, either clockwise or counterclockwise.
  - (b) Continue turning code switch (2) or time switch (3) past correct number and toward the next adjacent number, but stop before reaching next number.

## 5-16 PREPARATION FOR FIRING — CONTINUED

### b. M712 Projectile — Continued

- (c) Turn code switch (2) or time switch (3) back the other way and set on correct number. Be sure that number on code or time switch is centered on scribe line.
- 4 Set elevation of the cannon tube to approximately 300 mils. Place loading tray in loading position.
  - 5 Pass the M712 projectile (1) through the rear of the howitzer.
  - 6 Place the M712 projectile (1) on the loading tray with the nose cone (4) window (5) approximately 3 inches (7.62 cm) from the breech ring. Support the rear end of the M712 projectile at all times until it is loaded into the cannon tube. Recheck the nose cone window and obturator (6) for cleanliness. If necessary, wipe clean using a lint free cloth (item 10, Appx D) or tissue.
  - 7 Rotate the M712 projectile (1) until code and time switches (2 and 3) are up and then push M712 projectile forward until code and time switches are directly under overhead light (approximately 10 inches (25.40 cm) from breech ring).
  - 8 Visually recheck code and time switches (2 and 3). If numbers are not centered on scribe lines, or correct numbers have not been set, set them now, following procedures in step 3. Verify that the steel fin and wing retainer clamps have been removed. If the clamps have not been removed, remove before ramming the round.
  - 9 The projectile is now ready to load for firing. Loading, ramming, and firing the M712 projectile is the same as for all other ammunition in this manual.



## 5-17 MISFIRE AND CHECKFIRE PROCEDURES

The precautions and actions associated with misfire and checkfire are the same for the M712 projectile as for other projectiles in this manual. Refer to paragraph 2-15.

## 5-18 OPERATION OF PROJECTILE EXTRACTOR

### a. General

The projectile extractor (1) is used to remove the M712 and M823 projectiles from the weapon breech assembly. The following procedures include setting up the projectile extractor in preparation for use, and the breakdown procedures for stowage.

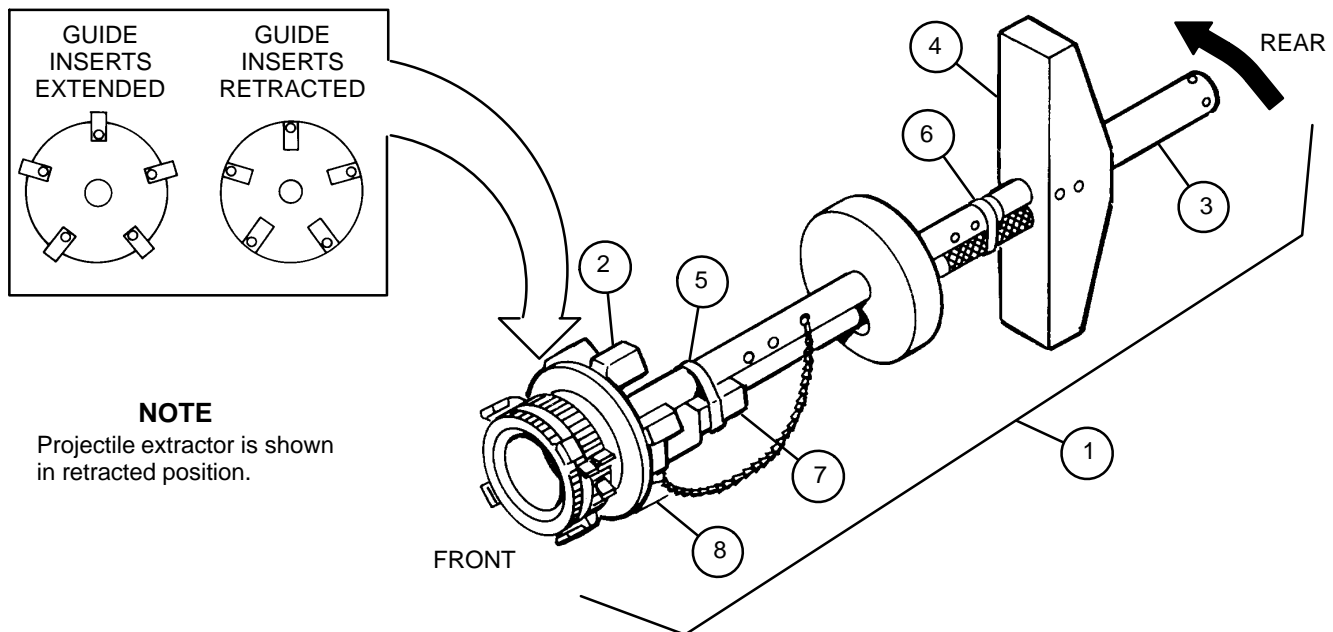
### b. Setup For Use

- 1 Get projectile extractor (1) from stowage brackets on right wall of the crew compartment.

#### NOTE

Extend the guides for M109A2/A3/A4 M185 Cannon tubes. Retract the guides for M109A5 M284 Cannon tube.

- 2 Inspect to make sure that the five guide inserts (2) on the projectile extractor (1) are correctly installed for cannon tube.
- 3 While standing at the rear loosen drive nut (3) (clockwise) to farthest white marks (forward mark).
- 4 Move brace (4) back.
- 5 Loosen two straps (5 and 6).
- 6 Remove ratchet (7).
- 7 Disengage locking pin (8).



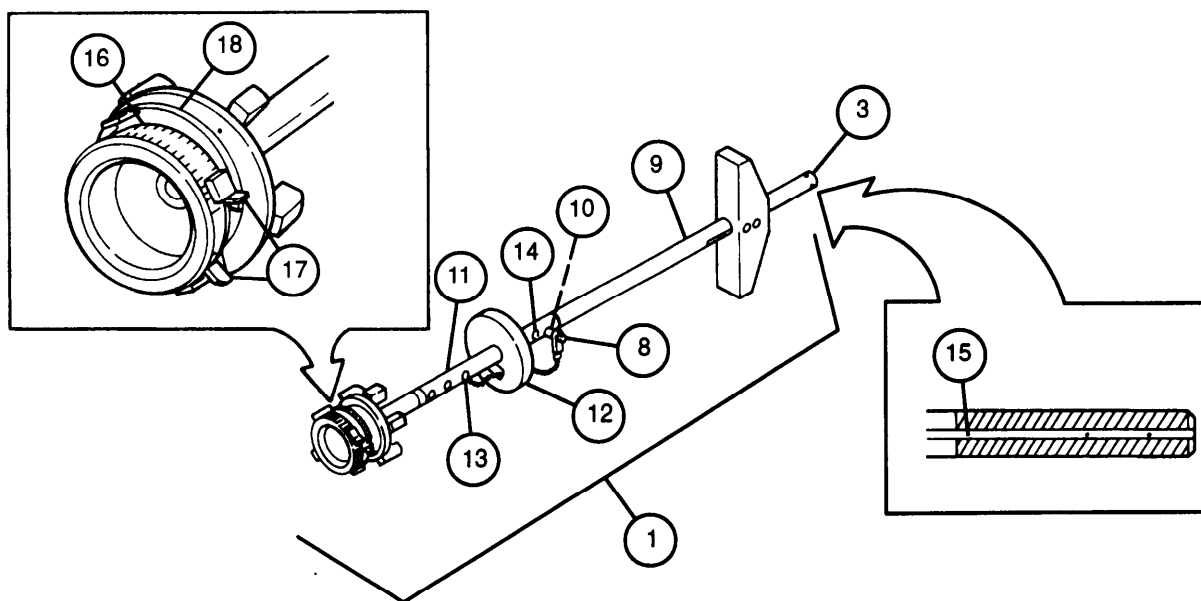
#### NOTE

Projectile extractor is shown in retracted position.

## 5-18 OPERATION OF PROJECTILE EXTRACTOR — CONTINUED

### b. Setup For Use —Continued

- 8 Extend telescoping shafts until hole in solid shaft (9) aligns with the nearest hole (10) in the hollow shaft (11).
- 9 Move alinement support (12) forward midway between locking pin chain screw (13) and the two holes (10 and 14) at end of the hollow shaft (11).
- 10 Guide the locking pin (8) through the slot in alinement support (12).
- 11 Insert locking pin (8) completely through solid shafts (9), hollow shaft (11), and into hole (10).
- 12 Turn drive nut (3) counterclockwise until forward edge of drive nut aligns with guide mark (white) on solid shaft (9) of projectile extractor (1). Use front mark (15) for M109 series howitzers.
- 13 Cock projectile extractor (1) as follows.
  - (a) Compress expansion ring (16) by squeezing tabs(17) together.
  - (b) Aline cutout in retaining ring (18) with tabs (17) on expansion ring (16) and slide retaining ring forward over expansion ring.



#### NOTE

Projectile extractor is shown in expanded position.

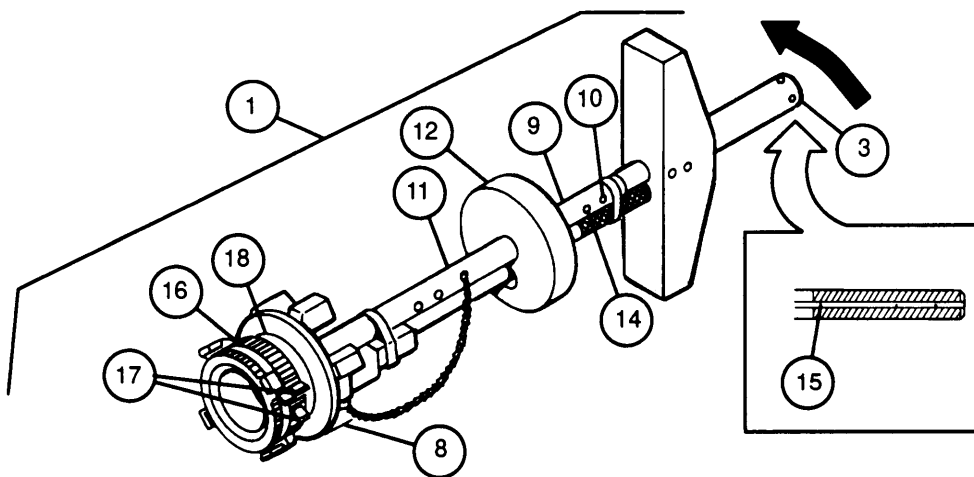
## 5-18 OPERATION OF PROJECTILE EXTRACTOR — CONTINUED

### c. Setup for Use Under Conditions of Poor Visibility

#### NOTE

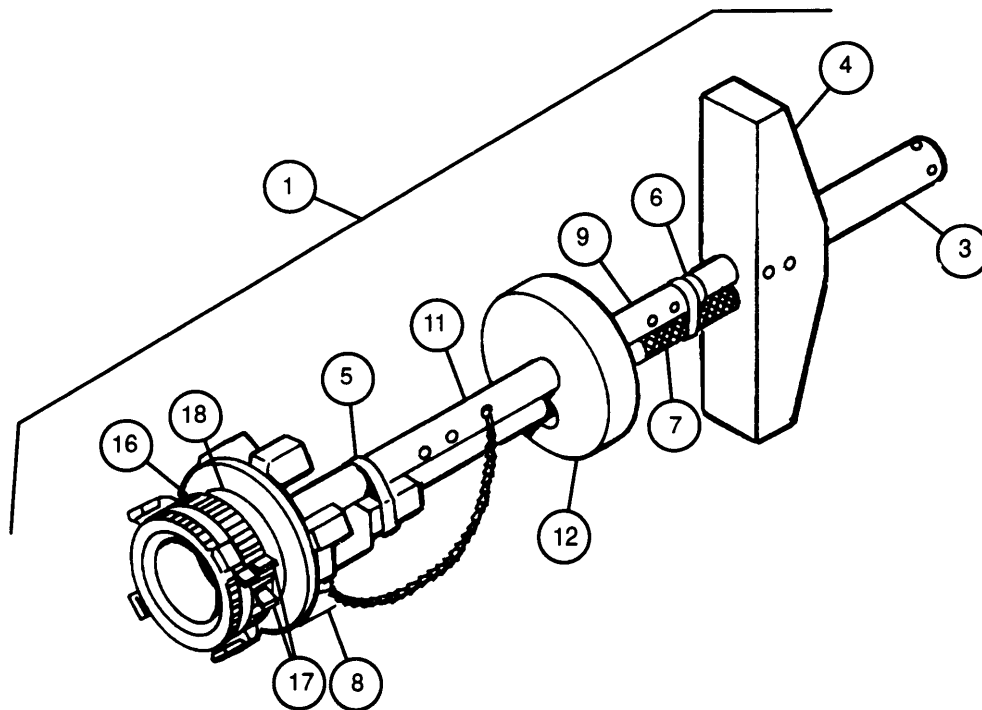
If the projectile extractor is being expanded under conditions of poor visibility, the alinement hole and shaft detent may be used as described below.

- 1 Disengage locking pin (8) and pull solid shaft (9) from hollow shaft (11).
- 2 Move alinement support (12) forward to the two holes (10 and 14) in hollow shaft (11).
- 3 Guide locking pin (8) through the slot in the alinement support (12).
- 4 Insert locking pin (8) in the alinement hole (14) (second hole from end of hollow shaft (11)).
- 5 Insert solid shaft (9) in hollow shaft (11) and rotate until alinement detent in end of solid shaft rests against locking pin (8).
- 6 While holding solid shaft (9) and hollow shaft (11), to prevent them from turning or sliding, remove locking pin (8) from alinement hole (14) and insert locking pin completely through farthest hole (10) to lock both shafts in extended position.
- 7 Turn drive nut (3) counterclockwise until forward edge of drive nut aligns with guide mark (white) on solid shaft (9) of projectile extractor (1). Use front mark (15) for M109 series howitzer.
- 8 Cock projectile extractor (1) as follows.
  - (a) Compress expansion ring (16) by squeezing tabs (17) together.
  - (b) Aline cutout in retaining ring (18) with tabs (17) on expansion ring (16) and slide retaining ring forward over expansion ring.



**5-18 OPERATION OF PROJECTILE EXTRACTOR — CONTINUED****d. Breakdown for Stowage**

- 1 Disengage locking pin (8) and compress telescoping shafts to retracted position.
- 2 Guide locking pin (8) through slot in alinement support (12).
- 3 Insert locking pin (8) completely through solid shaft (9) and hollow shaft (11).
- 4 Remove ratchet (7) and guide ratchet handle through the slot in alinement support (12).
- 5 Strap ratchet (7) to hollow shaft (11), using the straps (5 and 6) provided.
- 6 Slide brace (4) forward until it touches end of ratchet (7) handle. Turn drive nut (3) counterclockwise until brace is held firmly against ratchet handle.
- 7 Check to see if projectile extractor (1) is cocked. If it is not cocked, perform the following.
  - (a) Compress expansion ring (16) by squeezing tabs (17) together.
  - (b) Aline cutout in retaining ring (18) with tabs (17) on expansion ring (16) and slide retaining ring forward over expansion ring.
- 8 Stow projectile extractor (1) in stowage brackets on right sponson.





## 5-19 UNLOADING AN M712 PROJECTILE

**CAUTION**

Do not use bell rammer to unload the M712 projectile.

### a. Removal of Primer and Propelling Charge

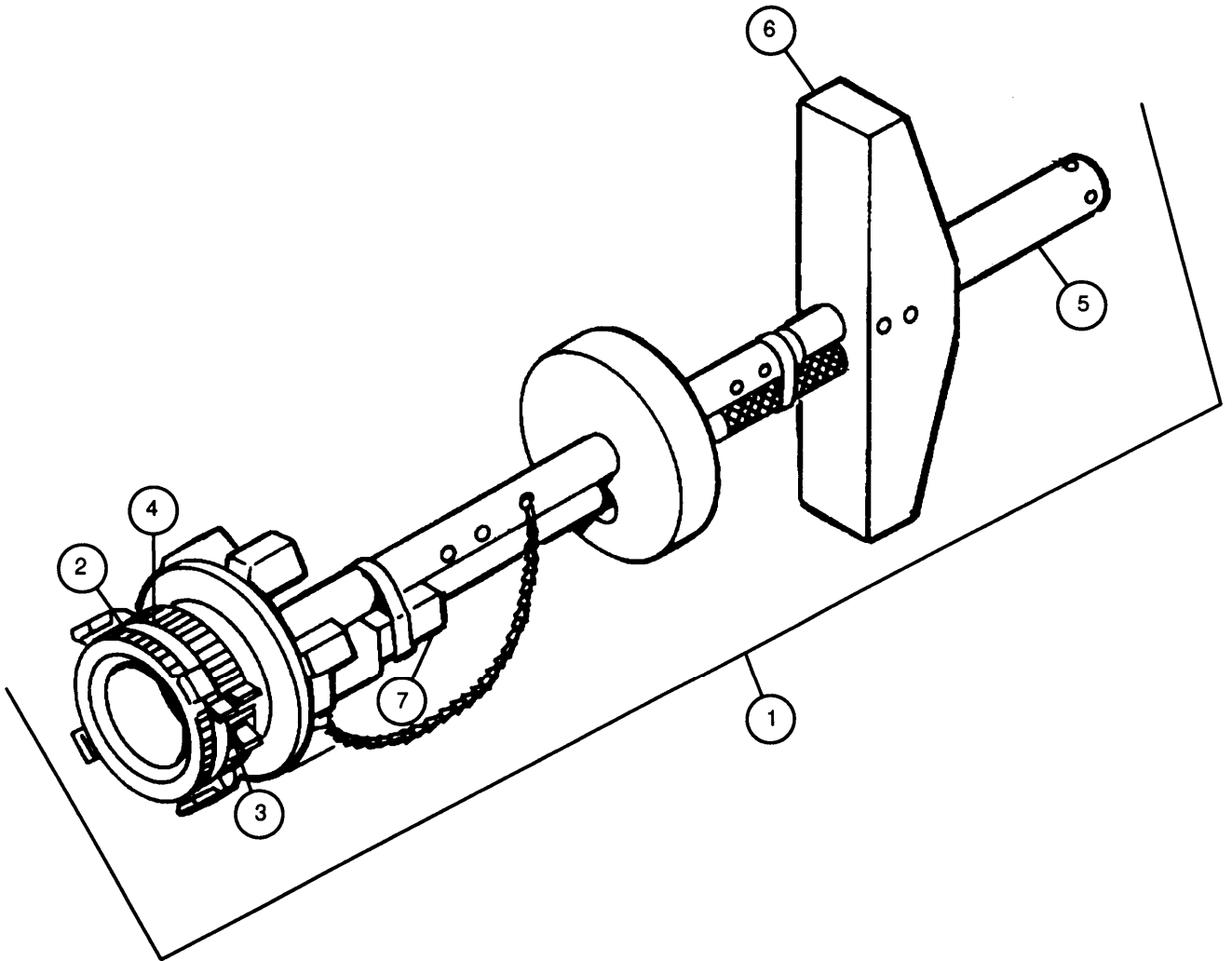
- 1 Remove primer and propelling charge as performed for other ammunition in this manual.
- 2 Elevate or depress cannon tube to approximately 300 mils.
- 3 Position loading tray in loading position.

### b. Unloading M712 Projectile

- 1 Obtain projectile extractor (1).
- 2 Check to see if projectile extractor (1) is cocked. If cocked, proceed to step 3; otherwise, cock projectile extractor as follows.
  - (a) Compress expansion ring (2) by squeezing tabs (3) together.
  - (b) Aline cutout in retaining ring (4) with tabs (3) on expansion ring (2) and slide retaining ring forward over expansion ring.
- 3 Insert projectile extractor (1) through breech ring until forward end makes contact with base of M712 projectile. Push projectile extractor firmly against M712 projectile until expansion ring (2) is seated in the base of the M712 projectile. Pull on projectile extractor to make sure that it is engaged with M712 projectile. If projectile extractor did not engage, remove it from cannon tube and repeat steps 2 through 3.
- 4 Turn projectile extractor (1) drive nut (5) counterclockwise by hand until brace (6) touches and is centered across face of breech ring assembly.
- 5 Connect ratchet (7) to end of projectile extractor (1) drive nut (5). Set ratchet to OFF and turn ratchet counterclockwise until M712 projectile is pulled free of forcing cone. Remove ratchet from drive nut.
- 6 Let M712 projectile and projectile extractor (1) slide slowly out of cannon tube until base of M712 projectile has passed through breech ring assembly. M712 projectile will have to be raised a little to pass obturator over Swiss groove.
- 7 Release projectile extractor (1) by squeezing tabs (3) on expansion ring (2).
- 8 Pass the M712 projectile out of the howitzer. Repackage the M712 projectile. If the M712 projectile is loaded in a hot cannon tube, follow the procedures in paragraph 2-15.1.

5-19 UNLOADING AN M712 PROJECTILE — CONTINUED

b. Unloading M712 Projectile — Continued



## 5-20 M712 AMMUNITION PREPARED FOR FIRING BUT NOT FIRED

### a. General

M712 projectiles that have been unpacked but not fired will be repacked within 30 days and returned to battalion ammunition section for further disposition. Long exposure of the M712 projectile to sunlight and other elements may cause it to fail. Code and time switch settings made during preparation need not be reset. An M712 projectile that has been unloaded from a weapon as result of a misfire or checkfire will be repacked as described below.

### b. Repacking M712 Projectile

#### NOTE

An M712 projectile which has been rammed and extracted from a cold cannon tube maybe reused.

- 1 Wipe all loose dirt and moisture from M712 projectile (1).
- 2 Locate original container (2). If container has become unserviceable, replace container. If original container cannot be found or has been replaced for unserviceability, make sure that markings on replacement container match markings on M712 projectile (1). If markings do not match, return container to battalion ammunition section for remarking.
- 3 Install M712 projectile (1) into container (2) as follows.
  - (a) Check red decals, stenciling, or stamping (if present) at nose end of container (2) halves to assure cover (3) and body (4) match. Switch container halves, if required.
  - (b) Open container (2) (para 5-15). Remove lifting straps (5). Also remove fin and wing preload bands (6).

#### CAUTION

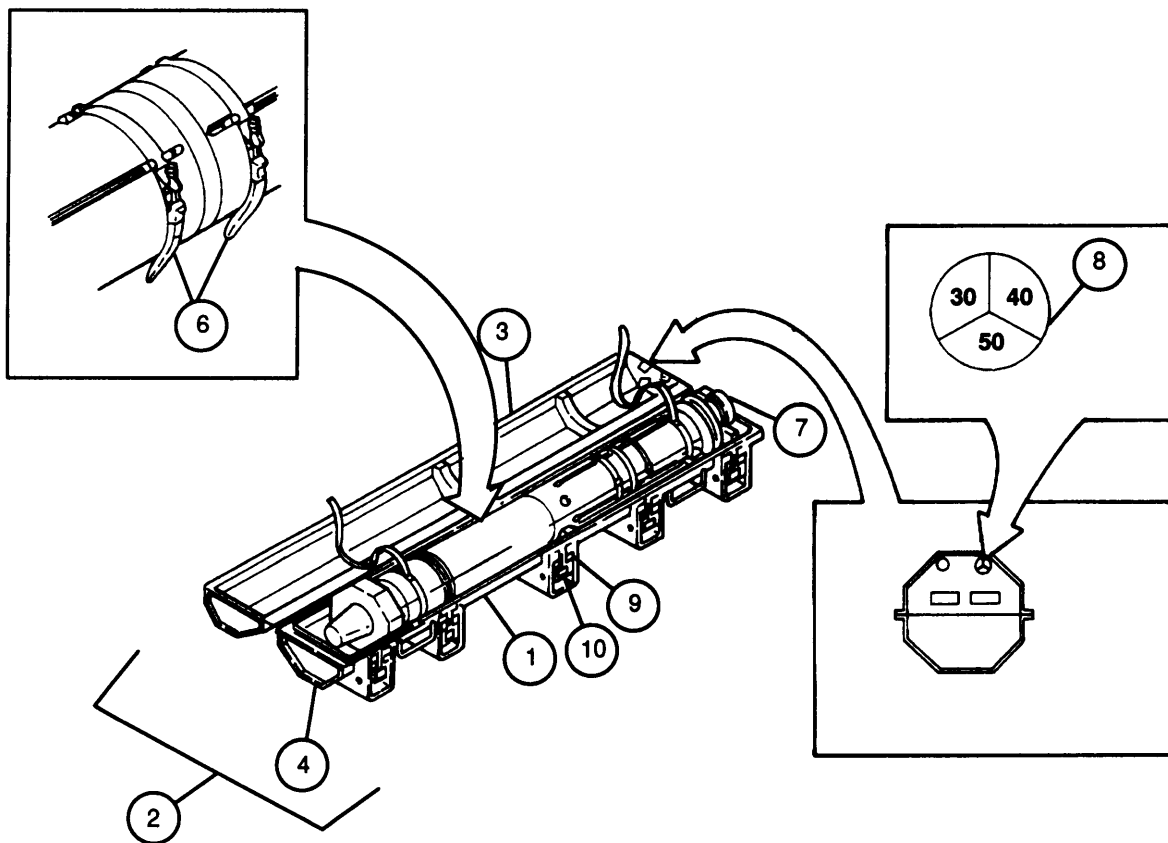
Make sure that all four fin and wing slots securely engage fins and wings.

- (c) Install fin and wing preload bands (6) on M712 projectile (1).
- (d) Install lifting straps (5) on M712 projectile (1).
- (e) Spin tension mechanism counterclockwise by hand until it stops.
- (f) Lift M712 projectile (1) and position over opened container (2).
- (g) Carefully lower M712 projectile (1), guiding nose cone into retainer ring in the container (2).
- (h) Using torquing rod (7), turn tension mechanism clockwise, as far as possible, to snug M712 projectile (1) into the retainer ring. Position torquing rod in holes so that torquing rod is horizontal (or as close to it as possible). This is required to avoid interference with the cover stops inside the cover (3).

**5-20 M712 AMMUNITION PREPARED FOR FIRING BUT NOT FIRED — CONTINUED**

**b. Repacking M712 Projectile — Continued**

- (i) Be sure that desiccant and protective bags are placed inside container (2).
- (j) Place container (2) cover (3) on lower container half in a manner that aligns the inside cradles and places both the relief valve and humidity indicator (8) to the rear of the container.
- (k) Starting on the end opposite the humidity indicator (8), straddle container (2), place T-bolts (9) in cover (3) recesses and close corresponding left and right side latches (10) at the same time in pairs.



## 5-21 STOWAGE OF M712 PROJECTILES IN HOWITZER

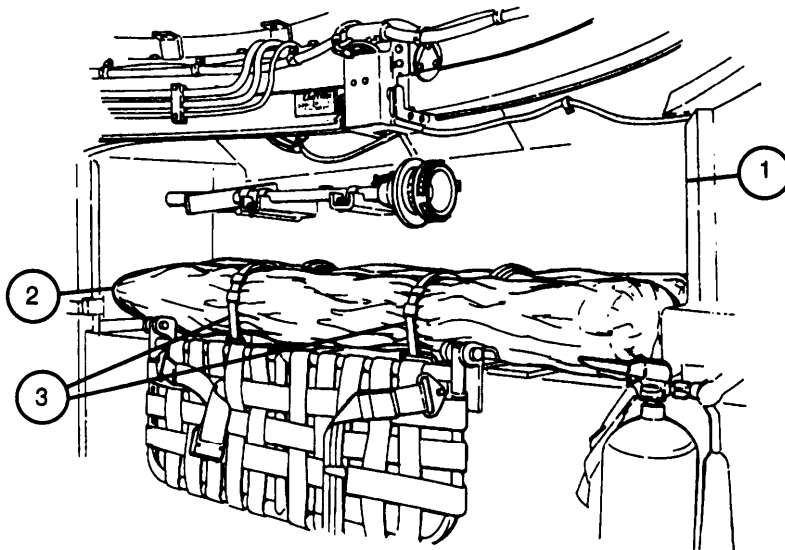
### a. General

Stowage facilities are provided for two M712 projectiles in the crew compartment of the howitzer. Use of these M712 projectiles is reserved for the time when the howitzer is operating in a buttoned-up mode or when M712 projectiles are not available from the external ammunition carrier.

### b. Stowage

The chief-of-section assisted by cannoneer no. 1 will place two uncontainerized M712 projectiles on the right-side sponson (1), with nose cone (2) facing forward. Protective bag is installed as follows.

- 1 Obtain protective bag from container and remove tie-wraps.
- 2 Remove lifting straps from M712 projectile and place lifting straps in container. As one person raises front of M712 projectile, a second person slides protective bag over M712 projectile as far as possible.
- 3 Lower M712 projectile into cradle.
- 4 Raise base of M712 projectile and slide bag over remainder of M712 projectile.
- 5 Lower M712 projectile into cradle.
- 6 Secure open end of protective bag with tie-wrap provided.
- 7 Securely fasten M712 projectile to sponson (1) with two straps (3) provided on sponson, tightening ratchets on straps.
- 8 Repeat steps 1 through 7 for second M712 projectile.

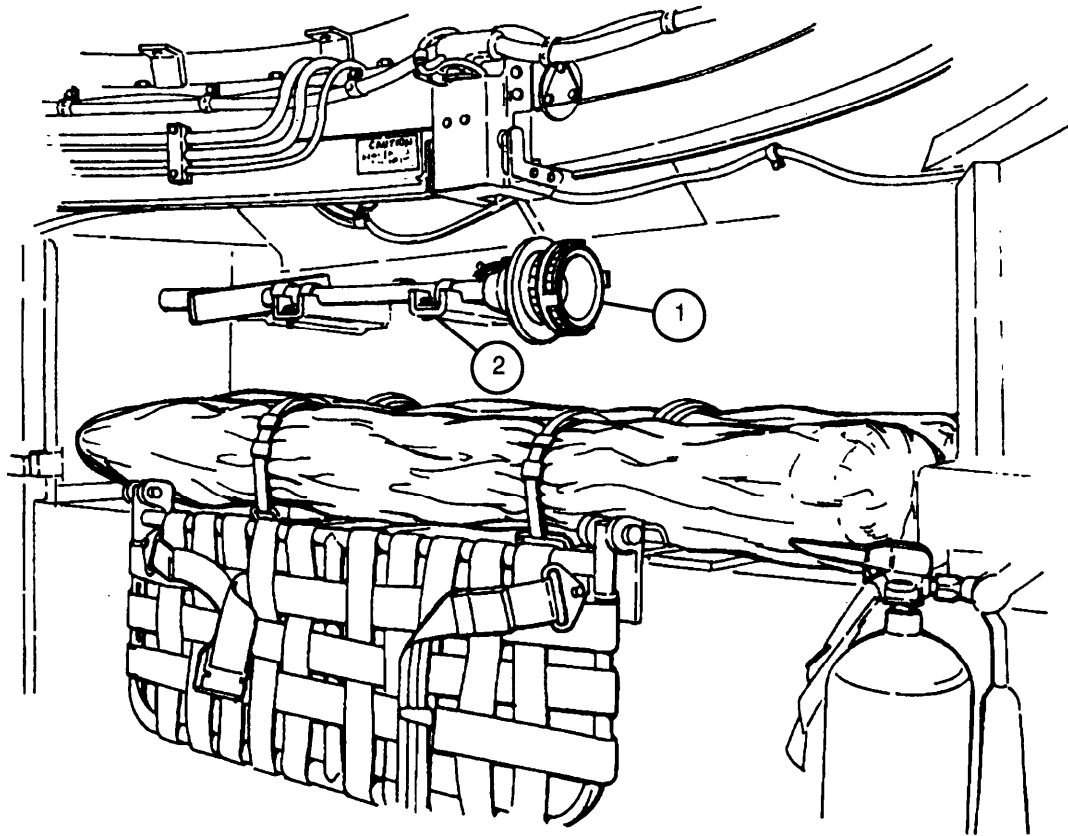


## 5-22 STOWAGE OF PROJECTILE EXTRACTOR IN HOWITZER

Stow the projectile extractor (1) in the holding brackets (2) provided. Due to space limitations, the projectile extractor must be stowed in the retracted position. See paragraph 5-18 for projectile extractor breakdown procedures.

## 5-23 M712 PROJECTILE MAINTENANCE

Humidity indicators on containerized M712 projectiles must be monitored for humidity every 90 days, as a minimum. If relative humidity in the container is 40 percent or greater, (40 percent section of humidity indicator card is not blue), turn containerized M712 projectile in to battalion ammunition section.





## CHAPTER 6

### FOREIGN AMMUNITION (NATO)

#### 6-1 GENERAL

Agreements between the United States and NATO allies have established the interoperability of weapon systems and ammunition of the nations. The agreements enable the safe and effective firing of major types of ammunition of the same size from the same compatible size and type weapon of the NATO armies.

The following pages cover only authorized German (GE), United Kingdom (UK), Canadian (CA), Netherlands (NL), French (FR), Norway (NO), Italy (IT), Denmark (DA), Greece (GR), or Belgium (BE), 155MM components. If a munitions item has not been authorized, it is because it has not yet been determined to be safe to fire or it has been determined that the munitions item cannot be safely fired from the U.S. weapon system.

**WARNING**

- Only under emergency combat conditions will zone 1 of M3A1 and DM62 propelling charge be fired from M109A2/M109A3/M109A4 M185 or M109A5 M284 cannon tube on M109 series howitzer weapon system because injury to personnel and equipment damage may occur.
- Do not mix US, GE, UK, CA, NL, FR, NO, IT, DA, GR, or BE components (i.e., projectile, propelling charge, flash reducer, fuze). Fire only all components from one nation except GE primer DM191A1. To prevent injury to personnel and equipment damage, GE must use DM191A1 primer when firing US, GE, UK, CA, NL, NO, IT, DA, GR, or BE 155MM munitions.

#### NOTE

- At the conclusion of any training exercise, ammunition drawn from a NATO nation and not fired should be returned to the NATO nation unit from whom it was obtained.
- Except as noted above, preparations for firing GE, UK, CA, NL, FR, NO, IT, DA, GR, or BE munitions in U.S. weapons system (preparation for firing, precautions during firing, misfire procedures, etc.) are contained in Chapter 5.

Foreign 155MM munitions authorized for use in U.S. M109 series howitzers are listed in Table 6-1.

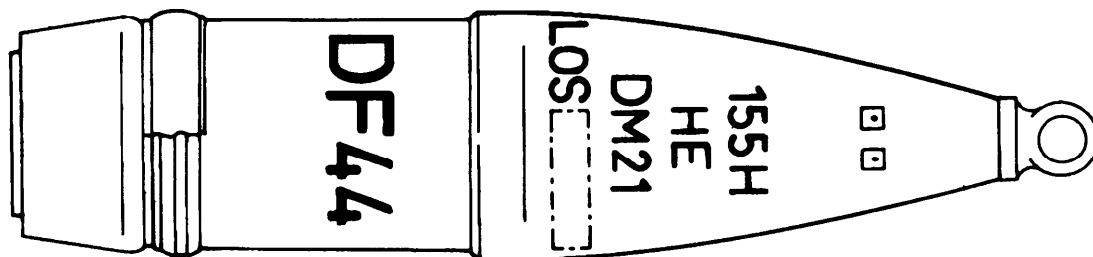
Foreign projectiles, fuzes, and primers authorized for use in U.S. M109 series howitzers are listed in Table 6-2.

U.S. munitions authorized for use in foreign M109 series howitzers are listed in Table 6-3.



**Table 6-1. FOREIGN 155MM AMMUNITION AUTHORIZED FOR USE IN U.S. M109 HOWITZERS**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
DM21 (GE), HE	High-explosive	<p style="text-align: center;"><b>NOTE</b></p> <p>The DM21 projectile is a hollow steel shell filled with TNT. A supplementary charge of 0.3 pound (0.135 kg) TNT is sealed in an aluminum container placed in the fuze cavity of the projectile.</p> <p>Weight: 92 pounds (41.7 kg)</p>	DM211 PD	For blast effect, fragmentation, and mining

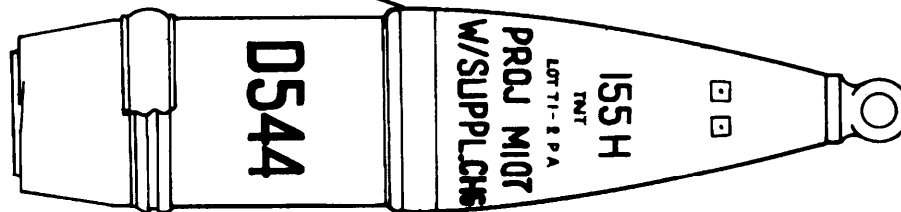


DM21 PROJECTILE

**Table 6-1. FOREIGN 155MM AMMUNITION AUTHORIZED FOR USE IN U.S. M109 HOWITZERS — CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M107, HE (UK, CA, NL, FR, NO, IT, DA, GR, BE)	<p style="text-align: center;"><b>NOTE</b></p> <ul style="list-style-type: none"> <li>The M1 07 HE projectile is a hollow steel shell filled with TNT. A supplementary charge of 0.3 pound (0.135 kg) TNT is sealed in an aluminum container placed in the fuze cavity of the projectile.</li> <li>With the exception of a yellow hazard band around the body of renovated projectile, UK munitions are identical to U.S. munitions.</li> </ul> <p>High-explosive, deep or shallow cavity</p>	<p>Weight: 92.3 pounds (41.9 kg)</p>	<p>UK: M557PD, L85A2PD CA: M557PD M564PD, M514A1 PROX NL: M 5 5 7 P D M557C PD FR: M 5 5 7 P D NO: M557 PD IT M557 PD M564 MTSQ DA: M557C1 PD M564 MTSQ GR: M557 PD M564 MTSQ BE: M557 PD M564 MTSQ</p>	<p>For blast effect, fragmentation, and mining</p>

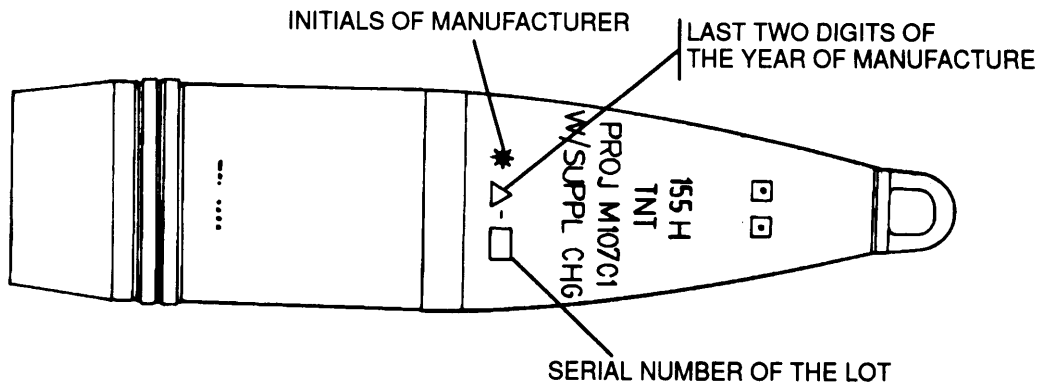
YELLOW BAND (UK ONLY) 1-1/2 INCHES (3.81 CM) WIDE



M107 PROJECTILE

**Table 6-1. FOREIGN 155MM AMMUNITION AUTHORIZED FOR USE IN U.S. M109 HOWITZERS — CONTINUED**

Authorized Projectiles	Classification	Identification	Fuzes	Remarks
M107CL (NL), HE	<p><b>NOTE</b></p> <ul style="list-style-type: none"> <li>•The M107CL projectile is a hollow steel shell filled with TNT.</li> <li>•The M107CL projectile is NL manufacture.</li> </ul> <p>High-explosive, deep or shallow cavity</p>	Weight: 92.3 pounds (41.9 kg)	M557C1 PD, TIME or PROX (deep cavity only)	For blast effect, fragmentation, and mining



M107C1 PROJECTILE

**Table 6-2. FOREIGN PROJECTILE/FUSE COMBINATIONS FOR USE IN U.S. MI 09 HOWITZERS**

PROJECTILE	COUNTRY	GREEN BAG M3 ZONES	GREEN BAG M3A1 ZONES	GREEN BAG M3C1 ZONES	WHITE BAG M4A1 ZONES	WHITE BAG M4A2 ZONES	GREEN BAG DM62 ZONES	WHITE BAG DM42B1 ZONES	OTHER	PRIMER
DM21	GE						1-5	3-7		M82(1)
M107	UK		1-5			3-7				M82
M107	CA	x (2)	x		) (2)	x				M82
M107	FR	1-5			5-7					M82 (3)
M107	NO		1-5						NM23(4) 3-7	M82
M107	IT		1-5			3-7				M82
M107	DA	1-5 <sup>(2)</sup>	1-5		3-7(2)	3-7				M82
M107	BE		1-5			3-7				M82
M107	NL				x					M82 (5) M82C1
M107C1 <sup>(5)</sup>	NL			x <sup>(5)</sup>	x				M4C3(5)	M82, M82C1(5)
M107	GR	1-5(2)	1-5		3-7(2)	3-7				M82
M107B2	GR	1-5(2)	1-5		3-7(2)	3-7				M82

**NOTE**

- (1) Do not use GE, DM191A1 primer.
- (2) These charges do not have flash reducers.
- (3) Use U.S. M82 only. Do not use MK2A4 primer. FR troops must use MK2A4 primer in FR F3AM weapon.
- (4) NM23 is same as U.S. M4A2.
- (5) Netherland manufacture.

**NOTE**

During training exercises, give either TNT or Comp B loaded 155MM, HE, M107 projectiles to UK, NL, and FR troops.

**Table 6-3. U.S. MUNITIONS AUTHORIZED FOR FOREIGN M109 HOWITZERS**

VEHICLE	COUNTRY	GREEN BAG	WHITE BAG	PRIMER
		M3A1 ZONES	M4A2 ZONES	
M109	GE	1-5	3-7	DM191A1
M109	UK	1-5	3-7	M82
M109	CA	1-5	3-7	M82
M109	NL	1-5	3-7	M82
F3AM	FR	1-5	3-7	MK2A4
M109G	NO	1-5	3-7	M82

**6-2 AUTHORIZED MUNITIONS**

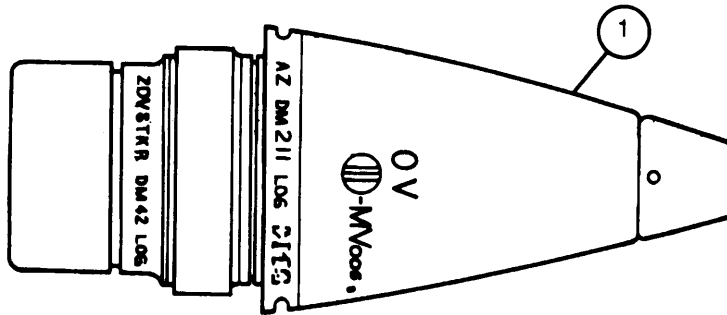
**6-2.1 Authorized Fuzes**

**a. U.S. Manufactured Fuzes**

Refer to paragraph 5-2.2 for description of U.S. manufactured fuzes.

**b. DM211 Point Detonating Fuze (GE and NO)**

The DM211 fuze (1) has a superquick element in the head consisting of a firing pin, firing pin support, and detonator. The fuze body contains a delay plunger assembly and a selective setting device for superquick or delay action. The DM211 is similar to the U.S. fuze M557.

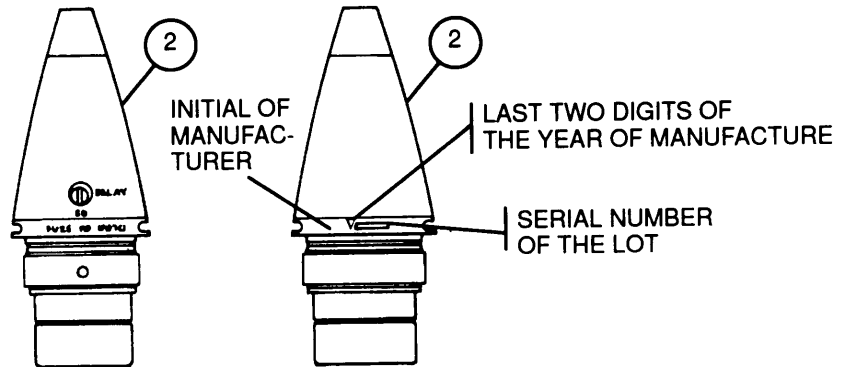


**6-2 AUTHORIZED MUNITIONS — CONTINUED**

**6-2.1 Authorized Fuzes — Continued**

**c. M557C1 Point-Detonating Fuze (NL)**

The M557C1 fuze (2) is a selective superquick or 0.05 second delay impact fuze. The M557C1 fuze is a U.S. M557 fuze with booster M125C1 of Italian manufacture. This booster is the same design as the U.S. M125A1 except it is fitted with a setback pin which locks one of the spin locks.



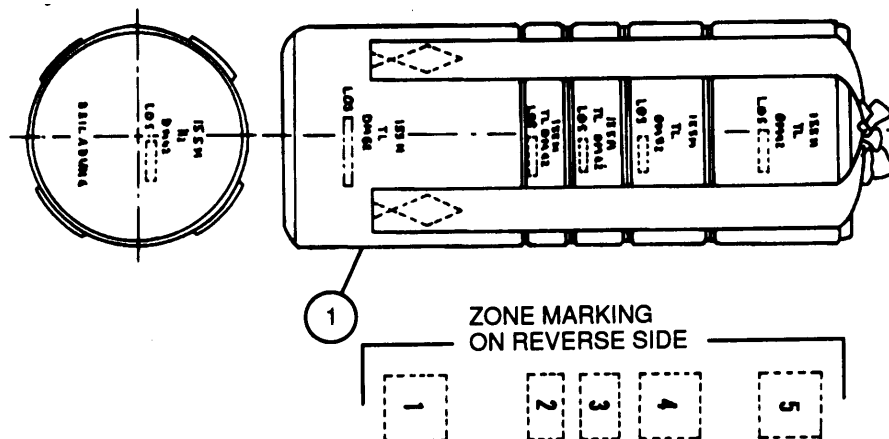
**6-2.2 Propelling Charges**

**a. U.S. Manufactured Propelling Charges**

Refer to paragraph 5-2.3 for description of US. manufactured propelling charges.

**b. DM62 Propelling Charge (GE)**

The DM62 propelling charge (1) is a green bag charge consisting of a base charge and four unequal increments loaded in cloth bags for firing in zones 1 through 5. The bags are fastened together with four cloth straps sewn to the base and tied on top of increment No. 5. The clean-burning igniter in a red or brown cloth bag is sewn to the rear of the base charge.

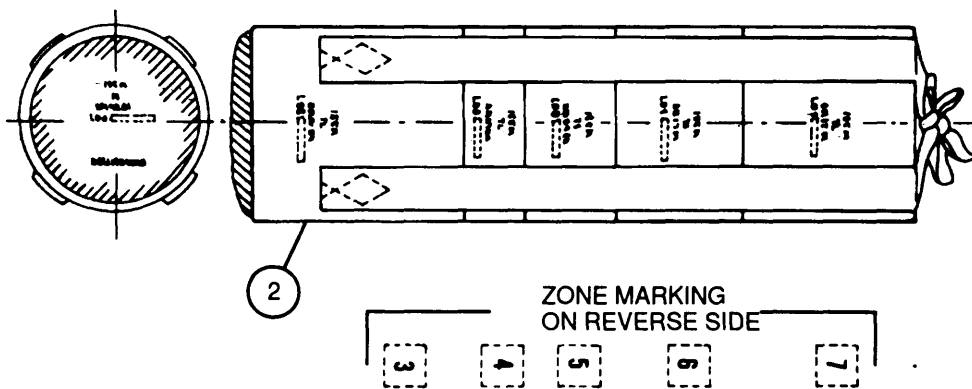


## 6-2 AUTHORIZED MUNITIONS — CONTINUED

### 6-2.2 Propelling Charges — Continued

#### c. DM42B1 Propelling Charge (GE)

The DM42B1 propelling charge (2) is a white bag charge consisting of a base charge and four unequal increments loaded in cloth bags for firing in zones 3 through 7. The increments are connected by four cloth tapes sewn to the base and tied on top of Increment No. 7. The clean-burning igniter in a red or brown cloth pad is sewn to the bottom of the base charge. A flash reducer pad is assembled at the front end of the base charge.



## 6-2 AUTHORIZED MUNITIONS — CONTINUED

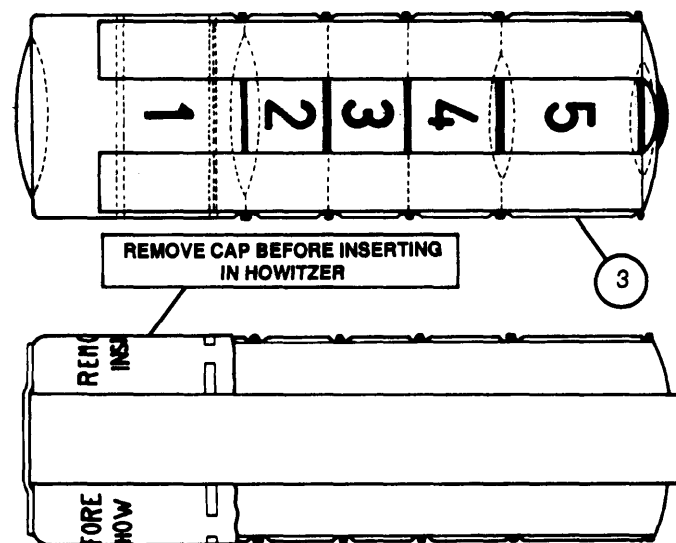
### 6-2.2 Propelling Charges — Continued

#### d. M3C1 Propelling Charge (NL)

#### NOTE

Lot number of assembled propellant charge is shown on the ground charge and all supplemental charges.

The M3C1 propelling charge (3) is a green bag charge consisting of a base charge and four unequal increments loaded in cloth bags for firing in zones 1 through 5. The bags are fastened together with four cloth straps sewn to the base and tied on top of Increment No. 5. It has a flash reducer pad forward the base charge and two flash reducer pads forward Increments 4 and 5. The clean-burning igniter in a red cloth bag is sewn to the rear of the base charge.





## 6-2 AUTHORIZED MUNITIONS — CONTINUED

### 6-2.2 Propelling Charges — Continued

#### e. M4C3 Propelling Charge (NL)

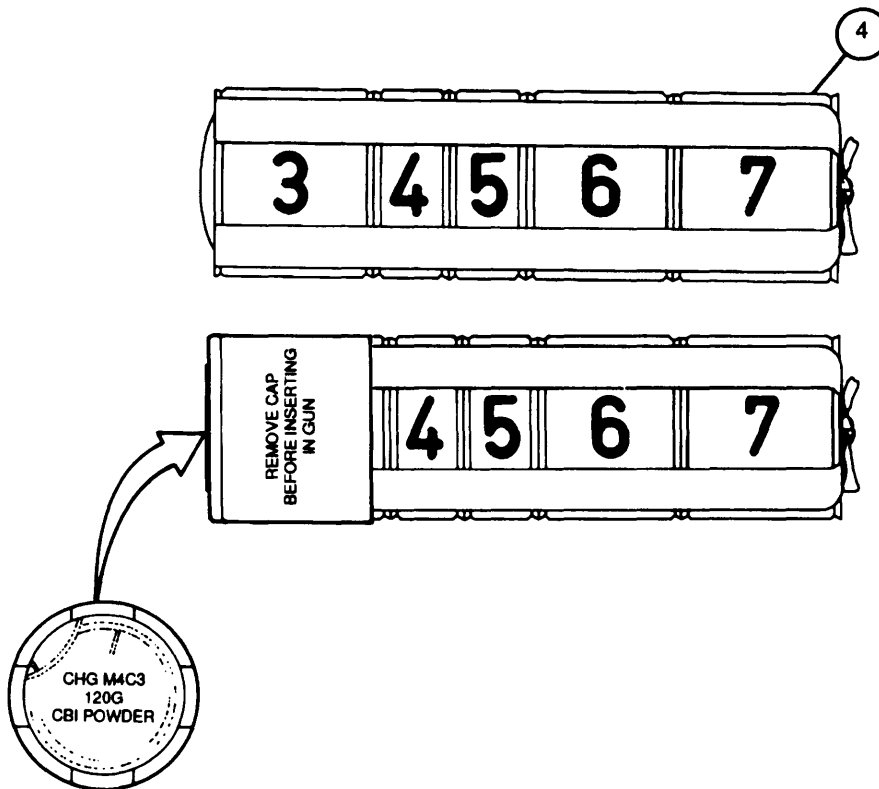
The M4C3 propelling charge (4) is a white bag charge consisting of a base charge and four unequal increments loaded into cloth bags for firing in zones 3 through 7. The increments are connected by four cloth tapes sewn to the base and tied on top of Increment 7. The clean-burning igniter in a red cloth pad is sewn to the bottom of the base charge, Increment 3. A flash reducer pad is assembled at the front end of the base charge, Increment 3.

#### NOTE

Lot number of assembled propellant charge is shown on the ground charge and all supplemental charges.

### 6-2.3 Primers

Refer to paragraph 5-2.4 for description of U.S. manufactured primers.



## APPENDIX A REFERENCES

### A-1 SCOPE

This appendix lists all forms, field manuals, technical bulletins, and technical manuals referenced in this manual.

### A-2 PAMPHLETS

Functional Users Manual for the Army Maintenance Management System (TAMMS)	DA PAM 738-750
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### A-3 FORMS

Recommended Changes to Publications	DA Form 2028
Recommended Changes to Equipment Technical Manuals	DA Form 2028-2
Equipment Inspection and Maintenance Worksheet	DA Form 2404
Weapon Record Data	DA Form 2408-4
Preventive Maintenance Schedule and Record	DD Form 314
Product Quality Deficiency Report	SF 368

### A-4 FIELD MANUALS (CIRCULARS)

NBC Contamination Avoidance	FM 3-3
NBC Protection	FM 3-4
NBC Decontamination	FM 3-5
Field Artillery Cannon Gunnery	FM 6-40
Tactics, Techniques and Procedures for the Field Artillery Cannon Battery	FM 6-50
Operations and Maintenance of Ordnance Materiel in Cold Weather	FM 9-207
First Aid for Soldiers	FM 21-11
Driver Selection, Training and Supervision, Track Combat Vehicles	FM 21-17
Manual for the Track Combat Vehicle Driver	FM 21-306

**TM 9-2350-311-10**

## **A-5 TECHNICAL BULLETINS**

Munitions, Restricted or Suspended

TB 9-1300-385

Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems

TB 750-651

## **A-6 TECHNICAL MANUALS**

Storage, Shipment, Handling, and Disposal of Chemical Agents and Hazardous Chemicals

TM 3-250

Operator's Manual, Projectile, 155 Millimeter: GB2, M687  
(NSN 1320-00-431-6249)

TM 3-1320-242-10

Operator's and Organizational Maintenance Manual Including Repair Parts and Special Tools List for Decontaminating Apparatus, Portable, 14 Liter, M13 (NSN 4230-01-133-4124)

TM 3-4230-214-12&P

Operator's Manual for Decontamination Kit, Skin: M258A1  
(NSN 4230-01-101-3984) and Training Aid, Skin Decontaminating:  
M58A1 (6910-01-101-1768)

TM 3-4230-216-10

Operator's Manual for Mask, Chemical-Biological: Aircraft, ABC-M24 and Accessories; Mask, Chemical-Biological, Tank, M25/M25A1 and Accessories

TM 3-4240-280-10

Operator's Manual for Chemical Agent Monitoring System (CAM)  
(NSN 6665-01-199-4153)

TM 3-6665-331-10

Operator's, Organizational, Direct Support, and General Support Maintenance Manual for Evaluation of Cannon Tubes

TM 9-1000-202-14

Operator's Manual for Machine Gun, Caliber .50; Browning, M2, Heavy Barrel, Flexible W/E (NSN 1005-00-322-9715) M48 Turret Type (NSN 1005-00-957-3893), Soft Mount (NSN 1005-LL-H11-5877) (NAVY) Fixed Type Right Hand Feed (NSN 1005-00-122-9339), (NAVY) Fixed Type Left Hand Feed (NSN 1005-00-122-9368), (NAVY) Mounts, Machine Gun, Caliber .50, M3 Tripod W/E (NSN 1005-00-322-9716), M63 Antiaircraft W/E (NSN 1005-00-673-3246)

TM 9-1005-213-10

Operator's, Unit, Direct Support, and General Support Maintenance Manual Including Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts) for M90 Radar Chronograph (NSN 1290-01-073-0764) (EIC:3TB) (TM 08221A-14&P)

TM 9-1290-359-14&P

**A-2 Change 2**

**A-6 TECHNICAL MANUALS - CONTINUED**

Operator's, Unit, Direct Support, and General Support Maintenance Manual Including Repair Parts and Special Tools List through Depot Level for Conventional Muzzle Velocity System M94 Part No: 12950994 (NSN 1290-01-412-5760) (EIC:3TB) {TM 09814A-14&P}	TM 9-1290-364-14&P
Ammunition and Explosives Standards	TM 9-1300-206
General Maintenance Procedures for Fire Control Materiel	TM 9-254
Operator's, Organizational, DS and GS Maintenance Manual for Lead-Acid Storage Batteries	TM 9-6140-200-14
Operator's Manual for Radio Set AN/PRC-68 (NSN 5820-01-079-9260)	TM 11-5820-882-10
Operator's Manual for SINCGARS Ground Combat NET Radio, ICOM Manpack Radio AN/PRC-1 19A (NSN 5820-01-267-9482) (EIC: L2Q) Short Range Vehicular Radio ANNRC 87A (582041-267-9480) (EIC: L22) Short Range Vehicular Radio with Single Radio Mount ANNRC-87C (5820-01-304-2045) (EIC: GDC) Short Range Vehicular Radio with Dismount ANNRC-88A (5820-01-267-9481) (EIC: L23) Short Range Vehicular Radio with Dismount and Single Radio Mount ANNRC-88C (5820-01-304-2044) (EIC: GDD) Short Range/Long Range Vehicular Radio ANNRC-89A (5820-01-267-9479) (EIC: L24) Long Range Vehicular Radio ANNRC-90A (5820-01-268-5105) (EIC: L25) Short Range/Long Range Vehicular Radio with Dismount ANNRC-91 A (5820-01-267-9478) (EIC: L26) Long Range/Long Range Vehicular Radio AN/VRC-92A (5820-01-267-9477) (EIC: L27)	TM 11-5820-890-10-1
Operator's and Organizational Maintenance for Intercommunications Set, AN/VIC-1 (V) (NSN 5830-00-856-3273); and Control Intercommunications Set, C-10456/VRC (NSN 5830-01-082-0804)	TM 11-5830-340-12
Operator's and Organizational Maintenance Manual for Computer Group, Gun Direction OL-200/GYK-29 (V) (NSN 7025-01-134-2331) (P/O Computer System, Gun, Direction, AN/GYK-29 (V))	TM 11-7440-283-12-1
Operator's and Organizational Maintenance Manual for Data Display Groups, Gun, Direction OD-144 (V)/GYK-29 (NSN 7025-01-134-2329) OD-144 (V) 2/GYK-29 (V) (NSN 7025-01-134-3218) OD-144 (V) 3/GYK-29 (V) (NSN 7025-01-134-3219) (P/O Computer System Gun Direction, AN/GYK-29 (V))	TM 11-7440-283-12-2
Army Ammunition Data Sheets for Artillery Ammunition: Guns, Howitzers, Mortars, Recoilless Rifle, Grenade Launchers and Artillery Fuzes	TM 43-0001-28

**TM 9-2350-311-10**

## **A-6 TECHNICAL MANUALS - CONTINUED**

Destruction of Conventional Ammunition and Improved Conventional Munitions (ICM) to Prevent Enemy Use	TM 43-0002-33
Painting Instructions for Army Materiel	TM 43-0139
Procedures for Destruction of Tank Automotive Equipment to Prevent Enemy Use	TM 750-244-6

## **A-7 REGULATIONS**

Notices, Instructions, and Report to Workers	10 CFR Part 19
Standards for Protection Against Radiation	10 CFR Part 20
Reporting of Defects and Noncompliance	10 CFR Part 21
Malfunctions Involving Ammunition and Explosives	AR 75-1
Accident Reporting and Records	AR 385-40
Prevention of Motor Vehicle Accidents	AR 385-55
Policies and Procedures for Training, Target Practice and Combat	AR 385-63

## **A-8 TABLES**

Army Medical Department Expendable/Durable Items	CTA 8-100
Expendable/Durable Items (Except: Medical, Class V, Repair Parts and Heraldic Items)	CTA 50-970

## **A-9 OTHER**

NRC License, License Conditions, and License Application
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## APPENDIX B

### COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

#### Section I. INTRODUCTION

##### B-1 SCOPE

This appendix lists components of the end item and basic issue items for the M109A2/M109A3/M109A4/M109A5 howitzer to help you inventory the items for safe and efficient operation of the equipment.

##### B-2 GENERAL

The Components of End Item (COEI) and Basic Issue Items (BII) Lists are divided into the following sections:

- a. Section II, Components of End Item. This listing is for informational purposes only, and is not authority to requisition replacements. These items are part of the M109A2/M109A3/M109A4/M109A5 howitzer. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Items of COEI are removed and separately packaged for transportation or shipment only when necessary. Illustrations are furnished to help you find and identify the items.
- b. Section III, Basic Issue Items. These essential items are required to place the M109A2/M109A3/M109A4/M109A5 howitzer in operation, operate it, and to do emergency repairs. Although shipped separately packaged, BII items must be with the M109A2/M109A3/M109A4/M109A5 howitzer during operation and when it is transferred between property accounts. This list is your authority to request/requisition items for replacement, based on authorization of the end item by the TOE/MTOE. Illustrations are provided to help you find and identify the items.

##### B-3 EXPLANATION OF COLUMNS

- a. Column (1), Illus Number, gives you the number of the item illustrated.
- b. Column (2), National Stock Number, identifies the stock number to be used for requisitioning.
- c. Column (3), Description and Usable on Code, identifies the Federal item name (in all capital letters) followed by a minimum description when needed. The last line below the description is the Commercial and Government Entity Code (CAGEC) (in parentheses) and the part number.

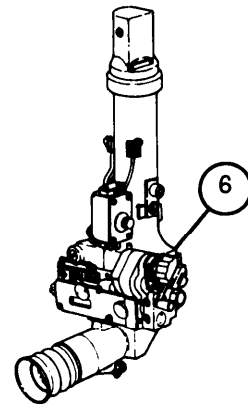
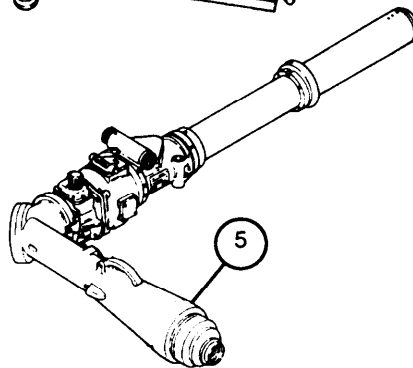
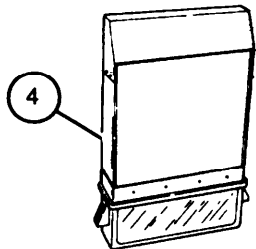
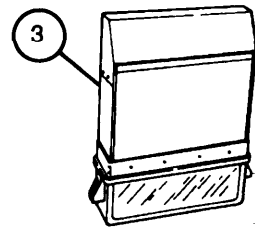
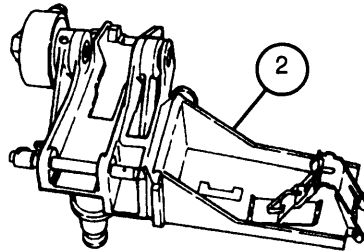
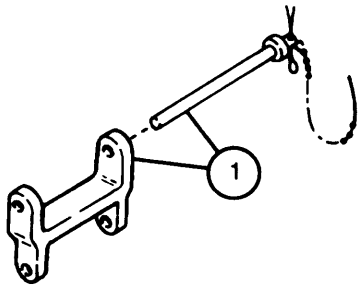
If the item you need is not the same for different models of the equipment, a Usable On Code will appear on the right side of the description column on the same line as the part number. These codes are identified below:

<u>CODE</u>	<u>USED ON</u>
G56	ModelM109A2
G78	ModelM109A3
AA5	Model M109A4
AH9	ModelM109A5

- d. Column (4), U/I (unit of issue), indicates how the item is issued for the National Stock Number shown in column two.
- e. Column (5), Qty Rqd, indicates the quantity required.

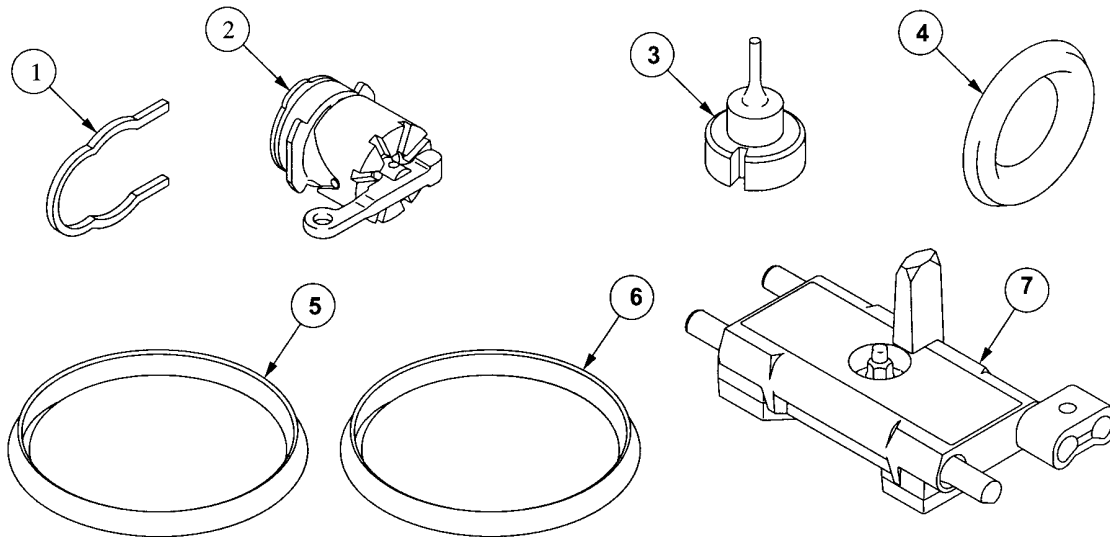
Section II. COMPONENTS OF END ITEM

COMPONENTS OF END ITEM LIST



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
1	1025-01-202-0418	ARM ASSEMBLY, ADAPTER (19200)12011777		EA	1
2	1005-00-704-6650	MOUNT, MACHINE GUN, CAL. 50 (19204)7046650		EA	1
3	1240-00-344-4643	PERISCOPE: M27 (chief of section's) (19200)7633132		EA	1
4	1240-00-509-2743	PERISCOPE, M45 (driver's) (19200)8213430		EA	3
5	1240-01-092-2693	TELESCOPE, M118A2 ELBOW (19200)118829207		EA	1
	1240-01-317-9241	or TELESCOPE, M118A3 ELBOW (19200)9356014		EA	1
6	124040-864-2930	TELESCOPE, M117 PANORAMIC (19200)7660400	Some G78	EA	1
	1240-00-106-7754	or TELESCOPE, M117A2 PANORAMIC (19200)11739510		EA	1

**ON-BOARD SPARES**



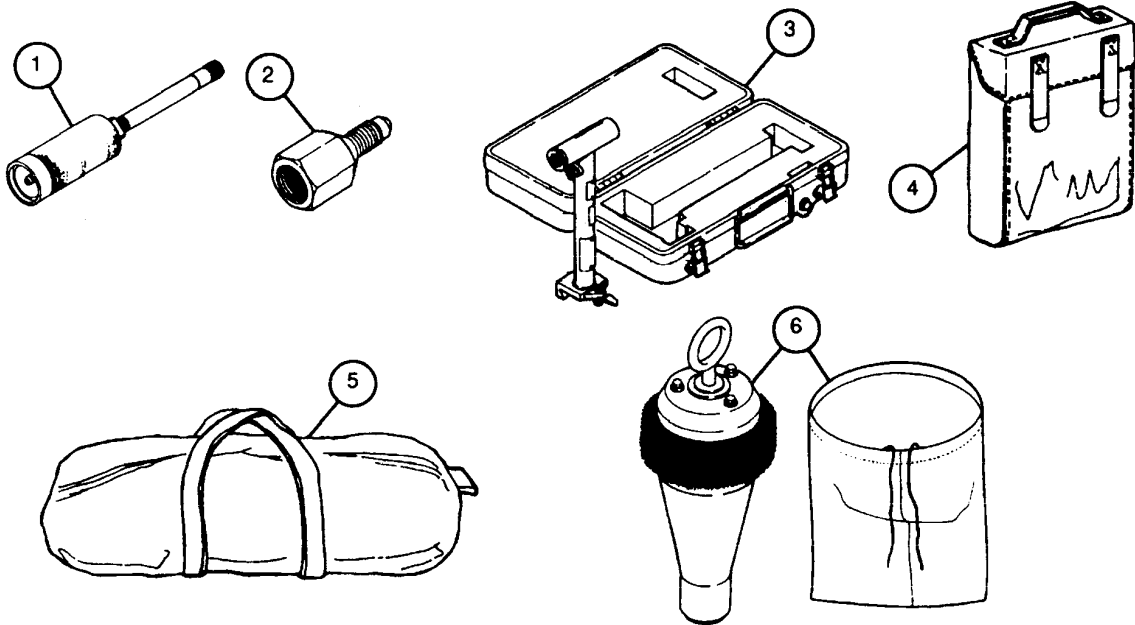
(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
*1	5340-01-368-9993	CLIP, RETAINING (cab rear stowage box) (19206) 11580634	AH9	EA	1
*2	1025-01-292-0960	FIRING MECHANISM, M49 (cab rear stowage box) (19206) 11580122	AH9	EA	1
*3	1025-00-361-1349	PIN, FIRING (cab rear stowage box) (19206) 11580504	AH9	EA	1
*4	1025-01-012-8271	RING, OBTURATOR, PAD (cab rear stowage box) (19206) 11578862	AH9	EA	1
*5	5365-00-861-1467	RING, RETAINING (FRONT) (cab rear stowage box) (19206) 8767139	AH9	EA	1
*6	5365-00-861-1468	RING, RETAINING (REAR) (cab rear stowage box) (19206) 8767140	AH9	EA	1
*7	2530-01-346-9233 or 2530-01-799-0020	TRACK SHOE, VEHICULAR (top rear exterior, cab) (19207) 12268550-1 (T-154) or (19207) 10954051-1 (T136)	AH9	EA	2

\* Designated as on-board spares which must accompany the end item in indicated quantities



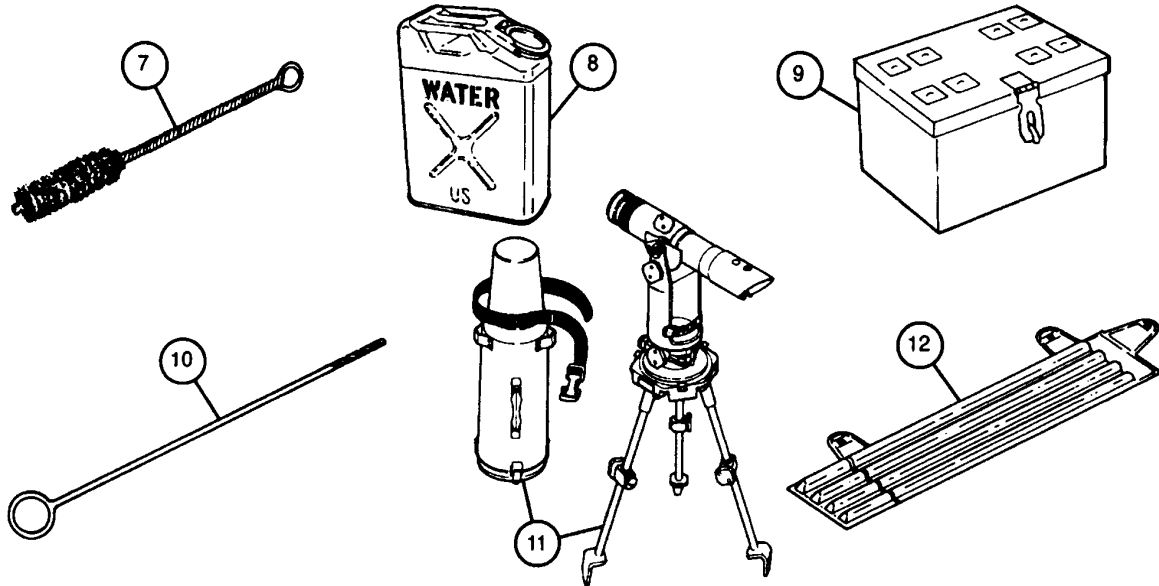
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
1	4930-00-204-2550	ADAPTER, GREASE GUN thin stem (19207) 5349744		EA	1
2	4933-00-087-1267	ADAPTER, GUN, OIL FILLING (19207) 11635708		EA	1
3	4931-01-472-7329	ALINEMENT DEVICE, M140A1 WITH CASE (19200) 12984665		EA	1
4	2540-00-670-2459	BAG ASSEMBLY, PAMPHLET (19207) 11676920		EA	1
5	5140-00-473-6256	BAG, TOOL, SATCHEL (19207) 11655979		EA	1
6	1025-01-196-2176	BRUSH AND BAG ASSEMBLY (27412) 155-110-401		EA	1

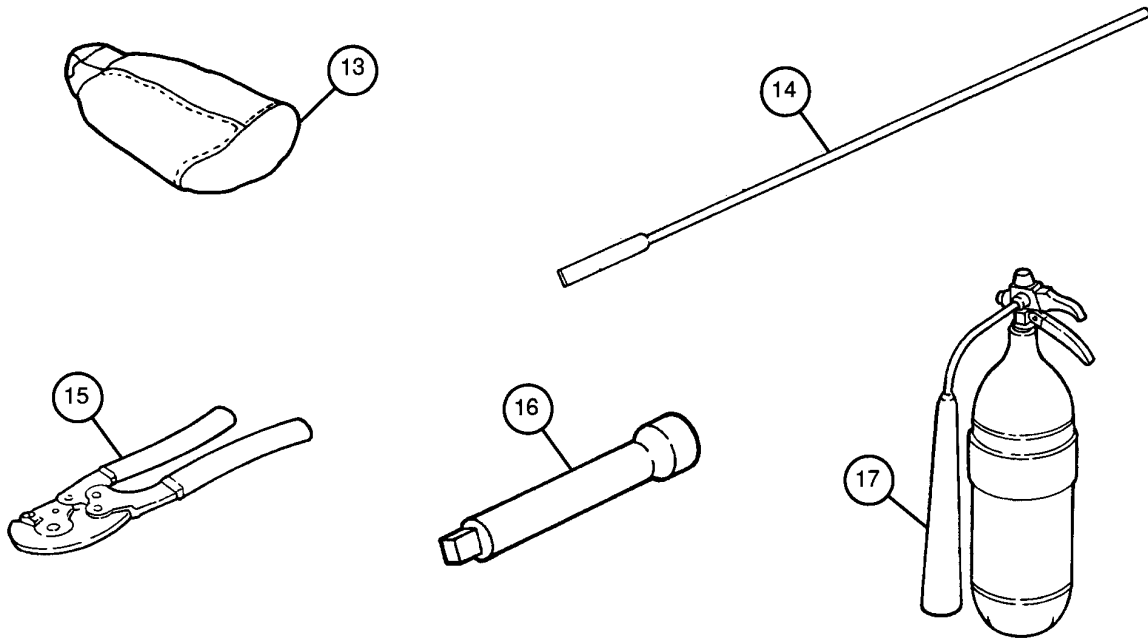
**BASIC ISSUE ITEMS LIST – CONTINUED**



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	(4) Usable U/I on Code	(5) Qty Reqd
7	4933-00-730-7183	BRUSH, CLEANING, PRIMER (19206) 7307183	EA	1
8	7240-00-089-3827	CAN, WATER MILITARY 5 gal. std (81349) MIL-C-43613-1 Tan or	EA	2
	7240-01-365-5317	(81349) MIL-C-43613-2 Green	EA	2
9	1240-00-654-6089	CASE, OPTICAL SPOTTING (19200) 6546089	EA	1
10	4933-00-601-9667	CLEANING TOOL, VENT (19206) 6019667	EA	1
11	1240-01-465-5452	COLLIMATOR, M1A2 (19200) 12984644	EA	1
12	1290-00-653-7993	COVER, FIRE CONTROL (19200) 6537993	EA	1

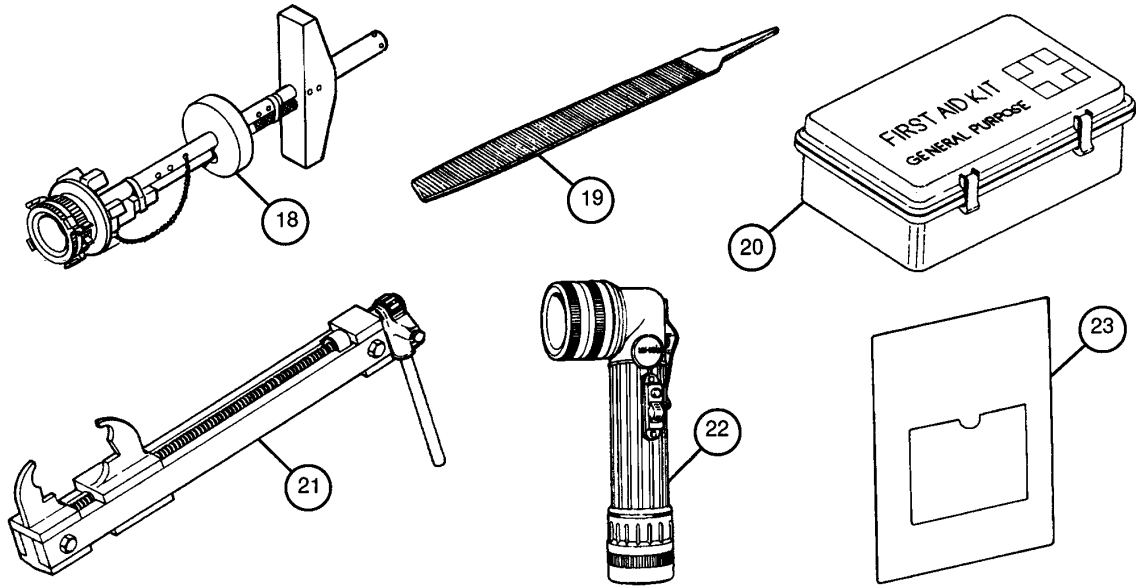
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST – CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
13	1025-01-054-5781	COVER, MUZZLE BRAKE sewn (19206) 11579522		EA	1
14	5120-00-224-1390	CROWBAR pinch point, 5 feet lg, 1-1/4 inches wd (80064) 1833244		EA	1
15	5110-00-595-8229	CUTTER, WIRE ROPE, HAND OPERATED (19207) 11655981		EA	1
16	5120-00-243-7326	EXTENSION, SOCKET WRENCH 1/2 inch dr., 5 inches lg (18876) 10394793		EA	1
17	4210-00-270-4512	EXTINGUISHER, FIRE, CO <sub>2</sub> portable, 3 pounds (19207) 7714780		EA	1

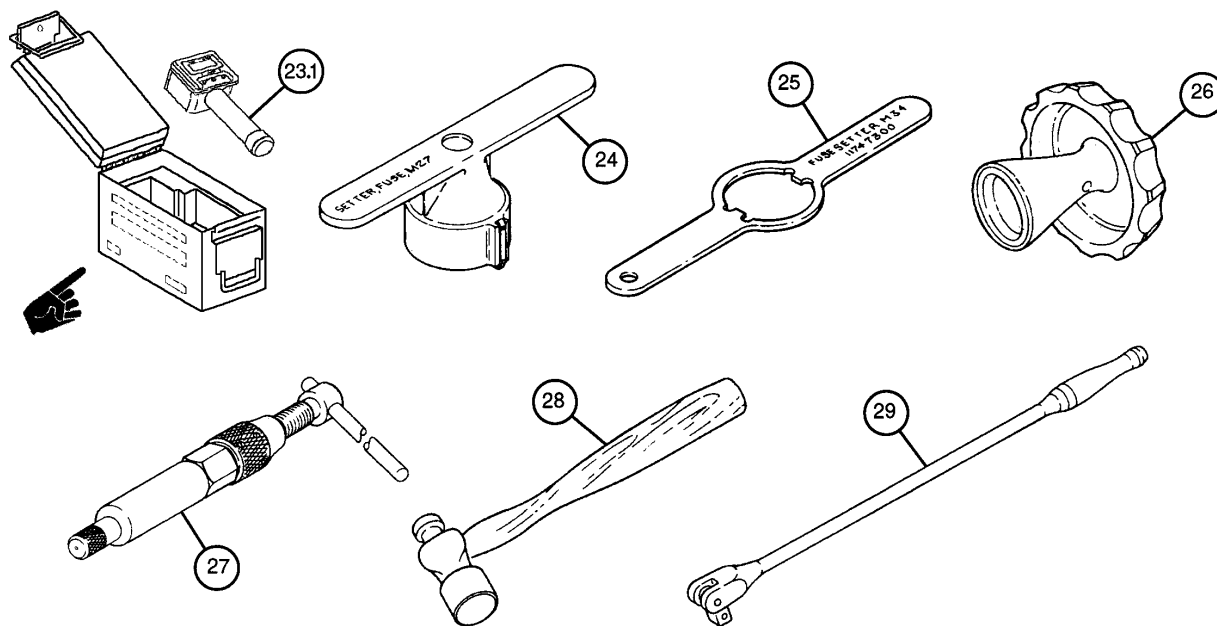
**BASIC ISSUE ITEMS LIST - CONTINUED**



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
18	1025-01-082-3586	EXTRACTOR, PROJECTILE (19200) 9305465		EA	1
19	5110-00-156-0059	FILE, HAND smooth, 10 inches lg (19204) 41F1030		EA	1
20	6545-00-922-1200	FIRST AID KIT, GENERAL (19207) 11677011		EA	1
21	5120-00-605-3926	FIXTURE, TRACK CONNECTOR (19207) 8741739		EA	2
22	6230-00-264-8261	FLASHLIGHT (81349) MIL-F-3747		EA	3
23	7510-00-889-3494	FOLDER, EQUIPMENT RECORD (19207) 11677003		EA	1

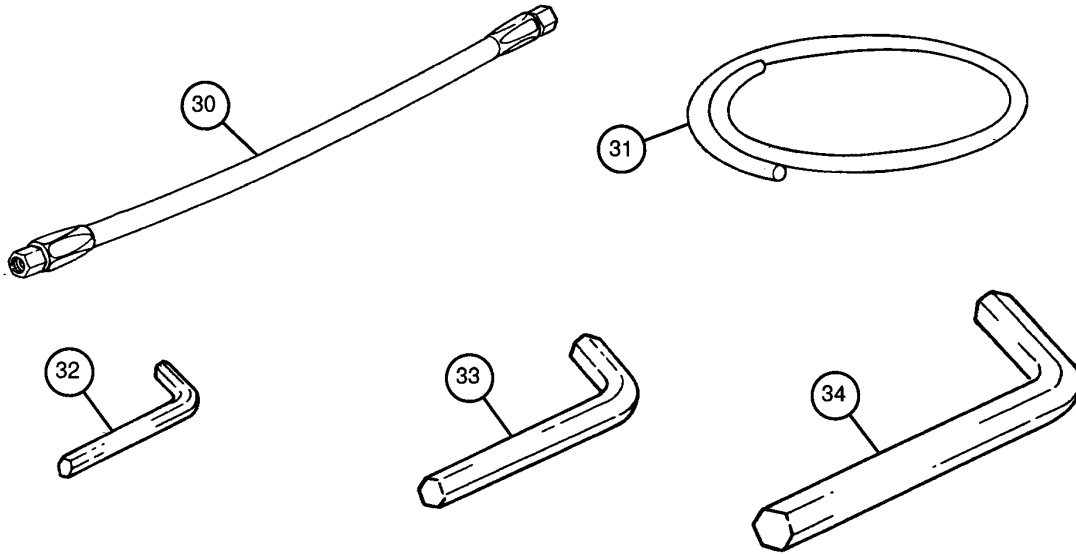
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST – CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
23.1	1290-01-480-1390	FUZE SETTER, M1155 (19200) 12994059		EA	1
24	1290-00-764-7761	FUZE SETTER, M27 (19200) 7647761		EA	1
25	1290-00-078-4367	FUZE SETTER, M34 (19200) 11747300		EA	1
26	1290-00-201-3507	FUZE SETTER, M35 (19200) 11729019		EA	1
27	4930-00-550-6661	GUN, OIL PNEUMATIC, M3 (19204) 5506661		EA	1
28	5120-00-061-8546	HAMMER, HAND machinist's, 2 pound ball peen (81348) GGG-H-86		EA	1
29	5120-00-236-7590	HANDLE, SOCKET WRENCH hinged, 1/2-inch dr., 17 inches lg (19207) 11655786-1		EA	1

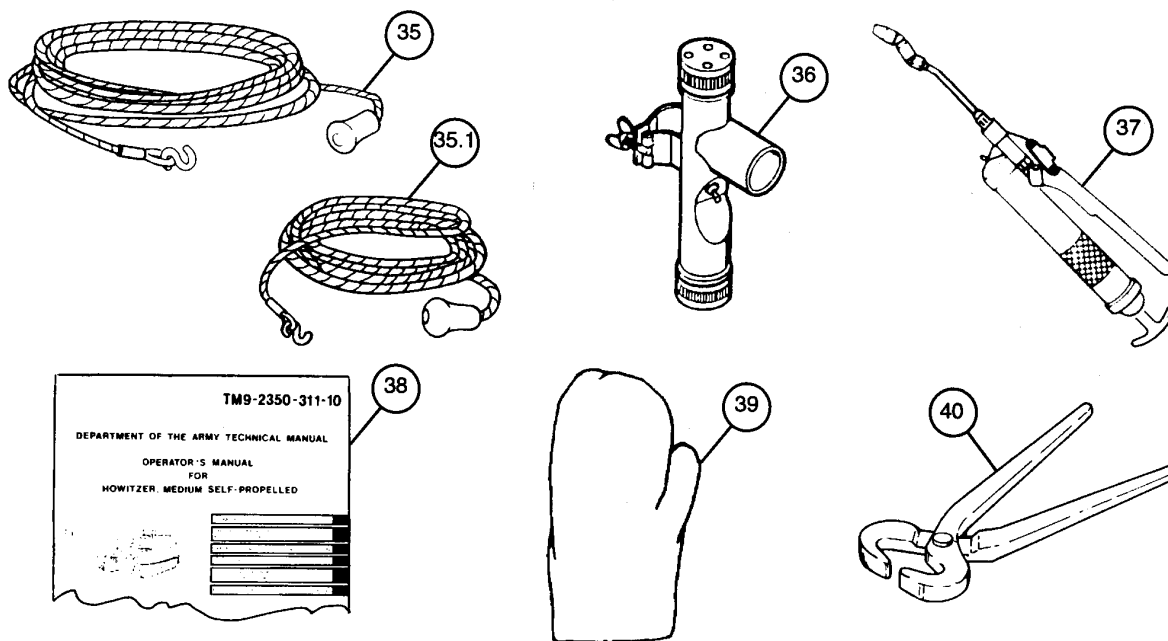
**BASIC ISSUE ITEMS LIST - CONTINUED**



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
30	4720-00-289-6335	HOSE ASSEMBLY, NON-METALLIC (used w/M3 oil gun) (96906) MS28741-4-0160		EA	1
31	4720-00-277-8982	HOSE, NON-METALLIC 24 inches lg (81349) MIL-M-5593		EA	1
32	5120-00-198-5390	KEY, SOCKET HEAD SCREW 3/8 inch (80064) 1940722		EA	1
33	5120-00-240-5274	KEY, SOCKET HEAD SCREW 5/16 inch (19200) 7596961		EA	1
34	5120-00-240-5300	KEY, SOCKET HEAD SCREW 3/16 inch (81348) GGG-K-275		EA	1

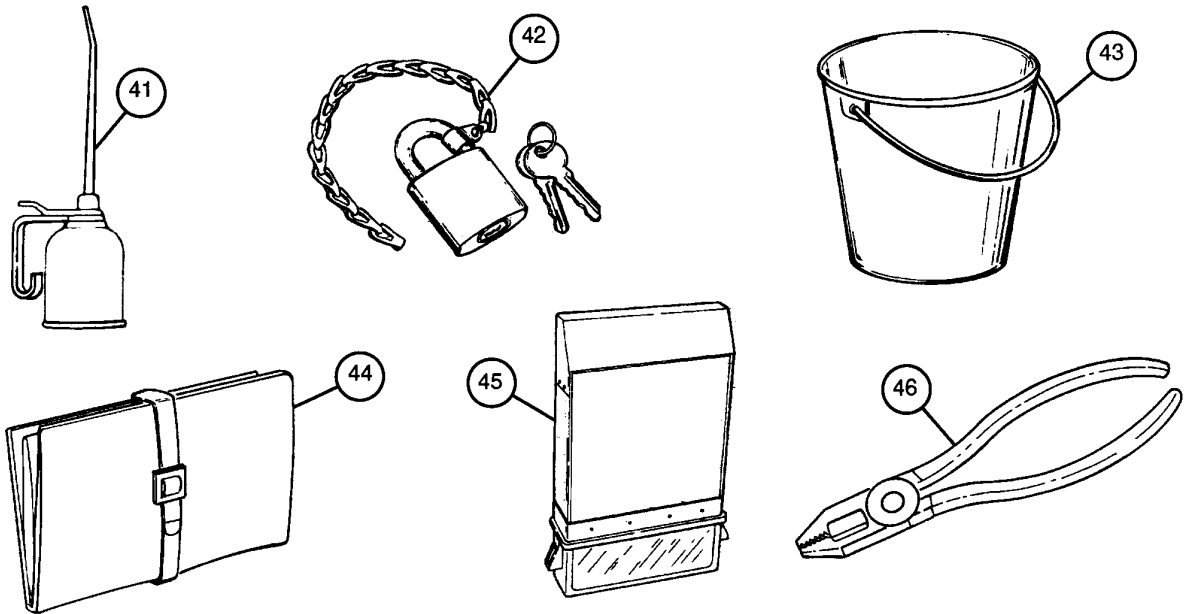
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST – CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
35	4020-00-610-9018	LANYARD (FIBER ROPE ASSEMBLY) 50 feet (19204) 6109018		EA	1
35.1	1095-00-600-6780	LANYARD 6 FT (19207) 6006780		EA	1
36	1290-01-487-6058	LIGHT, AIMING POST, M14 (11934) SLB10525		EA	2
37	4930-00-766-3545	LUBRICATING GUN, HAND high pressure (36251) 102758		EA	1
38		MANUAL, OPERATOR'S, HOWITZER MEDIUM, SELF-PROPELLED: 155MM M109A2/M109A3/M109A4/M109A5 (TM 9-2350-311-10)		EA	1
39	8415-01-092-0039	MITTEN, HEAT PROTECTIVE (81349) MIL-M-11199F		EA	2
40	5110-00-221-1499	NIPPERS, END CUTTING (81348) GGG-N-350		EA	1

**BASIC ISSUE ITEMS LIST – CONTINUED**

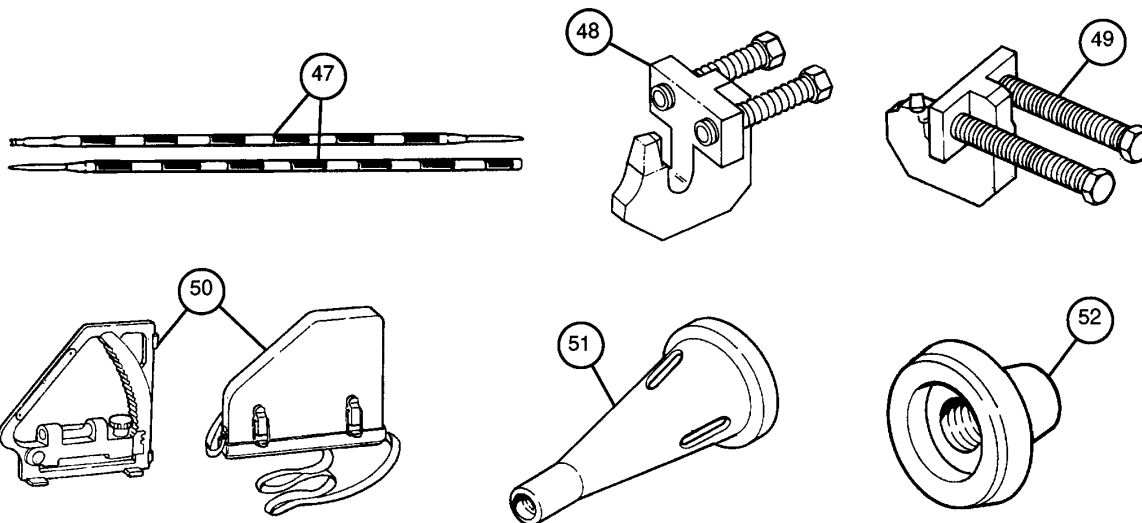


(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
41	4930-00-262-8868	OILER, HAND steel, pump type, 1 pint, spout, 9 inches lg (72798) 328		EA	1
42	5340-00-158-3807	PADLOCK SERIES 200 (81349) MILP17802		EA	3
43	7240-00-160-0455	PAIL, UTILITY 14 quart (58536) A-A-1273		EA	1
44	8345-00-174-6865	PANEL, MARKER signal, ground to air (81349) MIL-P-40061		EA	2
45	1240-00-509-2743	PERISCOPE, M45 (driver's) (19200) 8213430		EA	1
46	5120-00-239-8251	PLIERS linesman side cutting, 8 inches lg (95683) 41P1839		EA	1



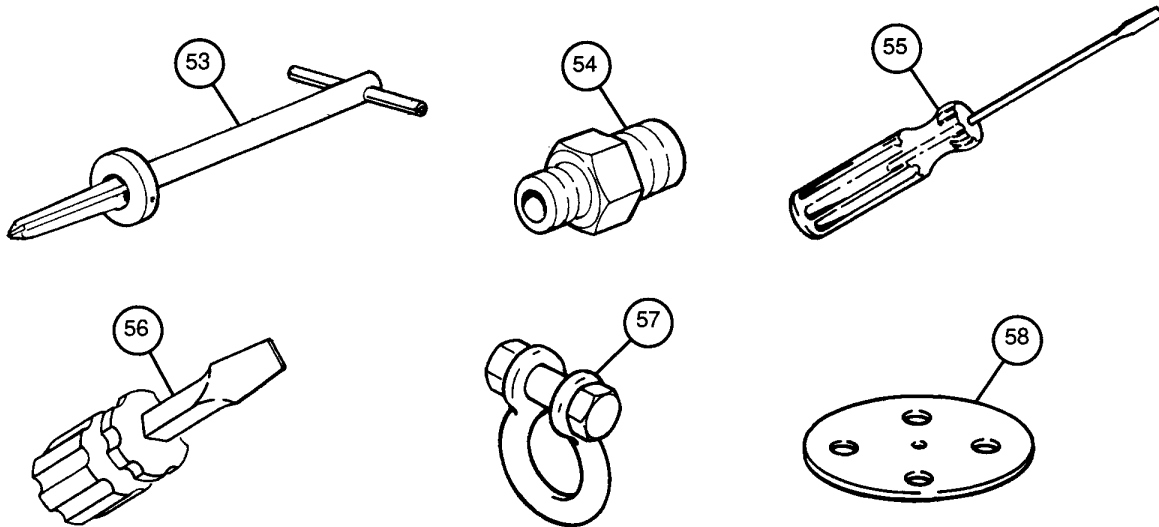
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST – CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
47	1290-00-535-7617	POST, AIMING, M1A2 (19200) 7687114		EA	2
48	5120-00-918-0596	PULLER, CONNECTOR, T-136 TRACK (19207) 10955156		EA	1
49	5180-01-477-8120	PULLER KIT, CONNECTOR, T-154 TRACK (19207) 57K3254		EA	1
50	1290-00-891-9999	QUADRANT, FIRE CONTROL, GUNNER'S M1A1 w/case (19200) 7197156		EA	1
51	1025-00-860-5443	RAMMER, ARTILLERY, UNLOADING (19206) 8767210		EA	1
52	1030-00-730-7416	RAMMER, ARTILLERY LOADING, M13 (19206) 7307416		EA	1

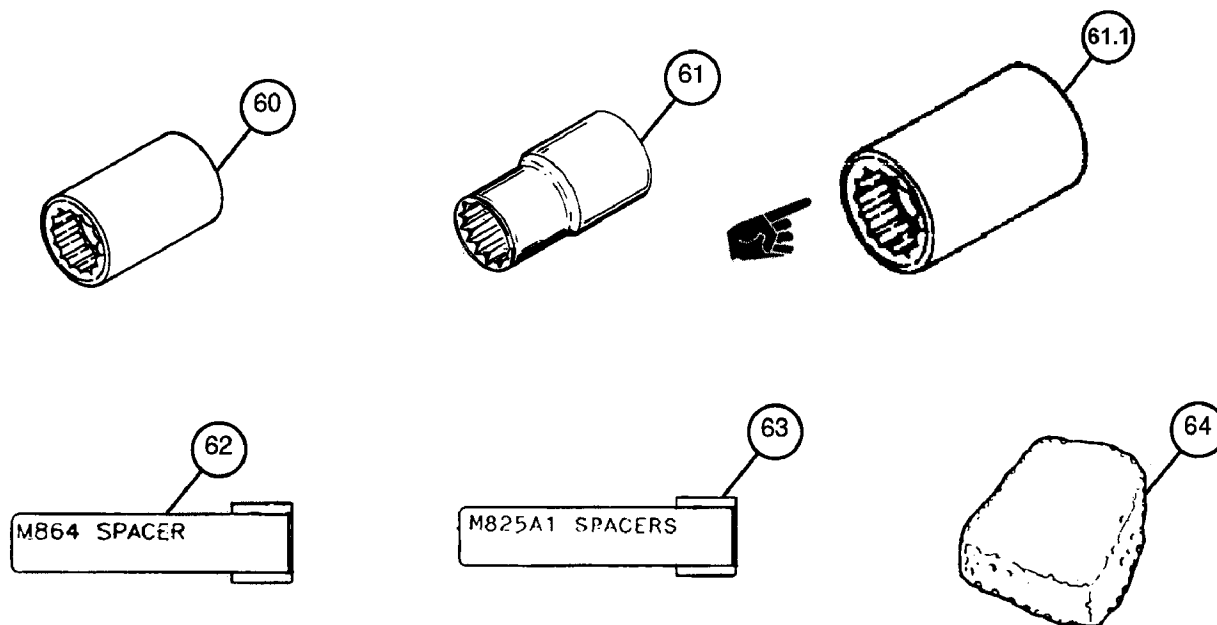
**BASIC ISSUE ITEMS LIST – CONTINUED**



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
53	5110-01-026-5253	REAMER, HAND (19206) 11578743		EA	1
54	4730-00-804-1907	REDUCER, TUBE (use w/M3 oil gun) (96906) MS24399-4		EA	1
55	5120-00-236-2140	SCREWDRIVER, FLAT TIP special purpose, 1/8 inch tip w/clip, 1-1/2 inches lg (80204) B107.15.TY1CL1/CL2DED		EA	1
56	5120-00-596-8502	SCREWDRIVER, FLAT TIP special purpose, 1/4 inch tip w/blade, 1-1/2 inches lg (63653) 45-11465TW		EA	1
57	4030-01-187-0964	SHACKLE, SAFETY ANCHOR (19207) 12328579		EA	4
58	4933-00-860-5445	SIGHT, BORE, BREECH (19206) 8767214		EA	1

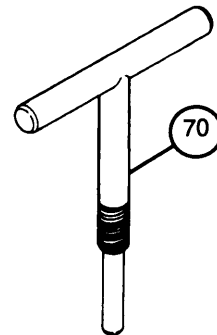
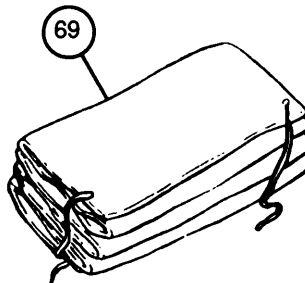
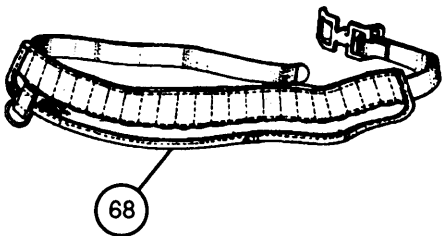
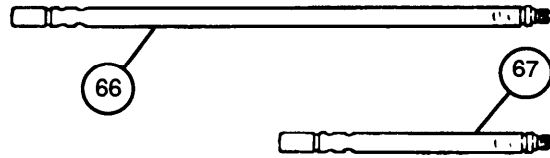
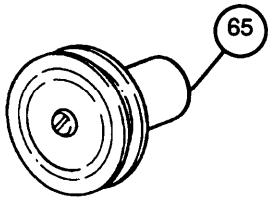
Section II. COMPONENTS OF THE END ITEM – CONTINUED

BASIC ISSUE ITEMS LIST – CONTINUED



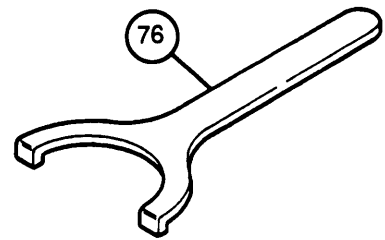
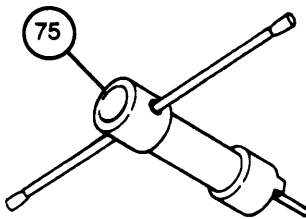
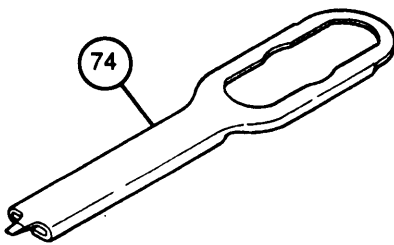
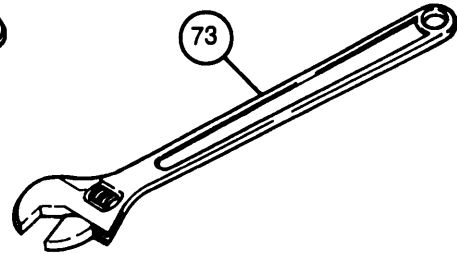
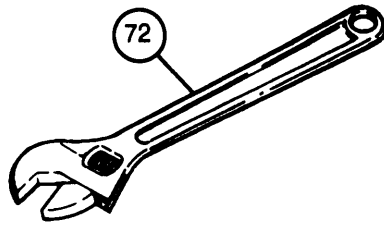
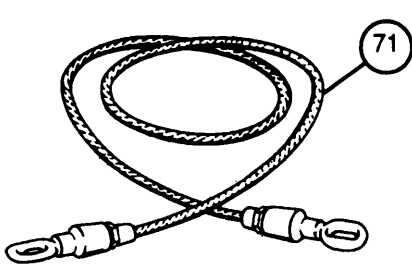
(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	Usable on Code	(4) U/I	(5) Qty Reqd
59	5120-00-189-7927	SOCKET, SOCKET WRENCH 1/2 inch dr. X 1 inch, 12 inch pt. X 1 inch opng (19207) 1167025-7		EA	1
60	5120-00-189-7932	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. X 9/16 inch opng (19207) 1167025-1		EA	1
61	5120-00-237-0984	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. X 1/2 inch opng (95683) 41W3007		EA	1
61.1	5120-00-189-7914	SOCKET, SOCKET WRENCH (19207) 11677025		EA	1
62	5365-01-333-4725	SPACER, PROJECTILE, M864 (19200) 12944302		EA	10
63	5365-01-334-9446	SPACER, PROJECTILE, M825A1 (19200) 9399090		EA	6
64	1025-01-232-6822	SWAB, CHAMBER (27412) 155CS		EA	1

BASIC ISSUE ITEMS LIST — CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	(4) Usable U/I on Code	(5) Qty Reqd
65	1030-00-859-4511	STAFF SECTION, CLEANING sponge (19206)8765688	EA	1
66	1025-00-563-7232	STAFF SECTION, CLEANING ARTILLERY M15A1 (19206)7309288	EA	7
67	1025-01-044-2587	STAFF SECTION, CLEANING ARTILLERY (2-foot) (19206)11579227	EA	1
68	5340-00-860-5446	STRAP, WEBBING (19206)8767215	EA	1
69	2540-00-653-7589	TARPAULIN w/ropes (19207)6537589	EA	1
70	5340-01-318-0197	T-HANDLE, MANUAL CONTROL (19207)9399097	EA	1

BASIC ISSUE ITEMS LIST — CONTINUED



(1) Illus Number	(2) National Stock Number	(3) Description CAGEC and Part Number	(4) U/I Usable on Code	(5) Qty Reqd
71	4010-00-202-2425	WIRE, ROPE ASSEMBLY towing cable 1-1/8 inches x 10 feet lg (19207) 7360553	EA	1
72	5120-00-240-5328	WRENCH, ADJUSTABLE single end, 15/16 inch, 8 inches lg. (92878)1500559	EA	1
73	5120-00-264-3796	WRENCH, ADJUSTABLE single end, 15/16 inch, 12 inches lg. (19207)11655778-5	EA	1
74	4933-00-723-1161	WRENCH, FUZE SETTER, M18 (19206)7231161	EA	1
75	5120-00-446-3750	WRENCH, SPANNER obturator nut (19206)8769014	EA	1
76	5120-00-293-0206	WRENCH, SPANNER (81348)GGG-W-665	EA	1

## **APPENDIX C ADDITIONAL AUTHORIZATION LIST**

### **Section I. INTRODUCTION**

#### **C-1 SCOPE**

This appendix lists additional items authorized for the support of the M109A2/M109A3/M109A4/M109A5 howitzer.

#### **C-2 GENERAL**

This list identifies items that do not have to accompany the M109 series, self-propelled howitzers and that do not have to be turned in with the vehicles. These items are all authorized by CTA, MTOE, TDA, or JTA.

#### **C-3 EXPLANATION OF LISTING**

National stock numbers, descriptions, and quantities are provided to help identify and request the additional items required to support this equipment.

Section II. ADDITIONAL AUTHORIZATION LIST

ADDITIONAL AUTHORIZATION LIST

(1) National Stock Number	(2) Description CAGEC and Part Number	Usable on Code	(3) U/I	(4) Qty Recm
4930-00-288-1511	ADAPTER, GREASE GUN 12 inches lg. (81349) MIL-L-4387		EA	1
5120-00-227-8088	ADAPTER, SOCKET WRENCH 1/2 inch - 3/4 inch (58536) A-A-2172		EA	1
5110-00-293-2336	AXE, SINGLE BIT 4 lb (19207) 6150925		EA	1
5120-00-526-6044	BAR, PINCH 1/2 inch x 11-7/8 inches lg. (19204) 5266044		EA	1
2540-00-906-4741	BOX, ACCESSORIES STOWAGE (19207) 10870949		EA	1
5140-00-261-4994	BRUSH, CLEANING, ARTILLERY (19200) QAA-1414		EA	1
5110-00-236-3272	CARRIER, TOOL (19207) 11655787		EA	1
5120-00-227-8074	CHISEL, COLD, HAND 3/4 inch x 8 inches lg. (81348) GGG-C-313		EA	1
5120-00-227-8074	EXTENSION, SOCKET WRENCH 1/2 inch dr. x 10 inches lg. (19207) 11655788-1		EA	1
5120-00-227-8079	EXTENSION, SOCKET WRENCH 3/4 inch dr. x 16 inches lg. (55719) L122		EA	1
5120-00-273-9208	EXTENSION, SOCKET WRENCH 3/4 inch dr. x 3 inches lg. (81348) GGG-W-641		EA	1
5110-00-241-9160	FILE, HAND three square, smooth, 6 inches lg. (81348) GGG-F-325		EA	1
4933-00-340-1129	FIXTURE AND CASE, GUN TUBE LEVELING (19206) 11578744		EA	1 per btry

## ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	Usable on Code	(3) U/I	(4) Qty Recm
5120-00-900-6097	HAMMER, HAND double face with handle, 10 pounds (81348)GGG-H-86		EA	1
5120-00-288-6574	HANDLE, MATTOCK-PICK (19207)11677021		EA	2
5120-00-099-8544	HANDLE, SOCKET WRENCH T-handle 3/4 inch dr. x 12 inches lg. (50024)2479141		EA	1
5120-00-249-1071	HANDLE, SOCKET WRENCH 1/2 inch dr. nutspeeder (58536)A-A-2166		EA	1
5120-00-230-6385	HANDLE, SOCKET WRENCH ratchet 1/2 inch dr. x 9-1/2 inches lg. (80064)14U1502		EA	1
5120-00-241-3142	HANDLE, SOCKET WRENCH T-handle, 1/2 inch dr., 7 inches lg. (55719)510		EA	1
5100-00-222-0457	HATCHET, CLAW 4-cut (81348)GGG-H-131		EA	1
5120-00-224-2510	KEY, SOCKET HEAD SCREW 5/8 inch (81348)GGG-K-275		EA	1
5120-00-224-4659	KEY, SOCKET HEAD SCREW 1/4 inch (80064)1940720		EA	1
5120-00-240-5292	KEY, SOCKET HEAD SCREW 1/8 inch (19200)10545649-1		EA	1
5120-00-242-7410	KEY, SOCKET HEAD SCREW 3/32 inch (92674)BA27077-4		EA	1
9905-00-148-9546	KIT, WARNING DEVICE (58536)A-A-2128		EA	1
6240-00-019-0877	LAMP, INCANDESCENT elec. 3cp 24-28v, No. 10 No. 1251 (blackout marker) (96906) MS15570-1251		EA	1



ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	(3) Usable on Code	(4) U/I Qty Recm
6240-00-019-3093	LAMP, INCANDESCENT elec.6cp 24-28v, No.623 (dome lights) (96906)MS15570-623	EA	1
6240-00-155-8714	LAMP, INCANDESCENT elec. 17 amp 24-28v, No. 313 (instrument panel warning light) (96906)MS25231-313	EA	1
6240-00-635-9800	LAMP, INCANDESCENT No. 325 (96906)MS51608-3	EA	4
5980-01-285-6689	LED T1-3/4based (19207)12360905-1	EA	4
5980-01-289-5274	LED T1-3/4based (19207)12360905-2	EA	4
5980-01-285-6688	LED T1-3/4based (19207)12360890-1	EA	4
6240-01-290-9346	LED (19207)12360860-2	EA	1
6220-01-284-2709	LIGHT, MARKER, CLEAR (19207)12360850-1	EA	1
6620-01-297-3217	LIGHT, STOP, VEHICULAR (19207)12360870-2	EA	1
5120-00-243-2395	MATTOCK head (19207)11677022	EA	1
5120-00-194-9458	PICK, DIGGING head (58536)A-A-338	EA	1
5315-00-861-1473	PIN, LOCK (19206)8767184	EA	2

## ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	(3) Usable on Code	(4) U/I Qty Recm
5120-00-223-7397	PLIERS, SLIP JOINT w/cutter 8 inches lg. (81348)GGG-P-471	EA	1
5120-00-293-0791	PUNCH, DRIVE PIN straight type, 3/16 inch dia. (81348)GGG-P-831	EA	1
4933-00-796-4537	ROLL ASSEMBLY, TOOLS AND EQUIPMENT (19207)7964537	EA	1
5210-00-234-5223	RULE, STEEL, MACHINIST 6 inches (81348)GGG--R-791	EA	1
5120-00-227-7338	SCREWDRIVER, FLAT TIP machinist extra heavy duty, 5 inch blade (77948)D339	EA	1
5120-00-236-2127	SCREWDRIVER, FIAT TIP 3 inch lg. blade, 3/16 inch tip (89905)133690-10	EA	1
5120-00-278-1283	SCREWDRIVER, FLAT TIP common normal duty single grip, 6 inch blade (19207)41S1104	EA	1
5120-00-188-8450	SHOVEL, HAND gent.purpose long handled strap, back rd. point (81348)GGG-S-326	EA	1
5120-00-293-3336	SHOVEL, HAND genl purpose, rd. point D-handle (19207)11655784	EA	1
5120-00-189-7911	SOCKET, SOCKET WRENCH 1/2 inch dr., 8 inch pt. x 3/8 inch opng. (65814) ST812	EA	1
5120-00-189-7913	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 1-1/16 inch opng. (19207)11677025-8	EA	1

## ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	(3) Usable on Code U/I	(4) Qty Recm
5120-00-189-791 4	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 1-1/8 inch opng. (19207)11 677025-10	EA	1
5120-00-189-7924	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 7/16 inch opng. (95683)41W3005	EA	1
5120-00-189-7930	SOCKET, SOCKET WRENCH 3/4 inch dr., 12 inch pt. x 1-3/8 inch opng. (47805)5544	EA	1
5120-00-189-7931	SOCKET, SOCKET WRENCH 3/4 inch dr., 12 inch pt. x 1-7/16 inch opng. (47805)5546	EA	1
5120-00-189-7934	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 7/8 inch opng. (19207)11677025-5	EA	1
5120-00-189-7935	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 15/16 inch opng. (19207)11677025-6	EA	1
5120-00-189-7946	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 5/8 inch opng. (19207)11677025-2	EA	1
5120-00-189-7985	SOCKET, SOCKET WRENCH 1/2 inch dr., 12 inch pt. x 3/4 inch opng. (19207)11677025-4	EA	1
5120-00-232-5681	SOCKET, SOCKET WRENCH 3/4 inch dr., 12 inch pt. x 1-5/16 inch opng. (58536) A-A-1394	EA	1
5120-00-293-0094	SOCKET, SOCKET WRENCH 3/4 inch dr., 12 inch pt. x 1-1/2 inch opng. (47805)5548	EA	1
5130-00-221-8005	SOCKET, SOCKET WRENCH 1/2 inch dr., 6 inch pt. x 7/16 inch opng. (81348) GGG-W-660	EA	1

## ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	(3) Usable on Code	(4) U/I Qty Recm
5130-00-221-8007	SOCKET, SOCKET WRENCH 1/2 inch dr., 6 inch pt. x 9/16 inch opng. (81348)GGG-W-660	EA	1
5120-00-235-5871	SOCKET, SOCKET WRENCH 3/4 inch dr., 1-1/4 inch (47805)5540	EA	1
7310-01-310-5155	STOVE, MULTIFUEL w/case (81349) MIL-S-44344	EA	1
6685-00-344-4603	THERMOMETER, SELF-INDICATING BIMETALLIC concentric dial, -80 to 160° F (81349) MIL-T-3618C	EA	1
6675-00-240-1881	TRIPOD, SURVEYING (use with aiming post for Arctic use only) (81349)MIL-T-11674	EA	2
5120-00-269-7971	UNIVERSAL JOINT, SOCKET WRENCH 1/2 inch dr. (53711)5166189	EA	1
5120-00-187-7123	WRENCH, OPEN END engr. 15 deg. angle double head 7/1 6 inch x 1/2 inch (19204)41W1000	EA	1
5120-00-187-7130	WRENCH, OPEN END eng. 15 deg. angle double head 13/1 6 inch x 7/8 inch (07971)E2628	EA	1
5120-00-224-3102	WRENCH, OPEN END engr. 15 deg. angle double head 5/8 inch x 3/4 inch (65814)729	EA	1
5120-00-277-2307	WRENCH, OPEN END engr. 15 deg. angle, double head 5/16 inch x 3/8 inch (55719)S1012	EA	1

ADDITIONAL AUTHORIZATION LIST — CONTINUED

(1) National Stock Number	(2) Description CAGEC and Part Number	(3) Usable on Code	(4) U/I Qty Recm
5120-00-277-7025	WRENCH, OPEN END enr. 15 deg. angle double head 15/16 inch x 1 inch (19207)11655789-5		EA 1
5120-00-293-2134	WRENCH, OPEN END enr. 15 deg. angle double head 9/16 inch x 11/16 inch (19207)5323330		EA 1
5120-00-264-3777	<b>WRENCH, SPANNER</b> adjustable (65814) 484		EA 1
5120-00-277-9076	WRENCH, SPANNER adjustable 2 inch to 4-3/4 inches (19207)5218469		EA 1

## APPENDIX D EXPENDABLE AND DURABLE ITEMS LIST

### Section I. INTRODUCTION

#### D-1 SCOPE

This appendix lists expendable and durable items needed to operate and maintain the 155MM self-propelled howitzer. This listing is for information only and is not authority to requisition the listed items. This items are authorized to you by CTA 50-970, Expendable/Durable Items (except Medical, Class V, Repair Parts, and Heraldic Items) or CTA 8-100, Army Medical Department Expendable/Durable Items.

#### D-2 EXPLANATION OF COLUMNS

- a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the item (e.g. "Use anti-freeze (item 4, Appx D)).
- b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the item.
  - C ..... Operator or Crew Maintenance
  - O ..... Unit Maintenance
  - F ..... Direct Support Maintenance
  - H ..... General Support Maintenance
- c. Column (3) - National Stock Number. This is the national stock number assigned to the item; use it to request the item.
- d. Column (4) - Item name, description, Commercial and Government Entity Code (CAGEC), and part number. This provides the other information needed to identify the item.
- e. Column (5) - Unit of Measure (U/M). This code shows the physical measurement or count of an item, such as gallon, dozen, gross, etc.

### Section II. EXPENDABLE AND DURABLE ITEMS LIST

#### EXPENDABLE AND DURABLE ITEMS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
1	C	6850-01-246-6544 6850-01-246-6545	Additive, diesel fuel: (81349) MIL-S-53021 5 gal. can 55 gal. drum	CN DR
2	C	6850-00-127-7193	Anti-fogging kit: (81361) 85-16-1	EA

EXPENDABLE AND DURABLE ITEMS LIST-CONTINUED

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
3	C	6850-00-174-1806	Antifreeze, arctic type, 55 gal. drum: (81349) MILA11755	GL
4	C	6850-40-181-7929	Antifreeze, perm O-A-548, 1 gal. can: (81349) MILA46153	GL
5	C	6850-40-181-7933	Antifreeze, perm O-A-548, 5 gal. can: (81349) MILA46153	GL
	C	8105-00-269-4662	Bag, plastic, std pkg 100: (81349) MIL-B-117	EA
	C	1005-00-903-1296	Brush, cleaning, small: (19204) 11686340	EA
	C		Cleaner, lubricant, and preservative (CLP) grade 2: (81349) MIL-L-63460	
		9150-01-054-6453		PT
		9150-01-053-6688		GL
9	C	6850-00-227-1887	Cleaning compound, optical lens, type 1: (81349) MILC43454	QT
9.1	C		Cleaning compound, solvent - detergent (OJVH6) PF DEGREASER	
		7930-01-328-2030	5 gal.	GL
		7920-01-328-4058	55 gal. drum	DR
10	C	7920-004-044-9281	Cloth, batiste (lint free), white, 39-1/2 in. wide: (81349) MIL-G-85043	YD
10.1	C	6850-00-880-7616	Compound, silicone: (81349) MIL-S-8660	TU
11	C		Corrosion preventive compound (CT): MIL-L-16173	
12	C	7930-00-282-9699	Detergent, general purpose, 1 gal.: (81349) MIL-D-16791	GL
13	C	6810-00-356-4936	Distilled water, 5 gal.: (96906) MIL-STD-1444	GL
14			DELETED	
15	C		Gloves, men's and women's, heavy duty: (81349) MIL-G-2366	EA
		8415-00-268-7868	Size 5	
		8415-00-268-7869	Size 3	
		8415-00-268-7870	Size 4	
		8415-00-268-7871	Size 1	
		8415-00-268-7872	Size 2	
16	C		Gloves, patient, exam: package of 100: (89875)	
		6515-01-150-2977	Size large, E-011	PG
		6515-01-150-2978	Size medium, E-012	PG
		6515-01-150-2976	Size small, E-010	PG

## EXPENDABLE AND DURABLE ITEMS LIST - CONTINUED

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
17	C	9150-01-197-7693 9150-01-197-7690 9150-01-197-7689	Grease, automotive art (GAA): 81349) 14 oz tube, M-10924-2-F 1.75 lb can, M-10924-3-F 6.5 lb can, M-10924-4-F	OZ CN LB
18	C	9150-00-985-7316 9150-00-823-8047	Grease, general purpose (GGP): 81349) MIL-G-23549 1-3/4 lb can 35 lb can	CN CN
19	C	9150-00-754-2595 9150-00-223-4004 9150-00-965-2003	Grease, molybdenum disulfide for low and high temperatures (GMD): 81349) MIL-G-21164 1-3/4 lb can 6-1/2 lb can 35 lb can	LB LB CN
20	C	9150-00-935-9807 9150-00-935-9808	Hydraulic fluid, PET, OHT: 98308) MIL-H-6083 BRAYC0783C	QT GL
21	C	1025-01-196-2172  1025-01-196-2174 1025-01-311-3770	(it artillery, cleaning and preservative 59678) SK1-84JS consisting of: Bottle, breakable (27412) 105-130 Cloth, cleaning sleeve (27412) 155/203-140 One liter CLP (27412) CLP-8 Primer vent seat (27412) 155-161 Bore evacuator brush (27412) 155-160	EA EA EA EA EA
22	C	9150-01-035-5390 9150-01-035-5391	Lubricating oil, gear (GO-75): 81349) MIL-L-2105 1 qt 5 gal. can	QT GL
23	C	9150-01-035-5392 9150-01-035-5393	Lubricating oil, gear (GO-80/90): (81349) MIL-L-2105 1 qt 5 gal. can	QT GL
24	C	9150-01-048-4591 9150-01-035-5395 9150-01-035-5396	Lubricating oil, gear (GO-85/140): (81349) MIL-L-2105 1 qt 5 gal. can 55 gal. drum	QT GL DR



EXPENDABLE AND DURABLE ITEMS LIST - CONTINUED

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
25	C	9150-00-402-2372	Lubricating oil, internal combustion engine (ICE), arctic (OEA) 5 gal. can: (81349) MIL-L-46167	GL
26	C	9150-00-189-6727 9150-00-186-6668	Lubricating oil, internal combustion engine (ICE), tactical service (OE/HDO-10): (81349) MIL-L-2104 1 qt 5 gal.	QT GL
27	C	9150-01-1524117 9150-01-1524118 9150-01-152-4119	Lubricating oil, internal combustion engine (ICE), tactical service (OE/HDO-15/40): (81349) MIL-L-2104 1 qt 5 gal. 55 gal.	QT CN DR
28	C	9150-00-186-6681 9150-00-188-9858	Lubricating oil, internal combustion engine (ICE), tactical service (OE/HDO-30): (81349) MIL-L-2104 1 qt 5 gal.	QT CN
29	C	9150-00-189-6730 9150-00-405-2987 9150-00-188-9862	Lubricating oil, internal combustion engine (ICE), tactical service (OE/HDO-40): (81349) MIL-L-2104 1 qt 1 gal. 55 gal.	QT GL GL
29.1	C	9150-00-231-2361	Lubricating oil, general (81349) MIL-L-3150	QT
30	C	1670-00-725-1437	Nylon, 1.719 in. wide, LPRS	EA
31	C	2590-01-223-2944	Panel, long, LPRS, 155MM: (28620) MIL-L-48664	EA
32	C	2590-01-223-2945	Panel, short, LPRS, 155MM: (28620) MIL-L-48664	EA
33	C	6640-00-285-4694	Paper, lens: (80244) NNN-P-40	EA
34	C	2590-01-223-2949	Rack assembly, 15 round, LPRS, 155MM: (28620) MIL-L-48664	EA
35	C	7920-00-205-1711	Rag, wiping: (58536) A-A-531	LB
36	C	5340-00-980-9277	Strap, webbing, LPRS, 1.75 in. wide: (19207) 10900880	EA

**EXPENDABLE AND DURABLE ITEMS LIST - CONTINUED**

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
37	C	5340-01-0894997	Strap, webbing tie down, cargo aircraft, LPRS: (19207) 11669588	EA
38	C	9905-00-537-8954	Tag, marking: (81349) MIL-T-12755CLRW	
39	C	4020-00-241-8875	Twine, fibrous, fine India: (80244) A-A-228SZ2TY1	BA
40	C	5510-00-220-6226	Wood. 4 x 4: (81348) MM-L-751	BF

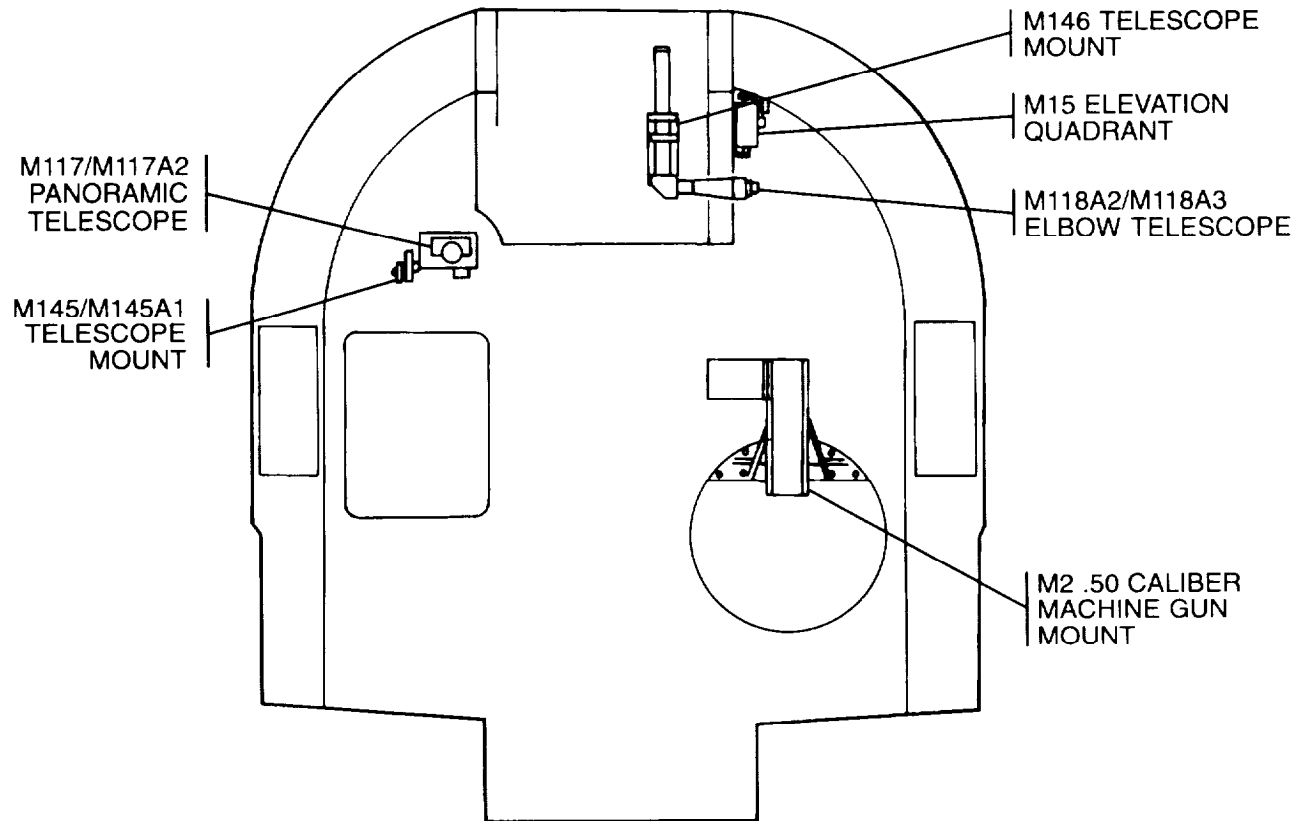


## APPENDIX E STOWAGE AND DECAL/DATA PLATE GUIDE

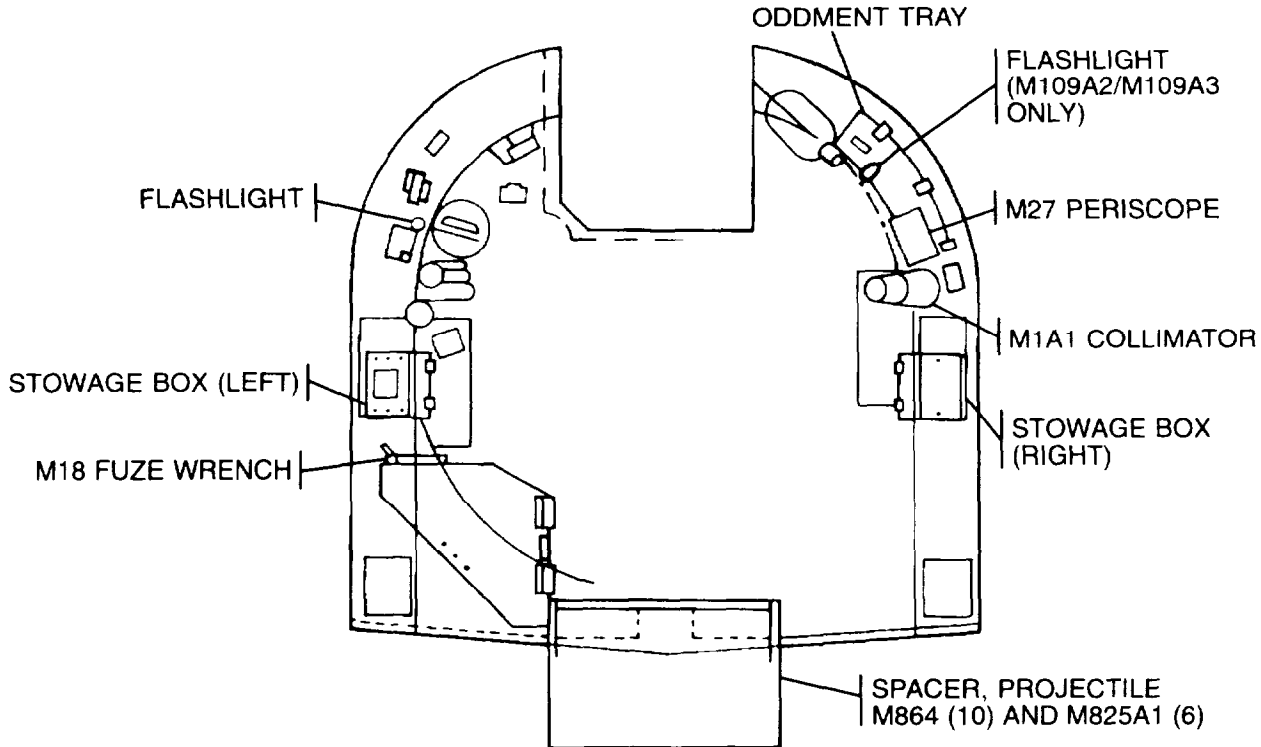
### E-1 SCOPE

This appendix shows the location of stowed equipment, decals, and data plates required on M109 series howitzer. Illustrations detail the physical installation and stowage of all Components of End Item (COEI), Basic Issue Items (BI), and Additional Authorization List (AAL) Items required to be carried on-board the M109 series howitzer. In addition there is a guide showing location of decals and data plates.

### E-2 CAB STOWAGE LOCATIONS (INTERIOR)



**E-2 CAB STOWAGE LOCATIONS (INTERIOR) - CONTINUED**

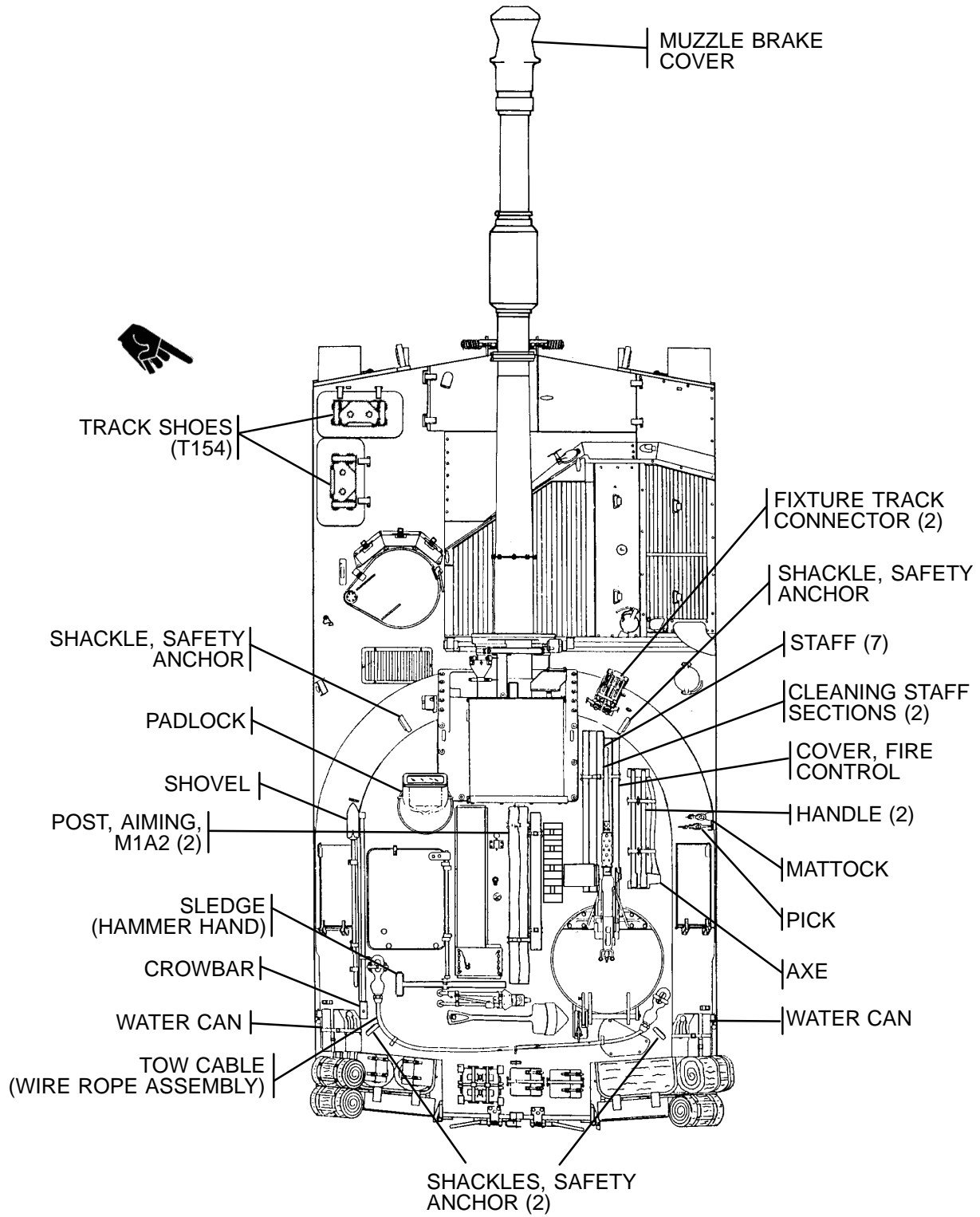


<b>EQUIPMENT IN STOWAGE BOX (LEFT)</b>
BOX, ACCESSORIES STOWAGE FOR SPARE BULBS FIRST AID KIT FUZE SETTER, M27 LIGHT, AIMING POST, M14 OILER, HAND

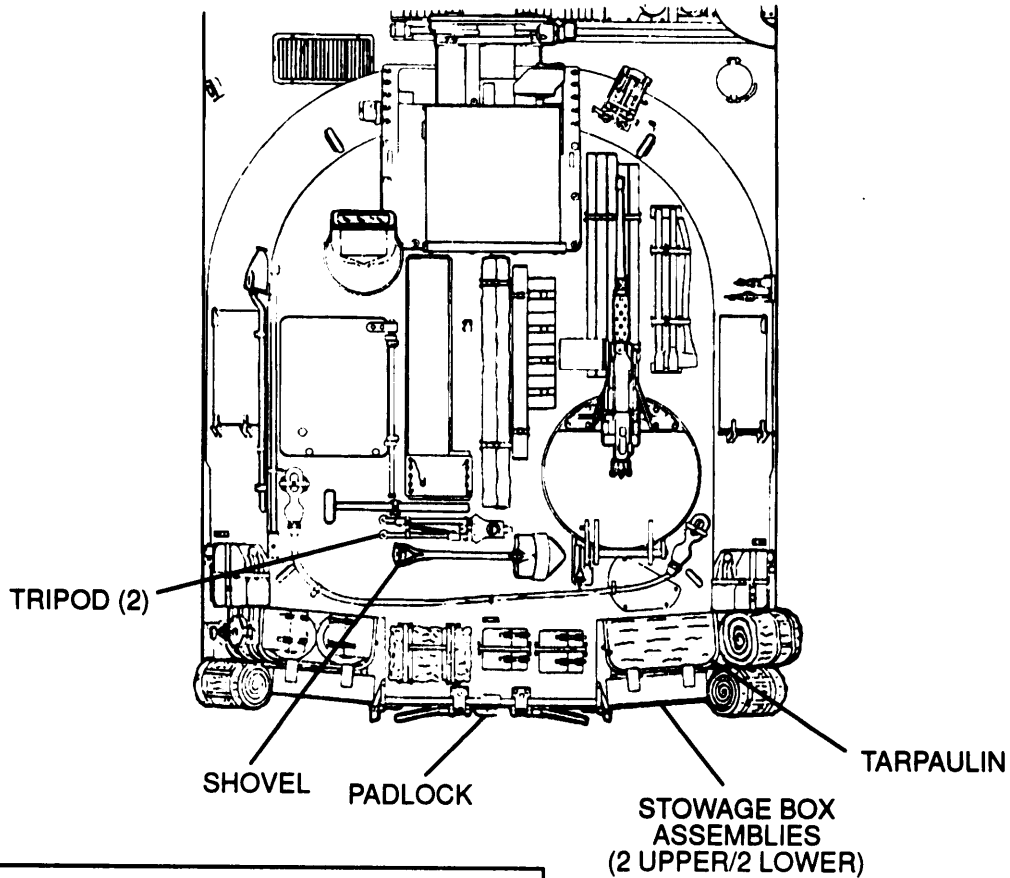
<b>EQUIPMENT IN STOWAGE BOX (RIGHT)</b>
LANYARD, 50 FT BAG ASSEMBLY, PAMPHLET FOLDER, EQUIPMENT RECORD OPERATOR'S MANUAL QUADRANT, FIRE CONTROL, GUNNER'S, M1A1 STRAP, WEBBING

<b>EQUIPMENT IN ODDMENT TRAY</b>
ARM ASSEMBLY, ADAPTER CLEANING TOOL, VENT FUZE SETTERS, M34 AND M35 HOSE, NON-METALLIC 24" LG LANYARD, 6 FT MITTEN, HEAT PROTECTIVE STAFF, SECTION CLEANING SPONGE SWAB, CHAMBER THERMOMETER

E-3 CAB STOWAGE LOCATIONS (EXTERIOR)



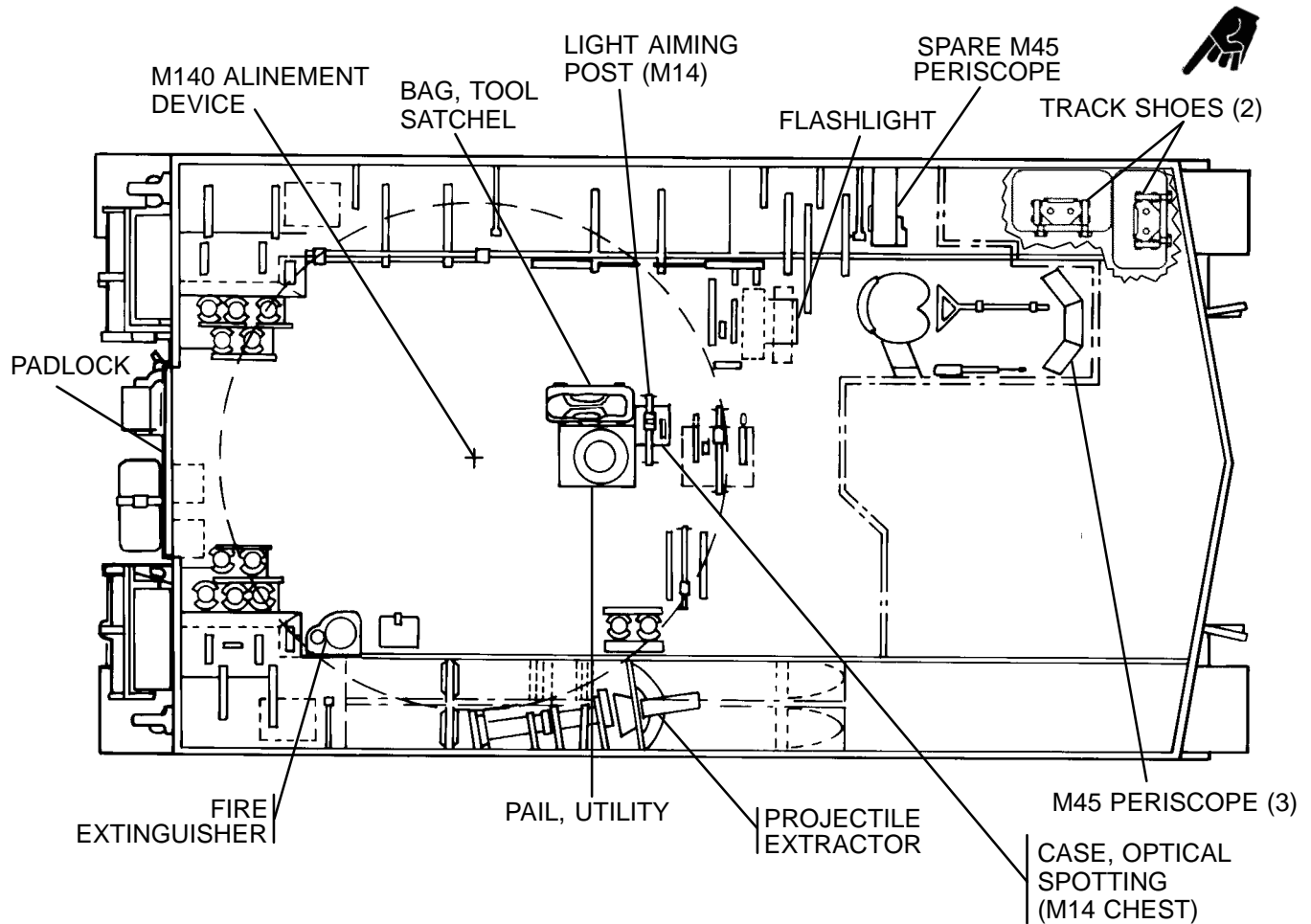
E-3 CAB STORAGE LOCATIONS (EXTERIOR) — CONTINUED



**EQUIPMENT IN CAB REAR STORAGE BOXES**

- BRUSH AND BAG ASSEMBLY
- CUTTER, WIRE ROPE AND CARRIER
- GUN, OIL PNEUMATIC, M3
- HATCHET
- HOSE ASSEMBLY, NON-METALLIC (USE W/M3)
- KIT, WARNING DEVICE
- PANEL, MARKER
- RAMMER, ARTILLERY UNLOADING
- RAMMER, LOADING M13
- REDUCER, TUBE (USE W/M3)
- SIGHT, BORE SIGHT
- STOVE, GASOLINE BURNER
- ROLL ASSEMBLY, TOOLS AND EQUIPMENT
  - BRUSH, CLEANING PRIMER
  - REAMER, HAND
  - WRENCH, SPANNER FOR OBTURATOR NUT
  - WRENCH, SPANNER

**E-4 HULL STORAGE LOCATIONS**



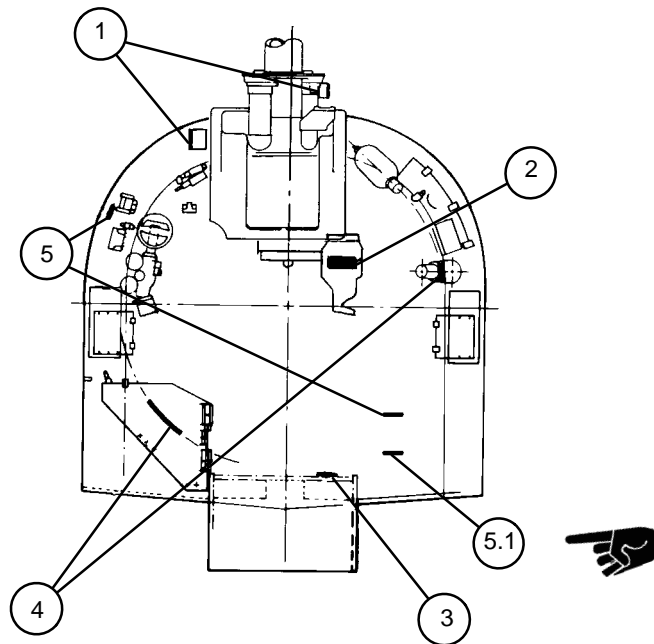
<b>BAG, TOOL SATCHEL</b>	
ADAPTER, GREASE GUN (2)	PIN, LOCK (2)
ADAPTER, GUN, OIL FILLING	PLIERS (2)
ADAPTER, SOCKET WRENCH	PUNCH, DRIVE PIN
BAR, PINCH	PULLER, CONNECTOR T136 AND T154
CHISEL, COLD HAND	RULE, STEEL MACHINIST
EXTENSION, SOCKET WRENCH (4 VARIED SIZES)	SCREWDRIVER, FLAT TIP (5 VARIED SIZES)
FILE, HAND (2)	SOCKET, SOCKET WRENCH (18 VARIED SIZES)
HAMMER, HAND	T-HANDLE
HANDLE, SOCKET WRENCH (5 VARIED TYPES AND SIZES)	UNIVERSAL JOINT, SOCKET WRENCH
KEY, SOCKET HEAD SCREW (7 VARIED SIZES)	WRENCH, ADJUSTABLE (2 VARIED SIZES)
LUBRICATING, GUN, HAND	WRENCH, OPEN-END (6 VARIED SIZES)
NIPPERS, END CUTTING	WRENCH, SPANNER, ADJUSTABLE (2 VARIED SIZES)



## E-5 SIGN GUIDE

### Location of Crew Area and Exterior Decals and Data Plates

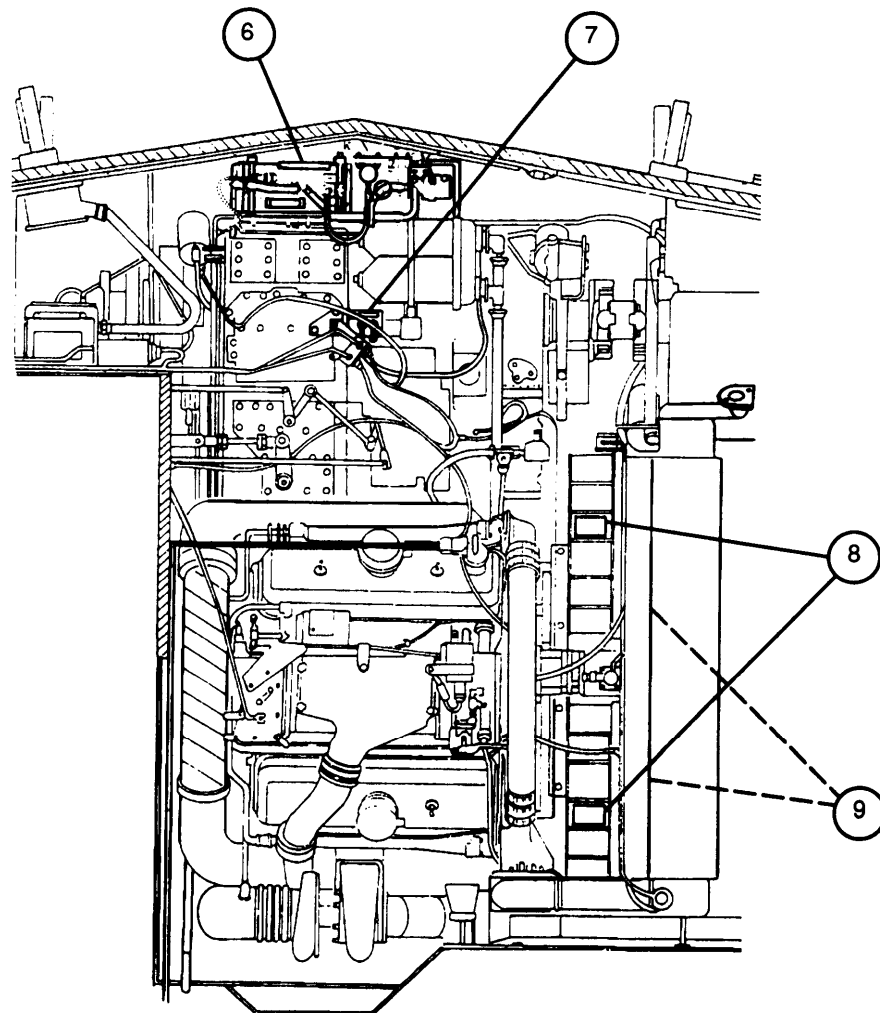
KEY	ITEM	VEHICLE APPLICATION
1	Decal, caution, M140 alinement device mount	All
2	Plate, instruction, direct fire range	All
3	Decals, projectiles	All
4	Sign, caution, high intensity noise	All
5	Plate, instruction, direct fire moving target	All
5.1	Sign, warning	All



**E-5 SIGN GUIDE — CONTINUED**

**Location of Crew Area and Exterior Decals and Data Plates — Continued**

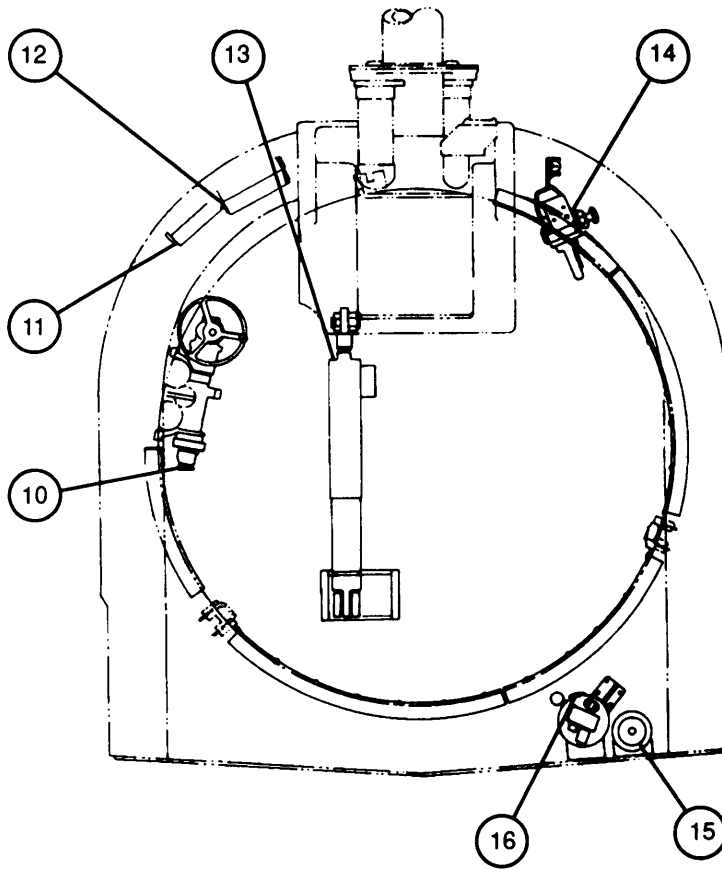
KEY	ITEM	VEHICLE APPLICATION
6	Plate, identification, winterization kit	All
7	Marker, engine, oil	All
8	Decal, warning, axial fan	All
9	Plate, identification, axial fan	All



**E-5 SIGN GUIDE — CONTINUED**

**Location of Crew Area and Exterior Decals and Data Plates — Continued**

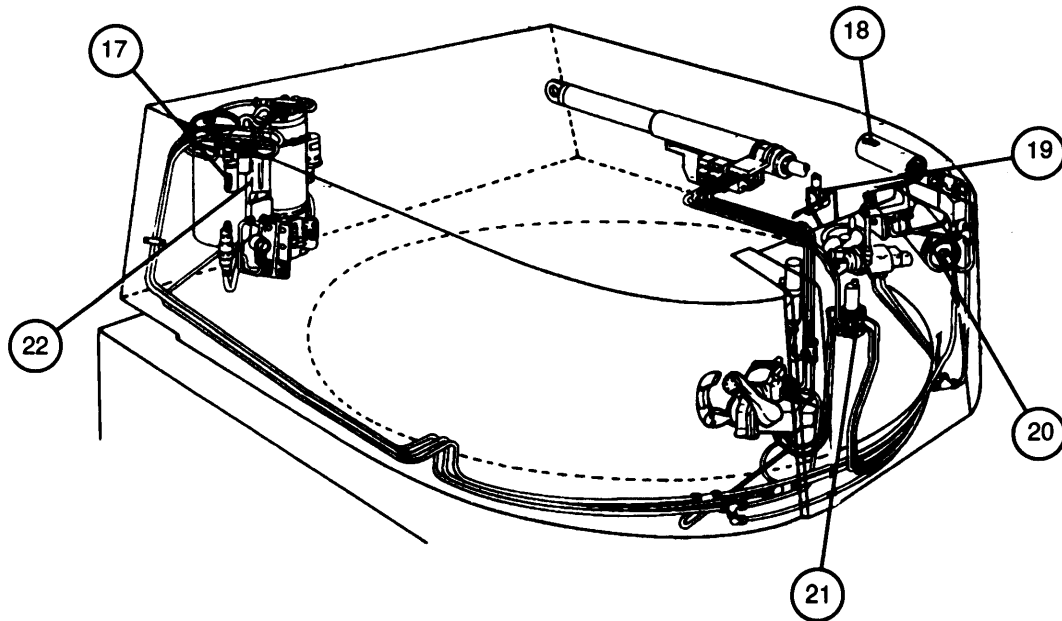
KEY	ITEM	VEHICLE APPLICATION
10	Plates, instruction, hydraulic motor assembly	All
11	Plate, instruction, primary accumulator assembly	All
12	Plate, instruction, manual pump accumulator	All
13	Plate, identification, equilibrated elevation mechanism assembly	All
14	Plate, identification, manual pump assembly	All
15	Plate, instruction, main accumulator assembly	All
16	Plate, identification, power pack assembly	All



**E-5 SIGN GUIDE — CONTINUED**

**Location of Crew Area and Exterior Decals and Data Plates — Continued**

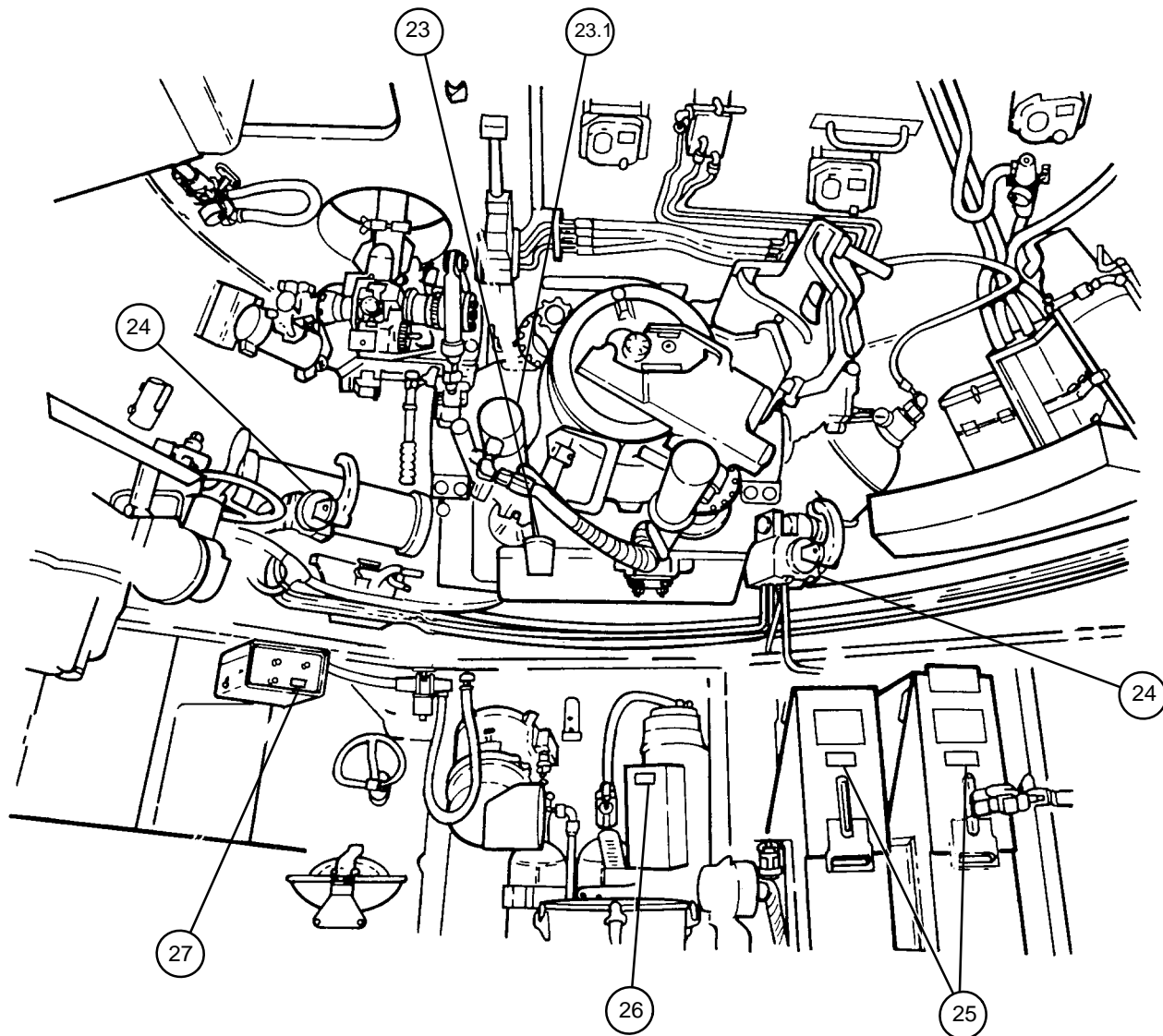
KEY	ITEM	VEHICLE APPLICATION
17	Marker, identification, hydraulic oil filter	M109A4, M109A5
18	Plate, instruction, secondary accumulator	All
19	Decal, by-pass valve assembly	All
20	Marker, identification, primary accumulator	All
21	Decal, elevation selector valve assembly	All
22	Plate, instruction, sight gage	All



### E-5 SIGN GUIDE — CONTINUED

#### Location of Crew Area and Exterior Decals and Data Plates — Continued

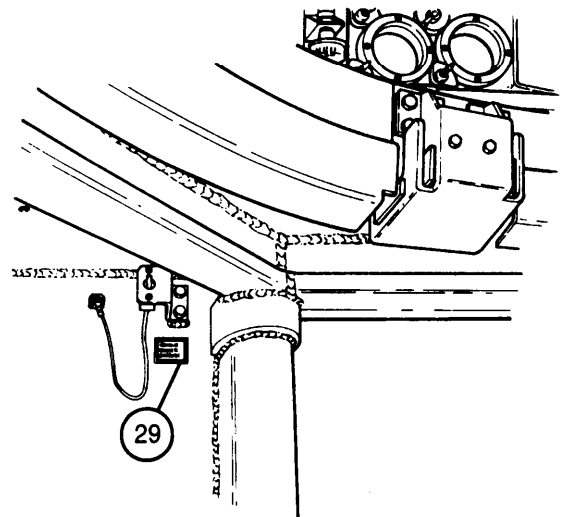
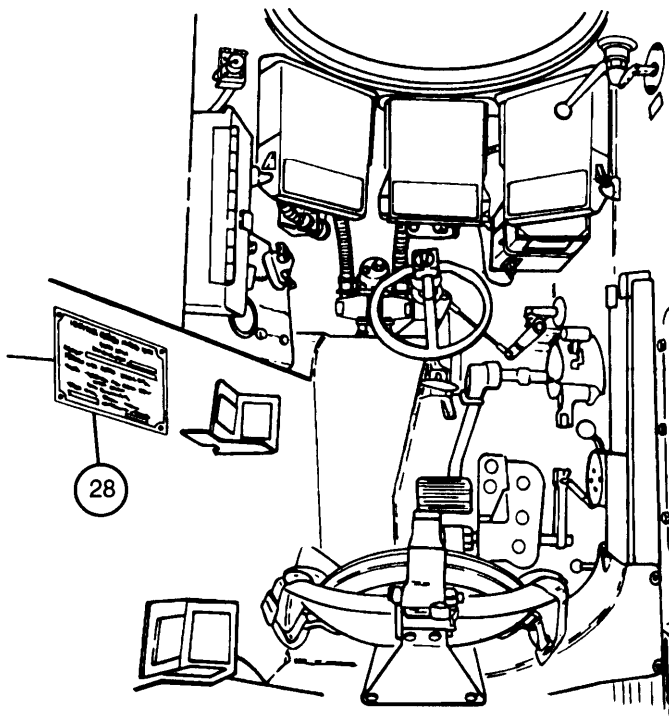
KEY	ITEM	VEHICLE APPLICATION
23	Plate, identification, M178/M182 mount	All
23.1	Decal, caution, loader rammer	All
24	Decal, identification, gunner's and assistant gunner's control assembly	All
25	Decal, warning, air cleaner	All
26	Sign, warning, personnel heater	All
27	Sign, warning, accessory control box	All



**E-5 SIGN GUIDE — CONTINUED**

**Location of Crew Area and Exterior Decals and Data Plates — Continued**

KEY	ITEM	VEHICLE APPLICATION
28	Plate, identification, vehicle	All
29	Decal, combat starter override	M109A4, M109A5





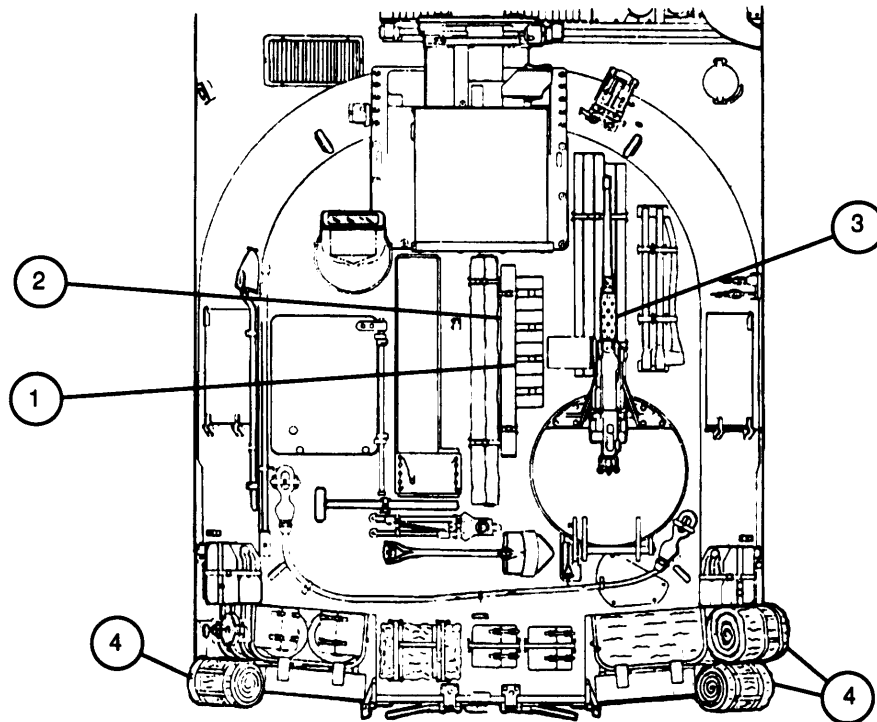
## APPENDIX F ON-VEHICLE EQUIPMENT LOADING PLAN

### F-1 SCOPE

This appendix shows the location for loading equipment and ammunition required to be carried on the M109 series howitzer. The on-vehicle equipment loading plan is designed to help load and inventory material required for safe and efficient operation on all M109 series howitzer.

### F-2 CAB ON-VEHICLE EQUIPMENT LOADING PLAN (EXTERIOR)

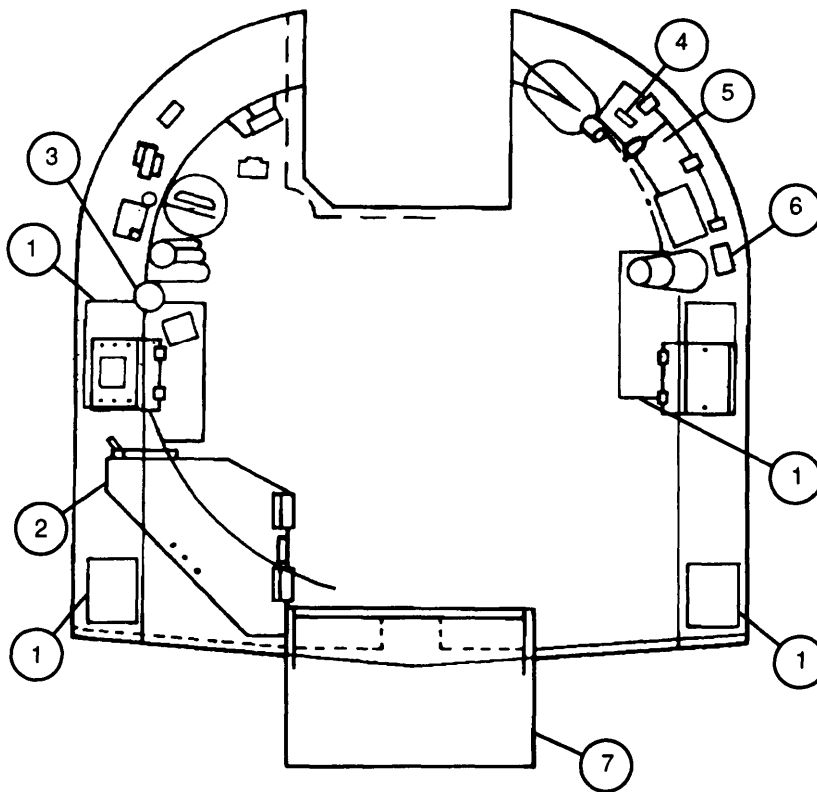
LOAD PLAN	
NO.	ITEM
1	AMMO BOXES, 50 CALIBER (2)
2	M2 .50 CALIBER SPARE BARREL W/COVER
3	M2 .50 CALIBER MACHINE GUN
4	BED ROLLS





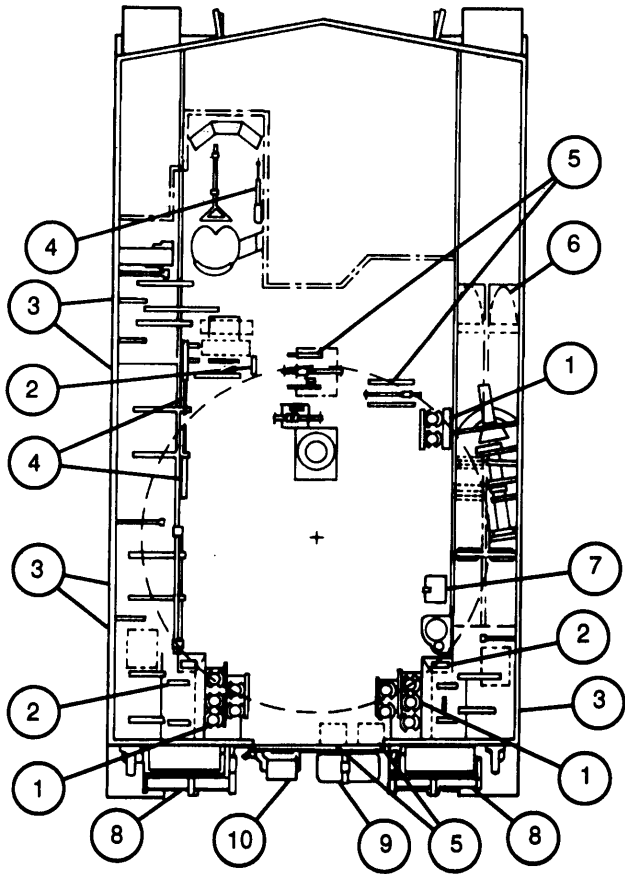
**F-3 CAB ON-VEHICLE EQUIPMENT LOADING PLAN (INTERIOR)**

LOAD PLAN	
NO.	ITEM
1	NBC MOPP GEAR (M109A4/M109A5)
2	M4 PROPELLANT CHARGES (14)
3	PHONE
4	RIFLE
5	CANTEEN
6	RATIONS
7	PROJECTILE STORAGE (22 RDS)



F-4 HULL ON-VEHICLE EQUIPMENT LOADING PLAN

LOAD PLAN	
NO.	ITEM
1	155MM PROJECTILES (12)
2	CANTEEN
3	155MM PROPELLING CHARGES AND PRIMERS
4	RIFLES (M16 SERIES) (5)
5	FUZES
6	M712 PROJECTILE (COPPERHEAD) (2)
7	STOWAGE BOX FOR M712 PROJECTILE SPACERS
8	RATIONS
9	M13 APPARATUS
10	TELEPHONE REEL



## F-5 HOW TO LOAD AND STOW PROJECTILES IN HOWITZER

### a. 155MM Projectiles

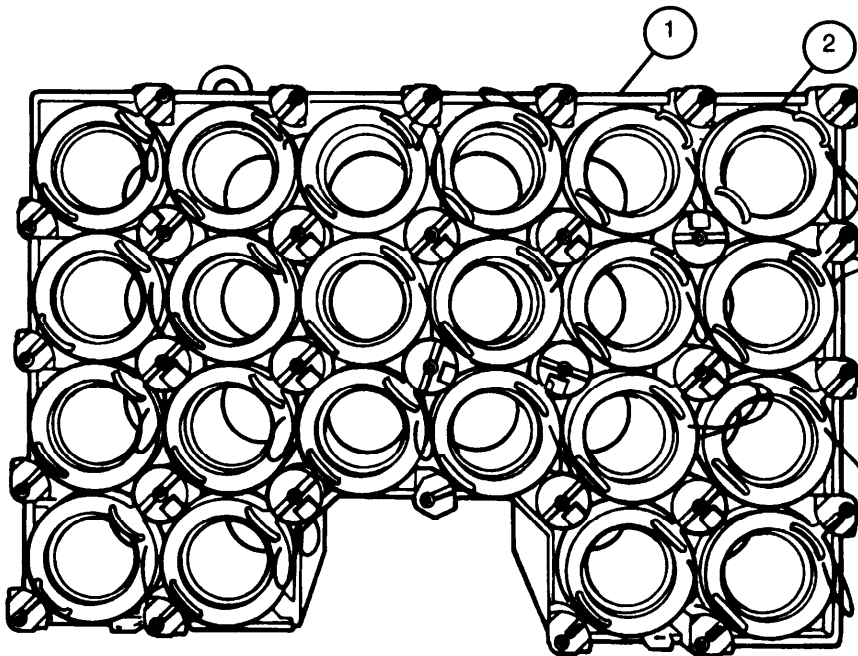
**CAUTION**

155mm projectiles weigh almost 100 pounds (45.36 kg). Be careful when placing ammunition in the hull and cab ammunition rack assembly to prevent damage to rotating band. Stand projectile up on base.

**NOTE**

For stowage of M712 projectile, see para 5-21. For stowage of projectile extractor, see paragraph 5-22.

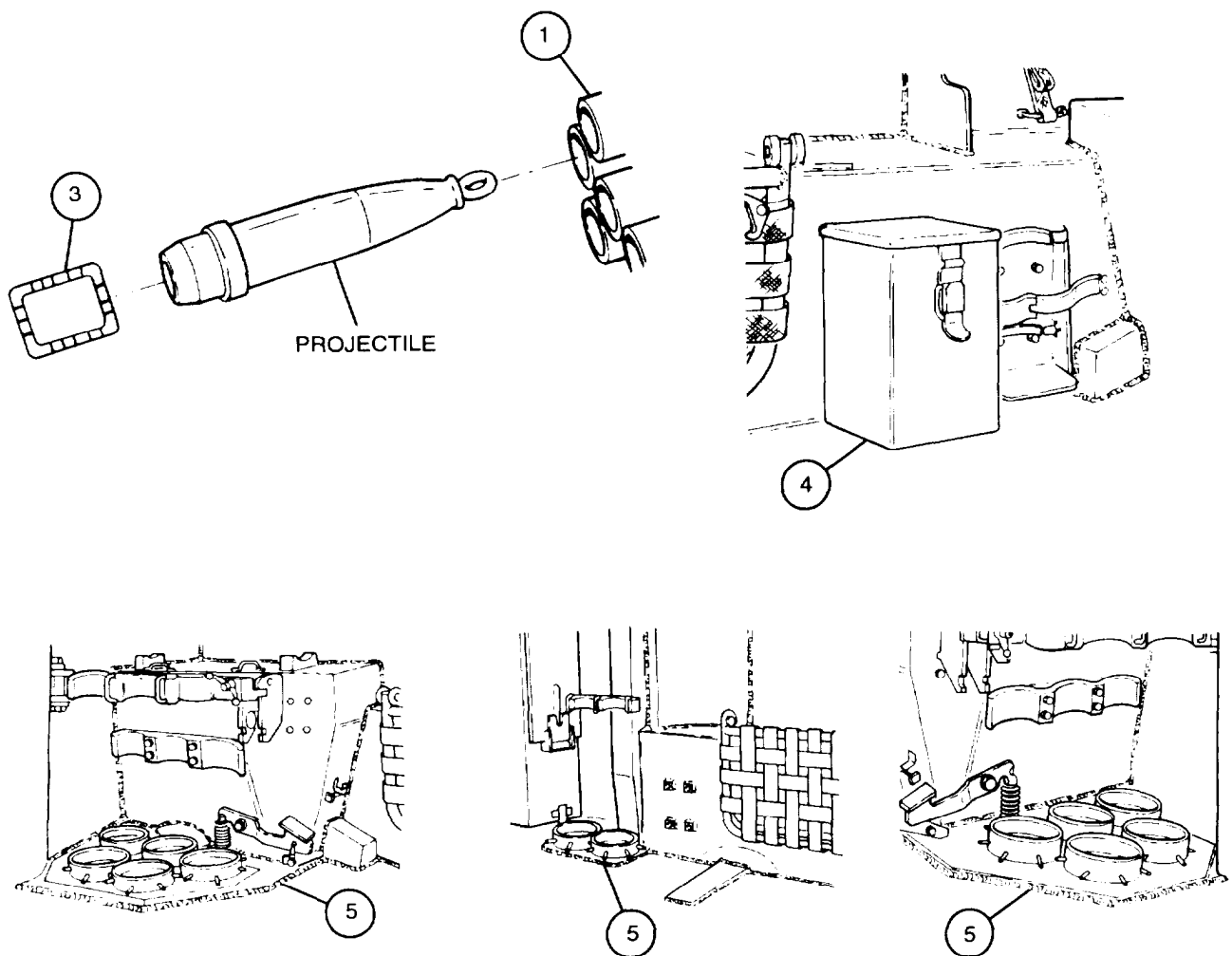
- 1 When loading cab ammunition rack assembly (1) from exterior, make sure all retainer assemblies (2) are secured.



## F-5 HOW TO LOAD AND STOW PROJECTILES IN HOWITZER - CONTINUED

### a. 155MM Projectiles - Continued

- 2 When standard length rounds are to be stowed in the cab ammunition rack assembly (1), push rounds completely to front of cab ammunition rack assembly and remove spacer (3) from stowage box (4) in right side of vehicle and set in cab ammunition rack assembly. Attach retainer assembly (2) (be sure to reverse the retainer assemblies) and secure. Close doors.
  
- 3 Stow only short length rounds in floor projectile racks (5).



**F-5 HOW TO LOAD AND STOW PROJECTILES IN HOWITZER - CONTINUED**

**b. Stowing Projectiles, 155MM: M107, M898, M825A1, M483A1, M549A1, M795, and M864 Using Projectile Retainer Assembly P/N 12940880 (NSN 5365-01-413-4557)**

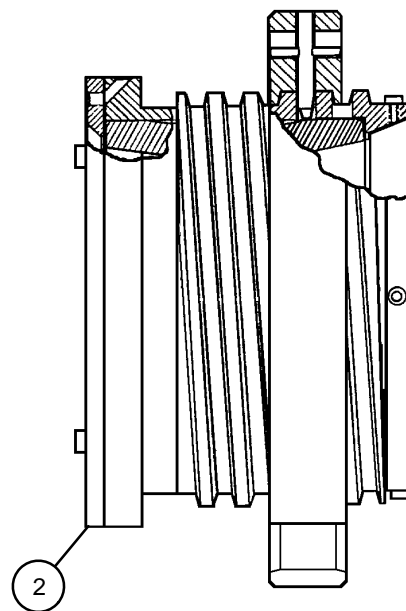
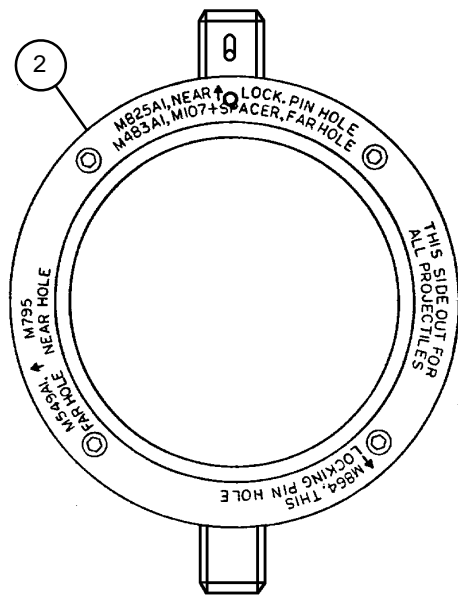
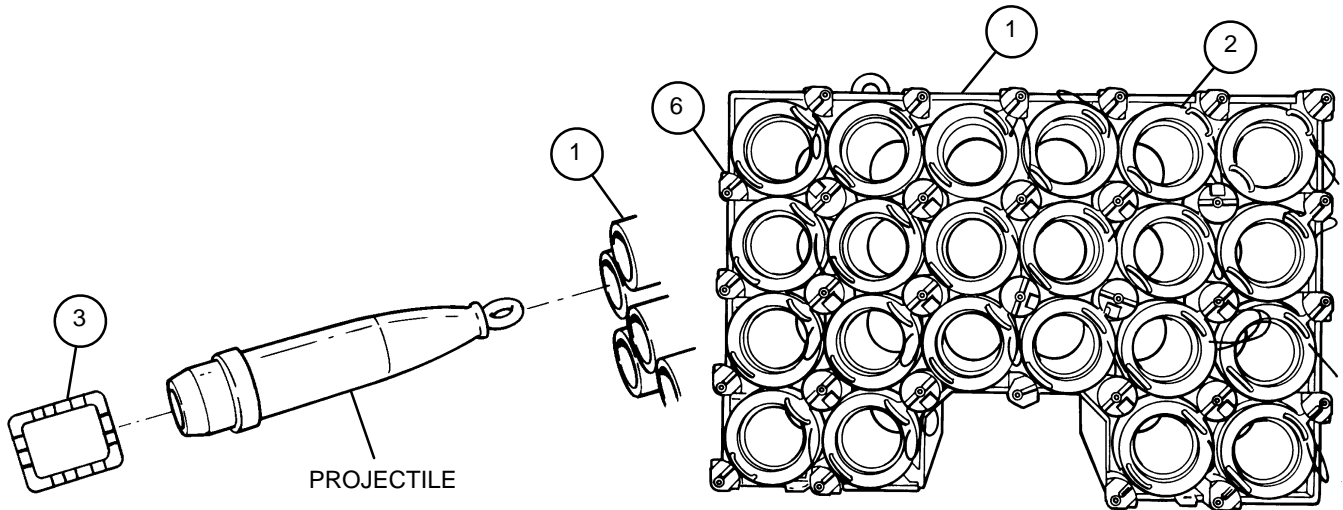
**NOTE**

When loading the above projectiles in the cab ammunition rack assembly (1) from exterior, perform the following procedures using the provided Projectile Retainer Assembly (2).

- 1 Unlock the retainer assembly (2) by turning the locking caps (6).
- 2 Pull out the retainer assembly (2) from the rack (1).
- 3 Once the retainer assembly (2) is out, turn it so the locking pin is in the 6 o'clock position. A slight shake of the retainer assembly will help the locking pin to come out.
- 4 Determine the projectile model to be stowed in the rack (1).
- 5 Rotate the outer ring in order to line up the locking pin with the correct hole in the inner ring, as indicated on the retainer (2) end plate.
  - a. There are two adjacent holes near the end plate: the NEAR hole locks the M795 projectile and the FAR hole locks the M549A1 projectile.
  - b. The next hole away from the end plate (not in line with the two previous holes) locks the M864 projectile.
  - c. The last two holes, away from the end plate, secure the following projectiles: the NEAR hole locks the M825A1 projectile and the far hole locks the M483A1 projectile, the M107 projectile with the spacer (3), and the SADARM M898.
- 6 Lock the outer ring by inserting the locking pin into the proper projectile hole in the inner ring.
- 7 Install the retainer assembly (2) back in the ammunition rack assembly (1).
- 8 Lock the retainer assembly (2) in the cab ammunition rack assembly (1) by turning the locking caps (6).
- 9 Push the projectile completely to the front of the cab ammunition rack assembly (1).
- 10 For standard length projectiles (M107 family), set the spacer (3) in cab ammunition rack assembly (1) behind the base of the projectile.
- 11 Close the doors.

F-5 HOW TO LOAD AND STOW PROJECTILES IN HOWITZER — CONTINUED

b. Stowing Projectiles, 155MM: M107, M898, M825A1, M483A1, M549A1, M795, and M864 Using Projectile Retainer Assembly P/N 12940880 (NSN 5365-01-413-4557) — Continued



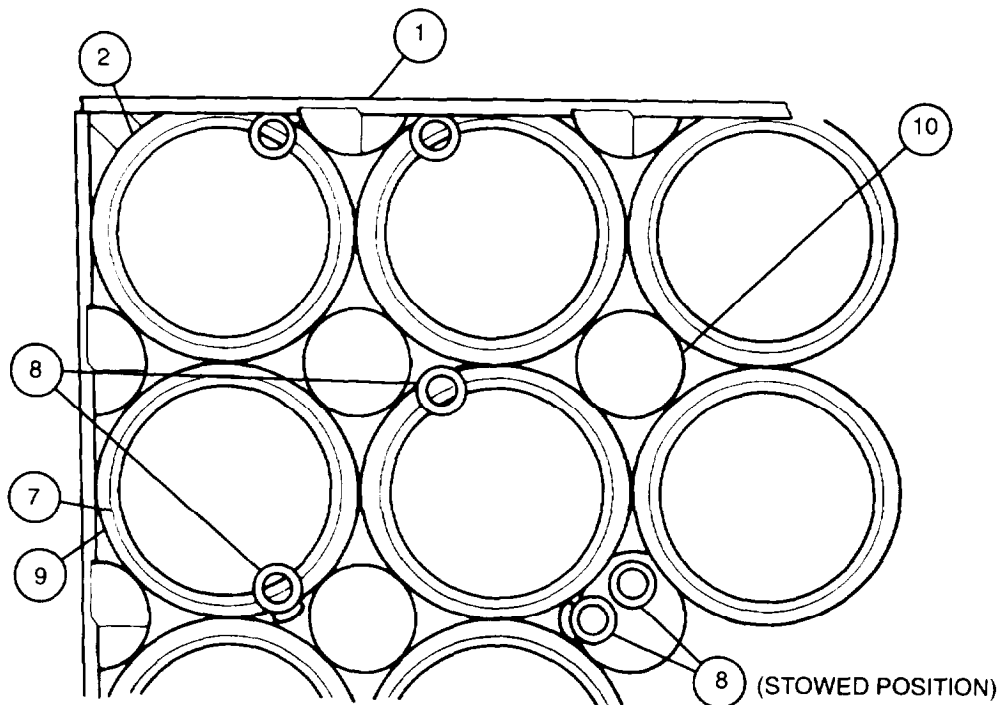
F-5 HOW TO LOAD AND STOW PROJECTILES IN HOWITZER - CONTINUED

c. M864 or M825A1 Projectiles

NOTE

When loading M864 or M825A1 projectiles in the cab ammunition rack assembly from exterior perform the following procedures using the specially provided spacers.

- 1 Ensure all retainer assemblies (2) are secured with the golden ring reading: THIS SIDE OUT M483A1 PROJECTILE AND M107 PROJECTILE PLUS SPACER.
- 2 Push M864 or M825A1 projectiles (7) completely to front of cab ammunition rack assembly (1).
- 3 Place the M864 or M825A1 spacers (8) in the gaps between the cab ammunition rack tubes (9) and the cylindrical spacers (10) which separate the tubes. Use one spacer for each M864 or M825A1 projectile.
- 4 Close doors.
- 5 When M864 or M825A1 spacers (8) are not in use, store the spacers in the gaps with the cylindrical section rotated so that other than M864 or M825A1 projectiles can be stowed in the bustle.



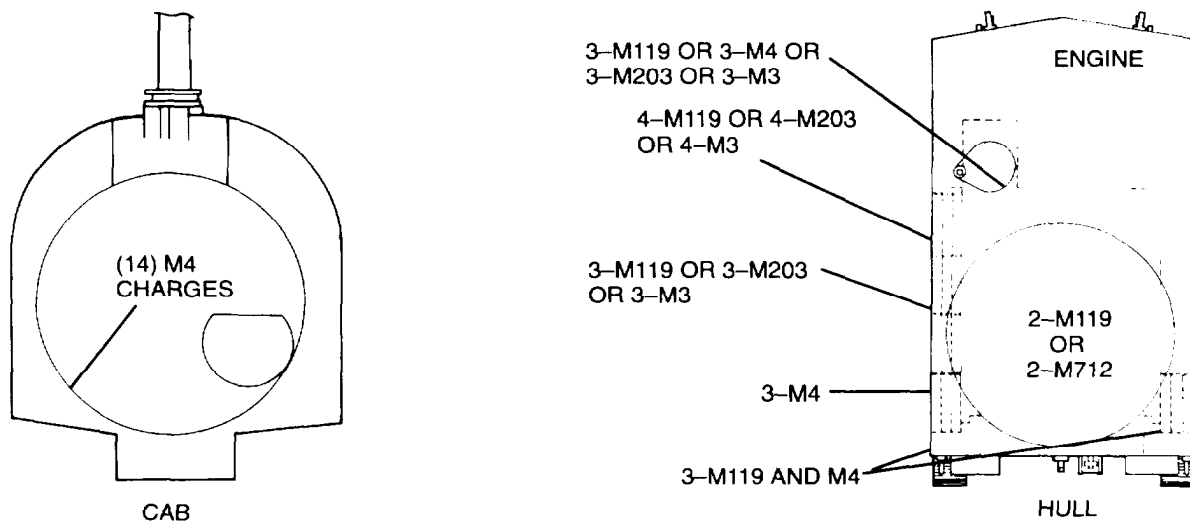
**F-6 HOW TO LOAD AND STOW PROPELLANT CANISTERS**

**a. Location**

The following schematic shows where propellant canisters are stowed in the cab and hull.

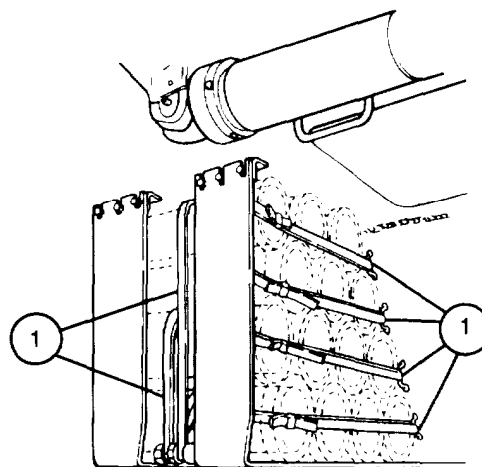
**NOTE**

Combination of 21-22 propellant canisters can be stowed in hull.



**b. Securing Canisters**

Secure the canisters vertically and horizontally using strap assemblies (1).







## APPENDIX G LUBRICATION INSTRUCTIONS

### G-1 GENERAL STATEMENTS

#### a. Scope

This appendix provides lubrication instructions, procedures, and information on the authorized lubricants, lubrication intervals, man-hour requirements, and Army Oil Analysis Program (AOAP) for the M109A2/M109A3/M109A4/M109A5 self-propelled howitzer.

#### b. Lubrication Intervals and Interval Symbols

The lubrication instructions found in this appendix are presented in grouped sequence by interval. The following lubrication interval symbols are used to indicate how often the lubrication service will be performed.

D - Daily	S - Semi-Annually
W - Weekly	A - Annually
M - Monthly	RDS - Round fired
Q - Quarterly	

#### c. Maintenance Levels

The maintenance level for all lubrication services in this appendix is Operator/Crew, indicated by "(C)" after the paragraph headings.

#### d. Exceptional Operational Requirements

Lubricate more often to compensate for abnormal operation and extreme conditions. High or low temperatures, prolonged periods of high rate operation, continued operation in sand, dust, or exposure to moisture may quickly destroy the protective qualities of the lubricant.

Before performing lubrication checks or services, observe the following.

- 1 NEVER:
  - (a) Use incorrect lubricant.
  - (b) Use too much lubricant.
  - (c) Use hydraulic fluid (FRH), MIL-H-46170, in hydraulic system.
- 2 ALWAYS:
  - (a) Clean grease fittings before lubrication.
  - (b) Use this appendix as a guide.
  - (c) Lubricate after fording operations.
  - (d) Ensure vehicle is level prior to checking fluid levels.

**G-1 GENERAL STATEMENTS - CONTINUED**

**e. Abbreviations**

The following abbreviations for the various lubricants used in this appendix are provided below.

OE/HDO	Lubricating Oil, Internal Combustion Engine (ICE), Tactical Service (MIL-L-2104)
OEA	Lubricating Oil, Internal Combustion Engine (ICE), Arctic (MIL-L-46167)
OHT	Hydraulic Fluid, Petroleum Base, Preservative, Hydraulic Equipment (MIL-H-6083)

**NOTE**

CLP replaces RBC, PL-S, LSA, and LAW.

CLP	Cleaner, Lubricant, Preservative (MIL-L-63460)
GO	Lubricating Oil, Gear, Multi-purpose (MIL-L-2105)
GGP	Grease, General Purpose (MIL-G-23549)
GMD	Grease, Molybdenum Disulfide (MIL-G-21164)
CT	Corrosion Preventive Compound (MIL-L-16173)
GAA	Grease, Automotive and Artillery (MIL-G-10924)
O-156	Lubricating Oil, Aircraft Turbine Engine (MIL-L-23699)

**f. Parts Cleaning**



Solvents can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If solvent gets on skin or clothing, wash immediately with soap and water.

- Use cleaning compound (item 9.1, Appx D) to clean parts.

**g. Corrosion Control**

Follow corrosion control procedures as indicated (para 14).

**G-2 OIL FILTER STATEMENT**

When Army Oil Analysis Program (AOAP) service is available, change oil and filters at the direction of the AOAP laboratory.

When AOAP service is not available, change oil and filters at 75 hours or 750 miles of operation.

**G-2 OIL FILTER STATEMENT — CONTINUED**

Always use Table G-1, Expected Temperature Lubrication Requirements, to determine seasonal lubrication requirements. When changing engine and transmission oil due to seasonal requirements, always change the oil filters.

Sound maintenance practice dictates that AOAP is not a maintenance substitute, but is used as an effective maintenance diagnostic tool. Therefore, if 12 months has elapsed since the last AOAP or seasonally directed oil and filter change, the oil and filters will be changed.

**G-3 LUBRICATION INSTRUCTIONS**

**Lubrication Interval Index**

<u>Interval</u>	<u>Page</u>
Daily .....	G-6
Weekly .....	G-19
Monthly .....	G-21
Quarterly, .....	G-25
Semi-Annually .....	G-29
Annually .....	G-36
Oil Can Points .....	G-8

**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

**Table G-1. Expected Temperature Lubrication Requirements**

LUBRICANT/COMPONENT	CAPACITIES	ABOVE -15° F (ABOVE -26° C)	-40 to -15° F (-40 to -26°C)	-40 to -65° F (40 to -54°C)	INTERVALS
Fuel Oil - Diesel	135 Gal.				
Anti-Freeze, Coolant	20.5 Gal./ Dry 14.5 Gal./ Refill	MILA46153 (NATO, S-750) (50% Water Mixture) (item 4 or 5, Appx D)	MILA46153 (NATO, S-750) (50% Water Mixture) (item 4 or 5, Appx D)		
Anti-Freeze, Arctic	20.5 Gal./ Dry 14.5 Gal./ Refill			MILA11755 (Full Strength) (item 3, Appx D)	
OE/HDO (MIL-L-2104) Lubricating Oil, Internal Combustion Engine (ICE), Tactical Service OEA (MIL-L46167) Lubricating Oil, Internal Combustion Engine (ICE), Arctic Engine Final Drive	38 Qts./Dry 27 Qts./ Refill  As Required	OE/HDO-40 (item 29, Appx D)  OE/HDO-30 (NATO, 0-238) (item 28, Appx D) OE/HDO-15/40 (NATO, 01236) (item 27, Appx D)  OE/HDO-30 NATO, 0-238) (item 28, Appx D)	OE/HDO-15/40 (NATO, 0-1236) (item 27, Appx D)  OE/HDO-10 (NATO, 0-237) (item 26, Appx D)	OEA (NATO, 0-183) (item 25, Appx D)  OEA (NATO, 0-183) (item 25, Appx D) NOTE 1	For arctic operation, refer to FM 9-207
Transmission	88 Qts./Dry 48 Qts./ Refill	OE/HDO-15/40 (NATO, 0-1236) (item 27, Appx D)  OE/HDO -10 (NATO, 0-237) (item 26, Appx D)	OE/HDO-10 (NATO, 0-237) (item 26, Appx D)	OEA (NATO, 0-183) (item 25, Appx D)	

**G-4 LUBRICATION INSTRUCTIONS — CONTINUED**

**Table G-1. Expected Temperature Lubrication Requirements — Continued**

LUBRICANT/COMPONENT	CAPACITIES	ABOVE -15° F (ABOVE -26° C)	-40 to -15° F (-40 to -26°C)	-40 to -65° F (-40 to -54° C)	INTER- VALS
GO (MIL-L-2105) Lubricating Oil, Gear, Multi-purpose Traversing Gear Box	4 Qts.	GO-80/90 (NATO,0-226) (item 23, Appx D)	GO-80/90 (NATO,0-226) (item 23, Appx D)	GO-75 (NATO,0-186) (item 22, Appx D)	
GAA (MIL-L-10924) Grease, Automotive and Artillery Suspension and Road Wheels GMD (MIL-G-21164) Grease, Molybdenum Disulfide GGP (MIL-G-23549) Grease, General Purpose Mount Cradle Sleeve Bearing and Torque Key Grooves  Muzzle Brake, Bore Evacuator	As Required  As Required  As Required	  GGP (NATO,0-303) (item 18, Appx D) or GMD (item19,AppxD) NOTE 3,4	  GGP (item 18, Appx D) NOTE 4	  GMD (item 19, Appx D) NOTE 3, 4  GMD (item 19, Appx D)	For arctic operation, refer to FM 9-207
OHT (MIL-H-6083) Hydraulic Fluid, Petroleum Base, Preventive, Hydraulic Equipment Hydraulic Power Pack Assembly and Equilibrated Elevating Cylinder Recuperator Assembly Gun Mount and Replenisher Accumulator Assembly	48 Qts.  .7/.4 Qts  30 Qts.	OHT (item 20, Appx D)	OHT (item 20, Appx D)	OHT (item 20, Appx D)	

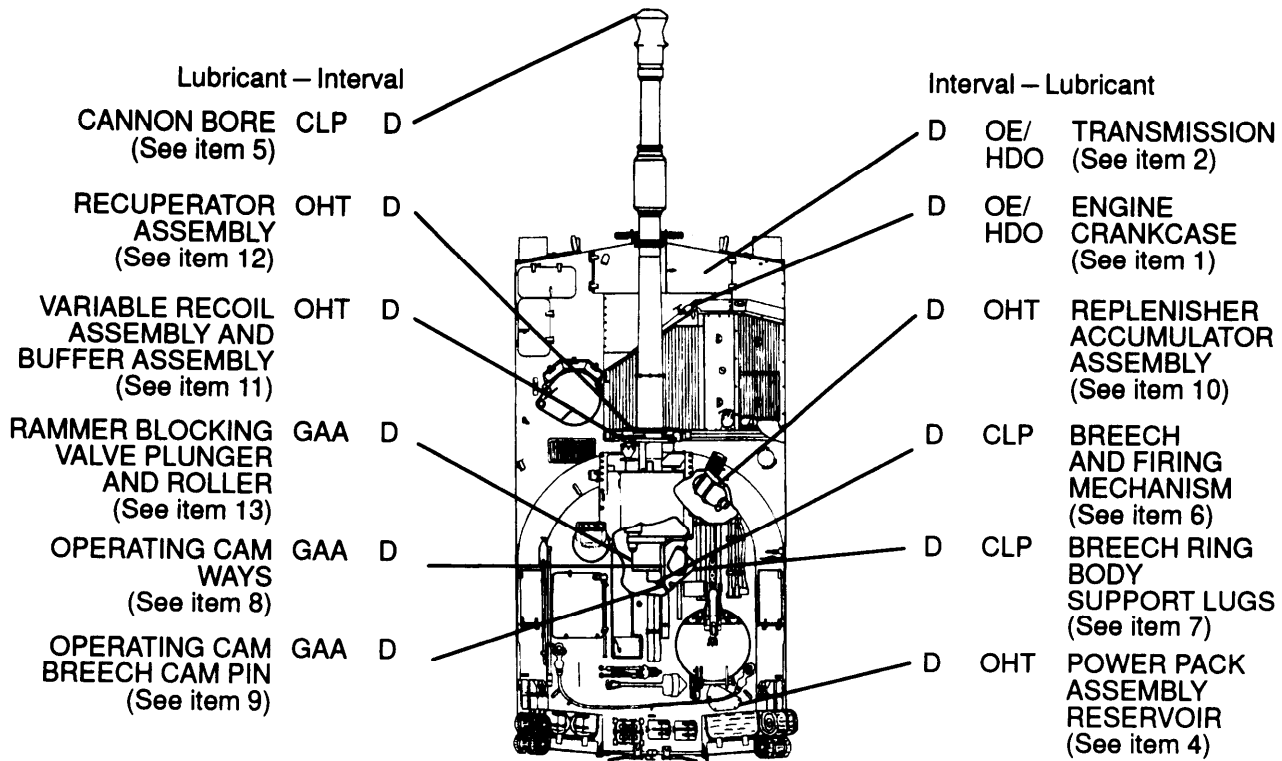
**NOTE**

1. If OEA lubricant is required to meet the low expected-temperature range, OEA lubricant is to be used in lieu of OE/HDO-10 lubricant for all expected temperature ranges where OE/HDO-10 is specified in the key.
2. Grade 85W-140 (GO-85/140) (NATO 0-228) (item 24, Appx D) may be used when expected temperatures are above 10° F (-12° C).
3. For sustained operation at 0°F(-18° C) temperature or below, change grease to GAA (item 17, Appx D).
4. Do not mix greases.

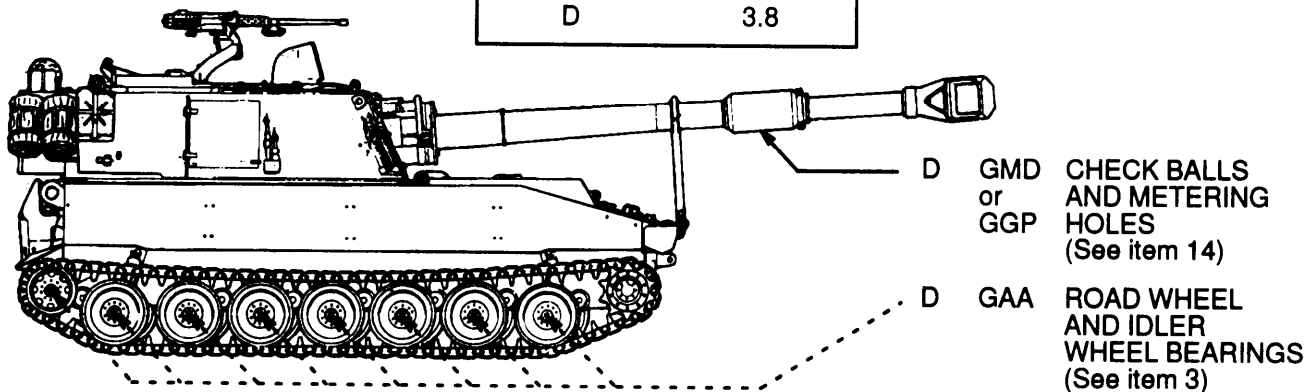
G-3 LUBRICATION INSTRUCTIONS — CONTINUED

DAILY

This page shows you what to lubricate daily when you operate or fire the weapon.



TOTAL MAN-HR	
INTERVAL	MAN-HR
D	3.8



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

1. ENGINE CRANKCASE (C)

**NOTE**

After an overnight stand, oil level may be 3/4 to 1 inch (1.91 to 2.54 cm) above the F (full) mark on the engine oil level dipstick. This is normal. However, if oil level is more than 1 inch (2.54 cm) above the F (full) mark, check for internal coolant or fuel oil leaks.

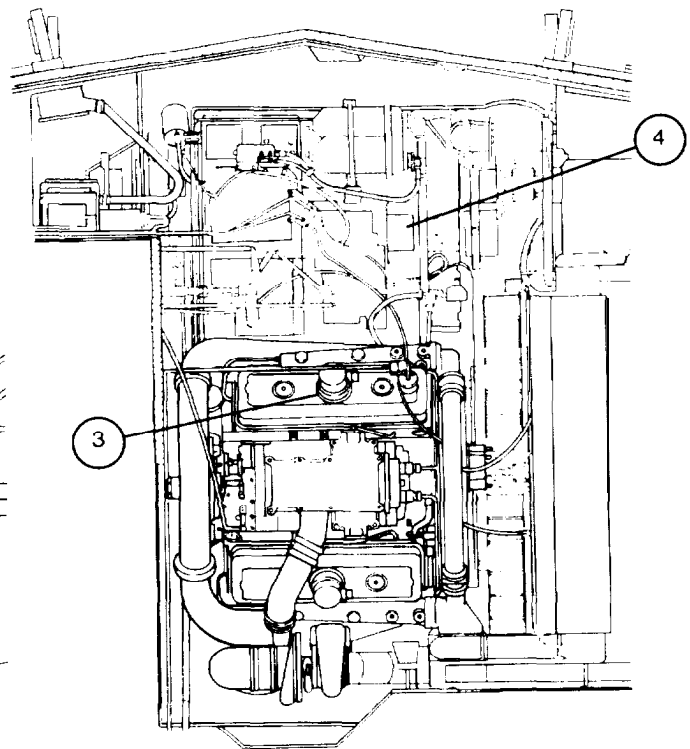
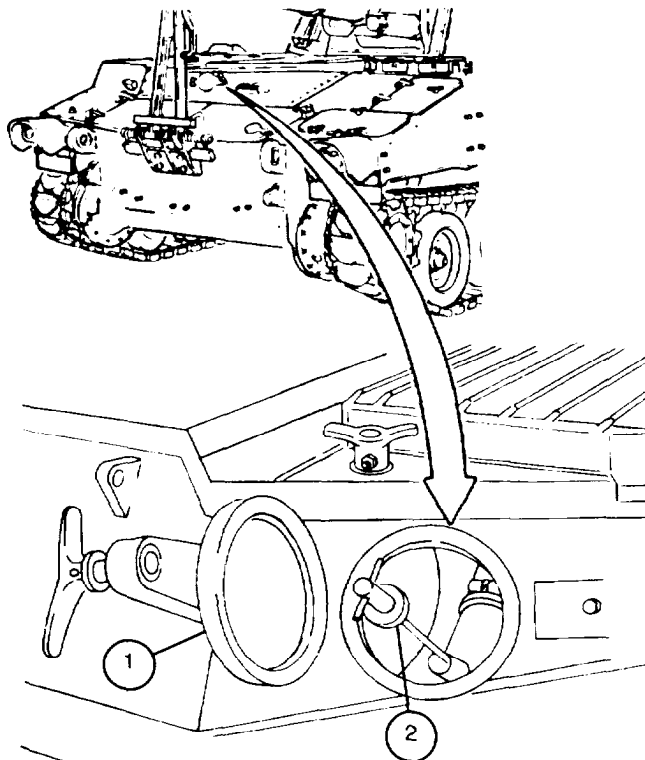
After operating engine, open engine oil level check access door (1) and check oil for level between L (low) and F (full) marks on engine oil level dipstick (2). Add oil (Table G-1) as required to bring level between L (low) and F (full) marks on engine oil level dipstick. Crankcase engine oil filler cap (3) is located in engine compartment.

2. TRANSMISSION (C)

**CAUTION**

Power train assemblies must use OE/HDO-10 (MIL-L-2104) while under warranty.

Check oil level after operating engine. The oil level must be within the L (low) and F (full) marks stamped on the dipstick (4). Add oil (Table G-1) or drain as required.





### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 3. ROAD WHEEL AND IDLER WHEEL BEARINGS (C)

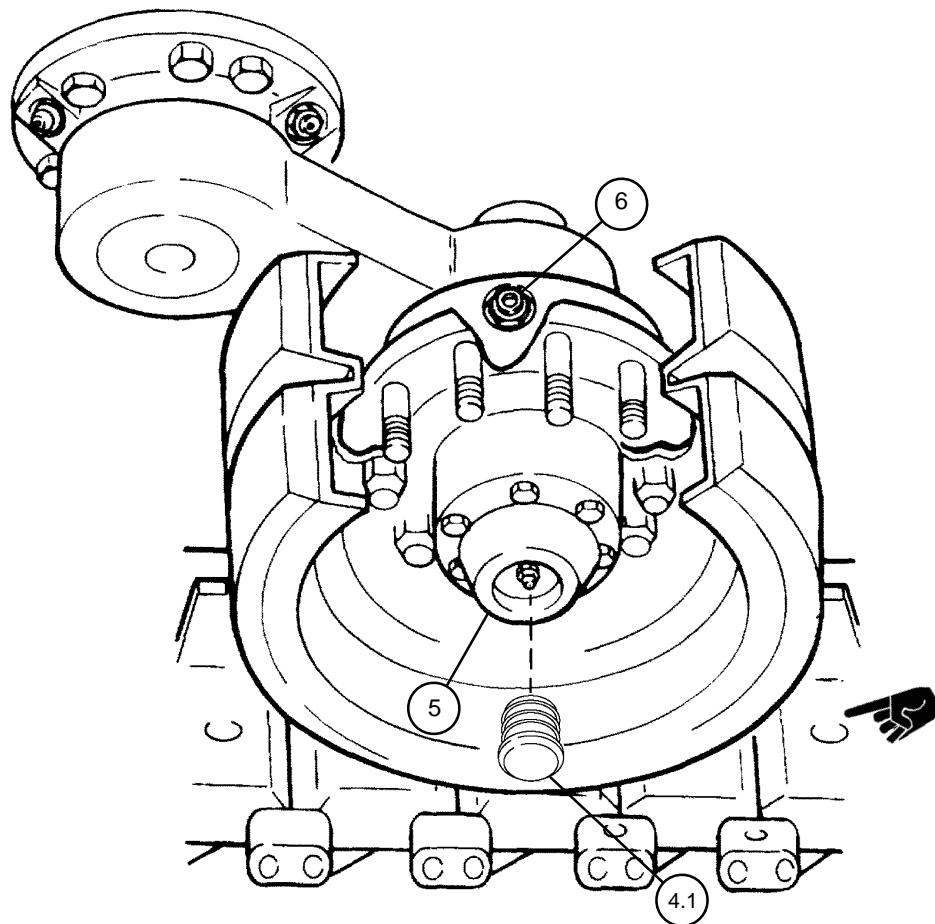
**CAUTION**

If grease seeps from hubs and/or housings before it flows from relief valve, notify unit maintenance.

- a. Remove protective cap (4.1).
- b. Fill road wheel and idler wheel hubs (5) with GAA (item 17, Appx D), stop and rotate hub a minimum of three revolutions, continue to fill with GAA (item 17, Appx D) until solid grease, without air, flows from relief valve (6).
- c. Install protective cap (4.1).

**NOTE**

Cutaway view is used for clarity.



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 4. POWER PACK ASSEMBLY RESERVOIR (C)

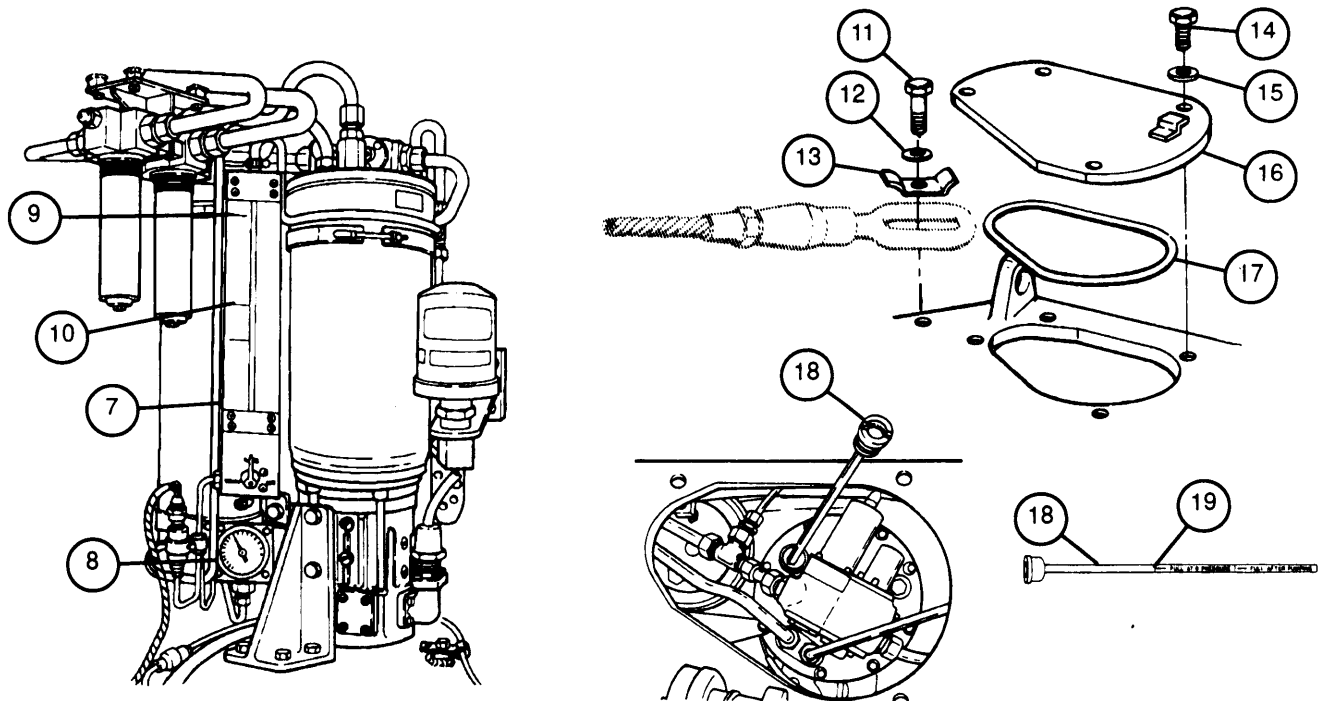
Before operation, check fluid level in sight gage (7). If pressure gage (8) reads zero, fluid level in sight gage should be up to FULL AT ZERO PRESSURE mark (9). If pressure gage reads between 925 and 1225 psi (6378 and 8446 kPa), the hydraulic system is fully charged and fluid level should be up to FULL AFTER PUMPING mark (10).

#### NOTE

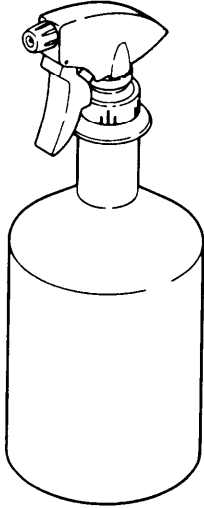
For accurate reading on power pack gage, perform zero pressure check (para 3-6.4).

To check hydraulic fluid:

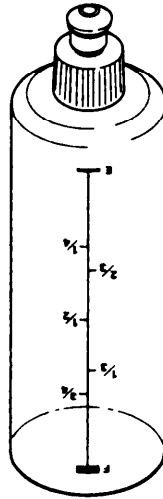
- a. Remove cap screw (11), flat washer (12), and towing cable strap (13) from cab roof.
- b. Remove four cap screws (14), four flat washers (15), and access cover (16) with gasket (17) from cab roof.
- c. Unscrew and remove power pack gage (18) from top of reservoir and note reading on power pack gage. Hydraulic fluid should be level with FULL AT 0 PRESSURE mark (19) on power pack gage. Add hydraulic fluid, OHT (Table G-1) to reservoir, if needed, and check level again with power pack gage.



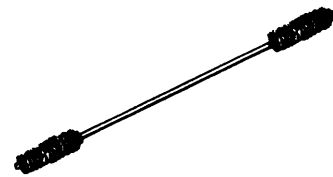
G-3 LUBRICATION INSTRUCTIONS — CONTINUED



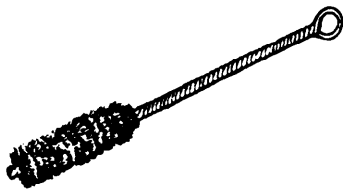
1 LITER SPRAY-TOP BOTTLE



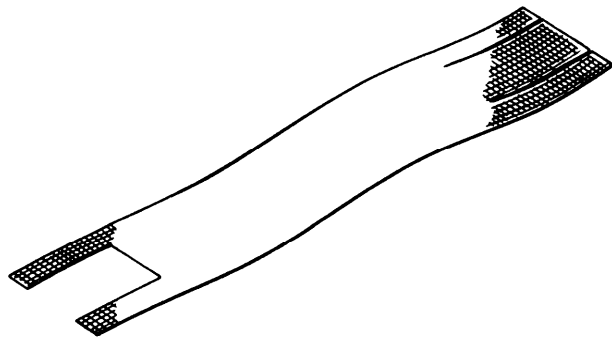
3.5 FL. OZ. CLP BOTTLE



BORE EVACUATOR BRUSH



PRIMER CLEANING BRUSH



CLEANING SLEEVE CLOTH

CLEANING AND PRESERVATIVE ARTILLERY KIT (item 21, Appx D)

**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

## 5. CANNON BORE (C). — CONTINUED

**NOTE**

Steps a. and b. apply to cleaning and preserving cannon assembly only.

## a. Day of Firing.

1 The following items are needed from the cleaning and preservative artillery kit (item 21, Appx D):

1 pre-measured bottle with CLP (item 8, Appx D)

2 Attach bore brush to cleaning staff section.

3 Inspect breech and cannon tube for obstructions. Clear obstructions, if necessary.

4 Wet punch the cannon tube as follows:

**NOTE**

Shake bottle well before each use.

- (a) Pour 1/4 of the bottle contents onto bore brush and punch the cannon tube once forward and once back.
- (b) Pour another 1/4 of the bottle contents onto bore brush and scrub back and forth the entire length of the cannon tube.
- (c) Repeat step (b) with another 1/4 of the bottle contents.
- (d) Pour final 1/4 of the bottle contents onto bore brush. Wet the entire length of the cannon tube once forward and once back.

## b. Day After Firing.

**NOTE**

If the cannon tube has not been previously cleaned with CLP (item 8, Appx D) and there is a heavy build up of coppering or carbon deposits, or severe heat cracking is evident, it may be necessary to repeat cleaning instructions until the cannon tube has been thoroughly cleaned with CLP (item 8, Appx D). For non-firing periods, cannon tube is cleaned and lubricated weekly.

1 The following items are needed from the cleaning and preservative artillery kit (item 21, Appx D):

2 pre-measured bottles with CLP (item 8, Appx D)

3 disposable cleaning sleeves

## G-3 LUBRICATION INSTRUCTIONS — CONTINUED

### 5. CANNON BORE (C). — CONTINUED

#### b. Day After Firing. — Continued

- 2 Attach bore brush to cleaning staff section.
- 3 Wet Punch. Wet punch the cannon tube following the procedures for “Day of Firing.”
- 4 Dry Punch. Wrap the bore brush with a new disposable cleaning sleeve and dry punch the entire length of the cannon tube once forward and back. Remove and dispose of the cleaning sleeve.
- 5 Wet Punch. Wrap the bore brush with a new disposable cleaning sleeve. Pour half of the pre-measured bottle contents onto cleaning sleeve. Wet punch the entire length of the cannon tube once forward and once back. Remove and dispose of cleaning sleeve.
- 6 Repeat step 5 with last half of bottle contents.

#### NOTE

Step c. applies to cleaning, lubricating, and preserving of both breech and bore evacuator.

#### c. After Firing is Completed.

- 1 The following items are needed from the cleaning and preservative artillery kit (item 21, Appx D):
  - 1 spray top bottle with CLP (item 8, Appx D)
  - 1 bore evacuator brush
  - 1 primer cleaning brush
  - Rags from general supply (item 35, Appx D)

#### NOTE

Shake the liter bottle well before each use.

- 2 Thoroughly wet all breech components with CLP. Let soak for 10-15 minutes and then wipe off. Reapply a light coat of CLP.
- 3 Spray CLP from the liter bottle onto all exposed metal surfaces.
- 4 Disassemble bore evacuator (item 14, Appx G).

#### NOTE

Bore evacuator brush (item 7, Appx D) maybe substituted for bore evacuator brush from the cleaning and preservative artillery kit (item 21, Appx D) to clean the bore evacuator.

- 5 Thoroughly wet the bore evacuator with CLP and scrub using bore evacuator brush.
- 6 Apply CLP to primer chamber and thoroughly brush with primer cleaning brush.
- 7 Thoroughly wet lock pin with CLP and wipe off all carbon and firing residue. Reapply a light coat of CLP.

### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 6. BREECH AND FIRING MECHANISM (C)

**CAUTION**

Do not clean obturator pad with CLP. Use soap (item 12, Appx D) and water only.

**NOTE**

Breech, firing mechanism, and firing mechanism housing are cleaned and lubricated weekly during non-firing periods.

Immediately after firing, remove firing mechanism (20) and spindle assembly (21) (para 3-6.8). Thoroughly clean all surfaces that have been in contact with powder gases with CLP (item 8, Appx D). Wipe dry and apply a light coating of CLP (item 8, Appx D) on all surfaces including breech threads. Lubricate the sliding area of firing mechanism housing (22) with CLP (item 8, Appx D).

#### 7. BREECH RING BODY SUPPORT LUGS (C)

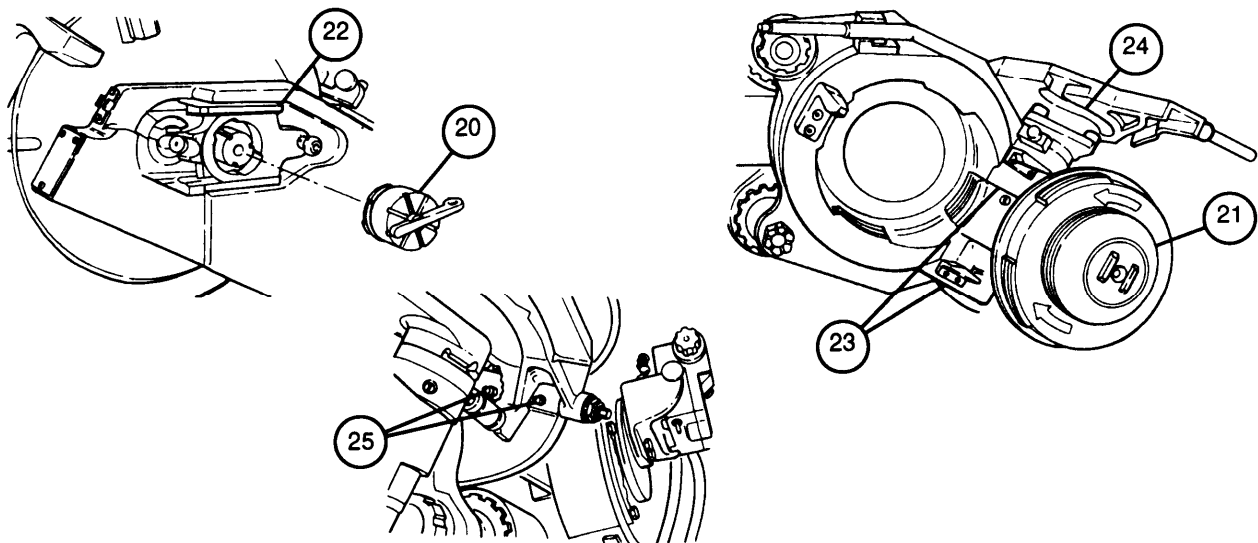
Lubricate both breech ring body support lugs (23) with CLP (item 8, Appx D) during periods when cannon assembly is being fired. These are cleaned along with cannon tube.

#### 8. OPERATING CAM WAYS (C)

Lubricate operating cam ways (24) with GAA (item 17, Appx D) during periods when cannon assembly is being fired.

#### 9. OPERATING CAM BREECH CAM PIN (C)

Lubricate two lubrication fittings (25) with GAA (item 17, Appx D) during periods when cannon assembly is being fired.



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

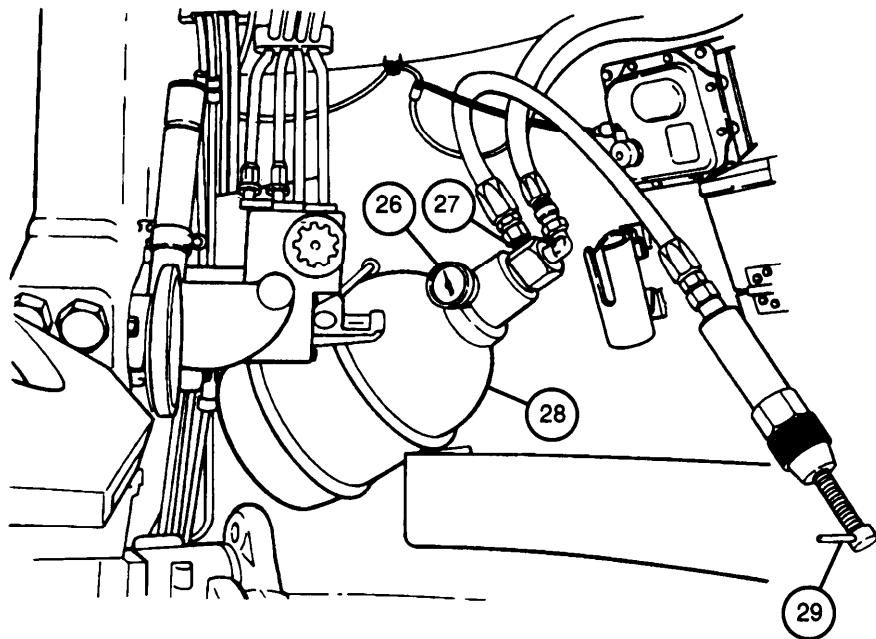
#### 10. REPLENISHER ACCUMULATOR ASSEMBLY (C)

##### NOTE

Pressure may increase during normal firing due to heat expansion. Safe-to-fire range is 17 to 50 psi (117 to 345 kPa).

Before firing, check pressure gage (26); reading should be 17 to 24 psi (117 to 165 kPa) at 70° F (210 C). If pressure gage reading is low, replenish system with hydraulic fluid, OHT (Table&l) as follows:

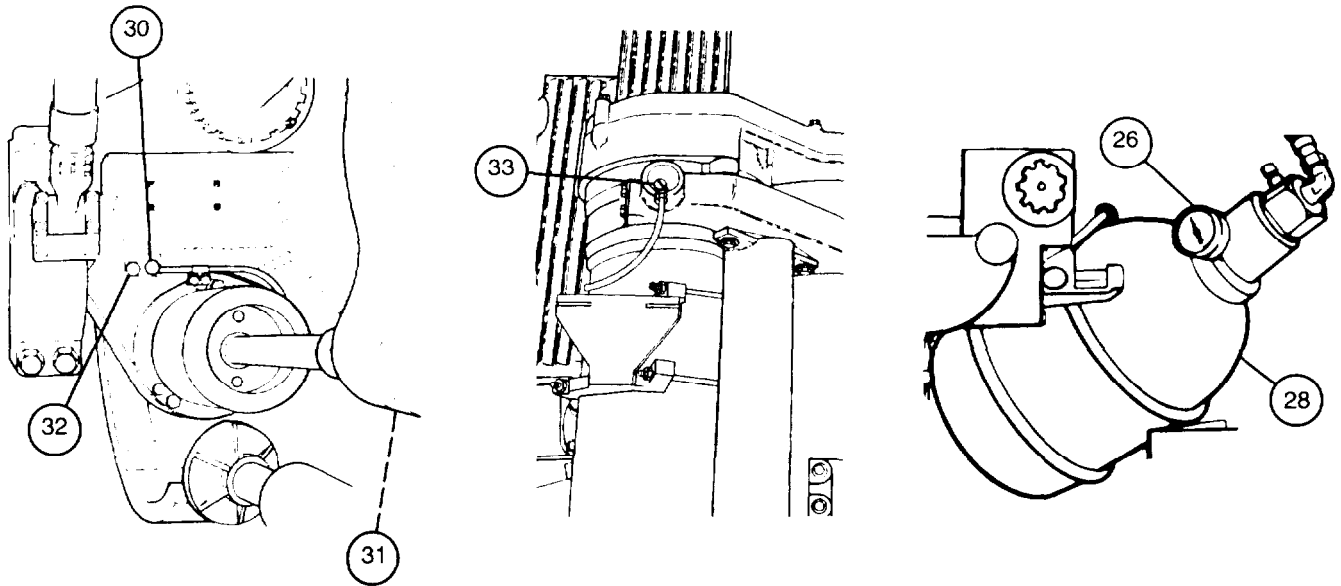
- a. Fill M3 oil gun (para 3-6.6).
- b. Place cannon tube at zero elevation.
- c. Using adapter, hose, and reducer, attach M3 oil gun loosely to filling valve (27) of replenisher accumulator assembly (28). Turn handle (29) of M3 oil gun clockwise until clean liquid flows around filling valve.
- d. Fill replenisher accumulator assembly (28) using M3 oil gun until pressure gage (26) reads 17 to 24 psi (117 to 165 kPa). If pressure is high, drain or bleed.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED****11. VARIABLE RECOIL ASSEMBLY AND BUFFER ASSEMBLY (C)**

To bleed variable recoil assembly and buffer assembly:

- a. Depress cannon assembly to maximum depression. Loosen right-hand bleeder plug (30) to bleed trapped air from rear of buffer assembly (31). When air-free fluid flows, tighten right-hand bleeder plug.
- b. Elevate cannon assembly to 50 mils. Loosen left-hand bleeder plug (32) to bleed trapped air from front of buffer assembly (31). When air-free fluid flows, tighten left-hand bleeder plug.
- c. Install hose before bleeding, then remove and stow in oddment tray after usage.
- d. Elevate cannon assembly to 180 mils; open bleeder valve (33). When air-free fluid flows from hose, tighten bleeder valve.
- e. Check replenisher accumulator assembly (28) pressure gage (26) for 17 to 24 psi (117 to 165 kPa).
- f. If low, add hydraulic fluid, OHT (item 20, Appx D) to correct operating range. If overfilled, drain.
- g. Rebleed system until all air is bled from replenisher accumulator assembly (28) and mount. Check for fluid leaks.





### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 12. RECUPERATOR ASSEMBLY (C)

**WARNING**

Do not attempt to remove drain plug completely. Hydraulic fluid in recuperator assembly is under high pressure and could cause injury.

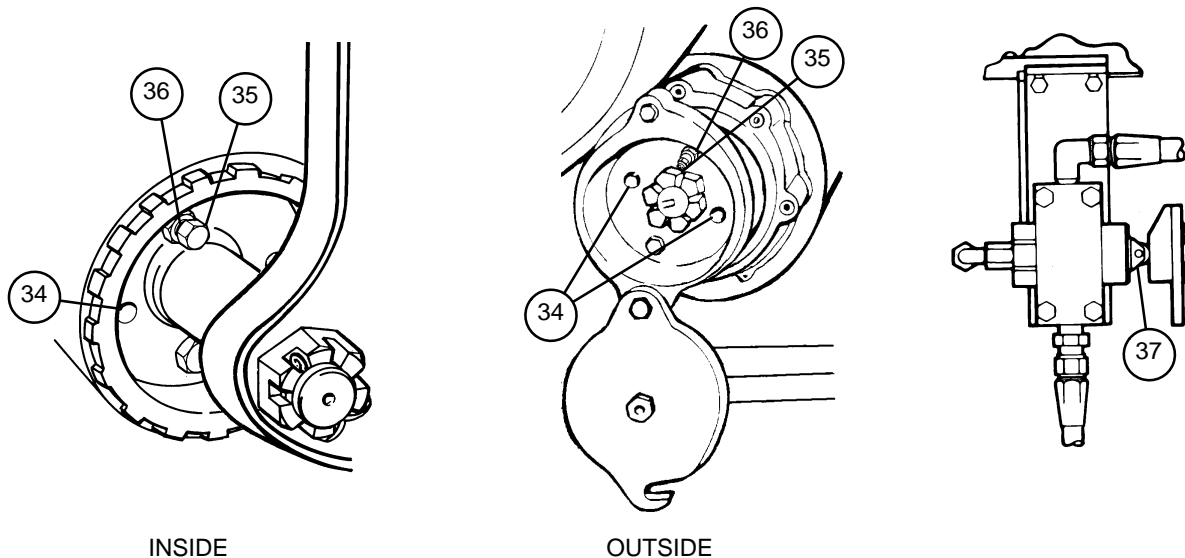
**CAUTION**

- If drain plug is loosened for draining hydraulic fluid, check for leaks after tightening cover.
- To prevent damage to gasket or cover, loosen cap screws to stop pins before rotating cover.
- Check M3 oil gun to be sure it contains hydraulic fluid and not grease to prevent damage to equipment. Do not overfill.

Before firing and after firing 100 rounds, sustained fire, check pins (34). Pins must extend from 1/4 to 3/4 inch (6.4 to 19.05 mm). If pins extend beyond 3/4 inch (19.05 mm), remove valve cap (35) from pneumatic valve (36) and add hydraulic fluid, OHT (Table G-1) until pins extend 1/4 inch (6.4 mm). If pins extend less than 1/4 inch (6.4 mm), loosen drain plug and drain hydraulic fluid, until pins extend 1/4 inch (6.4 mm).

#### 13. RAMMER BLOCKING VALVE PLUNGER AND ROLLER (C)

Coat plunger and roller (37) lightly with GAA (item 17, Appx D) during operation. Do not paint.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

14. CHECK BALLS AND METERING HOLES (C) (11578385)

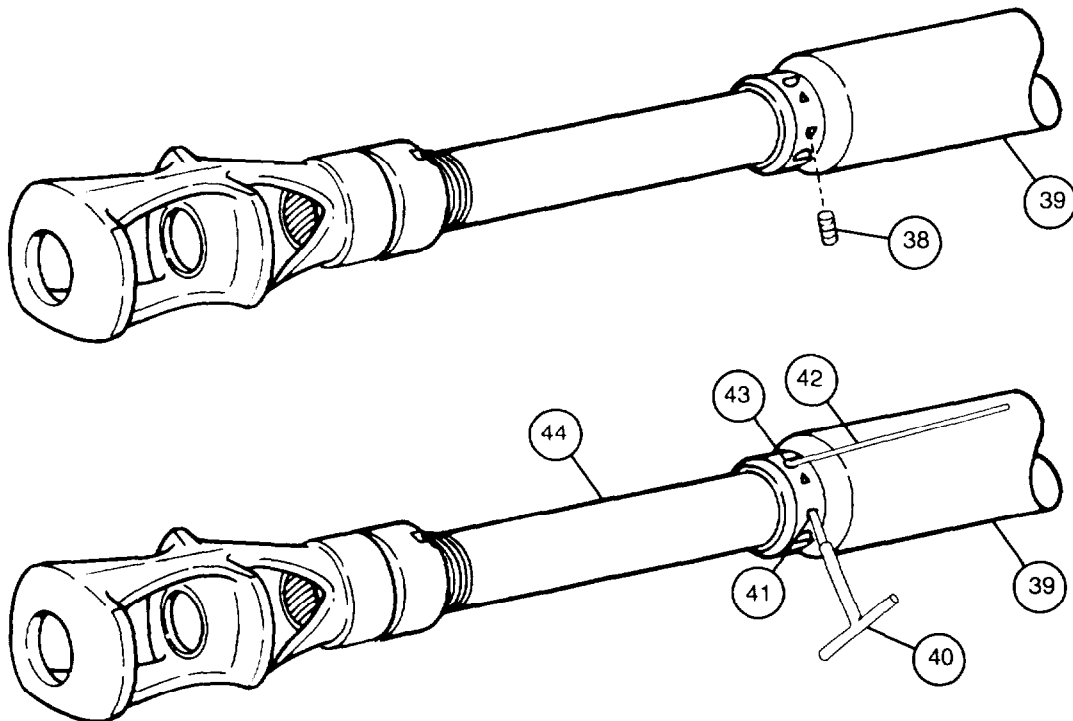
**NOTE**

There are two setscrews at the muzzle brake end of the bore evacuator. One setscrew is staked in place and should not be removed. It holds the bearing ball and spring in place. The second setscrew is not staked. Removal of this one will allow release of the bearing ball.

- a. Remove setscrew (38) from bore evacuator (39)

**NOTE**

- If T-handle is not available, a screwdriver can be used to depress bearing ball.
  - If bearing ball is stuck or spring appears broken, notify unit maintenance.
- b. Insert T-handle (40) into setscrew hole (41). Turn T-handle to engage with threads. Continue turning to depress ball and spring.
  - c. Insert pry bar (42) into hole (43). With bearing ball depressed, unscrew bore evacuator (39) and slide it forward on cannon tube (44).



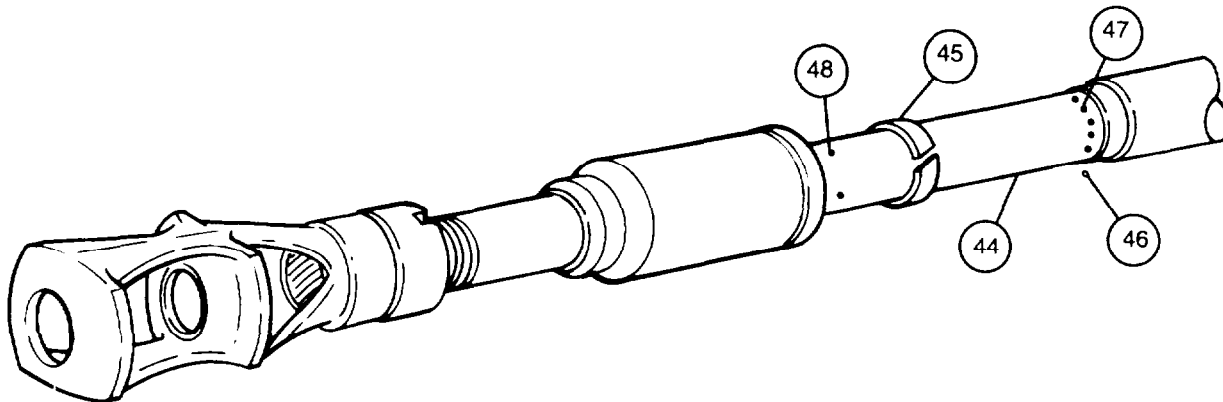
**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

■ 14. CHECK BALLS AND METERING HOLES (C) (11578385) -CONTINUED

**NOTE**

Use rag to catch ten check balls when sliding valve ring forward.

- d. Slide valve ring (45) forward and remove 10 check balls (46).
- e. Thoroughly wet check balls (46), vent seats (47), and metering holes (48) with CLP (item 8, Appx D) using the bore evacuator brush.
- f. Apply a light coat of GMD (item 19, Appx D) or GGP (item 18, Appx D) to check balls (46), valve ring (45), and unpainted cannon tube (44) surface before assembling.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

## 14.1. CHECK BALLS AND METERING HOLES (C) (11580776)

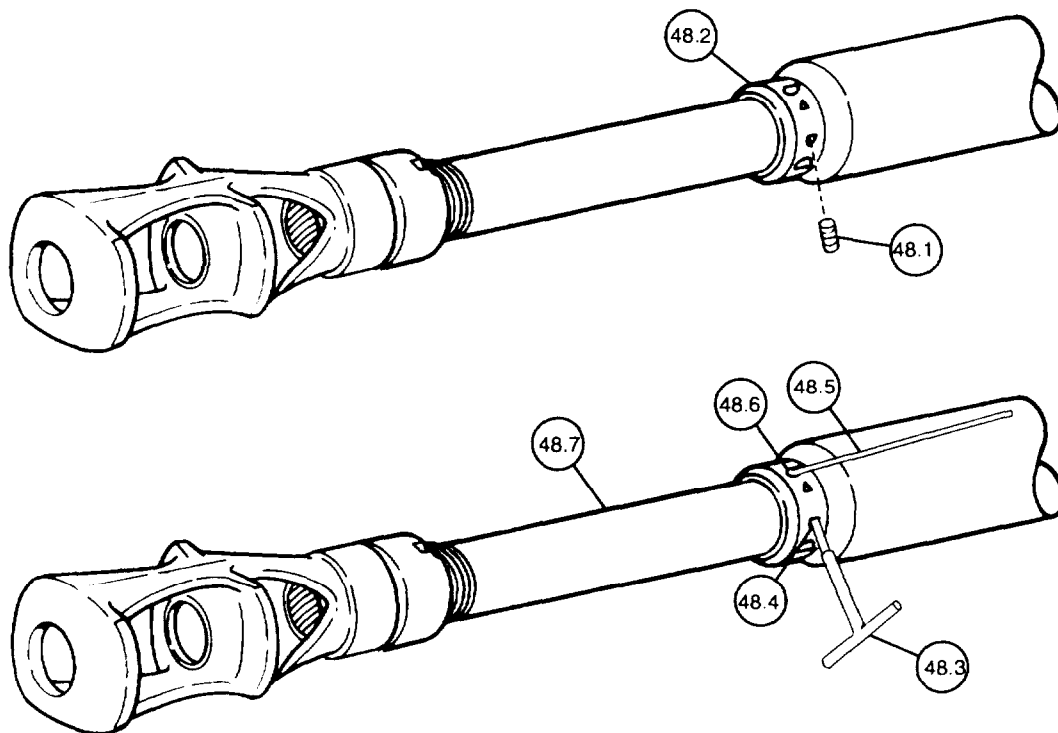
**NOTE**

There are two setscrews on the thrust collar at the muzzle brake end of the bore evacuator. One setscrew is staked in place and should not be removed. It holds the bearing ball and spring in place. The second setscrew is not staked. Removal of this one will allow release of the bearing ball.

- a. Remove setscrew (48.1) from thrust collar (48.2).

**NOTE**

- If T-handle is not available, a screwdriver can be used to depress bearing ball.
  - If bearing ball is stuck or spring appears broken, notify unit maintenance.
  - If o-rings are damaged, notify unit maintenance.
- b. Insert T-handle (48.3) into setscrew hole (48.4). Turn T-handle to engage with threads. Continue turning to depress ball and spring.
- c. Insert pry bar (48.5) into hole (48.6). With bearing ball depressed, unscrew thrust collar (48.2) and slide it forward on cannon tube (48.7).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

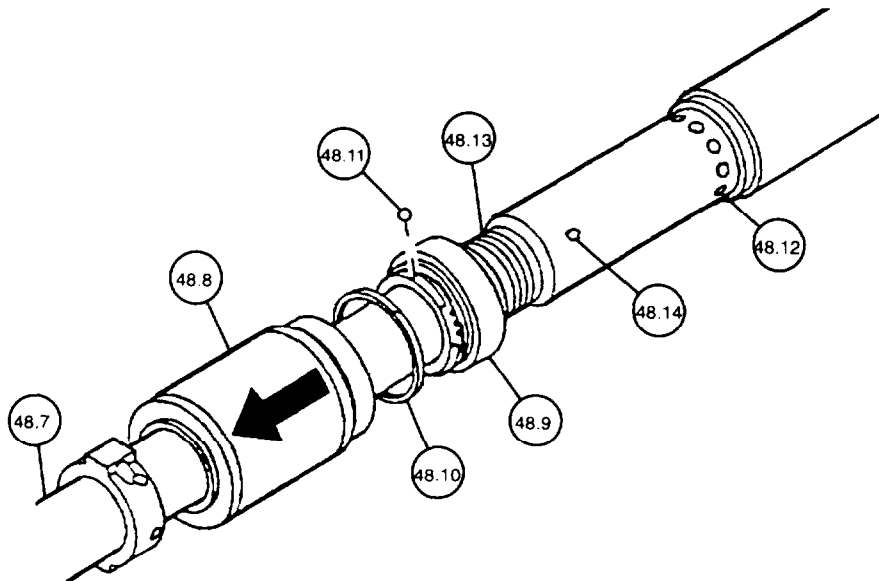
14.1. CHECK BALLS AND METERING HOLES (C) (11580776) -CONTINUED

- d. Slide main reservoir (48.8) forward on cannon tube (48.7) separating it from the preservoir (48.9).

**NOTE**

Use rag to catch nine check balls when sliding valve ring forward.

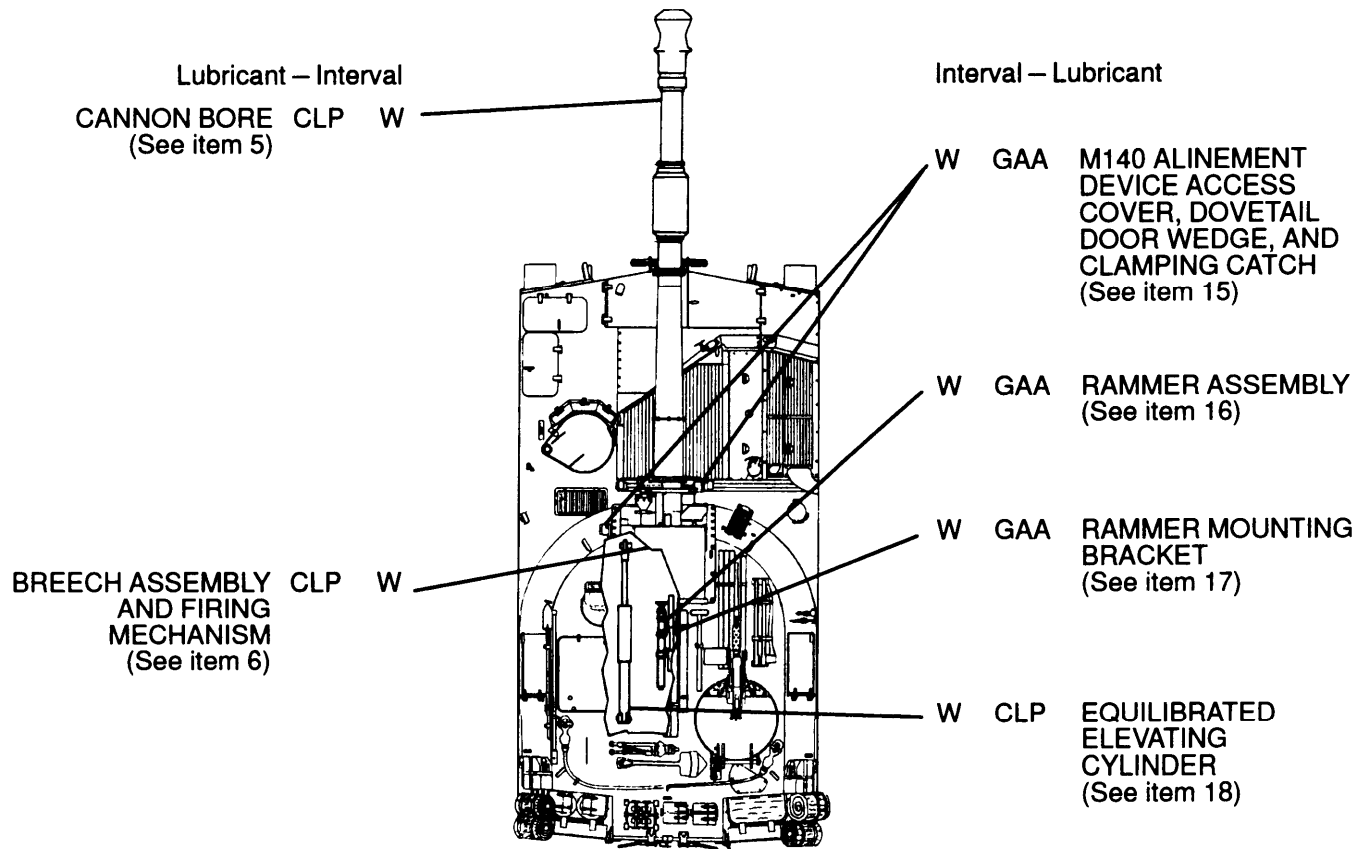
- e. Slide valve ring (48.10) forward and remove nine check balls (48.11). The balls should fall out.
- f. Slide preservoir (48.9) forward on cannon tube (48.7).
- g. Thoroughly clean evacuator ball valves (48.11), 10 evacuator orifices (48.12), and tube threads (48.13) with CLP (item 8, Appx D) using the bore evacuator brush. Clean three metering holes (48.14) with CLP using brush.
- h. Apply a light coat of GMD (item 19, Appx D) or GGP (item 18, Appx D) to check balls (48.11), valve ring (48.10) and unpainted cannon tube (48.7) surface before assembling. For nonfiring periods, bore evacuator and check balls are cleaned and lubricated monthly.



**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

**WEEKLY**

This page shows you what to lubricate weekly when you operate this weapon.



TOTAL MAN-HR	
INTERVAL	MAN-HR
W	2.9

**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

15. M140 ALINEMENT DEVICE ACCESS COVER, DOVETAIL DOOR WEDGE, AND CLAMPING CATCH (C)

Grease dovetail door wedge (49), access cover pin (50), and clamping catch (51 ) with GAA (item 17, Appx D).

16. RAMMER ASSEMBLY (C)

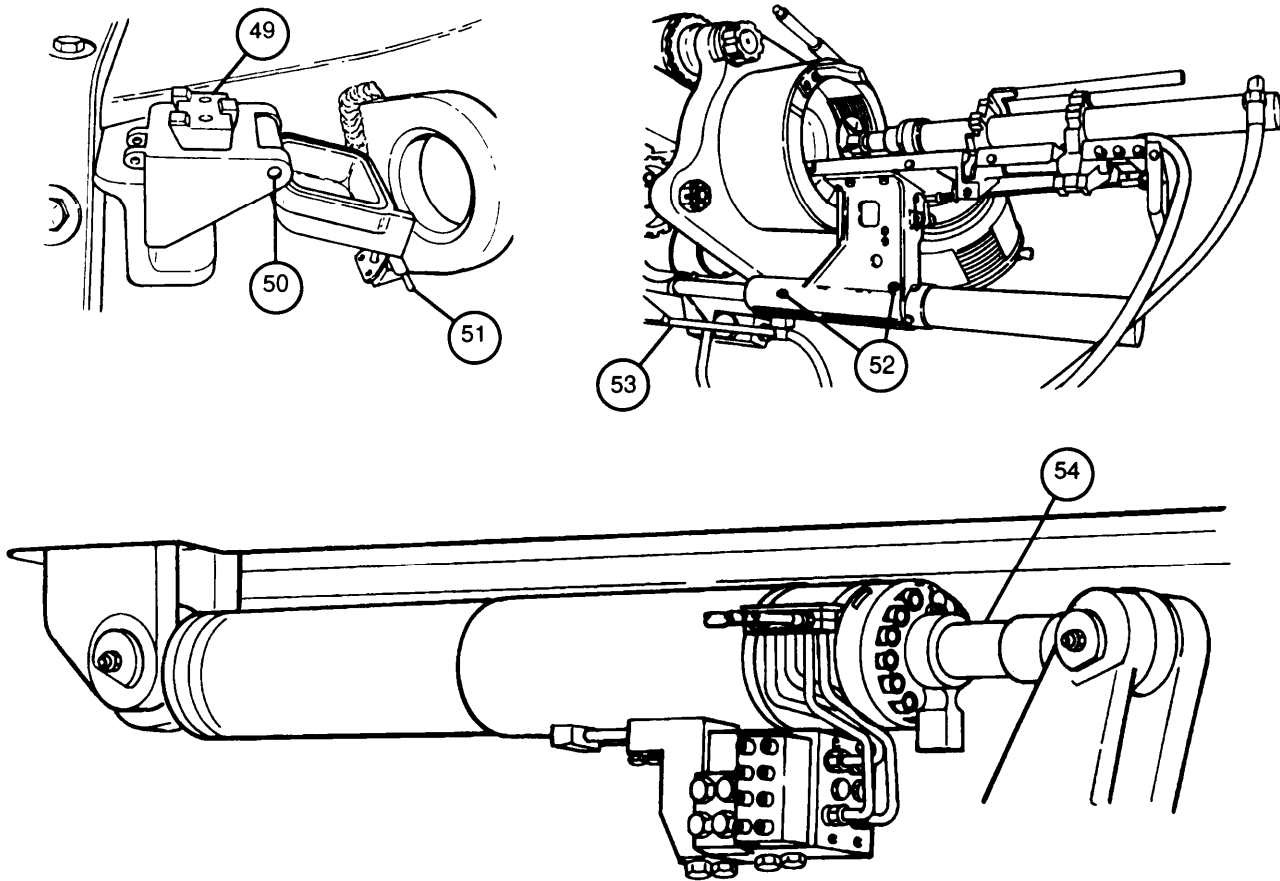
Lubricate two lubrication fittings (52) with GAA (item 17, Appx D).

17. RAMMER MOUNTING BRACKET (C)

Coat rammer mounting bracket (53) lightly with GAA (item 17, Appx D) before operation. Do not paint.

18. EQUILIBRATED ELEVATING CYLINDER (C)

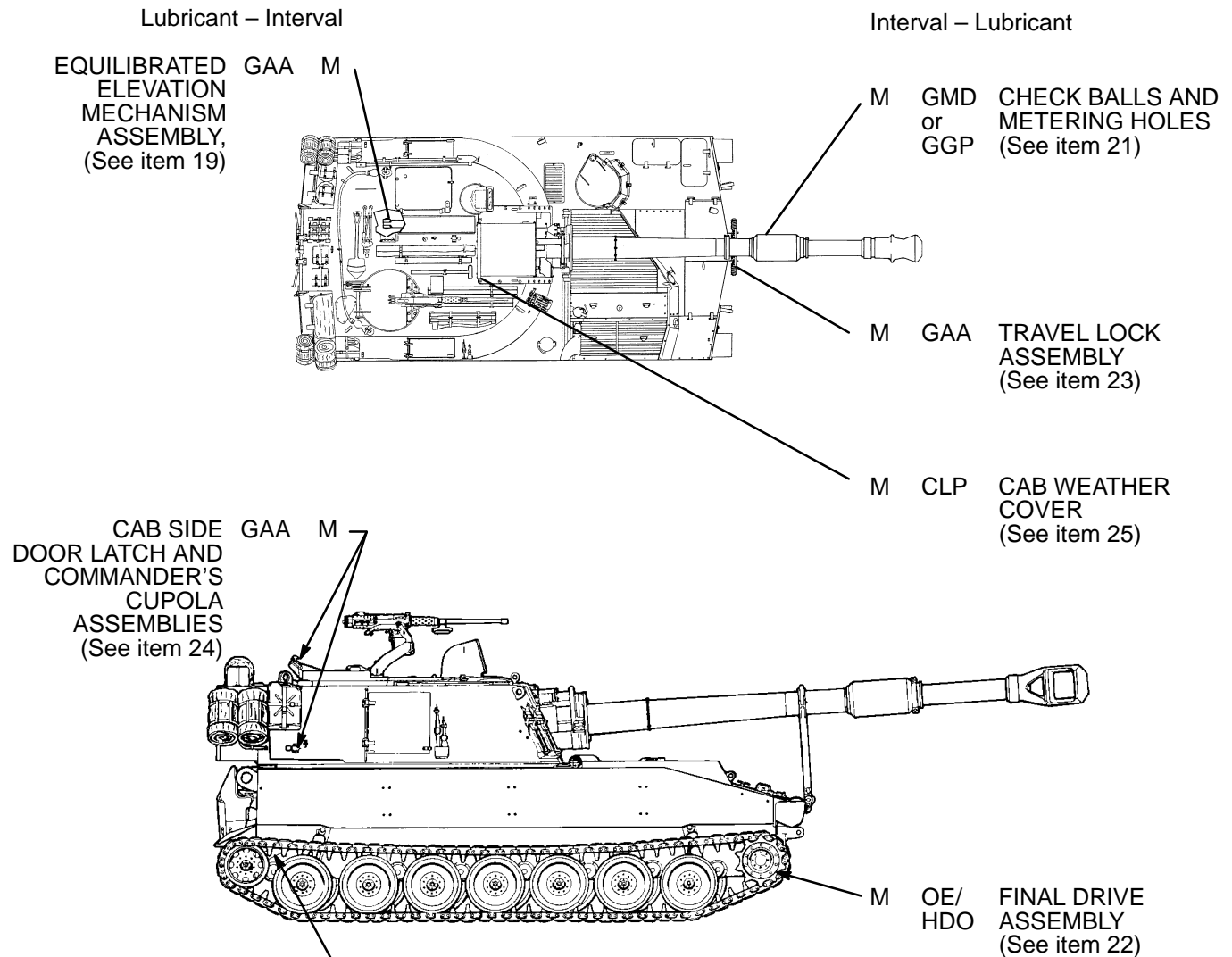
Clean exposed elevating piston rod (54) surfaces and coat with CLP (item 8, Appx D).



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### MONTHLY

This page shows you what to lubricate monthly when you operate the weapon.



TOTAL MAN-HR	
INTERVAL	MAN-HR
M	2.1



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 19. EQUILIBRATED ELEVATION MECHANISM ASSEMBLY (C)

Lubricate two lubrication fittings (55) with GAA (item 17, Appx D).

#### 20. TRACK ADJUSTER (C)

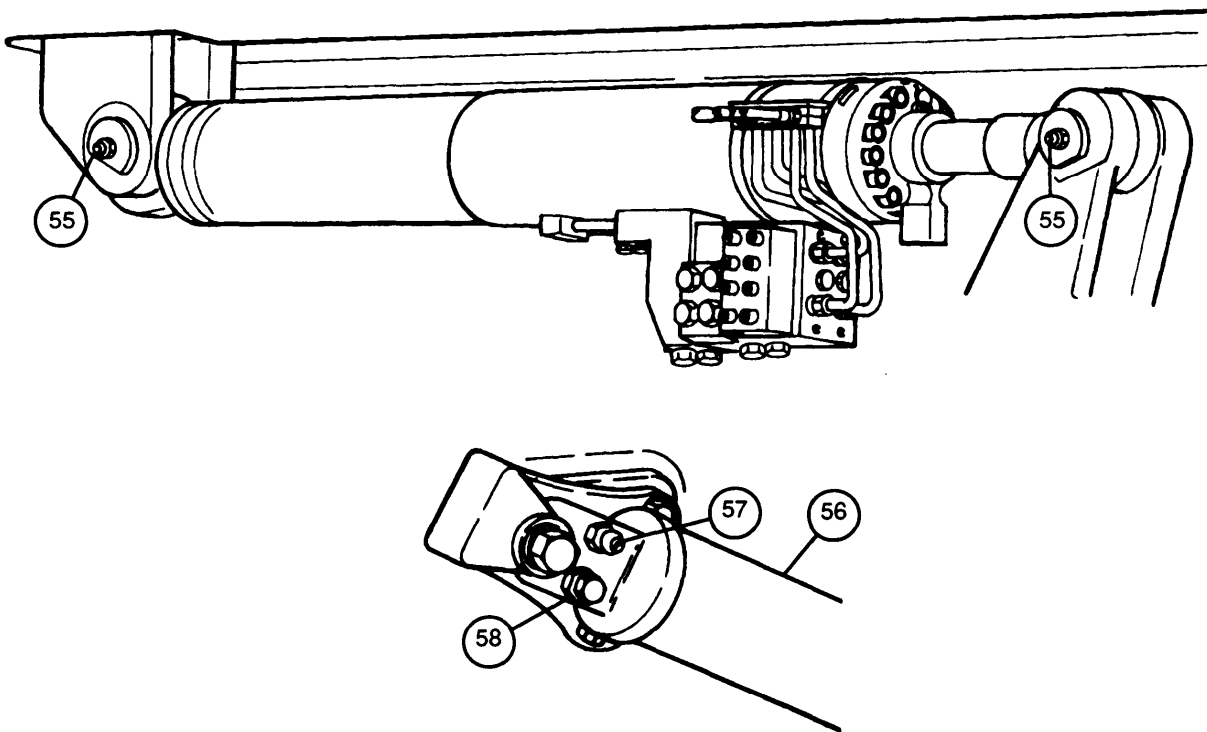
**WARNING**

Lubricant is under high pressure. Loosen bleeder plug slowly to avoid injury.

**CAUTION**

When increasing track tension, do not let track adjuster extend beyond 3-1/2 inches (8.89 cm) to avoid track adjuster damage.

Check track tension on track adjuster (56). Clean lubrication fitting (57). Pump GAA (item 17, Appx D) into lubrication fitting to increase track tension. Open bleeder plug (58) to decrease track tension.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

**21. CHECK BALLS AND METERING HOLES (C) (11578385)**

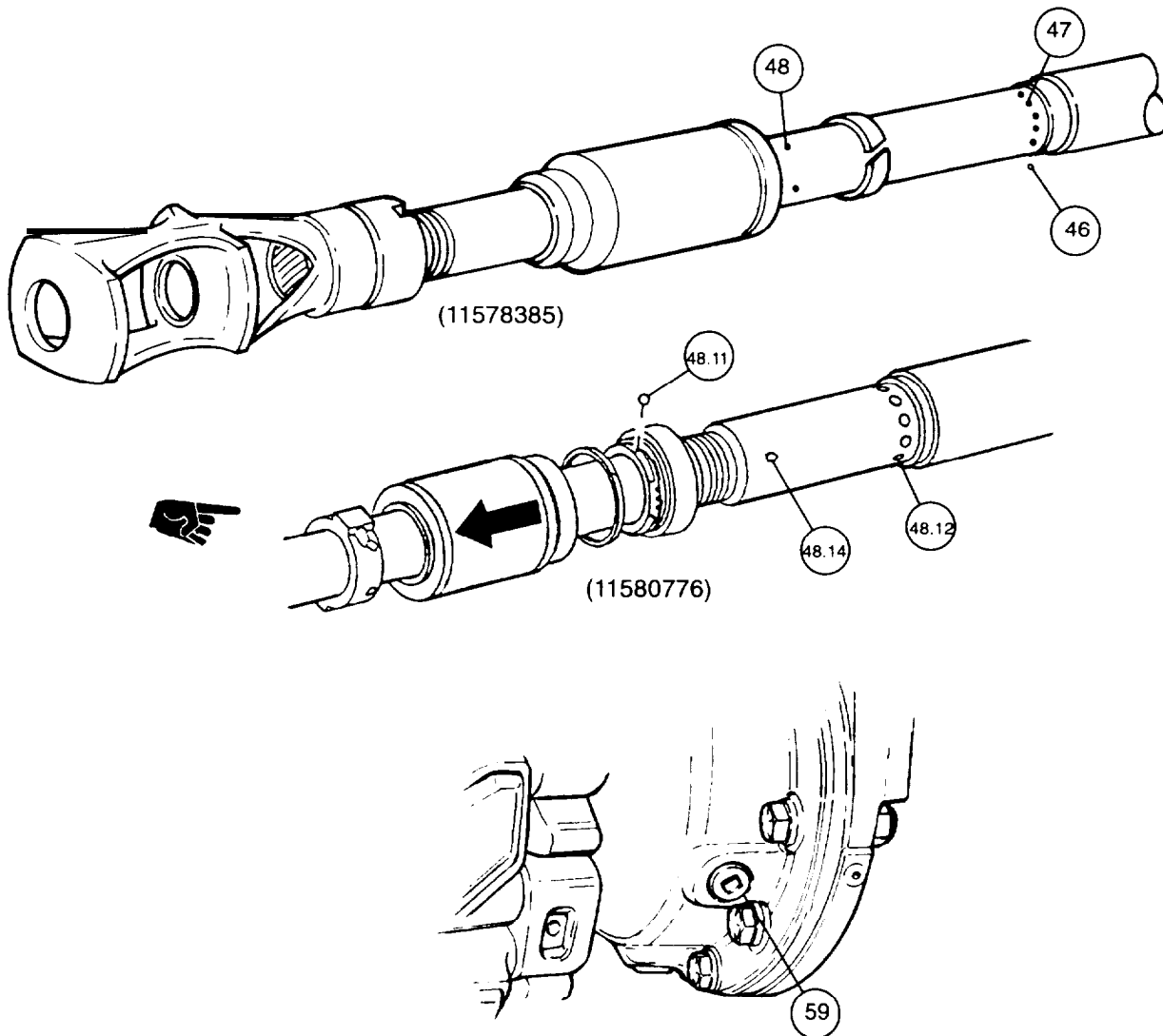
Even if howitzer hasn't been fired, clean vent seats (47), ten check balls (46), and metering holes (48) (item 14, Appx G).

**21.1. CHECK BALLS AND METERING HOLES (C) (11580776)**

Even if howitzer hasn't been fired, clean 10 evacuator orifices (48.12) nine check balls (48.11), and metering holes (48.14) (item 14, Appx G).

**22. FINAL DRIVE ASSEMBLY (C)**

Remove level plug (59). Oil should be level with bottom of opening. If not, add OE/HDO (Table G-1) until oil flows from level plug opening. Clean and reinstall level plug.



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 23. TRAVEL LOCK ASSEMBLY (C)

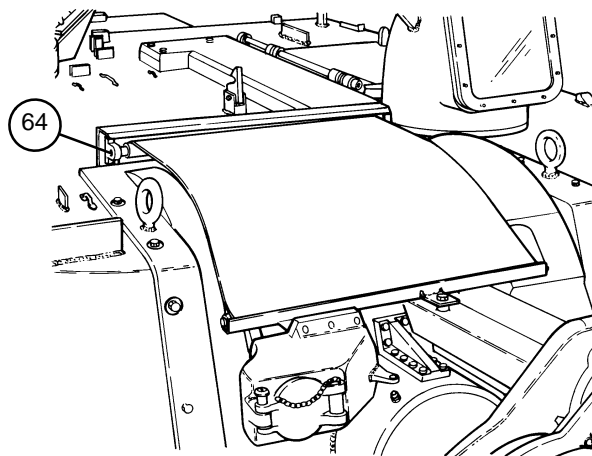
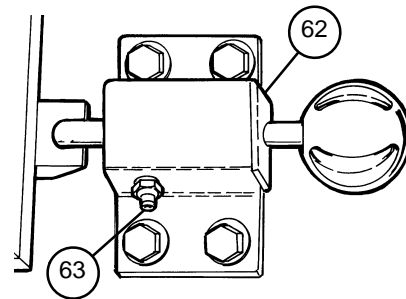
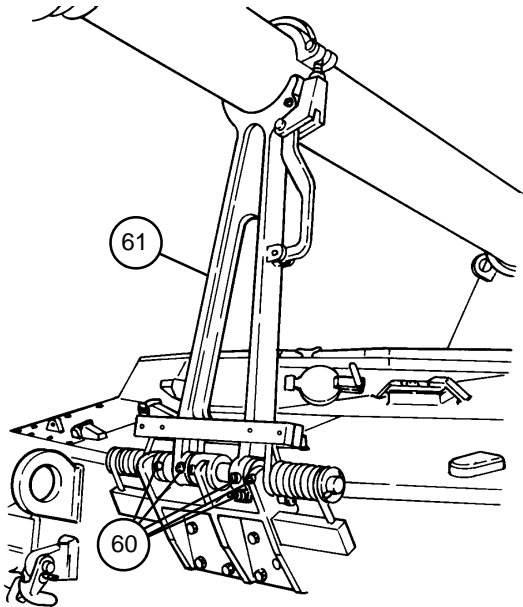
Lubricate five lubrication fittings (60) on travel lock assembly (61) with GAA (item 17, Appx D).

#### 24. CAB SIDE DOOR LATCH ASSEMBLIES (C)

Lubricate latch assembly (62) at lubrication fitting (63) on left and right cab side doors and commander's cupola with GAA (item 17, Appx D).

#### 25. CAB WEATHER COVER (C)

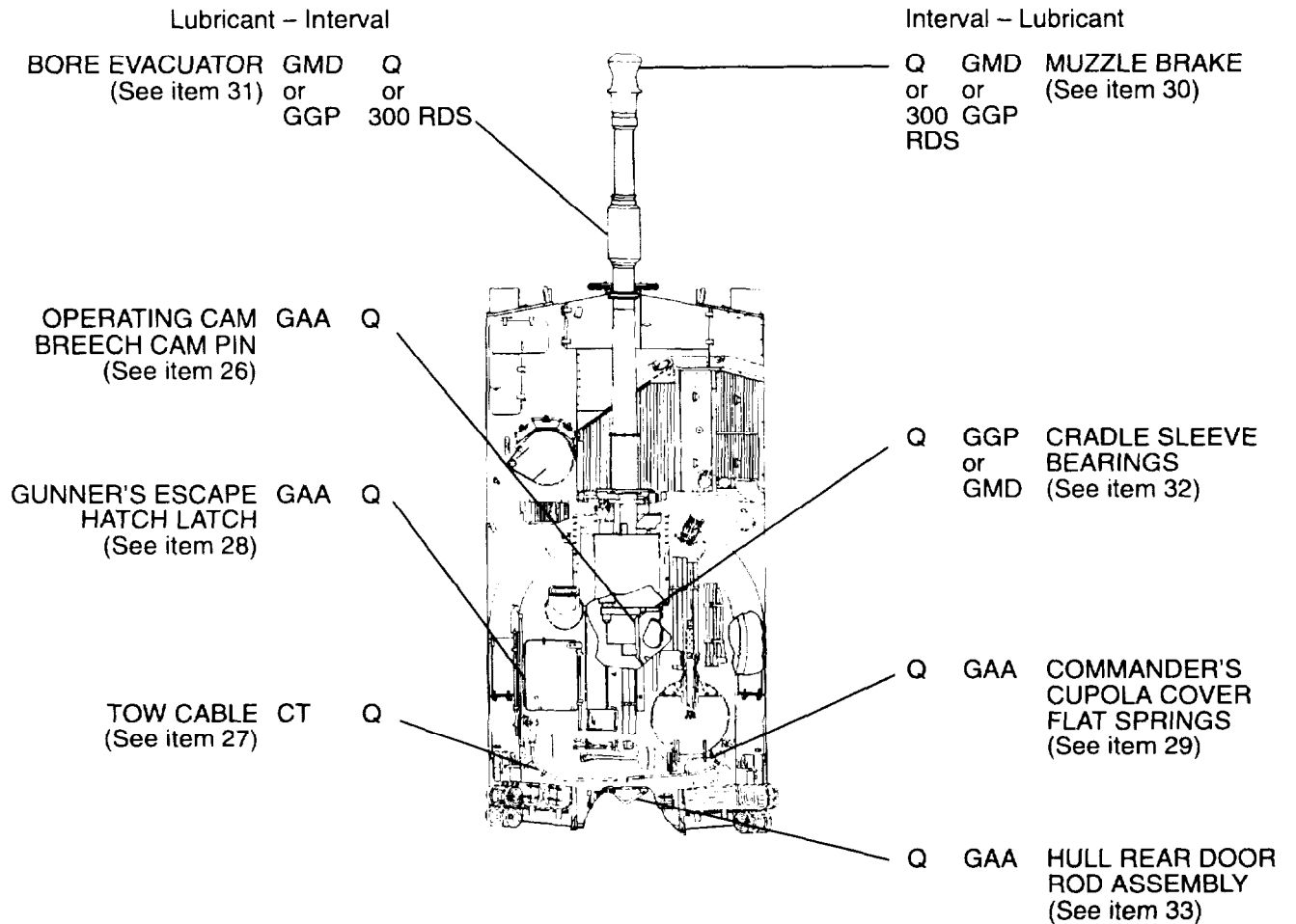
Lubricate helical compression spring and spring pin (64) with CLP (item 8, Appx D).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

**QUARTERLY**

This page shows you what to lubricate each quarter when you operate the weapon.



TOTAL MAN-HR	
INTERVAL	MAN-HR
Q	3.1

**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

26. OPERATING CAM BREECH CAM PIN (C)

Lubricate two lubrication fittings (25) with GAA (item 17, Appx D).

27. TOW CABLE (C)

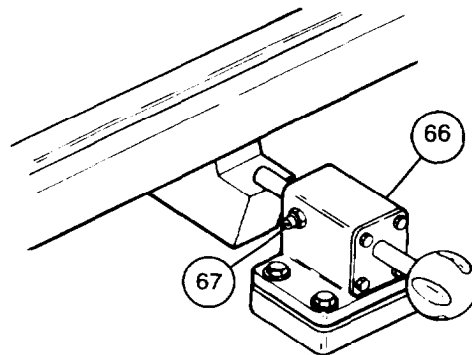
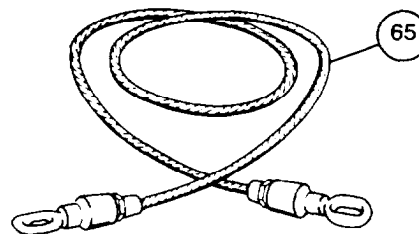
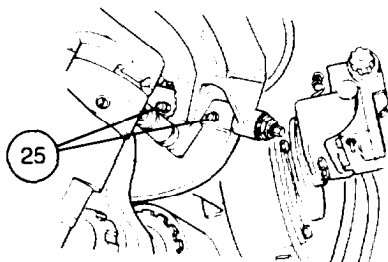


Solvents can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If solvent gets on skin or clothing, wash immediately with soap and water.

- Clean tow cable (65) with cleaning compound (item 9.1, Appx D) and coat with CT (item 11, Appx D).

28. GUNNER'S ESCAPE HATCH LATCH ASSEMBLY (C)

Lubricate latch assembly (66) at lubrication fitting (67) with GAA (item 17, Appx D).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

**29. COMMANDER'S CUPOLA COVER FLAT SPRINGS AND LATCH ASSEMBLY (C)**

**NOTE**

Not all commander's cupola covers contain knob latch assembly that requires lubrication.

Lubricate 12 flat springs (68) on commander's cupola cover (69) with GAA (item 17, Appx D). Lubricate latch assembly (69.1) at lubrication fitting (69.2) with GAA (item 17, Appx D).

**30. MUZZLE BRAKE (C)**

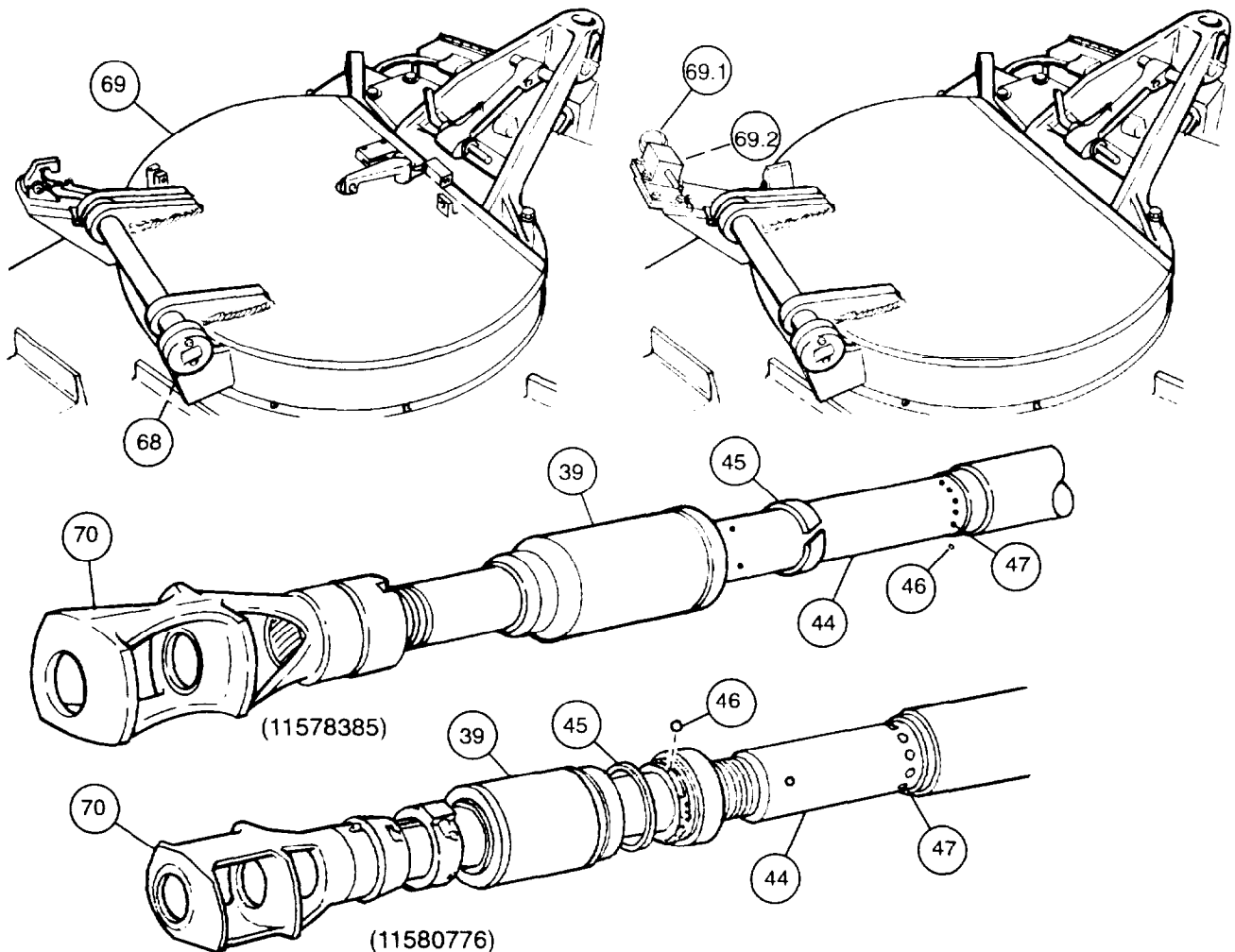
Quarterly or every 300 rounds fired, remove, clean threads, and coat unpainted surfaces of muzzle brake (70) with GMD (item 19, Appx D) or GGP (item 18, Appx D) before reinstalling.

**31. BORE EVACUATOR (C)**

**NOTE**

Bore evacuator (11578385) has ten check balls while bore evacuator (11580776) has nine check balls.

Quarterly or every 300 rounds fired, clean and lightly coat inside of bore evacuator (39), ten check balls (46), vent seats (47), valve ring (45), and unpainted cannon tube (44) surfaces with GMD or GGP (item 14, Appx G).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

32. CRADLE SLEEVE BEARINGS (C)

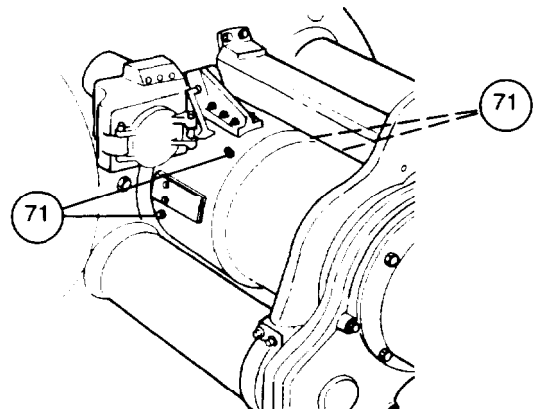
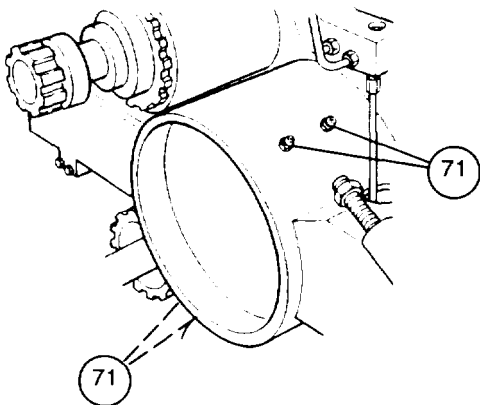
**CAUTION**

For sustained operation at 0° F (-18° C) temperature or below, change grease to GAA. When changing grease, cannon assembly must be removed. Notify unit maintenance for removal of cannon assembly. Wipe grease from recess between cradle sleeve bearings and repack with GGP or GAA. Do not mix greases.

Quarterly or every 500 rounds fired, lubricate cradle sleeve bearing lubrication fittings (71) (four inside and four outside) with GAA, GGP, or GMD (Table G-1).

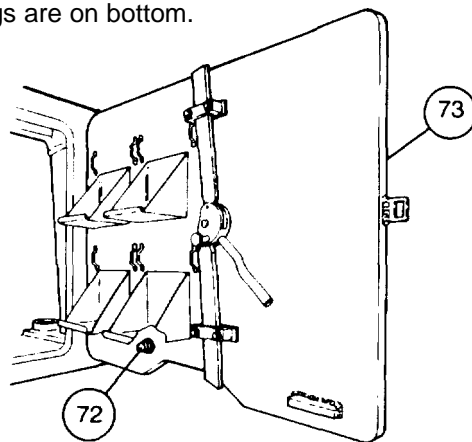
33. HULL REAR DOOR ROD ASSEMBLY (C)

Lubricate lubrication fitting (72) on hull rear door (73) with GAA (item 17, Appx D).



**NOTE**

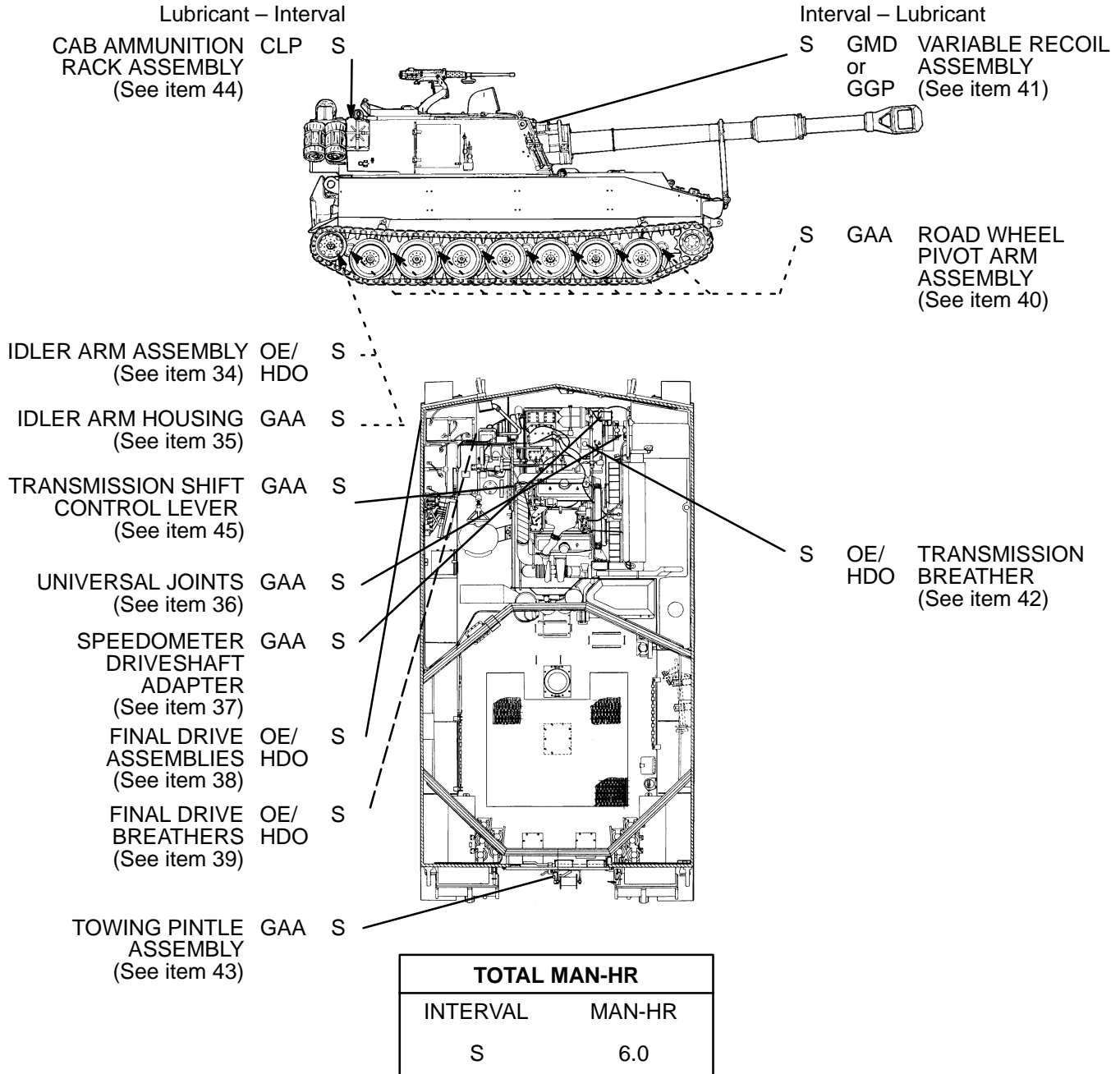
For clarity, inside of mount is shown out of howitzer. Right side lubrication fittings are shown on top and left side lubrication fittings are on bottom.



**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

**SEMI-ANNUALLY**

This page shows you what to lubricate semi-annually when you operate the weapon.





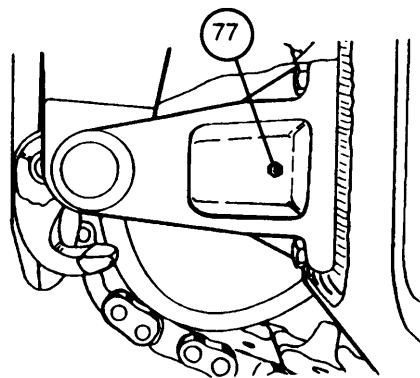
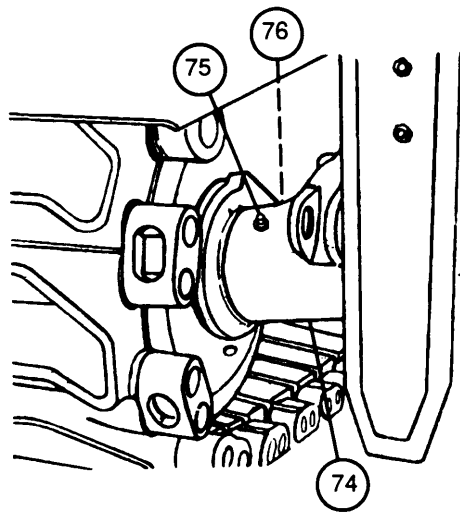
### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### 34. IDLER ARM ASSEMBLY (C)

Fill idler arm assembly (74) at lubrication fitting (75) with GAA (item 17, Appx D) until solid grease, without air, flows from safety relief valve (76).

#### 35. IDLER ARM HOUSING (C)

Remove plug (77) and install lubrication fitting. Lubricate with GAA (item 17, Appx D) using hand lubricating gun. Remove lubrication fitting and reinstall plug.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED****36. UNIVERSAL JOINTS (C)**

Lubricate two lubrication fittings (78) on each universal joint (79) with GAA (item 17, Appx D). Rotate universal joint to reach lubrication fittings.

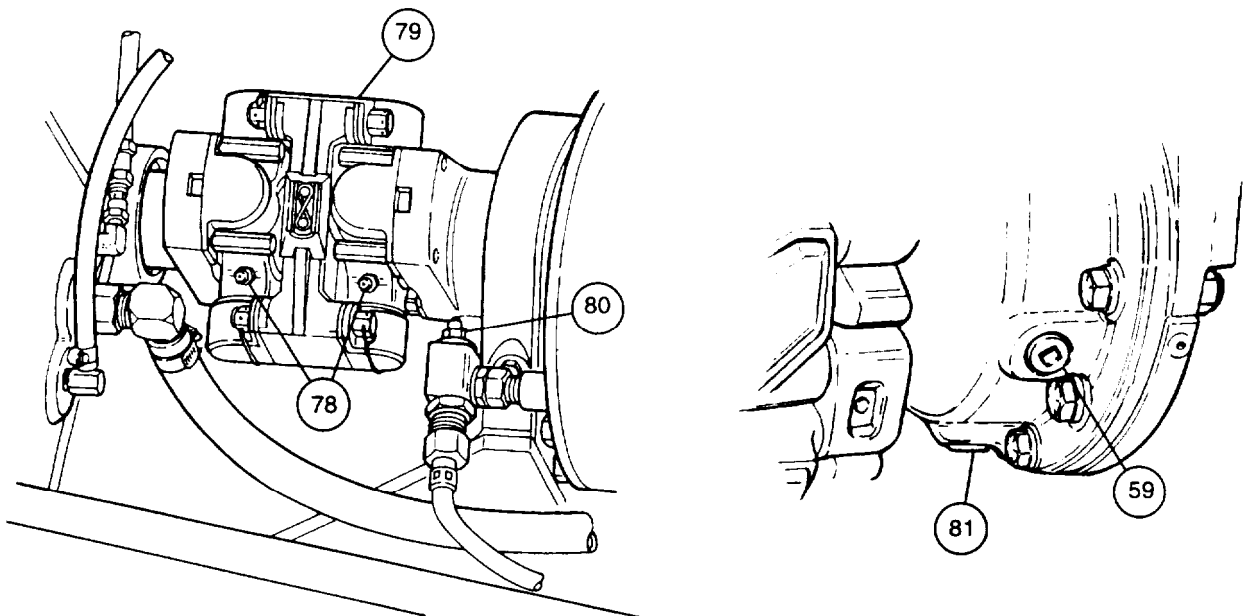
**37. SPEEDOMETER DRIVESHAFT ADAPTER (C)**

If a lubrication fitting (80) is present, lubricate sparingly with GAA (item 17, Appx D).

**38. FINAL DRIVE ASSEMBLIES (C)****NOTE**

Notify unit maintenance if pieces of metal are stuck to magnetic drain plug.

Drain final drive assemblies (only after operation). Coordinate any required seasonal change of oil weight with this service. Remove level plug (59) and magnetic drain plug (81). Clean and install magnetic drain plug and add OE/HDO (Table G-1) through level plug until oil flows from level plug opening. Clean and install level plug.



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

39. FINAL DRIVE BREATHERS (C)

**WARNING**

Solvents can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If solvent gets on skin or clothing, wash immediately with soap and water.

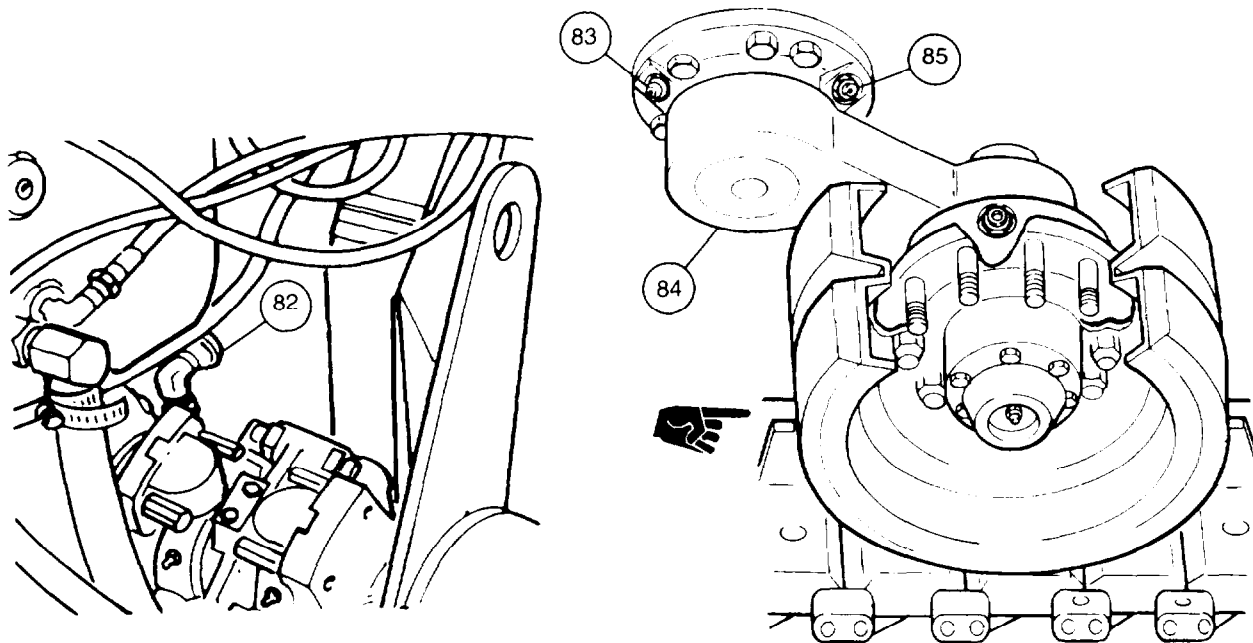
- Remove two breathers (82) and clean with cleaning compound (item 9.1, Appx D). Dry breather, dip in OE/HDO (item 26, Appx D), and install.

40. ROAD WHEEL PIVOT ARM ASSEMBLY (C)

**CAUTION**

If grease seeps from hubs and/or housings before it flows from safety relief valve, notify unit maintenance.

Connect grease gun to lubrication fitting (83) and fill road wheel arm housing (84) with GAA (item 17, Appx D) until solid grease, without air, flows from safety relief valve (85).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

41. VARIABLE RECOIL ASSEMBLY (C)

**CAUTION**

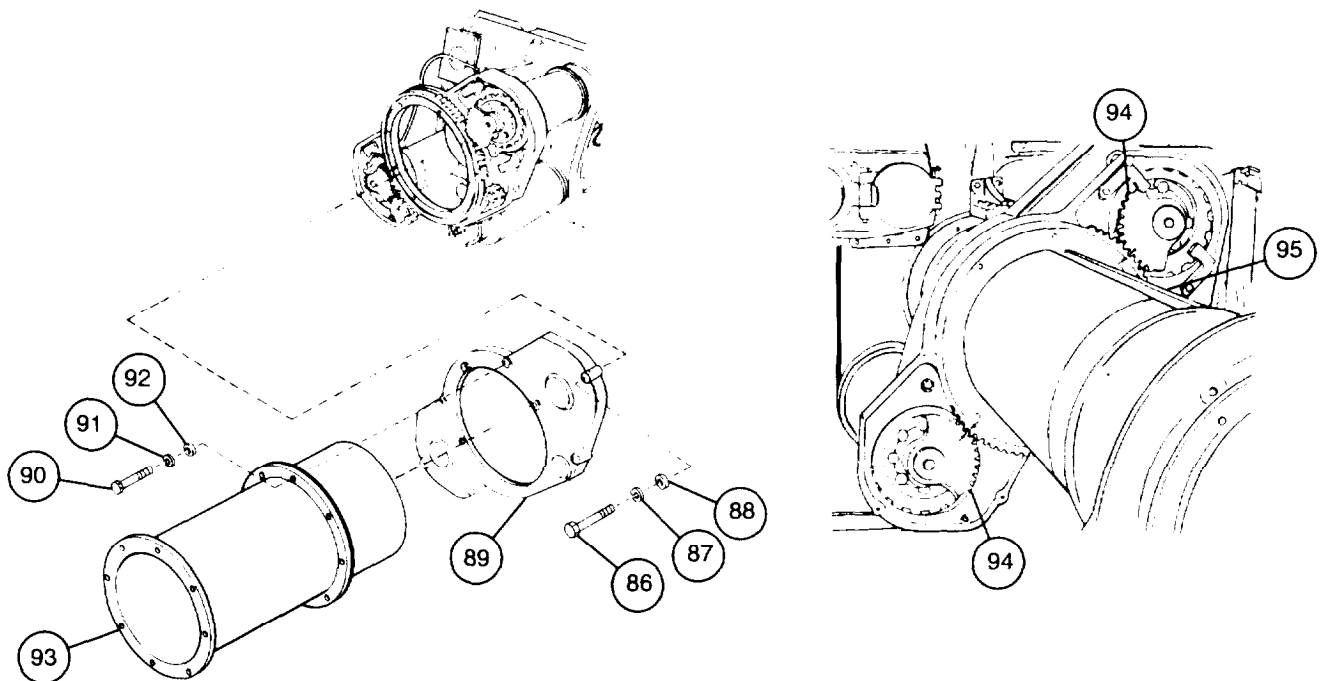
For sustained operation at 0° F (-18° C) temperature or below, change grease to GAA (item 17, Appx D). Do not mix greases.

- a. Remove six machine screws (86), six lockwashers (87), and six flat washers (88) from variable recoil access cover (89).
- b. Remove four machine bolts (90), four lockwashers (91), and four flat washers (92) from dust shield (93).
- c. Elevate cannon tube and check operation of variable recoil assembly components.
- d. Check for dirt/water accumulation and rust on sector gears (94) and torque key groove (95).

**NOTE**

M109A2/M109A3/M109A4 M185 cannon assembly has one torque key groove. M109A5 M284 cannon assembly has two torque key grooves.

- e. Lubricate sector gears (94) and torque key groove (95) with GMD or GGP (Table G-1) and replace dust shield (93) and variable recoil cover (89).



**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

42. TRANSMISSION BREATHER (C)

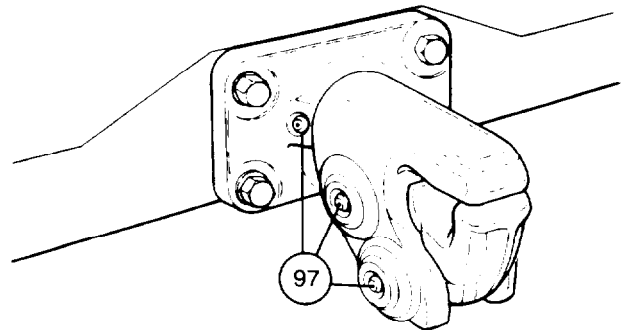
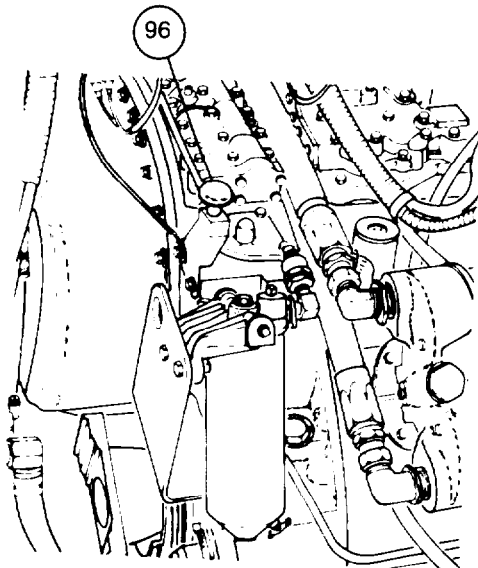
**WARNING**

Solvents can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If solvent gets on skin or clothing, wash immediately with soap and water.

■ Remove breather (96), clean with cleaning compound (item 9.1, Appx D). Dry breather, dip in OE/HDO (item 26, Appx D), and install.

43. TOWING PINTLE ASSEMBLY (C)

Lubricate three lubrication fittings (97) with GAA (item 17, Appx D).



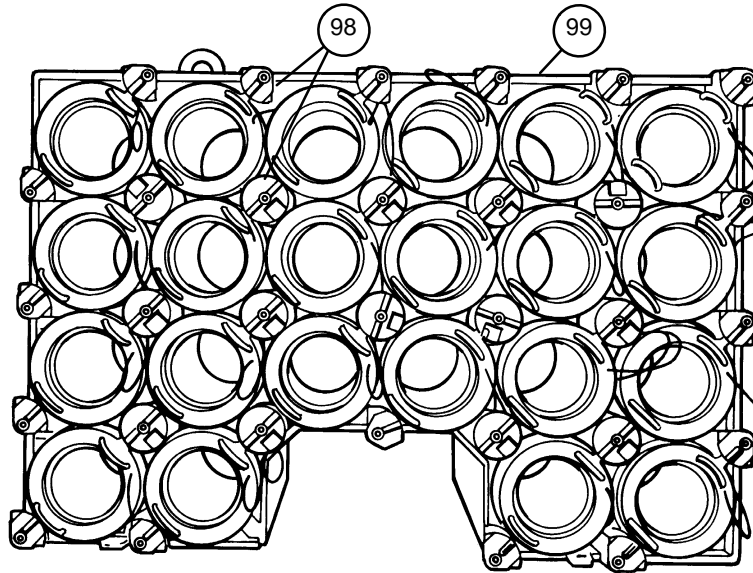
**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

44. CAB AMMUNITION RACK ASSEMBLY (C)

**NOTE**

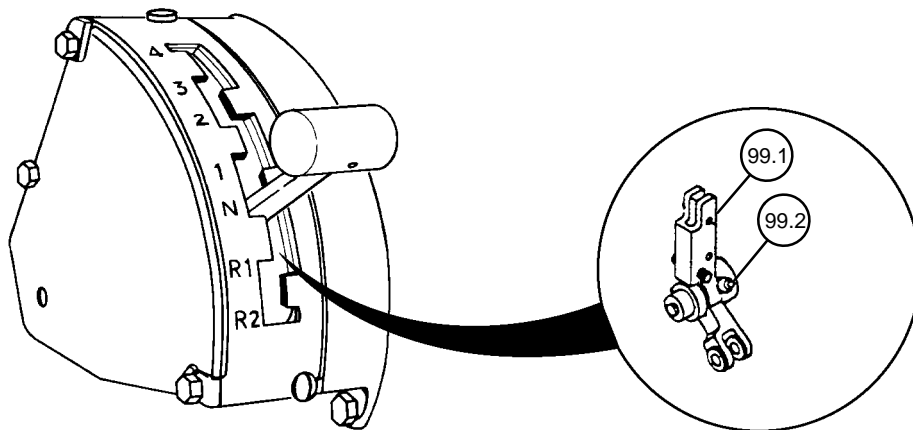
Wipe excess CLP from nonmetallic bushings.

Lubricate 31 locking caps (98) on cab ammunition rack assembly (99). Apply CLP (item 8, Appx D) to all surfaces which contact the locking caps.



45. TRANSMISSION SHIFT CONTROL LEVER (C)

Lubricate the lubrication fitting (99.1) on the transmission shift control lever (99.2) with GAA (item 17, Appx D).



### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

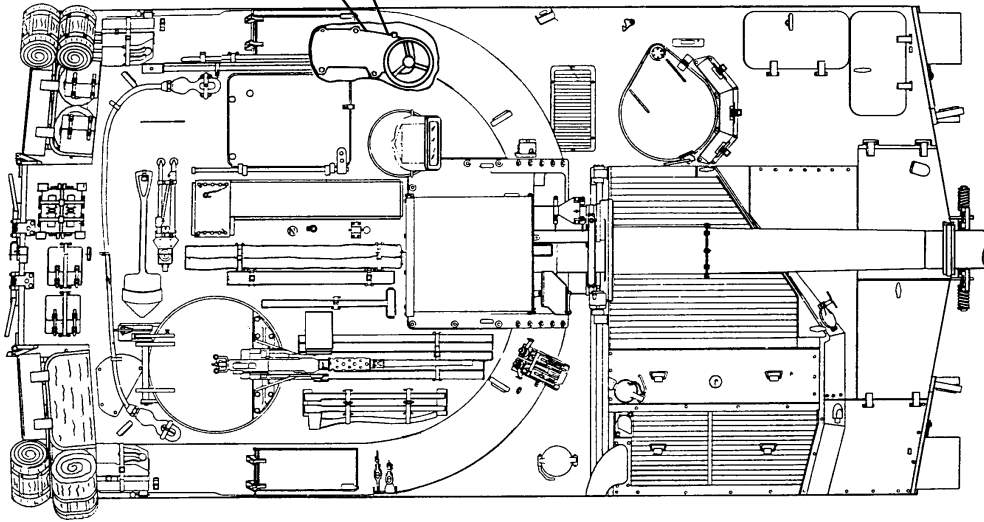
ANNUALLY

This page shows you what to lubricate annually.

Lubricant – Interval

TRAVERSING GAA A  
MECHANISM  
ASSEMBLY  
GEAR BEARING  
(See item 46)

TRAVERSING GO A  
MECHANISM OIL  
FILL AND LEVEL  
(See item 47)



TOTAL MAN-HR	
INTERVAL	MAN-HR
A	13.9

**G - 3 LUBRICATION INSTRUCTIONS - CONTINUED**

45. TRAVERSING MECHANISM ASSEMBLY GEAR BEARING (C)

**NOTE**

Cover plate removed for clarity.

Lubricate lubrication fitting (100) on traversing mechanism assembly (101) with GAA (item 17, Appx D). Wipe clean.

46. TRAVERSING MECHANISM OIL FILL AND LEVEL (C)

**NOTE**

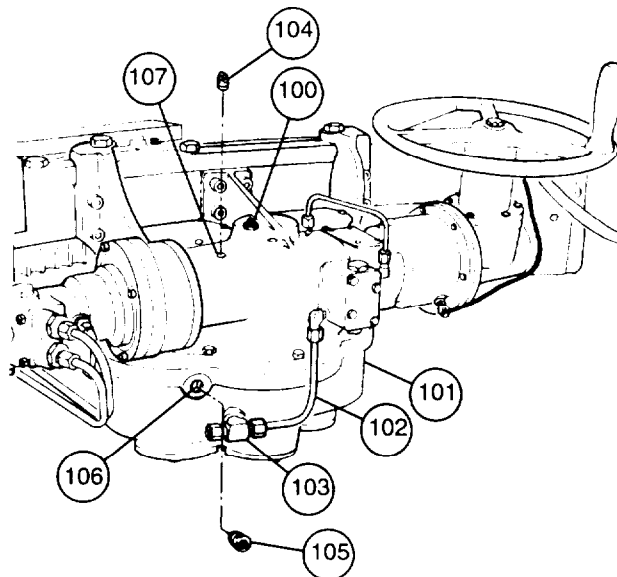
Place bucket under traversing mechanism assembly to catch oil.

**WARNING**

Solvents can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If solvent gets on skin or clothing, wash immediately with soap and water.

Remove hydraulic tube (102) from tee (103). Remove tee and clean inside of tee and screen with cleaning compound (item 9.1, Appx D). Dry tee and install.

Remove fill plug (104) and level plug (105). Oil should be level with bottom of level plug opening (106). If not, fill with GO (Table G-l) through fill plug hole (107).

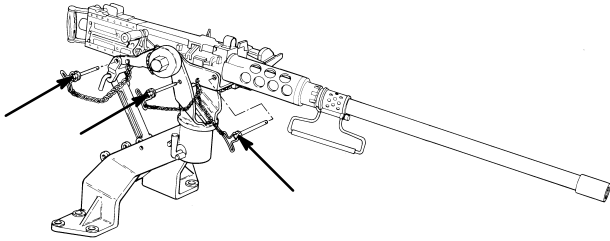




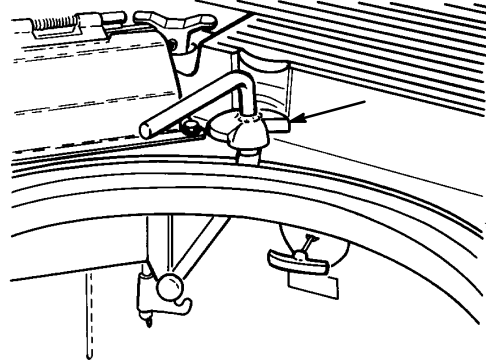
### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### OIL CAN POINTS (C)

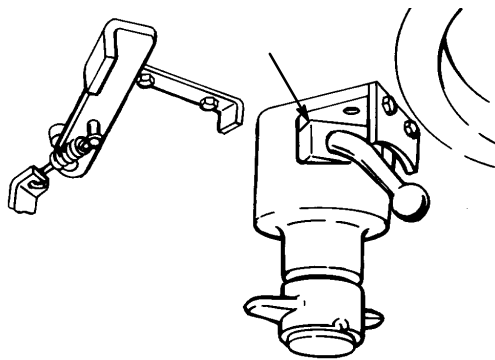
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



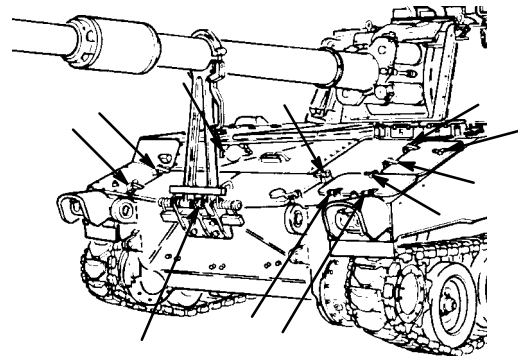
M2 .50 CALIBER MACHINE GUN MOUNT PIN ASSEMBLIES



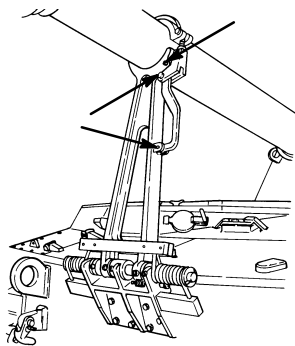
DRIVER'S HATCH COVER LOCKING CAM



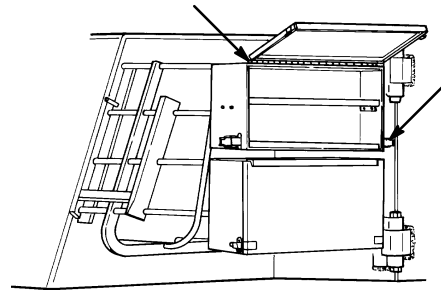
DRIVER'S HATCH COVER ELEVATING HANDLE



HINGES AND LATCHES FOR GRILLES, DOOR AND COVERS



TRAVEL LOCK ASSEMBLY

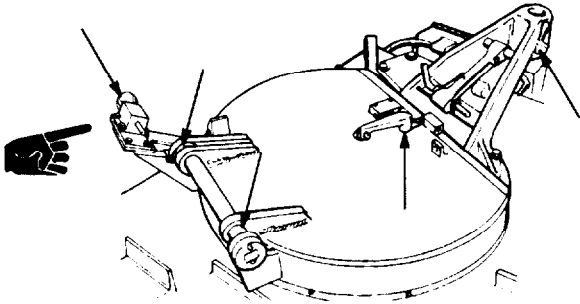


EXTERIOR STOWAGE BOXES, LATCHES, AND HINGES

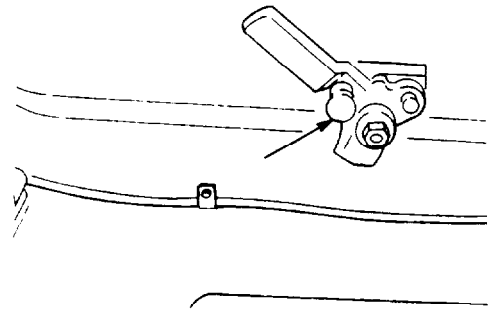
**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

**OIL CAN POINTS (C)**

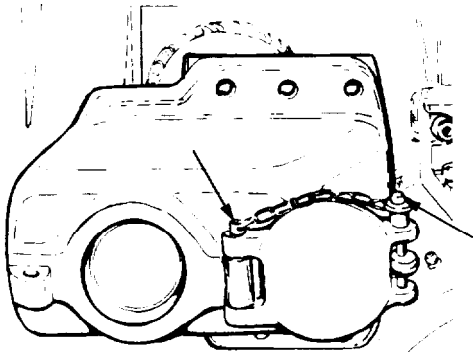
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



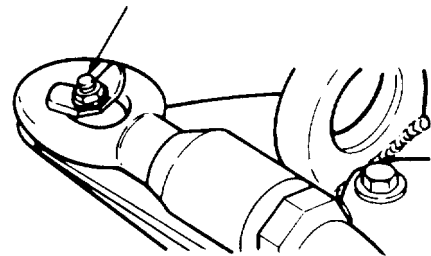
**COMMANDER'S CUPOLA COVER DOOR HANDLE ASSEMBLY, LATCH, HINGE, AND MACHINE GUN MOUNT SUPPORT**



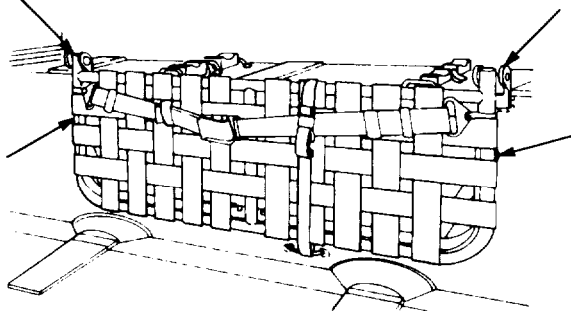
**GUNNER'S ESCAPE HATCH DOOR HANDLE**



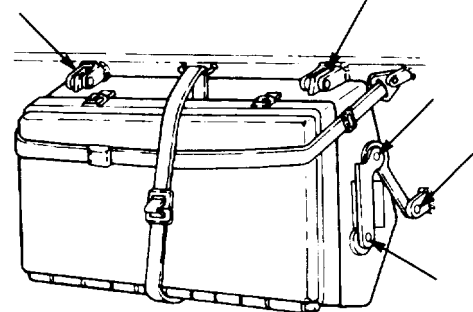
**M42 PERISCOPE COVER DOOR PIN**



**TOW CABLE RETAINER**



**LEFT AND RIGHT CANNONEER'S SEAT ASSEMBLIES HINGES (M109A2/M109A3)**

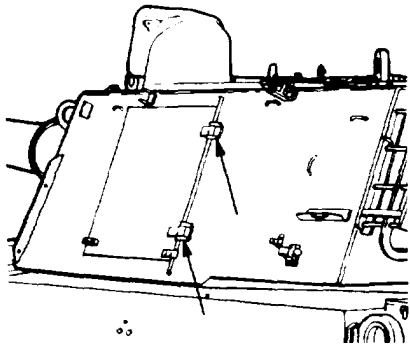


**LEFT AND RIGHT CANNONEER'S SEAT ASSEMBLIES HINGES AND PINS (M109A4/M109A5)**

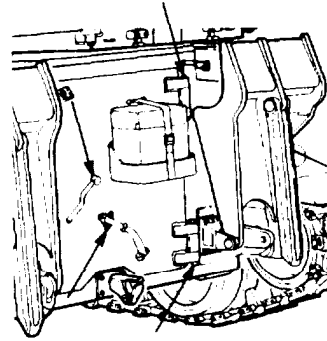
**G-3 LUBRICATION INSTRUCTIONS - CONTINUED**

**OIL CAN POINTS (C)**

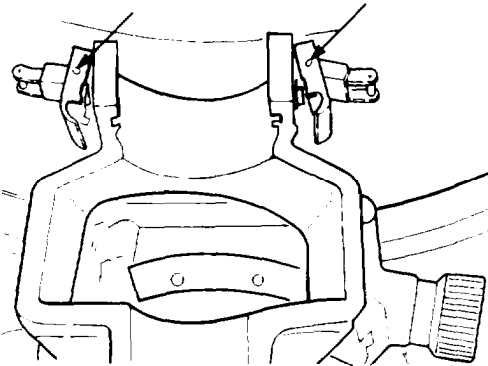
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



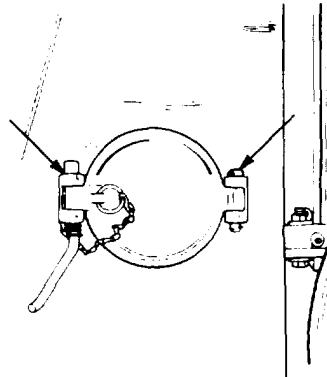
LEFT AND RIGHT CAB SIDE DOOR HINGES



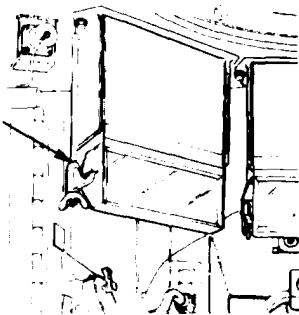
HULL REAR DOOR HINGES, HOLD-OPEN LATCH, HANDLE, AND HOLD-OPEN ROD HINGE AND PIN



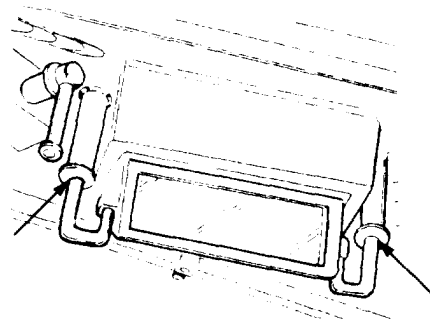
M145 TELESCOPE MOUNT CLAMPING CATCHES



FUEL TANK AND RADIATOR CAP ACCESS COVERS



M45 DRIVER'S PERISCOPE SUPPORTS

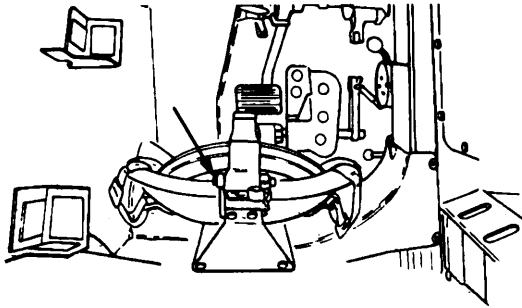


M27 COMMANDER'S PERISCOPE SUPPORT HOOKS

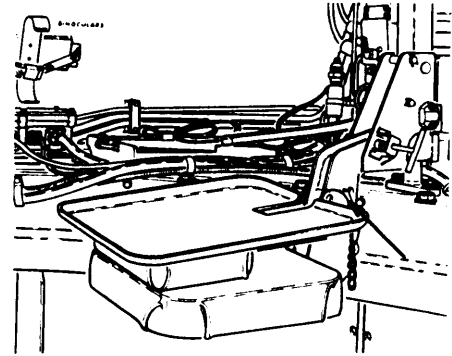
**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

**OIL CAN POINTS (C)**

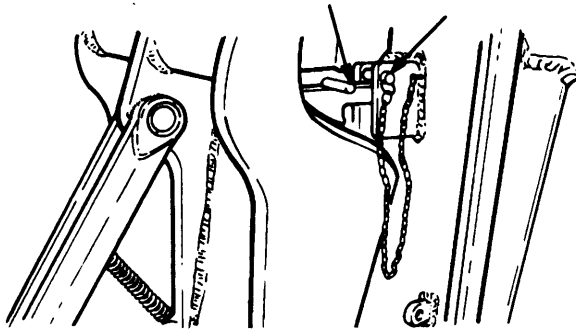
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



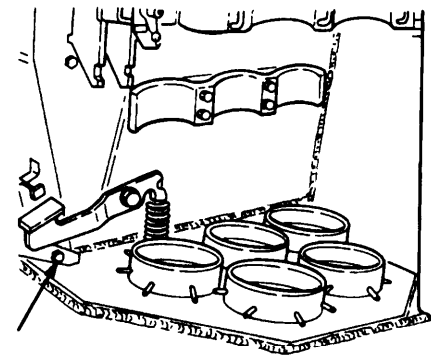
DRIVER'S SEAT MOVING PARTS



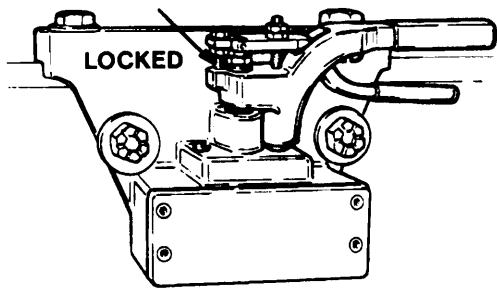
COMMANDER'S SEAT MOVING PARTS



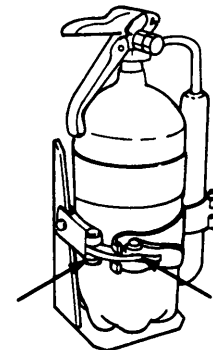
SPADE LATCH AND PIN ASSEMBLY



SPADE LATCH



TURRET LOCK ASSEMBLY

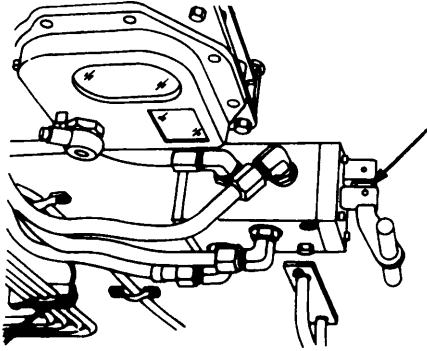


PORTABLE FIRE EXTINGUISHER MOUNTING BRACKET

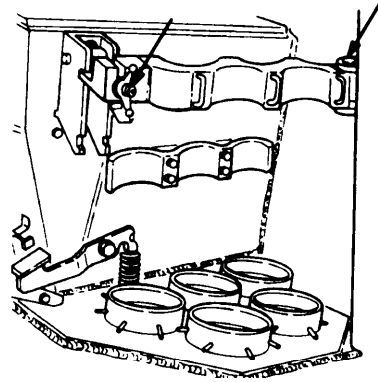
### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### OIL CAN POINTS (C)

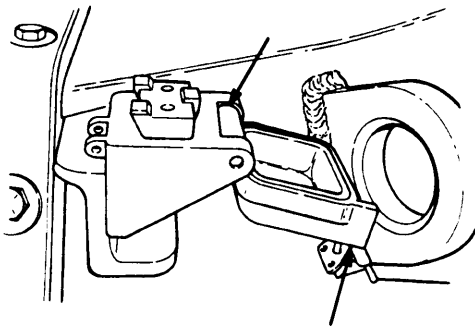
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



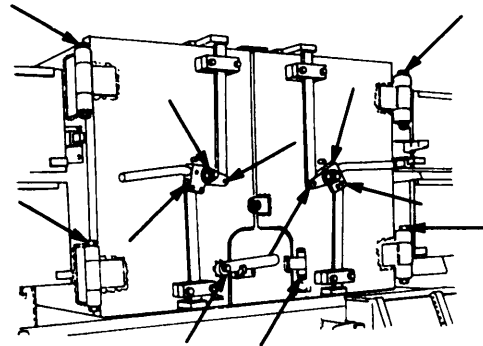
RAMMER ACTUATING VALVE



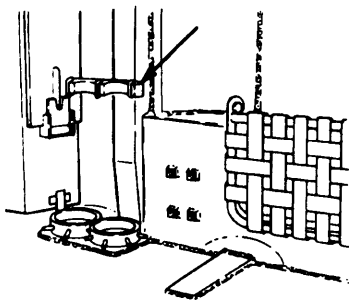
HULL AMMUNITION RACK HINGES



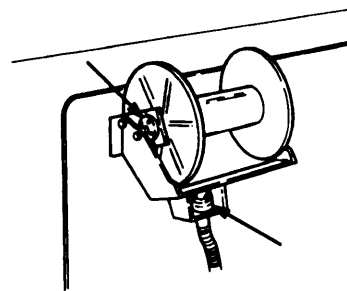
M140 ALINEMENT DEVICE MOUNT, COVER, DOVETAIL DOOR WEDGE, AND CLAMPING CATCH



LEFT AND RIGHT BUSTLE DOORS AND PROJECTILE ACCESS DOOR AND HINGE



HULL FRONT AMMUNITION RACK PINS

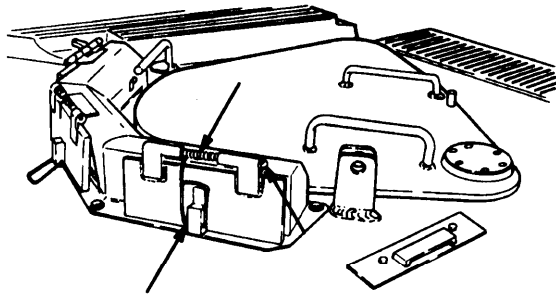


TELEPHONE CABLE REEL

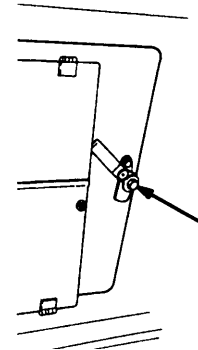
**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

**OIL CAN POINTS (C)**

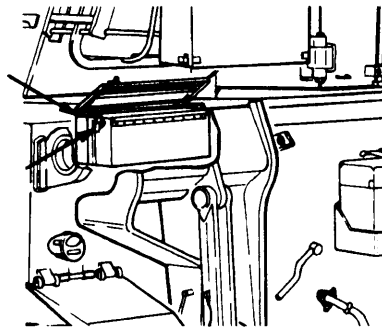
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



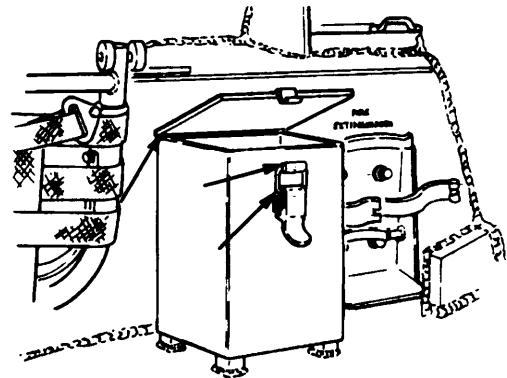
M45 DRIVER'S PERISCOPE COVER PINS, LATCHES, AND HINGES



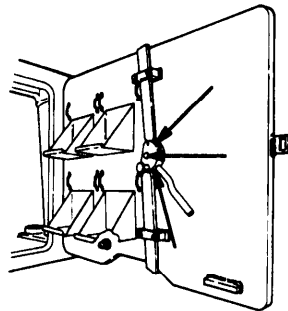
LEFT AND RIGHT CAB SIDE DOOR HANDLE ASSEMBLIES



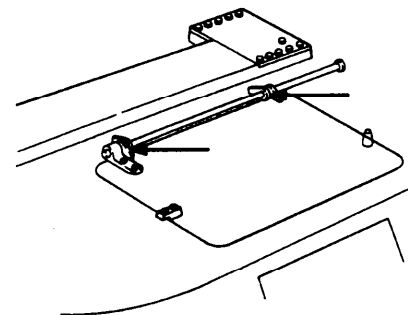
RATIONS STORAGE BOX ASSEMBLIES – HINGES AND LATCHES (EXTERIOR HULL)



STORAGE BOX – LATCH AND HINGE



HULL REAR DOOR HANDLE (INTERIOR)

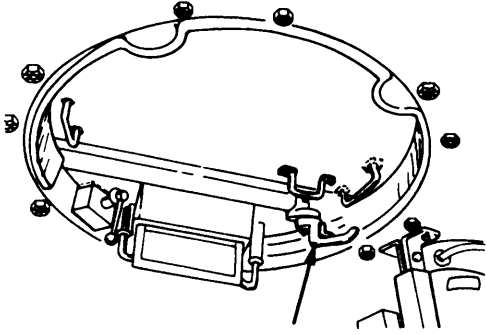


EXTERIOR GUNNER'S ESCAPE HATCH HINGES

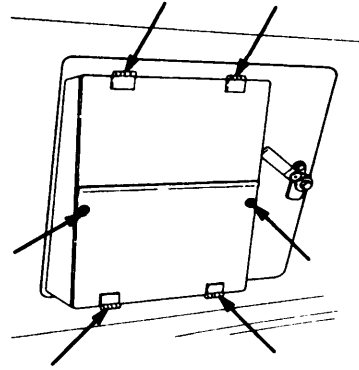
### G-3 LUBRICATION INSTRUCTIONS — CONTINUED

#### OIL CAN POINTS (C)

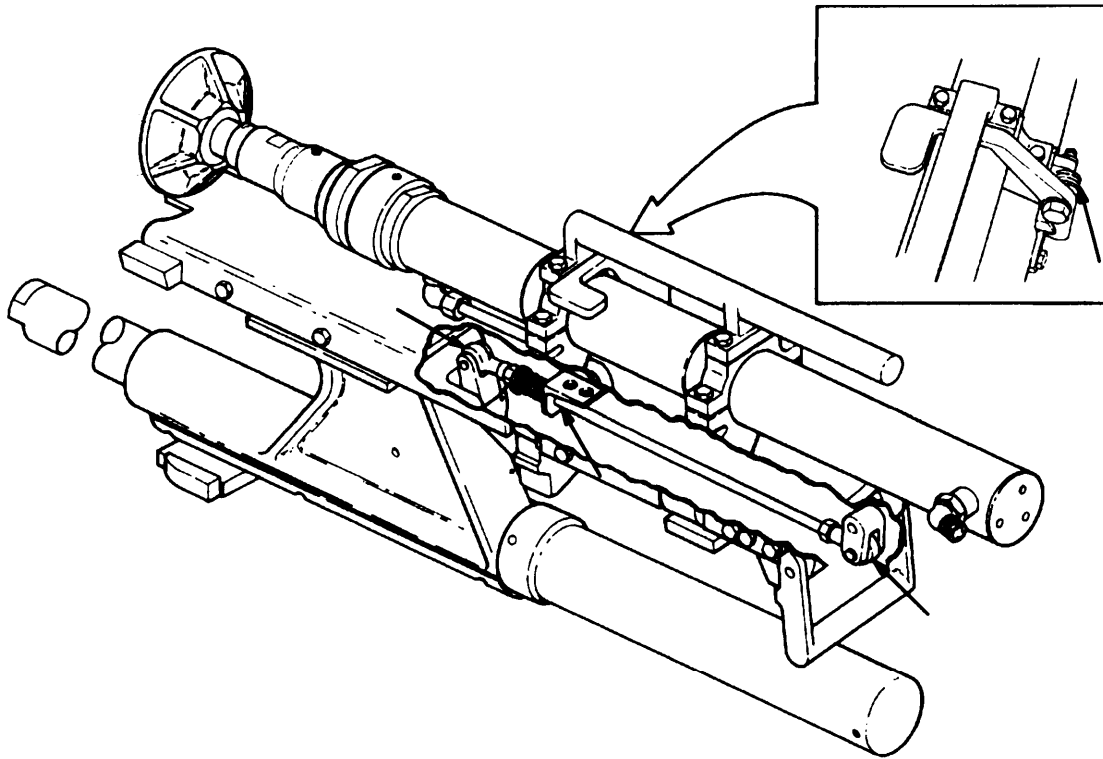
Lubricate quarterly with a few drops of seasonal grade oil, OE/HDO (item 26, Appx D), CLP (item 8, Appx D), or OEA (item 25, Appx D). (Clean lubrication points and wipe off excess lubricant.)



COMMANDER'S CUPOLA DOOR HANDLE ASSEMBLY



STORAGE BOXES LATCHES AND HINGES (INTERIOR CAB)

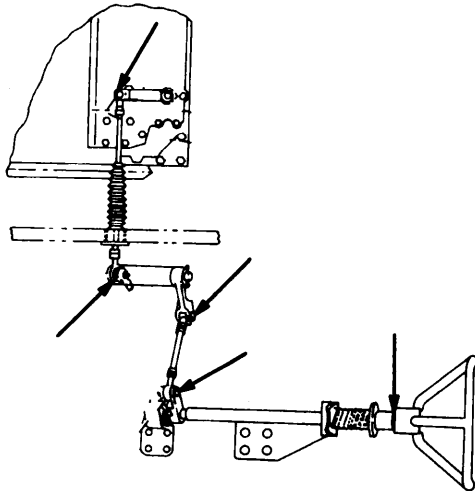


RAMMER ROD END BEARINGS, ANGLE BRACKET, AND LOCK-RELEASE LEVER

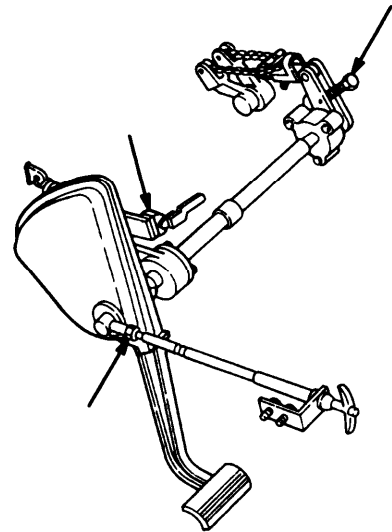
**G-3 LUBRICATION INSTRUCTIONS — CONTINUED**

OIL CAN POINTS (C)

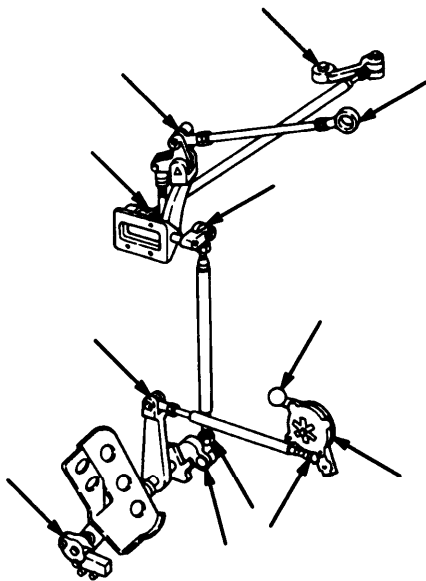
Apply a few drops of CLP (item 8, Appx D) on rod end bearing as indicated by arrows. Wipe off excess lubricant.



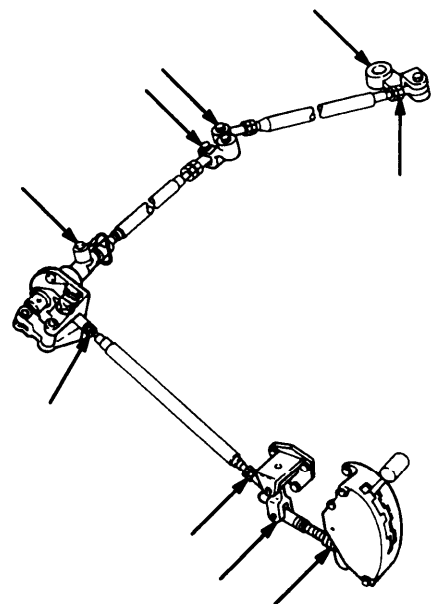
STEERING CONTROL LINKAGE



SERVICE AND PARKING BRAKE LINKAGE



ACCELERATOR PEDAL AND HAND THROTTLE CONTROL LEVER



TRANSMISSION SHIFT CONTROL LINKAGE





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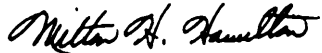
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**GORDON R. SULLIVAN**  
*General, United States Army*  
*Chief of Staff*

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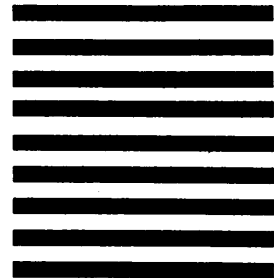
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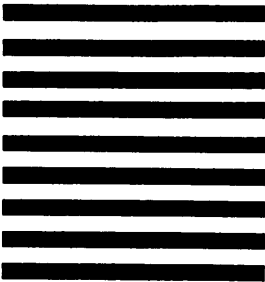
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TEAR ALONG PERFORATED LINE

## THE METRIC SYSTEM AND EQUIVALENTS

### LINEAR MEASURE

- 1 Centimeter = 10 Millimeters = 0.01 Meter = 0.3937 Inch
- 1 Decimeter = 10 Centimeters = 3.94 Inches
- 1 Meter = 10 Decimeters = 100 Centimeters  
= 1000 Millimeters = 39.37 Inches
- 1 Dekameter = 10 Meters = 32.8 Feet
- 1 Hectometer = 10 Dekameters = 328.08 Feet
- 1 Kilometer = 10 Hectometers = 1000 Meters  
= 0.621 Mile = 3,280.8 Feet
- Millimeters = Inches times 25.4
- Inches = Millimeters divided by 25.4

### WEIGHTS

- 1 Centigram = 10 Milligrams = 0.154 Grain
- 1 Decigram = 10 Centigrams = 1.543 Grains
- 1 Gram = 0.001 Kilogram = 10 Decigrams  
= 1000 Milligrams = 0.035 Ounce
- 1 Dekagram = 10 Grams = 0.353 Ounce
- 1 Hectogram = 10 Dekagrams = 3.527 Ounces
- 1 Kilogram = 10 Hectograms = 1000 Grams = 2.205 Pounds
- 1 Quintal = 100 Kilograms = 220.46 Pounds
- 1 Metric Ton = 10 Quintals = 1000 Kilograms = 1.102 Short Tons

### LIQUID MEASURE

- 1 Milliliter = 0.001 Liter = 0.034 Fluid Ounce
- 1 Centiliter = 10 Milliliters = 0.34 Fluid Ounce
- 1 Deciliter = 10 Centiliters = 3.38 Fluid Ounces
- 1 Liter = 10 Deciliters = 1000 Milliliters = 33.82 Fluid Ounces
- 1 Dekaliter = 10 Liters = 2.64 Gallons
- 1 Hectoliter = 10 Dekaliters = 26.42 Gallons
- 1 Kiloliter = 10 Hectoliters = 264.18 Gallons

### SQUARE MEASURE

- 1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inch
- 1 Sq Decimeter = 100 Sq Centimeters = 15.5 Sq Inches
- 1 Sq Meter (Centare) = 100 Sq Decimeters  
= 10,000 Sq Centimeters = 10.764 Sq Feet
- 1 Sq Dekameter (Are) = 100 Sq Meters = 1,076.4 Sq Feet
- 1 Sq Hectometer (Hectare) = 100 Sq Dekameters = 2.471 Acres
- 1 Sq Kilometer = 100 Sq Hectometers = 1,000,000 Sq Meters  
= 0.386 Sq Mile

### CUBIC MEASURE

- 1 Cu Centimeter = 1000 Cu Millimeters = 0.061 Cu Inch
- 1 Cu Decimeter = 1000 Cu Centimeters = 61.02 Cu Inches
- 1 Cu Meter = 1000 Cu Decimeters = 1,000,000 Cu Centimeters  
= 35.31 Cu Feet

### TEMPERATURE

- 5/9 (°F - 32°) = °C
- 9/5 (°C + 32°) = °F
- 35° Fahrenheit is equivalent to -37° Celsius
- 0° Fahrenheit is equivalent to -18° Celsius
- 32° Fahrenheit is equivalent to 0° Celsius
- 90° Fahrenheit is equivalent to 32.2° Celsius
- 100° Fahrenheit is equivalent to 38° Celsius
- 212° Fahrenheit is equivalent to 100° Celsius

## APPROXIMATE CONVERSION FACTORS

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>	<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Inches	Centimeters	2.540	Centimeters	Inches	0.394
Feet	Meters	0.305	Meters	Feet	3.281
Yards	Meters	0.914	Meters	Yards	1.094
Miles	Kilometers	1.609	Kilometers	Miles	0.621
Square Inches	Square Centimeters	6.452	Square Centimeters	Square Inches	0.155
Square Feet	Square Meters	0.093	Square Meters	Square Feet	10.764
Square Yards	Square Meters	0.836	Square Meters	Square Yards	1.196
Square Miles	Square Kilometers	2.590	Square Kilometers	Square Miles	0.386
Acres	Square Hectometers	0.405	Square Hectometers	Acres	2.471
Cubic Feet	Cubic Meters	0.028	Cubic Meters	Cubic Feet	35.315
Cubic Yards	Cubic Meters	0.765	Cubic Meters	Cubic Yards	1.308
Fluid Ounces	Milliliters	29.574	Milliliters	Fluid Ounces	0.034
Pints	Liters	0.473	Liters	Pints	2.113
Quarts	Liters	0.946	Liters	Quarts	1.057
Gallons	Liters	3.785	Liters	Gallons	0.264
Ounces	Grams	28.350	Grams	Ounces	0.035
Pounds	Kilograms	0.454	Kilograms	Pounds	2.205
Short Tons	Metric Tons	0.907	Metric Tons	Short Tons	1.102
Pound-Feet	Newton-Meters	1.356	Newton-Meters	Pound-Feet	0.738
Pounds-Inches	Newton-Meters	0.11298	Kilopascals	Pounds per Square Inch	0.145
Pounds per Square Inch	Kilopascals	6.895	Kilometers per Liter	Miles per Gallon	2.352
Ounce-Inches	Newton-Meters	0.007062	Kilometers per Hour	Miles per Hour	0.621
Miles per Gallon	Kilometers per Liter	0.425	° Fahrenheit	° Celsius	° C = (° F - 32) x 5/9
Miles per Hour	Kilometers per Hour	1.609	° Celsius	° Fahrenheit	° F = (9/5 x ° C) + 32

