

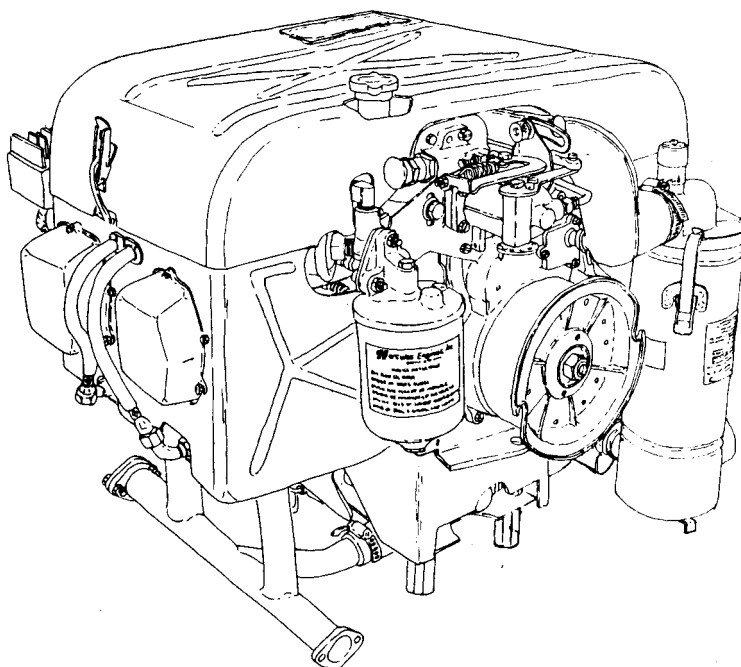
*** ARMY TM 9-2805-259-14**

AIR FORCE TO 38G2-89-54

NAVY NAVFAC P-8-615-14E

TECHNICAL MANUAL

**OPERATOR, UNIT, DIRECT SUPPORT,
GENERAL SUPPORT MAINTENANCE MANUAL**



**ENGINE, GASOLINE, 20 HP,
MILITARY STANDARD MODELS
(MODEL 4A084-2, NSN 2805-00-952-3926)
(MODEL 4A084-3, NSN 2805-00-872-5972)
(MODEL 4A084-4, NSN 2805-01-276-5947)**

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HEADQUARTERS, DEPARTMENT OF THE ARMY,
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12 JUNE 1990

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100-138°F (38-60°C).

WARNING

Serious eye injury can result from the starter rope knot. Wear eye protection when pull starting engine.

Before starting engine or operating any of the components insure that no loose bars, tools, or parts are lying in or on any part of the equipment, as they could cause serious damage to equipment or bodily injury to personnel.

Never wear loose clothing, or hanging appendages from person or clothing, while inspecting running engine, moving shafts, or like machinery.

WARNING

if operating the engine or equipment indoors insure that proper ventilation is provided. Carbon monoxide fumes are a colorless, odorless and deadly gas. These gases could cause permanent brain damage or death, if highly concentrated in any certain area. The symptoms are headache, dizziness, loss of muscular control, apparent drowsiness and coma. If exposure symptoms exist, move afflicted person or personnel to properly ventilated area and provide artificial respiration, if necessary.

WARNING

Always provide metal-to-metal contact between fuel container and fuel tank, while refueling, to avoid igniting fuel vapors with a static spark.

Do not refuel while engine is in operation.

Before refueling, insure that adequate fire fighting equipment is serviceable and is standing by for immediate use in event of fire or explosion.

During engine operation, proper fire fighting equipment should be serviceable and kept near in the event that fire is developed by electrostatic spark or detonation of the gas fumes. Do not smoke or use an open flame in the vicinity of these gasoline vapor hazards.

WARNING

Never touch engine or engine accessories with bare hands during operation, or before they have cooled sufficiently. Severe burns can be caused through carelessness.

WARNING

Do not touch the ignition system harness during starting or while in operation. Severe shocks or burns could result, and personnel may be seriously injured.

Disconnect the high tension cables prior to engine maintenance to prevent accidental starting and severe shock.

WARNING

Operation of the equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

Do not smoke or use an open flame in the vicinity of gasoline vapor hazards.

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Operator, Unit, Direct Support General Support
Maintenance Manual

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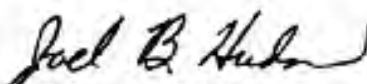
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Operator, Unit, Direct Support, General Support
Maintenance Manual

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MILITARY STANDARD MODELS
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NAVFAC P-8-615-14E
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General Support Maintenance Manual**

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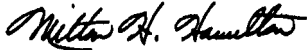
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Operator, Unit, Direct Support,
General Support Maintenance Manual

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(MODEL 4A084-3, NSN 2805-00-872-5972)
(MODEL 4A084-4, NSN 2805-01-276-5947)**

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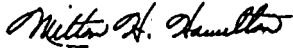
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AIR FORCE TO 38G2-89-54
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General Support Maintenance Manual**

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(MODEL 4A084-3, NSN 2805-00-872-5972)
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Operator, Unit, Direct Support and General Support Maintenance Manual

ENGINE, GASOLINE, 20 HP MILITARY STANDARD MODELS
(MODEL 4A084-2, NSN 2805-00-952-3926)
(MODEL 4A084-3, NSN 2805-00-872-5972)
(MODEL 4A084-4, NSN 2805-01-276-5947)

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You can help improve this manual. If you find any mistakes, or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. You may also submit your recommended changes by E-mail directly to <mpmf/oavma28@st-louis-emh7.army.mil>. A reply will be furnished directly to you. Instructions for sending an electronic 2028 may be found at the back of this manual immediately preceding the hard copy 2028.

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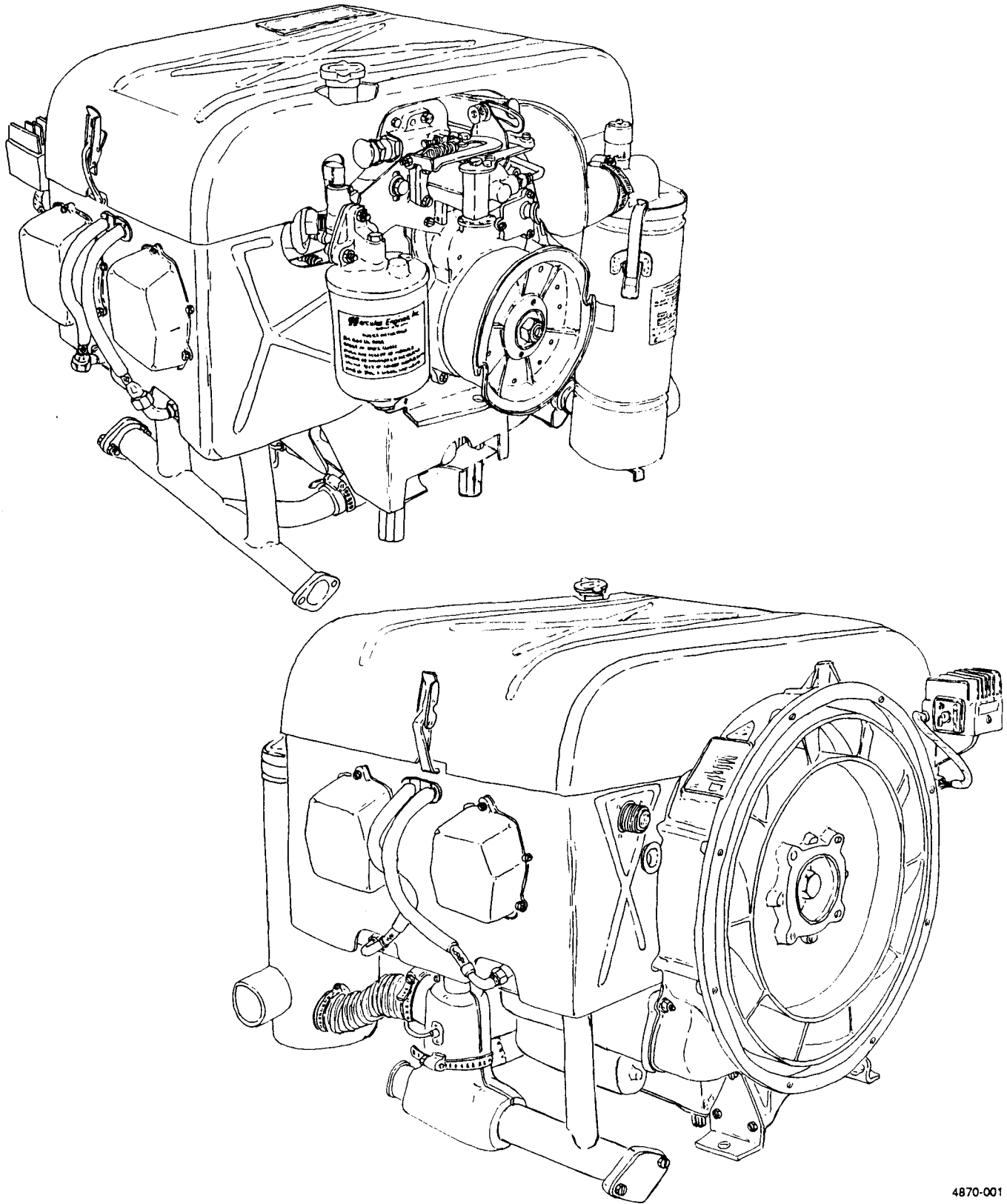
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4870-001

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CHAPTER 1

INTRODUCTION

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OVERVIEW

This chapter contains general information pertaining to 20 HP Military Standard Engine and its components.

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1-1. **Scope.** This manual contains operator, unit, direct support and general support maintenance for the 20 HP Military Standard Engine, Models 4A084-2, -3 and -4 (figure 1-1).

1-2. **Consolidated Index of Army Publications and Blank Forms.** Refer to the latest issue of DA PAM 25-30 to determine whether there are new editions, changes, or additional publications pertaining to the equipment

1-3. Maintenance Forms, Records and Reports.

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in Maintenance Management Update. Air Force personnel will use AFR 66-1 (Air Force Maintenance Management Policy) for maintenance reporting and TO-00-35D54 for unsatisfactory equipment reporting. Navy personnel will report maintenance performed utilizing the Maintenance Data Collection Subsystem (MDCS) IAW OPNAVINST 4790.2, Vol 3 and unsatisfactory material/conditions (UR submissions) IAW OPNAVINST 4790.2, Vol 2, chapter 17.

b. Reporting of Item and Packaging Discrepancies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 414-55/SECNAVINST 4355.18/AFR 400-54/MCO 4430.3J.

c. Transportation Discrepancy Report (TDR) (SF361). Fill out and forward Transportation Discrepancy Report (TDR) (SF 361) as prescribed in AR 55-28/NAVUSPINST 4610.33C/AFR 75-18/MCO P4610.19D/ DLAR 4500.15.

1-4. **Reporting Equipment Improvement Recommendations (EIR).**

a. Army. If your Military Standard Engine 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 us at: Commander U.S. Army Aviation and Troop Command, ATTN: AMSAT-I-MDO, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. We will send you a reply.

b. Air Force. Air Force personnel are encouraged to submit EIR's in accordance with AFR 900-4.

c. Navy. Navy personnel are encouraged to submit EIRs through their local beneficial suggestion program.

1-5. **Destruction of Army Materiel to Prevent Enemy Use.** Refer to TM 850-244-3 for procedures to destroy equipment to prevent enemy use.

1-6. **Preparation for Storage or Shipment.** Refer to Chapter 4, Section VI, and TB 740-97-2 for procedures to place the equipment into storage.

1-7. **Glossary.**

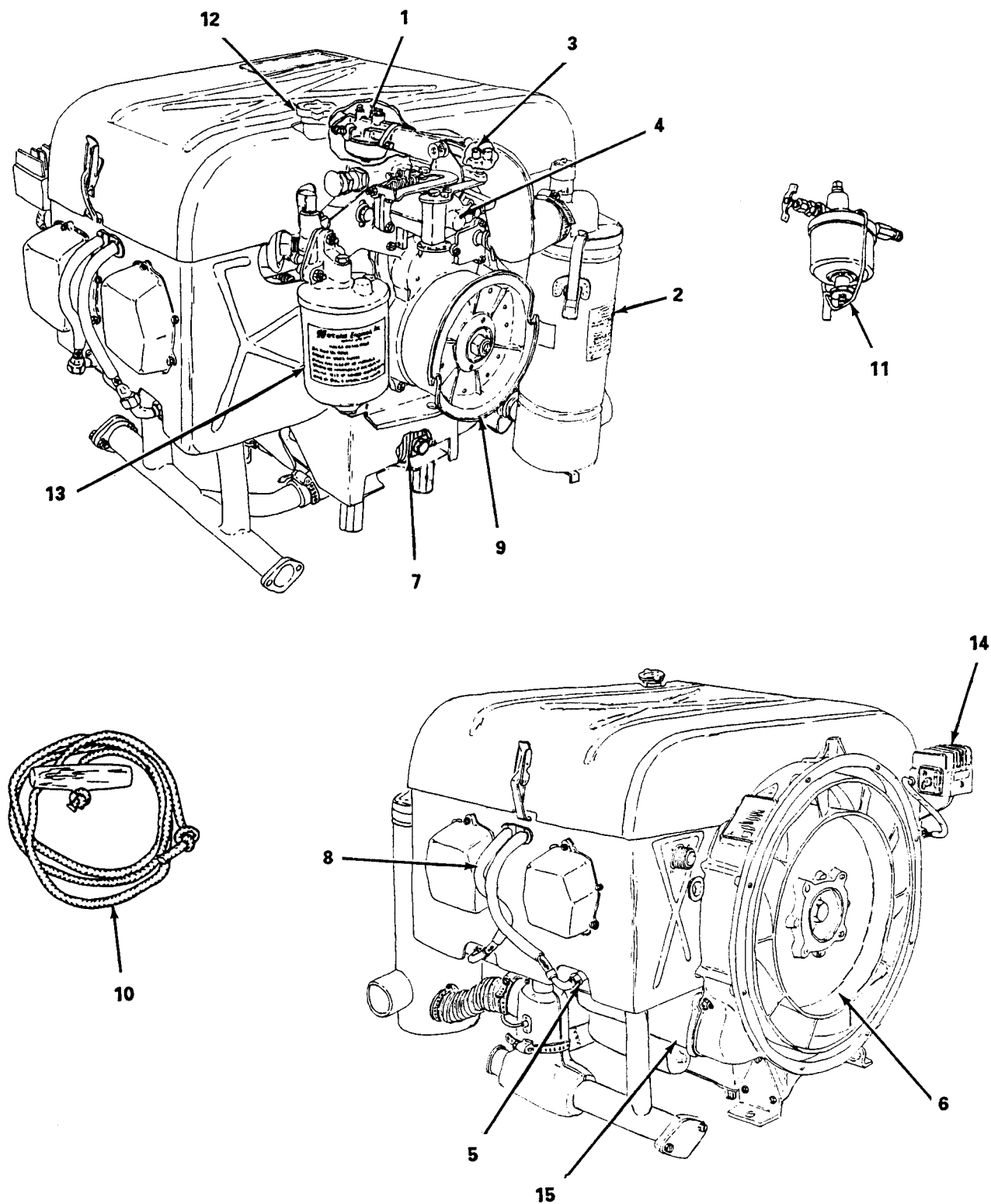
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1-13	Corrosion Prevention and Control	1-5

1-8. **Equipment Characteristics, Capabilities and Features.** The Military Standard Engine is an air cooled, horizontally opposed, four cylinder, four cycle gasoline engine. The engine is capable of developing 20 HP at 3600 RPM.

1-9. Location and Description of Major Components (Models 4A084-2, -3 and -4)
(figure 1-2).

- 1 Carburetor - Mixes air and fuel and delivers it to the engine
- 2 Air Cleaner - Cleans air going into the carburetor
- 3 Fuel Pump - Delivers fuel to carburetor
- 4 Governor - Regulates maximum speed of engine
- 5 Spark Plug - Delivers spark to air fuel mixture
- 6 Flywheel Fan - Provides air for cooling engine during operation
- 7 Oil Pan - Serves as a reservoir for engine oil
- 8 High Tension Cable - Delivers high voltage electrical charge to spark plug
- 9 Starter Rope Pulley/Alternator Rotor - Generates alternating current and provides area to attach starter rope when pull starting engine
- 10 Starter Rope - Used to pull start engine
- 11 Fuel Filter - Cleans fuel going to engine
- 12 Oil Gage and Filler Tube - Provides the means to check engine oil level and to add oil as needed
- 13 Oil Filter - Cleans engine oil
- 14 Regulator Rectifier - Changes alternating current generated by alternator into direct current
- 15 Electrical Starter - Used to start engine electrically, when engine is connected to an end item with power



4870-002

Figure 1-2. Location and Description of Major Components Models 2A042-2 and -3.

1-10. Equipment Data.

a. General.

Engine Model	41084-2, -3 and -4
Type	4 cycle gasoline powered
Number of cylinders	4 (horizontally apposed)
Horse power rating	20 at 3600 r.p.m.
Fuel pump	Diaphragm 3.0-4.5 psi outlet pressure
Air cleaner	Dry models 4A084-2, -3 and -4
Spark plug	Shielded
Gap	28-.033 in. (.071-.083 cm)
Magneto contact	
Gap, Fairbanks Morse015-.019 in. (.030-.48 cm)
Gap, Slick Aircraft008-.012 in. (.020-.030 cm)
Valve tappet clearance cold007-.009 in. (.017-.027 cm)
(Intake and exhaust)	
Governor	Centrifugal
Oil capacity	4 quarts (4 1/2 gts. with oil filter change)
Alternator	40 volts alternating current (ac)
Starter	24 volts direct current (dc)
Regulator-Rectifier	28.5 \pm .5 volts at 1.5 amps
Firing order	1-4-2-3

b. Dimensions and Weight Models 4A084, -3 and -4.

Length	20 in. (50.8 cm)
Width	28.50 in. (72.4 cm)
Height	22.10 in. (56.13 cm)
Weight	265 lb (120 kg)

1-11. **Differences Between Models.** Both models of the Military Standard are the same except for the following difference:

- a. All models are equipped with regulator-rectifiers but Models 4A084-3, -4 uses a slightly different model.
- b. Model 4A084-4 is equipped with a spin-on replaceable oil filter.

1-12. **Safety, Care, and Handling.** Observe all WARNINGS, CAUTIONS and NOTES in this manual. This equipment can be extremely dangerous if these instructions are not followed.

1-13. **Corrosion Prevention and Control.** Corrosion Prevention and Control (CPC) of Army material is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items. 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 maybe a corrosion problem. If a corrosion problem is identified, it can be reported using Standard Form 368, Product Quality Deficiency Report. Use of key words such as "corrosion," "rust," "deterioration," or "cracking" will ensure that the information is identified as a CPC problem. The form should be submitted to the address specified in DA PAM 738-750.

Section III. PRINCIPLES OF OPERATION

Paragraph	Page
1-14 Principles of Operation	1 - 6

1-14. Principles of Operation.

a. General. The 20 Hp Military Standard engine is a four cycle four cylinder, air cooled, gasoline powered internal combustion engine. The engine develops its full rated capacity at a governed 3600 r.p.m.

b. Simplified Principles of Operation. The engine can either be pull started, or started using the electric starter. A starter rope pulley mounted on the front of the engine provides a means to connect the starter when pull starting the engine. When the engine is mounted to an end item that has a separate power supply, the electric starter can be used to start the engine. An inline fuel filter cleans the fuel supplied to the engine. On the fuel filter is a fuel cutoff valve, which stops fuel flow to the engine when closed. The engine is equipped with a dry element air cleaner, with a service indicator, and air inlet control. The service indicator signals when the air cleaner element requires cleaning. The air inlet control adjusts the amount of heated air entering the air cleaner. An oil pan baffle directs the flow of cooling air, for operation in extreme cold weather conditions. The baffle is usually set in the back or open position to allow cooling air to flow around oil pan to help cool the engine. When the baffle is set to the forward or closed position, the cooling air no longer flows around the oil pan and the engine will run warmer.

c. Detailed Principles of Operation.

(1) Fuel system. The fuel system is composed of a fuel filter, fuel pump, fuel line, and carburetor. The fuel filter is a bowl type with a filtering screen. The screen filters dirt and other foreign materials from the fuel. The fuel pump draws fuel from an external fuel supply through the fuel filter, and delivers it to the carburetor. The fuel pump, a diaphragm type, is driven by the camshaft. The carburetor mixes the air, from the air cleaner, and the fuel. This is then delivered to the combustion chamber where it is compressed and burned.

(2) Cooling system. The flywheel fan draws cool air into the flywheel fan housing where it is then directed by the top, left, and right shrouds, cylinder baffles, oil pan baffle, and oil pan cover. The airflows around the cylinder heads, cylinders, and oil pan and cools the engine.

(3) Air supply. The air cleaner cleans the air going to the carburetor. The dry element air cleaner uses a dry fiber element to remove dirt from the air. As the element gets dirty, air flow through it decreases and creates a vacuum in the air cleaner. When air flow decreases too much, the service indicator shows a red signal and indicates the element requires cleaning.

(4) Speed regulation. Both models of the engine are equipped with a centrifugal flyweight governor connected to the carburetor by a control rod. The governor determines the fastest speed at which the engine will run. The engines are equipped with a throttle control, which overrides the function of the governor. The throttle control allows the engine speed to be adjusted between idle and full governed speed.

(5) Ignition system. A high voltage electrical charge is generated by a magneto, and is delivered to the spark plug, in the cylinder head, through a shielded cable. The electrical charge creates a spark at the electrode end of the spark plug. This spark ignites the air/fuel mixture in the cylinder, and generates power.

(6) *Lubrication.* Oil is pumped from the oil pan to the oil filter and then to the engine components. Rocker box hoses return oil from the cylinder heads back to the oil pan. A crankcase breather, vents oil vapors from the crankcase into the air supply.

(7) *Electrical system.* The engine is equipped with an alternator and a regulator-rectifier. The alternator produces up to 40 volts (ac) during engine operation. The regulator-rectifier converts the output of the alternator into direct current (dc), which is used to charge the end item battery.

(8) *Starting system.* The engine is equipped with both a rope start and an electric starter system.

CHAPTER 2

OPERATING INSTRUCTIONS

	Page
OVERVIEW	2-1
Section I. Description and Use of Operator's Controls and Indicators	2-1
Section II. Preventive Maintenance Checks and Services (PMCS)	2-4
Section III. Operation Under Usual Conditions	2-7
Section IV. Operation Under Unusual Conditions	2-7

OVERVIEW

This chapter contains instructions and procedures required to operate the engine safely and efficiently.

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

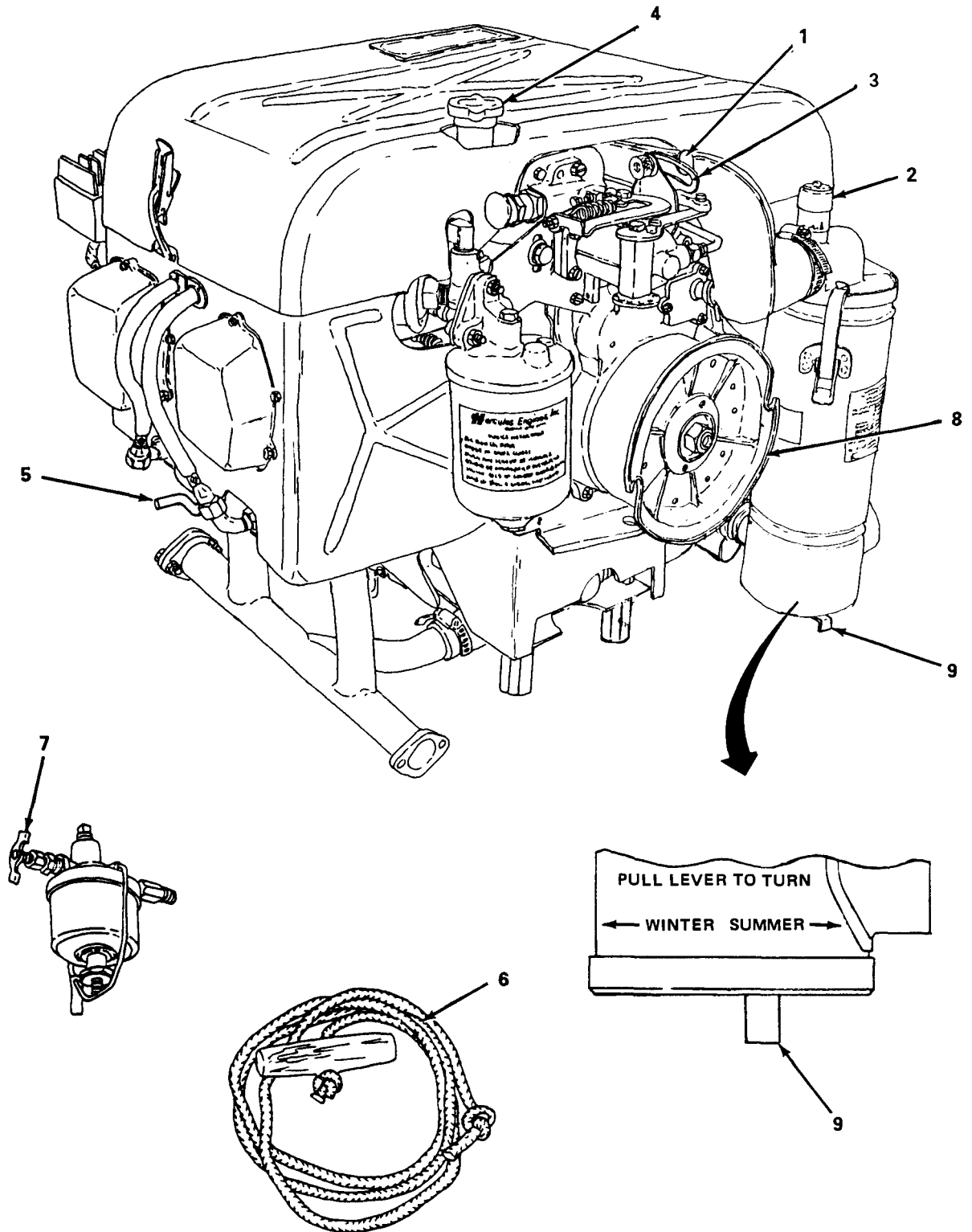
Paragraph	Page
2-1 General	2-1
2-2 Operator's Controls and Indicators	2-1

2-1. **General.** This section contains a list of operator controls and indicators and a description of their use.

2-2. **Operator's Control and Indicators.** The following is a list of operator controls and indicators for all models of the 20 HP Military Standard engine. Although the appearance of the engine may vary between models the location and function of the controls and indicators are similar (figure 2-1).

Key	Control or Indicator	Function
1	Manual Choke	Used during engine start-up to reduce air flow through carburetor, making starting easier.
2	Air Cleaner Service Indicator	Indicates to operator when air cleaner requires servicing.
3	Governor Control	Allows operator to regulate speed of engine between idle speed and full governed speed.
4	Oil Fill Tube and Gage	Allows operator to check oil level in engine, and provides means for adding oil as needed.
5	Oil Pan Baffle Control Rod	Positions oil pan baffle for hot and cold weather operation.

Key	Control or Indicator	Function
6	Starter Rope	Used to pull start engine.
7	Fuel Shutoff Valve	Stops fuel flow from fuel filter.
8	Starter Rope Pulley	Provides area for starter rope to be attached when pull starting engine.
9	Inlet Temperature Control	Used to adjust amount of cold air entering air cleaner.



4870-003

Figure 2-1. Operator's Controls and Indicators.

Section II. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Paragraph		Page
2-3	General	2-4
2-4	Purpose of PMCS Table	2-4
2-5	Explanation of Columns	2-4
2-6	Equipment is Not Ready/Available If Column	2-4
2-7	Reporting Deficiencies	2-5
2-8	Special Instructions	2-5

2-3. **General.** Operator PMCS are performed to ensure that the engine is ready for operation at all times. Perform the checks and services at the specified intervals.

- Before you operate, perform your before (B) PMCS. Observe all CAUTIONS and WARNINGS.
- While you operate, perform your during (D) PMCS. Observe all CAUTIONS and WARNINGS.
- After you operate, be sure to perform your after (A) PMCS.
- If your equipment fails to operate, refer to table 3-1 and report deficiencies on DA Form 2404.

2-4. **Purpose of PMCS Table.** The purpose of the PMCS table is to provide a systematic method of inspection and servicing the equipment. In this way, small defects can be detected early before they become a major problem causing the equipment to fail to complete its mission. The PMCS table is arranged with the individual PMCS procedures listed in sequence under assigned intervals. the most logical time (before, during, or after operation) to perform each procedure determines the interval to which it is assigned. Make a habit of doing the checks in the same order each time and anything wrong will be seen quickly. See paragraphs 2-5 and 2-6 for an explanation of the columns in table 2-1.

2-5. **Explanation Of Columns.** The following is a list of the PMCS table column headings with a description of the information found in each column.

- Item No. This column shows the sequence in which the checks and services are to be performed, and is used to identify the equipment area on the Equipment Inspection and Maintenance Worksheet, DA Form 2404.
- Interval. This column shows a dot (•) when each check is to be done.
- Item to be Inspected/Procedures. This column identifies the general area or specific part where the check or service is to be done, the checks or services to be done, and explains how to do them.
- Equipment is Not Ready/Available If. See paragraph 2-6.

2-6. **Equipment is Not Ready/Available If Column.** This column lists conditions that make the equipment unavailable for use because it is unable to perform its mission, or because it would represent a safety hazard. Do not accept or operate equipment with a condition in the "Equipment is Not Ready/Available If" column.

NOTE

The terms ready/available and mission capable refer to the same status: Equipment is on hand and is able to perform its combat mission. Refer to DA Pam 738-750.

2-7. Reporting Deficiencies. If any problem with the equipment is discovered during PMCS or while it is being operated that cannot be corrected at the operator/crew maintenance level, it must be reported. Refer to DA Pam 738-750 and report the deficiency using the proper forms.

2-8. Special Instructions. Preventive maintenance is not limited to performing the checks and services listed in the PMCS table.

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F - 138°F (38°C – 60°C).

a. Keep it clean. Dirt, grease, oil, and debris get in the way and may cover up a serious problem. Clean as you work and as needed. Use drycleaning solvent on all metal surfaces. Use soap and water to clean rubber or plastic material.

b. Bolts, Nuts, and Screws. Check them all for obvious looseness, missing, bent, or broken condition. You can't try them all with a tool, but look for chipped paint, bare metal, or rust around boltheads. If you find one you think is loose, tighten it, or report it to unit maintenance if you can't tighten it.

c. Electrical Wires and Cable Connectors. Look for bare wires, and loose or broken connectors. Report defects to unit maintenance.

d. Fluid Lines. Look for wear, damage, and leaks. Make sure clamps and fittings are tight. Wet spots and stains around a fitting or connector can mean a leak. If a leak comes from a loose connector, tighten it. If something is broken or worn out, report it to unit maintenance.

e. Leakage Definitions. It is necessary for you to know how fluid leakage affects the status of your equipment. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your equipment. Learn and be familiar with them. When in doubt, NOTIFY YOUR SUPERVISOR!

Leakage Definitions:

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.
Class III	Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

Equipment operation is allowable with minor leakage (Class I or II) of any fluid except fuel. Of course, consideration must be given to the fluid capacity in the item being checked/inspected. When in doubt, notify your supervisor.

When operating with Class I or II leaks, continue to check fluid level more often than required in the PMCS. Parts without fluid will stop working and/or cause equipment damage.

Class III leaks should be reported to your supervisor or unit maintenance.

f. Painting. Touch-up engine as needed. Refer to TM 43-0139 for specific painting procedures.

Table 2-1. Operator Preventive Maintenance Checks and Services (PMCS).

B – Before

D – During

A – After

Item No.	Interval			Item to be Inspected Procedure	Equipment is Not Ready/Available If
	B	D	A		
1	.	.		ENGINE a. Visually inspect engine for signs of damage or missing parts. b. Inspect engine for evidence of fuel or oil leaks. c. Check fuel filter for evidence of contaminated fuel. Notify unit maintenance as required. d. Perform lubrication on engine. Refer to LO 9-2805-259-12 for lubrication instructions. Check oil level with oil gage and add oil if required. e. Listen to engine for unusual sounds, rough running, or excessive exhaust smoke.	Class III oil leak, or Class I fuel leak is detected.
2	.	.	.	AIR CLEANER AND RESTRICTION INDICATOR a. Inspect clamps and hoses. b. Check indicator, and notify unit maintenance en indicator is in the red area.	Indicator is in the red area.
3	.			STARTER ROPE ASSEMBLY Inspect starter rope for cuts or signs of fraying.	

Section III. OPERATION UNDER USUAL CONDITIONS

Paragraph		Page
2-9	Starting Procedure	2-7
2-10	Stopping Procedures	2-7

2-9. **Starting Procedures.** Starting procedures vary depending on the end item on which the engine is used. Refer to the end item manual for specific starting procedures. The following are general instructions for operating the engine.

- a. Always allow sufficient warm-up time before applying end item load.
- b. Always allow sufficient time for the engine to cool down after removing end item load and before stopping engine.
- c. Provide a sufficient flow of fresh air to the engine to ensure proper engine cooling.

2-10. **Stopping Procedures.** Stopping procedures vary depending on end item on which the engine is used. Refer to end item technical manual for specific stopping procedure.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

Paragraph		Page
2-11	Operation in Dusty or Sandy Areas.	2-7
2-12	Operation in Rainy, Humid, or Salt Air Conditions	2-8
2-13	Operation in Extreme Heat	2-8
2-14	Operation at Different Altitudes	2-8
2-15	Operation in Extreme Cold	2-8

2-11. **Operation in Dusty or Sandy Areas.** The procedures for operating the engine are the same as under usual conditions except for the following special precautions:

- a. Keep fuel, lubrication, ignition and cooling systems free of dust and sand.
- b. Check air cleaner restriction indicator more often when operating in dusty or sandy areas. Have unit maintenance service air cleaner element as needed.
- c. In the event of severe dust or sand storms, provide a well protected sheltering device for the engine.
- d. Remove all dust or sand from the engine and inspect for damage.

2-12. Operation in Rainy, Humid, or Salt Air Conditions. The procedures for operating the engine are the same as under usual conditions except for the following special precautions:

- a. Remove all visible signs of corrosion as soon as possible.
- b. Keep fuel lines, and ignition lines as dry as possible.
- c. If possible, store engine indoors.
- d. Use a thin layer of oil or desiccants to keep corrosion to a minimum.

2-13. Operation in Extreme Heat. The procedures for operating the engine are the same as under normal condition except for the following special precautions:

- a. Check oil level more often when operating in extreme heat. Use appropriate grade oil. Refer to LO 9-2805-259-12.
- b. Allow engine to cool off longer after removing end item load.
- c. In extreme hot temperatures, the engine will run efficiently but at a reduced horse power rating. For each 10°F (12.2°C) above 60°F (15.5°C), a 1 percent loss of power should be expected.

2-14. Operation at Different Altitudes. The procedures for operating the engine are the same as under usual conditions. The engine will operate at altitudes of up to 5000 feet above sea level but at a reduced horse power rating. For every 1000 feet above sea level, a 3.5 percent power loss should be expected.

2-15. Operation in Extreme Cold. The engine can be operated in temperatures as cold as -25°F (-32°C). The procedures for operating the engine are the same as under usual conditions excepts for the following special precautions.

- a. Protect the engine from icing. Remove ice and snow from engine as often as possible.
- b. Allow engine sufficient warm-up time before apply end item load.
- c. Use appropriate grade oil. Refer to LO 9-2805-259-12.

CHAPTER 3

OPERATOR'S MAINTENANCE INSTRUCTIONS

	Page
OVERVIEW	3-1
Section I. Lubrication Instructions	3-1
Section II. Operator Troubleshooting Procedures	3-1
Section III. Operator's Maintenance	3-3

OVERVIEW

This chapter contains operator level maintenance instructions.

Section I. LUBRICATION INSTRUCTIONS

Paragraph	Page
3-1 General	3-1

3-1. **General.** This section contains operator lubrication instructions.

3-2. **Lubrication.** Refer to LO 9-2805-259-12 and perform operator level lubrication procedures. Operate the engine (para. 2-9) for at least 5 minutes, after lubrication. Stop the engine (para. 2-10) and perform operator level after Operation Preventive Maintenance Checks and Services (PMCS).

Air Force personnel use applicable T.O. 35C2-3-1-42C work cards for lubrication instructions.

Section II. OPERATOR TROUBLESHOOTING PROCEDURES

Paragraph	Page
3-3 General	3-1
3-4 Operator Troubleshooting Procedures.	3-1

3-3. **General.** This section contains troubleshooting procedures to determine the probable cause of observed equipment malfunctions. Inspections are provided to isolate the faulty component and corrective actions are provided to eliminate the malfunction.

3-4. **Operator Troubleshooting Procedures.** Refer to the Symptom Index to locate the troubleshooting procedure for the observed malfunction.

- Table 3-1 lists the common malfunctions which you may find during operation of 20 HP Military Standard Gasoline Engine Models 4A084-2, -3 and -4, and its components. Perform the test/inspections in the order listed.
- This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not corrected by listed corrective actions, notify your supervisor, and/or unit maintenance.

SYMPTOM INDEX

Symptom	Page
Engine will not start	3-2
Engine starts but fails to keep running	3-2
Engine runs excessively hot.....	3-3

Table 3-1. Operator Troubleshooting Procedures.

Malfunction	Testor	Inspection	Corrective	Action
1. ENGINE WILL NOT START				
Step 1. Check end item fuel supply.				
Replenish fuel supply if low.				
Step 2. Check fuel shutoff valve				
Turn valve counterclockwise to open.				
Step 3. Check choke position.				
Choke should be in closed position for starting.				
2. ENGINE STARTS BUT FAILS TO KEEP RUNNING.				
NTE				
If engine is warm, the choke may not need to be closed completely.				
Step 1. Check choke position.				
If engine is cold, close choke.				
If engine is warm, close choke halfway.				
Step 2. Check fuel shutoff valve.				
Turn valve counterclockwise to open.				
If engine still fails to keep running, notify unit maintenance.				

Table 3-1. Operator Troubleshooting Procedures (cont).

Malfunction	Test or Inspection	Corrective Action
3. ENGINE RUNS HOT		
	Step 1. Check oil level.	Replenish oil if low.
	Step 2. Check that cooling system ducts, covers, and deflectors are present and serviceable.	Notify unit maintenance if there are damaged or missing parts.

Section III. OPERATOR'S MAINTENANCE

NOTE

This section not applicable. Users should refer to the appropriate end item technical manual for operating procedures.

CHAPTER 4
UNIT MAINTENANCE

	Page
OVERVIEW	4-1
Section I. Repair Parts; Special Tools; Test, Measurement, Diagnostic Equipment (TMDE); and Support Equipment	4-1
Section II. Service Upon Receipt	4-2
Section III. Unit Preventive Maintenance Checks and Services (PMCS).....	4-2
Section IV. Unit Troubleshooting	4-3
Section V. Unit Maintenance Procedures	4-7
Section VI. Preparation for Shipment or Storage	4-115

OVERVIEW

This chapter contains those maintenance instructions that unit level maintenance is authorized to perform.

Section I. REPAIR PARTS; SPECIAL TOOLS, TEST, MEASUREMENT, DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

Paragraph	Page
4-1 Common Tools and Test Equipment	4-1
4-2 Special Tools, TMDE, and Support Equipment	4-1
4-3 Repair Parts	4-1

4-1. **Common Tools and Equipment.** For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-2. **Special Tools, TMDE and Support Equipment.** For a listing of special tools, TMDE, and support equipment authorized for use on this equipment, refer to the Repair Parts and Special Tools List, TM 5-2805-259-24P, and the maintenance allocation chart (MAC), appendix B of this manual.

4-3. **Repair Parts.** Repair parts are listed and illustrated in the Repair Parts and Special Tools List for 20 HP Military Standard Engine TM 5-2805-259-24P.

Section II. SERVICE UPON RECEIPT

Paragraph		Page
4-4	Inspection	4-2
4-5	Lubrication	4-2
4-6	Testing	4-2

4-4. Inspection.

- Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on SF Form 364, Report of Discrepancy (ROD).
- Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA PAM 738-750.
- Check to see whether the equipment has been modified.

4-5. **Lubrication.** Refer to LO 9-2805-259-12 and perform unit level and operator level lubrication on engine.

4-6. **Testing.** Perform unit level PMCS, and operator Before (B) PMCS before starting engine. Start engine, para. 2-9, and run for at least 15 minutes. Observe the engine during operation. If any malfunctions arise, troubleshoot using table 4-2.

Section III. UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Paragraph		Page
4-7	General	4-2
4-8	PMCS Procedures	4-2

4-7. **General.** Unit level maintenance PMCS are done to ensure that the engine is in top operating condition. A comprehensive PMCS program reduces equipment downtime and increases the operational readiness of the engine.

4-8. **PMCS Procedures.** Unit level PMCS is contained in table 4-1. The numbers in the Item No. column show the order in which the check or service should be done. These numbers should be used when recording deficiencies and shortcomings on DA Form 2404, Equipment Inspection and Maintenance Worksheet. The dot (•) in the Interval column indicates when a check or service should be done, as follows:

Table 4-1. Unit Preventive Maintenance Checks and Services (PMCS).

D - Daily

S - Semiannually (500 Hours)

H - Hours

Item No.	Interval			Item to be Inspected	Procedures
	D	S	H		
1		•		Spark Plug	Clean, inspect, and regap (para. 4-37).
2		•		High Tension Cables	Clean, inspect, and test (para. 4-36).
3		•		Magneto Contacts	Inspect, adjust magneto contacts (para. 4-34).
4		•		Fuel Filter	Service fuel filter (para. 4-13).
5		•		Crankcase Ventilation System	Inspect breather tube (para. 4-18), breather reed (para. 4-54), and crankcase breather (para. 4-27) and clean as needed.
6	•			Air Cleaner	Service air cleaner daily in extreme heat, dusty, or sandy conditions. Refer to para. 4-14.
7			15	Crankcase Oil	Drain and refill crankcase oil, service oil filter (para 4-19) in extreme heat, dusty, or sandy conditions. Refer to LO 9-2805-259-12.
8		•		Wiring Harness	Inspect for burnt, cracked, frayed or other damaged wiring (para. 4-52).

Section IV. UNIT TROUBLESHOOTING

Paragraph	Page
4-9 General	4-3
4-10 Troubleshooting	4-3

4-9. **General.** This section contains troubleshooting procedures to determine the probable cause of observed equipment malfunctions. Tests or inspections are provided to isolate the faulty component and corrective actions are provided to eliminate the malfunction.

4-10. **Unit Troubleshooting Procedures.** Refer to the symptom index to locate the troubleshooting procedure for the observed malfunction. The table lists the common malfunctions that may occur during the operation or maintenance of the engine. Perform the tests or inspections, and the recommended corrective action in the order listed in the troubleshooting table. If the malfunction is corrected by a specific correction action, do not continue with the remaining steps, if any, of the troubleshooting procedure, if the malfunction is not corrected by the listed corrective actions notify your supervisor and direct support maintenance.

SYMPTOM INDEX

Symptom	Page
Engine fails to start	4-4
Engine starts but fails to keep running	4-5
Engine misses or runs erratically	4-5
Engine surges or over speeds	4-6
Engine overheats	4-6
Engine oil consumption excessive	4-6
Engine lacks power	4-6

Table 4-2. Unit Troubleshooting Procedures.

Malfunction	Test or Inspection	Corrective Action
1. ENGINE FAILS TO START.		
	Step 1. Inspect fuel filter.	Service a dirty fuel filter (para. 4-13).
	Step 2. Inspect magneto contacts.	Adjust or replace worn magneto contacts (para. 4-34).
	Step 3. Inspect spark plugs.	Adjust or replace worn spark plug (para. 4-37).
	Step 4. Check condensor as follows:	
	a. Turn engine over so that breaker points (para. 4-34, figure 4-27) are in the open position,	
	b. Connect positive lead of multimeter to condensor terminal lead.	
	c. Set multimeter to highest resistance setting and zero meter.	
	d. Connect second lead of multimeter to ground while observing meter.	
		If meter shows a deflection, then goes to infinity, go to next step.
		If no deflection occurs, or does not go to infinity after deflection, replace condensor (para. 4-35).
		If meter does not return to infinity, disconnect condensor lead from points and retest. If deflection occurs, replace points (para. 4-35).
	Step 5. Inspect spark plug cables.	Replace a defective spark plug cable (para. 4-36).
	Step 6. Check carburetor adjustment.	Adjust carburetor (para. 4-46).
	Step 7. Check automatic choke operation.	Adjust or replace automatic choke solenoid (para. 4-30).
	Step 8. Check low oil pressure shutdown switch as follows:	
	a. Remove lead going to low oil pressure shutdown switch.	
	b. Connect lead end to ground,	
	c. Attempt to start engine (para. 2-9).	
		If engine starts and stays running, replace low oil pressure shutdown switch (para. 4-28).
		If engine starts but fails to keep running, go to malfunction 2.
		If engine fails to keep running, go to next step.

Table 4-2. Unit Troubleshooting Procedures (cont).

Malfunction	Test or Inspection	Corrective Action
1. ENGINE FAILS TO START (cont).		
	Step 9. Check fuel pump pressure.	Replace a defective fuel pump (para. 4-48).
2. ENGINE STARTS BUT FAILS TO KEEP RUNNING.		
	Step 1. Inspect fuel filter.	Service a dirty fuel filter (para. 4-13).
	Step 2. Check choke solenoid operation.	Adjust or replace choke solenoid (para. 4-30).
	Step 3. Test fuel pump pressure.	Replace a defective fuel pump (para. 4-48).
	Step 4. Check carburetor.	Adjust or replace a damaged carburetor (para. 4-46).
3. ENGINE MISSES OR RUNS ERRATICALLY.		
	Step 1. Check spark plugs.	Adjust or replace worn spark plugs (para. 4-37).
	Step 2. Check magneto contact points.	Adjust or replace worn contact points (para. 4-34).
	Step 3. Test high tension cables.	Replace defective high tension cables (para. 4-36).
	Step 4. Check carburetor.	Adjust carburetor (para. 4-46).
4. ENGINE SURGES OR OVERSPEEDS.		
	Step 1. Check governor.	Adjust governor (para. 4-43).
	Step 2. Check carburetor.	Adjust carburetor (para. 4-46).

Table 4-2. Unit Troubleshooting Procedures (cont).

Malfunction	Test or Inspection	Corrective Action
4. ENGINE SURGES OR OVERSPEEDS (cont).		
	Step 3. Test fuel pump pressure.	Replace a defective fuel pump (para. 4-48).
5. ENGINE OVERHEATS.		
	Step 1. Check ignition timing.	Adjust ignition timing (para. 4-33).
	Step 2. Check carburetor.	Adjust carburetor (para. 4-46).
6. ENGINE OIL CONSUMPTION EXCESSIVE.		
	Step 1. Check oil breather tube.	Clean a dirty oil breather tube (para. 4-18).
	Step 2. Check air breather reed.	Replace a worn or otherwise damaged breather reed (para. 4-54).
	Step 3. Check crankcase breather.	Clean or replace a clogged or otherwise damaged crankcase breather (para. 4-27).
7. ENGINE LACKS POWER.		
	Step 1. Check air cleaner restriction indicator.	Service air cleaner (para. 4-14).
	Step 2. Check compression (para. 4-55).	
		Notify direct support maintenance of inadequate readings.

Section V. UNIT MAINTENANCE PROCEDURES

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4-11. **General.** This section contains unit level maintenance procedures as authorized by the MAC in Appendix B of this manual. Refer to Appendix E, Torque Limits, when performing maintenance on engine. All maintenance procedures require only one person to perform. It may be necessary to remove the engine from the end item to perform some unit level maintenance procedures. Refer to the end item manual for procedures to remove the engine if authorized by end item MAC.

4-12. **Painting.** Refer to TM 43-0139 for painting procedures.

4-13. **Fuel Filter.**

This task covers: Service

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Service. (figure 4-1).

WARNING

Do not smoke or use an open flame in the vicinity of gasoline vapors.

- (1) Close fuel cutoff valve (1).

NOTE

Fuel filter is mounted on end item, not engine.

- (2) Loosen thumbscrew (2) and swing bail (3) out of way.

NOTE

Some fuel filters contain screens and others contain a filter element.

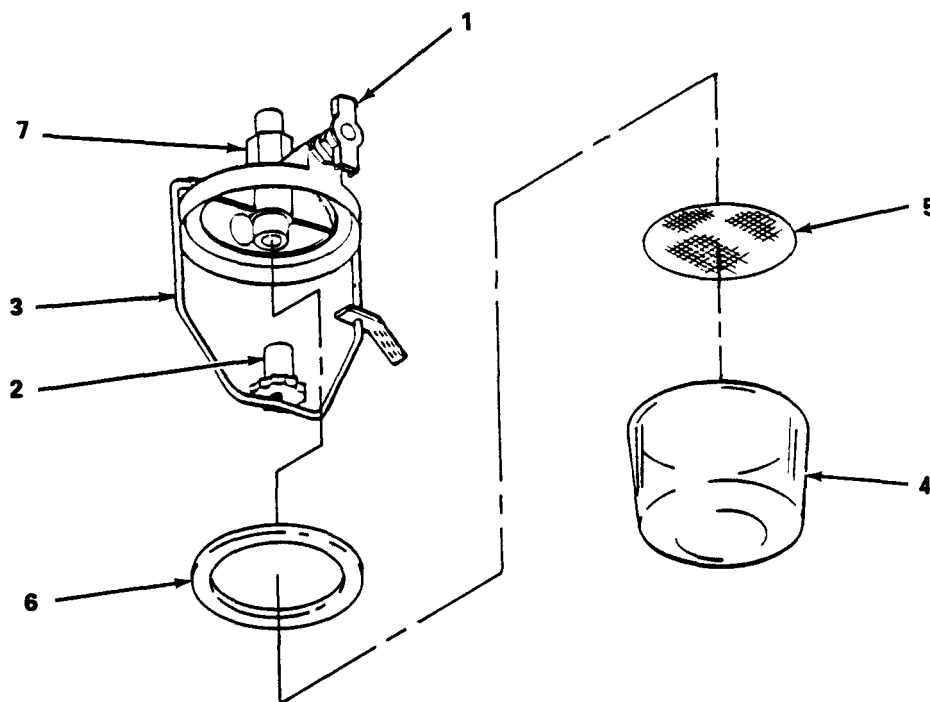
- (3) Remove bowl (4), element screen (or filter element) (5), and gasket (6).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-1 38°F. (38°C.-60°C.).

- (4) Clean screen (or filter element) (5), bowl (4), and filter head (7).
- (5) Inspect screen (or filter element) (5) and replace if torn or otherwise damaged, replace fuel filter.

- (6) Inspect gasket (6) and replace if ripped or otherwise damaged, replace fuel filter.
- (7) Install screen (or filter element) (5) in filter head (7).
- (8) Install bowl (4) and gasket (6) and secure with bail (3) and tighten thumbscrew (2).



4870-005

Figure 4-1. Fuel Filter, Service.

This task covers: a. Service b. Replacement

Tools

Materials/Parts

General Mechanic's Tool Kit (Item 1, Appendix B)

Detergent (Item 2, Appendix D)
Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

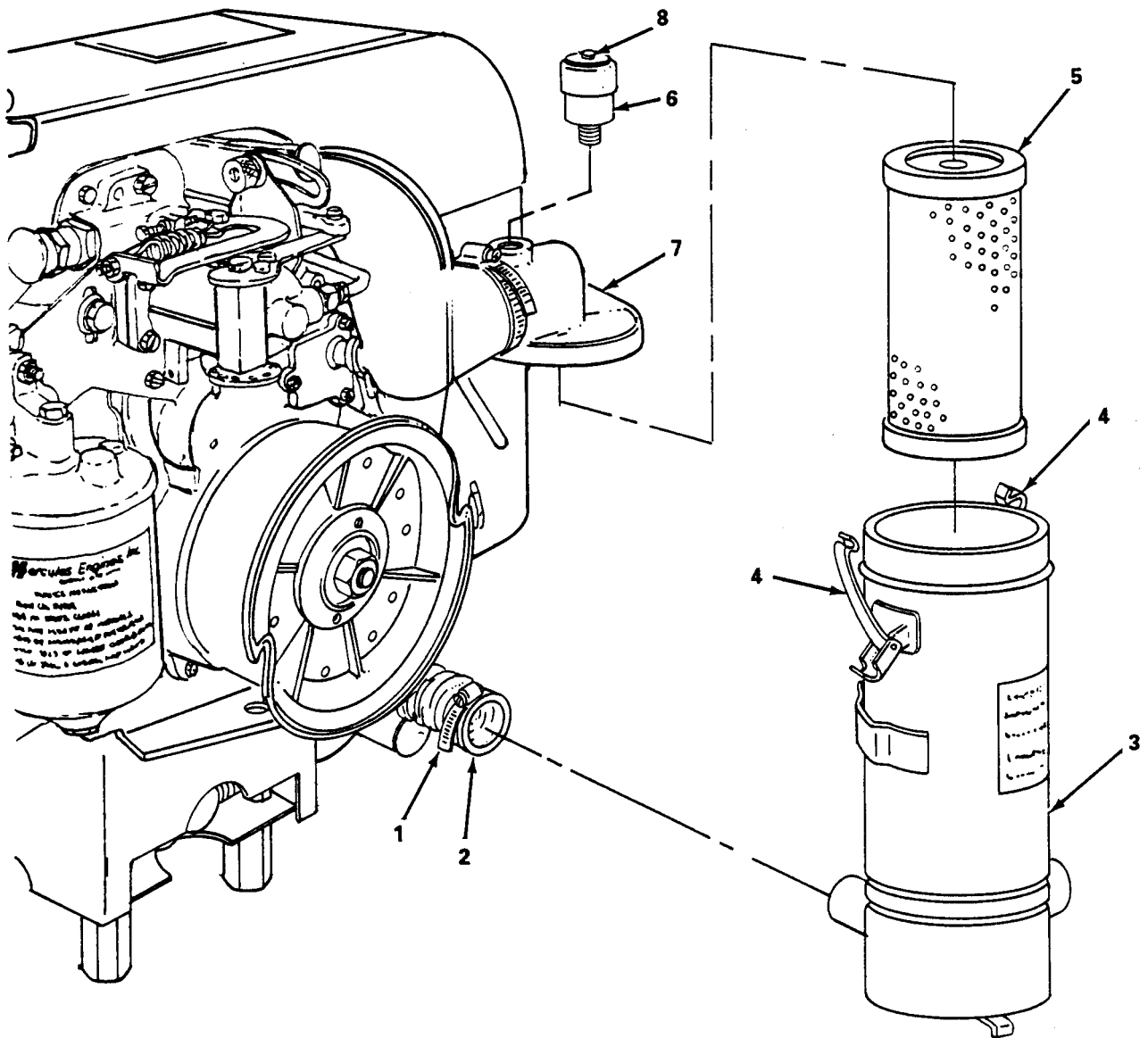
a. Service. (figure 4-2)

- (1) Loosen clamp (1) and remove hose (2) from air cleaner body (3).
- (2) Unsnap two clips (4) and remove air cleaner body (3).
- (3) Remove air cleaner element (5) from body (3).
- (4) Remove restriction indicator (6).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- 4-10**



4870-006

Figure 4-2. Air Cleaner Element, Service.

4-14. **Air Cleaner Element (cont).**

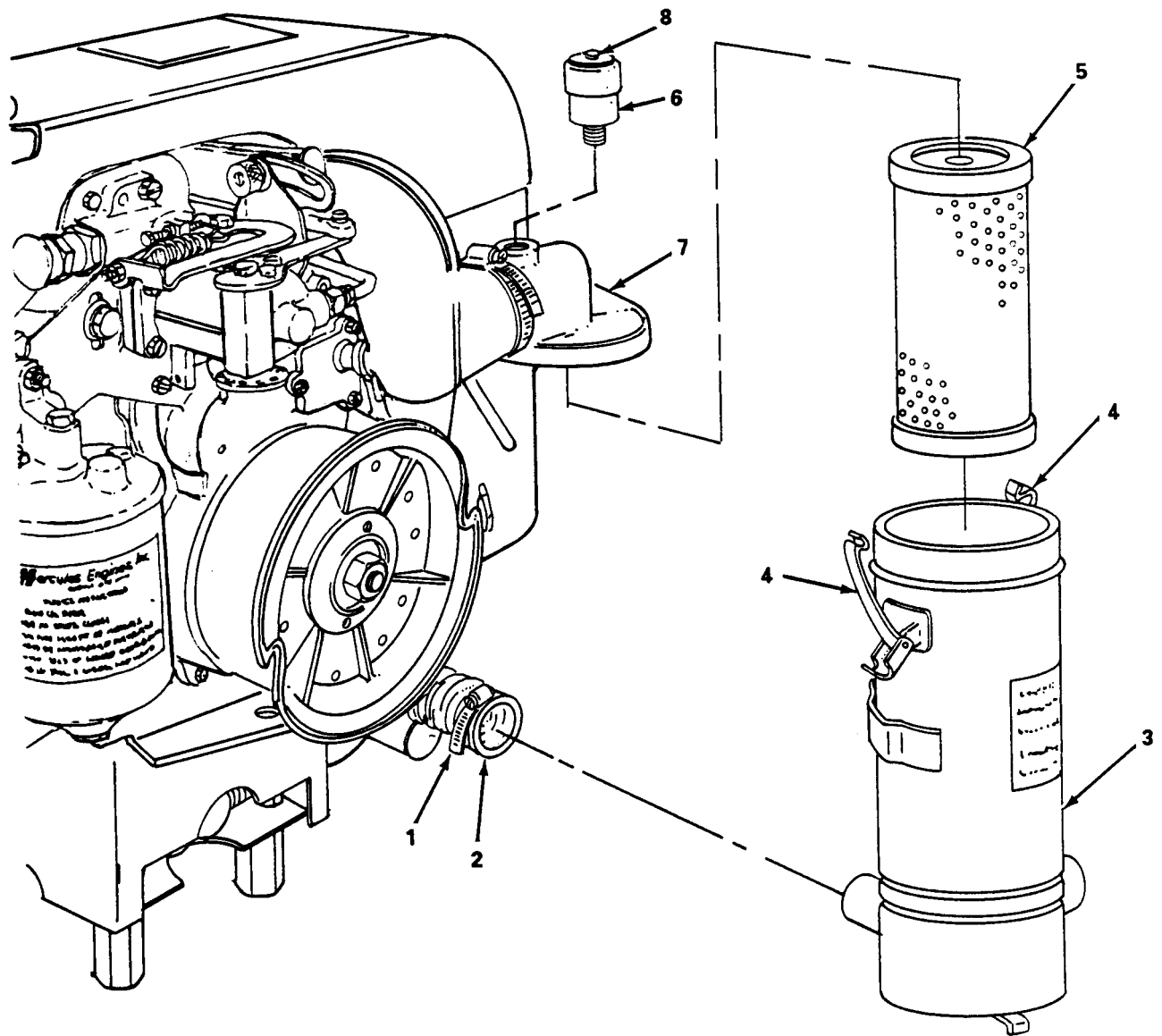
b. Replacement. (figure 4-3)

- (1) Loosen clamp (1) and remove hose (2) from air cleaner body (3).
- (2) Unsnap two clips (4) and remove body (3).
- (3) Remove element (5) from body (3).
- (4) Remove restriction indicator (6).

WARNING

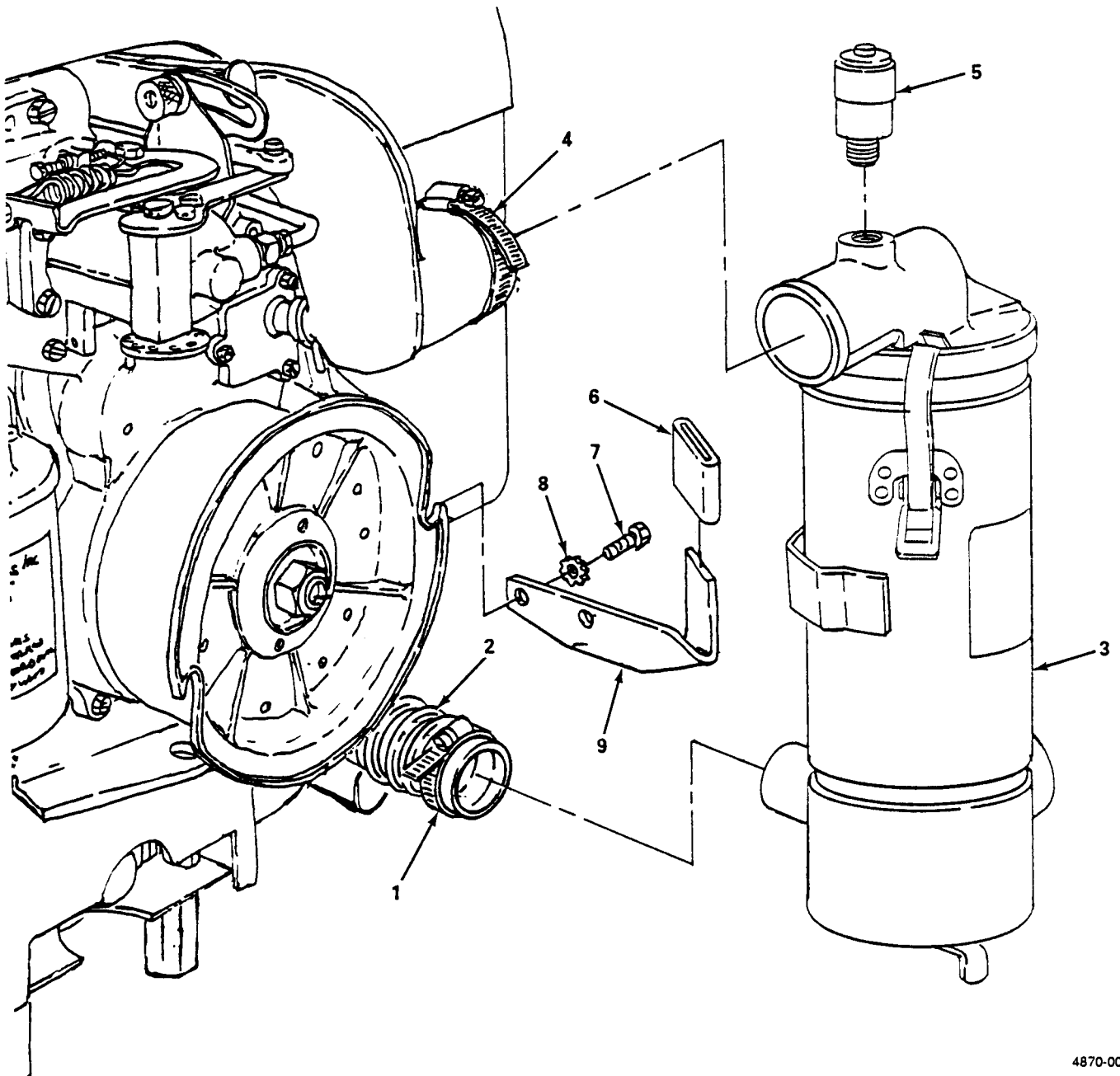
Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (5) Clean body (3) and head (7) with drycleaning solvent, and dry thoroughly.
- (6) Install element (5) in body (3).
- (7) Install body (3) and secure with two clips (4).
- (8) Install hose (2) and tighten clamp (1).
- (9) Install restriction indicator (6).
- (10) Press reset button (8) on restriction indicator (6).



4870-008

Figure 4-3. Air Cleaner Element, Replacement.



4870-009

Figure 4-4. Air Cleaner, Support Bracket and Restriction Indicator, Removal and Installation.

This task covers: a. Removal b. Installation

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

a. Removal. (figure 4-5)

- (1) Loosen clamp (1) and remove hose (2) from air cleaner (3).
- (2) Loosen clamp (4) and remove hose (2) from preheater (5).
- (3) Inspect hose (2) and replace if torn or otherwise damaged.
- (4) Inspect clamps (1) and (4) and replace if worn or otherwise damaged.

b. Installation. (figure 4-5)

Install hose (2) and tighten clamps (4) and (1).

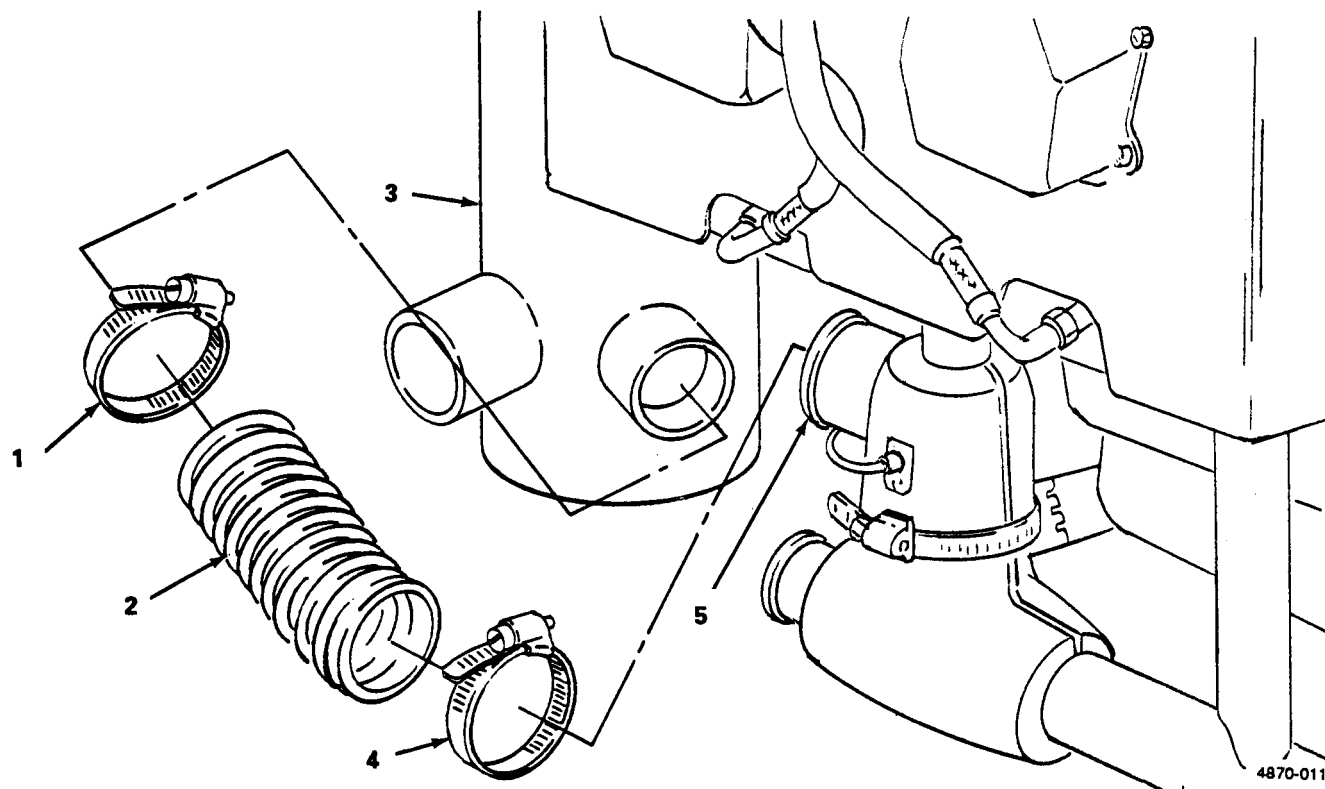


Figure 4-5. Clamps and Hose, Removal and Installation.

4-17. Air Cleaner Elbow.

This task covers: a. Removal b. Installation

INITIAL SETUP

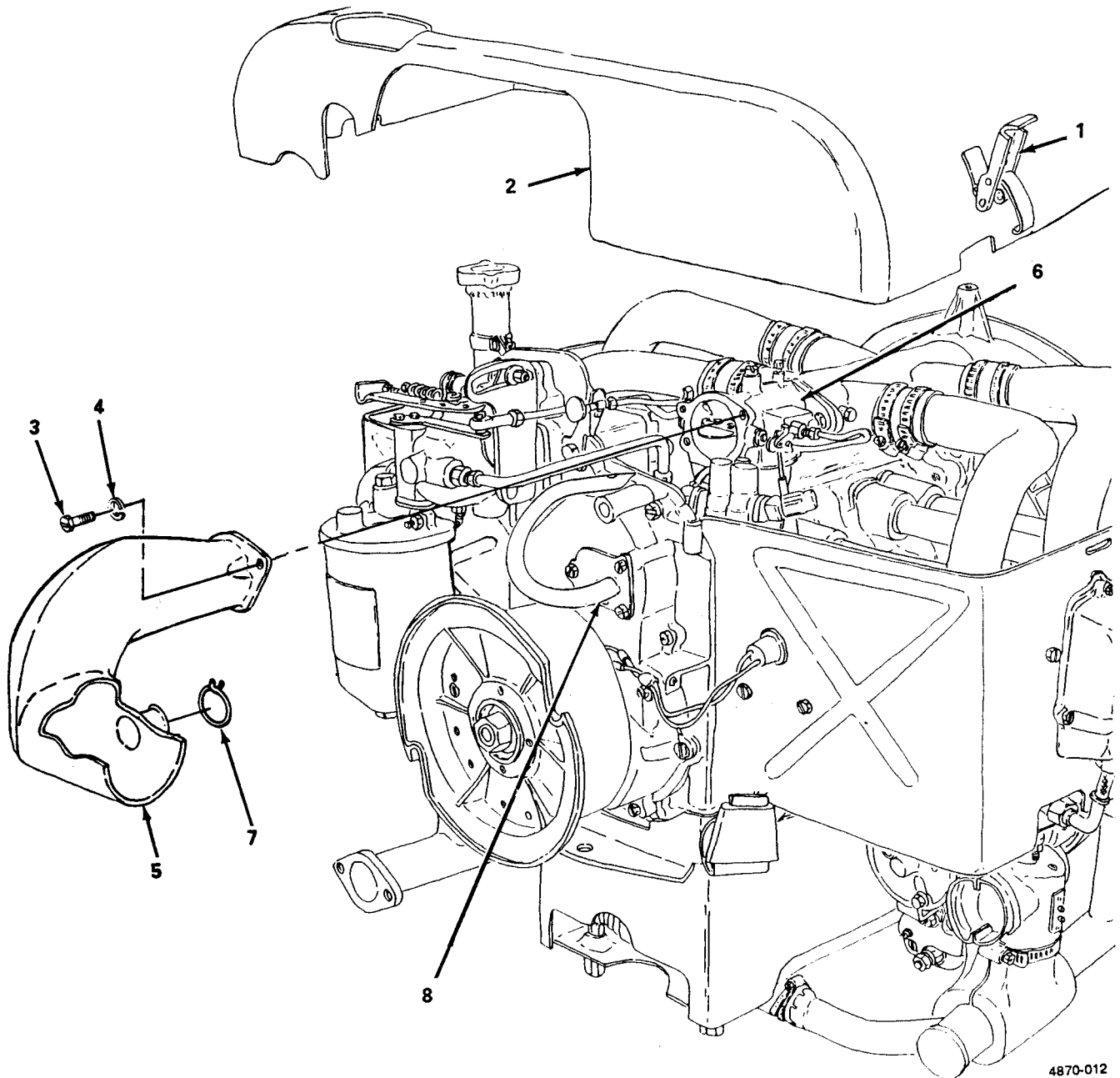
<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Air cleaner removed (para. 4-16).

a. Removal. (figure 4-6)

- (1) Unsnap two clips (1) and remove top cover (2).
- (2) Remove two screws (3) and washers (4) securing air cleaner elbow (5) to carburetor (6).
- (3) Remove clamp (7) and remove air cleaner elbow (5) from breather tube (8).
- (4) Inspect air cleaner elbow (5) and replace if torn or otherwise damaged.

b. Installation. (figure 4-6)

- (1) Ensure mounting surfaces are clean.
- (2) Slide air cleaner elbow (5) on breather tube (8) and install clamp (7).
- (3) Secure air cleaner elbow (5) with two screws (3) and washers (4).
- (4) Install top cover (2) and secure with two clips (1).



4870-012

Figure 4-6. Air Cleaner Elbow, Removal and Installation.

4-18. **Breather Tube.**

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Equipment Condition

Air cleaner elbow removed (para. 4-17).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)
Gasket, Breather Tube Mounting
(NSN 2805-00-937-0943)

a. Removal. (figure 4-7)

Remove three screws (1) and washers (2) and remove breather tube (3) and gasket (4).

b. Inspection. (figure 4-7)

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

(1) Clean breather tube in drycleaning solvent, and dry thoroughly.

(2) Ensure there are no obstructions in breather tube (3).

c. Installation. (figure 4-7)

(1) Ensure gasket mounting surfaces are clean and free of old gasket material.

(2) Install breather tube (3) and gasket (4) and secure with three screws (1) and washers (2).

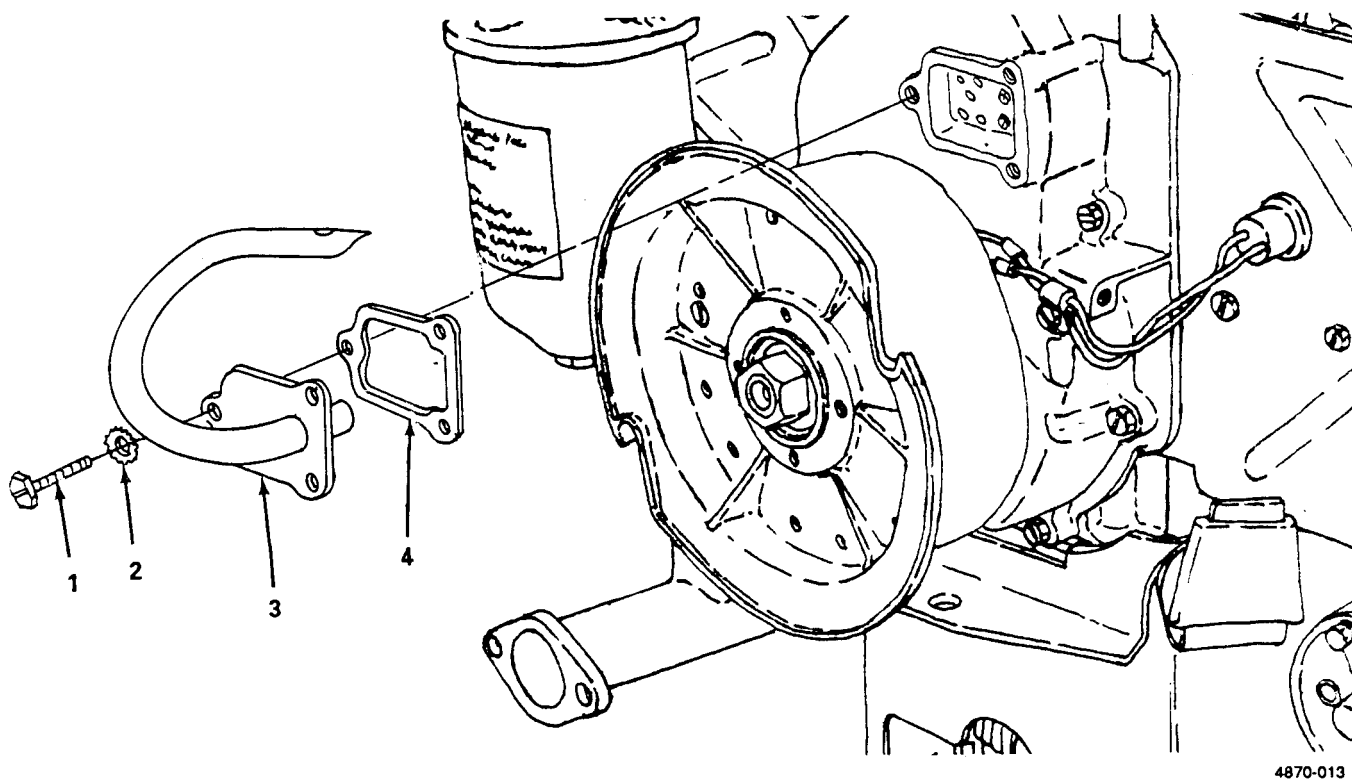


Figure 4-7. Breather Tube, Removal and Installation.

4-19. Oil Filter Element.

This task covers: a. Replacement (Element Type) b. Replacement (Spin on Type)

INITIAL SETUP

<i>Tools</i>	<i>Materials/Parts</i>
General Mechanic's Tool Kit (Item 1, Appendix B) Wrench, Oil Filter (NSN 5120-00-865-0933) (Item 2, Appendix B)	Oil, Engine (Item 3, Appendix D) Rags, Wiping (Item 7, Appendix D) Solvent, Drycleaning (Item 8, Appendix D)

a. Replacement (Element Type). (figure 4-8)

- (1) Remove screw (1) and gasket (2) and remove shell (3) and O-ring (4).
- (2) Pour oil out of shell (3) into suitable container
- (3) Remove element (5) from shell (3) and discard element (5).

WARNING

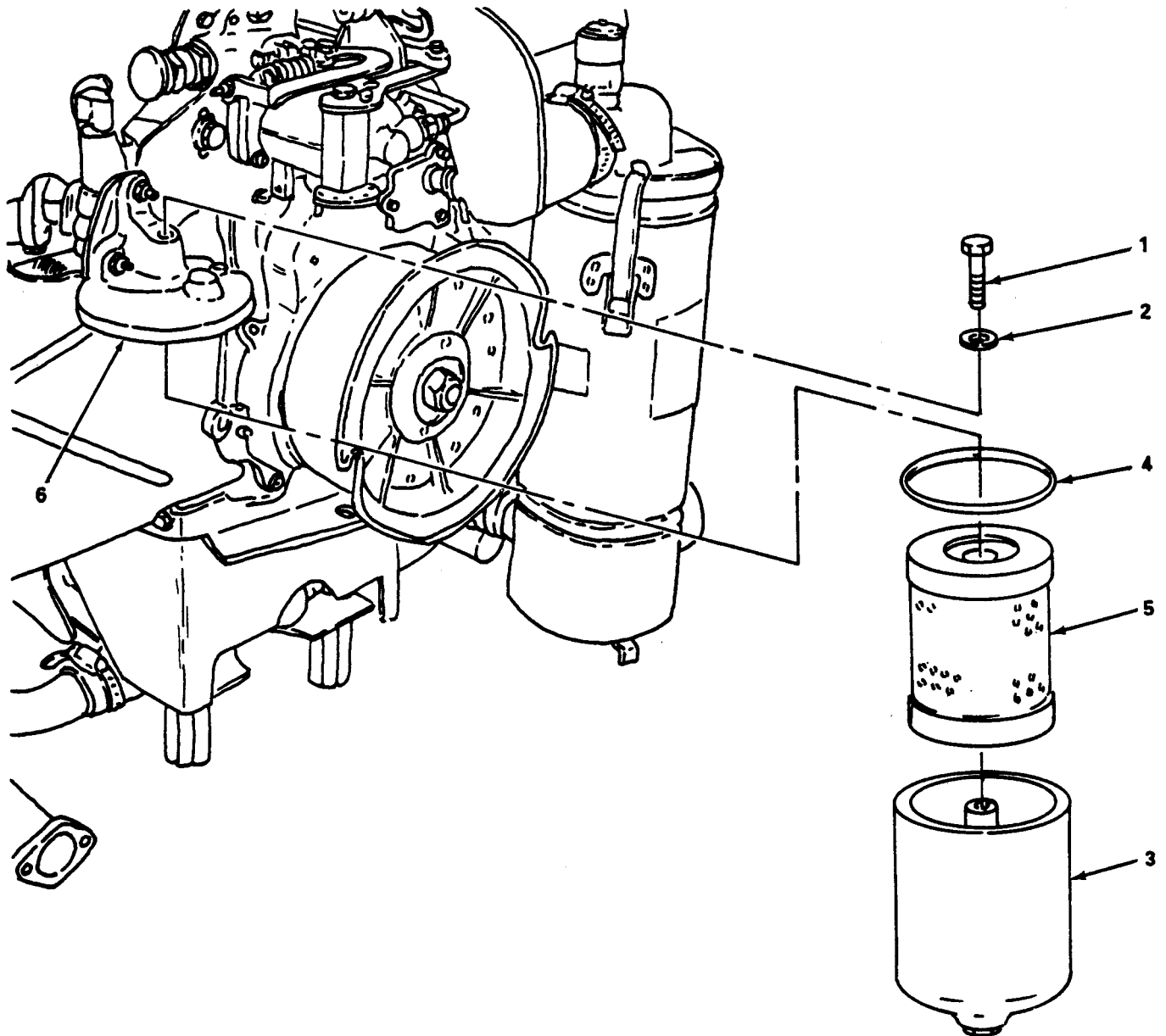
Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (4) Clean shell (3) and cover (6) with drycleaning solvent and dry thoroughly.
- (5) Install element (5) in shell (3).

NOTE

Do not reuse O-ring or gasket. Install new O-ring and gasket upon installation.

- (6) Install shell (3) and O-ring (4) and secure with screw (1) and gasket (2).
- (7) Operate engine (para. 2-9) and check for leaks. Stop engine (para. 2-10) and check engine oil level and replenish if low (refer to LO 9-2805-259-12 for proper grade oil).



4870-014

Figure 4-8. Oil Filter Element, Replacement

4-19. Oil Filter Element (cont).

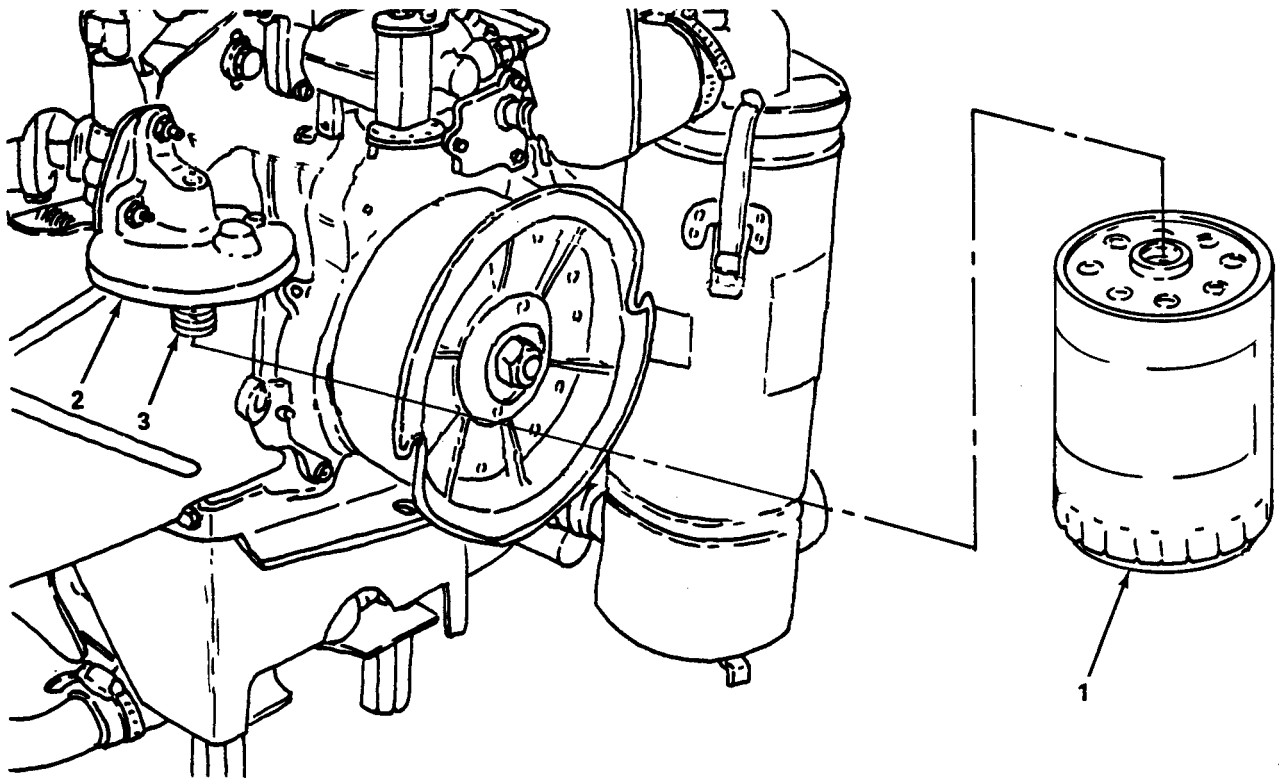
b. Replacement (Spin on Type). (figure 4-9)

- (1) Using suitable oil filter wrench, remove oil filter (1).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (2) Clean cover (2) with drycleaning solvent, and dry thoroughly,
- (3) Inspect nipple (3) and replace if threads are stripped or otherwise damaged.
- (4) Lightly lubricate rubber seal on oil filter with clean engine oil (LO 9-2805-259-12).
- (5) Install oil filter (1) tighten 3/4 turn after gasket contact is made.



4870-015

Figure 4-9. Oil Filter, Replacement.

This task covers: a. Removal b. Installation

Tools

Equipment Condition

Oil filter removed (para. 4-19).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)
Gasket, Oil Filter Mounting (NSN 5330-00-073-3038)

a. Removal. (figure 4-10)

- (1) Remove three nuts (1) and washers (2) and remove oil filter cover (3) and gasket (4).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (2) Clean oil filter cover (3) with drycleaning solvent, and dry thoroughly.
- (3) Inspect oil filter cover (3) and replace if cracked or otherwise damaged.
- (4) Inspect studs (5) and replace if damaged.

b. Installation. (figure 4-10)

- (1) Ensure gasket mating surfaces are clean and free of old gasket material.
- (2) Install gasket (4) and oil filter cover (3) and secure with three nuts (1) and washers (2).

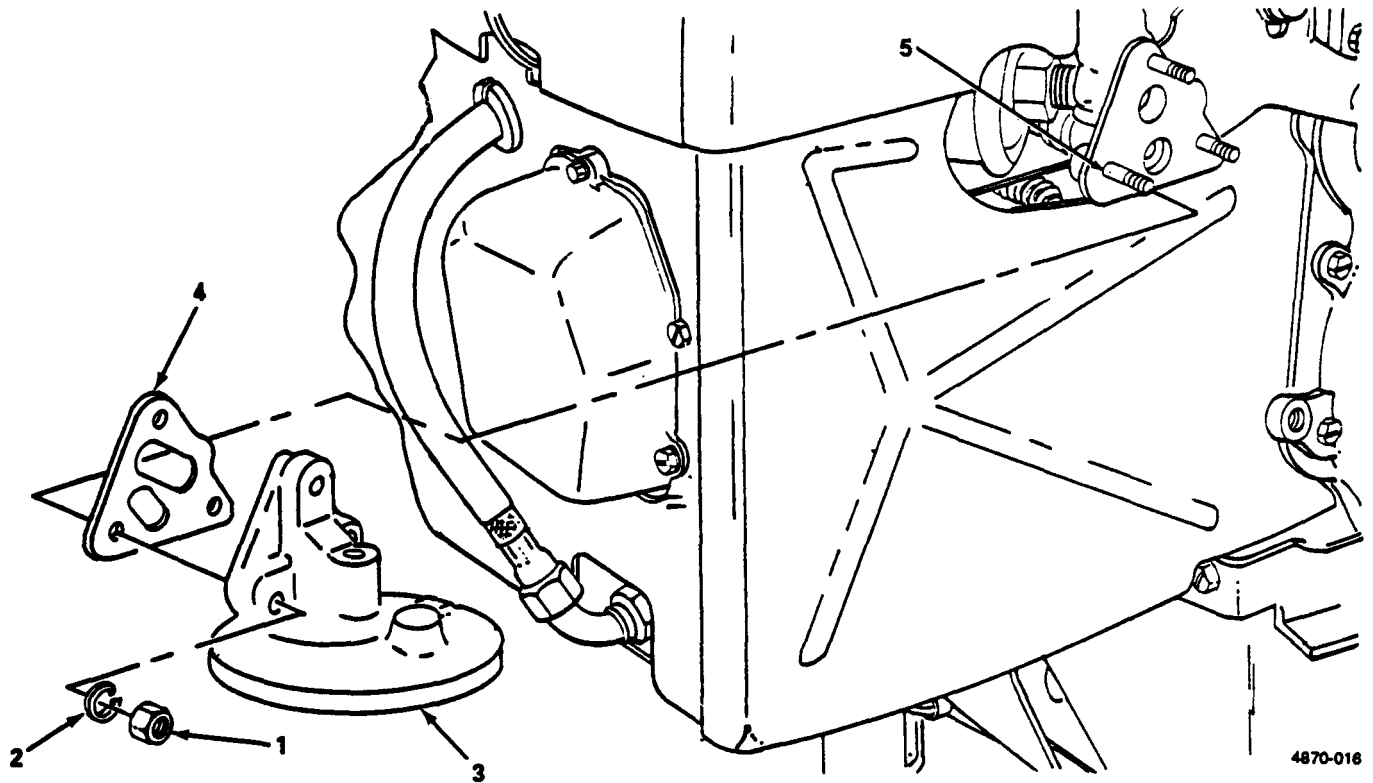


Figure 4-10. Oil Filter Cover and Studs, Removal and Installation.

4-21. Top Cover, Right and Left Shrouds and Cylinder Baffles.

This task covers: a. Removal b. Installation

INITIAL SETUP

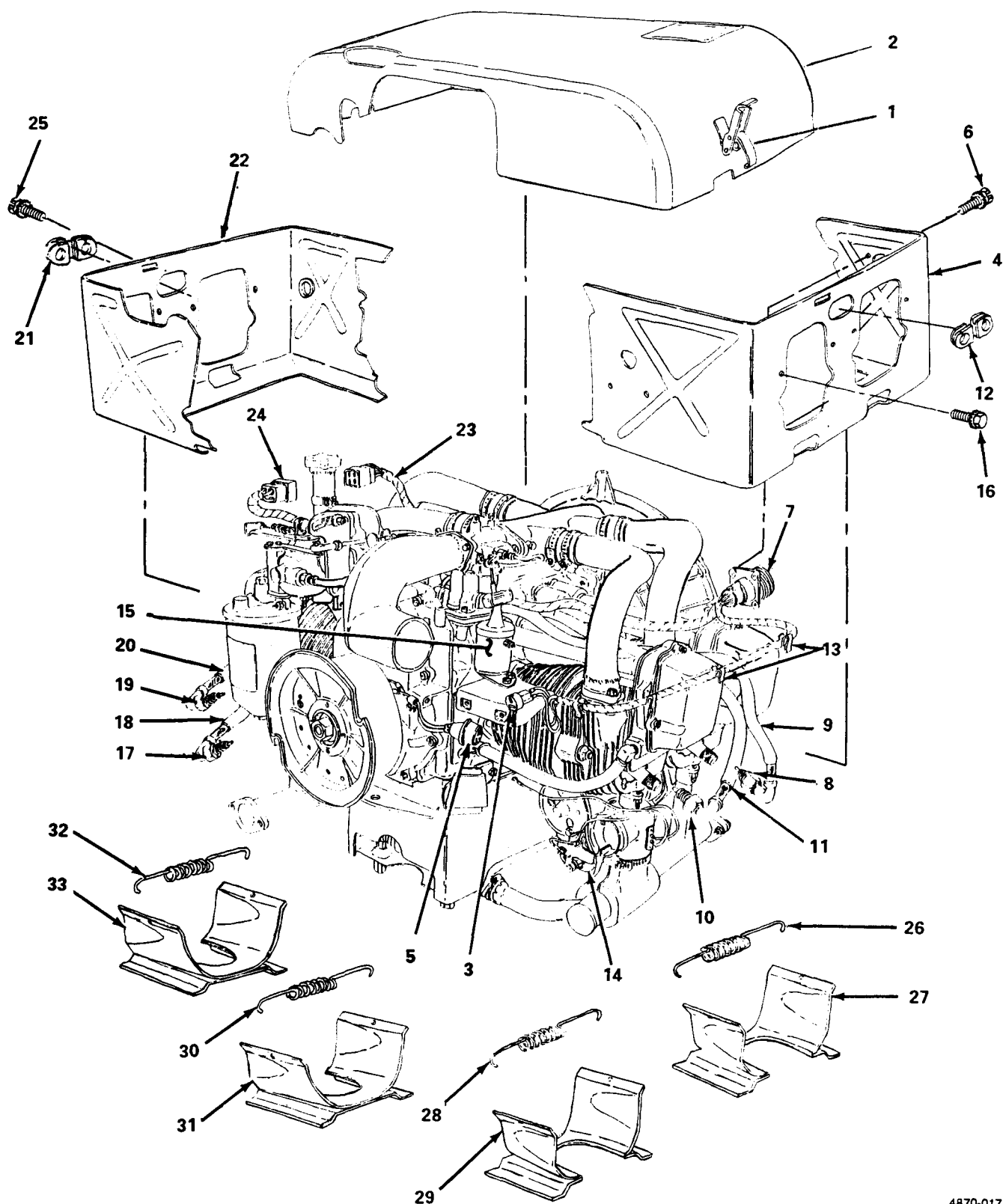
Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B) Air cleaner removed (para. 4-16).

a. Removal. (figure 4-11)

- (1) Unsnap two clips (1) and remove top cover (2).
- (2) Unplug wiring harness connector (3) from inside of right hand shroud (4).
- (3) Remove alternator connector (5) from outside of right hand shroud (4).
- (4) Remove four screws (6) and remove connector (7) from right hand shroud (4).
- (5) Loosen connector nut (8) and remove high tension cable (9).
- (6) Loosen connector nut (10) and remove high tension cable (11).
- (7) Remove grommet (12) and remove high tension cables (9) and (11) from right hand shroud (4).
- (8) Remove wiring harness clips (13) from right hand shroud (4).
- (9) Tag and disconnect wiring from starter solenoid (14) and automatic choke solenoid (15).
- (10) Remove six assembled screws and washers (16) and remove right hand shroud (4).
- (11) Loosen connector nut (17) and remove high tension cable (18).
- (12) Loosen connector nut (19) and remove high tension cable (20).
- (13) Remove grommet (21) and remove high tension cables (18) and (20) from left hand shroud (22).
- (14) Remove connectors (23) and (24) from left hand shroud (22).
- (15) Remove wiring harness clips (13) from left hand shroud (22).
- (16) Remove four assembled screws and washers (25) and remove left hand shroud (22).
- (17) Remove spring (26) and remove right hand cylinder baffle (27).
- (18) Remove spring (28) and remove right hand cylinder baffle (29).
- (19) Remove spring (30) and remove left hand cylinder baffle (31).
- (20) Remove spring (32) and remove left hand cylinder baffle (33).
- (21) Inspect all items and replace damaged or missing items.



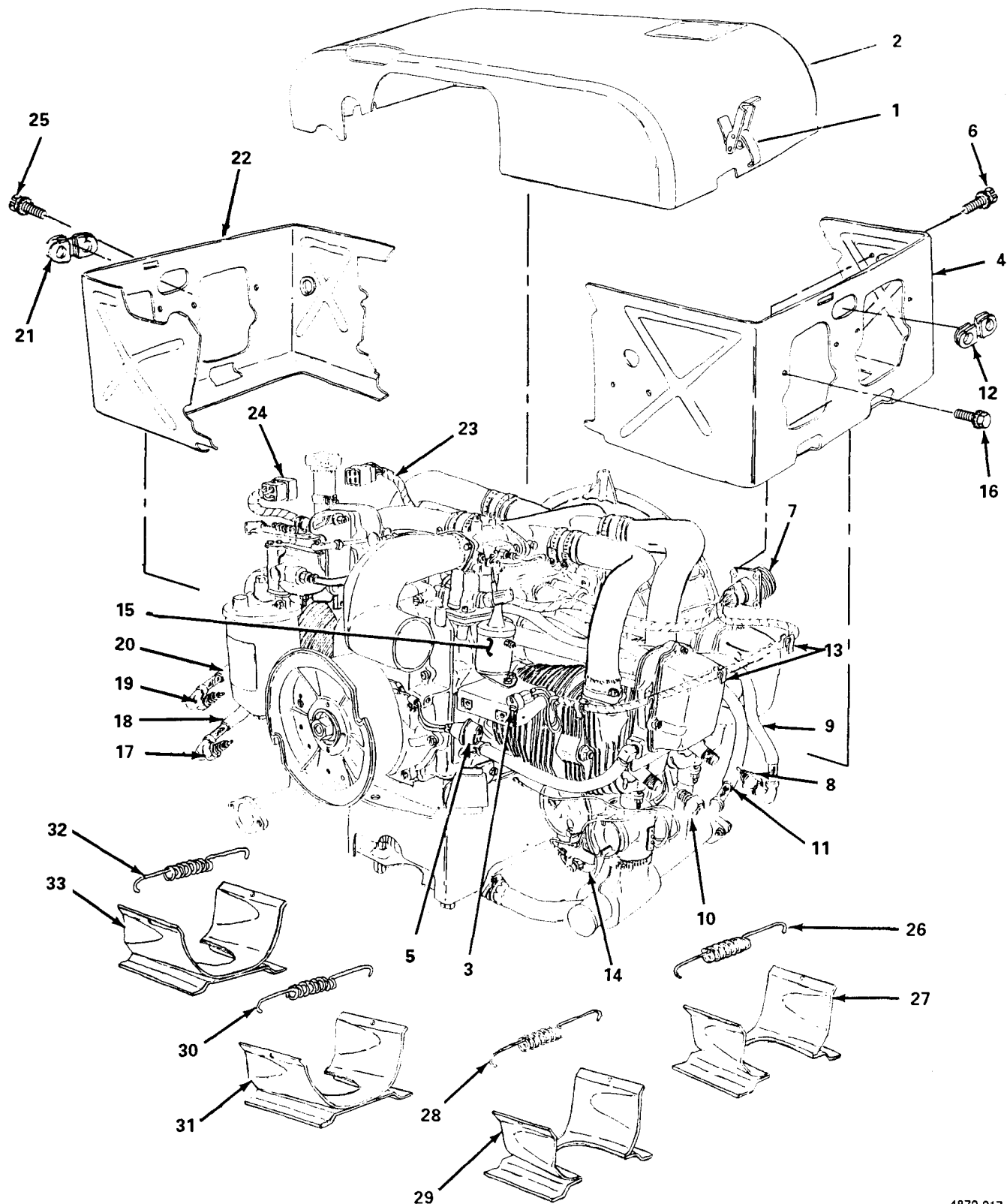
4870-017

Figure 4-11. Top Cover, Right and Left Shrouds and Cylinder Baffles, Removal.

4-21. **Top Cover, Right and Left Shrouds and Cylinder Baffles (cont).**

b. Installation. (figure 4-12)

- (1) Install left cylinder baffle (33) and secure with spring (32).
- (2) Install left cylinder baffle (31) and secure with spring (30).
- (3) Install right hand cylinder baffle (29) and secure with spring (28).
- (4) Install right hand cylinder baffle (27) and secure with spring (26).
- (5) Install left hand shroud (22) and secure with four assembled screws and washers (25).
- (6) Install wiring harness clips (13) on left hand shroud (22).
- (7) Install connectors (23) and (24) in left hand shroud (22).
- (8) Install high tension cables (20) and (18) and grommet (21) in left hand shroud (22).
- (9) Install high tension cable (20) and tighten connector nut (19).
- (10) Install spark plug cable (18) and tighten connector nut (17).
- (11) Install right hand shroud (4) and secure with six assembled screws and washers (16).
- (12) Install wiring harness clips (13) on right hand shroud (4).
- (13) Install high tension cables (11) and (9) and grommet (12) in right hand shroud (4).
- (14) Install high tension cable (11) and tighten connector nut (10).
- (15) Install high tension cable (9) and tighten connector nut (8).
- (16) Install connector (7) and secure with four screws (6).
- (17) Install alternator connector (5) in right hand shroud (4).
- (18) Connect wiring harness connector (3) in right hand shroud (4).
- (19) Connect wiring, as tagged to starter solenoid (14) and automatic choke solenoid (15).
- (20) Install top cover (2) and secure with two clips (1).



4870-017

Figure 4-12. Top Cover, Right and Left Shrouds and Cylinder Baffles, Installation.

This task covers: a. Removal b. Installation

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Top cover removed (para. 4-21).

a. Removal. (figure 4-13)

- (1) Tag and remove lead from choke solenoid (1).
- (2) Tag and remove leads from starter solenoid (2).
- (3) Remove two nuts (3), lockwashers (4), flat washers (5) and screws (6) and remove starter (2).
- (4) Loosen clamp (7) and remove hose (8) from air cleaner (9).

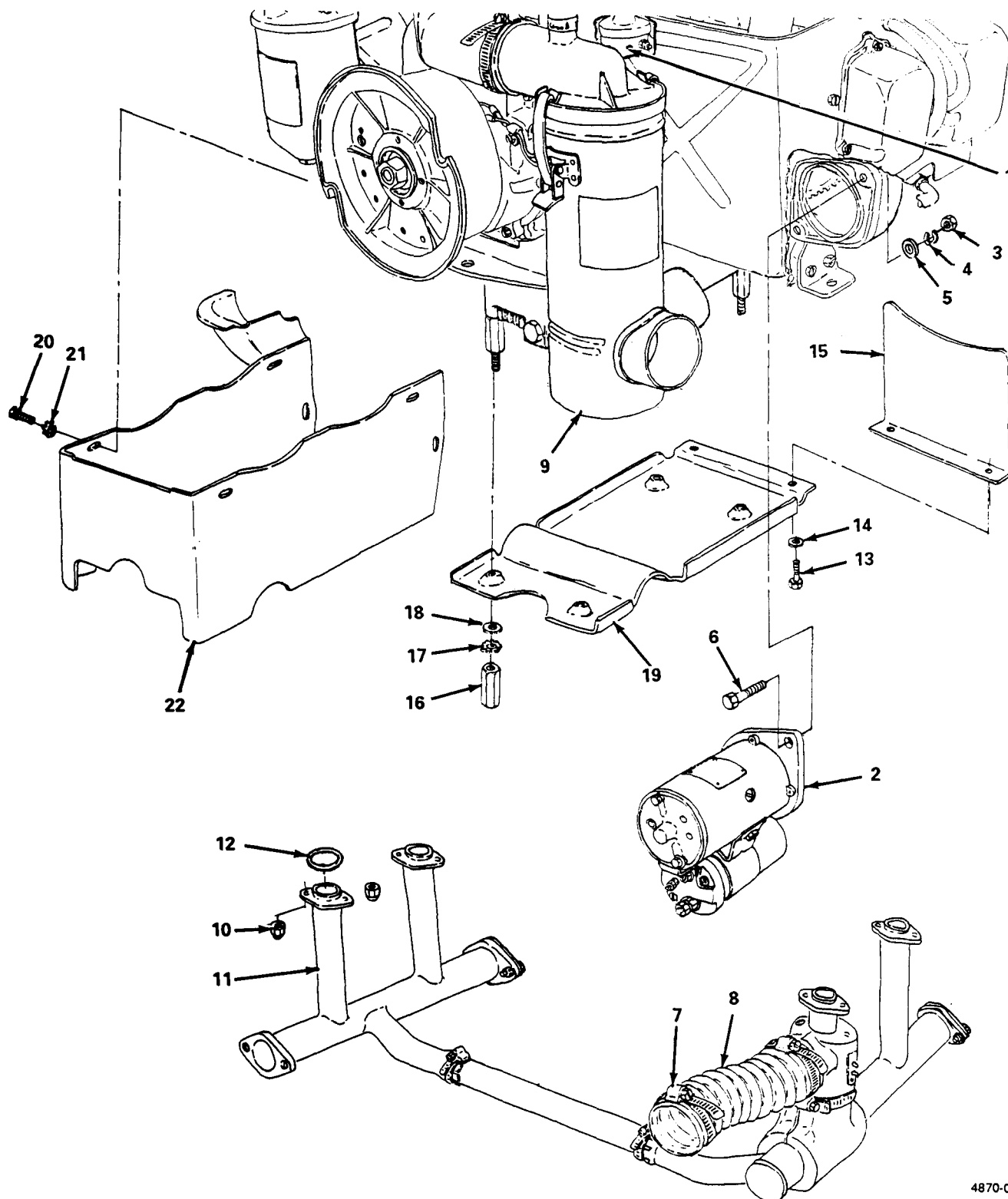
NOTE

Some engines are not equipped with seats.

- (5) Remove eight nuts (10) and remove exhaust manifold (11) and seats (12).
- (6) Remove two screws (13) and washers (14) and remove baffle plate (15).
- (7) Remove four posts (16), lockwashers (17), and flat washers (18) and remove oil pan cover (19).
- (8) Remove six screws (20) and washers (21) and remove oil pan shroud (22).

b Installation. (figure 4-13)

- (1) Install oil pan shroud (22) and secure with six screws (20) and washers (21).
- (2) Install oil pan cover (19) and secure with four posts (16), lockwashers (17) and flat washers (18).
- (3) Install baffle plate (15) and secure with two screws (13) and washer (14).
- (4) Install exhaust manifold (11) and seats (12) and secure with eight nuts (10).
- (5) Install hose (8) and tighten clamp (7).
- (6) Install starter (2) and secure with two screws (6), flat washers (5), lockwashers (4), and nuts (3).
- (7) Connect leads to starter solenoid (2) as tagged.
- (8) Connect lead to choke solenoid (1) as tagged.



4870-019

Figure 4-13. Oil Pan Cover, Shroud and Baffle Plate, Removal and Installation.

4-23. Oil Pan Baffle, Control Rod, Positioner and Front Engine Mount.

This task covers:	a. Removal	c. Installation (Front Engine Mount)
	b. Removal (Front Engine Mount)	d. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Oil pan cover and baffle plate removed (para. 4-22).

a. Removal. (figure 4-14)

- (1) Remove two screws (1) and washers (2) and remove oil pan shield (3).
- (2) Remove retaining ring (4) and remove baffle control rod (5).
- (3) Remove three assembled screws and washers (6) and remove baffle control rod positioner (7) and engine mount (8).

b. Removal (Front Engine Mount. (figure 4-14)

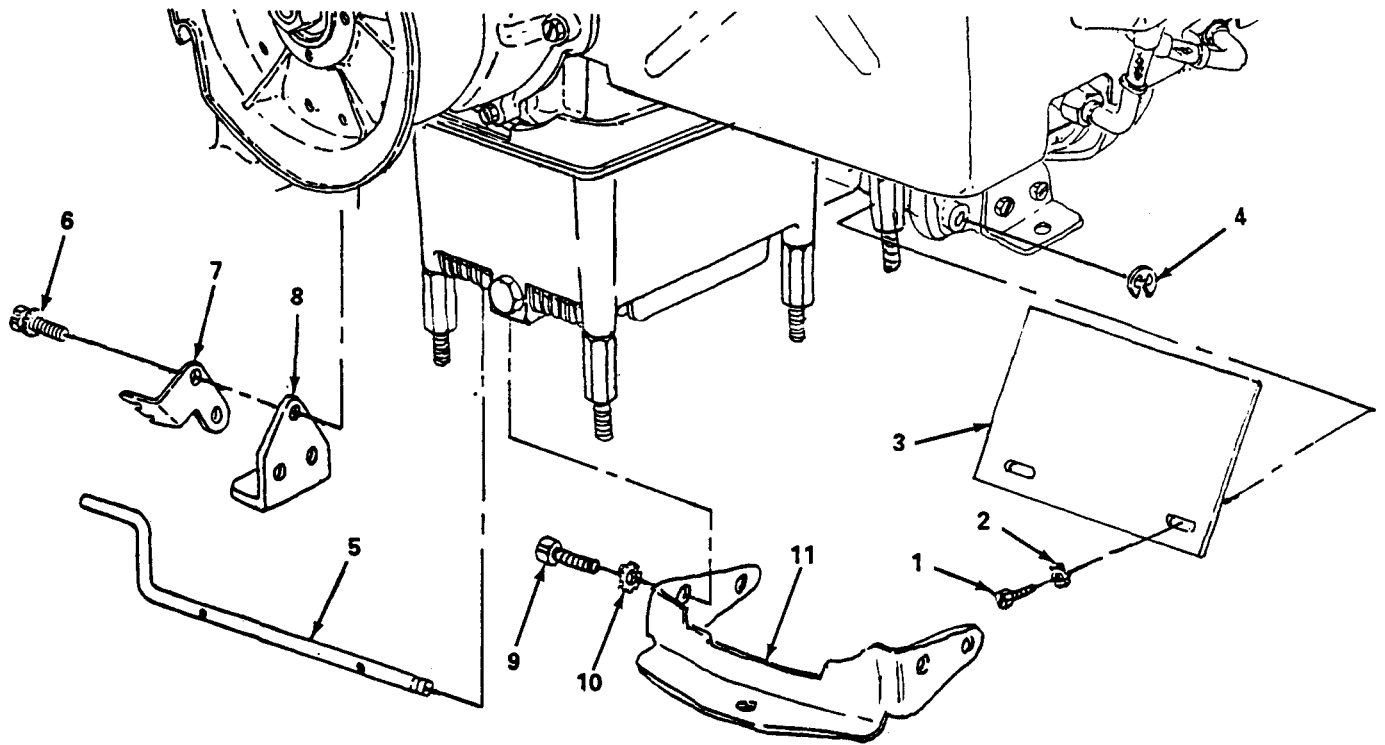
Remove four screws (9) and lockwashers (10) and remove front engine mount (11).

c. Installation (Front Engine Mount. (figure 4-14)

Install front engine mount (11) and secure with four screws (9) and lockwashers (10).

d. Installation. (figure 4-14)

- (1) Install engine mount (8) and baffle control rod positioner (7) and secure with three assembled screws and washers (6).
- (2) Install baffle control rod (5) and install retaining ring (4).
- (3) Install oil pan shield (3) and secure with two screws (1) and washers (2).



4870-020

Figure 4-14. Oil Pan Baffle Control Rod, Positioner and Front Engine Mount, Removal and Installation.

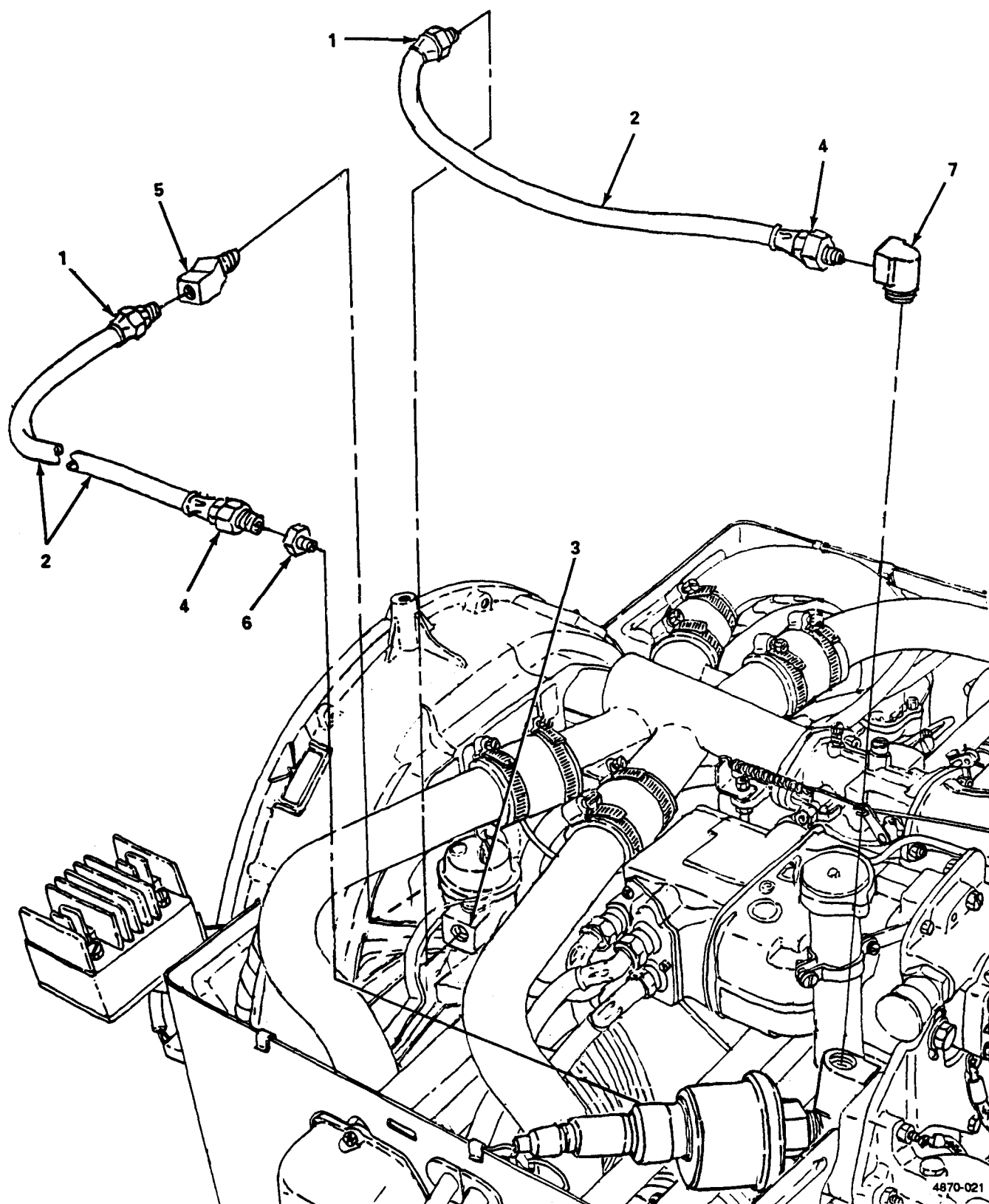


Figure 4-15. Oil Lines and Fittings, Removal and Installation.

This task covers: a. Removal b. Installation

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Top cover and left and right shrouds removed (para. 4-21).

NOTE

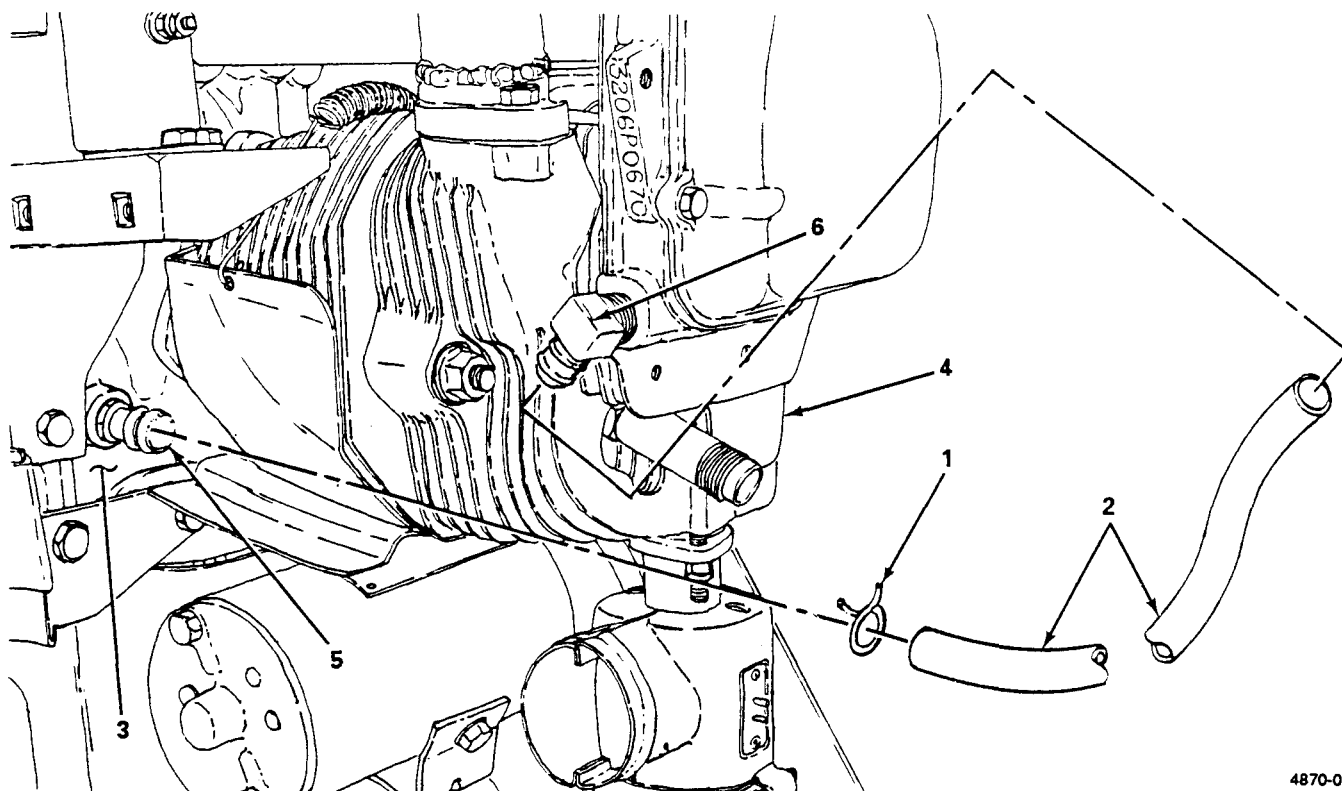
The removal and installation procedures are the same for all rocker box hoses.

a. Removal. (figure 4-16)

- (1) Remove clamp (1) and remove hose (2) from crankcase (3).
- (2) Remove hose (2) from cylinder head (4).
- (3) Remove fittings (5) and (6).
- (4) Inspect hose (2) and replace if torn or otherwise damaged.
- (5) Inspect fittings (5) and (6) and replace if damaged.
- (6) Remove all obstructions from hose (2).

b. Installation. (figure 4-16)

- (1) Install fittings (5) and (6).
- (2) Connect hose (2) to cylinder head (4).
- (3) Install hose (2) on crankcase (3) and secure with clamp (1).



4870-010

Figure 4-16. Rocker Box Hose and Fittings, Removal and Installation.

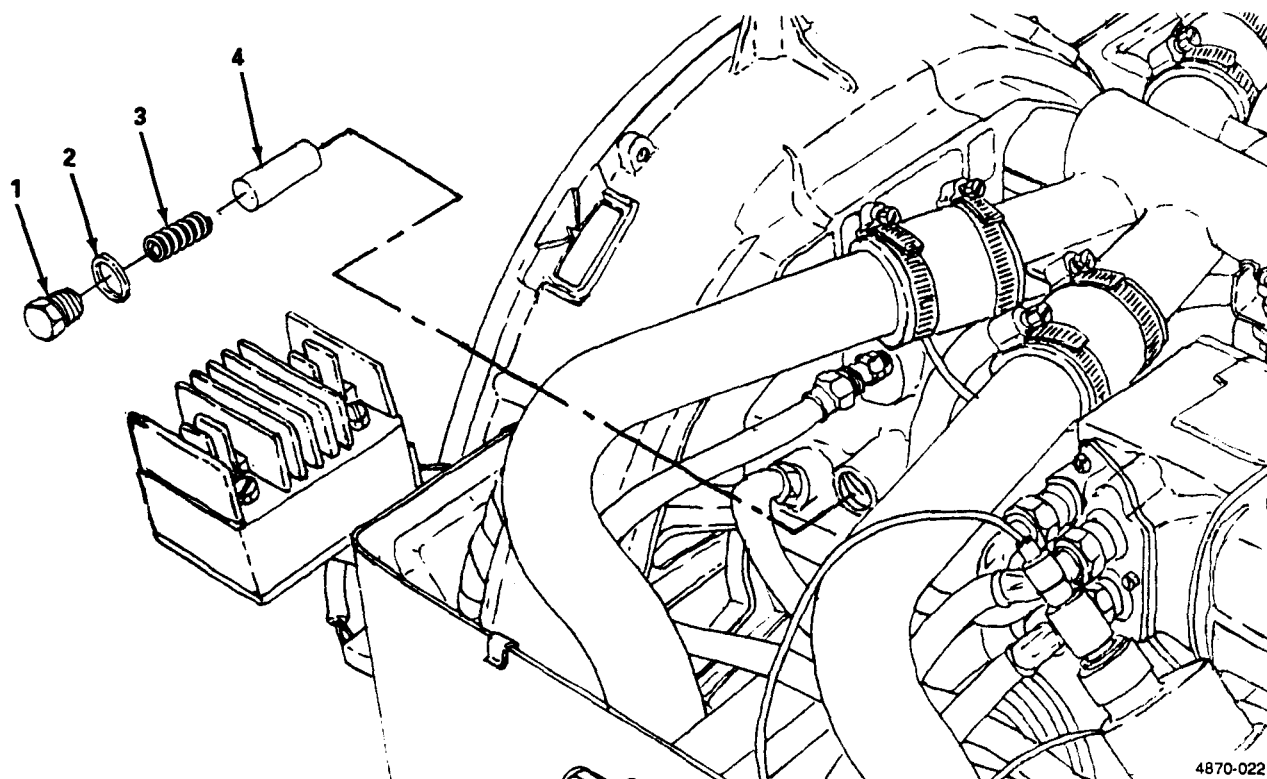


Figure 4-17. Pressure Regulator Valve, Removal and installation.

This task covers: a. Removal b. Installation

Tools

Equipment Condition

Top cover removed (para. 4-21).

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 4-18)

NOTE

It maybe necessary to loosen magneto mounting bolts to remove crankcase breather.

- (1) Using crows foot socket, remove crankcase breather (1).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.–138°F. (38°C.–60°C.).

-
- (2) Clean crankcase breather (1) with drycleaning solvent, and dry thoroughly.
- (3) Ensure there are no obstructions in crankcase breather, and replace if necessary.

b. Installation. (figure 4-18)

Install crankcase breather (1).

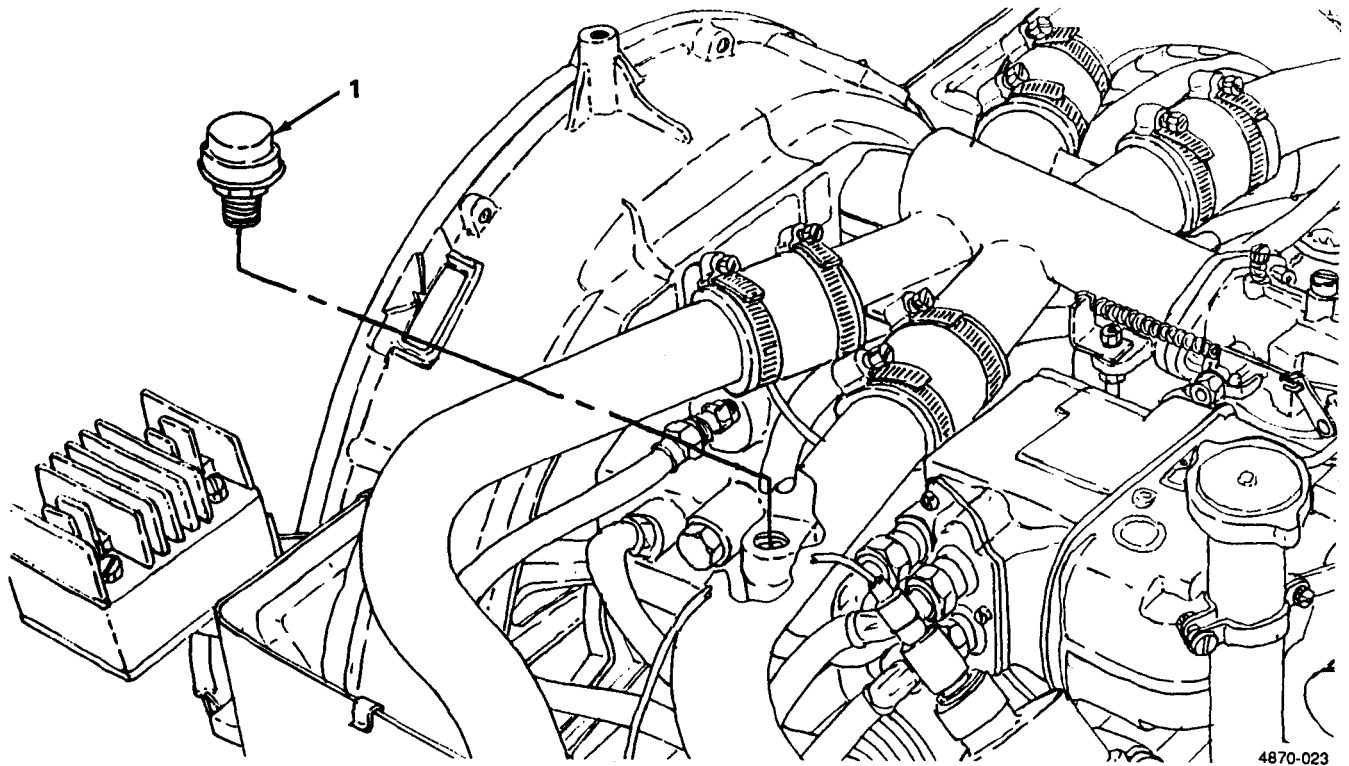


Figure 4-18. Crankcase Breather, Removal and Installation.

4-28. Low Oil Pressure Shutdown Switch and "T" Connector.

This task covers: a. Removal b. Installation c. Test

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)
Multimeter (NSN 6625-01-139-2512)
(Item 2, Appendix B)

Top cover removed (para. 4-21).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 4-19)

- (1) Tag and remove wiring from low oil pressure shutdown switch (1).
- (2) Remove switch (1).
- (3) Loosen fitting nut (2) and remove oil line (3).
- (4) Remove "T" connector (4).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-1 38°F. (38°C.-60°C.).

- (5) Clean switch (1) and "T" connector (4) with drycleaning solvent, and dry thoroughly.
- (6) Inspect switch (1) and replace if damaged.
- (7) Inspect "T" connector (4) and replace if damaged.

b. Installation. (figure 4-19)

- (1) Install "T" connector (4).
- (2) Install oil line (3) and tighten fitting nut (2).
- (3) Install switch (1).
- (4) Connect wiring, as tagged, to switch (1).

c. Test

- (1) Check for 0 ohms between N.C. contact and case.
- (2) Check for open circuit between N.O. contact and case.
- (3) Replace a shutdown switch that does not meet above specifications.

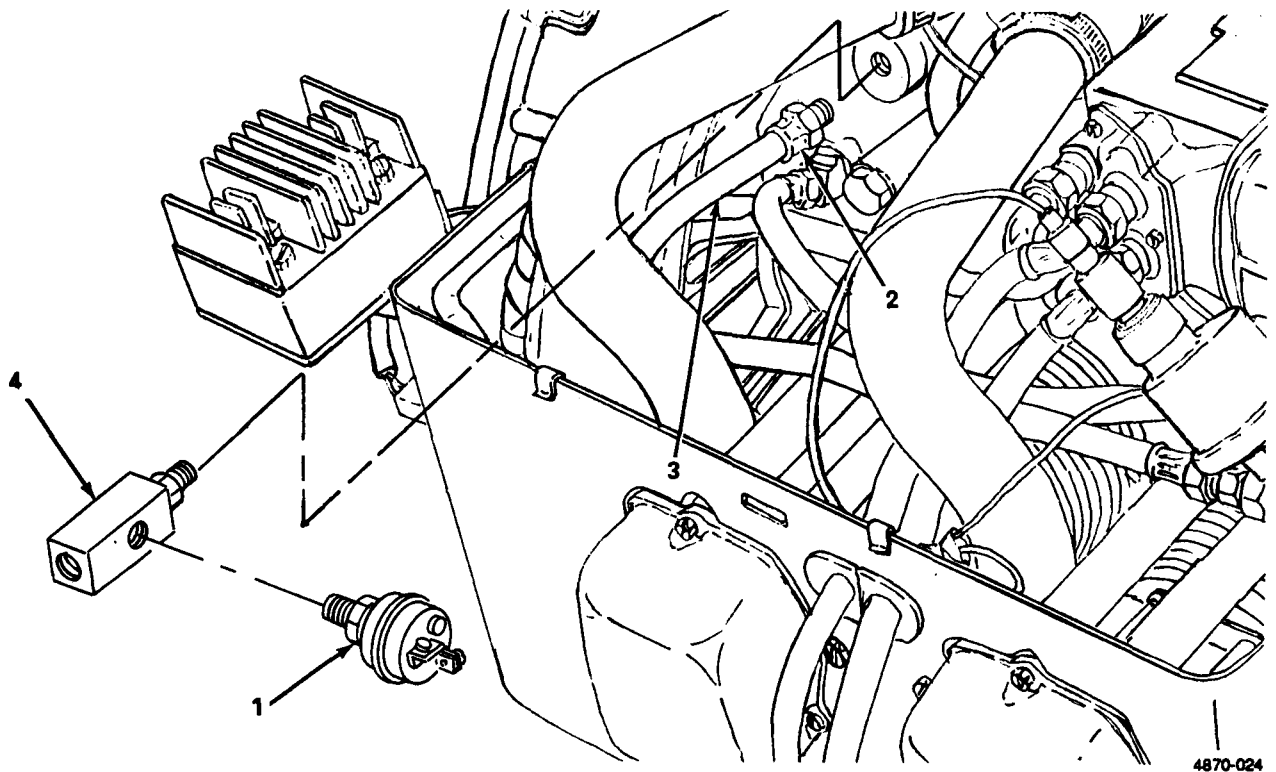


Figure 4-19. Low Oil Pressure Shutdown Switch and T Connector, Removal and Installation.

4-29. Oil Pressure Transmitter.

This task covers: a. Removal b. Installation c. Test

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B) Multimeter (NSN 6625-01-139-2512) (Item 2, Appendix B)	Top cover removed (para. 4-21).

- a. Removal. (figure 4-20)
- (1) Tag and remove wiring from oil pressure transmitter (1).
 - (2) Remove oil pressure transmitter (1).
- b. Installation. (figure 4-20)
- (1) Install oil pressure transmitter (1).
 - (2) Connect wiring as tagged.
- c. Test.
- (1) Check for less than 1 ohm resistance between contact and case.
 - (2) Replace an oil pressure transmitter that does not meet above specification.

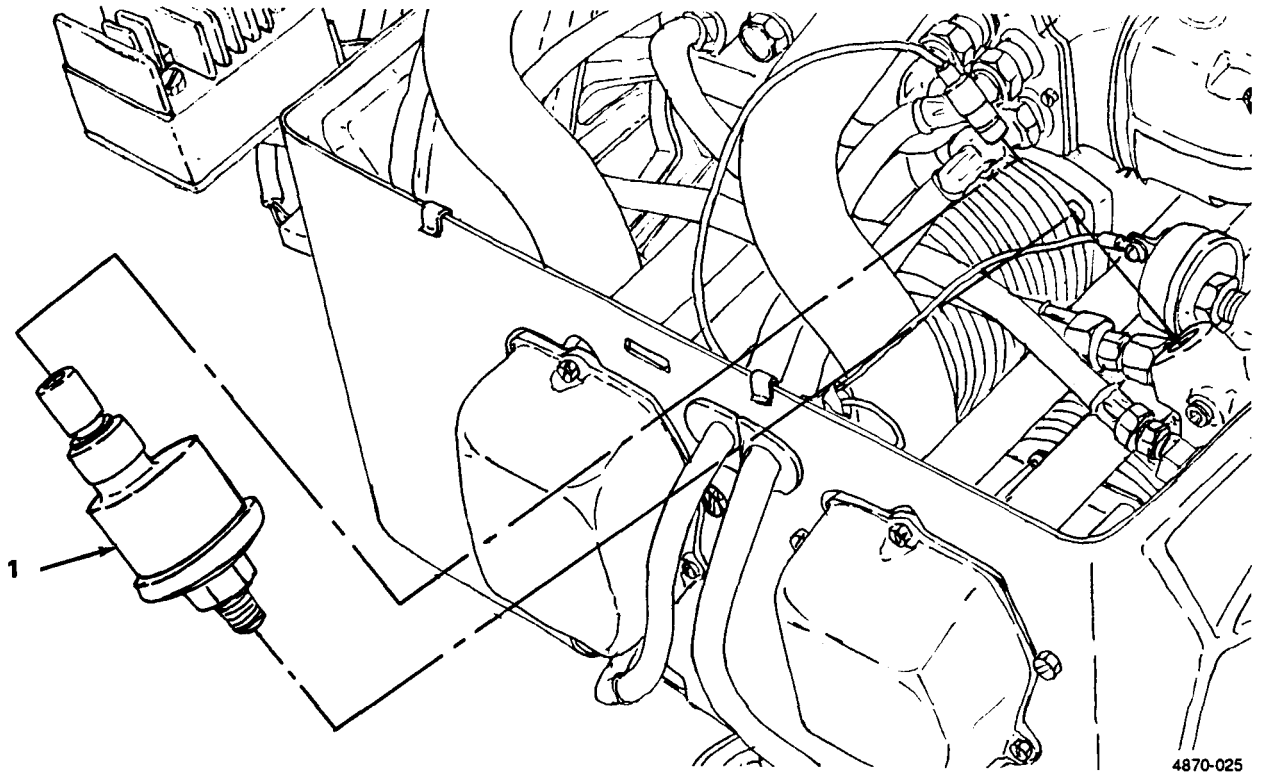


Figure 4-20. Oil Pressure Transmitter, Removal and Installation.

4-30. **Choke Solenoid and Bracket**

This task covers:	a. Adjustment	c. Removal	e. Installation (Bracket)
	b. Test	d. Removal (Bracket	f. Installation

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B) Multimeter (NSN 6625-01-139-2512) (Item 2, Appendix B)	Right hand shroud removed for bracket removal (para. 4-21).

a. Adjustment. (figure 4-21)

- (1) Loosen screw (1).
- (2) Place manual choke lever (2) in the full open position.
- (3) Place choke lever (3) in the horizontal position, and tighten screw (1).

b. Test.

- (1) Check for 8 ± 2 ohms of resistance between contact and case.
- (2) Replace a choke solenoid that does not meet the above specification.

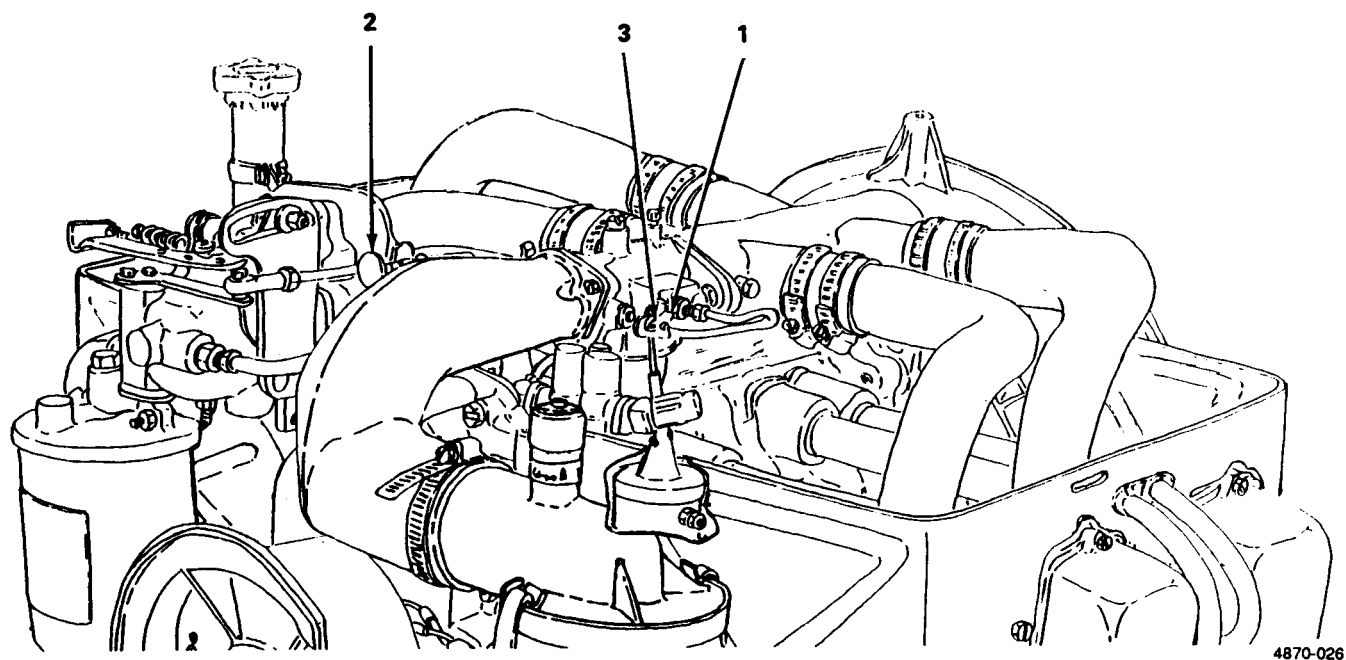


Figure 4-21. Choke Solenoid and Bracket, Adjustment.

4-30. **Choke Solenoid and Bracket (cont).**

c. Removal (figure 4-22)

- (1) Loosen screw (1) and remove choke lever (2) from choke shaft (3).
- (2) Tag and remove electrical lead from solenoid (4).
- (3) Remove two captive screws and washers (5) and remove solenoid (4).

NOTE

Perform step 4 only if solenoid is being replaced.

- (4) Remove cotter pin (6) and remove choke lever (2) from solenoid (4).

d. Removal (Bracket) (figure 4-22).

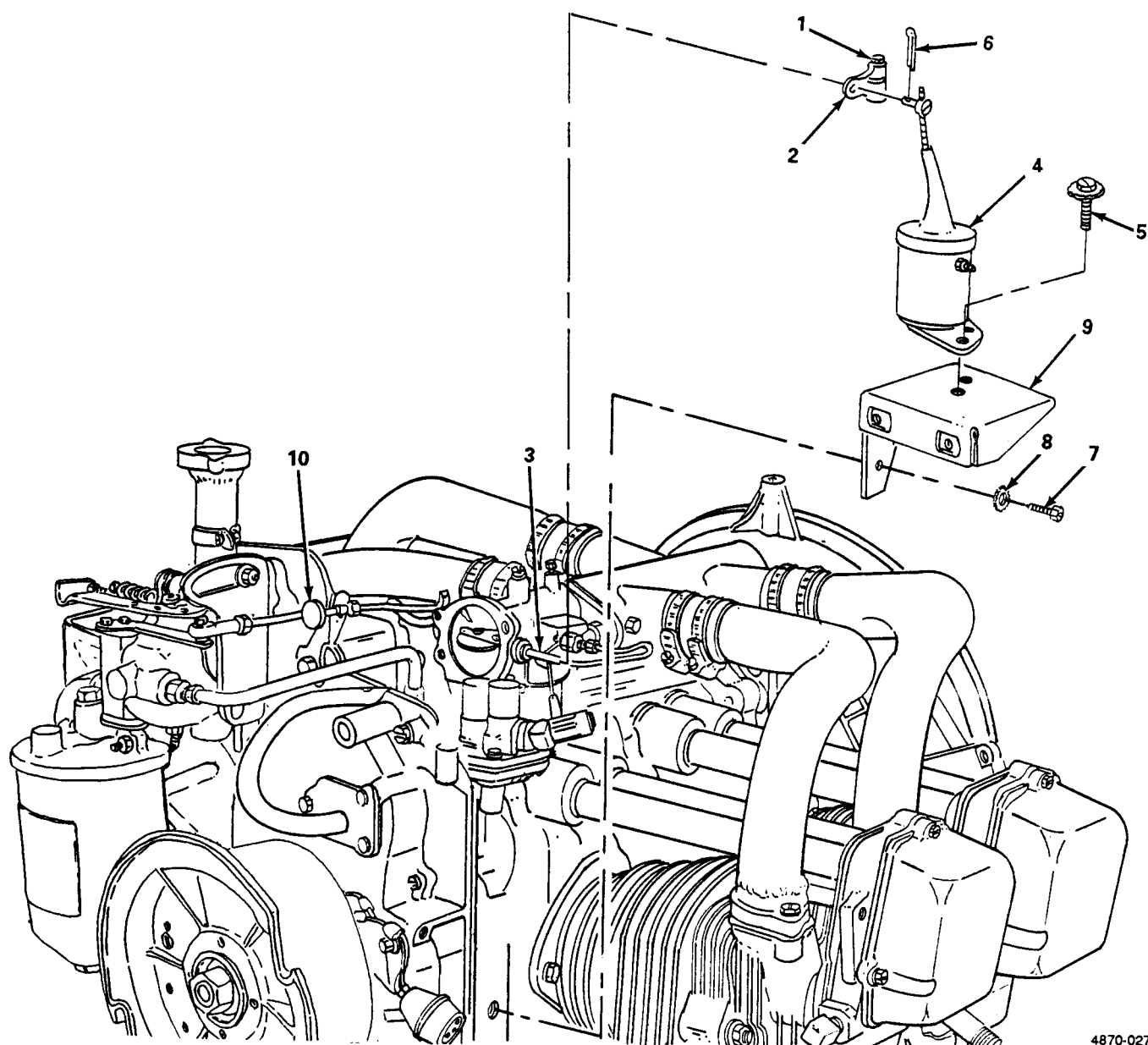
Remove screw (7) and lockwasher (8) and remove bracket (9).

e. Installation (Bracket) (figure 4-22).

Install bracket (9) and secure with screw (7) and lockwasher (8).

f. Installation (figure 4-22)

- (1) Install choke lever (2) on solenoid (4) and secure with cotter pin (6).
- (2) Install solenoid (4) and secure with two assembled screws and washers (5).
- (3) Connect lead to solenoid (4) as tagged.
- (4) Install choke lever (3) on choke shaft (2).
- (5) Move manual choke lever (10) to full open position.
- (6) Place choke lever (2) in horizontal position, and tighten screw (1).



4870-027

Figure 4-22. Choke Solenoid and Bracket, Removal and Installation.

4-31. Preheater.

This task covers: a. Removal b. Test c. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)
Multimeter (NSN 6625-01-139-2512)
(Item 2, Appendix B)

Top cover removed (para. 4-21).

a. Removal. (figure 4-23)

CAUTION

Electrical leads are permanently attached to thermostatic switch.

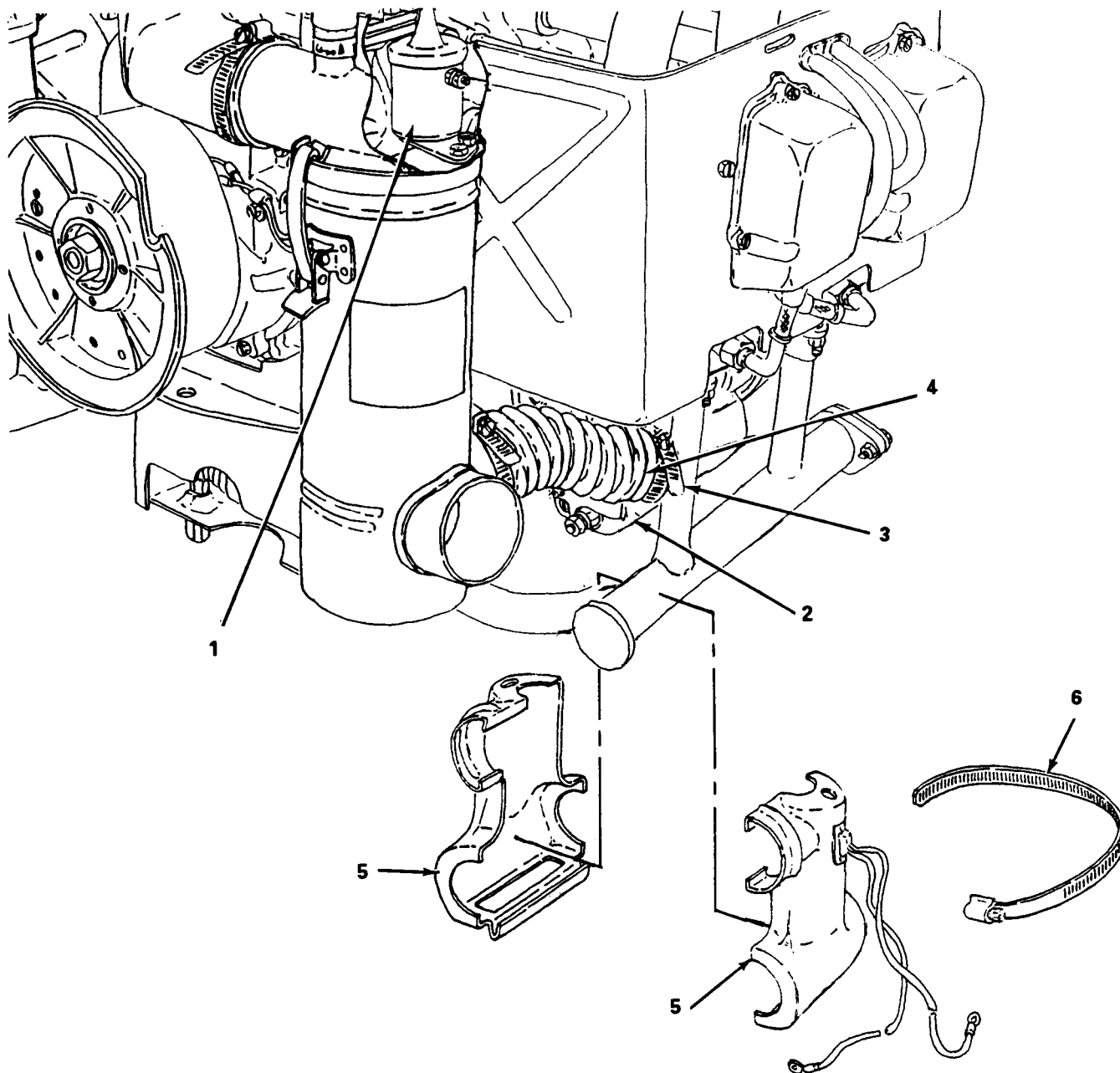
- (1) Tag and remove preheater lead from choke solenoid (1).
- (2) Tag and remove preheater lead from starter (2).
- (3) Loosen clamp (3) and remove hose (4) from preheater (5).
- (4) Remove clamp (6) and remove preheater (5).
- (5) Inspect both halves of preheater (5) and replace items as necessary.

b. Test.

- (1) Connect one lead of multimeter to one lead of preheater.
- (2) Set multimeter for checking continuity and connect second lead of multimeter to remaining lead of preheater.
- (3) If continuity is not present, replace preheater.

c. Installation. (figure 4-23)

- (1) Install preheater (5) and secure with clamp (6).
- (2) Connect preheater lead to starter (2) as tagged.
- (3) Connect preheater lead to choke solenoid (1) as tagged.
- (4) Install hose (4) on preheater (5) and secure with clamp (3).



4870-028

Figure 4-23. Preheater, Removal and Installation.

4-32. Magneto and Gear.

This task covers:	a. Removal	c. Installation (Gear)
	b. Removal (Gear)	d. Installation

INITIAL SETUP

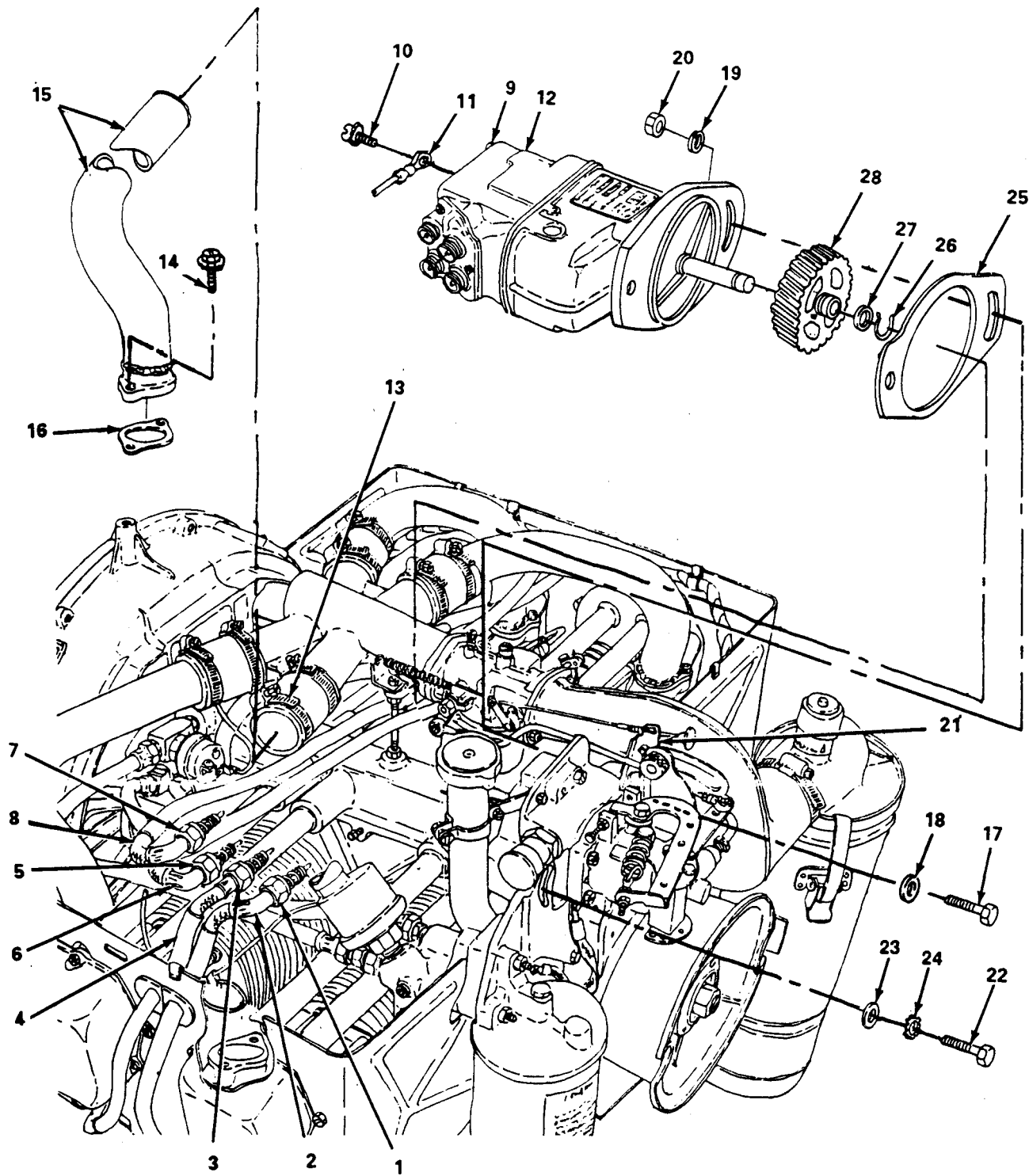
<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Top cover removed (para. 4-21). Governor removed (para. 4-43).
<i>Materials/Parts</i>	
Gasket, Magneto Mounting (NSN TBD)	
Gasket, Intake Manifold (NSN TBD)	

a. Removal. (figure 4-24)

- (1) Loosen connector nut (1) and tag and remove high tension cable (2).
- (2) Loosen connector nut (3) and tag and remove high tension cable (4).
- (3) Loosen connector nut (5) and tag and remove high tension cable (6).
- (4) Loosen connector nut (7) and tag and remove high tension cable (8).
- (5) Loosen screw (9).
- (6) Remove assembled screw and washer (10) and tag and remove lead (11) from magneto (12).
- (7) Loosen clamp (13).
- (8) Remove two assembled screws and washers (14) and remove intake manifold elbow (15) and gasket (16).
- (9) Remove bolt (17), washer (18), lockwasher (19) and nut (20) and move manual choke bracket (21) out of way.
- (10) Remove screw (22), washer (23) and lockwasher (24). Remove magneto (12) and gasket (25),

b. Removal (Gear). (figure 4-24)

- (1) Remove retaining ring (26) and washer (27) and remove gear (28).
- (2) Inspect gear (28) and replace if damaged.



4870-029

Figure 4-24. Magneto and Gear, Removal.

4-32. **Magneto and Gear (cont).**

c. Installation (Gear). (figure 4-25)

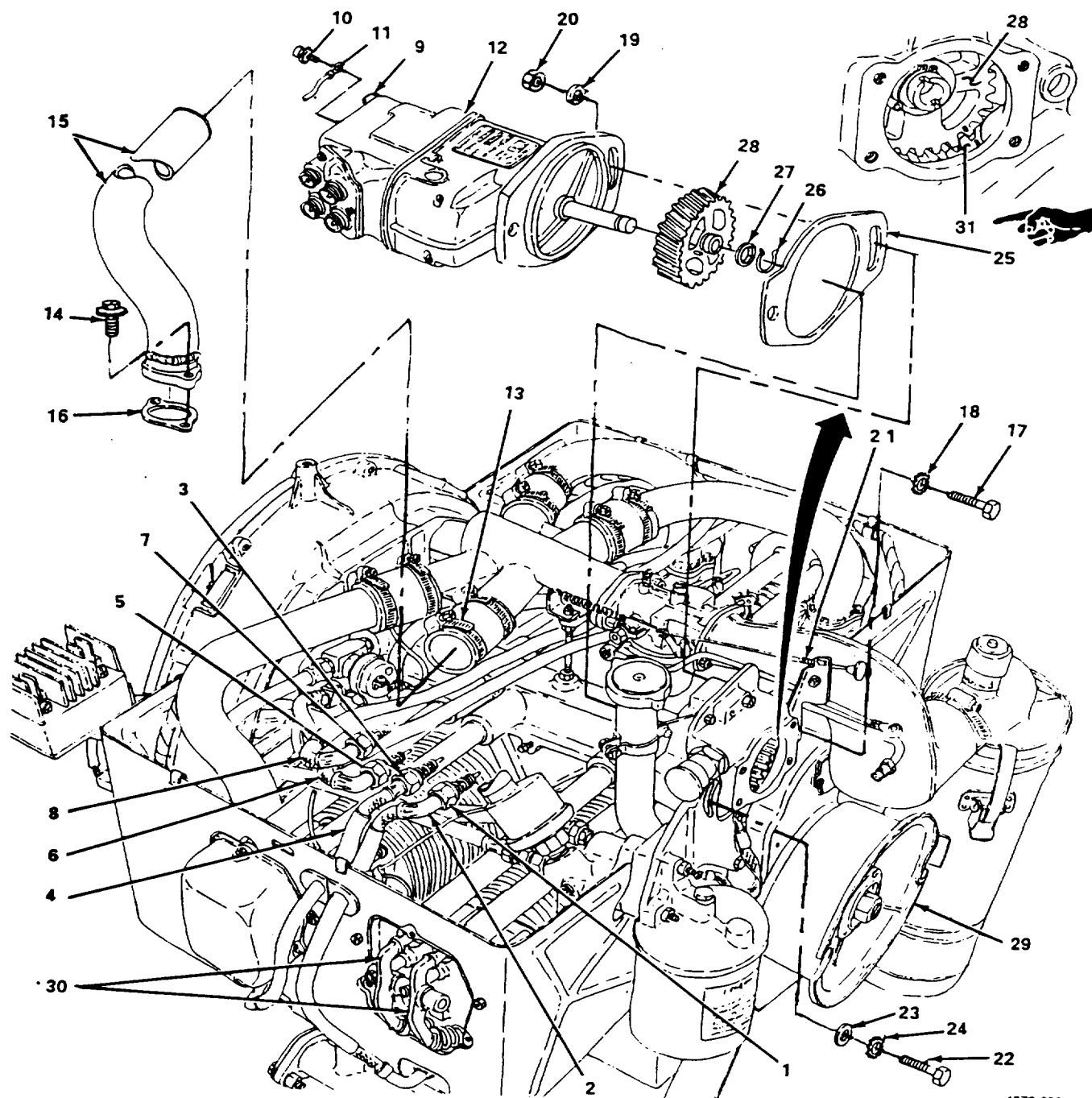
Install gear (28) and secure with washer (27) and retaining ring (26).

NOTE

Before installing magneto rotate magneto gear clockwise until spark is obtained from number one part of magneto housing.

d. Installation. (figure 4-25)

- (1) Rotate starter rope pulley (29) until both rockers on number one (1) cylinder (30) dose, and stop when timing mark on camshaft gear (31) is present.
- (2) Hold end of high tension wire from number one (1) terminal of magneto (12) 1/8 inch from magneto case. Turn magneto gear clockwise until magneto impulses and spark occurs. Turn magneto gear (28) counter clockwise until magneto gear (28) timing mark and camshaft gear (32) timing mark are aligned. Install magneto (12) and gasket (29) (3)Install screw (22), washer (23), and lockwasher (24).
- (4) Position manual choke bracket (21) and secure manual choke bracket (21) and magneto (12) with bolt (17), washer (18), lockwasher (19) and nut (20).
- (5) Install lead (11) as tagged and secure with assembled screw and washer (10).
- (6) Position lead (11) on magneto (12) and tighten screw (9).
- (7) Install intake manifold elbow (15), and gasket (16) and secure with two assembled screws and washers (14).
- (8) Tighten damp (13).
- (9) Install high tension cable (8) as tagged, and tighten connector nut (7).
- (10) Install high tension cable (6) as tagged, and tighten connector nut (5).
- (11) Install high tension cable (4) as tagged, and tighten connector nut (3).
- (12) Install high tension cable (2) as tagged, and tighten connector nut (1).



4A70-030

Figure 4-25. Magneto and Gear, Installation.

4-33. Ignition Timing.

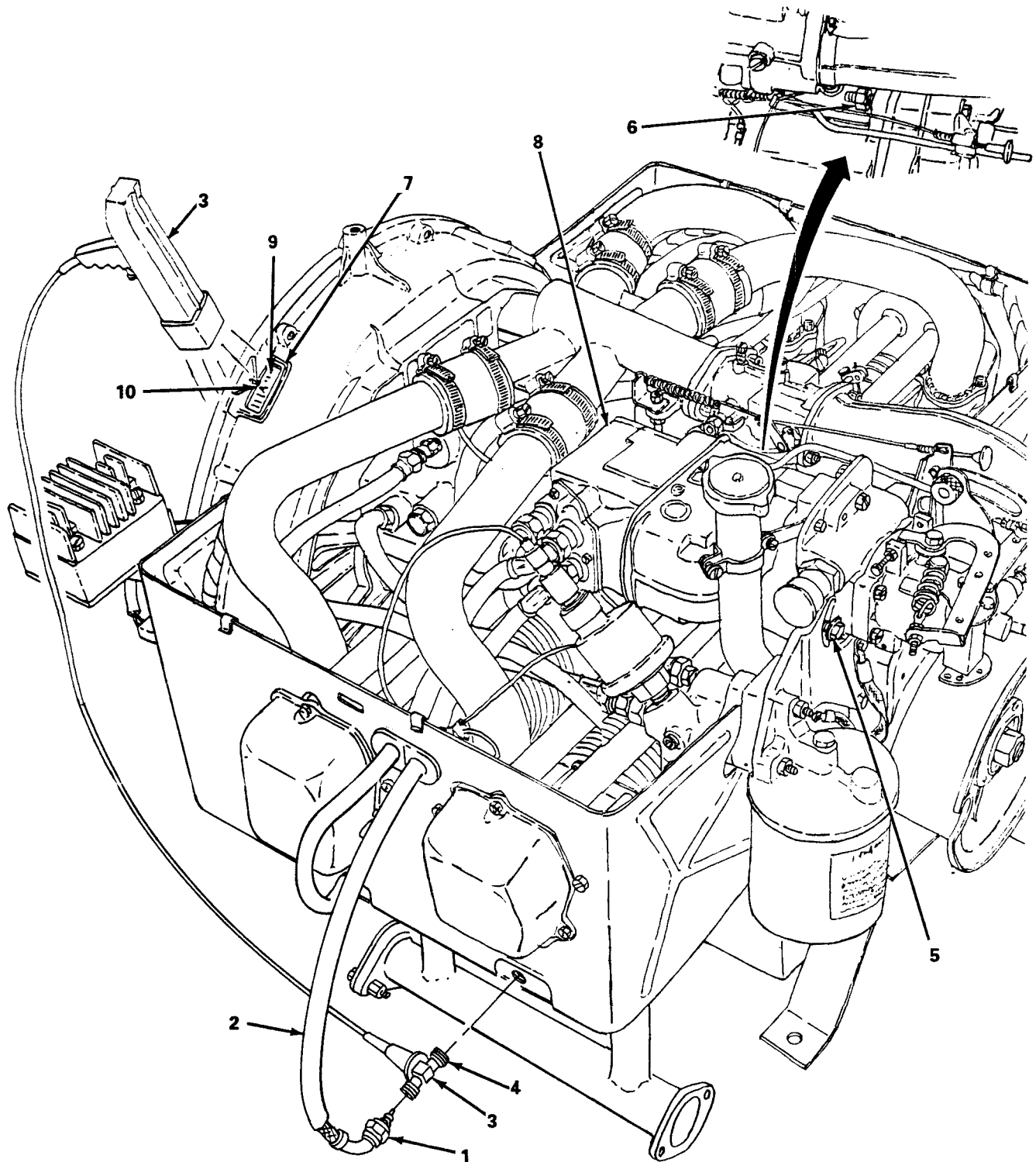
This task covers: Adjustment

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B) Light, Timing (NSN 4910-00-937-5724)	Governor adjusted (para. 4-44). Top cover removed (para. 4-21).

Adjustment. (figure 4-26)

- (1) Loosen connector nut (1) and disconnect high tension cable (2).
- (2) Connect timing light (3) to high tension cable (2) and spark plug (4).
- (3) Loosen bolt (5) and nut (6) slightly.
- (4) Start engine (para. 2-9) and run at full governed speed.
- (5) Point timing light (3) at timing hole (7) and adjust magneto (8) until timing mark on flywheel (9) aligns with pointer (10) and tighten bolt (5) and nut (6).
- (6) Stop engine (para. 2-10).
- (7) Disconnect timing light (3) from high tension cable (2) and spark plug (4).
- (8) Install high tension cable (2) on spark plug (4) and tighten connector nut (1).



4870-031

Figure 4-26. Ignition Timing, Adjustment.

4-34. Magneto Contacts and Rotor Button.

This task covers: a. Adjustment b. Removal c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Equipment Condition

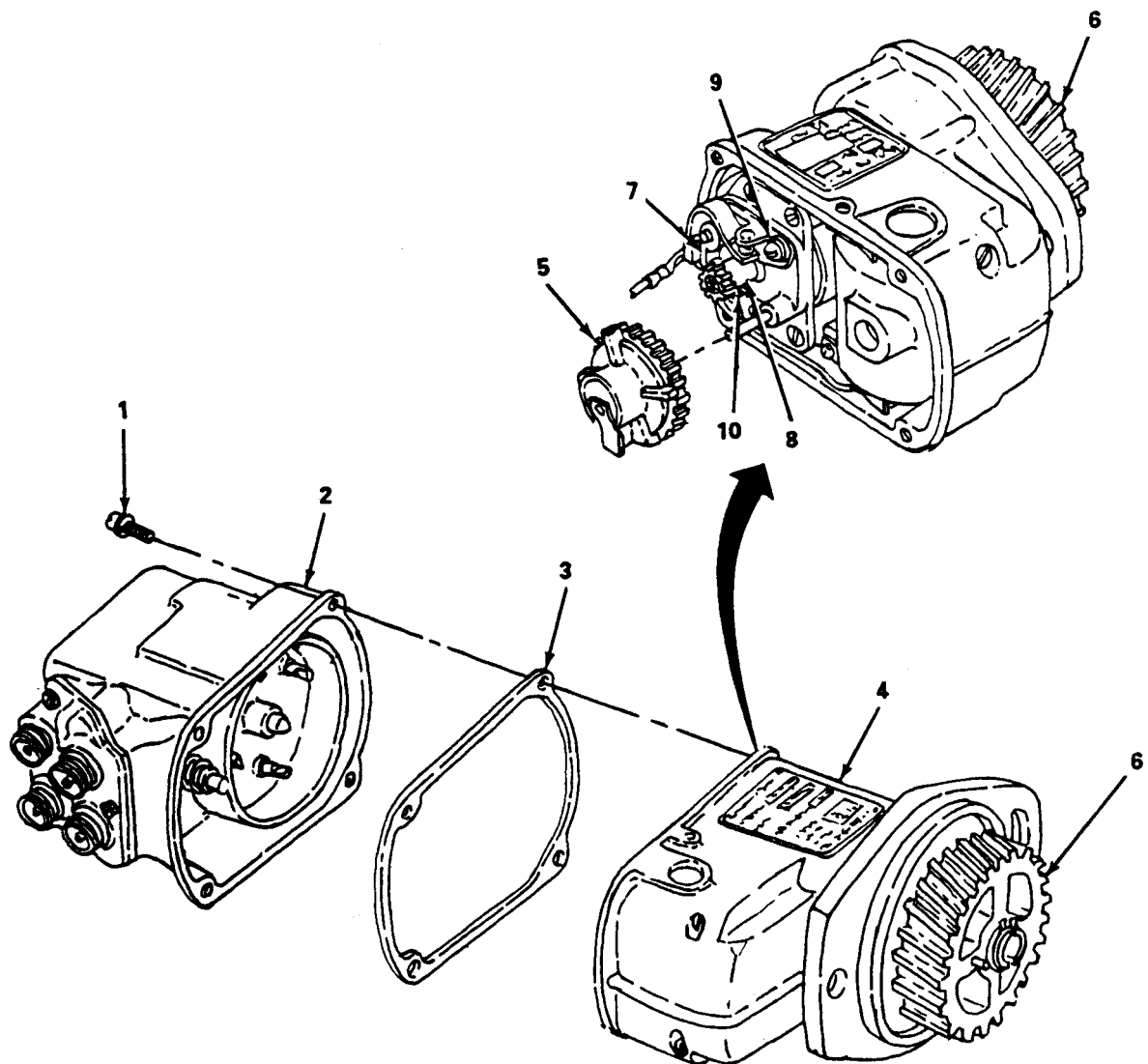
Magneto removed (para. 4-32).

Materials/Parts

Oil, Engine (Item 3, Appendix D)

a. Adjustment. (figure 4-27)

- (1) Remove four assembled screws and washers (1) and separate magneto cover (2) and gasket (3) from body (4).
- (2) Remove rotor button (5).
- (3) Rotate magneto gear (6) until cam follower (7) is on highest part of ignition cam (8).
- (4) Measure contact gap with a 0.015 in. (0.038 cm) feeler gage.
- (5) Loosen screw (9) and adjust gap as necessary, tighten screw (9).
- (6) Recheck gap and repeat steps 3 and 4 as necessary.
- (7) Lubricate cam wick (10) sparingly, with clean engine oil.
- (8) Inspect rotor button (5) and replace if worn, cracked, or otherwise damaged.
- (9) Install rotor button (5).
- (10) Install magneto cover (2) and gasket (3) and secure with four assembled screws and washers (1).



4870-034

Figure 4-27. Magneto Contacts, Adjustment.

4-34. Magneto Contacts (cont).

b. Removal. (figure 4-28)

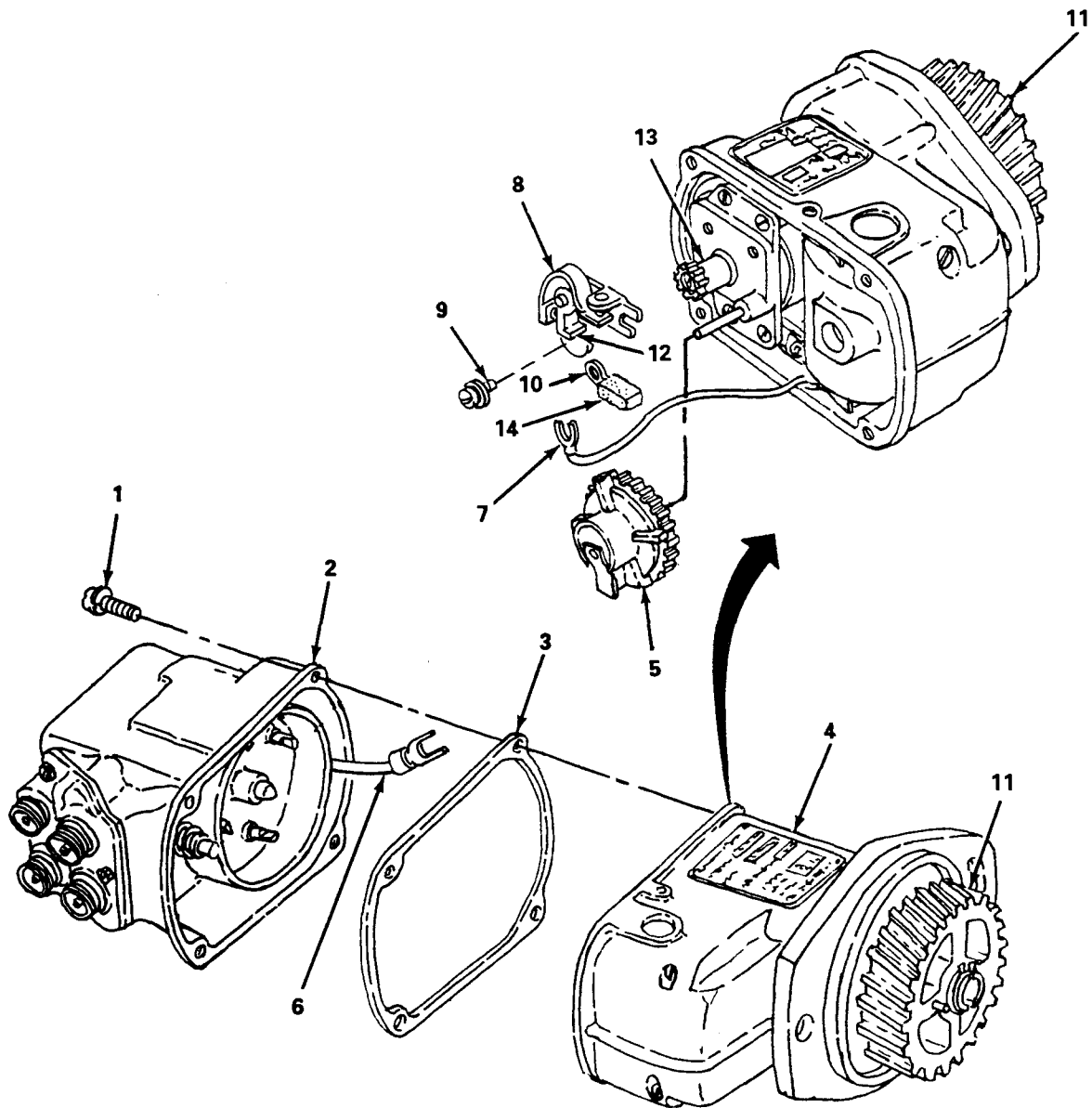
- (1) Remove four assembled screws and washers (1) and separate magneto cover (2) and gasket (3) from body (4).
- (2) Remove rotor button (5).
- (3) Tag and remove capacitor lead (6) and coil lead (7) from magneto contacts (8).
- (4) Remove two assembled screws and washers (9) and remove magneto contacts (8) and cam wick (10).
- (5) Inspect magneto contacts (8) and rotor button (5) and replace if worn, burnt, cracked or otherwise damaged.

c. Installation. (figure 4-28)

NOTE

Cam wick mounts under bottom screw.
Do not fully tighten top screw at this point.

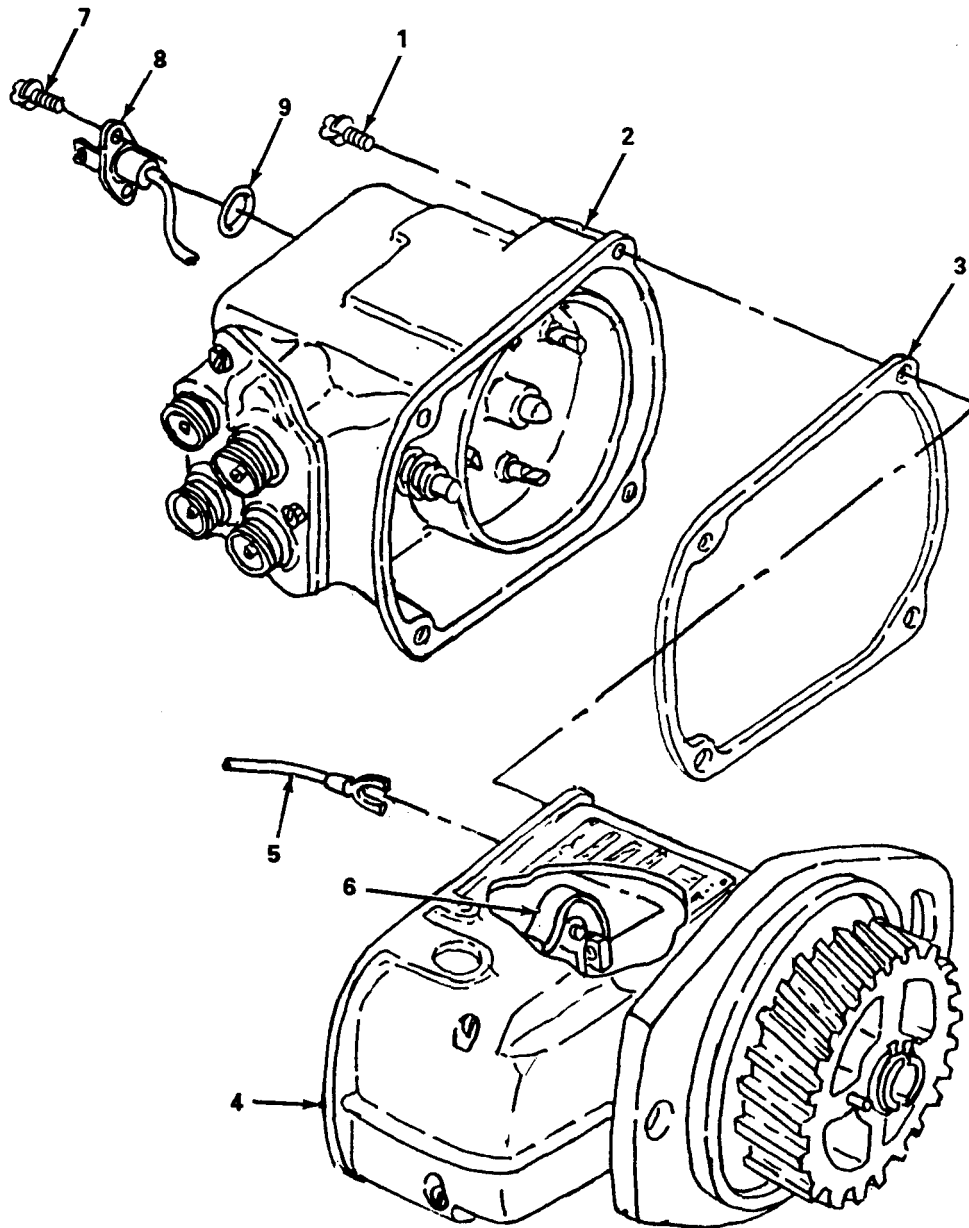
- (1) Install magneto contacts (8) and secure with two assembled screws and washers (9).
- (2) Rotate magneto gear (11) until cam follower (12) is on highest part of magneto cam (13).
- (3) Contact gap should be 0.015 in.-0.019 in. (.038-.048 cm) for Fairbanks Morse and 0.008 in.-0.012 in. (.020-.030 cm) for Slick Aircraft Magneto. Adjust contacts until correct gap is obtained and tighten upper screw (9).
- (4) Recheck gap and repeat step 3 as needed.
- (5) Lubricate cam wick (14) sparingly with clean engine oil
- (6) Connect condenser lead (6) and coil lead (7) to magneto contacts (8).
- (7) Install rotor button (5).
- (8) Install magneto cover (2) and gasket (3) and secure with four assembled screws and washers (1).



4870-035

Figure 4-28. Magneto Contacts and Rotor Button, Removal and Installation.

- 4-64



4870-004

Figure 4-29. Condenser, Removal and Installation.

4-36. High Tension Cables.

This task covers:	a. Removal	b. Test	c. Installation
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INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)
Multimeter (NSN 6625-01-139-2512)
(Item 3, Appendix B)

Top cover removed (para. 4-21).

a. Removal. (figure 4-30)

NOTE

The removal and installation procedures are the same for all high tension cables.

- (1) Loosen connector nut (1) and tag and remove high tension cable (2).
- (2) Loosen connector nut (3) and remove high tension cable (2).
- (3) Remove grommet (4) and remove high tension cable (2) from left hand shroud (5).

b. Test.

- (1) Perform continuity test between spring ends on high tension cable. If continuity is not present, replace high tension cable.
- (2) Perform continuity test between metal ends of high tension cable, if continuity is not present, replace high tension cable.
- (3) Perform continuity test between metal end of high tension cable and spring end. If continuity is present, replace high tension cable.

c. Installation. (figure 4-30)

- (1) Install grommet (4) on high tension cable (2) and install in left hand shroud (5).
- (2) Install high tension cable (2) and tighten connector nut (3).
- (3) Install high tension cable (2) as tagged and tighten connector nut (1).

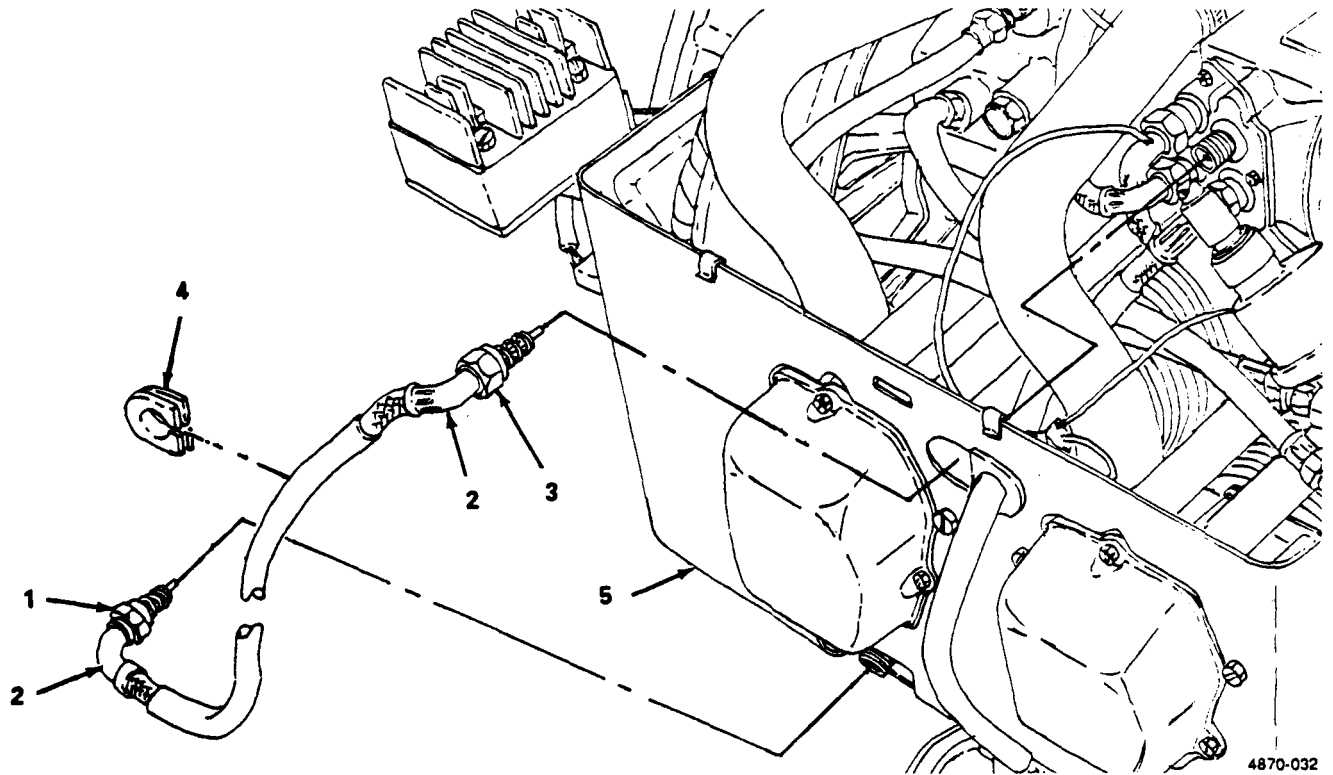


Figure 4-30. High Tension Cable, Removal and Installation.

4-37 Spark Plugs.

This task covers: a. Removal b. Inspection/Adjustment c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (item 1, Appendix B)

Materials/Parts

Rags, Wiping (item 7, Appendix D)
Solvent, Drycleaning (item 8, Appendix D)

a. Removal. (figure 4-31)

NOTE

The removal and installation procedures are the same for all spark plugs cables.

- (1) Loosen connector nut (1) and remove high tension cable (2).
- (2) Remove spark plug (3).

b. Inspection/Adjustment.

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to person-
nel and property. Avoid repeated and prolonged skin contact. Do not use near open
flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38° C.-60°C.).

- (1) Clean spark plug with drycleaning solvent and dry thoroughly.
- (2) Inspect spark plug for signs of excessive burning and cracked or otherwise damaged ceramic insulation and replace spark plug as needed.
- (3) Adjust spark plug gap to 0.028-0.033(0.071 -0.083 cm).

c. Installation. (figure 4-31)

- (1) Install spark plug (3) and torque to 23-25 lb-ft (49115-53580 gr-cm).
- (2) Install high tension cable (2) and tighten connector nut (1).

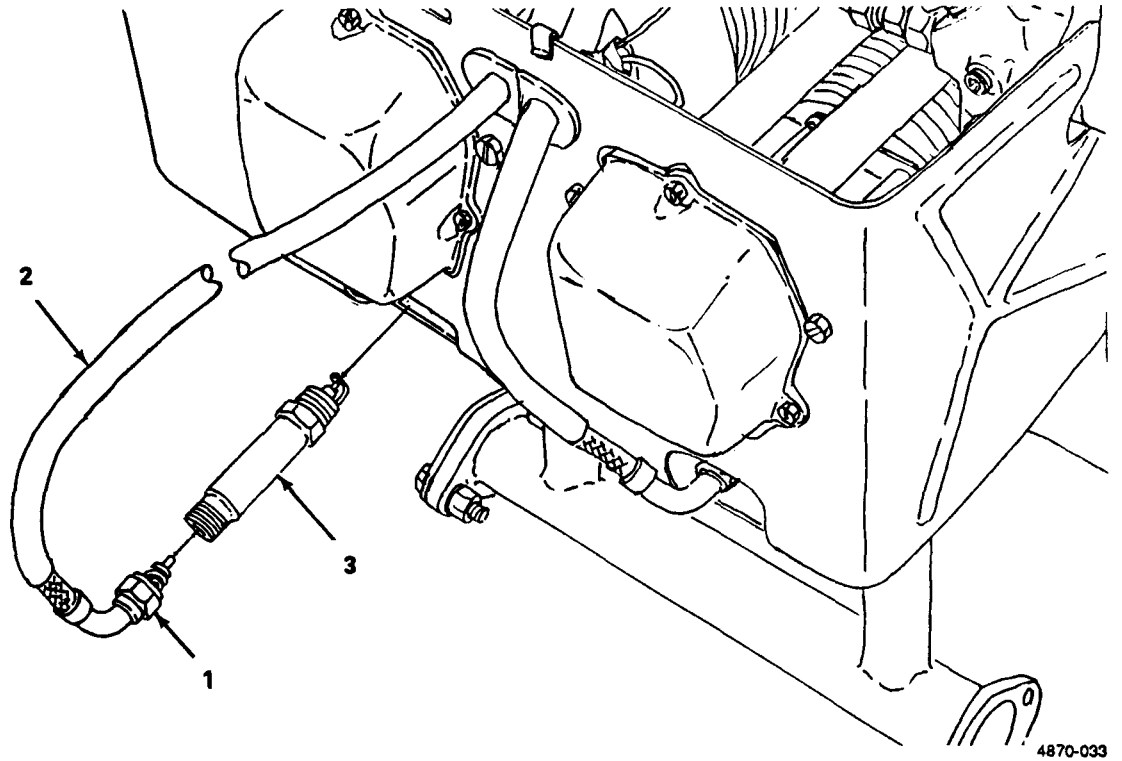


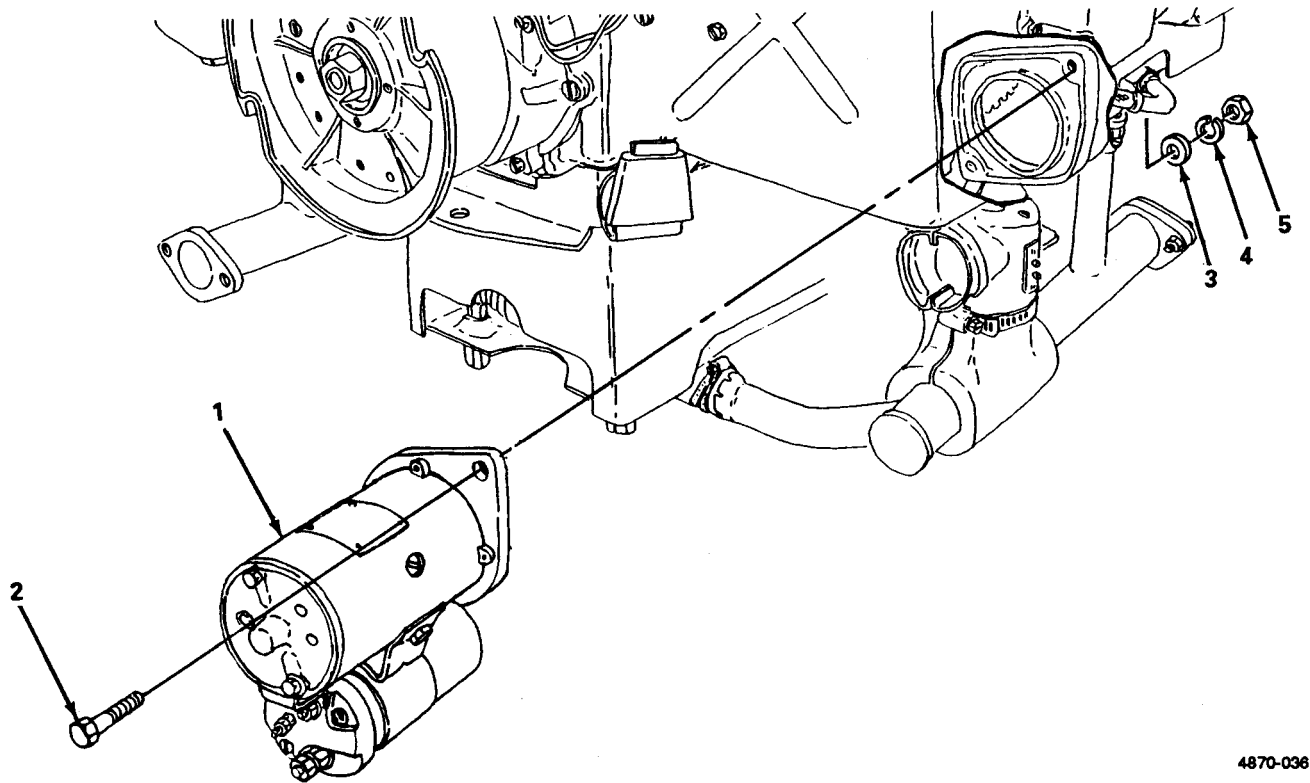
Figure 4-31. Spark Plug, Removal and Installation.

INITIAL SETUP

a. *Removal.* (figure 4-32)

- b. Installation. (figure 4-32)

- 4-70**



4870-036

Figure 4-32. Starter, Removal and Installation.

4-39. Regulator-Rectifier.

This task covers: a. Removal b. Test c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

a. Removal. (figure 4-33)

- (1) Disconnect regulator-rectifier connector (1) from left side shroud (2).

NOTE

Model 2A042-2 is equipped with a grounding strap. Make note of placement before removing regulator-rectifier.

- (2) Remove three assembled screws and washers (3) and remove regulator-rectifier (4).
- (3) Remove assembled screw and washer (5) and remove fuse cover (6) and two fuses (7).
- (4) Inspect fuses (7) and replace if burnt out or otherwise damaged.

b. Test.

- (1) Run alternator at 3400-3600 RPM.
- (2) Connect AC alternator leads to the regulator-rectifier.
- (3) Connect DC alternator leads to a battery or batteries, with an ammeter and a voltmeter in the circuit.
- (4) Meter readings should be as follows:

NOTE

Depending on condition of batteries used, meter readings can be anywhere between the minimum and maximum listed above.

Low Charge Battery	Full Charge Battery
Amperes (approx) 5-9	(approx) 0-1.5
Volts (approx) 25.0	(approx) 28.5

(5) Disconnect DC leads at battery; meter readings should be as follows:

Amperes	0.0
Volts (approx)	28.5

c. Installation. (figure 4-33)

- (1) Install regulator-rectifier (4) and secure with three assembled screws and washers (3).
- (2) Connect regulator-rectifier connector (1).
- (3) Install two fuses (7) and fuse cover (6) and secure with assembled screw and washer (5).

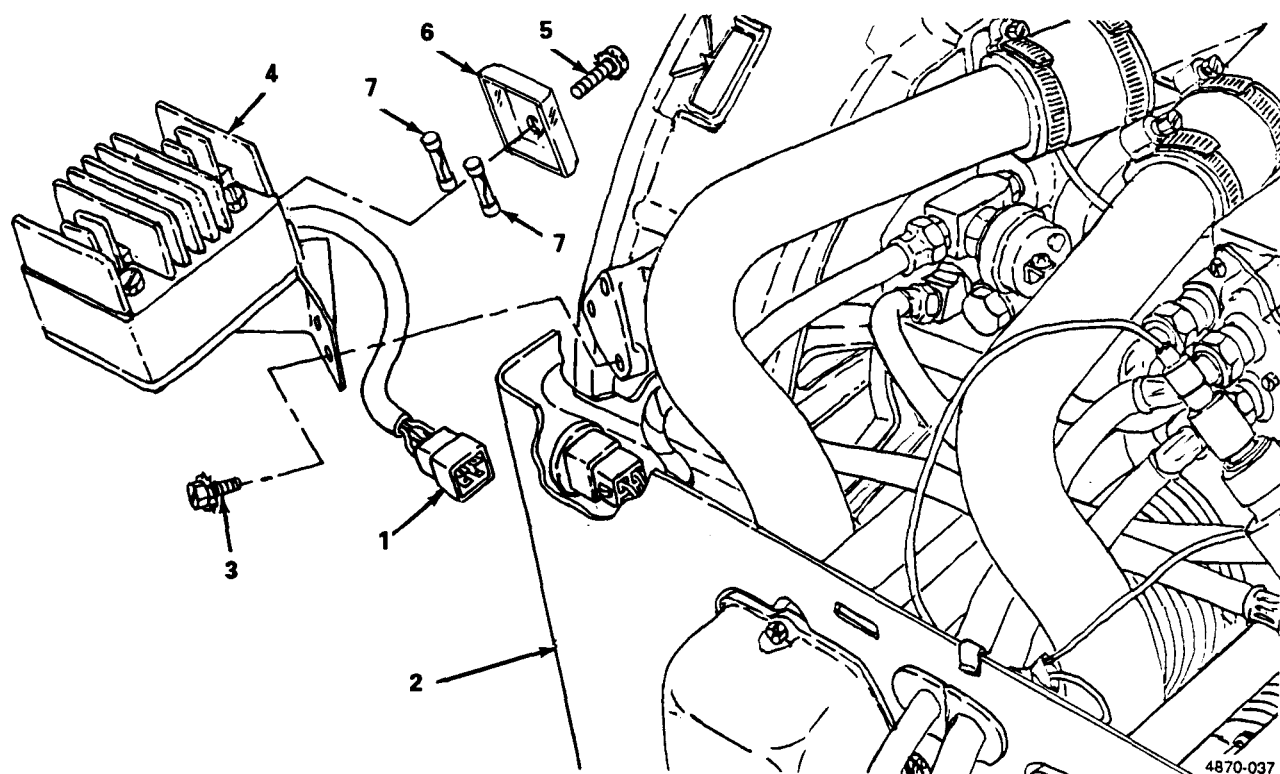


Figure 4-33. Regulator-Rectifier, Removal and Installation.

4-40. Governor/Carburetor Control.

This task covers: a. Removal b. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

a. Removal. (figure 4-34)

Remove two assembled screws and washers (1) and remove governor control (2).

b. Installation. (figure 4-34)

Install governor control (2) and secure with two assembled screws and washers (1).

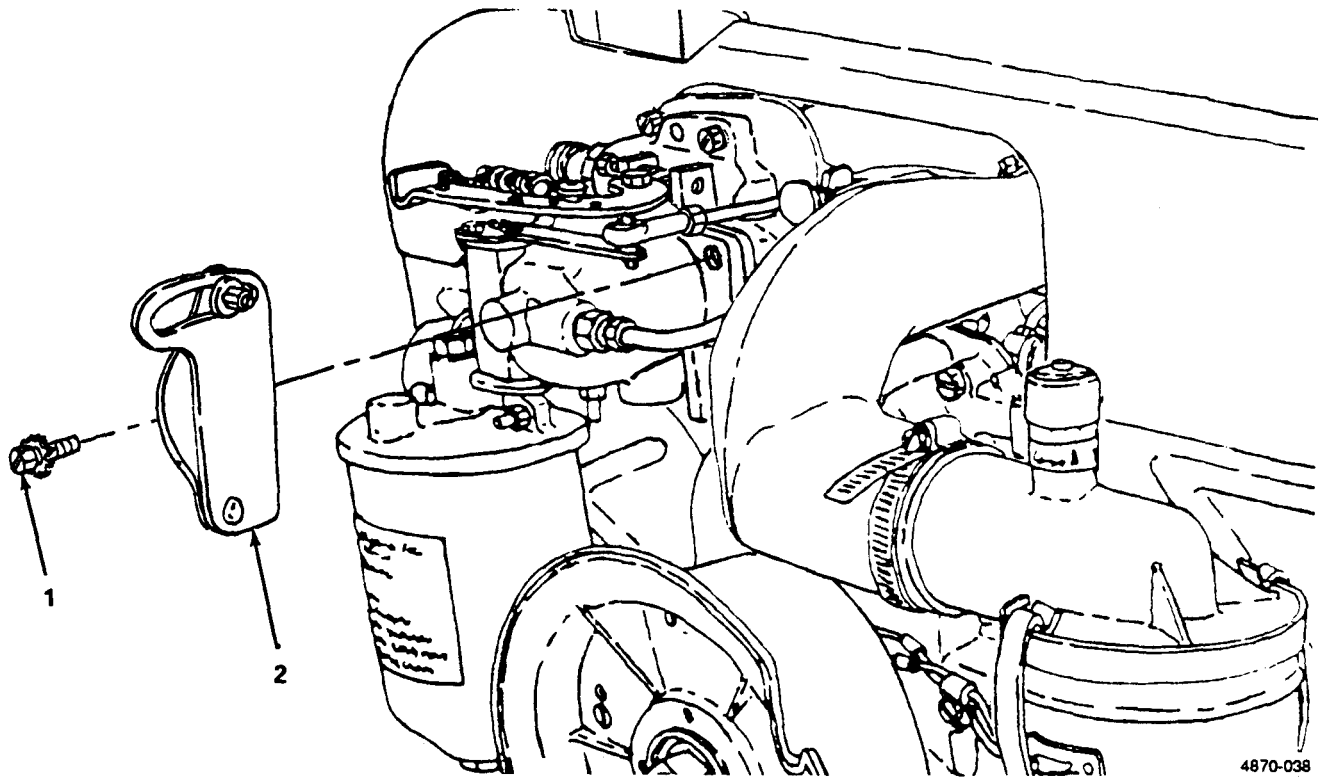


Figure 4-34. Governor/Carburetor Control, Removal and Installation.

4-41. Governor Control Rod.

This task covers: a. Adjustment b. Removal c. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Top cover removed (para. 4-21)

a. Adjustment. (figure 4-35)

- (1) Remove screw (1) and washer (2) and remove governor control rod (3) from governor arm (4).
- (2) Loosen lock nut (5).
- (3) Ensure governor control (6) is at full throttle position.

NOTE

If alignment can not be obtained on one end, utilize other end.

- (4) Push governor control rod (3) to full throttle position and adjust length as follows:
 - (a) For engines equipped with Tillotson carburetor, adjust rod length so that center hole of ball joint (6) aligns with mounting hole in governor arm (4).
 - (b) For engines equipped with Bendix carburetor adjust length so that center hole of ball joint (6) is approximately 1/2 in. (1.27 cm) from mounting hole in generator arm (4).
- (5) Tighten lock nut (5).
- (6) Install governor control rod (3) and secure with screw (1) and washer (2).

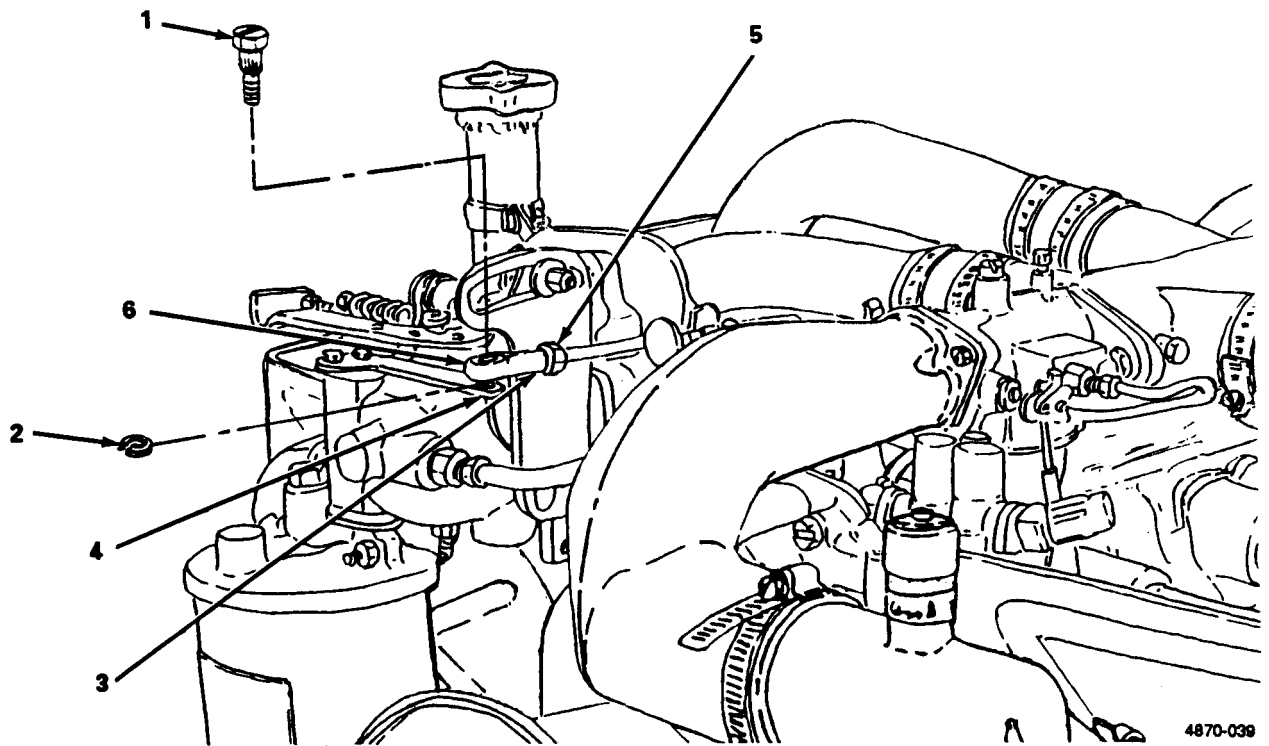


Figure 4-35. Governor Control Rod, Adjustment.

4-41. **Governor Control Rod (cont).**

- (1) Remove screw (1) and washer (2) and remove governor control rod (3) from governor arm (4).
- (2) Remove screw (5) and washer (6) and remove governor control rod (3) from carburetor.
- (3) Inspect governor control rod throttle rod (7) and ball joints (8), replace all items that are worn, bent, or otherwise damaged.

c. Installation. (figure 4-36)

- (1) Install governor control rod (3) and secure with screw (5) and washer (6).
- (2) Adjust governor control rod. (See para. a. above.)
- (3) Install governor control rod (3) and secure with screw (1) and washer (2).

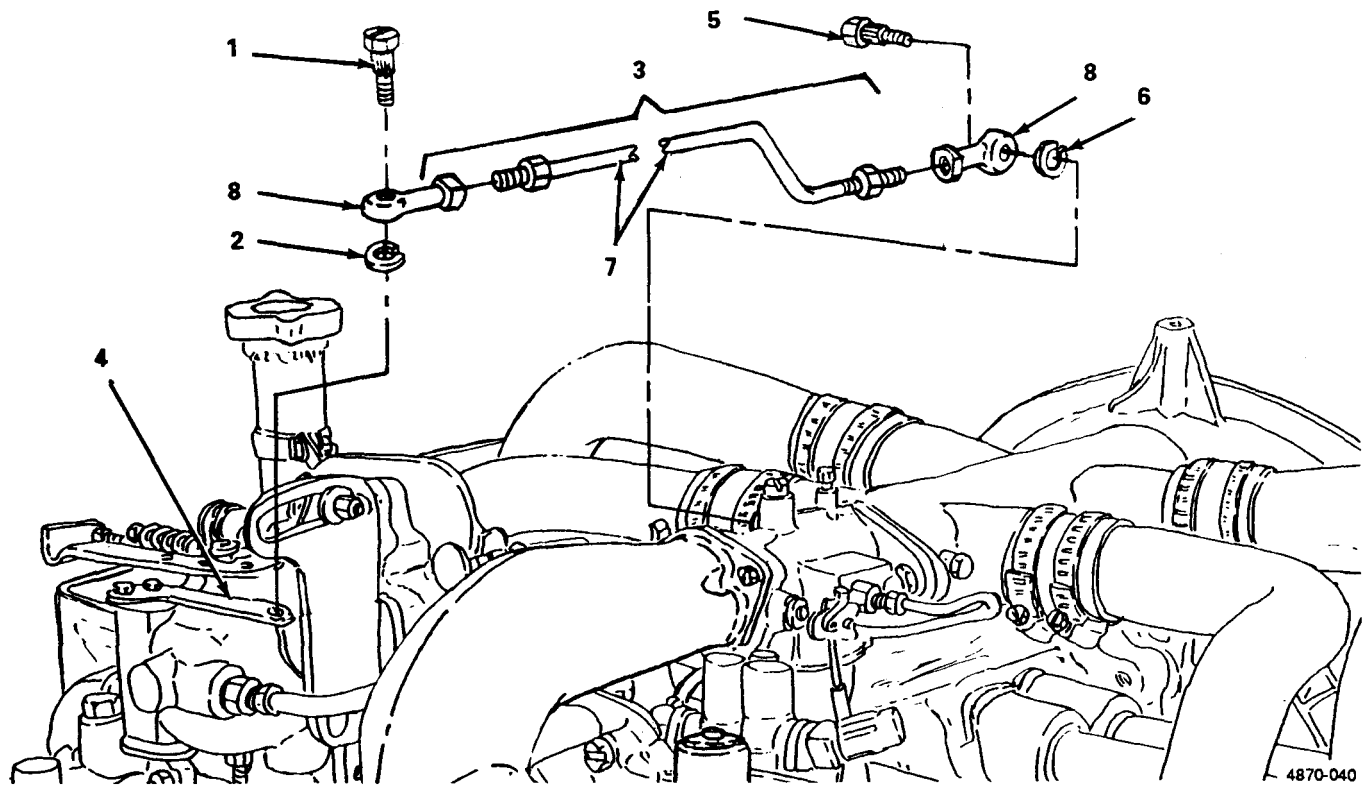


Figure 4-36. Governor Control Rod, Removal and Installation.

INITIAL SETUP

Tools

Equipment Condition

Materials/Parts

Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 4-37)

- (1) Loosen fitting nut (1).
- (2) Loosen fitting nut (2) and remove governor oil tube (3).
- (3) Remove two fittings (4).

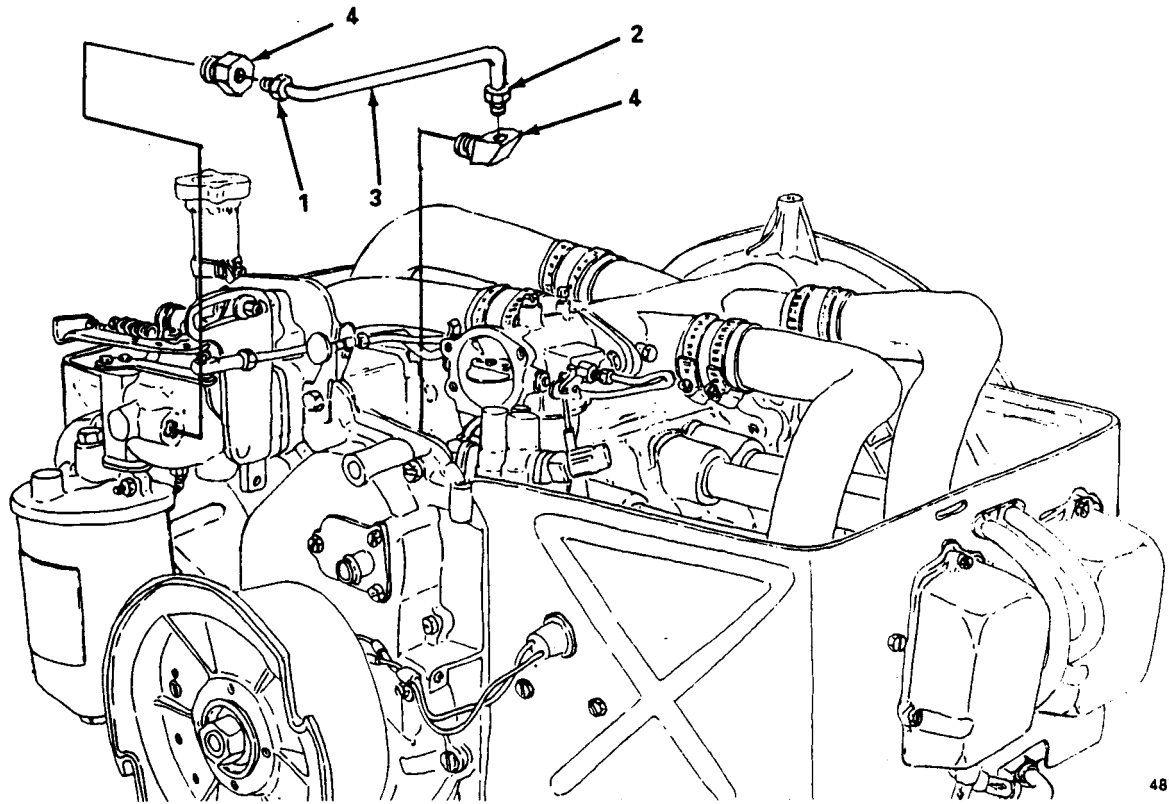
WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (4) Clean governor oil tube (3) and fittings (4) with drycleaning solvent and dry thoroughly.
- (5) Inspect governor oil tube (3) and replace if fitting nuts threads are stripped or otherwise damaged.
- (6) Inspect fittings (4) and replace if damaged.
- (7) Ensure there are no obstructions in governor oil tube (3).

b. Installation. (figure 4-37)

- (1) Install fittings (4).
- (2) Install governor oil tube (3) and finger tighten both fitting nuts (1) and (2).
- (3) Tighten both fitting nuts (1) and (2) fully.



4870-041

Figure 4-37. Governor Oil Tube, Removal and Installation.

4-43. **Governor.**

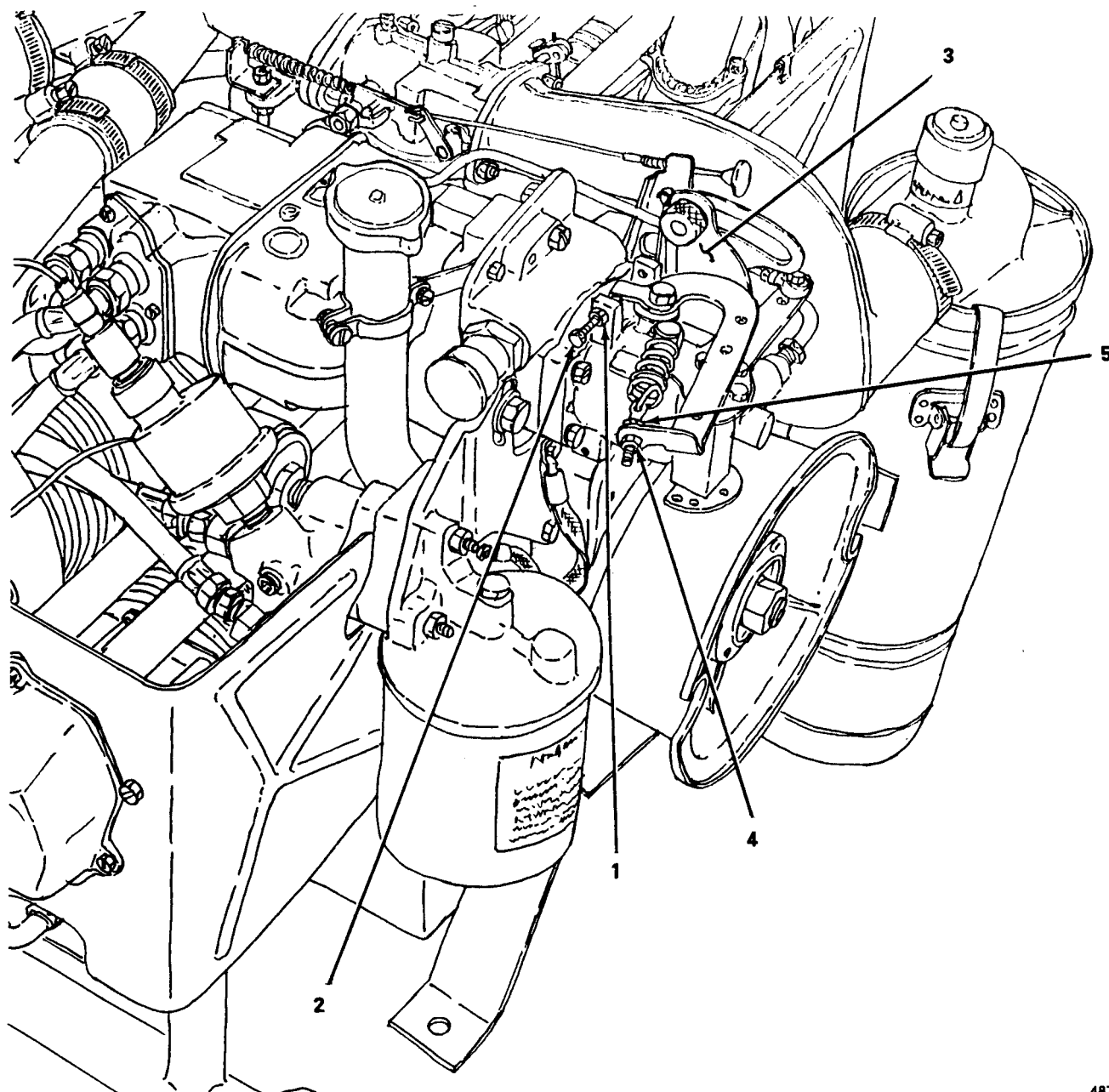
This task covers: a. Adjustment b. Removal c. Installation

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (item 1, Appendix B)	Top cover removed for removal of governor (para. 4-21).
<i>Materials/Parts</i>	Governor/carburetor control removed for governor removal (para. 4-40).
Gasket, Governor Mounting (NSN 5330-00-073-3053)	Governor control rod removed for governor removal (para. 4-41).

a. Adjustment. (figure 4-38)

- (1) Loosen lock nut (1) and turn minimum speed screw (2) four turns counterclockwise.
- (2) Start engine (para. 2-9) and allow to warm up for 15 minutes.
- (3) Place governor control (3) in fully governed position.
- (4) Apply end item load (refer to end item manual).
- (5) Adjust minimum speed screw (2) to obtain engine speed of 3600 r.p.m. and tighten lock nut (1).
- (6) Remove end item load (refer to end item manual) and recheck engine speed. If engine speed exceeds 3708 r.p.m., perform steps (7) and (8).
- (7) Loosen lock nut (5) and turn no-load adjustment nut (4) clockwise to lower the no-load speed.
- (8) Tighten lock nut (5) when engine speed of 3708 r.p.m. is obtained.
- (9) Perform steps 4 through 6 again as needed.
- (10) Stop engine (para. 2-10).



4870-042

Figure 4-38. Governor, Adjustment.

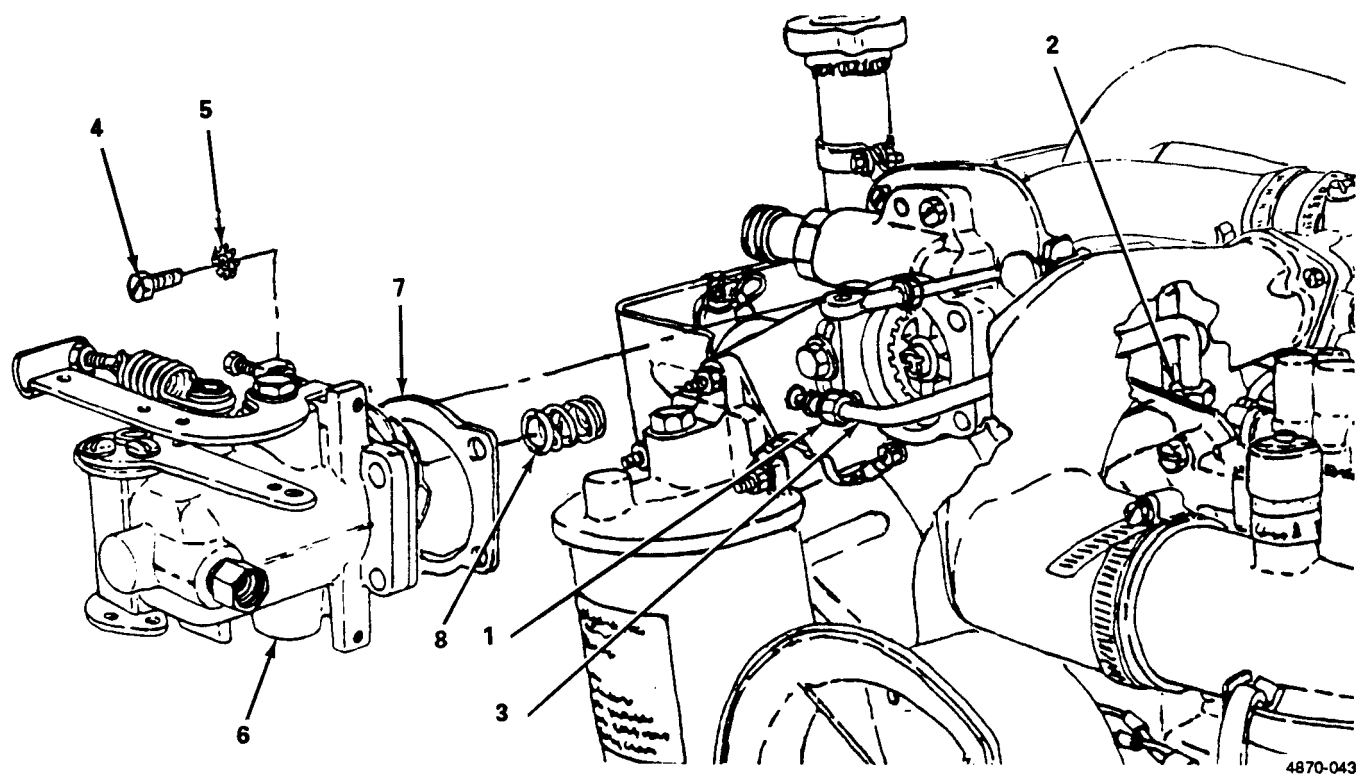
4-43. **Governor (cont).**

b. Removal. (figure 4-39)

- (1) Loosen fitting nuts (1) and (2) and move oil tube (3) out of way.
- (2) Remove two screws (4) and washers (5) and remove governor (6), gasket (7), and spring (8).

c. Installation. (figure 4-39)

- (1) Ensure gasket mating surfaces are clean and free of old gasket material.
- (2) Install governor (6), gasket (7) and spring (8) and secure with two screws (4) and washers (5).
- (3) Install oil tube (3) and tighten two fitting nuts (1) and (2).



4870-043

Figure 4-39. Governor, Removal and Installation.

This task covers: a. Removal b. Installation

Tools/s

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Preheater removed (para. 4-30).

Rags, Wiping (Item 7, Appendix D)

Solvent, Drycleaning (Item 8, Appendix D)

Seat, Exhaust Manifold (P/N 13206E0964)

a. Removal. (figure 4-40)

NOTE

Some engines are not equipped with seats.

- (1) Remove eight nuts (1) and remove two exhaust manifolds (2) and (3), exhaust pipe (4), and seats (5).
- (2) Loosen two clamps (6) and separate exhaust manifolds (2) and (3) from exhaust pipe (4).

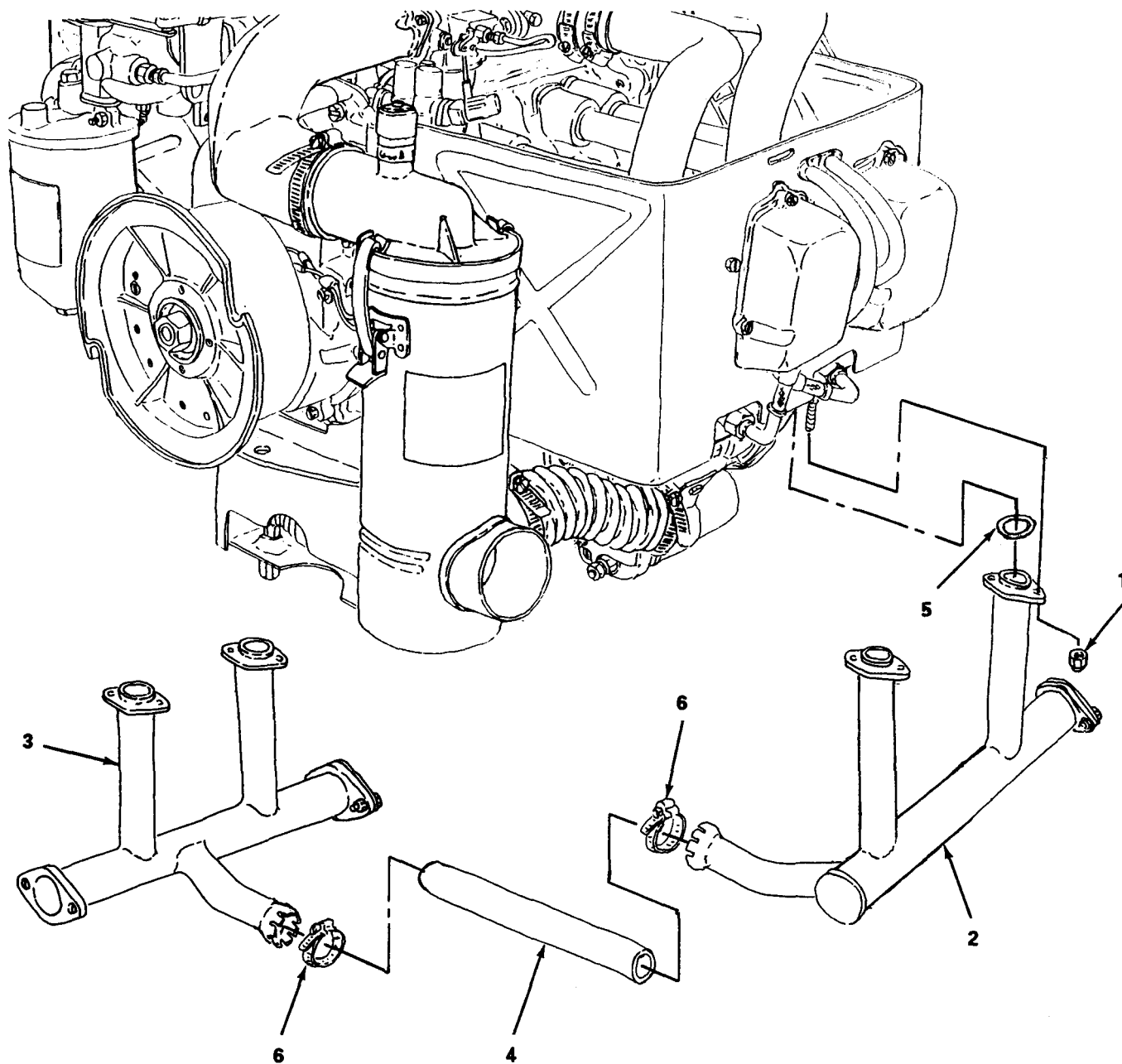
WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (3) Clean all items in drycleaning solvent, and dry thoroughly.
- (4) Replace all items that are worn or otherwise damaged.

b. Installation. (figure 4-40)

- (1) Install exhaust pipe (4) and clamps (6), but do not tighten clamps.
- (2) Install exhaust manifolds (2) and (3), exhaust pipe (4), and seats (5) and secure with eight nuts (1).
- (3) Tighten two clamps (6).



4870-044

Figure 4-40. Exhaust Manifold and Exhaust Pipe, Removal and Installation.

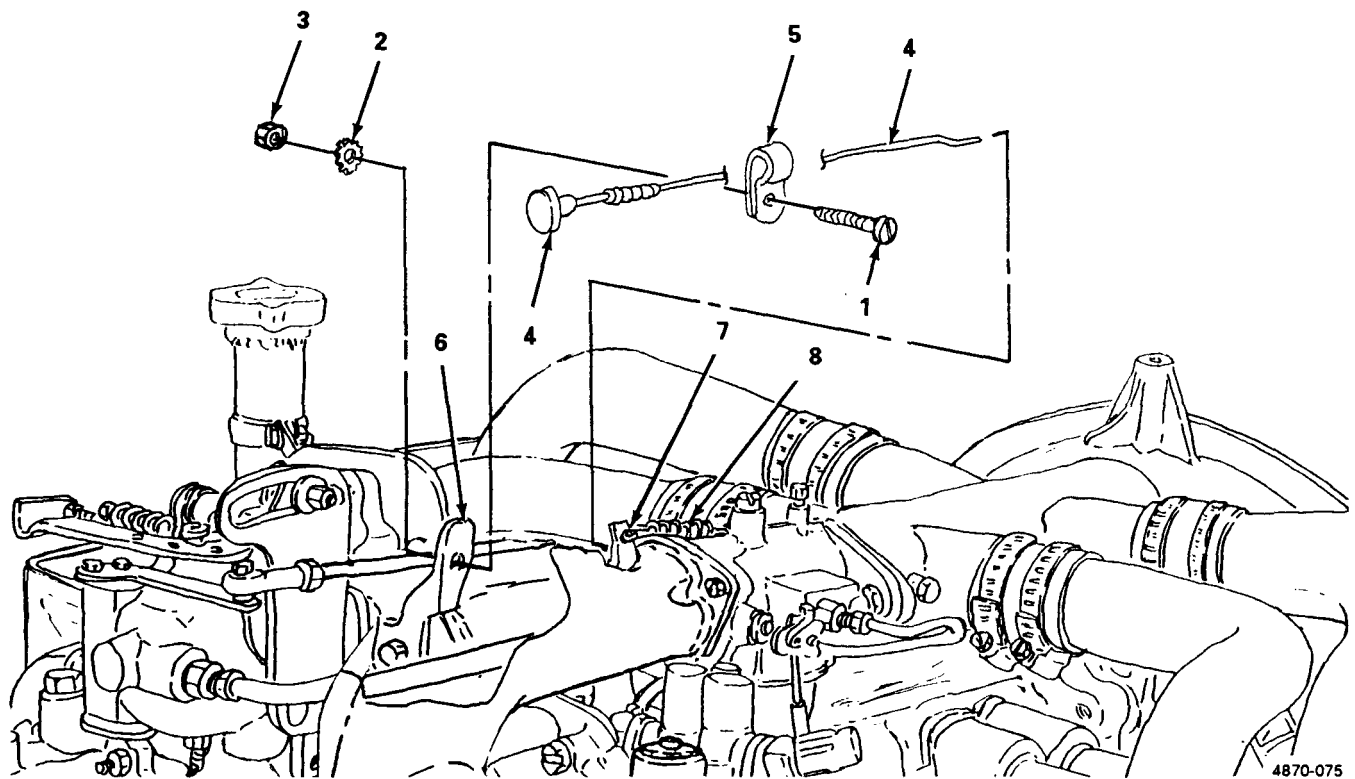


Figure 4-41. Manual Choke, Removal and Installation.

4-46. **Carburetor.**

This task covers: a. Adjustment b. Removal c. Installation

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Air cleaner elbow removed for carburetor removal (para. 4-17).
<i>Materials/Parts</i>	Top cover removed for carburetor adjustment (para. 4-21).
Rags, Wiping (Item 7, Appendix D)	
Solvent, Drycleaning (Item 8, Appendix D)	
Gasket, Carburetor Mounting (NSN 5330-00-073-3049)	

a. Adjustment. (figure 4-42)

- (1) Turn air/fuel mixture idle adjusting screw (1) fully clockwise until seated.
- (2) Turn air/fuel mixture screw (1) 1 1/2 turns counterclockwise.
- (3) Start engine (para. 2-9) and operate at idle until warm.

NOTE

Ensure governor/carburetor control is in the full idle position.

- (4) Adjust air/fuel mixture screw (1) until smooth idle is obtained.
- (5) Stop engine (para. 2-10).

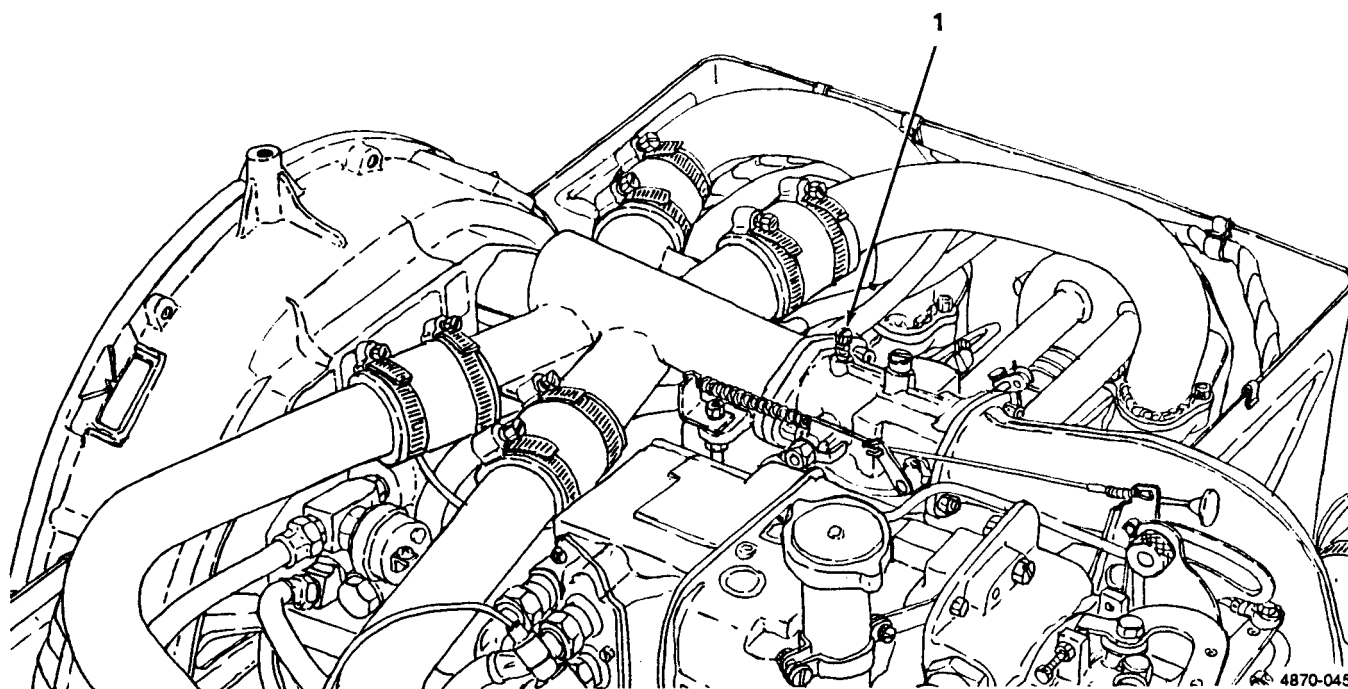


Figure 4-42. Carburetor, Adjustment.

4-46. **Carburetor (cont).**

b. Removal. (figure 4-43)

- (1) Remove screw (1) and washer (2) and remove governor control rod (3).

WARNING

Do not smoke or use an open flame in the vicinity of gasoline vapors.

- (2) Loosen fitting nut (4) on fuel line (5).
- (3) Loosen screw (6) and remove choke lever (7) from choke rod (8).
- (4) Remove screw (9), washer (10) and nut (11) securing manual choke bracket (12).
- (5) Remove manual choke (13) and spring (14) from manual choke lever (15).
- (6) Remove two nuts (16), lockwashers (17) and flat washers (18) and remove carburetor (19) and gasket (20).

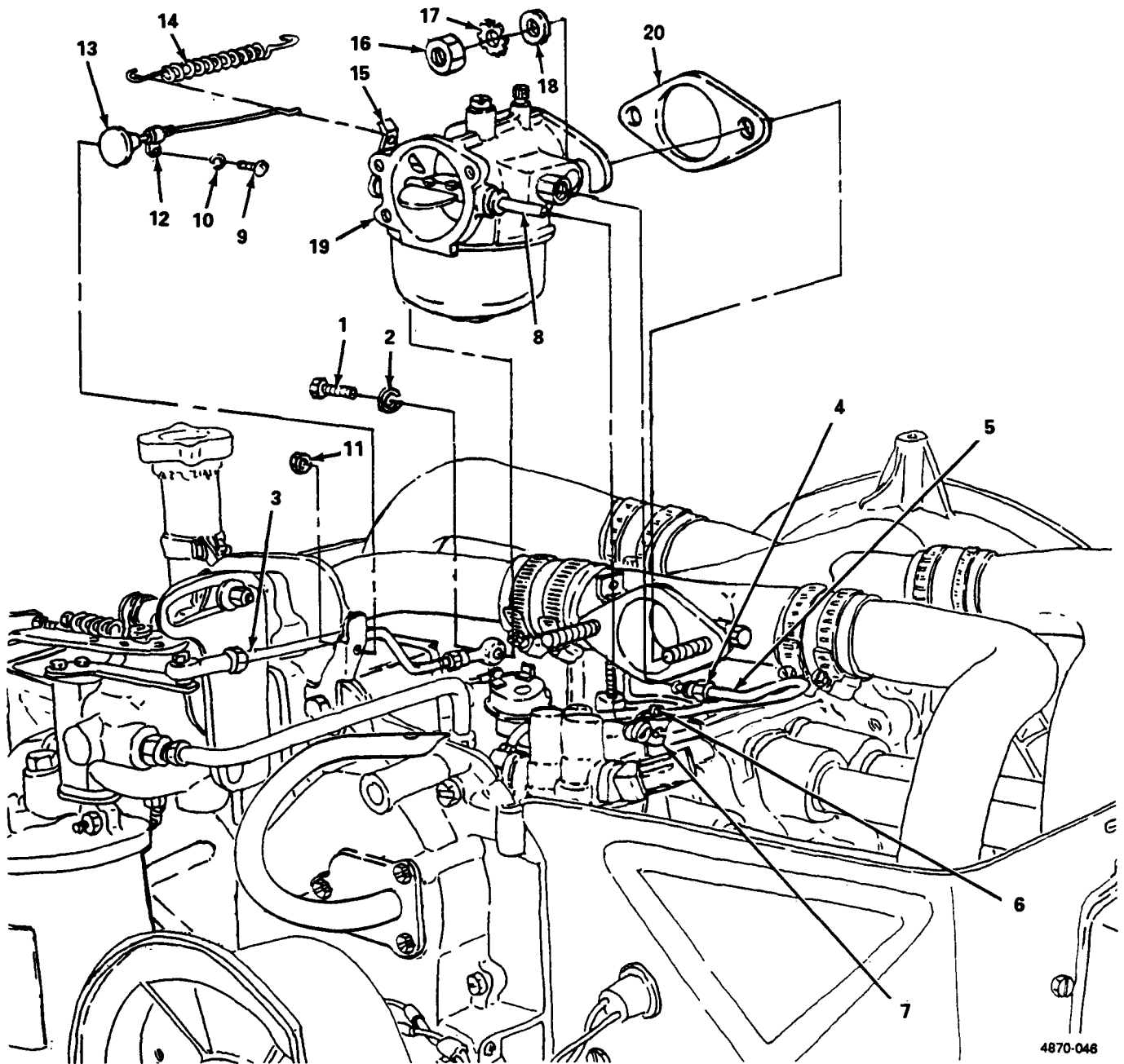
WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (7) Clean outside of carburetor (19) with drycleaning solvent and dry thoroughly.
- (8) Inspect carburetor (19) and replace if carburetor body is cracked or otherwise damaged.

c. Installation. (figure 4-43)

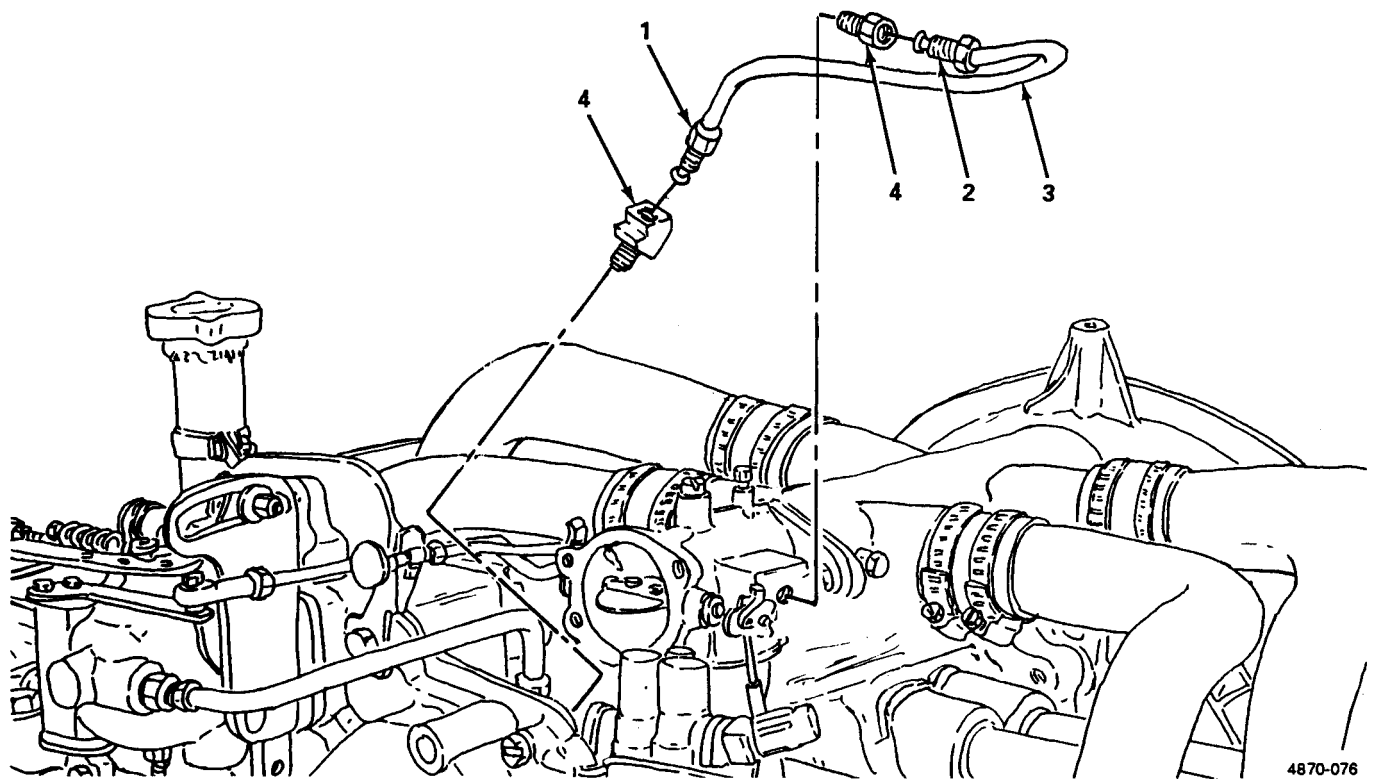
- (1) Ensure all gasket surfaces are clean and free of old gasket material.
- (2) Install carburetor (19) and gasket (20) and secure with two nuts (16), lockwashers (17), and flat washers (18).
- (3) Install spring (14) and manual choke (13).
- (4) Install manual choke bracket (12) and secure with screw (9) and washer (10) and nut (11).
- (5) Install fuel line (5) and tighten fitting nut (4).
- (6) Position choke lever (15) in the full open position and install choke lever (7) in horizontal position and tighten screw (6).
- (7) Install governor control rod (3) and secure with screw (1) and washer (2).



4870-048

Figure 4-43. Carburetor, Removal and Installation.

- 4-94



4870-076

Figure 4-44. Fuel Line and Fittings, Removal and Installation.

4-48. **Fuel Pump.**

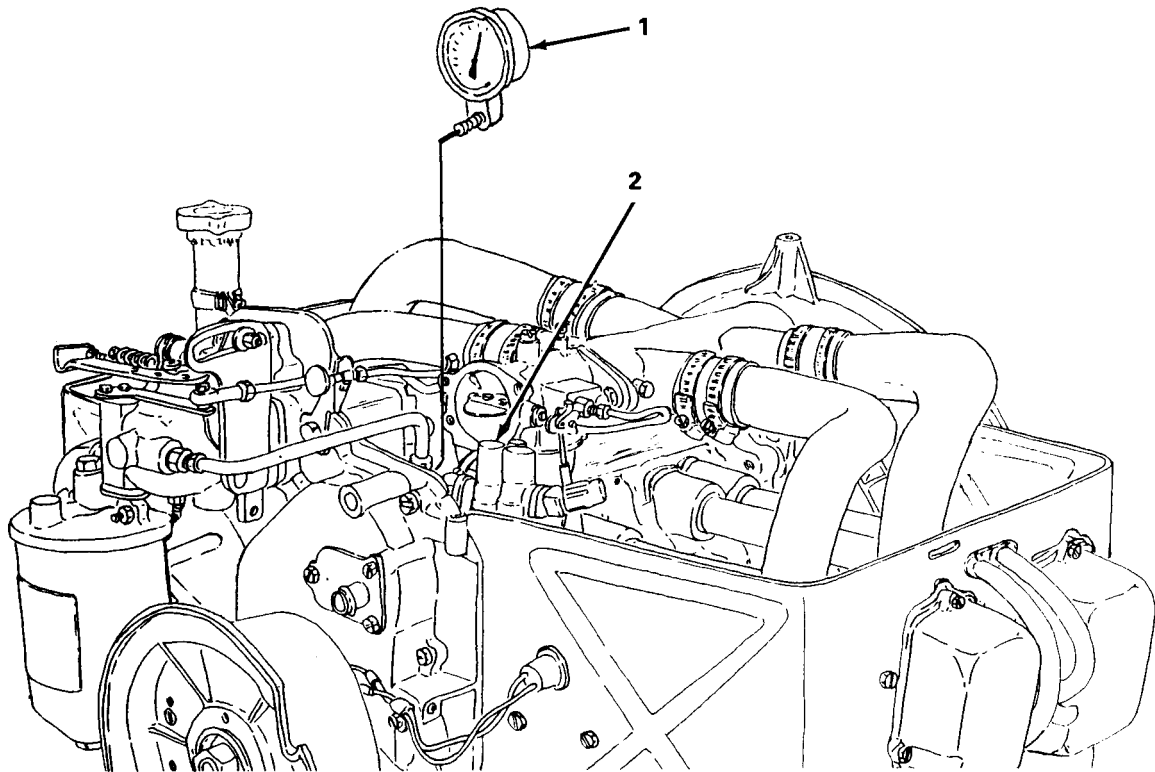
This task covers: a. Test b. Removal c. Installation

INITIAL SETUP

<i>Tools</i>	<i>Materials/Parts</i>
General Mechanic's Tool Kit (Item 1, Appendix B) Tester, Engine Vacuum and Pressure (NSN 4910-00-255-8673) (Item 2, Appendix B) Wrench, Torque (NSN 5120-00-853-4538) (Item 6, Appendix B)	Gasket, Fuel Pump Mounting (NSN 5330-00-756-1673) <i>Equipment Condition</i> Air cleaner removed (para. 4-17). Fuel line removed (para. 4-47).

a. Test. (figure 4-45)

- (1) Connect suitable pressure gage (1) to fuel pump (2).
- (2) Using starter rope, crank over engine several times, and check fuel pressure gage (1).
- (3) Fuel pressure should be 3 - 4.50 psi (20.69 - 31.02 Kpas).
- (4) Remove pressure gage (1).
- (5) Replace fuel pump which does not develop suitable pressure.



4870-077

Figure 4-45. Fuel Pump, Test.

4-48. **Fuel Pump (cont).**

b. Removal. (figure 4-46)

- (1) Remove two assembled screws and washers (1) and remove fuel pump (2) and gasket (3).

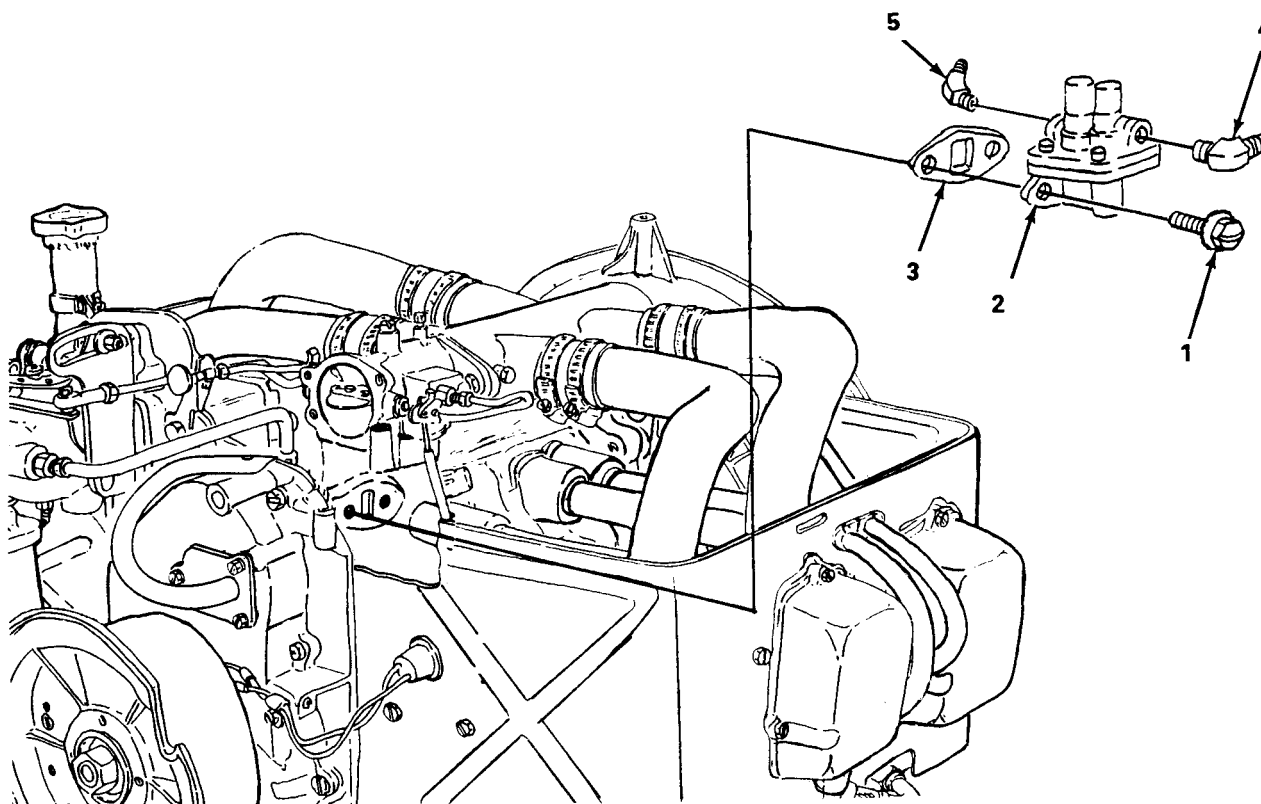
NOTE

Perform step 2 only if fuel pump is being replaced.

- (2) Remove elbows (4) and (5) from fuel pump (3).

c. Installation. (figure 4-46)

- (1) Install elbows (4) and (5).
- (2) Ensure gasket mating surfaces are clean and old gasket material is removed.
- (3) Install fuel pump (2) and gasket (3) and secure with two assembled screws and washers (1). Torque screws to 55-65 in.-lb (9831-11619 gr cm).



4870-078

Figure 4-46. Fuel Pump, Removal and Installation.

This task covers: a. Removal b. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)
Wrench, Torque (NSN 5120-00-640-6364)
(Item 2, Appendix B)

Carburetor removed (para. 4-46).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)
Gasket, Intake Manifold (NSN 5330-00-017-8927)

a. Removal. (figure 4-47)

- (1) Remove nut (1), lockwasher (2), washer (3), and remove choke return bracket (4).
- (2) Remove eight assembled screws and washers (5) and remove intake body (6) and manifold elbows (7), (8), (9) and (10) and gaskets (11).
- (3) Loosen eight clamps (12) and separate manifold elbows (7), (8), (9) and (10), hoses (13), (14), (15) and (16) and intake body (6).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (4) Clean all items, except adapters, in drycleaning solvent and dry thoroughly.
- (5) Inspect all items and replace if cracked or otherwise damaged.
- (6) Inspect studs (16) and (17) and replace if damaged.

b. Installation. (figure 4-47)

NOTE

Cut new hoses (13), (14), (15) and (16) to a minimum of 3 in. (7.62 cm).

Do not tighten clamps (12) at this point.

- (1) Assemble hoses (13), (14), (15) and (16), manifold elbows (7), (8), (9) and (10), clamps (12), and intake body (6).

- (2) Ensure all gasket mating surfaces are clean and free of old gasket material.
- (3) Install intake body (6), manifold elbows (7), (8), (9) and (10), and gaskets (11) and secure with eight assembled screws and washers (5) and torque to 36-50 in. lb (6434-8939 gr cm).
- (4) Tighten eight clamps (10).
- (5) Install choke return bracket (4) and secure with nut (1), lockwasher (2) and washer (3).

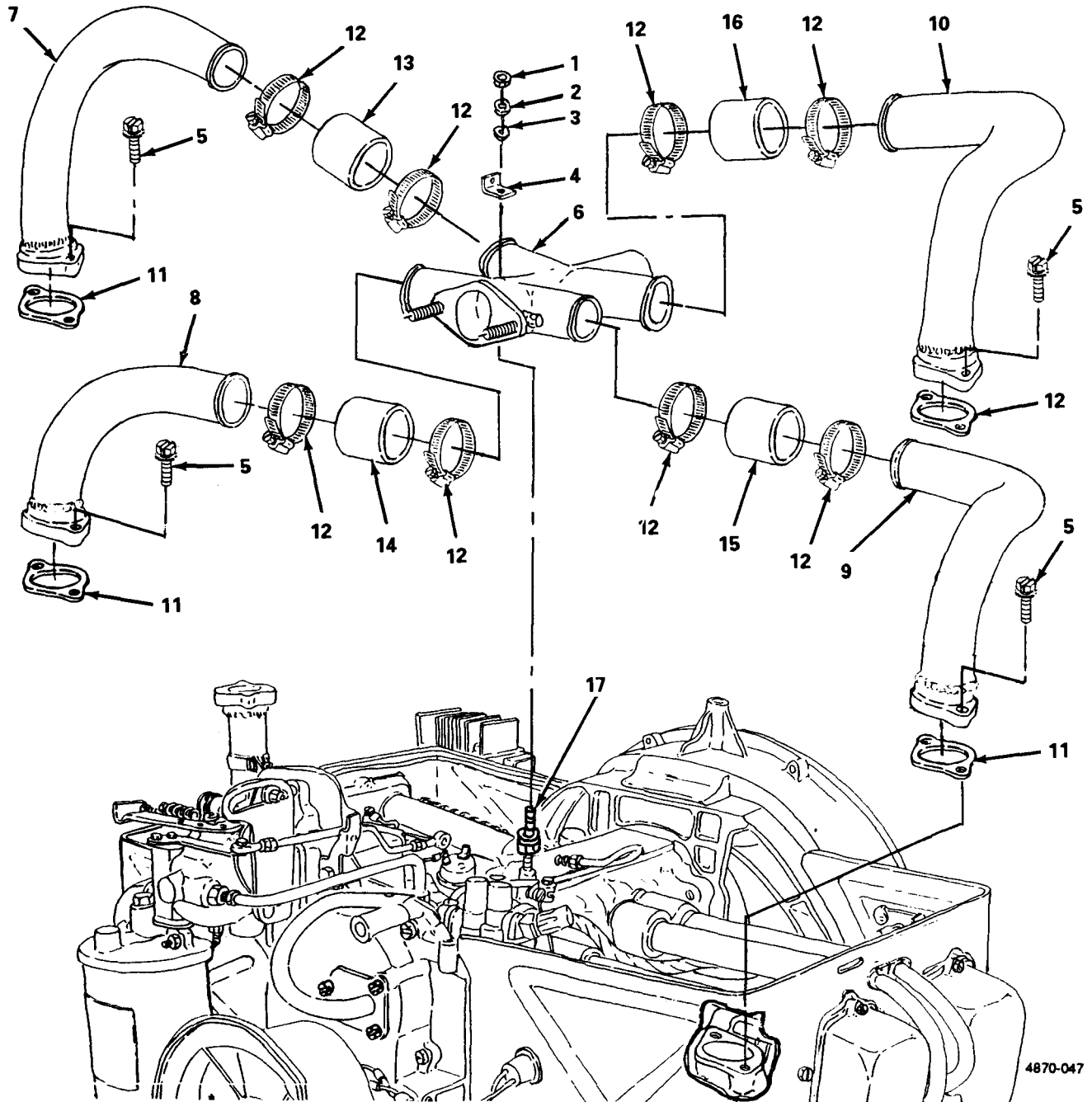
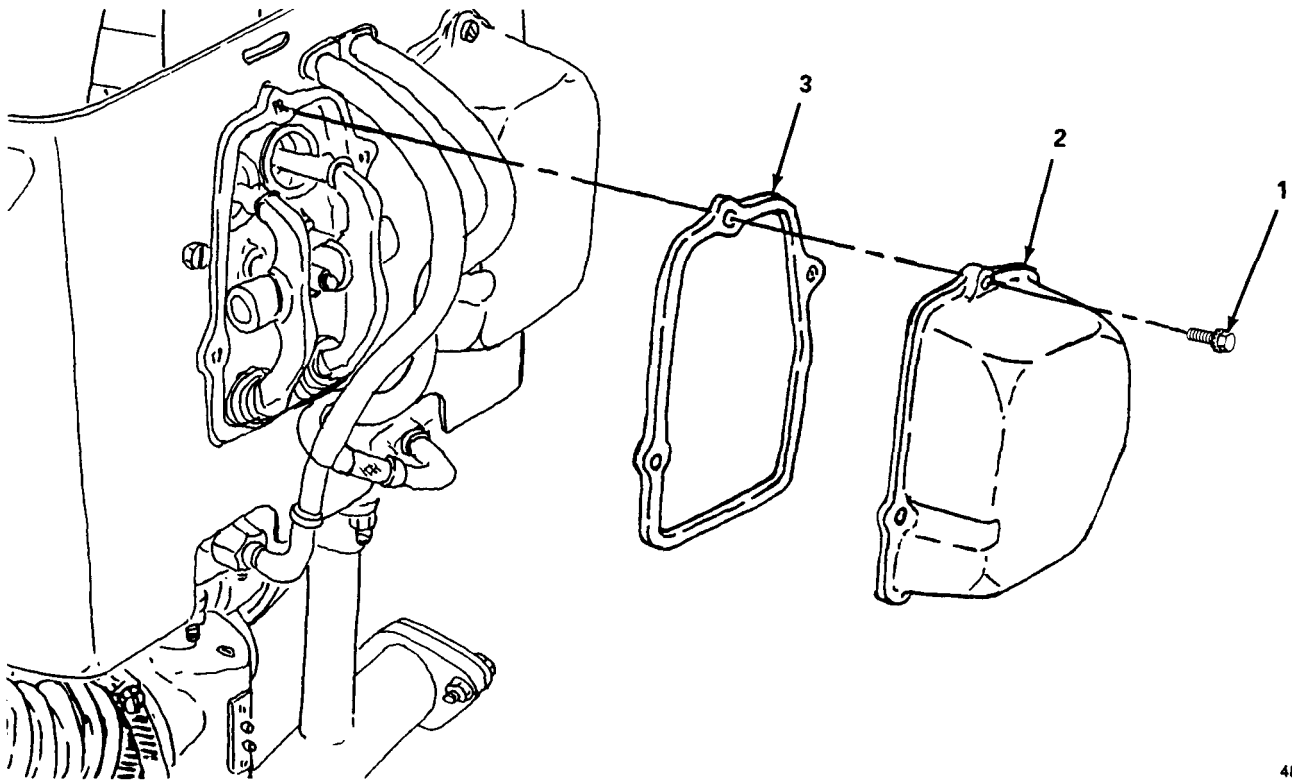


Figure 4-47. Intake Manifold Assembly, Removal and Installation.



4870-048

Figure 4-48. Rocker Box Cover, Removal and Installation.

4-51. Alternator.

This task covers:	a. Test	b. Removal	c. Installation
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INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)
 Multimeter (NSN 6625-01-139-2512)
 (Item 3, Appendix B)
 Wrench, Torque (NSN 5120-00-640-6364)
 (Item 2, Appendix B)
 Puller, Kit Mechanical (NSN 5120-00-313-9496)
 (Item 2, Appendix B)

Tools (cont)

Torque Wrench (NSN 5120-00-640-6364)
 (Item 2, Appendix B)

Equipment Condition

Top cover removed (para. 4-21).

a. Test. (figure 4-49)

- (1) Disconnect alternator connector (1) from right hand shroud (2).
- (2) Start engine (para. 2-9).
- (3) Perform voltage test between leads of alternator connector (1). Voltage should be 40V AC at 3600 RPM. Replace alternator if voltage is low.
- (4) Stop engine (para. 2-10).
- (5) Perform resistance test between leads of alternator connector (1), resistance should be 0.25-0.75 ohms.

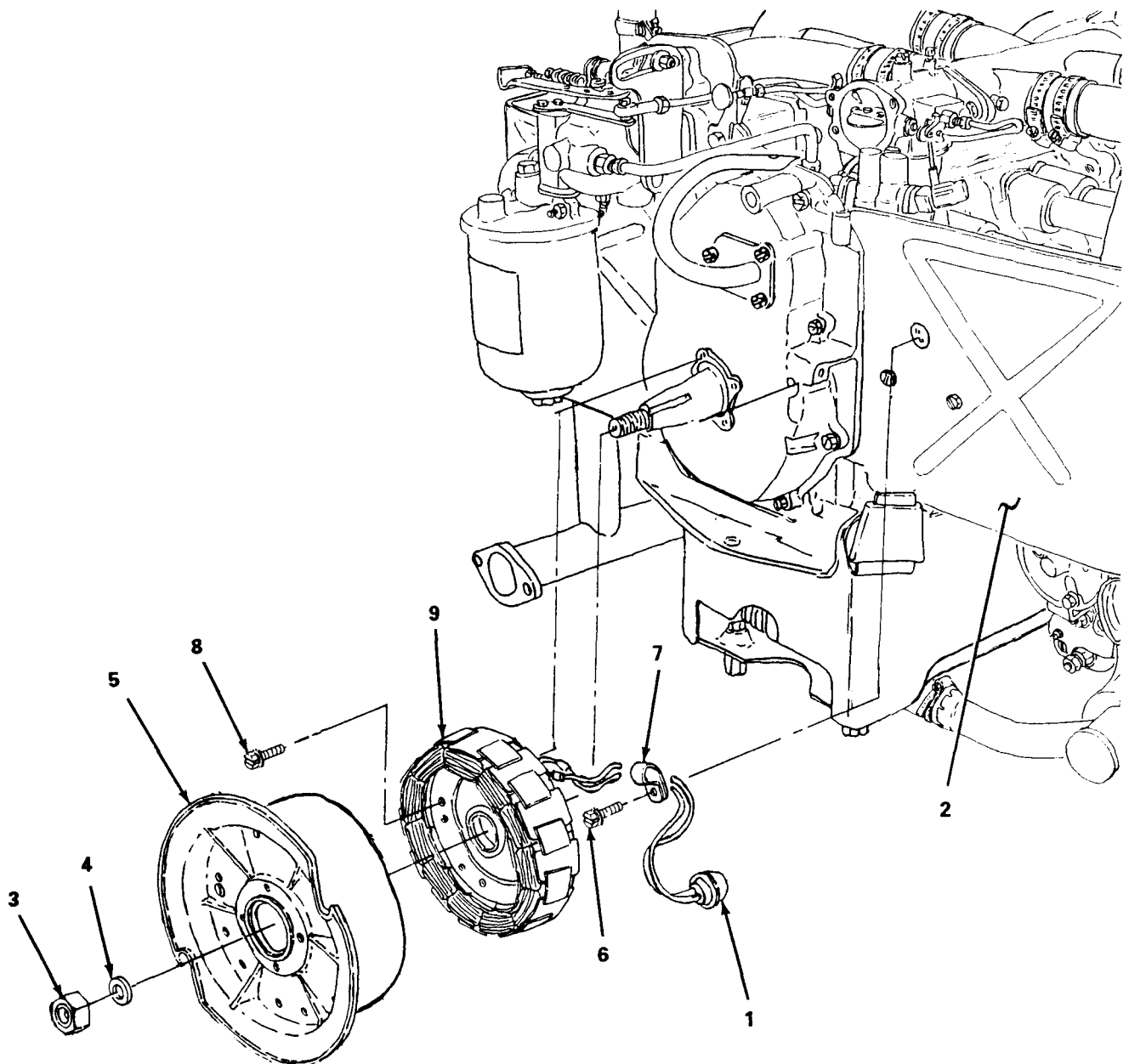
b. Removal. (figure 4-49)

- (1) Disconnect alternator connector (1) from right hand shroud (2).
- (2) Remove nut (3) and washer (4).
- (3) Using puller, remove engine start pulley (5).
- (4) Remove assembled screw and washer (6), and cable clamp (7).
- (5) Remove four assembled screws and washers (8), and remove alternator stator (9).
- (6) Inspect engine start pulley (5) for cracks and replace as needed.
- (7) Inspect alternator stator (9) and replace if insulation is cracked or otherwise damaged.

c. Installation. (figure 4-49)

- (1) Install alternator stator (9) and secure with four assembled screws and washers (8).

- (2) Install cable clamp (7) and secure with assembled screw and washer (6).
- (3) Install engine start pulley (5) and secure with nut (3) and washer (4) and torque to 80-83 lb-ft (171612-178048 gr cm).
- (4) Install alternator connector (1).



4870-049

Figure 4-49. Alternator, Removal and Installation.

4-52. **Wiring Harness.**

This task covers: a. Test b. Removal c. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)
Multimeter (NSN 6625-01-139-2512)
(Item 2, Appendix B)

Top cover removed (para. 4-21).

a. Test (figure 4-50)

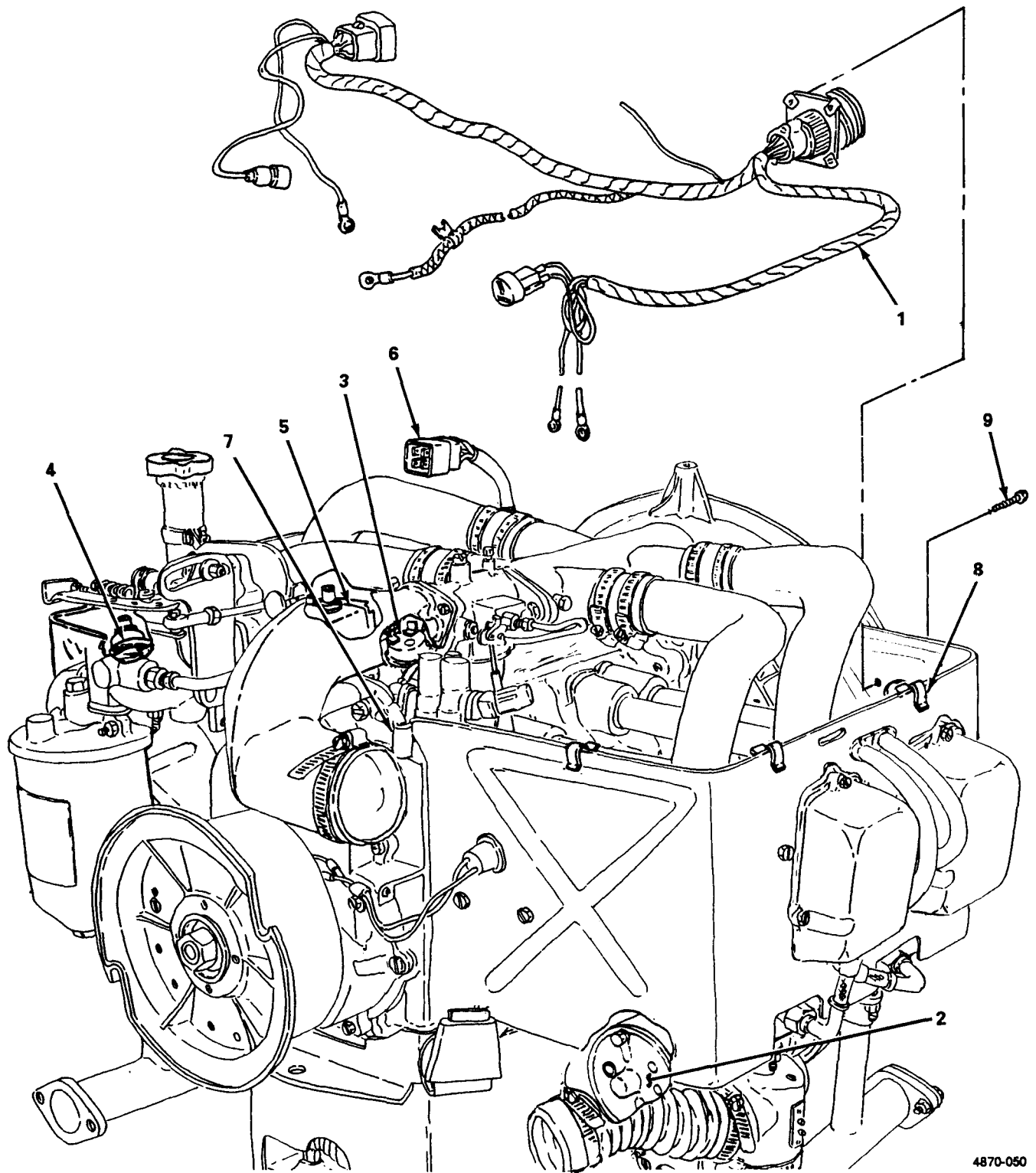
Perform end to end continuity test on wiring harness (1). (Refer to figure 4-54.)

b. Removal (figure 4-50)

- (1) Tag and remove wiring harness leads from starter solenoid (2), oil shutoff switch (3), oil pressure transmitter (4), magneto (5), regulator-rectifier connector (6) and alternator connector (7).
- (2) Remove wiring harness (1) from clips (8).
- (3) Remove four screws (9) and remove wiring harness (1).

c. Installation (figure 4-50)

- (1) Install wiring harness (1) and secure with four screws (9) and washers (10).
- (2) Install wiring harness (1) in clips (8).
- (3) Install wiring harness leads and connectors as tagged.



4870-050

Figure 4-50. Wiring Harness, Test, Removal and Installation.

4-53. Tachometer Adapter.

This task covers: Replacement

INITIAL SETUP

<i>Tools</i>	<i>Materials/Parts</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Gasket (PN 13206E0599) Rags, Wiping (Item 7, Appendix D) Solvent, Drycleaning (Item 8, Appendix D)

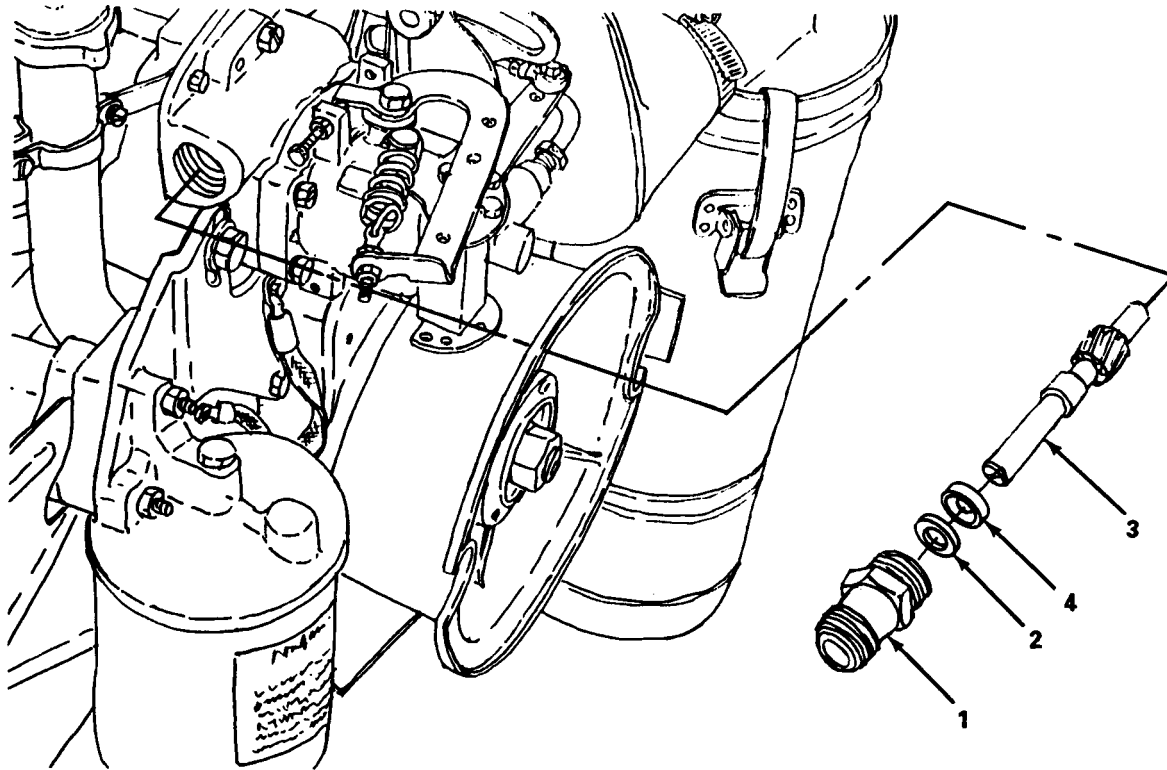
Replacement. (figure 4-51)

- (1) Remove tachometer adapter (1) and gasket (2) and remove gear shaft (3).
- (2) Inspect seal (4) and replace if torn or otherwise damaged.

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (3) Clean tachometer adapter (1) and gear shaft (3) with drycleaning solvent, and dry thoroughly.
- (4) Inspect tachometer adapter (1) and gear shaft (3) and replace if cracked or otherwise damaged.
- (5) Install seal (4) in tachometer adapter (1).
- (6) Install gear shaft (3), gasket (2), and tachometer adapter (1) as an assembly.



4870-051

Figure 4-51. Tachometer Adapter, Replacement.

This task covers: a. Removal b. Installation

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Breather tube removed (para. 4-18).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)

Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 4-52).

- (1) Remove two assembled screws and washers (1) and remove air breather reed support (2) and reed (3).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (2) Clean all items with drycleaning solvent, and dry thoroughly.
- (3) Inspect air breather reed support (2) and reed (3) and replace if cracked or otherwise damaged.

b. Installation. (figure 4-52)

Install reed (3) and air breather reed support (2) and secure with two assembled screws and washers (1).

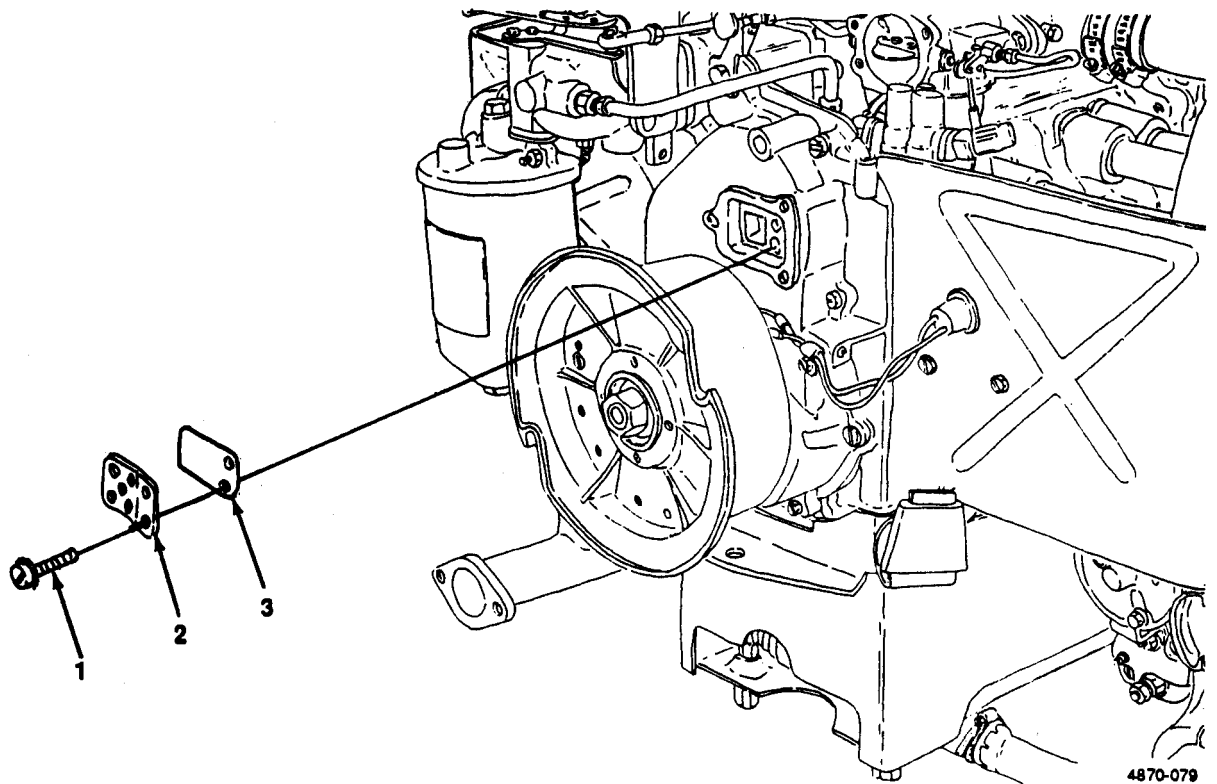


Figure 4-52. Air Breather Reed and Support, Removal and Installation.

4-55. Compression Test.

This task covers: Test

INITIAL SETUP

Tools

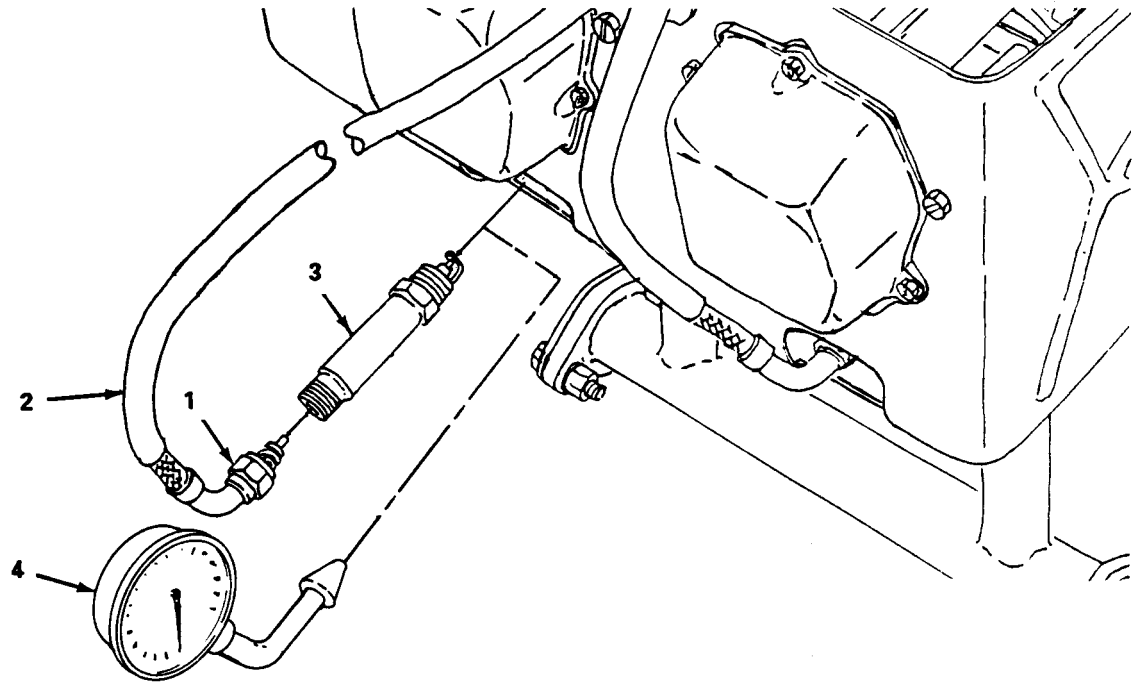
General Mechanic's Tool Kit (Item 1, Appendix B)
Tester, Cylinder Compression (NSN 4910-00-249-7318)

NOTE

Hold Carburetor throttle fully open to allow maximum air into the cylinder when testing for compression.

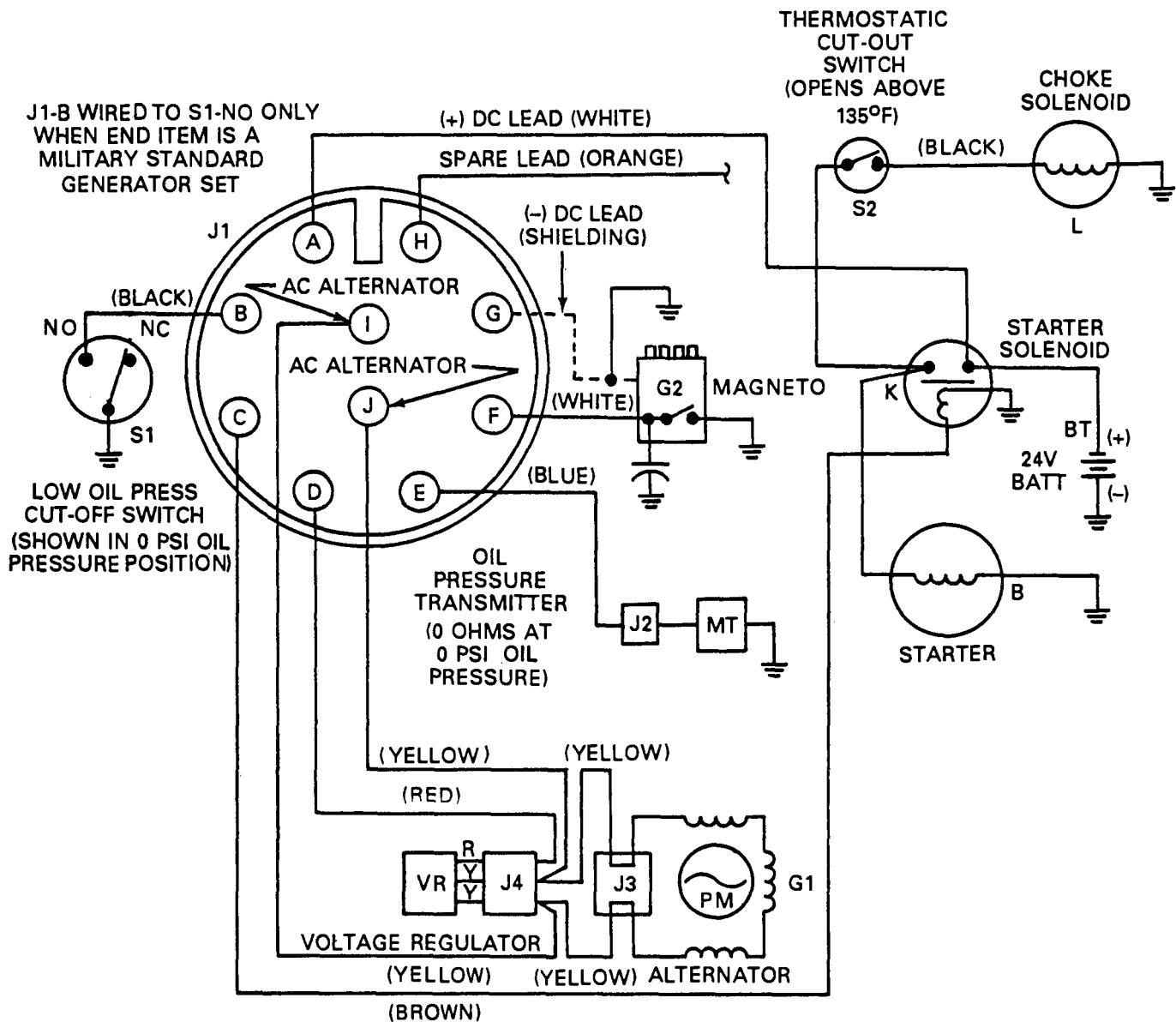
a. Test (figure 4-53)

- (1) Loosen connector nut (1) and remove high tension cable (2).
- (2) Remove spark plug (3).
- (3) Repeat steps 1 and 2 for remaining cylinders.
- (4) Install suitable pressure gage (4).
- (5) Using starter rope, crank engine over several times and check pressure gage reading on all cylinders.
- (6) Compression reading should be 115 - 25 psi (793 - 862 Kpas) at sea level. Pressure reading will be less above sea level.
- (7) Remove pressure gage (4).
- (8) Install spark plug (3) in all cylinders.
- (9) Install high tension cable (2) and tighten connector nut (1) in all cylinders.
- (10) Compare readings from each cylinder. The readings should be within 10 psi (69 Kpas) of each other. Further engine inspection is required if readings are not as specified.



4870-090

Figure 4-53. Compression, Test.



NOTE

BATTERY FURNISHED WITH APPLICABLE END ITEM.

4870-074

Figure 4-54. Wiring Diagram.

Section VI. PREPARATION FOR SHIPMENT OR STORAGE

Paragraph		Page
4-57	General	4-115
4-58	Short Term and Intermediate Storage Procedures	4-115
4-59	Administrative Storage	4-115

4-57. **General.** This section contains procedures to place the engine into either short term or intermediate storage.

NOTE

The procedures for placing the engine into either short term or intermediate storage are the same.

4-58. **Short Term and Intermediate Storage Procedures.**

- a. Perform operator Before and After and Unit PMCS.
- b. Remove end item fuel supply.
- c. Drain fuel system.
- d. Drain engine oil.
- e. Secure fuel filter and starter rope to engine.

4-59. **Administrative Storage.**

a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.

b. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be corrected, and all modification work orders (MWO's) should be applied.

c. Storage site selection. Inside storage is preferred for items selected for administrative storage. If inside storage is not available, trucks, vans, conex containers and other containers may be used.

CHAPTER 5

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

	Page
OVERVIEW	5-1
Section I. Repair Parts; Special Tools; Test, Measurement, Diagnostic Equipment (TMDE); and Support Equipment	5-1
Section II. Direct Support Troubleshooting.	5-1
Section III. Direct Support Maintenance Procedures	5-4

OVERVIEW

This chapter contains information for troubleshooting and maintenance of the engine by Direct Support Maintenance personnel.

Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT, DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

Paragraph		Page
5-1	Common Tools and Test Equipment	5-1
5-2	Special Tools, TMDE, and Support Equipment	5-1
5-3	Repair Parts	5-1

5-1. **Common Tools and Equipment.** For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

5-2. **Special Tools, TMDE and Support Equipment.** For a listing of special tools, TMDE, and support equipment authorized for use on this equipment, refer to the Repair Parts and Special Tools List, TM 5-2805-259-24P, and the maintenance allocation chart (MAC), appendix B of this manual.

5-3. **Repair Parts.** Repair parts are listed and illustrated in the Repair Parts and Special Tools List for 20 HP Military Standard Engine, TM 5-2805-259-24P.

Section II. DIRECT SUPPORT TROUBLESHOOTING

Paragraph		Page
5-4	General	5-1
5-5	Direct Support Troubleshooting Procedures	5-2

5-4. **General.** This section contains troubleshooting procedures to determine the probable cause of observed equipment malfunctions. Test or inspections are provided to isolate the faulty component and corrective actions are provided to eliminate the malfunction.

5-5. **Direct Support Troubleshooting Procedures.** Table 5-1 lists the common malfunctions that may be found during operation. Refer to symptom index to locate the troubleshooting procedures for the malfunction. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not corrected by listed corrective actions, notify your supervisor.

SYMPTOM INDEX

Symptom	Page
Engine Fails to Start	5-2
Engine Misses or Runs Erratically	5-2
Engine Lacks Power	5-3
Engine Oil Consumption Excessive	5-3
Engine Runs Excessively Noisy	5-3
Engine Exhaust Smoky	5-3

Table 5-1. Direct Support Troubleshooting Procedures.

Malfunction
Test or Inspection
Corrective Action
1. ENGINE FAILS TO START.
Step 1. Inspect valve tappets.
Replace worn or otherwise damaged valve tappets (para. 5-20).
Step 2. Inspect cylinder head assembly.
Replace or repair a damaged cylinder head assembly (para. 5-17).
2. ENGINE MISSES OR RUNS ERRATICALLY.
Step 1. Inspect cylinder head.
Replace or repair a damaged cylinder head (para. 5-17).
Step 2. Inspect valve tappets.
Replace worn or otherwise damaged valve tappets (para. 5-20).

Table 5-1. Direct Support Troubleshooting Procedures (cont).

Malfunction	Test or Inspection	Corrective Action
<hr/>		
3. ENGINE LACKS POWER.		
	Step 1. Inspect cylinder head.	
		Replace or repair a worn or damaged cylinder head (para. 5-17).
	Step 2. Inspect valve tappets.	
		Replace worn or otherwise damaged valve tappets (para. 5-20).
4. ENGINE OIL CONSUMPTION EXCESSIVE.		
	Step 1. Inspect timing cover oil seal.	
		Replace a worn timing cover oil seal (para. 5-14).
	Step 2. Inspect rear oil seal.	
		Replace a worn rear oil seal (para. 5-21).
5. ENGINE EXCESSIVELY NOISY.		
	Step 1. Inspect cylinder head assembly.	
		Repair or replace a worn cylinder head assembly (para. 5-17).
	Step 2. Inspect valve tappets.	
		Replace worn or otherwise damaged valve tappets (para. 5-20).
6. ENGINE EXHAUST SMOKY.		
	Inspect cylinder head assembly.	
		Replace or repair a damaged cylinder head assembly (para. 5-17).
<hr/>		

Section III. DIRECT SUPPORT MAINTENANCE PROCEDURE.

Paragraph		Page
5-6	General	5-4
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5-6. **General.** This section contains direct support maintenance procedures as authorized by the MAC in Appendix B of this manual. Table 5-2 located at the end of this section contains a list of engine components and their wear limits. Any item that does not meet the specified measurements must be replaced. Refer to Appendix E for torque valves. All maintenance procedures require only one person to perform. It maybe necessary to remove the engine from the end item to perform some direct support level maintenance procedures. Refer to the end item manual for procedures to remove the engine.

5-7. Flywheel.

This task covers: a. Removal b. Installation

INITIAL SETUP

Tools/

General Mechanic's Tool Kit (Item 1, Appendix B)
Kit, Puller (NSN 5120-00-423-1526)
(Item 4, Appendix B)
Wrench, Torque (NSN 5120-00-640-6364)
(Item 6, Appendix B)

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 5-1).

- (1) Remove assembled bolt and washer (1) securing flywheel (2).
- (2) Using puller, remove flywheel (2) and key (3).

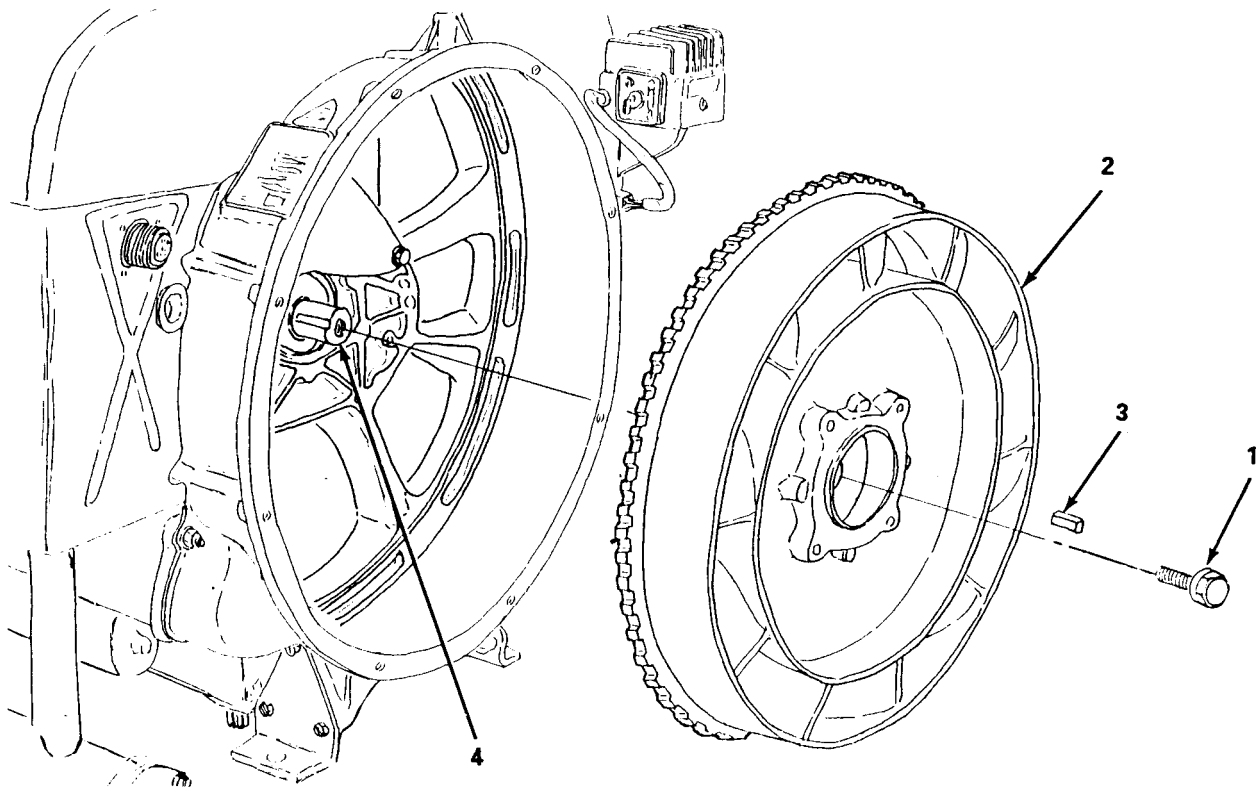
WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (3) Clean flywheel (2) with drycleaning solvent and dry thoroughly.
- (4) Inspect flywheel (2) and replace if missing teeth, cracked, or otherwise damaged.

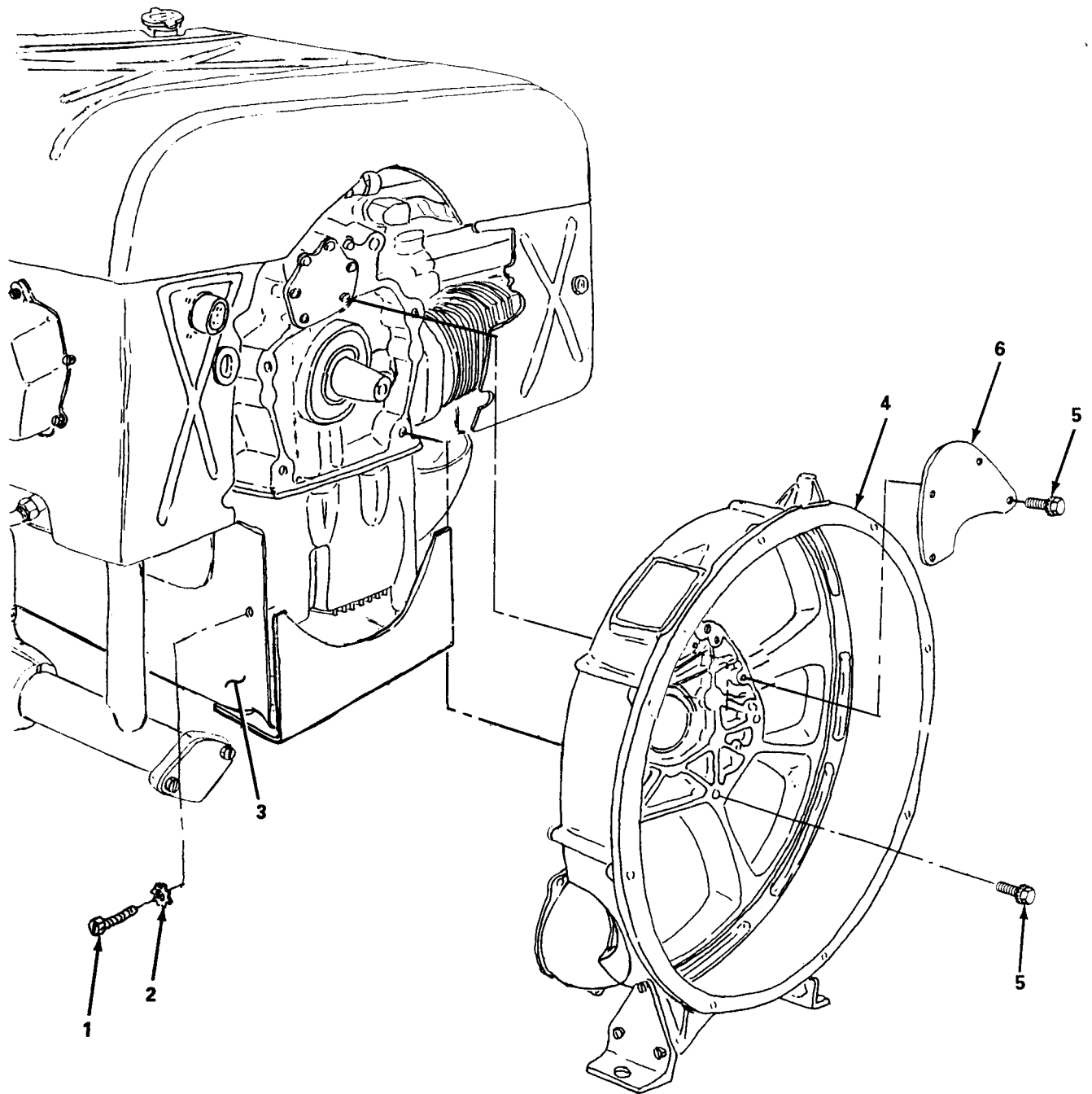
b. Installation. (figure 5-1)

- (1) Install key (3) and flywheel (2) on crankshaft (4).
- (2) Install assembled bolt and washer (1) and torque bolt to 80-83 lb-ft (171612 -178048 gr cm).



4870-052

Figure 5-1. Flywheel, Removal and Installation.



4870-053

Figure 5-2. Fan Housing, Removal and Installation.

Figure 5-3. Oil Pump Gears, Spacer and Oil Pump Cover, Removal and Installation.

5-10. Oil Filler Tube and Gage.

This task covers: Replacement

INITIAL SETUP

<i>Tools</i>	<i>Equipment Condition</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Top cover removed (para. 4-21).

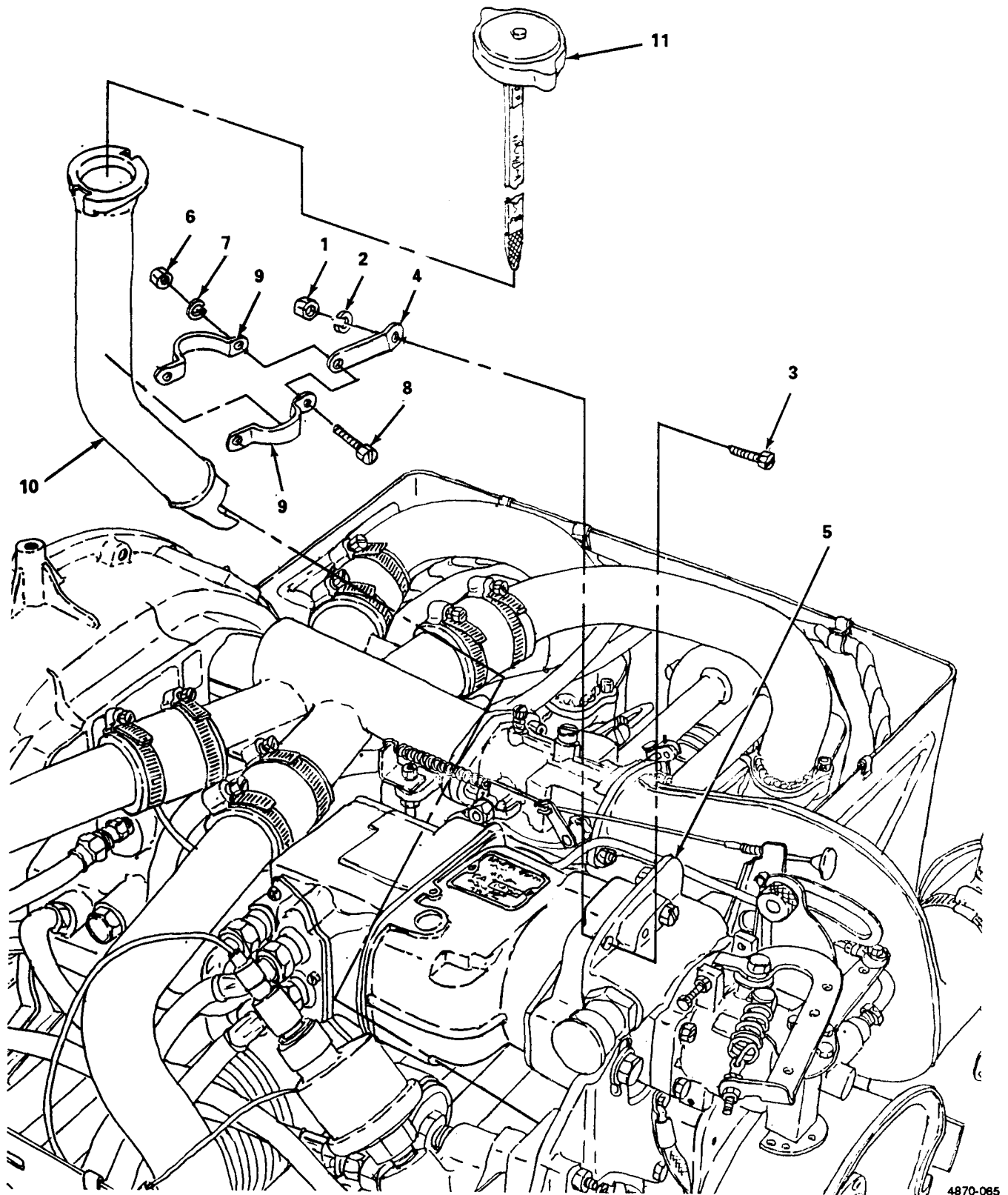
Replacement. (figure 5-4)

- (1) Remove nut (1), lockwasher (2), and screw (3) and move filler tube bracket (4) away from governor housing (5).
- (2) Remove two nuts (6), lockwashers (7) and screws (8) and remove retaining straps (9) and filler tube bracket (4) from filler tube (10).
- (3) Remove gage (11) from oil filler tube (10).
- (4) Gently tap oil filler tube (10) from side to side and remove.

NOTE

Do not use a hammer to install oil fill tube.

- (5) Position oil fill tube (10) and tap gently from top to install.
- (6) Install retaining straps (9) and filler tube bracket (4) and secure with two screws (8), lockwashers (7), and nuts (6).
- (7) Aline filler tube bracket (4) with governor housing (5) and secure with screw (3), lockwasher (2), and nut (1).



4870-065

Figure 5-4. Oil Filler Tube and Gage, Replacement.

5-11. Starter Assembly.

This task covers: Repair

INITIAL SETUP

Tools

Equipment Condition

General Mechanic's Tool Kit (Item 1, Appendix B)

Starter removed (para. 4-39).

Repair. (figure 5-5)

(1) Remove two screws (1) and remove front bracket (2) and washer (3).

(2) Remove stop ring (4) and stopper (5).

(3) Remove two screws (6) and washers (7) and open back cover (8).

On some models of the starter the yoke assembly can be removed from the center bracket at this point.

(4) Tag brush leads and remove back cover (8), and two washers (9).

(5) Remove armature (10).

(6) Using suitable punch, remove pin (11), lever (12), and drive clutch (13).

(7) Remove two screws (14) and washers (15) and remove yoke assembly (16) and solenoid assembly (17) from center bracket (18).

NOTE

On some models of the starter the solenoid mounting screws go thru center bracket.

(8) Inspect all items, and replace those items that show signs of excessive wear or damage.

(9) Install yoke assembly (16) and solenoid assembly (17) and secure with two screws (14) and washers (15).

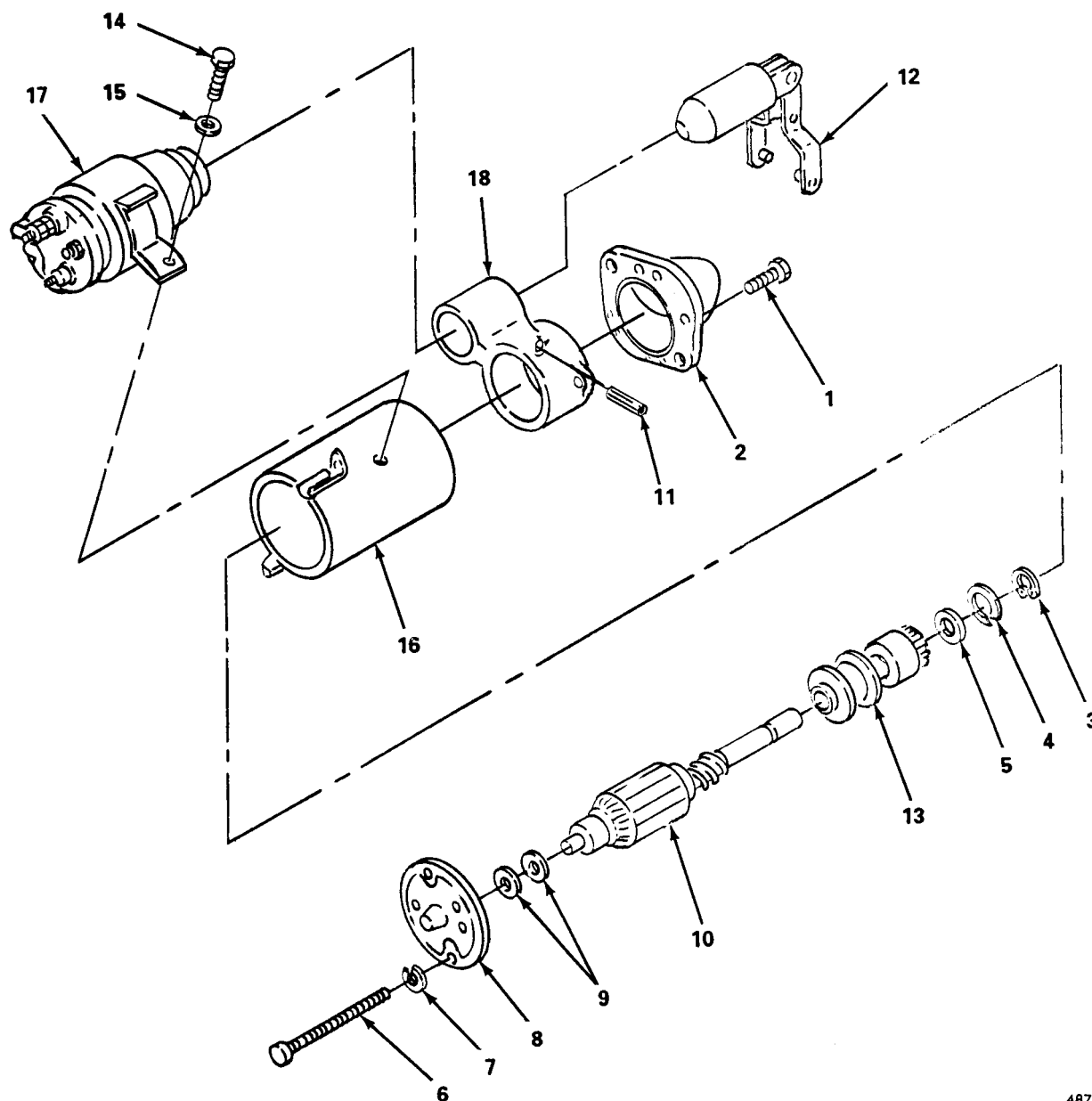
(10) Install lever (12) and drive clutch (13) and install pin (11).

(11) Install armature (10) and two washers (9).

(12) Connect brush leads as tagged and install back cover (8) and secure with two screws (6) and washers (7).

(13) Install stopper (5), stop ring (4) and washer (3).

(14) Install front bracket (2) and secure with two screws (1).



4870-085

Figure 5-5. Starter Assembly, Repair.

5-12. Carburetor.

This task covers: Repair

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Equipment Condition

Carburetor removed (para. 4-46).

Materials/Parts

Kit, Carburetor Repair (NSN 2910-01-273-7378)

Rags, Wiping (Item 7, Appendix D)

Solvent, Drycleaning (Item 8, Appendix D)

Repair. (figure 5-6)

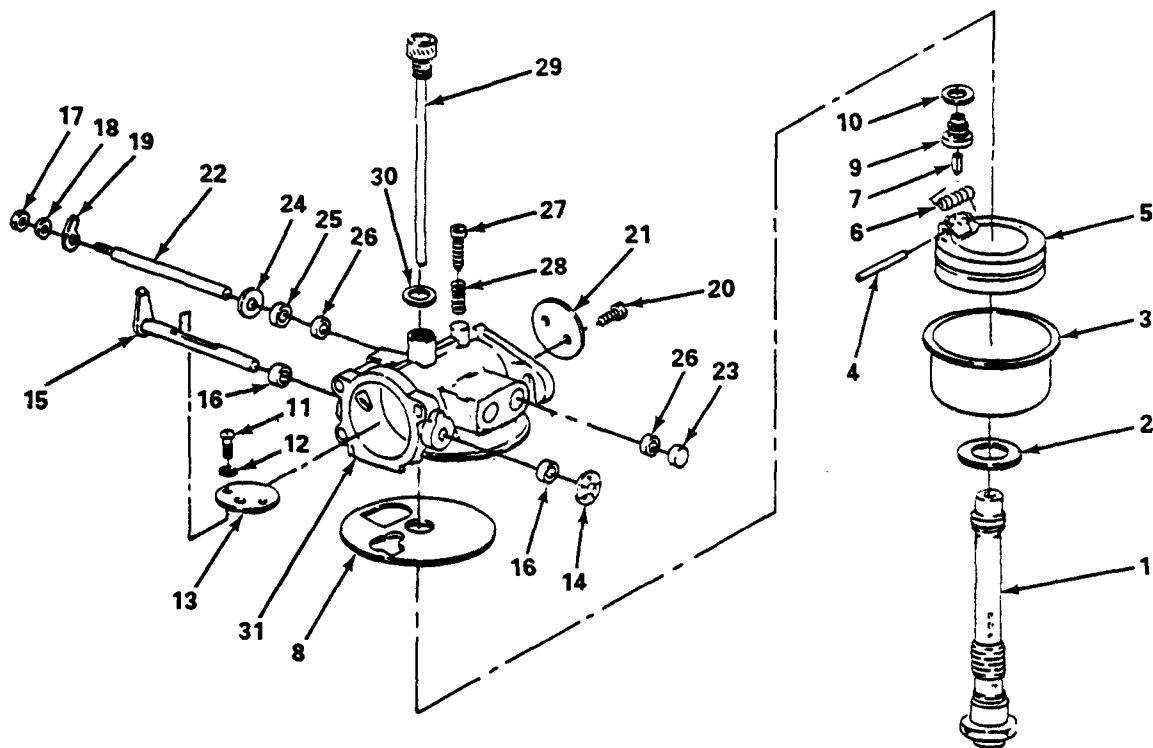
- (1) Remove screw (1) and gasket (2) and remove bowl (3).
- (2) Remove pin (4) and remove float (5), spring (6), float valve (7), and gasket (8).
- (3) Remove float valve seat (9) and gasket (10).
- (4) Remove two screws (11) and washers (12) and remove choke plate (13).
- (5) Remove retaining washer (14) and remove choke shaft (15) and two felt seals (16).
- (6) Remove nut (17) and washer (18) and remove throttle lever (19).
- (7) Remove two screws (20) and remove throttle plate (21).
- (8) Gently tap on end of throttle shaft (22) and remove cap plug (23).
- (9) Remove throttle shaft (22), seal retainer (24), rubber seal (25), and two bearings (26).
- (10) Remove idle speed jet (27) and spring (28).
- (11) Remove fuel metering tube (29) and seal washer (30).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (12) Clean all items with drycleaning solvent and dry thoroughly.

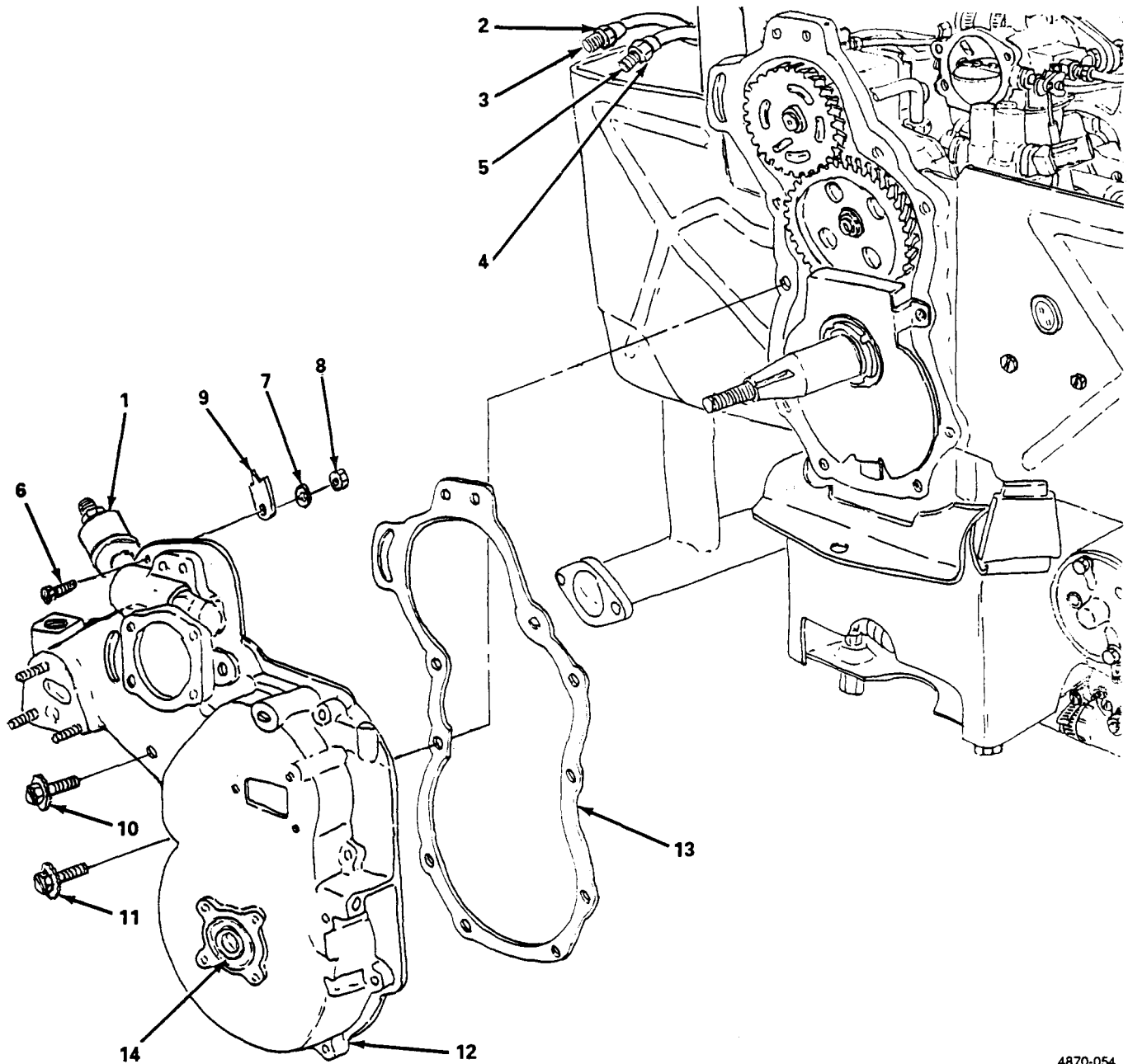
- (13) Replace all kit items. If any other parts are worn or damaged, replace carburetor.
- (14) Install fuel metering tube (29) and seal washer (30).
- (15) Install idle speed jet (27) and spring (28).
- (16) Install two bearings (26), rubber seal (25) and seal retainer (24).
- (17) Install throttle shaft (22).
- (18) Install throttle plate (21) and secure with two screws (20).
- (19) Install cap plug (23).
- (20) Install throttle lever (19) and secure with nut (17) and washer (18).
- (21) Install two felt seals (16), choke shaft (15) and retaining washer (14).
- (22) Install choke plate (13) and secure with two screws (11) and washers (12).
- (23) Install float valve seat (9) and gasket (10).
- (24) Install gasket (8), float (5), spring (6), fuel valve (7) and pin (4).
- (25) Turn carburetor (31) upside down and adjust float height to 0.20 in. (0.5 cm) above carburetor bottom by gently bending tab resting on float valve (7).
- (26) Install bowl (3) and secure with screw (1) and gasket (2).



4870-086

Figure 5-6. Carburetor, Repair.

- (2) Install assembled screw and washer (10).
- (3) Install oil filler tube bracket (9) and secure with screw (6), washer (7) and nut (8).
- (4) Install oil line (5) as tagged and tighten fitting nut (4).
- (5) Install oil line (3) as tagged and tighten fitting nut (2).
- (6) Install wiring on oil pressure transmitter (1) as tagged.



4870-054

Figure 5-7. Timing Gear Cover, Removal and Installation.

5-14. Timing Gear Cover Oil Seal.

This task covers: Replacement

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Equipment Condition

Alternator removed (para. 4-51).

Materials/Parts

Seal, Plain, Gear Cover to Crankshaft
(NSN 5330-01-174-8148)

Replacement. (figure 5-8)

- (1) Remove all dirt and debris from around oil seal (1).
- (2) Remove oil seal (1) from timing gear cover (2).
- (3) Clean oil seal mounting surfaces.

NOTE

Do not use a hammer to install oil seal.

- (4) Install oil seal (1) in timing gear cover (2).

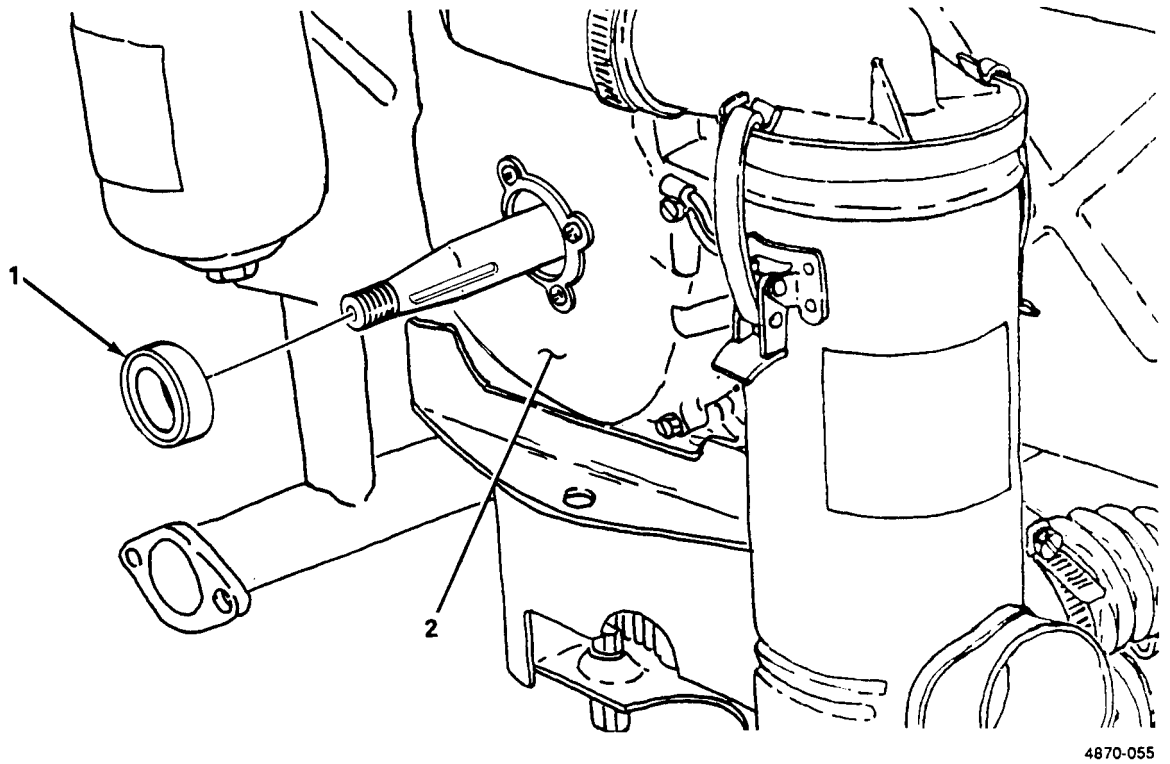
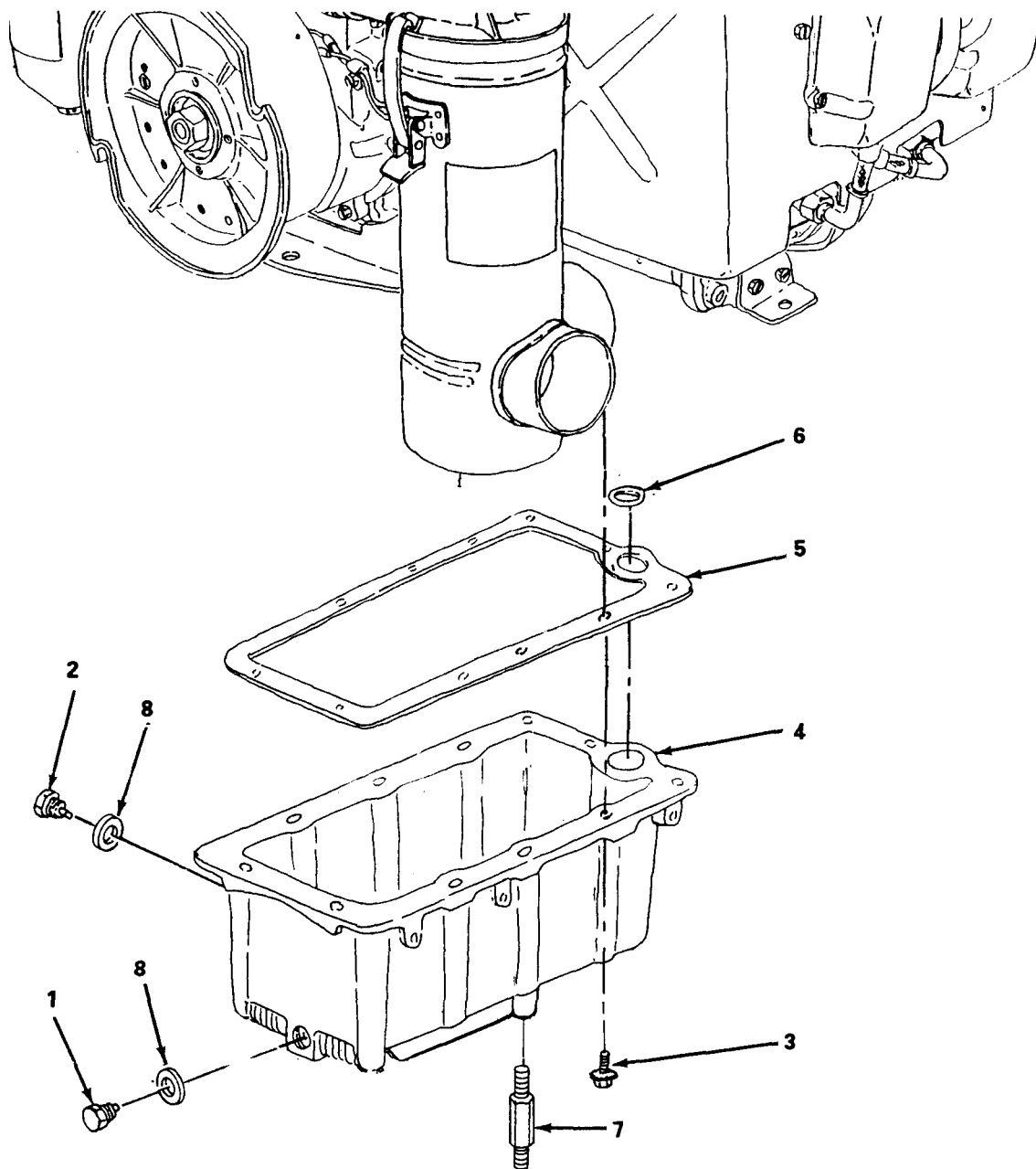


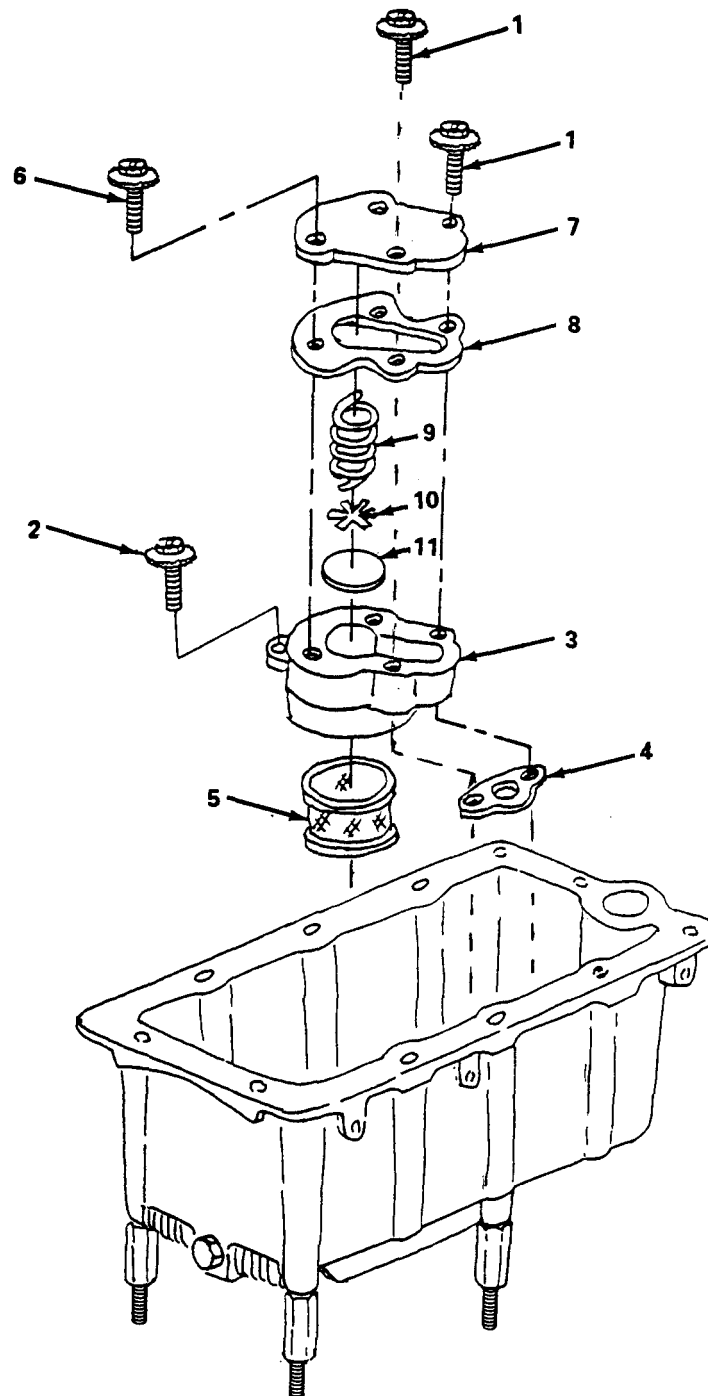
Figure 5-8. Timing Gear Cover Oil Seal, Replacement.

- (4) Fill crankcase with oil (refer to LO 9-2805-259-14 for proper grade of oil) and operate engine for ten minutes and check for leaks.



4870-058

Figure 5-9. Oil Pan, Removal and Installation.



4870-059

Figure 5-10. Check Valve, Removal and Installation.

5-17. Cylinder Head Assembly.

This task covers:	a. Removal	b. Repair	c. Installation
-------------------	------------	-----------	-----------------

INITIAL SETUP

<i>Tools</i>	<i>Materials/Parts (cont)</i>
General Mechanic's Tool Kit (Item 1, Appendix B)	Gasket, Intake Manifold to Cylinder Head
Wrench, Torque (NSN 5120-00-853-4538)	(NSN 5330-00-017-8927)
(Item 6, Appendix B)	
Compressor, Valve Spring (NSN 5130-00-096-6677)	<i>Equipment Condition</i>
(Item 4, Appendix B)	
Wrench, Torque (NSN 5120-00-640-6364)	Rocker covers removed (para. 4-50).
(Item 6, Appendix B)	Top cover, left and right shrouds removed (para. 4-21).
	Exhaust manifold removed (para. 4-44).
<i>Materials/Parts</i>	Spark plugs removed (para. 4-37).
Rags, Wiping (Item 7, Appendix D)	
Solvent, Drycleaning (Item 8, Appendix D)	

NOTE

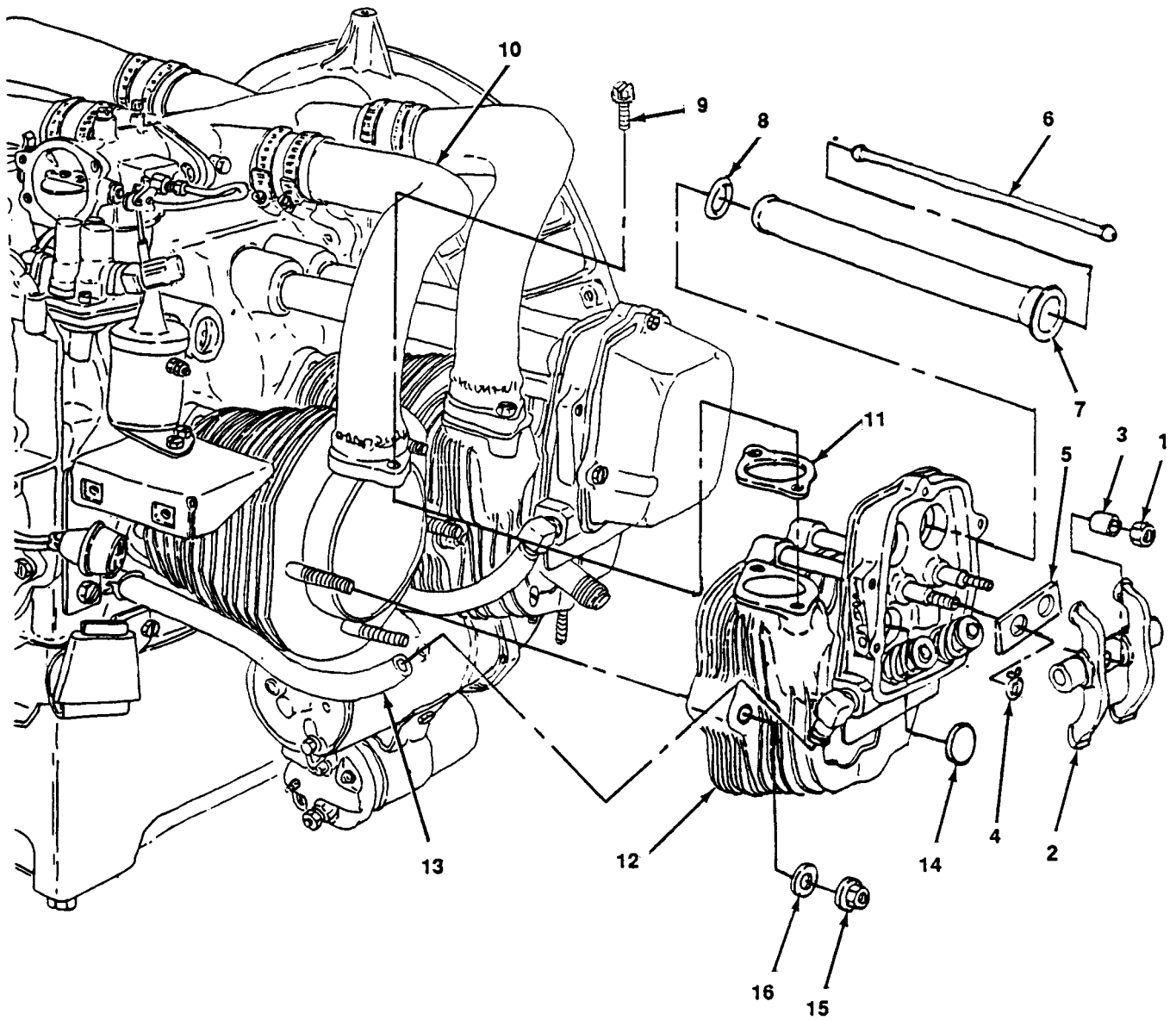
This engine is equipped with four cylinder head assemblies. The following maintenance procedures are the same for all cylinder head assemblies.

a. Removal. (figure 5-11)

NOTE

Older engine models have a spring located under rocker shaft. Remove and discard the spring, and replace it with retainer plate. Refer to TM 5-2805-259-24P.

- (1) Remove two nuts (1) and remove rocker assembly (2) and sleeve bushings (3).
- (2) Remove two spring clamps (4) and retainer plate (5).
- (3) Remove pushrods (6), pushrod housings (7), and preformed packings (8).
- (4) Remove two assembled screws and washers (9) securing intake manifold (10) and gasket (11) to cylinder head (12).
- (5) Disconnect rocker box hose (13) from cylinder head (12).
- (6) Remove rubber access plug (14).
- (7) Remove four nuts (15) and washers (16) and remove cylinder head (12).



4870-061

Figure 5-11. Cylinder Head Assembly, Removal.

5-17. **Cylinder Head Assembly (cont).**

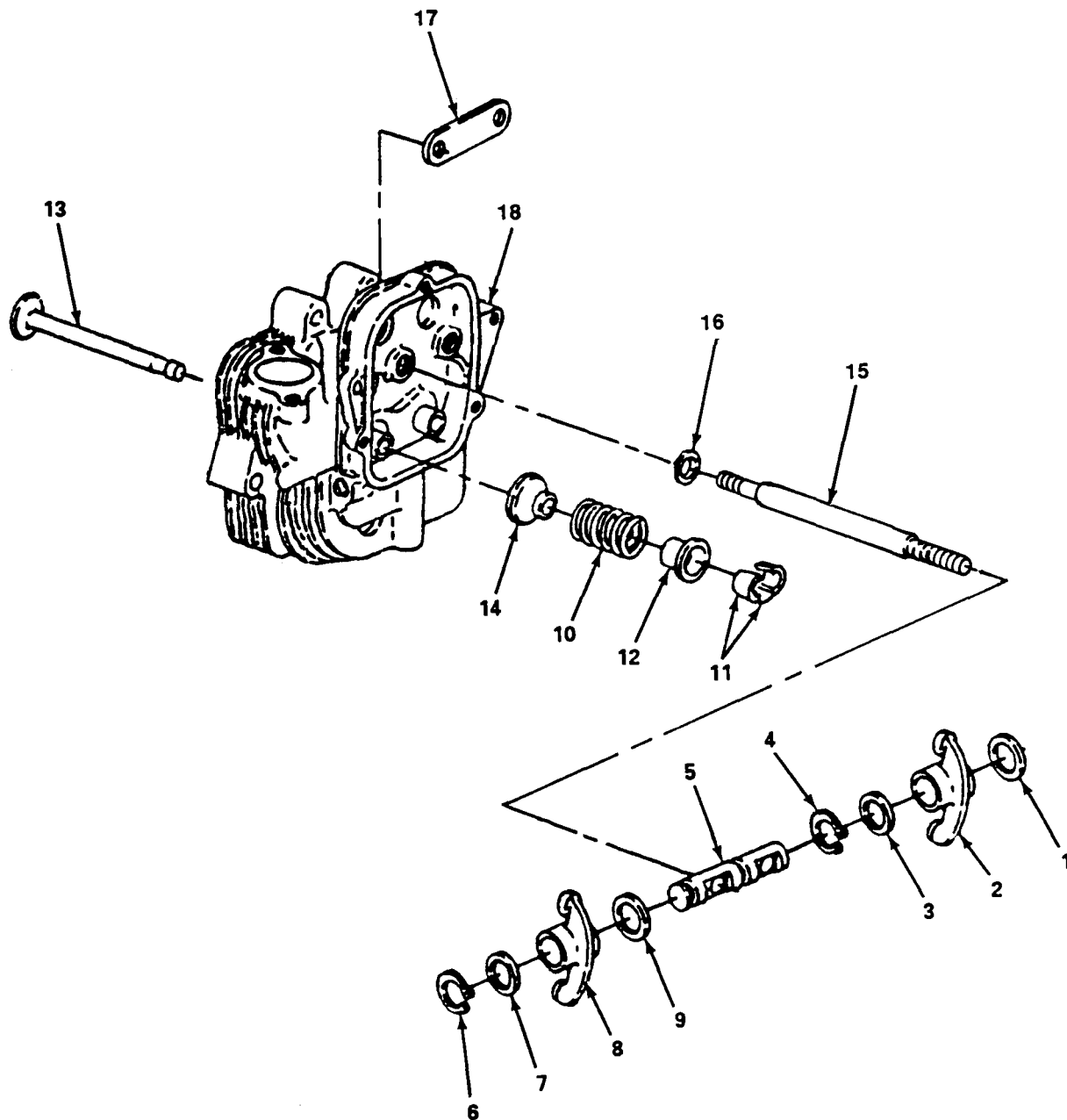
b. Repair. (figure 5-12)

- (1) Remove washer (1), rocker (2), washer (3) and retaining ring (4) from rocker shaft (5).
- (2) Remove retaining ring (6), washer (7), rocker (8) and washer (9) from rocker shaft (5).
- (3) Using suitable valve spring compressor, compress valve spring (10) and remove two retainers (11), roto cap (12), valve spring (10), valve (13) and seal (14).
- (4) Repeat steps 1 through 3 for remaining valve.
- (5) Remove rocker shaft supports (15), seals (16) and rocker shaft plate (17).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (6) Clean all items, except seals, in drycleaning solvent, and dry thoroughly.
- (7) Inspect all items and replace if worn or otherwise damaged. Refer to Table 5-1 for wear limits.
- (8) Reseat valves in cylinder head (18).
- (9) Install rocker shaft plate (17), seals (16) and rocker shaft supports (15).
- (10) Install valve (13), seal (14), spring (10), and roto cap (12).
- (11) Using valve spring compressor, compress valve spring (10) and install two retainers (11).
- (12) Repeat step 10 and 11 for remaining valve.
- (13) Install washer (9), rocker (8), washer (7) and retaining ring (6).
- (14) Install retaining ring (4), washer (3), rocker (2) and washer (1).



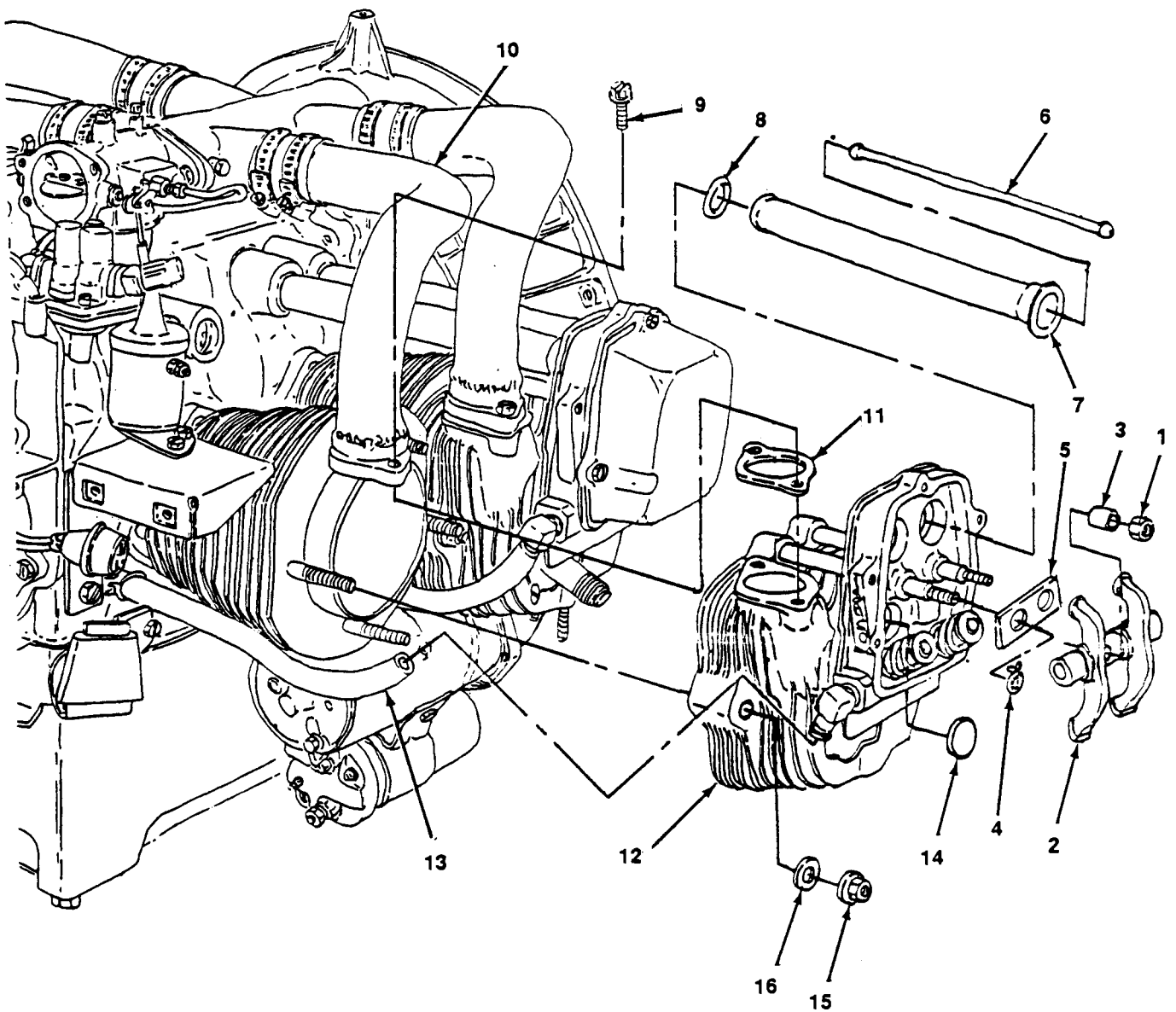
4870-062

Figure 5-12. Cylinder Head Assembly, Repair.

5-17. Cylinder Head Assembly (cont).

c. Installation. (figure 5-13)

- (1) Ensure gasket mating surfaces are clean and old gasket material is removed.
- (2) Install preformed packings (8).
- (3) Install cylinder head (12) and secure with four nuts (15) and washers (16). Torque nuts to 22-24 lb-ft (47193 - 51483 gr cm).
- (4) Install pushrod housings (7) through cylinder head (12).
- (5) Install pushrods (6).
- (6) Install retainer plate (5) and secure with two spring clamps (4).
- (7) Position rockers (2) and bushings (3) on pushrods (6) and tighten nuts (1). Torque nuts to 72-86 in.-lb (12870 -15373 gr cm).
- (8) Install rubber access plug (15).
- (9) Install rocker box hose (13).
- (10) Position intake manifold (10) and gasket (11) and secure with two assembled screws and washers (9).



4870-063

Figure 5-13. Cylinder Head Assembly, Installation.

5-18. **Rockers.**

This task covers: a. Removal b. Inspection/Repair c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)
Wrench, Torque (NSN 5120-00-853-4538)
(Item 6, Appendix B)

Equipment Condition

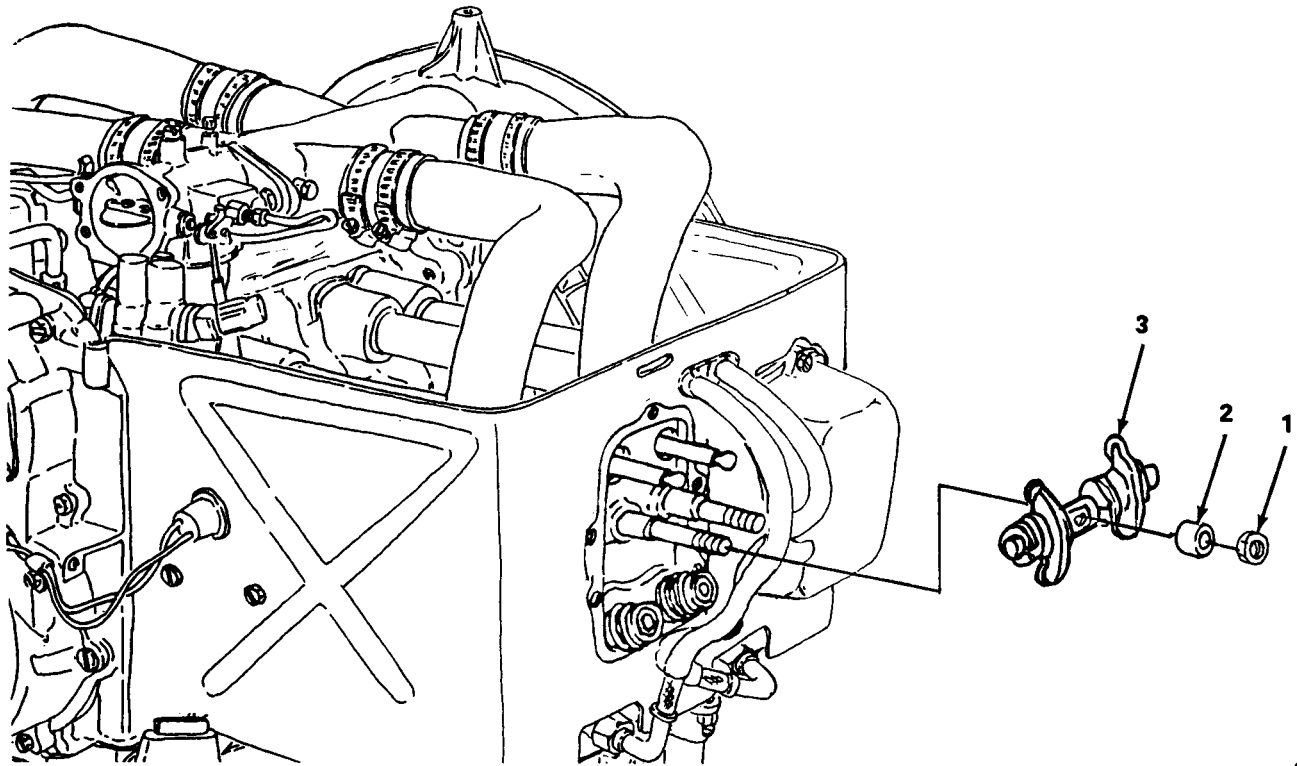
Rocker arm covers removed (para. 4-50).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

a. Removal. (figure 5-14)

Remove two nuts (1) and bushings (2) and remove rocker assembly (3).



4870-080

Figure 5-14. Rockers, Removal.

5-18. **Rockers (cont).**

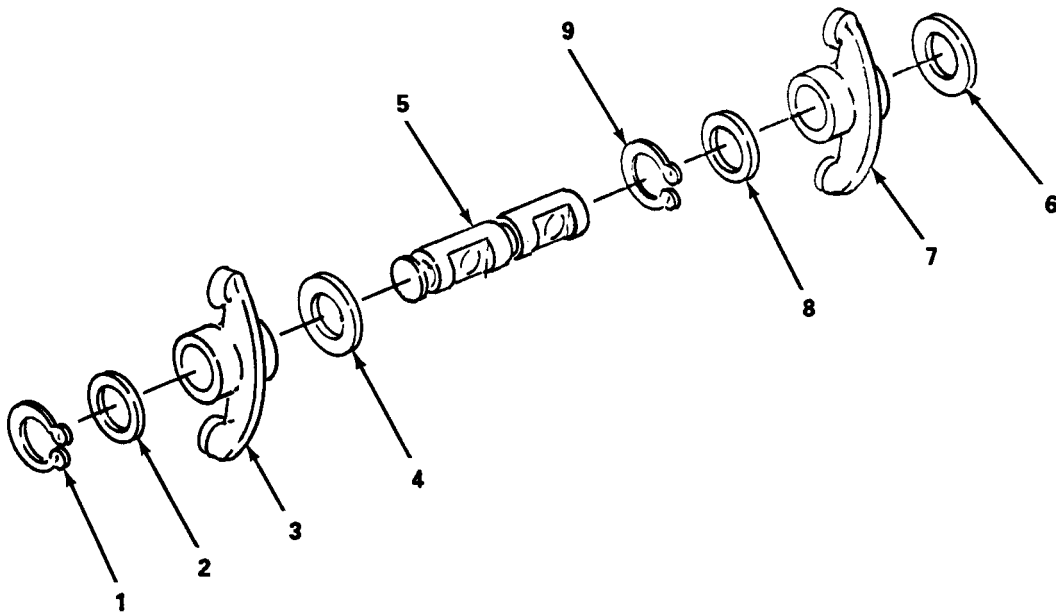
b. Inspection/Repair. (figure 5-15)

- (1) Remove retaining ring (1), washer (2), rocker (3), and washer (4) from rocker shaft (5).
- (2) Remove washer (6), rocker (7), washer (8), and retaining ring (9) from rocker shaft (5).

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F.(38°C.-60°C.).

- (3) Clean all items with drycleaning solvent and dry thoroughly.
- (4) Inspect all items and replace all items that are worn or otherwise damaged. Refer to Table 5-2 for wear limits.
- (5) Install retaining ring (9), washer (8), roller (7), and washer (6) on rocker shaft (5).
- (6) Install washer (4), rocker (3), washer (2), and retaining ring (1) on rocker shaft (5).

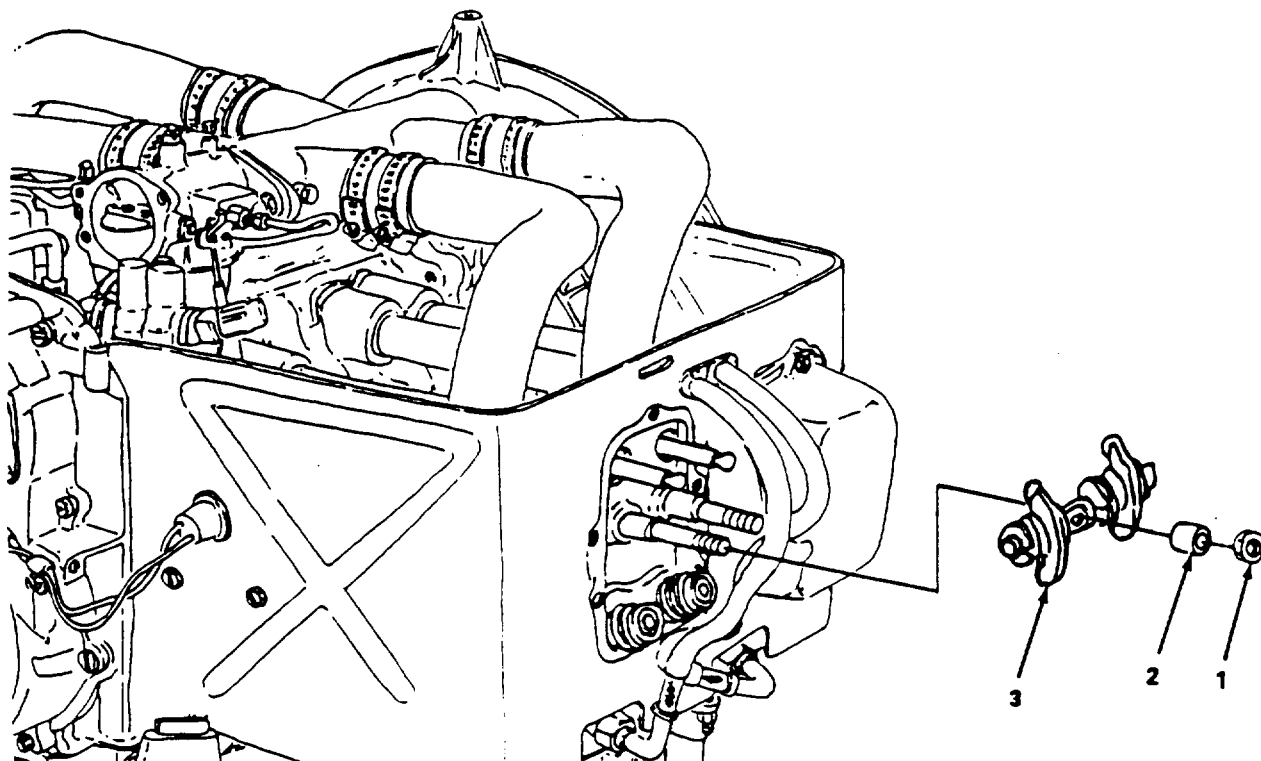


4870-081

Figure 5-15. Rockers, Inspection/Repair.

c. Installation. (figure 5-16)

Install rocker assembly (3) and secure with two nuts (1) and bushings (2). Torque nuts to 72 - 86 in.-lb (12870 - 15373gr cm).



48 70-082

Figure 5-16. Rockers, Installation.

Change 4 5-33

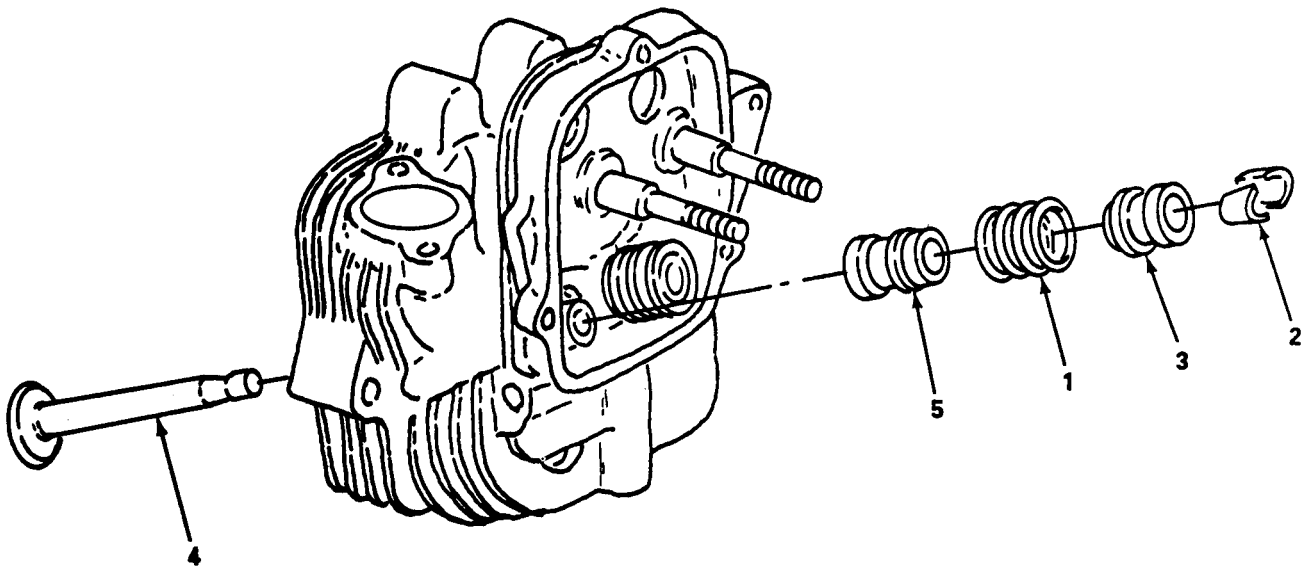
The following procedures are the same for both the intake and exhaust valves.

(1) Using valve spring compressor, compress valve spring (1) and remove two retainers (2), rotor cap (3), spring (1), valve (4), and seal (5).

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (2) Clean all items with drycleaning solvent and dry thoroughly.
- (3) Inspect all items and replace all worn or otherwise damaged components. Refer to Table 5-2 for wear limits.

- (1) Grind or seat valve (4) and install Valve (4), seal (5), spring (1) and roto cap (3).
- (2) Using valve spring compressor, compress valve spring (1) and install two retainers (2).



4870-103

Figure 5-17 Intake and Exhaust Valves, Removal and Installation.

487C-064

5-21. Rear Oil Seal.

This task covers: Replacement

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)
Seal Replacement Tool (NSN 5120-00-357-6917)
(Item 4, Appendix B)

Equipment Condition

Flywheel removed (para. 5-7).

Materials/Parts

Seal, Plain Encased (NSN 5330-00-073-3014)

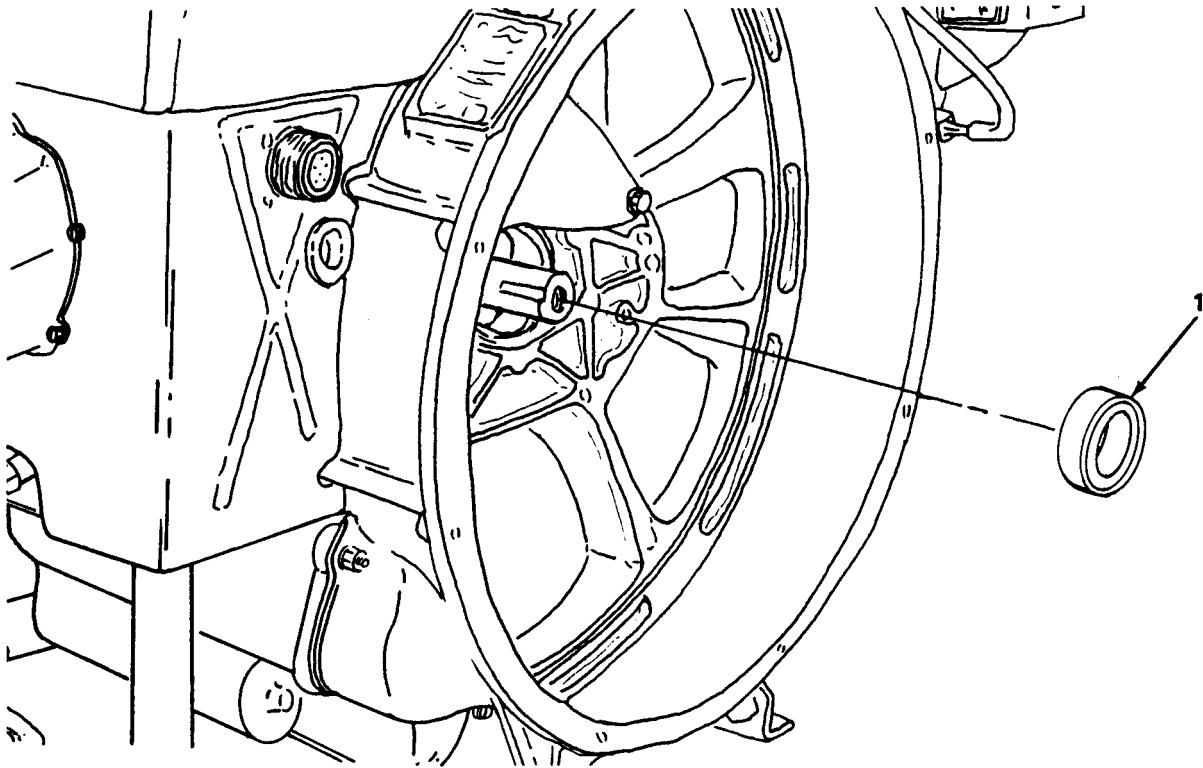
Replacement. (figure 5-19)

- (1) Clean all dirt and debris from around rear oil seal.
- (2) Remove rear oil seal (1).
- (3) Clean oil seal mounting surfaces.

NOTE

Do not use a hammer to install oil seal.

- (4) Using seal replacement tool install rear oil seal (1).



4870-056

Figure 5-19. Rear Oil Seal, Replacement.

Table 5-2. Engine Repair and Replacements Limits.

Item	Measurements	
	Minimum	Maximum
VALVES:		
Exhaust		
Length	4.3930 (11.1582)	4.4080 (11.1963)
Stem diameter	0.3405 (0.8649)	0.3415 (0.8674)
Head diameter	1.3700 (3.4798)	1.1380 (3.5052)
Seat angle	45°0'	45°15'
Stem to guide clear	0.0030 (0.0076)	0.00450 (0.0114)
Clear valve to lift	N/A	N/A
Minimum Edge - Thickness of valve head relative to seat surface	0.0000 (0.0000)	0.0310 (0.0787)
Intake		
Length	4.3930 (11.1582)	4.4080 (11.1963)
Stem diameter	0.3405 (0.8649)	0.3415 (0.8674)
Head diameter	1.3700 (3.4798)	1.3800 (3.5052)
Seat angle	45°0'	45°15'
Stem to guide clear	0.0005 (0.0013)	0.0020 (0.0050)
Clear valve to lift		
VALVE SPRINGS:		
Length (valve open)	1.1200	
Pounds load (valve open)	100 (454)	110 (499)
Length (valve closed)	1.4400 (3.6576)	
Pounds load (valve closed)	57 (259)	63 (286)
Valve Guide Exhaust		
Length	1.7970 (4.5644)	1.8280 (4.6431)
Outside dia	0.5005 (1.2713)	0.5010 (1.2725)
Inside dia	0.3420 (0.8687)	0.3425 (0.8899)

Table 5-2. Engine Repair and Replacements Limits (cont).

Item	Measurements	
	Minimum	Maximum
Intake		
Length	1.7970 (4.5644)	1.8280 (4.6431)
Outside dia	0.5005 (1.2713)	0.5010 (1.2725)
Inside dia	0.3420 (0.8687)	0.3425 (0.8899)
Valve Seat Inserts Exhaust		
Outside dia	1.2595 (3.1991)	1.2605 (3.2193)
Inside dia	0.9980 (2.5349)	1.0030 (2.5476)
Seat angle	44°30'	45°0'
Intake		
Outside dia	1.4895 (3.7833)	1.4905 (3.7859)
Inside dia	1.2100 (0.0734)	1.2200 (3.0988)
Seat angle	44°30'	45°0'
Valve Tappets		
Outside dia	0.8740 (2.2199)	0.8745 (2.2212)
Clearance in guide	0.0015 (0.0038)	0.0030 (0.0076)
Rocker Arms		
Rocker shaft od	0.6246 (1.5865)	0.6248 (1.5870)
Rocker arm bushing	0.7495 (1.9037)	0.7505 (1.9063)
Rocker arm bushing id	0.6253 (1.5883)	0.6259 (1.5898)
Oil Pump		
Gear to end cover tolerance	0.0043 (0.0109)	0.0097 (0.0246)
Gear tooth tolerance od	1.5270 (3.8785)	1.5280 (3.8811)

CHAPTER 6

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

	Page
OVERVIEW	6-1
Section I Repair Parts; Special Tools; Test, Measurement, Diagnostic Equipment (TMDE); and Support Equipment	6-1
Section II. General Support Troubleshooting	6-1
Section III. General Support Maintenance Procedures	6-3

OVERVIEW

This chapter provides procedures for troubleshooting and maintenance of the 20 HP Military Standard Engine by General Support maintenance personnel.

Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT, DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

Paragraph		Page
6-1	Common Tools and Test Equipment.....	6-1
6-2	Special Tools, TMDE, and Support Equipment	6-1
6-3	Repair Parts	6-1

6-1. Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

6-2. Special Tools, TMDE and Support Equipment. For a listing of special tools, TMDE, and support equipment authorized for use on this equipment, refer to the Repair Parts and Special Tools List, TM 5-2805-259-24P, and the maintenance allocation chart (MAC), appendix B of this manual.

6-3. **Repair Parts.** Repair parts are listed and illustrated in the Repair Parts and Special Tools List for 20 HP Military Standard Engine TM 5-2805-259-24P.

Section II. GENERAL SUPPORT TROUBLESHOOTING

Paragraph	Page
6-4 General	6-1
6-5 General Support Troubleshooting Procedures	6-2

6-4. **General.** This section contains troubleshooting procedures to determine the probable cause of observed equipment malfunctions. Tests or inspections are provided to isolate the faulty component and corrective actions are provided to eliminate the malfunction.

6-5. **General Support Troubleshooting Procedures.** Table 6-1 lists the common malfunctions that may be found during operation. Refer to Symptom Index to locate the troubleshooting procedures for the malfunction. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not corrected by listed corrective actions, notify your supervisor.

SYMPTOM INDEX	
Symptom	Page
Engine Misses or Runs Erratically	6-2
Engine Lacks Power	6-2
Engine Runs Excessively Noisy	6-2
Engine Oil Consumption Excessive..	6-3
Engine Exhaust Smoky	6-3

Table 6-1. General Support Troubleshooting Procedures.

Malfunction
Test or Inspection
Corrective Action
1. ENGINE MISSES OR RUNS ERRATICALLY.
Step 1. Inspect piston and piston rings.
Replace a worn or otherwise damaged piston and rings (para. 6-7).
Step 2. Inspect camshaft assembly.
Replace a worn or otherwise damaged camshaft assembly (para. 6-9).
2. ENGINE LACKS POWER.
Step 1. Inspect piston and connecting rod assembly.
Replace a worn piston and connecting rod assembly (para. 6-7).
Step 2. Inspect cylinder.
Replace a worn cylinder (para. 6-8).
3. ENGINE RUNS EXCESSIVELY NOISY.
Step 1. Inspect piston and connecting rod assembly.
Repair or replace worn or otherwise damaged piston and connecting rod assembly (para. 6-7).

Table 6-1. General Support Troubleshooting Procedures (cont).

Malfunction	Test or Inspection	Corrective Action
3. ENGINE RUNS EXCESSIVELY NOISY (cont).		
	Step 2. Inspect camshaft, camshaft gear, and bearing.	Replace a worn or otherwise damaged camshaft, camshaft gear, and bearing (para. 6-9).
	Step 3. Inspect crankshaft.	Replace a worn or otherwise damaged crankshaft (para. 6-10).
4. ENGINE OIL CONSUMPTION EXCESSIVE.		
	Step 1. Inspect piston and piston rings.	Replace worn or otherwise damaged piston and piston rings (para. 6-7).
	Step 2. Inspect cylinder.	Replace a worn or otherwise damaged cylinder (para. 6-8).
5. ENGINE EXHAUST SMOKY.		
	Step 1. Inspect piston and connecting rod.	Replace or repair a damaged piston and connecting rod (para. 6-7).
	Step 2. Inspect cylinder.	Replace a damaged or worn cylinder (para. 6-8).

Section III. GENERAL SUPPORT MAINTENANCE PROCEDURES

Paragraph		Page
6-6	General	6-3
6-7	Piston and Connecting Rod	6-4
6-8	Cylinder	6-10
6-9	Camshaft, Camshaft Gear, and Bearing	6-12
6-10	Crankshaft	6-14
6-11	Crankcase	6-18

6-6. **General.** This section contains general support maintenance procedures as authorized by the MAC in Appendix B of this manual. Table 6-2 at the end of this section, contains wear limits for those items maintained by general support maintenance. Those items which do not meet the specified measurements must be replaced. Refer to Appendix E for torque values. All maintenance procedures require only one person to perform. It may be necessary to remove the engine from the end item to perform some general support level maintenance procedures. Refer to the end item manual for procedures to remove the engine.

6-7. Piston and Connecting Rod.

This task covers: a. Removal b. Repair c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)
Wrench, Torque (NSN 5120-00-640-6364)
(Item 6, Appendix B)
Compressor, Piston Ring (NSN 5120-00-250-6055)
(Item 4, Appendix B)

Materials/Parts

Rags, Wiping (Item 7, Appendix D)
Solvent, Drycleaning (Item 8, Appendix D)

Materials/Parts (cont)

Nuts, Lock (NSN 5310-00-917-6624)
Nuts (NSN 5310-00-917-6624)

Equipment Condition

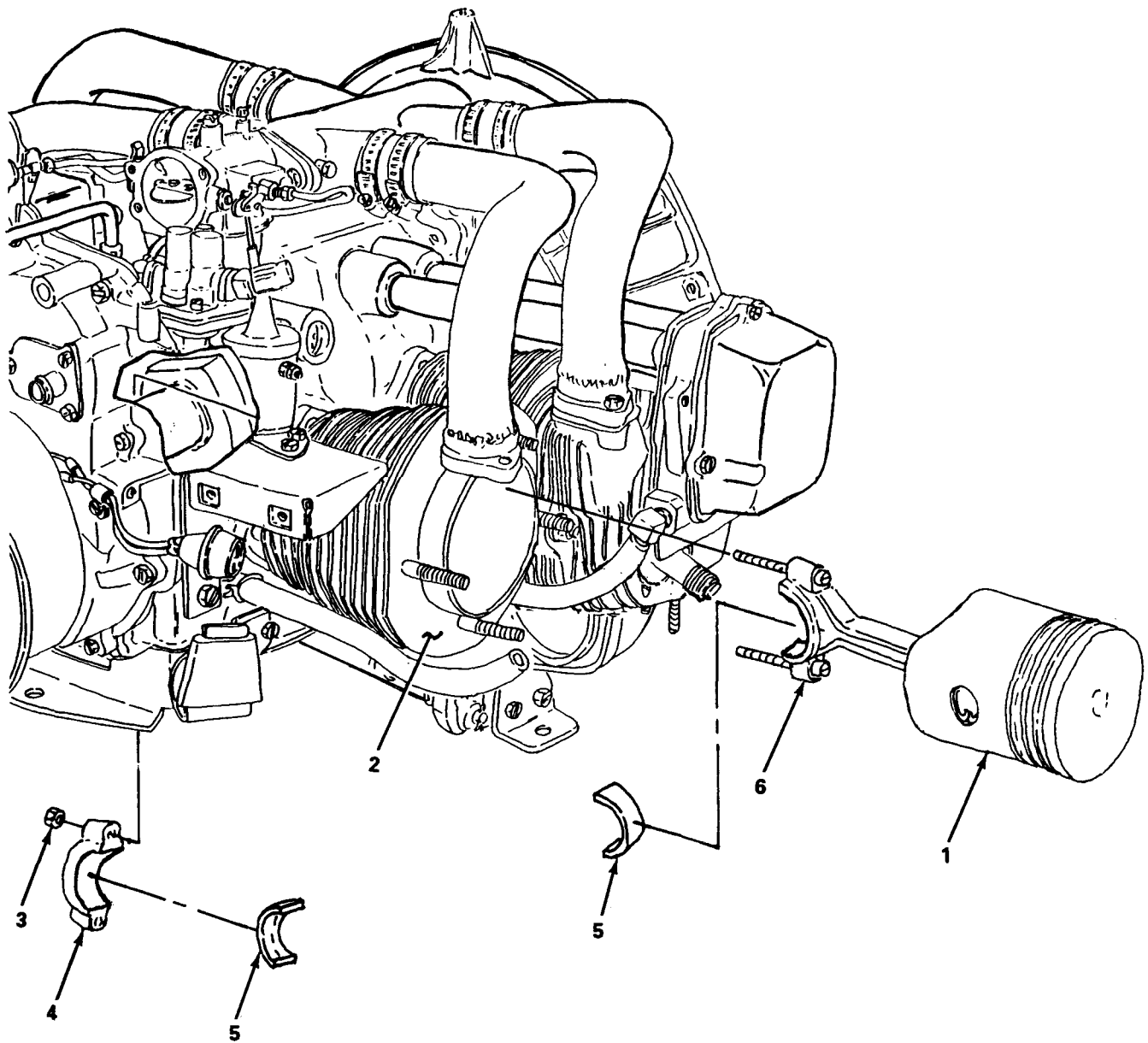
Cylinder head removed (para. 5-17).
Oil pan removed (para. 5-15).

NOTE

This engine is equipped with four pistons and connecting rods, the following procedures are the same for all.

a. Removal. (figure 6-1)

- (1) Remove all carbon deposits from top of piston (1) and cylinder (2).
- (2) Remove two nuts (3) and remove connecting rod bearing cap (4) and bearings (5).
- (3) Slide piston (1) with connecting rod (6) out of cylinder (2).



4870-067

Figure 6-1. Piston and Connecting Rod, Removal.

6-7. Piston and Connecting Rod (cont).

NOTE

Do not reuse piston rings or retaining rings.

b. Repair. (figure 6-2)

- (1) Remove two retaining rings (1) and slide piston pin (2) out of piston (3) and connecting rod (4).
- (2) Remove spacer ring (5), compression ring (6), intermediate compression ring (7), oil rings (8) and expander ring (9).

WARNING

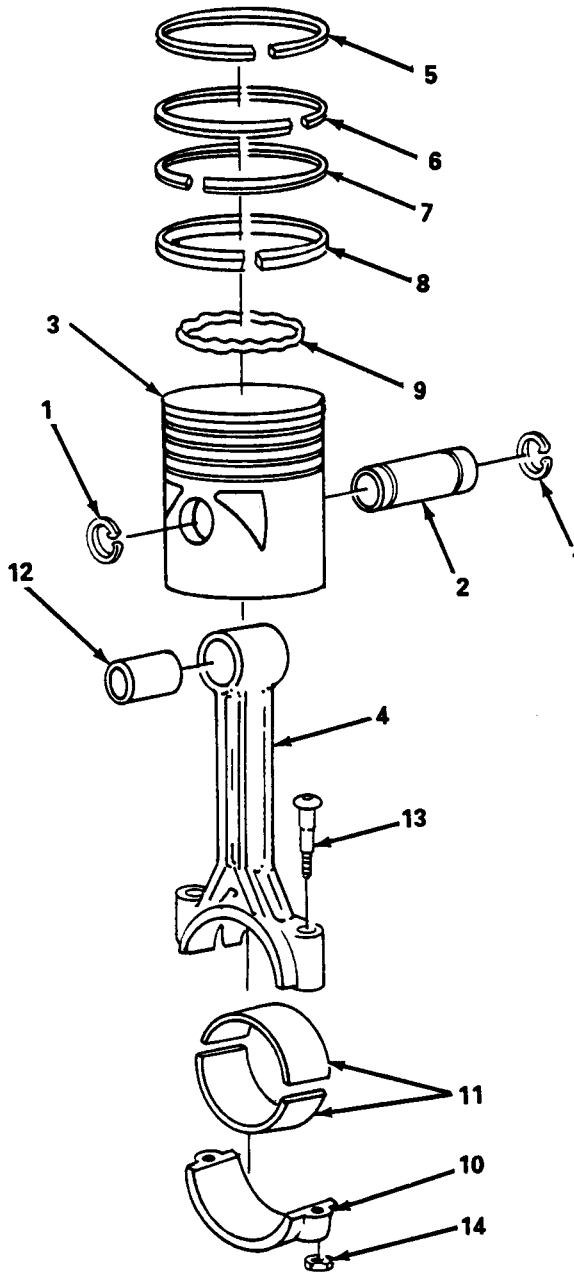
Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (3) Clean all items in drycleaning solvent, and dry thoroughly.

NOTE

Connecting rod bushing must be pressed out to replace.

- (4) Inspect connecting rod bearing cap (10), connecting rod (4), bearings (11), and bushing (12). Refer to Table 6-2 for wear limits. Replace all items that are worn or otherwise damaged.
- (5) Ensure piston ring grooves are clean, and all carbon deposits are removed.
- (6) Inspect piston (3) and replace a worn or otherwise damaged piston. Refer to table 6-2 for wear limits.
- (7) Install ring expander (9), oil rings (8), intermediate compression ring (7), compression ring (6), and spacer ring (5).
- (8) Position connecting rod (4) in piston (3) and install piston pin (2) and two retaining rings (1).



4870-070

Figure 6-2. Piston and Connecting Rod, Repair.

6-7. Piston and Connecting Rod (cont).

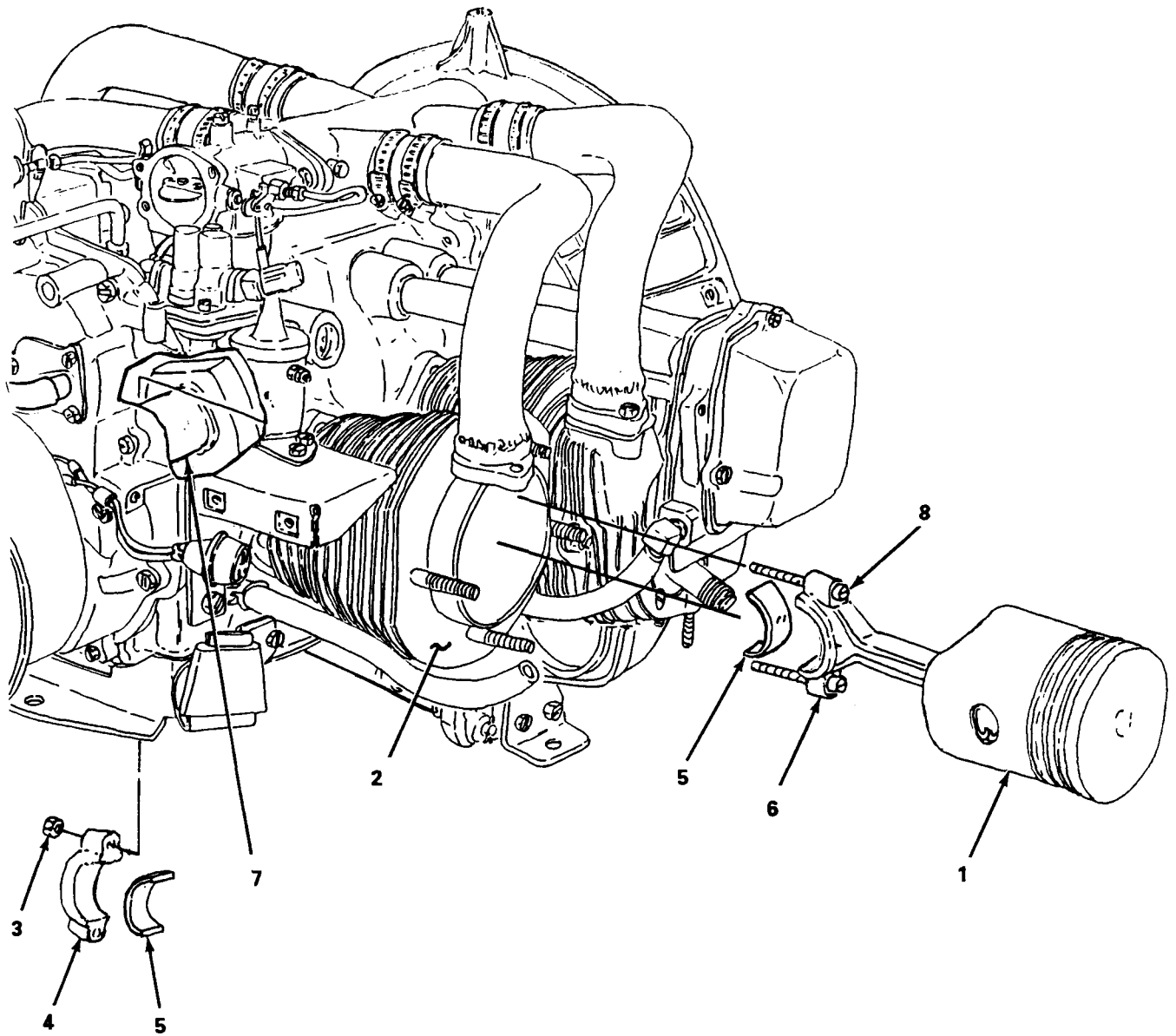
c. Installation. (figure 6-3)

- (1) Using ring compressor, install piston (1) with connecting rod (6) in cylinder (2).

NOTE

Before positioning connecting rod on crankshaft, ensure arrow on piston is in direction of rotation. See crankcase area to left of cylinder for reference rotation arrow.

- (2) Position connecting rod (6) and bearing (5) on crankshaft (7).
- (3) Install connecting rod bearing cap (4) and bearing (5) and secure with two new nuts (3) and bolts (8). Torque nuts to 24-26 lb-ft (51484-55774 gr cm.)



4870-071

Figure 6-3. Piston and Connecting Rod, Installation.

6-8. Cylinder.

This task covers: a. Removal b. Inspect c. Installation

INITIAL SETUP

Tools

General Mechanic's Tool Kit (Item 1, Appendix B)

Equipment Condition

Piston and connecting rod removed (para. 6-7).

Materials/Parts

Rags, Wiping (Item 7, Appendix D)

Solvent, Drycleaning (Item 8, Appendix D)

Gasket, Cylinder to Crankcase (NSN 5330-00-570-3224)

NOTE

The engine is equipped with four cylinders, the following are the same for all four.

a. Removal. (figure 6-4)

Gently work cylinder (1) from side to side and remove cylinder (1) and gasket (2) from crankcase (3).

b. Inspect. (figure 6-4)

WARNING

Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

(1) Clean cylinder (1) with drycleaning solvent and dry thoroughly.

NOTE

Any cylinder requiring honing or boring to restore concentricity and remove taper shall be done by machine. Cylinders should be honed or bored only to the degree necessary to restore concentricity and/or remove taper. Refer to table 6-2 for wear limits.

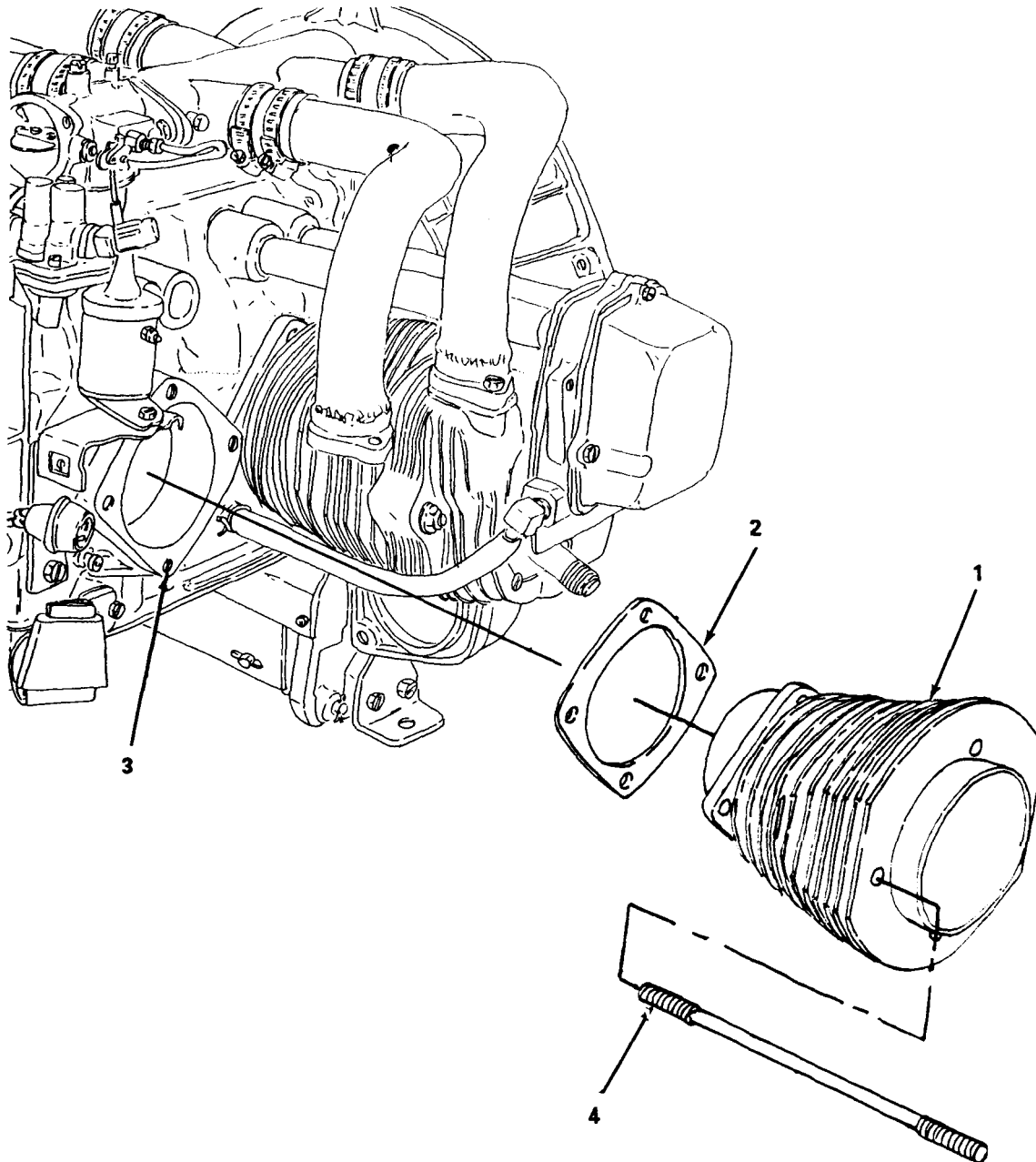
(2) Inspect cylinder (1) for wear or damage. Refer to table 6-2 for wear limits.

(3) Inspect studs (4) and replace if threads are stripped or otherwise damaged.

c. Installation. (figure 6-4)

(1) Ensure gasket mating surfaces are clean and old gasket material is removed.

(2) Install cylinder (1) and gasket (2) and gently tap cylinder with block of wood or mallet to seat.



4870-072

Figure 6-4. Cylinder, Removal and Installation.

This task covers: a. Removal b. Installation

Tools

Materials/Parts

Rags, Wiping (Item 7, Appendix D)

Solvent, Drycleaning (Item 8, Appendix D)

Equipment Condition

Oil pump gears removed (para. 5-9).

Fuel pump removed (para. 4-48).

Valve tappets removed (para. 5-20).

Timing cover removed (para. 5-13).

a. Removal. (figure 6-5)

NOTE

(2) Remove two assembled screws and washers (1), and remove camshaft gear (2), key (3), camshaft (4), spacer (5) and bearing (6).

WARNING

(3) Clean all items with drycleaning solvent and dry thoroughly.

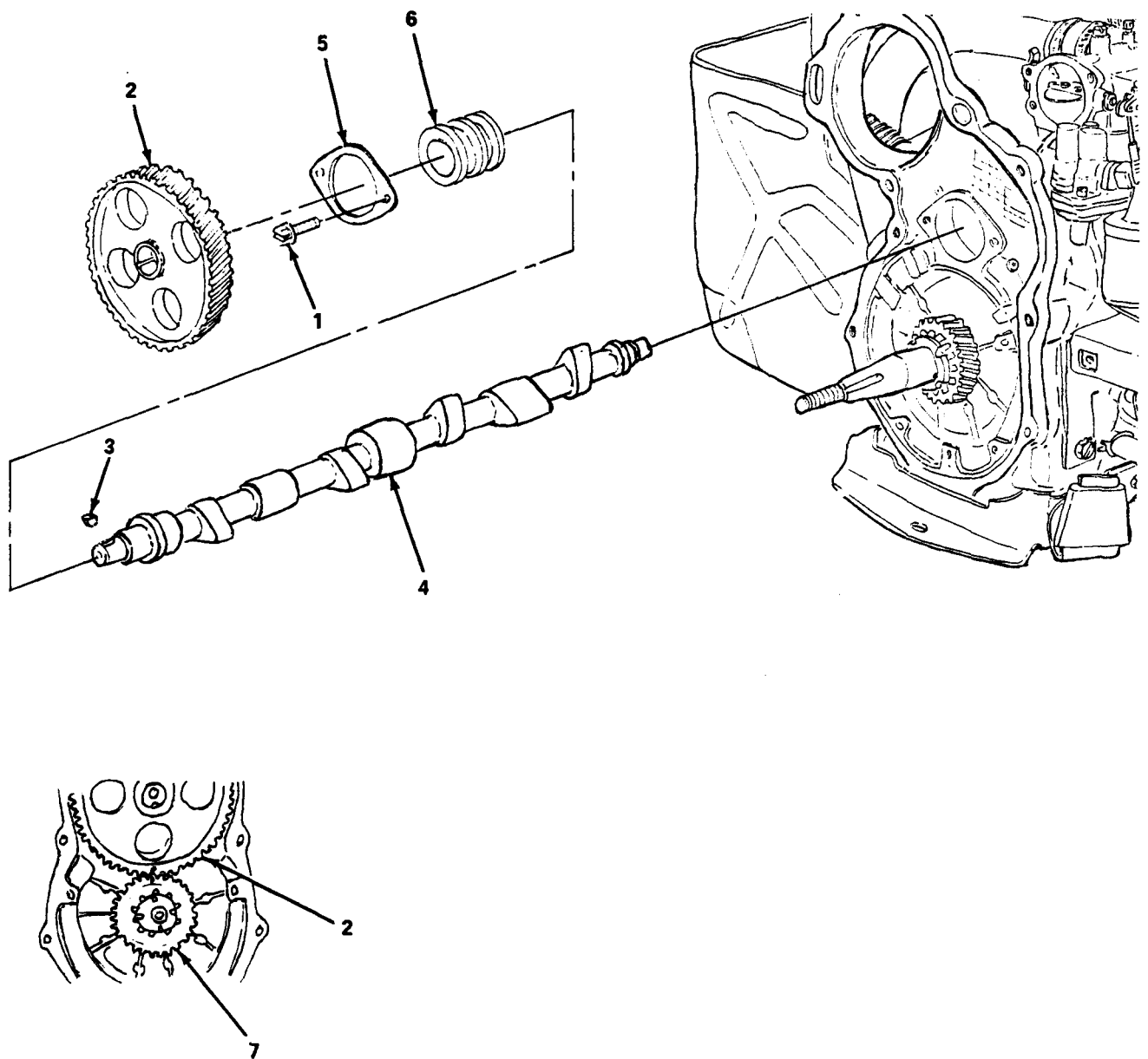
(4) Inspect all items and replace worn or otherwise damaged parts. Refer to Table 6-2 for wear limits.

b. Installation. (figure 6-5)

(1) Install bearing (6), spacer (5), key (3) and camshaft gear (2) onto camshaft (4).

(2) Install camshaft (4) with all items installed, and align timing marks on camshaft gear (2) with timing mark on crankshaft gear (7).

(3) Install two assembled screws and washers (1).



4870-086

Figure 6-5. Camshaft, Camshaft Gear and Bearing, Removal and Installation.

This task covers: a. Removal b. Installation

Tools

Materials/Parts

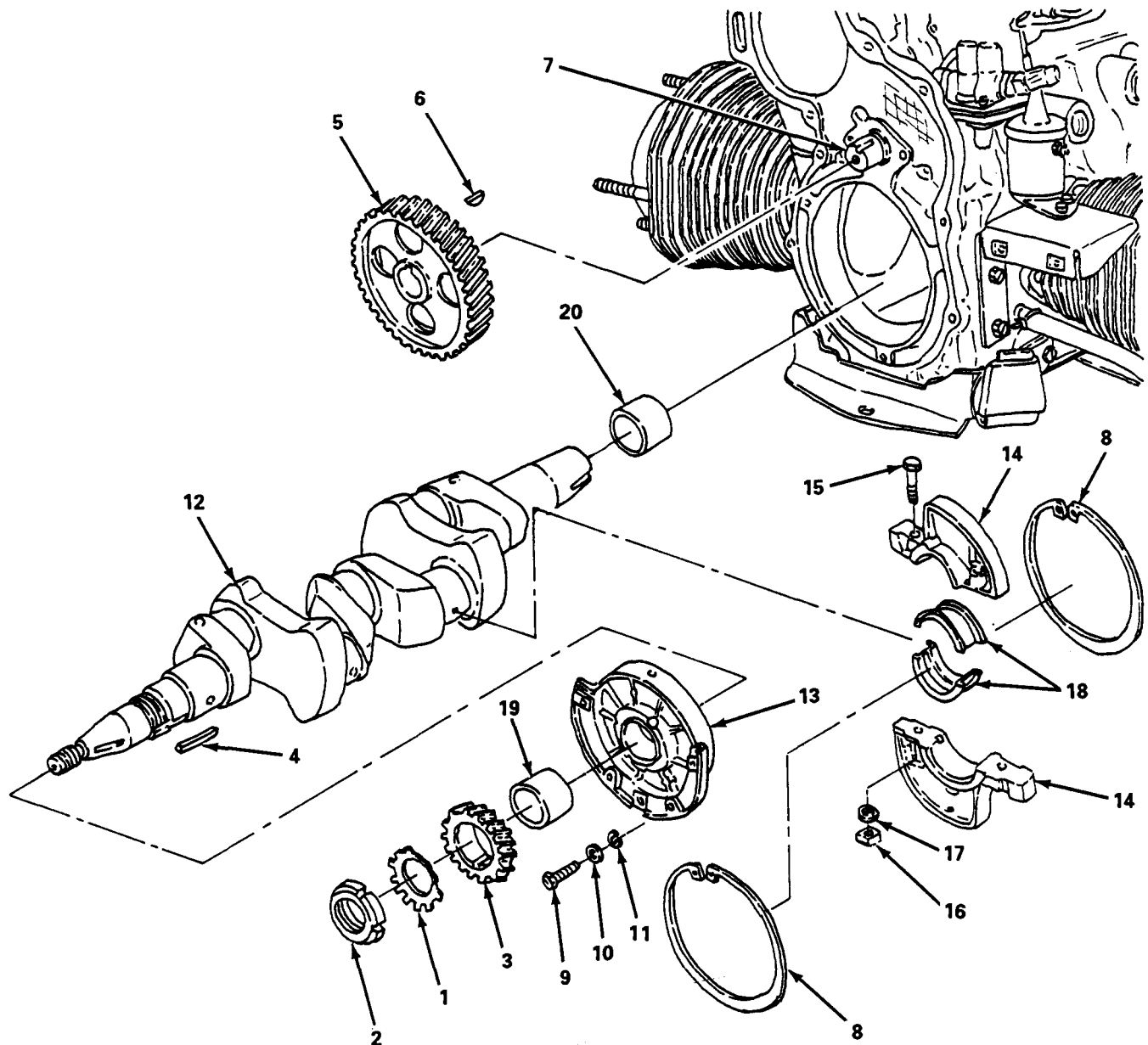
Equipment Condition

Timing cover removed (para. 5-13).
Flywheel removed (para. 5-7).
Piston and connecting rod removed (para. 6-7)

- (1) Bend out tangs on lockwasher (1).
- (2) Using spanner wrench, remove spanner nut (2), lockwasher (1), gear (3), and key (4).
- (3) Using puller remove camshaft gear (5) and key (6) from camshaft (7).
- (4) Using snap ring pliers, remove two center main bearing retaining rings (8).
- (5) Remove three screws (9), flat washers (10) and lockwashers (11).
- (6) Remove crankshaft (12), main bearing diaphragm (13), and center main bearing diaphragm (14).
- (7) Remove main bearing diaphragm (13) from crankshaft (12).
- (8) Remove two bolts (15), nuts (16) and washers (17) and remove center main bearing diaphragm (14) and bearings (18) from crankshaft (12).

WARNING

- (9) Clean all items with drycleaning solvent, and dry thoroughly.
- (10) Inspect all items and replace all items that are worn or otherwise damaged. Refer to table 6-2 for wear limits.



4870-068

Figure 6-6. Crankshaft, Removal.

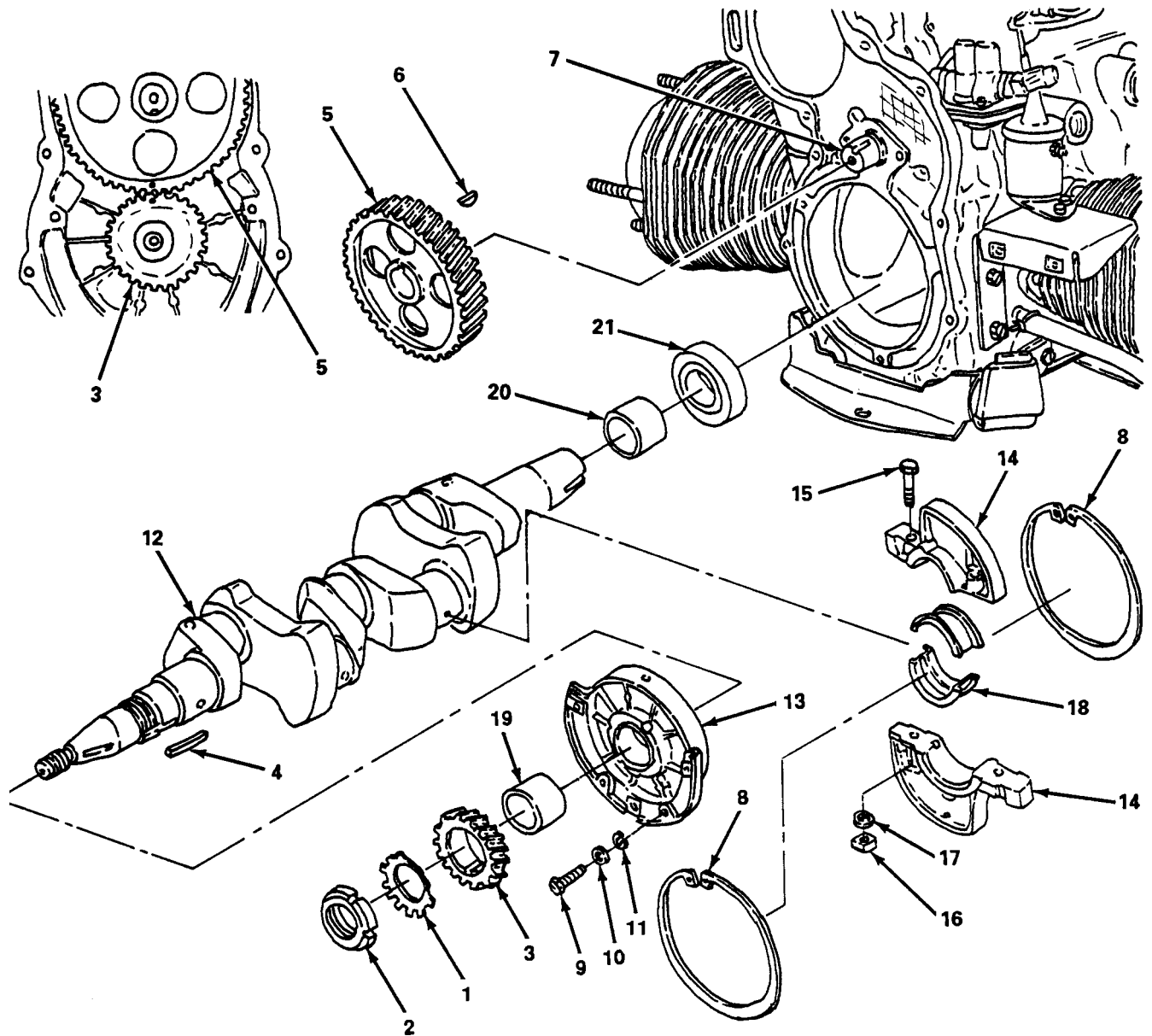
NOTE

Bearing (19) exploded out of diaphragm (13), and bearing (20) exploded out of crankcase for clarity.

6-10. **Crankshaft (cont).**

b. Installation. (figure 6-7)

- (1) Install bearing (19) in main bearing diaphragm (13).
- (2) Install bearing (20) if removed.
- (3) Install oil seal (21).
- (4) Install center main bearing diaphragm (14) and bearings (18) and secure with two bolts (15), washers (17) and nuts (16).
- (5) Install crankshaft (12), main bearing diaphragm (13) and center main diaphragm (14).
- (6) Install key (6) and camshaft gear (5).
- (7) Install key (4) and crankshaft gear (3). Aline timing marks on crankshaft gear (3) and camshaft gear (5).
- (8) Install new lockwasher (1) and spanner nut (2).
- (9) Bend tangs on lockwasher (1) out to lock spanner nut (2).
- (10) Install three screws (9), washers (10), and lockwashers (11). Torque screws to 41-57 in.-lb (7329 -10189 gr cm).



4870-089

Figure 6-7. Crankshaft, Installation.

6-11. Crankcase.

This task covers: Replacement

INITIAL SETUP

Tools	Equipment Condition (cont)
General Mechanic's Tool Kit (Item 1, Appendix B)	Cylinder removed (para. 6-8). Governor removed (para. 4-43). Flywheel housing removed (para. 5-8). Pressure regulator valve removed (para. 4-26).
Materials/Parts	Camshaft removed (para. 6-9). Crankshaft removed (para. 6-10). Intake manifold removed (para. 4-49). Magnetoroller removed (para. 4-32). Crankcase breather removed (para. 4-27).
Rags, Wiping (Item 7, Appendix D)	
Solvent, Drycleaning (Item 8, Appendix D)	

Replacement. (figure 6-8)

WARNING

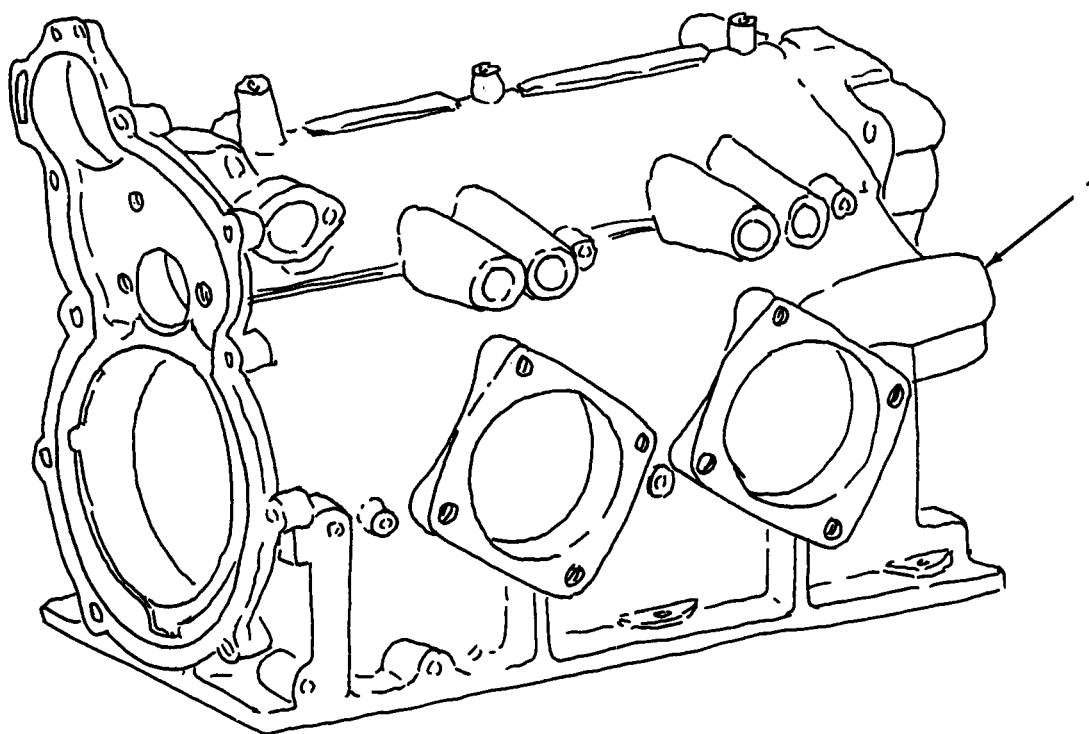
Drycleaning solvent PD-680 used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Do not use near open flame or excessive heat. Flash point of solvent is 100°F.-138°F. (38°C.-60°C.).

- (1) Clean crankcase (1) with drycleaning solvent and dry thoroughly.
- (2) Inspect crankcase for cracks or signs of excessive wear.

NOTE

If replacing a crankcase, transfer items from old crankcase as needed.

- (3) Replace crankcase if worn, cracked, or otherwise damaged.



4870-073

Figure 6-8. Crankcase, Repair.

Table 6-2. Engine Repair and Replacements Limits.

Item	Measurements	
	Minimum	Maximum
CONNECTING RODS		
Connecting rod bearing clearance	0.0004 (0.0010)	0.0029 (0.0074)
Slide clearance	0.0060 (0.0152)	0.0140 (0.0356)
Connecting rod bearing id	1.4984 (3.8060)	1.5004 (3.8100)
Connecting rod bearing od	1.6240 (4.1200)	1.6250 (4.1300)
Piston pin:		
Length	2.4850 (6.3100)	2.5000 (6.3500)
Diameter	0.8591 (2.1800)	0.8593 (2.1826)
Piston pin clearance in bearing	0.0001 (0.0003)	0.0006 (0.0015)
PISTON:		
Piston pin hole dia	0.8591 (2.1800)	0.8594 (2.1829)
Piston pin bushing od	0.9165 (2.3279)	0.9185 (2.3330)
Piston pin bushing id	0.8594 (2.1714)	0.8597 (2.1836)
Skirt od (A size)	2.9962 (7.6103)	2.9972 (7.6128)
NOTE: (B, C, and D size, .0005 larger)		
Piston to cylinder clearance	0.0018 (0.0046)	0.0033 (0.0084)
Piston ring groove		
Depth Top	2.6520 (6.7361)	2.6620 (6.7615)
Second	2.6300 (6.6802)	2.6410 (6.7081)
Third	2.6310 (6.6927)	2.6410 (6.7081)

Table 6-2. Engine Repair and Replacements Limits (cont).

Item	Measurements	
	Minimum	Maximum
Piston ring groove		
Width Top	0.1200 (0.3048)	0.1210 (0.3090)
Second	0.0955 (0.2426)	0.0965 (0.2451)
Third	0.1880 (0.4775)	0.1890 (0.4801)
Piston rings		
Width spacer	0.1460 (0.3708)	0.1520 (0.3861)
Top	0.1400 (0.3556)	0.1500 (0.3810)
Second	0.1290 (0.3277)	0.1390 (0.3531)
Third	0.1290 (0.3277)	0.1390 (0.3531)
Thickness spacer	0.0235 (0.0598)	0.0245 (0.0622)
Top	0.0930 (0.2362)	0.0940 (0.2388)
Second	0.0930 (0.2362)	0.0940 (0.2388)
Third	0.1860 (0.4724)	0.1870 (0.4750)
Gap clearance spacer	0.0100 (0.0254)	0.0060 (0.1524)
Top	0.0100 (0.0254)	0.0200 (0.0508)
Third	0.0100 (0.0254)	0.0200 (0.0508)
Side clearance	N/A	N/A
First	0.0015 (0.0038)	0.0045 (0.0011)
Second	0.0015 (0.0038)	0.0035 (0.0088)
Third	0.0010 (0.0038)	0.0030 (0.0076)

Table 6-2. Engine Repair and Replacement Limits (cont).

Item	Measurements	
	Minimum	Maximum
CYLINDERS		
Bore	2.9990 (7.6174)	2.9995 (7.6187)
Out of round	0.0000 (0.0000)	0.0005 (0.0001)
Taper	0.0000 (0.0000)	0.0010 (0.0002)
CAMSHAFT:		
Bearing journal dia		
Front	0.9365 (2.3787)	0.9370 (2.3799)
Rear	0.8740 (2.2199)	0.8745 (2.2212)
Center	1.7188 (4.3658)	1.7195 (4.3675)
Cam lift	0.2437 (0.6189)	0.2487 (0.6316)
End play	0.0020 (0.0050)	0.0080 (0.0020)
Bearing inside dia	0.9380 (2.3825)	0.9390 (2.3850)
Bearing journal to bearing clearance	0.0010 (0.0020)	0.0025 (0.0063)
CRANKSHAFT:		
Main bearing journals		
Front	1.6255 (4.1288)	1.6260 (4.1300)
Rear	1.6255 (4.1288)	1.6260 (4.1300)
Center	1.6255 (4.1287)	1.6260 (4.1300)
Connecting rod journal od	1.4975 (3.8037)	1.4980 (3.8049)
End play	0.0030 (0.0076)	0.0100 (0.0254)
Crankshaft bearings		
Main bearing id	1.6275 (4.1339)	1.6282 (4.1356)
Main bearing od	1.7545 (4.4564)	1.7560 (4.4602)
Timing gear tooth tolerance	0.002 (0.0050)	0.004 (0.010)

APPENDIX A

REFERENCES

A-1. **Scope.** This appendix contains all forms, lubrication orders, pamphlets and technical manuals referenced in this manual.

A-2. **Forms.**

Air Force Maintenance Policy	AFR 66-1
Air Force Suggestion Program	AFR 900-4
Recommended Changes to Publications	DA Form 2028
Recommended Changes to Publications	DA Form 2028-2
Equipment Inspection and Maintenance Worksheet	DA Form 2404
Transportation Discrepancy Report (TDR)	SF 361
Report of Discrepancy (ROD).....	SF 364
Quality Deficiency Report (QDR)	SF 368

A-3. **Lubrication Order.**

Lubrication Order, Gasoline Engine, 20 HP Military Standard Models 4A084-2, 3 and -4	LO 9-2805-259-12
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A-4. **Pamphlets.**

The Army Maintenance Management System (TAMMS)	DA Pam 738-750
Consolidated Index of Army Publications and Blank Forms	DA Pam 25-30

A-5. **Technical Manuals.**

Unit, Direct Support, General Support and Depot Maintenance Repair Parts and Special Tool List	TM 9-2805-259-24P TO 38G2-89-54 P-8-615-14P
Preservation, Packaging, and Packing of Military Supplies and Equipment	TM 38-230
Painting Instructions for Army Use.. ..	TM 43-0139
Procedures for Destruction of Equipment to Prevent Enemy Use	TM 750-244-3

A-6. **Field Manuals.**

First Aid for Soldiers	FM 21-11
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ARMY TM 9-2805-259-14
AIR FORCE TO 38G2-89-54
NAVY NAVFAC P-8-615-14E

A-7. **Technical Bulletins.**

Preservation of Mechanical Equipment for Shipment or Storage TB 740-97-2

A-8. **Army Regulations**

Army Corrosion Prevention and Control AR 750-59

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. Maintenance Allocation Chart (MAC). This MAC assigns maintenance functions in accordance with the Four Level Maintenance Concept.

B-2. Use of the Maintenance Allocation Chart, Section II.

a. The MAC assigns maintenance functions based on the following considerations:

- (1) Skills available.
- (2) Work time required.
- (3) Tools and test equipment required and/or available.

b. If a lower level of maintenance identified in column (4) of the MAC cannot perform all tasks of a single maintenance function (e.g., test, repair), that the higher level that can perform other tasks of that function is also indicated.

c. Higher maintenance levels are automatically authorized to perform maintenance functions assigned to a lower maintenance level.

d. Higher maintenance levels will perform the maintenance functions of lower maintenance levels when required or directed by the Commander who has authority to direct such tasking.

e. Assignment of a maintenance function in the MAC does not carry automatic authorization to carry the related spare or repair parts in stock. Information to requisition or secure parts will be as specified in the associated RPSTL.

f. Normally, there will be no deviation from the assigned level of maintenance. However, in cases of operational necessity, maintenance functions assigned a higher level may, at the request of the lower level, be assigned to the lower level on a one-time basis, if specifically authorized by the maintenance officer of the higher level to which the function is assigned. In such a case, the special tools, equipment, etc., required by the lower level to perform this function will be furnished by the higher level assigned the function. Also, transfer of a function to a lower level does not relieve the higher level of responsibility for the function, so the higher level will provide technical supervision and inspection of the function being performed at the lower level.

B-3. Maintenance Functions. Maintenance functions will be limited to and defined as follows:

a. Inspects. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b. Test. To verify serviceability and detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate), to preserve, to drain, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Aline. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, or module (component assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. The act of substituting a serviceable like type part, a subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, aline, calibrate, or replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable operational condition as prescribed by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul does not normally return an item to a like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

B-4. Explanation of Columns in the MAC, Section II.

a. Column (1). Group Number. Column 1 lists functional group code numbers which are assigned to identify maintenance significant components, assemblies, subassemblies, and modules to their next higher assembly.

b. Column (2). Component/Assembly. Column 2 contains the item names of components, assemblies, subassemblies, and modules for which group numbers (column 1) are assigned and for which maintenance is authorized.

c. Column (3). Maintenance Function. Column 3 lists the functions to be performed on items listed in Column 2. (Function definitions are contained in paragraph A-3.)

d. Column (4). Maintenance Level. The maintenance levels, Unit, Direct Support, General Support, and Depot, are allotted separate subcolumns within column 4. Entry of a work time figure (such as 1.0, 0.2) in a subcolumn indicates that that level is authorized to perform the function listed in column 3, and the average time required to do the function is the work time figure. If the number or complexity of tasks within a maintenance function varies from one maintenance level to another, the applicable work time figure for each level will be entered for that function. The work time figure represents the average time it takes to restore a component/assembly to a serviceable condition under a typical field operating environment.

e. Column (5). Tools and Equipment. Column 5 specifies, by code, common tool sets (not individual tools from those sets), common TMDE, and special tools, TMDE, and support equipment required to perform a designated function. The code in Column 5 keys to the listing in Section III of the MAC.

f. Column (6). Remarks. This column when applicable, contains a letter code which is keyed to an explanation of the code contained in Section IV of the MAC.

B-5. Explanation of Columns in the MAC, Section III.

a. Column (1). Tool or Test Equipment Reference Code. The tool or test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

b. Column (2). Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column (3). Nomenclature. Name or identification of the tool or test equipment.

d. Column (4). National/NATO Stock Number. The National stock number of the tool or test equipment.

e. Column (5). Tool Number. The manufacturer's part number.

B-6. Explanation of Columns in the MAC, Section IV.

a. Column (1). Reference Code. The code recorded in column 6, Section II.

b. Column (2). Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART

(1) Group number	(2) Component/ assembly	(3) Maintenance function	(4) Maintenance level					(5) Tools and eqpt.	(6) Remarks
			C	O	F	H	D		
00	Engine Assembly	Overhaul					40.0		
01	Fuel Filter Assembly	Inspect Service	0.1	0.1				1	
02	Air Cleaner Assembly								
	Element	Inspect Service Replace	0.1	0.1 0.1				1 1	
	Air Cleaner, Restriction Indicator and Support Bracket	Inspect Replace		0.1 0.3				1	
	Clamps and Hose	Inspect Replace	0.1	0.2				1	
	Air Cleaner Elbow, Breather Tube	Replace		0.2					
03	Oil Filter Assembly								
	Element	Replace		0.3				1	
	Oil Filter Cover and Stud	Inspect Replace		0.1 0.3				1	
04	Cooling System								
	Top Cover, Left and Right Shrouds, and Cylinder Baffles	Inspect Replace	0.1	0.2				1	
	Oil Pan Cover, Shroud and Baffle Plate	Inspect Replace	0.1	0.3				1	
	Oil Pan Baffle, Control Rod and Positioner	Replace		0.5				1	

Section II. MAINTENANCE ALLOCATION CHART (cont)

(1) Group number	(2) Component/ assembly	(3) Maintenance function	(4) Maintenance level					(5) Tools and eqpt.	(6) Remarks
			C	O	F	H	D		
05	Flywheel	Inspect Replace			0.2 0.3				
06	Fan Housing	Inspect Replace			0.2 0.3				
07	Lubrication System								
	Oil Lines	Inspect Replace		0.1 0.3				1	
	Rocker Box Hoses	Inspect Replace		0.1 0.2				1	
	Pressure Regulating Valve	Inspect Replace		0.2 0.2				1	
	Crankcase Breather	Replace		0.3				1,3	
	Low Oil Pressure Shutdown Switch	Test Replace		0.2 0.3				1	
	Oil Pressure Transmitter	Test Replace		0.2 0.2				1	
	Oil Pump	Inspect Replace			0.2 0.4			1	
	Oil Filler Tube	Replace			0.3			1	
08	Automatic Choke Assembly								
	Solenoid and Bracket	Test Adjust Replace		0.2 0.2 0.3				1 1	C
09	Preheater Assembly	Repair Replace		0.3 0.3				1 2,4	

Section II. MAINTENANCE ALLOCATION CHART (cont)

(1) Group number	(2) Component/ assembly	(3) Maintenance function	(4) Maintenance level					(5) Tools and eqpt.	(6) Remarks
			C	O	F	H	D		
10	Magneto Assembly								
	Magneto and Gear	Replace		0.3				1	
		Adjust		0.2				1	
	Contacts	Inspect		0.1					
		Adjust		0.2				1	
		Replace		0.2				1	
	Condenser	Test		0.1					
		Replace		0.3				1	
	Coil	Inspect		0.1					
		Test		0.1				1,2	
		Replace		0.3				1	
11	High Tension Cables	Inspect		0.1					
		Test		0.2				1,2	
		Replace		0.2				1	C
12	Spark Plugs	Inspect		0.1				1	
		Adjust		0.1				1	
		Replace		0.2				1	
13	Starter	Repair			1.0			2	
		Replace		0.3				1	
14	Regulator-Rectifier	Test		0.2				1,2	
		Replace		0.3				1	C
15	Governor Assembly								
	Governor/Carburetor Control	Adjust		0.2				1	
		Replace		0.2				1	
	Governor Control Rod	Adjust		0.2				1	
		Replace		0.2				1	
	Governor Oil Tube	Inspect		0.1					
		Replace		0.2				1	

Section II. MAINTENANCE ALLOCATION CHART (cont)

(1) Group number	(2) Component/ assembly	(3) Maintenance function	(4) Maintenance level					(5) Tools and eqpt.	(6) Remarks
			C	O	F	H	D		
16	Governor	Adjust Replace		0.2 0.3				1 1	
	Exhaust Manifold and Exhaust Pipe	Inspect Replace		0.1 0.4				1	
	Manual Choke	Adjust Replace	0.1					1	
18	Carburetor	Adjust Repair Replace		0.1 0.3	0.5			1 1 1	
19	Fuel System								
	Fuel Line and Fittings	Inspect Replace		0.1 0.3				1	
	Fuel Pump	Test Replace		0.2 0.2				1 1	A
20	Intake Manifold Assembly	Inspect Replace		0.1 0.4				1	
21	Rocker Box Covers	Replace		0.2				1	
22	Alternator Assembly								
	Engine Start Pulley	Replace		0.3				1	
	Alternator	Test Replace		0.2 0.4				1	
23	Wiring Harness Assembly	Test Replace		0.3 0.3				1,2 1	

Section II. MAINTENANCE ALLOCATION CHART (cont)

(1) Group number	(2) Component/ assembly	(3) Maintenance function	(4) Maintenance level					(5) Tools and eqpt.	(6) Remarks
			C	O	F	H	D		
24	Timing Gear Cover								
	Tachometer Adapter	Replace		0.2				1	
	Air Breather Reed and support	Inspect Replace		0.2 0.2				1	
	Oil Seal	Replace		0.3				1	
	Timing Gear Cover	Replace		0.3					
25	Oil Pan Assembly								
	Oil Pan	Replace			0.3			1	
	Check Valve	Service Replace			0.2 0.3			1 1	
26	Cylinder Head Assembly	Test Repair Repase		0.1				1,2 1,4 1	B
					1.4 1.0				
27	Piston and Connecting Rod Assembly	Repair Replace				1.4 1.0		4 1	
28	Cylinders	Inspect Replace				0.6 1.8		1	
29	Camshaft Assembly	Inspect Replace				0.8 0.8		1	
30	Crankshaft Assembly	Inspect Replace				0.2 0.3		1 1	
31	Crankcase	Replace				2.0		1	
32	Seal	Replace			0.2			1	

**Section III. TOOLS AND TEST EQUIPMENT REQUIREMENTS FOR 10 HP
 MILITARY STANDARD ENGINE**

Tool or test equipment ref code (1)	Maintenance category (2)	Nomenclature (3)	National/NATO stock number (4)	PN Tool number (5)
1	0	General Mechanic's Tool Kit	5180-00-177-7033	
2	0	Shop Equipment, Automotive Maintenance and Repair; Organizational Maintenance, No. 1 Common, Less Power	4910-00-754-0654	
3	0	Attachment, Crows Foot	5120-00-184-8400	
4	F	Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Wheeled Vehicles, Set A	4910-95-CL-A02 4910-00-348-7696	
5	0	General Mechanic's Tool Kit	5180-00-699-5273	
6	0	Shop Equipment, Automotive Maintenance and Repair; Organizational Maintenance, No. 2 Common, Less Power	4910-00-754-0650	

Section IV. REMARKS

Reference code	Remarks
A	Test includes pressure test.
B	Test includes compression test.
C	Test includes continuity test.

APPENDIX C

COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

C-1. Scope.

This appendix lists components of end item and basic issue items for the 20 HP Military Standard Engine to help you inventory items required for safe and efficient operation.

D-2. General.

The Components of End Item and Basic Issue Items 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. The items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between properly accounts. Illustrations are furnished to assist you in identifying the items.

b. Section III. Basic Issue Items. These are the minimum essential items required to place the 20 HP Military standard engine in operation. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TOE/MTOE authorization of the end item.

C-3. Explanation of Columns.

The following provides an explanation of columns found in the tabular listings:

a. Column (1). Illustration Number (Illus Number). This column indicates the number of the illustration in which the item is shown.

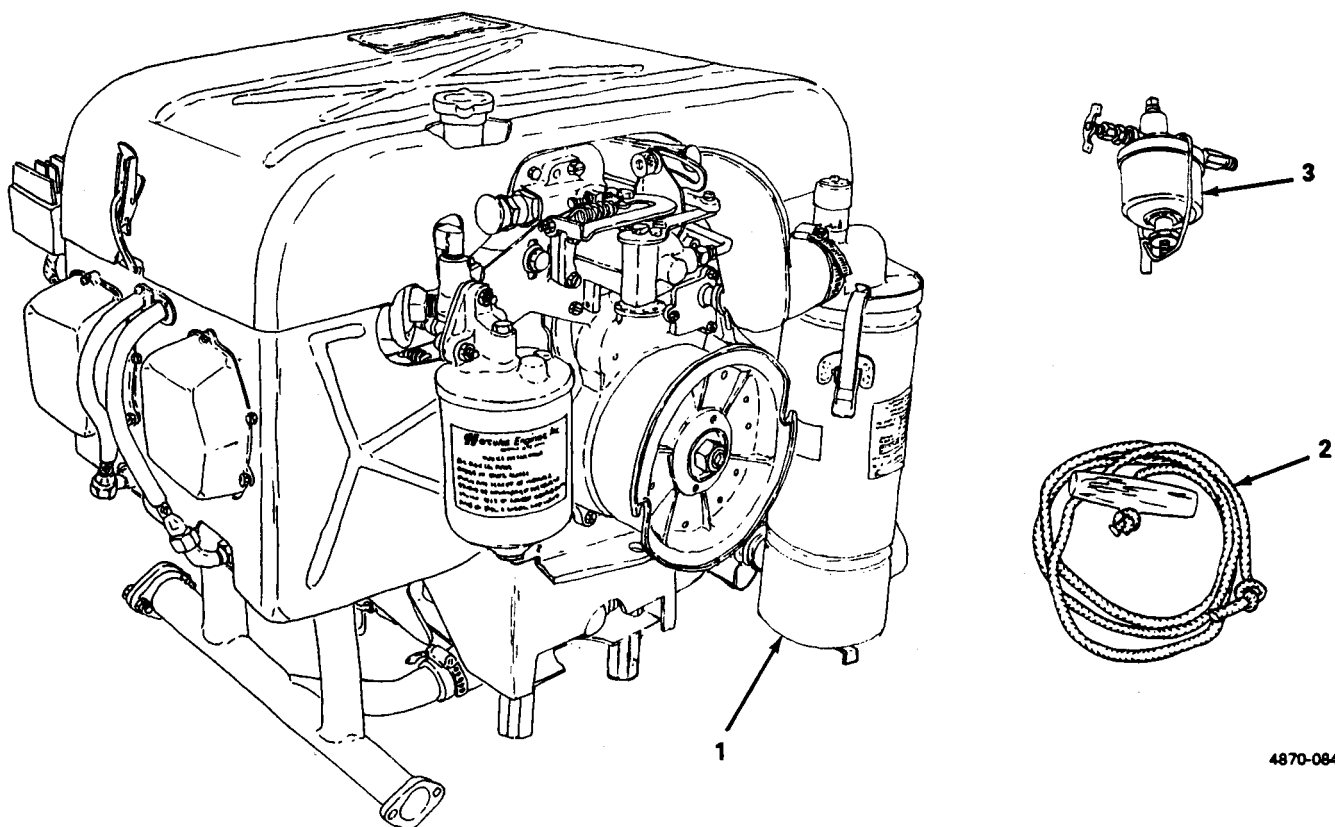
b. Column (2). National Stock Number. Indicates the National Stock Number assigned to the item and will be used for requisitioning purposes.

c. Column (3). Description. Indicates the Federal item name, and, if required, a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number.

d. Column (4). Unit of Measure (U/M). Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr).

e. Column (5). Quantity Required (QTY RQR). Indicates the quantity of the item authorized to be used with/on the equipment.

Section II. COMPONENTS OF END ITEMS



(1) Illus Number	(2) National Stock Number	(3) Description FSCM and Part Number	Usable On Code	(4) U/M	(5) Qty Rqqr
1	2805-00-952-3927	Engine, Military Standard 20 HP Model 4A084-2		ea	1
1	2805-00-872-5971	Engine, Military Standard 20 HP Model 4A084-3		ea	1
1	2805-01-276-5972	Engine, Military Standard 20 HP Model 4A084-4		ea	1
2	2990-00-961-3692	Rope, Starter Cable Assembly		ea	1
3	2910-00-905-9792	Filter Assembly, Fuel		ea	1

Section III. BASIC ISSUE ITEMS

Not Applicable

APPENDIX D

EXPENDABLE/DURABLE SUPPLIES MATERIALS LIST

Section I. INTRODUCTION

D-1. **Scope.** This listing is for informational purposes only and is not authority to requisition the listed items. These items are authorized to you by CTA50-970, Expendable/Durable Items (except medical, class V, repair parts, and heraldic 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 material (e.g., "Use cleaning compound, item 5, appendix C").

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item.

- C - Operator/Crew
- 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 or requisition the item.

d. Column (4) - Description. Indicates the Federal item name, and, if required, a description to identify the item. The last line for each item indicates the Commercial and Government Entity (CAGE) in parentheses followed by the part number.

d. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) Item number	(2) Level	(3) National stock number	(4) Description	(5) U/M
1	c	8010-01-229-7546	Coating, Chemical Agent Resistant	gal.
2	c	7930-00-282-9699	Detergent	gal.
3	c	9150-00-152-4117	Oil, Engine OE/HDO 15W-40	qt.
	c	9150-00-152-4118	Oil, Engine OE/HDO 15W-40	5 gal.
	c	9150-00-152-4119	Oil, Engine OE/HDO 15W-40	55 gal.
4	c	9550-00-183-7808	Oil, Engine OE/HDO 30	qt.
5	c		Oil, Engine OEA/APH-PD-1 (Obsolete, Use Item 6)	qt.
6	c	9150-00-402-4478	Oil, Engine OEA/APG-PD-1	qt.
7	c	7920-00-205-1711	Rag, Wiping 50/B (58536) A-A-531	ea
8	c	6850-00-281-1985	Solvent, Drycleaning PD-680	gal.

APPENDIX E

TORQUE LIMITS

E-1. **General.** Table E-1 provides torque limits to be observed when installing attaching hardware or spark plugs.

Table E-1. Torque Limits.

Attaching Part	Range
Flywheel bolt and engine start pulley nut	80-83 lb-ft (171 612-178048 gr cm)
Cylinder head nuts	22-24 lb-ft (47193-51484 gr cm)
Intake manifold to cylinder head bolts	36-50 in. lb (6435-8938 gr cm)
Muffler to cylinder head bolts	36-60 in. lb (6435-10725 gr cm)
Spark plugs	23-25 lb-ft (49339-53629 gr cm)
Connecting rod bolts	24-26 lb-ft (51484 -55774 gr cm)
Oil pan screws	25-30 in. lb (4469-5363 gr cm)
Fuel pump bolts	55-65 in. lb (9831-11619 gr cm)
Governor housing screws	25-30 in. lb (4469-5363 gr cm)
Carburetor mounting bolts	60-85 in. lb (10725-15194 gr cm)
Magneto mounting screws	120-144 in. lb (21450-25740 gr cm)
Oil filter cap	72-84 in. lb (1 2870-15015 gr cm)
Alternator mounting screws	12-24 in. lb (2145 -4290 gr cm)
Rocker shaft nuts	72 - 86in.-lb(12870 - 15373 gr cm)
Main bearing diaphragm bolts	41 - 57 in.-lb (7329-10189 gr cm)

APPENDIX F
ADDITIONAL AUTHORIZATION LIST (AAL)

Section I. INTRODUCTION

D-1. SCOPE. This appendix lists additional items you are authorized for the Engine, Gasoline, 20 HP MILSTD.

D-2. GENERAL. Section II identifies items that are not routinely used with the MILSTD and do not have to accompany it or be TURNED in with it.

D-3. EXPLANATION OF LISTING. National stock numbers, descriptions, and quantities are provided to help you identify and request the additional items you require to support this equipment. The items are listed in alphabetical sequence by item name.

Section II. ADDITIONAL AUTHORIZATION LIST

(1) ITEM NO	(2) NATIONAL STOCK- NUMBER	(3) DESCRIPTION, (FSCM) & PART NUMBER	USABLE ON CODE	(4) U/M	(5) QTY AUTH
1	2990-01-032-0775	SPARK ARRESTER		EA	1

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ENGINE GASOLINE, 20 HP

BE EXACT... PIN-POINT WHERE IT IS

PAGE
NO.

6

PARA-
GRAPH

2-1
a

FIGURE
NO.

4-3

TABLE
NO.

B1

125 line 20

IN THIS SPACE TELL WHAT IS WRONG
AND WHAT SHOULD BE DONE ABOUT IT:

In line 6 of paragraph 2-1a the
manual states the engine has
6 Cylinders. The engine on my
set only has 4 Cylinders.
Change the manual to show 4
Cylinders.

Callout 16 on figure 4-3 is
pointing at a bolt. In key
to figure 4-3, item 16 is called
a shim - Please correct
one or the other.

I ordered a gasket, item
19 on figure B-16 by NSN
2 910-00-762-3001. I got a
gasket but it doesn't fit.
Supply says I got what
I ordered, so the NSN is
wrong. Please give me a
good NSN

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigrams = .035 ounce
 1 dekagram = 10 grams = .35 ounce
 1 hectogram = 10 dekagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. 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 = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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