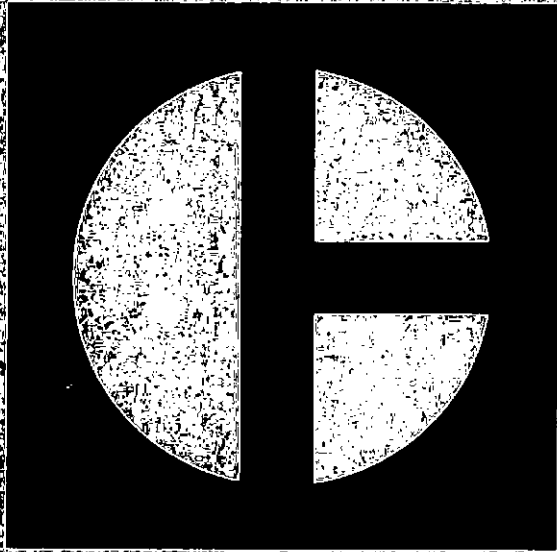


SEBU5366  
(REVISION TO GEG00310-01)



# **OPERATION GUIDE**

**D379  
INDUSTRIAL ENGINE  
68B1616-UP**

## FOREWORD

This Operation Guide contains operation instructions, and lubrication and maintenance information. Application of this information should maximize performance and life of the engine; and minimize the costs of engine operation.

Caterpillar engines are found in many applications. Therefore, the illustrations in this Guide are typical and may not be of your specific engine or application.

Familiarize yourself with the components installed on your engine as described in the instructions. Some components described in the instructions may not be on your engine or installation.

Continuing improvement and advancement of product design may cause changes to your engine which may not be included in this publication. Each publication is reviewed and revised, as required, to update and include these changes in later editions.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

The services of authorized Caterpillar dealers are recommended. Your dealer is staffed with trained personnel who are equipped with proper tools, necessary Caterpillar parts, and are trained in the latest service procedures.

## TABLE OF CONTENTS

INDUSTRIAL ENGINE OPERATION INSTRUCTIONS Index .....	A-28
ELECTRIC SET OPERATION INSTRUCTIONS Index .....	B-10
LUBRICATION AND MAINTENANCE CHART .....	1
LUBRICATION AND MAINTENANCE PROCEDURES Index .....	K-1



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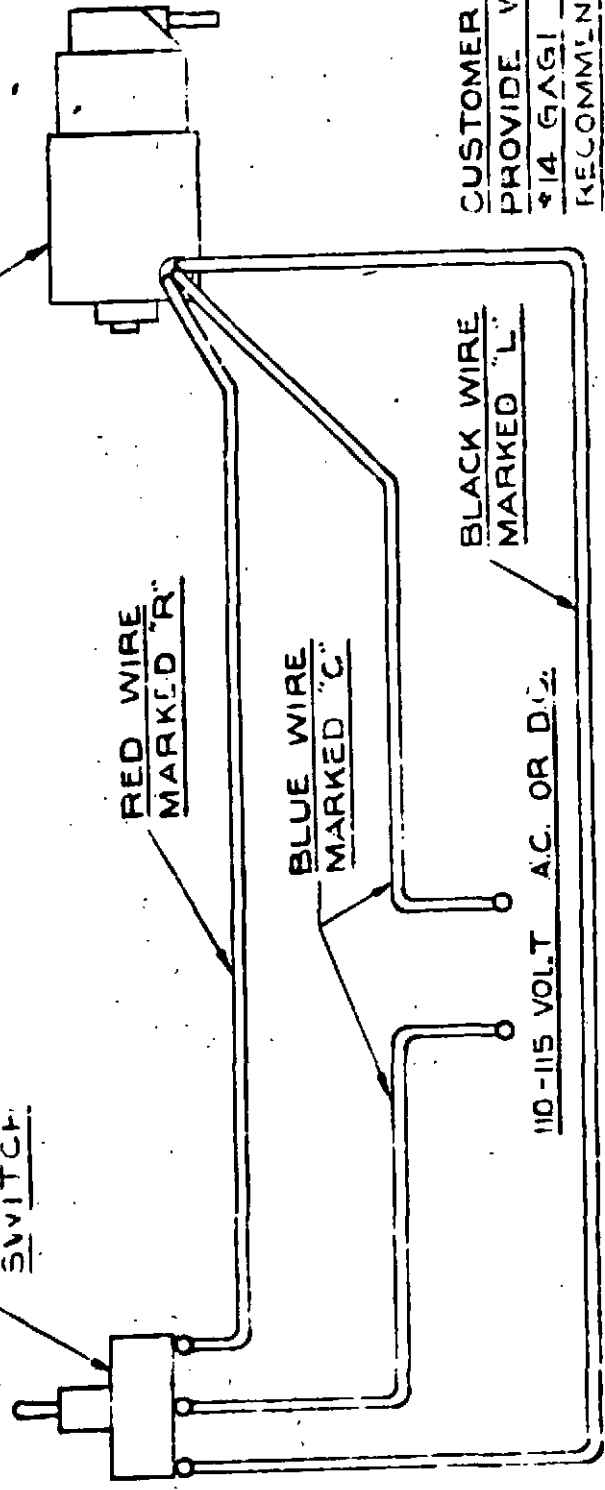
CATERPILLAR TRACTOR CO.  
Department 682  
Industrial Division  
Peoria, Illinois 61602



319429

REVERSIBLE  
SYNCHRONIZING  
MOTOR - 110 VOLT  
3 WIRE

SINGLE POLE  
DOUBLE THROW  
SWITCH



CUSTOMER TO  
PROVIDE WIRING -  
#14 GAGI JS  
RECOMMENDED

110-115 VOLT A.C. OR D.C.

BLACK WIRE  
MARKED "L"

RED WIRE  
MARKED "R"

BLUE WIRE  
MARKED "C"

**CATERPILLAR TRACTOR CO.**

**NAME** WIRING DIAGRAM  
**NOV** SYNCHRO MOTOR  
 DATE DRAWN 11/1/50  
 DRAWN BY W. J. H. H. H.  
 CHECKED BY W. J. H. H.  
 APPROV. W. J. H. H.  
 PROVE DESG. W. J. H. H.  
 MAC. W. J. H. H.  
 PRODUCTION W. J. H. H.

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HEAT TREATMENT

MATERIAL

SVN DATE

CHANGES

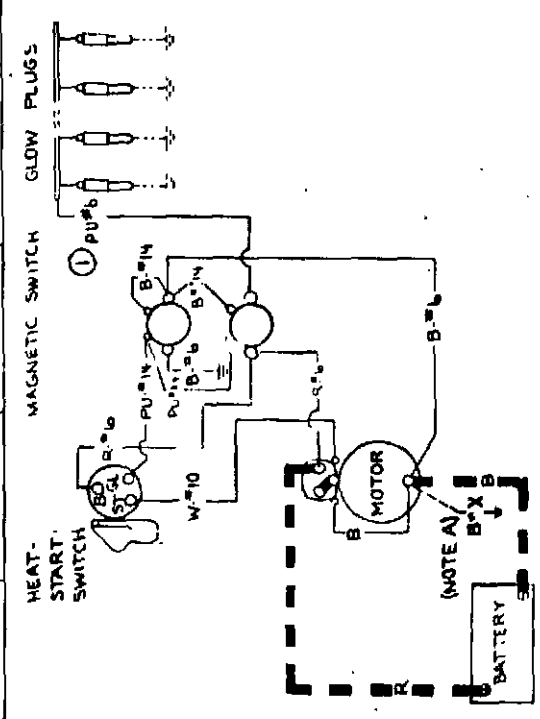


FIG. A SINGLE MOTOR DIRECT ELECTRIC STARTING WITH GLOW PLUGS

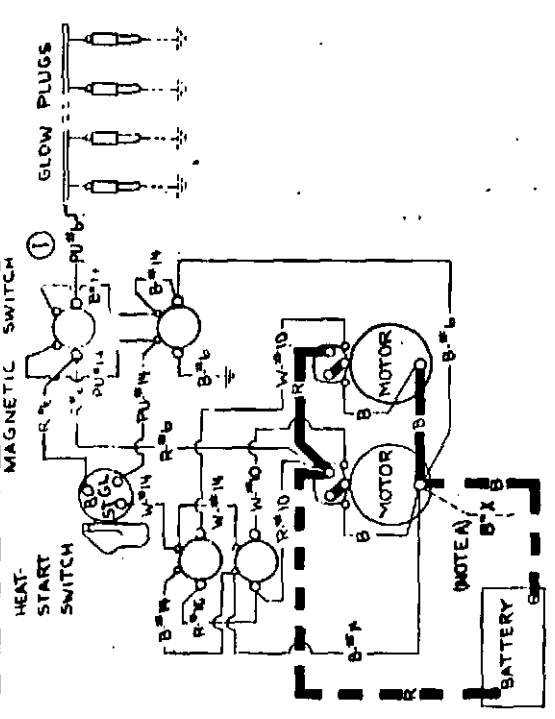


FIG. C DUAL MOTOR DIRECT ELECTRIC STARTING WITH GLOW PLUGS

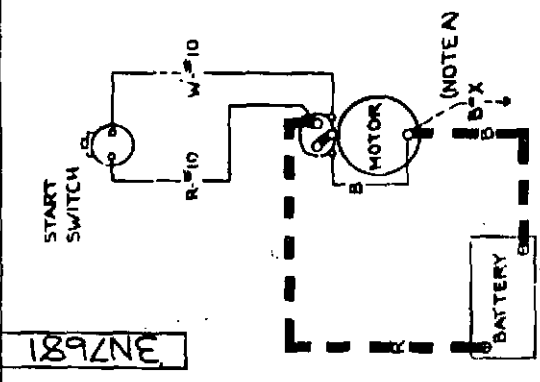


FIG. B SINGLE MOTOR DIRECT ELECTRIC STARTING

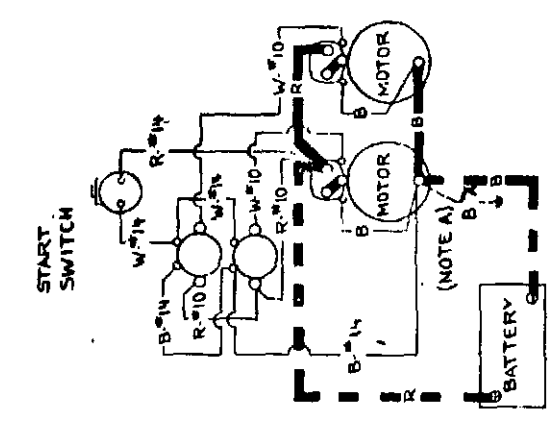


FIG. D DUAL MOTOR DIRECT ELECTRIC STARTING

**COLOR CODE**

B - BLACK  
 W - WHITE  
 R - RED  
 O - ORANGE  
 BR - BROWN  
 LGN - LIGHT GREEN  
 PU - PURPLE  
 W/B - WHITE WITH BLACK STRIPE

**MAXIMUM RECOMMENDED TOTAL BATTERY CABLE LENGTH**

CABLE SIZE	12 VOLT	24-32 VOLT
0	4.0 FEET	15.0 FEET
000	5.0	18.0
0000	6.0	21.0
00000	7.5	27.0

WIRE AND CABLE SHOWN DOTTED PURNISHED BY CUSTOMER

NUMBER FOLLOWING COLOR DESIGNATION INDICATES RECOMMENDED WIRE SIZE

NOTE A: THESE CONNECTIONS ARE REQUIRED FOR GROUND SYSTEM THIS DIAGRAM NOT REQUIRED WHEN A CHARGING GENERATOR IS USED.

3N7681

HEAT TREATMENT

DATE: APR 27 74

DESIGN: D HELM

CHK: L PERLEY

APPROV: [Signature]

PROV: DES [ ]

SCALE: 1"

UNLESS OTHERWISE SPECIFIED: DATE FEB 14, 73

THIRD ANGLE PROJECTION

DIMENSIONS IN INCHES

3 PLACE DIM = 3/16"

4 PLACE DIM = 1/32"

APPROX DIM = 1"

SCALE = 1"

**CATERPILLAR**

WIRING DIAGRAM

3N7681

WJ13



### ELECTRIC SET ALIGNMENT PROCEDURES

4450

DÉGAUCHISSAGE DE LA LIGNE D'ARBRE DES GROUPES ÉLECTROGÈNES

AUSRICHTMETHODEN FÜR STROMAGGREGATE

PROCEDIMIENTOS DE ALINEACION DE GRUPOS ELECTROGENOS

D353	46B	D397	41B
G353	64B	D398	66B, 75B
D375	43B	G398	73B
D379	68B, 76B	D399	35B
G379	72B	G399	49C

Dimensions in inches (mm) - Cotes en pouces (mm) - Abmessungen in Zoll (mm) - Dimensiones en pulgadas (mm)

Torques in lb-ft (mkg) (Nm) - Serrages en pieds-livres (mkg) (Nm)

Anzugsmomente in lb-ft (mkg) (Nm) - Par de apriete en lb-pie (mkg) (Nm)

∅ = Diameter - Diamètre - Durchmesser - Diámetro

c = Indicates change - Indique révision - Änderung - Indica cambio

Correct alignment between large bore engines and two-bearing generators should be maintained to provide peak performance and extended life. The engine crankshaft and generator shaft do not turn in the same horizontal centerline during operation as during the alignment test for the following reasons:

- A) During the alignment test, the shafts lie in the bottom of the bearing bores. During operation, the shafts are in the center of the bearing bores.
- B) The weight of the flywheel and the coupling members causes a small deflection of the shafts during the alignment test.
- C) Due to heat, expansion of the metal in the engine and generator causes the centerline of the shafts to change to different locations.

Therefore, in order to have alignment during operation of the unit, it is necessary to make certain adjustments to a cold alignment test. The tolerances shown on page 19 allow the best possible alignment during operation. Realignment of a unit that has been operated is not necessary unless the indicator readings during the alignment test exceed the tolerances shown on page 22.

L'alignement du rotor des génératrices à deux paliers sur l'arbre des moteurs de gros alésage doit être réalisé avec précision pour obtenir à la fois le meilleur fonctionnement possible du groupe et la durée de service maximale. Le vilebrequin du moteur et l'arbre de la génératrice ne tournent pas dans le même axe horizontal pendant la marche et pendant l'alignement, parce que:

- A) Pendant l'alignement, les arbres reposent dans les alésages des paliers, tandis qu'ils tournent concentriquement aux alésages pendant la marche.
- B) Le poids du volant et des éléments d'accouplement fait légèrement fléchir les arbres pendant l'alignement.
- C) La chaleur dégagée entraîne une dilatation du métal du moteur et de la génératrice, qui fait que les axes des arbres se trouvent déplacés.

En conséquence, pour que l'alignement soit correct en cours de marche, il faudra apporter quelques rectifications à l'alignement à froid. Les tolérances indiquées en page 19 donneront le meilleur alignement possible en cours de marche. Le réalignement d'un ensemble qui aura fonctionné ne sera pas nécessaire tant que les indications du comparateur lors du contrôle d'alignement ne dépasseront pas les tolérances indiquées en page 22.

Genauere Ausrichtung zwischen Motoren mit großer Bohrung und Doppellager-Generatoren muß unbedingt eingehalten werden, um beste Leistung und hohe Lebensdauer zu gewährleisten. Aus folgenden Gründen laufen die Kurbelwelle des Motors und die Generatorwelle im Betrieb nicht auf der gleichen waagrecht Mittellinie als während der Ausrichtprüfung:

- A) Während der Ausrichtprüfung liegen die Wellen unten in den Lagerbohrungen. Während des Betriebes liegen die Wellen in der Mitte der Lagerbohrungen.
- B) Das Gewicht der Schwungscheibe und der Kupplungsteile verursacht eine geringe Abweichung der Wellen während der Ausrichtprüfung.
- C) Durch die Wärmeausdehnung des Metalls im Motor und Generator wird eine Abweichung der Mittellinie der beiden Wellen herbeigeführt.

Damit im Betrieb genaue Ausrichtung vorliegt, ist es nötig, bestimmte Nachstellungen bei der Ausrichtprüfung vorzunehmen. Die Toleranzen auf Seite 19 ermöglichen die beste Ausrichtung im Betrieb. Eine Einheit, die bereits betrieben wurde, braucht nicht nachgestellt zu werden, außer wenn die Meßablesung während der Ausrichtprüfung die auf Seite 22 aufgeführten Toleranzen übersteigt.

Debe mantenerse la alineación correcta entre los motores con cilindros de gran diámetro y los generadores de dos cojinetes para proveer un rendimiento máximo y larga duración. El cigüeñal del motor y el eje del generador no giran en la misma línea de centro horizontal durante el funcionamiento que cuando se hacen pruebas de alineación por las razones siguientes:

- A) Durante las pruebas de alineación, el eje descansa en la parte inferior desde los cojinetes. Durante el funcionamiento, los ejes están en el centro de los cojinetes.
- B) El peso del volante y de los miembros de acoplamiento producen una pequeña deflexión de los ejes durante la prueba de alineación.
- C) Debido al calentamiento, el metal se expande en el motor y en el generador haciendo que la línea de centro de los ejes cambie de lugar.

Por lo tanto, a fin de tener alineación durante el funcionamiento de la unidad, es necesario hacer ciertos ajustes a las pruebas de alineación en frío. Las tolerancias que se indican en la página 19 permiten la alineación mejor posible durante el funcionamiento. La realineación de una unidad que estaba en funcionamiento no es necesaria menos que las lecturas del indicador durante las pruebas de alineación excedan de las tolerancias dadas en la página 22.

● TABLE OF CONTENTS

- c Initial Installation Alignment . . . . . 4
  - Preparing to Install Front Mounted Generator . . . . . 4
  - Preparing to Install Rear Mounted Generator . . . . . 7
  - Mating Generator to Engine . . . . . 10
- c Secondary Installation Alignment or Realignment of a Repaired Unit . . . . . 13
  - Face Alignment . . . . . 13
  - Bore Alignment . . . . . 15
  - Recheck Bore Alignment . . . . . 17
  - Final Alignment . . . . . 19
- c Alignment Test of a Unit That Has Been Operated . . . . . 20
  - Specifications . . . . . 23
  - Alignment Tabulation Chart . . . . . 25
  - 2N4664 and 2N4662 Adapters . . . . . 26

## TABLE DES MATIÈRES

c	Alignement initial .....	4
	Génératrice à montage AV - opérations préliminaires .....	4
	Génératrice à montage AR - opérations préliminaires .....	7
	Accouplement de la génératrice au moteur .....	10
c	Alignement complémentaire ou réalignement d'un ensemble révisé .....	13
	Parallélisme .....	13
	Concentricité .....	15
	Vérification de concentricité .....	17
	Alignement final .....	19
c	Vérification d'alignement d'un ensemble après fonctionnement .....	20
	Caractéristiques .....	23
	Tableau des cotes d'alignement .....	25
	Supports 2N4661 et 2N4662 .....	26

## INHALTSVERZEICHNIS

c	Ausrichtung bei Ersteinbau .....	4
	Vorbereitung zum Einbau frontmontierter Generatoren .....	4
	Vorbereitung zum Einbau heckmontierter Generatoren .....	7
	Anpassen des Generators an den Motor .....	10
c	Ausrichtung bei Zweiteinbau oder Wiederausrichtung nach Reparatur .....	13
	Flächenausrichtung .....	13
	Bohrausrichtung .....	15
	Nachprüfung der Bohrausrichtung .....	17
	Endausrichtung .....	19
c	Ausrichtprüfung an einer betriebenen Einheit .....	20
	Technische Daten .....	23
	Aufzeichnungen .....	25
	Anschlüsse 2N4664 und 2N4662 .....	26

## TABLA DE MATERIAS

c	Alineación inicial de la instalación .....	4
	Preparación para instalar generador de montaje delantero .....	4
	Preparación para instalar generador de montaje trasero .....	7
	Acoplamiento del generador al motor .....	10
c	Alineación secundaria de instalación o realineación de una unidad reparada .....	13
	Paralelismo .....	13
	Concentricidad .....	15
	Comprobación de la concentricidad .....	17
	Alineación final .....	19
c	Prueba de alineación de una unidad que ha estado en funcionamiento .....	20
	Especificaciones .....	23
	Tabla de alineación .....	25
	Adaptadores 2N4664 y 2N4662 .....	26

## INITIAL INSTALLATION ALIGNMENT

### ALIGNEMENT INITIAL

## AUSRICHTUNG BEI ERSTEINBAU

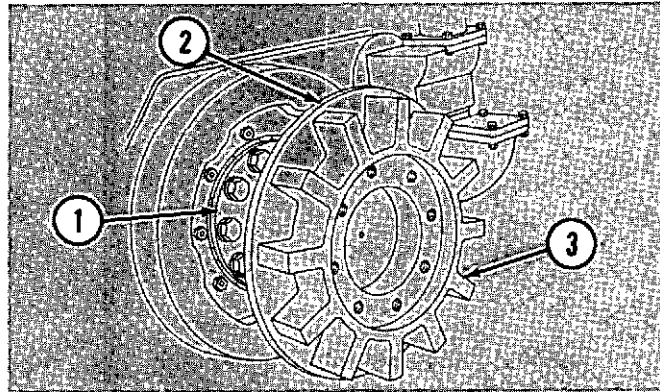
### ALINEACION INICIAL DE LA INSTALACION

#### Preparing to Install Front Mounted Generator

#### Vorbereitung zum Einbau frontmontierter Generatoren

#### Génératrice à montage avant - opérations préliminaires

#### Preparación para instalar generador de montaje delantero

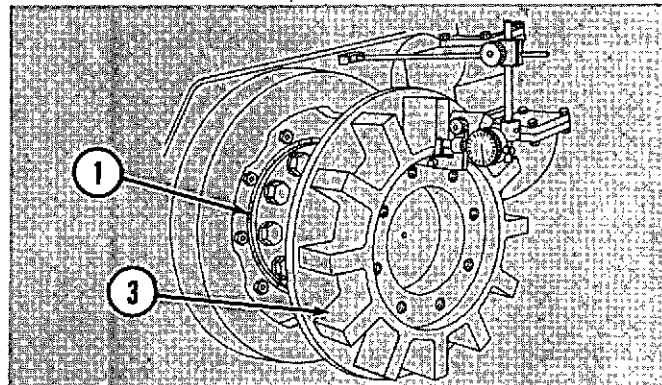


- 1 Place retainer plate (2) over spacer shaft (1) and install inner coupling member (3).

Placer la bride de retenue (2) sur l'embout d'arbre (1) et boulonner le moyeu d'accouplement (3).

Halteplatte (2) über die Anschlußwelle (1) führen und inneren Kupplungskranz (3) einbauen.

Coloque la plancha retén (2) sobre el espaciador del eje (1) e instale el miembro de acoplamiento interior (3).

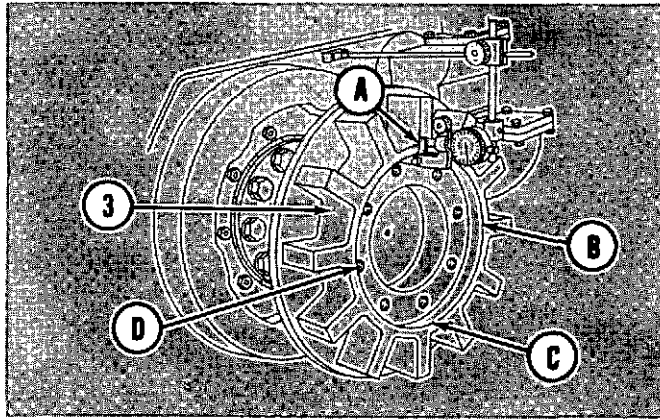


- 2 Mount a dial indicator, with adapters, to the front accessory housing on the engine. Set the tip of the indicator on the top of the inner bore surface of coupling member (3), and zero the indicator. Using a crowbar, pry against a floor mounted support and spacer shaft (1) to raise the crankshaft to the top of its clearance in the main bearings. The Total Indicator Reading (TIR) is equal to  $2C$ , which is the bearing clearance factor. A TIR of  $.015''$  ( $0,38$ ) is permitted. The chart on page 25 is provided for recording indicator readings. A list of the tolerances is shown on page 23.

A l'aide des supports prévus, fixer un comparateur sur le carter de prise de mouvement avant du moteur. Poser le palpeur du comparateur sur le haut de l'alésage du moyeu d'accouplement (3) et régler le cadran au zéro. A l'aide d'une pince droite prenant appui sur un support reposant sur le sol, soulever l'embout d'arbre (1) de façon que le vilebrequin appuie contre le haut du coussinet du palier avant du moteur. Noter la déviation totale marquée par le comparateur; elle est égale à  $2C$  qui est le jeu de palier. On tolère une déviation totale de  $0,015''$  ( $0,38$ ). Inscrive les indications du comparateur dans le tableau de la page 25. La liste des tolérances est donnée en page 23.

Meßuhr mit den nötigen Anschlüssen am vorderen Steuerantriebsgehäuse des Motors anbringen. Sondenspitze an der Innenseite des Kupplungskranzes (3) ansetzen und die Meßuhr nullen. Mit einer Brechstange auf einem Drehpunkt gegen die Anschlußwelle (1) drücken, bis die Kurbelwelle an der Oberseite des vorderen Hauptlagers fest anliegt. Die Gesamtmeßablesung (GMA) entspricht  $2C$  und stellt den Lagerspielfaktor dar. Eine Gesamtmeßablesung von  $0,015''$  ( $0,38$ ) ist zulässig. Meßablesungen werden in der Tabelle auf Seite 25 eingetragen. Die richtigen Lagerspiele sind auf Seite 23 angegeben.

Monte un indicador de esfera, con los adaptadores, a la parte delantera de la caja de accesorios del motor. Ajuste la punta del indicador en la parte superior de la superficie interior del miembro de acoplamiento (3), y coloque el indicador en cero. Usando una barra, haga palanca contra un soporte montado en el piso y el eje de espaciador (1) para levantar el cigüeñal a la parte superior de su juego en los cojinetes de bancada. La Lectura Total del Indicador es igual a  $2C$ , que es el factor de juego del cojinete. Una Lectura Total del Indicador de  $0,015''$  ( $0,38$ ) es permisible. La tabla en la página 25 se suministra para registrar las lecturas del indicador. En la página 23 se da una lista de las tolerancias.

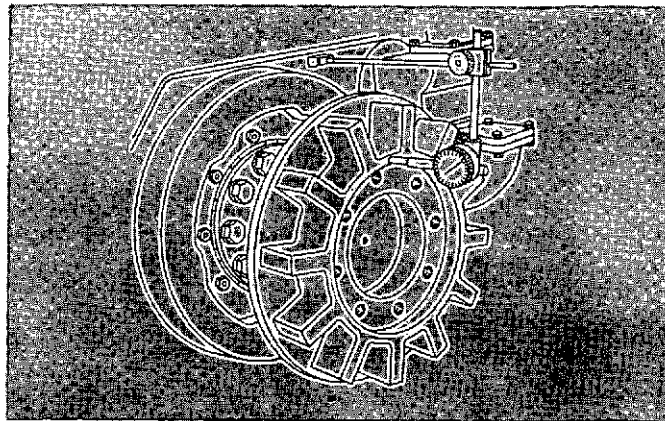


- 3 Set the dial indicator tip on the inner bore surface of coupling member (3) and zero the indicator. Mark coupling member (3) at points (A), (B), (C), (D), 90° apart. Rotate the crankshaft in the normal direction. Record the indicator reading when positions (A), (B), (C), and (D) are at the top. A TIR of .010" (0,25) is permitted.

Le palpeur reposant toujours contre le haut de l'alésage du moyeu d'accouplement (3), régler le comparateur à zéro. Marquer quatre repères à 90° (A), (B), (C) et (D) sur le moyeu (3). Tourner le vilebrequin dans le sens de rotation normal et noter la déviation du comparateur quand chaque repère (A), (B), (C) et (D) est en haut, au droit du palpeur. On tolère une déviation totale de 0,010" (0,25).

Die Sondenspitze an der Innenseite des Kupplungskranzes (3) ansetzen und die Meßuhr nullen. Den Kupplungskranz (3) bei (A), (B), (C) und (D) jeweils im Abstand von 90° anreißen. Kurbelwelle nur in normaler Drehrichtung drehen und die GMA bei Lage der einzelnen Kurbelwellenmarken (A), (B), (C) und (D) oben aufzeichnen. Eine GMA von 0,010" (0,25) ist zulässig.

Coloque la punta del indicador de esfera en la superficie interior del miembro de acoplamiento (3) y coloque el indicador en cero. Marque el miembro de acoplamiento (3) en los puntos (A), (B), (C), (D), 90° aparte. Gire el cigüeñal en la dirección normal de rotación. Anote la lectura del indicador cuando las posiciones (A), (B), (C) y (D) estén en la parte de arriba. Una lectura total del indicador de 0,010" (0,25) es permisible.

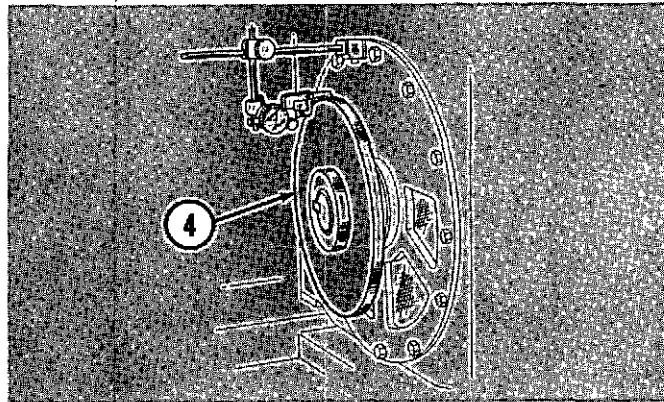


- 4 Set the tip of the indicator on the face of the coupling member. Position the crankshaft to the rear of its end play and set the indicator to zero. Shift the crankshaft forward and record the indicator reading. A TIR of .035" (0,89) is permitted.

Le palpeur du comparateur reposant contre la joue du moyeu d'accouplement, repousser le vilebrequin à fond vers l'arrière et régler le comparateur au zéro. Tirer le vilebrequin à fond vers l'avant et noter la déviation totale du comparateur. On tolère une déviation totale de 0,035" (0,89).

Sondenspitze an der Stirnseite des Kupplungskranzes ansetzen. Kurbelwelle bis zum Abschluß des Endspiels zurückdrücken und Meßuhr nullen. Dann Kurbelwelle vordrücken und GMA aufzeichnen. Eine GMA von 0,035" (0,89) ist zulässig.

Coloque la punta del indicador en la cara del miembro de acoplamiento. Ubique el cigüeñal hacia la parte de atrás de su juego axial y coloque el indicador en cero. Mueva el cigüeñal hacia adelante y anote la lectura del indicador. Una lectura total del indicador de 0,035" (0,89) es permisible.

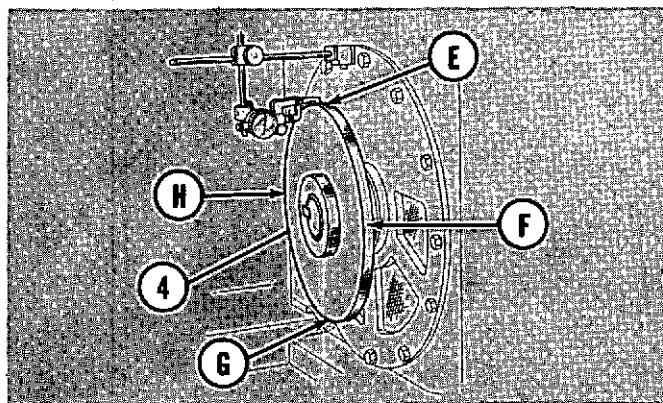


- 5 Clean the generator support pads of all dirt, burrs, and excessive paint before assembly. Bolt coupling adapter (4) to the generator hub. Mount the dial indicator to the generator housing and set the tip of the indicator on the adapter as shown.

Nettoyer les semelles-support de la génératrice pour obtenir une portée unie, sans impuretés, bavures ni excès de peinture. Visser le flasque d'accouplement (4). Fixer le comparateur sur le carter de la génératrice et disposer le palpeur du comparateur contre l'intérieur du flasque d'accouplement, comme représenté.

Auflager für den Generator gründlich von Schmutz, Graten und Farbresten säubern. Kupplungsanschluß (4) an der Generatornabe anschrauben. Meßuhr am Generatorgehäuse anbringen und die Sondenspitze, wie gezeigt, auf dem Anschluß ansetzen.

Limpie los soportes del generador de toda suciedad, rebabas y exceso de pintura antes de armar. Emperne el adaptador de acoplamiento (4) a la maza del generador. Monte el indicador de esfera en la caja del generador y coloque la punta del indicador en el adaptador, como se muestra.

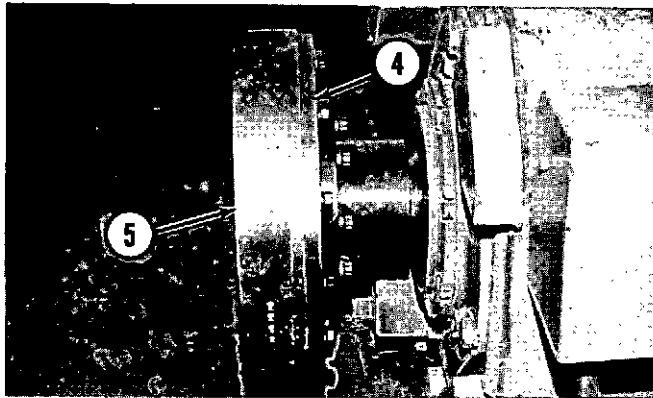


- 6 Mark coupling adapter (4) at (E), (F), (G), and (H), 90° apart. Zero the indicator with the adapter at position (E). Rotate the generator shaft and record the indicator readings when adapter positions (E), (F), (G), and (H) are at the top. A TIR of .005" (0,13) is permitted.

Marquer sur le flasque d'accouplement (4) quatre points (E), (F), (G) et (H) à 90°. Régler le comparateur à zéro quand le repère (E) est en haut. Tourner l'arbre de la génératrice et noter la déviation quand les repères (E), (F), (G) et (H) sont en haut. On tolère une déviation totale de 0,005" (0,13).

Kupplungsanschluß (4) bei (E), (F), (G) und (H) jeweils 90° versetzt anreißen. Meßuhr mit Stellung (E) oben nullen. Dann Generatorwelle drehen und GMA mit den Reißmarken (F), (G), (H) und nochmals (E) oben aufzeichnen. Eine GMA von 0,005" (0,13) ist zulässig.

Marque el adaptador de acoplamiento (4) en (E), (F), (G) y (H), 90° aparte. Coloque el indicador en cero con el adaptador en la posición (E). Gire el eje del generador y anote las lecturas del indicador cuando las posiciones del adaptador (E), (F), (G) y (H) estén en la parte de arriba. Una lectura total del indicador de 0,005" (0,13) es permisible.



c 7 Install outer coupling member (5) on adapter plate (4).

c Boulonner la couronne d'accouplement (5) sur le flasque (4).

c Äußeren Kupplungskranz (5) am Kupplungsanschluß (4) anbauen.

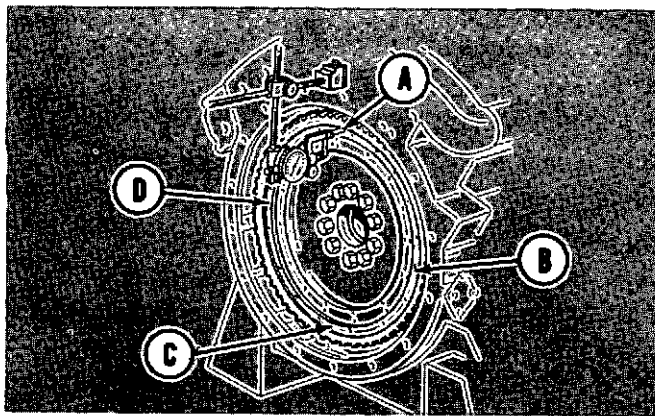
c Instale el miembro de acoplamiento exterior (5) en la plancha adaptadora (4).

### Preparing to Install Rear Mounted Generator

Génératrice à montage arrière - opérations préliminaires

Vorbereitung zum Einbau heckmontierter Generatoren

Preparación para instalar generador de montaje trasero



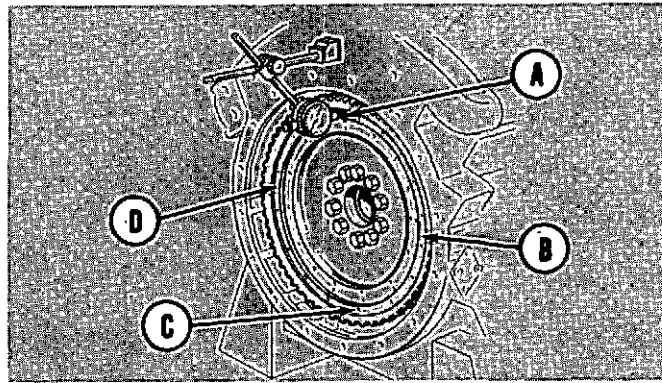
1 Position a dial indicator on the flywheel pilot bore as shown. Mark the flywheel at points (A), (B), (C) and (D), 90° apart. Zero the indicator. Rotate the crankshaft in the normal direction and record the indicator readings when flywheel positions (A), (B), (C) and (D) are at the top. A TIR of .006" (0,15) is permitted.

Fixer le comparateur sur l'alésage pilote du volant. Marquer sur le volant quatre repères (A), (B), (C) et (D) à 90°.

c Régler le comparateur à zéro. Tourner le vilebrequin dans le sens de rotation normal et noter la déviation du comparateur quand les repères (A), (B), (C) et (D) sont en haut. On tolère une déviation totale de 0.006" (0,15).

Meßuhr in der Schwunzscheibenbohrung des Motors anbringen. Schwunzscheibe bei (A), (B), (C) und (D) jeweils im Abstand von 90° anreißen. Meßuhr nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei Lage der Reißmarken (A), (B), (C) und (D) oben aufzeichnen. Eine GMA von 0,006" (0,15) ist zulässig.

c Coloque un indicador de esfera en la perforación piloto del volante, como se muestra. Marque el volante en los puntos (A), (B), (C) y (D), 90° aparte. Coloque el indicador en cero. Gire el cigüeñal en la dirección normal de rotación y anote las lecturas del indicador cuando las posiciones (A), (B), (C) y (D) del volante estén en la parte de arriba. Una lectura total del indicador de 0,006" (0,15) es permisible.

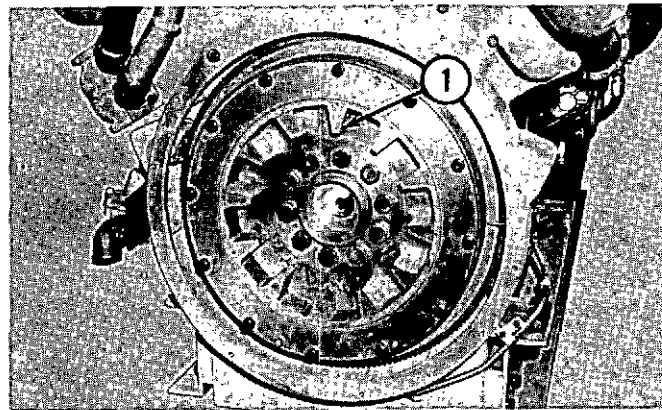


- 2 Set the tip of the indicator on the face of the flywheel. Position the crankshaft to the front of its end play and zero the indicator. Shift the crankshaft to the rear of its end play and record the indicator reading. A TIR of .035" (0,89) is permitted. Zero the indicator. Rotate the crankshaft and record the indicator readings when flywheel positions (A), (B), (C) and (D) are at the top. Remove all end play before recording each reading. A TIR of .006" (0,15) is permitted.

Poser le palpeur du comparateur contre la face du volant. Repousser le volant à fond vers l'avant, le repère (A) étant en haut, et régler le comparateur à zéro. Tirer le volant à fond vers l'arrière et noter la déviation du comparateur. On tolère une déviation totale de 0,035" (0,89). Régler le comparateur à zéro. Tourner le volant dans le sens de rotation normal et noter la déviation du comparateur quand les repères (A), (B), (C) et (D) sont en haut. S'assurer que le volant est tiré à fond vers l'arrière à chacune de ces mesures. On tolère une déviation totale de 0,006" (0,15).

Sondenspitze an der Stirnseite des Schwungrades ansetzen. Kurbelwelle bis zum Abschluß des Endspiels ganz nach vorne drücken und Meßuhr nullen. Dann Kurbelwelle bis zum Abschluß des Endspiels ganz nach hinten drücken und GMA aufzeichnen. Mit der Kurbelwelle am Hinterende des Endspiels Meßuhr nullen, Dann Kurbelwelle in normaler Drehrichtung drehen und GMA mit Reißmarken (A), (B), (C) und (D) oben aufzeichnen. Für die Aufzeichnungen darf kein Endspiel vorliegen. Eine GMA von 0,006" (0,15) ist zulässig.

Ajuste la punta del indicador en la cara del volante. Ubique el cigüeñal hacia la parte de adelante de su juego axial y coloque el indicador en cero. Mueva el cigüeñal hacia la parte de atrás de su juego axial y anote la lectura del indicador. Una lectura total del indicador de 0,035" (0,89) es permisible. Coloque el indicador en cero. Gire el cigüeñal y anote las lecturas del indicador cuando las posiciones (A), (B), (C) y (D) del volante estén en la parte de arriba. Remueva todo el juego axial antes de anotar cada lectura. Una lectura total del indicador de 0,006" (0,15) es permisible.

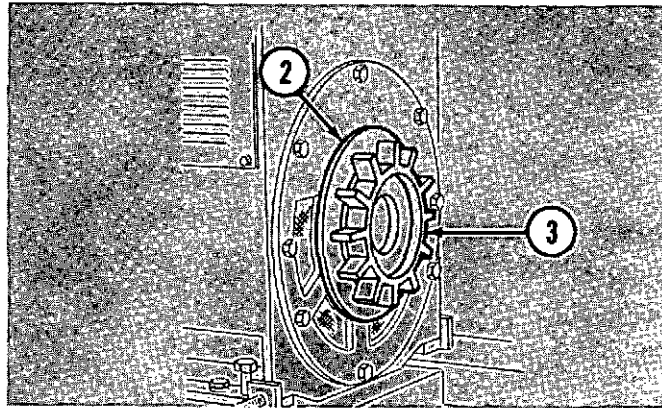


- 3 Install outer coupling member (1) to the engine flywheel. Mount a dial indicator on the flywheel housing and set the tip of the indicator on the top of the coupling member. Zero the indicator. Raise the crankshaft to the top of its bearing clearance. The TIR is equal to 2C which is the bearing clearance factor. A TIR of .015" (0,38) is permitted.

Fixer la couronne (1) d'accouplement au volant du moteur. Monter un comparateur sur le carter de volant et poser le palpeur du comparateur sur le dessus de la couronne. Régler le comparateur au zéro. Soulever le vilebrequin pour l'appuyer contre le haut du coussinet de palier arrière et noter la déviation du comparateur. La déviation totale du comparateur est égale à 2C qui est le jeu de palier. On tolère une déviation totale de 0,015" (0,38).

Äußeren Kupplungskranz (1) an der Schwungscheibe anbauen. Meßuhr am Schwungscheibengehäuse anbringen und Sondenspitze oben am Kupplungskranz (1) ansetzen. Meßuhr nullen, Kurbelwelle anheben, bis alles Lagerspiel behoben ist. Die GMA entspricht nun 2C, welches den Lagerspielfaktor darstellt. Eine GMA von 0,015" (0,38) ist zulässig.

Instale el miembro de acoplamiento exterior (1) al volante del motor. Monte un indicador de esfera en la caja del volante y coloque la punta del indicador en la parte superior del miembro de acoplamiento. Coloque el indicador en cero. Levante el cigüeñal a la parte superior de su juego. La lectura total del indicador es igual a 2C, lo que es el factor de juego de cojinete. Una lectura total del indicador de 0,015" (0,38) es permisible.

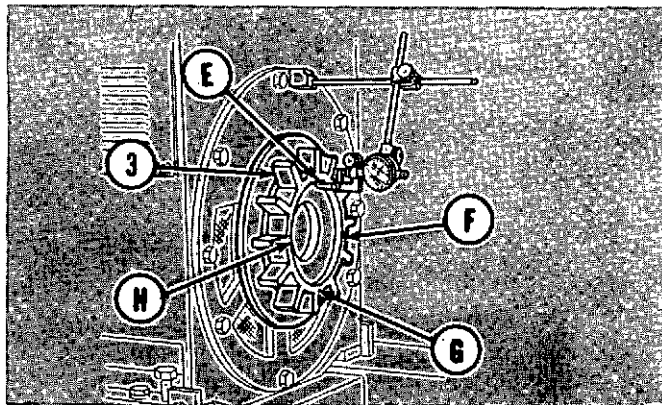


- 4 Clean the generator support pads of all dirt, burrs and excessive paint before assembly. Place rear retainer plate (2) on the generator shaft and install inner coupling member (3).

Nettoyer les semelles-support de la génératrice pour enlever toutes les saletés, bavures, et tout excès de peinture. Placer la bride circulaire (2) sur l'arbre de la génératrice et monter le moyeu d'accouplement (3).

Auflager des Generators von Schmutz, Graten und Farbresten gründlich säubern. Hintere Halteplatte (2) auf die Generatorwelle aufziehen und inneren Kupplungskranz (3) einbauen.

Limpie los soportes del generador de toda suciedad, rebabas y exceso de pintura antes de armar. Coloque la plancha retén trasera (2) en el eje del generador e instale el miembro de acoplamiento interior (3).

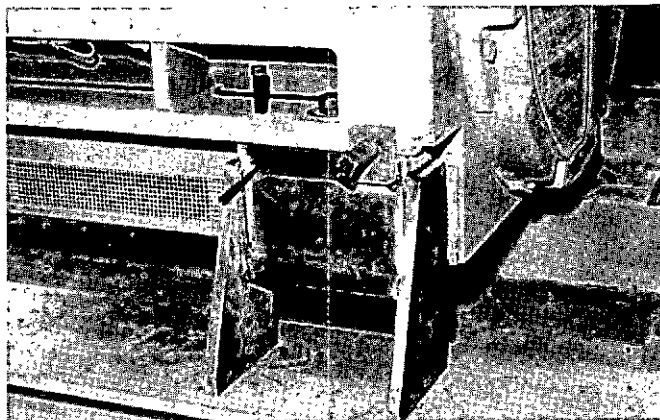


- 5 Mark coupling (3) at points (E), (F), (G) and (H), 90° apart. Mount the dial indicator on the generator and set the tip of the indicator on the inner bore surface of the coupling. Zero the indicator. Rotate the generator shaft and record the indicator readings when coupling positions (E), (F), (G) and (H) are at the top. A TIR of .005" (0,13) is permitted.

Marquer quatre repères à 90° (E), (F), (G) et (H) sur le moyeu (3). Monter le comparateur sur la génératrice et poser le palpeur du comparateur contre l'alésage du moyeu. Mettre le comparateur au zéro. Tourner l'arbre de la génératrice et noter la déviation du comparateur quand les repères (E), (F), (G) et (H) sont en haut. On tolère une déviation totale de 0.005" (0,13).

Kupplung (3) bei (E), (F), (G) und (H) im Abstand von jeweils 90° anreißen. Meßuhr am Generator anbringen und Sondenspitze auf der Innenfläche der Bohrung in der Kupplung ansetzen. Meßuhr nullen, Generatorwelle drehen und GMA bei Lage der Reißmarken (E), (F), (G) und (H) oben aufzeichnen. Eine GMA von 0,005" (013) ist zulässig.

Marque el acoplamiento (3) en los puntos (E), (F), (G) y (H), 90° aparte. Monte el indicador de esfera en el generador y coloque la punta del indicador en la superficie interior del acoplamiento. Coloque el indicador en cero. Gire el eje del generador y anote las lecturas del indicador cuando las posiciones (E), (F), (G) y (H) del acoplamiento estén en la parte de arriba. Una lectura total del indicador de 0,005" (0,13) es permisible.

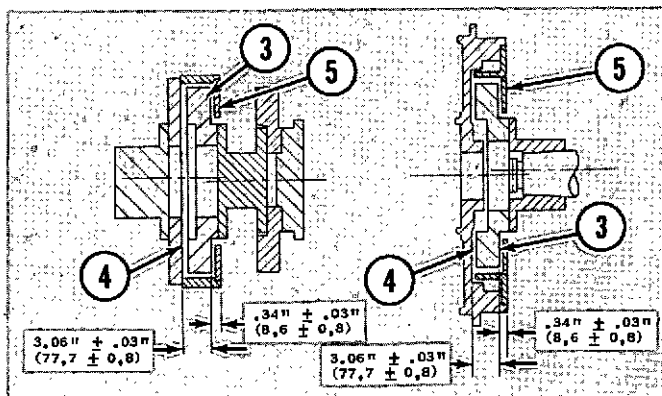
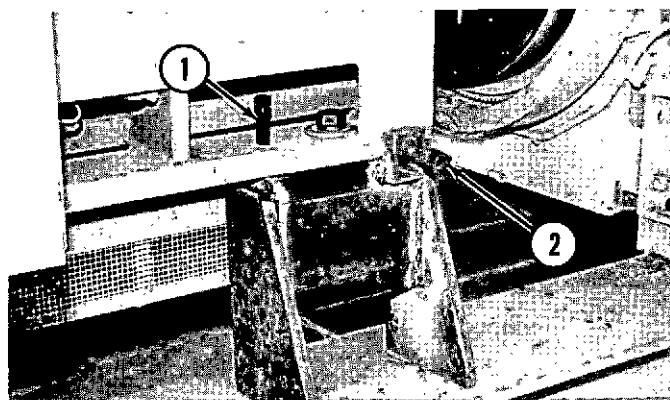


- 1 Place at least .25" (6,4) of shims under each mounting pad. When reinstalling a reconditioned generator, place the previously used shim packs at their former locations.

Placer une épaisseur de cales d'au moins 0,25" (6,4) sous chaque semelle. Si l'on procède à la pose de la génératrice après révision, placer sous chaque semelle les mêmes jeux de cales que ceux que l'on a enlevés à la dépose.

Beilagen von mindestens 0,25" (6,4) unter jedem Auflager anbringen. Beim Wiedereinbau generalüberholter Generatoren die vorher verwendeten Beilagen in ihrer alten Lage wiederverwenden.

Coloque debajo de cada soporte una cantidad de laines de por lo menos 0,25" (6,4). Cuando vuelva a instalar un generador reacondicionado, coloque las laines usadas anteriormente en las ubicaciones en que estaban.



- 2 Position the generator using leveling screws (1) and alignment bolts (2), so that the two coupling members slide together. Using a depth gauge or a flexible steel scale, measure the distance from the face of inner coupling member (3) to either the inner face of retainer plate (4) or the outer face of retainer plate (5). The distance from coupling member (3) to plate (4) should be 3.06" ± .03" (77,7 ± 0,8). The distance from coupling member (3) to plate (5) should be .34" ± .03" (8,6 ± 0,8).

Positionner la génératrice par les vis (1) de réglage vertical et les vis (2) de réglage latéral de façon que les deux parties de l'accouplement moteur et génératrice soient complètement engagées. A l'aide d'un micromètre de profondeur ou d'un calibre à lames, mesurer la distance de la face (3) du moyeu d'accouplement intérieur à la face intérieure du flasque (4) ou à la face extérieure du flasque (5). La distance entre le moyeu (3) et le flasque (4) doit être de 3.06" ± 0.03" (77,7 ± 0,8). La distance entre le moyeu (3) et le flasque (5) doit être de 0.34" ± 0.03" (8,6 ± 0,8).

Den Generator mit Schrauben (1) und Stellschrauben (2) so aufstellen, daß die beiden Kupplungskränze ineinander gleiten. Den Abstand von der Stirnseite des inneren Kupplungskranzes (3) bis zur inneren Stirnseite der Halteplatte (4) mit einem Tiefenmikrometer oder Maßband messen. Der Abstand vom Kupplungskranz zur Platte (4) sollte  $3,06'' \pm 0,03''$  ( $77,7 \pm 0,8$ ) betragen. Der Abstand vom Kupplungskranz (3) zur Platte (5) sollte  $0,34'' \pm 0,03''$  ( $8,6 \pm 0,8$ ) betragen.

Ubique el generador usando los tornillos de nivelación (1) y los pernos de alineación (2), de manera que un miembro de acoplamiento se deslice dentro del otro. Usando un calibrador de espesor o una regla metálica flexible, mida la distancia desde la cara del miembro de acoplamiento interior (3) a la cara interior de la plancha retén (4) o de la cara exterior de la plancha retén (5). La distancia desde el miembro de acoplamiento (3) a la plancha (4) debe ser de  $3,06'' \pm 0,03''$  ( $77,7 \pm 0,8$ ). La distancia desde el miembro de acoplamiento (3) a la plancha (5) debe ser de  $0,34'' \pm 0,03''$  ( $8,6 \pm 0,8$ ).

**3** Place three rubber elements between the teeth of the couplings.

Placer la garniture de caoutchouc en trois pièces entre les dentures des pièces d'accouplement.

Drei Gummieinlagen zwischen die Kupplungszähne legen.

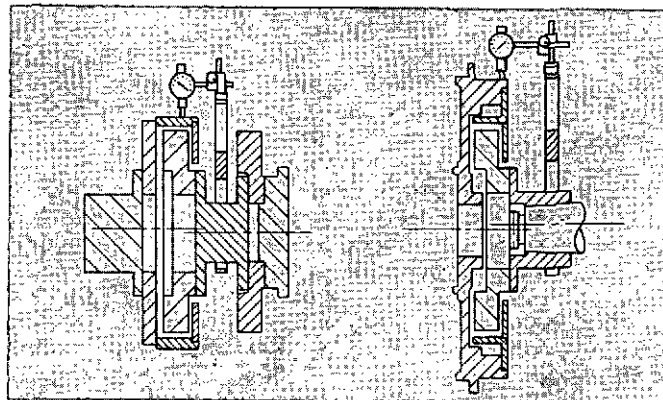
Coloque tres elementos de goma entre los dientes de los acoplamientos.

Front Mounted

Montage AV

Frontmontiert

Montaje delantero



Rear Mounted

Montage AR

Heckmontiert

Montaje trasero

**4** For front mounted generators, install the 2N4661 and 2N4662 Adapters on the engine front extension shaft. Use the adapters to mount the dial indicator to the outer coupling member on the generator side as shown. For rear mounted generators, install the 2N4661 and 2N4662 Adapters on the generator hub. Use the adapters to mount the dial indicator to the flywheel as shown.

Pour les génératrices à montage AV, monter les supports 2N4661 et 2N4662 sur l'embout avant d'arbre du moteur. Utiliser ces supports pour monter le comparateur sur la couronne d'accouplement du côté de la génératrice, comme représenté. Pour les génératrices à montage AR, monter les supports 2N4661 et 2N4662 sur le moyeu de la génératrice. Utiliser ces supports pour monter le comparateur sur le volant comme indiqué.

An frontmontierten Generatoren die Anschlüsse 2N4661 und 2N4662 an der vorderen Motoranschlußwelle anbauen. Die Meßuhr mit den Anschlüssen am äußeren Kupplungskranz auf der Generatorseite, wie gezeigt, anbauen. An heckmontierten Generatoren die Anschlüsse 2N4661 und 2N4662 an der Generatornabe anbauen. Meßuhr mit den Anschlüssen an der Schwungscheibe, wie gezeigt, anbauen.

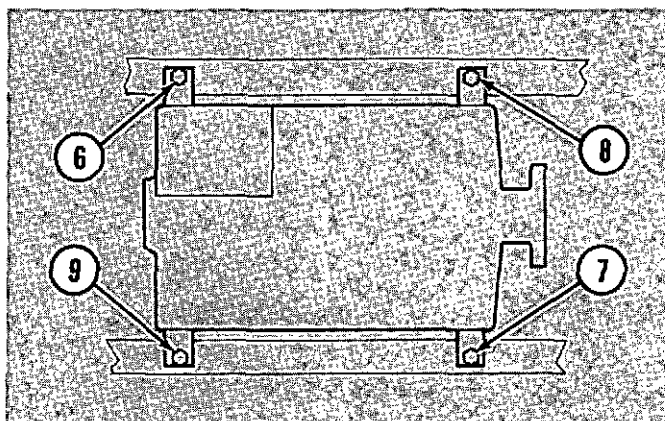
Para generadores de montaje delantero, instale Adaptadores 2N4661 y 2N4662 en el eje de extensión delantera del motor. Use los adaptadores para montar el indicador de esfera al miembro de acoplamiento exterior en el lado del generador, como se muestra. Para generadores de montaje trasero, instale Adaptadores 2N4661 y 2N4662 en la maza del generador. Use los adaptadores para montar el indicador de esfera en el volante, como se muestra.

- 5 With the shims installed between the generator support pads and the base plate, loosen the leveling screws.

Les cales étant en place entre les semelles-support de la génératrice et le socle, desserrer les vis de réglage vertical.

Wenn die Beilagen zwischen den Generatörauflagern und dem Unterbau angebracht sind, Richtschrauben lösen.

Con las laines instaladas entre los soportes del generador y la plancha base, afloje los tornillos de nivelación.



- 6 Tighten hold-down bolts (6) and (7) to approximately one-half of the recommended final torque shown on page 23. Observe the dial indicator while each bolt is tightened. If there is a sizeable change in the indicator readings, loosen the bolt being tightened and add more shims to that particular support. If there is no change, tighten remaining bolts (8) and (9) to one-half of the final torque. If there is a change in the indicator reading, loosen the bolt being tightened and add more shims. Loosen all of the hold-down bolts, then tighten bolts (8) and (9) to one-half of the final torque. Observe the indicator for any change in the reading and repeat the above procedure if necessary. When there is no change in the indicator reading, tighten bolts (6) and (7) and observe the indicator for any change. Add more shims to any support which affects the indicator reading.

Serrer les vis de fixation (6) et (7) à environ la moitié du couple recommandé pour le serrage final donnée page 23. Observer le comparateur pendant le serrage de chaque vis. Si le comparateur dévie de façon appréciable, desserrer la vis de fixation et ajouter une ou plusieurs cales sous la semelle portant cette vis. Si l'indication du comparateur reste fixe, serrer les deux autres vis (8) et (9) à la moitié du couple de serrage final. Si le comparateur dévie, desserrer la vis en cause, rajouter des cales sous la semelle correspondante. Desserrer toutes les vis de fixation, puis resserrer les vis (8) et (9) à la moitié du couple final tout en observant le comparateur. Répéter cette succession d'opérations si nécessaire. Quand l'indication du comparateur reste fixe, serrer les vis (6) et (7) et observer le comparateur. Ajouter des clinquants sous les semelles dont le serrage fait dévier le comparateur.

Halteschrauben (6) und (7) auf etwa die Hälfte des auf Seite 23 angegebenen Anzugsmoments anziehen. Meßuhr beim Anziehen jeder Schraube beobachten. Falls eine merkbare Änderung in der Ablesung eintritt, die gerade angezogene Schraube lösen und an diesem Auflager mehr Beilagen zugeben. Falls keine Abweichung auftritt, verbleibende Schrauben (8) und (9) auf die Hälfte des angegebenen Anzugsmoments anziehen. Falls nun eine Abweichung auftritt, die Schraube lösen und mehr Beilagen zugeben. Nun alle Halteschrauben lösen, dann Schrauben (8) und (9) auf die Hälfte des Endanzugsmoments anziehen. Dabei die Meßuhr auf Abweichungen prüfen und den oben beschriebenen Vorgang wiederholen, falls nötig. Falls keine Abweichung in der Ablesung auftritt, Schrauben (6) und (7) anziehen und Meßuhr beobachten. Falls eine Abweichung auftritt, am betroffenen Auflager mehr Beilagen zugeben.

Apriete los pernos de sujeción (6) y (7) a aproximadamente la mitad del par final recomendado que se da en la página 23. Observe el indicador de esfera mientras se aprieta cada perno. Si hay un cambio de importancia en las lecturas del indicador, afloje el perno que se estaba apretando y agregue más laines a ese soporte. Si no hay cambio, apriete los pernos restantes (8) y (9) a la mitad del par final. Si hay cambio en la lectura del indicador, afloje el perno que se estaba apretando y agregue más laines. Afloje todos los pernos de sujeción; en seguida, apriete los pernos (8) y (9) a la mitad del par final de apriete. Observe el indicador para ver si se producen cambios en la lectura y repita el procedimiento anterior en caso necesario. Cuando no exista cambio en la lectura del indicador, apriete los pernos (6) y (7) y observe el indicador para ver si indica cambios. Agregue más laines a cualquier soporte que produzca cambios en la lectura del indicador.

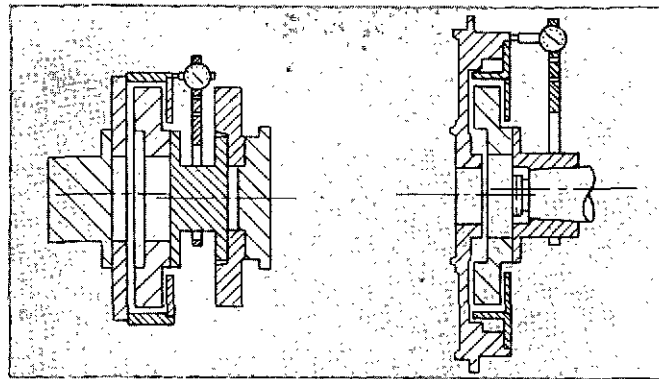
**SECONDARY INSTALLATION ALIGNMENT OR REALIGNMENT OF A REPAIRED UNIT**  
**ALIGNEMENT COMPLÉMENTAIRE OU RÉALIGNEMENT D'UN ENSEMBLE RÉVISÉ**  
**AUSRICHTUNG BEI ZWEIFTEINBAU ODER WIEDERAUSRICHTUNG NACH REPARATUR**  
**ALINEACION SECUNDARIA DE INSTALACION O REALINEACION DE UNA UNIDAD REPARADA**

Face Alignment

Parallélisme

Flächenausrichtung

Paralelismo



**1** Mount the dial indicator, using the adapter, as shown. Position the crankshaft to the rear of its end play and zero the dial indicator at position (A).

**NOTE:** The crankshaft must be positioned to the rear of its end play and the hold-down bolts at one-half final torque before each reading is recorded.

Monter le comparateur avec son bras support comme représenté. Repousser le vilebrequin à fond vers l'arrière et régler le comparateur à zéro au point (A).

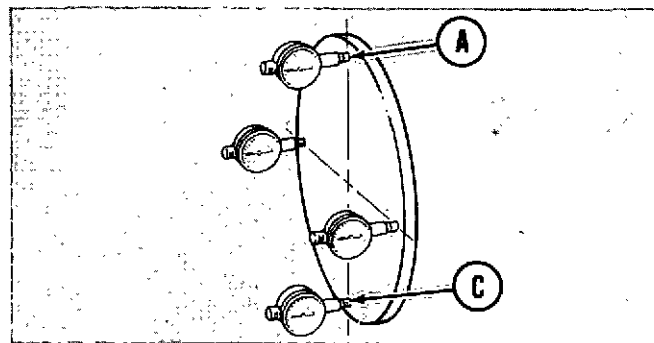
**NOTA:** Le vilebrequin doit être repoussé à fond vers l'arrière et les vis de fixation de la génératrice serrées à la moitié du serrage final avant chaque lecture de vérification du parallélisme.

Meßuhr mit Anschlüssen, wie gezeigt, anbringen. Kurbelwelle bis zum Abschluß des Enspiels zurückdrücken und Meßuhr in Stellung (A) nullen.

**MERKE:** Vor Aufzeichnung der Ablesungen muß das Endspiel der Kurbelwelle nach hinten abgeschlossen sein und die Halteschrauben müssen auf die Hälfte des Endanzugsmoments angezogen sein.

Monte el indicador de esfera usando el adaptador, como se muestra. Ubique el cigüeñal hacia la parte de atrás de su juego axial y coloque el indicador de esfera en cero en la posición (A).

**NOTA:** El cigüeñal debe ubicarse hacia la parte de atrás de su juego axial y los pernos de sujeción deben estar apretados a la mitad de su par final antes de anotar las lecturas.

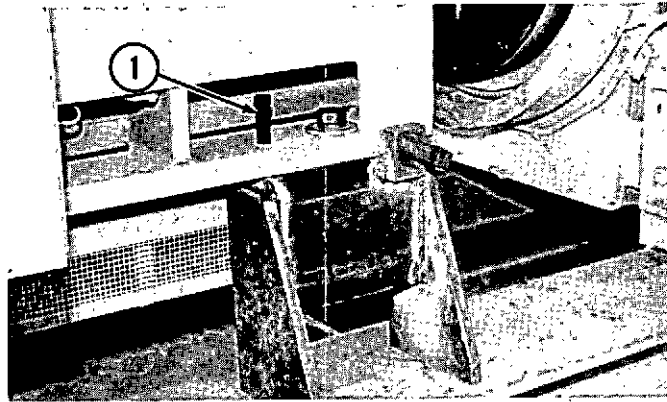


**2** Rotate the crankshaft, in the normal direction only, and record the TIR when the indicator is at position (C) and again at (A). Due to the droop of the cold crankshaft, a minus reading (minus being when the pointer moves out of the indicator) occurs at position (C). A TIR between points (A) and (C) of  $-.008''$  ( $-0,20$ ) is permitted.

Tourner le vilebrequin dans son sens de rotation normal uniquement et noter la déviation totale du comparateur quand celui-ci est en (C), puis à nouveau en (A). Étant donné le fléchissement du vilebrequin à froid, le comparateur donnera une lecture négative en (C) (c'est-à-dire que le palpeur sort du comparateur). On tolérera une déviation maximale du comparateur de  $-.008''$  ( $-0,20$ ).

Kurbelwelle in normaler Drehrichtung drehen und GMA bei (C) und nochmals bei (A) ablesen. Beim Durchhängen einer kalten Kurbelwelle kann eine negative Ablesung (wenn die Nadel unter den Skalenbereich ausschlägt) bei (C) eintreten. Die GMA darf zwischen (A) und (C)  $-0,008''$  ( $-0,20$ ) betragen.

Gire el cigüeñal en la dirección normal de rotación solamente y anote la lectura total del indicador cuando éste esté en las posiciones (C) y de nueva en (A). Debido a la flexión de un cigüeñal frío, una lectura negativa (esto cubre cuando el puntero se mueve fuera del indicador) ocurre en la posición (C). Una lectura total del indicador entre los puntos (A) y (C) de  $-0,008''$  ( $-0,20$ ) es permisible.

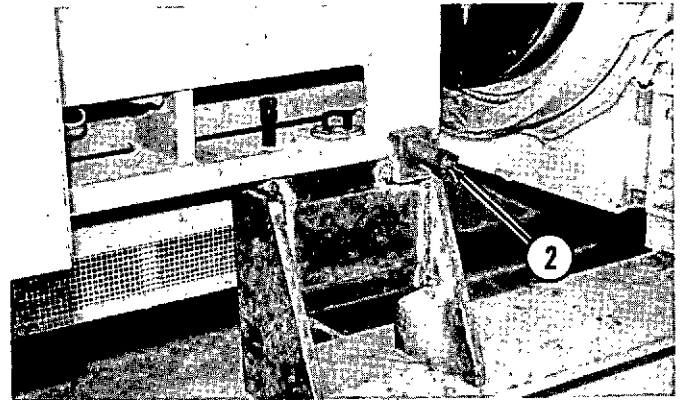
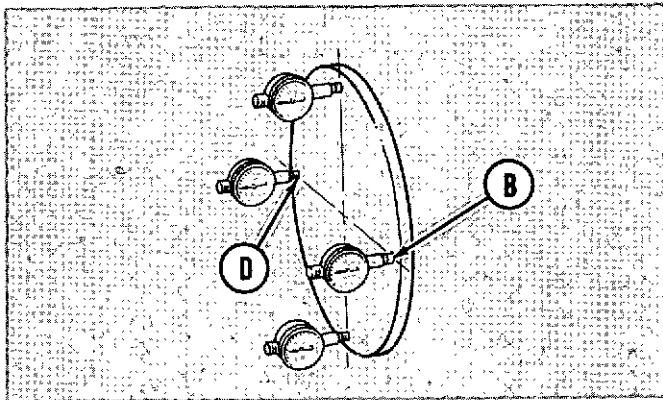


- 3 If a TIR of more than .008" (0,20) is recorded, loosen the hold-down bolts, adjust leveling screws (1), and add shims as required. Repeat the above procedure until a TIR of .008" (0,20) or less is obtained.

Si la déviation totale du comparateur dépasse 0,008" (0,20), desserrer les vis de fixation, régler les vis de réglage vertical (1) et ajouter des cales à la demande. Répéter les opérations ci-dessus jusqu'à ce que la déviation totale du comparateur ne dépasse pas 0,008" (0,20).

Falls GMA mehr als 0,008" (0,20) beträgt, Halteschrauben lösen, dann Richtschrauben (1) nachstellen und Beilagen, wie benötigt, zugeben. Dies wiederholen, bis eine GMA von 0,008" (0,20) oder weniger vorliegt.

Si la lectura total del indicador es mayor de 0,008" (0,20), afloje los pernos de sujeción, ajuste los tornillos de nivelación (1) y agregue laines en la forma necesaria. Repita el procedimiento anterior hasta que se obtenga una lectura total del indicador de 0,008" (0,20) o menos.

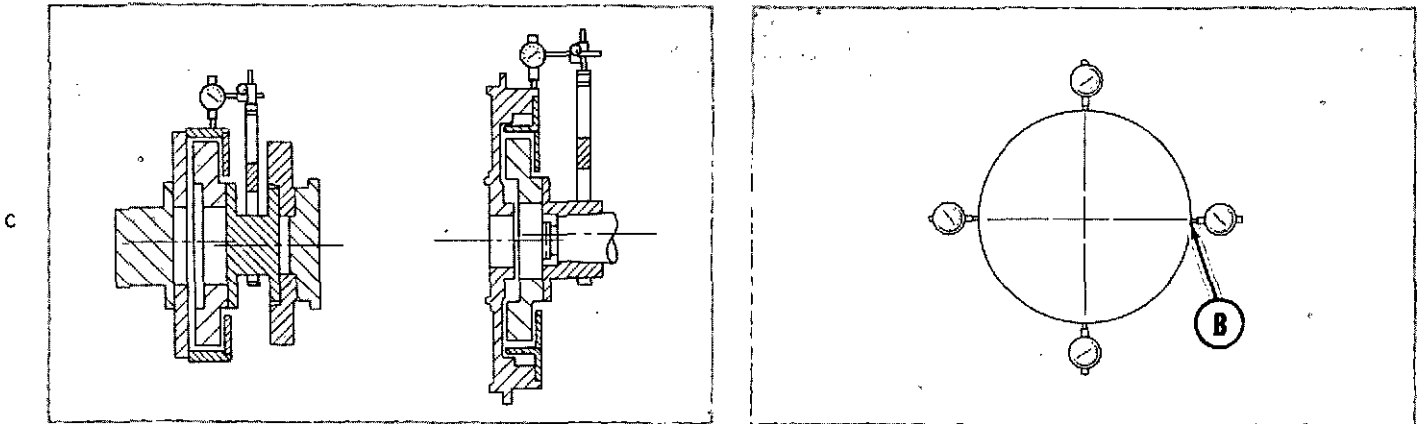


- 4 Zero the dial indicator at position (B). Rotate the crankshaft and record the TIR when the indicator is at position (D) and again at (B). A TIR between points (B) and (D) of .008" (0,20) is permitted. If a TIR of more than .008" (0,20) is recorded, loosen the hold-down bolts and adjust alignment bolts (2). Repeat the above procedure until a TIR of .008" (0,20) or less is obtained.

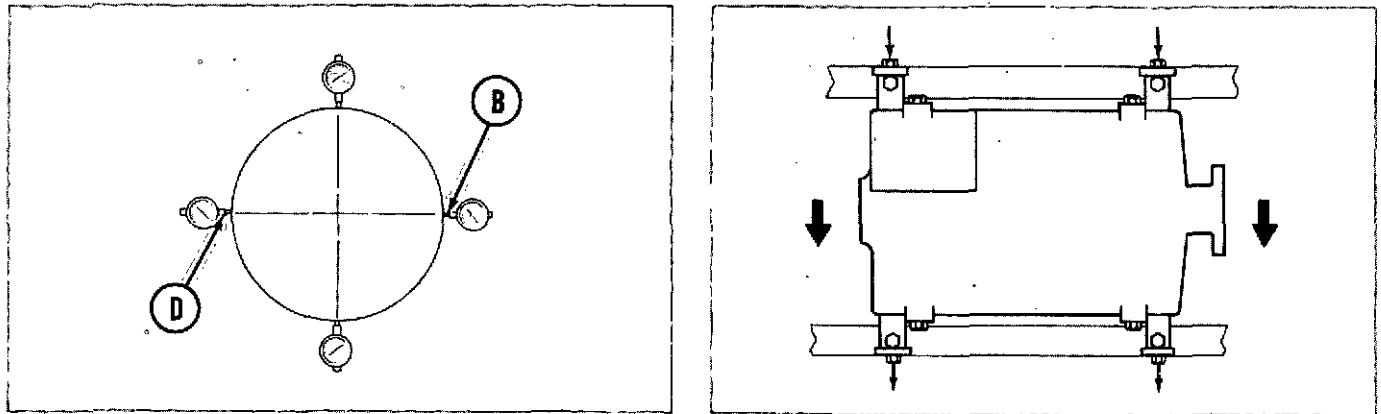
Régler le comparateur à zéro à la position (B). Tourner le vilebrequin et noter la déviation du comparateur quand celui-ci est en (D), puis à nouveau en (B). La déviation totale du comparateur ne doit pas dépasser 0,008" (0,20). Si la déviation totale du comparateur dépasse 0,008" (0,20), desserrer les vis de fixation et régler à la demande les vis (2) de réglage latéral. Répéter cette opération jusqu'à ce que la déviation totale du comparateur ne dépasse pas 0,008" (0,20).

Meßuhr bei (B) nullen. Kurbelwelle drehen und GMA bei (D) und nochmals bei (B) aufzeichnen. Die GMA darf zwischen (B) und (D) 0,008" (0,20) betragen. Falls GMA mehr als 0,008" (0,20) beträgt, Halteschrauben lösen und Stellschrauben (2) nachstellen. Den obigen Vorgang wiederholen, bis GMA 0,008" (0,20) oder weniger beträgt.

Coloque el indicador de esfera en cero en la posición (B). Gire el cigüeñal y anote la lectura total del indicador cuando éste esté en la posición (D) y de nuevo en (B). Una lectura total del indicador entre los puntos (B) y (D) de 0,008" (0,20) es permisible. Si la lectura total del indicador es mayor de 0,008" (0,20), afloje los pernos de sujeción y ajuste los pernos de alineación (2). Repita el procedimiento anterior hasta que se obtenga una lectura total del indicador de 0,008" (0,20) o menos.



**1** Mount the dial indicator, using the adapters as shown. Zero the indicator at position (B).  
 Disposer le comparateur sur le bras support comme représenté. Mettre le comparateur à zéro à la position (B).  
 Meßuhr mit Anschlüssen, wie gezeigt, anbringen. Meßuhr bei (B) nullen.  
 Monte el indicador de esfera usando los adaptadores, como se muestra. Coloque el indicador en cero en la posición (B).

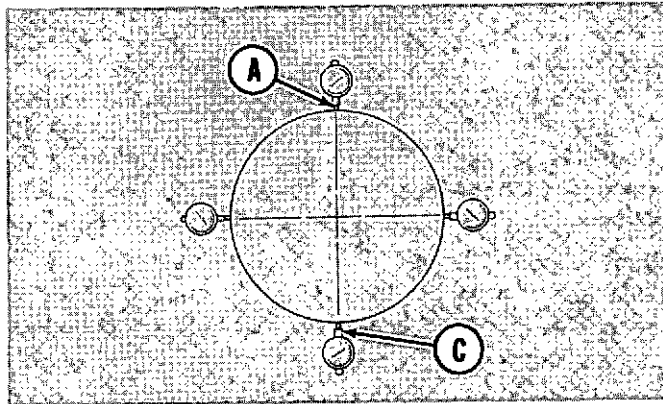


**2** Rotate the crankshaft in the normal direction and record the TIR when the indicator is at positions (D) and again at (B). A TIR of .008" (0,20) between points (B) and (D) is permitted. If a TIR of more than .008" (0,20) is obtained, loosen the hold-down bolts and adjust the lateral alignment bolts until a TIR of .008" (0,20) or less is obtained. Be sure that each bolt is turned the same number of turns, or portion of a turn, to retain the face alignment. Then retighten the hold-down bolts to one-half of recommended torque.

Tourner le vilebrequin dans le sens de rotation normal et relever la déviation totale du comparateur en position (D) et à nouveau (B). La déviation totale entre (B) et (D) ne doit pas dépasser 0,008" (0,20). Si la valeur lue dépasse 0,008" (0,20), desserrer les vis de fixation de la génératrice et modifier le réglage des vis de réglage latéral jusqu'à ce que le comparateur ne dévie pas de plus de 0,008" (0,20). S'assurer que l'on tourne chaque vis du même nombre de tours ou fractions de tour pour maintenir le parallélisme. Puis resserrer les vis de fixation à la moitié du serrage final recommandé.

Kurbelwelle in normaler Drehrichtung drehen und GMA bei Lage der Meßuhr bei (D) und nochmals bei (B) aufzeichnen. GMA zwischen (B) und (D) darf 0,008" (0,20) betragen. Falls GMA größer ist, Halteschrauben lösen und seitliche Stell-schrauben nachstellen, bis GMA 0,008" (0,20) oder weniger beträgt. Dabei darauf achten, daß jede Schraube die gleiche Anzahl von Drehungen gedreht wird, um die Stirnseitenausrichtung beizubehalten. Dann Halteschrauben auf die Hälfte des angegebenen Anzugsmoments anziehen.

Gire el cigüeñal en la dirección normal de rotación y anote las lecturas totales del indicador cuando éste esté en las posiciones (D) y de nuevo en (B). Una lectura total del indicador de 0,008" (0,20) entre los puntos (B) y (D) es permisible. Si se obtiene una lectura total del indicador de más de 0,008" (0,20), afloje los pernos de sujeción y ajuste los pernos de alineación lateral hasta que se obtenga una lectura total del indicador de 0,008" (0,20) o menos. Asegúrese que cada perno se gira el mismo número de vueltas o una parte de una vuelta, para retener el paralelismo. En seguida, vuelva a apretar los pernos de sujeción a la mitad del par recomendado de apriete.

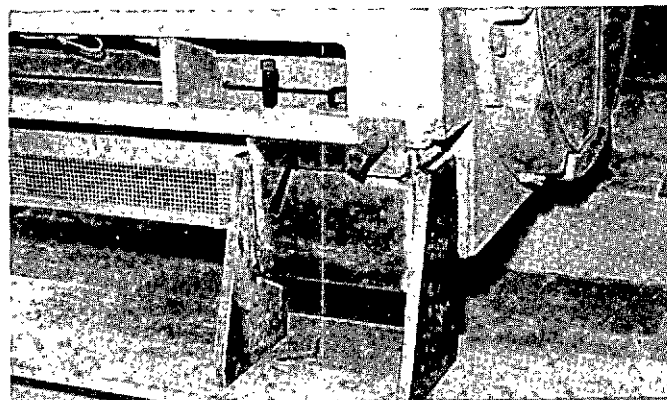


- 3 Zero the indicator at position (A). Rotate the crankshaft in the normal direction, and record the TIR at position (C) and again at (A). The TIR between point (C) and (A) must be  $.018'' \pm .002''$  ( $0.46 \pm 0.05$ ) for front mounted generators and  $.015'' \pm .002''$  ( $0.38 \pm 0.05$ ) for rear mounted generators. In both cases, the generator shaft centerline must be positioned above the crankshaft centerline. The above measurements apply only when the engine and generator are cold.

Mettre le comparateur à zéro à la position (A). Tourner le vilebrequin dans le sens normal de rotation et relever la déviation totale du comparateur à la position (C), puis à nouveau en (A). La déviation totale du comparateur entre les points (A) et (C) doit être de  $0.018'' \pm 0.002''$  ( $0.46 \pm 0.05$ ) pour les génératrices à montage avant et de  $0.015'' \pm 0.002''$  ( $0.38 \pm 0.05$ ) pour les génératrices à montage arrière. Dans les deux cas, l'axe de l'arbre de la génératrice doit être plus haut que l'axe du vilebrequin et les cotes indiquées ci-dessus ne sont valables qu'à froid pour le moteur et la génératrice.

Meßuhr bei (A) nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei (C) und nochmals bei (A) aufzeichnen. Die GMA zwischen (C) und (A) muß  $0,018'' \pm 0,002''$  ( $0,46 \pm 0,05$ ) an frontmontierten Generatoren und  $0,015'' \pm 0,002''$  ( $0,38 \pm 0,05$ ) an heckmontierten Generatoren betragen. In beiden Fällen muß die Mittellinie der Generatorwelle über der Mittellinie der Kurbelwelle liegen. Obige Maße treffen jedoch nur zu, wenn Motor und Generator kalt sind.

Coloque el indicador en cero en la posición (A). Gire el cigüeñal en la dirección normal de rotación y anote la lectura total del indicador en la posición (C) y de nuevo en la posición (A). La lectura total del indicador entre el punto (C) y el punto (A) debe ser de  $0,018'' \pm 0,002''$  ( $0,46 \pm 0,05$ ) para los generadores de montaje delantero y de  $0,015'' \pm 0,002''$  ( $0,38 \pm 0,05$ ) para los generadores de montaje trasero. En ambos casos, la línea de centro del generador debe quedar sobre la línea de centro del cigüeñal. Las medidas anteriores aplican solamente cuando el motor y el generador están fríos.

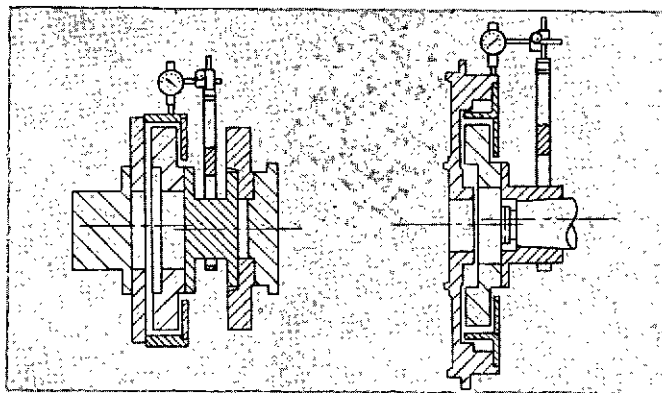


- 4 If the TIR is not within the above limits, loosen the hold-down bolts and install or remove shims of equal thickness under all four supports until the applicable TIR is obtained.

Si la déviation totale du comparateur n'est pas dans les tolérances indiquées ci-dessus, desserrer les vis de fixation et ajouter ou retirer la même épaisseur de cales sous chacune des semelles-support jusqu'à ce que les valeurs données ci-dessus soient respectées.

Falls GMA nicht innerhalb der obengenannten Grenzen, Halteschrauben lösen und Beilagen gleicher Stärke unter allen vier Auflagern zugeben oder entnehmen, bis zutreffende GMA erreicht ist.

Si la lectura total del indicador no está dentro de los límites anteriores, afloje los pernos de sujeción e instale o remueva láminas de igual espesor debajo de los cuatro soportes hasta que se obtenga la lectura total del indicador correcta.



c.

- 5 Tighten the generator hold-down bolts to one-half the final torque (page 23) and repeat steps 1 and 2 on page 15 for a final check.

Serrer les vis de fixation de la génératrice à la moitié du couple de serrage final (page 23) et, à titre de vérification finale, répéter les opérations 1 et 2 décrites en page 15.

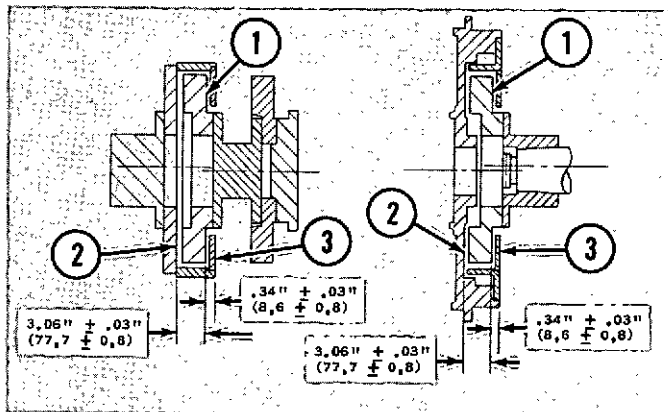
Halteschrauben des Generators auf die Hälfte des Endanzugsmoments (Seite 23) anziehen und Schritte 1 und 2 auf Seite 15 als letzte Prüfung wiederholen.

Apriete los pernos de sujeción del generador a la mitad del par final de apriete (página 23) y repita las fases 1 y 2 en la página 15, para una comprobación final.

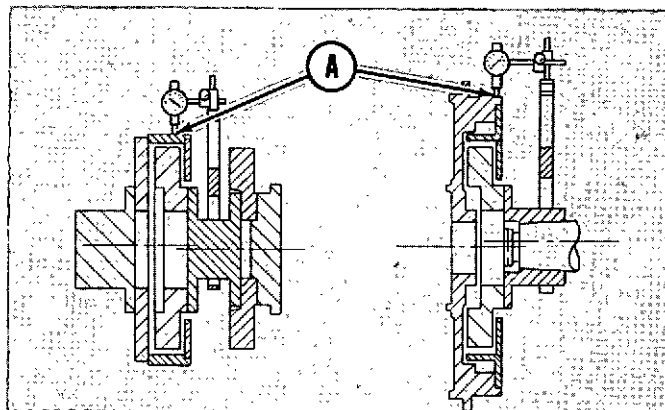
RECHECK BORE ALIGNMENT  
VÉRIFICATION DE CONCENTRICITÉ

NACHPRÜFUNG DER BOHRAUSRICHTUNG  
COMPROBACION DE LA CONCENTRICIDAD

c.



c.



- 1 Using a depth gauge or a flexible steel scale, measure the distance from the face of inner coupling member (1) to either the inner face of retainer plate (2) or the outer face of retainer plate (3). The distance from coupling member (1) to plate (2) should be  $3.06'' \pm .03''$  ( $77,7 \pm 0,8$ ). The distance from coupling member (1) to plate (3) should be  $.34'' \pm .03''$  ( $8,6 \pm 0,8$ ). Mount the dial indicator, using the adapters as shown. Place the tip of the indicator in the outer surface of the outer coupling member and zero the indicator at position (A).

A l'aide d'un micromètre de profondeur ou d'un calibre à lames, mesurer la distance de la face du moyeu d'accouplement intérieur (1) à la face intérieure du flasque (2) ou à la face extérieure du flasque (3). La distance entre le moyeu (1) et le flasque (2) doit être de  $3.06'' \pm 0.03''$  ( $77,7 \pm 0,8$ ). La distance entre le moyeu (1) et le flasque (3) doit être de  $0.34'' \pm 0.03''$  ( $8,6 \pm 0,8$ ). Monter le comparateur sur le support comme indiqué. Placer le palpeur du comparateur contre la surface extérieure du flasque d'accouplement extérieur et régler le comparateur à zéro à la position (A).

Abstand von der Stirnseite des inneren Kupplungskranzes (1) entweder zur inneren Stirnseite der Halteplatte (2) oder zur äußeren Stirnseite der Halteplatte (3) mit einem Tiefenmikrometer oder Maßband messen. Der Abstand vom Kupplungskranz (1) zur Platte (2) sollte  $3.06'' \pm 0.03''$  ( $77,7 \pm 0,8$ ) betragen. Der Abstand vom Kupplungskranz (1) zur Platte (3) sollte  $0.34'' \pm 0.03''$  ( $8,6 \pm 0,8$ ) betragen. Meßuhr mit Anschlüssen, wie gezeigt, anbringen. Sondenspitze auf der äußeren Oberfläche des äußeren Kupplungskranzes ansetzen und Meßuhr in Stellung (A) nullen.

Use un calibrador de profundidad o una regla metálica flexible para medir la distancia desde la cara del miembro de acoplamiento interior (1) a la cara interior de la plancha retén (2) o a la cara exterior de la plancha retén (3). La distancia desde el miembro de acoplamiento (1) a la plancha (2) debe ser de  $3.06'' \pm 0.03''$  ( $77,7 \pm 0,8$ ). La distancia desde el miembro de acoplamiento (1) a la plancha (3) debe ser de  $0.34'' \pm 0.03''$  ( $8,6 \pm 0,8$ ). Monte el indicador de esfera usando los adaptadores, como se muestra. Coloque la punta del indicador en la superficie exterior del miembro de acoplamiento exterior y coloque el indicador en cero en la posición (A).

- 2 Tighten two diagonally opposite generator hold-down bolts to the final torque specified on page 23. Observe the dial indicator as each bolt is tightened. A TIR of .002" (0,05) is permitted. The crankshaft is stationary during this step and position (A) is always on top.

Serrer deux vis de fixation diamétralement opposées au couple final spécifié page 23. Observer le comparateur pendant le serrage de chaque vis. On peut admettre une déviation totale du comparateur de 0,002" (0,05). Pendant cet essai, le vilebrequin doit être immobile et (A) est le point le plus haut de l'accouplement.

Die jeweils diagonal gegenüberliegenden Halteschrauben des Generators auf das auf Seite 23 angegebene Endanzugsmoment anziehen. Meßuhr während des Anzugs jeder Schraube beobachten. GMA darf 0,002" (0,05) betragen. Die Kurbelwelle ist während dieses Arbeitsganges unbeweglich und Stellung (A) verbleibt oben.

Apriete dos pernos de sujeción del generador opuesto diagonalmente al par final de apriete especificado en la página 23. Observe el indicador de esfera a medida que se aprieta cada perno. Una lectura total del indicador de 0,002" (0,05) es permisible. El cigüeñal está estacionario durante esta fase y la posición (A) está siempre en la parte de arriba.

- 3 If the TIR is more than .002" (0,05) repeat step 7 on page 12 until a TIR of .002" (0,05) or less is obtained.

Si la déviation totale du comparateur dépasse 0,002" (0,05), répéter l'opération 7, page 12, jusqu'à ce que la déviation observée ne dépasse pas 0,002" (0,05).

Falls GMA mehr als 0,002" (0,05) beträgt, Schritt 7 auf Seite 12 wiederholen, bis GMA 0,002" (0,05) oder weniger beträgt.

Si la lectura total del indicador es más de 0,002" (0,05), repita la fase 7 en la página 12 hasta que se obtenga una lectura total del indicador de 0,002" (0,05) o menos.

- 4 If the TIR is .002" (0,05) or less, tighten the remaining generator hold-down bolts to the final torque (page 23).

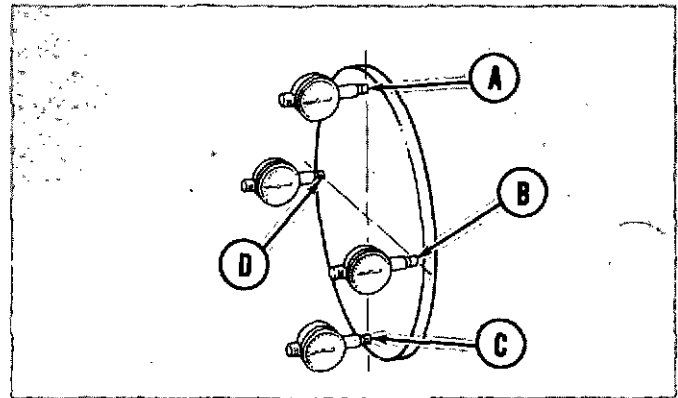
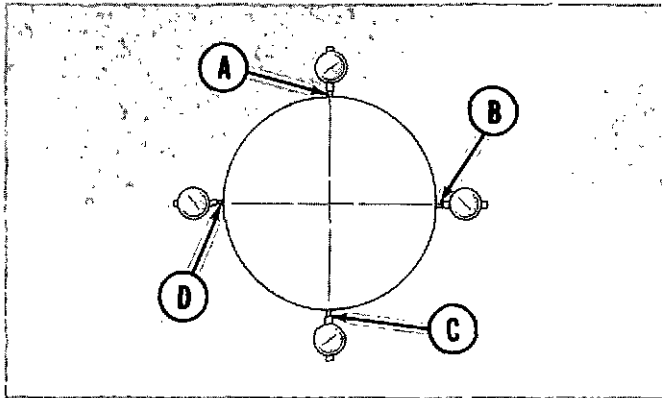
Si la déviation totale du comparateur ne dépasse pas 0,002" (0,05), serrer les autres vis de fixation de la génératrice au couple final spécifié page 23.

Falls GMA 0,002" (0,05) oder weniger beträgt, verbleibende Halteschrauben des Generators anziehen auf Endanzugsmoment (siehe Seite 23).

Si la lectura total del indicador es 0,002" (0,05) o menos, apriete los pernos de sujeción del generador restante al par final de apriete (página 23).

**FINAL ALIGNMENT  
ALIGNEMENT FINAL**

**ENDAUSRICHTUNG  
ALINEACION FINAL**

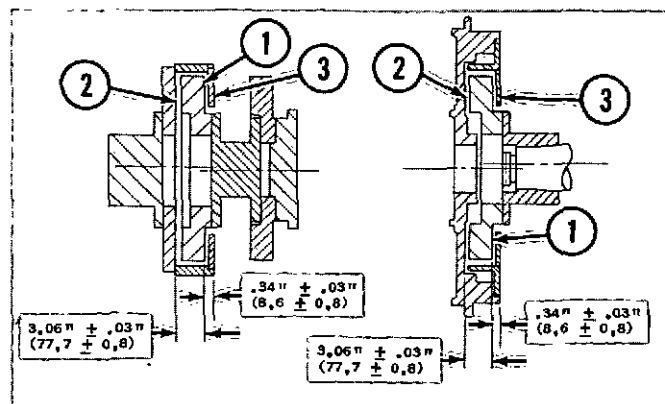


- 1 Record the indicator readings as the crankshaft is rotated to positions (A), (B), (C) and (D). FACE READINGS: a TIR of .008" (0,20) is permitted. BORE READINGS: a TIR of .008" (0,20) between (B) and (D) is permitted. The TIR between (A) and (C) must be  $.018" \pm .002"$  ( $0,46 \pm 0,05$ ) for front mounted generators and  $.015" \pm .002"$  ( $0,38 \pm 0,05$ ) for rear mounted generators. In both cases the generator shaft centerline must be positioned above the crankshaft centerline. The above measurements apply only when the engine and generator are at room temperature.

- Relever les indications du comparateur en tournant le vilebrequin successivement aux positions (A), (B), (C) et (D). PARALLÉLISME: On tolère une déviation totale de 0,008" (0,20). CONCENTRICITÉ: On tolère une déviation totale de 0,008" (0,20) entre (B) et (D). La déviation maximale entre les positions (A) et (C) ne doit pas dépasser  $0,018" \pm 0,002"$  ( $0,46 \pm 0,05$ ) si la génératrice est montée à l'avant, et  $0,015" \pm 0,002"$  ( $0,38 \pm 0,05$ ) si la génératrice est montée à l'arrière. Dans les deux cas, l'axe de l'arbre de la génératrice devra être plus haut que l'axe du vilebrequin. Les mesures ci-dessus s'entendent uniquement pour un moteur et une génératrice à la température ambiante de la pièce.

- Die Meßablesung an der Bohrung beim Drehen der Kurbelwelle nach (A), (B), (C) und (D) aufzeichnen. STIRNABLESUNGEN: Eine GMA von 0,008" (0,20) ist zulässig. BOHRUNGSABLESUNG: Eine GMA von 0,008" (0,20) zwischen (B) und (D) ist zulässig. Die GMA zwischen (A) und (C) muß  $0,018" \pm 0,002"$  ( $0,46 \pm 0,05$ ) für frontmontierte Generatoren und  $0,015" \pm 0,002"$  ( $0,38 \pm 0,05$ ) für heckmontierte Generatoren betragen. In beiden Fällen muß die Achse der Generatorwelle über der Kurbelwellenachse liegen. Diese Maße gelten nur, wenn Motor und Generator auf Zimmertemperatur sind.

- Anote las lecturas del indicador a medida que se gira el cigüeñal a las posiciones (A), (B), (C) y (D). LAS LECTURAS DEL PARALELISMO DEBEN SER: Una lectura del indicador de 0,008" (0,20) es permisible. LECTURAS DE LA CONCENTRICIDAD: Una lectura total del indicador de 0,008" (0,20) entre (B) y (D) es permisible. La lectura total del indicador entre (A) y (C) debe ser de  $0,018" \pm 0,002"$  ( $0,46 \pm 0,05$ ) para los generadores de montaje delantero y de  $0,015" \pm 0,002"$  ( $0,38 \pm 0,05$ ) para generadores de montaje trasero. En ambos casos la línea de centro del eje del generador debe quedar sobre la línea de centro del cigüeñal. Las medidas anteriores se aplican solamente cuando el motor y el generador están a la temperatura ambiente.



- 2 Measure the distance between inner coupling member (1) to either the inner face of retainer plate (2) or the outer face of retainer plate (3), as in step 3 on page 11.

- Mesurer la distance entre le moyeu intérieur (1) d'accouplement et la face intérieure du flasque (2) ou la face extérieure du flasque (3), ainsi qu'il est décrit pour l'opération 3 page 11.

- Den Abstand zwischen der inneren Kupplung (1) und entweder der inneren Stirnseite der Halteplatte (2) oder der äußeren Stirnseite der Halteplatte (3), wie in Abschnitt 3 auf Seite 11 angegeben, messen.

- Mida la distancia entre el miembro de acoplamiento interior (1) y la cara interior de la plancha retén (2) o la cara exterior de la plancha retén (3), en la forma indicada en la fase 3 de la página 11.

- 3 Pack grease between the teeth of the coupling and the rubber elements. Install the gasket and the retainer plate.

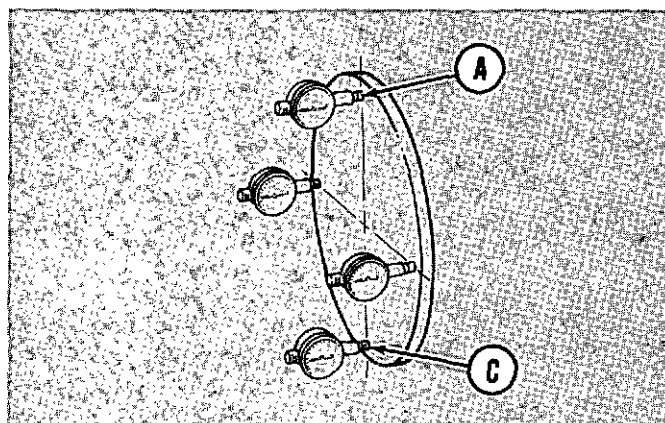
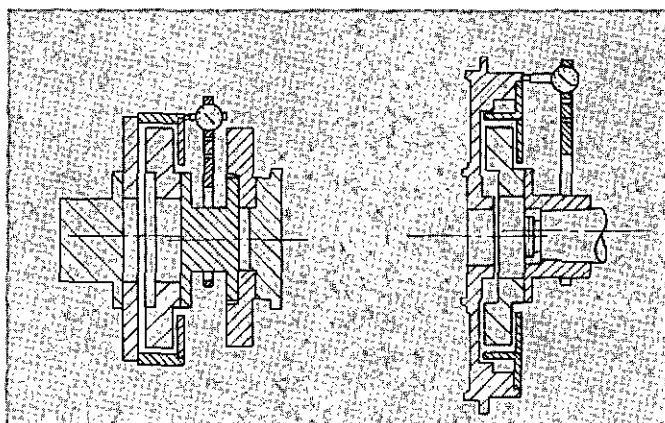
Garnir de graisse l'interstice existant entre la garniture de caoutchouc et le moyeu et la couronne d'accouplement. Monter la bride de retenue et son joint.

Schmierfett zwischen die Kupplungszähne und die Gummieinlagen packen. Dann Dichtung und Halteplatte einbauen.

Coloque grasa entre los dientes del acoplamiento y los elementos de goma. Instale la empaquetadura y la plancha retén.

**ALIGNMENT TEST OF A UNIT THAT HAS BEEN OPERATED**  
**VÉRIFICATION D'ALIGNEMENT D'UN ENSEMBLE APRÈS FONCTIONNEMENT**

- c **AUSRICHTPRÜFUNG AN EINER BETRIEBENEN EINHEIT**  
**PRUEBA DE ALINEACION DE UNA UNIDAD QUE HA ESTADO EN FUNCIONAMIENTO**

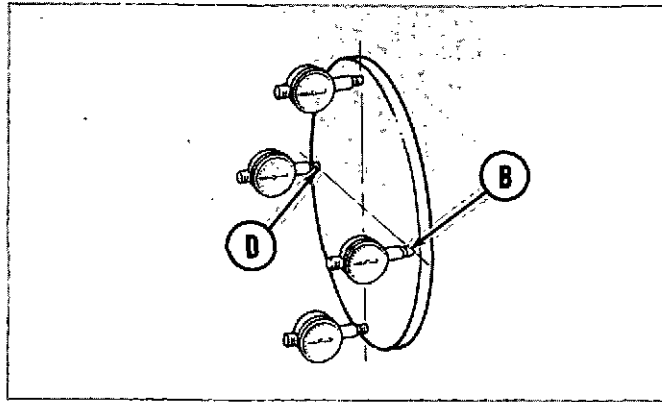


- 1 Mount the dial indicator, using the adapter as shown. Position the crankshaft to the rear of its end play and zero the indicator at position (A). Rotate the crankshaft, in the normal direction only, and record the TIR at position (C) and again at (A). A TIR of .008" (0,20) between point (C) and (A) is permitted. If the TIR exceeds .008" (0,20), perform steps 2 and 3 on pages 13 and 14.

- c Monter le comparateur avec le support, comme représenté. Repousser le vilebrequin à fond vers l'arrière et régler le comparateur à zéro à la position (A). Tourner le vilebrequin dans le sens de rotation normal seulement et noter la déviation du comparateur à la position (C), puis à nouveau à la position (A). On tolère une déviation totale de 0,008" (0,20) entre les points (C) et (A). Si la déviation dépasse 0,008" (0,20), effectuer les opérations 2 et 3 décrites aux pages 13 et 14.

- c Meßuhr mit Anschluß, wie gezeigt, anbringen. Kurbelwelle bis zum Abschluß des Endspiels zurückdrücken und Meßuhr in Stellung (A) nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei (C) und nochmals (A) ablesen. Eine GMA von 0,008" (0,20) zwischen (C) und (A) ist zulässig. Wenn die GMA 0,008" (0,20) übersteigt, Abschnitte 2 und 3 auf Seiten 13 und 14 durchführen.

- c Monte el indicador de esfera, usando el adaptador como se muestra. Ubique el cigüeñal hacia la parte de atrás de su juego axial y coloque el indicador en cero en la posición (A). Gire el cigüeñal en la dirección normal de rotación solamente, y anote la lectura total del indicador en la posición (C) y de nuevo en la posición (A). Una lectura total del indicador de 0,008" (0,20) entre los puntos (C) y (A) es permisible. Si la lectura total del indicador excede de 0,008" (0,20), ejecute las fases 2 y 3 dadas en las páginas 13 y 14.

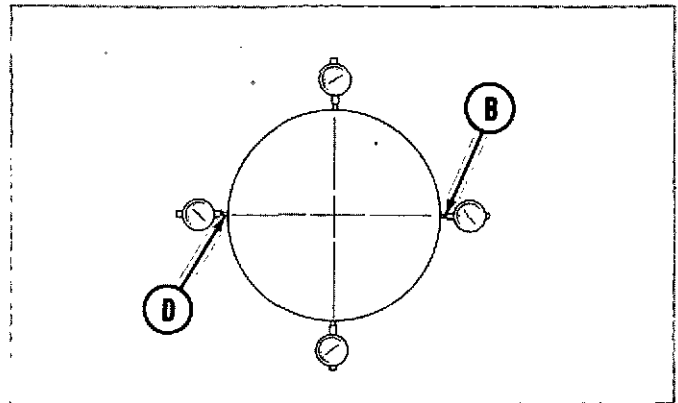
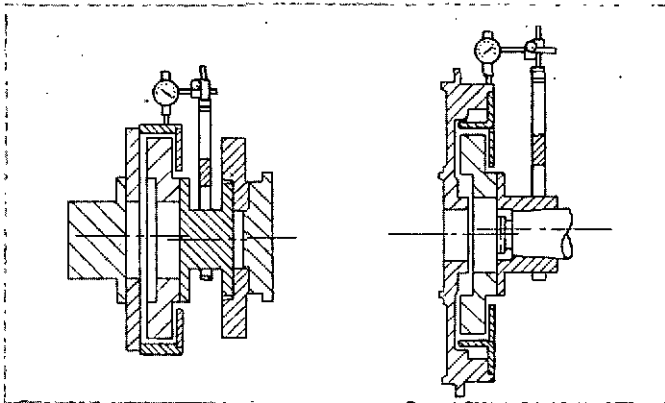


2 Zero the indicator at position (B). Rotate the crankshaft in the normal direction and record the TIR when the indicator is at position (D) and again at (B). A TIR of .008" (0,20) between points (B) and (D) is permitted. If the TIR exceeds .008" (0,20), perform step 4 on page 14.

Régler le comparateur à zéro à la position (B). Tourner le vilebrequin dans le sens de rotation normal seulement et noter la déviation du comparateur à la position (D), puis à nouveau à la position (B). On tolère une déviation totale de 0,008" (0,20) entre les points (B) et (D). Si la déviation dépasse 0,008" (0,20), effectuer l'opération 4 décrite en page 14.

Meßuhr bei (B) nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei (D) und nochmals (B) aufzeichnen. Die GMA darf zwischen (B) und (D) 0,008" (0,20) betragen. Falls GMA mehr als 0,008" (0,20) beträgt, Abschnitt 4 auf Seite 14 durchführen.

Coloque el indicador en cero en la posición (B). Gire el cigüeñal en la dirección normal y anote la lectura total del indicador cuando éste esté en la posición (D) y de nuevo en la posición (B). Una lectura total del indicador de 0,008" (0,20) entre los puntos (B) y (D) es permisible. Si la lectura total del indicador excede de 0,008" (0,20), ejecute la fase 4 indicada en la página 14.

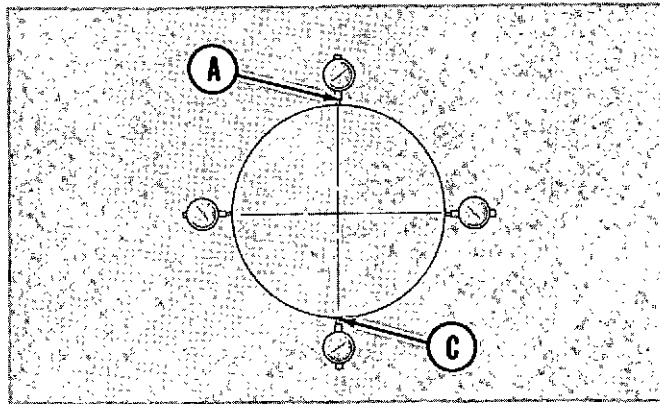


3 Mount the dial indicator, using the adapters as shown. Zero the indicator at position (B). Rotate the crankshaft in the normal direction and record the TIR at position (D) and again at (B). A TIR of .012" (0,30) between points (D) and (B) is permitted. If the TIR exceeds .012" (0,30), perform step 2 on page 15.

Monter le comparateur avec les supports, comme représenté. Régler le comparateur à zéro à la position (B). Tourner le vilebrequin dans le sens normal de rotation et noter la déviation du comparateur à la position (D), puis à nouveau à la position (B). On tolère une déviation totale de 0,012" (0,30) entre les points (D) et (B). Si la déviation dépasse 0,012" (0,30), effectuer l'opération 2 décrite en page 15.

Meßuhr mit Anschlüssen, wie gezeigt, anbringen. Meßuhr bei (B) nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei Lage der Meßuhr bei (D) und nochmals bei (B) aufzeichnen. GMA von 0,012" (0,30) zwischen (D) und (B) ist zulässig. Falls die GMA 0,012" (0,30) übersteigt, Abschnitt 2 auf Seite 15 durchführen.

Monte el indicador de esfera, usando los adaptadores que se muestran. Coloque el indicador en cero en la posición (B). Gire el cigüeñal en la dirección normal de rotación y anote la lectura total del indicador en la posición (D) y de nuevo en la posición (B). Una lectura total del indicador de 0,012" (0,30) entre los puntos (D) y (B) es permisible. Si la lectura total del indicador excede de 0,012" (0,30), ejecute la fase 2 en la página 15.



- 4 Zero the indicator at position (A). Rotate the crankshaft in the normal direction and record the TIR at positions (C) and again at (A). The TIR between points (C) and (A) must be  $.018'' \pm .010$  ( $0,46 \pm 0,25$ ) for front mounted generators and  $.015'' \pm .010$  ( $0,38 \pm 0,25$ ) for rear mounted generators. In both cases, the generator shaft centerline must be positioned above the crankshaft centerline. If the TIR is not within these tolerances, perform steps 2, 3 and 4 on pages 15 and 16.

Régler le comparateur à zéro à la position (A). Tourner le vilebrequin dans le sens de rotation normal et noter la déviation du comparateur à la position (C), puis à nouveau à la position (A). La déviation totale entre les points (C) et (A) ne doit pas dépasser  $0,018'' \pm 0,010''$  ( $0,46 \pm 0,25$ ) si la génératrice est montée à l'avant, ou  $0,015'' \pm 0,010''$  ( $0,38 \pm 0,25$ ) si la génératrice est montée à l'arrière. Dans les deux cas, l'axe de l'arbre de la génératrice devra être plus haut que l'axe du vilebrequin. Si la déviation dépasse ces tolérances, effectuer les opérations 2, 3 et 4 décrites aux pages 15 et 16.

Meßuhr bei (A) nullen. Kurbelwelle in normaler Drehrichtung drehen und GMA bei (C) und nochmals bei (A) aufzeichnen. Die GMA zwischen (C) und (A) muß  $0,018'' \pm 0,010''$  ( $0,46 \pm 0,25$ ) für frontmontierte Generatoren und  $0,015'' \pm 0,010''$  ( $0,38 \pm 0,25$ ) für heckmontierte Generatoren betragen. In beiden Fällen muß die Generatorwellenachse höher liegen als die Kurbelwellenachse. Wenn die GMA nicht innerhalb dieser Toleranzen fällt, Abschnitte 2, 3 und 4 auf Seiten 15 und 16 durchführen.

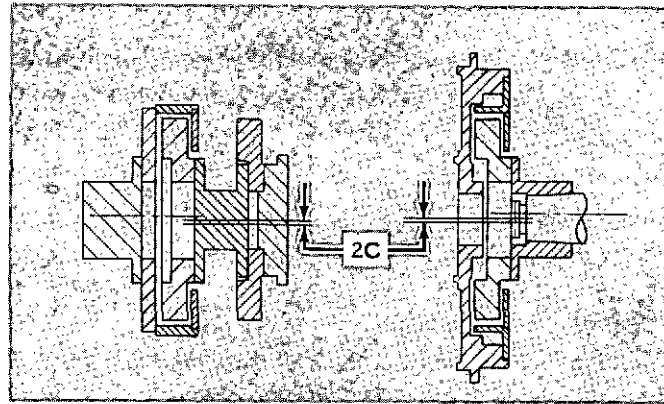
Coloque el indicador en cero en la posición (A). Gire el cigüeñal en la dirección normal de rotación y anote la lectura total del indicador en las posiciones (C) y de nuevo en (A). La lectura total del indicador entre los puntos (C) y (A) debe ser de  $0,018'' \pm 0,010$  ( $0,46 \pm 0,25$ ) para generadores de montaje delantero y de  $0,015'' \pm 0,010$  ( $0,38 \pm 0,25$ ) para generadores de montaje trasero. En ambos casos, la línea de centro del eje del generador debe quedar sobre la línea de centro del cigüeñal. Si la lectura total del indicador no está dentro de estas tolerancias, ejecute las fases 2, 3 y 4 en las páginas 15 y 16.

- 5 If it was necessary to adjust in any of the 4 previous steps, then perform step 5 on page 17, steps 2, 3, and 4 on page 18 and step 1 on page 19.

Si l'alignement a dû être rectifié à l'une ou l'autre des quatre vérifications ci-dessus, effectuer l'opération 5 de la page 17, les opérations 2, 3 et 4 de la page 18 et l'opération 1 de la page 19.

Wenn in den vier vorhergegangenen Abschnitten eine Nachstellung nötig war, Abschnitt 5 auf Seite 17, Abschnitte 2, 3 und 4 auf Seite 18 und Abschnitt 1 auf Seite 19 durchführen.

Si fue necesario ajustar en cualquiera de las cuatro fases anteriores, ejecute en seguida la fase 5 indicada en la página 17, fases 2, 3 y 4 en la página 18 y fase 1 en la página 19.



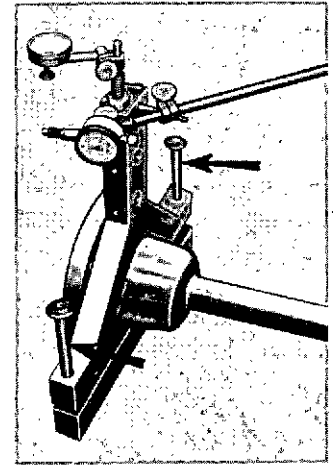
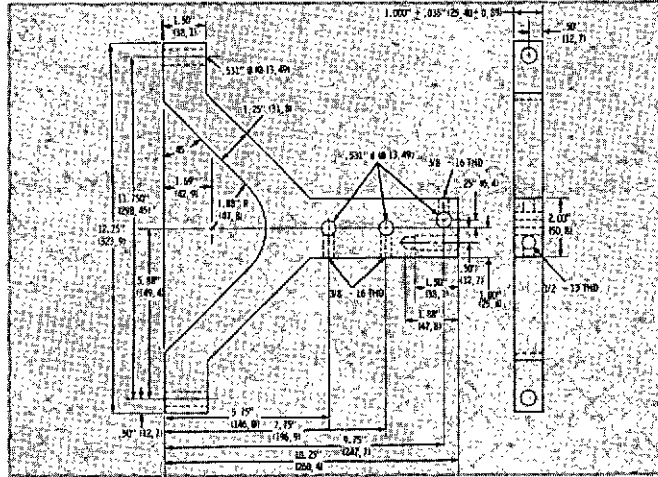
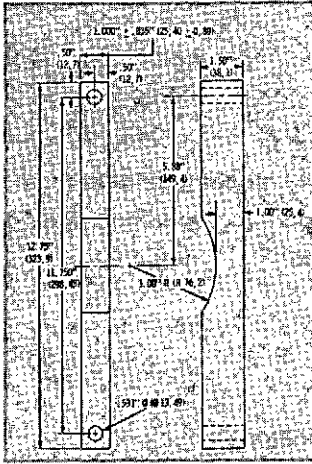
● Alignment check on engine and generator.

Vérification de l'alignement sur moteur et génératrice.

Ausrichtprüfung am Motor und Generator.

Comprobación de alineación entre el motor y el generador.

	FRONT MOUNTED GENERATOR GÉNÉRATRICE POUR MONTAGE AVANT FRONTMONTIERTER GENERATOR GENERADOR DE MONTAJE DELANTERO				REAR MOUNTED GENERATOR GÉNÉRATRICE POUR MONTAGE ARRIÈRE HECKMONTIERTER GENERATOR GENERADOR DE MONTAJE TRASERO			
	A	B	C	D	A	B	C	D
● 1. BEARING CLEARANCE FACTOR 1. JEU DE PALIER 1. LAGERSPIELFAKTOR 1. FACTOR DE JUEGO DE COJINETE		(+C)	(+2C)	(+C)		(-C)	(-2C)	(-C)
● 2. ACTUAL INDICATOR READINGS 2. CHIFFRE RÉEL RELEVÉ AU COMPARATEUR 2. TATSÄCHLICHE MESSABLESUNG 2. LECTURAS ACTUALES DEL INDICADOR	0.000 0.000		- -		0.000 0.000		+ +	
● 3. ADJUSTED ALIGNMENT (1 PLUS 2) 3. COTE D'ALIGNEMENT CORRIGÉE (1 + 2) 3. NACHGESTELLTE AUSRICHTUNG (1 PLUS 2) 3. ALINEACION AJUSTADA (1 MAS 2)								



The 2N4661 and 2N4662 Adapters are available as parts service items or can be fabricated as indicated above. Use two .50" (Ø12,7) threaded rods or bolts to assemble the adapters.

- c Les supports 2N4661 et 2N4662 sont fournis comme pièces de rechange ou peuvent être fabriqués comme indiqué ci-dessus. Assembler à l'aide de deux vis ou tiges filetées de Ø 0.50" (12,7).
- c Die Anschlüsse 2N4661 und 2N4662 sind als Ersatzteile erhältlich oder können, wie oben angegeben, selbst hergestellt werden. Zum Zusammenbau der Anschlüsse zwei Gewindestäbe oder Schrauben von 0,50" (12,7) Ø verwenden.
- c Los Adaptadores 2N4661 y 2N4662 se suministran como repuestos o pueden fabricarse en la forma indicada anteriormente. Para armar los adaptadores, use dos pernos de 0,50" (12,7) de diámetro o varillas roscadas.



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# INDUSTRIAL ENGINE OPERATION INSTRUCTIONS

## GENERAL

Proper engine operation and maintenance are essential for long engine life and maximum performance. The basic operation and periodic maintenance procedures are outlined in this OPERATION GUIDE. Before starting the engine, familiarize yourself with these procedures.

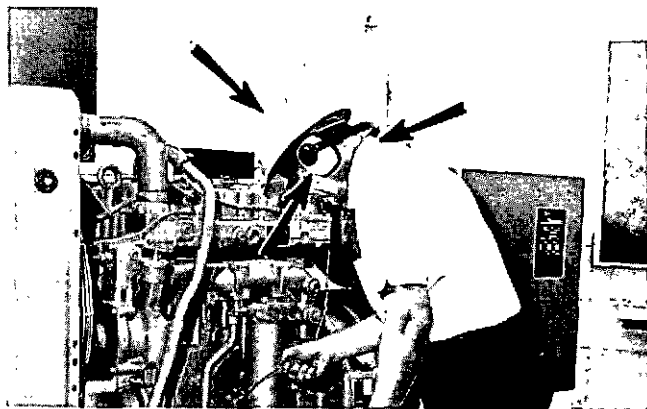
Your Caterpillar dealer is available for troubleshooting, testing and servicing when required.

## SAFETY PRECAUTIONS

Safety is basically common sense. A general guide of safety precautions may be listed, but each installation has its own peculiarities which cannot always be predicted and covered by rules. Past experience and common sense are needed for the necessary safety measures. Lack of attention to safety can result in serious accidents. Be alert. Watch for hazards. Use preventive measures. Correct deficiencies promptly.

The following safety precautions are a guide to safe operation:

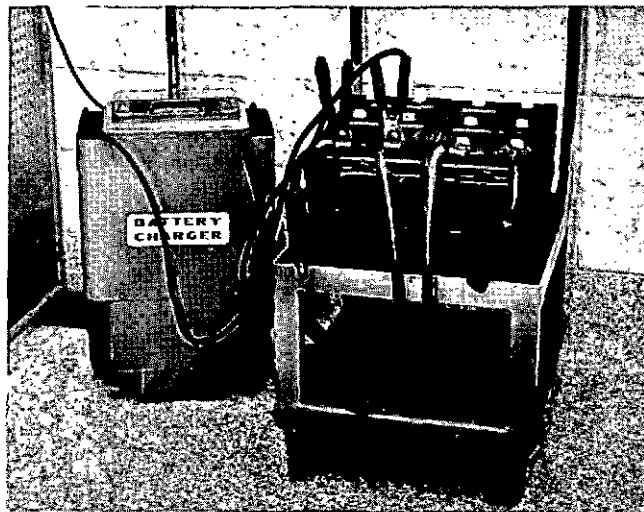
1. Install guards over all exposed rotating parts. If guards are missing, inadequate or in need of repair, repair or replace them.
2. Wear ear protective devices if working inside an enclosed engine room with engine running.



3. Wear a safety hat when working in the area of overhead equipment.
4. Do not wear loose clothing whenever working around engines or machinery.

5. Keep the engine room and floor clean. Wipe up spilled oil or fuel.

6. Keep batteries in a well ventilated area.

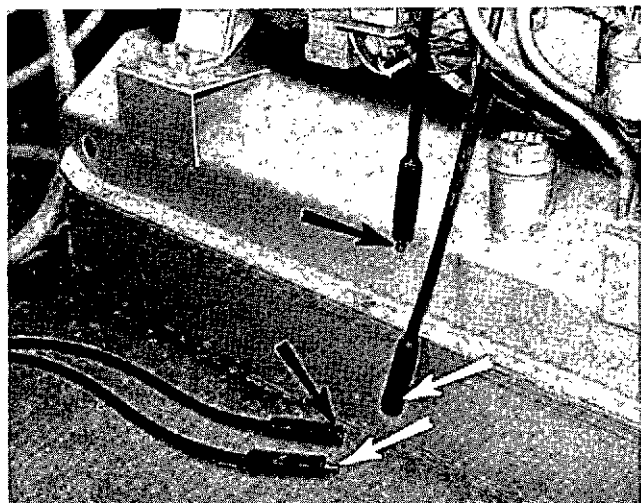


Hydrogen gas, which is present in the area of the batteries, is highly explosive. Do not smoke around batteries.

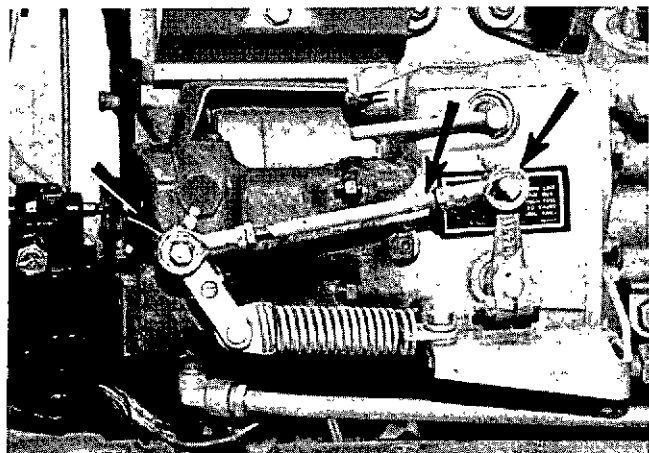


7. Provide adequate waste oil disposal.
8. Store oily rags in containers. Don't leave rags on an engine.
9. Remove all tools and electrical cords from the engine before starting.
10. Disconnect and tape the battery ground lead before working on an engine. Be sure an automatic start-

stop system cannot operate and start the engine while working on it.



11. Never start, nor attempt to run, an engine with the governor linkage disconnected.



12. Never try adjusting or repairing either the engine, or the driven equipment, while the engine is running.

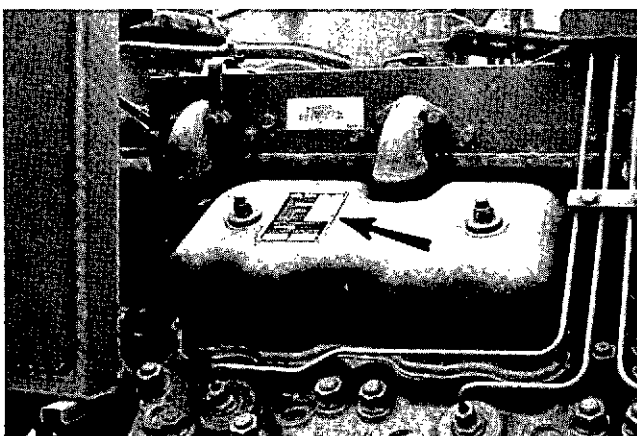
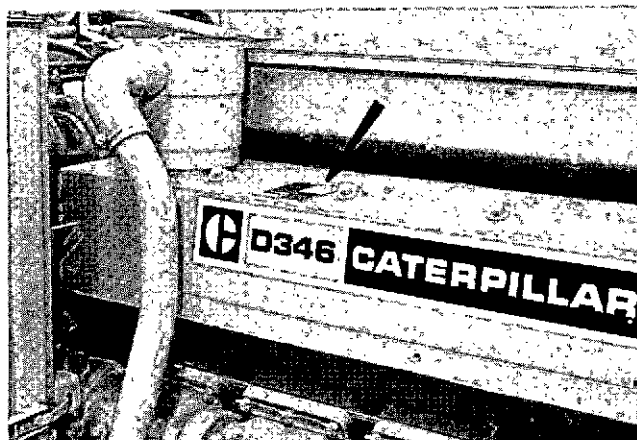
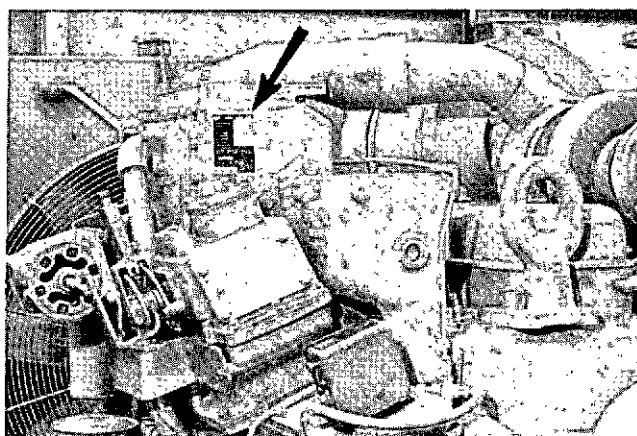
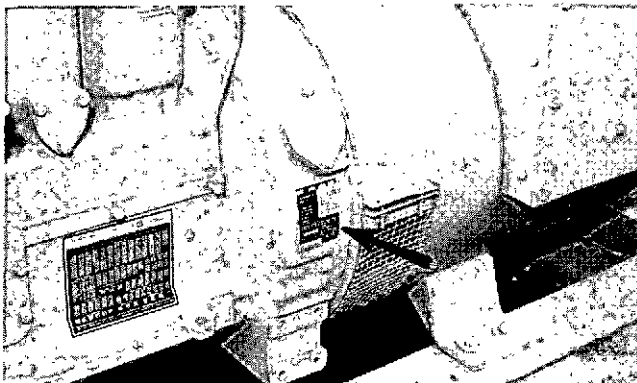
Safety is EVERYONE'S Business!!

### ALTITUDE OPERATION

The fuel system settings and altitude limits are stamped on the engine information plate. When an engine is moved to a higher altitude, these settings must be changed by your Caterpillar dealer in order to prevent damaging the turbo-charger, and to provide maximum engine efficiency.

If the engine is moved to a lower altitude than that which is stamped on the engine information plate, the engine can be operated safely, but it will deliver less than rated horsepower.

Typical warning plate locations on several engines are shown below.



## COLD WEATHER STARTING

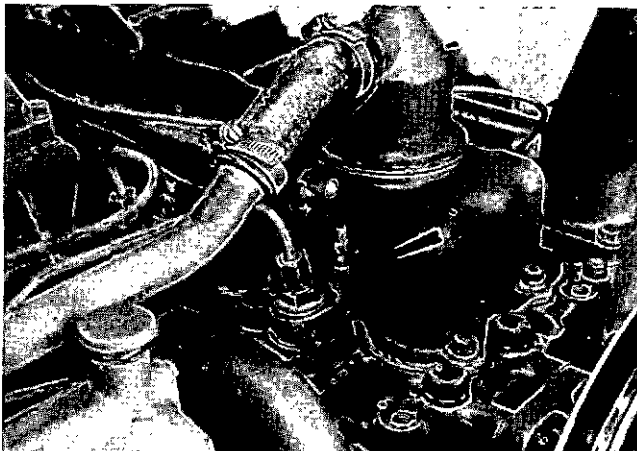
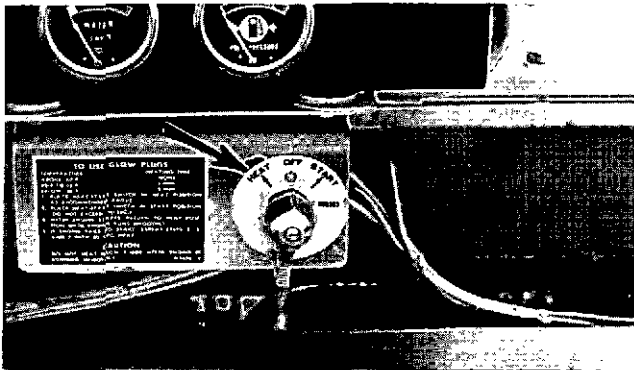
STARTING TEMP.	STARTING AID	HEATING TIME
Above 60°F (15°C)	None	None
60°F to 32°F (15°C to 0°C)	Glow Plugs	1 Minute
32°F to 0°F (0°C to -20°C)	Glow Plugs	2 Minutes
Below 0°F (-20°C)*	Glow Plugs & Starting Fluid	3 Minutes

\*Heating of jacket water and/or crankcase oil; and/or use of extra battery capacity may be required.

Many variables can affect cold weather starting. Use the above chart as a guide, but actual experience will determine when aids are necessary and how they should be used. The following starting aids are available:

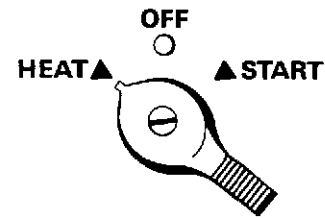
### Glow Plugs (Attachment)

Use glow plugs before cranking the engine, immediately after the engine has started, and until the engine is running smoothly.

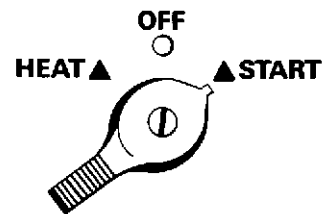


### Operation:

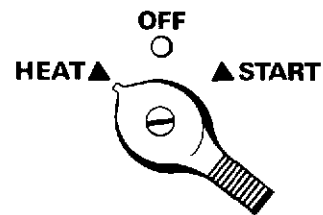
1. Push in and turn the HEAT-START switch to the HEAT position and hold for the approximate heating time shown in the Cold Weather Starting Chart.



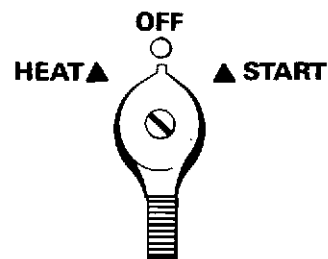
2. Turn the HEAT-START switch to the START position.



3. As soon as the engine starts, turn the HEAT-START switch to the HEAT position. Hold the switch in this position until the engine is running smoothly.



4. Release the switch.



### CAUTION

**NEVER** use glow plugs when the engine is warm and running.

## Starting Fluid

### CAUTION

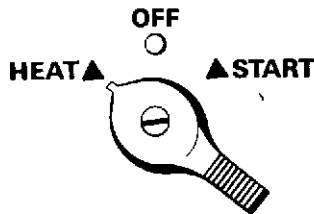
Spray starting fluid only while cranking the engine.

If starting fluid is sprayed into an engine that is running, the fluid would cause severe preignition in all cylinders until the fluid is consumed.

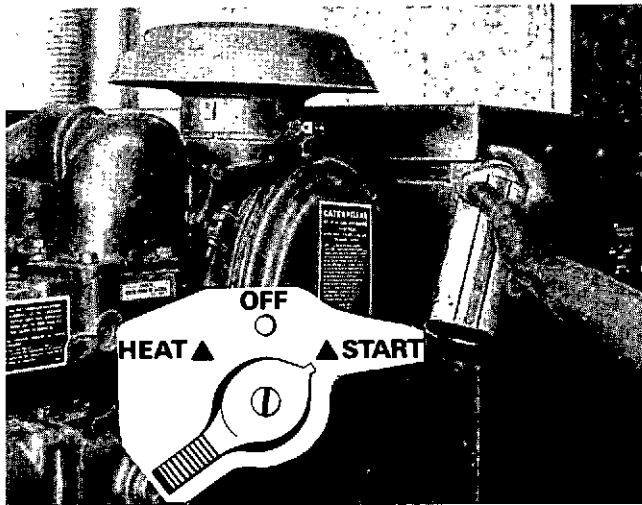
### WARNING

Starting fluid is volatile and must be stored away from heat and direct sunlight. If an aerosol container is used, follow the instructions on the container.

1. Heat the glow plugs for the approximate heating time shown in the Cold Weather Starting Chart.



2. Turn the HEAT-START switch to the START position. While cranking, discharge a quick spray of starting fluid into the air inlet or air cleaner.



3. If necessary, repeat the procedure.
4. After the engine starts, it may be necessary to return the HEAT-START switch to the HEAT position until the engine runs smoothly. Then release the switch.

## Jacket Water Heater (Attachment)

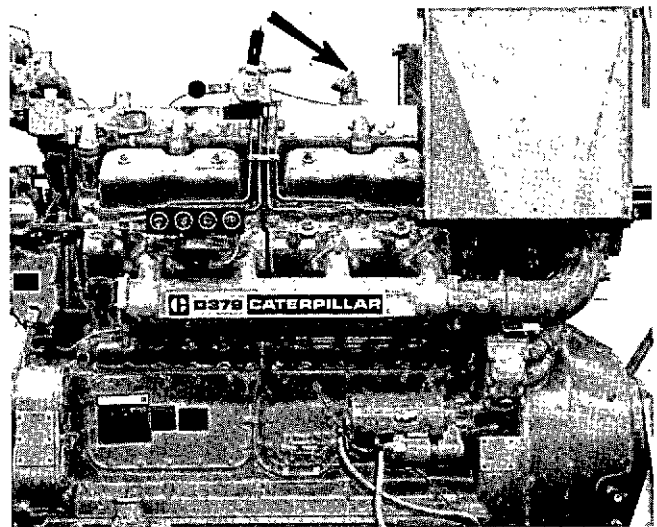
In very low temperatures, the lubricating oil must be warmed to allow starting. A jacket water heater can maintain the jacket water temperature at approximately 90°F (32°C). The warm jacket water will keep the oil in the upper part of the engine block warm enough to flow when starting.

## Dipstick Oil Heater

Contact your Caterpillar dealer before installing a dipstick crankcase oil heater.

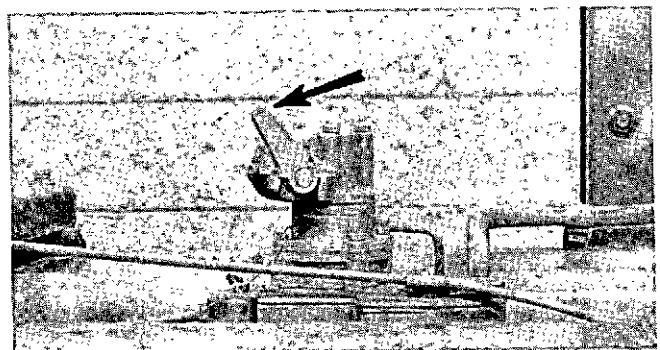
## Air/Fuel Ratio Control With Over-Ride

The large V-type engines are equipped with an air/fuel ratio control which has an over-ride lever. During extremely cold weather, more fuel and a richer fuel mixture may be necessary when starting.



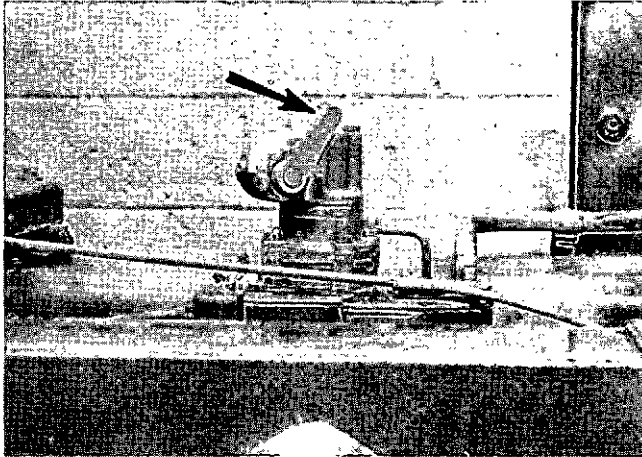
If the engine is blowing white smoke, but will not start:

1. Release the start switch.
2. Move the over-ride lever to the START position.



3. Use starting aids and crank the engine.

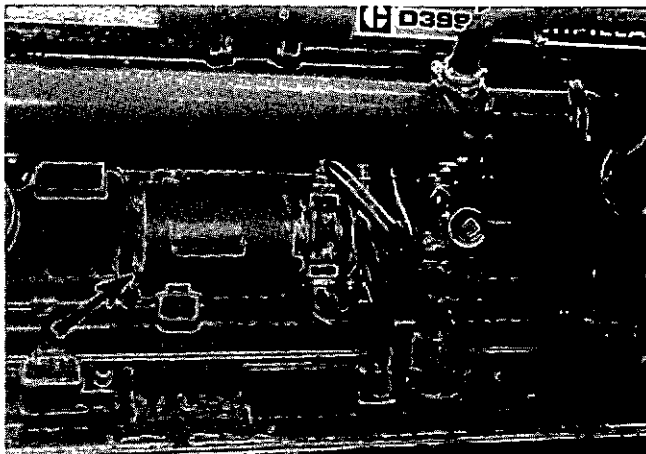
As soon as the engine starts and runs, the lever will return to the RUN position.



## AUTOMATIC START-STOP

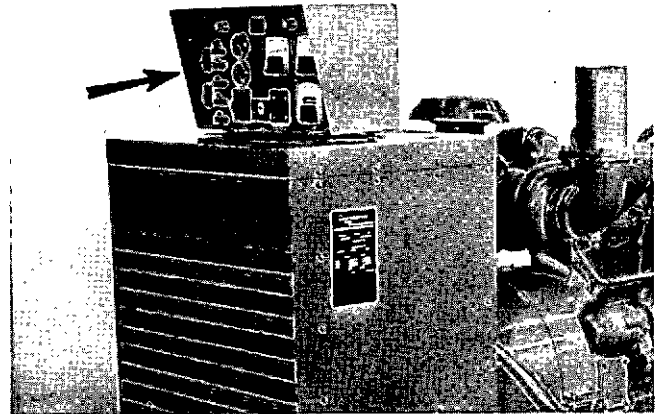
An automatic start-stop system is used when an engine must start when a specific condition occurs and with no one in attendance. The engine will start, increase speed, pick-up the load, operate the load until a second condition occurs, remove the load, cool and stop. The following conditions must exist for the engine to start unattended:

1. Either the ambient (engine room) temperature must be at least 70° F (20° C); or, the engine jacket water temperature must be at least 90° F (32° C). A jacket water heater can maintain this temperature.
2. If a prelube oil pump is used (large bore engines), the pump must operate before the starting motor(s) are energized, and stop when the engine starts and oil pressure increases.



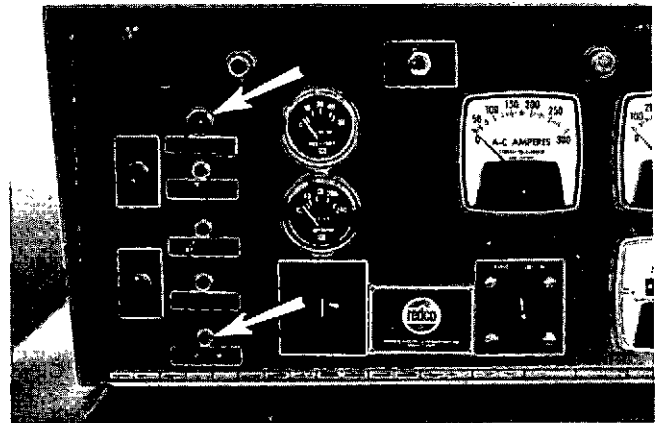
## PROTECTION DEVICES

The engine's control panel may be equipped with protection devices to protect the engine while cranking,



### Batteries:

Lights can indicate if a fault has occurred in the battery charging system causing the battery to be either undercharged or overcharged.



### Overcranking:

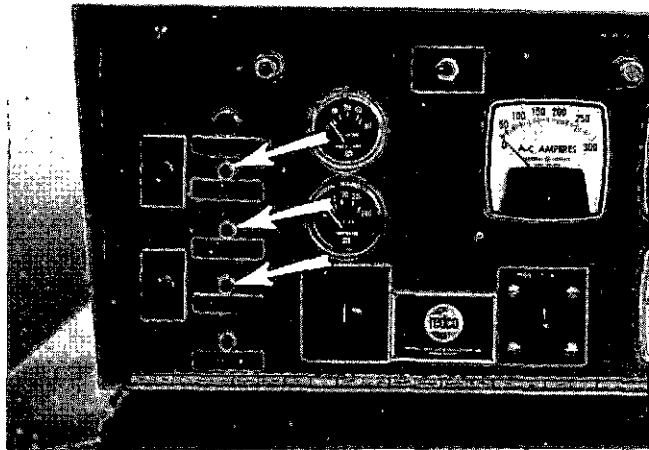
A timer allows the engine to crank either once for 30 seconds, or to crank through 5 ten-second cranking cycles (depending upon the device used) while unattended. If the engine does not start before the time elapsed, the fuel system will be shutoff and a light will indicate a starting failure.

### Engine Operation:

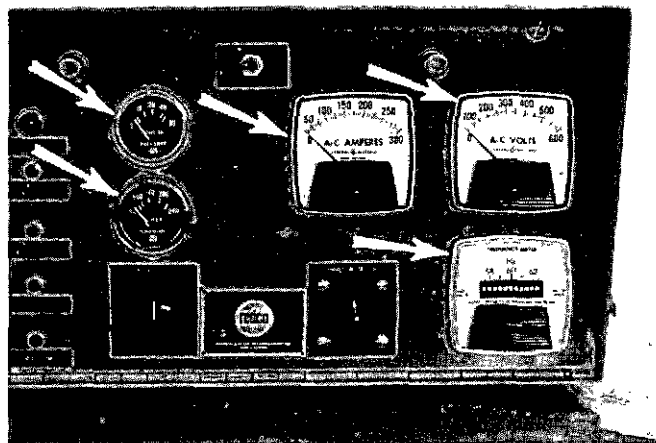
Prealarm systems provide an audible and/or a visual indication for low oil pressure, high water temperature, low

fuel supply or low jacket water temperature before the condition becomes critical. These alarms are self resetting when the condition is corrected.

The engine may also be equipped with shutdown devices. If low oil pressure, high jacket water temperature or an engine overspeed condition occurs, the engine will be shutdown and a corresponding light will indicate the cause of the shutdown. These devices must be reset after repairs have been made and before starting. See the topic, EMERGENCY SHUTOFF DEVICES AND ALARMS.



If the engine is equipped with an electric set, the control panel should be equipped with an ammeter, a frequency meter and a voltmeter. Depending upon the type of operation, the panel may also be equipped with other meters and lights. Know these instruments and their normal readings. They will indicate how the engine is performing.



### Shutting Down:

A timer allows the engine to remove or transfer the load, and to continue running for up to 2 minutes for cooling purposes before stopping.

### Engine Exerciser:

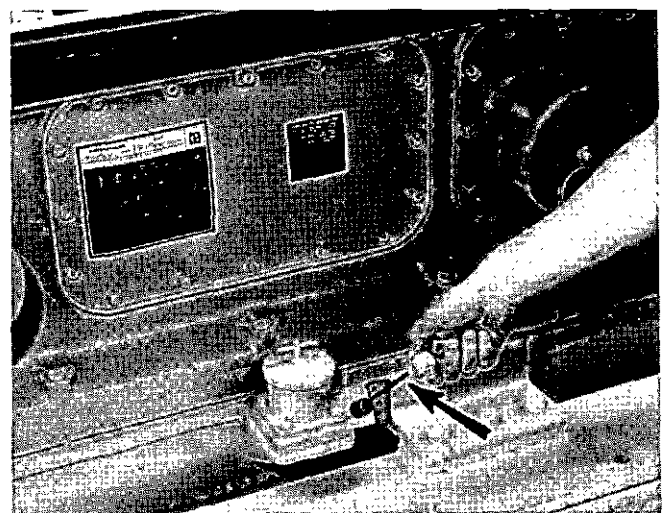
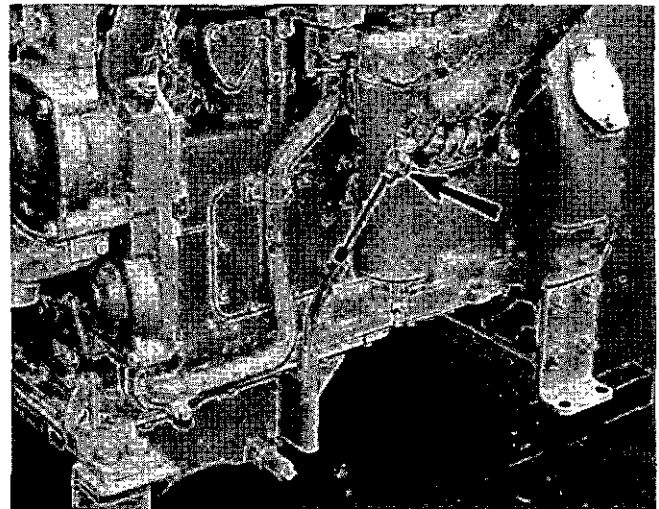
At preset times, the exerciser will start, run and stop the engine in order to ensure both proper lubrication of all engine parts and proper equipment operation if and when the standby unit is needed.

Become familiar with all instructions included with the equipment.

## ENGINE OPERATION

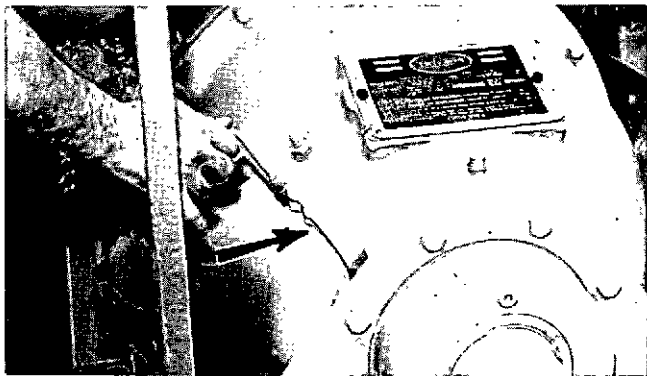
### PRE-START CHECKS AND PROCEDURES

1. Make a "walk-around" check of the engine and components. Correct minor adjustments before they develop into major repair jobs.
2. Check the crankcase oil level. Maintain the oil level between the ADD and FULL marks on the dipstick. See the LUBRICATION AND MAINTENANCE CHART for proper type and viscosity of oil to use.

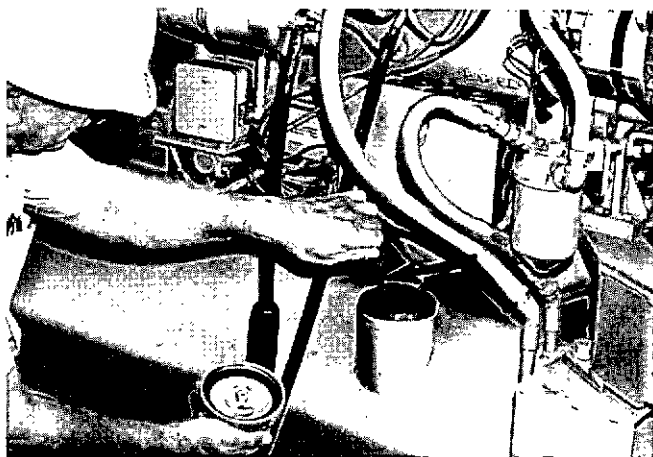


D346, D348, D379 and D398 Engines are equipped with a combination sump pump and pre-lube hand pump. After a long shut down or after a filter and oil change, operate the hand pump to fill the oil passages in the lube system before starting. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Oil Filter Elements, before starting any one of these models of engines.

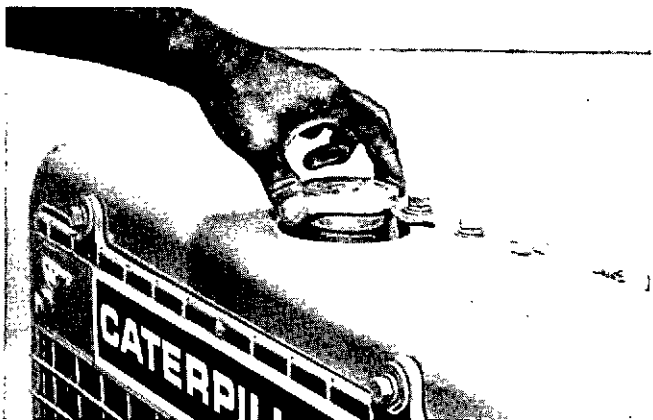
3. Check oil level(s) on driven equipment.



4. Check the fuel tank level. See the LUBRICATION AND MAINTENANCE CHART for proper fuel to use.

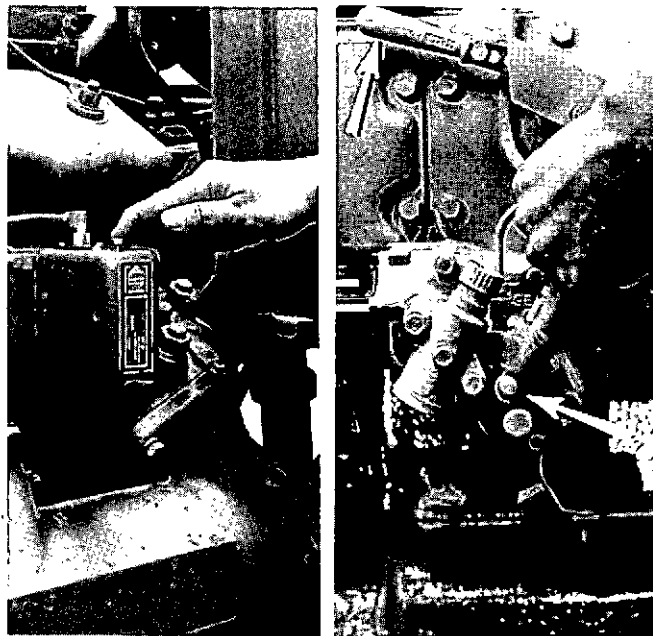


5. Check the engine jacket coolant level. Maintain coolant level to the base of the fill pipe. See the LUBRICATION AND MAINTENANCE CHART for proper make-up coolant to use.



6. Open the raw water valve (if so equipped) on the engine jacket heat exchanger system.

7. Reset shutoff devices. See the topic, ATTACHMENTS, Emergency Shutoff Devices and Alarms.

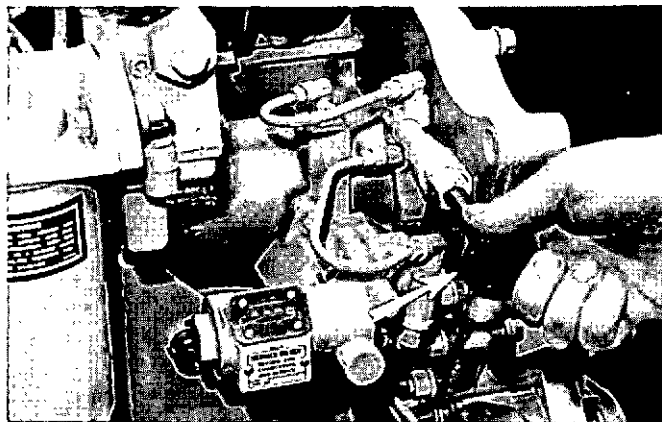


8. Open the fuel supply valve.

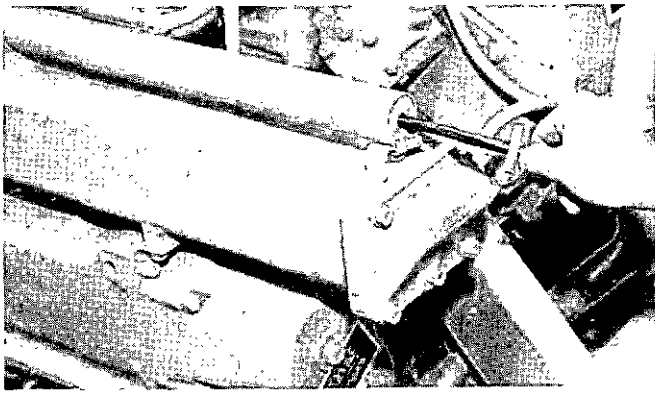
#### CAUTION

The fuel return line must be open to prevent engine damage.

9. If air has entered the fuel system, prime the fuel system. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Priming the Fuel System.

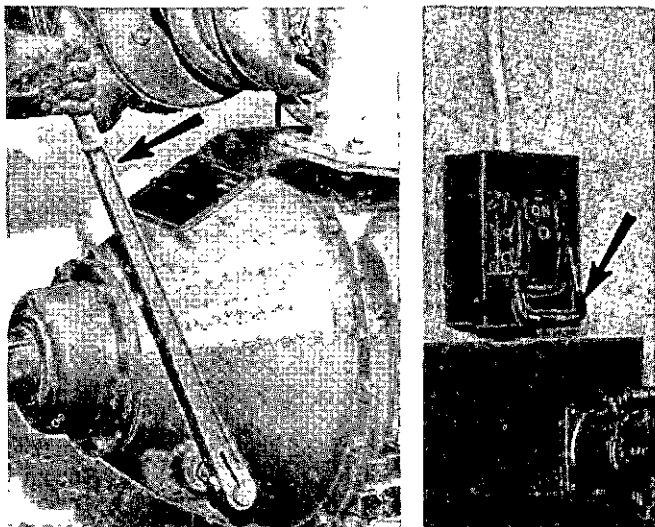


PRIMING PUMP ON 6 CYLINDER ENGINE



**PRIMING PUMP ON V-ENGINE**

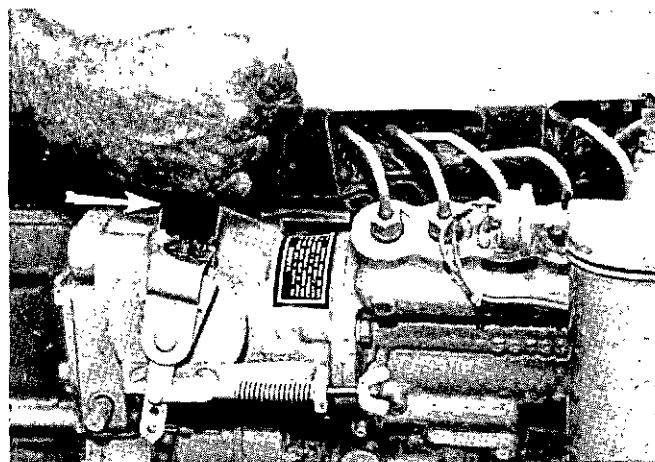
10. Disconnect any battery charger which is not protected against starting motor drain.
11. Disengage the clutch, or open the circuit breaker on an electric set.



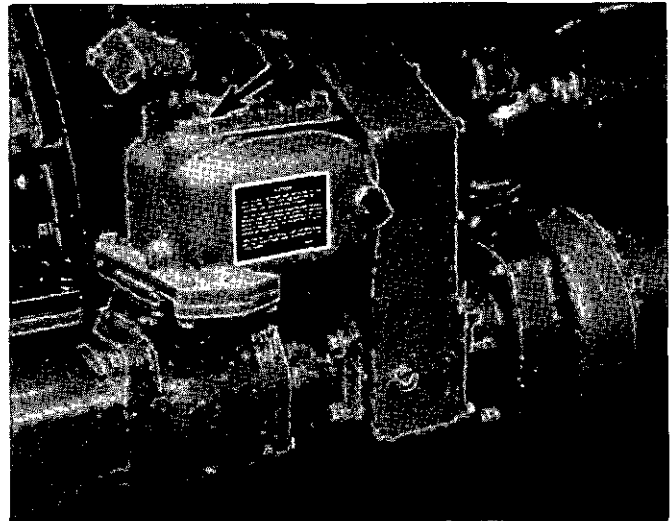
**CAUTION**

Do not start an engine under load.

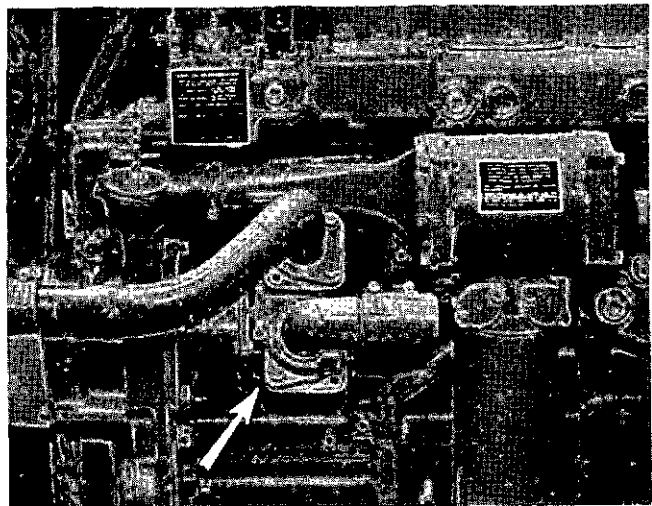
12. Move the governor control lever to half engine speed position or to speed limiter stop.



13. Prime the raw water pump if necessary. (Only water pumps equipped with a water reservoir and fill plug require priming.)



If the raw water pump is of the type shown below, the pump is a self priming pump. This pump does not have a priming chamber or fill plug.



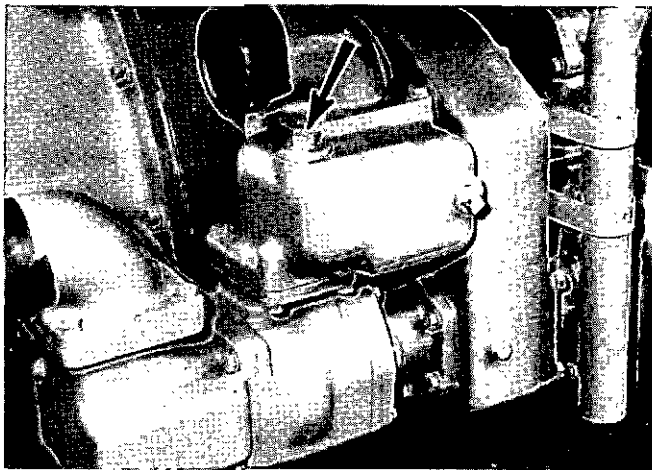
**SELF PRIMING RAW WATER PUMP**

**Priming The Raw Water Pump:**

**CAUTION**

The priming chamber must be filled with water before starting the engine to prevent pump or engine damage. After the engine is started, increase engine speed immediately to obtain and maintain system flow.

1. Carefully loosen the fill plug. If water is present immediately tighten the plug; the pump is full.
2. If water is not present, pour approximately two gallons (7.5 liters) (1.5 Imp. Gals.), or until overflow occurs, into the fill hole.
3. Install the fill plug.



FILL PLUG

4. Start the engine at fast enough speed to obtain the normal water flow from the overboard raw water discharge or water cooled exhaust pipe.

If the proper flow is not observed, stop the engine and repeat this procedure. If the pump does not hold water in the priming chamber, the water pump seals should be replaced.

## STARTING THE ENGINE

### CAUTION

Do not engage the starter when the flywheel is moving.

### Electric Starting:

1. Use starting aids if required. See the topic, GENERAL, Cold Weather Starting.

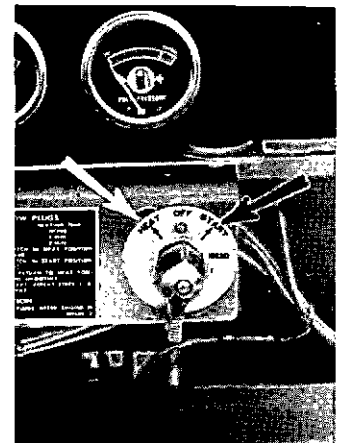
### NOTE

#### D349 and D399 Engines:

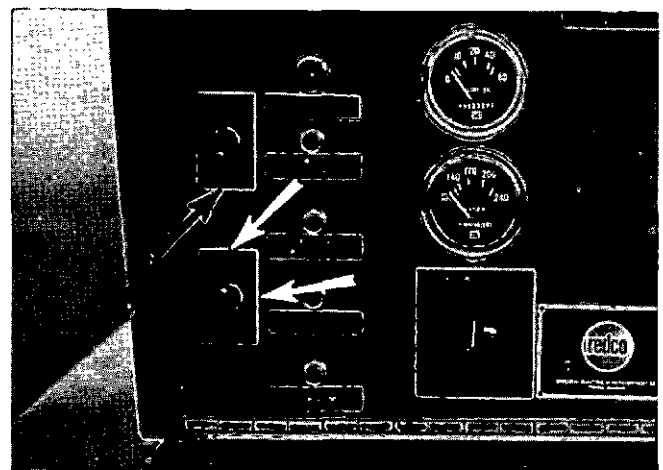
When the START switch is turned to the START position, a prelube pump driven by an electric motor will pressurize the engine lubrication system with oil. The crankcase oil will develop sufficient pressure before closing a switch which will energize the starting motor(s). The starting motor(s) will then crank the engine. After the engine starts, the starter switch is released, the prelube pump stops and the engine oil pump continues lubricating the lube system.

Prelube time will vary with the temperature of the oil. Hot oil will require more time to attain oil pressure before the engine can crank than will cold oil.

2. Push the START button; or turn the HEAT-START switch to the START position, depending upon the control the engine has. Release the control as soon as the engine starts.



For electric sets, place the AUTO-MAN switch in the MAN position; place the ON-OFF-STOP switch in the ON position to crank the engine. As soon as the engine starts, move the switch to the OFF position. (The STOP position is used to stop the diesel engine.)

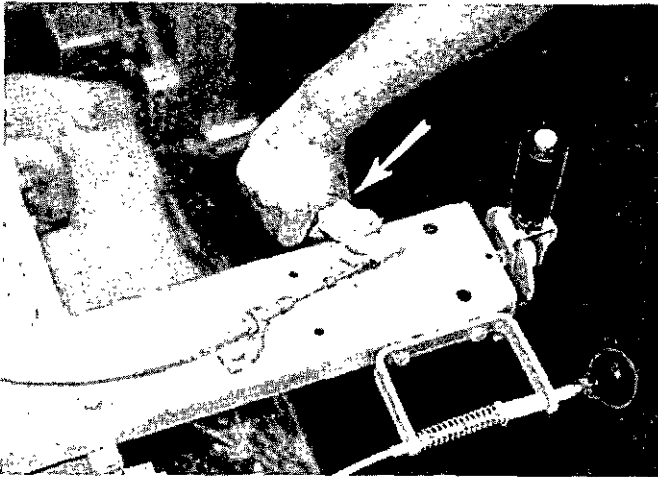
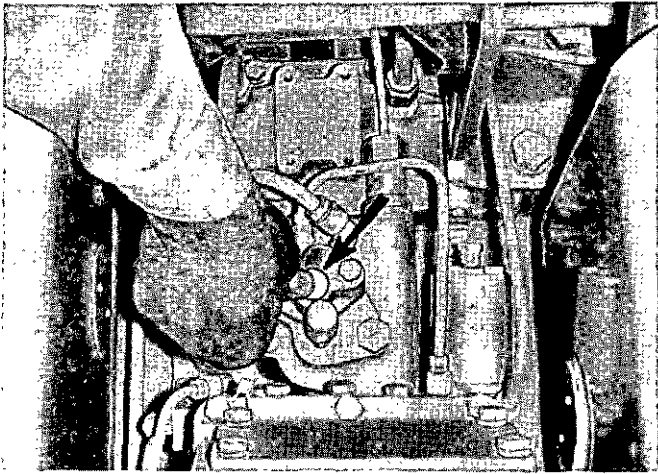


If the engine fails to start in a few seconds, move the governor control lever to the fuel off position, then continue to crank for 10 seconds. This will clear the cylinders of unburned fuel.

If the engine fails to start after 30 seconds of cranking, allow the starter to cool for 2 minutes before repeating the starting procedure.

### CAUTION

Prolonged cranking at low oil pressure can energize the mechanical safety shutoff which is used on 5.4" bore and larger engines. If the reset lever is in the shutoff position, reset the mechanical shutoff control.



RESETTING MECHANICAL SHUTOFF CONTROL

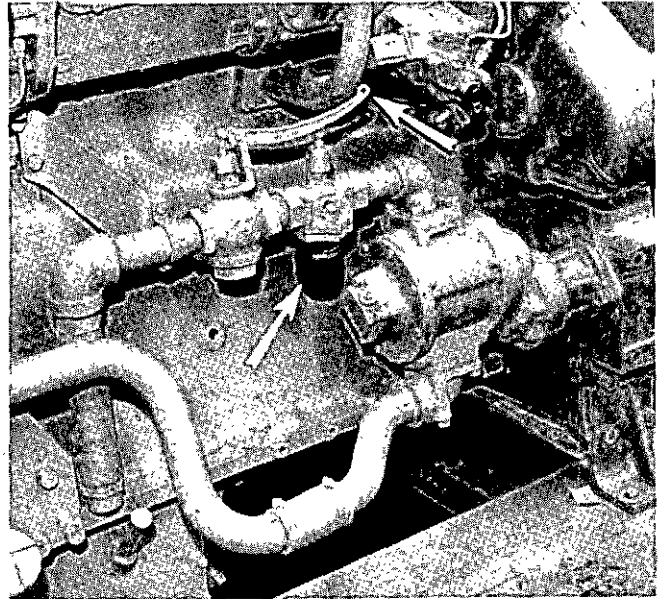
**CAUTION**

**NEVER** use starting aids when the engine is warm and running.

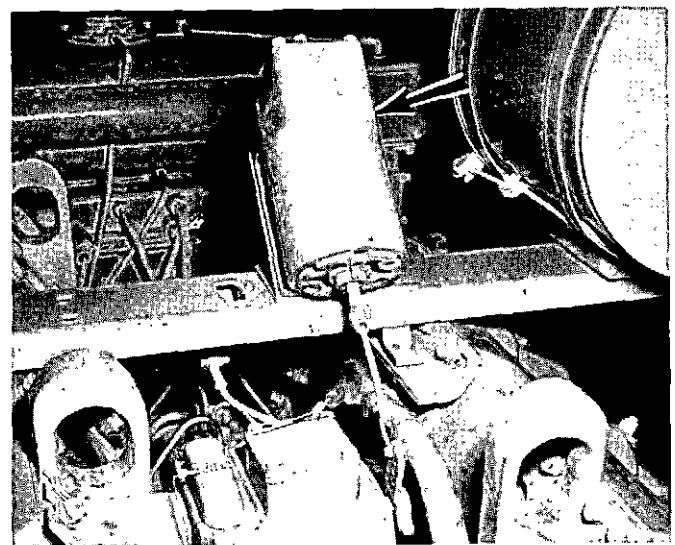
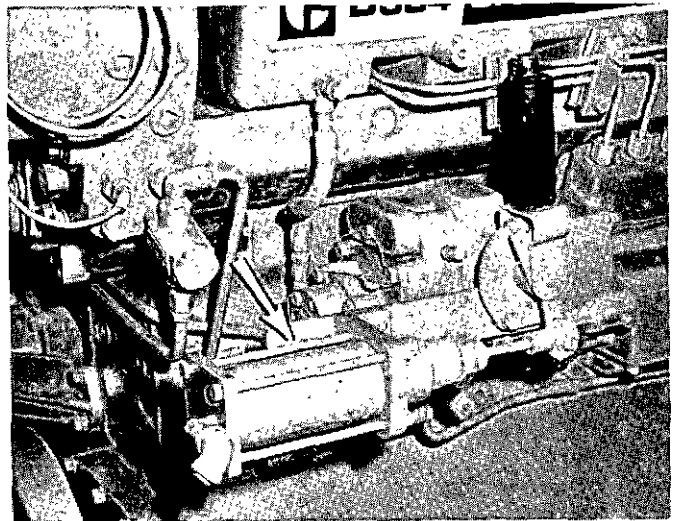
If the engine is equipped with either a Woodward PSG or UG8 Governor, see the topic, **WOODWARD GOVERNORS** for the governor operation instructions.

**Air Starting:**

1. Open and close the bleed valve on the bottom of the air tank to drain condensation and oil carryover.
2. Check the air supply pressure. The air start must have 100 PSI (7 kg/cm<sup>2</sup>) to operate properly.
3. Check the oil level in the oiler jar. Keep jar at least half full. Add oil if necessary. See the **LUBRICATION AND MAINTENANCE CHART** for the proper oil to use.
4. Pull the air valve upward to crank the engine. As soon as the engine starts, release the valve.



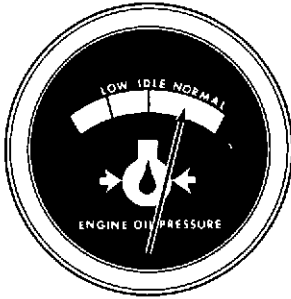
The engine governor may be controlled by an air regulator valve. One control panel can regulate several synchronous operating engines.



GOVERNOR AIR REGULATOR VALVES

## AFTER ENGINE STARTS

1. Observe the oil pressure gauge immediately after starting.



### CAUTION

If oil pressure is not indicated, stop the engine and have necessary repairs made.



### WARNING

Stop the engine if any repairs or adjustments are required. Do not work on machinery while the engine is running.

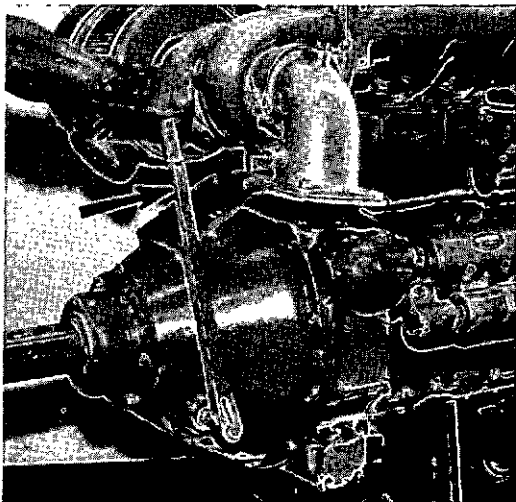
2. Move the governor control to low idle, allow the engine to warm (usually several minutes). Make another "walk-around" inspection for leaks, etc.

## STARTING THE LOAD

### Driven Equipment Without Load:

To engage the driven equipment before applying load:

1. Move the governor control to half engine speed.
2. Engage the driven equipment without load.



3. Check the engine gauges and equipment.
4. Move the governor control to high idle (full load) position.
5. Apply the load to the driven equipment.

### Driven Equipment With Load:

1. Move the governor control to half engine speed. Check the engine gauges.
2. Move the governor control to high idle (full load) position.
3. Engage the load.

## ENGINE OPERATION

### INSTRUMENT PANEL GAUGES

After the engine starts, and at frequent intervals while the engine is operating, the gauges should be observed. Determine the normal reading for each gauge. Investigate the cause whenever there is a significant change in the reading.

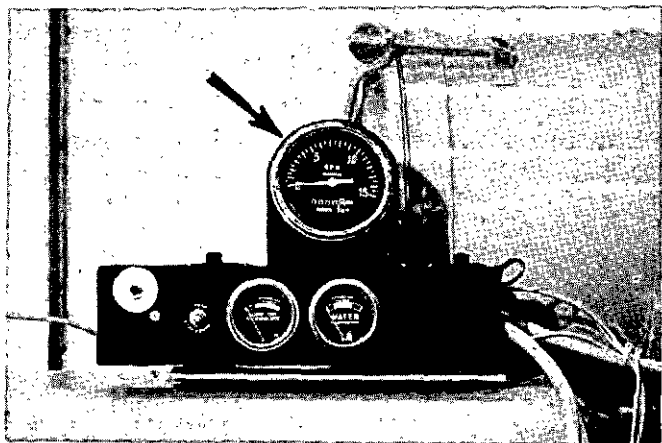
Your engine may be equipped with calibrated gauges. Periodic monitoring and recording of the gauge readings will provide a history of the engine's performance. As certain conditions develop, a change in the readings will indicate a problem is developing. The necessary repairs can be scheduled before the failure and the resulting unexpected downtime occurs.

### CAUTION

If a large quantity of oil or water is lost in a short period of time — as when the line ruptures — manually shut down the engine immediately. If the oil or water levels are allowed to go below the ADD levels, the safety shutoff devices will not protect your engine.

### Tachometer:

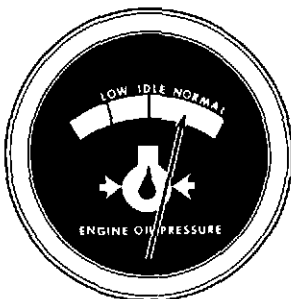
The tachometer indicates engine RPM. When the governor control lever is moved to the full speed position without load, the engine is running at high idle. When the governor control lever is moved to the full speed position and load is applied, the engine will slow slightly to full load speed. The high idle RPM and the full load RPM are stamped on the engine's altitude information plate. The engine can be operated between these two speed limits for long periods of time without shortening engine life.



If the engine speed drops below full load speed with the governor control lever positioned in the full load position, the engine will be operating in a lug condition; see the topic, LUGGING.

### Engine Oil Pressure:

Oil pressure will be greatest after starting a cold engine. Oil pressure will decrease as the engine warms while idling. As the engine speed is increased to full load speed, oil pressure will increase into the NORMAL range and stabilize.

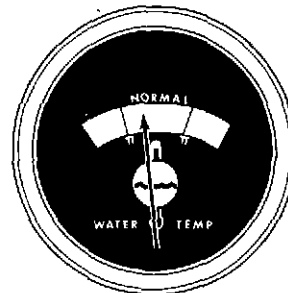


If the gauge reading fluctuates:

1. Remove the load.
2. Reduce engine speed to low idle.
3. Check the oil level. Maintain the oil level between the ADD and FULL mark on the dipstick. If the reading continues to fluctuate, call your Caterpillar dealer.

### Engine Jacket Water Temperature:

The water temperature reading may vary according to load, but should never exceed the boiling temperature for the pressurized system being used.



If the engine operates with the indicator in the HOT range and steam becomes apparent:

1. Reduce the load and speed.
2. Inspect for pressure steam or water leaks. Determine if the engine must be shut down immediately; or if the engine can be safely cooled by reducing the load.

### CAUTION

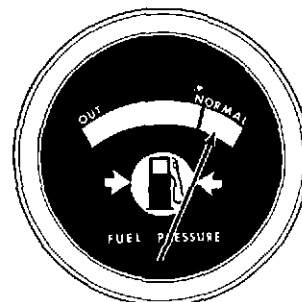
**Do not add cold water to a hot engine: Cracking of engine components may occur. Allow the engine to cool, then add coolant.**

The engine operating temperature should be approximately 200°F (95°C). If the temperature gauge reading registers in, or near, the cold range — approximately 170°F (75°C):

1. Check the temperature regulators for proper temperature range; and replace if necessary.
2. Check the water temperature gauge for accuracy.
3. Determine if the radiator is overcooled, and if radiator louvers are required.

### Fuel Pressure:

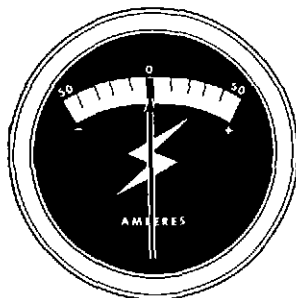
The fuel filter gauge indicates pressure of the filtered fuel. If the fuel filter gauge registers in the OUT range, clean the primary fuel filter if so equipped, and install new fuel filter elements. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fuel Filters.



In cold weather, paraffin crystals can form in the fuel and plug the fuel filter. If this occurs, a fuel that has a lower CLOUD POINT must be used. See your fuel distributor.

### Ammeter:

The ammeter should indicate just to the right of zero (in the "+" range) when the engine is warm and running at rated speed. If the gauge registers to the left (in the "-" range) as the engine speed is increased, determine and correct the cause.



### Engine Oil Temperature:

The purpose of the oil is to lubricate all moving parts inside the engine, and to cool (remove the heat from) the pistons, liners and bearings. The lube oil cooler transfers the heat in the oil to the engine water. If the radiator cannot expel the necessary heat from the water, the engine oil cannot be properly cooled. Above normal oil temperature indicates a heat problem has occurred with the cooling system and/or engine, and a problem can occur with cylinder heads, liners, pistons or bearings.

### Exhaust Temperature Gauge:

This gauge measures exhaust gas temperature. On V-engines, temperature readings are taken from both the left and right banks. If the exhaust temperature increases:

1. Check the load on the engine. Running the engine below rated full speed RPM at full load causes excessive exhaust temperatures, overheating of the engine's cooling system, and possible engine damage. See the topic, LUGGING. Reduce the load if necessary.
2. Check the air cleaner service indicator or air cleaner pressure gauge; the air cleaner element may be plugged. Stop the engine and service the air cleaner if necessary.
3. After the engine has been stopped, check the tightness of the inlet and exhaust manifold bolts. These bolts must be tight to prevent air leakage.

### Inlet Air Temperature Gauge:

As the inlet air increases in temperature, the inlet air expands. As the air expands, less fuel is burned in the cylinders; and less horsepower is developed. As a result, at full load position with a normal load, the engine may be overloaded.

If excessive air inlet temperature occurs:

1. Check the water temperature gauge. Determine if the engine jacket water system is able to cool the engine properly.
2. Listen for unusual water pump noises. Be sure the V-belts are properly operating the water pump. Check belt adjustment when the engine is stopped.
3. Reduce the load if necessary.
4. Determine if there is an adequate supply of cool air to the engine air inlet. Be sure hot air from another engine or exhaust system isn't being drawn into the air cleaner or radiator.

### Air Cleaner Service Indicator:

This gauge measures the difference of air pressure between the inlet side (dirty side) and the engine side (clean side) of the air filter element. As the element becomes plugged, the gauge indicator reading will increase when the gauge indicates the filter element is dirty, service the air cleaner when the engine is stopped; see the LUBRICATION AND MAINTENANCE PROCEDURES topic, Air Cleaner Service Indicator.

### Oil Filter Service Indicator:

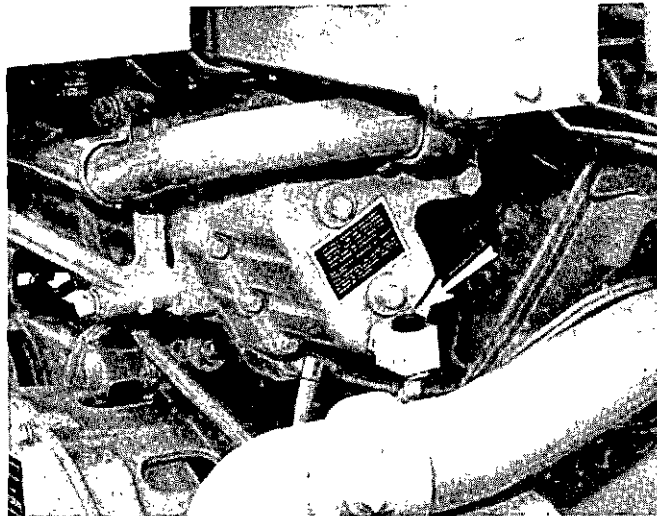
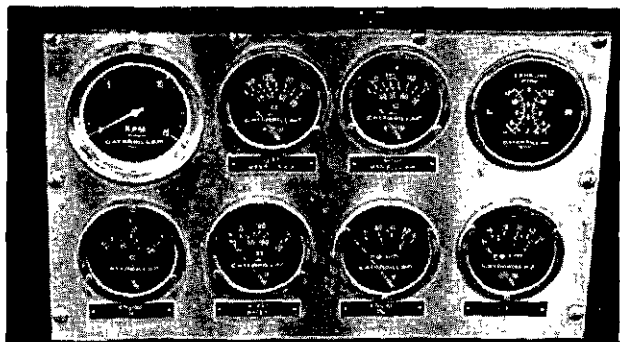
This gauge measures the difference of oil pressure between the inlet side (dirty outer side) and the outlet side (inner diameter side) of the oil filter elements. As the element becomes plugged, the difference of pressure between the inner and outer sides of the element will increase. Then the gauge reading indicates the filter element is almost plugged, change filter elements when the engine is stopped. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Oil Filter Service Indicator.



**WARNING**

**Shut the engine down if work on, or around, the engine is required.**

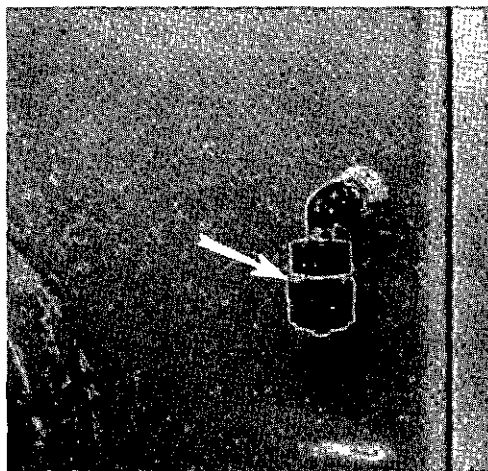
Observe all gauge readings periodically. Know the normal indication of each gauge. If there is a sudden change, investigate the cause immediately, and make repairs if needed.



## INDICATORS

### Air Cleaner Service Indicator:

Periodically check the air cleaner service indicator. If the red piston remains in the visible position, the air cleaner element requires servicing. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Air Cleaner Service Indicator.

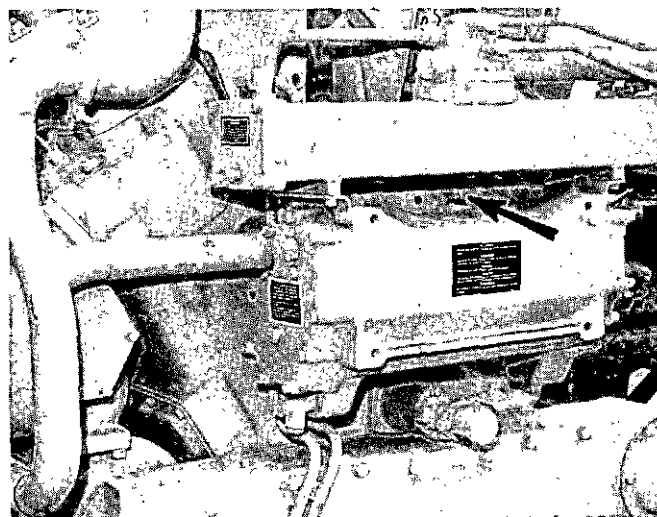


### Oil Filter Change Indicator:

On Vee engines, periodically check the oil filter change indicator. When the red piston has raised half way in the clear plastic window, change the oil filter elements.

#### NOTE

The engine is shipped with an opaque covering over the clear plastic window. Be sure this covering is removed.



## ENGINE HORSEPOWER RATINGS

There are two general horsepower ratings for industrial engines and two for electric set engines. They are: intermittent or continuous; standby or prime. These ratings are the recommended engine horsepower settings based upon load requirements and type of operation.

### Continuous and Prime Ratings:

Horsepower settings for these two ratings allow the engine to operate a constant load at full speed for long periods of time without shortening engine life.

### Intermittent Rating:

Horsepower settings for this rating requires the engine to be operated at full load and speed for periods up to an hour, followed by an equal time of operation at reduced load and speed.

### CAUTION

If an engine is set for an intermittent rating and is operated for long periods of time at constant full load, the engine life will be shortened.

### Standby Rating:

Horsepower settings for this rating allows the electric set to supply rated power for a period of time, after which the engine is stopped.

Contact your Caterpillar dealer if there is doubt as to which rating the engine has.

### CAUTION

Horsepower settings should only be done by authorized personnel.

### Full Load Operation:

The governor control lever should remain in the full governed position while powering full load.

### Reduced Load Operation:

If the load varies, or is cyclic, the governor usually will adjust the engine speed as required. If a slower constant speed is desired, move the governor control lever to desired speed position.

### CAUTION

Be sure to increase engine speed before increasing the load.

### No Load Operation:

If the load is temporarily removed, engine speed may be reduced by manually moving the governor control. However, the engine may be operated at high idle without causing shortened engine life.

### CAUTION

Never operate an electric set below 2/3 full load RPM: Overheating and possible damage could occur to the generator below this RPM.

### Lugging:

Lugging can occur at any engine speed and with most applications. Lugging occurs whenever engine speed decreases below full load speed with the governor control at

full load speed position; or when an increase in governor control setting will not increase engine speed.

Lugging can damage an engine: Maximum fuel is injected at reduced engine speed; and the water pump, oil pump and fan run slower than required to cool the engine. Certain engine areas will become extremely hot and failure of parts could occur.

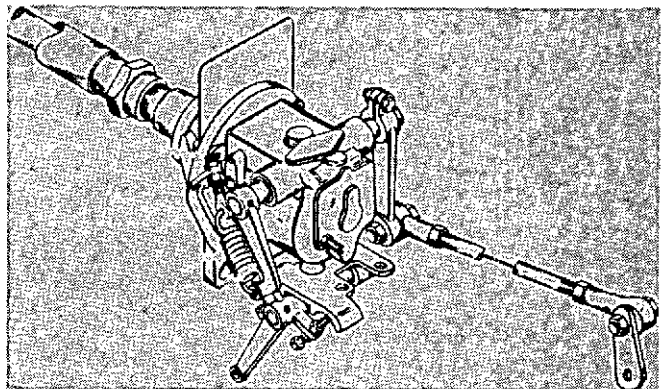
Because maximum engine torque is developed, lugging — if properly used — can be useful. Lugging will not cause damage if the lugging period is short in duration, and if the engine is allowed to cool.

An example of lugging could be a shovel digging through rock and clay. As the bucket is raised, the governor increases engine speed. If the bucket becomes lodged on a rock, the engine speed will drop, but the fuel consumption rate, exhaust temperatures and torque will increase. The operator must determine if either the rock can be loosened in a short period of time, or the bucket should be repositioned and the load reduced. If the rock is to be loosened while in lug condition, the engine must be able to cool in the time it takes to finish the cut, swing and dump the load, and return to the next load.

The temperature gauges for the engine should be closely watched during periods of lugging. If the temperature readings increase, the load must be reduced.

### Output Shaft Governor Operation:

When the load can overspeed the torque converter output shaft, an output shaft governor should be installed. The output shaft governor is a speed limiting device which eliminates having to frequently change engine speed by using the engine governor control lever.



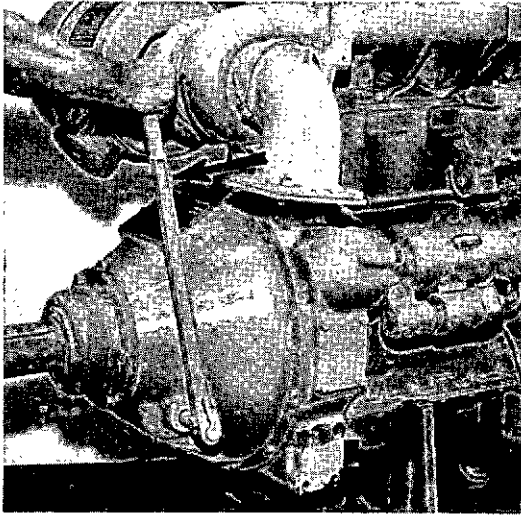
The output shaft governor is installed on the torque converter output shaft and is connected to the engine governor through a hydraulic servo mechanism. When under load, the engine governor regulates engine speed. If the load is removed and the torque converter output shaft speed exceeds desired operating speed, the output shaft governor will operate the engine governor so as to reduce the speed of the engine. When the output shaft speed returns to normal operating speed, the engine governor maintains full load engine speed.

## ELECTRIC SET OPERATION

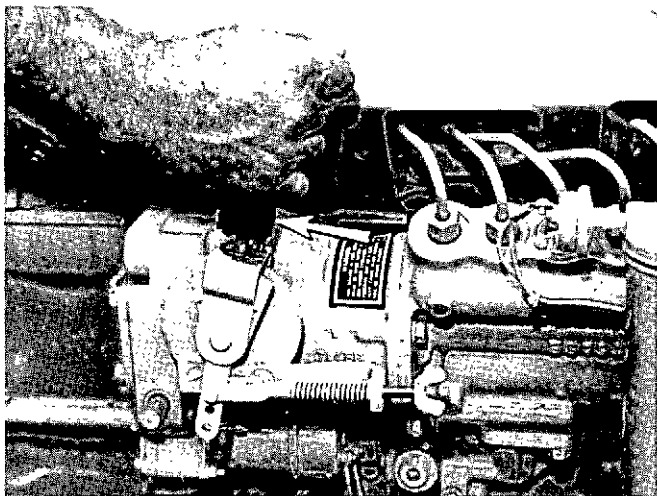
See the **ELECTRIC SET OPERATION INSTRUCTIONS**.

### STOPPING

1. Flywheel clutch operation: Quickly pull the clutch lever to the released position. For electric set operation, see the **ELECTRIC SET OPERATION** instructions. For Woodward Governor operation, see the topic, **WOODWARD GOVERNORS**, Stopping the Engine.

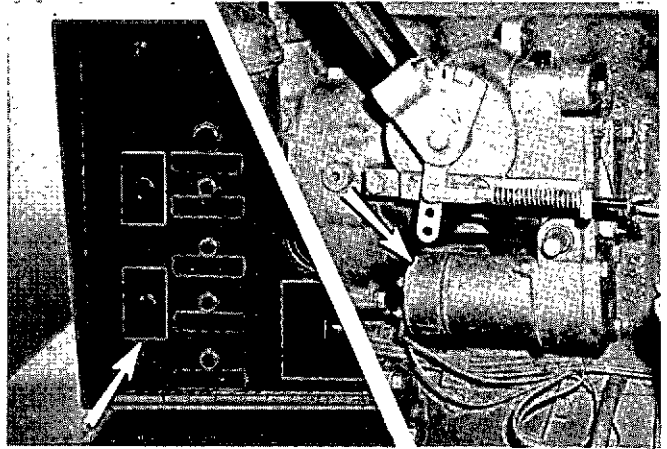


2. Reduce engine speed to half speed. Run for 5 minutes to cool engine.



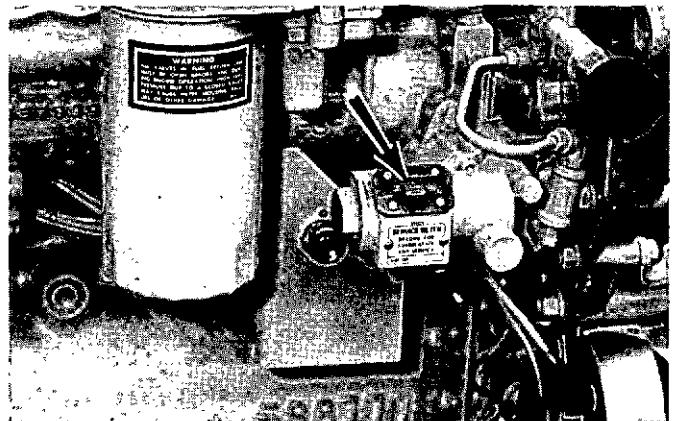
3. Reduce engine speed to low idle.
4. Check the crankcase oil level while the engine is idling. Maintain the oil level between the **ADD** and **FULL** marks on the side of the dipstick stamped **CHECK WITH ENGINE RUNNING**. See the **LUBRICATION AND MAINTENANCE PROCEDURES** topic, Diesel Engine Lube Oil.

5. Stop the engine by either moving the engine governor control to the shutoff position, or by pushing and holding the **ON-OFF-STOP** switch until the engine stops; depending upon how your engine is equipped.

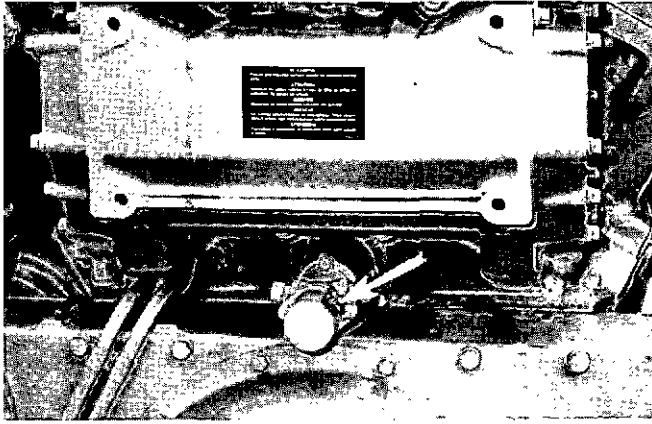


### AFTER STOPPING CHECKS AND PROCEDURES

1. Fill the fuel tank. See the **LUBRICATION AND MAINTENANCE PROCEDURES** topic, Fuel Tank.
2. Drain the raw water system if below freezing temperatures are expected; see Section D: Draining Raw Water System.
3. If below freezing temperatures are expected, allow the engine jacket water expansion tank to cool; then check the coolant for proper antifreeze protection. Add permanent type antifreeze if required. See the **LUBRICATION AND MAINTENANCE PROCEDURES** topic, Cooling System.
4. Repair any leaks, correct major adjustments, tighten loose bolts, etc.
5. Observe the Service Meter reading. Perform the periodic maintenance as instructed in the **LUBRICATION AND MAINTENANCE CHART**.



**SERVICE METER ON 6 CYLINDER ENGINE**



SERVICE METER ON V-ENGINE

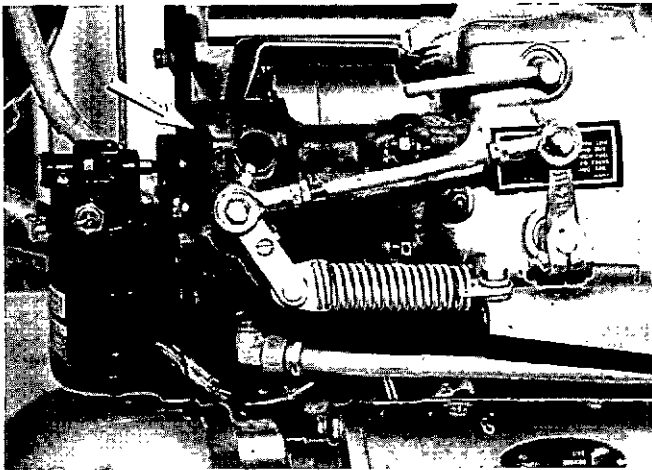
6. Perform the required maintenance on all other equipment; see the equipment manufacturer's instructions.

## WOODWARD GOVERNORS

Woodward Governors are usually electrically operated from a control panel.

### STARTING THE ENGINE

#### Woodward PSG Governor:



1. Perform all pre-start checks outlined previously. In addition, be sure the alternator and alternator belt are properly installed and adjusted.
2. Push the START-STOP switch to the START position.
3. When the engine starts, release the START-STOP switch.

On some installations, low alternator output frequency will operate a relay to stop the starter. The alternator belts on these arrangements must be inspected regularly for proper belt tension and conditions.

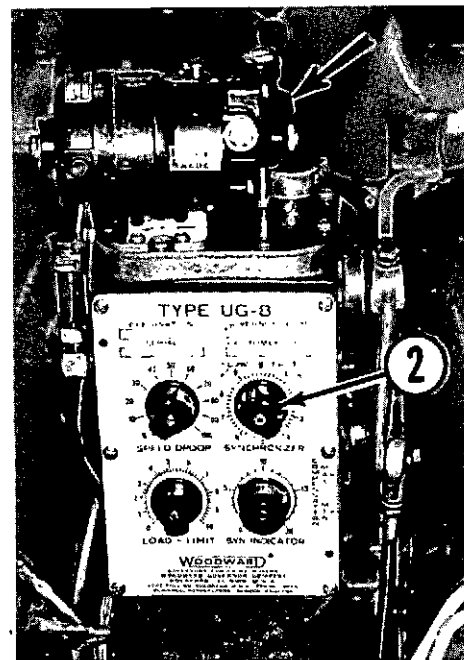
4. Start the load.
5. Regulate the engine speed with the RAISE-LOWER switch to attain the required instrument panel gauge readings.

#### Woodward UG8 Governor:

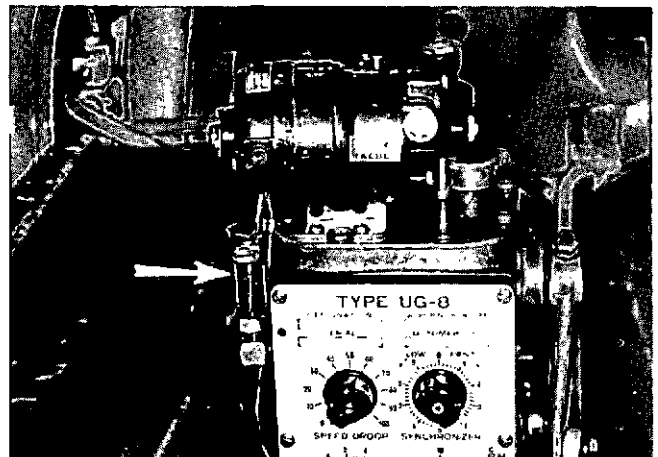
Start the engine as follows:

#### NOTE

If the governor is equipped with an electric motor, operate synchronizer knob (2) by using the RAISE-LOWER switch on the control panel.

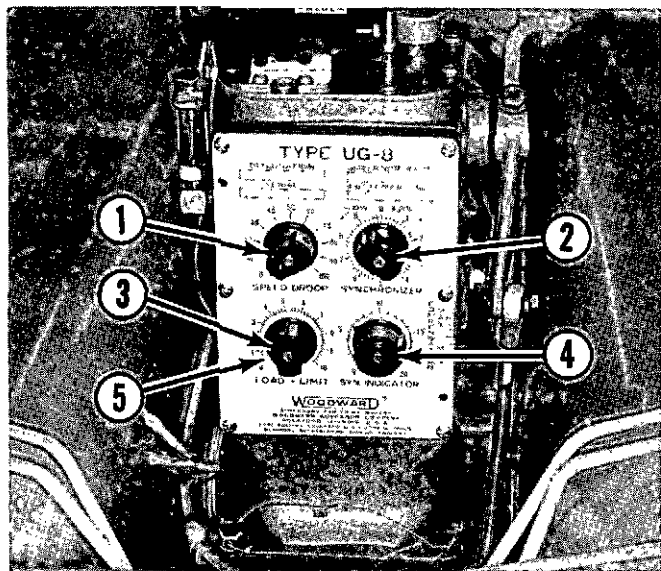


1. Perform all pre-start checks outlined previously.
2. Check the oil level in the sight level gauge with the engine stopped. Oil level should be near the top of



the sight level gauge. See the LUBRICATION AND MAINTENANCE PROCEDURES topic, Woodward UG8 Governor.

3. Turn the load limit knob (3) until the indicator is between "5" and "7".



1—Droop knob. 2—Synchronizer knob.  
3—Load limit knob. 4—Synchronizer Indicator.  
5—Load pointer.

4. Turn the synchronizer knob (2) clockwise until the indicator (4) is at "8".
5. Move the START-STOP switch to the START position; start the engine.
6. Run the engine at low idle for 5 minutes.
7. Turn the load limit knob (3) to "10".
8. Turn synchronizer knob (2) clockwise until the engine runs at full governed speed.
9. Turn speed droop knob (1) to obtain proper droop for the operation:
  - a. For single unit operation, set knob (1) at "0".
  - b. For parallel operation: See Parallel Operation Droop Adjustment in the ELECTRIC SET OPERATION instructions. Speed droop knob (1) on the first unit on the line may be set at "0" droop, and the remaining units set between "30" and "70". These settings should provide constant speed or frequency. If constant speed is not re-

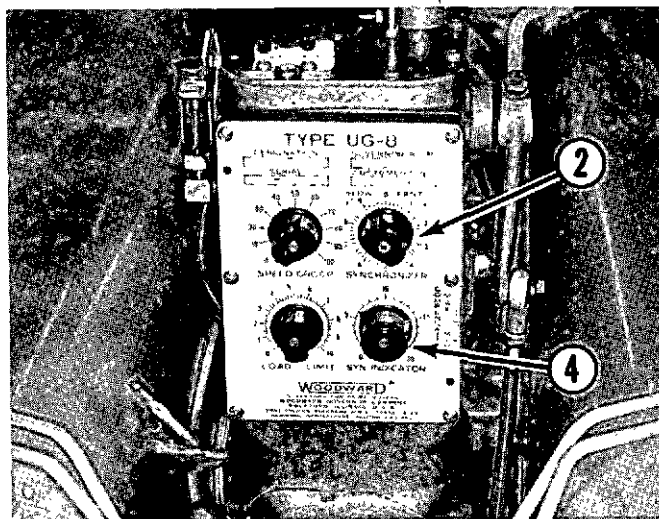
quired, set droop knob (1) on all units between "30" and "70".

10. Apply the load and readjust the synchronizer knob (2) to obtain the desired load division. Load pointer (5) indicates the relative load.

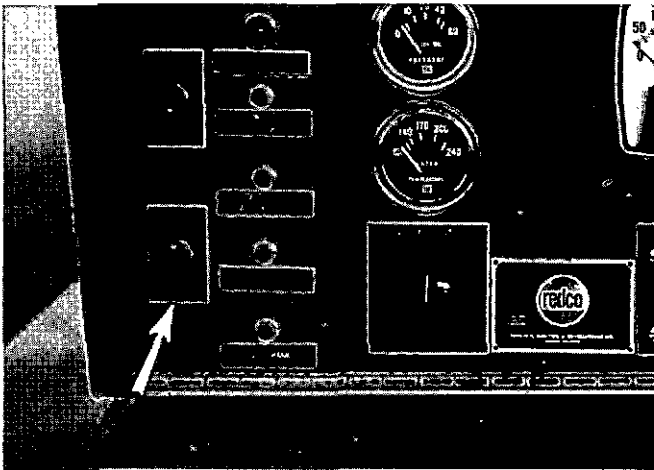
## STOPPING THE ENGINE

1. Remove the load. See ELECTRIC SET OPERATION instructions if equipped with an electric set generator.
2. Reduce engine speed to low idle: Push down and hold the RAISE-LOWER switch until the engine low idle speed is reached.

When manually operating a UG8 Governor, move the synchronizer knob until the synchronizer indicator points to "8", or the low idle stop is reached.

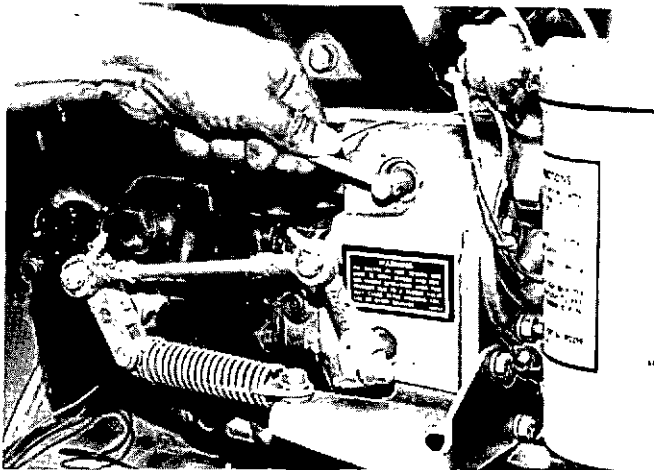


3. While the engine is idling, check the engine oil level. Oil level must be maintained between the ADD and FULL mark on the side of the dipstick marked "CHECK WITH ENGINE RUNNING".
4. Stop the engine.
  - a. **Solenoid Shutoff:** Move the ON-OFF-STOP switch to the STOP position. Hold the switch until the engine stops. (Do not confuse this with the "RAISE-LOWER" switch.)

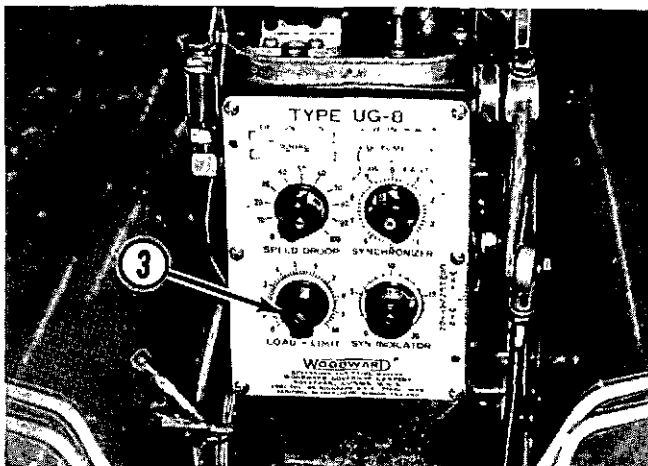


**ON-OFF-STOP SWITCH**

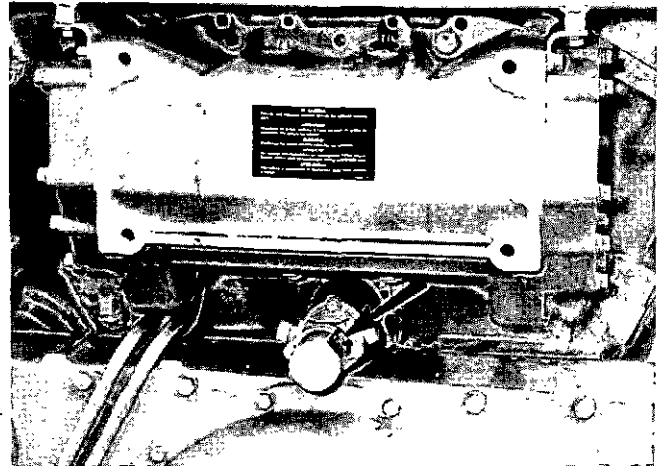
- b. **PSG Governor:** Move the shutoff lever forward, or hold the lever up, depending upon installation. Hold the lever in this position until the engine stops.



- c. **UG8 Governor:** Turn the load limit knob to "0".



- 5. Fill the the fuel tank. See the **LUBRICATION AND MAINTENANCE PROCEDURES** topic, Fuel Tank.
- 6. Drain the raw water system if below freezing temperatures are expected.
- 7. Observe the Service Meter reading. Perform the periodic maintenance as instructed in the **LUBRICATION AND MAINTENANCE CHART**.

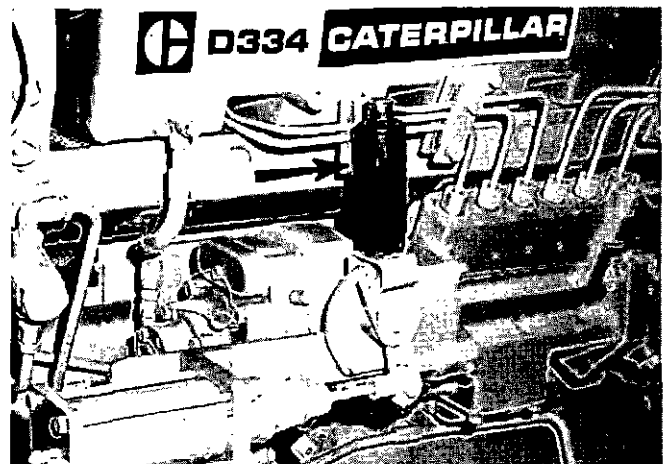


## **EMERGENCY STOPPING**

To stop in an emergency:

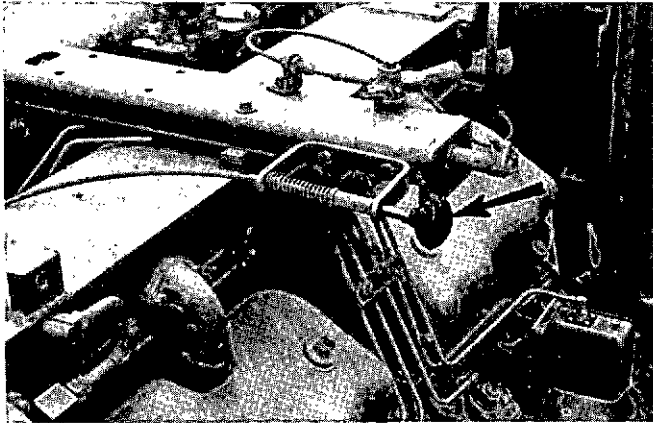
### **Mechanical Governor Control:**

Pull upward on the hand grip, and move the control to the shutoff position.



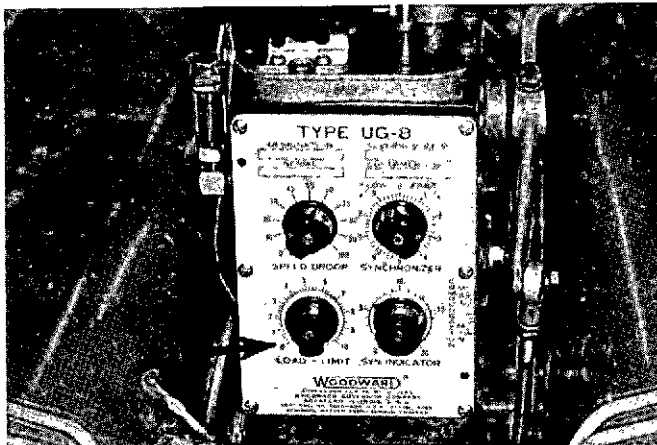
### Manual Shutoff Control:

Push and hold the control handle until the engine stops.



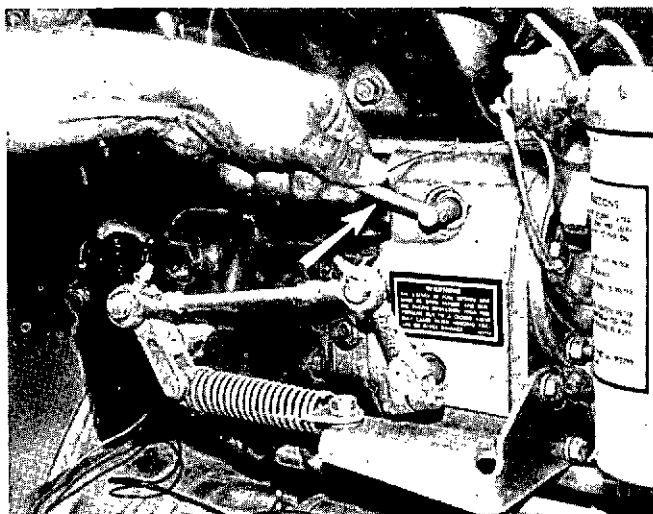
### Woodward UG8 Governor:

Turn the load limit knob to "0".



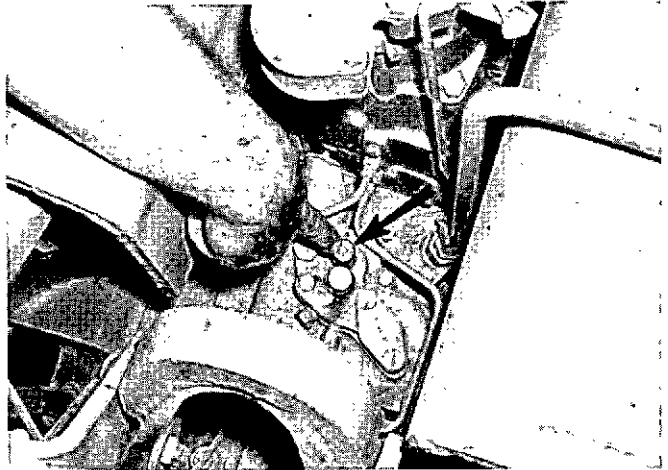
### Woodward PSG Governor:

Move the lever forward against the stop; hold the lever until the engine is stopped.



### Mechanical Safety Shutoff Control:

Push and hold the emergency stop button momentarily to allow the overspeed mechanism to trip and start slowing the engine.

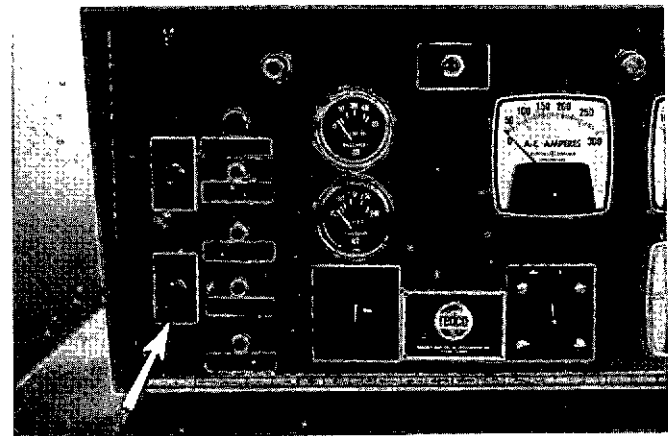


### CAUTION

This button has a skirt. Do not confuse it with the reset button which is flat. Use this mechanical shutoff button for emergencies only. Do not use it for normal stopping.

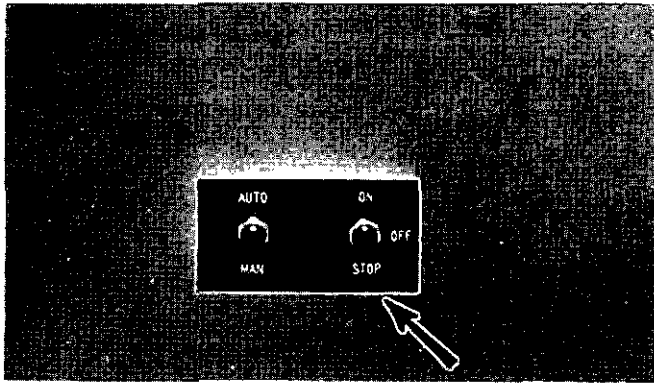
### Electric Shutoff Solenoid:

Push and hold the ON-OFF-STOP switch in the STOP position until the engine stops.



### Air Controls:

Push and hold the ON-OFF-STOP switch in the STOP position until the engine stops.



## EMERGENCY SHUTOFF DEVICES AND ALARMS

Emergency shutoff devices are either electrically, mechanically or hydraulically operated. Familiarize yourself with the types and locations of the shutoff devices, the conditions which cause each control to function, and the resetting procedure required to start your engine.

### CAUTION

Always determine the cause of the shutdown, and have the necessary repairs made before restarting the engine.

Emergency shutoff controls are for emergency use only. Do not use an emergency shutoff device for a normal stopping procedure.

## ELECTRIC SHUTOFF CONTROLS

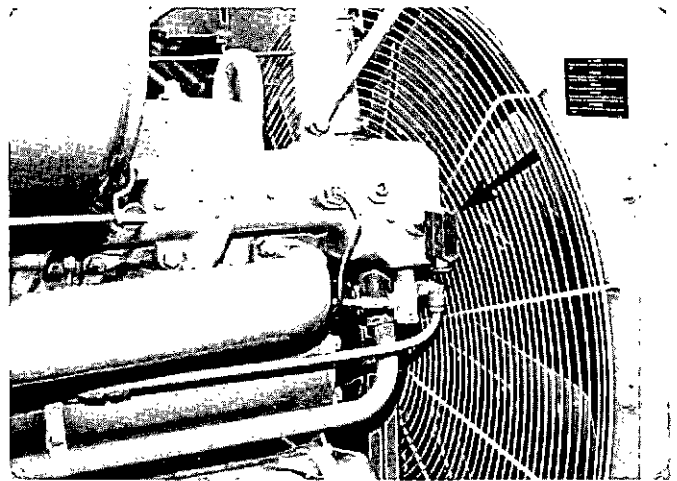
The operation of all electric shutoff controls is similar: A critical operating condition actuates a switch in the sensing unit. The switch closes the circuit to the shutoff solenoid which moves linkage to bypass the fuel to the cylinders; thus stopping the engine. The shutoff control may require resetting before the engine can start.

### High Water Temperature Shutoff:

The shutoff switch is located in the water temperature regulator housing. Excessive water temperature closes the switch. No resetting procedure is required: As the coolant cools, the switch opens.

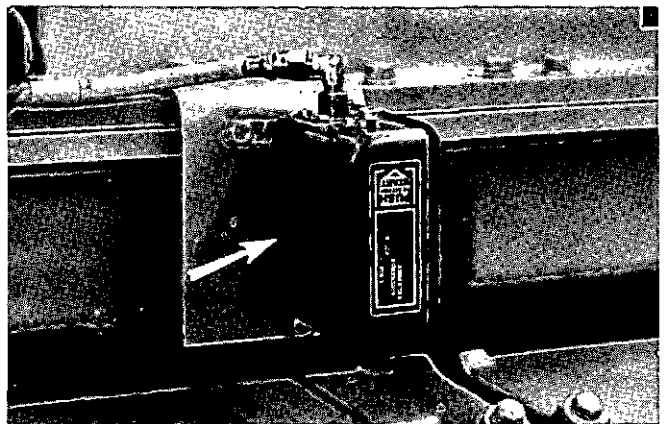
### CAUTION

The sensing element must be submerged in the coolant to operate. A low coolant level cannot actuate the shutoff.



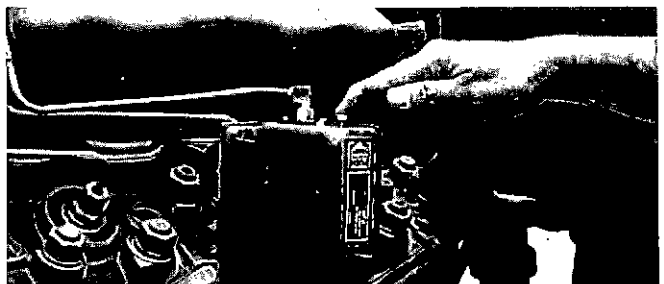
### Low Oil Pressure Shutoff Switch:

This device is usually mounted on the side of the engine with oil lines connected to the switch. Low oil pressure closes the switch.



Manually operated systems require resetting of this switch before starting. Automatic start-stop systems use a pressure switch which resets itself.

To reset the switch, push the button until it latches. After the engine starts and develops oil pressure, the oil pressure will push the button to the extended running position.



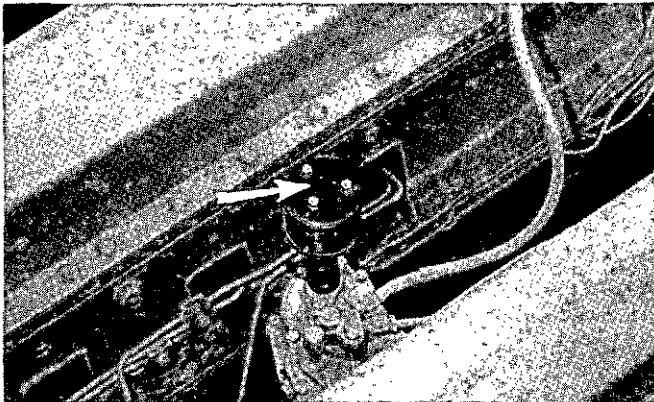
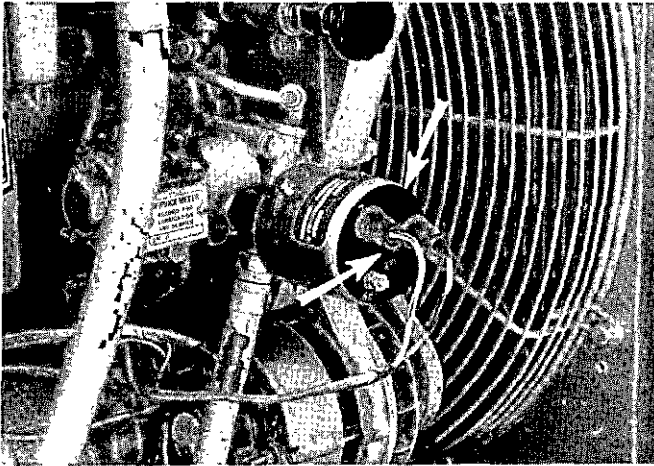
### CAUTION

The engine will not be protected if the engine is operated with the button latched in the START position.

If the button remains in the reset position, the engine oil pump is not developing normal oil pressure and a check should be made.

### Overspeed Shutoff Switch (Electro-Mechanical):

This switch is mounted either on the tachometer drive or on the governor. Excessive engine speed closes a switch by centrifugal force.



TWO INSTALLATIONS OF OVERSPEED SWITCH

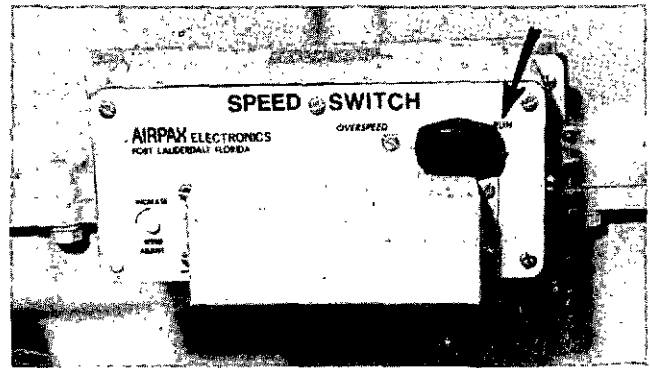
To reset the switch, push the button marked RESET. The knob will remain down until the engine overspeeds.

### Overspeed Shutoff Switch (Electronic):

This switch is a magnetic pick-up which is mounted on the flywheel housing and senses engine speed. The control box is mounted on the engine block. Excessive engine speed closes a circuit breaker. To reset the switch, push arm of breaker to the run position.

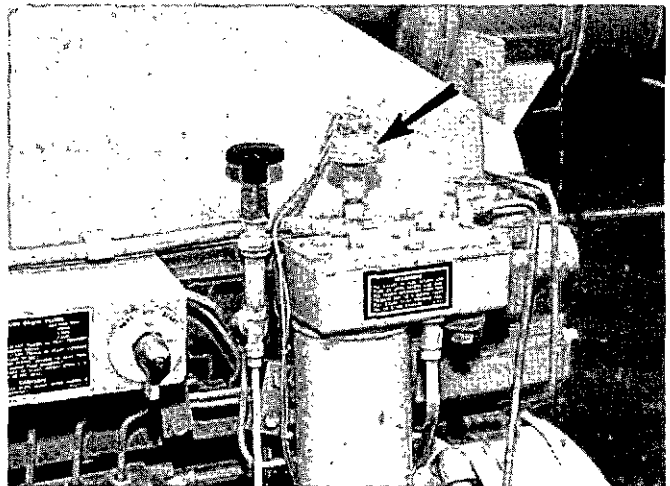
#### CAUTION

This switch will not provide overspeed protection if there is no power to the control box.

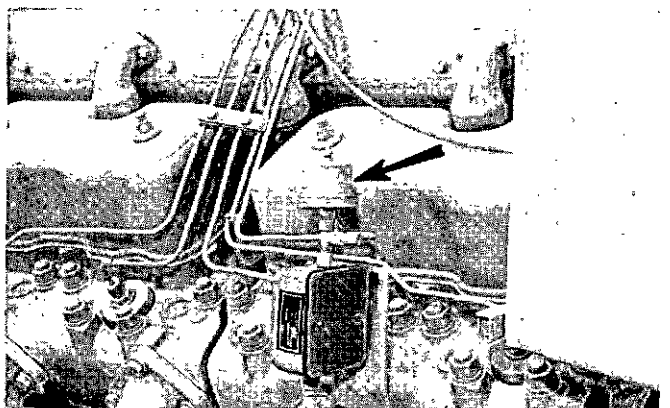


### Fuel/Oil Pressure Switch:

This switch is mounted in the fuel manifold between the clean side of the fuel filter and the fuel injection pump housing. Low fuel pressure (below 3 psi) opens the switch and the electrical circuit to either the shut off solenoid or the circuit between the alternator and the alternator regulator. Opening of these circuits prevents the battery from becoming discharged while the engine is stopped.



This switch can also be used with an electric governor. In this application, oil pressure closes the switch to allow the electric governor to control engine speed.

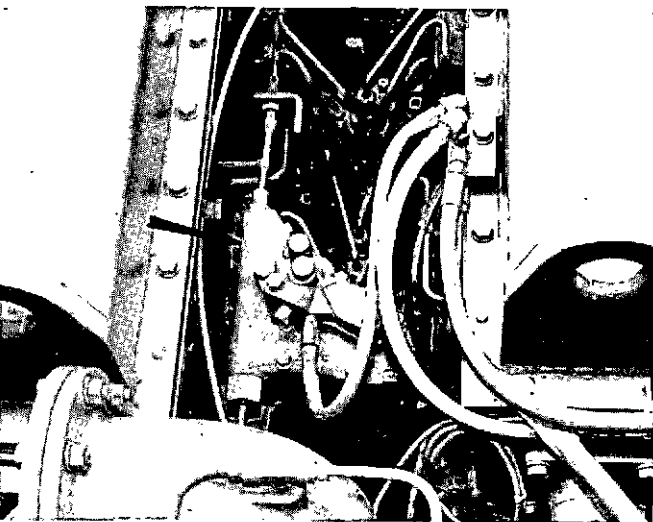
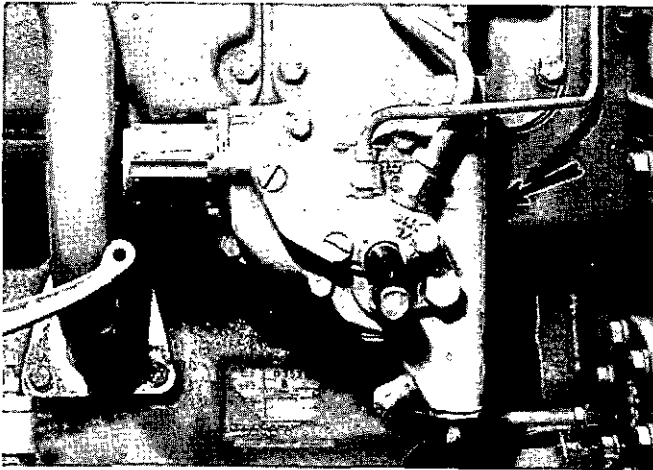


This switch does not require resetting.

## MECHANICAL SAFETY SHUTOFF CONTROL

The mechanical safety shutoff is both a low oil pressure and an overspeed shutoff device. A high water temperature shutoff can be installed which uses the low oil pressure shutoff device to stop the engine.

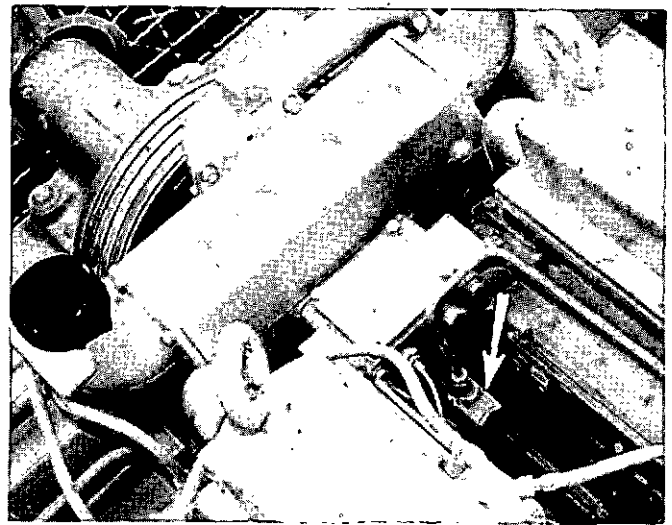
On 6 cylinder engines, the mechanical shutoff is mounted on the side of the engine. On vee engines, the shutoff is mounted in the vee of the engine between the two banks of cylinders.



The high water temperature shutoff is installed in the temperature regulator housing of all engines.

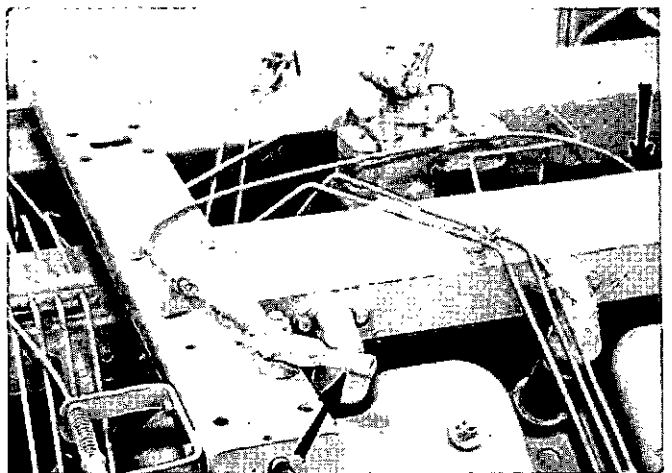
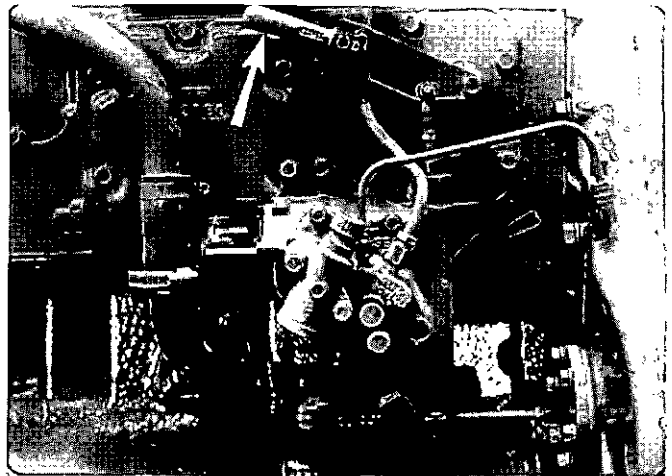
If an overspeed, low oil pressure, or high water condition occurs, a spring loaded rod is mechanically tripped internally, which moves and holds the rack in the shutoff position.

Difficult starting with long periods of cranking can trip the low oil pressure shutoff. The reset lever must be moved and latched in the run position before starting can be accomplished. Normal stopping of the engine will not trip the shutoff device.



The basic cause for the shutdown can be determined by the manner in which the shutoff must be reset:

1. Push the reset lever (or handle).

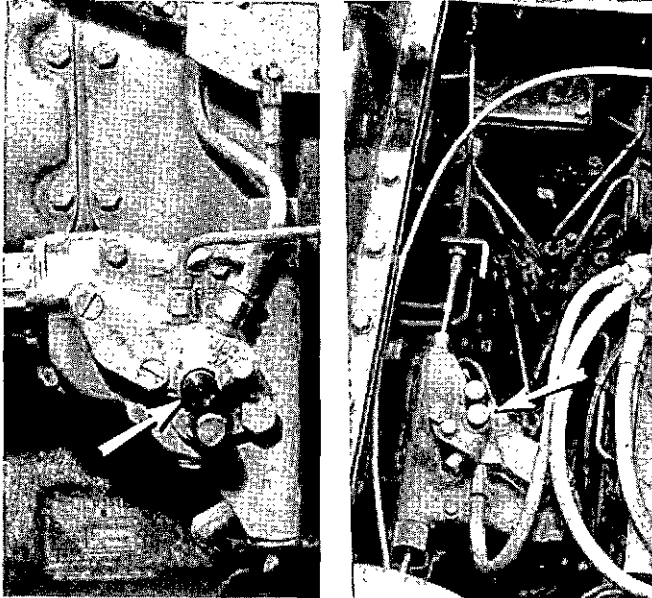


If the rod latches, an overspeed condition stopped the engine. Investigate the cause for overspeed condition.

If the rod does not latch, the engine was stopped because of a low oil supply to the shutoff control. This could

be caused by either low engine oil pressure, or by the high water temperature shutoff bypassing the oil to the mechanical shutoff. Therefore, perform checks for both low oil supply and high water temperature. Reset the control by the following steps:

1. Push the reset button firmly.

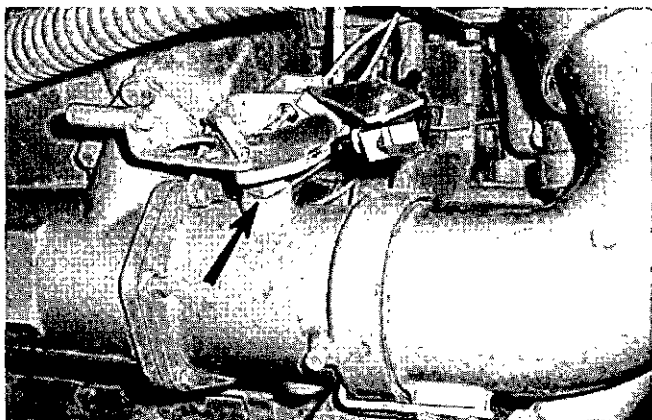


2. Push the reset lever (or handle) until the rod latches.

If the reset lever does not move freely, check the reset cable for kinks, binds, or lack of lubrication. Make needed repairs or adjustments.

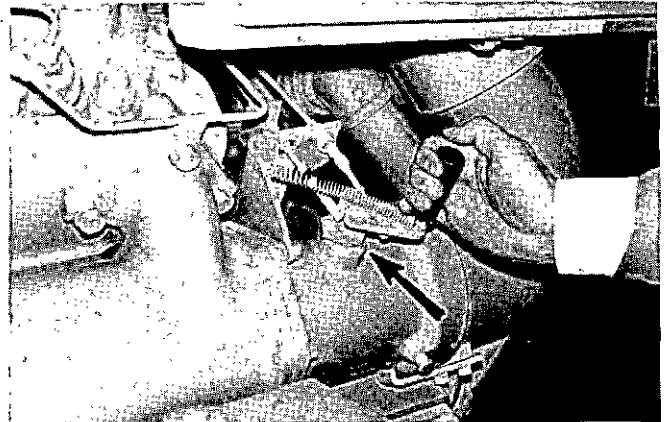
### AIR SAFETY SHUTOFF CONTROL

The air shutoff control is an attachment to the mechanical safety shutoff device installed on large bore vee type engines. When an emergency condition occurs, the mechanical shutoff pushes the rack into the shutoff position and pulls a butterfly valve, located in each inlet manifold, to the closed position. The air safety shutoff control must be reset before starting.

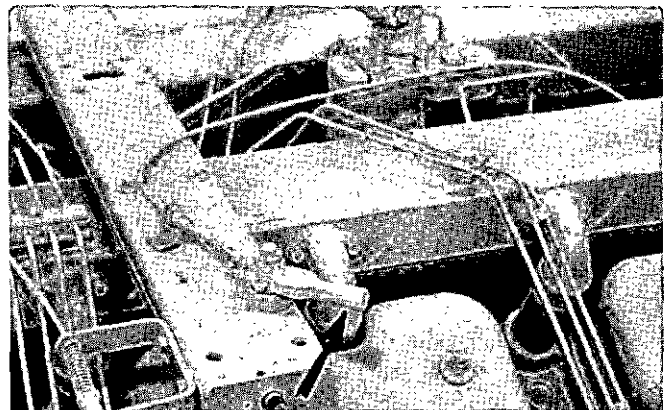


If an overspeed condition shut the engine down:

1. Pull the air shutoff reset lever on the air inlet manifold to the RESET position.

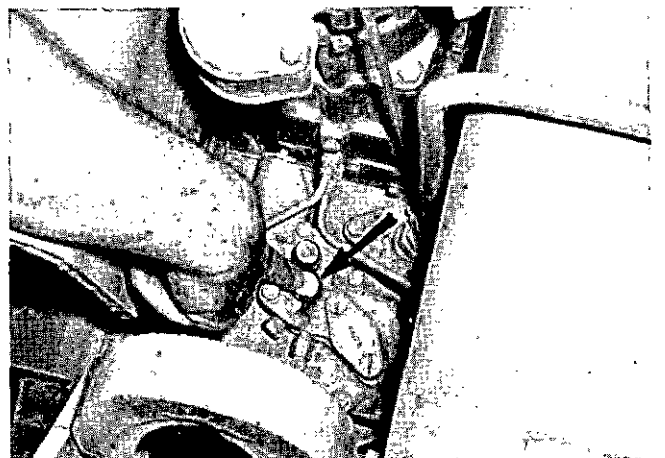


2. Release the lever. The lever should move slightly and then latch in the RUN position.
3. Push the mechanical shutoff reset lever until the rod latches.

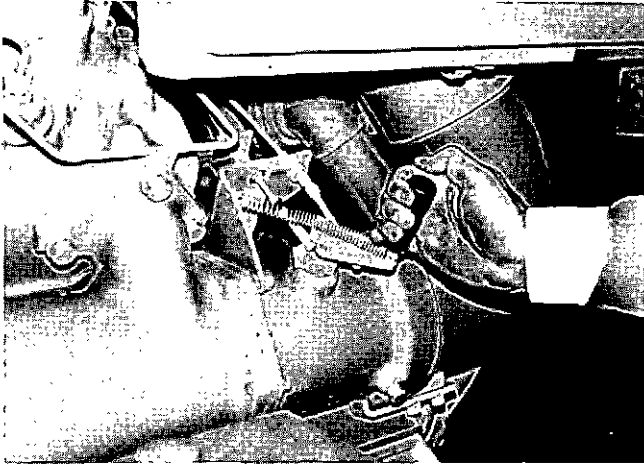


If a low oil pressure or high water temperature condition shut the engine down:

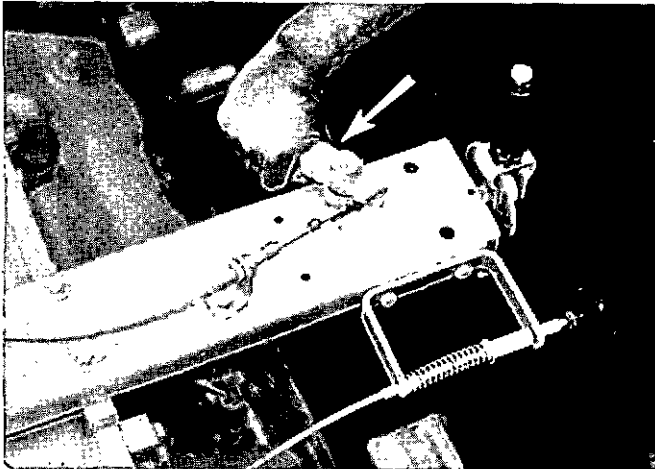
1. Firmly push the reset button in the vee of the engine.



2. Pull the air shutoff reset handle on the air inlet manifold to the RESET position.



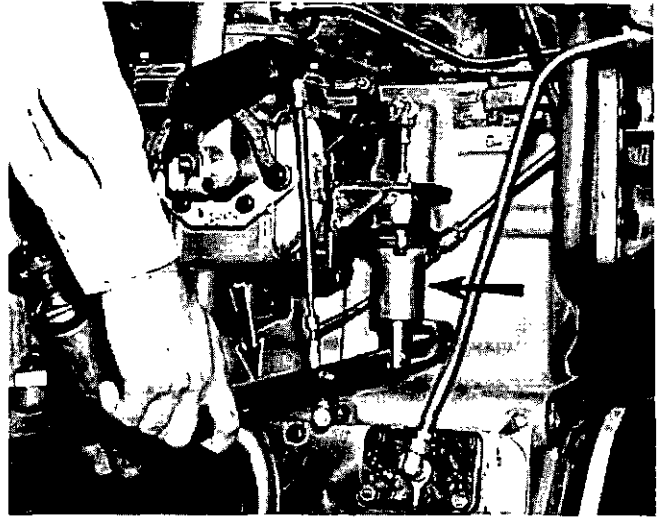
3. Release the lever. The lever should move slightly and latch in the RUN position.
4. Push the mechanical shutoff reset lever until the rod latches.



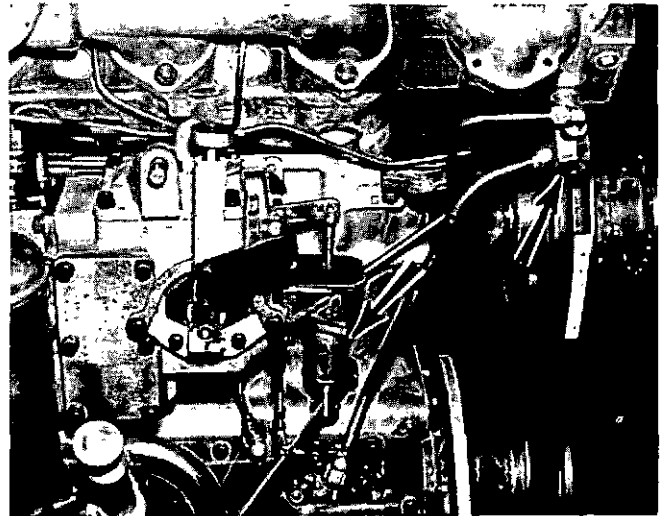
## HYDRAULIC SHUTOFF CONTROLS

The hydraulic shutoff control is mounted on (or near) the governor. When oil pressure drops below 8 PSI, the fuel injection pumps bypass the fuel to the cylinders.

To start the engine, move and hold the reset lever against the stop while cranking the engine. After the engine starts, the lever will stay in the running position. Manually reset the control each time the engine is stopped.



A high water temperature shutoff can be used with this shutoff control. Excessive coolant temperature causes the temperature sensor to open a dump valve which empties the pressure oil from the low oil pressure shut off device. The low oil pressure shutoff control shuts down the engine.



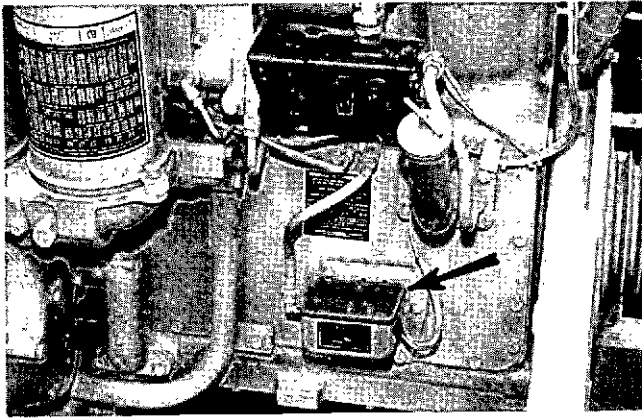
Reset the oil pressure control as instructed above. Allow the water sensor to cool: No resetting of the water temperature shutoff switch is required.

## CAUTION

The water temperature sensor must be submerged in the coolant to operate. A low coolant level, or a failed water pump cannot actuate the shutoff.

## ALARM SWITCHES

Alarm switches are set at a less critical temperature, pressure, or level limit than the comparable shutoff control. The purpose of the alarm switch is to warn the operator an unsafe operating condition is starting to occur, and that corrective measures should be taken to avoid possible damage to the engine and/or a possible shutdown of the engine.



**LOW OIL PRESSURE ALARM SWITCH**

**CAUTION**

It could be hazardous to have the engine stop unexpectedly when engine power is needed. However, if the engine overspeeds, the engine should be stopped immediately.

When the preset temperature, pressure or fluid level occurs, the sensor of the alarm switch will move and close an electrical circuit. Either a light or an audible alarm will be energized. The light or alarm will continue to operate until the condition is corrected. When the condition is corrected the alarm will automatically reset and the light will turn off.

**CAUTION**

The cause of the shutdown must be investigated and corrected before starting and operating the engine.

**Alarm Shutoff Switch:**

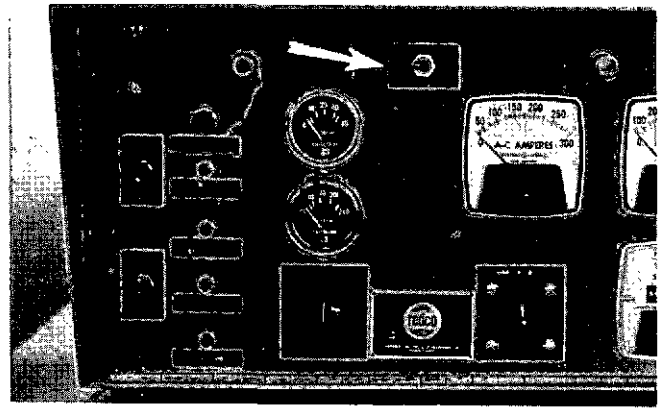
A switch may be installed in the alarm circuit for silencing the alarm while the engine is stopped for repairs. Be sure the switch is moved to the closed (ON) position and the warning lights are lit before starting.

**CAUTION**

If the switch is left in the open (OFF) position when the engine is started, the engine will not be protected.

**Testing Indicator Lights:**

Most control panels are equipped with a test switch. By turning the switch ON, all of the indicator lights can be checked for proper operation. Test the indicator lights periodically, replace burned out light bulbs immediately.



**TESTING SHUTOFF DEVICES AND ALARMS**

Have all shutoff controls and alarms on the engine checked twice a year by your Caterpillar dealer.

It is important that these controls function properly. Their operating condition can only be checked by simulating extreme operating conditions under controlled testing procedures. To avoid damage to the engine, only authorized personnel should conduct these checks.

**DETERMINING CAUSE OF SHUTDOWN**

**CAUTION**

If the engine has been shutdown by a safety device, do not start the engine and place it into service without having the cause of the shutdown investigated and corrected.

**Low Oil Pressure Checks:**

If the low oil pressure shutoff control has stopped the engine, make the following checks:

1. Check the water temperature gauge. Determine if the engine was overheated. Check for external water leaks.



**WARNING**

Beware of steam or scalding water. Do not attempt to loosen the radiator cap until the temperature gauge indicates the coolant has sufficiently cooled. Then, loosen the cap slowly.

2. Check the oil level. Oil level must be between the ADD and FULL marks on the side of the dipstick stamped CHECK WITH ENGINE STOPPED.

3. If the oil level is below the ADD mark, check for oil

spray and/or oil accumulations. If any are found, have the necessary repairs made. Before starting, add oil to the FULL mark.

4. Reset the shutoff control.
5. Remove the load and start the engine at its slowest speed. Be prepared to shut the engine down manually.
6. Be alert for unusual sounds or noises. If the engine knocks, stop the engine immediately and call your Caterpillar dealer.
7. If the engine blows excessive black exhaust or has excessive crankcase blow-by, the engine may need reconditioning. Stop the engine and call your Caterpillar dealer.
8. If the engine runs satisfactorily, observe the oil pressure gauge. If satisfactory pressure is not indicated, shut the engine down; call your Caterpillar dealer.
9. If proper oil pressure is registered, check to see if the reset knob has moved to the run position. If the knob does not move, stop the engine. Check the shutoff control, the oil line, and the oil pressure gauge. Have necessary repairs made.
10. If the oil pressure gauge registers normal oil pressure, if the knob on the shutoff control moves to the run position, and if the engine operation is otherwise satisfactory, determine if the high water temperature shutoff may have shut down the engine.

#### High Water Temperature Checks — Engine Running:

1. Determine if the load was too great for the engine: Reduce the load and allow the engine to cool while running.
2. If pressure steam or water leaks are visible, remove the load and stop the engine. Have necessary repairs made.
3. Check for collapsing or deteriorated water hoses. Have repairs made.
4. Check for noisy water pump operation. Have necessary repairs made.
5. Refill the cooling system with a solution of water and permanent type antifreeze if below freezing temperatures are expected; or with a solution of approved

water and Caterpillar Corrosion Inhibitor. Follow the instructions on the container.



#### WARNING

**DO NOT** remove the pressure cap on an overheated engine. The coolant is under pressure and relieving the pressure will cause the coolant to flash into steam. Serious flash burns and engine damage can result. If necessary, reduce pressure in a surge tank by pouring warm water on top of the tank. Never add cold water to a hot engine.

#### NOTE

If there is adequate coolant in the cooling system, gradual cooling is preferred by running the engine at half speed. This eliminates hot spots in the engine, and possible failure.

#### High Water Temperature Checks — Engine Stopped and Cold:

1. Check coolant level. Determine if the coolant has proper antifreeze protection. A 50–50 solution of permanent type antifreeze and approved water will give protection below  $-20^{\circ}\text{F}$  ( $-29^{\circ}\text{C}$ ).
2. Check to be sure the raw water valve has been opened.
3. Check water pump drive belts for proper tension; see the LUBRICATION AND MAINTENANCE PROCEDURES topic, Fan Belts.
4. Check engine room vents and/or louvers. Be sure the engine is receiving sufficient air.
5. Be sure temperature regulators are operating at proper temperature range.
6. Inspect all water hoses carefully for collapsing, external and internal failures. Replace hoses as required.
7. Have the cooling system cleaned.

#### CAUTION

If severe or prolonged overheating has occurred, contact your Caterpillar dealer to have your engine checked for possible damage.



# ELECTRIC SET OPERATION INSTRUCTIONS

## GENERAL

Proper engine operation and maintenance are essential to long engine life and maximum performance. The essentials for proper operation and normal periodic maintenance are outlined in this guide. However, your Caterpillar dealer is available for troubleshooting and/or repairs when required.

Before starting the engine, familiarize yourself with these procedures. Even though your engine may not be equipped with the exact attachment illustrated, the operating procedures will be similar.

This guide contains information for Caterpillar Statically Regulated Controlled Rectifier (SRCR) and SR 4 generators. Caterpillar SR 4 refers to the brushless type generators. Study the guide carefully and apply the principles to your particular installation.

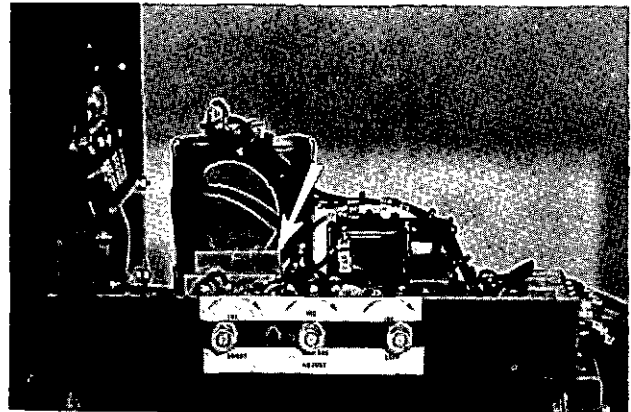
### SAFETY PRECAUTIONS

You can do something about safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all—loss of life.

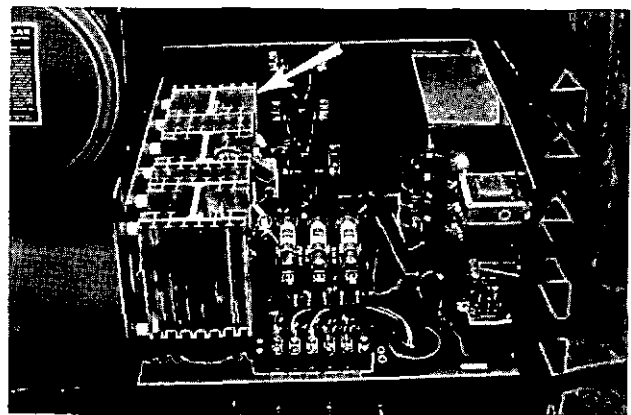
Safety is basically common sense. There are standard safety rules but each situation has its own peculiarities which cannot always be covered by rules. Therefore, your experience and common sense will be your best guides to safety. Watch for safety hazards. Correct deficiencies promptly.

Use the following safety precautions as a general guide to safe operation.

1. Observe NO SMOKING signs.
2. Do not wear loose clothing around machinery.
3. Be sure the engine room is properly ventilated.
4. Do not smoke around batteries. Hydrogen gas generated by charging batteries is explosive. Keep batteries in a well ventilated area.
5. All electrical equipment must be grounded according to local building codes.
6. Remove tools and electrical cords from the engine before starting.
7. All fans, shafts, pulleys, etc. must have guards.
8. Check all connections periodically for tightness and insulation.
9. Never adjust or repair a machine while in operation.
10. Never operate a diesel engine with the governor linkage disconnected. Human reactions are not fast enough to control the fuel rack.
11. Do not touch the heat sink on the generator regulator when the generator is running. It is electrically "hot".
12. Always disconnect and tape the ground battery lead before working on the electrical system.
13. Be sure the remote starting system is inoperative when the engine is being worked on. Disconnect the starter from the start switch.
14. Always disconnect the engine starter circuit when working on the generator.
15. Keep the engine room and floor area clean.
16. Store oily rags in metal covered containers.
17. Never store flammable liquids near the engine.



HEAT SINK (SR 4)



HEAT SINK (SRCR)

- 18. Insulate all connections and disconnected wires.
- 19. Do not use carbon tetrachloride fire extinguishers. Fumes are toxic and the liquid has a deteriorating effect on insulation.
- 20. Do not work on electrically "hot" equipment.



REMOVE SHIPPING SCREWS BEFORE STARTING  
(SRCR ONLY)

## IDENTIFICATION

### Voltage Setting

Generators are set at the factory for the voltage and type of operation specified. Voltage control initial adjustment instructions are located inside the generator exciter and regulator access cover. These instructions are for adjusting the generator output to nameplate ratings. For further adjustments, see page 5 for single and parallel unit operation.

### Generator Serial Number

The engine serial number is stamped on the engine information plate and on a plate on the left side of the block toward the rear. The generator serial number is stamped on the generator nameplate and on the right side of the generator frame forward of the terminal box. Requests for information and orders for parts should be accompanied by the engine and generator serial numbers.

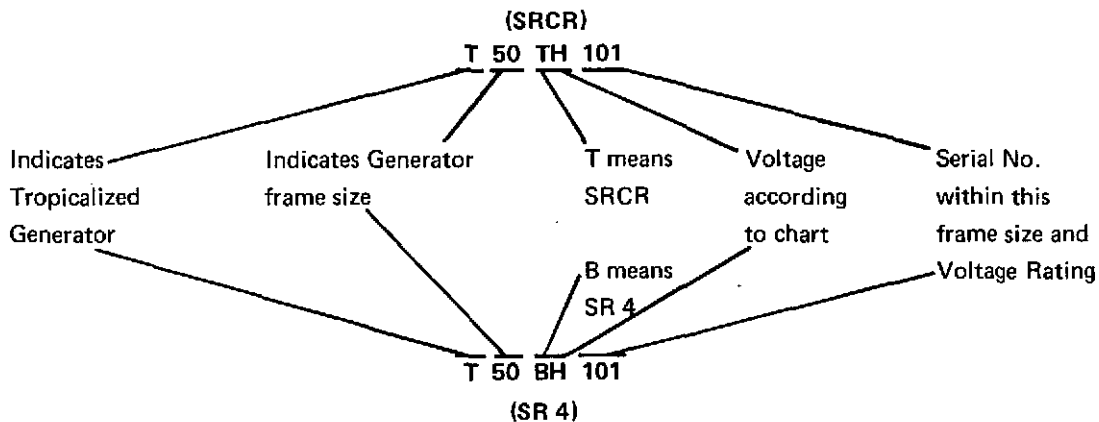
1. The group of numbers before the letters indicates generator frame size. The letter T may appear before the first group of numbers. This indicates a "tropicalized" generator, that has been dipped in epoxy to prevent moisture entrapment in windings.
2. The letter T is the symbol for Caterpillar Statically Regulated Controlled Rectifier generators. The letter B is the symbol for Caterpillar Statically Regulated Brushless Excited generators.
3. The next letter indicates the voltage rating of the generator as follows:

#### SRCR

L	115-230 volts .....	60 Hz
	125-250 volts—Single Phase .....	60 Hz
H	230-460 volts .....	60 Hz or
	125-216 volts .....	60 Hz or
	200-400 volts .....	50 Hz
G	287-575 volts .....	60 Hz or
	230-460 volts .....	50 Hz
N	2400 volts .....	60 Hz

#### SR 4

L	120-240 volts .....	60 Hz or
	125-250 volts—Single Phase .....	60 Hz
S	208-416 volts .....	60 Hz
H	240-480 volts .....	60 Hz or
	200-400 volts .....	50 Hz
G	300-600 volts .....	60 Hz or
	240-480 volts .....	50 Hz

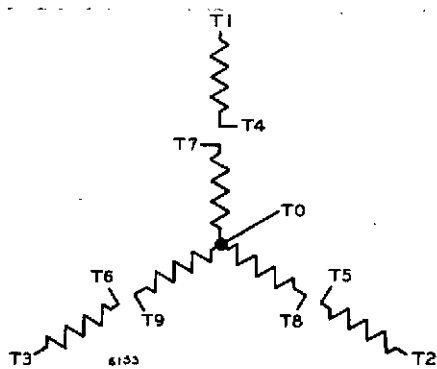


- The last group of numbers are the actual serial numbers of the generator in the frame size and voltage rating. Always use the complete serial number.

### Generator Lead Numbering

Each coil lead is marked according to the following diagram.

Numbering is clockwise from the top and from the outside in. Terminal **T0** is the neutral lead on all high voltage connections. On low voltage connections **T0** is connected with **T4**, **T5**, and **T6** to form the neutral terminal. The standard generator diagram and the terminal connections are on the nameplate of each generator.



### THREE PHASE NEUTRAL CONNECTIONS

#### Single Units

**Three Wire:** In a three phase, three wire system, the generator should normally be grounded according to local wiring codes. In some cases, however, it is undesirable to ground the neutral wire. For example, on boats a grounded neutral may increase the problem of electrolysis. In applications where definite measures are taken to prevent grounds to the load leads, an ungrounded neutral can be used. Be sure to check your local wiring codes.

**Four Wire:** In a three phase, four wire system, the neutral wire should be grounded according to local wiring codes. For only single unit operation, there should never be a need for a disconnect switch, or device, in the neutral line.

### Multiple Units

Operation of multiple generators in parallel, having all neutrals grounded, may result in current circulating through the neutral connections. To eliminate the possibility of circulating currents, ground the neutral of only one generator. If multiple generators are alternated on line, a single pole single throw knife switch should be installed in the neutral ground circuit of each generator, so all but one neutral ground circuit can be opened. Be sure one neutral ground circuit is closed.

### VOLTAGE CONNECTIONS

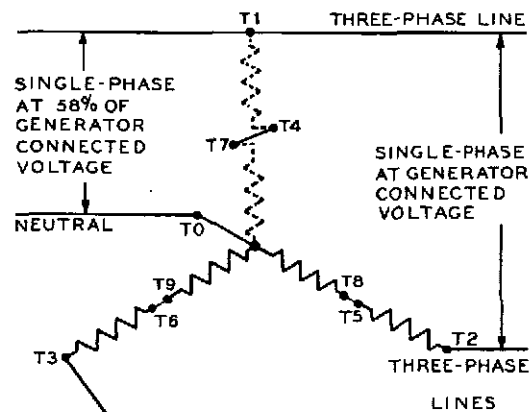
#### Three Phase

The connections for both high and low voltage are given in the following chart.

The terminals must be connected securely and insulated with a good quality electrical tape.

REQUIRED VOLTAGE	CONNECT LINE LEADS TO			NEUTRAL	CONNECT
3 Phase High Voltage	T1	T2	T3	T0	T4 to T7 T5 to T8 T6 to T9
3 Phase Low Voltage	T1 & T7	T2 & T8	T3 & T9	T4, T5, T6 & T0	T4, T5, T6 & T0 For Neutral

#### Single Phase Current From A Three-Phase Generator



Three phase and single phase current can be taken simultaneously from a generator connected for three phase service. Connecting any two of the three phase leads will provide single phase current at the same voltage as three phase power. Connecting a three phase lead to neutral will produce current at 58% of the three phase voltage. DO NOT exceed the nameplate current rating for any one phase.

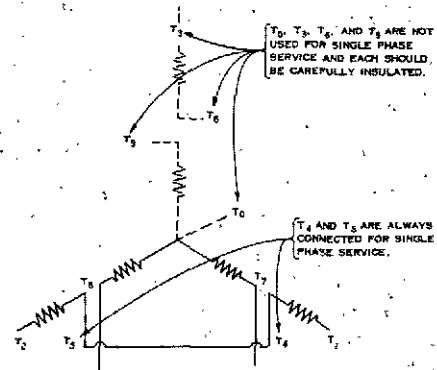
### Single Phase

When a generator is connected for single phase operation, do not exceed these limits:

1. The nameplate amperage limits.
2. Fifty-eight percent of the KVA and KW ratings. (The engine will only work about half as hard.)

Three phase (230-460V and 115-230V for SRCR) and (240-460V, 125-250V and 208-416V for SR 4) generators can be connected for two or three wire service at either voltage. When generators are connected for three wire ser-

vice both high and low voltages may be obtained simultaneously without reconnecting the leads. In this case DO NOT ground T0. Generator neutral is not T0 but a point in the windings electrically half way between T1 and T8. This point is not wired to a terminal.



To reconnect the generator for single phase voltage follow the chart. Wrap all connections and unused terminals with a good grade of insulation.

REQUIRED VOLTAGE	CONNECT LINE LEADS TO			CONNECT	TAPE INDIVIDUALLY
Single-Phase 2 Wire Low Voltage	T2&T8		T1&T7	T4&T5	T3 T6 T9 T0
Single-Phase 3 Wire Low/High Voltage	T2	T1&T8 Neutral	T7	T4&T5	T3 T6 T9 T0
Single-Phase 2 Wire High Voltage	T2		T7	T1&T8 T4&T5	T3 T6 T9 T0

## ELECTRIC SET OPERATION

### Generator Loading

A three phase load is usually balanced and presents no problem when kept within the amperage limits. However, single phase power taken from a three phase source can be a problem unless the single phase loading is equally distributed.

When a generator is installed or reconnected, be sure the total current in one phase does not exceed the nameplate rating. Each phase should carry the same load, allowing the engine to work at its rated capacity. An electrical unbalance can result in an electrical overload and overheating if one phase exceeds the nameplate amperage.

## Power Factor

Power factor may be thought of as the efficiency of the load — the ratio of apparent power to total power. Power factor is expressed as a decimal and denotes that portion of current supplied to a system doing useful work. The portion of current not doing useful work is absorbed in maintaining the magnetic field in motors. This current, although it is called the reactive load, does not require engine horsepower to maintain it. The only horsepower consumed in a reactive load is used to start motors. This is the inrush or starting current.

In most applications electric motors and transformers determine the power factor of the system. Induction motors usually have a .8 power factor. Incandescent lighting is a resistive load of about 1.0 power factor, or unity.

The power factor of a system may be determined by a power factor meter or by calculations. Determine the power requirement in KW by multiplying the power factor by the KVA supplied to the system. As the power factor goes up the total current supplied to a constant power demand will go down. A 100 KW load at .8 power factor will draw more current than a 100 KW load at .9 power factor. A higher power factor increases the possibility of overloading the engine. A lower power factor increases the possibility of overloading the generator.

## Low Idle Adjustment

Electric sets require higher low idle setting than do industrial engines. Low idle must not be below 2/3 the full load speed of 60 Hz units (4/5 full load speed of 50 Hz units).

### CAUTION

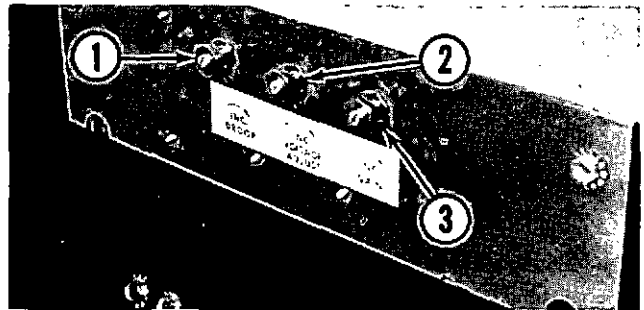
Disconnect the exciter circuit by removing fuses F1 and F2 (on SRCR) or Fuse F1 (on SR 4) before operating the engine below the low idle rating. Failure to do this will result in generator damage.

On electric sets with Woodward governors, there is no low idle stop. On electric sets with mechanical governors and natural gas electric sets, the low idle is set at the factory, and should only be adjusted by your Caterpillar dealer if adjustment is required.

## SINGLE UNIT OPERATION

Final adjustments for a new installation are given here.

1. Remove the exciter regulator cover and loosen the locknuts on the voltage level, voltage droop and regulator gain controls.
2. Turn the voltage droop control counterclockwise to zero droop and tighten the locknut.



### VOLTAGE ADJUSTMENT CONTROLS

1. Voltage Droop 2. Voltage Level 3. Voltage Gain
3. Run the engine at full governed speed.
4. Using the voltage level control, adjust the open circuit (no load) voltage to equal nameplate voltage.
5. Apply rated load and adjust the governor control for rated speed.
6. Adjust the regulator gain control until the line voltage is equal to rated voltage at rated load.
7. Allow the electric set to operate about one hour until temperature in the generator has stabilized.
8. Repeat steps 4, 5 and 6.
9. Tighten the locknuts on the voltage level and regulator gain controls, and install the exciter-regulator assembly access cover.

The electric set is now properly adjusted for single unit operation.

## PARALLEL OPERATION

Preparing a generator for parallel operation requires special attention. Before attempting to parallel units for the first time, all units must be checked to be sure the following three conditions are met:

1. Same phase rotation.
2. Same speed capabilities.
3. Same voltage characteristics.

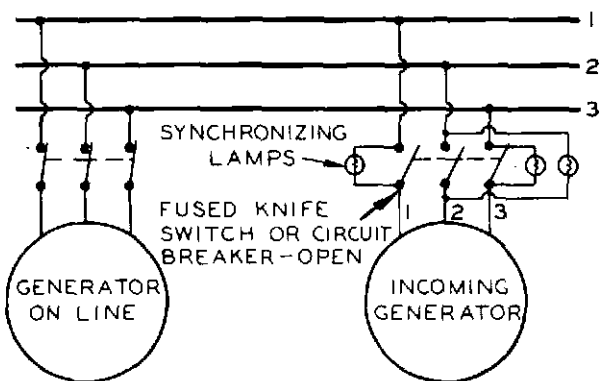
These three conditions may be compared to similar conditions required for engagement of two gears. To mesh as smoothly as possible, two gears must meet the following three conditions:

1. Correct rotation.
2. Same rotation speed.
3. The tooth of one segment must fit the root of the engaging segment.

### Phase Rotation

The phase rotation must be the same. A set of three light bulbs is used to determine whether the phase rotation of the incoming unit and the phase rotation of the line are the same.

1. Connect the light bulbs between the generator leads and the corresponding line phase, i.e. terminal 1 to line 1 across the open circuit breaker.
2. Start the units to be paralleled and bring them up to speed. As they approach the same speed the lights will start to blink.



SYNCHRONIZING LIGHTS

- a. If the lights blink in sequence one of the units is connected backward. To correct this remove generator leads 1 and 3 at the circuit breaker and exchange them. This reverses the direction of phase rotation. Line 2 should always be connected to line 2.

### WARNING

Never attempt to work on electrically hot wiring. Stop the electric set before rewiring generator leads. Open circuit breakers before working on the equipment which they control.

- b. If lights blink in unison the phase rotation of both engines is the same, and condition 1 has been met.

### Engine Speed

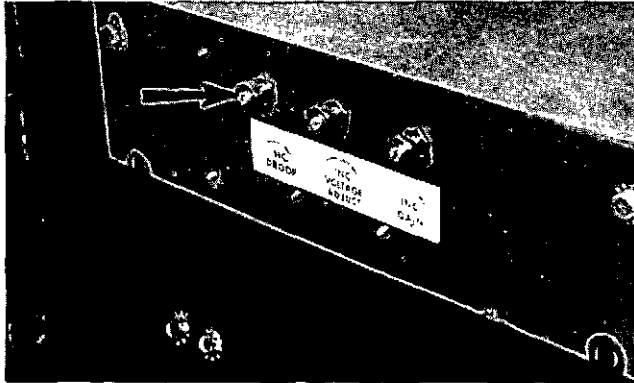
The speed of units to be paralleled must be the same. Speed refers to the alternating current frequency.

1. Allow each electric set to run under load long enough for the internal temperatures to stabilize (about one hour).
2. Adjust the governor control to give rated frequency at full load.
3. Remove the load and check the high idle speed; it should be approximately 3% above full load speed. If these speeds can not be obtained, contact your Caterpillar dealer.
4. For the most consistent results repeat steps 2 and 3. Condition 2 has been met.

### Voltage Adjustment

The voltage level and voltage droop adjustments determine the amount of circulating currents between generators. Carefully matched voltage regulator adjustments will reduce the circulating currents. Adjustments to the voltage droop control should be made to give a 2% droop for load of unity power factor (load composed primarily of lighting). Loads of .8 power factor (primarily motors) require a generator voltage droop of about 5%. Voltage droop is expressed as the percentage of voltage change from no load to full load.

1. Remove the exciter-regulator access cover and loosen the locknuts of the voltage level and droop controls and the regulator gain control.
2. Turn the droop control counterclockwise to zero.
3. Run the engine at high idle.
4. Adjust the open circuit voltage level to equal nameplate rated voltage.



#### DROOP ADJUSTMENT

5. Apply full load and adjust the governor control to the rated full load speed.
6. Adjust the regulator gain control to equal nameplate rated voltage at full speed.
7. Run the electric set at full load until internal temperatures have stabilized (about 1 hour) remove the load and repeat steps 4, 5, and 6.
8. Tighten the locknut on the regulator gain control.
9. With the engine running at high idle, turn the voltage droop clockwise about 1/4 of full range.
10. Readjust the voltage level control until the voltage is about 5% above rated voltage.
11. Apply full load at .8 power factor.

#### NOTE

If a generator is paralleled with other generators, the voltage droop of each generator must be the same to satisfactorily divide reactive load.

12. Readjust the voltage droop control to get rated voltage with full load at .8 power factor.
13. Repeat steps 10, 11 and 12 until line voltage is equal to nameplate rating at .8 power factor and open circuit voltage is approximately 5% above rated voltage.
14. Tighten the locknuts on all controls and install the access cover. Condition 3 has been met.

#### Starting Single Unit Operation

1. Make all preliminary engine starting checks.
2. Be sure the main or line circuit breaker is open.
3. Start the engine and allow it to warm up.
4. Close the main circuit breaker.
5. Apply the load. Do not try to apply full load in one move, rather apply the load in increments to maintain system frequency at a constant level.

#### Stopping

1. Remove the load in increments.
2. Open the circuit breaker.
3. Allow the engine to run for 5 minutes to cool.
4. Stop the engine.

#### Standby Electric Sets

Most standby units are automatic. They start, pickup the load, run and stop without an operator in attendance. Standby units can not change the governor control setting automatically. The throttle must be preset for the proper operation of that unit. Whenever the set is exercised or operated manually, be sure the throttle setting is correct for automatic operation. Check all switches to see they are properly set: Start Selector Switch in AUTOMATIC position and any Emergency Stop Switches in RUN position.

#### MULTIPLE UNITS

**STARTING** – Units are started the same as single units. See page 5, steps 1 – 3.

## Paralleling

Units may be paralleled at no load or paralleled with units under load. To parallel two or more units the following conditions must be met:

1. Same phase rotation.
2. Same voltage level.
3. Same voltage droop.
4. Same frequency.
5. Voltages must be in phase.

The first three conditions have been met in the parallel operation. See page 5.

1. Start the unit to be paralleled according to the procedure in the engine operation section.
2. Turn the synchronizer lights on.
3. After the engine has run long enough to warm up, bring it up to synchronous speed (the same frequency as the unit on the line). The synchronizing lights will begin to blink.
4. Using the governor control adjust the speed until the lights blink very slowly.
5. The lights are off when the voltages of the two units are in phase. At this point very quickly close the breaker while the lights are out.

### NOTE

The frequency of the incoming unit should be slightly greater than the line frequency. This will allow the incoming unit to assume some of the load rather than add to the system load.

## Circulating Currents

When two units are paralleled there will be circulating currents. These currents are not doing useful work, but are flowing between the generators. By determining the total generator amperage and subtracting the amperage going to the load, the amount of circulating current can be determined.

Circulating currents are caused by voltage differences between the two units. As the oncoming generator warms up the circulating current will be reduced.

In a cold unit, circulating current may be as high as 25% of rated amperes without being considered harmful. Circulating current is part of the total generator current which must not exceed the rated amperage.

## Load Division

Once two units have been paralleled their share of the load is determined by the governor control setting. If two units of the same capacity and the same governor characteristics have the same governor control settings they will share the load equally.

To transfer the load from one engine to the other follow this procedure:

### NOTE

The total load must not exceed the capacity of the engine, or the engine will be overloaded.

1. Increase the governor speed control of the unit to the high idle position to assume the load.
2. Reduce the governor speed control of the outgoing unit until the generator amperage is at a minimum. (The amperage may never be zero due to circulating currents.) At this point transfer the load.

## Stopping

To remove a generator from the line do the following:

1. Check the load. It must be less than the rated capacity of remaining units.
2. Be sure the neutral of one of the remaining units is grounded.
3. Remove the load from the outgoing unit as described in LOAD DIVISION.
4. Open the circuit breaker.
5. Allow the engine to cool for 5 minutes.
6. Stop the engine.

## GENERATOR STORAGE

When a generator is stored for any length of time moisture condenses in the windings. Minimize the condensation by providing a dry storage space.

To remove moisture caused by high humidity or dampness, dry the generator by one of the following methods:

1. Place the generator in an oven and bake at a temperature not above 185°F (85°C) for four hours.

### CAUTION

If an oven is used for drying, use a forced air type rather than a radiant type. Radiant ovens can cause localized overheating.

2. Enclose the generator and heating lamps in canvas to raise the temperature. Leave an opening in the top for the moisture to escape.
3. Pass a low voltage current through the windings to raise the temperature of the windings to 185°F (85°C).

If there is a possibility the insulation resistance has deteriorated to a dangerously low level, contact your Caterpillar Dealer.

If a brush type generator (SRCR) is to be stored for a prolonged time, lift the brushes off the slip ring to prevent chemical action from damaging the slip ring.

# INDEX

	Section B Page		Section B Page
<b>C</b>			
Circulating Currents .....	8		
<b>D</b>			
Droop Adjustment .....	6		
<b>E</b>			
Engine Speed .....	6		
<b>G</b>			
General .....	1		
Generator Lead Numbering .....	3		
Generator Loading .....	4		
Generator Storage .....	9		
<b>I</b>			
Identification .....	2		
<b>L</b>			
Load Division .....	8		
Low Idle .....	5		
<b>M</b>			
Multiple Units			
Paralleling .....	8		
Starting .....	7		
Stopping .....	8		
		<b>N</b>	
		Neutral Connections .....	3
		<b>P</b>	
		Parallel Operation .....	5
		Phase Rotation .....	6
		Power Factor .....	5
		<b>S</b>	
		Safety Precautions .....	1
		Single Unit Operation .....	5
		Starting .....	5
		Stopping .....	7
		Standby Electric Sets .....	7
		<b>V</b>	
		Voltage Adjustments	
		Parallel Operation .....	6
		Single Unit .....	5
		Voltage Connections	
		Single Phase .....	4
		Three Phase .....	3



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# LUBRICATION AND MAINTENANCE CHART

## D379 INDUSTRIAL ENGINE

68B1616-UP

This LUBRICATION AND MAINTENANCE CHART lists those items commonly ordered on this engine which require servicing.

The time intervals are based on the numbers showing on the engine's service meter. Use the daily readings of the Service Meter to determine maintenance intervals. For those areas which require periodic maintenance which cannot be given a definite service hour, see the column "WHEN TO SERVICE".

Perform required maintenance at multiples of each unit. "EVERY 10" means perform that maintenance at 10, 20, 30, etc., service meter units. For items requiring service intervals of 125 through 1000 service meter units, service each item at multiples of the time indicated. After each 1000 units, repeat the sequence at the same interval. "EVERY 2000" means to service the item every 2,000, 4,000, 6,000, etc., hours or once each 12 months.

For items marked (\*) see "KEY TO FUELS, LUBRICANTS AND WATER" on Page C-3 of this chart. "Page" refers to the page number in the LUBRICATION AND MAINTENANCE PROCEDURES where the service procedure is detailed for that item.

SCHEDULED ITEM	MAINTENANCE	LUBE	PAGE
<b>FREQUENTLY DURING OPERATION</b>			
Observe all gauge readings. Determine the normal reading for each gauge. Note any change from the normal reading; then determine the cause and have necessary repairs made. See the OPERATION INSTRUCTIONS topic: Instrument Panel Gauges.			
<b>EVERY 10 SERVICE METER UNITS OR DAILY</b>			
ENGINE OIL LEVEL — observe dipstick with engine idling, oil hot:	Maintain oil level between the ADD and FULL marks on the dipstick.	CD*	A-1
ENGINE OIL FILTER SERVICE INDICATOR — observe indicator while engine is operating:	When indicator rises half the height of the window, change oil filter element.	—	A-3
AIR CLEANER INDICATOR — observe position of indicator piston:	If piston locks in "up" position, service the element.	—	B-1
FUEL TANK — fill:		*	C-1
WOODWARD UG8 GOVERNOR:	Maintain oil level between marks on sight glass.	CD*	C-6
COOLANT LEVEL — if filler cap must be removed, observe level with engine stopped and cold:	Maintain level in range above baffle plate and ½" (15 mm) below fill pipe.	*	D-1
— if equipped with water level gauge:	Maintain coolant level between ADD and FULL marks on gauge.	*	D-1
FRONT AND REAR CLUTCH SHIFT COLLAR — heavy duty application only:	Lubricate 1 fitting — 2 strokes.	MPGM*	G-1

SCHEDULED ITEM	MAINTENANCE	LUBE	PAGE
<b>EVERY 50 SERVICE METER UNITS</b>			
DUST COLLECTOR CUP — (two stage air cleaner):	Empty dust cup and clean tubes; may be required more often in dusty conditions.	—	B-3
ZINC RODS — (salt water operation only), inspect zinc:	If zinc deteriorates when tapped, install new rod.	—	D-6
<b>EVERY 125 SERVICE METER UNITS</b>			
FRONT OR REAR CLUTCH — SHIFT COLLAR — light duty service only:	Lubricate 1 fitting — 2 strokes.	MPGM*	G-1
CONTROL LEVER BEARINGS:	Lubricate — 2 strokes each.	MPGM*	G-1
PILOT BEARING:	Lubricate 1 fitting — 2 strokes.	MPGM*	G-1
MAIN SHAFT BEARING:	Lubricate 1 fitting — 2 strokes.	MPGM*	G-1
<b>EVERY 250 SERVICE METER UNITS</b>			
FAN AND ALTERNATOR BELTS — Check wear and belt tension:	Belts should deflect $\frac{9}{16}$ " to $\frac{13}{16}$ " (15-20 mm) @ 25 lbs. (11 kg) force.	—	D-5, F-4
BATTERY ELECTROLYTE LEVEL:	Maintain electrolyte level to base of each vent well.	—	F-2
<b>EVERY 500 SERVICE METER UNITS</b>			
RADIATOR FAN:	Lubricate 1 fitting, 2 strokes.	MPGM*	D-5
JACKET WATER COOLING SYSTEM:	Add cooling system inhibitor. Follow instructions on the container.	—	D-4
SRCR GENERATOR SLIP RINGS (2):	Check for discoloration, clean with electrical cleaning solvent.	—	G-2
SRCR GENERATOR BRUSHES:	Measure, install new brushes when less than $\frac{9}{16}$ " (15 mm).	—	G-3
<b>EVERY 750 SERVICE METER UNITS — 50 Gal. Crankcase Engines Only</b>			
ENGINE OIL AND FILTERS: Capacity: 50 Gals., 42 Imp. Gals., 189 Liters:	Change (See NOTE A).	CD*	A-1
ENGINE BREATHER:	Clean, use clean solvent.	—	A-2
<b>EVERY 1000 SERVICE METER UNITS OR 6 MONTHS</b>			
FUEL TANK:	Drain water and sediment.	—	C-1
FUEL PRIMING PUMP:	Lubricate 2 fittings — 2 strokes each.	MPGM*	C-1
FUEL FILTER HOUSING:	Drain water and sediment.	—	C-2
WOODWARD UG8 GOVERNOR OIL:	Change, fill to full mark on sight gauge.	CD*	C-6
WOODWARD UG8 GOVERNOR MOTOR:	Lubricate wick in oil cup.	CD*	C-8
SHUTOFF CONTROL RESET LEVER:	Lubricate 1 fitting — 2 strokes. Inspect cable for kinks and movement drag.	MPGM*	H-1
SHUTOFF CONTROLS:	Have operation checked by Caterpillar dealer.	—	H-1
TACHOMETER DRIVE:	Lubricate 1 fitting — 1 stroke.	MPGM*	H-1
<b>EVERY 1200 SERVICE METER UNITS — 92 Gal. Crankcase Engines Only</b>			
ENGINE OIL AND FILTERS: Capacity: 92 Gals., 77 Imp. Gals., 348 Liters:	Change (See clean solvent).	—	A-2
ENGINE BREATHER:	Clean; use clean solvent.	—	A-2

SCHEDULED ITEM	MAINTENANCE	LUBE	PAGE
<b>EVERY 2000 SERVICE METER UNITS OR 1 YEAR</b>			
VALVE LASH — check adjustment, set:	INLET VALVE LASH = .015" (0.38 mm).	—	B-5
	EXHAUST VALVE LASH = .035" (0.89 mm).	—	B-5
VALVE ROTATORS — check rotation of valves:	Observe rotation of valves with engine idling.	—	B-8
COOLING SYSTEM — clean. If Cooling System Inhibitor was added every 500 Hours or 3 Months, cleaning of system may be extended to once every 2 Years.	Follow instructions in Procedures, or on commercial cleaner container.	—	D-4
ELECTRIC SET GENERATOR — lubricate rear bearing:	Remove 2 plugs, install upper fitting, lubricate until old grease appears.	MPGM*	G-3
NON-SCHEDULED ITEMS	WHEN TO SERVICE ITEMS	LUBE	PAGE
AIR CLEANER ELEMENT — clean and/or replace (elements may be cleaned 4-6 times):	Install clean filter elements when air cleaner indicator piston locks "up", See NOTE B.	—	B-1
AIR CLEANER PRECLEANER:	Remove and wash when 3/4 full.	—	B-5
FUEL SYSTEM:	Prime after servicing fuel system.	—	C-1
PRIMARY FUEL FILTER:	Clean when FUEL PRESSURE gauge registers OUT.	—	C-2
FUEL FILTER ELEMENTS:	Replace when FUEL PRESSURE gauge registers OUT.	—	C-2
WOODWARD UG8 GOVERNOR:	Bleed if engine surges.	—	C-7
AIR STARTING SYSTEM — COLLECTOR JAR:	Empty when jar is half full. Do not reuse oil.	—	E-1
OILER JAR:	Fill when jar is half empty.	CD*	E-1
OILER FEED:	Adjust when oiler uses more than 4 drops per minute.	—	E-1
BATTERY:	Clean with baking soda when white deposit forms.	—	F-2
GLOW PLUGS:	Replace when ammeter reading is closer than usual to "0" with HEAT-START switch in HEAT position.	—	F-4
CLUTCH ADJUSTMENT:	Adjust when lever no longer "snaps" past center position.	—	G-1

### NOTES

**NOTE A:** This is the normal change interval to use when fuel sulphur content is 0.4% or less. When sulphur content is 0.4% to 1.0%, reduce oil change interval one-half. When sulphur content is above 1.0%, reduce oil change interval to one-fourth the normal interval, regardless of hours, change oil filters every 6 months.

Change oil and filter after the first 50 hours of operation of a new or reconditioned engine or marine gear.

**NOTE B:** Service intervals may be shortened in dusty operating conditions. If the exhaust smoke and/or loss of power continues after servicing the air cleaner, discard that element and install a new element. Install a new element at least once a year.

### \*KEYS TO FUELS, LUBRICANTS AND WATER

**FUEL:** Use only distillate fuels (ASTM No. 1 or No. 2 Fuel Oil, or No. 1D or No. 2D Diesel Fuel Oil are examples) with a minimum cetane number of 35. Heavier oil is generally preferable because of its energy content.

**CD:** Use oils which meet Engine Service Classification CD, or MIL-L-2104C, in Caterpillar diesel engine crankcases and gear compartments.

**MPGM:** Use Multipurpose-type Grease which contains both 3 to 5% molybdenum disulfide conforming to MIL-L-7866, and a suitable corrosion inhibitor. NLGI No. 2 Grade is suitable for most temperatures. NLGI No. 1 or No. 0 are suitable for extremely low temperatures.

**BATTERY WATER:** Add either distilled water; or, odorless, tasteless drinking water. Do not use mineral water, water containing iron, salt water or softened water. Water level must be to base of vent well for each cell.

**ENGINE COOLANT:** When ambient temperatures remain above freezing, use a mixture of Caterpillar Cooling System Inhibitor, or equivalent, and clean, odorless, tasteless drinking water. Do not use chemically softened water.

When operating conditions are severe, or if ambient temperatures are below freezing, use a 50-50 solution of antifreeze and water.

Drain, flush and fill with new coolant every 2000 Service Meter Units or annually. Coolant change period may be extended to 2 years by adding corrosion inhibitor every 500 Service Meter Units.

### D379 INDUSTRIAL ENGINE SPECIFICATIONS

<b>NUMBERING OF CYLINDERS, Front to Rear:</b>	1-3-5-7	RIGHT BANK	
		FLYWHEEL	
	2-4-6-8	LEFT BANK	
<b>FIRING ORDER:</b>			
<b>Standard (Counterclockwise) Rotation:</b>	1-8-5-4-7-2-3-6		
<b>Opposite (Clockwise) Rotation:</b>	1-4-5-2-7-6-3-8		
<b>REFILL CAPACITIES (Approximate):</b>	Gals.	Imp. Gals.	Litres
Engine Crankcase, Standard Pan:	50	42	189
Large Capacity Pan:	92	77	348
Coolant, Radiator only:	28	23	105
Engine and Radiator:	68	57	257
<b>RECOMMENDED OIL VISCOSITY:</b>			
Diesel Engine:	SAE 10W:	-20°F to 70°F (-29°C to 21°C)	
	SAE 10W/30:	-10°F to 90°F (-23°C to 32°C)	
	SAE 20W/40:	15°F to 120°F (-9°C to 49°C)	
	SAE 30*:	20°F to 120°F (-7°C to 49°C)	
	SAE 40:	45°F to 120°F (7°C to 49°C)	
	*SAE 40 is preferred above 90°F (32°C).		
Woodward UG8 Governor: Same as Diesel Engine.			
Air Starting Motor Oiler Jar: SAE 10W in all temperatures.			
<b>CHECK VALVE LASH ADJUSTMENT:</b>	<b>NO. 1 CYLINDER ON COMPRESSION STROKE:</b>		
		<b>COUNTERCLOCKWISE ROTATION</b>	<b>CLOCKWISE ROTATION</b>
Exhaust Valves for Cylinders	1-4-5-8		1-4-5-8
Inlet Valves for Cylinders	1-2-3-6		1-3-6-8
<b>CHECK VALVE LASH ADJUSTMENT:</b>	<b>NO. 1 CYLINDER ON EXHAUST STROKE:</b>		
Exhaust Valves for Cylinders:	2-3-6-7		2-3-6-7
Inlet Valves for Cylinders:	4-5-7-8		2-4-5-7
<b>VALVE LASH CLEARANCE ADJUSTMENT:</b>			
Exhaust Valves:	.035 inch (0.89 mm).		
Inlet Valves:	.015 inch (0.38 mm).		
<b>ALTERNATOR BELT ADJUSTMENT:</b> $\frac{9}{16}$ " to $\frac{13}{16}$ " (14 to 20 mm). @ 25 lbs. (11,3 kg).			
<b>CLUTCH ADJUSTMENT:</b> Lever must engage with distinct snap.			

# LUBRICATION AND MAINTENANCE PROCEDURES

## ENGINE LUBRICATION SYSTEM

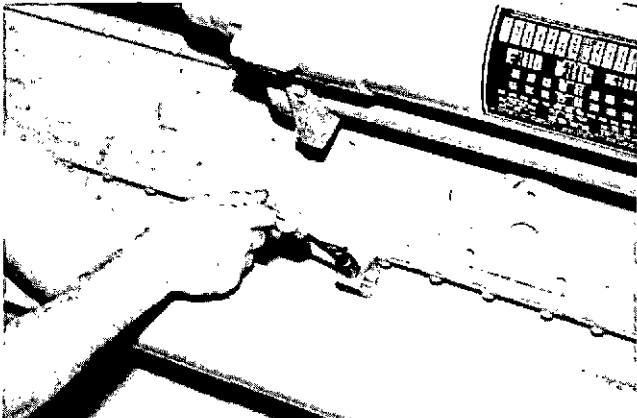
### DIESEL ENGINE LUBE OIL

#### CHECKING OIL PRESSURE GAUGE READING

After starting and during operation, frequently observe the oil pressure gauge. If the gauge indicator registers below "NORMAL", or if the indicator fluctuates, check the oil level and take corrective measures.

#### CHECKING OIL LEVEL

Check the oil level with the engine idling. Oil level must be between the ADD and FULL marks on the oil level gauge. Add oil as required. See Lubrication and Maintenance Chart for proper oil.

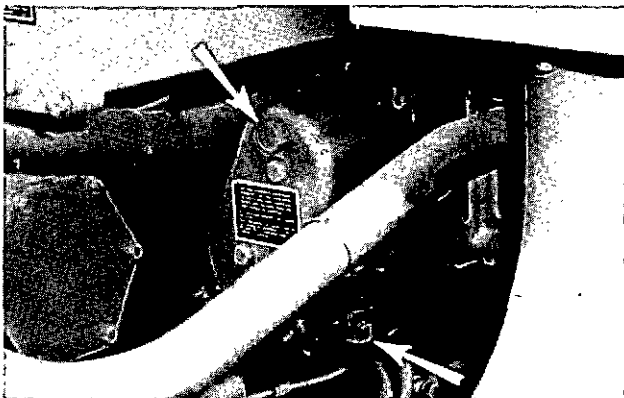


CHECKING CRANKCASE OIL LEVEL

#### DRAINING CRANKCASE LUBE OIL

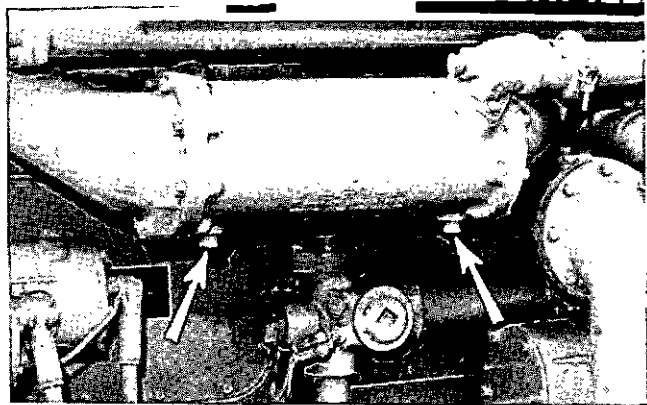
With engine stopped and oil warm:

1. Wipe dirt from the right hand oil filter housing cover.
2. Remove the vent plug.
3. Open the oil filter housing drain valve.



VENT PLUG AND DRAIN VALVE

4. Remove the oil cooler drain plug.



OIL COOLER DRAIN PLUGS

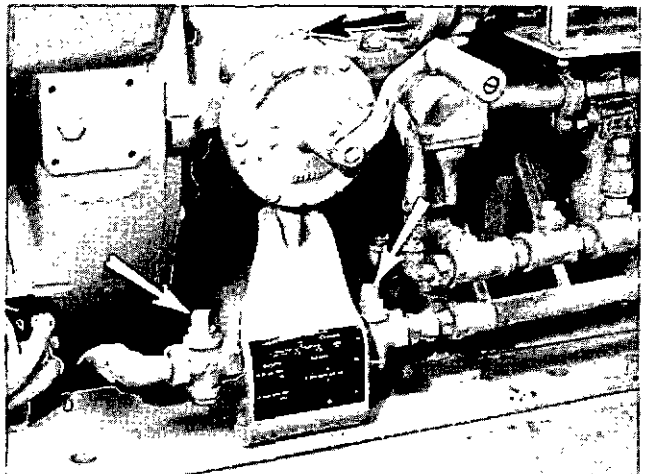
5. Remove the oil pan drain plug.



OIL PAN DRAIN PLUG

If a sump pump is used:

- a. Connect a suitable drain to the pump outlet.

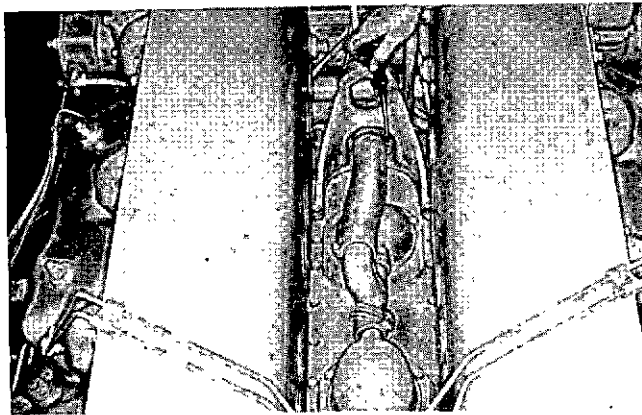


SUMP PUMP VALVES AND PUMP OUTLET

- b. Open the valve to the engine crankcase.
- c. Close the valve to the marine gear housing.
- d. Operate the sump pump handle until the crankcase is empty.
- e. Close the valve to the engine crankcase.

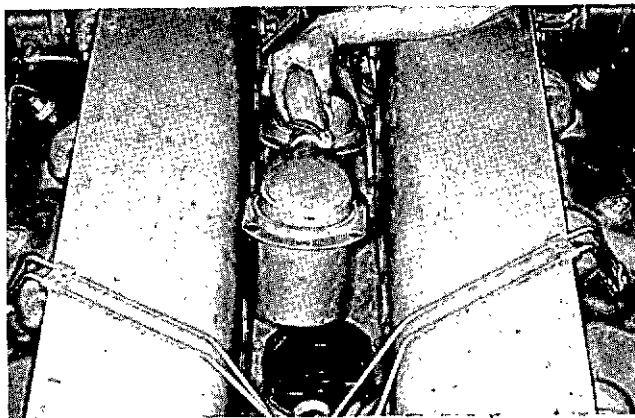
#### CLEANING BREATHER(S) (D379, D398, D399 Engines)

1. D399 Engine Only: Loosen the front hose clamp from the breather tube.



LOOSENING HOSE CLAMP

2. All Engines: Remove breather mounting bolts. Lift off breathers.



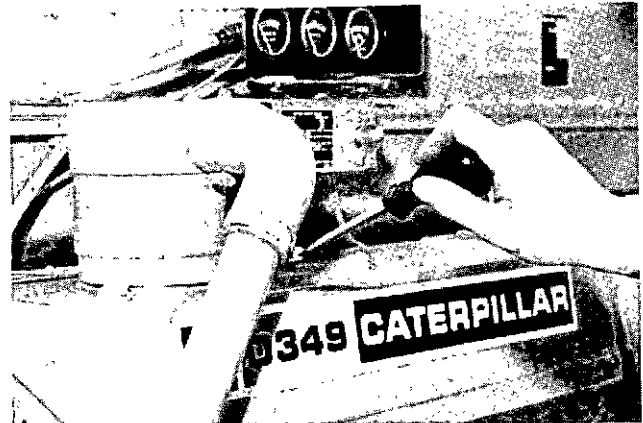
REMOVING BREATHERS

3. D399 Engine Only: Remove and inspect the upper and lower hoses from the breathers.
4. All Engines: Wash the breather(s) in clean diesel fuel or solvent.
5. All Engines: Install breather(s).
6. D399 Engine Only: Install lower and upper hose. Tighten all clamps. Connect breather tube.

#### CLEANING BREATHER(S) (D346, D348, D349 Engines)

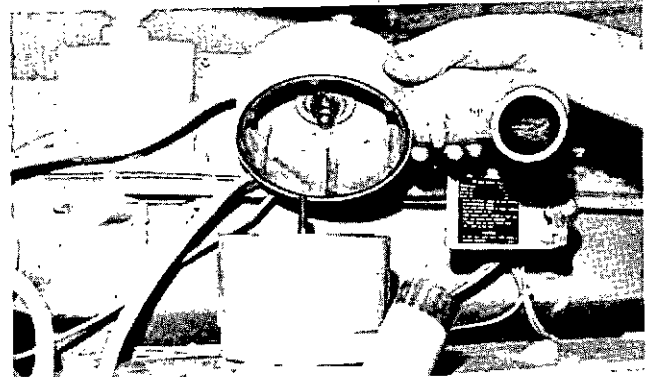
One breather is mounted on the left front valve cover. On D349 Engines, a second breather is mounted on the right rear valve cover. Service both breathers when so equipped.

1. Loosen the hose clamp.



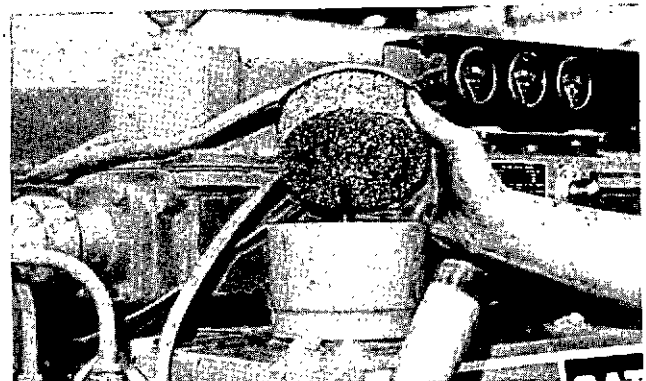
LOOSENING HOSE CLAMP

2. Loosen the cover bolt and lift off the breather cover.



REMOVING THE BREATHER COVER

3. Remove and inspect breather element.



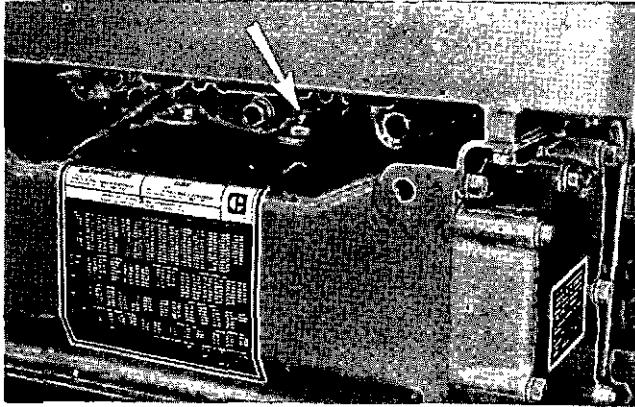
REMOVING BREATHER ELEMENT

4. Wash breather element in clean diesel fuel or kerosene.
5. Install breather element and cover. Connect hose.

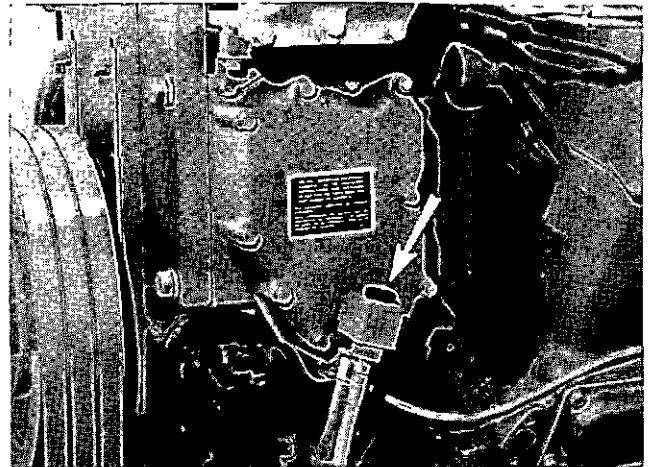
## OIL FILTER SERVICE INDICATOR

### CHECKING OIL FILTER CHANGE INDICATOR

When the engine is operating under full load with the oil at operating temperature, observe the position of the red plunger of the indicator. When the plunger rises approximately half the height of the plastic window, install new oil filter elements.



OIL FILTER SERVICE INDICATOR (Filter housing)



OIL FILTER SERVICE INDICATOR (Left cover)

If the normal oil filter period occurs before the plunger rises, change the oil filter elements at that time. See the LUBRICATION CHART for the oil filter change period.

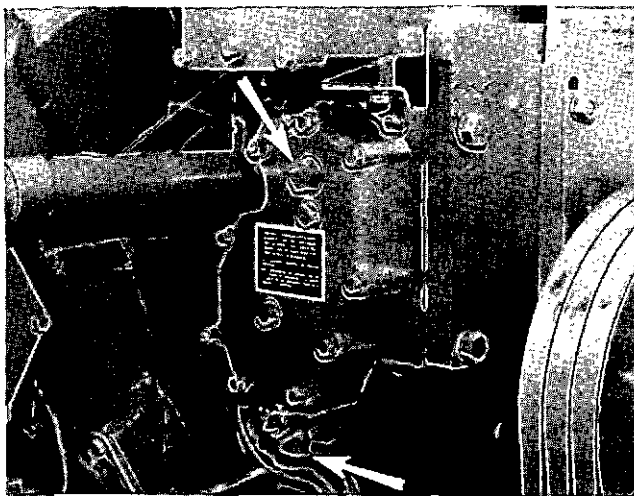
## OIL FILTER ELEMENTS

### INSTALLING OIL FILTER ELEMENTS

If your engine is equipped with a standard oil filter system, read the following instructions. If your engine is equipped to permit changing the oil filter elements while the engine is running, read the topic, "DUPLEX OIL FILTER SYSTEM".

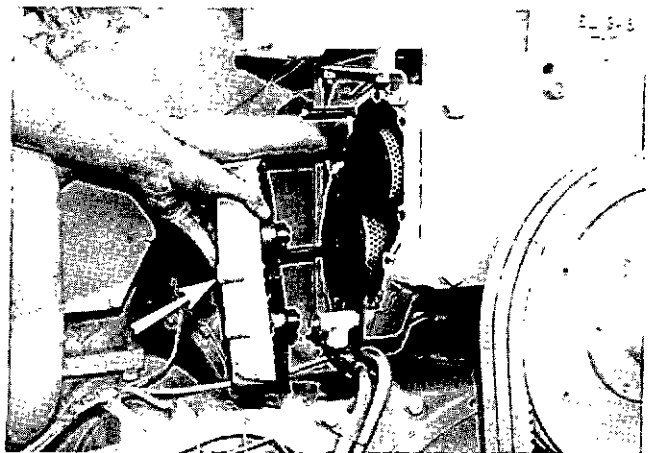
### INSTALLING OIL FILTER ELEMENTS

1. Drain the oil filter housing.



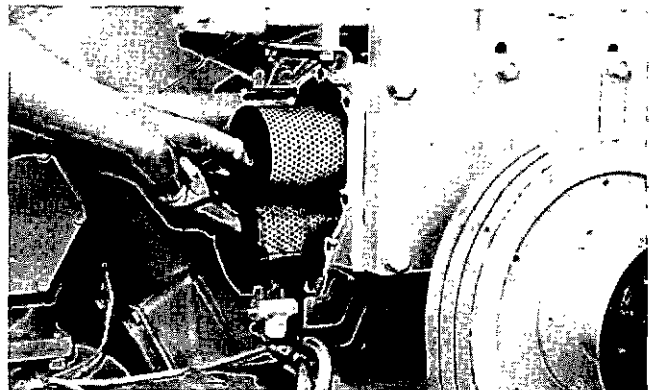
VENT PLUG AND DRAIN VALVE

2. Remove the right hand cover from the filter housing.



OIL FILTER HOUSING COVER

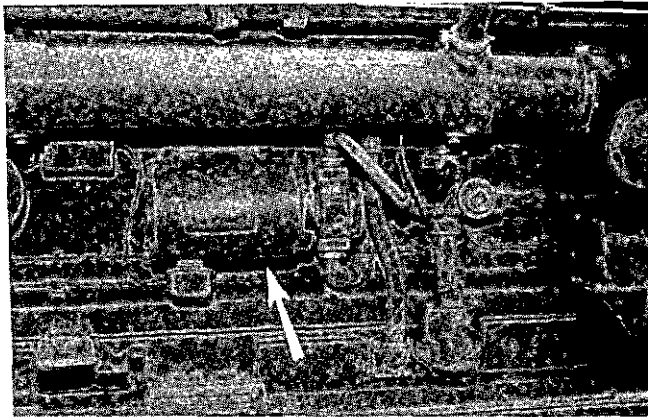
3. Remove the oil filter elements.



REMOVING OIL FILTER ELEMENTS

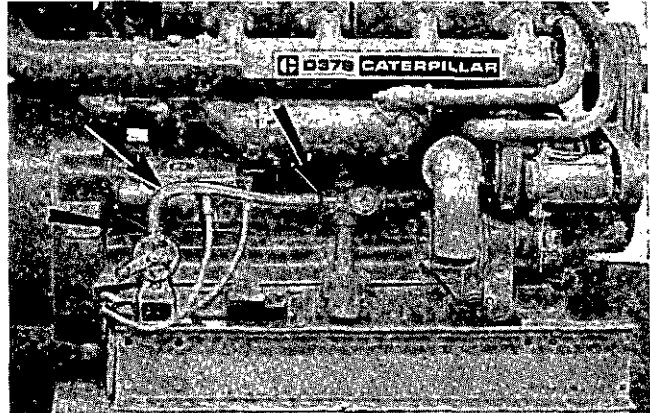
4. Wipe the oil filter housing with a clean rag.
5. Install new filter elements, and the filter housing cover.
6. Close the filter housing drain valve.
7. Fill the oil filter housing and oil cooler with oil; add the oil through the vent plug opening. See the LUBRICATION AND MAINTENANCE CHART for proper oil to use. Do not try to overfill; the excess oil will return through the oil lines to the engine crankcase.
8. Install the vent plug.
9. Fill the crankcase to the FULL mark on the oil level gauge.
10. Prelubricate the engine oil system, if equipped to do so:

D349 and D399 Engines: When the START switch is energized, the prelube pump will develop oil pressure in the engine before the starting motors are energized.



PRELUBE PUMP - D349 and D399 Engines

D346, D348, D379 and D398 Engines equipped with a sump pump: The sump pump can be used as a prelube pump by connecting a line from the outlet of the sump pump, through a threeway valve into the oil cooler bypass line.



SUMP PUMP CONNECTED AS PRELUBE PUMP

11. Start the engine; reduce engine speed to low idle. Observe the oil pressure gauge reading.  
If oil pressure does not register, the low oil pressure shut-off control will stop the engine in approximately seven seconds.  
If the low oil pressure shut-off control stops the engine, investigate the cause and make repairs before attempting to restart.
12. Reduce engine speed to low idle. Observe the oil pressure gauge. Oil pressure must be indicated, or shut the engine down and investigate the cause.
13. Allow the engine to reach operating temperatures.
14. Check the oil level with the engine running. Oil level should be between the ADD mark and the FULL mark. Add oil if necessary.

## DUPLEX OIL FILTER SYSTEM

### DUPLEX OIL FILTER SYSTEM

Marine propulsion engines and marine auxiliary electric set engines, which operate under the jurisdiction of international marine classification societies, are required to be equipped with a duplex oil filter system. The duplex oil filter system permits changing oil filter elements without stopping the engine.

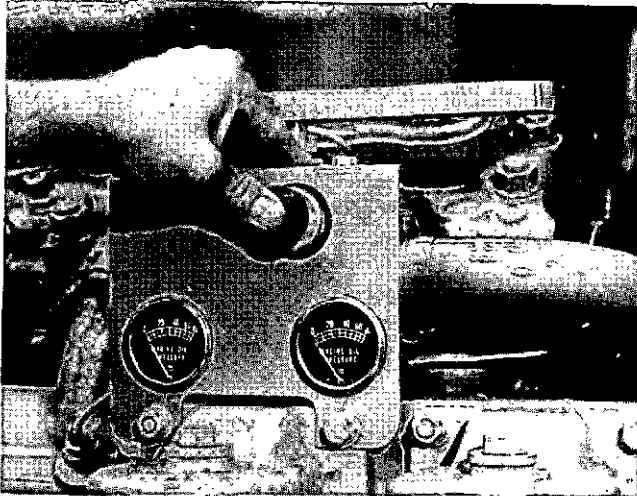
The filter elements, located in the horizontal oil filter housing, filter the oil during normal operation. The two oil filter cans, located on the right side of the engine, are auxiliary filter elements. At the specified oil filter element change interval, or when the oil filter change indicator is

raised approximately one half its maximum height, move the selector lever so as to divert the crankcase oil through the two auxiliary filter elements while the main filter elements are changed.

### INSTALLING NEW MAIN FILTER ELEMENTS

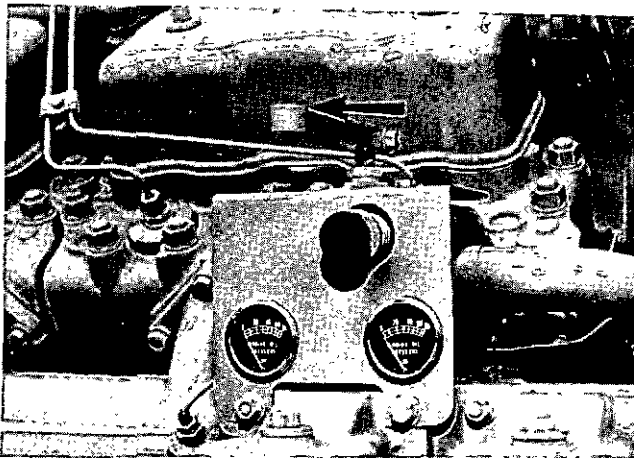
The main oil filter elements may be changed with the engine running as follows:

1. Push down and hold the fill valve to insure that the auxiliary oil filter housing is filled with oil. When the indicated filter pressure stops rising, release the fill valve.



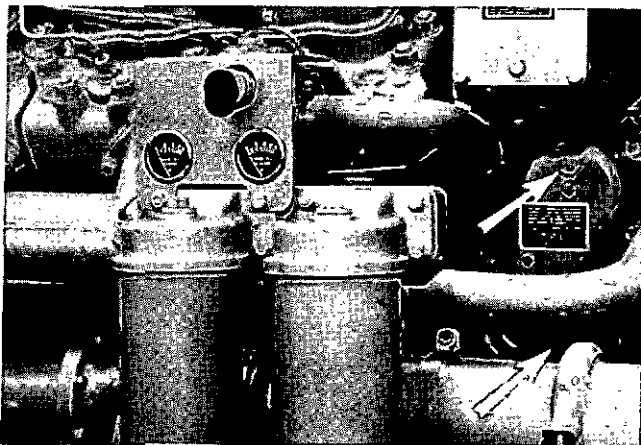
FILL VALVE AND FILTER PRESSURE GAUGES

2. Move the selector lever 90° in a clockwise motion to the auxiliary filter position. The crankcase oil is now being filtered through the auxiliary oil filter elements.



SELECTOR LEVER—AUXILIARY FILTER POSITION

3. Open the main filter drain valve.
4. Remove the vent plug from the right hand end cover and allow the filter housing to drain.



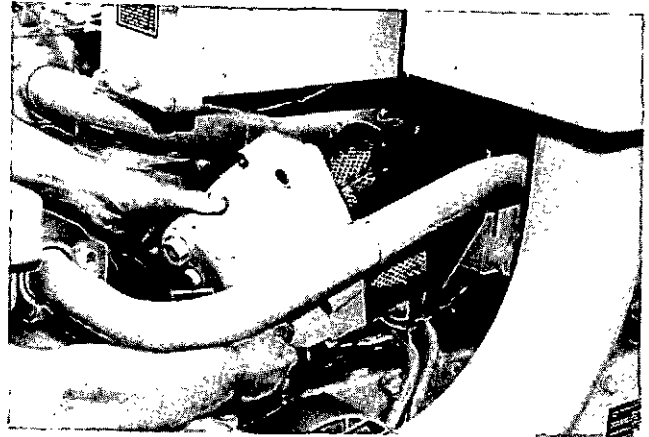
VENT PLUG AND DRAIN

5. Remove the right hand housing cover.

**WARNING**

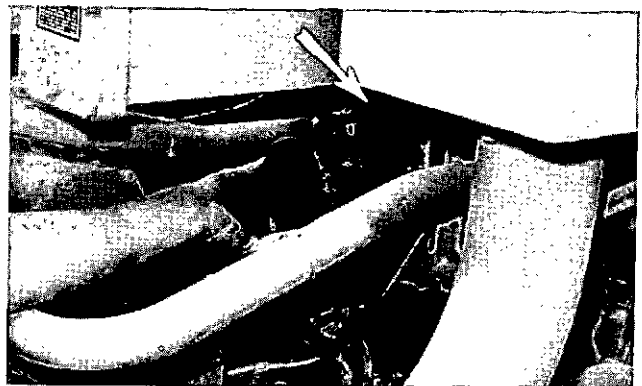
Protect hands to avoid injury from hot oil or hot engine parts. Photographs show bare hands only for illustrative purposes.

6. Remove the used filter elements from the filter housing.



REMOVING OIL FILTER HOUSING COVER

7. Wipe sediment from inside the filter housing using clean cloth.
8. Install new filter elements.
9. Inspect the cover gasket. Install a new gasket if necessary.

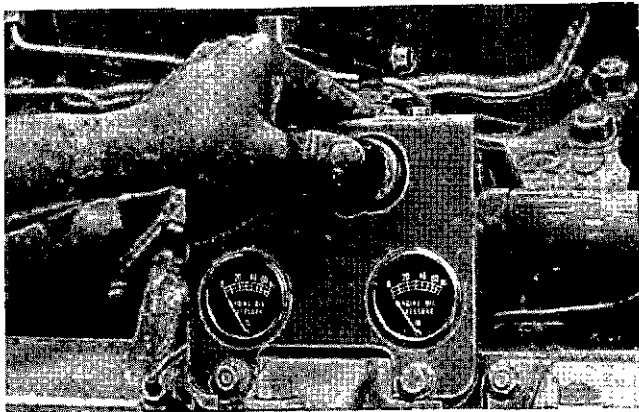


INSTALLING NEW ELEMENTS AND GASKET

10. Install the filter housing cover.
11. Close the drain valve, install the vent plug.
12. Push down and hold the fill valve until the indicated filter pressure stops rising; then release the fill valve.

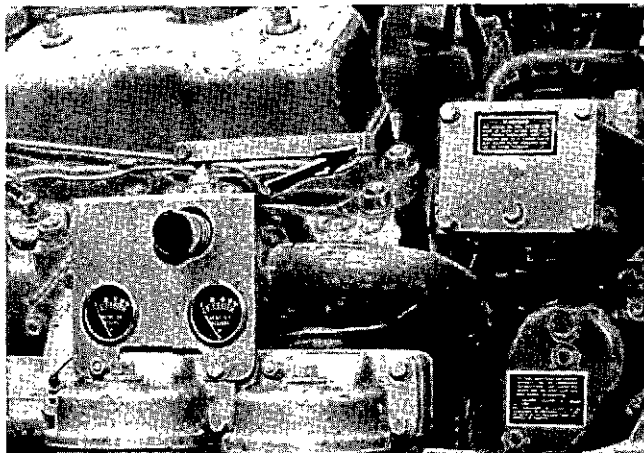
**CAUTION**

The oil must force the air out of the main filter housing to prevent air from later entering the oil lines and engine bearings.



**FILLER VALVE AND OIL PRESSURE GAUGES**

13. Move the selector lever 90° in a counterclockwise motion to the main filter position. The crankcase oil is now being filtered through the main oil filter elements.



**SELECTOR LEVER—NORMAL OPERATION**

**CAUTION**

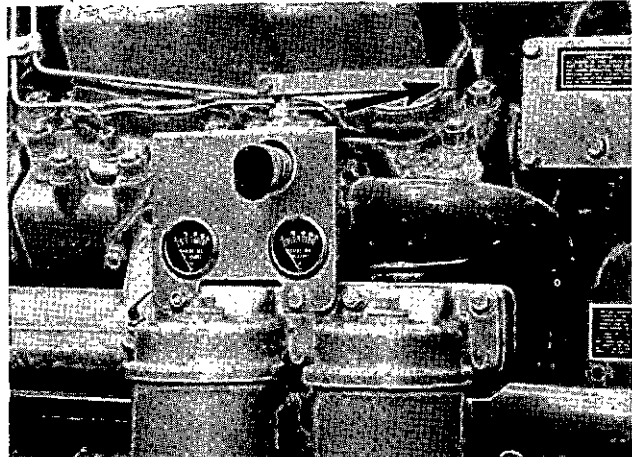
For long periods of running, the selector lever must be turned so it is parallel with the engine. If the selector lever remains positioned at right angle to the engine, only two filter elements will be filtering the engine crankcase oil instead of five. Early plugging of these two elements will result, and dirty oil will be by-passed through the engine.

14. Check for oil leaks.

**SERVICING THE AUXILIARY OIL FILTER ELEMENTS**

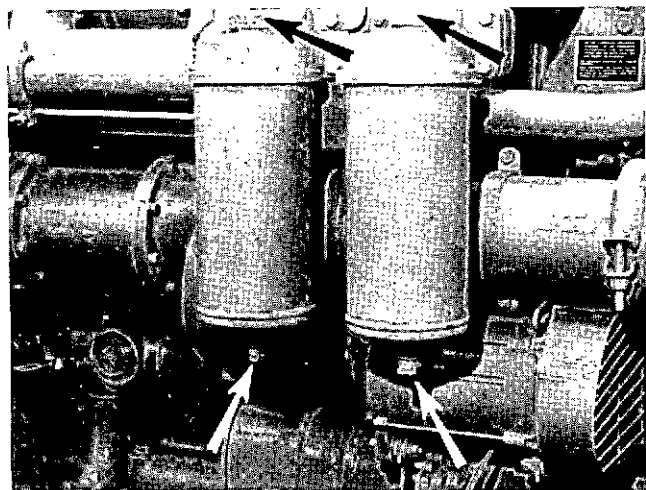
The auxiliary oil filter elements should be changed after each main oil filter change. This will insure that clean auxiliary filter elements are available for emergency use at all times. The auxiliary oil filter elements may be changed with the engine running as follows:

1. Service the auxiliary filter elements during normal operation with the selector lever pointed forward



**SELECTOR LEVER—NORMAL OPERATION**

2. Wipe dirt from each auxiliary oil filter housing.
3. Remove the auxiliary oil filter housing drain plugs.
4. Loosen each filter housing mounting bolt.

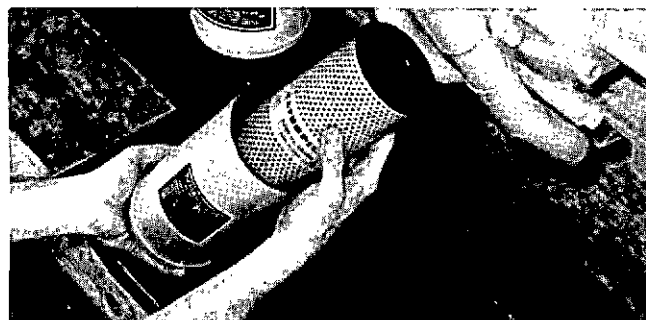


**AUXILIARY OIL FILTERS**

5. Remove each housing and element.

**WARNING**

Protect hands to avoid injury from hot oil or hot engine parts. Photographs show bare hands only for illustrative purposes.

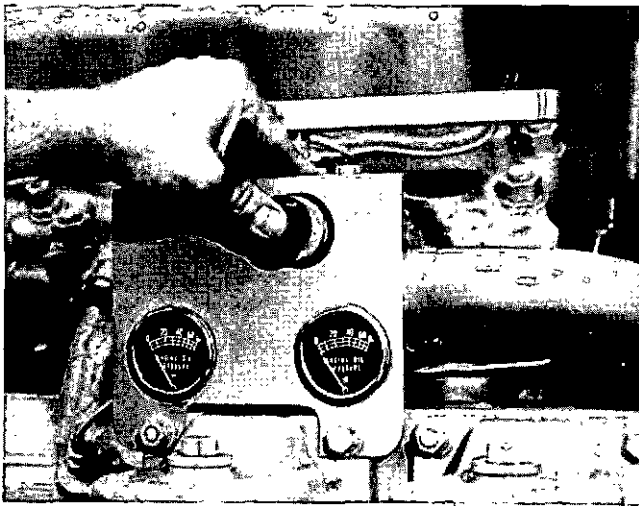


**REMOVING AUXILIARY FILTER HOUSING AND ELEMENT**

6. Remove the gasket from each filter housing base.
7. Remove the element from each filter housing, and wipe the inside of the housing with a clean rag.
8. Install new gaskets.
9. Install a new element into each housing.
10. Install the filter housings to the filter bases.
11. Install the drain plugs.
12. Push down and hold the fill valve until the indicated filter pressure stops rising; then release the fill valve.

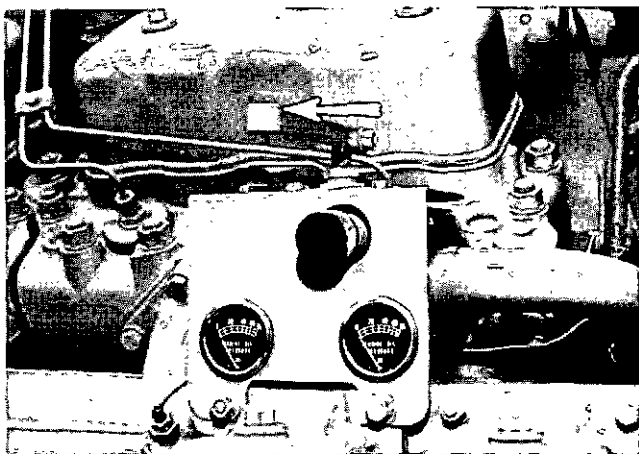
**CAUTION**

The air must be removed from the auxiliary filter housings to prevent air from later entering the oil lines and engine bearings.



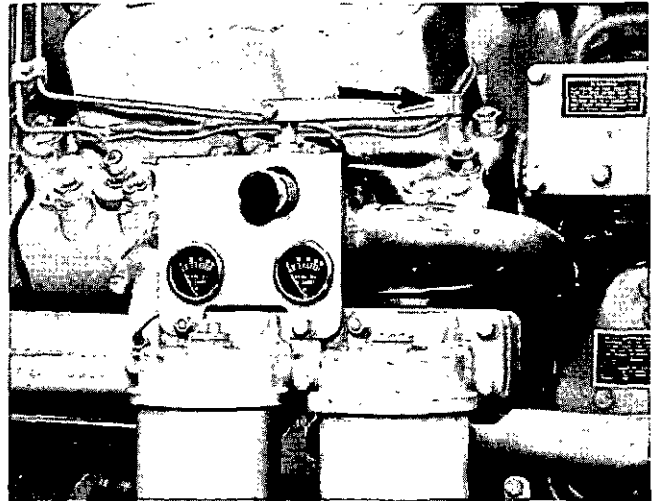
**FILL VALVE AND FILTER PRESSURE GAUGE**

13. Move the selector lever 90° in a clockwise motion to the auxiliary filter position. Check for oil leaks.



**SELECTOR LEVER - AUXILIARY FILTER POSITION**

14. After determining the auxiliary filter system is ready for use, move the selector lever 90° in a counterclockwise motion to the main filter position.



**SELECTOR LEVER—MAIN FILTER POSITION**

15. Continue running on the main filters until they require changing. Then follow the instructions for installing new main oil filter elements.

**CAUTION**

For long periods of running, the selector lever must be turned parallel with the engine crankshaft. With the selector lever at right angles to the engine, only two filter elements will be used instead of five elements. Early filter element plugging will result.

## PRELUBE PUMP (D349 and D399 Engines)

When the START switch is energized, the prelube pump will build oil pressure in the engine lubrication system before the starting motors are energized.

A prelube pump with grease plugs on the rear bearing and a separate lube system for the prelube pump reduction drive, as shown in these photos, requires servicing as follows:

### CHECKING PRELUBE PUMP OIL LEVEL

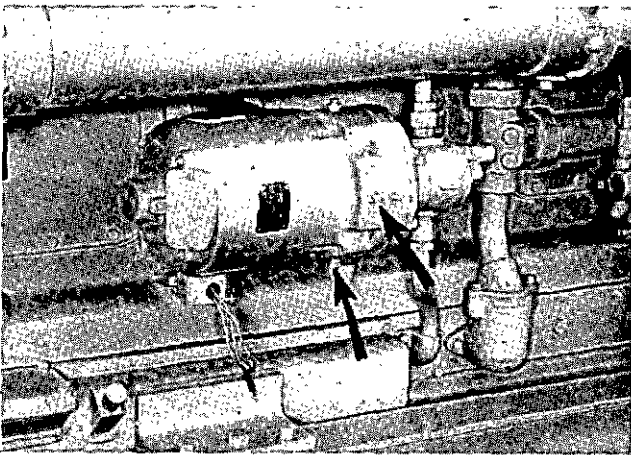
Check the pre-lube gear case oil level before starting the diesel engine. Oil level must be between the LOW and HIGH marks on the bayonet gauge. Add oil as required. See Lubrication and Maintenance Chart for proper oil.



CHECKING OIL LEVEL

### DRAINING PRE-LUBE PUMP OIL

1. Remove drain plug and drain oil.

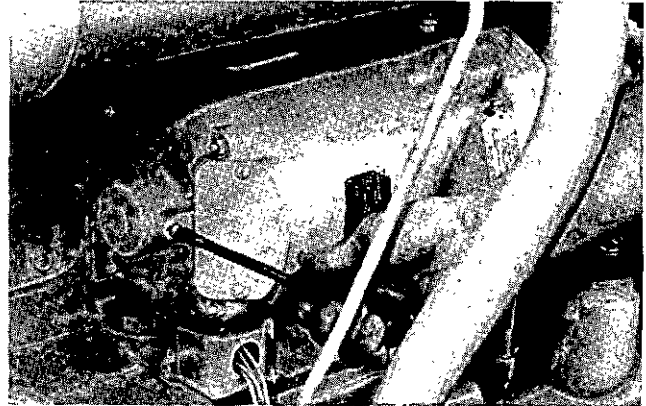


### FILLER AND DRAIN PLUGS

2. Flush the gear case with diesel fuel or kerosene.
3. Fill gear case with oil. See Lubrication and Maintenance Chart for proper oil.

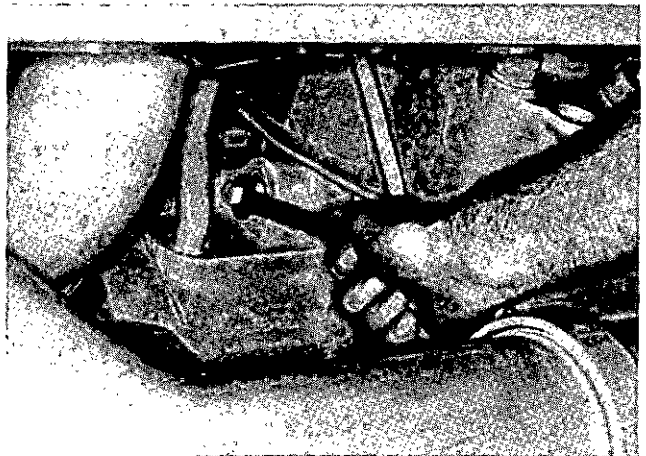
### LUBRICATING PRE-LUBE PUMP REAR BEARING

1. Remove the rear bearing grease plug.



### REMOVING GREASE PLUG

2. Clean out old grease.
3. Install a grease fitting. Lubricate; see Lubrication and Maintenance Chart for proper grease.
4. Remove the grease fitting.
5. Move the compression release lever to START to prevent the engine from starting.



### COMPRESSION RELEASE LEVER (1 each bank)

6. Turn the start switch to START; the running pre-lube pump motor will push the excess grease out the plug hole.
7. Wipe excess grease from outside of motor.
8. Clean and install the grease plug.

# AIR INDUCTION AND EXHAUST SYSTEM

## AIR CLEANER SERVICE INDICATOR

### CHECKING AIR CLEANER SERVICE INDICATOR

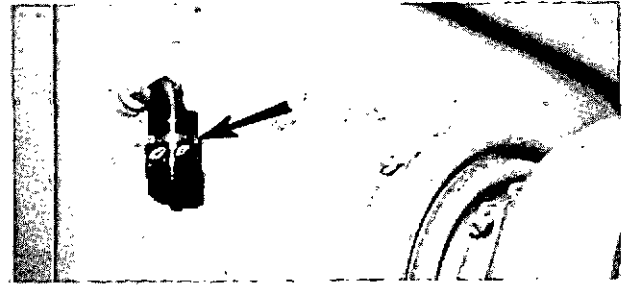
Before starting, check the window of the indicator. If the red piston is locked in the raised position, service the air cleaner as outlined.

#### NOTE

Have spare elements on hand to install while cleaning used elements.

#### CAUTION

Service the air cleaner with the engine STOPPED.

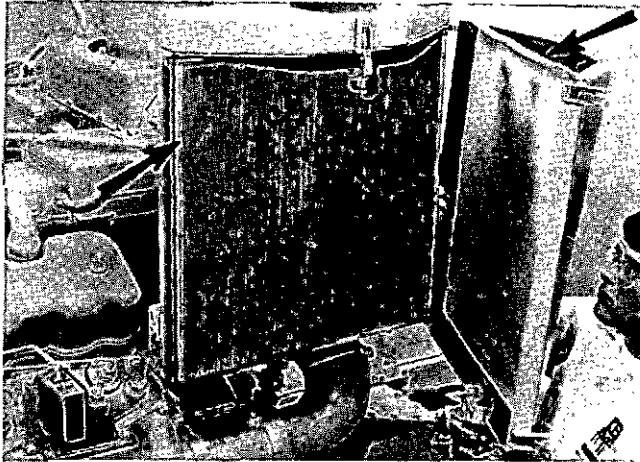


PISTON LOCKED IN RAISED POSITION

## SINGLE STAGE AIR CLEANER

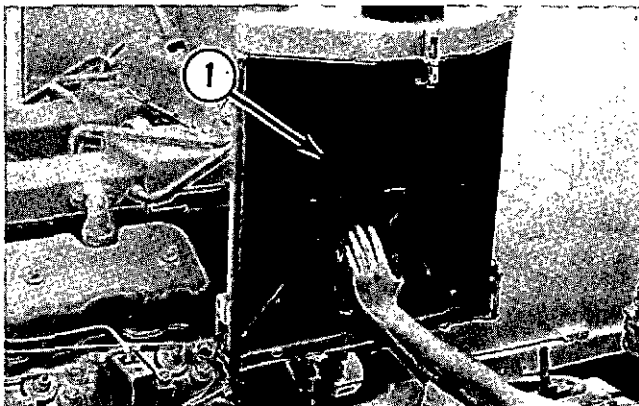
### SERVICING

1. Remove the air cleaner cover and filter element. On some engines, a soot filter may cover the filter element.



REMOVING COVER, SOOT FILTER AND FILTER ELEMENT

2. Cover the turbocharger air inlet opening to prevent dirt from entering the engine.
3. Clean the inside of the air cleaner cover and the air cleaner body.



CLEANING INSIDE OF AIR CLEANER

1. Air Inlet Cover

4. Inspect the replacement element for damage and dirt.
5. Remove the covering from the turbocharger inlet opening.
6. Install the element.

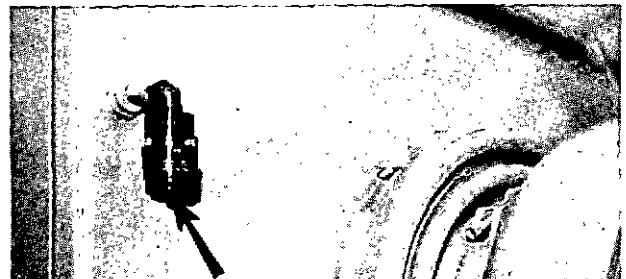


INSTALLING AIR CLEANER ELEMENT

#### CAUTION

The reinforcing brace across the middle of panel type elements fits over the supporting bar of the turbocharger.

7. If a soot filter is used, place a new soot filter over the air cleaner element.
8. Install the air cleaner cover.
9. Reset the service indicator piston by pushing the reset button. See the instructions for cleaning the used air cleaner element.

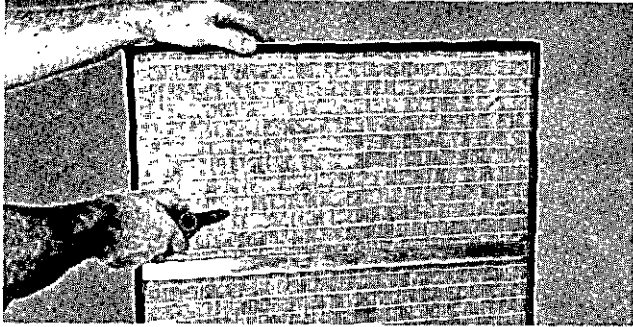


RESETTING AIR INDICATOR PISTON

## CLEANING USED AIR CLEANER ELEMENTS

### CLEANING WITH PRESSURE AIR

1. Use clean, dry air— 40 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)

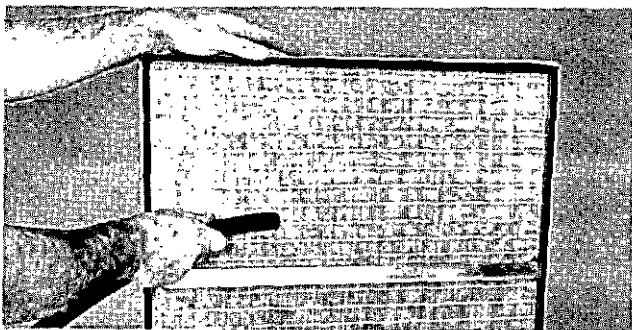


### CLEANING ELEMENT WITH AIR

2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)
3. Blow the loosened dirt from the DIRTY side.
4. Direct the air from the CLEAN side through to the DIRTY side to remove dirt blown into the pleating.

### CLEANING WITH WATER

1. Use clean water at no more than 40 PSI. Do not use a nozzle.
2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.

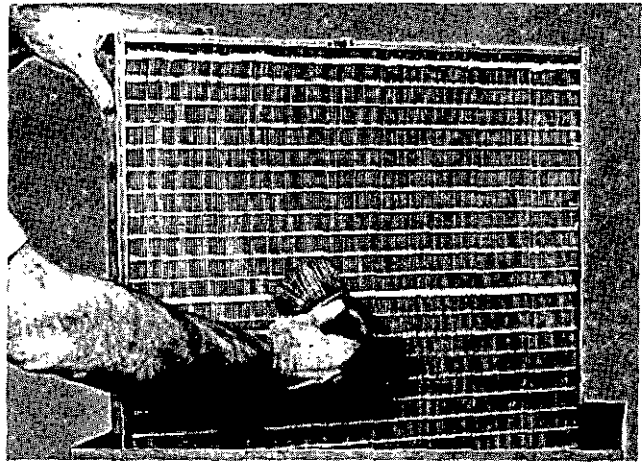


### CLEANING ELEMENT WITH WATER

3. Direct water along the complete length of each pleat on the DIRTY side of the element.
4. Rinse the CLEAN side of the element.
5. Allow the cleaned element to dry thoroughly.

### CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.
2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.

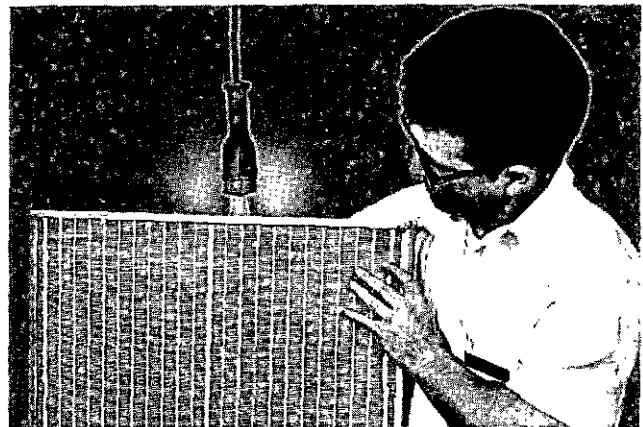


### WASHING ELEMENT WITH DETERGENT

3. Rinse the opposite side of the element along the complete length of each pleat.
4. Rinse the first side again to remove all loosened dirt.
5. Allow the cleaned element to dry thoroughly.

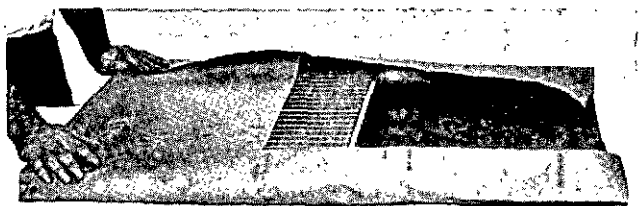
### STORING CLEANED ELEMENTS

1. Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.



### INSPECTING ELEMENT

2. Wrap usable elements in heavy paper.



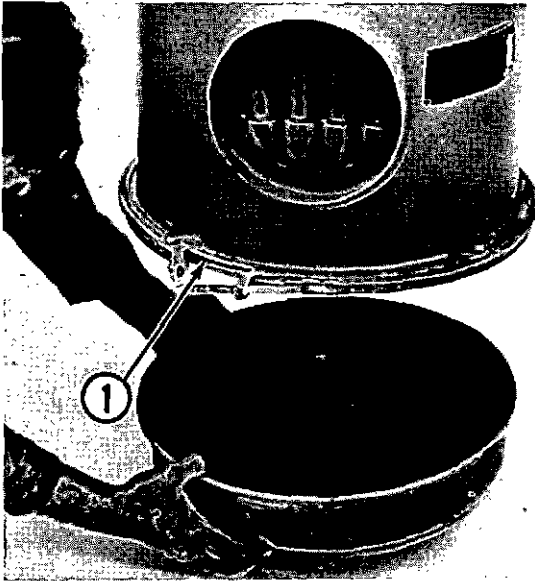
### WRAPPING ELEMENT FOR STORAGE

3. Store the wrapped element in a dry, clean place.

## TWO STAGE AIR CLEANER

### EMPTYING DUST COLLECTOR CUP

1. Loosen the clamping bolt on the lower body.
2. Remove and empty the dust collector cup.
3. Inspect and install the seal; install a new seal if necessary.



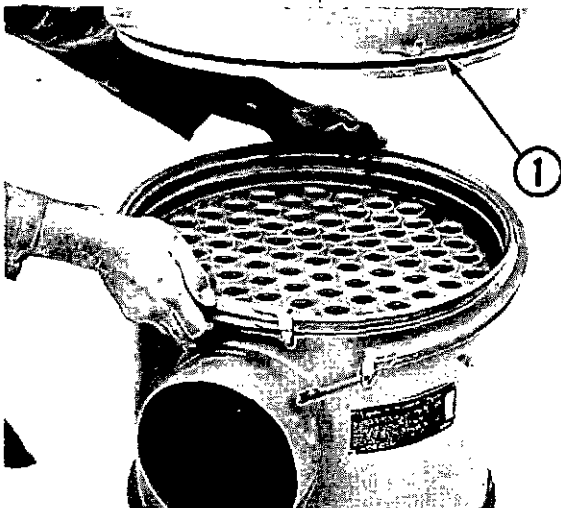
#### REMOVING DUST CUP

1. Seal

4. Inspect the tubes in the lower body. If dirty, clean the tubes with a round bottle brush.
5. Install the dust collector cup.

### CLEANING THE LOWER BODY

1. Remove the dust collector cup.
2. Loosen the clamping bolt on the upper body.



#### REMOVING LOWER BODY

1. Seal

3. Remove the lower body. Clean the tubes from both ends.
4. Inspect and install the upper body seal. Install a new seal if it is damaged.

### INSTALLING REPLACEMENT FILTER ELEMENT

1. Remove the cover.



#### REMOVING COVER AND INNER COVER

2. Remove the inner cover and filter element. In cold weather, a stuck inner cover may be removed by warming the air cleaner cover to 70-75°F (21-24°C).



#### REMOVE ELEMENT

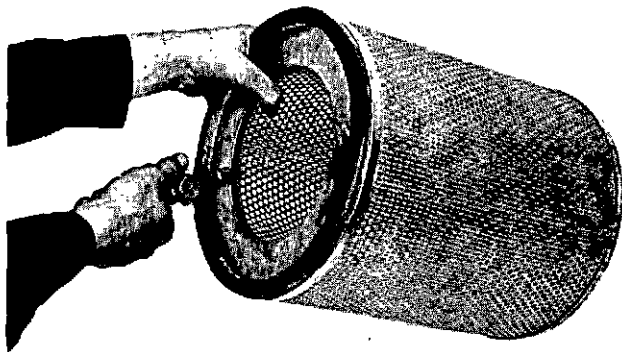
3. Clean all parts of the air cleaner.
4. Inspect the replacement element for damage and cleanliness.
5. Install the element, inner cover, and wing nut. Tighten the wing nut to prevent dust from bypassing the filter element.
6. Install the cover.

If, after servicing the air cleaner, the exhaust smoke and/or loss of power continues; or the service indicator locks in the raised position, discard that element and install a new element. Install a new element at least once a year.

## CLEANING USED AIR CLEANER ELEMENTS

### CLEANING WITH PRESSURE AIR

1. Use clean, dry air— 40 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)



### CLEANING ELEMENT WITH AIR

2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)
3. Blow the loosened dirt from the DIRTY side.
4. Direct the air from the CLEAN side through to the DIRTY side to remove dirt blown into the pleating.

### CLEANING WITH WATER

1. Use clean water at no more than 40 PSI. Do not use a nozzle.
2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.

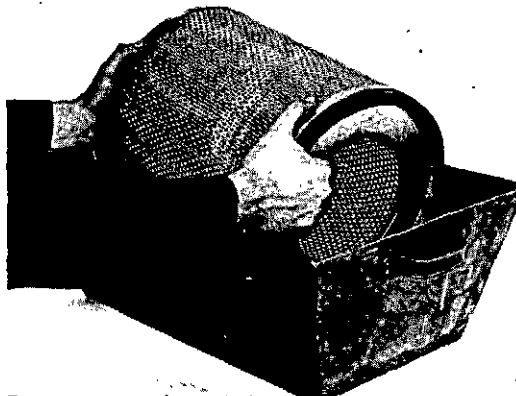


### CLEANING ELEMENT WITH WATER

3. Direct water along the complete length of each pleat on the DIRTY side of the element.
4. Rinse the CLEAN side of the element.
5. Allow the cleaned element to dry thoroughly.

### CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.
2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.

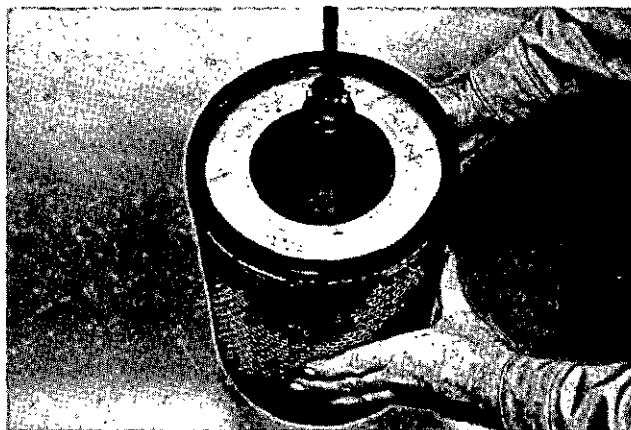


### WASHING ELEMENT WITH DETERGENT

3. Rinse the opposite side of the element along the complete length of each pleat.
4. Rinse the first side again to remove all loosened dirt.
5. Allow the cleaned element to dry thoroughly.

### STORING CLEANED ELEMENTS

1. Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.



### INSPECTING ELEMENT

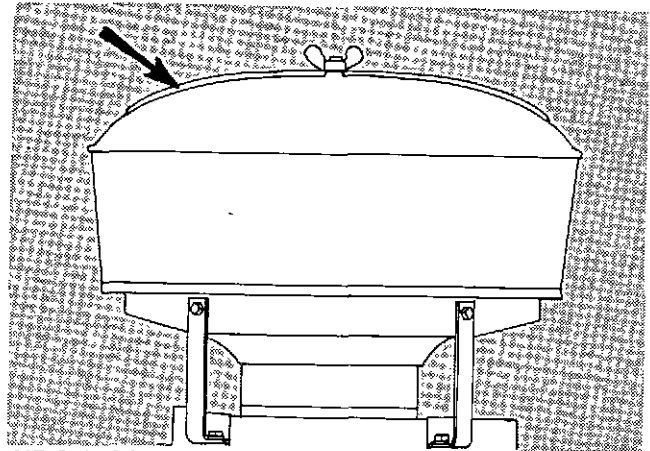
2. Wrap usable elements in heavy paper.
3. Store the wrapped element in a dry, clean place.

## PRECLEANER

### SERVICING

When the precleaner body is 3/4 full, remove and empty the precleaner.

1. Remove the dust collector cover.
2. Remove and empty the dust collector body.
3. If necessary, wash the dust collector in water.



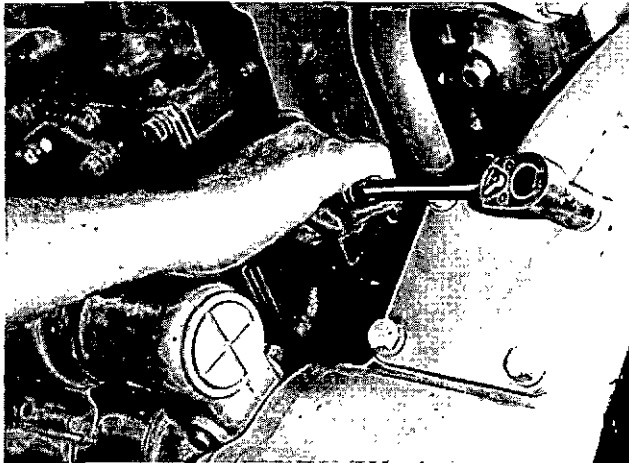
AIR CLEANER PRECLEANER

## ENGINE VALVE LASH

(D379, D398, D399 Engines)

### VALVE LASH

1. Stop the engine.
2. Remove the flywheel housing timing cover.



REMOVING TIMING COVER

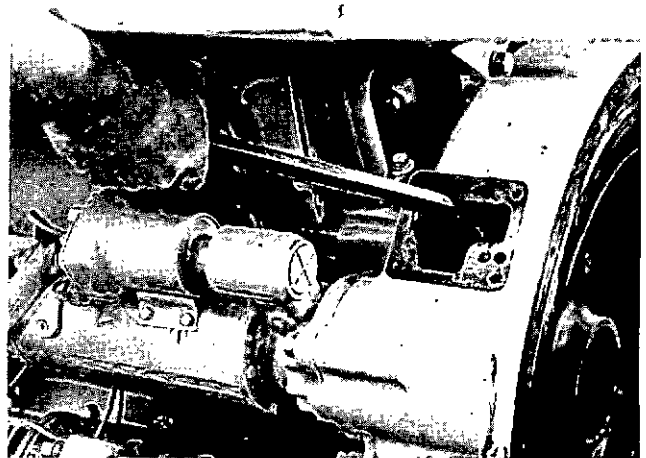
3. Determine the direction of flywheel rotation. See the decal above the flywheel housing.



FLYWHEEL ROTATION DECAL

4. Wipe dirt from the base of the valve covers.
5. Remove the valve covers.

6. Bar the flywheel in the direction of normal rotation. Align the "TDC 1" timing mark for your engine, ("TDC 1-7", "TDC 1'11", or "TDC 1-15"), with the timing pointer on the flywheel housing.



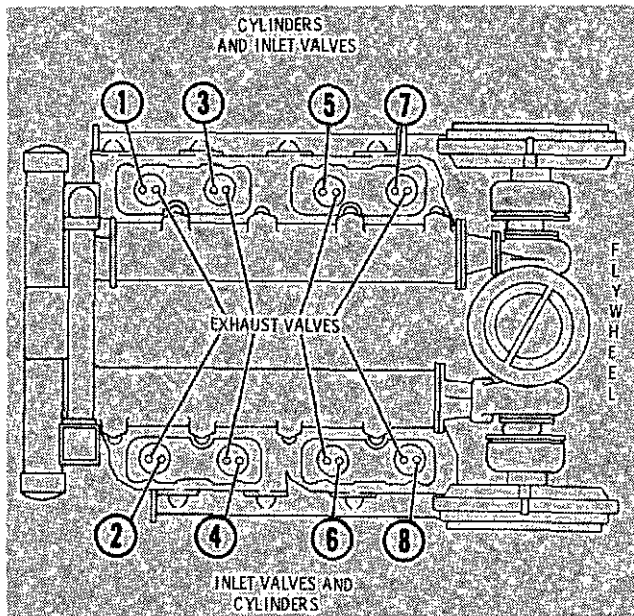
BARRING FLYWHEEL

### CHECKING ADJUSTMENT

1. Observe the rocker arms for cylinder No. 1. Determine if the piston is on compression or exhaust stroke.

Compression stroke: Both intake and exhaust valves are closed.

Exhaust stroke: Intake valve is closed, exhaust valve is opened.

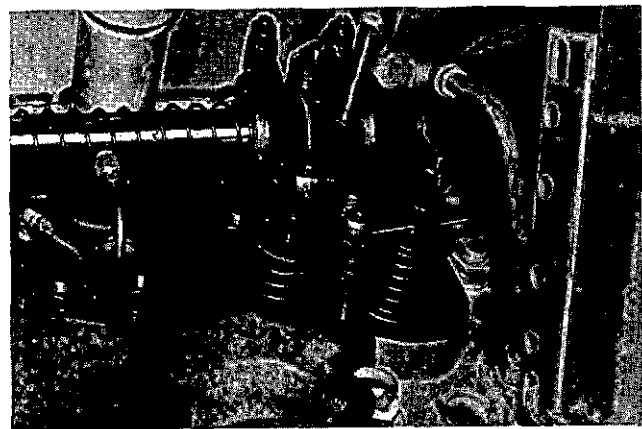


**NUMBERING OF CYLINDERS AND VALVES**

2. With NO 1 CYLINDER ON COMPRESSION STROKE, check the lash of the following valves: Adjust if necessary. See the Lubrication and Maintenance Chart for correct valve lash.

NO. 1 CYLINDER ON COMPRESSION STROKE COUNTERCLOCKWISE ROTATION - Viewed from Flywheel			
VALVES	D379 CYLINDERS	D398 CYLINDERS	D399 CYLINDERS
Exhaust	1-4-5-8	1-4-5-6-9-12	1-2-3-4-5-6-8-9
Intake	1-2-3-6	1-3-6-7-10-12	1-2-7-8-11-12-13-14

CLOCKWISE ROTATION - Viewed from Flywheel			
VALVES	D379 CYLINDERS	D398 CYLINDERS	D399 CYLINDERS
Exhaust	1-4-5-8	1-4-5-8-9-12	1-2-3-4-5-6-9-10
Intake	1-3-6-8	1-3-4-6-7-12	1-2-6-7-8-11-13-14



**CHECKING VALVE LASH**

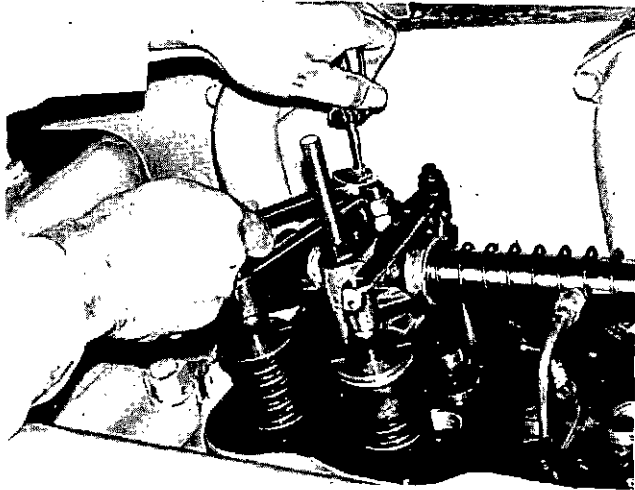
- Bar the flywheel one revolution in the direction of normal rotation. Align the "TDC 1" timing mark for your engine, ("TDC 1-7", "TDC 1-11" or "TDC 1-15"), with the timing pointer on the flywheel housing.
- With NO. 1 CYLINDER ON EXHAUST STROKE, check the lash for the following valves. Adjust if necessary. See the Lubrication and Maintenance Chart for correct valve lash.

NO. 1 CYLINDER ON EXHAUST STROKE COUNTERCLOCKWISE ROTATION - Viewed from Flywheel			
VALVES	D379 CYLINDERS	D398 CYLINDERS	D399 CYLINDERS
Exhaust	2-3-6-7	2-3-7-8-10-11	7-10-11-12-13-14-15-16
Intake	4-5-7-8	2-4-5-8-9-11	3-4-5-6-9-10-15-16

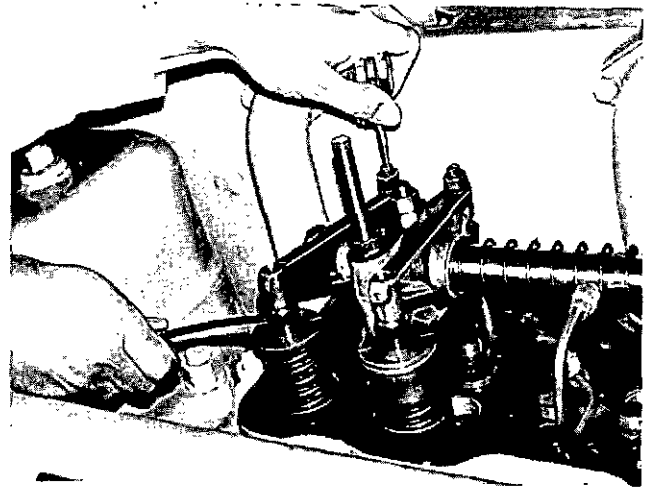
CLOCKWISE ROTATION - Viewed from Flywheel			
VALVES	D379 CYLINDERS	D398 CYLINDERS	D399 CYLINDERS
Exhaust	2-3-6-7	2-3-6-7-10-11	7-8-11-12-13-14-15-16
Intake	2-4-5-7	2-5-8-9-10-11	3-4-5-9-10-12-15-16

### ADJUSTING VALVE LASH

- Loosen the locknut on the adjusting screw.
- Hold the locknut and turn the adjusting screw to obtain the proper lash.
- Hold the adjusting screw and tighten the locknut.
- Recheck the lash.



LOOSENING LOCKNUT



ADJUSTING VALVE LASH

### ENGINE VALVE LASH

(D346, D348, D349 Engines)

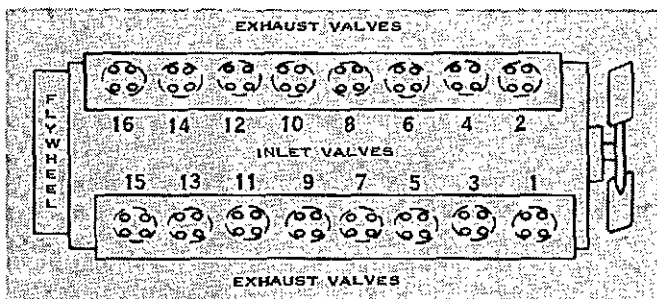
#### PREPARING TO SET VALVE LASH

1. Stop the engine.
2. Remove the flywheel housing timing cover.
3. Wipe the base of the valve covers to keep dirt from getting into the valve mechanism.
4. Remove both valve covers.
5. Bar the flywheel in the direction of normal rotation. Align the "TC1" timing mark with the flywheel housing timing pointer.
6. Observe the rockers for cylinder No. 1. Determine if the piston is on COMPRESSION OR EXHAUST STROKE. COMPRESSION STROKE: Both inlet and exhaust valve rockers can be moved freely. EXHAUST STROKE: Only inlet valve rockers move freely.

7. Refer to the tables below, and set only those valves specified in the appropriate table.

D346 ENGINES		
NO. 1 CYLINDER ON COMPRESSION STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	6-8	1-3
EXHAUST	4-8	1-5
NO. 1 CYLINDER ON EXHAUST STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	2-4	5-7
EXHAUST	2-6	3-7

D348 ENGINES		
NO. 1 CYLINDER ON COMPRESSION STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	6-10-12	1-3-7
EXHAUST	4-6-12	1-5-9
NO. 1 CYLINDER ON EXHAUST STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	2-4-8	5-9-11
EXHAUST	2-8-10	3-7-11



D349 ENGINE SHOWN

Inlet Valves: Located toward center of vee.

Exhaust Valves: Located toward outside of vee.

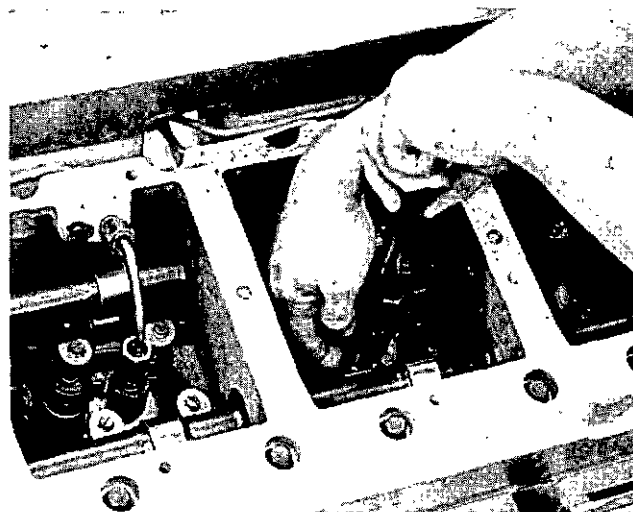
D349 ENGINES		
NO. 1 CYLINDER ON COMPRESSION STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	2-8-12-14	1-7-11-13
EXHAUST	2-4-6-8	1-3-5-9

NO. 1 CYLINDER EXHAUST STROKE		
VALVES	CYLINDERS	
	LEFT BANK	RIGHT BANK
INLET	4-6-10-16	3-5-9-15
EXHAUST	10-12-14-16	7-11-13-15

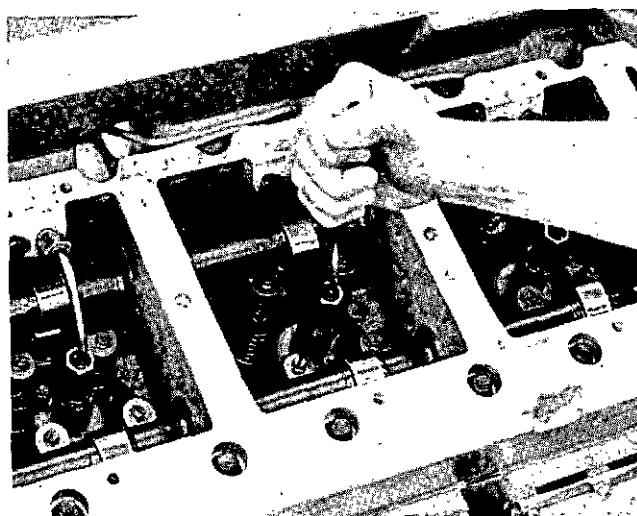
- Bar the flywheel one revolution in the direction of normal rotation and align the flywheel TDC timing mark.
- Set the remaining valves as specified in the remaining table.

#### SETTING VALVE LASH

- Turn the adjusting screw clockwise to zero lash position: The precise position where rocking movement of the rocker can no longer be detected with finger pressure. Further turning of the adjusting screw beyond this point will begin raising the valve from the valve seat.
- Turn each adjusting screw counterclockwise for the exact number of clicks shown in the Lubrication and Maintenance Chart.
- After adjusting all of the valves specified in one of the two tables, bar the flywheel one revolution in the direction of normal rotation and adjust all of the valves specified in the other table.



FINDING ZERO LASH POSITION



SETTING VALVE LASH

## VALVE ROTATORS

#### CHECKING ROTATION

After checking all valve clearances, and before installing the valve covers:

- Start the engine.
- Move the governor control to low idle position.
- Watch the serrations on each valve retainer. Each valve retainer should turn slightly each time the valve closes.

If a valve retainer fails to rotate, contact your Caterpillar dealer. Repairs must be made to prevent burning the valve.

*If all valves rotate, proceed as follows:*

- Stop the engine.
- Inspect and install valve cover gaskets. Install new gaskets if necessary.
- Install the valve covers.
- Install the flywheel housing timing cover.

# FUEL SYSTEM

## FUEL

Check the fuel supply. Order fuel as required. See Lubrication and Maintenance Chart for fuel recommendations.

## FUEL TANK

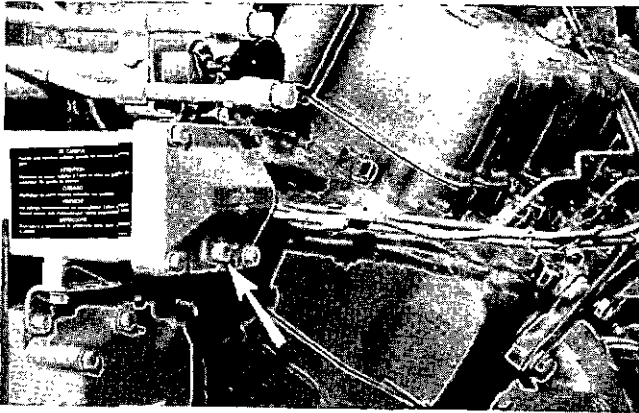
Open the fuel tank drain valve to drain water and sediment from the fuel tank. To minimize water contamination, fill the fuel tank in the late afternoon if possible. As the fuel is consumed, air with some humidity must replace

the fuel in the tank. By filling the tank in the late afternoon, this humid air is expelled before the moisture can condense on the cool inside walls of the fuel tank.

## FUEL FILTERS

### DRAINING WATER AND SEDIMENT

1. Close the fuel supply valve if the fuel tank is located above the level of the fuel filters.
2. Remove the drain plug from one cover of the fuel filter housing. Drain water and sediment from the filter housing.



REMOVING FILTER HOUSING DRAIN PLUG

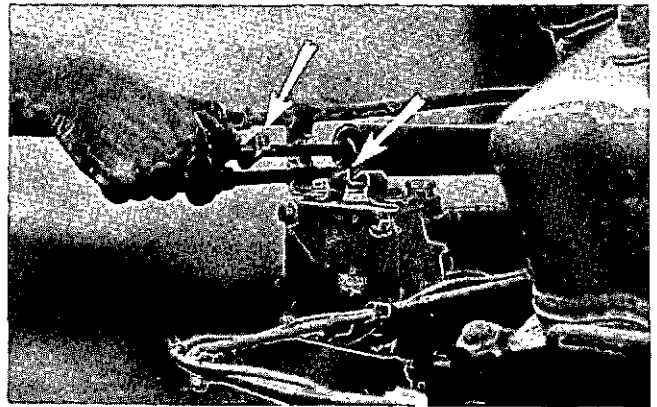
3. Install the drain plug.
4. Remove the drain plug from the other cover of the fuel filter housing.
5. Drain water and sediment from that end.
6. Install the drain plugs and vent plug.
7. Prime the fuel system.

### PRIMING THE FUEL SYSTEM

1. Open the fuel supply line valve.
2. Move the governor control lever to the shut-off position.
3. Turn the pump handle knob counterclockwise; release the lock plate from the retainer on the fuel priming pump.

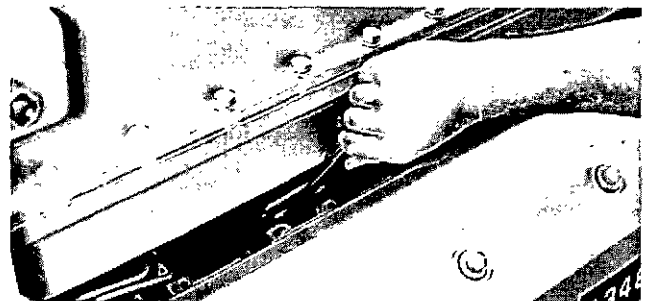
4. Operate the fuel priming pump until the air in the fuel system has been pumped through the fuel return line to the fuel tank.

If desired, the fuel return line connection may be loosened. When a solid stream of fuel flows from the connection, air has been expelled and the connection can be tightened.



OPERATING THE PRIMING PUMP

5. Secure the pump handle: Turn the lock plate vertically, turn the pump handle knob clockwise until the lock plate contacts the plate retainer.
6. Start the engine. If the engine misfires or smokes, loosen a fuel injection line nut, and allow the fuel to flow until free of air bubbles. Tighten the line nut; open the next line nut and continue venting each successive line.



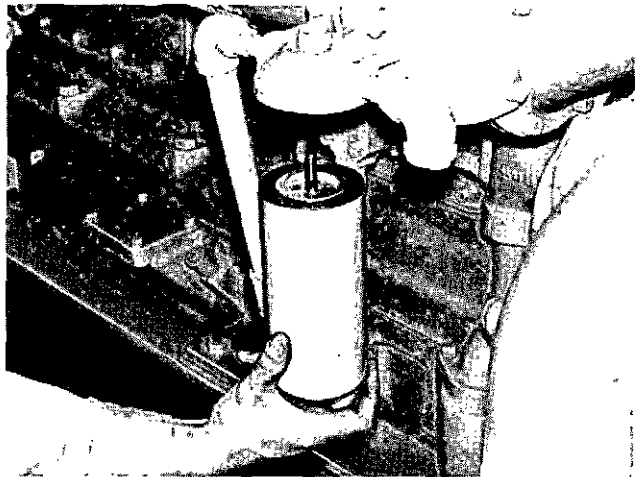
LOOSENING FUEL LINE NUT AT THE NOZZLE

## CHECKING FUEL PRESSURE GAUGE

With engine running, the fuel pressure gauge should register in the NORMAL range. If the gauge registers in the OUT range, service the fuel filter elements.

## CLEANING PRIMARY FILTER ELEMENT

1. Stop the engine.
2. Close the diesel fuel supply line valve.
3. Loosen the nut on the cover and remove the case.



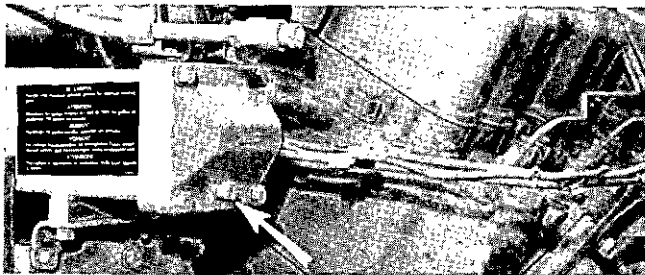
## REMOVING PRIMARY FUEL FILTER

4. Remove the filter element. Clean the element and case in kerosene or diesel fuel.
5. Inspect and install the upper and lower cover gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Open fuel supply line valve.
8. Prime the fuel system.

## INSTALLING FINAL FUEL FILTER ELEMENTS

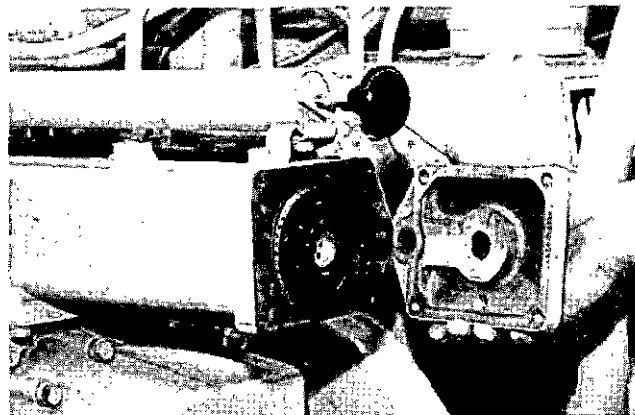
If your engine is equipped with a standard fuel filter system, read the following instructions. If your engine is equipped so as to permit changing the fuel filter elements while the engine is operating, read the topic, "DUPLEX FUEL FILTER SYSTEM".

1. Close the fuel supply line valve.
2. Remove the drain plug in each cover. Drain the fuel filter housing.



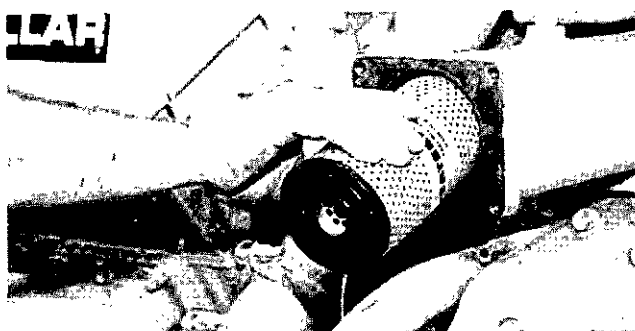
**DRAIN PLUG**

3. Remove both end covers.



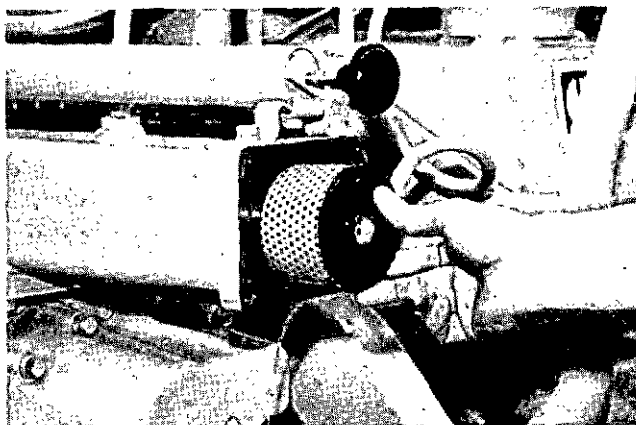
## REMOVING FILTER COVER

4. Push the used filter elements from left to right through the filter housing.



## REMOVING USED FILTER ELEMENTS

5. Wipe sediment from inside the filter housing; use a clean cloth.
6. Inspect the cover gaskets. Install new gaskets if necessary.
7. Install the right cover. Install new filter elements,



## INSTALLING NEW FILTER ELEMENTS

8. Install the left cover.
9. Install the drain plugs in the covers.
10. Open the fuel supply line valve.
11. Prime the fuel system.

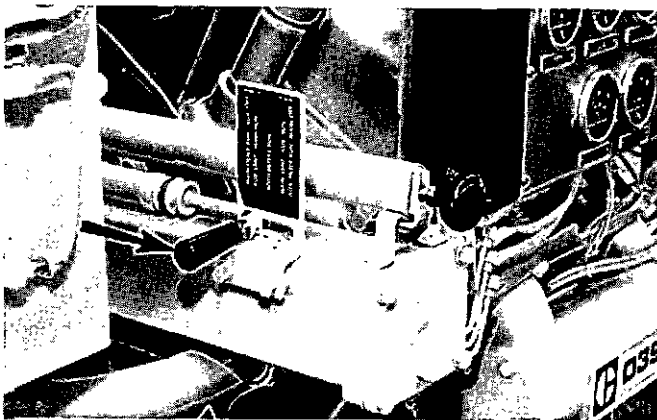
## DUPLEX FUEL FILTER SYSTEM

During normal engine operation, the selector lever should be positioned in the "MAIN FILTER RUN-AUX. OFF" position. The fuel will then be filtered by the main filter elements located in the right hand side of the fuel filter housing. Two filter elements, located in the left hand side of the fuel filter housing, are auxiliary filter elements. When standing at the flywheel and looking forward, the right hand side is to the right, and the left hand side is to the left.

When the fuel pressure gauge indicates minimum acceptable pressure (20 psi), the main fuel filter elements must be changed. The fuel must be filtered by the two auxiliary filter elements while the main filter elements are being changed.

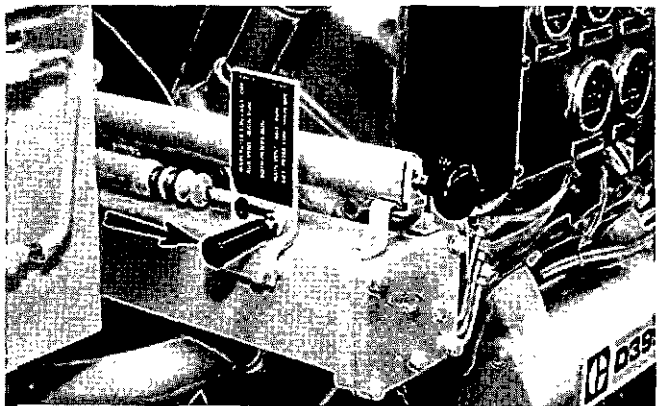
1. Move the selector lever to the AUX. VENT-MAIN RUN position.

Any air in the auxiliary filter housing will be vented back to the fuel tank while the main fuel filters will continue to filter the diesel fuel.



"AUX. VENT-MAIN RUN" POSITION

2. After air bubbles are no longer visible in the sight gauge, move the selector lever to the AUX. FILTER RUN-MAIN OFF position.



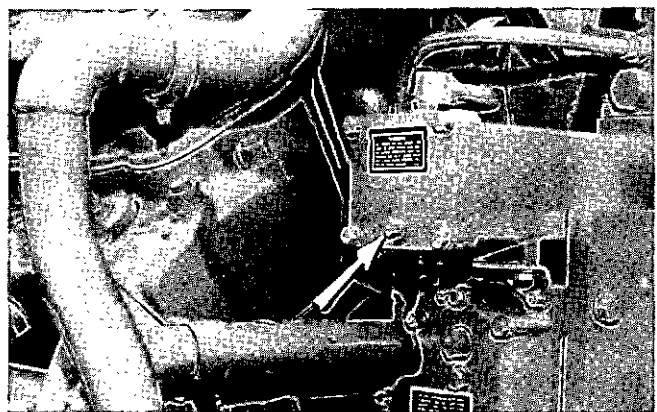
"AUX. FILTER RUN-MAIN OFF" POSITION

The auxiliary filter elements now filter the diesel fuel instead of the main filter elements.

3. Remove the drain plug from the right hand filter housing (as viewed from the flywheel looking forward) and remove the vent plug from the right hand cover. Drain that side of the filter housing.

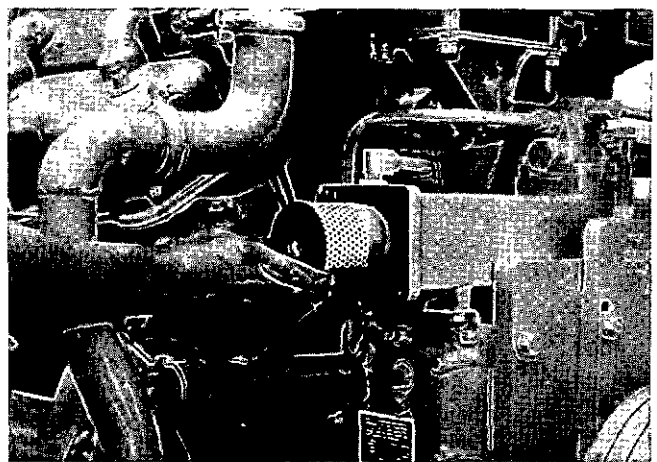
### CAUTION

Be sure you are removing the drain plug from the right hand filter cover. As soon as the drain plug is loosened, fuel will spray out under high pressure for a short time until pressure drops in the housing. If spraying of fuel continues, you are removing the wrong drain plug and preparing to remove the wrong cover.



RIGHT COVER AND DRAIN PLUGS

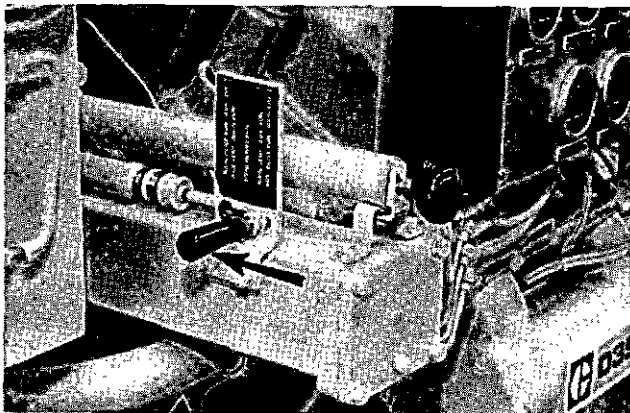
4. Remove the right hand cover. Remove the five filter elements.



REMOVING MAIN FILTER ELEMENTS

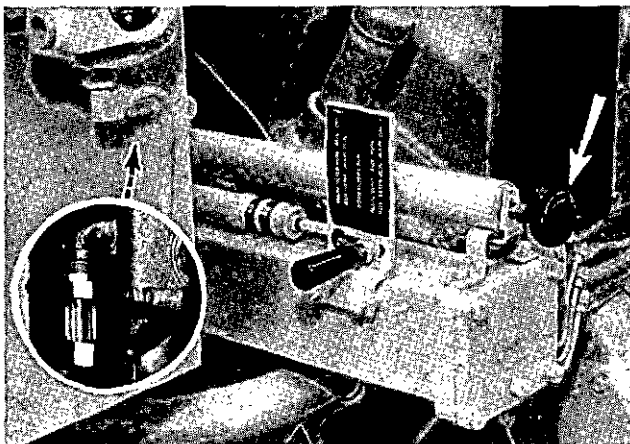
5. Check inside the filter housing for sediment. Remove sediment with a clean cloth.
6. Install new filter elements.
7. Inspect the cover gasket. Install a new gasket if necessary.
8. Install the cover.

9. Install the vent plug in the cover and the drain plug in the housing.
10. Observe the fuel pressure gauge reading. The gauge reading will indicate the condition of the auxiliary filter elements. If the fuel pressure gauge indicates minimum acceptable operating pressure (20 psi), service these auxiliary elements as described in the following topic.
11. Move the selector lever to the MAIN VENT-AUX. RUN position. While the auxiliary filter elements filter the fuel, the main filter housing will fill with fuel.



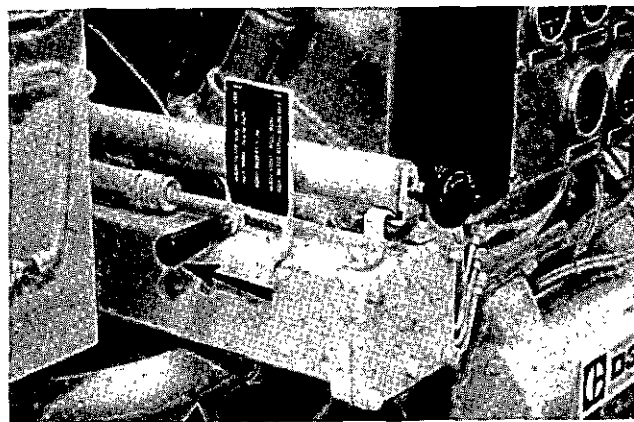
"MAIN VENT-AUX. RUN" POSITION

If the fuel filter elements are changed while the engine is stopped, prime the fuel system by pumping the fuel priming pump until bubbles are no longer visible in the bleed window.



FUEL PRIMING PUMP

12. After air bubbles are no longer visible in the bleed window, move the selector lever to the MAIN FILTER RUN-AUX. OFF position. The main filters will now be filtering the fuel.

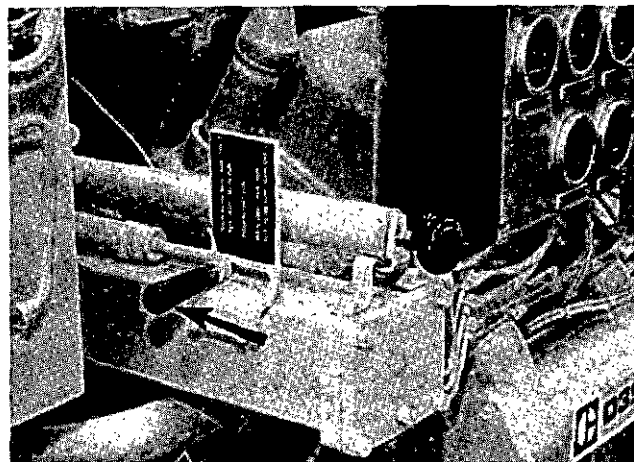


"MAIN FILTER RUN-AUX. OFF" POSITION

13. Check for fuel leaks.

#### INSTALLING AUXILIARY FUEL FILTER ELEMENTS

When the fuel is being filtered by the auxiliary fuel filter elements and the fuel pressure gauge indicates minimum acceptable pressure (20 psi), the auxiliary fuel filter elements must be changed. This can be done with the engine running and with the selector lever in the MAIN FILTER RUN-AUX. OFF position.

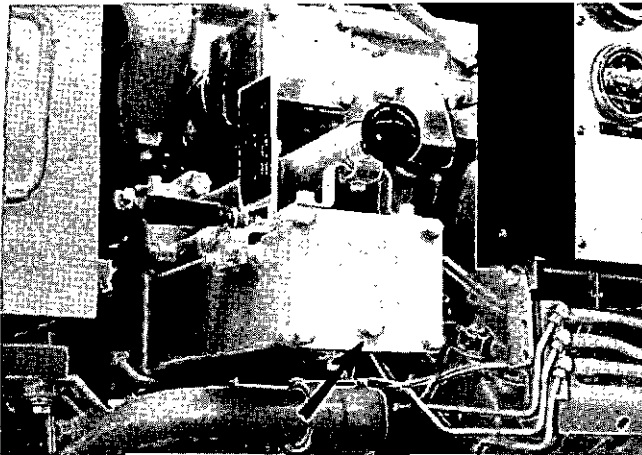


"MAIN FILTER RUN-AUX. OFF" POSITION

1. Remove the drain plug from the left hand housing, (as viewed from the flywheel looking forward), and remove the vent plug from the left hand cover. Drain that side of the filter housing.

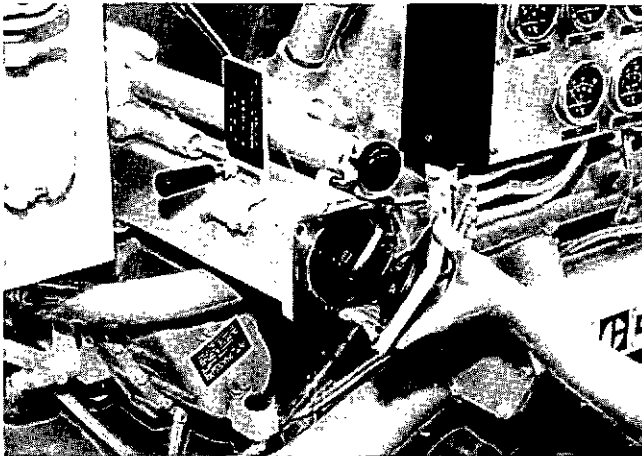
#### CAUTION

Be sure you are removing the drain plug from the left hand filter cover. As soon as the drain plug is loosened, fuel will spray out under high pressure for a short time until pressure drops in the housing. If spraying of fuel continues, you are removing the wrong drain plug and preparing to remove the wrong cover.



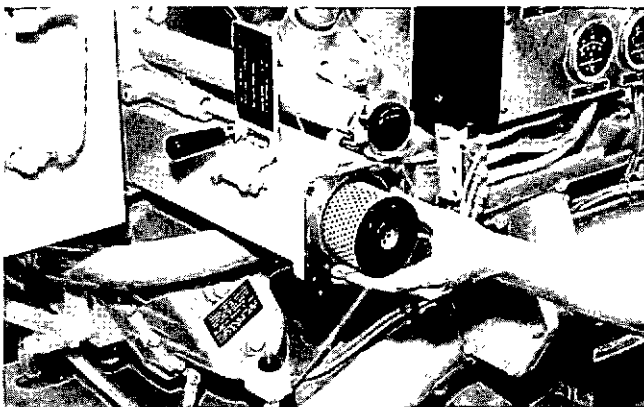
**LEFT COVER AND DRAIN PLUG**

2. Remove the left hand cover. Remove the two filter elements.



**REMOVING LEFT COVER**

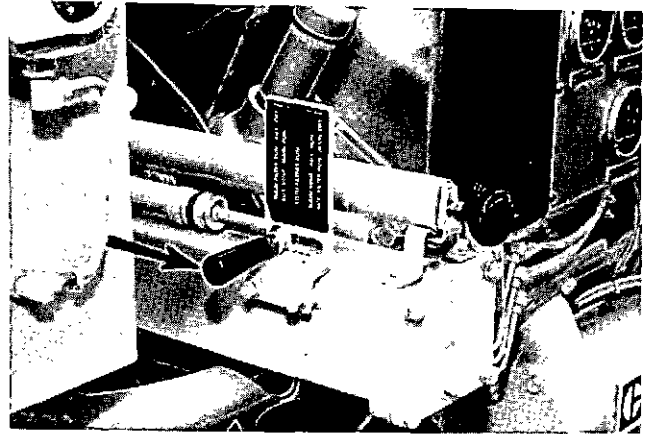
3. Check inside the filter housing for sediment. Remove sediment with a clean cloth.
4. Install new filter elements.



**INSTALLING NEW FILTER ELEMENTS**

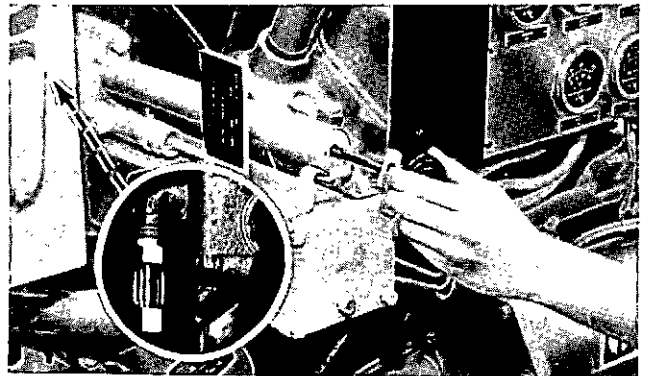
5. Inspect the cover gasket. Install a new gasket if necessary.
6. Install the cover.

7. Install the drain plug in the cover.
8. Move the selector lever to the AUX. VENT-MAIN RUN position. While the main filter elements filter the fuel, the auxiliary filter housing will fill with fuel.



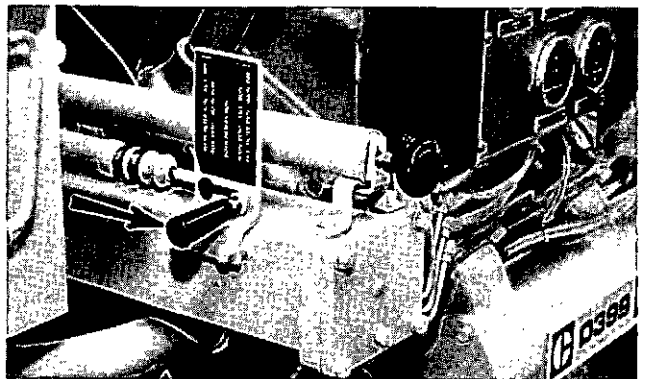
**"AUX. VENT-MAIN RUN" POSITION**

If the fuel filter elements are changed while the engine is stopped, prime the fuel system by pumping the fuel priming pump until bubbles are no longer visible in the bleed window.



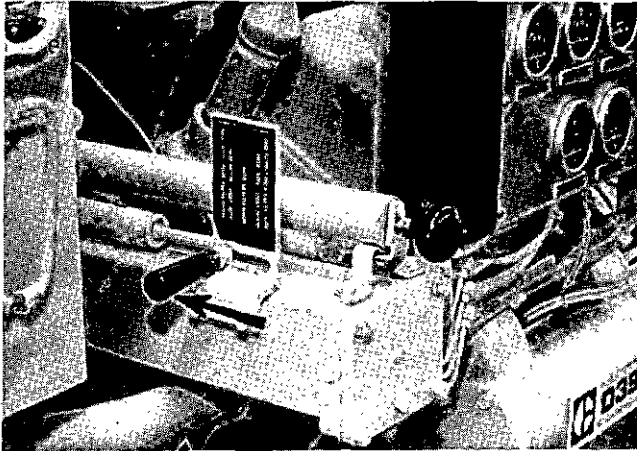
**OPERATING FUEL PRIMING PUMP**

9. After air bubbles are no longer visible in the bleed window, move the selector lever to the AUX. FILTER RUN-MAIN OFF position. Check for fuel leaks.



**"AUX. FILTER RUN-MAIN OFF" POSITION**

- After determining the auxiliary filters are ready for use, move the selector lever to the MAIN FILTER RUN-AUX. OFF position. The main filters will again be filtering the fuel.

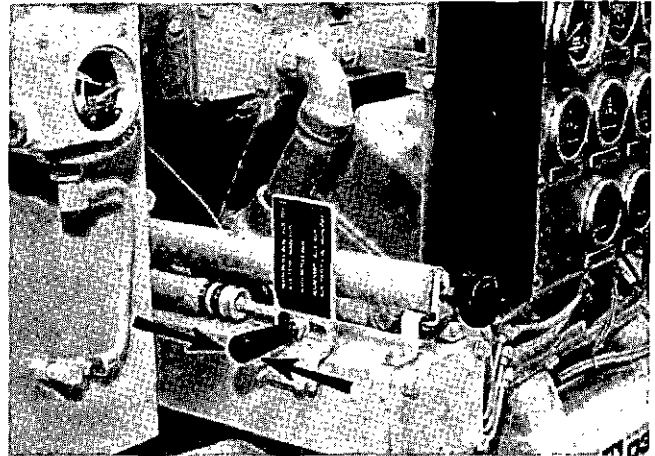


"MAIN FILTER RUN-AUX. OFF" POSITION

- When the fuel pressure gauge indicates minimum acceptable pressure (20 psi) with the engine running, the main fuel filter elements must be changed. See the topic, INSTALLING NEW FINAL FUEL FILTER ELEMENTS.

## RUNNING ON BOTH FILTER SYSTEMS

The engine can run using all of the filter elements in both fuel systems at the same time. Move the selector lever to the BOTH FILTERS RUN position. This will allow additional running time when both filter systems could be approaching a plugged condition as indicated by the fuel pressure gauge. As soon as possible, change all elements in both filter systems.

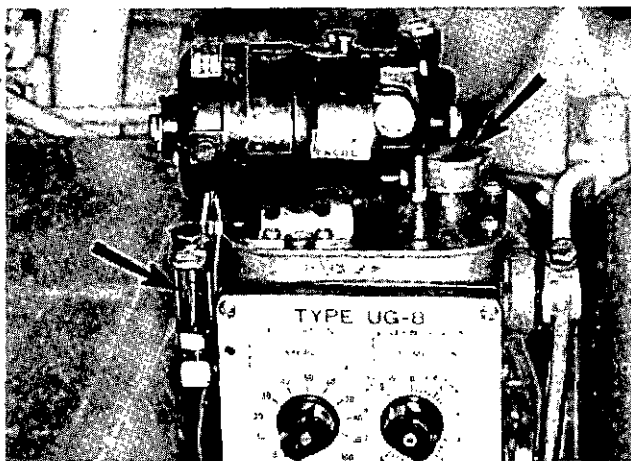


"BOTH FILTERS RUN" POSITION

## WOODWARD UG8 GOVERNOR

### CHECKING GOVERNOR OIL LEVEL

- Check the governor oil level sight gauge.
- Maintain the oil level between the ADD and FULL marks. Add oil as required. See Lubrication and Maintenance Chart for proper oil.



### CHECK OIL LEVEL AND FILL

### CHANGING GOVERNOR OIL

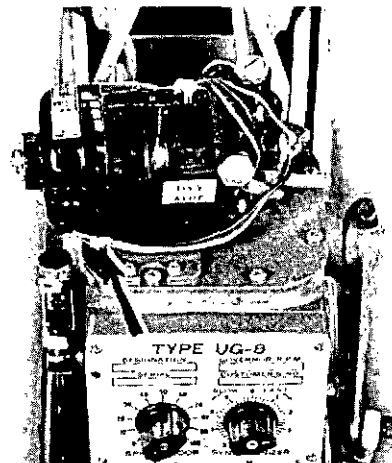
- Move the governor control lever to the shut-off position.

- Shut off the fuel tank fuel supply valve.
- Disconnect the ground cable from the battery.

### WARNING

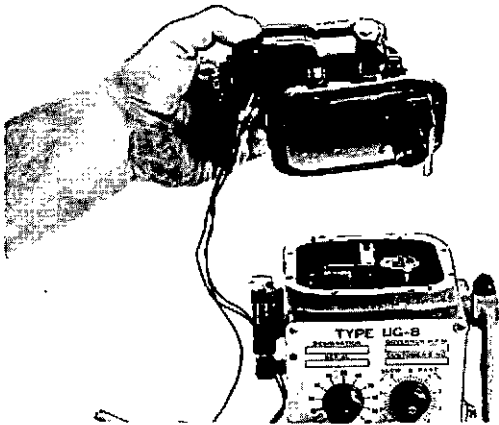
Be sure the engine cannot be started while work is being done. This is very important when the engine is equipped with an Automatic Start-Stop System.

- Disconnect the governor linkage from the governor.
- Disconnect the governor synchronizing motor wires.



DISCONNECT SYNCHRONIZING MOTOR

6. Remove the governor from the engine.
7. Remove the governor cover.



#### REMOVING GOVERNOR COVER

8. Turn the governor upside down and drain the oil.
9. Flush the governor with clean diesel fuel or kerosene.
10. Install the governor on the engine.
11. Fill the governor, with clean oil, to the FULL mark on the sight gauge. See Lubrication and Maintenance Chart for proper oil.
12. Connect the governor linkage.

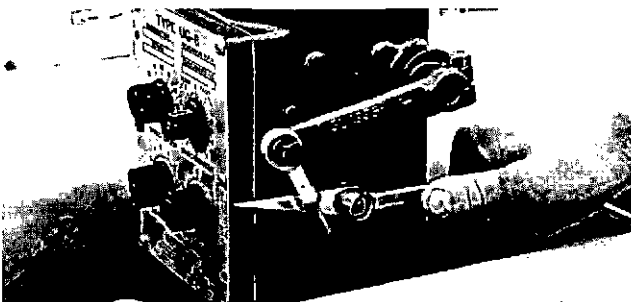
#### WARNING

Before starting the engine, check to be sure the governor linkage has been connected to the governor.

13. Connect the ground cable to the battery.

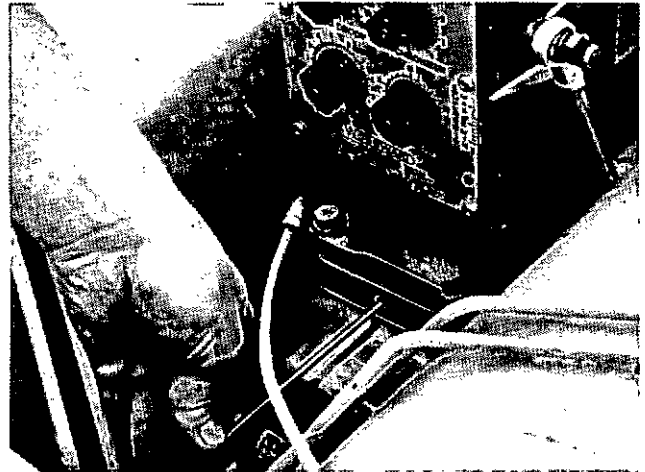
#### BLEEDING GOVERNOR

1. Start the engine and allow the engine to reach normal operating temperature.
2. Loosen the nut on the side of the governor which holds the compensation adjusting pointer.
3. Manually move the pointer to the extreme upper position and tighten the nut. This will allow the governor to be purged of air.



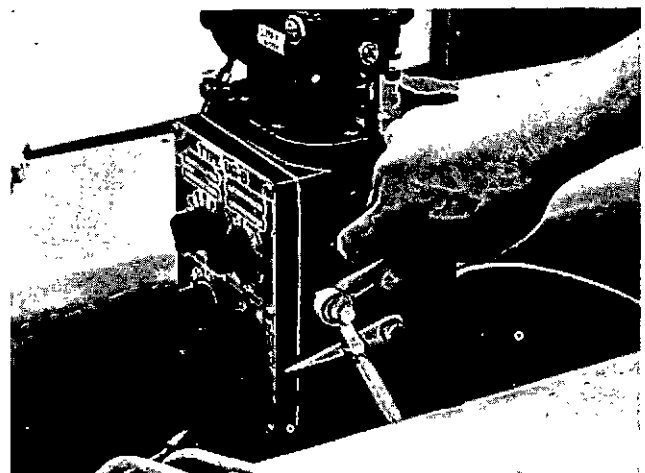
SETTING POINTER AT UPPER POSITION

4. Remove the plug from the base of the governor.
5. Using a wide blade screwdriver, engage the wide shallow screwdriver slot and turn the needle valve 3 or more turns counterclockwise.



#### OPENING NEEDLE VALVE

6. Allow the engine to surge for approximately 30 seconds.
7. Loosen the nut and move the compensation adjusting pointer to the extreme downward position. Tighten the nut.
8. Slowly turn the needle valve (wide shallow slot) clockwise until the surging stops.
9. It should now take less than one turn from this point to close the valve completely.
10. Open the valve to the same position where the surging had stopped.
11. Manually move the governor linkage to disturb the engine speed.



MANUALLY CHANGING ENGINE SPEED

If the engine speed stabilizes, and the needle valve is only 1/2 to 3/4 turn open, the governor is properly adjusted. Install the base plug.

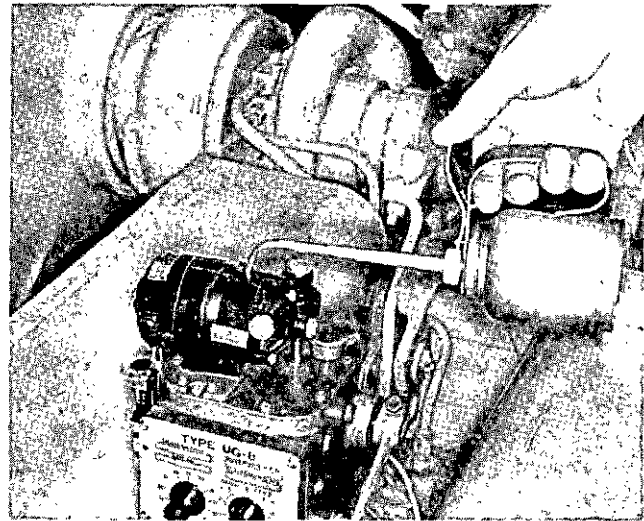
If more than a 3/4 turn is required to stop the engine from surging, proceed with the following steps.

12. Raise the pointer two divisions on the pointer scale.
13. Engage the wide shallow slot and turn the needle valve counterclockwise 3 or more turns.
14. Allow the engine to surge approximately 30 seconds.
15. Gradually turn the needle valve clockwise until surging just stops.
16. Note the portion of a turn required to close the needle valve.
17. Open the valve exactly to the same position surging stopped.
18. Manually move the governor linkage to disturb the engine speed. The engine speed should stabilize with the needle valve opened 1/2 to 3/4 turn.
19. A valve opened less than 1/2 of a turn produces a slow response to load changes. A valve opened more than 3/4 of a turn produces excessive speed response to load change. If the engine does not stabilize between 1/2 to 3/4 turn open, raise the pointer two divisions and repeat steps 12 through 19.

20. When the engine speed stabilizes, install the base plug.

#### LUBRICATING THE GOVERNOR SYNCHRONIZING MOTOR

Fill the cup on top of the motor with clean oil. See Lubrication and Maintenance Chart for proper oil.



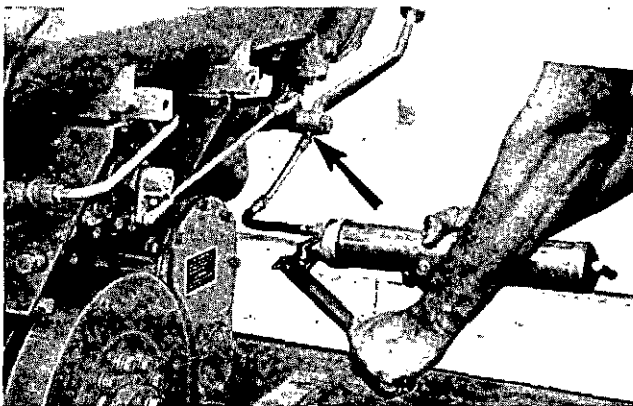
LUBRICATING ELECTRIC MOTOR

### FUEL PRIMING PUMP LUBRICATION

Earlier drum type fuel priming pumps require the pump shaft bearings be lubricated with grease. The priming pump shaft of the D346, D348, D379 and D398 Engines requires 1 or 2 strokes of a grease gun. Each bearing supporting the D399 pump lever shafting requires 1 or 2 strokes of a grease gun.

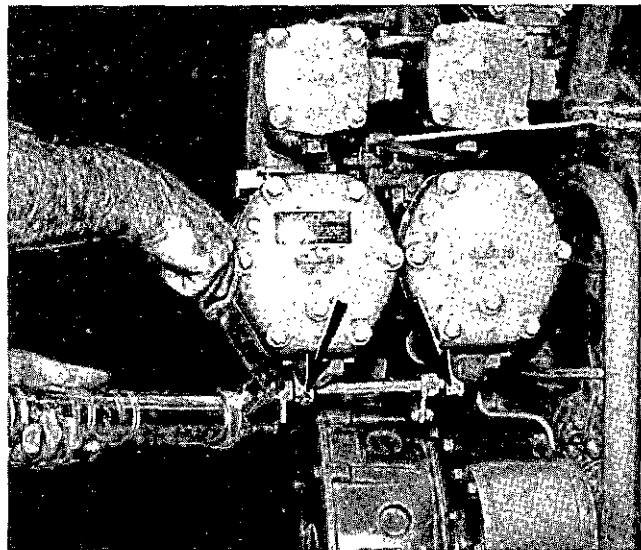
Lubricate the fuel priming pump shaft bearing with grease:

- 1 or 2 strokes, 1 fitting in the lever bearing.



LUBRICATING FUEL PRIMING PUMP BEARINGS

D399: 1 or 2 strokes, 2 fittings; 2 bearings:



LUBRICATING FUEL PRIMING PUMP BEARINGS

The horizontal type priming pump on top of the fuel filter housing of the D349 and the later D346, D348, D379, D398 and D399 Engines does not require servicing.

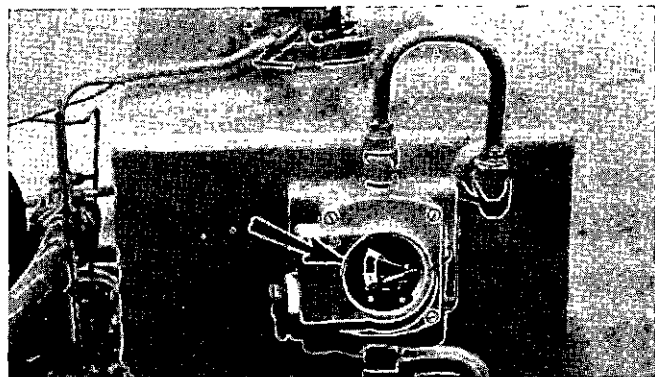
# COOLING SYSTEM

## ENGINE JACKET WATER

### CHECKING COOLANT LEVEL— Using Coolant Sight Level Gauge

If the engine is equipped with a sight level gauge on either the radiator, expansion tank, or heat exchanger system, the coolant level can be checked with the engine either running or stopped.

Add coolant whenever the coolant level is in the LOW level range. A warning device will be actuated when the level is lowered to the unsafe operating level.



SIGHT LEVEL GAUGE

### CHECKING COOLANT LEVEL

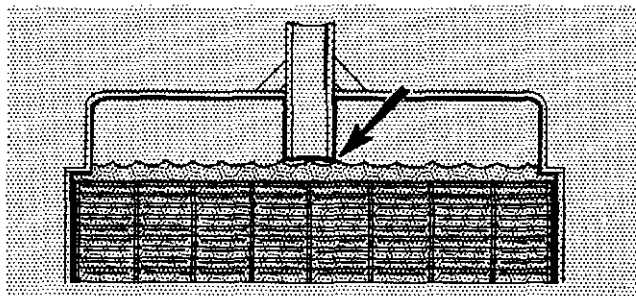
With the engine stopped:

1. Slowly turn the filler cap to the first stop and release pressure.

#### WARNING

**Be careful. If the engine is warm—steam may spray outward under high pressure.**

2. Push the cap down; turn until the cap is released.
3. Maintain level to base of fill pipe. The coolant requires expansion space as it is heated.



PROPER COOLANT LEVEL

4. Make-up coolant should be one of the following, in the order of preference:
  - a. Permanent anti-freeze and fresh water solution,

- b. Rust inhibitor and fresh water solution.
- c. Drinkable water,
- d. Any available untreated raw water—never salt water.

(a) Must be used if engine is to be shut down in below freezing weather without draining the coolant. (b) Can only be used when the coolant temperature is above freezing, or if the coolant will be immediately drained after shut down during below freezing temperatures.

(c) or (d) Should only be used as a "temporary fix". As soon as possible, return the system to either (a) or (b).

### CHECKING WATER TEMPERATURE GAUGE READING

The water temperature gauge should normally register in the NORMAL range when operating. However, with some systems, as long as the coolant does not boil the cooling system is functioning properly.

1. If the water temperature gauge continually registers near—or in the "HOT" range—without boiling, have the system checked to determine if the cooling system is functioning properly.
2. Frequently check the water temperature gauge while operating. Be sure to note any deviation from the normal reading.
3. Whenever the reading changes, investigate the cause and have necessary repairs made.

### DRAINING RADIATOR OR EXPANSION TANK

Whenever it is necessary to drain the cooling system for repairs:

1. Shut the engine off.
2. Slowly turn the pressure cap to the first stop and release pressure.

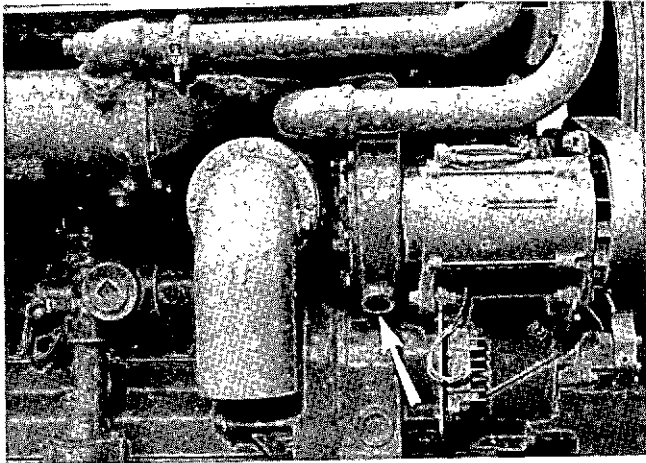
#### WARNING

**Be careful. If the engine is warm—steam may spray outward under high pressure.**

3. Push the cap down and turn until the cap is released.
4. Open the drain valve for the radiator, or expansion tank.

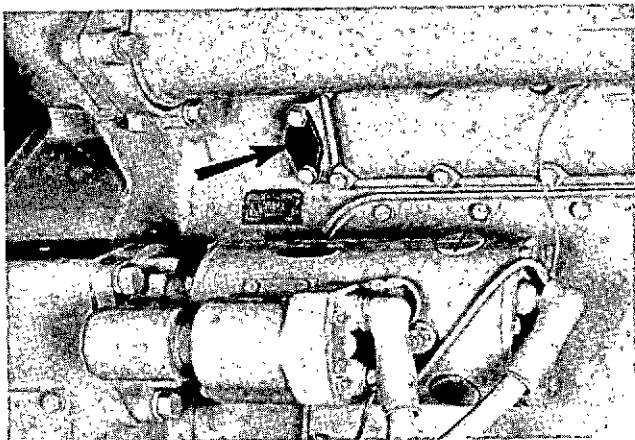
**DRAINING COMPLETE COOLING SYSTEM  
(D379, D398, D399 Engines)**

1. Drain the radiator or expansion tank.
2. Remove the water pump drain plug.



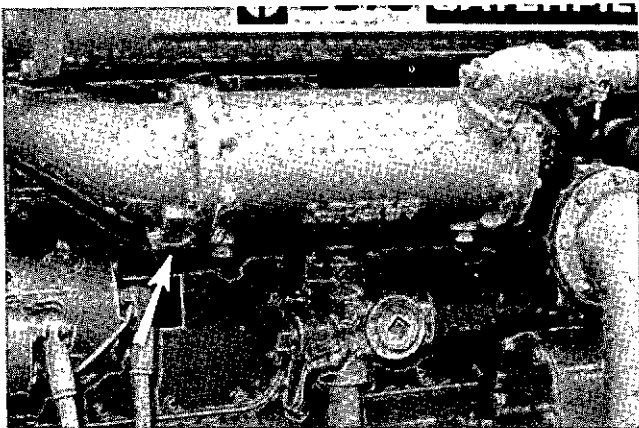
**COOLANT DRAIN**

3. Remove the engine block right rear drain cover.



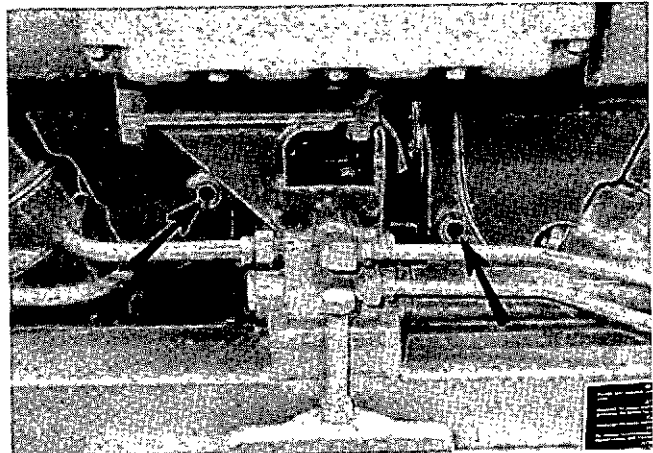
**COOLANT DRAIN**

4. Remove the drain plug from the elbow of the oil cooler.



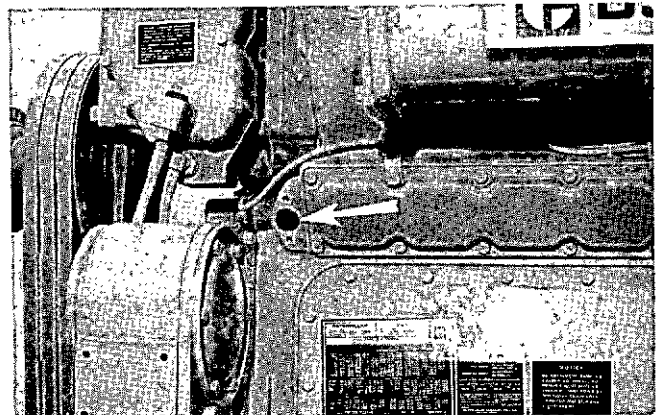
**COOLANT DRAIN**

5. Remove the drain plugs from the front of the left and right water shields.

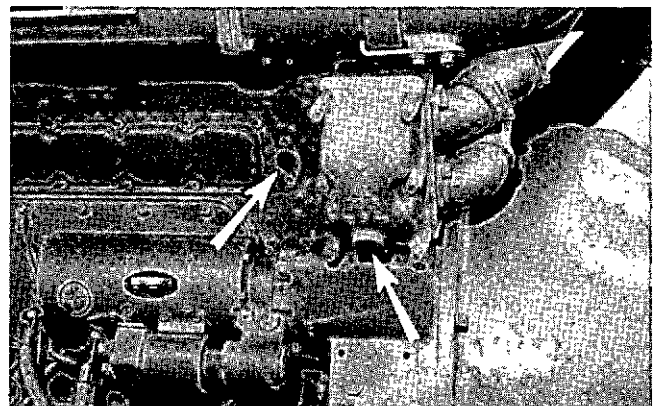


**COOLANT DRAINS**

6. Remove the front and rear drain covers from the left side of the engine block.
7. Remove the drain plug from the elbow on the left side of the flywheel housing.

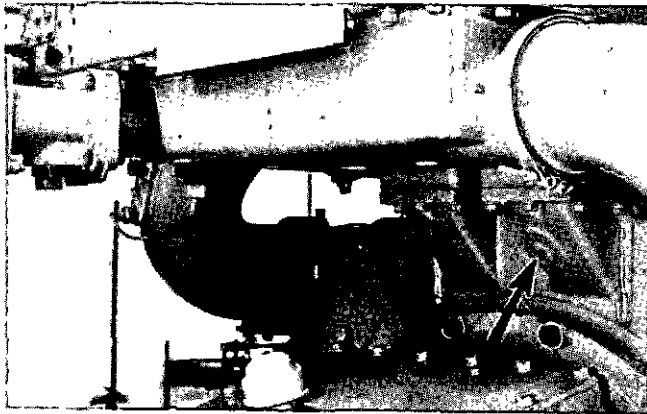


**COOLANT DRAIN**



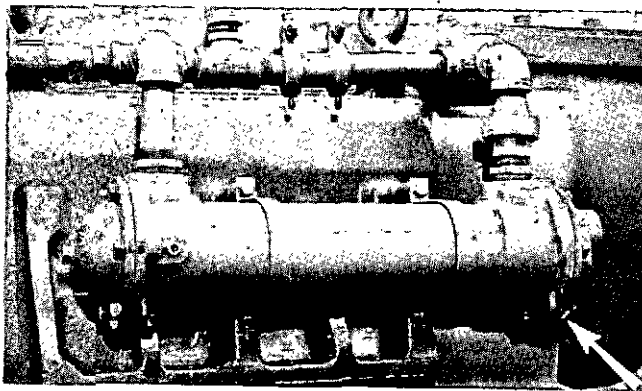
**COOLANT DRAINS**

8. Remove the aftercooler drain plugs.



**COOLANT DRAIN**

9. If equipped with a marine gear oil cooler, remove the oil cooler bonnet drain plug.

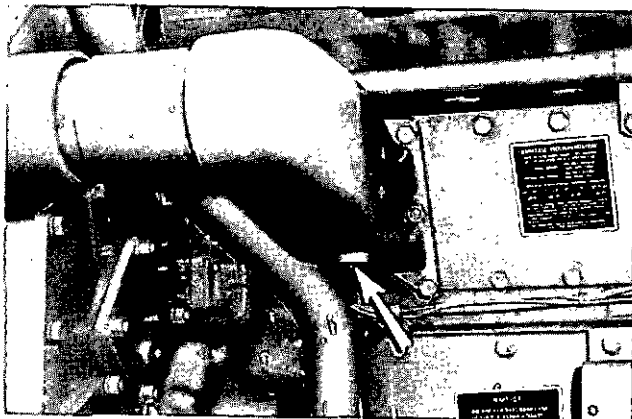


**COOLANT DRAIN**

10. Allow the coolant to drain.
11. Install all drain covers and plugs. Close the radiator or expansion tank drain valve.

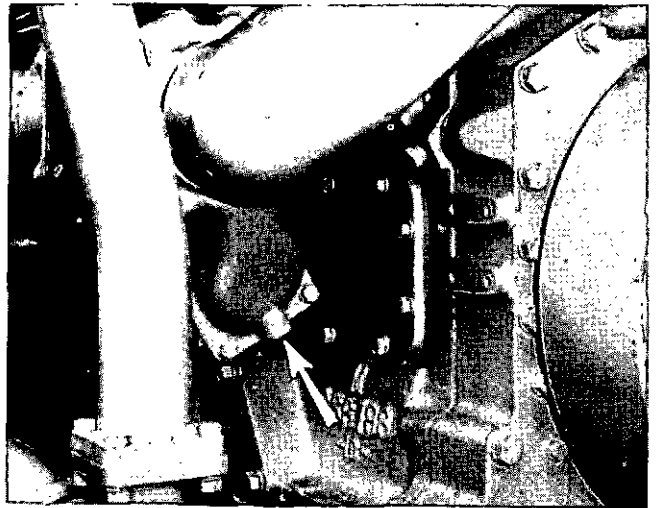
**DRAINING COMPLETE COOLING SYSTEM  
(D346, D348, D349 Engines)**

1. Open the radiator or expansion tank drain.
2. Remove the left front elbow drain plug.



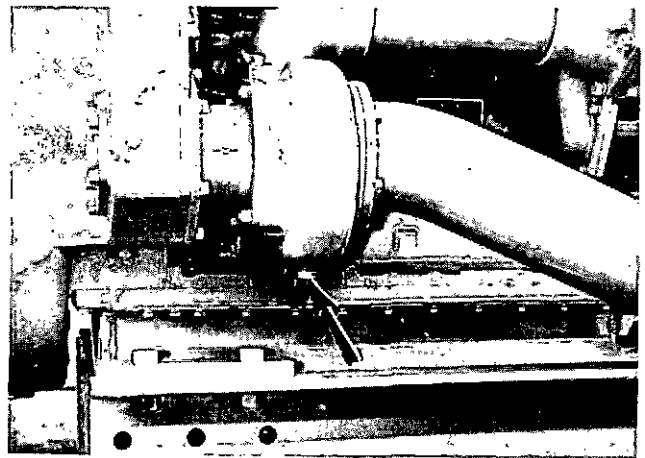
**ELBOW DRAIN**

3. Remove the oil cooler bonnet drain plug.



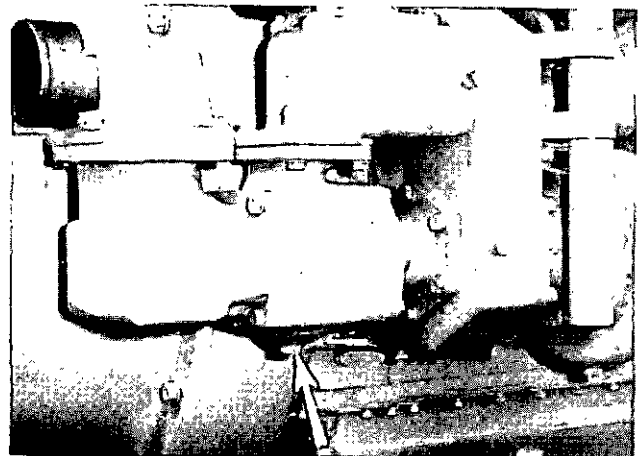
**OIL COOLER WATER DRAIN**

4. Remove the engine jacket water pump drain plug.



**WATER PUMP DRAIN PLUG**

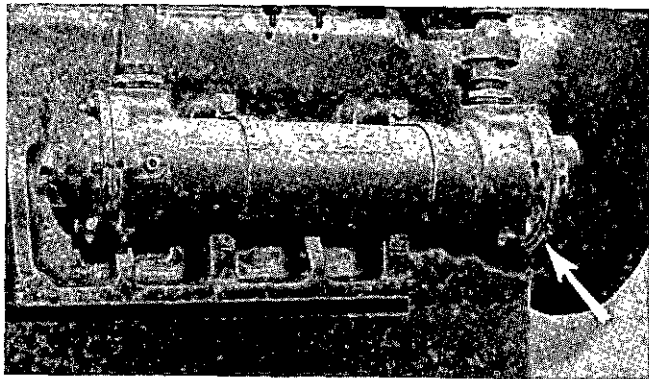
5. Remove the auxiliary water pump drain plug if so equipped.



**AUXILIARY WATER PUMP DRAIN**

6. After draining, install all drain plugs.

- If equipped with a marine gear oil cooler, remove the heat exchanger drain plug.



**COOLANT DRAIN**

- Allow the coolant to drain.
- Install all drain covers and plugs. Close the radiator or expansion tank drain valve.

#### FLUSHING COOLING SYSTEM

To clean the cooling system, any good commercial radiator cleaning solution can be used. Follow the instructions included with the cleaner.

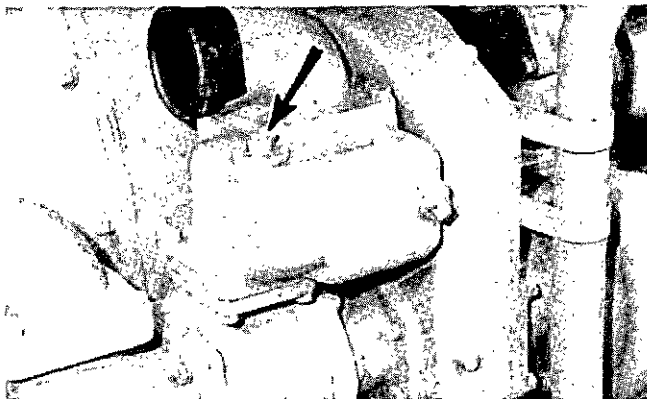
The cooling system can be cleaned using oxalic acid and sodium carbonate as follows:

- Fill the cooling system with a solution consisting of 2 pounds of oxalic acid or sodium bisulfate ( $\text{NaHSO}_4$ ) with every 10 gallons of water. (Mix 25 grams with every 1 liter of water).
- Start the engine and operate at operating temperatures for 1/2 to 1 hour.
- Stop the engine and drain the cooling system.
- Flush the system with clean water until the draining water is clear.

- Install all drain plugs.
- Fill with a solution consisting of 1/2 pound sodium carbonate crystals ( $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ ) with every 10 gallons of water. (Mix 6 grams with every 1 liter of water),
- Start and run the engine for 10 minutes.
- Stop the engine and drain the cooling system.
- Flush the cooling system with clean water.
- Install all drain plugs.

#### FILLING COOLING SYSTEM

- Add antifreeze, if required.
- Fill to correct level with water which is free as possible from scale forming minerals.
- Fill the auxiliary water pump tank, if the raw water system was drained. Open the raw water valve.



**AUXILIARY WATER PUMP FILL PLUG**

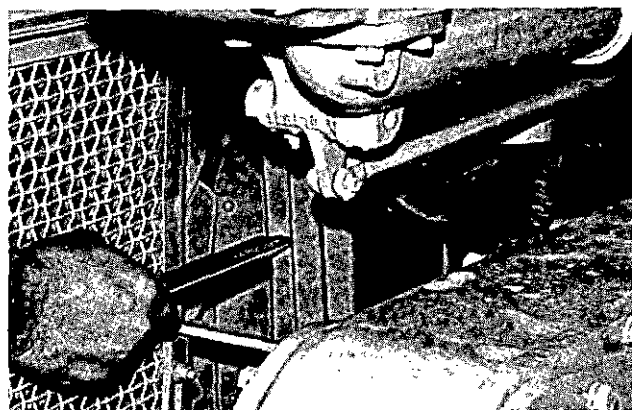
- Start and run engine for 10 minutes.
- Remove the pressure cap and check the coolant level.
- Add coolant, if needed, until coolant is to the bottom of the filler tube.
- Install the radiator or expansion tank cap.

#### FAN BELTS AND DRIVE

- Check belt wear.
- Apply a 25 pound (10 kg) force, perpendicular to the belt, midway between the driver and driven pulley and measure the belt deflection.

#### BELT DEFLECTION

ENGINE	BELT DEFLECTION
D346, D348, D349, D379	9/16" to 13/16" (15 to 20 mm)
D398, D399	1 1/8" to 1 3/8" (30 to 35 mm)

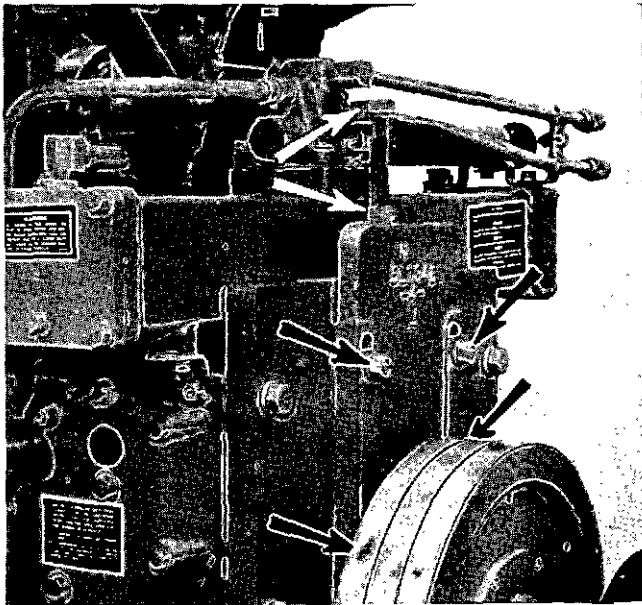


**MEASURING BELT DEFLECTION**

3. If one belt in a set requires replacement, always install a new matched set of belts—never replace just the worn belt. If only the worn belt is replaced, the new belt will be carrying all of the load—as it will not be stretched as much as the older belts—and all of the belts will fail in rapid succession.

#### ADJUSTING THE D346, D348 OR D379 FAN BELTS

1. Loosen the four nuts holding the fan plate to the engine block.
2. Loosen locknut. Turn the adjusting screw until belt is adjusted properly.

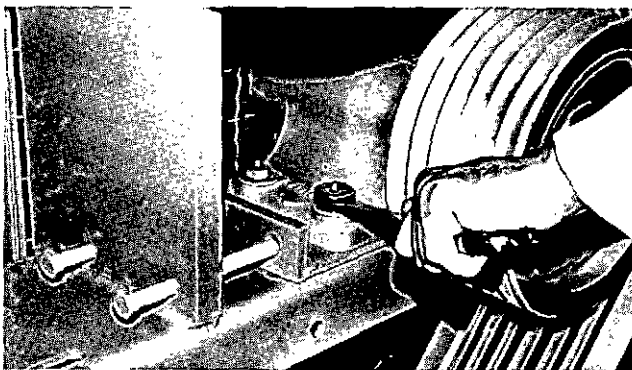


ADJUSTING D379 FAN BELT

3. Tighten the four nuts and locknut.
4. Check the belt adjustment.

#### ADJUSTING THE D349, D398 OR D399 FAN BELTS

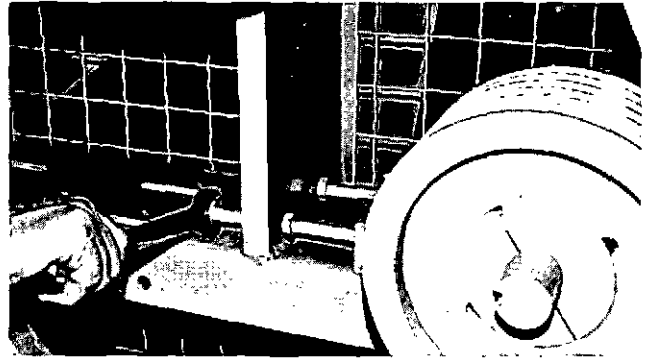
1. Loosen the idler pillow block mounting bolts.



LOOSENING MOUNTING BOLTS

2. Loosen the locknut on the pillow block positioning screw.

3. Turn the positioning screw until the belt is adjusted properly.

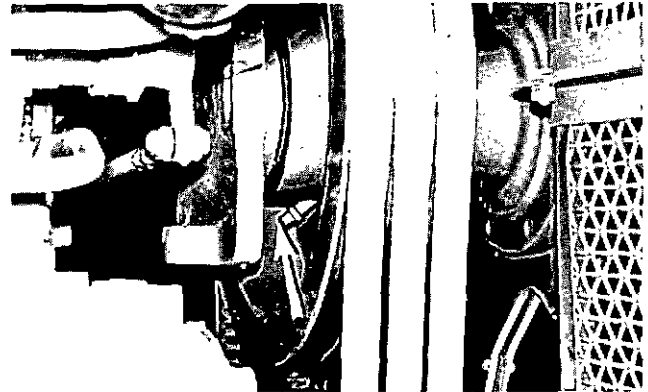


POSITIONING SCREW

4. Tighten the pillow block mounting bolts.
5. Tighten the locknut on the positioning screw.
6. Check the belt adjustment.

#### LUBRICATING D346, D348 OR D379 FAN DRIVE

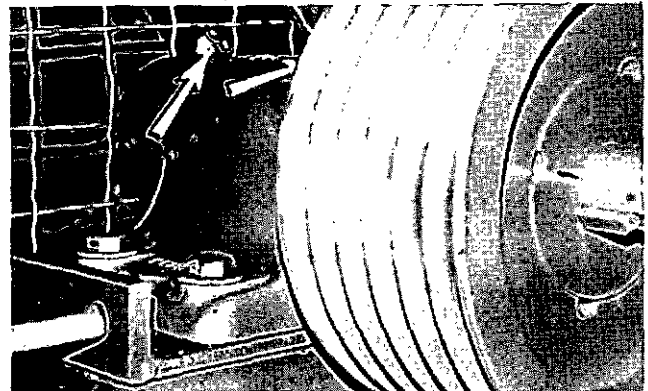
Lubricate the fan drive bearing with grease; 1 or 2 strokes, 1 fitting.



FAN DRIVE BEARING

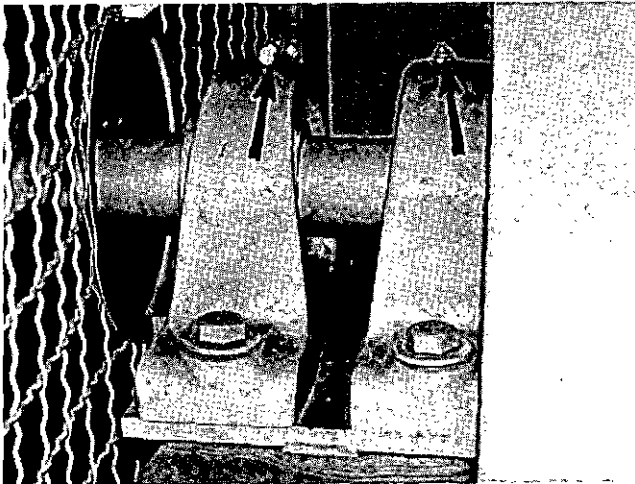
#### LUBRICATING D349, D398, D399 FAN DRIVE

1. Lubricate the idler pillow block bearings with grease; 1 or 2 strokes, 2 fittings.



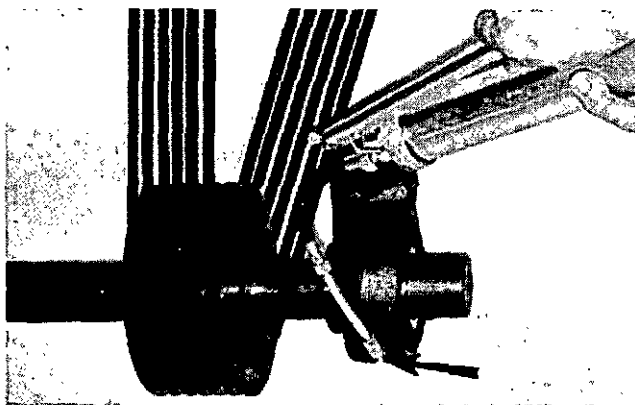
IDLER PILLOW BLOCK BEARINGS

2. Lubricate the upper pillow block bearings with grease; 1 or 2 strokes, 2 fittings.



UPPER PILLOW BLOCK BEARINGS

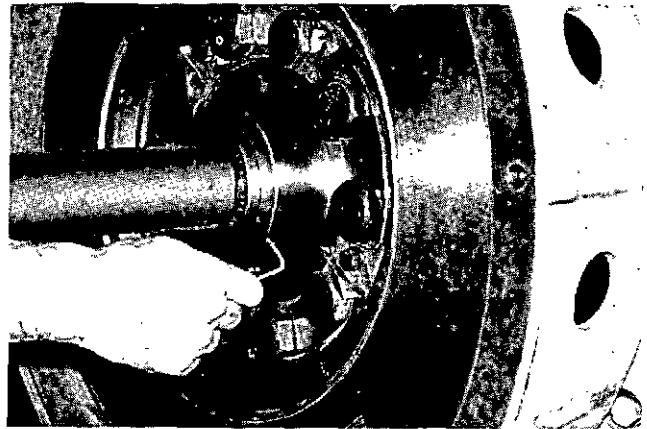
3. D399 Engine only: Lubricate the lower pillow block bearing with grease; 1 or 2 strokes, 1 fitting.



LUBRICATING LOWER PILLOW BLOCK BEARING

#### LUBRICATING D399 CRANKSHAFT COUPLING

1. Rotate the crankshaft until the two lubricating plugs are 45° from horizontal.
2. Remove the lower plug.
3. Remove the upper plug and install a grease fitting.
4. Lubricate with grease until the grease appears at the lower hole.
5. Remove the fitting, wipe off the excess grease, and install both plugs.



REMOVING LUBRICATING PLUGS ON CRANKSHAFT COUPLING

#### RAW WATER ZINC RODS

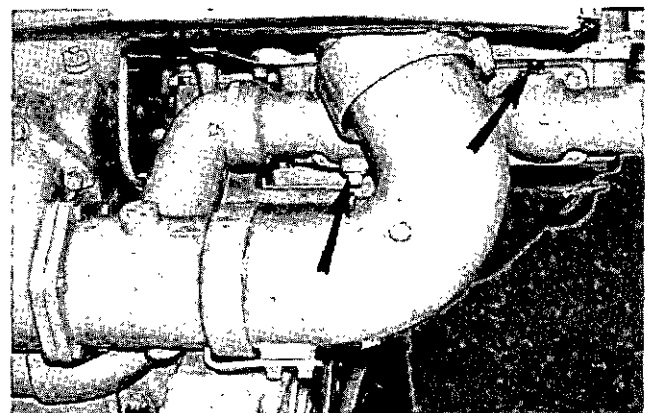
Salt water has a highly corrosive reaction with metal by a chemical action called "electrolysis". To prevent this chemical action taking place, with parts used in the raw water system, zinc plugs are placed in the raw water piping. Zinc is a relatively soft metal which reacts quite readily with the salt water. Thus, by the deterioration of the zinc, the raw water system parts are protected from corrosion.

The zinc rods must be inspected regularly and be replaced as they become deteriorated. The zinc rod plugs are painted red for easy identification.

#### INSPECTING ZINC RODS

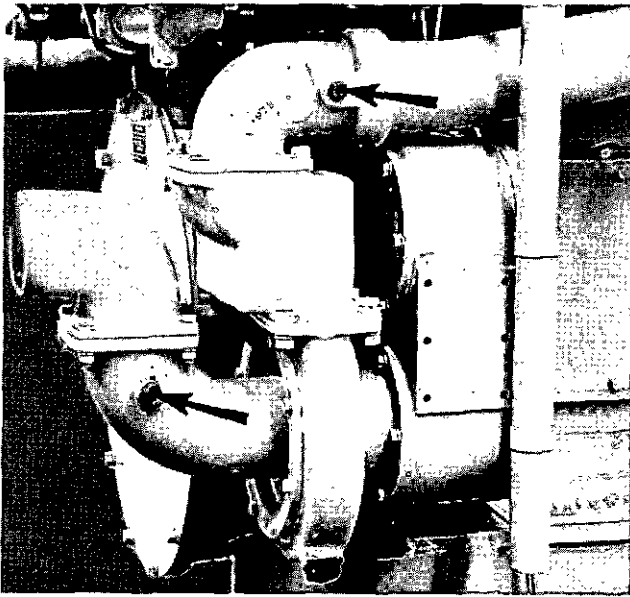
1. Move the governor control lever to the shut-off position.

2. Remove the two plugs with zinc rods from the after-cooler line.



ZINC PLUGS IN AFTERCOOLER LINES

3. Remove the two plugs with zinc rods from the raw water pump and line.



**ZINC PLUGS IN RAW WATER PUMP AND LINE**

4. Tap the zinc rods lightly with a small hammer.

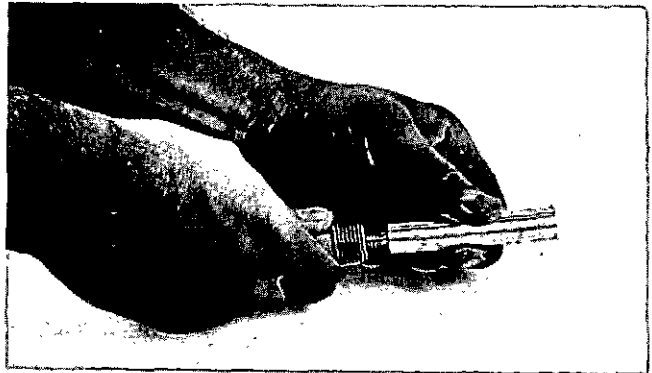


**INSPECTING ZINC ROD**

5. Inspect the rods. If a rod has deteriorated, or flakes apart when tapped, install a new zinc rod.

#### **INSTALLING NEW ZINC ROD**

1. Unscrew or drill the existing rod from the plug base.
2. Install a new rod in the plug base.



**INSTALLING NEW ZINC ROD**

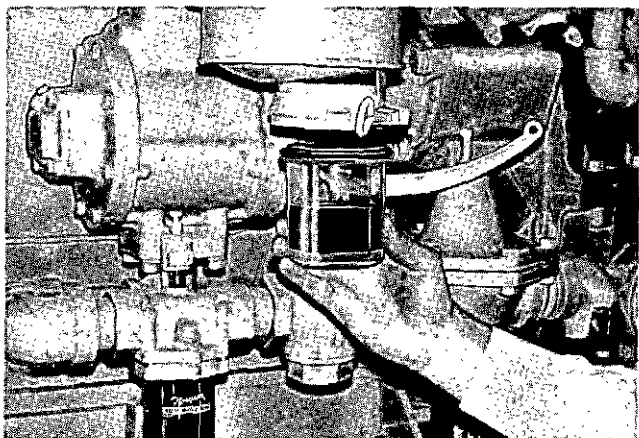
3. Install the plug.

# STARTING SYSTEM

## AIR STARTING

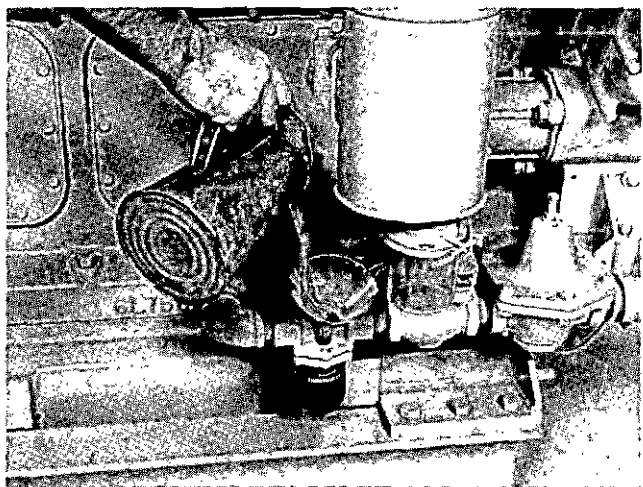
The motor oiler lubricates the vanes of the starting motor with a fine oil mist as the motor is operating.

The collector jar collects both the oil after it has lubricated the starting motor vanes, and the moisture condensation from the compressed air. Empty the collector jar whenever the jar becomes half full.



REMOVING OIL COLLECTOR JAR

When the oiler jar becomes half empty, remove the oil filler plug and fill the jar with clean oil. Refer to Lubrication and Maintenance Chart for proper oil.



ADDING OIL TO MOTOR OILER

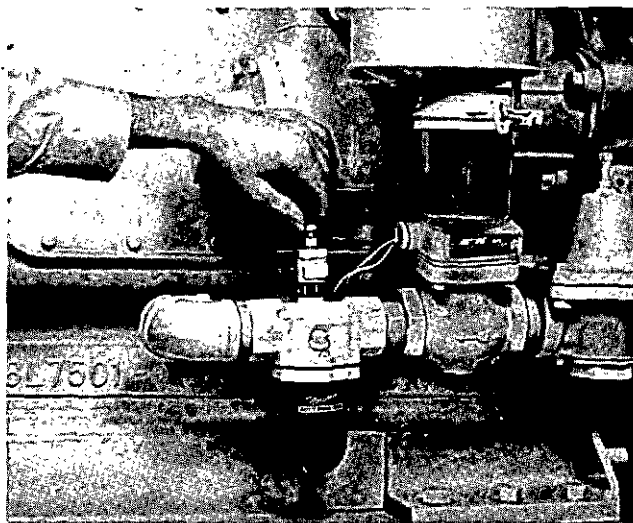
### CAUTION

*Never allow the jar to become empty. The starting motor will be damaged by lack of proper lubrication.*

### ADJUSTING THE AIR STARTING MOTOR OILER FEED

If necessary, adjust the oiler to release approximately four drops of oil per minute into the starting motor air stream.

1. Move the compression release lever to the START position, and move the governor control lever to the SHUT-OFF position.
2. Pull up on the air start control lever and crank the engine.
3. Count the drops of oil released per minute into the air stream.
  - a. Turn the valve needle (the uppermost knob on the oiler) counterclockwise to increase the number of drops.
  - b. Turn the valve needle clockwise to decrease the number of drops.



ADJUSTING MOTOR OILER

# ELECTRICAL SYSTEM

## BATTERY INSTALLATION

### PREPARING DRY CHARGE BATTERIES

One day before installing a new dry charge battery, add the electrolyte solution to each cell.

1. Fill each cell to the bottom of the vent with electrolyte solution.

#### CAUTION

If the battery is initially filled with water by mistake, the battery is ruined and must be replaced.

2. Allow the battery to sit for several minutes to permit the battery plates to absorb the electrolyte.
3. Add make-up electrolyte solution until the level stabilizes. Once the level stabilizes, never add anything but water.
4. Install the vent caps.
5. Remove the tape covering the vent hole in each cap.
6. Slowly charge the battery on a battery charger until the specific gravity of the solution is at least 1.240 at a temperature of 80°F (27°C).

#### NOTE

If the electrolyte solution temperature nears 125°F (53°C) reduce the charging rate. Temperature in excess of 125°F (53°C) will ruin the battery.

### PREPARING WET CHARGE BATTERIES

The electrolyte solution was added by the manufacturer. Make-up solution must be water; never add electrolyte or acid to a wet charge battery. If necessary, slowly charge the battery before using.

### USING A BATTERY CHARGER

A desirable charging rate can be calculated by multiplying the amp-hour rating of the battery by .07 (7%).

## BATTERY MAINTENANCE

### TESTING THE ELECTROLYTE SOLUTION

The general condition of a battery can be determined by measuring the specific gravity of the electrolyte solution and adjusting the reading to 80°F (27°C). If the electrolyte level is too low to allow taking a hydrometer reading, add make-up water to the correct level and then charge the battery 2 to 4 hours before taking a reading.

1. Insert the hydrometer into a cell. Fill the hydrometer barrel while holding it vertically. The float must not drag on the wall of the barrel.

Shut off the battery charger before disconnecting the booster charger clamps from the battery terminals. While the battery is charging, hydrogen gas is being given off through each vent cap. When hydrogen gas is mixed with air, the mixture is highly explosive and will explode in the presence of a spark or small flame.

#### WARNING

Never smoke near the area where batteries are being charged.

### INSTALLING BATTERY

1. Be sure the tray is free of objects which may puncture the battery case when the hold down straps are tightened.
2. Be sure terminal posts and cable clamps are clean.
3. Place the battery in the tray. Tighten the hold downs evenly until the battery is snug. Do not over-tighten.
4. Connect the "hot" terminal first.
5. Connect the ground terminal last.

#### CAUTION

Always connect the "hot" terminal first.

When the "hot" terminal is connected first, no arcing can occur if the wrench accidentally contacts both the terminal and the frame or tray. The part that is contacted will take the same polarity as the battery terminal.

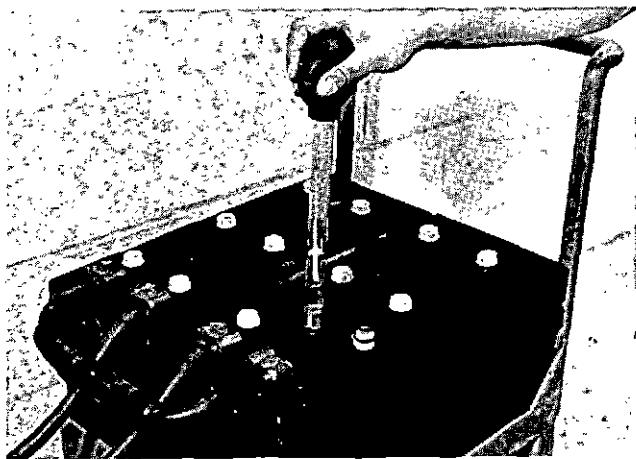
By connecting the ground terminal first, the frame or tray is connected to ground. Then, if the wrench accidentally contacts the frame while connecting the "hot" terminal, a circuit is completed through the wrench. A hot spark will occur which could burn the person holding the wrench, or possibly explode the battery if an excess of hydrogen gas is present at any one of the vent holes.

After connecting both cables, apply a thin coating of grease over the cable clamps, terminals and hold down fasteners.

2. Read the hydrometer:

1.250 or above - fully charged battery cell  
1.250-1.225 - full to half charged battery cell  
1.225-1.150 - half to low charged battery cell  
Below 1.150 - dead cell  
1.000 - water

3. Test each cell in the same manner.



#### MEASURING SPECIFIC GRAVITY

4. If there is more than .050 (50 gravity points) variation between the highest and lowest reading, the battery should be replaced.
5. Adjust the readings to 80°F (27°C).
  - a. For every 10°F (5.5°C) the electrolyte temperature is above 80°F (27°C), add .004 (4 gravity points) to the specific gravity reading.

Example: Electrolyte temperature = 100°F; 38°C  
 Corrected temperature = 80°F; 27°C  
 Difference = 20°F; 11°C  
 Increments: 10; 5.5  
 $20 \div 10 = 2$  ;  $11 \div 5.5 = 2$   
 $2 \times 4$  gravity points = 8 gravity points

Add 8 gravity points to your hydrometer reading to obtain the adjusted reading at 100°F. If the uncorrected hydrometer is 1.240 the corrected reading would be: 1.240 + 8, or 1.248

- b. For every 10°F (5.5°C) the electrolyte temperature is below 80°F (27°C), subtract .004 (4 gravity points) from the specific gravity reading.

Example: Electrolyte Temperature = 10°F; -13°C  
 Corrected temperature = 80°F; 27°C  
 Difference = 70°F; 40°C  
 Increments: 10; 5.5  
 $70 \div 10 = 7$ ;  $40 \div 5.5 = 7$   
 $7 \times 4$  gravity points = 28 gravity points

If the uncorrected hydrometer reading is 1.210 the corrected reading would be  $1.210 - 28 = 1.182$

The corrected reading is of most importance during cold weather when the hydrometer reading is always corrected to a lower specific gravity reading. A low reading signifies the battery has less available power to crank the engine and that booster batteries may be required.

#### CHECKING ELECTROLYTE LEVEL

Check the electrolyte level of each cell and the general condition of the battery.

1. Maintain the electrolyte level to the base of each vent well.
2. The make-up water must be one of the following (in order of preference):
  - a. Distilled water.
  - b. Odorless, tasteless drinking water.
  - c. Iron free water.
  - d. Any available water.

#### WARNING

Never add acid or electrolyte.

#### READING THE AMMETER

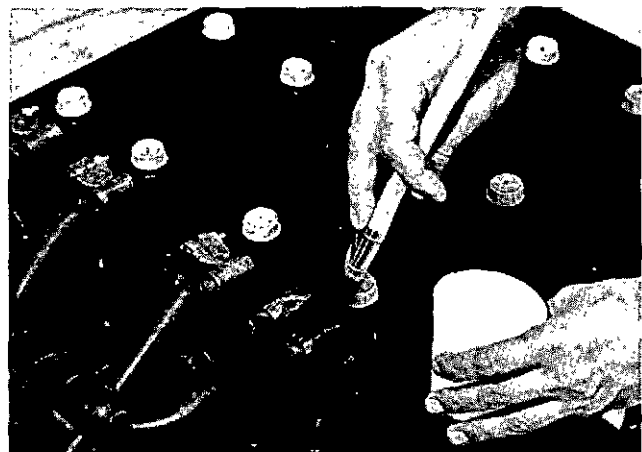
1. After starting the engine, the ammeter indicator should register to the right of zero, but should never be "pegged".
2. After the engine has been running, the indicator should be just to the right of zero.

If the indicator either "pegs" to the right, or remains to the left of zero with an increase of engine speed, have the electrical charging system checked.

The alternator charging rate maintains the battery's electrolyte specific gravity reading, and the battery's performance. An undercharge rate cannot maintain a desired 1.250 specific gravity reading. An overcharge rate will boil the water from the electrolyte solution. A proper charging rate should require no more than one ounce (30 cc) of water per cell per week to maintain a fully charged battery.

#### CLEANING BATTERY

1. Mix a weak solution of baking soda and water. Apply the solution with a bristle brush.



#### CLEANING BATTERY TERMINALS

2. Thoroughly rinse the battery and battery tray with clean water.
3. Apply grease to the battery cable clamps and terminals and to all threads.



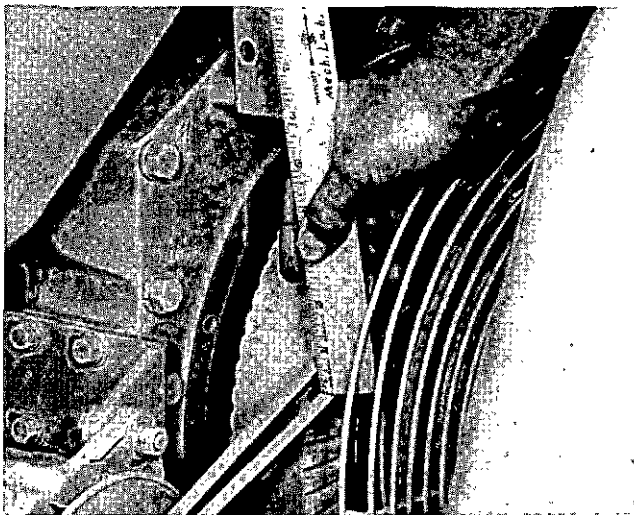
2. Disconnect the red jumper cable from the engine battery "hot" terminal.
3. Disconnect the black jumper cable from the booster batteries.

4. Disconnect the red jumper cable from the booster batteries.
5. Disconnect the booster batteries. Charge them to full capacity with a battery charger.

## CHARGING ALTERNATOR

### CHECKING ALTERNATOR BELTS

1. Check belt wear.
2. Apply a 25 pound (11,34 kg) force, perpendicular to the belt, midway between the driver and driven pulleys. Measure the belt deflection.



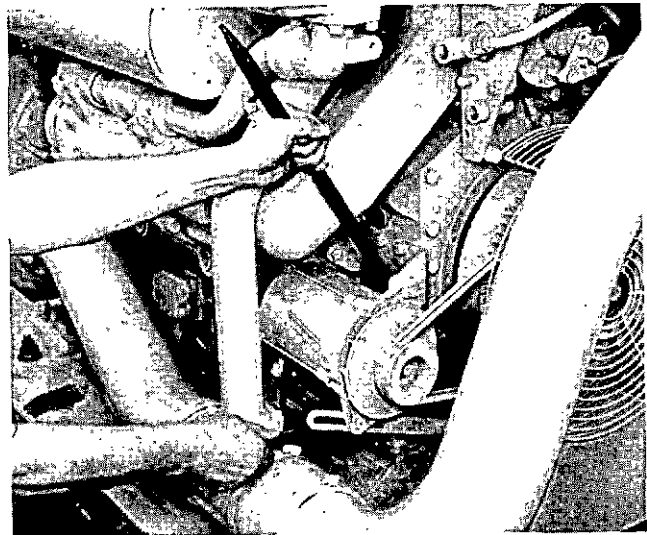
MEASURING BELT DEFLECTION

3. Proper belt deflection is 9/16 to 13/16" (14 to 20 mm). Adjust the belt tension as required.
4. If one belt in a set requires replacement, always install a new matched set of belts—never replace just the worn belt. If only the worn belt is replaced, the new belt will be carrying all of the load—as it will

not be stretched as much as the older belts—and all of the belts will fail in rapid succession.

### ADJUSTING ALTERNATOR BELTS

1. Remove the belt guard.
2. Loosen the alternator mounting bolts.
3. Push the alternator outward until the belt is properly adjusted.
4. Tighten the mounting bolts.
5. Check the belt adjustment.
6. Install the belt guard.



ADJUSTING BELT TENSION

### TESTING GLOW PLUGS

1. Stop the engine.
2. Disconnect the lead harness wire from the magnetic switch.
3. Connect an ammeter of sufficient capacity between the magnetic switch terminal and the lead harness wire.
4. Push in, turn and hold the HEAT-START switch in the HEAT position.

5. The ammeter reading should be approximately equal to the number of glow plugs multiplied by 5, the approximate amperage used by each glow plug.

A deviation of 5 or more amps from this reading may indicate one or more defective glow plugs.

### LOCATING DEFECTIVE GLOW PLUGS

1. Push in, turn and hold the HEAT-START switch in the HEAT position. Observe the ammeter reading.

2. Pull the lead from a glow plug. Observe the ammeter reading.

#### NOTE

If the ammeter reading does not change, the glow plug was not drawing current when connected and can be assumed to be defective. If the ammeter reading decreases, the glow plug is working properly.

3. Release the HEAT-START switch.
4. Connect the lead to the glow plug.
5. Test each glow plug individually.

#### INSTALLING GLOW PLUGS

1. Disconnect the lead wire at the defective glow plug.

2. Remove the defective glow plug.
3. Apply anti-seize compound to the threads of the new glow plug.
4. Install the new glow plug and tighten to a torque of 10 to 12 pounds feet.
5. Turn the HEAT-START switch to the HEAT position and observe the ammeter reading.
6. Release the switch.
7. Install the lead wire.
8. Turn the HEAT-START switch to the HEAT position. The reading should be increased. If the reading is the same, check the glow plug wiring.
9. Disconnect the ammeter.

# POWER COUPLING SYSTEM

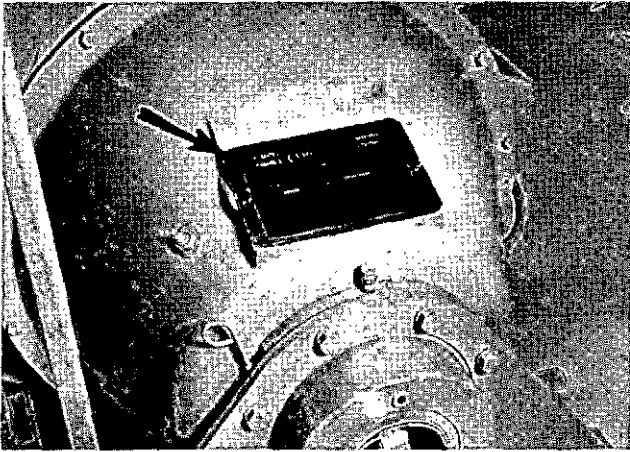
## ENCLOSED CLUTCHES AND/OR FRONT POWER TAKE-OFF

### CHECKING CLUTCH ADJUSTMENT

While engaging the clutch to pick up the load, check the clutch adjustment. The clutch should engage with a hard push and distinct snap. If engagement is "soft", adjust the clutch.

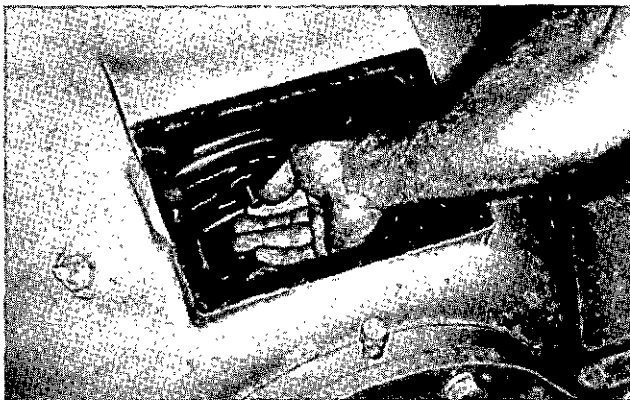
### ADJUSTING CLUTCH

1. Stop the engine and remove the clutch inspection cover.



CLUTCH INSPECTION COVER

2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.
3. Pull the lock pin out and rotate the locking ring clockwise until the lock pin pops into the next notch.



PULLING LOCKING PIN

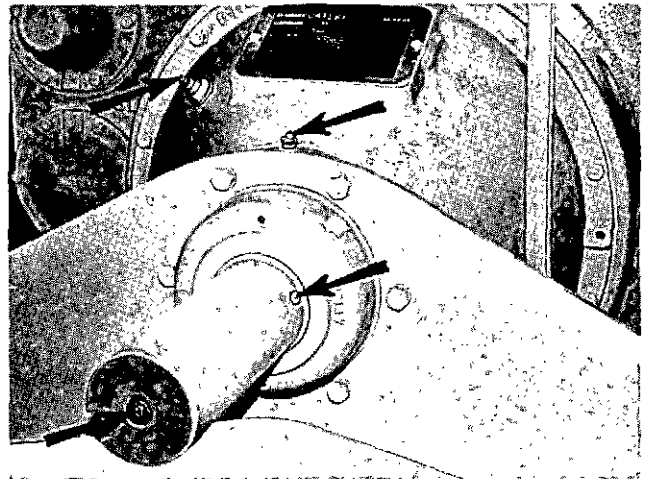
4. Test the clutch adjustment. If still too "soft", rotate the ring to the next notch. If the adjustment is too tight—turn the ring back one notch.
5. Install the cover.

### LUBRICATING D346, D379, D398 FLYWHEEL CLUTCHES:

### AND ALL FRONT POWER TAKE-OFF CLUTCHES

Lubricate the clutch bearings with grease, 1 or 2 strokes each fitting.

1. Lubricate the shift-collar bearing; 1 fitting at top-left of center.
2. Lubricate the shaft bearing; 1 fitting on top-rear of housing.
3. Lubricate the pilot bearing; 1 fitting at the end of the shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing.



PILOT, SHIFT COLLAR AND SHAFT BEARINGS

4. Lubricate the shift lever bearings; 1 fitting on each side of the clutch housing.



LUBRICATING SHIFT LEVER BEARINGS

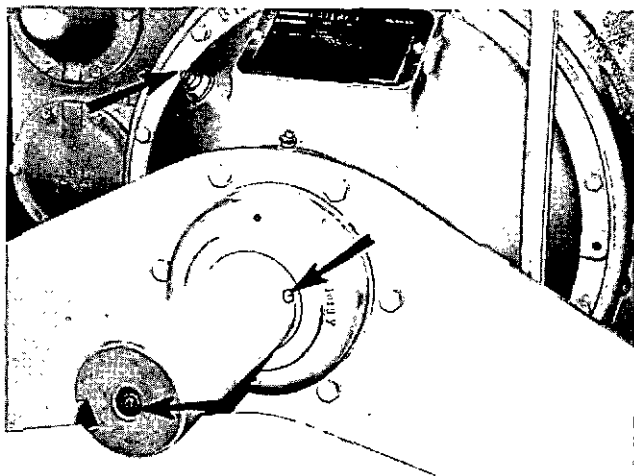
## LUBRICATING D348, D349 OR D399 ENGINE FLYWHEEL CLUTCH

1. Lubricate the shift lever bearings; 1 fitting on each side of clutch housing.



SHIFT LEVER BEARING

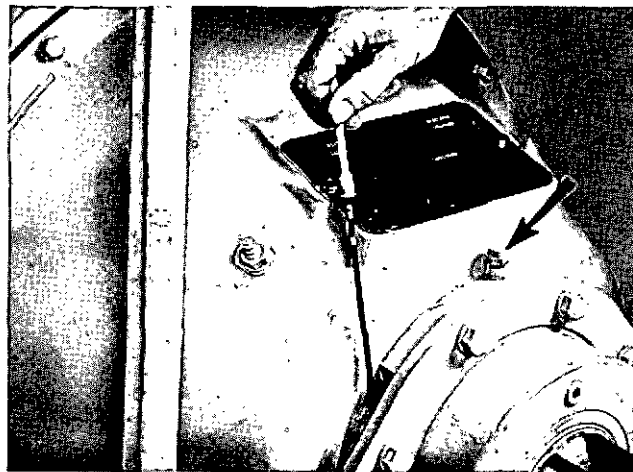
2. Lubricate the pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.



PILOT AND SHIFT COLLAR BEARINGS

3. Lubricate the shift-collar bearing; 1 fitting at top-left of center.

4. Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. Refer to Lubrication and Maintenance Chart for proper oil.



CHECKING OIL LEVEL

5. To drain the reservoir: Remove the drain plug located on the lower left side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install the filler cap.



CLUTCH SHAFT BEARING DRAIN PLUG

## ELECTRIC SET GENERATOR

If the electric set generator is not of Caterpillar design, see the manufacturer's instructions for the required lubrication and maintenance procedures.

### INSPECTING SLIP RING

1. Remove the two lower panels from the rear of the generator housing.

2. Inspect the slip ring color. The slip ring color may be shiny copper to straw, or chocolate to black, but the color must be uniform to indicate satisfactory operation.

If the ring is basically one of the above shades, but contains blotches of green, blue or black, clean the ring with an electrical cleaning solvent.

### CAUTION

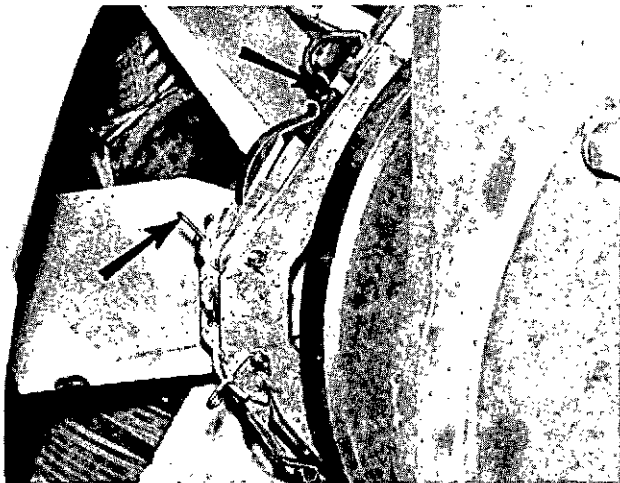
Do not use gasoline or carbon tetrachloride. Both solvents will dissolve insulation. The vapors from carbon tetrachloride can be harmful when inhaled.

Green blotches are caused by chlorine vapors, blue blotches are caused by sulphuric fumes, black blotches are caused by oil.

3. Inspect the slip ring for pitting. If the slip rings are rough, pitted, or worn eccentric, contact your Caterpillar dealer. The rings must be reconditioned.
4. Check the following to determine the cause for pitting:
  - a. Check the generator nameplate rating. The generator load must be within this rating.
  - b. Check brush tension (SRCR Generators only).

### INSPECTING BRUSHES

The brush must move freely within the holder, but with enough spring tension to prevent brush flotation during operation.



CHECKING BRUSH SPRING TENSION

BRUSH CONTACT AREA		SPRING TENSION	
in.	mm	ounces	grams
5/8 x 5/16	(16 x 8)	14	400
7/8 x 5/16	(22 x 8)	20	550
1 1/8 x 1/2	(29 x 13)	40	1100

New brush length measures 1 1/8 inch (29 mm). Replace the brushes when brush length measures 9/16 inch (15 mm).

If brush tension is weak, push the spring forward into the next notch. If the spring is in the front notch, remove the brush and check the brush length. If the brush length is less than the minimum required, install a new brush.

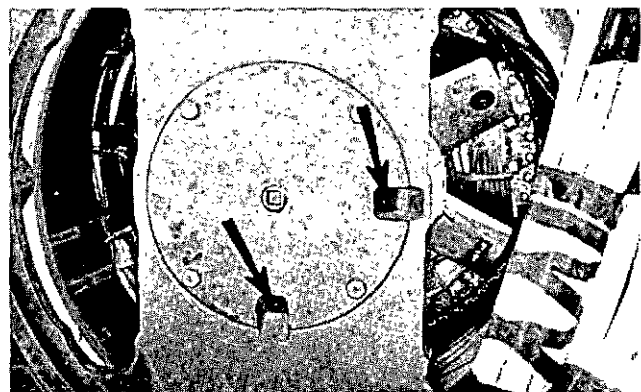
If the spring is moved forward and the brush tension is greater than chart specifications, release the spring one notch. Excessive spring tension will cause excessive brush wear.

### INSTALLING NEW BRUSHES

1. Release spring tension.
2. Disconnect the lead wire from the brush and pull the brush from the brush holder.
3. Insert a new brush. Be sure it moves freely in the brush holder. Connect the lead wire.
4. Place a narrow piece of "00" sandpaper between the brush and slip ring with the abrasive surface against the brush. (Never use emery cloth as the emery contains small metallic particles which will damage the copper.)
5. Engage the spring in the middle notch.
6. Slowly pull the sandpaper from beneath the brush.
7. Remove all dust with a suction hose. If suction is not available, use a very low pressure blower. Do not use metal hose tips.
8. Check brush tension.
9. Install the two panels.

### LUBRICATING THE REAR BEARING

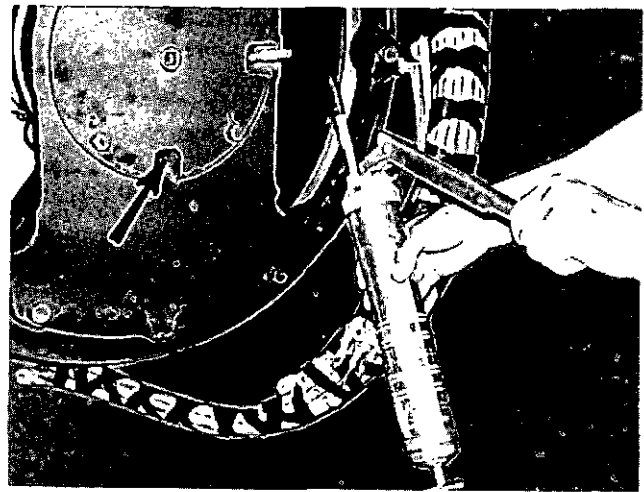
1. Remove the two lower panels from the rear of the generator housing.
2. Remove the upper and lower grease fitting plugs.



LUBRICATION PLUGS

3. Install the grease fitting in the upper threaded hole.

4. Lubricate with grease until clean lubricant appears at the lower threaded hole.
5. Wipe off the excess grease. Install the lower plug.
6. Remove the fitting from the upper threaded hole.
7. Start the engine and allow the grease to expand from the upper hole.
8. Stop the engine. Install the plug in the upper hole and wipe off excess grease.
9. Install the two panels.



**LUBRICATING BEARING**

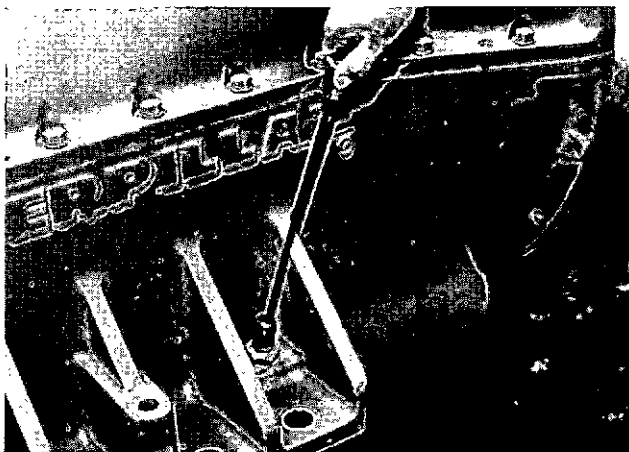
## MARINE GEAR

FOR OTHER THAN CATERPILLAR MARINE GEARS,  
SEE THE MARINE GEAR  
MANUFACTURER'S INSTRUCTIONS

The instructions which pertain to checking and draining marine gear oil, apply to the 7261, 7251 and 7241 Marine Gears. To service the oil filter, oil strainer, breather and output shaft seal; see the instructions concerning your specific marine gear.

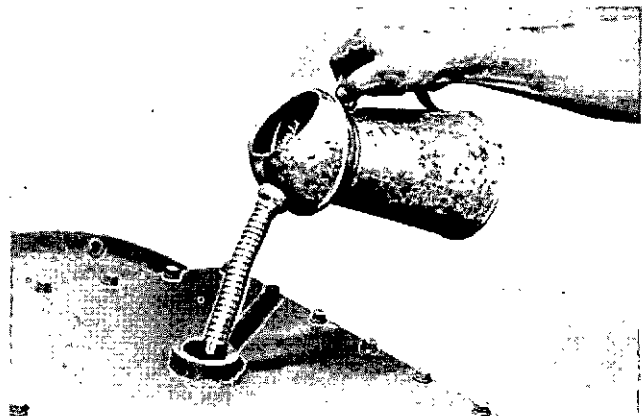
### CHECKING OIL LEVEL

1. Check the oil level with the engine warm, idling, and the clutch engaged.



**CHECKING OIL LEVEL**

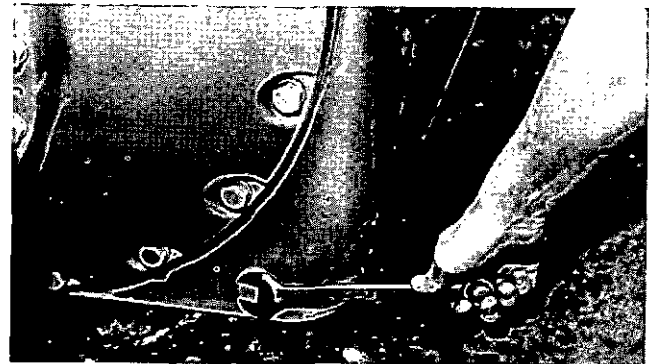
2. Maintain oil level at the FULL mark on the oil level gauge. Add oil through the breather tube on top of the marine gear housing. Refer to Lubrication and Maintenance Chart for proper oil to use.



**ADDING OIL**

### DRAINING LUBRICATING OIL

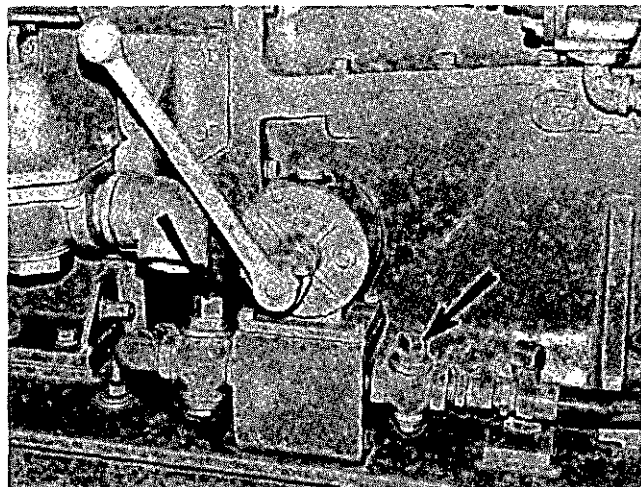
1. Remove the marine gear drain plug.



**REMOVING DRAIN PLUG**

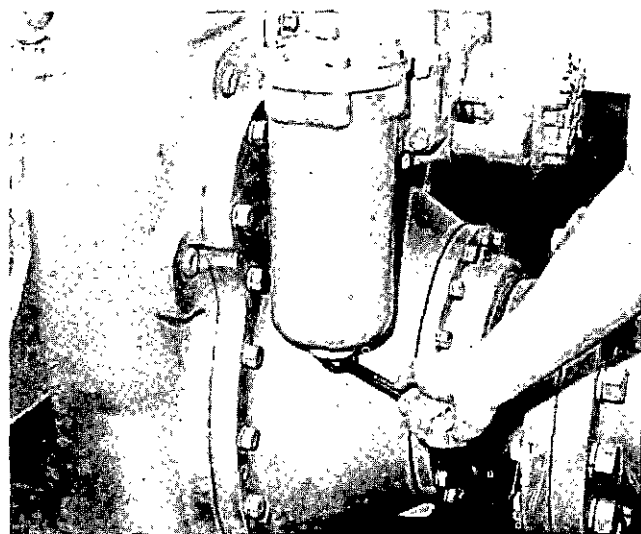
If a sump pump is used:

- a. Connect a drain line to the top outlet of the sump pump.



**SUMP PUMP VALVES**

- b. Be sure the valve on the engine oil pan line is closed. Marks on the valve must be turned at right angles to the direction of the oil line.
  - c. Open the valve on the marine gear oil line.
  - d. Operate the sump pump handle until the oil is drained.
2. Remove the marine gear oil filter housing drain plug.

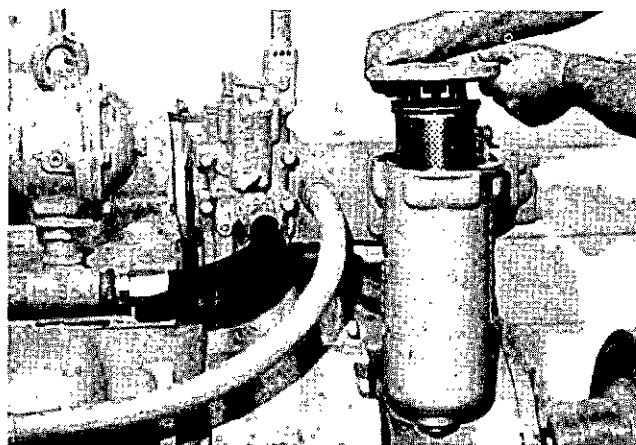


**OIL DRAIN**

### 7261 AND 7251 MARINE GEARS

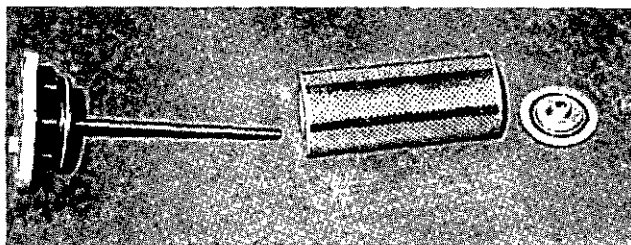
#### INSTALLING MARINE GEAR OIL FILTER ELEMENT

1. Drain the marine gear lubricating oil.
2. Remove the cover assembly – with filter attached.



#### REMOVING COVER AND FILTER ELEMENT

3. Remove the nut, retainer, and element from the cover.
4. Clean the filter housing and the cover assembly with clean diesel fuel or kerosene.
5. Inspect the retainer plate seal, and cover seals. Install new seals if necessary.
6. Install a new filter element, the retainer, and nut to the cover assembly. Tighten the nut to  $10 \pm 2$  foot pounds (1,38 mkg).

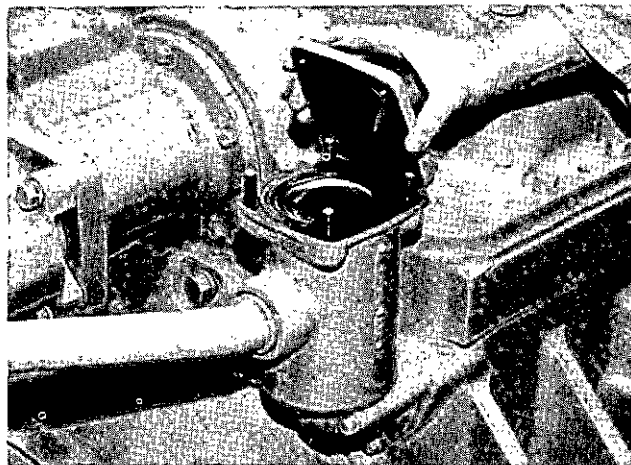


#### ELEMENT DISASSEMBLED FROM COVER

7. Install element and cover. Tighten all bolts.
8. Install the drain plug.

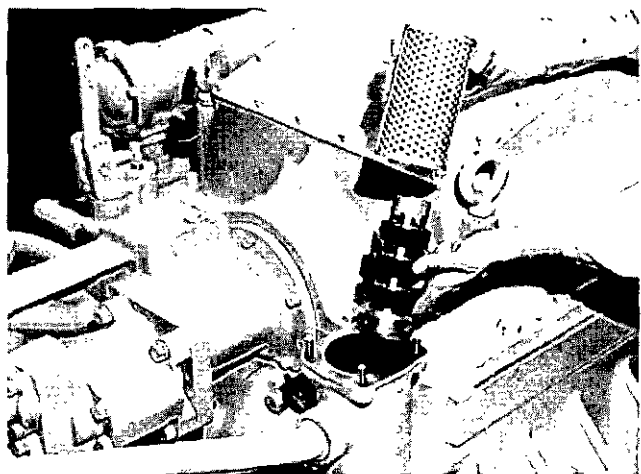
#### CLEAN MARINE GEAR OIL STRAINER

1. Remove the strainer cover.



**REMOVING STRAINER COVER**

- Remove the spring washer, strainer and magnetic screen tube.



#### REMOVING STRAINER AND MAGNETIC SCREEN TUBE

- Wash the strainer and magnetic screen tube in clean diesel fuel or kerosene.

If a magnet is broken, install the new magnet properly; the N poles and S poles of the magnets are adjacent to each other so that they repel instead of attract: S - N, N - S, S - N.

- Inspect the strainer, and the seal in the cover for damage. Obtain new parts if necessary.
- Install the magnetic core tube, strainer, spring washer, seal and cover.

#### FILLING THE MARINE GEAR LUBE SYSTEM

- Install the marine gear drain plug, or close the sump pump valve on the oil line to the marine gear.

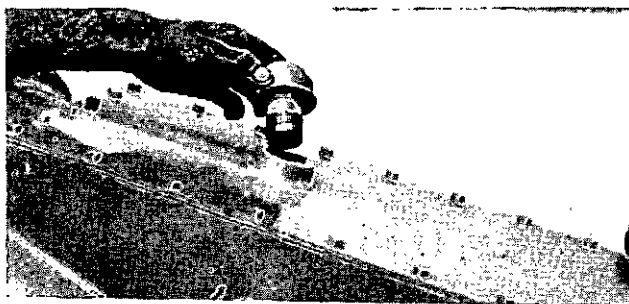
#### CAUTION

Be sure both valves (one to the marine gear and one to the engine oil pan) are closed. Otherwise, a transfer of oil may occur during operation and damage could result.

- Fill the marine gear to the FULL mark on the oil level gauge. Refer to the Lubrication and Maintenance Chart for proper oil to use.

#### CLEANING THE BREATHER

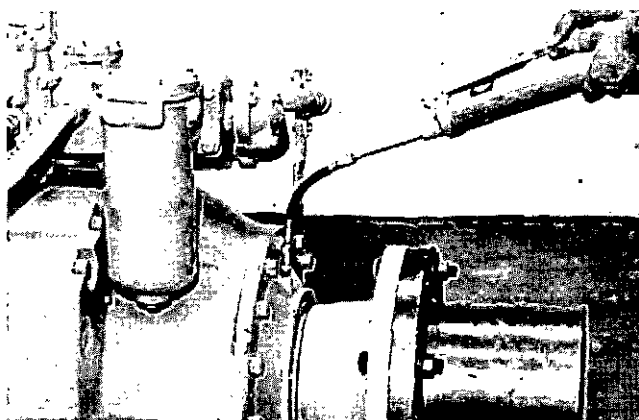
- Remove the breather.
- Wash it in clean diesel fuel or kerosene.
- Install the breather.



REMOVING THE BREATHER

#### OUTPUT SHAFT SEAL

Lubricate the output shaft seal, 1 fitting at top rear of marine gear. Slowly rotate the output shaft while lubricating the seal.

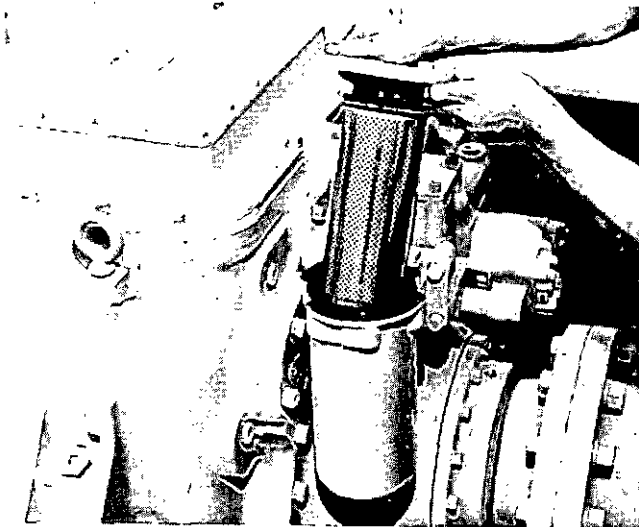


LUBRICATING OUTPUT SHAFT SEAL

#### 7241 MARINE GEAR

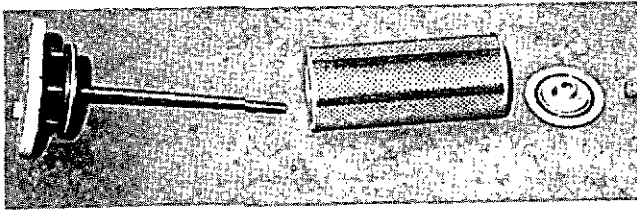
#### INSTALLING MARINE GEAR OIL FILTER

- Drain the marine gear lubricating oil.
- Remove the cover assembly—with filter attached.



REMOVING COVER AND FILTER ELEMENT

3. Remove the nut, retainer, and element from the cover.

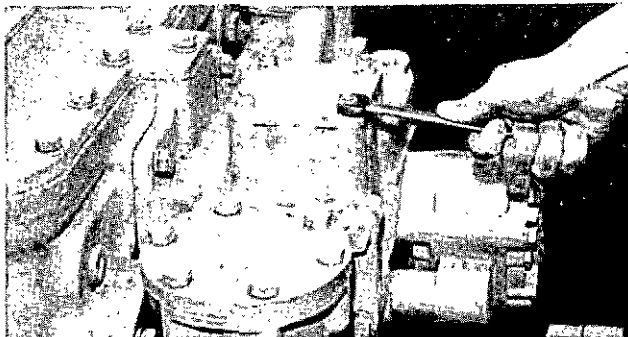


#### ELEMENT DISASSEMBLED FROM COVER

4. Clean the filter housing and the cover assembly with clean diesel fuel or kerosene.
5. Inspect the retainer plate seal, and cover seals. Install new seals if necessary.
6. Install a new filter element, the retainer, and nut to the cover assembly. Tighten the nut to  $10 \pm 2$  foot pounds (1,38 mkg).
7. Install element and cover. Tighten all bolts.
8. Install the drain plug.

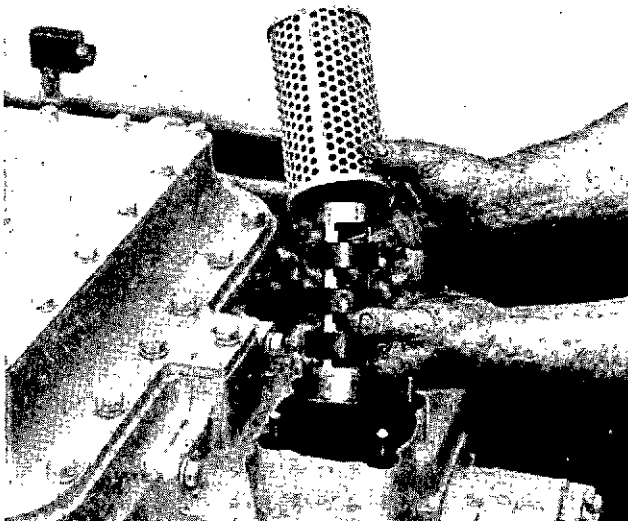
#### CLEANING MARINE GEAR OIL STRAINER

1. Remove the strainer cover.



#### REMOVING STRAINER COVER

2. Remove the spring washer, strainer and magnetic screen tube.



#### REMOVING STRAINER AND MAGNETIC SCREEN TUBE

3. Wash the strainer and magnetic screen tube in clean diesel fuel or kerosene.

If a magnet is broken, install the new magnet properly; the N poles and S poles of the magnets are adjacent to each other so that they repel instead of attract: S - N, N - S, S - N.

4. Inspect the strainer, and the cover seal for damage. Install new parts if necessary.
5. Install the magnetic core tube, strainer, spring washer, seal and cover.

#### FILLING THE MARINE GEAR LUBE SYSTEM

1. Install the marine gear drain plug, or close the sump pump valve on the oil line to the marine gear.

#### CAUTION

**Be sure both valves (one to the marine gear and one to the engine oil pan) are closed. Otherwise, a transfer of oil may occur during operation and damage could result.**

2. Fill the marine gear to the FULL mark on the oil level gauge. Refer to the Lubrication and Maintenance Chart for proper oil to use.

#### CLEANING THE BREATHER

1. Remove the breather.

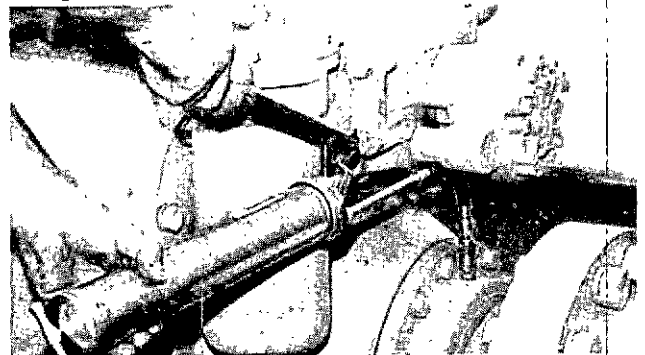


#### REMOVING THE BREATHER

2. Wash the breather in clean diesel fuel or kerosene.
3. Install the breather.

#### OUTPUT SHAFT SEAL

Lubricate the output shaft seal, 1 fitting at top rear of the marine gear. Slowly rotate the output shaft while lubricating the seal.

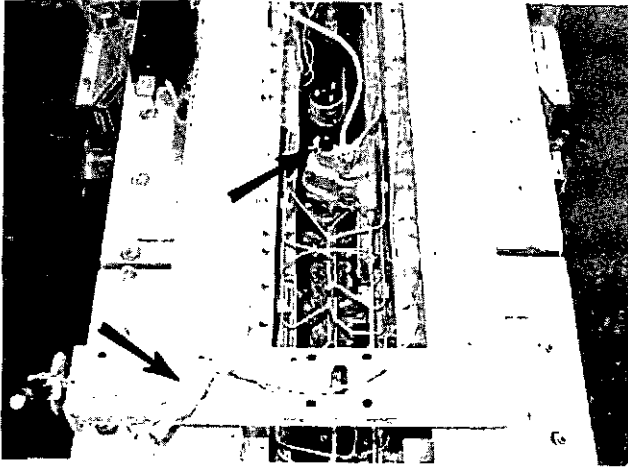


#### LUBRICATING OUTPUT SHAFT SEAL

## MISCELLANEOUS MAINTENANCE

### OVERSPEED SHUT-OFF CONTROL DRIVE AND RESET LEVER

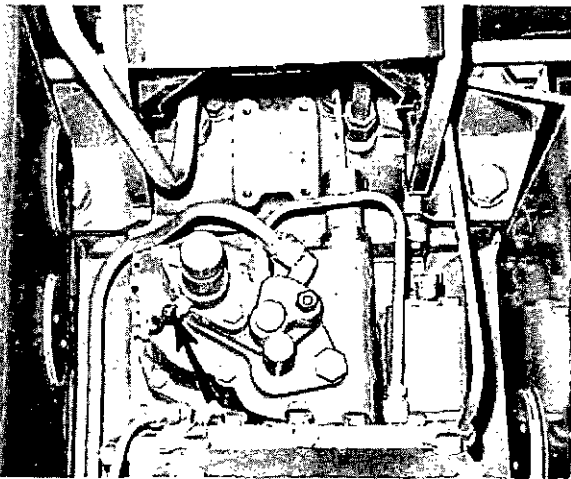
Lubricate the shut-off control reset lever and overspeed drive with grease; 1 or 2 strokes each fitting; 2 fittings.



RESET LEVER AND OVERSPEED DRIVE FITTINGS

### TACHOMETER DRIVE

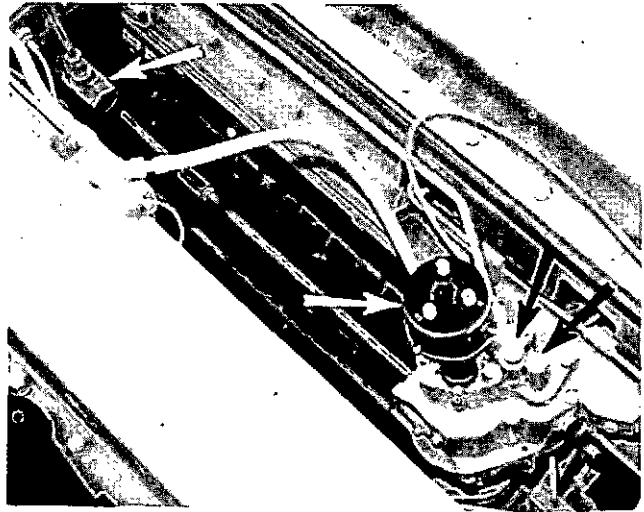
Lubricate the tachometer drive bearing with grease; 1 or 2 strokes, 1 fitting.



TACHOMETER LUBRICATION FITTING

### SAFETY SHUT-OFF CONTROLS

The shut-off controls must be checked to insure proper functioning if and when needed. To prevent damage to your engine while making the required tests, only authorized personnel should perform the checks. Contact your Caterpillar dealer.



SAFETY SHUT-OFF CONTROLS

# INDEX

## Lubrication and Maintenance Procedures

A			
Adjusting Valve Lash	B-6	Filling	D-4
Air Cleaner:		Flushing	D-4
Cleaning Instructions		Crankcase Lube Oil:	
Panel Type	B-2	Checking Oil Level	A-1
Drum Type	B-4	Draining Oil	A-1
Pre-cleaner	B-5	Filling	A-4
Service Indicator	B-1		D
Single Stage	B-1	Duplex Fuel Filter System	C-3
Two Stage	B-3	Duplex Oil Filter System	A-4
Air Induction and Exhaust System	B-1		E
Air Starting System	E-1	Electric Set Generator	G-2
Collector Jar	E-1	Inspecting Brushes	G-3
Motor Oiler	E-1	Inspecting Slip Ring	G-2
Alternator Belts	F-4	Lubricating Rear Bearing	G-3
Ammeter Reading	F-2		F
Auxiliary Fuel Filter Elements	C-4	Fan Belts	
Auxiliary Oil Filter Elements	A-6	Adjusting Belt Tension	D-5
	B	Checking Belt Tension	D-4
Batteries	F-1	Fan Drive Lubrication	D-5
Booster Batteries	F-3	Filter Element Maintenance	
Charging	F-1	Air Cleaner	B-1
Cleaning	F-2	Diesel Engine Lube Oil	A-3
Installing	F-1	Duplex Auxiliary Fuel Filter	C-3
Jumper Cable Usage	F-3	Duplex Auxiliary Oil Filter	A-6
Make-up Water	F-2	Fuel	C-1
Preparing for Installation	F-1	Marine Gear	G-5
Testing Electrolyte	F-1	Flywheel Clutch Maintenance:	
Belts:		D346, D379, D398	G-1
Alternator	F-4	D348, D349, D399	G-2
Fan	D-4	Front Power Take-off Maintenance	G-1
Breather:		Fuel System	C-1
Diesel Engine	A-2	Filters	C-1
7261, 7251 Marine Gear	G-6	Fuel Tank and Fuel	C-1
7241 Marine Gear	G-7	Pressure Gauge	C-2
Brushes, Electric Set Generator	G-3	Priming	C-1
	C		G
Cleaning Used Air Cleaner Elements	B-2	Glow Plugs	F-4
Clutch, Flywheel and Front Power		Governor, Woodward UG8	C-6
Take-off	G-1		M
Adjusting Clutch	G-1	Marine Gear	G-4
Checking Adjustment	G-1	7261 and 7251 Maintenance	C-5
Lubrication	G-1	7241 Maintenance	G-6
Cooling System	D-1	Miscellaneous Maintenance	H-1
Checking Coolant Level	D-1		
Draining Coolant:			
D379, D398, D399	D-1		
D346, D348, D349	D-3		

## O

Oil Filter Elements .....	A-3
Oil Filter Service Indicator .....	A-3
Oil Level:	
Diesel Engine .....	A-1
Flywheel Clutch .....	G-2
Marine Gear .....	G-4
Woodward UG8 Governor .....	C-6
Oil Pressure Gauge .....	A-1

## P

Precleaner .....	B-5
Primary Fuel Filter .....	C-2
Priming Fuel System .....	C-1

## R

Raw Water Zinc Rods .....	D-6
Reset Lever .....	H-1

## S

Safety Shut-off Controls .....	H-1
Slip Ring – Electric Set Generator .....	G-2
Starting System .....	E-1
Strainer for Marine Gear .....	G-5
Sump Pump	
Draining Crankcase .....	A-1
Draining Marine Gear .....	G-1
Used As A Prelube Pump .....	A-4
Systems	
Air Induction and Exhaust .....	B-1
Cooling .....	D-1
Engine Lubrication .....	A-1
Electrical .....	A-1
Fuel .....	C-1
Miscellaneous Maintenance .....	H-1
Power Coupling .....	G-1
Starting .....	E-1

## V

Valves:	
Checking Rotation .....	B-8
Setting Lash .....	B-5

## W

Water Temperature Gauge .....	D-1
Woodward UG8 Governor .....	C-6
Bleeding Air .....	C-7
Changing Oil .....	C-6
Checking Oil .....	C-6
Lubricating Control Motor .....	C-8

## Z

Zinc Rods	
Inspecting Rod .....	D-6
Installing New Rod .....	D-7



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