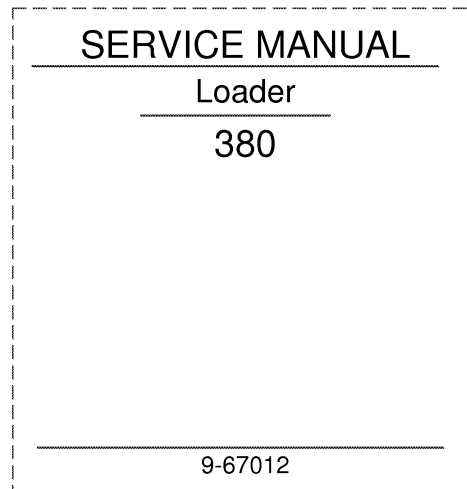


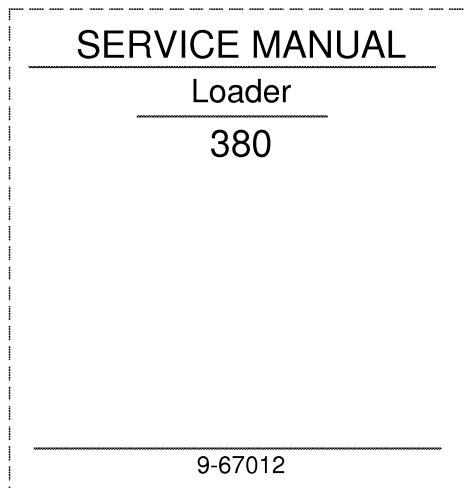
1. Trim along dashed line.
2. Slide into pocket on Binder Spine.

TYPE 1-4



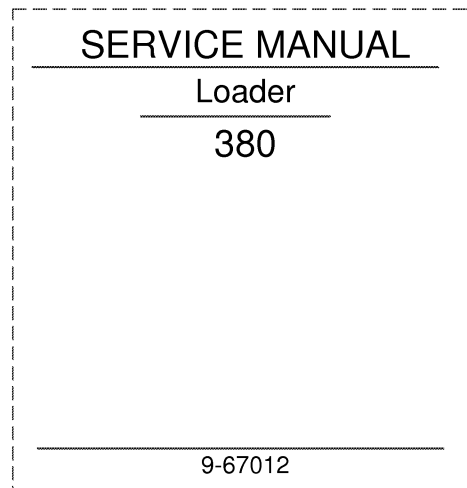
1. Trim along dashed line.
2. Slide into pocket on Binder Spine.

TYPE 1-4



1. Trim along dashed line.
2. Slide into pocket on Binder Spine.

TYPE 1-4



1. Trim along dashed line.
2. Slide into pocket on Binder Spine.

TYPE 1-4

**380 LOADER LANDSCAPER****TABLE OF CONTENTS AND SERVICE MANUAL INTRODUCTION****Table of Contents**

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**Reprinted**

SECTION

SECTION NO.

FORM NO.

## HYDRAULICS

Hydraulic Diagrams and Trouble Shooting .....	8002	9-67011
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## Service Manual Introduction

## Safety Rules



**This Safety Alert Symbol Indicates Important Safety Messages In This Manual. When You See This Symbol, Carefully Read The Message That Follows and Be Alert To the Possibility Of Personal Injury Or Death.**

1-1



**WARNING:** Before starting engine, study operator's manual safety messages. Read all safety signs on machine. Clear the area of other persons. Learn and practice safe use of controls before operating.

*It is your responsibility to understand and follow manufacturer's instructions on machine operation, service, and to observe pertinent laws and regulations. Operator's and service manuals may be obtained from your J I Case dealer.*

45-2



**WARNING:** Read operator's manual to familiarize yourself with control lever functions.

46-27



**WARNING:** Operate controls from the operator's seat only.

35-7



**WARNING:** This is a one man machine, no riders allowed.

35-8



**WARNING:** When working in the area of the fan belt with the engine running, avoid loose clothing if possible, and use extreme caution.

35-4



**WARNING:** When performing checks and tests on the equipment hydraulic system or steering system, DO NOT deviate from the written procedure.

40-13



**WARNING:** After installing tire on rim (wheel), place wheel in a safety cage before inflating tires. If proper equipment is not available, have a tire repair shop do the work.

40-5



**WARNING:** Locate the machine on level ground and block the wheels securely before working under the machine. Failure to follow the above procedure can result in personal injury.

46-77



**WARNING:** Never pass your hand under the three point hitch lift rod and ramshaft arm to release the lift latch. Serious injury will occur if the links fall.

47-1



**CAUTION:** When removing hardened pins such as a pivot pin, or a hardened shaft, use a soft head (brass or bronze) hammer or use a driver made from brass or bronze and a steel head hammer.

46-17



**CAUTION:** When using a hammer to remove and install pivot pins or separate parts, using compressed air or using a grinder, wear eye protection that completely encloses the eyes (approved goggles or other approved eye protectors). 46-13



**CAUTION:** When servicing or repairing the machine, keep the shop floor and operator's compartment and steps free of oil, water, grease, tools, etc. Use an oil absorbing material and/or shop cloths as required. Use safe practices at all times. 40-8



**CAUTION:** Use suitable floor (service) jacks or chain hoists to raise wheels off the floor. Always block machine in place with suitable safety stands. 40-7



**CAUTION:** Pin sized and smaller streams of hydraulic oil under pressure can penetrate the skin and result in serious infection. If hydraulic oil under pressure does penetrate the skin, seek medical treatment immediately. Maintain all hoses and tubes in good condition. Make sure all connections are tight. Make a replacement of any tube or hose that is damaged or thought to be damaged. DO NOT use your hand to check for leaks; use a piece of cardboard or wood. 40-6-A



**CAUTION:** Some components of this machine are very heavy. Use suitable lifting equipment or additional help as instructed in this service manual. 40-10



**CAUTION:** Wear the proper safety equipment - avoid loose clothing. Obtain additional safety equipment when your safety may be in doubt. Hard hat, safety shoes, ear protectors, reflective clothing, safety goggles and heavy gloves may be required. 45-3



**CAUTION:** Do not attempt repairs you do not understand. There is no disgrace in asking for help. 46-21



**CAUTION:** Lower or block elevated components and engage hand brake before leaving machine. D-46-78

## General

This service manual has been prepared with the latest service information available. Trouble shooting,

removal, disassembly, inspection and installation procedures coupled with complete specifications and tightening references can be found in most sections. Some sections will have exploded views without accompanying text due to the simplicity of the procedure. This service manual is one of the most important tools available to the service technician. It is an invaluable aid in properly performing any phase of service.

The terms right-hand and left-hand as used in this manual indicate the right and left sides of the machine as viewed from the operator's seat for proper operation of the machine or attachment.

The information contained in this manual is current at the time of printing.

## Text

If this manual covers more than one machine, or different models of component parts (planetary axles, gear boxes, control valves, etc.) the procedures will apply to all unless otherwise noted.

## Illustrations

Where possible, illustrations are placed as close as possible to the accompanying text and should be used as part of the text.

## Serial and Model Numbers

When requisitioning repair or replacement parts it may be necessary to furnish the parts department with one or both numbers. Serial and model numbers will be found in the following locations.

Machine and engine - Serial number plate on tool box.

Machine serial number - stamped in front frame extension.

Engine serial number - stamped on block.

Loader - Left loader upright.

Backhoe - Side of control tower.

ROPS - Upper ROPS crossmember.

Component parts - plate attached to part or number stamped on part.

## Table of Contents

The preceeding pages contain a Table of Contents which list the Series number and title, and the sections contained in each series. The individual sections, where required, will have a Table of Contents on the second page of that section.

## Page Numbers

All page numbers consist of two sets of digits separated by a dash, such as 4002-9. The digits preceeding the dash identify the section. The digits following the dash represent the consecutive page number within that section. Page numbers will be found at the upper right or left of each page.

## Torque References

Essentially two grades of fasteners (bolts, nuts and screws) are used on Case machinery. They are grade 5 and grade 8. Refer to Section 1051 for torque specifications and means of identification.

The specifications in Section 1051 are standard torque values for dry threads and must be used on all fasteners during assembly and installation unless special torque values are noted in a particular section.

## Classification of Lubricants

Oil, lubricants and grease are classified and graded according to standards recommended by the Society of Automotive Engineers (SAE), the American Petroleum Institute (API), and the National Lubricating Grease Institute (NLGI).

## Engine Oil

The SAE number indicates the viscosity of engine oils, for example, SAE 30, a single grade oil. Engine oils are also identified by dual numbers, such as SAE 20W/30, a multigrade oil.

The API classification (MS DS SD CA) defines oil performance in terms of engine usage. Only oils specified in Section 1050 should be used. These oils contain sufficient chemical additives to provide maximum engine protection. Both the SAE grade and API designation must be found on the container.

## Lubricants and Greases

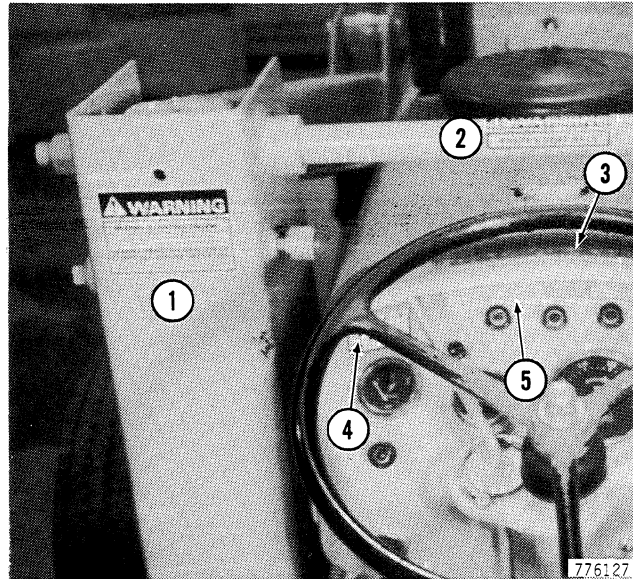
Lubricants and greases used in the hydraulic reservoirs, transmission, etc. must be those specified in Section 1050.

# **Section 1012**

## **DECALS AND REPAINTING**

## GENERAL INFORMATION

1. All decals relating to operation and servicing of the machine and mounted equipment must be in such condition that they can be read without difficulty. Any decal that is damaged or cannot be read must be replaced.
2. All decals that contain a safety message as indicated by DANGER, WARNING or CAUTION, must be in such condition that they can be read without difficulty. Any decal that is damaged or cannot be read must be replaced.
3. Whenever a machine or attachment is being repainted, cover good decals and remove damaged decals and decals that cannot be read. Use enamel thinner to aid in decal removal.
4. Whenever a decal is being replaced, remove the existing decal first. Use enamel thinner to aid in decal removal.
5. When repainting a machine or attachment use standard procedure; degrease, wash, sand, wipe down, mask as required and paint.
6. The following pages show decals as they are installed and their part number. Verify part number in parts catalog before ordering a decal.
7. Use the decal illustrated in this section if it is different from the one used on your machine. This section illustrates the most recent decals used in production as of the date on the cover.



1. 321-3705 see Figure 2
2. 321-3060 see Figure 3
3. K949136 see Figure 4
4. K948903 see Figure 5
5. K921368 see Figure 6

Figure 1



770298

Figure 2 - 321-3705, see Figure 1 for location



770299

Figure 3 - 321-3060, see Figure 1 for location

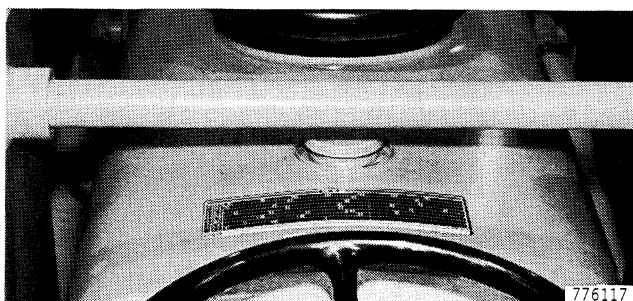


Figure 4 - K949136

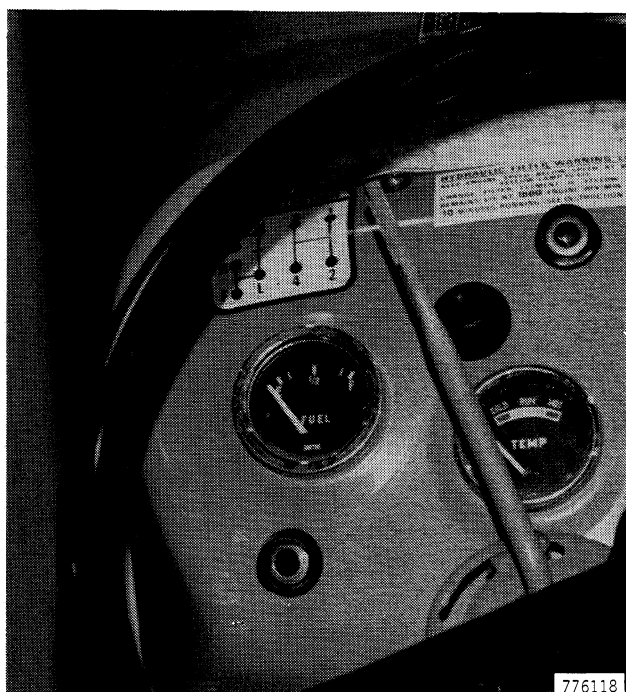


Figure 5 - K948903

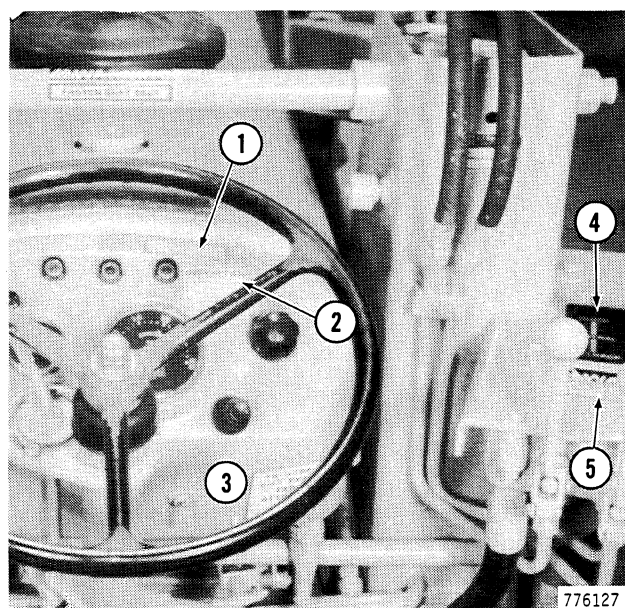
## HYDRAULIC FILTER WARNING LAMP

KEEP ENGINE SPEED BELOW SPEED AT WHICH  
YELLOW LAMP IS LIT

CHANGE FILTER ELEMENT IF YELLOW LAMP  
REMAINS LIT AT 1800 ENGINE REV/MIN AFTER  
30 MINUTES RUNNING (SEE INSTRUCTION BOOK)

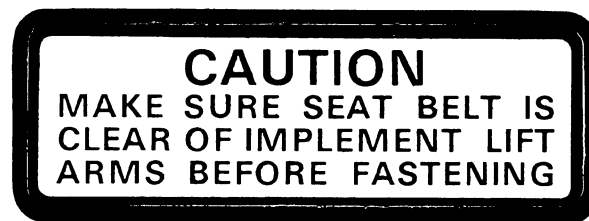
776135

Figure 6 - K921368 see Figure I for location



1. K945069 see Figure 8
2. 321-4277 see Figure 9
3. K961999 see Figure 10
4. 321-1230 see Figure 11
5. 321-3050 see Figure 12

Figure 7



776135

Figure 8 - K945069, see Figure 7 for location



# IMPORTANT

MAXIMUM ENGINE SPEED FOR  
BACKHOE OPERATION  
**1800 RPM**

321-4277

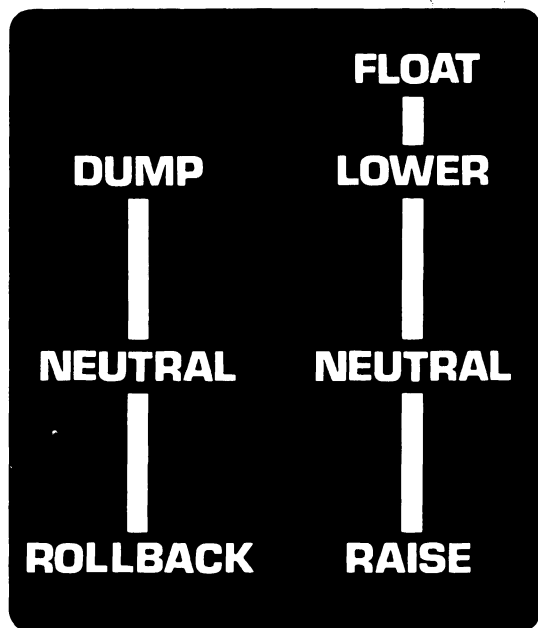
770300

Figure 9 - 321-4277, see Figure 7 for location



776124

Figure 10 - K961999, see Figure 7 for location



770307

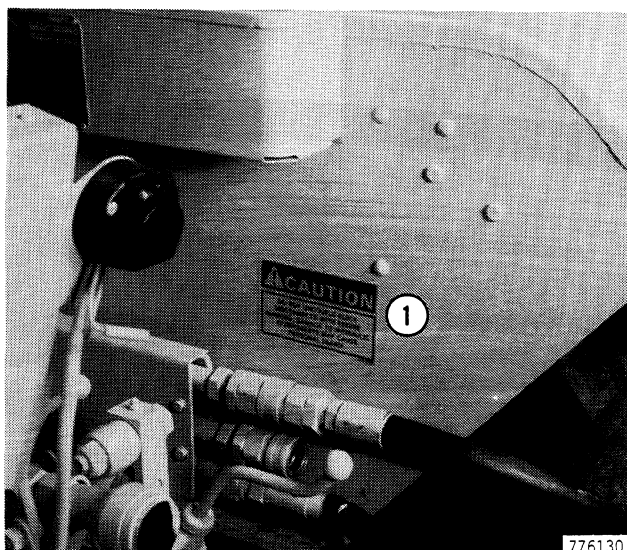
Figure 11 - 321-1230, see Figure 7 for location

# ! WARNING

DO NOT ROLLBACK LOADER  
BUCKET WHEN RAISED ABOVE  
HOOD LEVEL

770308

Figure 12 - 321-3050, see Figure 7 for location



776130

1. 321-4395, see Figure 14

Figure 13

# ! CAUTION

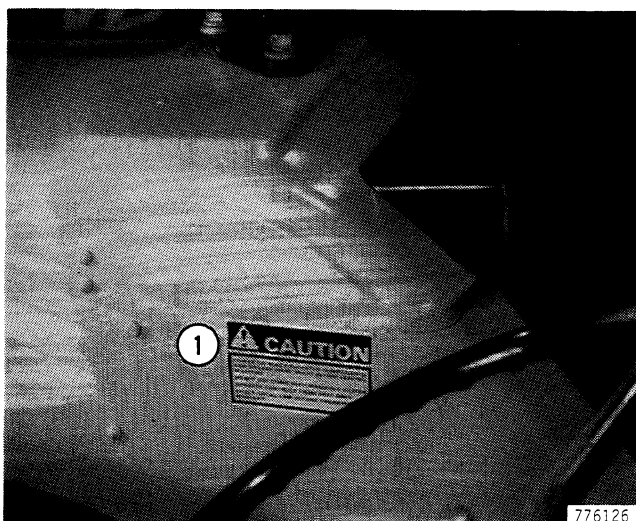
DO NOT UNCOUPLE QUICK  
DISCONNECTS WITH ENGINE RUNNING.  
WITH ENGINE STOPPED, ALWAYS  
CONNECT TRACTOR FEMALE TO  
MALE COUPLING WHEN BACKHOE  
IS REMOVED.

FAILURE TO FOLLOW THIS PROCEDURE  
COULD CAUSE PERSONAL INJURY  
FROM HYDRAULIC FLUID UNDER  
PRESSURE.

321-4395

770301

Figure 14 - 321-4395, see Figure 13 for location



1. 321-3051, see Figure 16

Figure 15

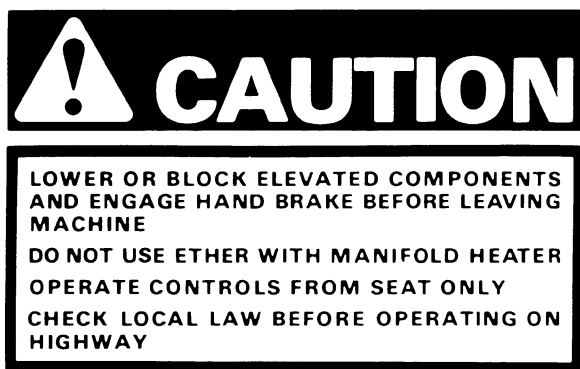
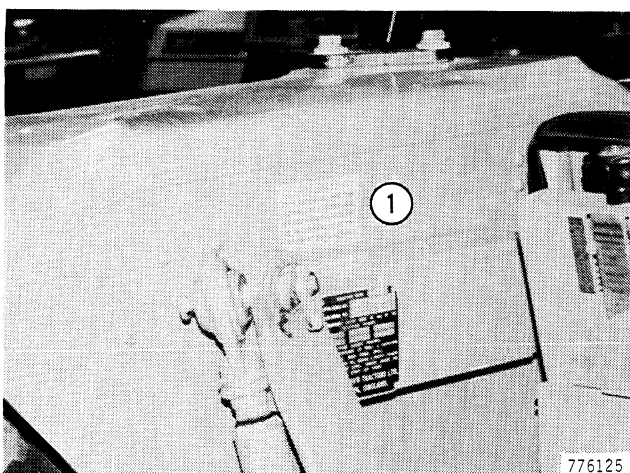
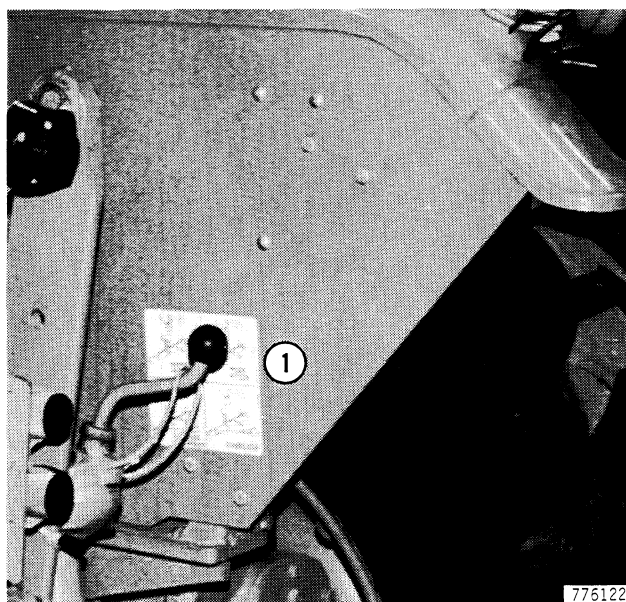


Figure 16 - 321-3051, see Figure 15 for location



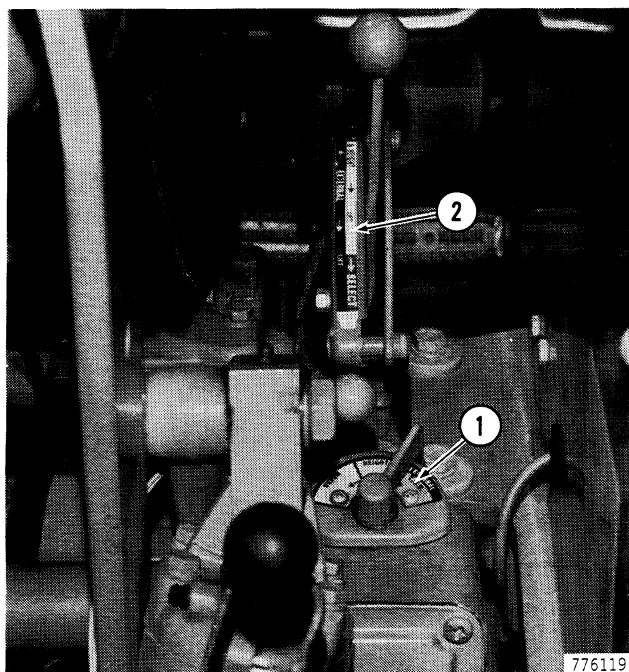
1. K949760

Figure 17



1. K943645

Figure 18



1. K915179, see Figure 20  
2. K915178, see Figure 21

Figure 19

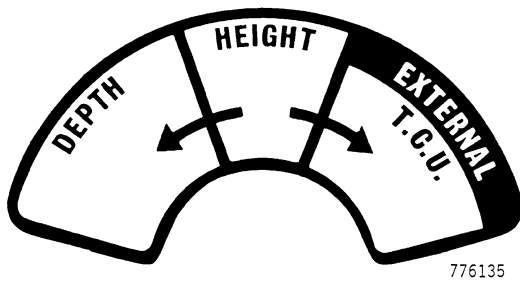


Figure 20 - K915179, see Figure 19 for location

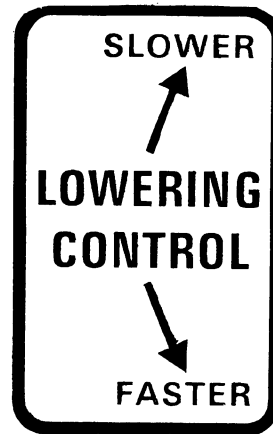
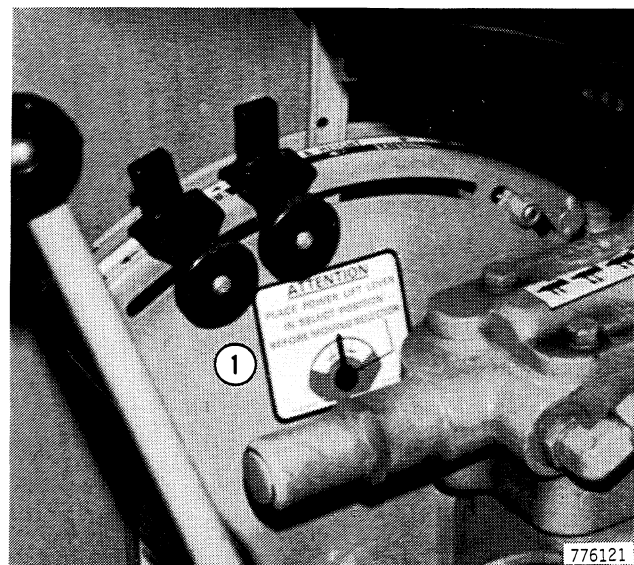


Figure 23 - K917242, see Figure 22 for location

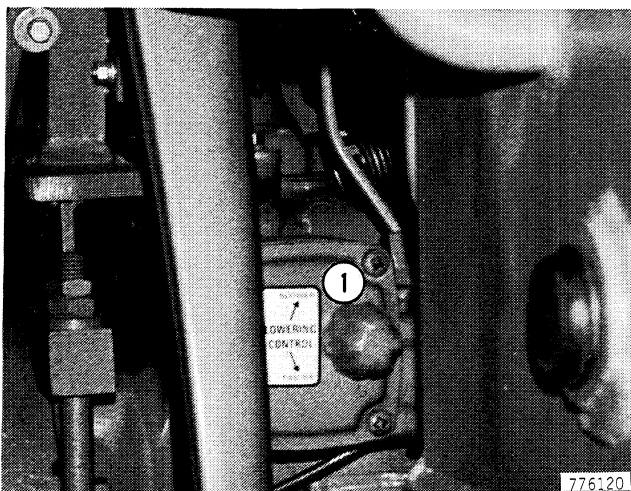


Figure 21 - K915178, see Figure 19 for location



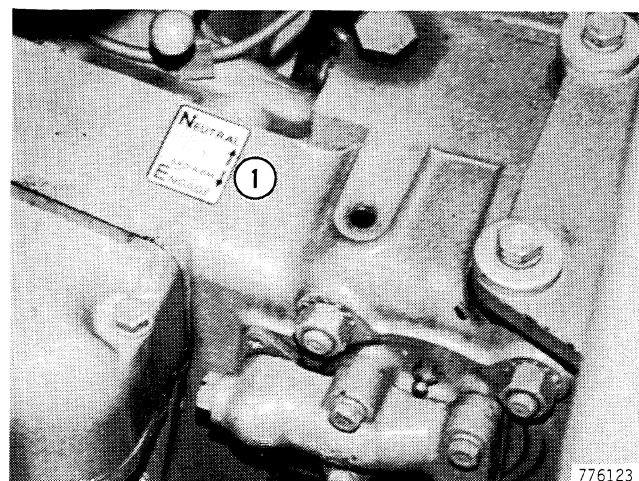
1. K915177

Figure 24



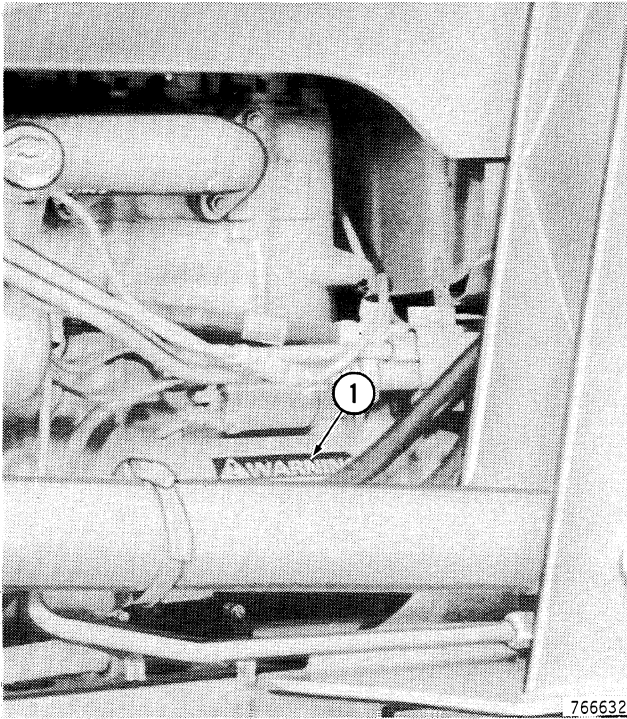
1. K917242, see Figure 23

Figure 22



1. K923336

Figure 25



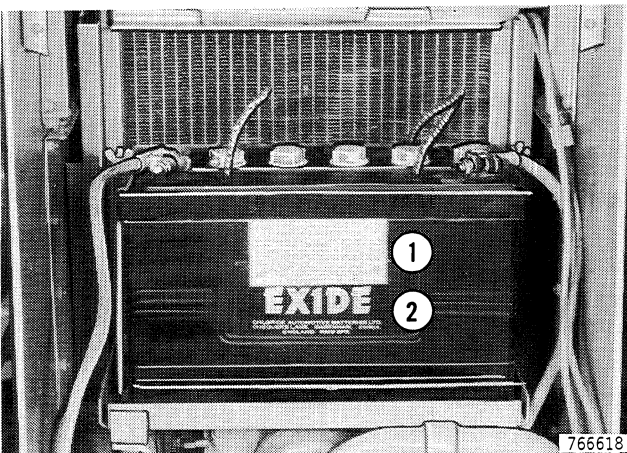
1. 321-3709, see Figure 27

Figure 26



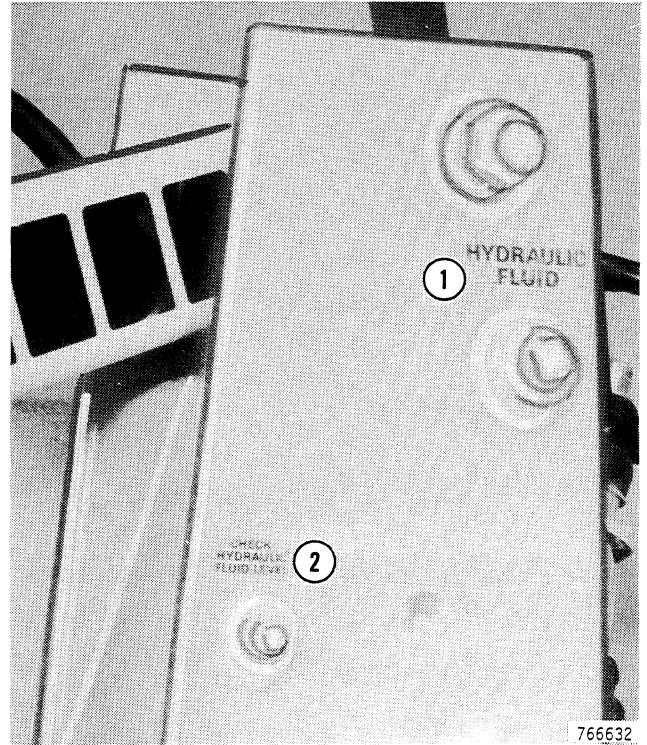
770303

Figure 27 - 321-3709, see Figure 26 for location



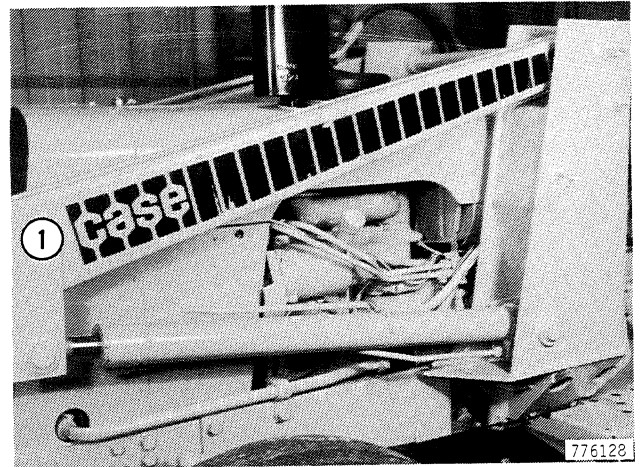
1. 321-2996  
2. K950011

Figure 28



1. 321-229  
2. 321-2733

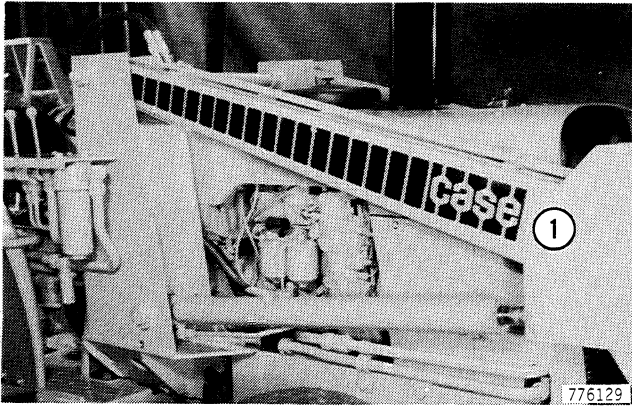
Figure 29



1. 321-3179

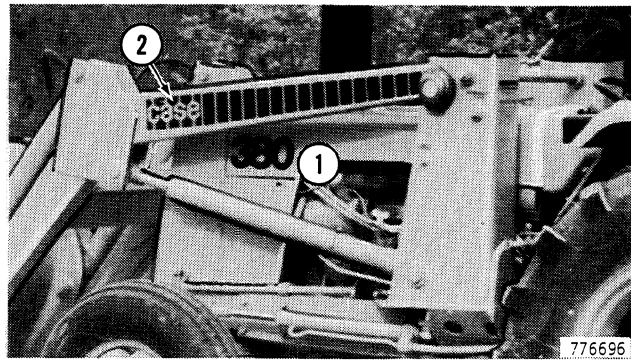
Figure 30





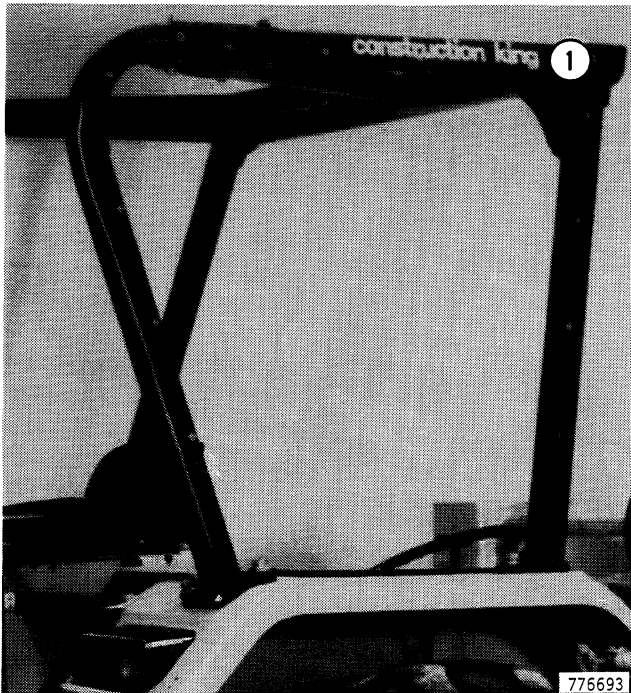
1. 321-3180

Figure 31



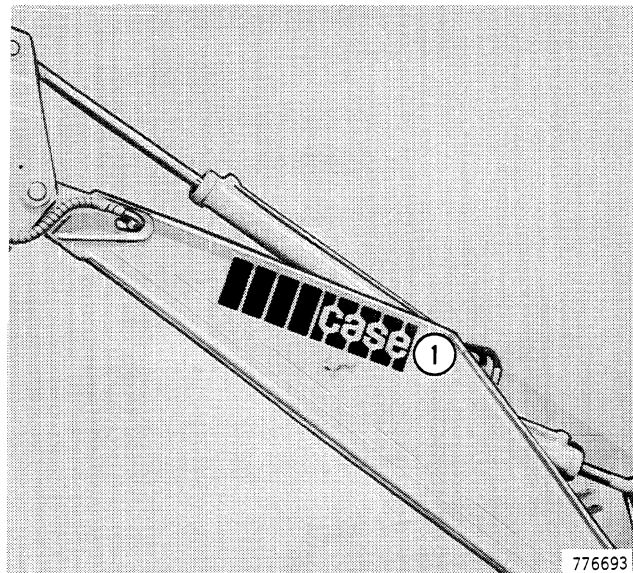
1. 321-3181  
2. 321-3179, see Figure 30

Figure 33



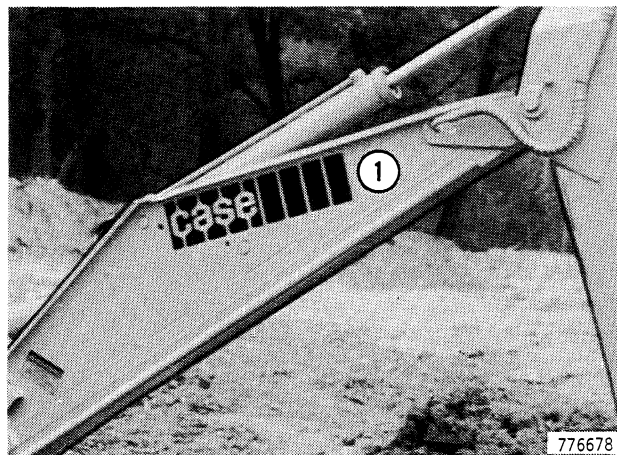
1. 321-3231

Figure 32



1. 321-3182

Figure 34



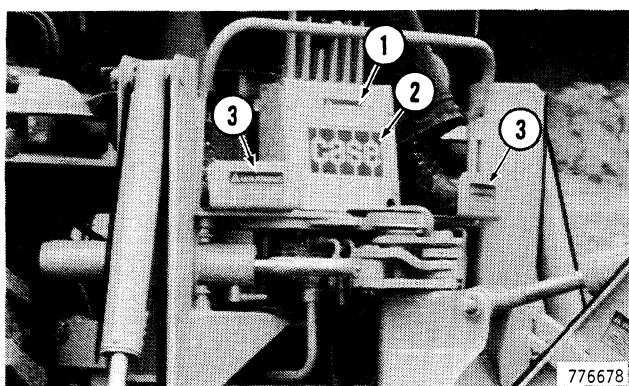
1. 321-3183

Figure 35



1. 321-3885

Figure 36



- 1. 321-3054, see Figure 38
- 2. 321-1572
- 3. 321-3997, see Figure 39

Figure 37



770304

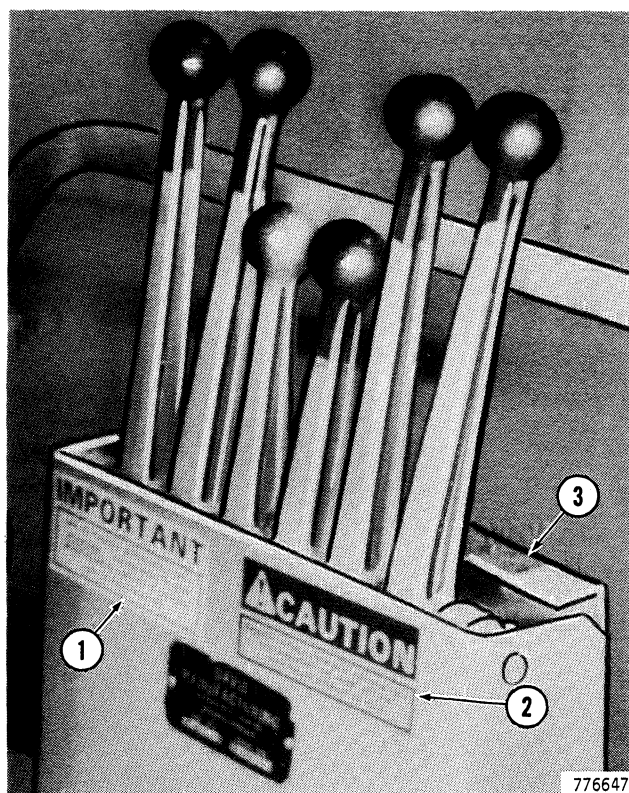
Figure 38 - 321-3054, see Figure 37 for location



321-3997

770309

Figure 39 - 321-3997, see Figure 37 for location



- 1. 321-3994, see Figure 41
- 2. 321-4130, see Figure 42
- 3. H102749, see Figure 43


Figure 40



321-3994

770305

Figure 41 - 321-3994, see Figure 40 for location

**CAUTION**

OPERATE BACKHOE FROM SEAT POSITION ONLY  
FOR TRANSPORT, USE BOOM LOCK PIN,  
WITH BUCKET STRAIGHT TO REAR

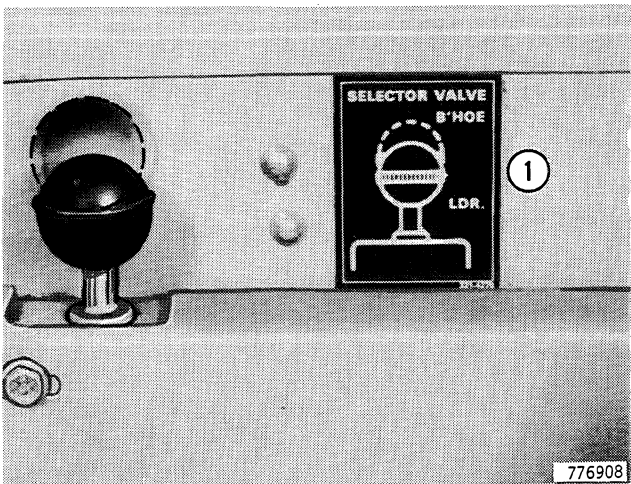
321-4130  
770306

Figure 42 - 321-4130, see Figure 40 for location

LOWER BOOM LIFT	RIGHT SWING LEFT	DOWN STABILIZER LEFT UP	DOWN STABILIZER RIGHT UP	OUT CROWD IN	DUMP BUCKET CURL
-----------------------	------------------------	----------------------------------	-----------------------------------	--------------------	------------------------


776135

Figure 43 - H102749, see Figure 40 for location



1. 321-4276

Figure 44

**WARNING**

HOT COOLANT CAN SPRAY OUT IF CAP IS REMOVED SUDDENLY.  
REMOVE CAP BY TURNING TO FIRST NOTCH. WAIT UNTIL  
PRESSURE IS RELEASED. THEN CONTINUE REMOVAL.  
SCALDING CAN RESULT FROM FAST CAP REMOVAL.

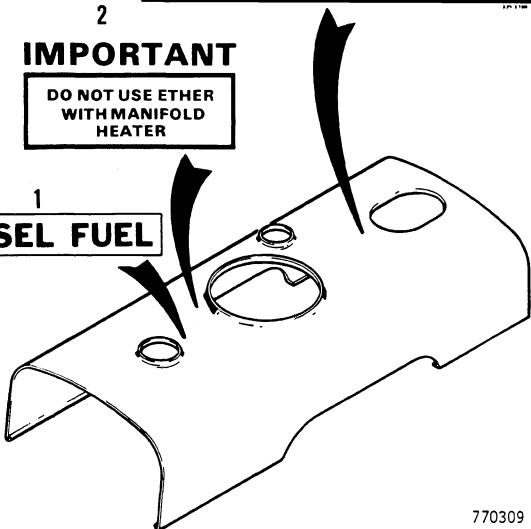
2

**IMPORTANT**

DO NOT USE ETHER  
WITH MANIFOLD  
HEATER

1


**DIESEL FUEL**



1. 321-230  
2. 321-2646  
3. 321-3708

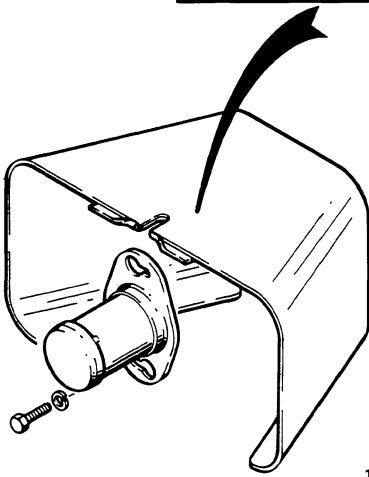
770309

Figure 45

**WARNING**

1

ROTATING MACHINE PARTS  
STAY CLEAR, KEEP SHIELDS INSTALLED  
TO HELP PROTECT FROM CLOTHING  
ENTANGLEMENT AND INJURY.



1. 321-3710

770311

Figure 46

# **Section 1050**

## **MAINTENANCE AND LUBRICATION**



## FLUIDS AND LUBRICANTS CHART

COMPONENTS	CAPACITY		SPECIFICATIONS
	U.S.	Metric	
Fuel tank	12-1/2 gal.	47 litres	No. 2 diesel fuel
Engine crankcase with filter change without filter change	7 qts. 6-1/2 qts.	6.6 litres 6.2 litres	Case HDM oil (API Classification CD) Above 90° F. (32° C.) - SAE 30 20° to 90° F. (-7° to 32° C.) - SAE 20 Below 20° F. (-7° C.) - SAE 10
Hydraulic System [Loader and Backhoe] (single reservoir) with filter change without filter change	4-1/4 gal. 4-1/8 gal.	16 litres 15.6 litres	Case TCH Fluid Alternate oils: Engine oils - SD - service class D, or CA - commercial class A (service MS or DG) Above 32° F. (0° C.) - SAE 10W Below 32° F. (0° C.) - SAE 5W Type C-2 transmission fluid such as Tenneco Hytrans Fluid
Hydraulic system [Loader and Backhoe] (dual reservoir) with filter change without filter change	8-1/2 gal. 8-1/4 gal.	32 litres 31 litres	
Transmission	6 gal.	22.7 litres	Case TFD Fluid Alternate oils: Case HDM oil, SAE 20W/20 Engine oil, API classification SA or CA, SAE 20W/30 or 20W/40
Final Drives (each)	2-1/2 pints	1.1 litres	Case FDL Multipurpose Gear lubricant or SAE 140 gear lubricant
Steering reservoir	1-3/4 pints	0.85 litres	Case TCH Fluid Alternate oils: Tenneco Hytrans Fluid Engine Oil - SD - Service class D or CA - Commercial class A Above 32° F. (0° C.) - SAE 10W Below 32° F. (0° C.) - SAE 5W
Batteries	As required		Add colorless, odorless drinking water or distilled water.
Grease Fittings  <b>NOTE:</b> Includes all grease fittings except king pins and axle trunnion [see following page]	As required		No. 2 moly-disulfide grease  Alternate grease: Above 32° F. (0° C.) - Case Multi-purpose or No. 2 lithium-soap base grease  Below 32° F. (0° C.) - Case Multi-purpose or No. 1 lithium-soap base grease

**FLUIDS AND LUBRICANTS CHART**

COMPONENTS	CAPACITY		SPECIFICATIONS
	U.S.	Metric	
King pins and front axle trunnion	As required		Case FDL Multipurpose gear lubricant or SAE 140 gear lubricant
Cooling system	As required		Ethylene glycol and water must be mixed for prevailing temperatures. Follow anti-freeze manufacturers specifications.

## MAINTENANCE CHART

**NOTE:** This chart is based on maximum service intervals. If operating in sever working conditions, service more often.

INTERVAL	SERVICE	INSTRUCTIONS
Run-in period. every two hours until stable	Tighten front wheel cap screws to a torque of 70 foot-pounds (95 N m)  Tighten rear wheel nuts to a torque of 120 foot-pounds (162 N m)	Section 6429  Section 6429
Run-in period. after first 20 hours	Check alternator and steering pump drive belt tension.  Change loader and backhoe hydraulic oil.  Change loader and backhoe hydraulic oil filter.  Tighten the backhoe mounting hardware, if equipped.	Section 4007  Section 8002  Section 8002  Section 9100
Run-in period. After first 50 hours	Replace fuel filter element.  Replace transmission three point hitch filter.	Section 8034
Every 10 hours or daily, whichever occurs first	Check engine oil level.  Check transmission oil level.  Check radiator coolant level and clean out trash, leaves, etc.  Check fuel sediment bowl for water or sediment. If found, drain and clean sediment bowl.  Grease equipment pivot points.  In dusty or muddy conditions, grease king pins, front axle trunnions and front wheel hubs.  Check steering reservoir oil level.  Check under machine for leaks.  Check machine for broken, loose, or missing parts.	Section 8034
Every 50 hours or weekly whichever occurs first	Check brake and clutch pedal adjust- ments.  Grease tractor pivot points.  Check tire pressure.	Section 6406, 7124  Section 6429

INTERVAL	SERVICE	INSTRUCTIONS
Every 100 hours	Drain and refill engine crankcase with oil.  Replace engine oil filter (every other oil change)  Check final drive oil level.  Check belt tension.  Check battery fluid level.  Check spark arresting muffler.	      Section 4005  Section 2051
Every 500 hours	Replace transmission filter element  Drain and clean fuel sediment bowl.  Replace fuel filters.  Check ROPS and related parts.  Drain and refill steering reservoir.  Change steering reservoir filter element.  Drain and refill loader and backhoe hydraulic reservoir.  Replace loader and backhoe hydraulic filter.  Check all safety decals for existence and legibility.	Section 8034          Section 9061  Section 5002  Section 5002  Section 8002  Section 8002  Section 1012
Every 1000 hours or Yearly, whichever occurs first	Drain and refill final drives.  Check front hub, front axle and steering for wear and adjustment.  Check brake and clutch adjustments.	   Section 5021  Section 6406, 7124




INTERVAL	SERVICE	INSTRUCTIONS
Every 2000 hours or Yearly, whichever occurs first	Drain, flush, and refill cooling system.	
As required	<p>Replace or clean air filter element.</p> <p>Replace transmission filter element when indicated by warning light.</p> <p>Check engine oil level when indicated by warning light.</p> <p>Service electrical system when indicated by warning light.</p> <p>After removing and installing a wheel, check cap screw or nut torque every two hours until stable.</p>	<p>Section 2051</p> <p>Section 4002</p> <p>Section 6429</p>

# **Section 1051**




## **TORQUE SPECIFICATIONS**

## U.S. AND METRIC TORQUE SPECIFICATIONS

### Grade 5 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m		Thread size	Ft-lbs	N m
1/4"-20 NC	5-10	7-13		3/4"-10 NC	235-285	319-386
1/4"-28 NF	10-15	13-20		3/4"-16 NF	270-330	366-447
5/16"-18 NC	15-20	20-27		7/8"-9 NC	360-440	488-597
5/16"-24 NF	15-20	20-27		7/8"-14 NF	395-490	536-664
3/8"-16 NC	25-35	34-47		1"-8 NC	520-640	705-867
3/8"-24 NF	30-40	41-54		1"-12 NF	575-705	780-955
7/16"-14 NC	45-55	61-74		1-1/8"-7 NC	720-820	976-1111
7/16"-20 NF	50-60	68-81		1-1/8"-12 NF	790-970	1071-1315
1/2"-13 NC	65-85	88-115		1-1/4"-7 NC	1010-1240	1370-1681
1/2"-20 NF	80-100	109-135		1-1/4"-12 NF	1115-1365	1512-1850
9/16"-12 NC	100-120	135-163		1-3/8"-6 NC	1315-1610	1783-2182
9/16"-18 NF	110-130	149-176		1-3/8"-12 NF	1510-1850	2047-2508
5/8"-11 NC	135-165	183-223		1-1/2"-6 NC	1745-2135	2366-2894
5/8"-18 NF	160-200	216-271		1-1/2"-12 NF	1880-2420	2549-3281

### Grade 8 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m		Thread size	Ft-lbs	N m
1/4"-20 NC	10-15	13-20		3/4"-10 NC	340-420	461-569
1/4"-28 NF	15-20	20-27		3/4"-16 NF	380-460	515-623
5/16"-18 NC	20-30	27-40		7/8"-9 NC	540-660	732-894
5/16"-24 NF	25-30	34-40		7/8"-14 NF	595-725	807-982
3/8"-16 NC	40-50	54-67		1"-8 NC	810-990	1098-1342
3/8"-24 NF	45-55	61-74		1"-12 NF	900-1100	1220-1491
7/16"-14 NC	60-80	82-102		1-1/8"-7 NC	1150-1400	1559-1898
7/16"-20 NF	70-90	95-122		1-1/8"-12 NF	1295-1585	1756-2148
1/2"-13 NC	100-120	136-162		1-1/4"-7 NC	1640-2000	2224-2711
1/2"-20 NF	110-130	149-176		1-1/4"-12 NF	1800-2200	2440-2982
9/16"-12 NC	135-165	183-223		1-3/8"-6 NC	2140-2620	2901-3552
9/16"-18 NF	155-190	210-257		1-3/8"-12 NF	2450-3000	3322-4067
5/8"-11 NC	200-240	271-325		1-1/2"-6 NC	2845-3475	3857-4711
5/8"-18 NF	215-265	292-359		1-1/2"-12 NF	3200-3900	4339-5287

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Figure 1

**U.S. AND METRIC TORQUE SPECIFICATIONS****Hydraulic Fittings (Steel)**

Dash Size	Tube O.D. Hose I.D.	Thread Size	37° Flare Torque		Straight Thread O-ring Torque	
			Ft-lbs	N m	Ft-lbs	N m
4	1/4"	7/16"-20	6-12	8-16	12-19	16-25
5	5/16"	1/2"-20	8-16	11-21	16-25	22-33
6	3/8"	9/16"-18	10-25	14-33	25-40	34-54
8	1/2"	3/4"-16	15-42	20-56	42-67	57-90
10	5/8"	7/8"-14	25-58	34-78	58-92	79-124
12	3/4"	1-1/16"-12	40-80	54-108	80-128	108-174
14	7/8"	1-3/16"-12	60-100	81-135	100-160	136-216
16	1"	1-5/16"-12	75-117	102-158	117-187	159-253
20	1-1/4"	1-5/8"-12	125-165	169-223	165-264	224-357
24	1-1/2"	1-7/8"-12	210-250	285-338	250-400	339-542

Figure 2





# **Section 2001**

## **ENGINE DIAGNOSIS**

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## GENERAL INFORMATION

Before making any repairs or adjustments on an engine, the mechanic must properly diagnose the trouble.

Locating the trouble and repairing it is only part of the job, a mechanic must find and eliminate the cause of the trouble as well. Too many repairs are made with no thought to removing the causes that made the repair necessary.

For the engine to start and perform properly, three main requirements must be present:

1. Fuel
2. Air.
3. Compression - Ignition

When any of these requirements are not present or limited for some reason, the engine will not start or will fail to operate properly throughout the power range.

### Fuel

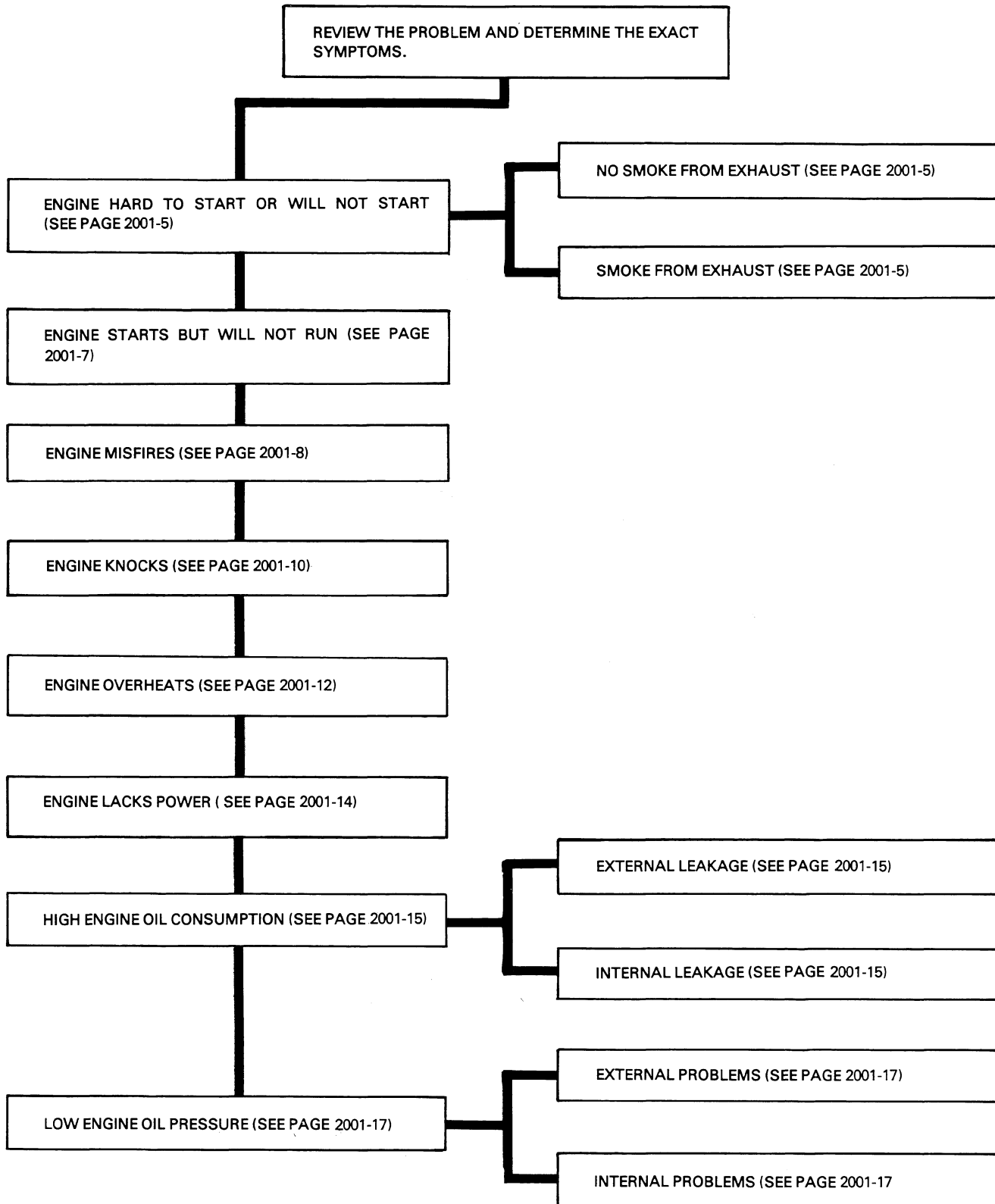
Fuel system problems can be present anywhere from the fuel tank, through the filters and injection pump as well as the injectors. Correct injection pump timing is important in the overall fuel system performance.

### Air

Air in an engine is related to the breathing of the engine; the intake of air into the engine and the expulsion of exhaust. Proper air flow is affected by the air cleaner condition, muffler restriction, valve condition, and adjustment, cylinder head gaskets, condition of cylinder walls, rings, pistons, camshaft and crankshaft timing.

### Compression - Ignition

Ignition is the result of adequate compression of the intake air in the cylinder to provide enough heat to fire the fuel being injected into the engine cylinder. Proper spray pattern and atomization of the fuel by the injector is very important. Timing the fuel injection pump to the engine is a vital requirement for proper ignition.

**ENGINE DIAGNOSIS CHART**

**ENGINE HARD TO START OR WILL NOT START****No Smoke From Exhaust****1. Fuel Shut-Off Not Open Completely:**

Improper cable adjustment, damaged cable, cable slipping in clamps will not allow the fuel shut-off to open completely. Check lever to be sure it is opening completely. Adjust cable.

**2. Air Filter Plugged:**

A dirty filter will cause rich fuel mixture and low engine power. Service air filter if required.

**3. Slow Cranking Speed:**

Starter must crank engine 200 to 300 rpm (r/min) in order to ignite the diesel fuel. Check engine speed while cranking. If cranking is slow, check starter amperage draw to help determine the following defective areas: batteries, cables, solenoid and starting motor.

Slow cranking speed can be caused by the following internal and external engine defects: scuffing and scoring of pistons and cylinder walls, improper crankshaft or camshaft end play, defective rod or crank bearings, oil pump, water pump and hydraulic pump.

**4. Fuel Supply Shut-Off or No Fuel:**

Check that the fuel tank to fuel pump tube is open. Check fuel supply in tank.

**5. Air In Fuel System:**

Bleed fuel system until fuel flows steadily with no bubbles. Check for air leaks at fittings between tank and fuel pump.

**6. Camshaft Damaged:**

A sheared key in the cam drive gear or a broken camshaft will throw valve and injection pump timing out of sequence affecting engine operation. Check valve timing.

**7. Fuel Injection Nozzle Not Seated In Head:**

A nozzle that is not seated in the cylinder head will leak air and not allow enough compression to fire the injected fuel. Check for damaged nozzle gasket or seals, loose nozzle, or broken stud.

**8. Fuel Line Plugged:**

A fuel line plugged with dirt will not let fuel through to the injection pump. Remove line at fuel filters and check for fuel flow through line.

**9. Clogged Fuel Filter:**

Check and service fuel filters.

**10. Wrong Fuel or Contaminated Fuel:**

Wrong fuel or contaminated fuel can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

**11. Piston Rings Worn:**

As piston rings become worn, they lose tension and ability to seal and wipe lubrication oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly new pistons.

**12. Injection Pump Malfunction:**

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.