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ervicemen's
Reference
Book

Caterpillar

REG. U.S. PAT. OFF.

Diesel Engines

(4½" BORE 4-CYLINDER)

D315 INDUSTRIAL
D315 ELECTRIC SET
D315 MARINE
D4 TRACTOR
NO. 112 MOTOR GRADER
NO. 955 TRAXCAVATOR

ATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS, U. S. A.

Foreword

IT is the purpose of Caterpillar Tractor Co., to build into its products the capability of a long life of useful work. The records of tens of thousands of users testify to success in the achievement of that purpose. It is natural, however, that length of life and cost of operation and maintenance will vary — top records are the reward of the owners and operators who are diligent and conscientious in the care, operation and maintenance of their machines.

The Operator's Instruction Book, a copy of which is supplied with each machine, tells what to do, and how and when to do it, with regard to the day-to-day lubrication, operation and maintenance of the machine. It is urged that these instructions be studied carefully and reread frequently until the operator is thoroughly familiar with them. By following the instructions, the operator is best assured of obtaining maximum life and performance from his machine and of minimizing the frequency, number and cost of repairs.

Even the best of care will not eliminate the necessity, in course of time, of making minor repairs or complete reconditioning.

Your "Caterpillar" dealer has exceptionally complete facilities for such work. He carries a stock of genuine replacement parts and has in his employ competent factory trained servicemen. For work that cannot be done in the field, dealers have well equipped shops. Both the shop and the field servicemen have many special tools, designed and developed by "Caterpillar", that make easier and quicker the disassembly and assembly operations.

Though most "Caterpillar" owners prefer to make use of the excellent service and shop facilities of their dealers, some are themselves skilled mechanics or have such mechanics in their employ for reconditioning their equipment. To those owners this book, issued as a guide for "Caterpillar" dealer servicemen, will be of equal value.

The special tools pictured in various operations throughout are among the many which can be purchased from dealers. These tools are illustrated and listed in the Catalog for Service Tools, a copy of which is available on request.

Table of Contents

TABLE OF CONTENTS—Continued

SPECIFICATIONS

DIESEL ENGINE

Bore and stroke—number of cylinders	4½"x5½"—4 cyl.
Firing order	1-3-4-2

Camshaft

Bearing, journal diameter	2.495 - 2.496 -in.
Bearing clearance	.003 - .006 -in.
Maximum permissible clearance	.010 -in.
End clearance	.006 - .010 -in.
Maximum permissible end clearance (thrust plate and washer)	.025 -in.
Camshaft gear backlash	.003 - .004 -in.
Maximum backlash	.010 -in.
Minimum backlash	.003 -in.

Crankshaft

Main journal, diameter	3.499 - 3.500 -in.
Main bearing clearance (aluminum)	.0055- .0085-in.
Main bearing clearance (steel backed aluminum)	.0048- .0071-in.
Maximum permissible clearance	.015 -in.
End clearance	.009 - .015 -in.
Maximum permissible end clearance	.030 -in.
Main bearing stud nuts, torque	120 lb. ft.
Connecting rod, journal diameter	2.999 - 3.000 -in.
Maximum permissible out-of-roundness	.006 -in.
Maximum permissible journal wear	.007 -in.

Connecting Rod

Connecting rod bearing clearance (aluminum)	.005 - .0075-in.
Connecting rod bearing clearance (steel backed aluminum)	.0035- .0055-in.
Maximum permissible clearance	.013 -in.
Connecting rod bolt nuts, torque, minimum	58 lb. ft.
Center-to-center distance between connecting rod bearing and piston pin bushing	10.249 -10.251 -in.

Cylinder Liner

Diameter	4.500 - 4.501 -in.
Maximum permissible liner wear (at top of ring travel)	.015 -in.

Piston Pins

Clearance in rod bushing	.001 - .0018-in.
Maximum permissible clearance in rod	.006 -in.
Maximum permissible clearance in piston	.006 -in.

Piston Rings

Piston ring side clearance	
Top ring	.003 - .004 -in.
2nd and 3rd ring	.0025- .0035-in.
Oil control ring	.0015- .0035-in.
Maximum permissible side clearance in groove (top compression ring, new)	.010 -in.

Ring gap, top	.010 -	.021 -in.
Ring gap, 2nd and 3rd	.010 -	.026 -in.
Ring gap, 4th and 5th	.013 -	.027 -in.

Valves

Clearance (hot)		.010 -in.
Exhaust Valves		
Stem clearance in bushing	.005 -	.007 -in.
Maximum permissible clearance in bushing		.012 -in.
Valve seat angle		45°
Valve face angle		44¼°
Inlet Valves		
Stem clearance in bushing	.004 -	.006 -in.
Maximum permissible clearance in bushing		.012 -in.
Valve seat angle		45°
Valve face angle		44¼°

Valve Timing (Zero Lift)

Exhaust opens	88° BBC
Exhaust closes	55° ATC
Inlet opens	50° BTC
Inlet closes	62° ABC

Valve Spring—Outer (Later Engines)

Lbs. pressure	53
When compressed to	1½-in.

Valve Spring—Outer (Earlier Engines)

Lbs. pressure	57.50-62.50
When compressed to	2⅞-in.

Valve Spring—Inner (Later Engines)

Lbs. pressure	18
When compressed to	1½-in.

Valve Spring—Inner (Earlier Engines)

Lbs. pressure	9-11
When compressed to	2 13/32-in.

Rocker Arm Bushings

Clearance between shaft and bushings	.001 -	.003 -in.

Oil Pump

Clearance between gears and separator plates	.002 -	.004 -in.

Fuel Injection Pump Lifter Setting 1.736-in.

Fuel Pump Plunger

Length	2.6575-	2.6577-in.
Maximum wear		.005 -in.

Fuel Injection Pump Timing 15° BTC

Flywheel Housing

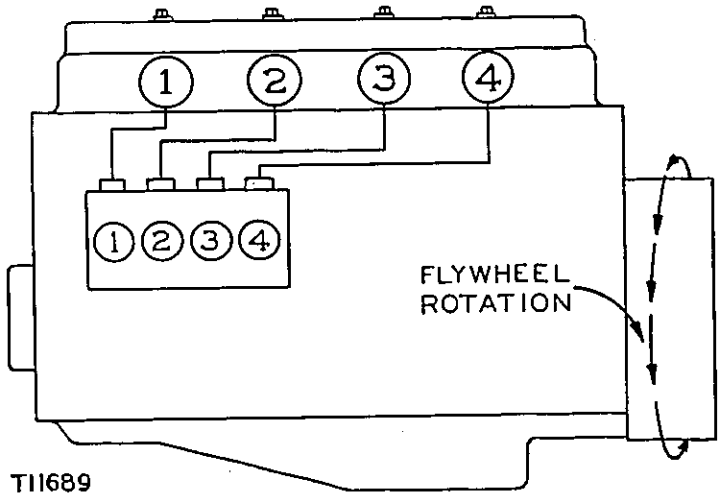
Bore run-out	.010 -in.
Face run-out	.010 -in.
Nut torque	150 lb. ft.

Flywheel Run-Out

Outside diameter (Maximum)	.006 -in.
Face (Maximum)	.006 -in.

	Earlier	Hardened washers and hardened nuts
Cylinder Head		
Tighten nuts (see text for sequence):		
1/2" nuts	58 lb. ft.	70 lb. ft.
5/8" nuts	130 lb. ft.	140 lb. ft.
Accessory Shaft		
End clearance	.003 - .010 -in.	
Maximum	.025 -in.	
Compression Release Clearance (nonadjustable)		
Between rocker arm button, and compression release shaft	.120 - .125 -in.	
Timing Gear Housing		
Capscrew torque	35 lb. ft.	
Hour Meter		
Bearing clearance (Maximum)	.012 -in.	
Pre-combustion Chamber		
Torque	200 lb. ft.	

The following illustration shows the numbering of the cylinders and of fuel injection pumps.



STARTING ENGINE

Bore and stroke	2 3/4"x3"—2 cyl.
Brake horsepower	10 at 3000 RPM
Spark plug gap	.025 -in.
Camshaft	
Bearings, journal diameter, front and rear	1.496 - 1.497 -in.
Bearing clearance	.0025 - .004 -in.
End clearance	.007 - .015 -in.
Maximum permissible end clearance	.025 -in.

Crankshaft

Main journal, diameter	1.8120- 1.8125-in.
Main bearing clearance	.005 - .0085-in.
Maximum permissible clearance	.015 -in.
End clearance, front main bearing	.010 - .015 -in.
Maximum permissible end clearance	.025 -in.
Connecting rod, journal diameter	1.7495- 1.7500-in.
Maximum permissible out-of-roundness (journal)	.003 -in.
Maximum permissible wear on journal	.005 -in.

Connecting Rod

Connecting rod bearing clearance (Babbitt)	.002 - .0035-in.
Maximum permissible clearance	.009 -in.
Center-to-center distance	5.748 - 5.750 -in.

Cylinder Bore

Diameter	2.751 - 2.752 -in.
Cylinder bore wear limit (out-of-round)	.004 -in.
Cylinder bore wear limit (taper)	.006 -in.
Piston clearance (skirt)	.004 - .006 -in.

Piston Pins

Clearance in rod bushing	.0008- .0013-in.
Maximum permissible clearance between bushing and pin	.003 -in.
Clearance in piston	.0004- .001 -in.
Maximum permissible clearance between piston and pin	.0025-in.

Piston Rings

Compression ring gap	.015 - .028 -in.
Oil ring gap	.015 - .026 -in.
Compression ring groove clearance	.0015- .003 -in.
Oil ring groove clearance	.001 - .0025-in.
Maximum permissible groove clearance (new ring) compression and oil rings	.009 -in.

Valves

Clearance (cold nonadjustable)	.007 - .010 -in.
Exhaust valves	
Stem clearance in bushing	.003 - .005 -in.
Maximum permissible clearance in bushing (with new valve)	.007 -in.
Valve seat angle	45°
Valve face angle	44¼°
Inlet valves	
Stem clearance in bushing	.0015- .003 -in.
Maximum permissible clearance in bushing (with new valve)	.005 -in.
Valve seat angle	45°
Valve face angle	44¼°

Valve Timing (Zero Lift)

Exhaust opens	40° BBC
Exhaust closes	5° ATC
Inlet opens	10° BTC
Inlet closes	35° ABC

Valve Spring

Lbs. pressure	35-38
When compressed to	1-29/32-in.

Carburetor

Float level	1⅛±3/64-in.

	Earlier	Hardened washers and hardened nuts
Cylinder Head		
Tighten nuts (see text for sequence):		
1/2" nuts	58 lb. ft.	70 lb. ft.
5/8" nuts	130 lb. ft.	140 lb. ft.
Accessory Shaft		
End clearance	.003 - .010 -in.	
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Torque	200 lb. ft.	

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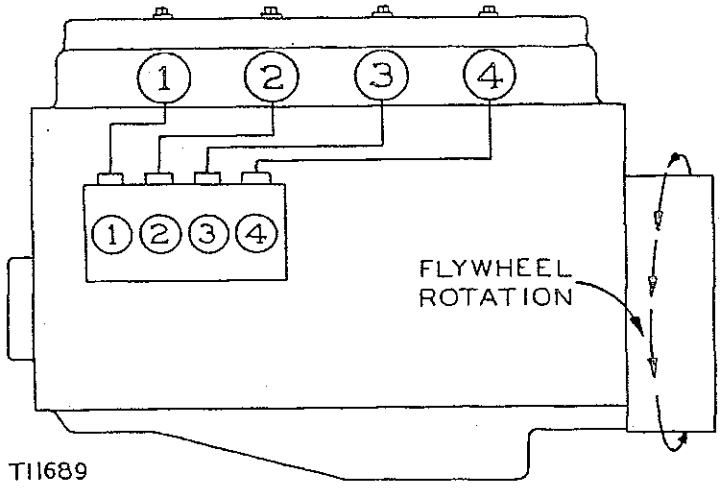


STARTING ENGINE

Bore and stroke	2¾"x3"—2 cyl.
Brake horsepower	10 at 3000 RPM
Spark plug gap	.025 -in.
Camshaft	
Bearings, journal diameter, front and rear	1.496 - 1.497 -in.
Bearing clearance	.0025 - .004 -in.
End clearance	.007 - .015 -in.
Maximum permissible end clearance	.025 -in.

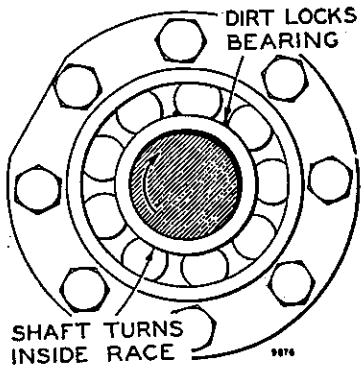
General Instructions

These general instructions will be extremely helpful in following the detailed instructions in the main sections of the book. They should be read and then kept in mind while assembling or disassembling the engine.

KEEP DIRT OUT

The most important single item in preserving the long life of the engine is to keep dirt out of vital working parts. Caterpillar Tractor Co. has taken precautions to safeguard against dirt entering working parts. Enclosed compartments, seals and filters have been provided to keep the supply of air, fuel, and lubricants clean. It is highly important that the effectiveness of these safeguards be maintained. Filters should be replaced or cleaned regularly. Worn seals or broken gaskets should be replaced immediately.

Anti-friction bearings, properly lubricated with clean lubricant, will last indefinitely. Abrasives in the lubricant will cause rapid wear on the extremely hard races and balls or rollers. Dirt in an anti-friction bearing can cause the bearing to lock, with the result that the shaft will turn in the inner race or the outer race will turn within the cage. Dirt and abrasives in lubricants will embed in bushing-type bearings and act like fine sandpaper against the shaft, causing extremely rapid wear.



EFFECT OF DIRT IN BEARING

◆

Lubricant must be changed at recommended intervals. Use clean containers. Before removing the filler cap, brush away the dirt with the brush provided in the tool kit.

Wear on fuel injection pumps and other parts of the fuel system will be almost negligible if the fuel is perfectly clean. Adequate fuel filters have been provided to safeguard fuel injection equipment. However, dirty fuel caused by careless handling or improper storage facilities will cause wear on the fuel transfer pump, prematurely clog the fuel filter, and eventually result in improper operation of the Diesel engine.

MAINTAIN ADJUSTMENTS

Operating adjustments have been kept to a minimum on "Caterpillar"-built engines but they are important and should be carefully maintained.

Keep the fan belt adjusted to the proper tension to obtain maximum belt life and proper cooling.

Follow the recommendations in the Operator's Instruction Book.

INSPECT FREQUENTLY AND CORRECT MINOR TROUBLES

A bearing changed in time will save a crankshaft. A water leak corrected prevents loss of coolant and an overheated engine. A nut tightened in time will prevent the loss or breakage of an associated part.

RECONDITIONING PROCEDURE

This book has been arranged for the disassembly and reconditioning of the individual assemblies of the engine. If the engine is to be disassembled for complete inspection and reconditioning, let the following procedure be your guide, after the engine has been removed from its particular point of installation.

If possible, determine which assemblies will not be disassembled, in order to remove a group of assemblies as a unit at one time. This will save time and labor if an assembly is not to be reconditioned and if it can be removed from the engine without disturbing the assembly.

1. Remove radiator or heat exchanger and all water lines.
2. Remove oil cooler (if installed separately), oil filters and oil manifold.
3. Remove fan group (if installed), water pump or pumps and regulator housing or adapter housing.
4. Remove air cleaner.
5. Remove starting engine.
6. Remove fuel lines.
7. Remove manifolds, cylinder head and valve mechanism.
8. Remove governor, fuel injection pump housing, fuel filter housing and fuel transfer pump.
9. Remove oil pan, crankcase inspection covers and valve lifters.
10. Remove flywheel, flywheel housing and starter pinion.
11. Remove charging generator (if installed), timing gear cover, timing gears, camshaft, accessory shaft and timing gear housing.

12. Remove suction bells, oil lines, oil pump and oil pump drive.
13. Remove connecting rods and pistons.
14. Remove crankshaft.
15. Remove cylinder liners.

Instructions for removing and disassembling these parts are contained in this Reference Book, although not necessarily in the above order.

SAFETY AND WORKMANSHIP SUGGESTIONS

There are certain practices which should be followed in the interest of safety and good workmanship when working around machinery.

Always show proper respect for weight. Do not attempt to lift heavy parts where a hoist should be used. Never leave heavy parts in an unstable position. When raising a machine make sure that it is blocked securely. Then block it up so that the weight will be supported by the blocks rather than the lifting equipment.

Tools

All service tools should be kept in first class condition. Use the proper tool for the job at hand. Special service tools are available for specific jobs and they should be used when recommended. The use of these tools will save time and prevent damage to parts.

In the following pages puller arrangements are illustrated for separating tightly fitted parts. However, if the machine is being reconditioned in a shop, it may in many cases be easier and faster to use a press. When pulling a bearing or gear from a shaft, always use a centering spacer between the forcing screw and the end of the shaft.

Disassembly

If a part offers unexpected resistance to removal, check carefully to see that all nuts and capscrews have been removed before using force. Possibly some other part is interfering and should be removed first. Parts which are fitted together with tapered splines are always very tight. If they are not tight when disassembled, inspect the tapered splines and discard the part if the splines are worn.

Identical parts, such as pistons and valves, should be kept in order or marked so they can be reinstalled in the same position from which they were removed.

Where shims are used, be sure to remove them all. Tie the shims together and identify them as to their location. Then keep them clean and flat until they are reinstalled.

Whenever fuel injection lines are disconnected, the ends of the lines should be capped with the fittings supplied in the tool kit. Also cap the pumps and valves. This will prevent dirt and other foreign matter from entering the fuel injection system.

CLEANING AND INSPECTION

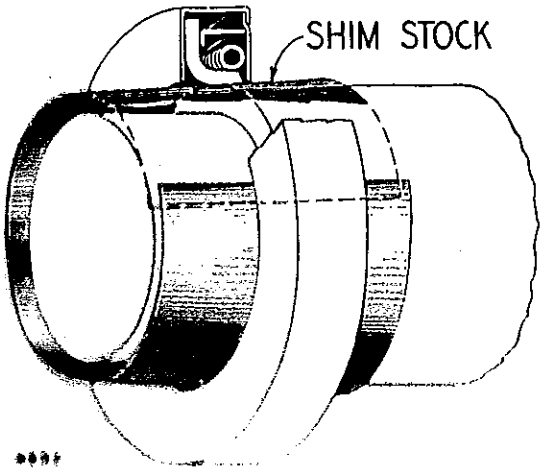
Clean all parts thoroughly after they are removed and inspect them. Be sure all lubricant passages and oil holes are open. Badly worn or damaged parts should not be put back in the machine. Cover all parts to keep them clean until they are installed.

Anti-friction bearings should receive special handling. As soon as a bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in non-inflammable cleaning solution and inspect the races and balls or rollers. Discard the bearings if they are pitted, scored, or burned. If the bearing is serviceable, coat it with light oil and wrap it in clean paper. Do not unwrap new bearings until ready to install them.

ASSEMBLY

Clean the rust preventive compound from all machined surfaces of new parts before installing them. Be sure to install parts in the proper location and position.

When one part is pressed into another, use white lead or a suitable prepared compound to lubricate the mating surfaces. Tapered parts, however, should be assembled dry. Before assembling parts with tapered splines, be sure the splines are clean, dry and free from burrs. Then press the parts together tightly.

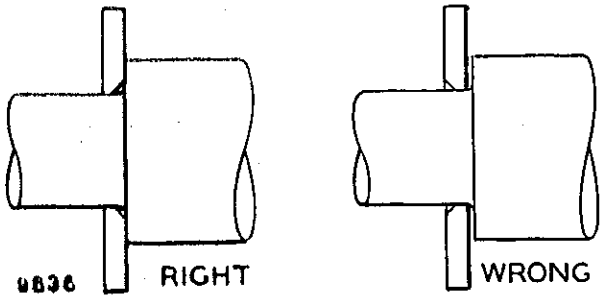


PROTECTING SEAL DURING INSTALLATION

Lubricant should be applied to the lip of all shaft-type rubber seals before installation. This will prevent damage to the seal during the initial running until the oil being sealed has contacted the sealing face.

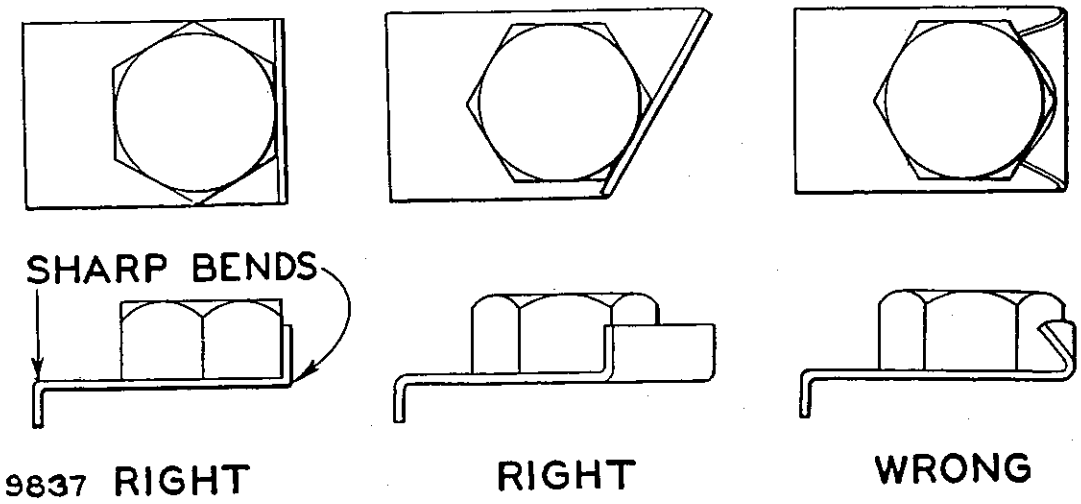
When possible, soak new rawhide seals in warm oil for a half hour before installing. Install the seal with the wiping edge turned in the direction recommended. Be careful not to cut the leather seal as it is installed or when installing a shaft through the seal. Use shim stock if necessary to protect the seal from shoulders or sharp edges during installation. Packing-type seals should always be renewed if the contacting part is removed.

HOW TO INSTALL SPACER AGAINST SHOULDER ON SHAFT

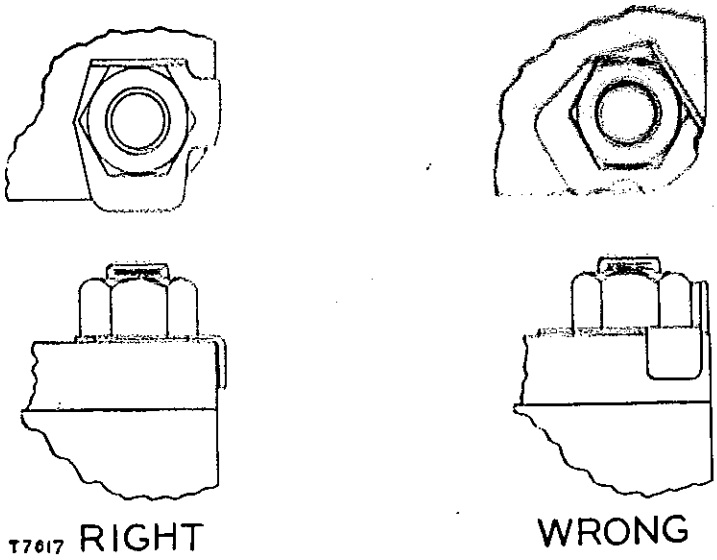


When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder. If the washer is turned in the wrong direction the radius may interfere and prevent the washer from seating against the shoulder.

Do not install bushings by driving them in with a hammer. Use a press if possible and be sure to apply the pressure directly in line with the bore. If a bushing must be driven in, use a bushing driver or a bar with a smooth flat end. If the bushing has an oil hole, be sure it is aligned with the oil hole in the part into which it is assembled.



HOW TO INSTALL FLAT METAL LOCKS



T7617 RIGHT WRONG

METHOD FOR LOCK POSITIONING AND BENDING

Install gaskets where required and use new ones if necessary. Never use cork or felt gaskets or seals a second time. Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select stock of the proper type and thickness and be sure to cut sufficient holes in the right places. Blank gaskets can cause serious damage.

Use capscrews of the correct length. A capscrew which is too long may "bottom" before the head is tight against the part it is to hold, and in addition the threads may be damaged when the capscrew is removed.

If a capscrew is too short, there will not be enough threads to hold the part securely.

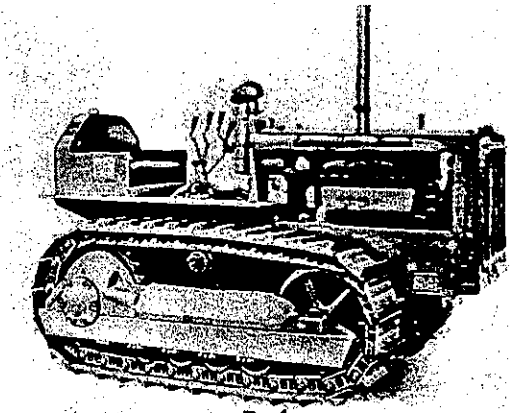
Lockwashers, cotter pins, or flat metal locks should be used to lock each nut and capscrew. Flat metal locks must be installed properly to be effective. Bend one end of the lock sharply around the edge of the part. Bend the other end sharply against one flat surface of the nut or capscrew head. Do not bend the lock against more than one side of the nut.

When assembling a machine complete each step in turn. Do not leave one part partially assembled and start assembling some other part. Make all adjustments as recommended. Always check the job after it is completed to see that nothing has been overlooked.

PREPARATION FOR STARTING

After assembling a machine, lubricate it thoroughly. Fill the various compartments with the type and grade of lubricant recommended in the Operator's Instruction Book. Fill the crankcases of both the Diesel engine and starting engine with the grade of oil recommended for the prevailing temperature. Fill the cooling system with water or anti-freeze solution.

Recheck the various adjustments by operating the machine before returning it to the job. If a machine has been completely rebuilt, it should be run-in gradually before subjecting it to a full load. See the topic, RUNNING-IN SCHEDULE.



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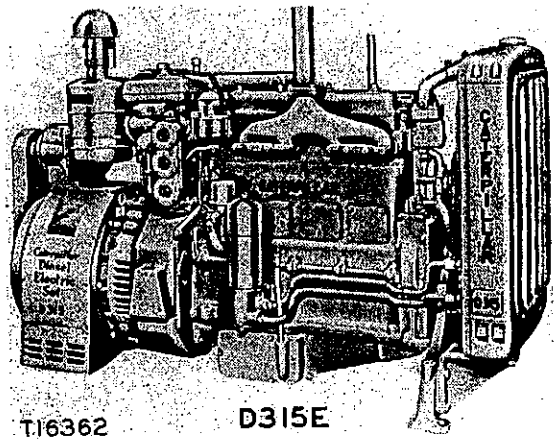

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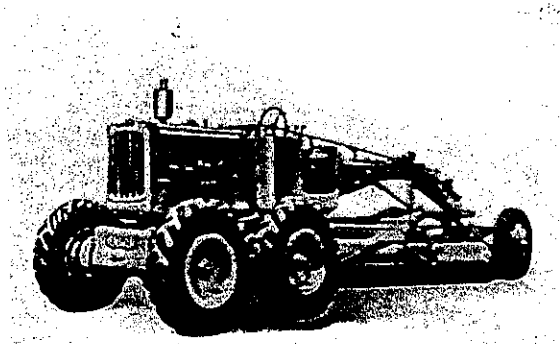

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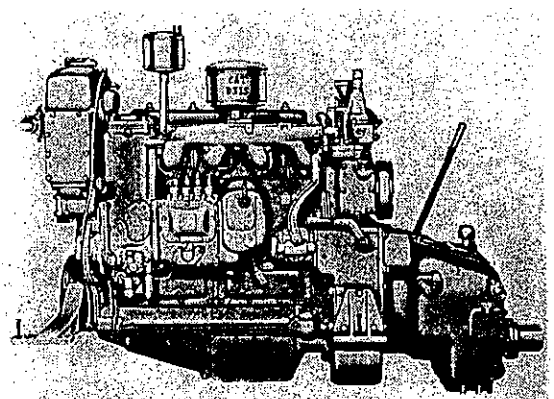
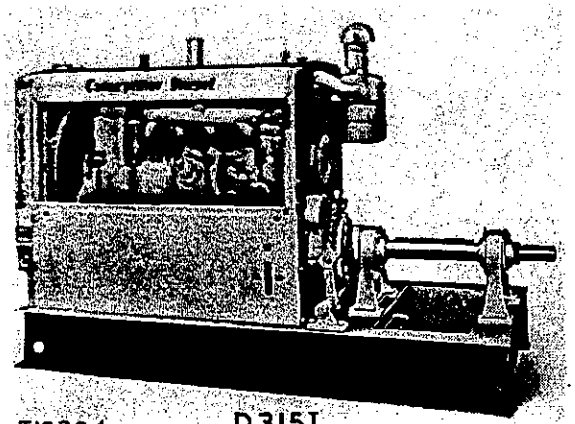


T16363 D315M



T16364 D315I

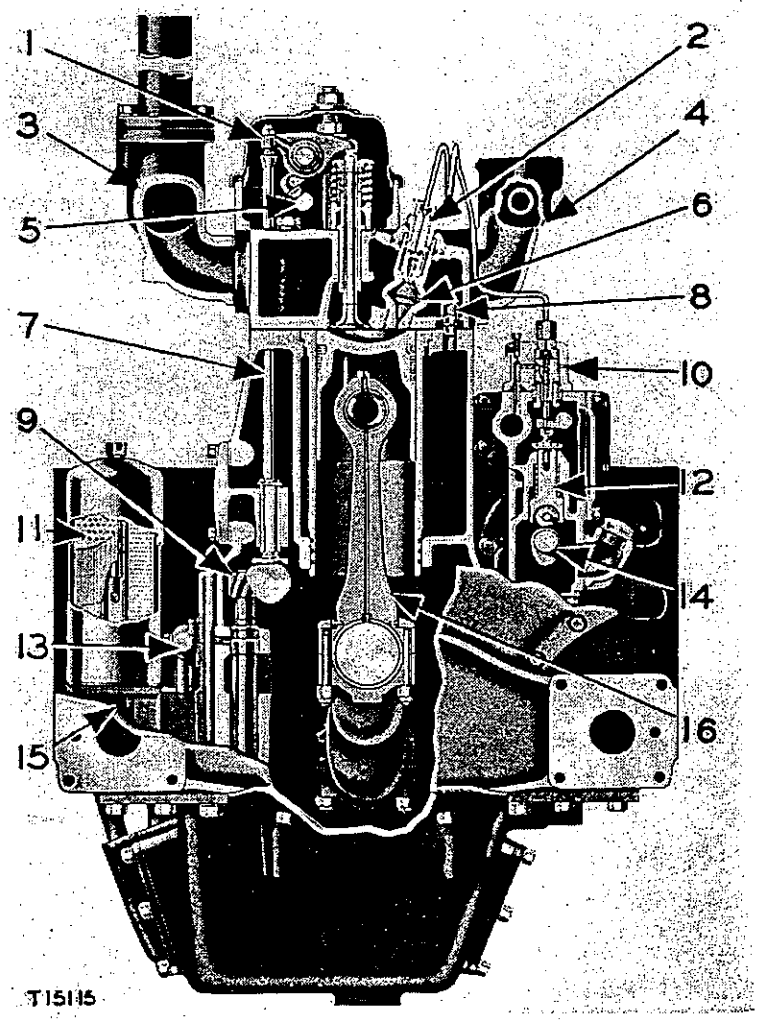
Introduction

This book contains illustrations and reconditioning information for the 4½" bore, 4-cylinder Diesel Engines.

The following models which are included, are the engines for the D4 Tractor, the No. 112 Motor Grader, the D315 Industrial, the D315 Electric Set and the D315 Marine.

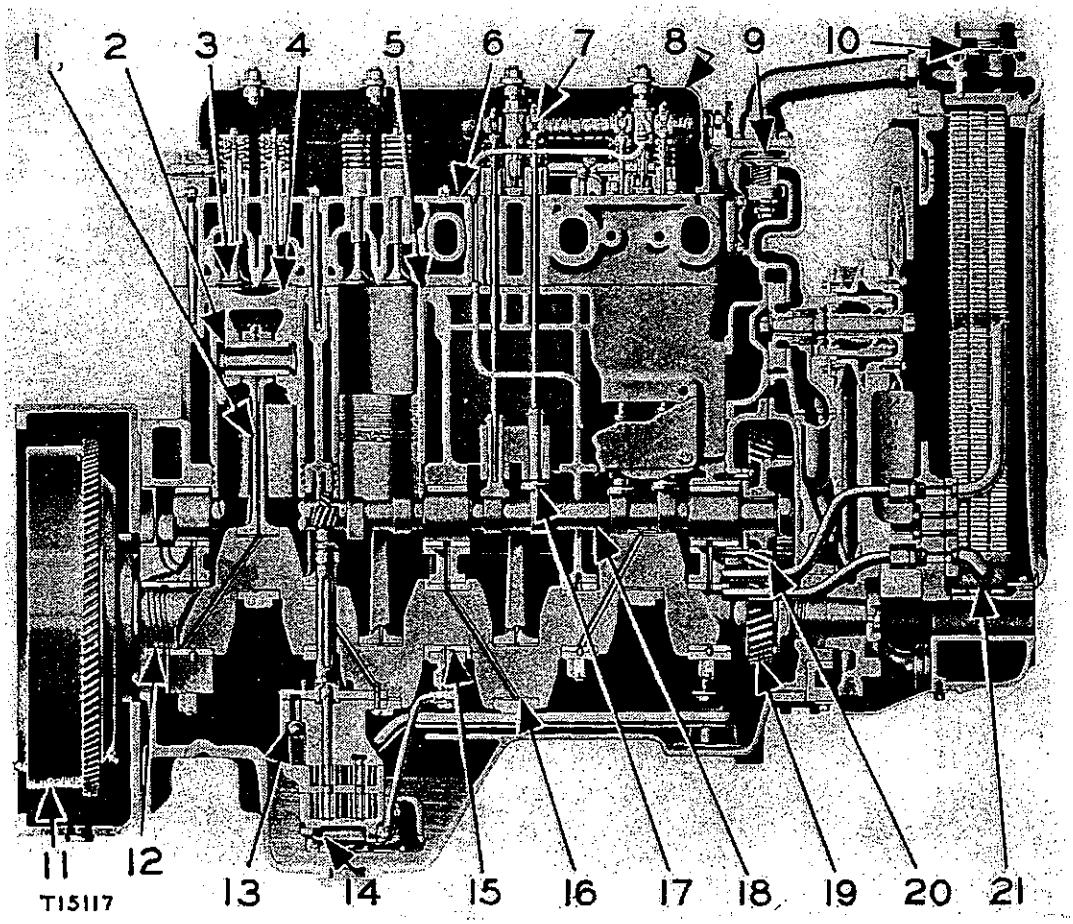
An abbreviation of each model is used: D4 for the engine as used in a D4 Tractor; No. 112, the No. 112 Motor Grader version; D315I, the industrial version; D315E, the engine used in the electric set; and the D315M, the marine version.

Certain items which are standard equipment on some models and are optional or attachments on others, are covered in the appropriate places along with standard parts with no differentiation noted.



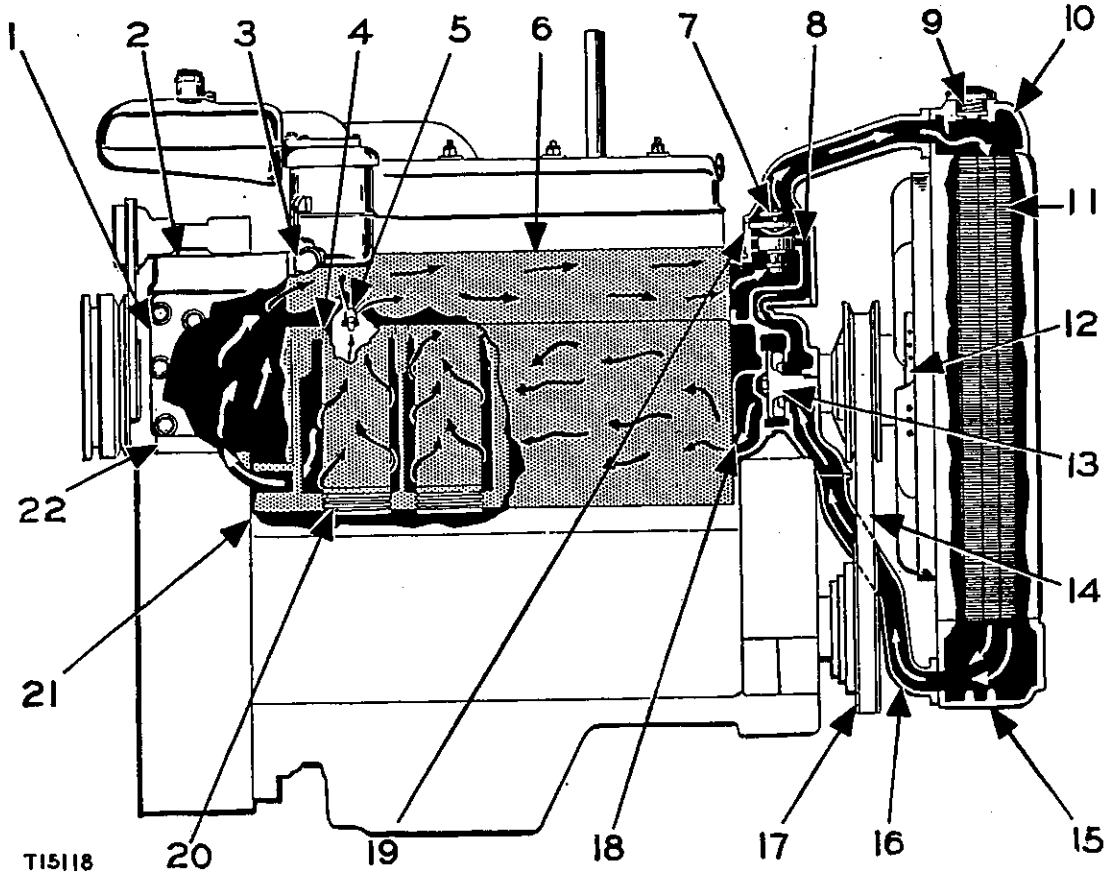
SECTIONAL VIEW OF ENGINE (FRONT)
(D4 Illustrated)

1–Rocker arm assembly. 2–Fuel injection valve. 3–Exhaust manifold. 4–Inlet manifold. 5–Compression release shaft. 6–Pre-combustion chamber. 7–Push rod. 8–Water director. 9–Oil pump drive gear. 10–Fuel injection pump. 11–Lubricating oil filter element. 12–Fuel pump lifter assembly. 13–Oil manifold. 14–Fuel pump camshaft. 15–Oil filter base. 16–Connecting rod.



CUTAWAY VIEW OF ENGINE (RIGHT SIDE)
(Earlier D4 Illustrated)

1–Connecting rod. 2–Piston pin. 3–Valve. 4–Piston. 5–Cylinder liner. 6–Cylinder head. 7–Valve rocker arm assembly. 8–Valve cover. 9–Temperature regulator. 10–Pressure overflow assembly. 11–Flywheel. 12–Crankshaft. 13–Pressure relief valve. 14–Oil pump. 15–Center thrust main bearing. 16–Connecting rod bearing. 17–Valve lifter. 18–Camshaft. 19–Crankshaft gear. 20–Camshaft gear. 21–Oil cooler.



FLOW OF FRESH WATER COOLANT

1–Starting engine cylinder head. 2–Starting engine manifold. 3–Elbow. 4–Cylinder liner. 5–Water director. 6–Cylinder head. 7–Water temperature regulator. 8–By-pass passage. 9–Pressure relief valve. 10–Radiator top tank. 11–Radiator core. 12–Fan assembly. 13–Fresh water pump. 14–Fan belt. 15–Radiator lower tank. 16–Water line. 17–Crankshaft pulley. 18–Cylinder block inlet passage. 19–Regulator housing. 20–Liner seal. 21–Cylinder block. 22–Starting engine cylinder block.

DIESEL ENGINE

Cooling Systems

FRESH WATER COOLING SYSTEM
(Radiator-Cooled)

The centrifugal-type fresh water pump **(13)** circulates the coolant through the cooling system. The water pump and the fan assembly **(12)** are driven by the fan belt **(14)** and the crankshaft pulley **(17)**.

The fresh water pump delivers the coolant into the cylinder block inlet passage **(18)** of the cylinder block **(21)**. The coolant passes through the water jackets which extend practically the full length of the cylinder liners **(4)**. The liner seals **(20)** prevent leakage.

A portion of the coolant is transmitted into the starting engine and cools the starting engine cylinder block **(22)**, the cylinder heads **(1)**, and the manifold **(2)**. The coolant then passes through the elbow **(3)** into the cylinder head **(6)** of the Diesel engine.

When the starting engine is running, the starting engine discharges the warm water into the Diesel engine to aid starting of the Diesel engine. The cooling systems are interconnected.

The greater portion of the coolant passes directly from the cylinder block through the water seals, ferrules and water directors **(5)** into the cylinder head.

The coolant passes from the cylinder head into the regulator housing **(19)** and contacts the water temperature regulator **(7)**.

The flow of the coolant from the water regulator to the water pump is as follows: On initial starting (in most cases) the temperature of the coolant is not sufficient to open the water temperature regulator, which remains closed until the engine coolant is approximately 160°F. In this case none of the coolant is admitted to the radiator to be cooled, thus assuring rapid warmup. The coolant flows into the by-pass water passage **(8)**, which is connected to the inlet side of the water pump and returns the coolant to the water pump. Thus, the circuit is completed for the flow of coolant with the regulator in a closed position.

The flow with the water temperature regulator in the open position is as follows: When the engine coolant is at approximately 160°F., the regulator opens and the coolant passes through to the radiator top tank **(10)**. As the coolant passes through the radiator core **(11)**, it is aided in cooling by the fan and is admitted to the radiator bottom tank **(15)**. The water line **(16)** is attached to the suction side of the water pump, and returns

the coolant to the water pump. A small portion of the coolant flows through the by-pass passage **(8)** even when the regulator is in the open position.

The fuel filter housing (not shown) is mounted on the left side of the engine. The fuel compartment of the fuel filter housing is warmed by the coolant as it passes through the water passage of an elbow which is attached to the fuel filter housing.

A sealed pressure overflow assembly **(9)**, which is part of the radiator cap, prevents the loss of coolant when the engine is operated on steep inclines. By maintaining a pressure of about six PSI in the cooling system, the sealed pressure overflow reduces the natural loss of coolant by evaporation.

Use soft water or clean rain water in the cooling system whenever possible. If it is necessary to use hard water, it should first be treated with water softener. The use of "Caterpillar" Rust Inhibitor in cooling systems is recommended. This soluble oil will increase the life and efficiency of the cooling system by retarding mineral deposits when hard water is used and by preventing the formation of rust.

FRESH WATER AND RAW WATER COOLING SYSTEMS
(Heat Exchanger-Cooled)

The flow of fresh water coolant is as follows:

The centrifugal-type fresh water pump **(16)** circulates the coolant through the fresh water cooling system. The water pump is mounted on the auxiliary drive housing **(15)**, which is attached to the timing gear housing and cover.

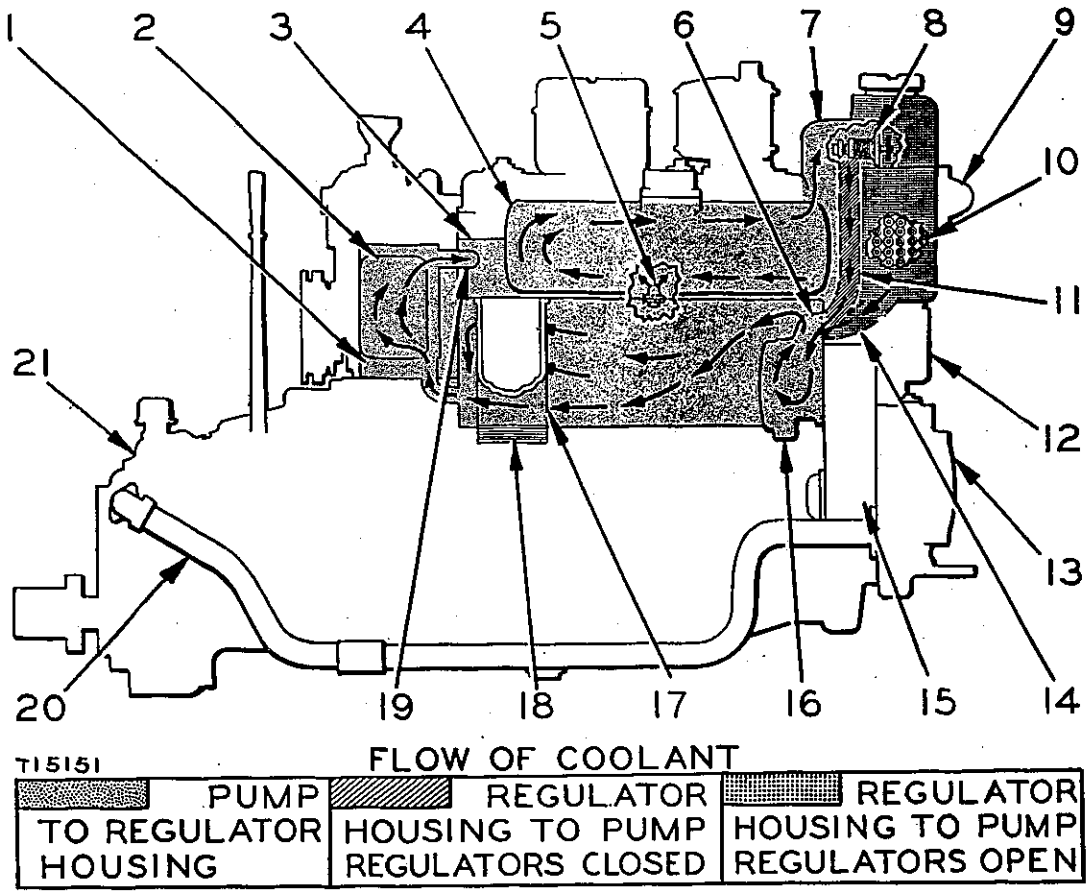
The fresh water pump is driven by the auxiliary drive idler gear which in turn is driven by the camshaft gear.

The fresh water pump delivers the coolant into the cylinder block inlet passage **(6)** and the water-cooled exhaust manifold **(4)**.

The coolant passes through the water jackets which extend practically the full length of the cylinder liners **(17)**. The liner seals **(18)** prevent leakage.

The engine exhaust gases are cooled as they pass through an inner manifold, which is cast within the water-cooled manifold.

A portion of the coolant is transmitted into the starting engine and cools the starting engine cylinder block **(1)**, and the starting engine cylinder heads **(2)**. This coolant is then delivered through the elbow **(19)** into the cylinder head **(3)** of the Diesel engine.



HEAT EXCHANGER COOLING SYSTEM

1–Starting engine cylinder block. 2–Starting engine cylinder head. 3–Diesel engine cylinder head. 4–Water-cooled exhaust manifold. 5–Water director. 6–Cylinder block inlet passage. 7–Adapter housing. 8–Water temperature regulator. 9–Raw water outlet pipe. 10–Heat exchanger core assembly. 11–By-pass passage. 12–Oil cooler. 13–Raw water pump. 14–Passage. 15–Auxiliary drive housing. 16–Fresh water pump. 17–Cylinder liner. 18–Liner seal. 19–Water elbow. 20–Pipe. 21–Reverse and reduction gear.

When the starting engine is running, the starting engine discharges warm water into the Diesel engine to aid starting of the Diesel engine. The cooling systems are interconnected.

The greater portion of the coolant passes directly from the cylinder block through the water seals, ferrules and water directors **(5)** into the cylinder head.

The coolant passes from the cylinder head into the adapter housing **(7)** and contacts the water temperature regulator **(8)**.

The flow of the coolant from the water regulator to the water pump is as follows: On initial starting, the temperature of the coolant is not sufficient to open the water temperature regulator, which remains closed until the engine coolant is approximately 160°F. In this case none of the coolant is admitted to the heat exchanger to be cooled, thus assuring rapid warm up. The coolant flows into the by-pass passage **(11)** within the adapter housing, which is connected to the inlet side of the water

pump and returns the coolant to the fresh water pump. Thus, the circuit is completed for the flow of coolant with the regulator in a closed position.

The flow of fresh water coolant with the water temperature regulator in the open position is as follows: When the engine coolant is at approximately 160°F., the regulator opens and the coolant passes around the heat exchanger core assembly **(10)** to be cooled. The passage **(14)** returns the coolant to the water pump. A small portion of the coolant flows through the by-pass passage **(11)** even when the regulator is in the open position.

The fuel filter housing (not shown) is mounted on the left side of the engine. The fuel compartment of the fuel filter housing is warmed by the coolant as it passes through the water passage of an elbow which is attached to the fuel filter housing.

Use soft water or clean rain water in the cooling system whenever possible. If it is necessary to use hard water, it should first be treated with water softener. The use of "Caterpillar" Rust Inhibitor in cooling systems is recommended. This soluble oil will increase the life and efficiency of the cooling system by retarding mineral deposits when hard water is used and by preventing the formation of rust.

The flow of raw water coolant is as follows:

The raw water pump **(13)** is mounted on the auxiliary drive housing, and is driven in the same manner as the fresh water pump.

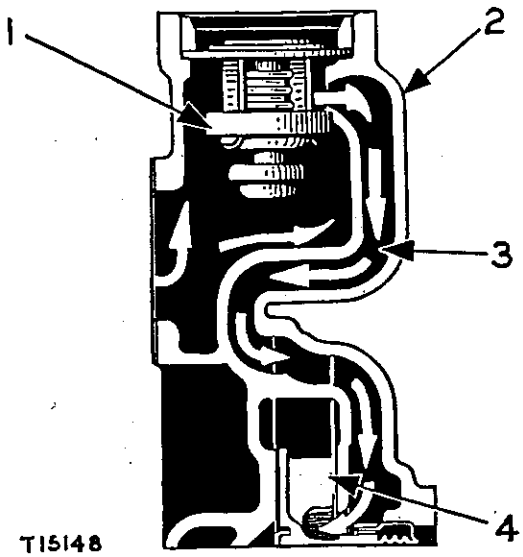
The raw water pump draws the raw water from the source of supply through the inlet pipe into the water compartment of the reverse and reduction gear **(21)**. As the raw water passes through the water compartment, it cools the lubricating oil in the reverse and reduction gear.

The pipe **(20)** transmits the raw water to the raw water pump, which delivers the raw water into the water compartment of the oil cooler **(12)**. See the topic, FLOW OF RAW WATER THROUGH THE OIL COOLER AND THE HEAT EXCHANGER.

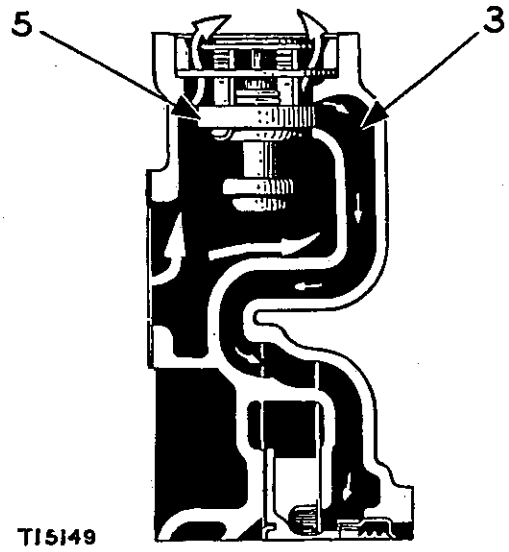
The raw water flows from the oil cooler into the heat exchanger core assembly **(10)** where it cools the fresh water. The raw water is then discharged by the outlet pipe **(9)** into the source of supply.

FLOW OF COOLANT THROUGH TEMPERATURE REGULATOR HOUSING
(All Models)

The flow of the coolant through the regulator housing or the adapter housing is similar for all models. The regulators used in the heat exchanger system differ only in the method of installation.



WATER TEMPERATURE REGULATOR CLOSED
1–Regulator (closed). 2–Regulator housing. 3–By-pass passage. 4–Water pump impeller.



WATER TEMPERATURE REGULATOR OPEN
3–By-pass passage. 5–Regulator (open).

The coolant passes into the regulator housing **(2)** and flows into contact with the water temperature regulators as shown in the schematic illustrations.

When the temperature of the coolant is less than 160°F., the regulators are in a closed position as illustrated by the regulator **(1)**. The coolant passes into the by-pass passage **(3)** and then returns to the suction side of the water pump, where it is again picked up by the water pump impeller **(4)**.

When the temperature of the coolant has reached approximately 183°F., the regulators are in the open position as illustrated by the regulator **(5)**. The coolant passes through the regulators and then to the radiator or heat exchanger to be cooled, before it returns to the suction side of the water pump. A small portion of the coolant passes through the by-pass passage **(3)** to the water pump at all times. See the topic, COOLING SYSTEMS.

FLOW OF RAW WATER THROUGH THE OIL COOLER AND THE HEAT EXCHANGER

The flow of raw water is as follows: The raw water is drawn into the system at the inlet pipe **(8)** and flows to the suction side of the raw water pump **(6)**.

The impeller **(7)** delivers the raw water into the oil cooler **(5)**. The raw water passes around the oil cooler core **(4)** to cool the oil as it passes through the core.