HYDRAPOWER

Service Manual

801.4
801.5
801.6

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Introduction

This publication is designed for the benefit of JCB Distributor Service Engineers who are receiving, or have received, training by JCB Technical Training Department.

It is assumed that these personnel have a sound knowledge of workshop practice, safety procedures and general techniques associated with the maintenance and repair of hydraulic earthmoving equipment. Therefore, these basic subjects generally are omitted from this manual, the intention being to convey only more specialised information concerning particular aspects of a machine or component.

For example, renewal of oil seals, gaskets etc., and any component showing obvious signs of wear or damage is expected as a matter of course and, therefore, information of this nature is included only in the context of specialised procedures or where a range of wear tolerances is required. Similarly, it is expected that components will be cleaned and lubricated where appropriate, also that any opened hose or pipe connections will be blanked to prevent excessive loss of hydraulic fluid and ingress of dirt. Finally, please remember above all **SAFETY MUST COME FIRST!**

The manual is compiled in sections, the first three are numbered and contain information as follows:

1 = General Information - includes torque settings and service tools
2 = Care & Safety - includes warnings and cautions pertinent to aspects of workshop procedures etc.
3 = Routine Maintenance - includes service schedules and recommended lubricants for the machine.

The remaining sections are alphabetically coded and deal with Dismantling, Overhaul etc. of specific components, for example:

A = Attachments
B = Body & Framework ... etc.

The page numbering in each alphabetically coded section may not be continuous. This allows for the insertion of new items in later issues of the manual.

Section contents, technical data, circuit descriptions, operation descriptions etc. are inserted at the beginning of each alphabetically coded section.

All sections are listed on the front cover; tabbed divider cards align directly with individual sections on the front cover for rapid reference.

Illustrations which show a dismantled component are numbered as a guide to the dismantling sequence, which generally can be reversed for assembly.

Torque settings are given as a 'mean' figure which may be varied by plus or minus 3%. Torque figures indicated are for dry threads, hence for lubricated threads may be reduced by one third.

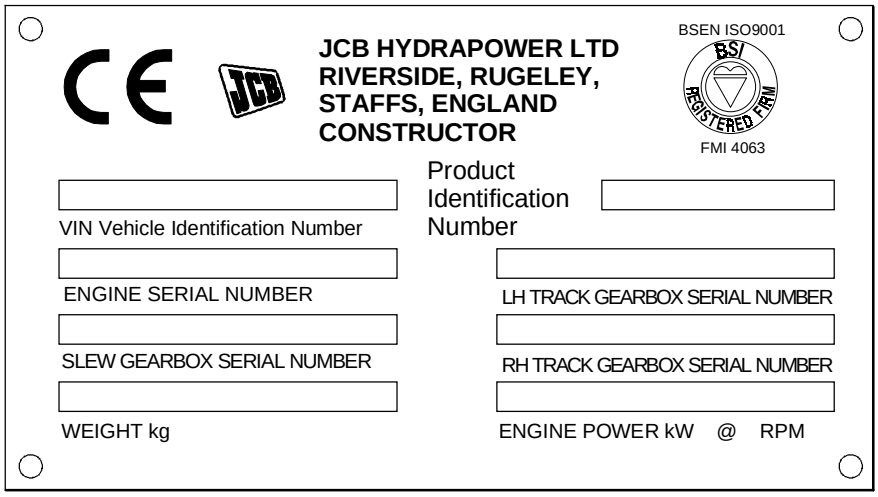
'Left Hand' and 'Right Hand' are as viewed from the rear of the machine.

References to alternative servicing intervals are to be treated on a 'whichever occurs first' basis.

Contents

Identification Plate

Your machine is fitted with an identification plate which is located on the front of the mainframe.



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Preparation for Storage

The operations to place a machine into storage (-15°C to 44° C) are given below.

1 Park the machine safely with the bucket and dipper rams retracted and the dig end outstretched. Lower the boom until the bucket rests on the ground. Lower the dozer to the ground.

2 Switch off the engine. Operate controls to release pressure from the rams.

3 Disconnect battery to prevent discharge.

4 Ensure the fuel tank is filled to a maximum, leaving no air space.

5 Ensure hydraulic tank is filled to maximum on the sight gauge.

6. Spray exposed ram rods with Waxoyl.

7. Slacken off rubber tracks until no visible spring tension exists.

Preparation after Storage

The operations to remove a machine from storage (-15°C to 44° C) and prepare it for use are given below.

1 Lower the fuel tank to ensure that sufficient air space exists in the tank.

2 Check all oil and water levels, adjust contents to correct levels as necessary.

3 Ensure the battery is fully charged.

4 Reconnect battery.

5 Remove electrical contact from fuel injection pump solenoid.

6 Crank engine for 20 seconds or until oil pressure warning light goes out.

7 Reconnect electrical supply to the fuel injection pump solenoid.

8 Start the engine. If the engine fails to start after several attempts, bleed the fuel system.

9 Adjust track tensions.

10 Grease all lubrication points.

Contents **Page No.**

Safety Notices

In this handbook and on the machine there are safety notices. Each notice starts with a signal word. The signal word meanings are given below.

DANGER

Denotes an extreme hazard exists. If proper precautions are not taken it is highly probable that the operator (or others) could be killed or seriously injured.

INT-1-2-1

WARNING

Denotes a hazard exists. If proper precautions are not taken, the operator (or others) could be killed or seriously injured.

INT-1-2-2

CAUTION

Denotes a reminder of safety practices. Failure to follow these safety practices could result in injury to the operator (or others) and possible damage to the machine.

INT-1-2-3

All construction and agricultural equipment can be hazardous. When a JCB Mini Excavator is correctly operated and properly maintained it is a safe machine to work with. But when it is carelessly operated or poorly maintained it can become a danger to you (the operator) and others.

Do not work with the machine until you are sure that you can control it.

Do not start any job until you are sure that you and those around you will be safe.

*If you are unsure of anything, about the machine or the job, ask someone who knows. Do not assume anything.

Remember

BE CAREFUL
BE ALERT
BE SAFE

GEN-1-6

As well as the warnings in the following pages, specific warnings are given throughout the book. This section is designed to give a safety code for use of the machine generally and for operation and maintenance practices.

Note: *This section includes a certain amount of operating safety information. But remember that whenever you drive the machine or operate its controls you are, in effect, a machine operator. Therefore, you should read and understand the information given in the Operator Handbook before driving the machine or operating its controls.*

General Safety

WARNING

Lifting Equipment

You can be injured if you use faulty lifting equipment. Make sure that lifting equipment is in good condition. Make sure that lifting tackle complies with all local regulations and is suitable for the job. Make sure that lifting equipment is strong enough for the job.

INT-1-3-7

WARNING

Clothing

You can be injured if you do not wear the proper clothing. Loose clothing can get caught in the machinery. Wear protective clothing to suit the job. Examples of protective clothing are: a hard hat, safety shoes, safety glasses, a well fitting overall, ear-protectors and industrial gloves. Keep cuffs fastened. Do not wear a necktie or scarf. Keep long hair restrained.

INT-1-3-6

WARNING

Care and Alertness

All the time you are working with or on the machine, take care and stay alert. Always be careful. Always be alert for hazards.

INT-1-3-5

WARNING

Raised Equipment

Raised equipment can fall and injure you. Do not walk or work under raised equipment unless safely supported.

13-1-1-6

DANGER

Before removing the boom from the machine, ensure that the counterweight is adequately supported as in certain ground conditions the machine could tip backwards. Never travel or transport the machine with the boom removed.

BF 6-3

Operating Safety

WARNING

Engine

The engine has rotating parts. Do not open the engine cover while the engine is running. Do not use the machine with the cover open.

INT-2-1-6

WARNING

Entering/Leaving

Always face the machine when entering and leaving the cab. Use the step(s) and handrails. make sure the step(s), handrails and boot soles are clean and dry. Do not jump from the machine. Do not use the machine controls as handholds, use the handrails.

INT-2-1-7

WARNING

Visibility

Accidents can be caused by working in poor visibility. Keep windows clean and use your lights to improve visibility. Do not operate the machine if you cannot see properly.

INT-2-1-11

WARNING

Machine Limits

Operating the machine beyond its design limits can damage the machine, it can also be dangerous. Do not operate the machine outside its limits. Do not try to upgrade the machine performance with unapproved modifications.

INT-2-1-4

WARNING

Exhaust Gases

Breathing the machine exhaust gases can harm and possibly kill you. Do not operate the machine in closed spaces without making sure there is good ventilation. If possible, fit an exhaust extension. If you begin to feel drowsy, stop the machine at once. Get out of the cab into fresh air.

INT-2-1-10

WARNING

Hazardous Atmospheres

This machine is designed for use in normal outdoor atmospheric conditions. It should not be used in an enclosed area without adequate ventilation. Do not use the machine in a potentially explosive atmosphere, i.e. combustible vapours, gas or dust, without first consulting your JCB Hydrapower Distributor.

INT-2-1-14

WARNING

Ramps and Trailers

Water, mud, ice, grease and oil on ramps or trailers can cause serious accidents. Make sure ramps and trailers are clean before driving onto them. Use extreme caution when driving onto ramps and trailers.

INT-2-2-6

WARNING

Communications

Bad communications can cause accidents. Keep people around you informed of what you will be doing. If you will be working with other people, make sure any hand signals that may be used are understood by everybody. Work sites can be noisy, do not rely on spoken commands.

INT-2-2-3

WARNING

Sparks

Explosions and fire can be caused by sparks from the exhaust or the electrical system. Do not use the machine in closed areas where there is flammable material, vapour or dust.

INT-2-2-10

WARNING

Controls

Keep the machine controls clean and dry. Your hands and feet could slide off slippery controls. If that happens you will lose control of the machine.

2-2-3-6

Maintenance Safety

WARNING

Soft Ground

A machine can sink into soft ground. Never work under a machine on soft ground.

INT-3-2-4

WARNING

Metal Splinters

You can be injured by flying metal splinters when driving metal pins in or out. Use a soft faced hammer or drift to remove and fit metal pins. Always wear safety glasses.

INT-3-1-3

WARNING

Communications

Bad communications can cause accidents. If two or more people are working on the machine, make sure each is aware of what the others are doing. Before starting the engine make sure the others are clear of the danger areas; examples of danger areas are: the rotating blades and belt on the engine, the attachments and linkages, and anywhere beneath or behind the machine. People can be killed or injured if these precautions are not taken.

INT-3-1-5

WARNING

Diesel Fuel

Diesel fuel is flammable; keep naked flames away from the machine. Do not smoke while refuelling the machine or working on the engine. Do not refuel with the engine running. There could be a fire and injury if you do not follow these precautions.

INT-3-2-2

WARNING

Petrol

Do not use petrol in this machine. Do not mix petrol with the diesel fuel; in storage tanks the petrol will rise to the top and form flammable vapours.

INT-3-1-6

WARNING

Oil

Oil is toxic. If you swallow any oil, do not induce vomiting, seek medical advice. Used engine oil contains harmful contaminants which can cause skin cancer. Do not handle used engine oil more than necessary. Always use barrier cream or wear gloves to prevent skin contact. Wash skin contaminated with oil thoroughly in warm soapy water. Do not use petrol, diesel fuel or paraffin to clean your skin.

INT-3-2-3

WARNING

Fires

If your machine is equipped with a fire extinguisher, make sure it is checked regularly. Keep it in the operator's cab until you need to use it.

Do not use water to put out a machine fire, you could spread an oil fire or get a shock from an electrical fire. Use carbon dioxide, dry chemical or foam extinguishers. Contact your nearest fire department as quickly as possible. Firefighters should use self-contained breathing apparatus.

INT-3-2-7/1

WARNING

Battery

A battery with frozen electrolyte can explode if it is used or charged. Do not use a machine with a frozen battery. To help prevent the battery from freezing, keep the battery fully charged.

INT-3-1-7

WARNING

Battery Gases

Batteries give off explosive gases. Keep flames and sparks away from the battery. Do not smoke close to the battery. Make sure there is good ventilation in closed areas where batteries are being used or charged. Do not check the battery charge by shorting the terminals with metal; use a hydrometer or voltmeter.

INT-3-1-8

WARNING

Battery Terminals

The machine is negatively earthed. Always connect the negative pole of the battery to earth.

When connecting the battery, connect the earth lead (-) last. When disconnecting the battery, disconnect the earth lead (-) first.

INT-3-1-9

WARNING

Electrical Circuits

Understand the electrical circuit before connecting or disconnecting an electrical component. A wrong connection can cause injury and/or damage.

INT-3-1-4

CAUTION

Never use water or steam to clean inside the cab. The use of water or steam could damage the on-board computer and render the machine inoperable. Remove dirt using a brush or damp cloth.

8-3-4-8

Maintenance Safety (cont'd)

CAUTION

Arc Welding

Before carrying out any arc welding on the machine, completely remove the Control Computer to avoid damage to the circuits; also disconnect the alternator plug and battery leads.

*When welding items to the mainframe make sure that the earth clamp is positioned on the mainframe and when welding to the undercarriage make sure the earth clamp is positioned on the undercarriage. If you earth one and weld the other, you may cause severe damage to the slew ring.

Always connect the earth clamp to any other component being welded, i.e. boom or dipper, to avoid damage to pivot pins and bushes.

8-1-2-6/1

WARNING

Hydraulic Hoses

Damaged hoses can cause fatal accidents. Inspect the hoses regularly for:
Damaged end fittings
Chafed outer covers
Ballooned outer covers
Kinked or crushed hoses
Embedded armouring in outer covers
Displaced end fittings.

INT-3-3-2

WARNING

DO NOT remove the hydraulic tank filler cap or cover plate when the engine is running. The hydraulic system is under pressure. You or others could be injured. First stop the engine and then release the pressure.

8-3-4-4/1

WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before disconnecting or connecting hydraulic hoses, stop the engine and operate the controls to release pressure trapped in the hoses. Makes sure the engine cannot be started while the hoses are open.

INT-3-1-11/1

WARNING

Hydraulic Fluid

Fine jets of hydraulic fluid at high pressure can penetrate the skin. Do not use your fingers to check for hydraulic fluid leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of hydraulic fluid. If hydraulic fluid penetrates your skin, get medical help immediately.

INT-3-2-4

CAUTION

Rams

The efficiency of the rams will be affected if they are not kept free of solidified dirt. Clean dirt from around the rams regularly. When leaving or parking the machine, close all rams if possible to reduce the risk of weather corrosion.

INT-3-2-10

CAUTION

Cleaning

Cleaning metal parts with incorrect solvents can cause corrosion. Use only recommended cleaning agents and solvents.

INT-3-2-11

CAUTION

'O' rings, Seals and Gaskets

Badly fitted, damaged or rotted 'O' rings, seals and gaskets can cause leakages and possible accidents. Renew whenever disturbed unless otherwise instructed. Do not use Trichloroethane or paint thinners near 'O' rings and seals.

INT-3-2-12

WARNING

Hot Coolant

The cooling system is pressurised when the engine is hot. Hot coolant can spray out when you remove the radiator cap. Let the system cool before removing the radiator cap. To remove the cap; turn it to the first notch and let the system pressure escape, then remove the cap.

INT-3-2-9

Contents **Page No.**

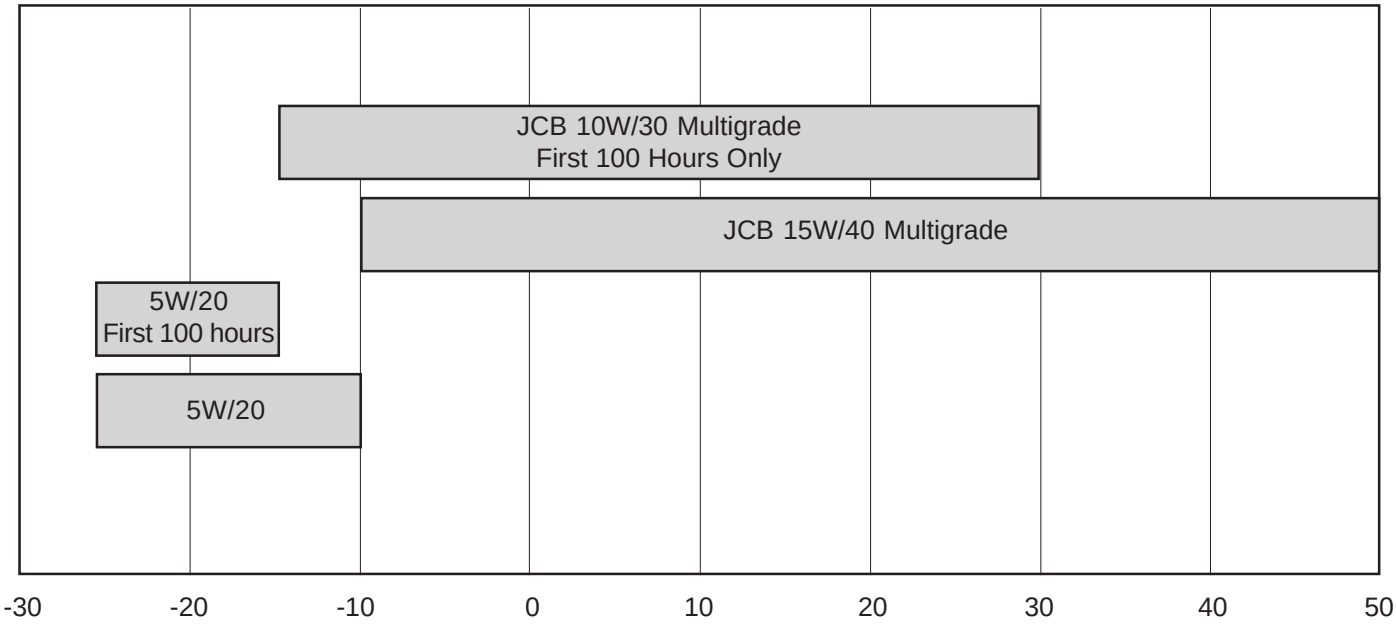
*New engines DO NOT require a running-in period. The engine/machine should be used in a normal work cycle immediately; glazing of the piston cylinder bores, resulting in excessive oil consumption, could occur if the engine is gently run-in. Under no circumstances should the engine be allowed to idle for extended periods; (e.g. warming up without load). Engines of new machines are filled at the factory with JCB 10W/30 Multigrade oil. This oil should be drained after the first 100 hours operation and the engine filled with the appropriate recommended grade as shown in the lubrication chart. JCB 10W/30 Multigrade should also be used for the first 100 hours operation whenever a new or reconditioned engine is fitted to the machine. After the first 100 hours operation, it is essential that the 10W/30 oil is replaced by the lubricant recommended below.

ITEM	CAPACITY Litres (Gal)	FLUID / LUBRICANT	INTERNATIONAL SPECIFICATION
Fuel Tank	17.0 (3.75)	Diesel Oil (See Types of Fuel)	ASTM D975-66T Nos. 1D, 2D
Engine (Oil)			
First 100 hours only	3.5 (0.77)	**JCB 10W/30 Multigrade** above -15°C (above 5°F) **5W/20** -15°C to -25°C (5°F to -13°F)	MIL-L-46152, API CC/SF API CC/SE (recommended)
After first100 hours		**JCB 15W/40 Multigrade** above -10°C (above 14°F) **5W/20** -10°C to -25°C (14°F to -13°F)	SAE15W/40, MIL-L-46152B, AP1 CD/SE MIL-L-2104D API CC/SE or API CD/SE
Engine (Coolant)			
Canopy Cab	4.5 (1.0) 5.0 (1.1)	**JCB Universal Antifreeze/water** (See **Coolant Mixtures**)	ASTM D3306-74
Track Gearbox (each)	0.3 (0.07)	**JCB SAE 30 Engine Oil** (NOT Multigrade)	API CD/SF, MIL-L-46152 MIL-L-2104D
Slew Gearbox (Lubrication)			
801.4 to M721136 801.5 to M730003 801.6 to M728056		**From Hydraulic System**	
801.4 M721137 on 801.5 M730004 on 801.6 M728057 on	0.7 (0.15)	**JCB HD90 Gear Oil** Below 0°C (32°F) **JCB HD140 Gear Oil** 0°C to 40°C (32°F to 104°F)	API-GL-5, MIL-L-2105D API-GL-5, MIL-L-2105D
Track Idler Wheels	0.025 (0.006)	**JCB HD90 Gear Oil**	API-GL-5, MIL-L-2105D
Track Rollers	0.025 (0.006)	**JCB HD90 Gear Oil**	API-GL-5, MIL-L-2105D
Hydraulic System	30 (6.6)	**JCB Special Hydraulic fluid** Below -10°C (14°F) **JCB Hydraulic Fluid 46** -10°C to 40°C (14°F to 104°F) **JCB Hydraulic Fluid 68** Over 40°C (104°F)	
Slew Ring Bearings Gear Teeth		**JCB MPL Grease** **JCB Slew Pinion Grease ##**	Lithium based, No. 2 consistency.
All Other Grease Points		**JCB MPL Grease**	Lithium based, No. 2 consistency.

WARNING

JCB Slew Pinion Grease is harmful. It contains bitumen compounds 2811 with possible risks of irreversible effects. Excessive contact may lead to dermatitis or skin cancer. Always use a barrier cream or wear gloves.
Wash contaminated skin thoroughly with soap and water. In the event of contact with the eye, immediately wash with plenty of water and seek medical advice.

***Engine Lubrication Chart**



*Every 10 Operating Hours (Or Daily) whichever occurs first

Clean

1 Machine generally

Check and Adjust where necessary (engine stopped)

2 Generally for damage
3 Hydraulic oil level
4 Engine oil level
5 Engine coolant
6 Fuel system for leaks
7 Operation of horn
8 Operation of all other electrical equipment
9 Track adjustment

Check and Adjust where necessary (engine running)

10 Exhaust (excessive smoke)
11 Dozer operation
12 Excavator operation
13 Track and Running Gear operation
14 Hourmeter operation

Grease

15 All pivot pins

Every 50 Operating Hours (Or Weekly) whichever occurs first

Do the daily jobs plus:

Clean

1 Drain and clean fuel filter
2 Drain fuel sediment bowl
3 Radiator matrix

Check and Adjust where necessary (engine stopped)

4 Fan belt adjustment (see Note 1)

Note 1: *Failure to maintain correct fan belt adjustment may result in damage to the timing case cover.*

First 100 Hours Only

Do the jobs listed in 50 hours plus:

Change

1 Engine oil and filter canister
2 Slew gearbox oil.

Every 100 Operating Hours (Or 2 Weeks) whichever occurs first

Do the daily jobs through to 50 hours plus:

Clean

1 Battery terminals

Check and Adjust where necessary (engine stopped)

2 Hose and pipework for security and damage
3 Condition of ram piston rods
4 All grease seals
5 Track plate condition/rubber condition
6 Engine mounting bolts
7 Air cleaner hose security
8 Wiring for damage
9 Track tension

First 250 Operating Hours

1 Change track gearbox oil
2 Check kingpost pivot pins retaining bolt torque.

Every 250 Operating Hours (Or Monthly) whichever occurs first

Do the daily jobs through to 100 hours plus:

Change

1 Engine oil and filter canister

Check

2 Operation of excavator lever and swing pedal lock(s)

Grease

3 Slew ring grease nipples

Every 500 Operating Hours (Or 6 Months) whichever occurs first

Do the daily jobs through to 250 hours plus:

Clean

1 Fuel lift pump
2** Fuel injectors (and test)

Note: *Jobs which should only be done by a specialist are indicated by ***

Change

3 Fuel filter element
4** Hydraulic fluid return filter
5 Outer air cleaner element (very dusty conditions only)

Every 500 Operating Hours (Or 6 Months) continued

Check and Adjust where necessary (engine stopped)

6 Exhaust system security
7** Cylinder head torque tighten
8** Valve clearances

Check and Adjust where necessary (engine running)

9** Main relief valve pressure
10** Auxiliary relief valve pressures
11** Slew crossline relief valve
12** Engine idle speed
13** Engine maximum speed

Every 1000 Operating Hours (Or Yearly) whichever occurs first

Do the daily jobs through to 500 hours plus:

***Change**

1 Air filter dust valve
2 Air filter element (outer)
3 Track gearbox oil
4 Slew gearbox oil

Check

5 Cab frame

Grease

6 Slewing pinion and slew ring teeth

Every 2000 Operating Hours (Or 2 Years) whichever occurs first

Do the daily jobs through to 1000 hours plus:

Change

1. Air cleaner element (inner)
2** Track idler and rollers oil and seals
3** Hydraulic fluid and clean suction strainer
4 Engine coolant

Check (engine stopped)

5 Battery electrolyte level (low maintenance)
6** Valve clearance and lubrication
7** Starter motor and alternator brush gear

Note: *Jobs which should only be done by a specialist are indicated by* ********

You must grease the machine regularly to keep it working efficiently. Regular greasing will also lengthen the machine's working life.

Greasing should be done with a grease gun. Normally, two strokes of the gun should be enough. Stop greasing when fresh grease appears at the joint.

WARNING

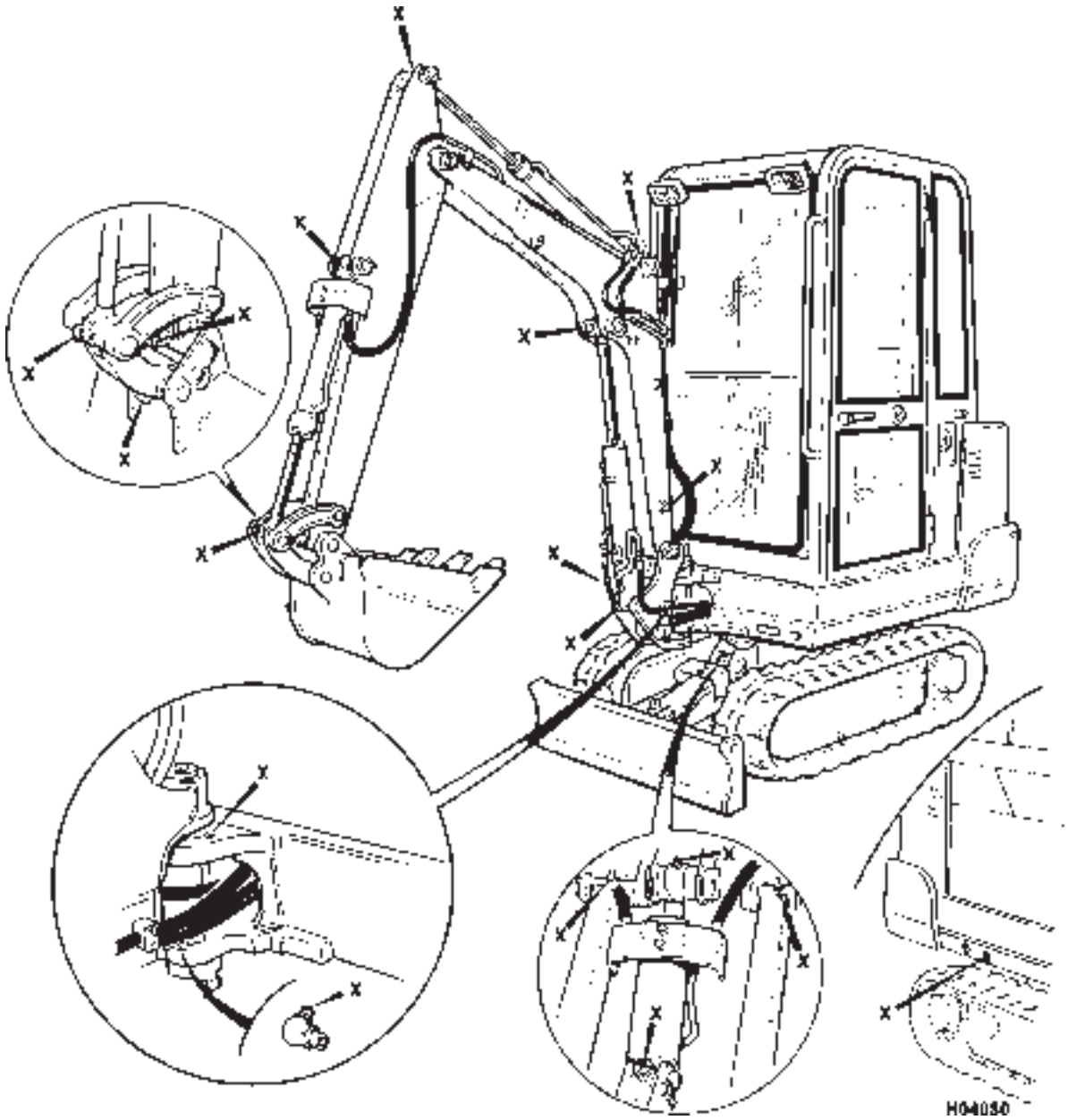
You will be working close into the machine for these jobs. Lower the attachments if possible. Remove the starter key . This will prevent the engine being started.

8-3-1-3

For the types of grease to use at each point see the **Lubricants and Capacities** chart.
Do not mix different types of grease, keep them separate.

Note: *Some optional attachments may need greasing more often. See Section A - ATTACHMENTS .*

Daily



Every 250 Hours

Slew Ring Bearings

Ensure the slew ring is kept full of grease.

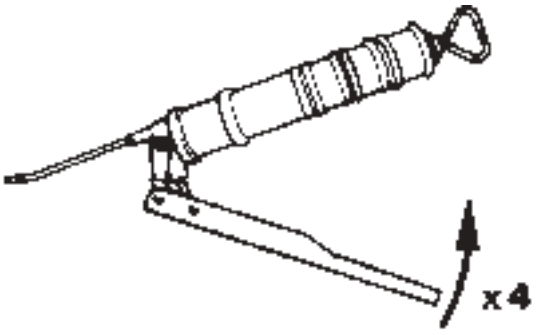
Grease point on right hand side of mainframe.

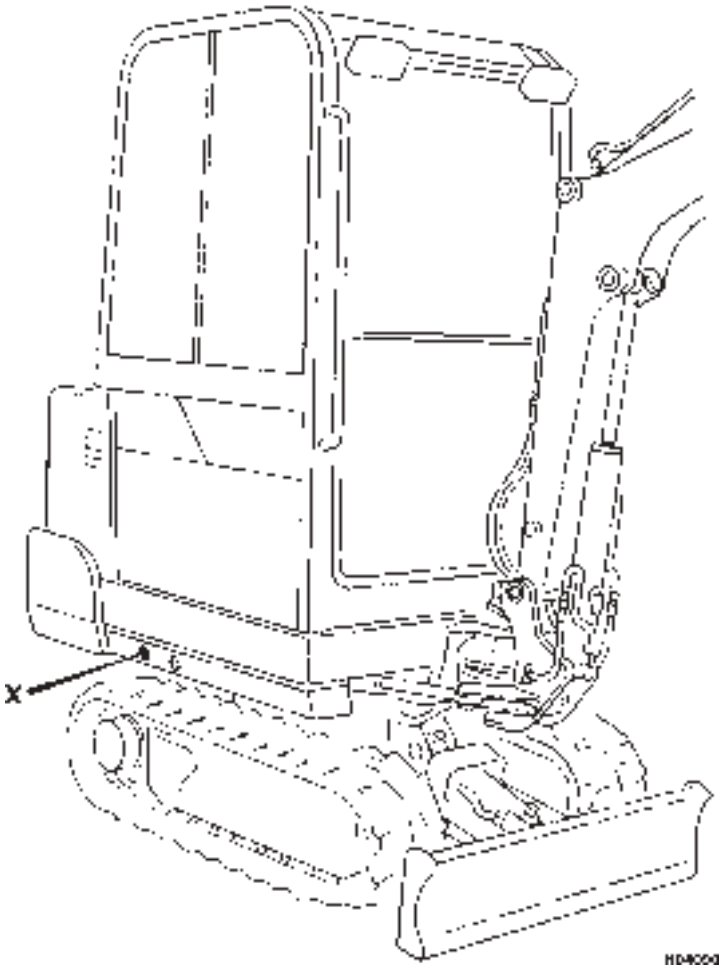
To ensure distribution of grease, use the following procedure:

1 Grease 'IN', rotate 180°

2 Grease 'IN', rotate 180°

3 Grease 'IN',





Every 1000 Hours

Slew Ring Gear Teeth

WARNING

JCB Slew Pinion Grease is harmful as it contains bitumen compounds 2811. Excessive contact may lead to dermatitis or skin cancer. Always use a barrier cream or wear gloves; wash contaminated skin thoroughly with soap and water. In the event of eye contact, immediately wash with plenty of water and seek medical advice.

8-1-1-7

WARNING

Soft Ground

A machine can sink into soft ground. Never work under a machine on soft ground.

INT-3-2-4

WARNING

Jacking

A machine can roll off jacks and crush you. Do not work under a machine supported only by jacks.

MD-1-6-1

1 Raise machine and support the undercarriage.

2 Remove the bolts **A** and plate **B** in the underside of the undercarriage.

3 Apply the grease to the pinion using an applica tor (see **Lubricants & Capacities**).

4 Remove personnel from the machine.

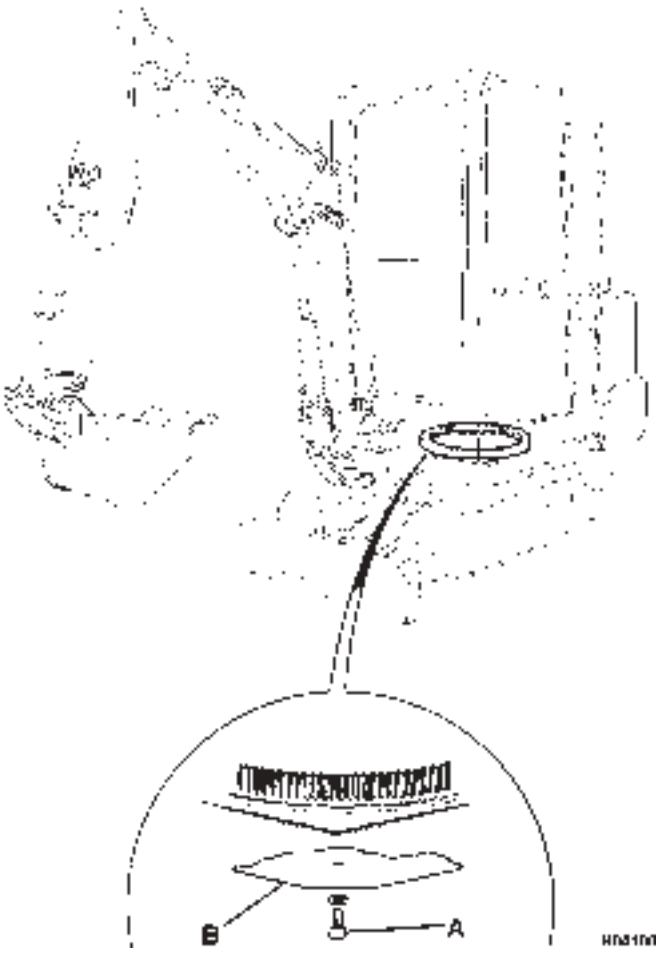
5 Slew the machine through 360^0 twice.

6 Stop the engine.

7 Repeat step 3 as necessary.

8 Refit the plate **B** and bolts **A**.

9 Lower the machine to the ground.



Cooling System

WARNING

The cooling system is pressurised when the coolant is hot. Hot coolant will burn you. Make sure that the engine is cool before checking the coolant level or draining the system.

Checking the Coolant level

1 **Prepare the Machine**
Park the machine on level ground and raise the engine cover.

2 **Remove the Filler Cap**
Carefully slacken cap **A.** Let any pressure escape. Remove the cap

3 **Check the Level**
The level should be 12mm (0.5in) below the filler neck. Top up with pre-mixed water/antifreeze if necessary. See **Coolant Mixtures.**

4 **Refit the Filler Cap**
Make sure it is tight

Note: Check the quality of the antifreeze mixture every year - before the cold weather starts. Change it every two years.

CAUTION

Keep your face away from the cylinder block tap and the radiator drain plug when you drain the system.

Changing the Coolant

1 Do steps 1 and 2 of "Checking the Coolant level"

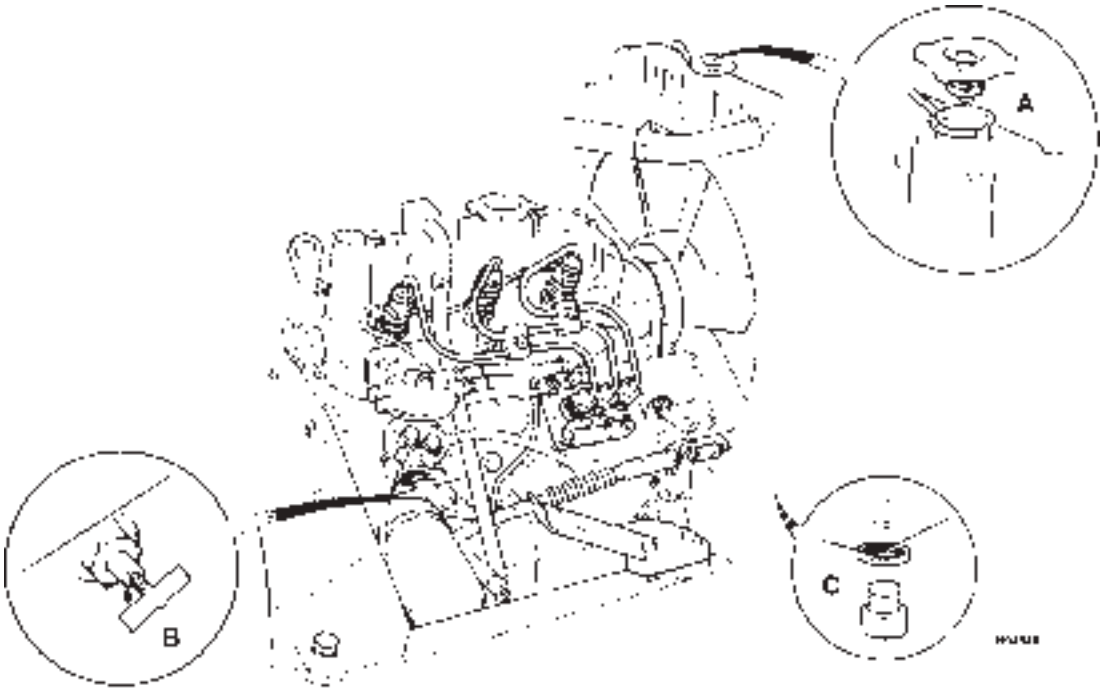
2 **Drain the system**
Undo the speed plug **B** on the cylinder block and let the coolant drain out. Remove the radiator drain plug **C** and let the coolant drain out. Make sure the drain holes are not blocked.

3 **Flush the System if necessary**
Use clean water

4 **Close the Speed Plug and Refit the Drain Plug**
Close the speed plug **B.** Make sure the drain plug **C** is clean and refit it. Make sure it is tight.

5 **Fill the system**
Use the necessary mix of clean, soft water and anti freeze (see Coolant Mixtures)

Note: A 50% antifreeze mixture is recommended even if frost protection is not needed. This gives protection against corrosion and raises the coolants boiling point.



Cooling System - Continued

6. Refit the Filler Cap
Make sure it is tight

7. Check for leaks
Run the engine for a while, to raise the coolant to working temperature and pressure. Stop the engine. Check for leaks.

*Coolant Mixtures

The protection provided by JCB Universal Anti-freeze is shown below. If any other anti-freeze is used, refer to the manufacturers' instructions and ensure that a corrosion inhibitor is included.
DO NOT use solutions of more than 60% or less than 50% or damage to the cooling system will occur.

Solution	Maintains circulation down to		Protects against damage down to	
	deg. C	deg. F	deg. C	deg. F
55%	- 36	- 33	- 41	- 42

The strength of the anti-freeze solution must be checked at least once a year, preferably at the beginning of the cold period. Renew the anti-freeze every two years.
A 50% anti-freeze mixture must be used even if frost protection is not needed.
In climates where anti-freeze is not necessary, a reputable inhibitor must be used. Renew the mixture every 6 months.

WARNING

Anti-freeze can be harmful. Obey the manufactures instructions when handling neat or diluted anti-freeze.

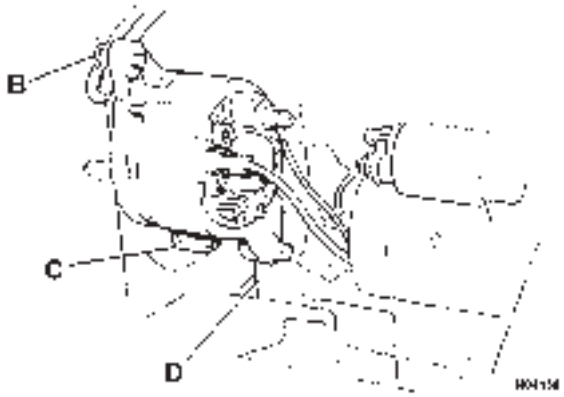
*Adjusting the Fan Belt

WARNING

Make sure that the engine cannot be started. Disconnect the battery before doing this job.

1. Raise the Engine Cover

2. Check the Fan Belt Tension
There must be 5mm (0.2in) slack midway between the crankshaft pulley and the alternator pulley when the belt is loaded with a force of 5kgf (10lbf).



3. Loosen the Alternator
Loosen the alternator mounting bolts **B**, **C** and **D**.

IMPORTANT

Excessive fan belt slack can result in damage to the timing cover.

CAUTION

Any leverage required to position the alternator must be applied at the drive end only. Use only a wooden lever.

4. Adjust the Fan Belt
Position the alternator so that there is 5mm (0.2in) slack at point **A**.

5. Secure the Alternator
Tighten the alternator mounting bolts **B**, **C** and **D**, (tightening bolt **D** last).

Torque Settings

Only use the following when no setting is specified in text of manual.

CAUTION: All bolts used on JCB equipment are high tensile and must not under any circumstances be replaced with bolts of a lesser tensile specification

Metric Grade 8.8 Bolts

Bolt Size	(mm)	Hexagon (A/F) mm	Torque Settings Nm	kgf m	lbf ft
M5	(5)	8	7	0.7	5
M6	(6)	10	12	1.2	9
M8	(8)	13	28	3.0	21
M10	(10)	17	56	5.7	42
M12	(12)	19	98	10.0	72
M16	(16)	24	244	25.0	180
M20	(20)	30	476	48.0	352
M24	(24)	36	822	84.0	607
M30	(30)	46	1633	166.0	1205
M36	(36)	55	2854	291.0	2105

Table Of Important Tightening Torques

Tightening Points	**Tightening Torque** Nm	kgf m	lbf ft
Track roller	77.5 - 90.2	7.9 - 9.2	57.1 - 66.5
Idler/yoke	77.5 - 90.2	7.9 - 9.2	57.1 - 66.5
Slew ring	77.5 - 90.2	7.9 - 9.2	57.1 - 66.5
Hydraulic filter cap	Max. 30	Max. 3.1	Max. 22
Piping clamp	27.5 - 29.4	2.8 - 3.0	20.3 - 21.7
Swing pivot pin bolts	250	25.6	185
Engine shock absorber	48.1 - 55.9	4.9 - 5.7	35.4 - 41.2
Engine bracket	48.1 - 55.9	4.9 - 5.7	35.4 - 41.2
Engine support	48.1 - 55.9	4.9 - 5.7	35.4 - 41.2
Rear counterweight	98	10	72
Rams			
Head nut (all except dozer)	314	32.0	232
Head nut (dozer)	345	35.2	255
End cap (all except dozer)	610	62.2	450
End cap (dozer)	400	40.8	295
Valve Block			
Tie rod (large)	45	4.6	33
Tie rod (small)	19	1.9	14

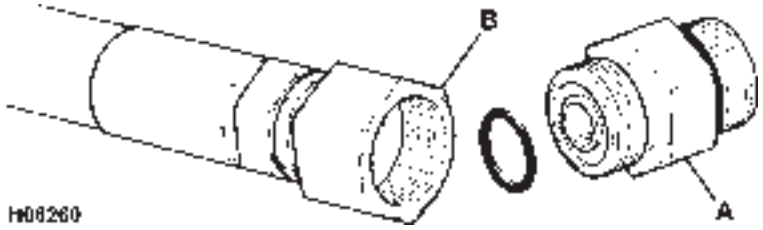
Table Of Important Tightening Torques (cont'd)

Tightening Points	Tightening Torque		
	Nm	kgf m	lbf ft
Pump			
Drive coupling	54	5.5	40
Tie bolts	44 - 52	4.5 - 5.3	32 - 38
Engine			
Bearing holder bolts	24 - 30	2.4 - 3.1	19 - 22
Rear plate bolts	46 - 54	4.7 - 5.5	34 - 40
Flywheel bolts	59 - 69	6.0 - 7.0	43 - 51
Connecting rod nuts	29 - 34	3.0 - 3.5	22 - 25
Suction filter bolts	10 - 12	1.0 - 1.2	7 - 9
Sump bolts	10 - 12	1.0 - 1.2	7 - 9
Sump drain plug	29 - 40	3.0 - 4.1	22 - 29
Oil pipe banjo bolts	10 - 12	1.0 - 1.2	7 - 9
Crankshaft pulley nut	117 - 127	11.9 - 12.9	87 - 94
Cylinder head bolts (oiled)	49 - 52	5.0 - 5.3	36 - 38
Injection pump bolts	10 - 12	1.0 - 1.2	7 - 9
Injection pump nut	10 - 12	1.0 - 1.2	7 - 9
Rocker arm nuts	20 - 24	2.0 - 2.4	15 - 19
Head cover nuts	10 - 12	1.0 - 1.2	7 - 9
Cooling fan bolts	10 - 12	1.0 - 1.2	7 - 9
Injector nozzle	78 - 83	8.0 - 8.5	58 - 62
Injector pipe	20 - 24	2.0 - 2.4	15 - 19
Thermo switch	24 - 29	2.4 - 3.0	19 - 22
Oil pressure switch	15 - 20	1.5 - 2.0	11 - 15
Glow plug	15 - 20	1.5 - 2.0	11 - 15
Solenoid	15 - 20	1.5 - 2.0	11 - 15
Oil pressure switch	15 - 20	1.5 - 2.0	11 - 15

Hydraulic Fittings & Torque Settings

'O' Ring Face Seal

All the hydraulic fittings on the JCB 801.4/801.5/801.6 Mini-Excavators use the 'O' ring face seal system which achieves a leak-proof, non-loosening connection.



Adapters screwed to valve blocks etc. seal onto an 'O' ring which is compressed into a 45° seat machined in the face of the tapped port.

ADAPTER (A)

SAE Tube Size	SAE Port Thread Size	A/F mm	A/F in.	Tightening Torque Nm	Tightening Torque lbf ft
4	7/16 - 20	15.9	0.625	20 - 28	16.5 - 18.5
6	9/16 - 18	19.1	0.750	46 - 54	34 - 40
8	3/4 - 16	22.2	0.875	95 - 105	69 - 77
10	7/8 - 14	27.0	1.063	130 - 140	96 - 104
12	1.1/16 - 12	31.8	1.250	190 - 210	141 - 155
16	1.5/16 - 12	38.1	1.500	290 - 310	216 - 230
20	1.5/8 - 12	47.6	1.875	280 - 380	210 - 280

OUTER SLEEVE NUT (B)

SAE Tube Size	Hose/pipe Thread Size	A/F mm	A/F in.	Tightening Torque Nm	Tightening Torque lbf ft
4	9/16 - 18	17.5	0.688	20 - 30	15 - 21
6	11/16 - 16	20.6	0.813	31 - 39	23 - 29
8	13/16 - 16	23.8	0.937	45 - 55	33 - 41
10	1 - 14	28.6	1.125	80 - 90	59 - 67
12	1.3/16 - 12	35.0	1.375	105 - 125	77 - 93
16	1.7/16 - 12	41.5	1.625	155 - 175	114 - 130

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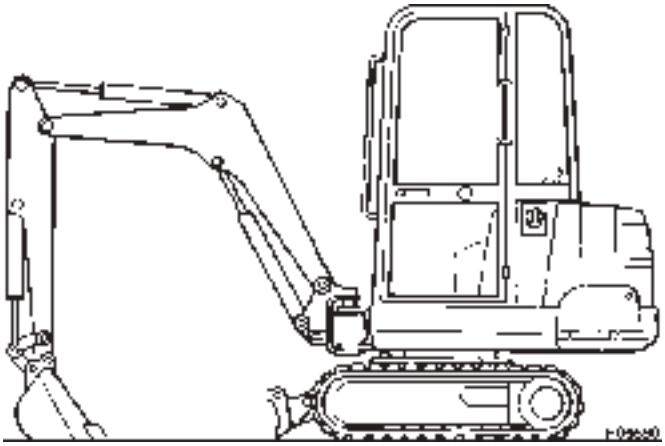
Bucket Dismantling and Assembly



When Dismantling

1 Set up the machine in the posture shown, with the bucket lightly grounded.

2 Shut down the machine and post **WARNING** notices to prevent operation during maintenance.

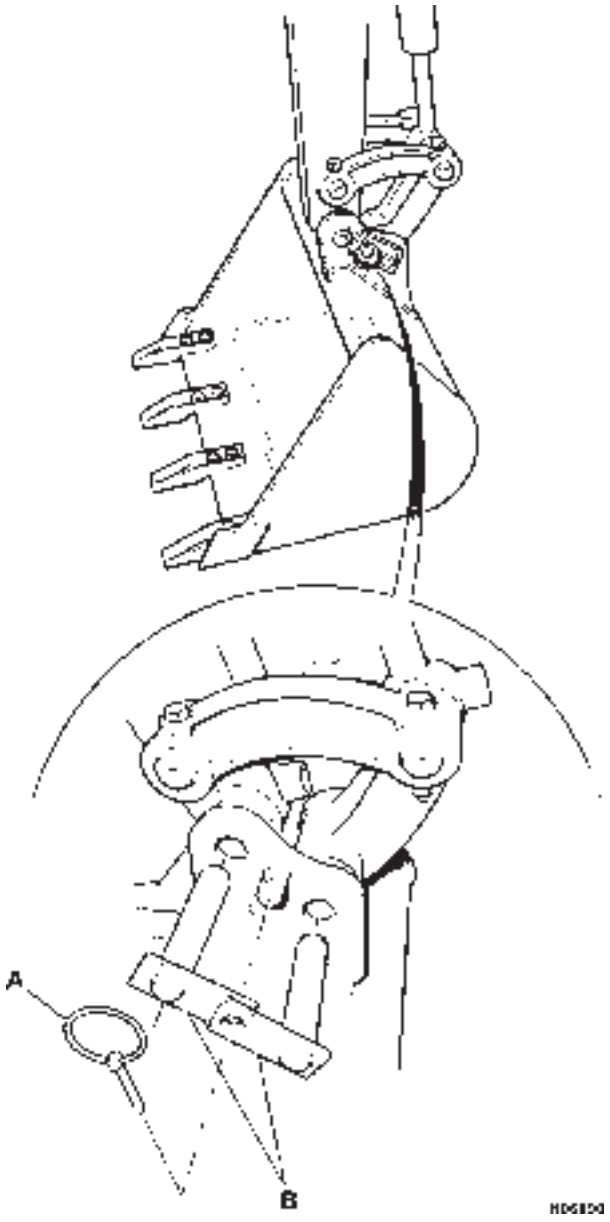
3 Remove the lynch pin **A**. Drive out the bucket pivot pins **B**.

4 Separate the bucket from the machine.

*__5__ Check the wear on the bucket teeth. Remove and renew as necessary.

Bucket Tooth Wear

Reference value	104 mm	(4.1 in.)
Allowable limit	78 mm	(3.1 in.)



Bucket Dismantling and Assembly (cont'd)

When Assembling

1 Check the bucket pivot pins and the bushing in the bucket linkage are within the permitted tolerances. Renew the pivot pins as necessary. Remove and maintain the bucket ram pivot linkage before refitting the bucket.

TOLERANCES - Pivot Pin/Pivot Bush

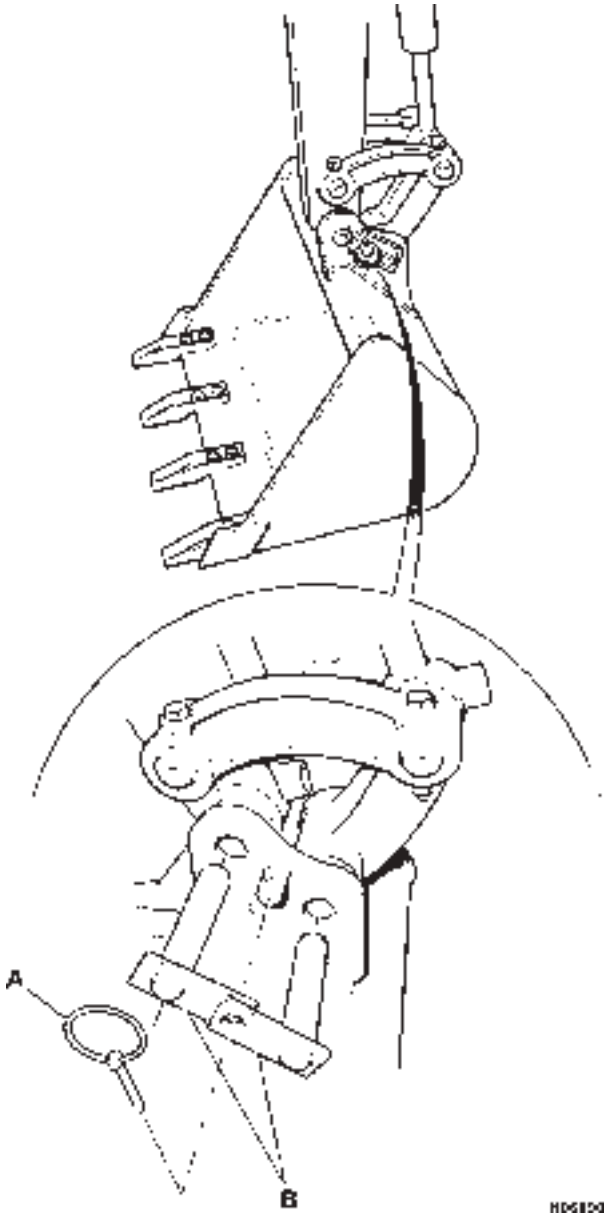
	Pin	Bush
Reference value	25 mm	25 mm I/D
Allowable limit	24 mm	26 mm I/D

2 Locate the bucket onto the dipper arm and adjust to align the bores of the bucket bosses, the dipper arm end boss and link.

WARNING

DO NOT align pivot pin holes with your fingers.

3 Fit the bucket pivot pins **B** and secure by fitting the lynch pin **A**.



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***Front Attachment**		
Wear on pins and bushes (clearance)	2.0 mm	(0.08 in.) maximum
Pin wear	-1.0 mm	(0.04 in.) minimum
Bush wear inside diameter	+1.0 mm	(0.04 in.) maximum

General Description

The Mini Excavator body and framework is of fabricated steel construction and comprises the upper structure and front attachment. The upper structure comprises a fabricated steel base that provides housing and mounting for the machine controls and services above and below a floor plate. The machine cab is mounted on the floor plate. The engine is mounted behind the cab. The front attachment is pivoted on the kingpost enabling movement right and left. The bucket, dipper and boom are connected through pivots enabling a full range of bucket, or other attachment operations.

Dismantling and Assembly

When Dismantling

1 Remove the bucket.

2 Remove the self-locking nut **C** and the bolt **D**. Support the link **H**. Drive out the pivot pin **E**, remove the link **H**. Lower the piston rod end of the bucket ram **F** clear of the link **G**.

3 Clean all old grease from the links **G** and **H** and pivot pin **E**.

Inspection

1 Check that the link bushes and the pivot pin are within permitted tolerances. Renew pivot pin and/or remove and replace link bushes as necessary.

TOLERANCES - Pivot Pin/Pivot Bush

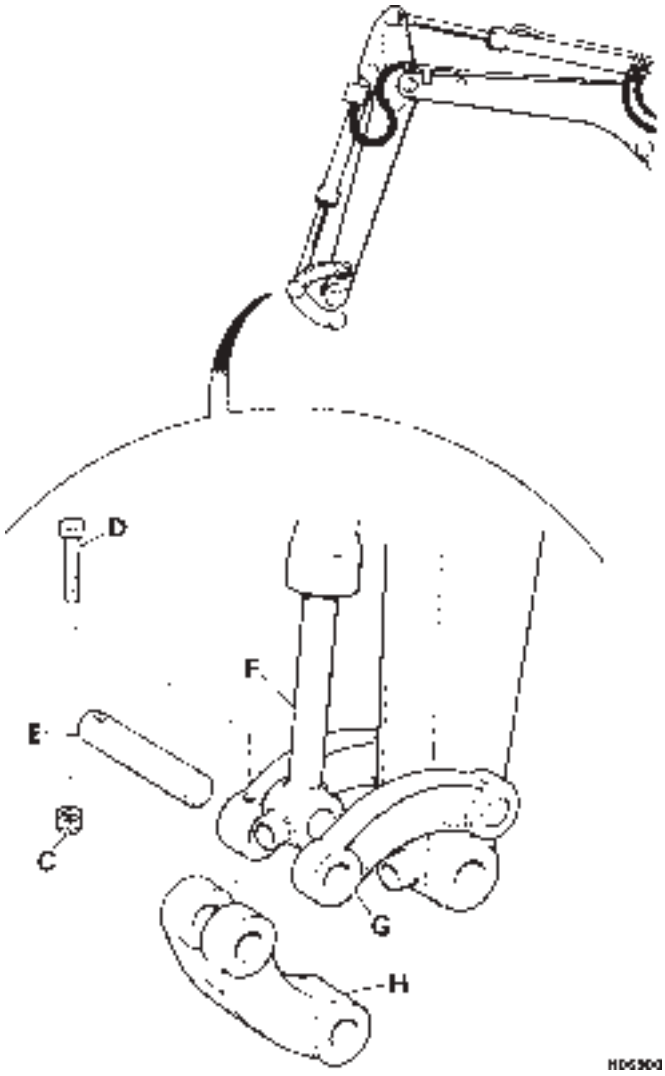
	Pin	Bush
Reference value	30 mm	30 mm I/D
Allowable limit	29 mm	29 mm I/D

When Assembling

1 Locate the fork end of the link **H** into the fork of the dipper end link **G**. Locate the rod end location of the bucket ram **F** into the fork of the link **H**.

2 Fit the pivot pin **E** through both links and the ram end. Secure using bolt **D** and new self-locking nut **C**.

3 Grease the linkage through the grease nipple on the ram end boss, refer to Section 3.



*Removal and Replacement

When Removing

1 Remove the bucket.

2 Remove the bucket ram.

3 Remove the self-locking nut **A** and bolt **B**. Drive out the dipper ram pivot pin **C**. Separate the dipper ram end **D** from the dipper pivot **E**.

Note: *The machine may be fitted with either of two dipper options. Apart from dimensions and weight the dippers are identical.*

WARNING

The long dipper is 1140 mm long and weighs 29 kg. The short dipper is 740 mm long and weighs 22 kg. Take care when lifting or handling them.

4 Attach suitable lifting equipment to the dipper **J** and take up the slack.

5 Remove the self-locking nut **F** and the bolt **G**. Drive out the pivot pin **H**.

6. Remove the dipper from the machine.

Inspection

1 Check that the dipper pivot bushes and the pivot pin are within permitted tolerances. Renew pivot pin and/ or remove and replace dipper pivot bushes as necessary.

TOLERANCES - Pivot Pin/Pivot Bush

	Pin	Bush
Reference value	30 mm	30 mm I/D
Allowable limit	29 mm	29 mm I/D

*When Replacing

Note: *See* ***When Removing*** *for dipper weights.*

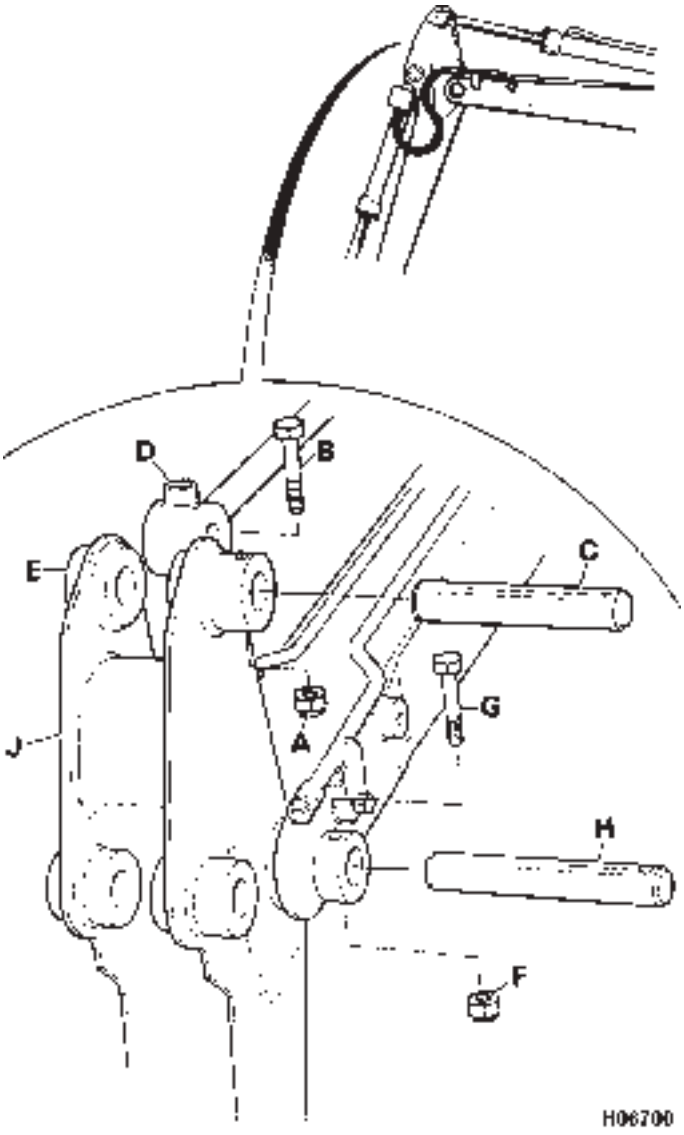
1 Using suitable lifting equipment locate the dipper **J** onto the boom.

2 Fit the pivot pin **H** and secure with the bolt **G** and a new self-locking nut **F**.

3 Locate the dipper ram end **D** into the dipper pivot **E**. Fit the pivot pin **C** and secure with the bolt **B** and new self-locking nut **A**.

4 Fit the bucket ram.

5 Fit the bucket.



Removal and Replacement

***When Removing**

1 Remove the bucket link and dipper.

2 Remove the dipper and boom rams.

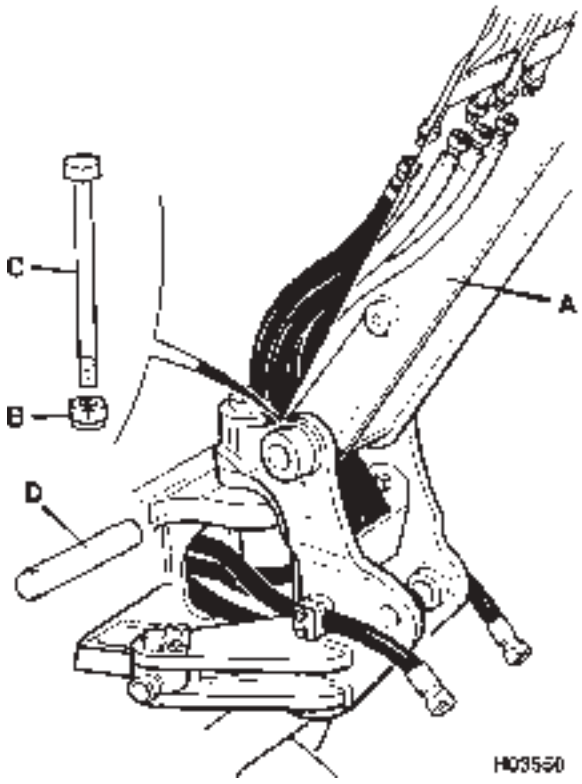
3 Disconnect the hydraulic hoses from the pipes on the boom. Blank off the open ends of the hoses and pipes. Fold the hoses clear of the boom and disconnect the boom working light.

WARNING

The boom weighs 45 kg. Take care when lifting or handling it.

4 Attach suitable lifting equipment to the boom **A** and take up the slack.

5 Remove the self-locking nut **B.** Drive out the bolt **C** and the pivot pin **D**. Remove the boom from the machine.



Inspection

1 Check that the boom pivot bushes and the pivot pin are within permitted tolerances. Renew pivot pin and/or boom pivot bushes as necessary.

TOLERANCES - Pivot Pin/Pivot Bush

	Pin	Bush
Reference value	30 mm	30 mm I/D
Allowable limit	29 mm	31 mm I/D

2 Examine the boom structure for wear, damage or corrosion. Renew as necessary.

***When Replacing**

WARNING

The 801.4/801.5 boom weighs 45 kg. The 801.6 boom weighs 53 kg. Take care when lifting or handling them.

1 Using suitable lifting equipment locate the boom onto the kingpost.

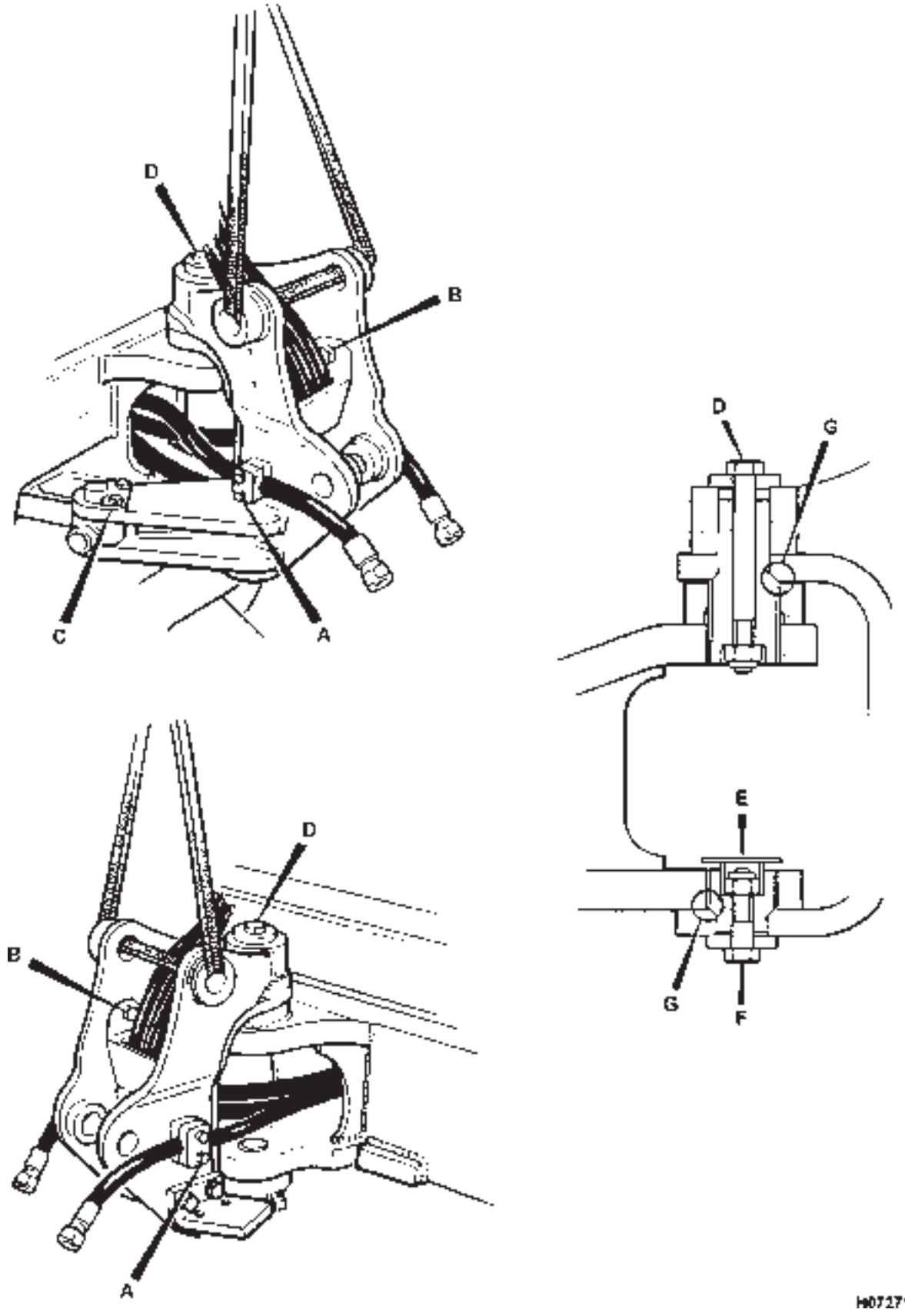
2 Fit the pivot pin **D** and secure with the bolt **C** and a new self-locking nut **B.**

3 Fit the dipper and boom rams.

4 Fit the dipper, bucket link and bucket.

5 Connect the hydraulic hoses to the pipes on the boom.

6 Restore the hydraulic fluid level and check the operation of the hydraulic circuit.



Removal

1 Remove the boom, ensure the boom working light is disconnected.

2 Remove both outer hose clamps **A**.

3 Remove the bolts securing the central hose clamp **B**.

4 Remove the swing ram locking plate **C** and drive out the rod side pivot pin.

WARNING

The kingpost weighs 29 kg. Take care when lifting or handling it.

5 Support the weight of the kingpost with suitable lifting equipment.

***6** Undo the top mounting securing bolt **D** and washer and remove them, drive out the upper pivot pin in a downward movement, avoid contact with the hydraulic hoses.

***7** Remove the kingpost lower support protection cap **E**. Undo the lower mounting securing bolt **F** and washer and remove them, drive out the lower pivot pin in an upward movement, avoid contact with the hydraulic hoses.

8 Using suitable lifting equipment lift away the kingpost, feeding the boom hoses out of the kingpost.

Replacement

***1** Clean paint and loose scale from the pin abutment area **G** on both the upper and lower kingpost pivot pins and from the kingpost abutment areas.

2 Using suitable lifting equipment locate the kingpost onto the mainframe, locating the hoses through the centre of the kingpost.

3 Fit both the lower and upper pivot pins, locating the abutment areas into the kingpost.

4 Fit the attaching parts to the upper and lower pivot pins and torque tighten to 270Nm (200lbf ft.).

5 Fit the swing ram pivot pin and secure with the locking plate.

6 Arrange the boom hoses in the central kingpost clamp and tighten the clamp.

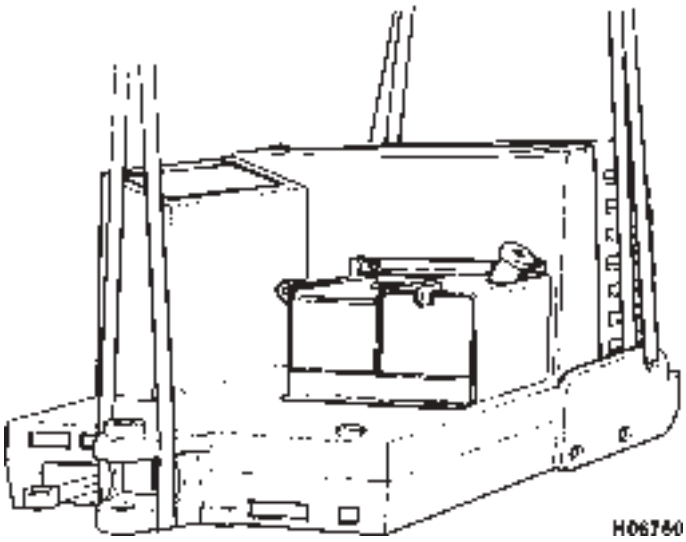
7 Fit both the outer hose clamps.

8 Fit the boom and connect the working light.

Dismantling and Assembly

When Dismantling

Note: *The upper structure encompasses all equipment and structure located above the track and running gear with the exception of the front attachment.*



1 Remove the excavator end, capping all hoses and pipes.

2 Disconnect the wiring from all electrical equipment on the cab/canopy structure.

3 Remove the cab/canopy.

4 Remove the seat.

5 Disconnect the battery terminals and remove the battery.

6 Remove the floor plates.

7 Remove the control pedal and dozer control lever.

8 Remove the engine assembly, if necessary.

9 Attach lifting equipment to the upper structure frame as shown. Take up the slack in the slings.

10 Remove the bolts **A** securing the upper structure frame to the slew ring. Lift the upper structure frame clear of the machine. Take care not to foul the rotary coupling.

11 Remove dowels **D**.

12 Remove the bolts **B** securing the slew ring **C** to the machine undercarriage.

13 Remove the slew ring from the machine.

Contents **Page No.**

Technical Data

System Type	12 volt negative earth
Battery (Type N70)	
Voltage	12V
Capacity	70 ampere/hour
Specific Gravity (fully charged)	1.260 at 20^0C
Starter Motor (Type S114 - 381)	
Direction of Rotation (viewed from pinion side)	Clockwise
Rated Time	30 seconds
Speed (off-load)	6000 rev/min
Current (off-load)	60A max.
Current (on-load)	540A max.
Terminal voltage (off-load)	12V
Terminal voltage (on-load)	5V
Torque (on-load)	15.69 Nm (1.6 kgf/m, 11.57 lbf ft)

Bulbs

Function	**Rating**
Cab light	18W
Working lights	55W
Indicators	3W
Power on	3W
Glow plug	3W
Working lights on/off	1.2W

Circuit Protection

The electrical circuits are protected by fuses located in a fuse box in the cab (to the right of the seat).

***Fuse**	**Circuit**	**Rating**
1	Fuel shut-off solenoid	5A
2	Horn	15A
3	Alternator feed, Instruments	15A
4	Boom light, Cab working lights	5A
5	Wiper, Heater	5A
6	Cab Light	5A

Note: The optional flashing beacon is protected by a 10A in-line fuse.

Battery

Negative Earth Electrical System

1 Always connect the negative terminal of the battery to **EARTH.**
2 When connecting the battery, connect the earth lead **LAST.**
3 When disconnecting the battery, disconnect the earth lead **FIRST.**

*Inspection

Check the level of the electrolyte (low maintenance). Make sure that the terminals are tight and clean. Coat them with petroleum jelly to prevent corrosion. Ensure the battery vent tube is correctly fitted.

Testing the Specific Gravity

The specific gravity of the electrolyte gives an indication of the state of charge of the battery. Readings should be taken using a hydrometer, when the electrolyte temperature is 15°C (60°F). If the battery has recently been charged, wait approximately one hour to dissipate the 'surface charge' before testing.

Readings should be as the table and should not vary between cells by more than 0.04. A greater variation indicates an internal fault on that particular cell.

If the electrolyte temperature is other than 15°C (60°F) a 'correction factor' must be applied to the reading obtained. Add 0.0007 per 1°C higher than 15°C, and subtract the same if the temperature is lower.

Specific Gravity (20°C)	Quantity of Electricity Discharged (%)	Residual Capacity (%)
1.260	0	100 **(**fully charged)
1.210	25	75
1.150	50	50
1.110	75	25
1.060	100	0 (fully discharged)

High Rate Discharge Test

This test is to determine the electrical condition of the battery and to give an indication of the remaining useful 'life'

Before testing, ensure that the battery is at least 75% charged.

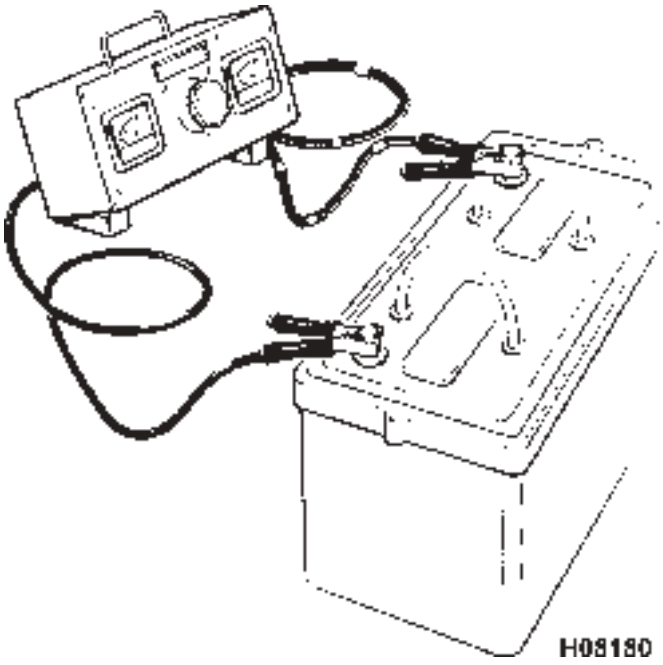
1 Disconnect both terminals of the battery.

2 Adjust the discharge tester to 3 x amp/hour rating of the battery.

3 Connect the tester to the battery terminals, observing the polarity.

4 Note the voltmeter reading. The battery should be capable of maintaining at least 9 volts for 10 seconds. A rapidly falling voltage indicates a fault in one or more of the battery cells.

Note: *Do not leave the discharge tester connected to the battery for longer than is necessary to complete the test.*



Alternator

Removal and Replacement

Removal

1 Raise the engine cover.

2 Remove the interior access panel.

3 Disconnect the battery.

4 Loosen the alternator mounting bolts **A** and **C.** Remove the fan belt from the alternator drive pulley.

5 Remove nuts and washers **B** and disconnect the electrical wires.

6 Support the alternator and remove the mounting bolts.

7 Remove the alternator.

Replacement

1 Put the alternator in place and install the mounting bolts Do not tighten the bolts.

2 Put the fan belt on to the pulley.

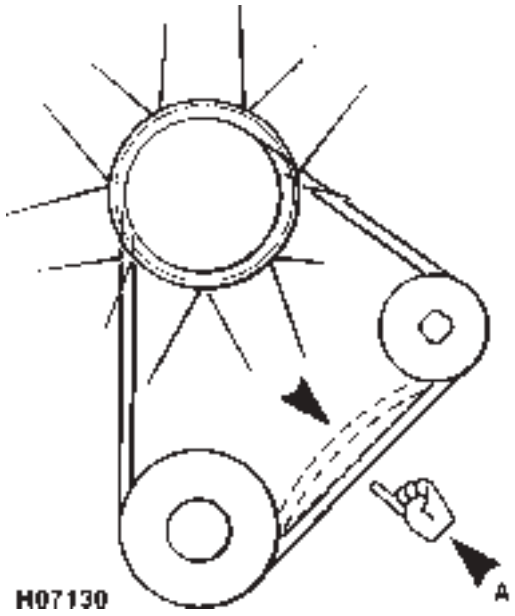
3 Adjust the position of the alternator, so that when the belt is depressed at the mid-point between the crankshaft and alternator pulleys, the deflection is 5 mm (0.2 in.). Tighten the mounting bolts. Ensure that bolt **C** is tightened last.

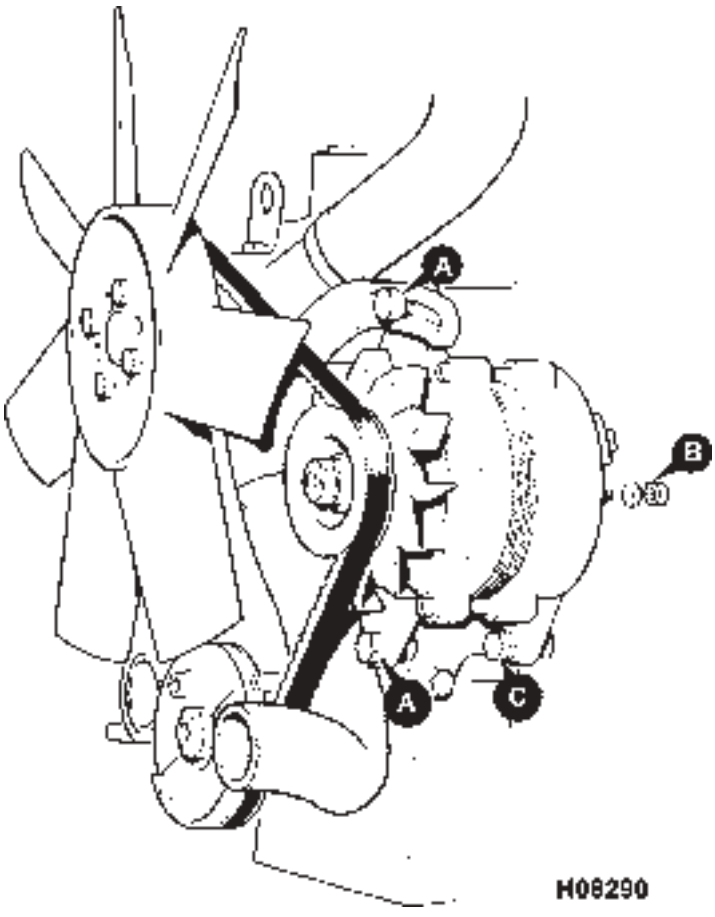
Note: *Failure to maintain correct fan belt adjustment can result in damage to timing case cover.*

4 Correctly locate the electrical wire connections and install washers and nuts **B** and tighten.

5 Fit the interior access panel.

6 Lower the engine cover.





Alternator (cont'd)

Dismantling and Assembly

Dismantling

1 Scribe an alignment mark across the end housing and the stator frame.

2 Remove the housing through bolts **A.**

3 Separate the front housing **B** and rotor assembly **C** from the rear housing **D.**

4 Remove the nut **E** and the lockwasher **F** from the end of the rotor shaft.

5 Remove the pulley **G** and the fan **H.**

6 Remove the pulley key from the end of the rotor shaft.

7 Remove spacer **J.**

8 Remove the rotor assembly **C** from the front housing **B.**

9 Remove collar **K.**

10 Remove the front bearing cover screws **L** and cover M.

11 Remove the front bearing **N** from the front housing.

NOTE: *If a press is required to remove the bearing from the housing, support the housing close to the bearing boss to prevent damage to the housing:*

12 Remove the dust seal cover **P** and dust seal 0.

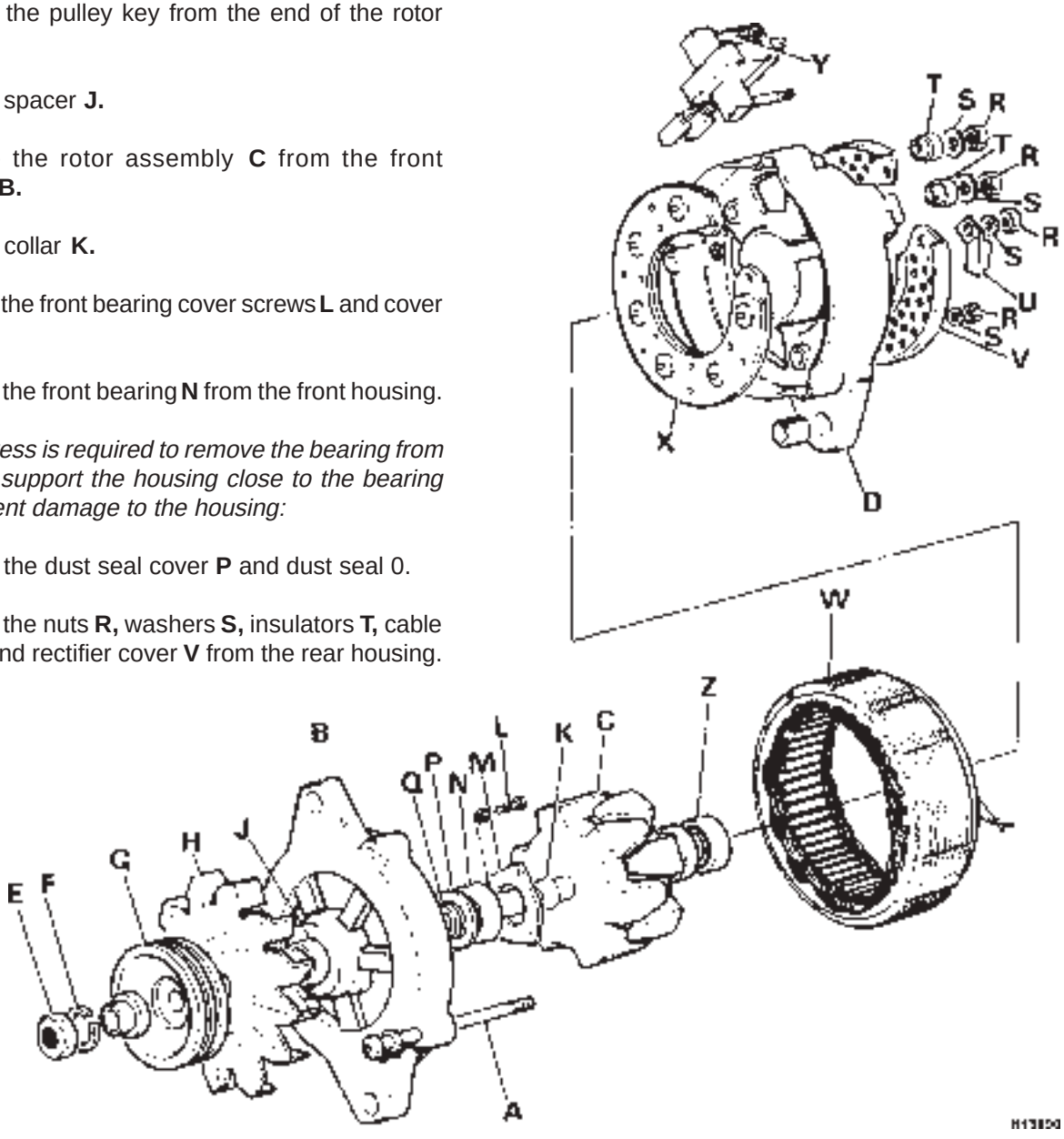
13 Remove the nuts **R,** washers **S,** insulators **T,** cable clips **U** and rectifier cover **V** from the rear housing.

14 Remove the stator assembly **W** with rectifier plate **X** from the rear housing **D**.

15 Using a pre-heated soldering iron, unsolder the stator wire from the rectifier terminals. Grip each rectifier terminal with needle nose pliers and separate the wire from the terminal as soon as the solder melts. When the wire is separated from each rectifier terminal, touch the terminal with a damp cloth.

16 Remove the brush holder assembly **Y** from the rectifier plate **X**.

17 Using a suitable puller, remove the rear bearing **Z** from the rotor shaft.

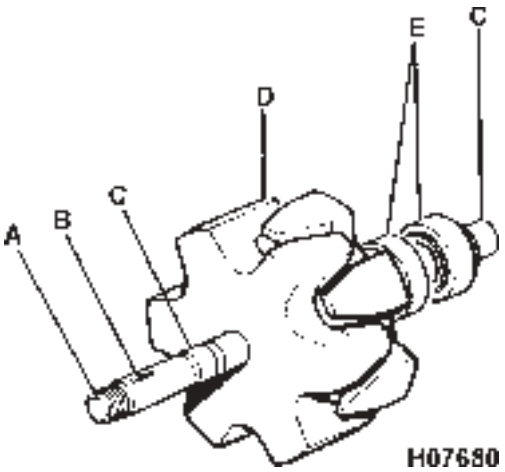


Alternator (cont'd)

Inspection/Testing

Rotor Assembly

1 Inspect the rotor assembly for the following:
- **a** Stripped or damaged threads **A.**
- **b** Damaged or enlarged key slot **B.**
- **c** Damaged or scored bearing journals **C** (indicates bearing spinning on shaft).
- **d** Scuff marks on pole fingers **D** (indicates a bent shaft).
- **e** Dirty or damaged slip rings **E.** If the slip rings are dirty or lightly scored, use silicon carbide paper No 400 **(**not emery cloth) to clean them. Finish with crocus cloth. Rotate the rotors in a lathe or drill press to prevent flat spots.



2 Using an ohmmeter, touch one of the ohmmeter leads to each of the slip rings **E** (winding continuity test).

3 Observe the ohmmeter reading. If the ohmmeter indicates approximately 4.2Ω the rotor winding resistance is satisfactory. If the ohmmeter indicates low zero resistance, the rotor winding is short circuited renew the rotor assembly. If the ohmmeter indicates high resistance, the rotor winding is open circuited - renew the rotor assembly.

4 Using the ohmmeter, touch one ohmmeter lead to a slip ring **E** and the other ohmmeter lead to the pole fingers **D** (insulation resistance test).

5 Observe the ohmmeter reading. If a high resistance is indicated, the insulation resistance is satisfactory. If a low resistance is indicated, the winding is grounding to the rotor - renew the rotor assembly.

Alternator (cont'd)

Inspection/Testing

Stator Assembly

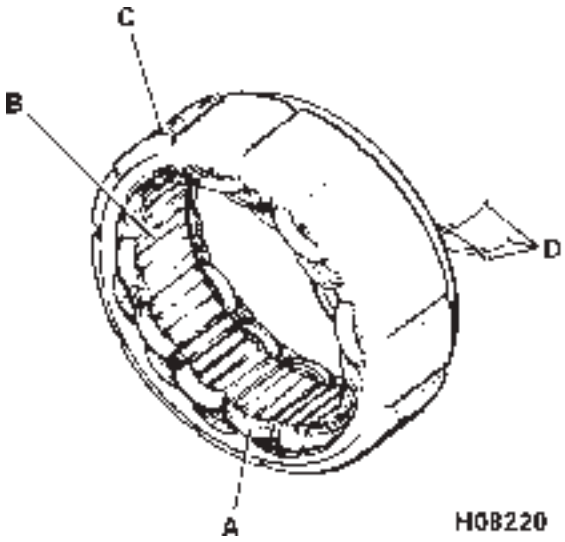
1 Inspect the stator for the following:
- **a** Burnt or discoloured winding **A** (indicates electrical overload)
- **b** Scuff marks on inside of the stator pole faces **B** (indicates bent shaft).
- **c** Damage to the stator frame **C**/pole faces **B**.
- **d** Missing, damaged or burnt winding insulator.

e Using an ohmmeter, touch one ohmmeter lead to one of the stator leads **D**, and the other ohmmeter lead to each of the other stator leads in turn (stator winding continuity test).

3 Observe the ohmmeter reading. If a low resistance is indicated, stator winding continuity is satisfactory. If a high resistance is indicated, the stator winding is open circuited - replace the stator.

4 Using the ohmmeter, touch on ohmmeter lead to one of the stator leads **D** and the other ohmmeter lead to the stator fame **C** (stator insulation resistance test).

5 Observe the ohmmeter reading. If a high resistance is indicated, the stator insulation resistance is satisfactory. If a low resistance is indicated, the stator winding is grounding to the stator frame - replace the stator assembly.



ALTERNATOR (cont'd)

Inspection/Testing

Rectifier Assembly

1 Inspect the rectifier assembly for any obvious damage.

2 Using a ohmmeter, touch one ohmmeter lead to the rectifier frame **A** and the other ohmmeter lead to each of the diodes **B** (6 off) terminals in turn.

3 Observe the ohmmeter readings.

4 Change over the ohmmeter leads and repeat step **2**.

5 Observe the ohmmeter readings.

NOTE: *A serviceable diode shown continuity in one direction and high resistance in the other direction.*

6 If each diode gives a high and low resistance, the rectifier is satisfactory.

7 ft one or more diodes shows a high resistance in both directions - replace the rectifier assembly.

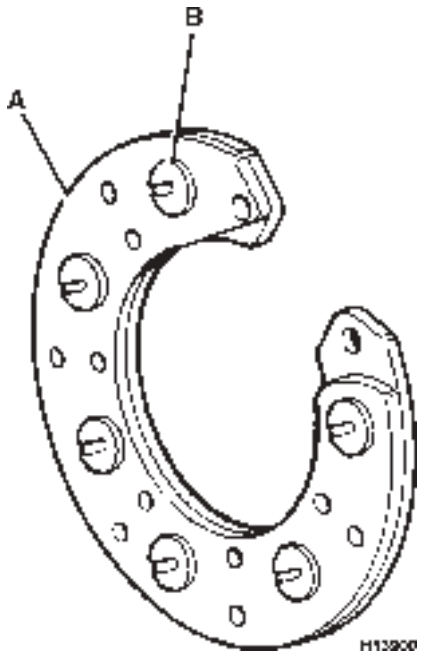
8 If one or more diodes shows a low resistance in both directions - replace the rectifier assembly.

Brush Holder and Brushes

1 Inspect the brush holder assembly for the following:
a Damaged, corroded or stretched brush springs.
b Chipped or broken bushes.
c Dirt or contamination.
d Broken mounting holes, cracks or other damage.

2 Measure the length of the brushes. If less than 0.217in (5.5mm) replace them.

3 If the bushes are to remain in use, clean them with a soft cloth.



Alternator (cont'd)

inspection/Testing

Bearings

1 Rotate the bearings, on the shaft or between the fingers to determine their condition. Replace the bearing if the movement is not smooth and regular.

2 Examine the seal **A** for grease leakage.

3 Examine the inner race **8** for signs of spinning on the shaft.

4 Examine the outer race **C** for signs of spinning in the housing.

5 Inspect the bearing for signs of oil leakage past the bearing to the front housing seal.

Fan

1 Inspect the fan for cracks or damage around the mounting hole **A**.

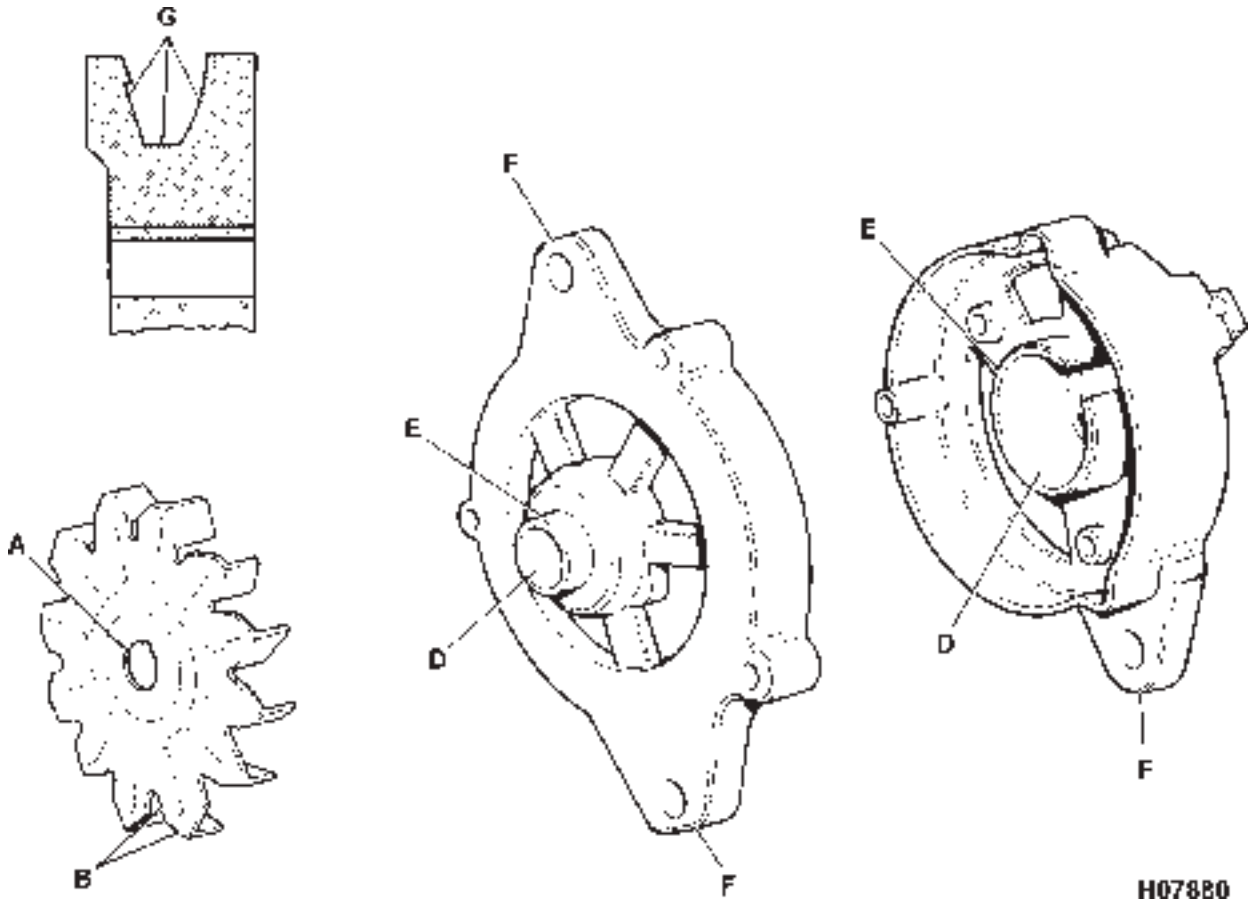
2 Inspect the fan blades **B** for damage and distortion.

Drive Pulley

1 Inspect the pulley for the following:
a Worn, bent or cracked pulley groove. If the groove is polished at positions **A**, it indicates a worn groove.
b Wear or damage to the pulley key slot, which could prevent a tight fit on the shaft.

Front and Rear Housings

1 Inspect the housings for the following:
a Scoring in the bearing bosses **A**, which indicates that the bearing is spinning in the housing.
b Cracked or damaged bearing mounting bosses **B**.
c Cracked or damaged mounting bosses **C**.
d Generally, for cracks and damage.



Alternator (cont'd)

Assembly

1 Using a suitable press and sleeve, install the rear bearing **Z** in the rear housing **D**. Make sure that the sleeve only touches the inner race.

2 Install the brush holder assembly **V** on the rectifier plate **X**.

3 Connect the rectifier plate assembly **X** to the stator **W** as follows:

a Clean the ends of the stator wire and the diode terminals.

b Hold the diode terminals with needle nose pliers (to protect the diodes from heat damage during soldering).

c Using a pre-heated soldering iron, solder the stator wires to the diode terminals. Use a resin cored solder.

d After soldering, cool the connection quickly with a damp cloth.

4 Install the stator **W** and rectifier plate assembly **X** in the rear housing **D**. Make sure the scribe marks on the housing and stator frame are aligned.

5 Install the rectifier cover **V**, the insulators **T**, washers **S** and nuts **R** in the positions from which they were removed on the rear housing.

6 Install the dust seal **Q** and dust seal cover **P** in the front housing **B**.

7 Install the front bearing **N** in the front housing. If necessary, use a press and sleeve. Make sure the sleeve only touches the inner race,

8 Fit the front bearing cover **M** with the washers and screws **L.**

9 Fit the collar **K** to the shaft of the rotor assembly **C**.

10 Install the rotor assembly **C** in the front housing **B**.

11 Fit the spacer **J** on the rotorshaft.

12 Fit the pulley key in the slot in the rotor shaft.

13 Install the fan **H** and pulley **G** on the rotor shaft, located correctly on the key.

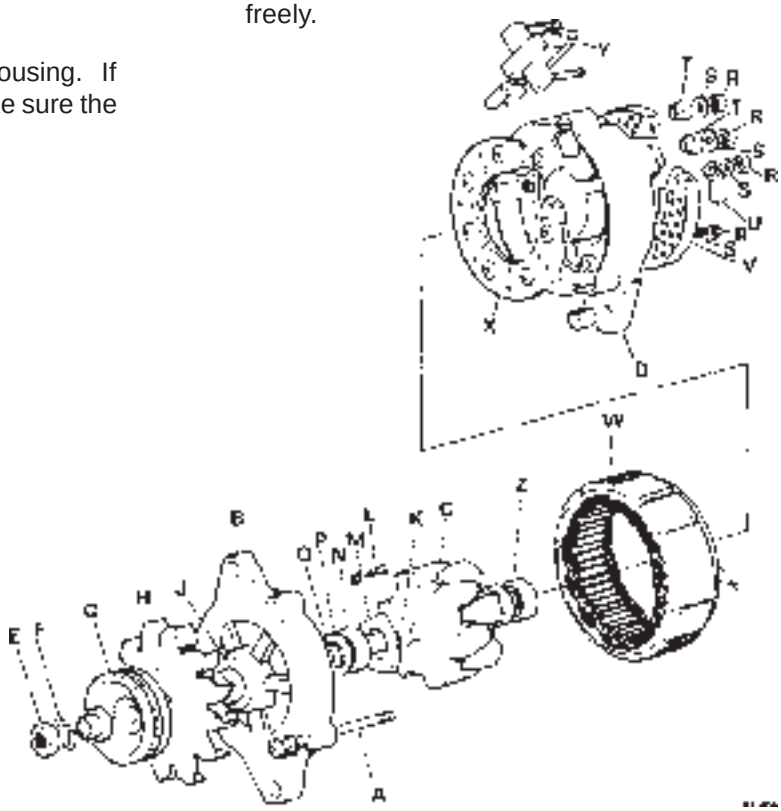
14 Fit the lockwasher **F** and nut **E** and tighten the nut **E**.

15 On the rear housing assembly, push the brushes into the brush holder assembly and insert a pin punch through the back of the alternator to hold the bushes back.

16 Align the scribe marks on the housings and stator frame, and fit the front housing **B** and rotor **C** to the rear housing assembly

17 Fit the through bolts **A** and tighten them evenly.

18 Spin the fan and make sure that the rotor rotates freely.



VOLTAGE REGULATOR OPERATION

Key on - Engine off (see fig. 1)

Indicator Lamp Circuit

When the starter switch is turned to the ON position, battery current will flow from the switch through the indicator lamp to the L terminal of the regulator. In the regulator, the current flows through the closed points P5 and P6 to the regulator E terminal. From the E terminal the current flows to earth at the alternator. When the current reaches earth, the circuit is complete and the charge indicator lamp will illuminate.

Field Circuit

When the starter switch is turned to the ON position, battery current will flow from the switch to the IG terminal of the regulator. In the regulator, the current flows through the closed points Pl and P2 to the regulator F terminal. From this terminal the current flows to the alternator F terminal which is the battery side of the rotor field coil. It is the current flowing from the F terminal through the rotor coil to earth which provides the initial magnetic field needed by the alternator before it can begin producing its own current.

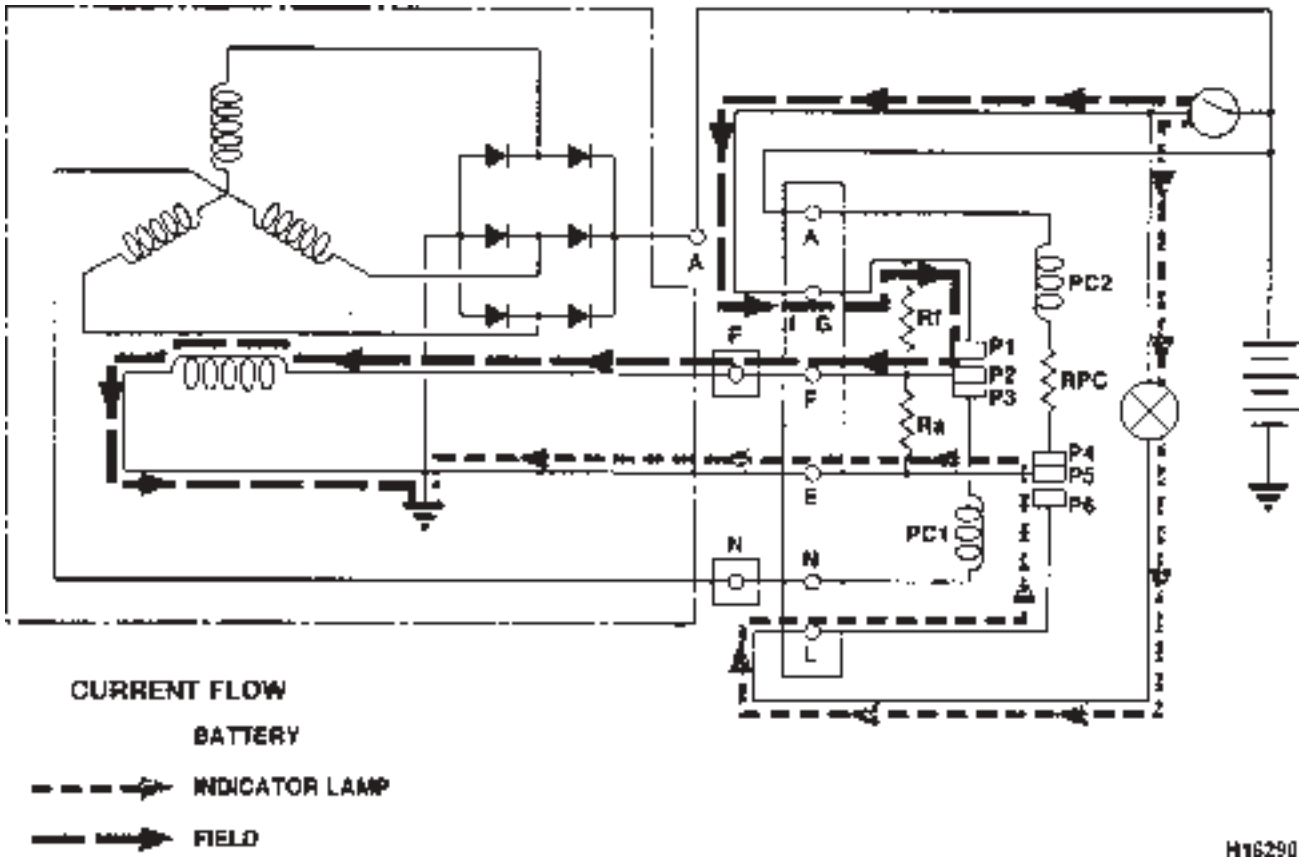


Figure 1
Alternator - Regulator Circuit
Key ON - Engine Off

VOLTAGE REGULATOR OPERATION (continued)

Engine on - Low speed (see fig. 2)

Indicator Lamp Circuit

A phase tap is connected to the stator winding in such a manner that when the alternator begins charging approximately 5 volts will be generated at the N terminal of the alternator. The current resulting from this voltage is applied to the N terminal of the regulator. In the regulator the current flows through coil PC1 to earth through terminal E. The current flow through PC2 will create a magnetic field strong enough to attract point P5 away from point P6 to point P4. The connection of P5 and P4 will accomplish two things:

1 With points P5 and P6 separated, the lamp circuit is open and the charge indicator light will go out.

2 The closing of points P5 and P4 will provide an earth circuit for coil PC2.

Field Circuit

As the alternator speed increases the voltage generated will approach 14 volts. This voltage is applied to the A terminal of the regulator. In the regulator the current flow resulting from the voltage will flow through coil PC2 and points P4 and P5 to earth at terminal E. The magnetic field generated in coil PC2, will become strong enough to attract point P2 away from point Pl. With points Pl and P2 open, field current will flow through resistance RI. The resistor reduces current flow to the alternator field which reduces the voltage generated by the alternator. During low speed operation and when electrical loads are high, point P2 will vibrate against Pl to maintain the alternator voltage at 13.8 to 14.8 volts.

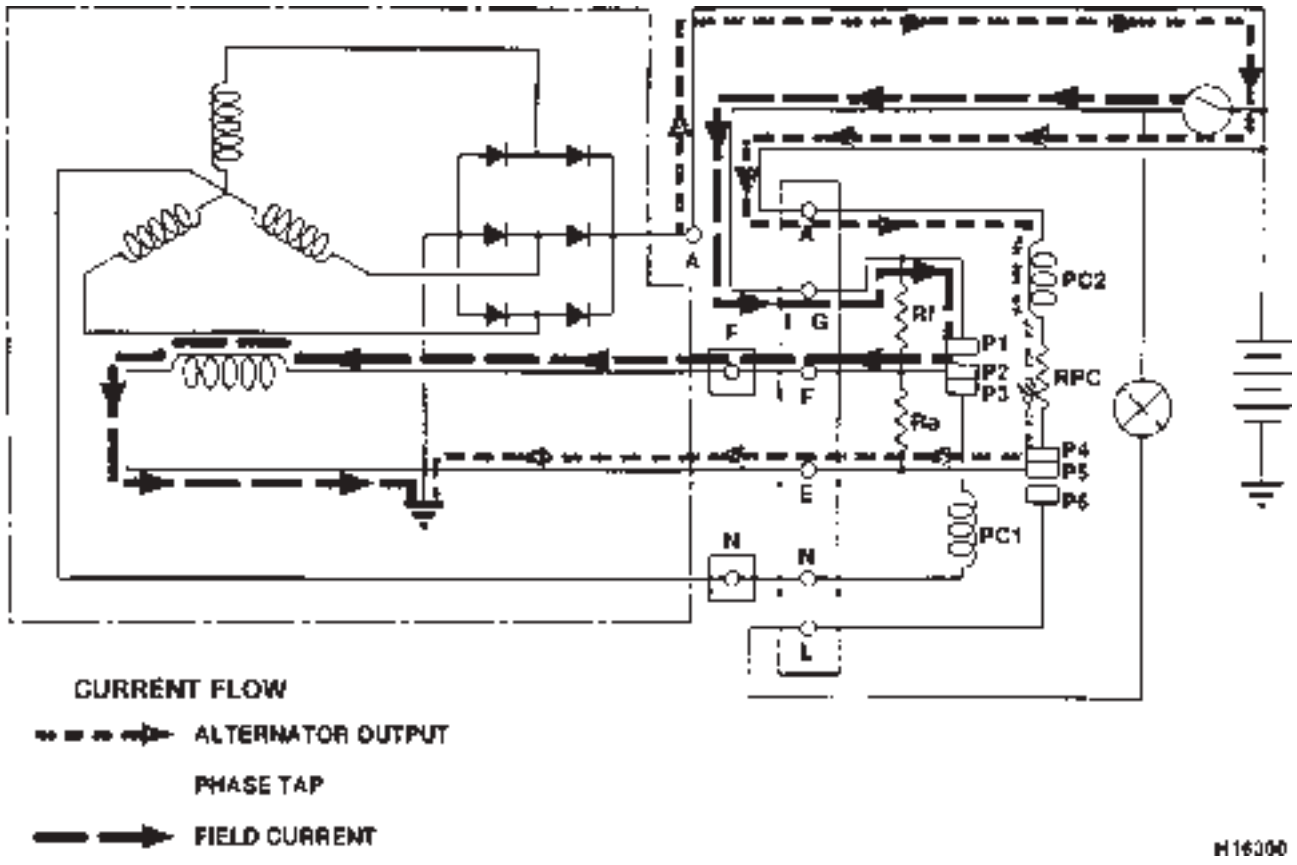


Figure 2
Alternator - Regulator Circuit
Key ON - Low Speed

VOLTAGE REGULATOR OPERATION (continued)

Engine on - High speed (see fig. 3)

As engine speed increases the higher rotor speed will cause the alternator output voltage to rise even though the current flow to the field has been reduced by resistor RI. The increased voltage level raises the amount of current flowing through coil PC2 which generates a stronger magnetic field around the coil. The coil now has enough force to pull point P2 into contact with point P3.

The closing of points P2 and P3 earths the field circuit at the regulator. Without field current the alternator stops charging which causes the voltage level to drop. The reduced voltage allows spring pressure to open points P2 and P3 - restoring field current. During high speed operation, point P2 will vibrate against point P3 to maintain the alternator voltage at 13.8to 14.8 volts

CHARGING SYSTEM - PRELIMINARY CHECK AND ELECTRICAL TEST

Service Precautions

To avoid damage to the components of the charging system, observe the following precautions.

- Never connect or disconnect any of the charging system circuit connections when the engine is running.
- Never short any of the charging components to earth.
- Always disconnect the battery earth cable when installing or removing the alternator.
- Always disconnect the battery earth cable when charging the battery in the machine using a battery charger
- Always observe the correct polarity when installing the, battery or using a slave battery to start the engine.

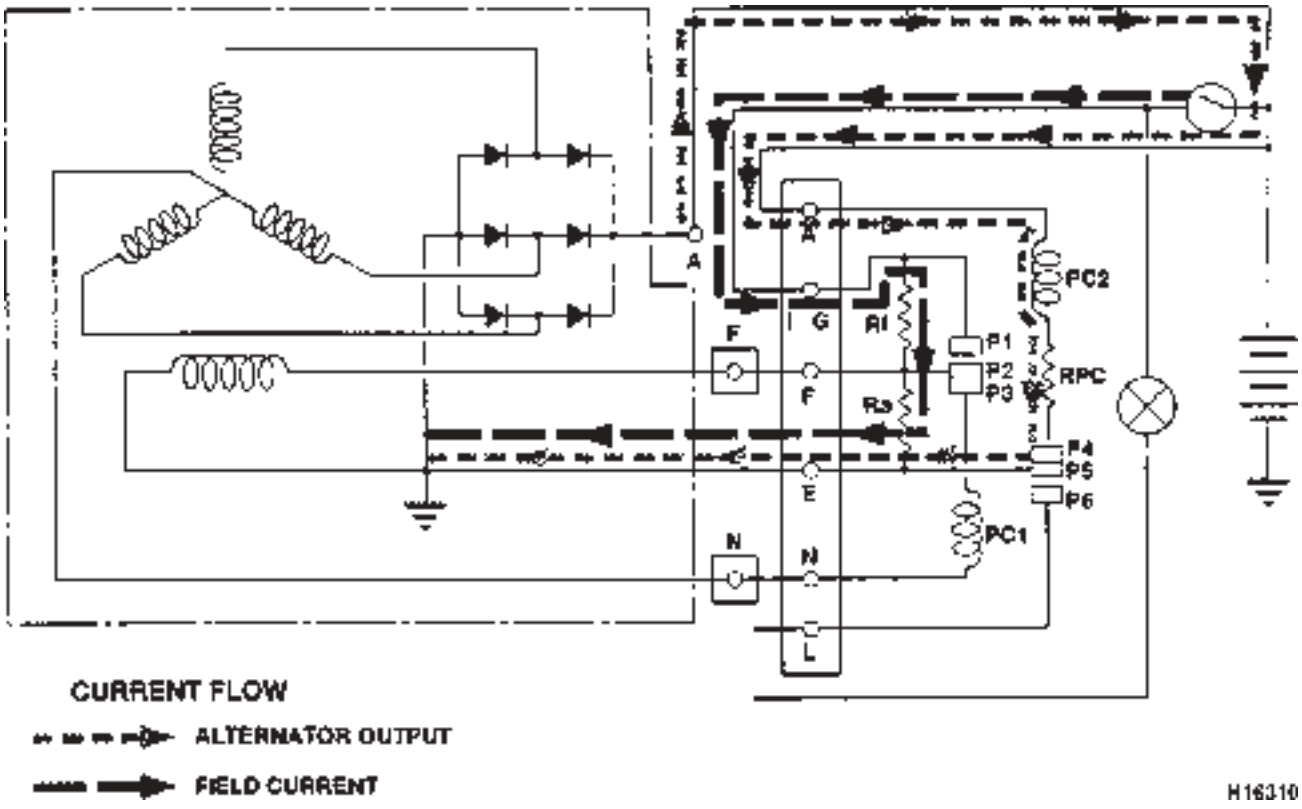


Figure 3
Alternator - Regulator Circuit
Engine On - High Speed

PRELIMINARY CHECKS

Prior to electrical testing, thoroughly inspect the charging and electrical system leads and connections.

ALTERNATOR VOLTAGE OUTPUT TEST (see fig. 4)

Indicator Lamp On - **Engine Running**

1 Turn on the headlights for 1 minute.

2 Connect a load tester and voltmeter to the battery. Make sure the load control knob is in the OFF position before making the connection.

NOTE: Connect the red reads to the battery *positive post and the black leads to the battery negative post Make sure the voltmeter leads contact the battery posts - not the load tester leads.*

3 Read and record the voltage indicated on the voltmeter.

4 Start the engine and adjust the speeds to 1400-1800 rpm.

5 Using the load tester, apply a 30 amp load to the battery.

6 Read and record the voltage indicated on voltmeter.

TEST RESULTS

• Voltmeter reading increases but remains below 15.5 volts	=	Perform output current test
• Voltmeter reading remains the same or decreases	=	Perform max. field output test
• Voltmeter reading increases above 15.5 volts	=	Replace regulator and check battery

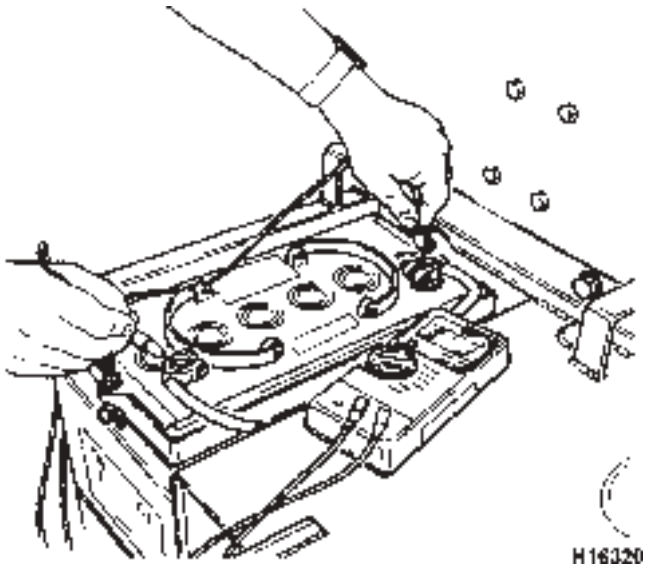


Figure 4
Voltage Output Test

ALTERNATOR CURRENT OUTPUT TEST (see fig. 5)

Indicator Lamp On - Engine Running

NOTE: *This test is a continuation* of *the output voltage test.*

1 Disconnect the voltmeter and load tester leads from **the** battery negative terminal.

2 Disconnect the cable from the battery negative post, Observe all safety precautions as outlined in the Battery Chapter.

3 Disconnect the output terminal at the alternator.

4 Connect an ammeter in series with the alternator output terminal and the wiring terminal. Connect the ammeter negative lead to the output terminal and the positive lead to the output terminal.

5 Connect the cable, load tester and voltmeter to the battery negative post.

6 Start the engine and adjust the engine speed to 1000 rpm.

7 Using the load tester, load the charging system enough to produce a 3-4 amp reading on the ammeter. Maintain this load for 2-3 minutes to stabilise alternator and regulator temperature.

8 Increase the engine speed to 1400-1800 rpm.

9 Using the load tester apply a 30 amp load to the charging system and observe the reading on the ammeter connected to the alternator.

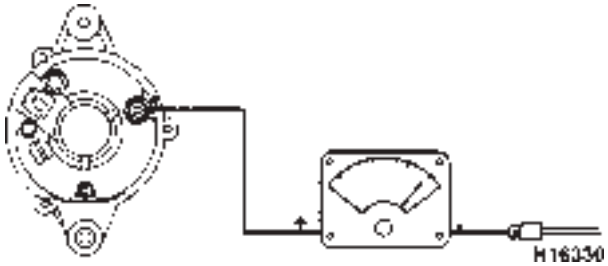


Figure 5
Current Output Test

TEST RESULTS

• Voltmeter reading increases but remains below 15.5 volts and the ammeter reads a minimum of 18 amps	=	Charging system is operating properly check for an earthed lamp circuit
• Voltmeter reading remains the same or decreases and the ammeter reads a minimum of 18 amps	=	Perform max. field output test

MAXIMUM FIELD OUTPUT TEST (see fig. 6)

Indicator Lamp On - Engine Running

NOTE: *This test should* be *performed only as a continuation of the output voltage or output cuffent tests.*

1 Perform all the steps outlined under the output voltage or output current tests, except, before starting the engine connect a jumper wire from the output terminal to the field terminal.

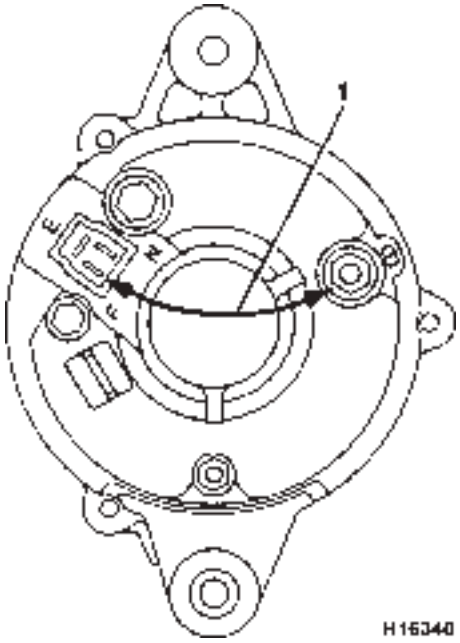


Figure 6
Maximum Field Output Test

TEST RESULTS

• Voltmeter or ammeter reading increases	=	Perform N circuit tests
• Voltmeter or ammeter reading remains the same or decreases	=	Disassemble alternator and test corrponents

ALTERNATOR - N TERMINAL TEST (see fig. 7)

Indicator Lamp On - Engine Running

1 Connect the voltmeter red lead to the N terminal of the alternator.

2 Connect the voltmeter black lead to a good earth.

3 Start the engine and adjust the engine speed to 1400-1800 rpm.

4 Observe the voltmeter reading.

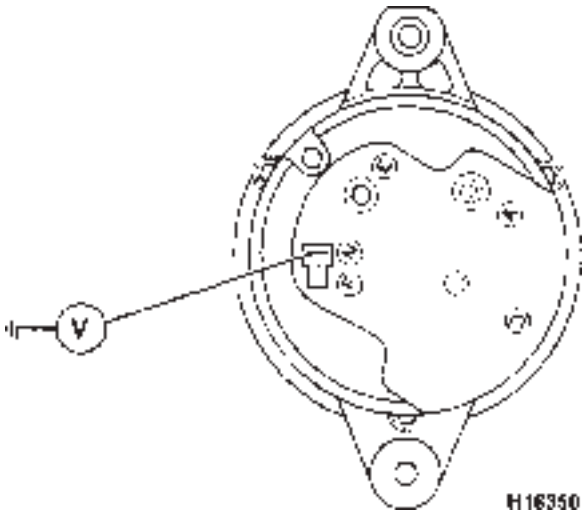


Figure 7
Alernator N Terminal Test

REGULATOR - N TERMINAL VOLTAGE TEST (see fig. 8)

Indicator Lamp On - Engine Running

NOTE: *This test is a continuation of the N terminal voftage check made at the aftemator.*

2 Connect the voltmeter red **lead** to **the** voltage regulator N terminal.

NOTE: *Do not disconnect the regulator connector for this* test.

2 Connect the voltmeter black lead to a good earth.

3 Start the engine and adjust the engine speed to 1400 - 1800 rpm.

4 Observe the voltmeter reading.

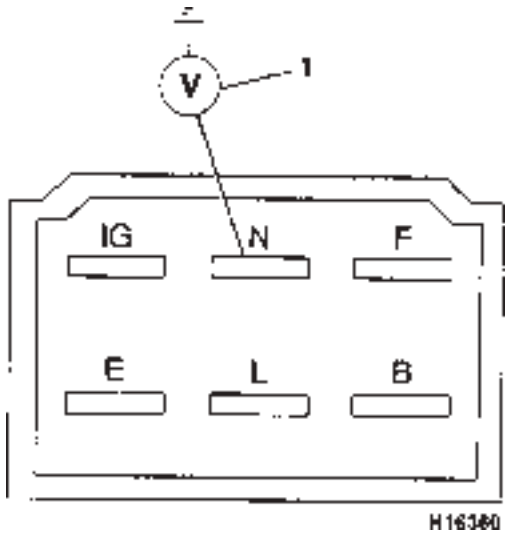


Figure 8
Regulator N Terminal Voltage Test

TEST RESULTS

- Voltmeter reads 4.0 - 5.8 volts = Check N terminal voltage at regulator
- Voltmeter reads less than: 4.0 = Disassemble alternator and bench lest components

1 Voltmeter

- Low Resistance Reading = Good
- High Resistance Reading = Replace Switch
- Voltmeter reads: 4.0 - 5.8 volts = Check N circuit continuity in regulator

CONTINUITY TESTS

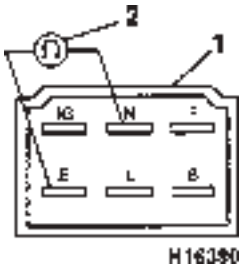
N CIRCUtT IN REGULATOR (see fig. 9)

Indicator Lamp On - Engine Running

1 Disconnect the regulator from the wiring harness.

2 Connect one ohmmeter load to the N terminal.

3 Connect the remaining ohmmeter load to the E terminal and observe the ohmmeter.



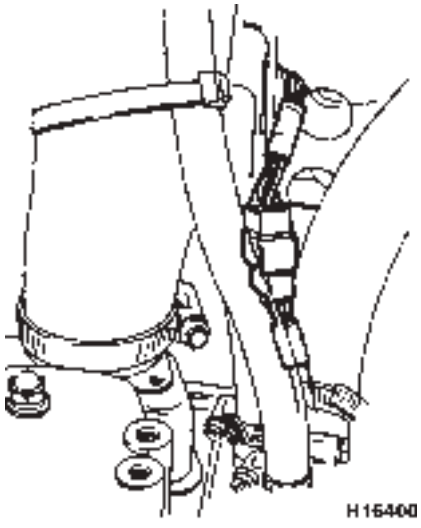


Figure 9
Regulator N Circuit Continuity Test

1 Regulator Wiring Connector **2** Ohmmeter

TEST RESULTS

- High Resistance Reading = Repair open or
- Low Resistance Reading = Proceed to F circuit continuity test

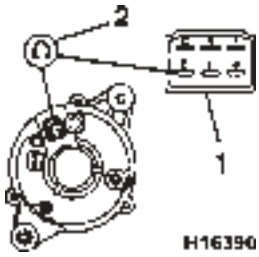
ALTERNATOR TO REGULATOR E CIRCUIT (see fig. 10)

Indicator Lamp On - Engine Running

1 Disconnect the regulator from the wiring harness.

2 Connect one ohmmeter lead to the wiring harness E terminal.

3 Connect the remaining ohmmeter lead to the alternator E terminal and observe the ohmmeter.



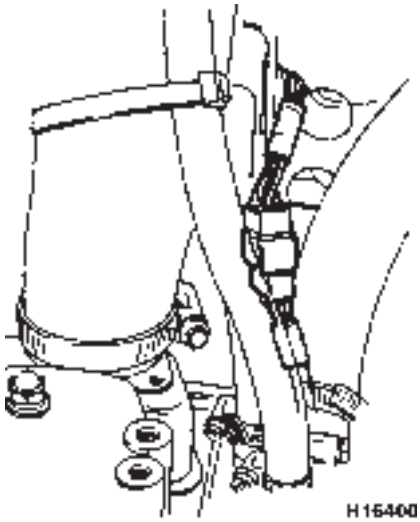


Figure 10
Alternator to Regulator E Circuit ContinuityTest

1 Regulator Wiring Connector **2** Ohmmeter

TEST RESULTS

- High Resistance Reading = Repair open or cause of high resistance in the E wire
- Low Resistance Reading = Proceed to F circuit continuity check - alternator to regulator

ALTERNATOR TO REGULATOR F CIRCUIT CONTINUITY TEST (see fig. 11)

Indicator Lamp On - Engine Running

1 Disconnect the regulator from the wiring harness.

2 Connect one ohmmeter load to the wiring harness F terminal.

3 Connect the remaining ohmmeter lead to alternator F terminal and observe the ohmmeter reading.

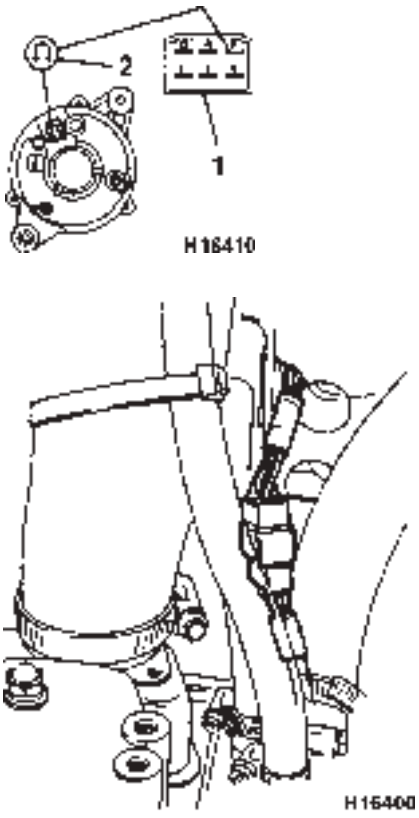


Figure 11
Alternator to Regulator F Circuit ContinuityTest

1 Regulator Wiring Connector 2 Ohmmeter

TEST RESULTS

- High Resistance Reading = Repair open or cause of high resistance in the F wire
- Low Resistance Reading = Proceed to F circuit continuity - in regulator

REGULATOR TO F CIRCUIT CONTINUITY TEST (see fig. 12)

Indication Lamp On - Engine Running 1

1 Disconnect the regulator from the wiring harness.

2 Connect one ohmmeter lead to regulator F terminal

3 Connect the remaining ohmmeter load to the IG terminal and observe the ohmmeter reading.

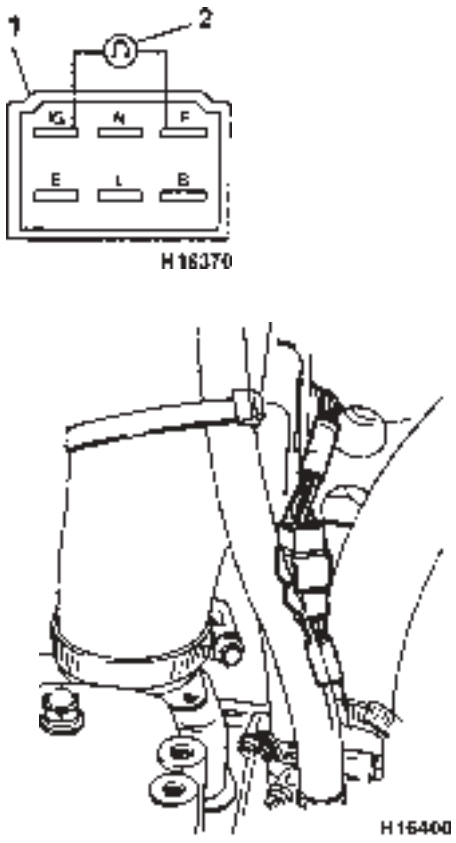


Figure 12
Regulator F Circuit Continuity Test

1 Regulator Wiring Connector 2 Ohmmeter

TEST RESULTS

- High Resistance Reading = Replace Regulator
- Low Resistance Reading = Proceed to B cicuit continuity check - alternator to regulator

ALTERNATOR TO REGULATOR B CIRCUIT CONTINUITY TEST (see fig. 13)

indication Lamp On - Engine Running

1 Disconnect the cable from the battery negative post.

2 Turn the starter switch to the ON position.

3 Disconnect the regulator from the wiring harness.

4 Connect one ohmmeter lead to the wiring harness B terminal.

5 Connect the remaining ohmmeter load to alternator B terminal and observe the ohmmeter reading.

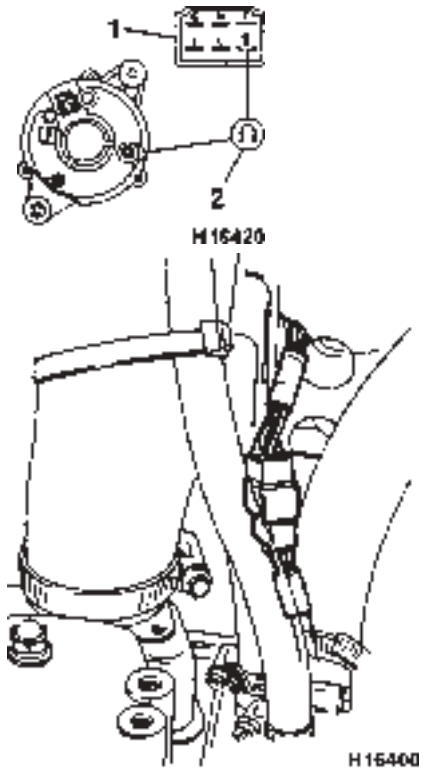


Figure 13
Alternator to Regulator B Circuit ContinuityTest

1 Regulator Wiring Connector 2 Ohmmeter

TEST RESULTS

- High Resistance Reading = Repair open or cause of high resistance in the B circuit
- Low Resistance Reading = Replace regulator

FUSE TO REGULATOR L TERMINAL CIRCUIT CONTINUITY TEST (see fig. 14)

Starter Switch On - Indicator Lamp Off

1 Disconnect the wiring harness at the regulator.

2 Connect a jumper from the wiring harness L terminal to ground.

3 Turn the starter switch to the ON position and observe the indicator lamp.

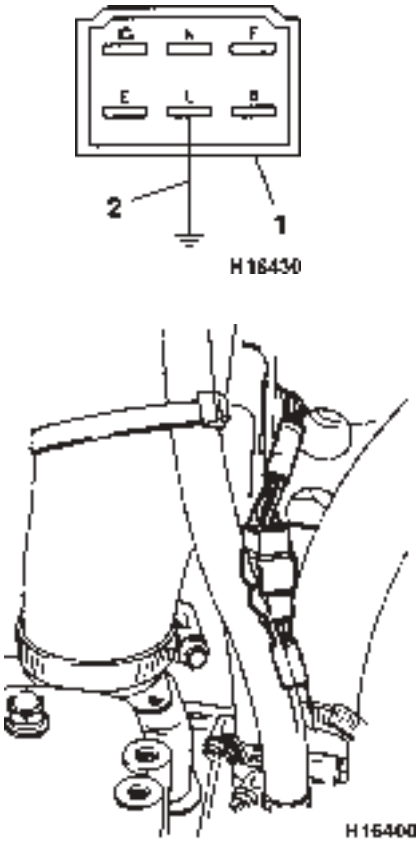


Figure 14
Fuse to Regulator L Terminal Circuit Continuity Test

1 Regulator Wire Connector 2 Jumper Wire

TEST RESULTS

- Indicator lamp is ON = Check L circuit continuity in regulator

  Check fuse, bulb and wiring for an open circuit

REGULATOR L CIRCUIT CONTINUITY TEST (see fig. 15)

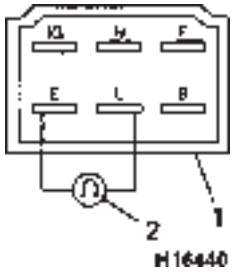
Starter Switch On - Indicator Lamp Off

NOTE: *This* test *is* a *continuation* of the *SWITCH ON - LAMP* OFF TEST

1 Disconnect the regulator from the wiring harness.

2 Connect one ohmmeter lead to the L terminal.

3 Connect the remaining ohmmeter lead to E terminal and observe the ohmmeter reading.



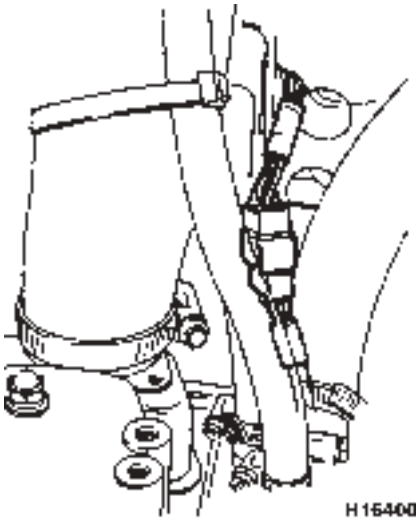


Figure 15
Regulator L Circuit Continuity Test

1 Regulator Wire Connector **2** Jumper Wire

TEST RESULTS

- High Resistance Reading = Replace regulator
- Low Resistance Reading = L circuit check is complete

STARTER MOTOR

Removal and Replacement

Removal

1 Raise the engine cover.

2 Remove the interior access panel.

3 Disconnect the battery.

4 Disconnect the starter electrical connections.

5 Support the starter motor **A**, loosen and remove the securing bolts **B**.

6 Disengage the pinion from the flywheel gear teeth and remove the starter motor.

Replacement

1 Put the starter motor in position and align the pinion in the flywheel gear teeth.

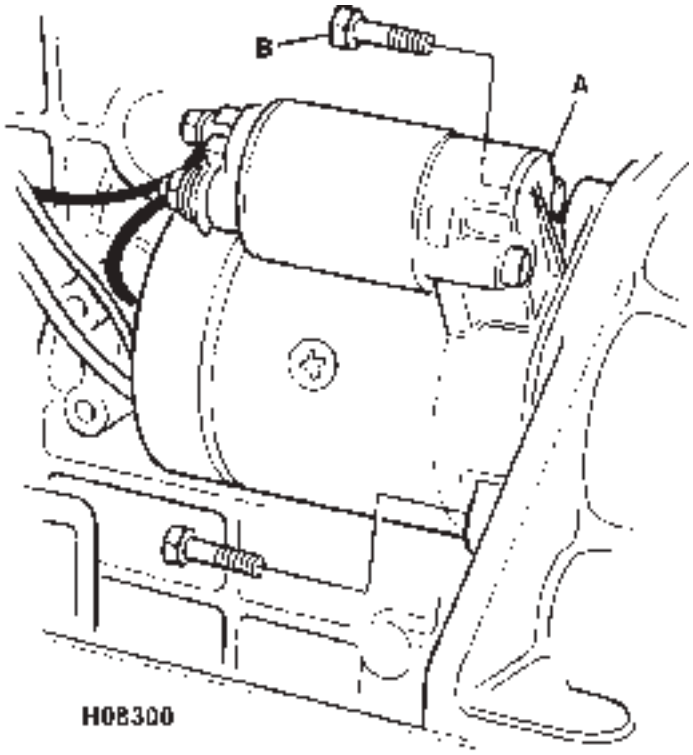
2 Fit and tighten the securing bolts **S**

3 Connect the electrical connections.

4 Connect the battery terminals. Connect the earth terminal last.

5 Fit the interior access panel.

6 Close the engine cover.



STARTER MOTOR (Cont'd)

Disassembly and Assembly

Disassembly

1 Remove the screws **A**.

2 Remove the solenoid **B** and the washers **C**.

3 Remove the dust cover and take out the **E** ring **D** and thrust washer **E**, if fitted.

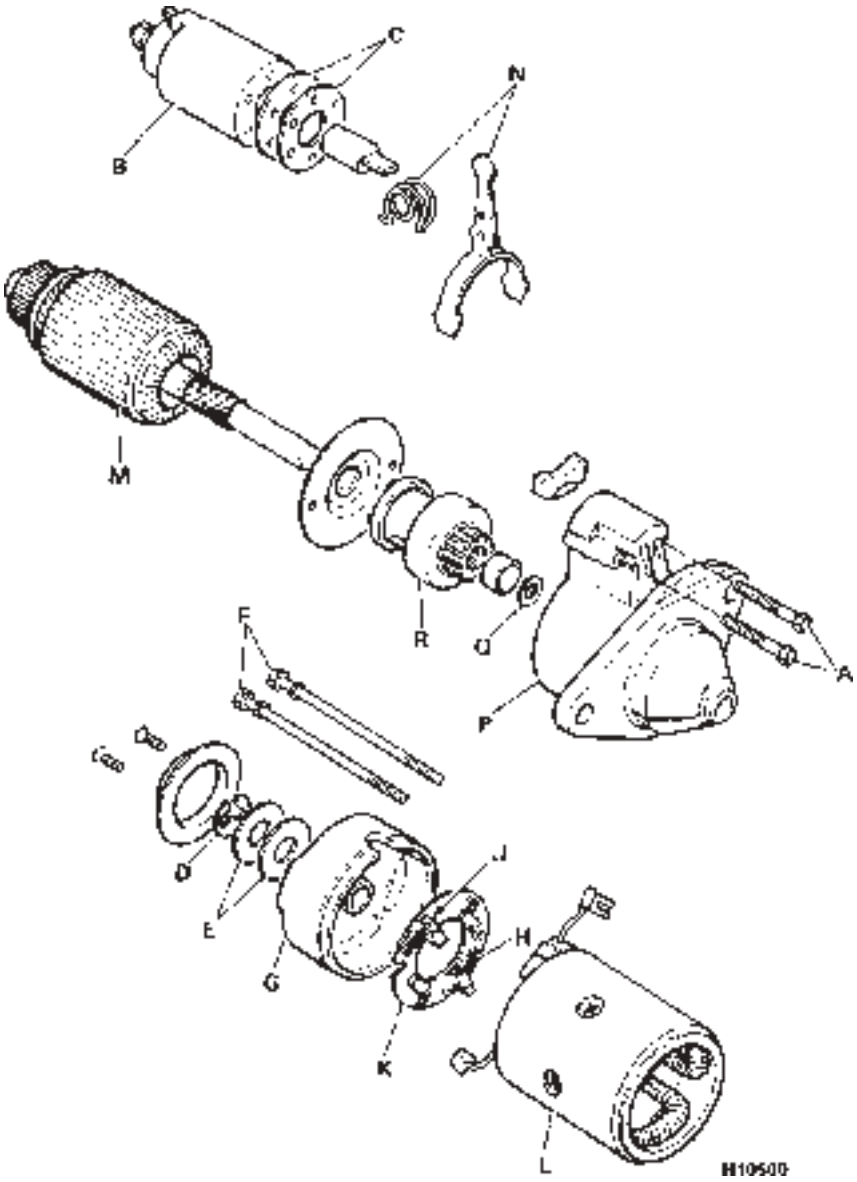
4 Remove the screws **F** and the rear cover **G**.

5 Remove the springs **H** and lift the brushes **J** from the brush assembly **K**.

6 Remove the brush assembly **K** and the yoke **L**.

7 Remove the armature **M** and the shift lever **N** from the front plate **P**.

8 Remove the snap ring **Q** and then remove the pinion **R**.



STARTER MOTOR (cont'd)

Inspection

1 Armature

a Short-circuit lest of the coil.
Use a growler tester for the test. Place the armature core in a growler tester and, applying an iron piece, turn the armature. Vibration of the iron piece indicates short-circuit. Renew the armature.

b Check the insulation between commutator and shaft. If continuity is indicated, it shows poor insulation. Renew the armature. Proper measurement with a circuit tester is impossible. Be sure to use a 500V megger for checking. If the test result is more than 1 MW, it is acceptable.

c inspection of the surface of commutator.
The part of the commutator surface where the brush is in contact can be distinguished clearly. If the contact area is rough, grind with sand paper of No. 500 or 600. If the indication of a dial gauge exceeds 0.5 mm (0.002 in.), correct with a lathe.

d Insulation of the commutator.
Measure the depth of the commutator segments and correct if the result is 0,2 mm (0.008 in.) or less.

e Shaft bend.
Measure the bend of the shaft with a dial gauge. Holding the centre of the armature shaft ends, measure the run-out of the centre section. Turn the armature and read the value indicated by the dial gauge pointer. Real bend is 112 of the reading. Allowable bend limit: 0.08 mm (0.003 in.)

2 Field Coil

a Check the field coil for disconnection using a tester. Check the continuity between the two brushes which are in effect the terminals of the field coil. If no continuity is indicated on the tester, ft shows disconnection. Renew the field coil.

a Check the continuity between the field coil and yoke with a tester. Continuity indicates insufficient insulation. Renew the coil.

3 Movement of the brush

a Check movement of the brush. When the brush does not move smoothly, check the brush holder for distortion and the sliding surface of the brush for damage. Correct and clean.

b Check the insulation between the brush holder (positive (+) side) and holder case (negative (-) side). If continuity is indicated, it shows insufficient insulation. Renew the brush holder assembly.

c Allowable wear limit of the brush is12 mm (0.472 in.) [new length 16 mm (0.630 in)].

d Measure the tension of the brush springs.
Standard tension is 1.6 kg to 2.0 kg (3.5 to 4.4 lb). Set the brush spring, pull up with a spring balance and measure the load when the brush is raised up. Renew faulty springs.
Service limit: 1.4kg (3.0 lb)

4 Magnetic switch

a Check the shunt coil for disconnection.
Check the continuity between the magnetic switch S terminal and coil case (metal part). If continuity is not indicated, it shows disconnection. Renew the switch.

STARTER MOTOR (cont'd)

Assembly

1 Fit the pinion **R** and snap ring **0**.

2 Insert the armature **M** into the front plate **P** and fit the shift lever **N**.

3 Fit the yoke **L** and the brush assembly **K**.

4 Insert the brushes **J** into the brush assembly and fit the springs **H**.

5 Fft the rear cover **G** with the screws **F**. Tighten the screws **F**.

6 Install the **E** ring **D** and thrust washer **E**, if fitted and fit the dust cover.

7 Insert the washer **C** in the front plate and fit the solenoid **B**.

8 Insert the screws **A** and tighten them.

9 Check the thrust gap for the armature is 0.5 mm (.01 97 in.) maximum.

10 Check the distance that the pinion is pushed by the solenoid as follows:

a Measure the distance between the pinion and the stop-ring (pinion clearance).

b Connect a 12V battery to the solenoid. The battery positive (+) should be connected to terminal **S** of the solenoid.

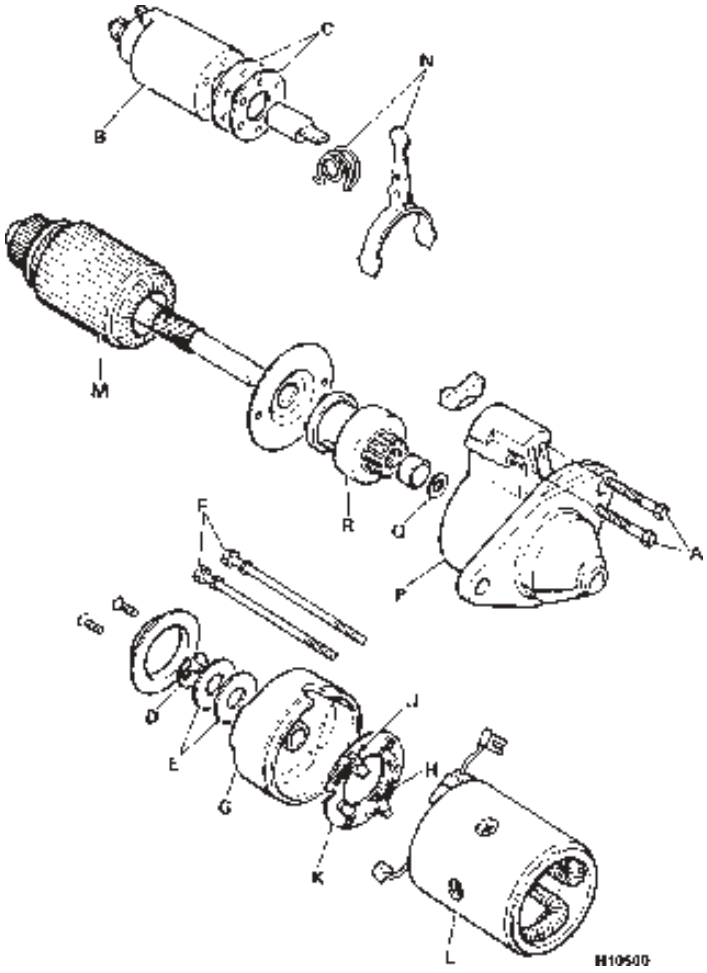
c Measure the pinion clearance again.

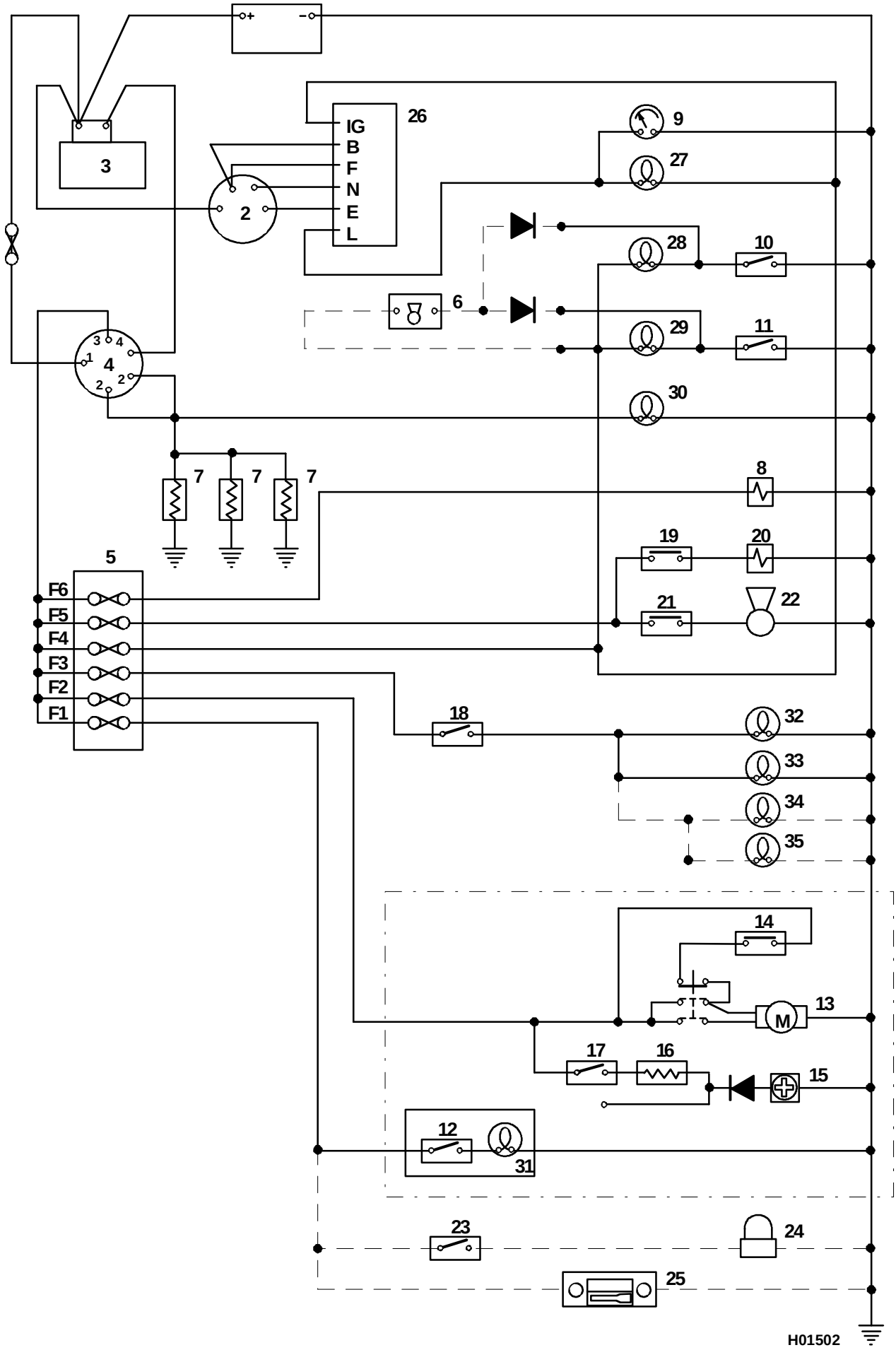
d Disconnect the battery.

The pinion clearance should be be 0.2 to 1.5 mm (0.008 to 0.060 in.)

If the pinion clearance is incorrect, loosen the adjusting nut and adjust the adjusting screw. or shims where fitted.

11 Check the operation of the solenoid and change adjusting plate if necessary.





Component Key

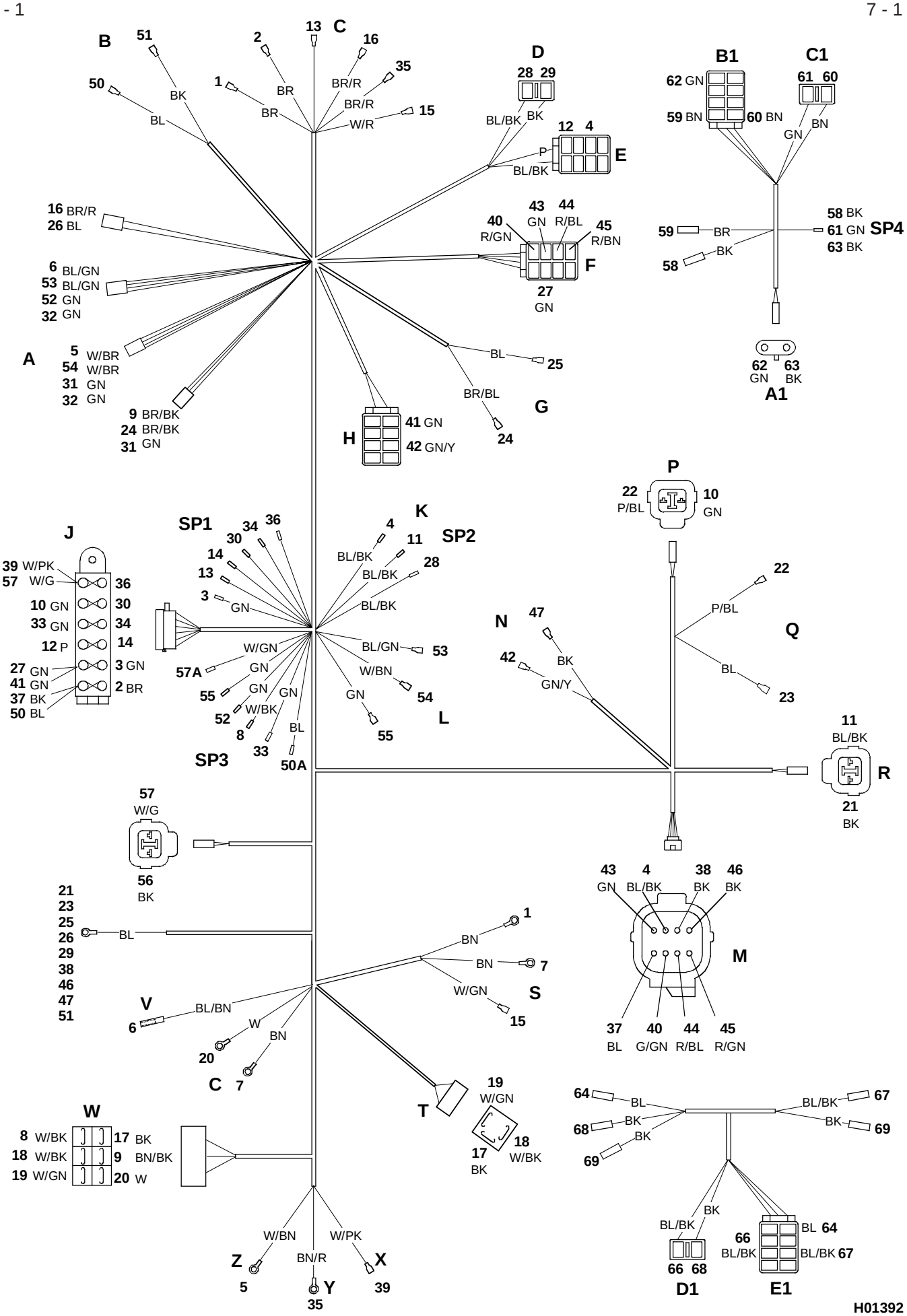
1 Battery
2 Alternator
3 Starter Motor
4 Starter Switch
5 Fuse Block
6 Warning Buzzer
7 Glow Plugs
8 Fuel Solenoid
9 Hourmeter
10 Engine Oil Pressure Switch
11 Engine Coolant Temperature Switch
12 Interior Light Switch
13 Windscreen Wiper motor
14 Wiper Motor Parking Switch
15 Heater Motor
16 Resistor
17 Heater Switch
18 Lamps Switch
Cab Roof - Optional
Boom
19 Servo Isolator Switch - Optional
20 Servo Supply Solenoid - Optional
21 Horn Switch
22 Horn
23 Beacon Light Switch - Optional
24 Beacon - Optional
25 Radio - Optional
26 Regulator

Lamps

27 Alternator Warning
28 Engine Oil Pressure Warning
29 Engine Coolant Temperature Warning
30 Glowplug Warning
31 Interior
32 Lamp Switch
33 Boom
34 Cab Roof - Optional
35 Cab Roof - Optional

Fuses

F1 Fuel Solenoid
F2 Servo Isolator Switch
Servo Supply Solenoid
Horn and Switch
F3 Engine Oil Pressure Switch
Engine Coolant Temperature Switch
F4 Lamps Switch
Cab Roof - Optional
Boom
F5 Windscreen Wiper Motor and Switch
Heater Motor and Switch
F6 Interior Light and Switch



WIRE COLOUR KEY

BR - BROWN
BK - BLACK
BL - BLUE
GN - GREEN
PK - PINK
LG - LIGHT GREEN
W - WHITE
P - PURPLE
Y - YELLOW

QUICK REFERENCE KEY

A AWARNING LIGHTS
*A1 TWO-SPEED TRACKING SOLENOID
B AUX CONNECTORS
*B1 TWO-SPEED TRACK SWITCH
C IGNITION SWITCH
*C1 TWO-SPEED TRACK WARNING LIGHT
D BOOM LIGHT WARNING SYSTEM
*D1 BEACON WARNING LIGHTS
E BOOM LIGHT SWITCH
*E1 BEACON SWITCH
F WIPER MOTOR
G HOUR METER
H HEATER SWITCH
J FUSE BOX
K BOOM LIGHT SWITCH
L CONNECTION TO SUB HARNESS
M CAB CONNECTOR
N HEATER
P HORN BUTTON (on control lever to M727693 on instrument panel M722694 on)
Q HORN
R BOOM LIGHT
S STARTER
T ALTERNATOR
U ALTERNATOR B
V WATER TEMPERATURE SENDER
W REGULATOR
X ELECTRIC STOP SOLENOID
Y GLOW PLUG
Z ENGINE OIL PRESSURE
SP1 EXTERNAL SPLICE 1
SP2 EXTERNAL SPLICE 2
SP3 EXTERNAL SPLICE 3
*SP4 EXTERNAL SPLICE 4

1 IGNITION SWITCH TO STARTER
2 IGNITION SWITCH TO FUSE BOX
3 FUSE BOX TO SP1
4 BOOM SWITCH TO CAB WORKING LIGHT
5 ENGINE OIL PRESSURE TO WARNING LIGHT
6 WATER TEMPERATURE SENDER TO WARNING LIGHT
7 ALTERNATOR ‘B’ TO STARTER
8 SP3 TO REGULATOR ‘IG’
9 REGULATOR ‘IND’ TO WARNING LIGHT
10 FUSE BOX TO HORN BUTTON
11 BOOM LIGHT TO SWITCH
12 FUSE BOX TO BOOM LIGHT SWITCH
13 IGNITION SWITCH TO SP1
14 FUSE BOX TO SP1
15 IGNITION SWITCH TO STARTER
16 IGNITION SWITCH TO WARNING LIGHT
17 ALTERNATOR TO REGULATOR ‘E’
18 ALTERNATOR TO REGULATOR ‘N’
19 ALTERNATOR TO REGULATOR ‘F’
20 ALTERNATOR B TO REGULATOR ‘B’
21 EARTH TO BOOM LIGHT
22 HORN TO HORN BUTTON
23 EARTH TO HORN
24 HOUR METER TO WARNING LIGHT
25 EARTH TO HOUR METER
26 EARTH TO WARNING LIGHT
27 FUSE BOX TO WIPER SWITCH
28 BOOM LIGHT SWITCH TO LIGHT SWITCH WARNING LIGHT
29 EARTH TO BOOM LIGHT
30 FUSE BOXTO SP1
31 WARNING LIGHT LINK
32 WARNING LIGHT LINK
33 FUSE BOX TO SP3
34 FUSE BOX TO SP1
35 IGNITION SWITCH TO GLOW PLUGS
36 FUSE BOX TO SP1
37 FUSE BOX TO CAB LIGHT
38 EARTH TO CAB PLUG
39 FUSE BOX TO ELECTRIC STOP SOLENOID
40 SWITCH TO WIPER
41 FUSE TO HEATER SWITCH
42 SWITCH TO HEATER
43 SWITCH TO CAB PLUG
44 WIPER SWITCH TO CAB PLUG
45 WIPER SWITCH TO CAB PLUG
46 EARTH TO CAB PLUG
47 EARTH TO HEATER
50 FUSE TO AUX CONNECTION
*50A SP3 TO AUX CONNECTION (TWO-SPEED TRACK ONLY)
51 EARTH TO AUX CONNECTION
52 SP3 TO WARNING LIGHTS
53 WATER TEMP LIGHT TO BUZZER
54 OIL PRESSURE LIGHT TO BUZZER
55 SP3 TO BUZZER
56 SERVO PLUG TO EARTH
57 PLUG TO FUSE BOX
*57A PLUG TO SP3 (TWO SPEED TRACKING ONLY)
*58 CONNECT TO 51 ON MAIN HARNESS
*59 CONNECT TO 50 ON MAIN HARNESS
*60 SWITCH TO WARNING LIGHT (TWO SPEED TRACKING ONLY)
*61 WARNING LIGHT TO SPLICE(T.S.T. ONLY)
*62 SWITCH TO SOLENOID (T.S.T. ONLY)
*63 SOLENOID TO SPLICE (T.S.T. ONLY)
*64 BEACON HARNESS TO SWITCH
*65 BEACON SWITCH TO SOCKET
*66 BEACON LIGHT TO SWITCH
*67 BEACON SWITCH TO SOCKET
*68 BEACON HARNESS TO LIGHT
*69 BEACON SOCKET TO HARNESS

Beacon

Mounting

The rotating beacon relies on the force of a magnet to hold it in position on the machine. A cable and plug from the beacon fits into a socket located on a panel in the cab of the machine. The panel is wired to provide a beacon operating switch and warning light.

The intended beacon mounting position must be flat, clean and dry. When mounted, particularly ensure beacon positioning conforms to the following:

- Is in accordance with National and local legal requirements.
- The light is visible from any point at a reasonable distance from the machine.
- Beacon base parallel to the ground and on the machine longitudinal centre line.
- If radio equipment is fitted to the machine, there should be a minimum distance of 500 mm (20 in.) between the beacon and the radio antenna.

CAUTION

The beacon must be removed before the machine is towed or loaded onto a trailer for towing. The beacon must not be fitted if the machine is moved at speeds exceeding 80 kph (50 mph).

Bulb Change

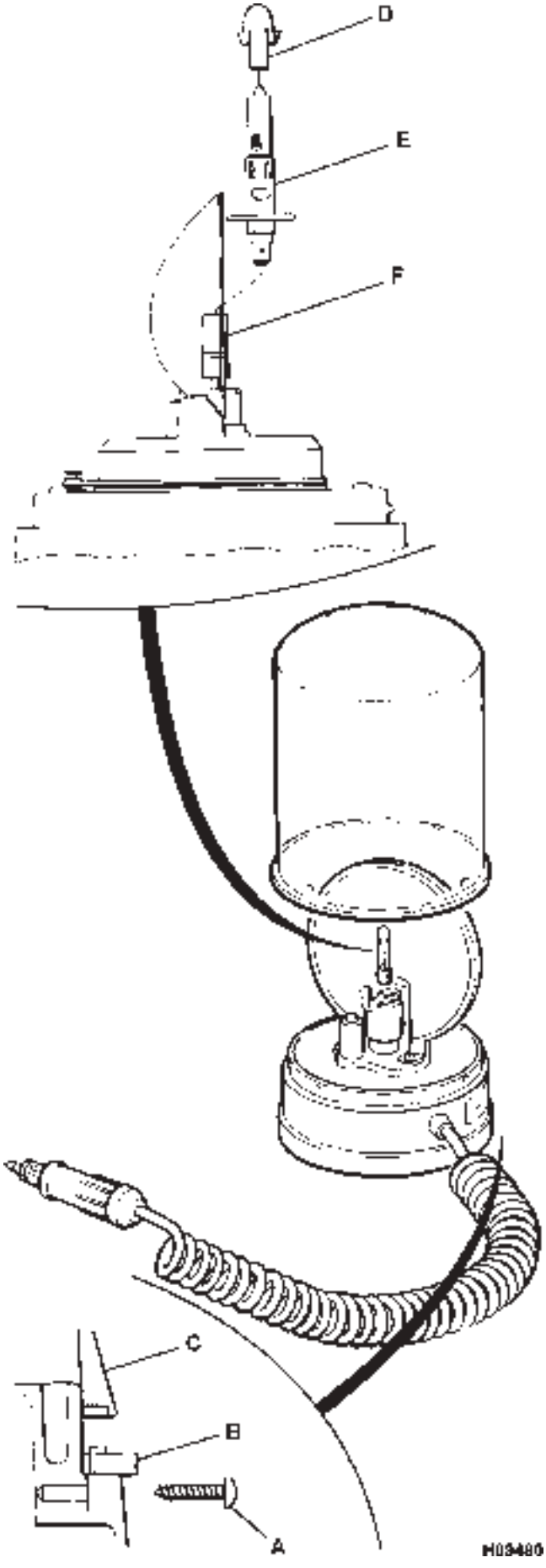
1 Remove the lens latch locking screw **A**.

2 Push down the lens latch **B**. Turn lens **C** anti-clockwise to release and remove it.

3 Taking care not to touch the bulb glass, release the bulb retaining clip **D** and lift bulb **E** and attached clip from the connector **F**. Disconnect bulb **E.**

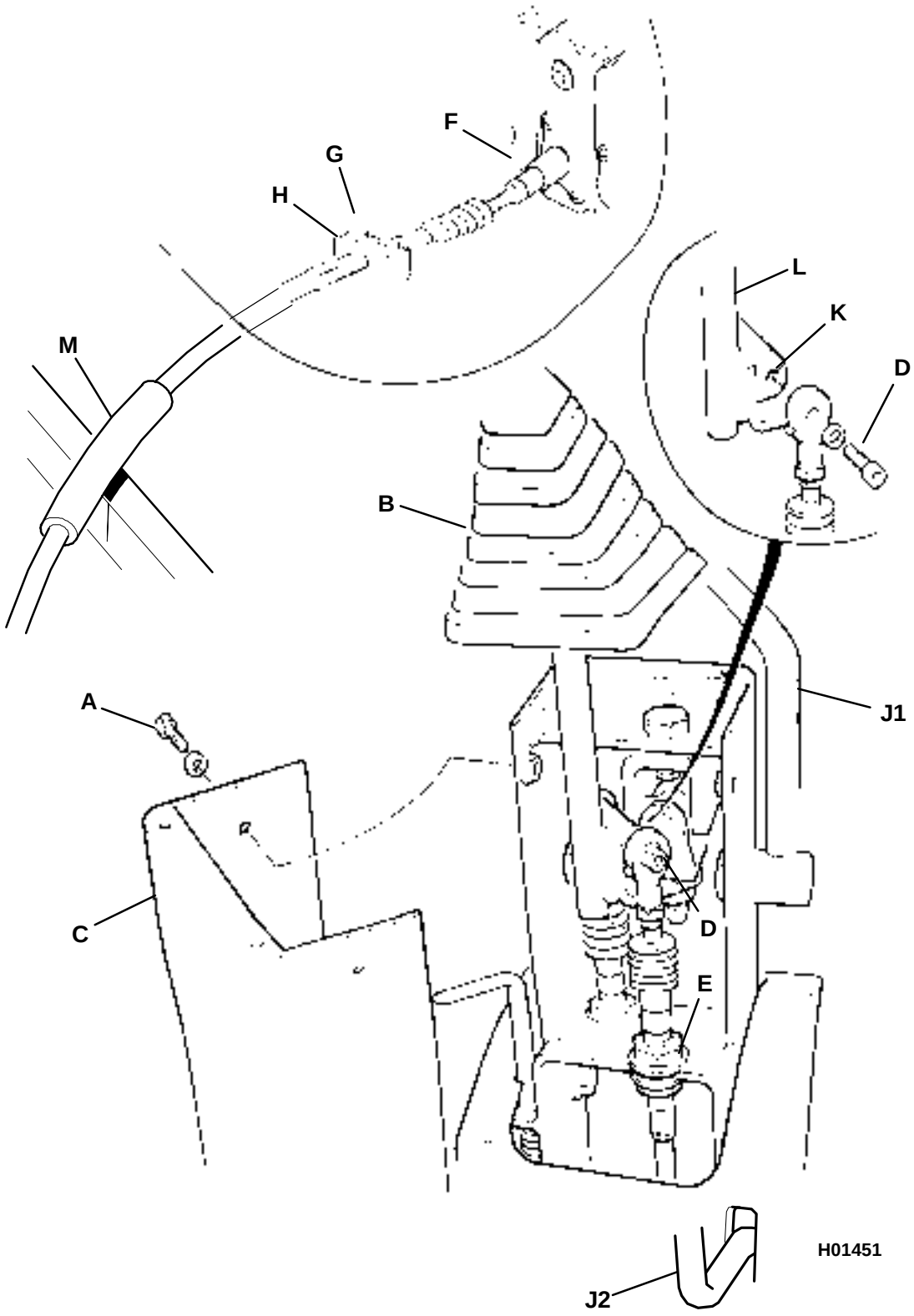
4 Remove the unserviceable bulb from clip **D**.

5 Fit a new bulb and assemble the beacon in reverse order of dismantling. Do not tighten the lens latch locking screw **A** to more than 0.65Nm (5.75 lbf in.).



Contents	**Page No.**

Play in Control Levers	
Boom lever	25 mm (1 in.)
Swing and slew lever	25 mm (1 in.)
Travel lever	6 mm (0.24 in.)
Bucket lever	25 mm (1 in.)
Dozer lever	5 mm (0.19 in.)
Dipper lever	20 mm (0.78in)
Stroke of Control Levers	
Boom lever	85 mm (3.3 in)
Swing and slew lever	L90 mm (3.5 in.) R80 mm (3.1 in.)
Travel lever	85 mm (3.3 in.)
Bucket lever	85 mm (3.3 in.)
Dozer lever	70 mm (2.7 in.)
Control Pressure of Levers	
Boom lever	29.4N (3.0 kgf, 6.6 lbf)
Swing and slew lever	29.4N (3.0 kgf, 6.6 lbf)
Travel lever	24.5N (3.0 kgf, 5.5 lbf)
Bucket lever	29.4N (3.0 kgf, 6.6 lbf)
Dozer lever	24.5N (2.5 kgf, 5.5 lbf)



Control Cables

Removal

1 Switch off the engine and disconnect the battery.

2 Vent the hydraulics.

3 Remove both screws **A**.

4 Remove the rubber gaiter **B**.

5 Remove the front cover **C**.

6 Disconnect the screw **D** securing the eye end and the locknut **E** securing the cable to the bracket.

7 Remove the seat and the seat mounting brackets.

8 Remove the battery and the lower battery plate.

*__9__ Undo the locknuts **F** securing the cables to the valve block and unscrew cable end from spool.

10 Remove the screws **G** in the saddle **H** retaining the cable, remove the cable from the block.

11 For the dipper cable, remove the swing pedal and the floor matting.

12 Remove the floor plate nearest the door, complete with the swing cable attached.

13 Remove the screws in the saddle retaining the cable, remove the cable from the block.

14 Undo the locknut securing the cable to the dipper service.

15 Remove the cables.

Replacement

Care should be taken when refitting the control cables. If the cable bend radius is too tight then damage to the cable's inner swaging will occur, causing premature cable failure.

When refitting the cables, follow the fitting sequence.

Excavator Control Cables

1 Locate cable ferrule under saddle **H** and attach with bolts **G**. To prevent excessive flexing, fully retract cable into the outer sleeve before screwing the threaded shank to the spool end, leaving 10mm of exposed thread, secure with locknut **F**.

*__2__ Position cable across slew frame and instal in lever pod. Position adjuster **E** centrally. With lever lock **J1** (to M722269) **J2** (M722270 on) raised fully into the locked condition, check rose joint hole aligns with tapped hole **K** in lever base **L** before fitting capscrew **D.** If necessary adjust height of rose joint with adjuster **E.**

3 Apply Loctite 222 to threads of capscrew **D**. To prevent crushing of rose joint, always replace spacer under capscrew head.

4 Ensure cable protector sleeves **M** are positioned to prevent chaffing where they cross the slew frame fabrication.

Swing Control cable (foot pedal)

1 Fit cable to slew frame with cable saddle **H** and bolts **G**.

2 Connect cable ends to valve block spool and foot pedal link with the clevis pins.

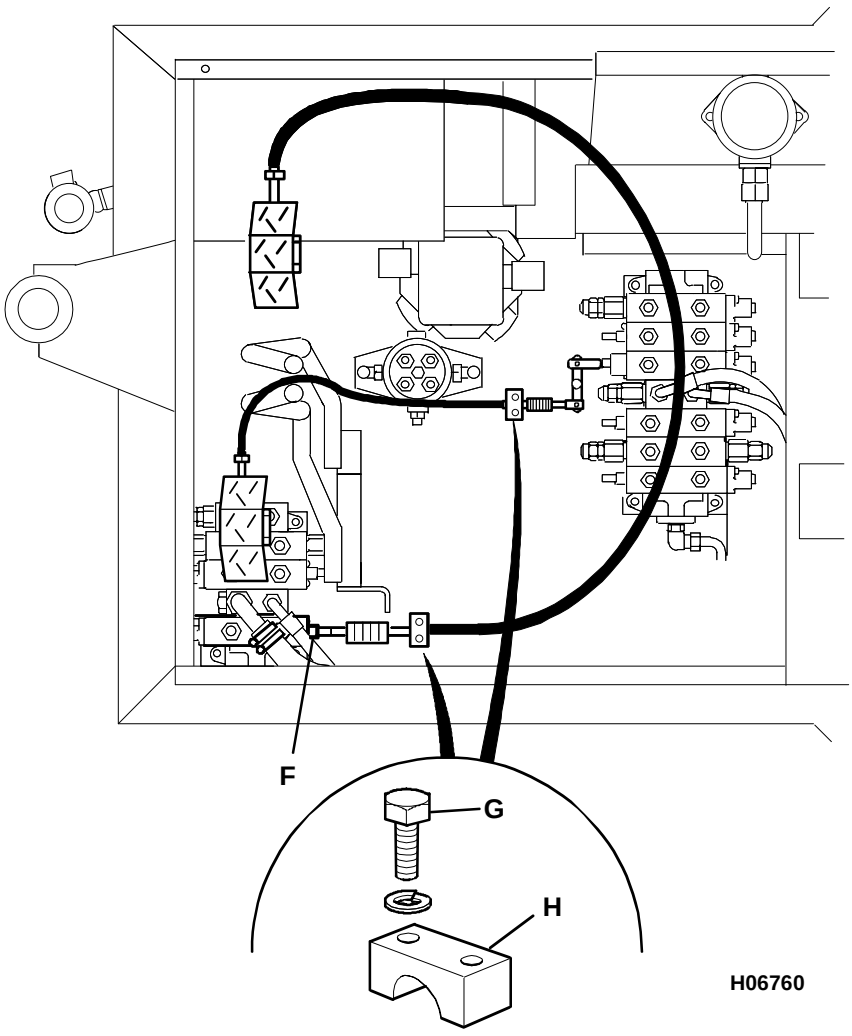
3 Adjust cable length until foot pedal pad is horizontal.

Auxiliary Control Cable (foot pedal)

1 Fit cable to slew frame with cable saddle **H** and bolts **G**.

2 Screw cable end into spool following Excavator Control Cable fitting precautions above, and tighten locknut **F**. Fit the cable end to the foot pedal link with clevis pin.

3 Adjust cable length until foot pedal stem is in the centre of floor plate slot.



Servo Hand Controllers

Removal

1 Set the machine with the bucket on the ground. Stop the engine and remove starter key.

2 Remove the four screws securing the hand controller.

3 Carefully withdraw the hand controller. Disconnect all servo hoses noting the position of each hose. The hoses are colour coded for ease of recognition. Plug the servo hoses immediately.

Replacement

For replacement the removal sequence should be reversed.

Test hand controller operation and check for oil leaks.

Hand Controller Handles

Removal

Note: *It is recommended that only the handle and gaiter of the hand controller be renewed. Do not attempt to dismantle the main assembly. Renew complete assembly if required. The handle can be renewed without disconnecting the servo hoses, however, the hand controller will have to be lifted from the armrest to gain access to the electrical connections.*

1 Set the machine with the bucket on the ground. Stop the engine and remove starter key.

2 Remove screws securing hand controller to the armrest. Lift out of armrest to gain access to the electrical connections.

3 Disconnect the electrical connections noting the position of each of the wires. Unscrew the handle and remove. Clean threads of flange / pivot assembly **5.**

Replacement

1 Fit 1/4 in. male Lucar connectors **2** to the wires of the new handle **1.**

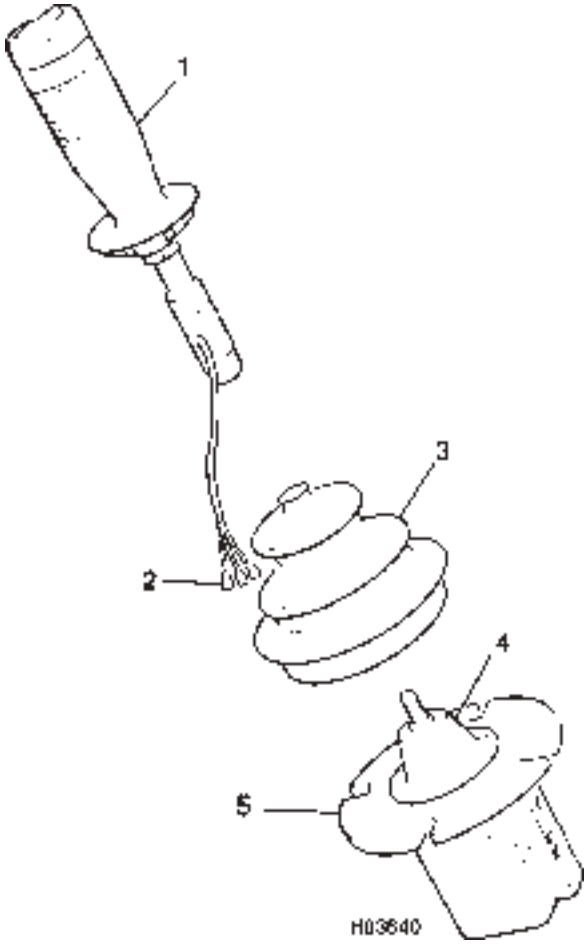
2 Back-off cam **4** until it is clear of spool plungers.

3 Apply Loctite 270 to threads of flange and pivot assembly **5.**

4 Fit gaiter **3** to new handle. Screw handle along threads of **5** until it just touches cam **4.**

5 Screw handle and cam along threads of **5** until the cam just touches the spool plungers.Screw a further quarter turn. Torque back cam against handle to 18 Nm.

6 Reconnect Lucar connectors and refit hand controller in position on the armrest.



Engine Throttle Cable

Removal and Replacement

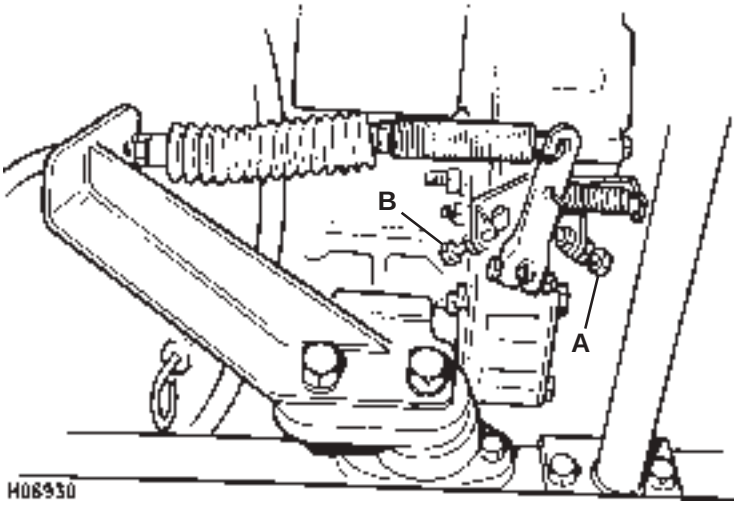
The figure shown is a guide to removal and replacement.

Check that the engine speed is correct. If incorrect, adjust by throttle stop screw **A**.

Adjusting Idling Speed

Engine idle speed is adjusted by setting screw **A.** Turning clockwise increases engine speed, turning anti-clockwise decreases engine speed.

Engine flight speed is adjusted by setting screw **B.** Turning clockwise decreases engine speed, turning anti-clockwise increases engine speed.



H06880

Contents

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Technical Data

Pump Type - Three element gear pump driven from the engine crankshaft.

Pump Flow Rate (at 2200 engine revs/min. and M.R.V. pressure)	**801.4/801.5/801.6**	**801.5 Power Plus**
No. 1 Element	8.8 litre/min. (1.9 UK gal/min.)	11.0 litre/min (2.4 UK gal/min.)
No. 2 Element	12.1 litre/min. (2.6 UK gal/min.)	12.1 litre/min (2.6 UK gal/min.)
No. 3 Element	12.1 litre/min. (2.6 UK gal/min.)	12.1 litre/min (2.6 UK gal/min.)

Relief Valve Operating Pressures	**801.4 / 801.5**			**801.5 Power Plus**			**801.6**		
	bar	**kgf/cm²**	**lbf/in²**	**bar**	**kgf/cm²**	**lbf/in²**	**bar**	**kgf/cm²**	**lbf/in²**
Main Relief Valves (M.R.V.)									
- Dipper/L.H. Track/Auxiliary	207	211	3000	230	235	3350	220	224	3200
- Bucket/Boom/R.H. Track/Auxiliary	207	211	3000	230	235	3350	220	224	3200
- Swing/Slew/Dozer	155	158	2250	155	158	2250	155	158	2250
Auxiliary Relief Valves (A.R.V.)									
- Boom, Head side/Rod side	240	245	3480	275	280	4000	275	280	4000
- Dipper, Head side/Rod side	240	245	3480	275	280	4000	275	280	4000
- Dozer, Head side	220	224	3190	220	224	3190	220	224	3190
Cross Line Relief Valves									
- Slew (801.6 to M728056)	140	150	2130	140	150	2130	125	132	1800
- Slew (801.6 from M728057)	140	150	2130	140	150	2130	140	150	2130
- Start up	70	71	1000	70	71	1000	70	71	1000

***Servo Pressures**	**801.4, 801.6**
- Pressure Relief	41.5-44.5 bar 42-45 kgf/cm³ 600-650 lbf/in²
- Pressure Maint.	30-33 bar 30-33 kgf/cm³ 430-480 lbf/in²

Ram Dimensions	**801.4**	**801.5**	**801.6**
Boom/Dipper/Bucket/Swing			
- Bore	50 mm (1.97 in.)	50 mm (1.97 in.)	55 mm (2.16 in.)
- Rod Dia.	30 mm (1.18 in.)	30 mm (1.18 in.)	30 mm (1.18 in.)
Dozer			
- Bore	70 mm (2.76 in.)	70 mm (2.76 in.)	70 mm (2.76 in.)
- Rod Dia.	35 mm (1.38 in.)	35 mm (1.38 in.)	35 mm (1.38 in.)
Ram Stroke			
- Boom	360 mm (14.17 in.)	360 mm (14.17 in.)	360 mm (14.17 in.)
- Dipper	400 mm (15.75 in.)	400 mm (15.75 in.)	400 mm (15.75 in.)
- Bucket	286 mm (11.26 in.)	286 mm (11.26 in.)	286 mm (11.26 in.)
- Swing	340 mm (13.39 in.)	340 mm (13.39 in.)	340 mm (13.39 in.)
- Dozer	85 mm (3.35 in.)	85 mm (3.35 in.)	85 mm (3.35 in.)

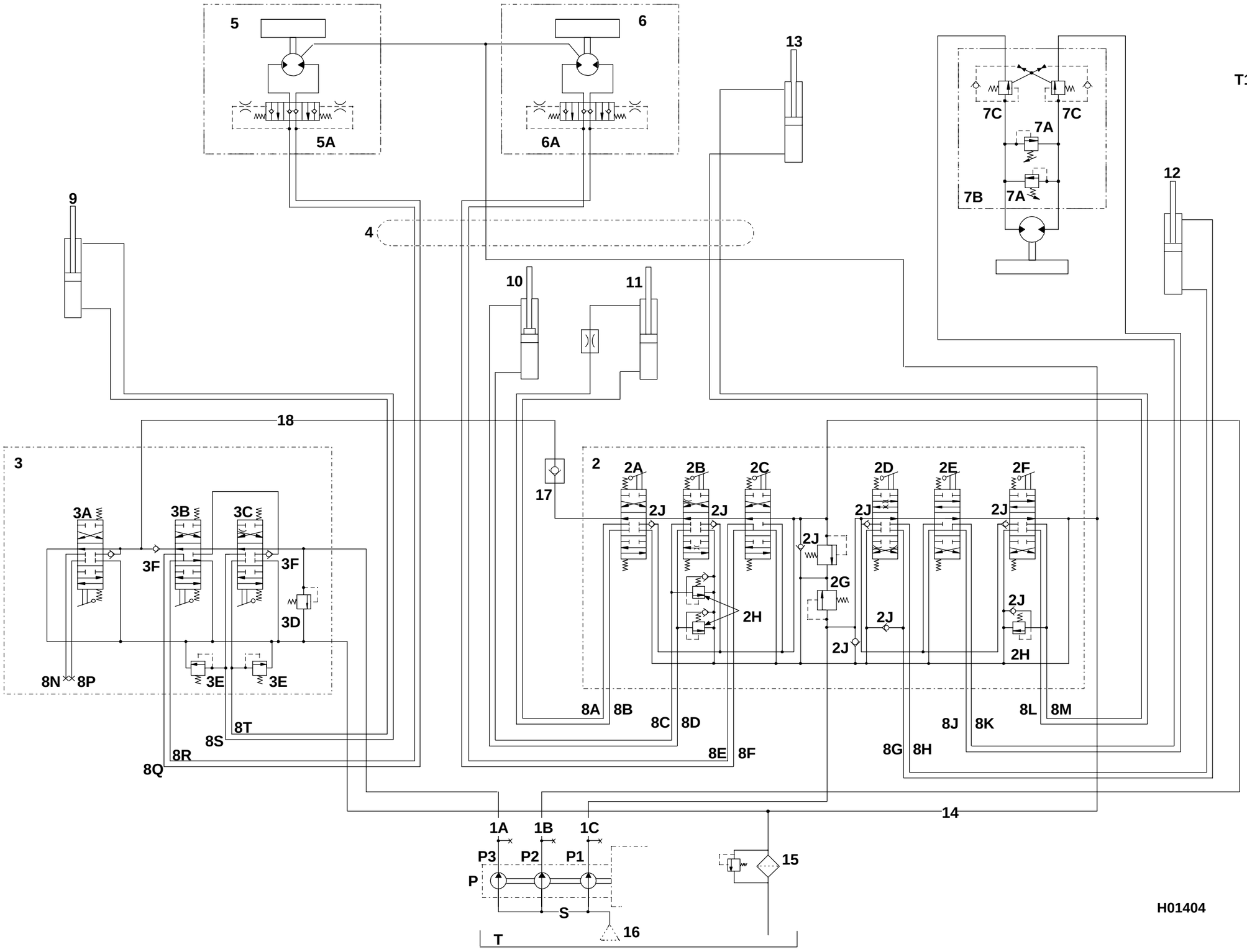
***Ram Speed at max. engine revs.**	**801.4 Cable Machines & 801.5 to M730030**	**801.6**
- Boom Up (excluding end damping)	3.3 sec.	3.2 sec.
- Boom Down	4.5 sec.	3.87 sec.
- Dipper In	3.7 sec.	3.76 sec.
- Dipper Out	2.4 sec.	2.76 sec.
- Bucket Open	2 sec.	2.15 sec.
- Bucket Crowd	2.8 sec.	2.79 sec.
- Dozer Up	1.8 sec.	1.57 sec.
- Dozer Down	2.3 sec.	2.17 sec.
- Slew (5 rev.)	34.5 sec.	N/A
- Tracking (25m)	44.7 sec.	N/A
- Swing (60°) L to R	4.3 sec.	4.72 sec.
- Swing (60°) R to L	4.1 sec.	5.04 sec.

***Slew Piston Motor (to M721136, 801.4 - M730003, 801.5 - M728056, 801.6) & Track Motor Leakage Test Data.**

Conditions of test	
- Oil temperature	50°C
- Services	Neutral
Acceptable rotation of track sprocket	1 revolution in 7 minutes, 15 seconds
Acceptable rotation of superstructure	1 revolution in 3 minutes

***Slew Motor (from M721137 801.4 - M730004 801.5 - M728057 801.6)**

Reduction Gearbox	Output torque 30 kgf m max.
	Output shaft speed 57 rev/min max.
	Gear reduction ratio 1:7.9
Hydraulic Motor	Capacity 20 cc/rev.
	Operating pressure 140 kgf/cm²
	Hydraulic motor speed 451 rev/min max.
	Flow rate 9.3 litre/min.
Cross-line Relief Valve	Working pressure 155 kgf/cm² max.
	Overload relief setting 140 kgf/cm²



Component Key

P1 Pump Section 1
P2 Pump Section 2
P3 Pump Section 3
T Tank
***T1** Drain to Tank
S Suction Line
1A Neutral Circuit Lines
1B Neutral Circuit Lines
1C Neutral Circuit Lines
2 Control Valve (Rear)
2A Bucket Spool
2B Boom Spool
2C Track Spool
2D Swing Spool
2E Slew Spool
2F Dozer Spool
2G Main Relief Valves
2H Auxiliary Relief Valves
2J Load Hold Check Valves
3 Control Valve (Forward)
3A Auxiliary Spool
3B Track Spool
3C Dipper Spool
3D Main Relief Valve
3E Auxiliary Relief Valves
3F Load Hold Check Valves
4 Rotary Coupling
5 L.H. Track Motor
5A Counterbalance Valve
6 R.H. Track Motor
6A Counterbalance Valve
***7** Slew Motor - 801.4 to M721136
801.5 to M730003, 801.6 to M728056
***7A** Crossline Relief Valve
***7B** Slew Motor - 801.4 M721137 on
801.5 M730004 on, 801.6 M728057 on
***7C** Start Up Valve
8A/8T Service Lines
9 Dipper Ram
10 Boom Ram
11 Bucket Ram
12 Swing Ram
13 Dozer Ram
14 Return Line
15 Return Filter
16 Suction Strainer
17 Non-return Valve
18 High Pressure Carry Over Line

Description

The 1.4 Tonne mini-excavator hydraulic circuit is fed from a 30 litre (6.6 UK gal) capacity tank, **T**, located in the operator's cab on the right hand side of the seat.

The system is powered by a three section gear pump, **P**, mounted directly to the engine crankshaft.

When the engine is running the pump draws fluid from the tank and routes it through a twin inlet on the rear valve block, **2**, this valve block comprises six operating sections.

Pump section **P1** supplies valve block **2** the control sections for:
- Swing ram **12**
- Slew motor **7**
- Dozer ram **13**

Pump section **P2** supplies valve block **2** the control sections for:
- Right hand track motor **6**
- Boom ram **10**
- Bucket ram **11**

P2 is also routed from valve block **2** via. a HPCO to valve block **3** for the Auxiliary service.

Pump section P3 supplies valve block **3** the control sections for:
- Dipper ram **9**
- Left hand track motor **5**

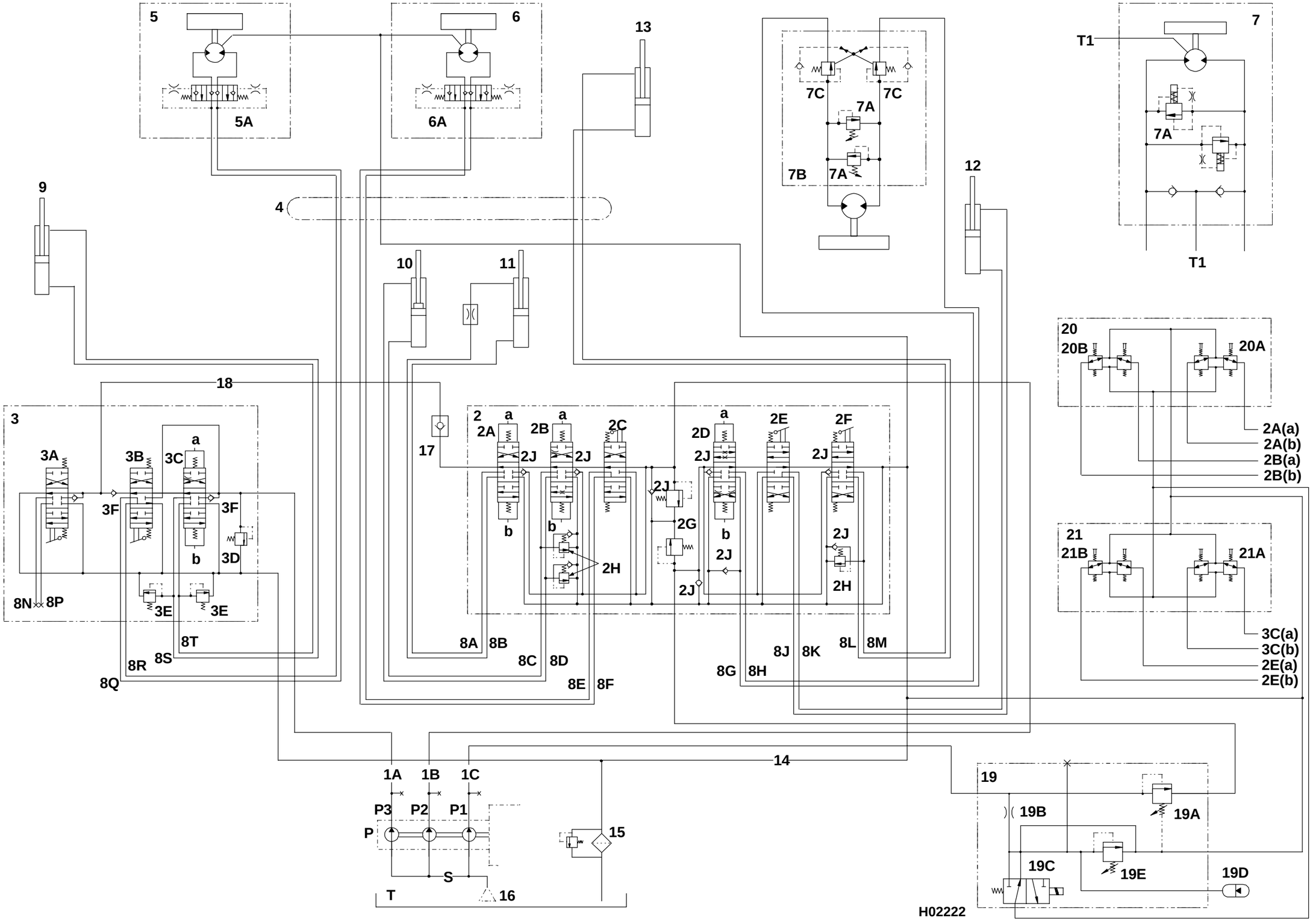
Main relief valves (MRV) **2G** and **3D**, fitted to the inlet sections of the control valves dump over-pressure fluid through the control valve exhaust chamber to tank **T**.

Auxiliary relief valves (ARV) **2H** and **3E,** are fitted to protect the dipper, boom and dozer rams from damage that might be generated through over pressure conditions during operation.

When ARV's are open, over pressure fluid is routed to the control valve exhaust chamber and back to tank.

The service lines **8L** and **8M** to the dozer ram, **8Q**, **8R, 8E** and **8F** to the track motors are routed through a rotary coupling **4**.
This allows the machine superstructure to turn without causing damage to hose connected services mounted on the undercarriage.

The remaining service lines connect directly to their relevant devices. Return fluid from services or from the neutral pressure circuit is routed back to tank through exhaust line **14** and return filter **15**.



Component Key

P1 Pump Section 1
P2 Pump Section 2
P3 Pump Section 3
T Tank
***T1** Drain to Tank
S Suction Line
1A Neutral Circuit Lines
1B Neutral Circuit Lines
1C Neutral Circuit Lines
2 Control Valve (Rear)
2A Bucket Spool
2B Boom Spool
2C Track Spool
2D Swing Spool
2E Slew Spool
2F Dozer Spool
2G Main Relief Valves
2H Auxiliary Relief Valves
2J Load Hold Check Valves
3 Control Valve (Forward)
3A Auxiliary Spool
3B Track Spool
3C Dipper Spool
3D Main Relief Valve
3E Auxiliary Relief Valves
3F Load Hold Check Valves
4 Rotary Coupling
5 L.H. Track Motor
5A Counterbalance Valve
6 R.H. Track Motor
6A Counterbalance Valve
***7** Slew Motor - 801.4 to M721136
801.5 to M730003, 801.6 to M728056
***7A** Crossline Relief Valve
***7B** Slew Motor - 801.4 M721137 on
801.5 M730004 on, 801.6 M728057 on
***7C** Start Up Valve
8A/8T Service Lines
9 Dipper Ram
10 Boom Ram
11 Bucket Ram
12 Swing Ram
13 Dozer Ram
14 Return Line
15 Return Filter
16 Suction Strainer
17 Non-return Valve
18 High Pressure Carry Over Line
19 Servo Pressure Control Valve
20 Hand Controller, RH
21 Hand Controller, LH

Servo Circuit Description

Flow from pump **P1** enters servo pressure control valve **19** where its path is momentarily blocked by maintenance valve **19A.** This immediately pressurises the pump, which on reaching the preset value of **19A** will open it, allowing full pump flow to supply the neutral circuit of the slew, swing and dozer spools. Pressure at the pump however, will be held by valve **19A** to the required servo operating pressure. This maintained pressure is sensed via. restrictor **19B** to the servo isolator solenoid **19C**, retained until the solenoid is energised which pushes the spool across against its return spring allowing the pressure to cross the spool and feed the hand controllers **20** and **21**. Plungers **20A, 20B, 21A** and **21B** in the hand controllers meter this pressure to progressively select the required excavator spool as the machine is operated. An optional servo accumulator **19D** is available to store servo pressure, this pressure may be used to vent trapped pressure from the system with the engine stopped, or as a safety measure to enable the excavator end to be lowered to the ground in the event of an engine failure.

When either the slew, swing or dozer service is selected, pump **P1** will be pressurised to the demands of that circuit. Because this system pressure is likely to be much higher than the requirements of the servo, it is necessary to install a servo protection MRV item **19E,** to limit the pressure transmitted to the hand controllers **20** and **21.** This MRV senses the pressure via. restrictor **19B**, opens and remains open whilst pump **P1** is pressurised by the excavator circuit, to vent away excess pressure to tank.

For description of main hydraulic circuit, see page 2-2.

WARNING

Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for small leaks. Hold a piece of cardboard close to the suspected leak and then inspect the cardboard for signs of hydraulic fluid. If hydraulic fluid penetrates the skin, get medical help quickly.

HYD001

Checking the Fluid Level

1 Prepare the Machine

(a) Park the machine on level ground with the rams positioned as shown.

(b) Stop the engine and remove the starter key.

2 Check the Level

(a) Check the level indicator inside the cab.

3 Gain Access to the Hydraulic Tank
*(on machines with inside the cab filling)

(a) Pull out the access panel **A**.

4 Add Fluid

(a) If necessary, remove the filter cap **B** and add fluid. Ensure that only correct grade of fluid is used (see **Section 3, Lubricants & Capacities**).

***5 Refit the Filter Cap**

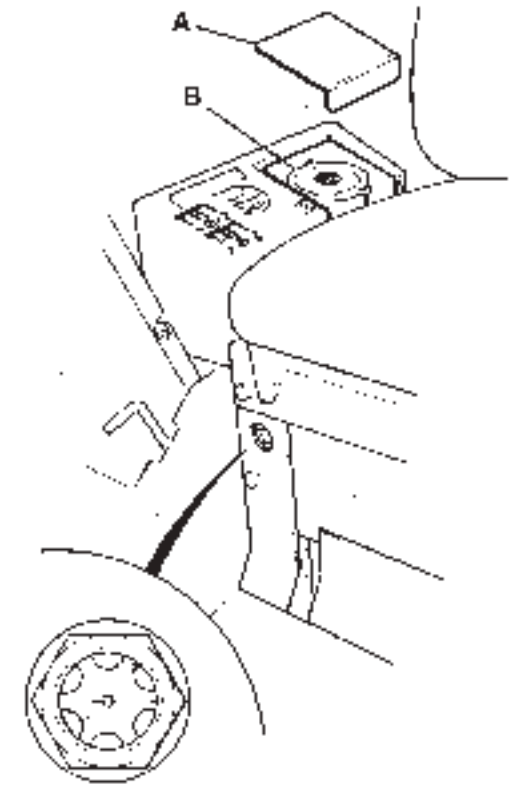
Screw down type
(a) Tighten to 25 Nm. Refit access panel.

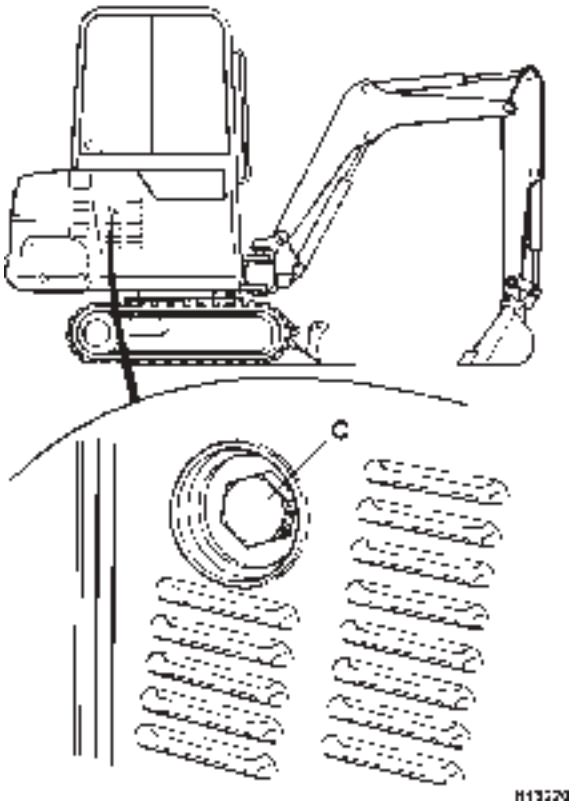
Three screw type
(a) Ensure filter tension spring locates in lugs on filter cap. Replace the three capscrews and refit access panel.

On machines with external filler.

(a) Ensure the area around the filler is clean. Remove the hexagonal filler nut **C** and add fluid. Ensure that only correct grade of fluid is used (see **Section 3, Lubricants & Capacities**).

(b) Refit the filler nut.





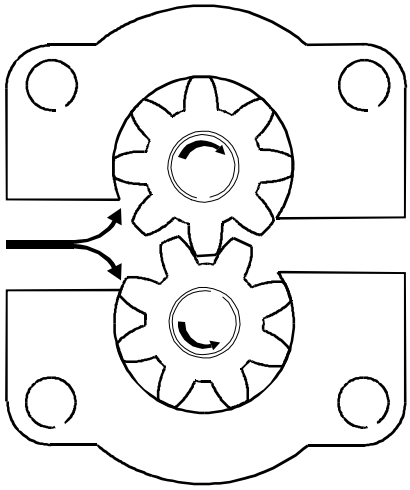
Description

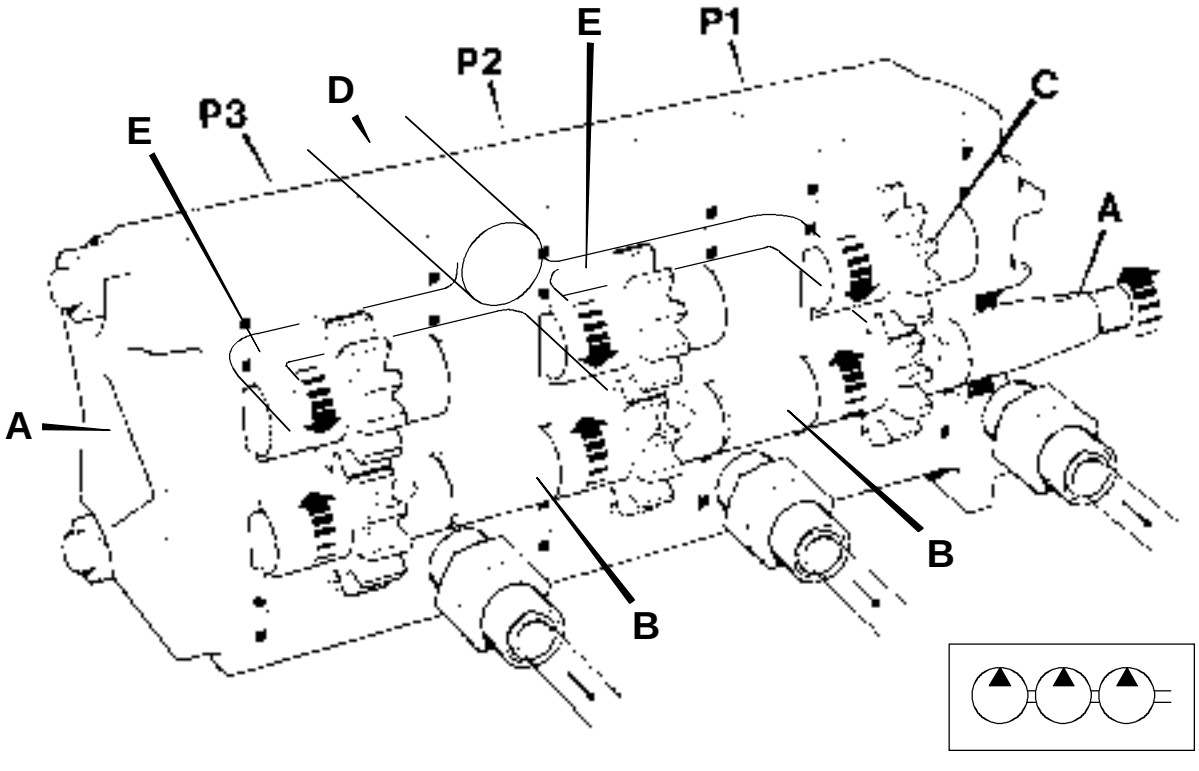
The three section gear pump **A** is driven directly from the engine crankshaft. All three gear pump drive shafts **P1, P2** and **P3** are linked together via a splined coupling **B.**

Each pump consists of two equal sized gears **C** running in mesh, one gear is part of the pump driven shaft and the second gear is part of an idler shaft.

The basic principle of a gear pump depends on the meshing of these two equal size spur gears **C.** On the inlet side of the pump, oil is picked up and trapped in the space between the teeth on both gear wheels and the pump body. As the gears rotate the oil is carried around the pump until the spaces are filled by the meshing teeth of the second gear. This forces the oil out of the space, through the pump outlet and into the machine's hydraulic circuit.

The three section pumps fitted to the JCB 801.4, 801.5 and 801.6 machines have a single inlet port **D** to the centre pump section, the two end pumps are fed via an internal gallery **E**.





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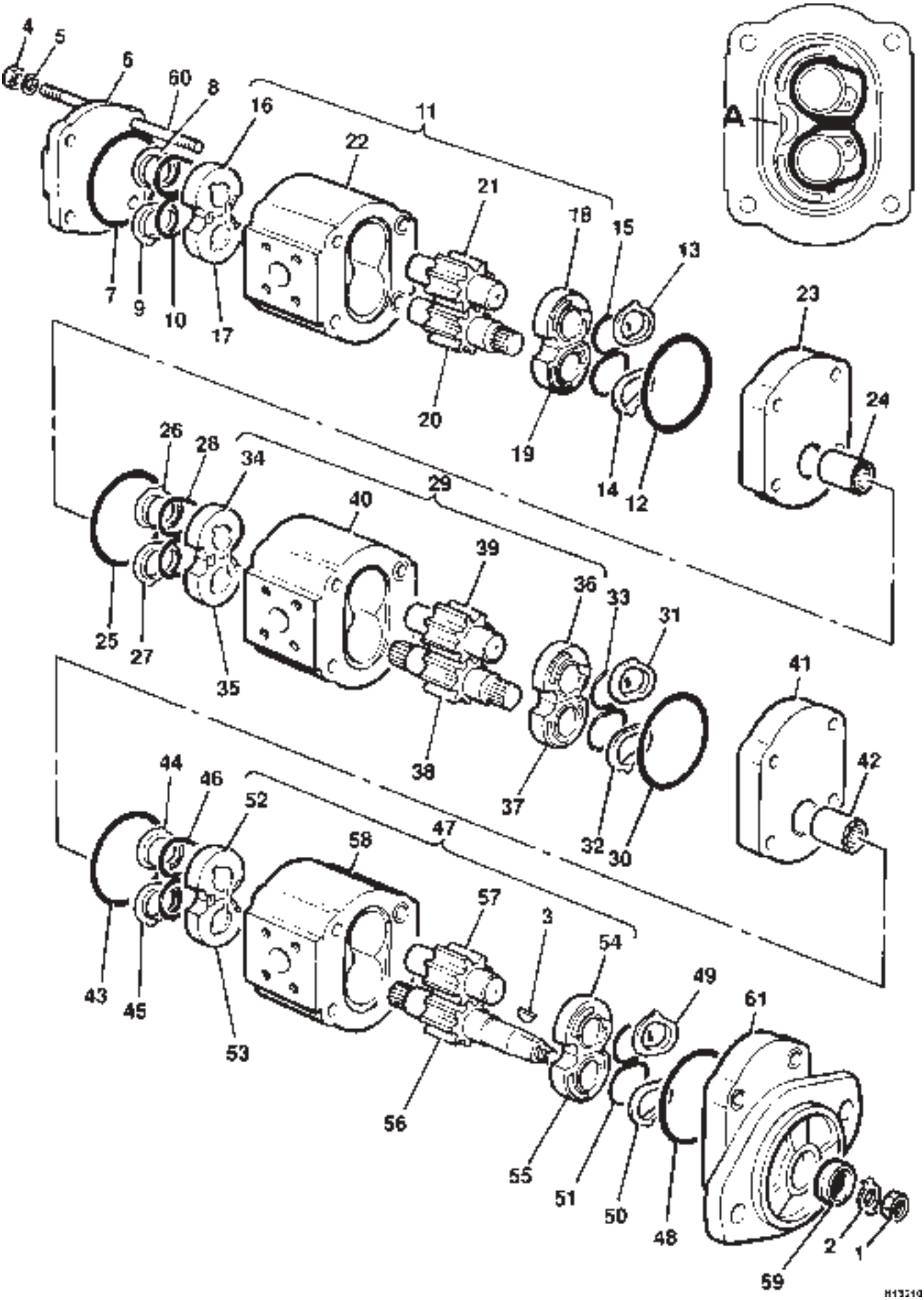


Dismantling and Assembly

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

When Dismantling

Note: *Before starting, lightly mark the pump sections, flange and end cover to ensure correct alignment on re-assembly.*

Use a soft-faced hammer to separate the pump sections but do not hammer the coupling off the shaft as this will result in internal damage. Do not use levers of any kind to separate pump components.

Bushes **16 - 19**, **34 - 37** and **52 - 55** must be marked to denote their location within the body. Do not dismantle sub-assemblies **11**, **29** or **47** until this has been done.

Note: *The bushes are split into two halves, e.g. items **16** and **17**. Each half must be individually marked to ensure correct re-assembly.*

Remove bushes, gears and seals, keeping components of each section of the pump together in their relative positions.

Note: *Replacement pump sections are available.*

Inspection

Bodies **22**, **40** and **58** can only be re-used if the 'cut-in' (where the gears wipe into the body) is bright and polished in appearance and the depth does not exceed 0.076 mm (0.003 in.)

Ensure that the end cover, spacer plates and flange are free from damage which could result in oil leakage in the region of the seal contact faces.

If the shaft seal bore is worn, Loctite hydraulic sealant should be applied to the outside diameter of the seal.

The bushes must be perfectly flat on the faces which contact the gear side faces. The bearing bores must be free from scoring or other damage. The outside of the bushes should not show any prominent signs of wear.

Gear side faces, teeth and journals must be free from scoring, wear steps, bruising or pitting.

When Assembling

Renew all seals and 'O' rings.

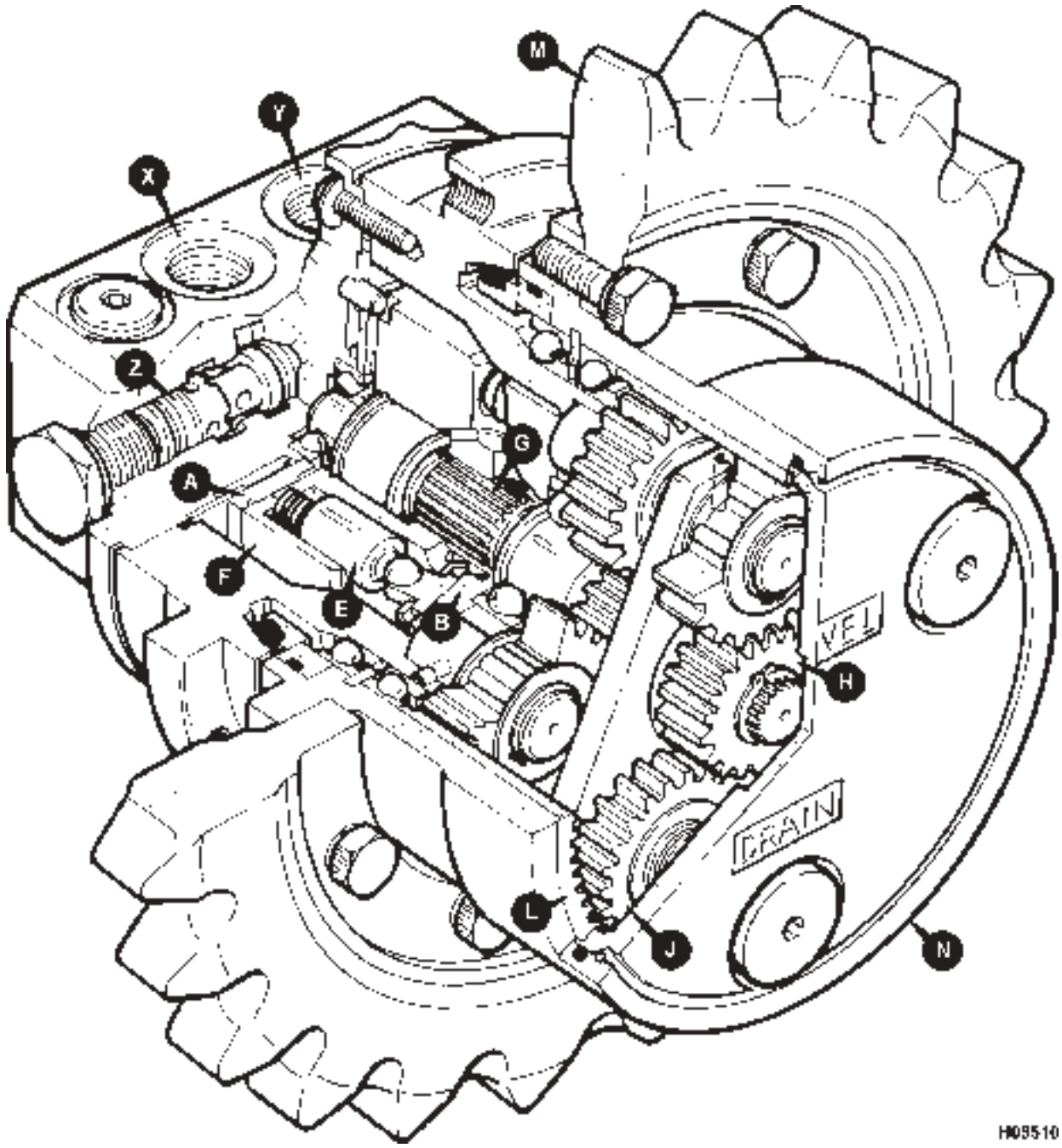
If refitting used components, ensure that they are fitted in their original positions.

When fitting bushes, ensure that the 'C' shape, formed by two mating bushes, is located against the flat in the body, as shown at **A**.

Fit seal **59** with its spring inwards.

Tighten nuts **1** and **4** to the torque settings given in Section 1.

After assembly, pour a small amount of hydraulic oil into each outlet port and check that the shaft can be rotated without undue force, using a smooth jawed hand wrench hooked around the shaft or a suitable half coupling locked against the key.



Operation

General

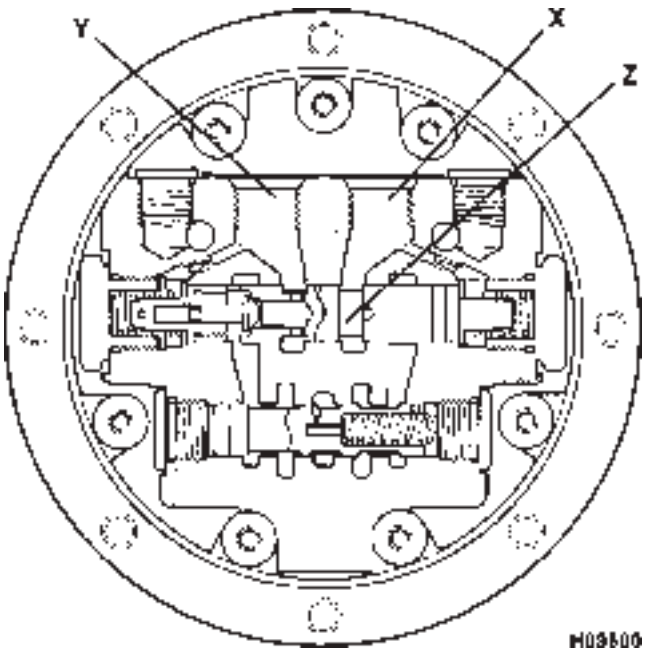
The track motor and gearbox assembly consists of a hydraulic motor and valve unit, and a two-stage planetary speed reduction.

When travel is selected, the pump feeds the respective track motors via the selected spools and the rotary coupling.

The motor valve plate **A** has two sets of ports which are connected to the motor inlet and outlet lines via the counterbalance plunger **Z**. When pressurised fluid is introduced through **A**, pistons **E** on one side are forced against the swash plate **B**.

Reaction force from the swash plate generates radial force causing rotation of the cylinder block **F**. Torque generated at the cylinder block is transmitted to the output shaft **G** through splines on the cylinder block.

The outer end of the output shaft carries a sun gear **H** which drives two sets of planetary gears **J** and **K**. These reduce output speed in two stages and transmit rotation to the ring gear **L** which in turn drives sprocket **M** via motor casing **N**.



Normal Operation

When travel is selected, pressure is fed from the main pump to one of the motor control valve ports, either **X** or **Y** depending on the direction of travel. Each port provides a restricted feed to either end of plunger **Z** via a small drilling from the port into the plunger bore. Pressure from the inlet port causes the plunger to move across, allowing flow to enter the motor. Oil is returned through the other port back to the tank.

Counterbalance Operation

When the machine is running down an incline its rate of descent must be kept within safe limits. Under such conditions the motor tends to overspeed, acting as a pump, increasing outlet pressure and lowering inlet pressure.

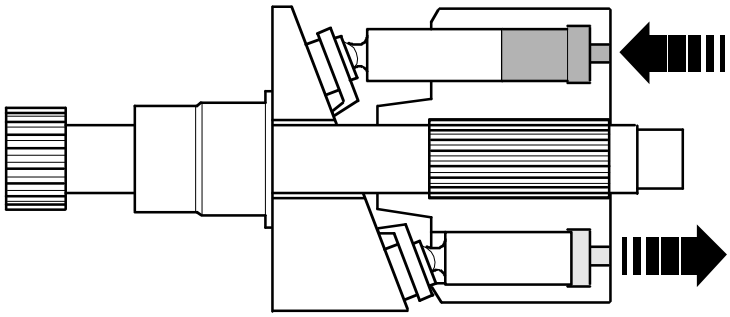
Differential pressures acting on the ends of plunger **Z** via the small drillings from the ports cause the plunger to move back and restrict flow from the counterbalance valve. This prevents the motor from excessively overspeeding thus keeping the machine travel speed under control.

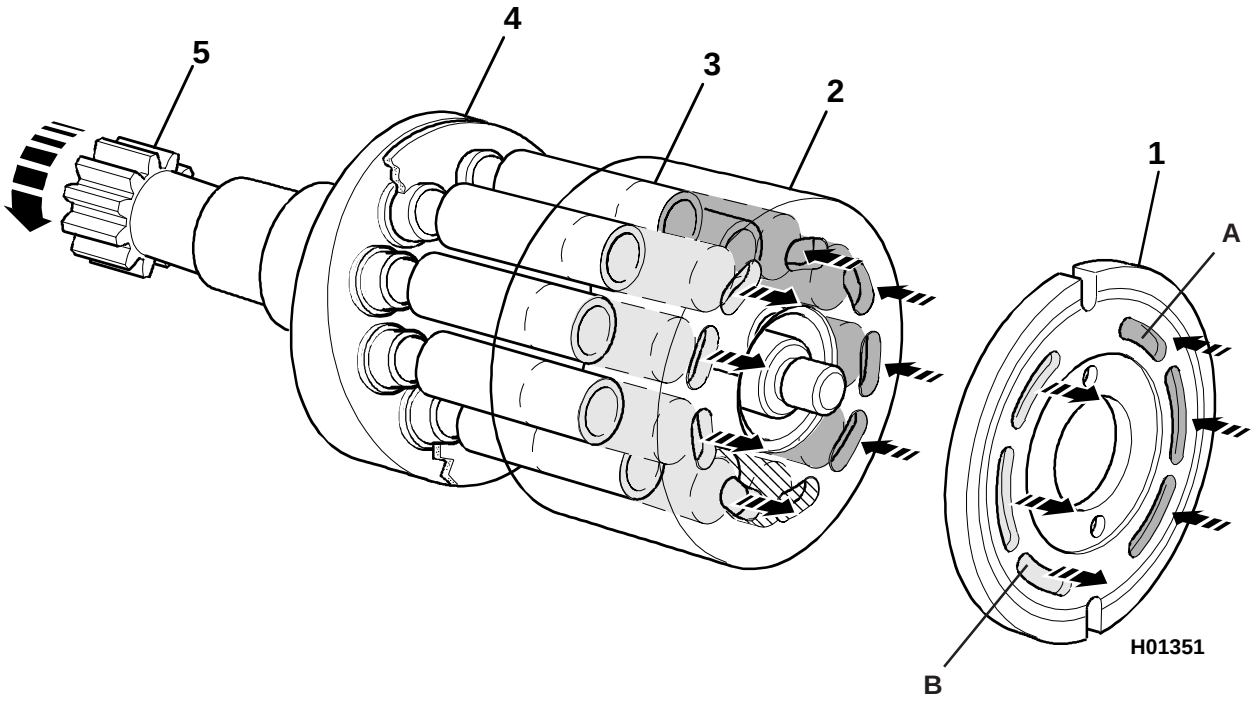
Braking

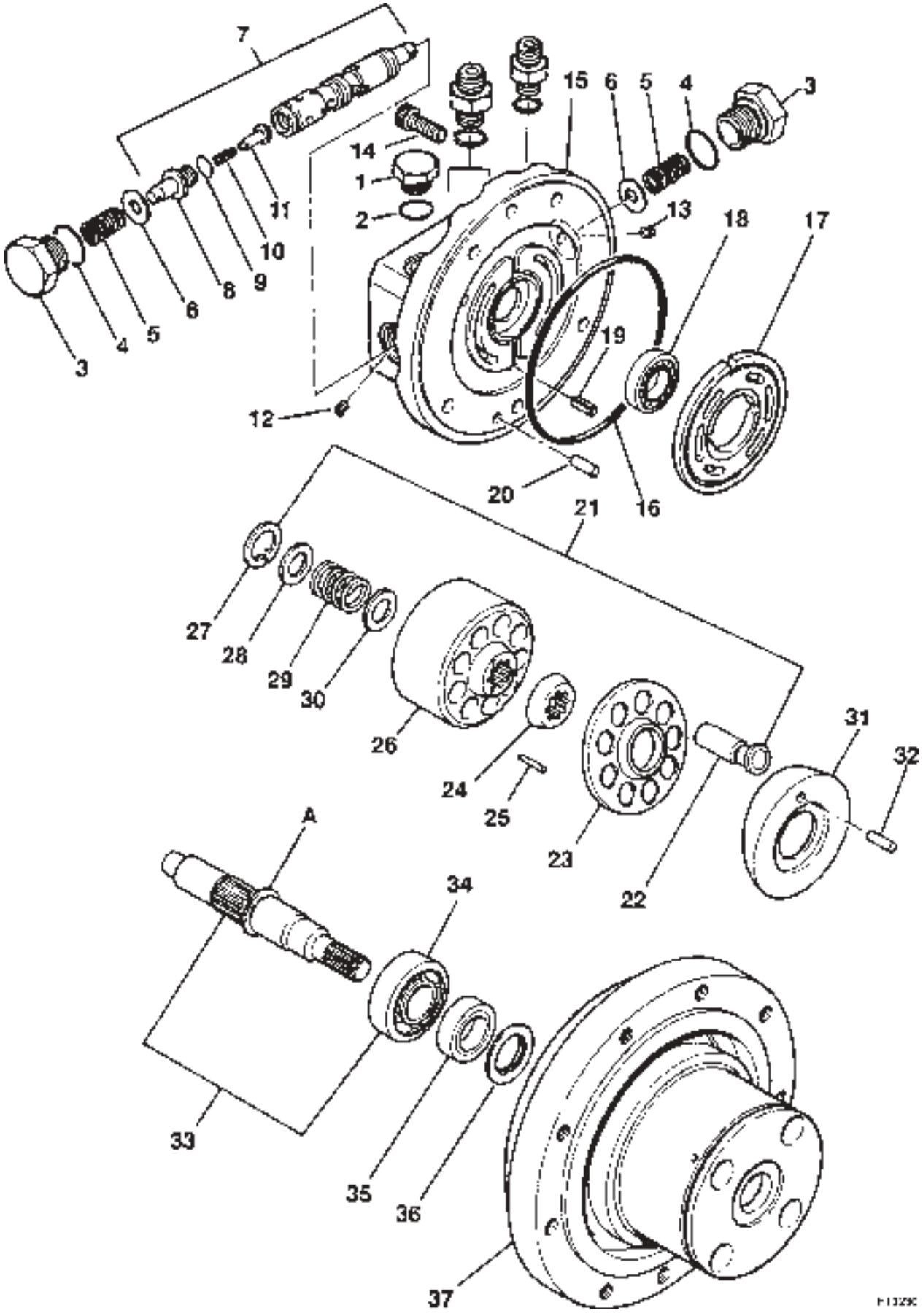
When the control valve is reset to neutral, ports **X** and **Y** are connected to the tank return line. Pressure on both ends of the plunger is reduced to exhaust value and the plunger is re-centred. The metering notches on the plunger gradually limit the flow of return fluid from the motor and machine speed is smoothly reduced.

*Operation (cont'd)

Hydraulic oil enters the motor via the counter balance valve (page E6-2). From the counterbalance system the pressurised flow passes through three of the six slots **A** in fixed valve plate **1** and reacts against the crowns of piston **3** located in cylinders of rotating barrel **2**.
The pressurised oil pushes the pistons down and the slipper pads fitted to the base of the pistons, slide on the angle face of fixed swash plate **4**.
As the barrel is driven round, it is splined to and rotates the drive shaft of sun gear **5** which inputs the drive to the track gearbox. The pistons then reach bottom dead centre, their oil port is first masked by valve plate **1** and then aligns with the first of the remaining three slots **B** which connects the oil in the cylinders with the return line to tank.
This allows the barrel to continue to rotate and as the pistons are pushed back up the cylinders, the oil above them is displaced to tank.
When the operator selects reverse drive, then the oil under pressure enters slots **B** in the valve plate, the pistons are pushed down their cylinders and the barrel and drive shaft rotate in the opposite direction.







Dismantling and Assembly - Early machines

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

When Assembling

Renew 'O' rings **4, 9** and **16**, spring pin **19** and oil seal **35**.

Before fitting the oil seal **35**, fill the inside of the lip with grease and ensure that the seal support **36** is in position.

Press fit bearing **34** onto the shaft until it abuts shoulder **A**.

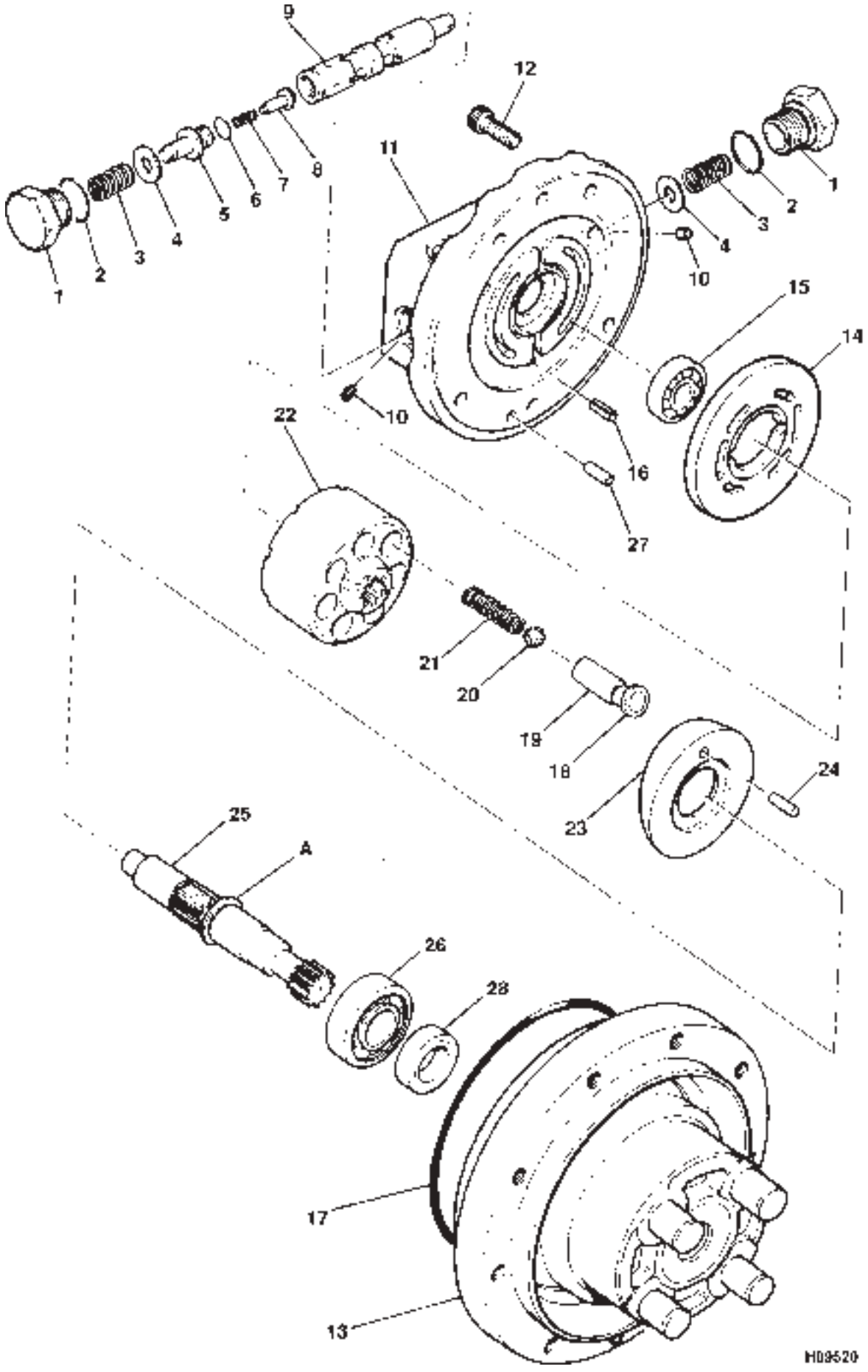
Ensure that the oil seal is not damaged by the shaft splines when entering the shaft and bearing assembly. **33**.

Before fitting the body **15** to body **37**, pour hydraulic fluid into body **37**.

After fitting restrictors **12** and **13**, centre-punch them to prevent loosening.

Torque Settings

Item	Nm	kgf m	lbf ft
3	170 - 200	17 - 20	125 - 150
4	25 - 32	2.5 - 3.0	18 - 24



Dismantling and Assembly - Later machines

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

When Assembling

Renew 'O' rings **2, 6** and **17**, spring pin **16** and oil seal **28**.

Before fitting the oil seal **28**, fill the inside of the lip with grease.

Press fit bearing **26** onto the shaft **25** until it abuts shoulder **A**.

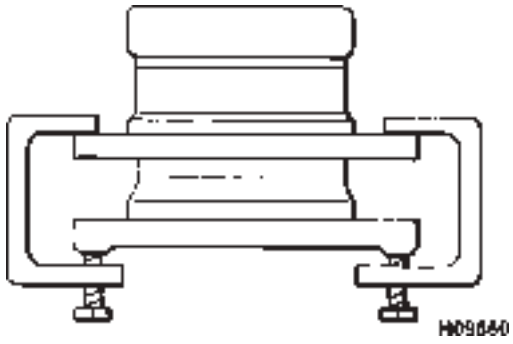
Ensure that the oil seal is not damaged by the shaft splines when entering the shaft and bearing assembly.

Before fitting the body **11** to body **13**, pour hydraulic fluid into the motor side of body **13**.

When assembling the gearbox to the track motor, compress the floating seat seal with 'G' clamps as shown.

Note: *When clamping, do not exceed a force of 4000N (890 kgf).*

After fitting restrictors **10**, centre-punch them to prevent loosening.



Torque Settings

Item	Nm	kgf m	lbf ft
1	170 - 200	17 - 20	125 - 150
12	77	7.8	56.8

Slew Motor

(801.4 to M721136, 801.5 to M730003, 801.6 to M728056)

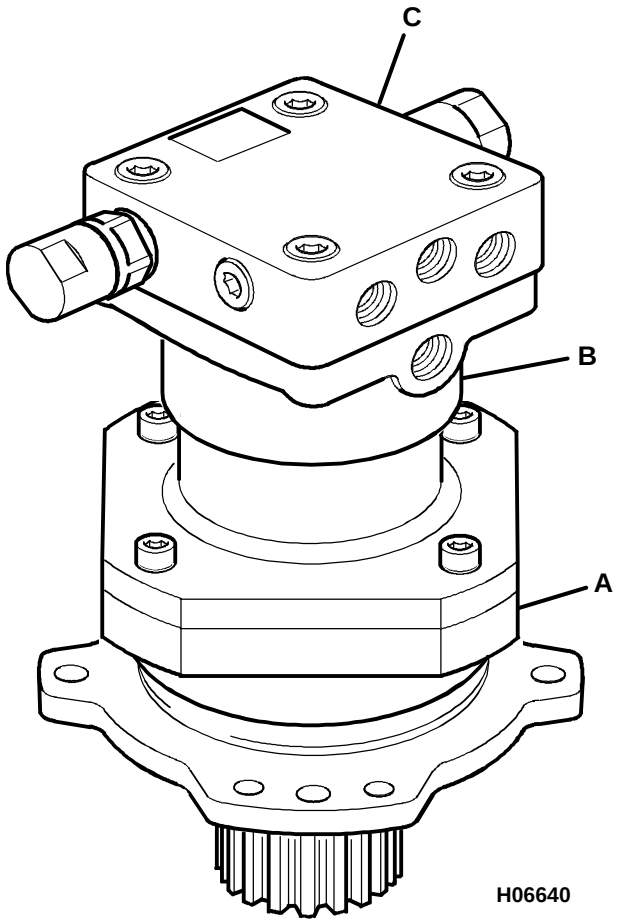
Description

The slew motor consists of a reduction gearbox **A**, hydraulic motor **B** and hydraulic cross-line relief valve assembly **C**.

The hydraulic motor is an axial piston type and converts hydraulic energy supplied from the hydraulic pump into a rotary motion.

The hydraulic valve consists of cross-line relief valves, which in conjunction with a D/A spool fitted to the valve block prevents the hydraulic motor from becoming overloaded and ensures that the inertia produced when stopping the machine is absorbed through the cross-line relief valves producing a smooth machine stop.

The gearbox is a single step planetary type, the gearing converts high speed rotary motion from the hydraulic motor into low-speed high torque transmitted to the pinion shaft.



Slew Gearbox

Removal and Replacement (typical)

WARNING

Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for small leaks. Hold a piece of cardboard close to the suspected leak and then inspect the cardboard for signs of hydraulic fluid. If hydraulic fluid penetrates the skin, get medical help quickly.

HYD001

When Removing

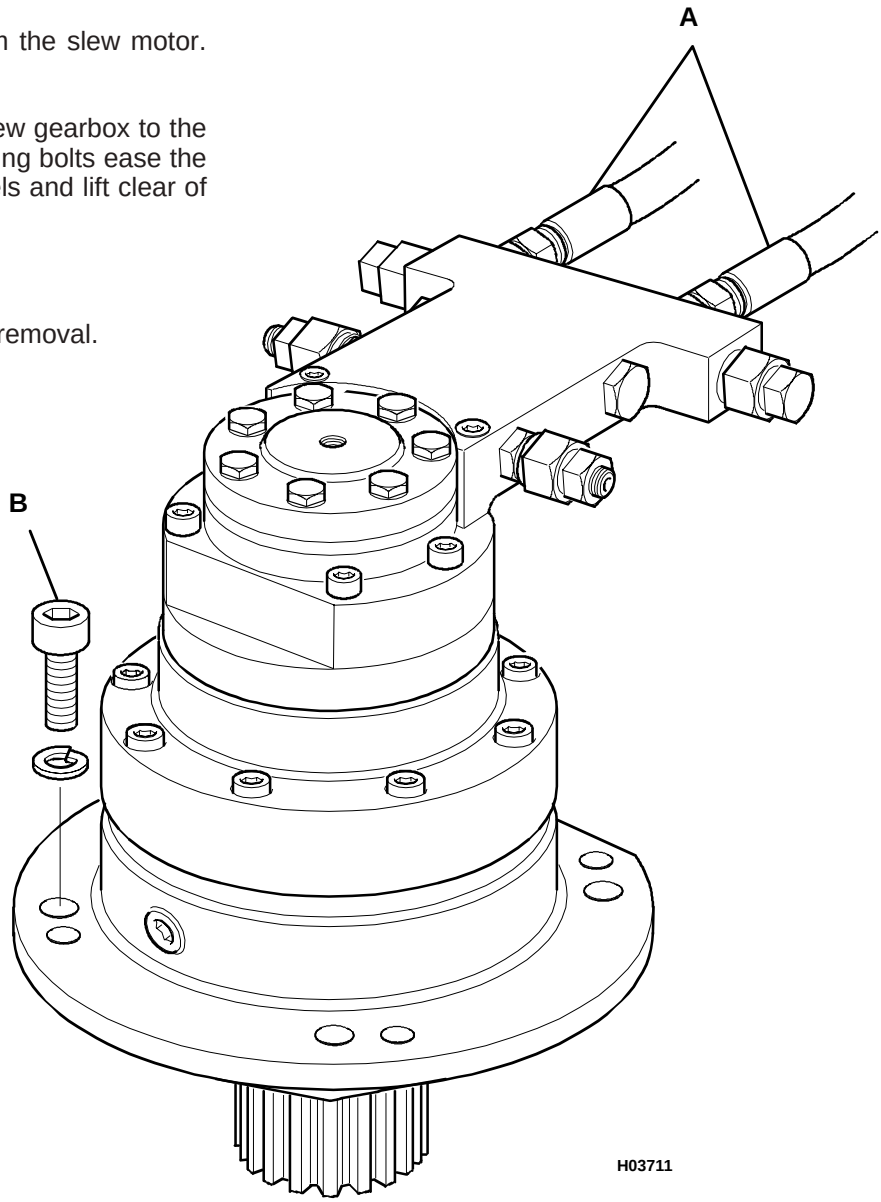
1 Vent residual pressure from within the hydraulic tank by releasing the tank filler cap. Remove seat, floor matting and floorplates as required to gain access to the slew motor.

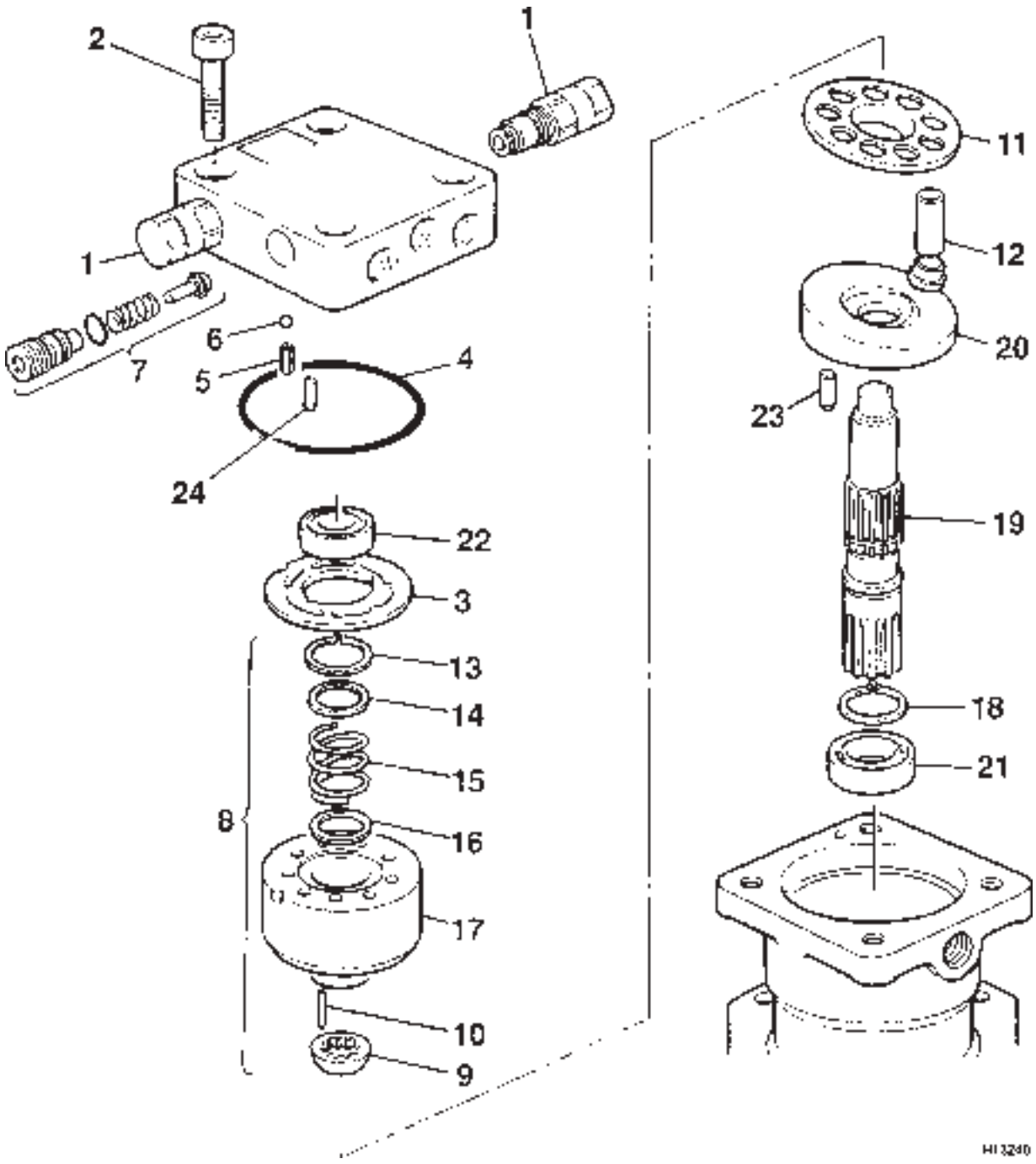
2 Remove hydraulic hoses **A** from the slew motor. Blank off the hoses and ports.

3 Remove bolts **B** securing the slew gearbox to the slew frame. Using two M12 jacking bolts ease the gearbox from its mounting dowels and lift clear of the machine.

When Replacing

1 Replace in the reverse order of removal.





Slew Motor

(801.4 to M721136, 801.5 to M730003, 801.6 to 728056)

Dismantling

Remove both relief valves **1** from the motor.

Unscrew the four retaining screws **2** securing the motor head to the reduction gear assembly.

Remove the valve plate **3** and 'O' ring **4.** Remove the roll pin **5** and ball bearing **6**. Remove the check valves **7**.

Remove the cylinder barrel assembly **8** from the motor shaft **19**.

Remove the barrel holder **9** and the three locating pins **10**.

Remove the shoe holder **11** and pistons **12.**

*Remove the circlip **13**,collar **14**,spring **15** and retainer **16** from the barrel **17**.

Remove circlip **18**, shaft assembly **19**, swashplate **20** and bearings **21** and **22**.

Remove both locating pins **23** and **24**.

*Thoroughly clean all parts in solvent before assembly to ensure they are free from foreign matter, O ring seals must be re-newed.

Assembly

Insert the locating pin **23** into the flange.

Press the ball bearing **21** inner race onto the shaft until it abuts the snap ring.

Place the swashplate **20** over the long spline of the shaft **19** and locate its recess over the outer ball bearing race.

Fit the bearing/swashplate/shaft assy into the body locating the bearing in its housing. Ensure the swashplate **20** is fully engaged with its locating pin **23**.

Assemble the retainer **16**, spring **15** and collar **14** in to the cylinder barrel **17**, secure them with the snap ring **13**.

Attach the piston **12** and shoe assemblies to the shoe holder **11**.

Insert three pins **10** into the cylinder barrel and locate the flat face of the barrel holder **9** onto the exposed ends of the pins.

Fit the shoe holder assembly to the cylinder barrel.

Engage the cylinder barrel assembly with the motor shaft and slide into the body until all of the piston shoes contact the swashplate.

Assemble an 'O' ring, spring and poppet onto a check valve **7** and fit into the two ports in the body, torque tighten to 120 Nm.

Press the roll pin and ball bearing into the body.

Apply grease to the recess of the body and locate a new 'O' ring **4**.

Fit the valve plate over the outer ball bearing race and locate it over the roll pin.

Assemble the motor body to the gearbox housing, engage the locating pin. Secure with four screws and torque tighten to 54 - 64 Nm.

Fit a relief valve assembly into each of the two ports in the motor body torque tighten to 150 Nm.

Slew Motor Operation

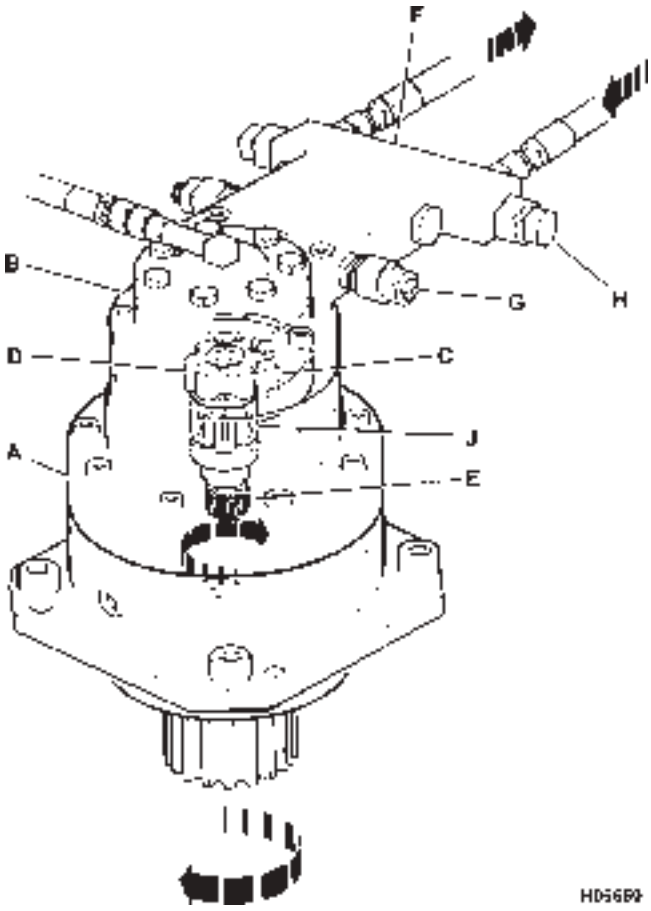
801.4 from M722497

360^{O} slew drive is achieved through an epicyclic reduction gearbox **A**, which is hydraulically driven by an Orbitrol motor **B**. This motor consists of an outer annulus which has seven lobes formed by rollers **C** located in recesses machined in the circumference of the motor cavity. Located inside the annulus is a six pointed rotor **D** which runs around inside the annulus describing an elliptical path. The rotor has a splined drive shaft **E** which locates in the sun gear of the epicyclic gearbox.

When the slew service is selected, pressurised oil enters the slew motor control valve **F**, which houses two start-up pressure valves **H** and two crossline relief valves **G** which hydraulically brake the motor when slew service is disengaged.

The start-up valve ensures that incoming pressure is sufficient to drive the slew in the direction selected even if the machine is positioned across an incline with the excavator end extended and the operator slews uphill. Once the start-up valve is open, the pressure is able via a system of machined galleries **J** in the sun gear shaft to enter and turn the motor to drive the slew. Exhaust oil from the motor leaves via a second set of sun gear galleries and returns to the slew spool.

As the slew service is released, the momentum of the slewing superstructure turns the motor into a pump. The free escape of this oil is prevented by the crossline relief valves **H**, inducing back pressure in the displaced oil. Whilst this pressure is high enough the crossline is held open allowing the oil to escape and the motor to keep turning. However, this back pressure slows the slew, reduces the momentum and consequently the back pressure until it is insufficient to hold the crossline valve open. The motor stops, held in place by oil trapped on either side by the crossline relief valves.



Slew Gearbox

801.4 from M722497

Motor Removal and Replacement

The slew motor may be removed without removing the gearbox complete from the machine.

Position the machine on firm level ground, rest the bucket on the ground and stop the engine.

Remove the cab/canopy floor plates to gain access to the slew gearbox.

Vent residual pressure in the hydraulic tank by releasing the filler cap.

To remove the motor, mark, disconnect and plug the two supply hoses and the motor drain hose **1**.

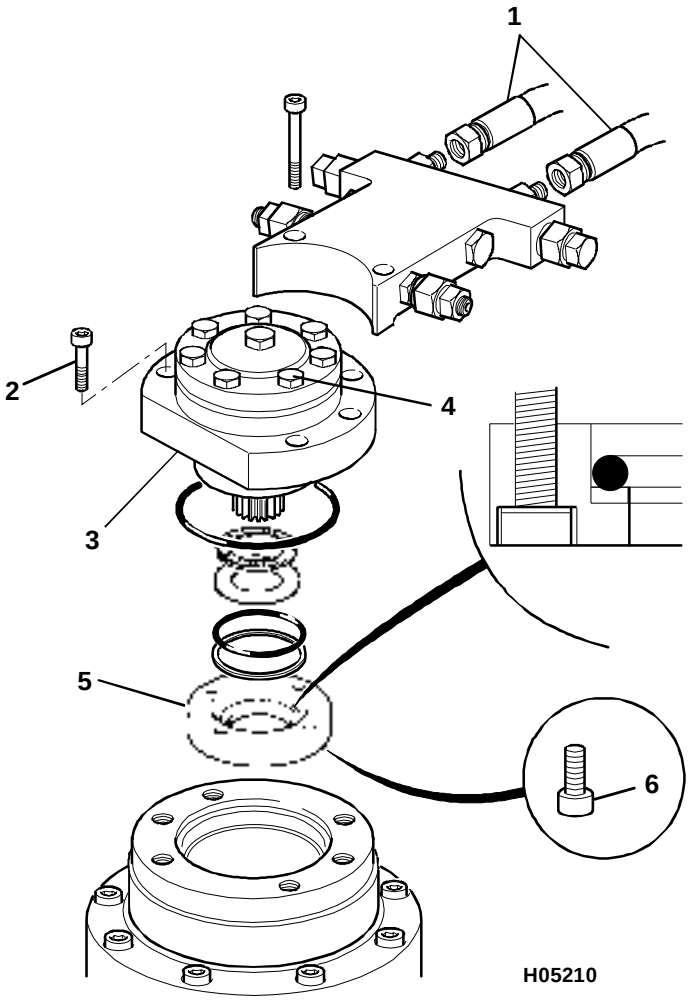
*****Note:** When the supply hoses are disconnected, there is a direct connection via the control valve spool to the hydraulic tank, consequently both hoses must be quickly plugged to prevent the hydraulic tank syphoning.*

Remove the six capscrews**2** holding the hydraulic motor **3** to the slew gearbox casing, including the long screws that hold the crossline relief valve assembly to the motor. Lift the motor clear.

*****Note:** Unless there is evidence of oil leaking past the motor top cover seals there is no need to remove the top bolts**4** as internal motor components other than 'O' rings are not renewable. If there is evidence of oil leaking from between motor sections, the 'O' rings sealing the joints may be renewed. However, the motor sections must be marked, as must the relationship between the rotor and centre shaft, this ensures correct motor timing will be maintained.*

To renew the motor shaft seal housing **5**, remove the four capscrews**6** retaining the housing. Replace the seal housing complete if it contains a lip seal, otherwise just the 'O' ring and back-up ring in the later housings may be renewed.

Refit capscrews **6** using Loctite 270 and torque tighten to 20Nm.



Track Motors and Slew Motor

***Slew Motors** **801.4 to M721136**
801.5 to M730003
801.6 to M728056

Fault		Probable Cause		Action
1	Motor fails to rotate	**1**	Abnormal wear or seizure of sliding parts.	Replace worn parts. Repair sliding surfaces or replace rotating parts sub-assembly.
		2	Damage to internal parts.	Replace rotating parts sub-assembly or motor assembly.
		3	Plunger of counterbalance valve sticking.	
			3.1 Overtightening.	Apply correct torque.
			3.2 Dirt in clearances.	Clean, repair scratching as necessary.
		4	Relief valve pressure too low.	
			4.1 Dirt in poppet seat or orifice.	Clean and/or replace relief valve sub-assembly
		5	Check valve sticking.	
			5.1 Dirt in valve seat, clearances or orifice.	Clean and/or replace plunger sub-assembly.
2	Low or uneven speed of rotation	**1**	Wear of sliding parts.	Repair sliding surfaces or replace rotating parts as necessary.
		2	Wear of bearings and/or splined parts.	Replace bearings and/or shaft. Replace rotating parts sub-assembly.
3	Creep speed high.	**1**	Increase of clearance between piston and bores.	Strip, check clearances, replace rotating parts sub-assembly as necessary.
		2	Damage to sliding surfaces.	Repair sliding surfaces or replace valve plate and/or rotating parts sub-assembly.
		3	Increase of clearance between:	Replace parts as necessary.
			3.1 Valve body and plunger.	
			3.2 Valve body and shockless piston.	

Track Motors and Slew Motor

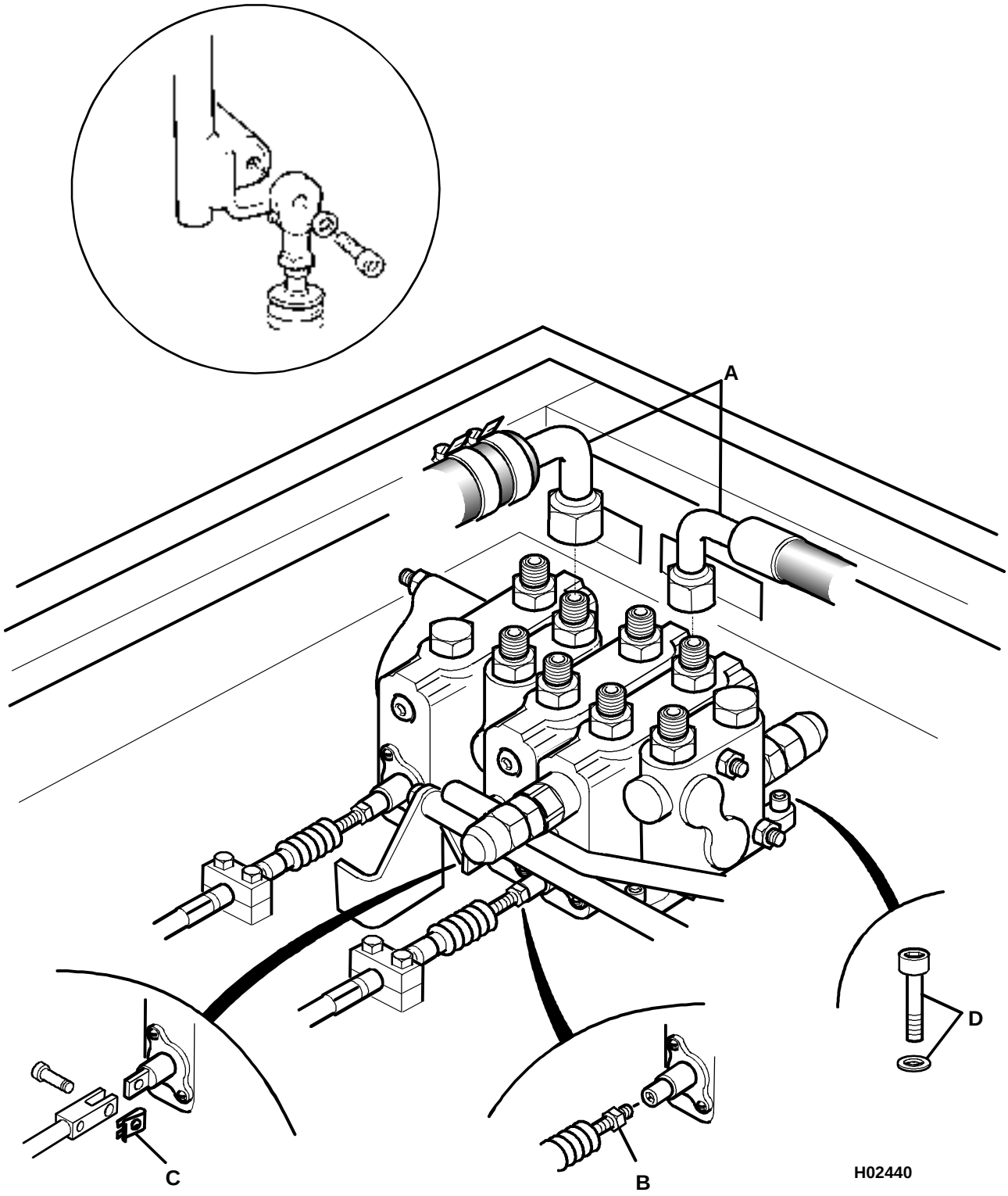
Mating Parts	Nominal Clearance	Allowable Clearance
Cylinder block bore and piston.	0.02 mm	0.05 mm
Valve body bore and plunger.	0.015 mm	0.03 mm
Valve body bore and shockless piston	0.015 mm	0.03 mm

		4	Dirt in valve seat of relief valve and/or check valve.	Strip and clean
4	Oil leaks from seals.	**1**	Damage to seals	Replace oil seals and/or 'O' rings.

Slew Motor

801.4 From M721137
801.5 From M730004
801.6 From M728057

Fault	Probable Cause	Action
1 Motor fails to rotate.	**1** Abnormal wear or seizure of sliding sliding parts.	Replace motor components.
	2 Damage to internal parts.	Replace motor components.
	3 Start up valves inoperative.	Renew valve housing complete.
	4 Relief valve pressure too low.	Pressure test.
	4.1 Dirt in poppet seat or orifice.	Clean and/or replace relief valve housing complete.
	5 Check valve sticking.	
	5.1 Dirt in valve seat, or orifice.	Clean and/or replace relief valve housing complete.
2 Low or uneven speed of rotation.	**1** Motor timing lost.	Renew motor complete.
	2 Wear of bearings and/or splined parts.	Replace bearings and/or shaft. Replace rotating parts sub-assembly.
3 Creep speed high.	**1** Orbitrol motor leakage	Renew motor complete.
	2 Internal leakage in:	
	2.1 Crossline relief valves.	Renew valve housing complete.
	2.2 Start-up valves.	Renew valve housing complete.
	2.3 Dirt in valve seat of relief valve.	Check valve. Renew valve complete if necessary.
4 Oil leaks from seals.	**1** Damage to seals.	Replace oil seals and/or O-rings as necessary.



Forward Valve

Removal

WARNING

Fine jets of Hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for suspected leaks. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.

HYD001

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.
Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN001

1 Undo and plug the feed and return hoses to the hydraulic tank.

2 Remove the swing pedal.

3 Remove the floor matting

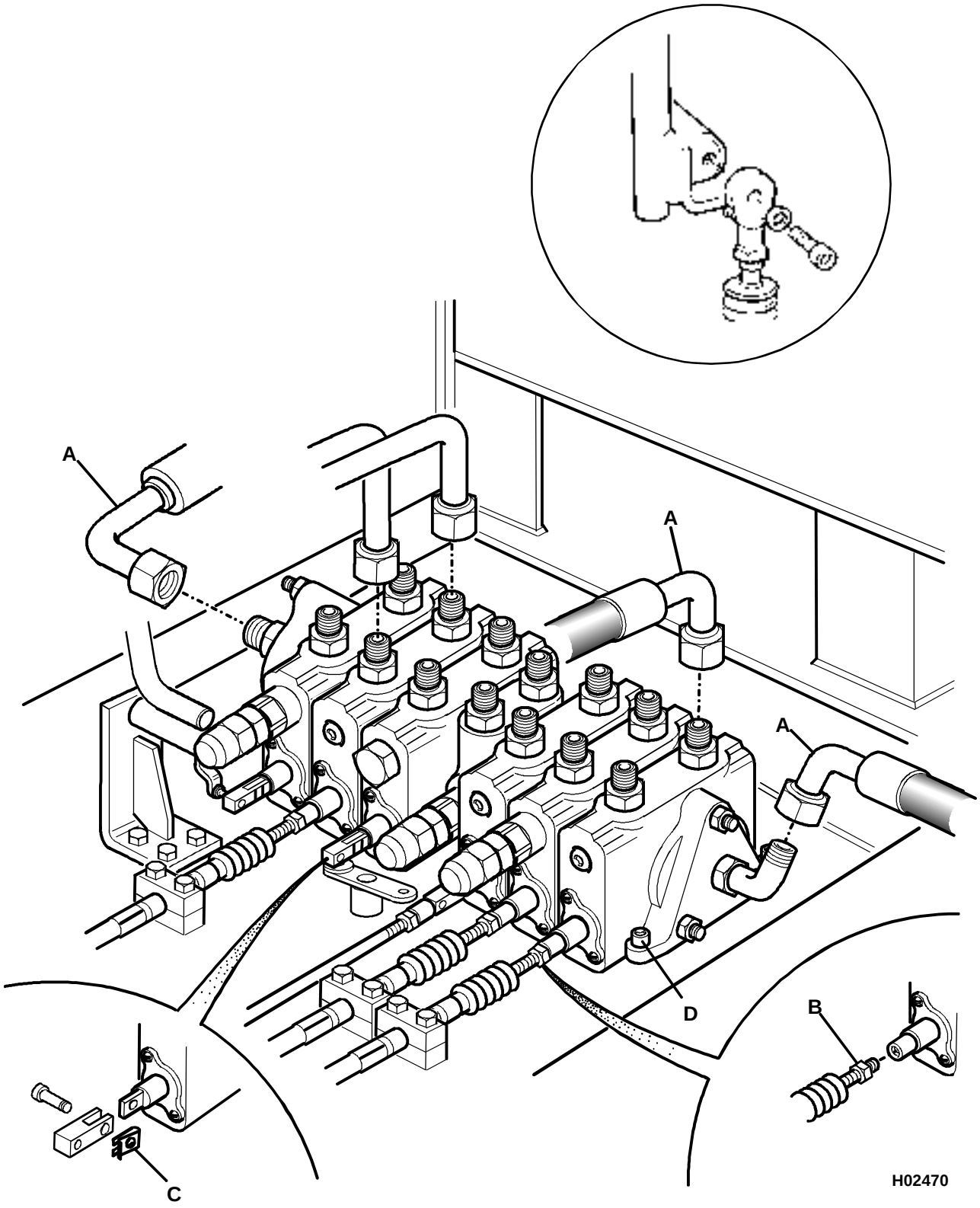
4 Remove the floor plate nearest the door, complete with the swing cable attached.

5 Disconnect the hydraulic hoses **A** from the valve block, plug both the hoses and the valve block to prevent the ingress of dirt. Identify the hoses as they are removed, ready for replacement.

*__6__ To protect cable, first remove cable rose joint from control lever base. Pull the cable free end away from the spool as it is unthreaded. Refer to control cable page for cable refitting precautions. Undo the locknuts **B** securing the cables to the spools on the Dipper and Auxiliary service.
On servo machines, hoses replace cables on some spools, these hoses must be removed, See paragraph 5.

7 Remove the clip **C** securing the Track fork end to the valve spool.

8 Remove the three screws and washers **D** securing the valve block to the frame. Remove the valve block from the machine to a clean working area.



Rear Valve

Removal

WARNING

Fine jets of Hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for suspected leaks. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.

HYD001

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.
Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN001

1 Undo and plug the feed and return hoses to the hydraulic tank.

2 Remove the seat and the seat mounting brackets

3 Remove the battery and the lower battery plate.

4 Disconnect the hydraulic hoses **A** from the valve block, plug both the hoses and the valve block to prevent the ingress of dirt. Identify the hoses as they are removed, ready for replacement.

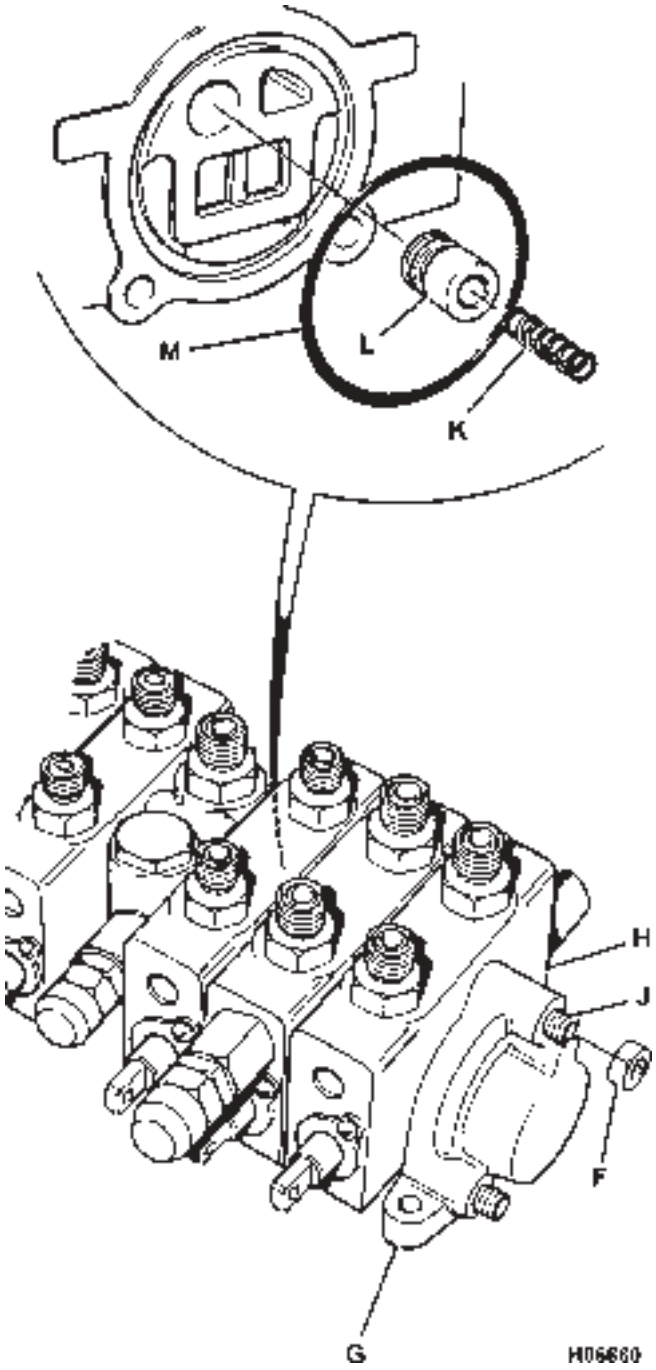
5 To protect cable, first remove cable rose joint from control lever base. Pull the cable free end away from the spool as it is unthreaded. Refer to control cable page for cable refitting precautions. Undo the locknuts **B** securing the cables to the spools on the Bucket, Boom and Slew services. On servo machines, hoses replace cables on some spools, these hoses must be removed, See paragraph **4** for precautions.

6 Remove the clips **C** securing the Track, Swing and Dozer spools.

7 Remove the three screws and washers **D** securing the valve block to the frame. Remove to a clean working area.

Replacement

For replacement the removal sequence should be reversed.



Dismantling and Assembly

When Dismantling

CAUTION: Absolute cleanliness is essential when stripping and assembling hydraulic components.

Note: *It is not necessary to separate valve sections to remove spools, connections, relief valves etc. from the valve block.*

1 Remove nuts **F** from end cover **G** and remove cover from valve.

*__2__ Withdraw the valve sections **H** from the tie rods **J**. Collect the springs **K** and check valves **L** (if fitted).

3 Remove and discard 'O' rings **M.**

Inspection

1 Check the mating faces of the valve sections for scratching, pitting, burrs and/or corrosion. Renew valve sections as necessary.

2 Check the 'O' ring seatings, check valve locations and check valves for scratching, pitting, burrs and/or corrosion. Renew valve sections or check valves as necessary.

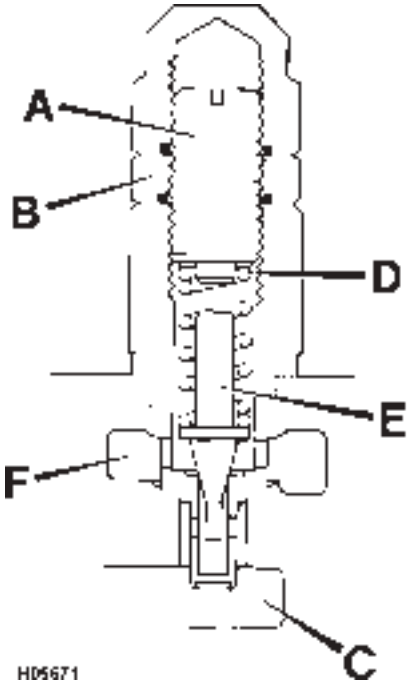
When Assembling

Note: *Lubricate all seals and 'O' rings with hydraulic fluid on assembly.*

1 Slide the valve section onto the tie rods **J** in the correct order and orientation, fitting new 'O' rings **M,** new springs **K** and check valves as necessary.

2 Fit nuts **F** to tie rods **J.** Lay the valve onto a smooth surface and progressively tighten the nuts to the specified torque setting (see Technical Data), checking for correct section alignment as the nuts are tightened.

Operation



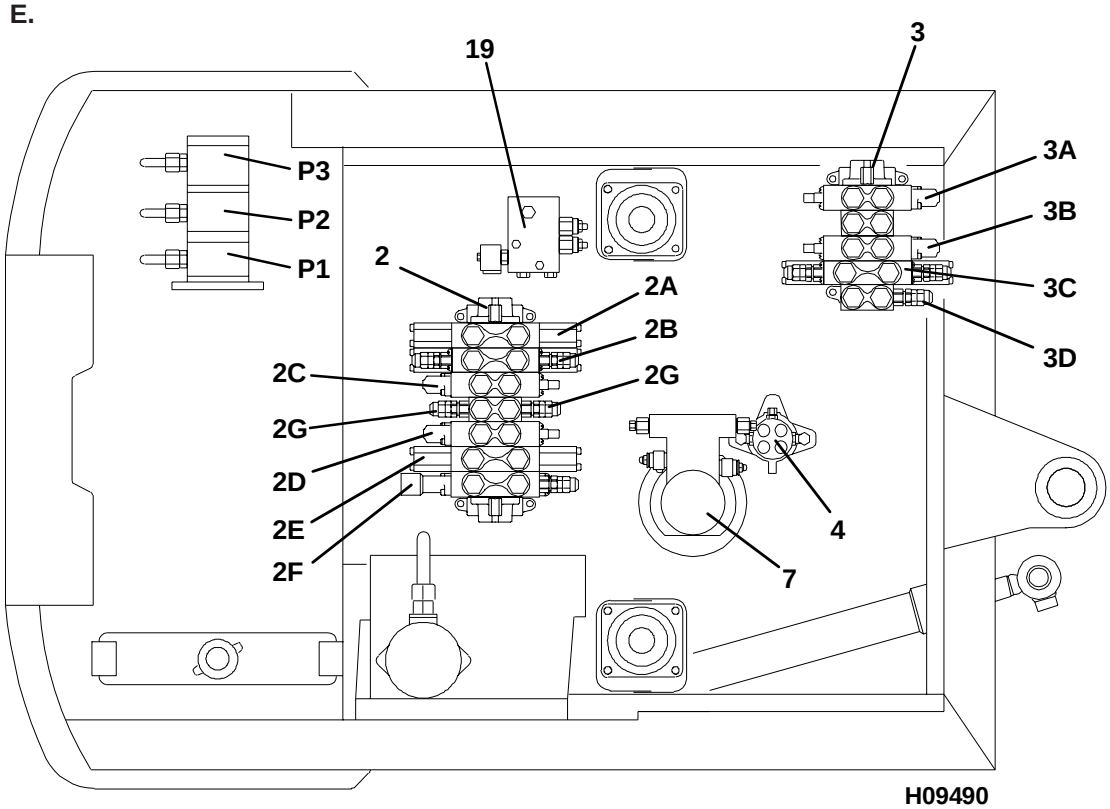
A main relief valve (M.R.V.) is fitted to protect each set of control valve sections served by one of the pumps **P1, P2** and **P3.**

M.R.V.'s control the maximum system pressure generated by the pumps. The pressure setting of the M.R.V. is adjusted by means of screw **A.**

*As pump pressure builds in gallery **C** it is sensed under the poppet valve **E** of the M.R.V. but with the system working below MRV operating pressure it is insufficient to overcome spring force **D.**

*When the MRV operating pressure is reached the force generated lifts the poppet valve **E** against the spring **D**. This opens up exhaust gallery **F** to pump pressure gallery **C** allowing excess pressure to escape harmlessly away to tank.

When system pressure falls away, spring **D** reseats poppet valve **E.**



P1	Pump Section 1	**3**	Control Valve (Forward)
P2	Pump Section 2	**3A**	Auxiliary Spool
P3	Pump Section 3	**3B**	Track Spool
2	Control Valve (Rear)	**3C**	Dipper Spool
2A	Bucket Spool	**3D**	Main Relief Valve
2B	Boom Spool	**4**	Rotary Coupling
2C	Track Spool	**7**	Slew Motor
2D	Swing Spool	**19**	Servo Pressure Control
2E	Slew Spool		
2F	Dozer Spool		

Removal

WARNING

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HYD001

1 Obtain access to the control valve.

2 Relieve hydraulic pressure and disconnect hydraulic hoses and pipework from the control valve.

3 Unscrew the main relief valve(s) from the valve block and remove to a clean working area.

Dismantling and Assembly

When Dismantling

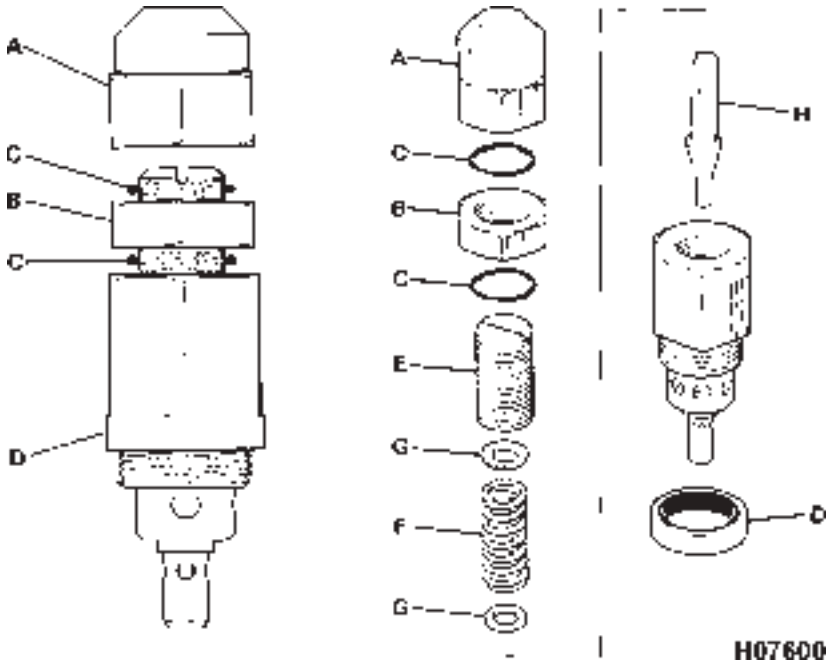
1 Remove acorn nut **A**, lock nut **B** and 'O' rings **C**.

2 Remove washer **D**.

3 Remove pressure setting plug **E**.

4 Tip the valve and collect:

- thrust washers **G**
- spring **F**
- poppet **H**



Inspection

*__1__ Check valve components for scratching, pitting, distortion and/or corrosion. If any parts other than 'O' rings **C** and washer **D** are damaged, the entire valve assembly must be renewed.

When Assembling

1 Assemble in reverse order of dismantling and refit to the valve block.

**Note:* *Ensure that special short hose adaptors are fitted to the valve block service ports to prevent MRV damage.*

2 Reconnect hydraulics and pressure test the valve.

*__3__ Refit the components removed to gain MRV access.

Boom, Dipper and Bucket - Removal & Replacement

WARNING

Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for hydraulic oil leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leak and then inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.
HYD001

WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or jacks to support the machine when working under it.
Disconnect the battery, to prevent the engine being started while you are beneath the machine.
GEN001

WARNING

If air or hydraulic pressure is used to force out the piston assembly, ensure that the end cap is securely fitted. Severe injury can be caused by a suddenly released piston rod.
HYD002

When Removing

1 With the engine idling, set the machine with the bucket on the ground.

2 Support the excavator under the angle between the dipper and boom to ensure it will not move when the ram is removed.

*__3__ On boom and bucket rams, remove the protection plate. Support the ram under the gland bearing and remove locknut **A** and bolt **B** from the pivot at the eye end of the ram. Drive out the pivot pin **C**.

4 With the engine idling, gently retract the ram rod into the cylinder by operating the relevant service.

5 On manual control machines, stop the engine. Operate the lever controlling the ram to be removed, in both directions to vent any trapped pressure. Remove the hoses, plug and cap any open hydraulic ports to prevent ingress of dirt.
On servo machines, run the engine at idle and with the servo isolator lock in the operate position move the control lever rapidly in both directions to vent any trapped pressure. Stop the engine.

CAUTION: This operation may not fully release all the trapped pressure. Consequently, when removing the hoses, progressively slacken the fittings to vent any residual pressure to atmosphere.

6 Support the ram and remove the locknut **D** and the bolt **E** from the pivot at the base of the piston. Drive out the pivot pin **F**. Remove the ram from the machine.

When Replacing

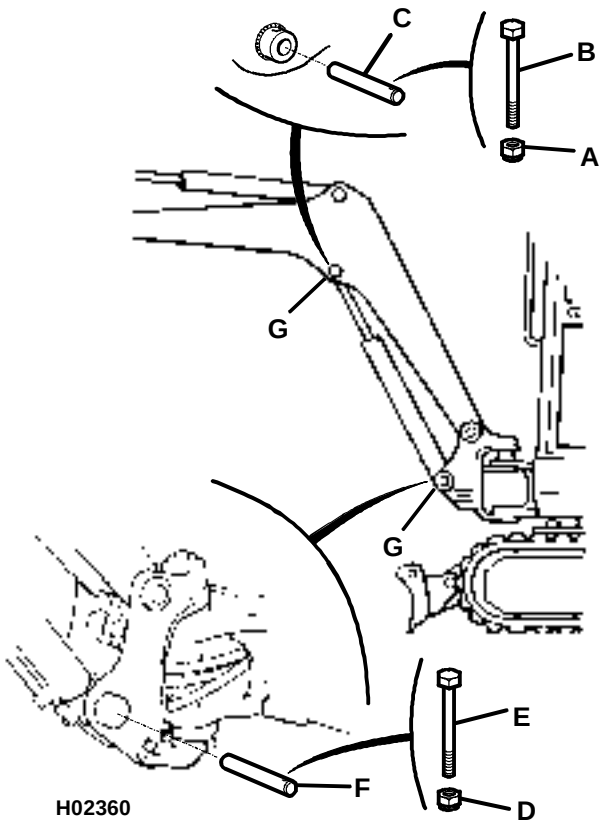
*__1__ Locate the pivot point on the ram into the location on the machine structure. Fit the pivot pin **F** and secure using the bolt **E** and new locknut **D.**

2 Support the ram under the gland end of the cylinder, reconnect the hoses. With the engine idling, slowly extend the ram until the eye end locates correctly in the machine structure. Fit pin **C**. Secure using the bolt **B** and new locknut **A**.

3 Apply grease to the pivot points through the grease nipples **G**. For grease specification see **Lubricants and Capacities.**

4 Connect the hoses to the cylinder, see **Hydraulic Fittings and Torque Settings.**

5 On the bucket and boom rams, fit the protection plate and secure using the bolts.



H02360

Dozer - Removal & Replacement

When Removing

1 Set the machine in the posture shown with the dozer grounded onto suitable supports.

2 With the starter switch turned **OFF**, relieve residual hydraulic pressure by operating the hydraulic controls.

3 Remove the bolts **A** and take off the protection plate **B.**

4 Disconnect the hydraulic hoses from the pivot end of the ram. Blank off the hoses and the open ports of the ram.

*__5__ Remove the locknut **C** and the bolt **D** from the pivot at the rod end of the ram. Support the ram and drive out the pin **E**. Lower the ram end onto a suitable support.

6 Remove the locknut **F** and bolt **G** from the pivot at the dozer end of the ram. Support the ram and drive out the pivot pin **H**. Remove the ram from the machine.

When Replacing

1 Locate the pivot point on the base of the ram into the dozer frame.

2 Fit the pivot pin **H** and secure using the bolt **G** and new locknut **F**.

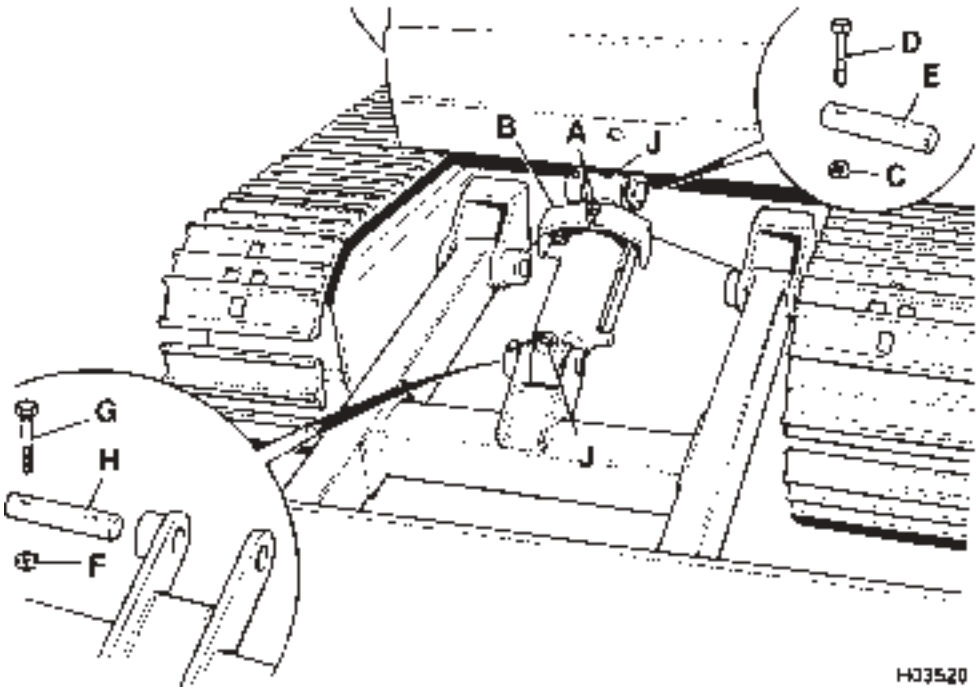
3 Fit the pivot point at the rod end of the ram to the machine.

4 Fit the pivot pin **E** and secure using the bolt **D** and new locknut **C**

5 Apply grease to the pivot points through the grease nipples **J**. For grease specification see **Lubricants and Capacities.**

6 Connect the hoses to the cylinder, see **Hydraulic Fittings and Torque Settings.**

7 Fit the protection plate **B** and secure using the bolts **A**.



Swing - Removal & Replacement

When Removing

1 Position the machine with upper structure slewed at 90^0 right to the tracks.

2 Swing the machine dig end through 45^0 to the left and lower the excavator to the ground.

3 Remove the bolts **B** and spring washers **C** securing the pivot keep plate **D** at the rod end of the cylinder.

4 Support the cylinder **A** and drive out the pivot pin **E.** With the engine idling, slowly retract the ram until the eye end clears the king post **H**. Stop the engine.

5 Operate the swing pedal in both directions to vent any residual pressure.

6 Remove floor mat and floorplates. Disconnect the ram feed hoses at the valve block, Plug the hoses and cap the open ports of the valve.

7 Locate the ram from underneath the upper structure. Remove the bolts and the spring washers **F** securing the keep plate at the base end of the cylinder.

8 Remove the pivot pin **G**.

9 Withdraw ram with hoses attached.

When Replacing

*__1__ Connect hoses to new/serviced ram. Locate the ram into the machine upper structure and align the base pivot point with the mating location in the machine frame.

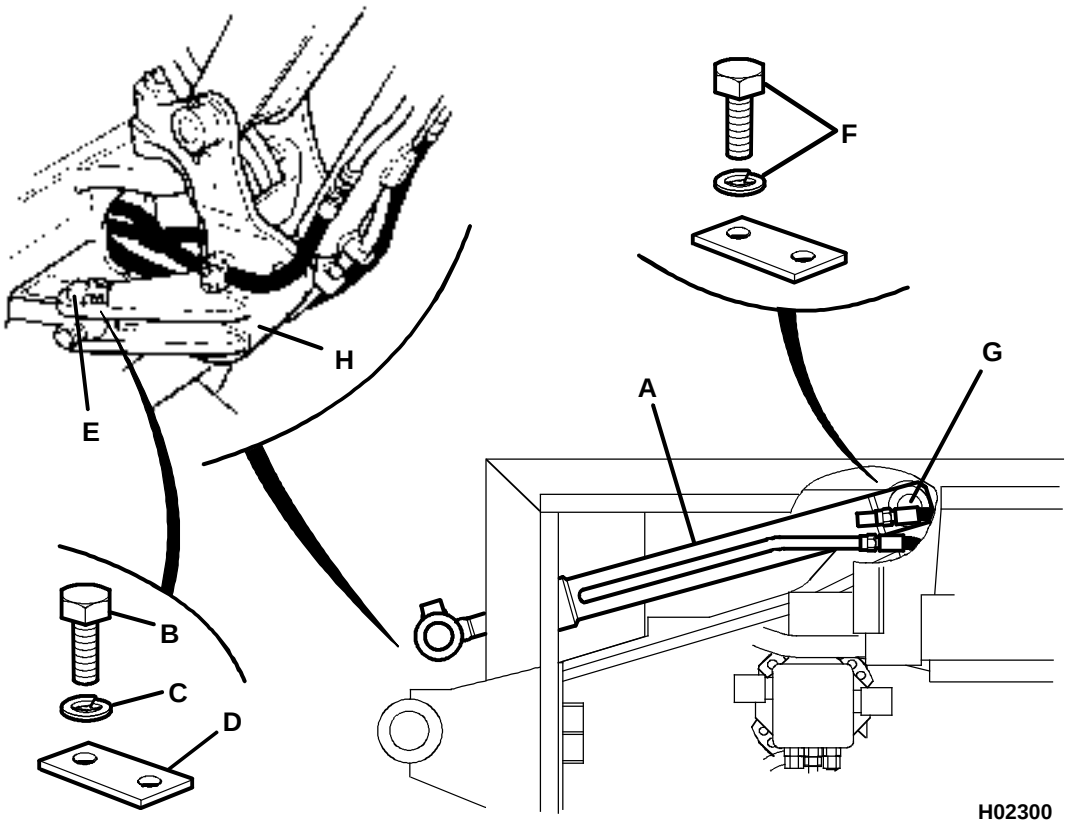
2 Fit the pivot pin **G**. Refit and secure with bolts, spring washers **F** and keep plate.

3 Reconnect the hoses.

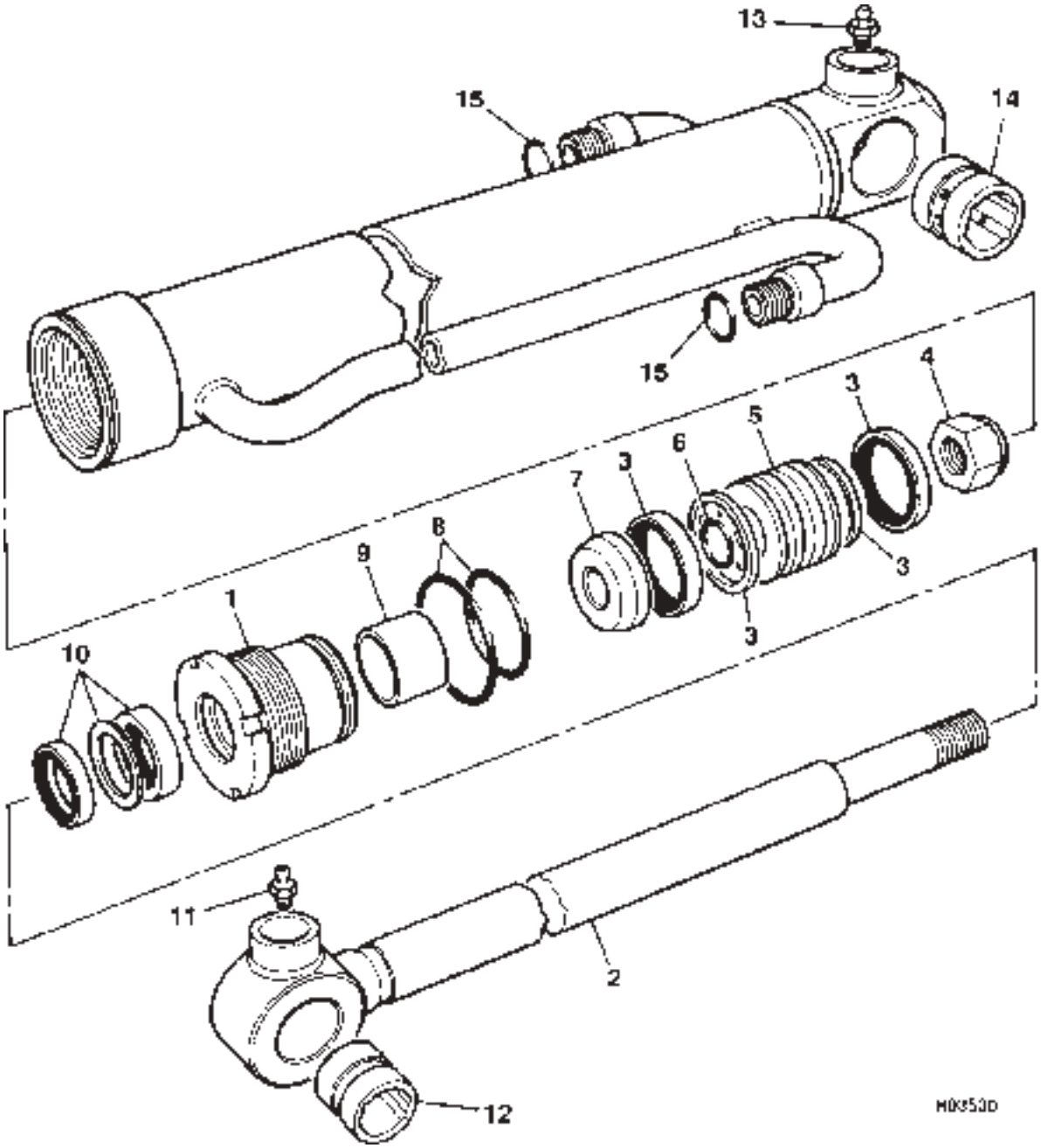
4 With the engine idling, slowly extend the ram until the eye end locates into the kingpost **H,** stop the engine

5 Fit the pivot pin **E**. Refit and secure keep plate **D** with bolts **B** and spring washers **C.**

Note: *See section 1 for torque tightening and sealant information.*



Typical - Dismantling and Assembly



Typical - Dismantling and Assembly

WARNING

If air or hydraulic pressure is used to force out the piston assembly, ensure that the end cap is securely fitted. Severe injury can be caused by a suddenly released piston rod.

HYD002

The numerical sequence shown in the figures are intended as a guide to dismantling.

Discard all seals and 'O' rings.

Try to lay out the parts in the correct order for assembly.

For assembly the sequence should be reversed.

Fit new 'O' rings and seals on assembly.

Torque tighten the end cap and piston nut.

For correct torque settings, refer to Section 3.

Typical - Inspection

Piston rod warp

1 Support the piston rod **A** on a pair of 'V' blocks.

2 Set a dial test indicator (D.T.I.) at the approximate centre of the rod at top dead centre.

3 Rotate the piston rod and read off any variation on the D.T.I.

4 If warp (half the difference between the minimum and maximum readings) exceeds 0.5 mm (0.02 in.) the piston rod must be replaced.

Piston rod / Rod bush clearance

1 Using internal and external micrometers measure the piston rod outside diameter (O.D.) and the rod bush **B** inside diameter (I.D.).

2 Compare the readings taken with the permitted clearances. If necessary replace the piston rod and/ or remove the rod bush **B** and replace with new.

Piston/Cylinder clearances

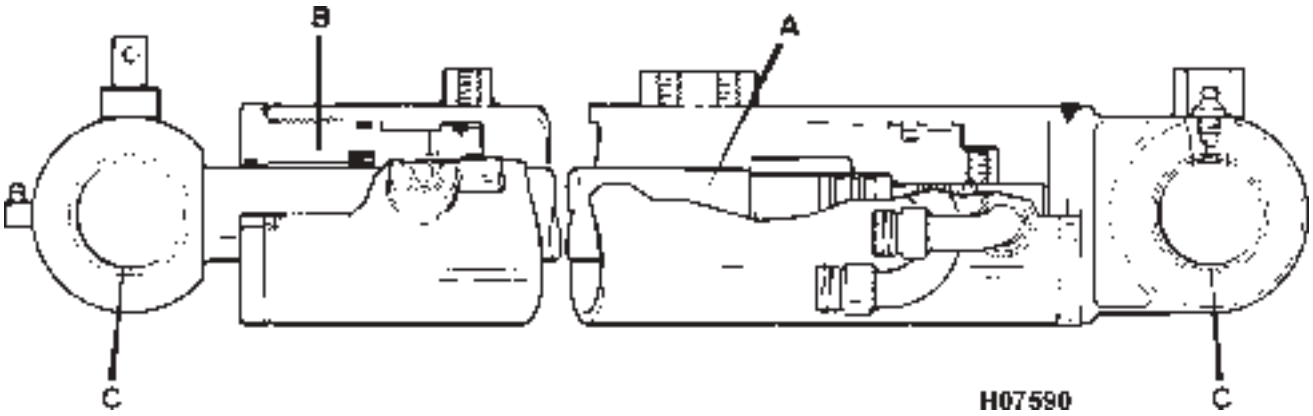
1 Using internal and external micrometers measure the piston O.D. and the cylinder I.D.

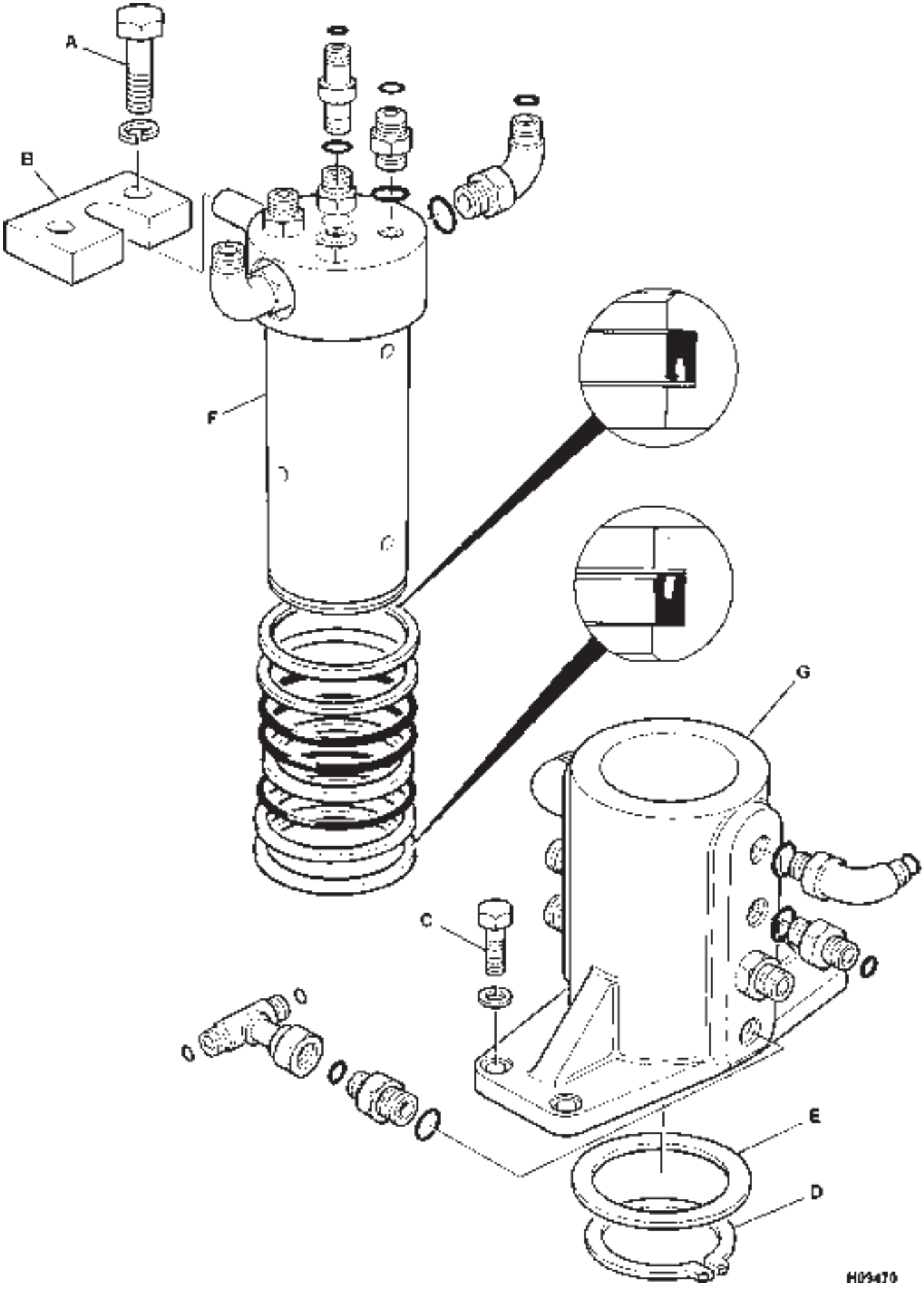
2 Compare the readings taken with the permitted tolerances. If necessary replace the piston and/or the cylinder with new.

Pin bush clearances

1 Using internal micrometers measure the I.D. of the pin bushes **C** in the piston rod and cylinder ends.

2 Compare the readings with the permitted tolerances shown.





Rotary Coupling

Removal

**Note:* *Before removing a suspected leaking coupling, ensure that the leak is from the coupling core and not a hose adaptor. Ensure all adaptors are tight.*

WARNING

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HYD001

WARNING

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Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN001

1 Undo and plug the feed and return hoses to the rotary coupling.

2 Remove the seat, the seat mounting brackets, the battery and the lower battery plate.

3 Remove the swing pedal and fold back the floormatting clear of the middle floor plate.

4 Remove the forward middle floor plate and forward battery plate, giving a clear central working area.

5 Identify and remove the hydraulic hoses from the adaptors. Blank both the hoses and the adaptors.

6 From underneath the machine, remove the bottom access plate.

7 Identify and remove the remaining hoses from the adaptors. Blank both the hoses and the adaptors.

***8** From above, remove the two bolts **A** securing the torque plate **B** and remove the plate.

***9** Remove the four bolts and washers **C** securing the rotary coupling to the undercarriage and lift clear of the mainframe

*Dismantling and Assembly

WhenDismantling

1 Remove the external circlip **D** and the ring **E** from the base of the coupling.

2 From the top of the coupling, carefully withdraw the core **F** from the shell **G.**

3 Remove and discard the 'O' rings and seals from the shell **G**.

Inspection

1 All 'O' rings and seals must be replaced with new.

2 If the core or shell show signs signs of wear, replace the complete rotary coupling.

When Assembling

1 Assemble in the reverse order of dismantling. Fit new O' rings and seals lightly lubricated with hydraulic fluid.

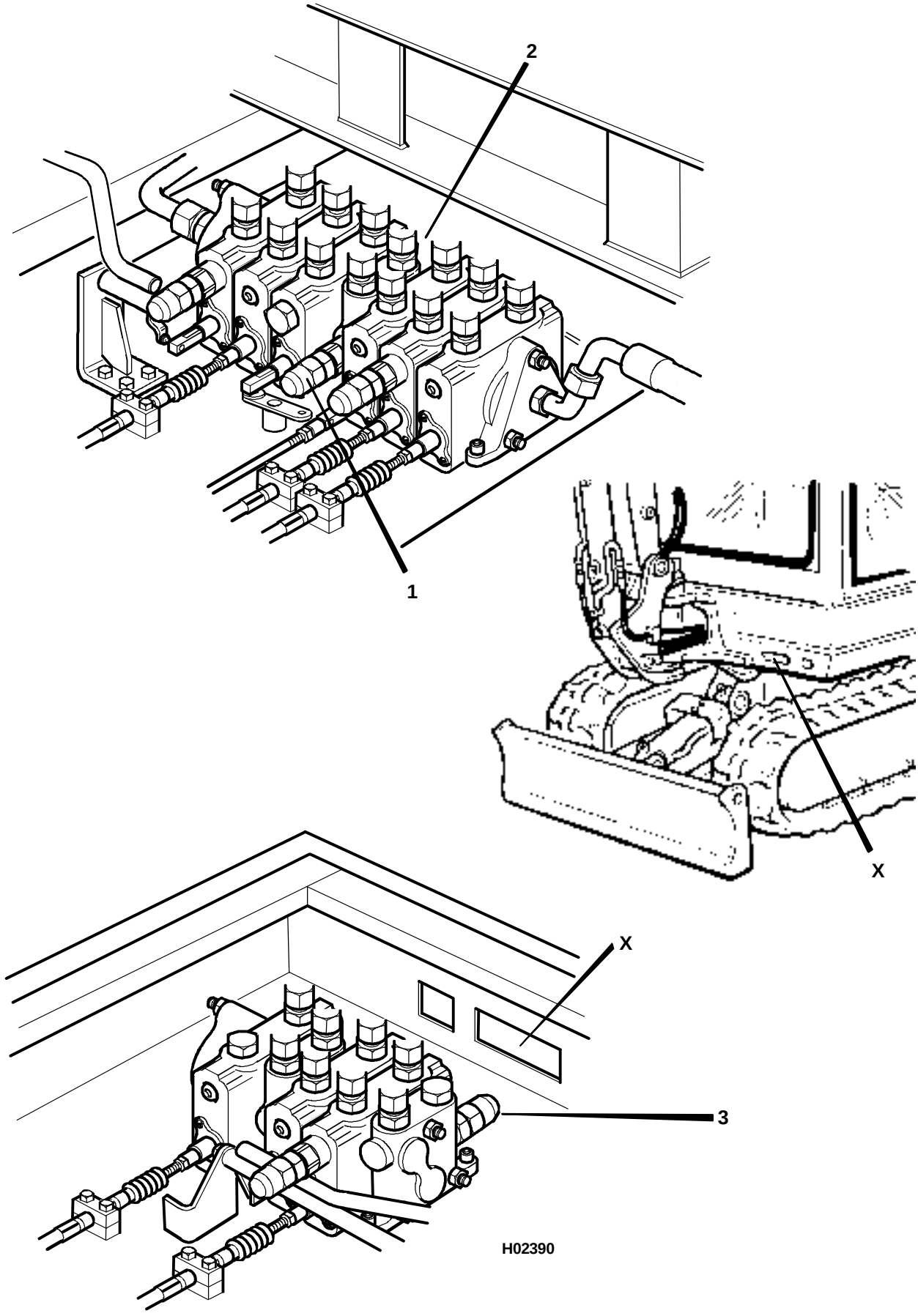
2 Ensure core **F** is well lubricated on assembly.

Replacement

1 Replace in reverse order of removal.

2 Reconnect hydraulic hoses using new lightly lubricated 'O' rings.

3 Test the assembly for leaks.



Hydraulic Oil Temperature

If the hydraulic oil is not up to its full working temperature prior to pressures being set to their specified value during pressure testing, the pressure will progressively fall with increase in temperature, resulting in a drop in machine performance.

To compensate for this, the hydraulic oil temperature should be measured, and the MRV should be set to the quoted value given on the graph.

Main Relief Valves (M.R.V.s)

1 Park the machine on flat, even ground, with the dozer blade and bucket resting on the ground, the dig end situated over the dozer.
The left hand controller pod should be positioned as far back as possible and locked.

Dozer, Swing & Slew M.R.V. - Pump 1

1 Remove the floor mat.

2 Remove the Swing pedal floor plate but do not disconnect the pedal.

3 Remove centre floor plate (Over tracking levers).

4 Remove the tool box and heel plate.

5 The M.R.V. for pump 1 is now accessible for adjustment.

Bucket, Boom & R.H. Track M.R.V. - Pump 2

1 Remove sump plate from beneath engine compartment.

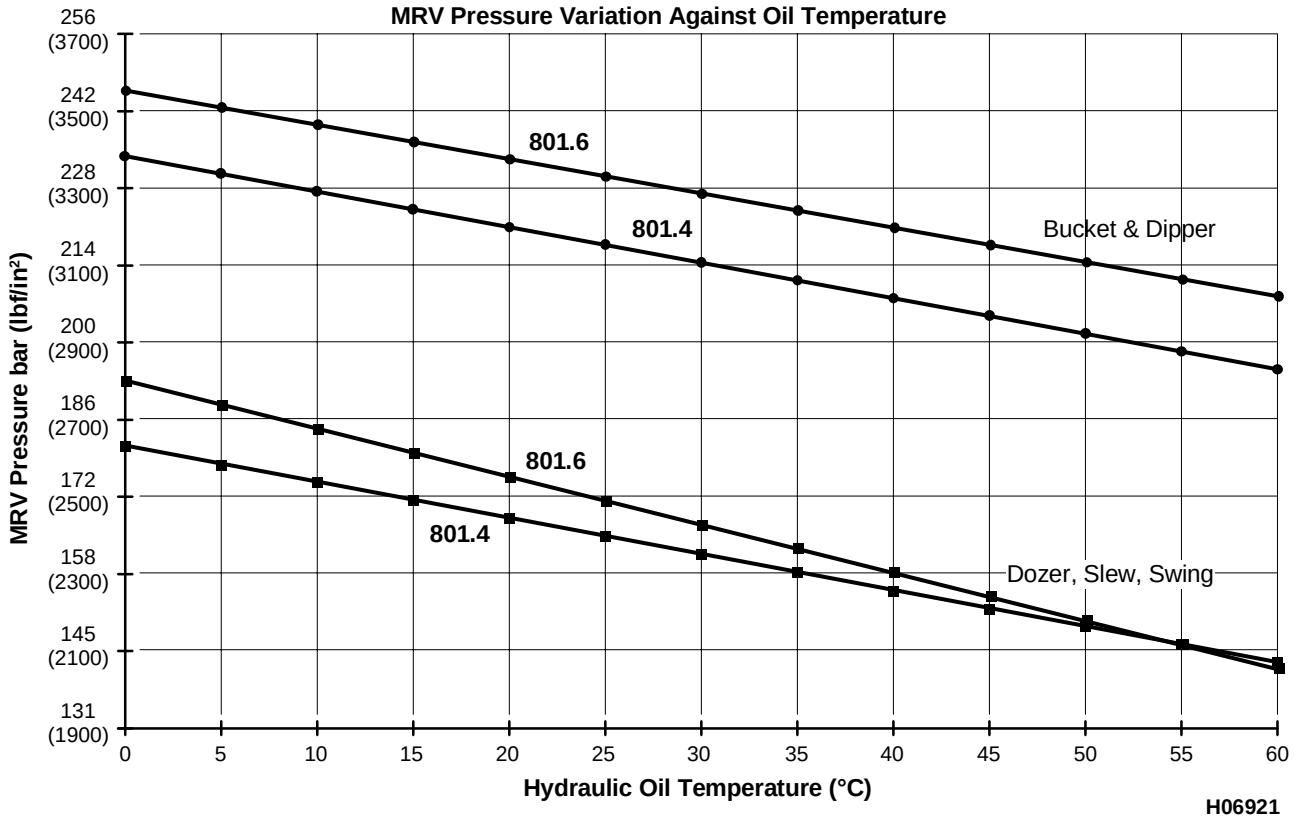
2 The M.R.V. for pump 2 is now accessible for adjustment from beneath the engine compartment.

Dipper & L.H. Track M.R.V. - Pump 3

1 Remove the M.R.V. access plate **X** located on the outside front edge of the slew frame.

2 The M.R.V. for pump **3** is now accessible for adjustment. However, if further work is required it will be necessary to increase accessibility.

3 Remove the floor mat. Remove the swing pedal floor plate but do not disconnect the pedal.



Main Relief Valves (M.R.V.s) (cont'd)

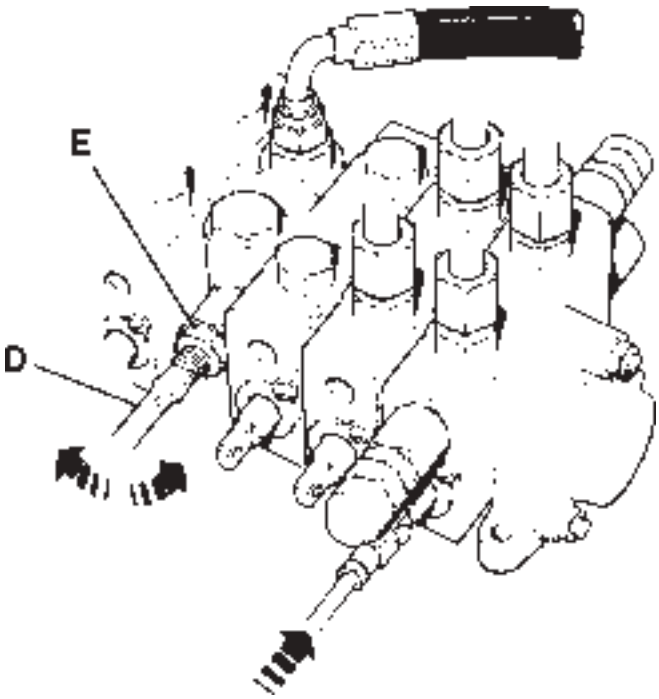
1 Connect a 0-400 bar (0-6000 lbf/in^2) pressure gauge to the relevant test point for the system to be set.

2 With the engine running at maximum speed, and hydraulic fluid at working temperature, refer to Technical Data, operate the service served by the valve under test.

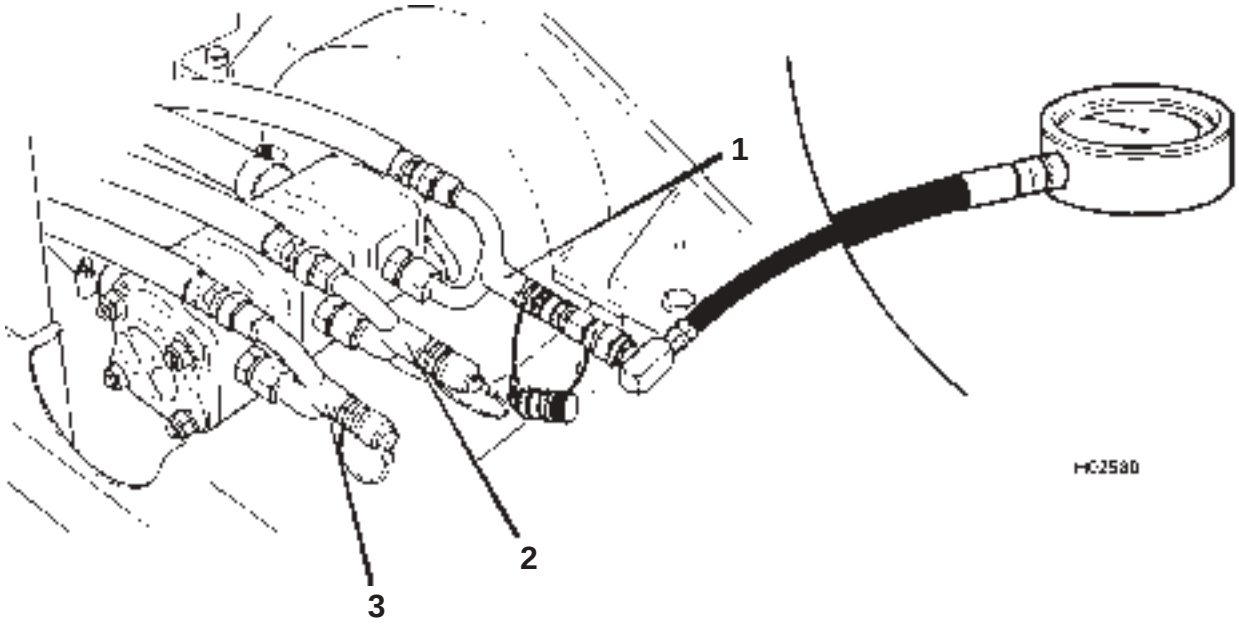
3 Check the gauge reading is as defined in Technical Data. If incorrect remove M.R.V. caps. With the ram held at full travel adjust the M.R.V. by means of the screw **D** until the gauge reads the correct pressure.

4 Tighten the locknut **E.** Check gauge reading is correct. Repeat procedure as necessary. Return the service to a safe condition, i.e. with excavator bucket resting on the ground.

5 Stop the engine. Remove pressure gauge.



PUMP 1	Dozer	Swing	Slew
PUMP 2	Bucket	Boom	RH Track
PUMP 3	Dipper	LH Track	Auxiliary



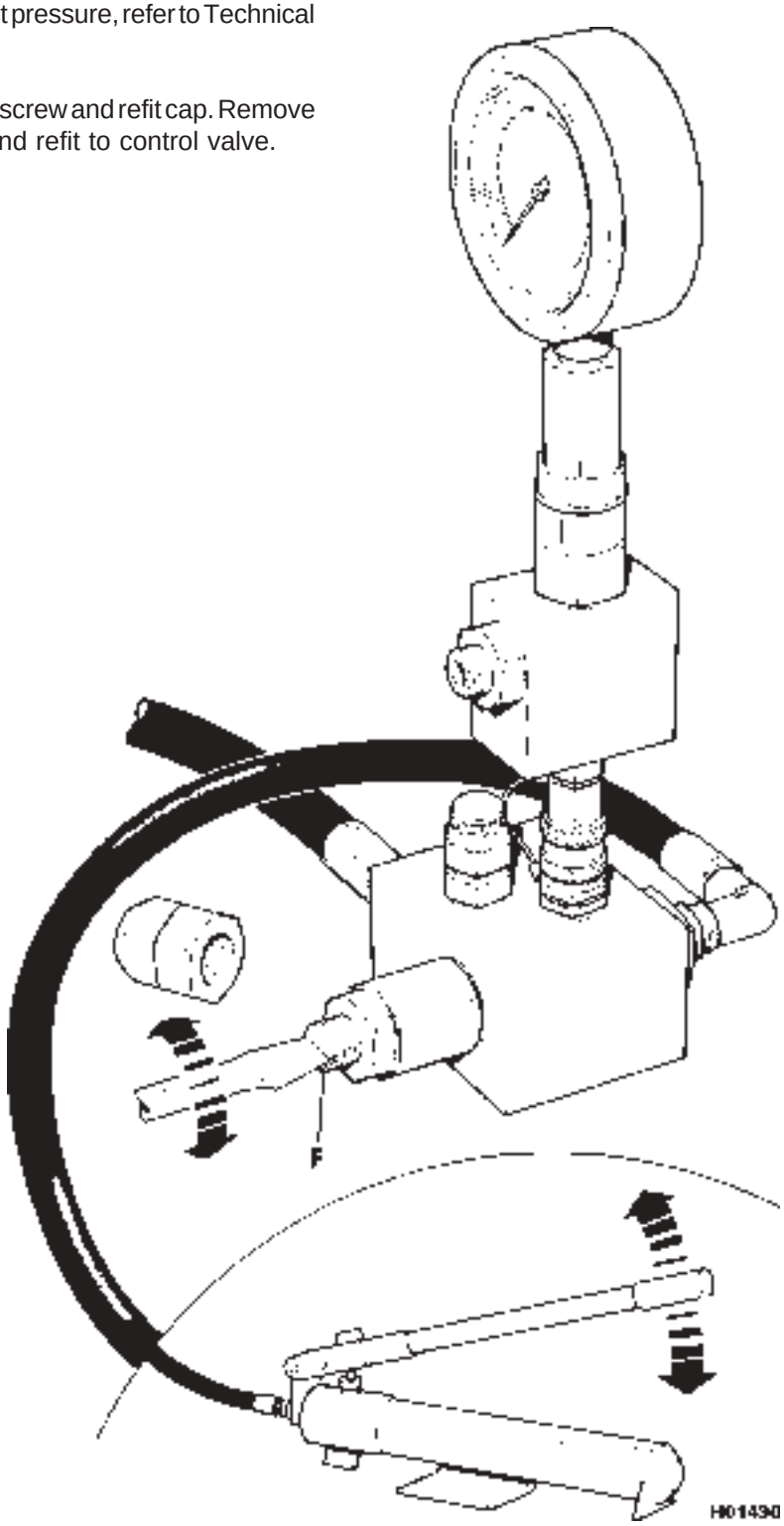
Auxiliary Relief Valves (A.R.V.s)

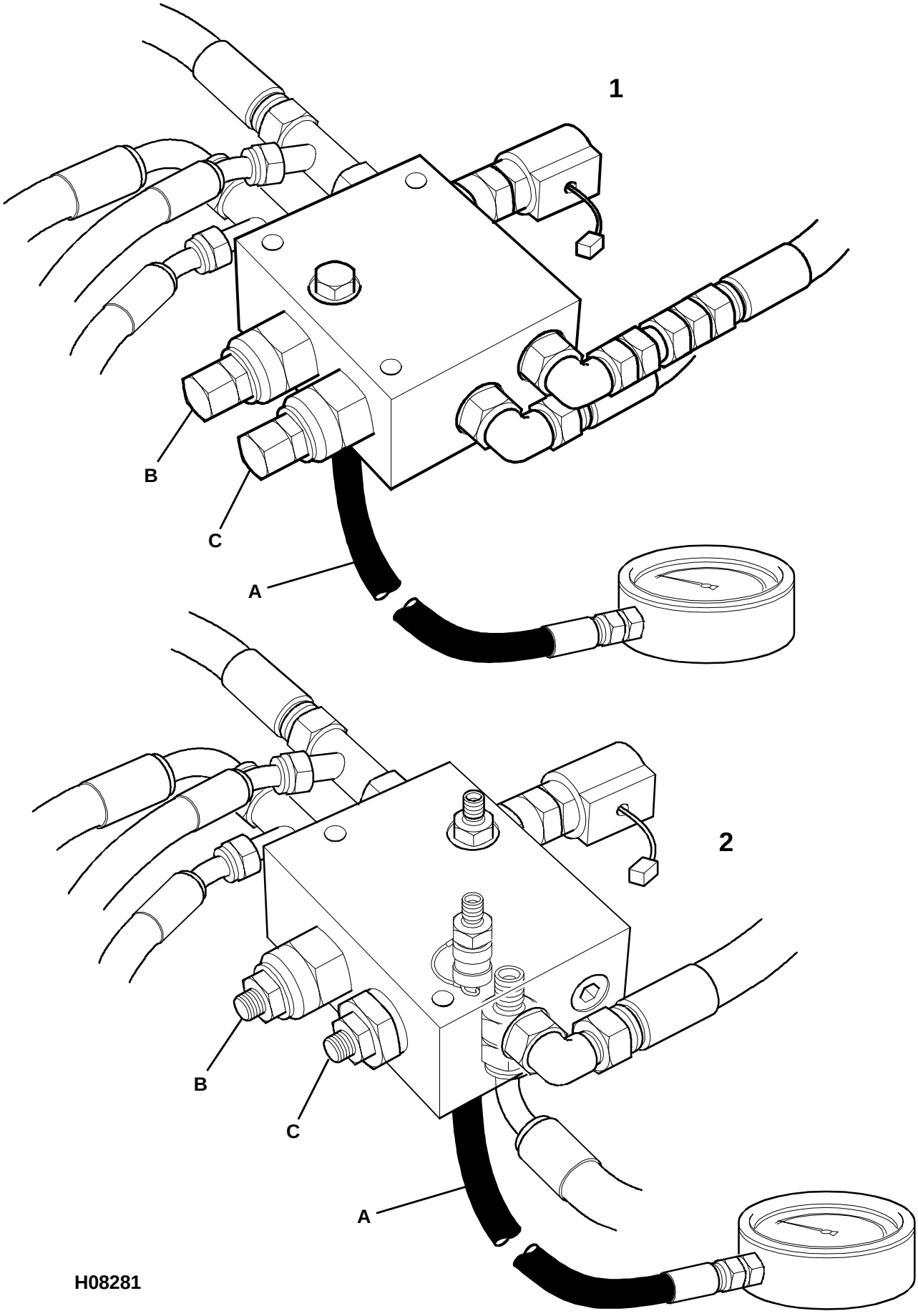
1 Connect the valve to test block number 892/00252.

2 Connect a 0-400 bar (0-6000 lbf/in$^{2)}$ pressure gauge and hand pump, number 892/00223, to test block.

3 Operate pump and adjust pressure setting screw **F** until valve opens at correct pressure, refer to Technical Data.

4 Lock the pressure setting screw and refit cap. Remove A.R.V. from test block and refit to control valve.





Servo Relief Valves

***1. 801.4 to M722283, 801.6 to M726166**
***2. 801.4 M722284 on, 801.6 M726167 on**

Note: *Relief valves on early valve blocks are non-serviceable.*

*All pressure testing must be carried out with the machine hydraulic system within the range 30 - 40 deg. C.

If the servo pressure requires adjusting, always adjust the Servo Pressure Relief Valve first.

Servo Pressure Relief Valve and Pressure Maintenance Valve

1 Connect a 0 - 400 bar (0 - 6000 lbf/in^2) pressure gauge to test point **A** on the servo valve block.

2 With the engine at maximum speed, fully raise dozer until the ram is fully closed and hold selected, check gauge reading which should be as detailed in Technical Data. If it is incorrect remove cap from relief valve **B**, slacken locknut and slowly adjust valve until gauge registers the correct pressure. Tighten locknut and replace cap, recheck the pressure.

3 Stop the engine.

4 Switch on ignition but do not start the engine.

5 Operate servo hand controllers to vent residual hydraulic pressure (this ensures the pressure relief valve is fully seated). Restart the engine and run at maximum speed, with no service selected.
Check the gauge reading for the pressure maintenance relief valve is as described in Technical Data. If it is incorrect, remove cap from relief valve **C,** slacken locknut and slowly adjust valve until gauge reading is correct. Tighten locknut and replace cap, recheck the pressure.

Crossline Relief Valves and Slew Start-up Pressure Control Valves

There are two relief valves for each direction of slew. These valves are located in the block bolted to the top of the slew motor. The pressures should be checked to the values quoted in the Technical Data section using the method described below.

NOTE: *Do not dismantle relief valves or mix up their locations. The valves are matched to their relevant valve block to maintain correct operation. If a valve cannot be pressure set, the complete valve assembly must be renewed.*

Crossline Relief Valves (A and B)

1 Connect a 0-400 bar (0-6000 lbf/in^2) pressure gauge to the test point on the pump section nearest the engine.

2 Engage slew lock. With the engine running at maximum speed and the hydraulic fluid at working temperature, fully select slew left and hold whilst checking the pressure gauge reading.

3 Check that the pressure gauge reading equals the crossline relief setting. If incorrect, unscrew the locknut and turn the adjusting screw of relief valve **A** until the correct reading is obtained. Turning the screw clockwise increases pressure and anti-clockwise decreases pressure.

4 When the pressure gauge reading is correct, tighten the locknut. Repeat the test and check that the setting has been retained.

5 Repeat the test fully selecting slew right. If necessary, turn adjusting screw of relief valve **B** until the correct reading is obtained.

6 Stop the engine, remove the pressure gauge and fit the blanking cap.

Slew Start-up Pressure Control Valve (C and D)

CAUTION

During this test the machine will slew. Warn all nearby personnel of the danger and check for adequate clearance.

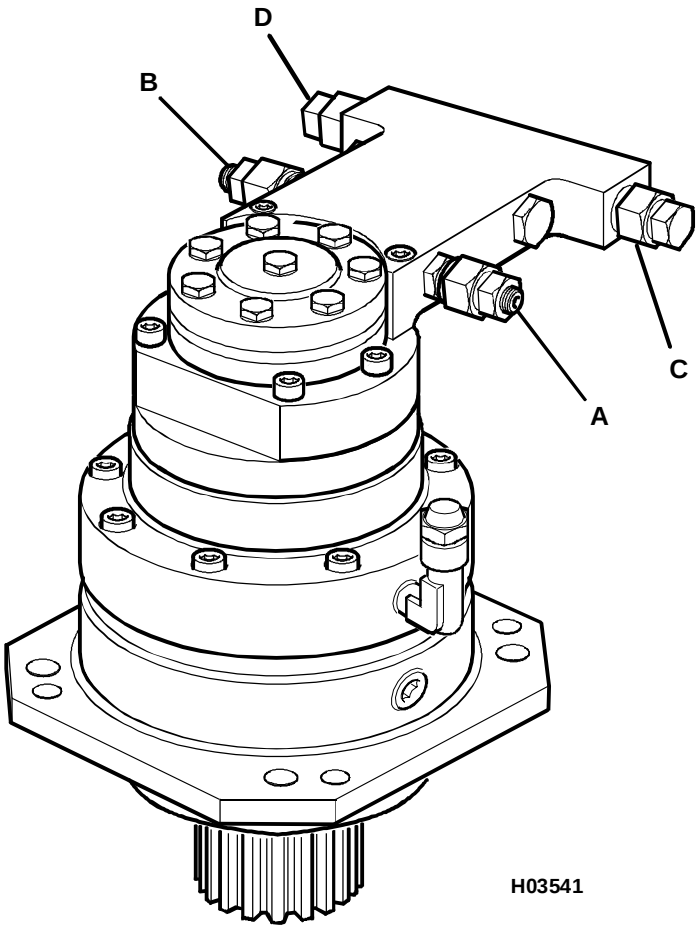
1 Connect a 0-400 bar (0-6000 lbf/in^2) pressure gauge to the test point on the pump section nearest the engine.

2 Disengage slew lock. With the engine at idle, slowly and progressively select left whilst watching the pressure gauge. At the point where the machine begins to slew, check the reading on the pressure gauge. This should equal the start-up pressure (refer to Technical Data). If incorrect, unscrew the locknut and turn the adjusting screw of relief valve **C** until the correct reading is obtained. Turning the screw clockwise increases pressure and anti-clockwise decreases pressure.

3 When the pressure gauge reading is correct, tighten the locknut. Repeat the test and check that the setting has been retained.

4 To test relief valve **D**, repeat operations 2 and 3 above, slowly and progressively selecting slew right. If necessary, turn adjusting screw of relief valve **D** until the correct reading is obtained.

5 Stop the engine, remove the pressure gauge and fit the blanking cap.



Contents **Page No.**

Technical Data

***Oil Capacity**

Slew:
Note: *Early slew gearboxes were lubricated from the hydraulic system.*

801.4 M721137 on) 801.5 M730004 on) 801.6 M728057 on)	0.7 litres (0.15 UK Gal)
Track	1.6 litres (0.4 UK gal)

General Description

This range of Mini Excavators is fitted with three gearboxes, one providing drive for the slew ring and one each for the machine tracks. The gearboxes produce high speed reduction whilst maintaining high torque. The track gearboxes are mounted onto flanges on the undercarriage side frames and are covered by guards. Drive to the track is transmitted through the gearbox output pinion to the track assembly driven sprocket. The slew gearbox is mounted below the cab floor plate and transmits drive through an output pinion to the machine slew ring.

Check Level - *For interval see Service Schedule*

1 Position the machine on firm level ground with the drain plug **B** at the lowest point and with safe access to the level plug **A** and filler plug **C**.

2 Remove the level plug **A**. Oil should flow from the hole.

3 If necessary, remove filler plug **C** and top up the oil.

4 Refit the filler plug **C**.

5 Fit the level plug **A**.

Note: *There is a track gearbox on each track.*

Drain & Refill - *For interval see Service Schedule*

1 Position the machine on firm level ground with safe access to the level plug **A**, and the drain plug **B** at the lowest point.

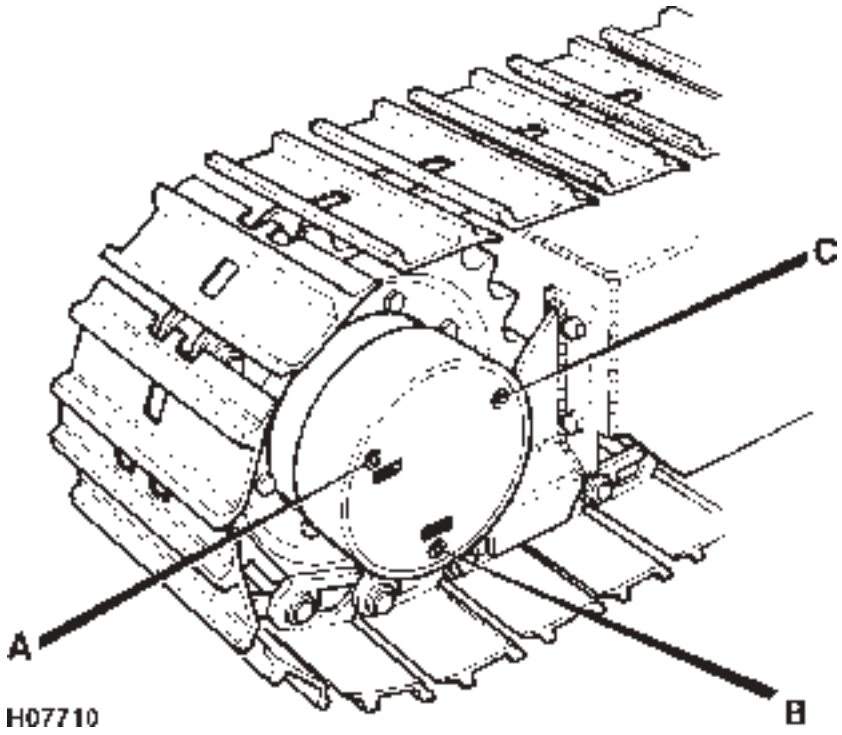
2 Remove plugs **B** and **C** and allow oil to drain completely.

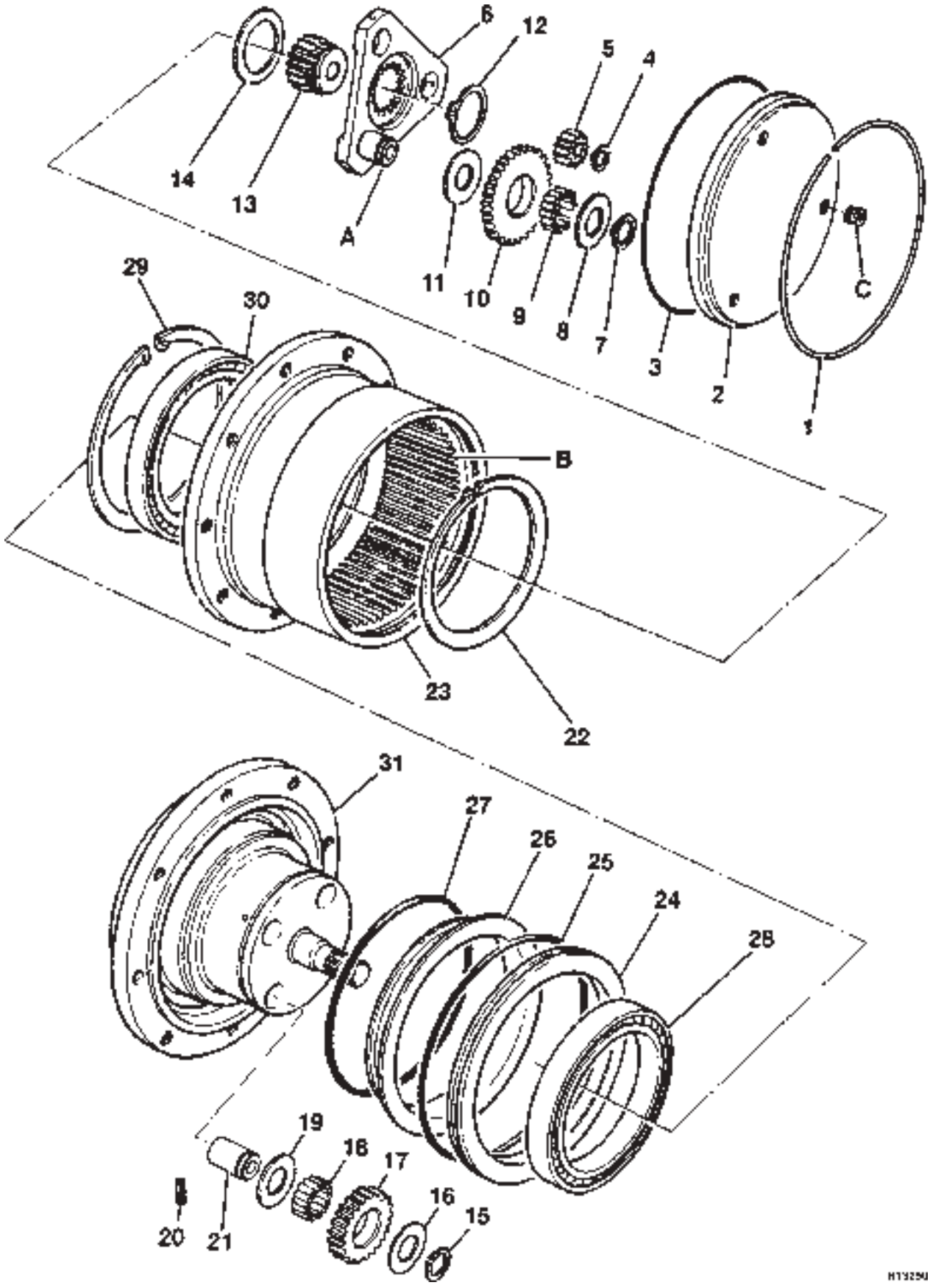
3 Fit the drain plug **B**.

4 Fill the gearbox through the filler hole at **C** to the correct level at **A**.

5 Fit the plugs **A** and **C**.

Note: *There is a track gearbox on each track.*





*Dismantling and Assembly - Early machines

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

When Dismantling

Remove planet carrier **16** as an assembly complete with planet gears, thrust washers, bearings and pivot pins etc. (items **7** to **13**).

Remove circlips **7** only to allow removal and inspection of bearings **9**. Planet pins **A** can then be inspected in position. If any of these parts are needing renewal, fit a new planet carrier assembly complete as components are not available separately.

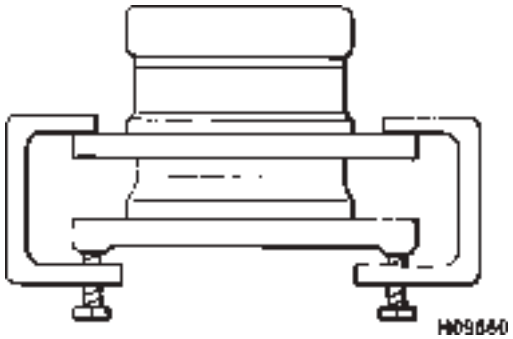
Remove circlips **15** to allow removal and inspection of bearings **18** and planet pins **21**. These parts may be renewed separately.

Remove circlip **22** to allow gear housing **23** to be withdrawn from motor housing **31**.

Note: *It may be necessary to clamp the two housings together to relieve the load from the circlip and allow it to be removed. When clamping, do not exceed a force of 4000N (890 kgf).*

Remove and discard 'O' rings **25** and **27** also floating seals **24** and **26**.

Do not remove bearings **28** and **30** unless requiring renewal.



When Assembling

When fitting new bearings, ensure that:

1 Bearing **30** has the narrower side of its outer race facing towards gear teeth **B**.

2 Bearing **28** has the narrower side of its outer race facing away from gear teeth **B**.

Apply grease to the floating seals to retain the 'O' rings and to facilitate fitting of the seal assemblies to the housings. After fitting, wipe away excess grease from the mating faces of the floating seals.

*When fitting the gear housing **23** to the motor housing **31**, it may be necessary to clamp the two housings together to allow circlip **22** to be fitted. Compress the floating seals with 'G' clamps as shown.

Note: *When clamping, do not exceed a force of 4000N (890 kgf).*

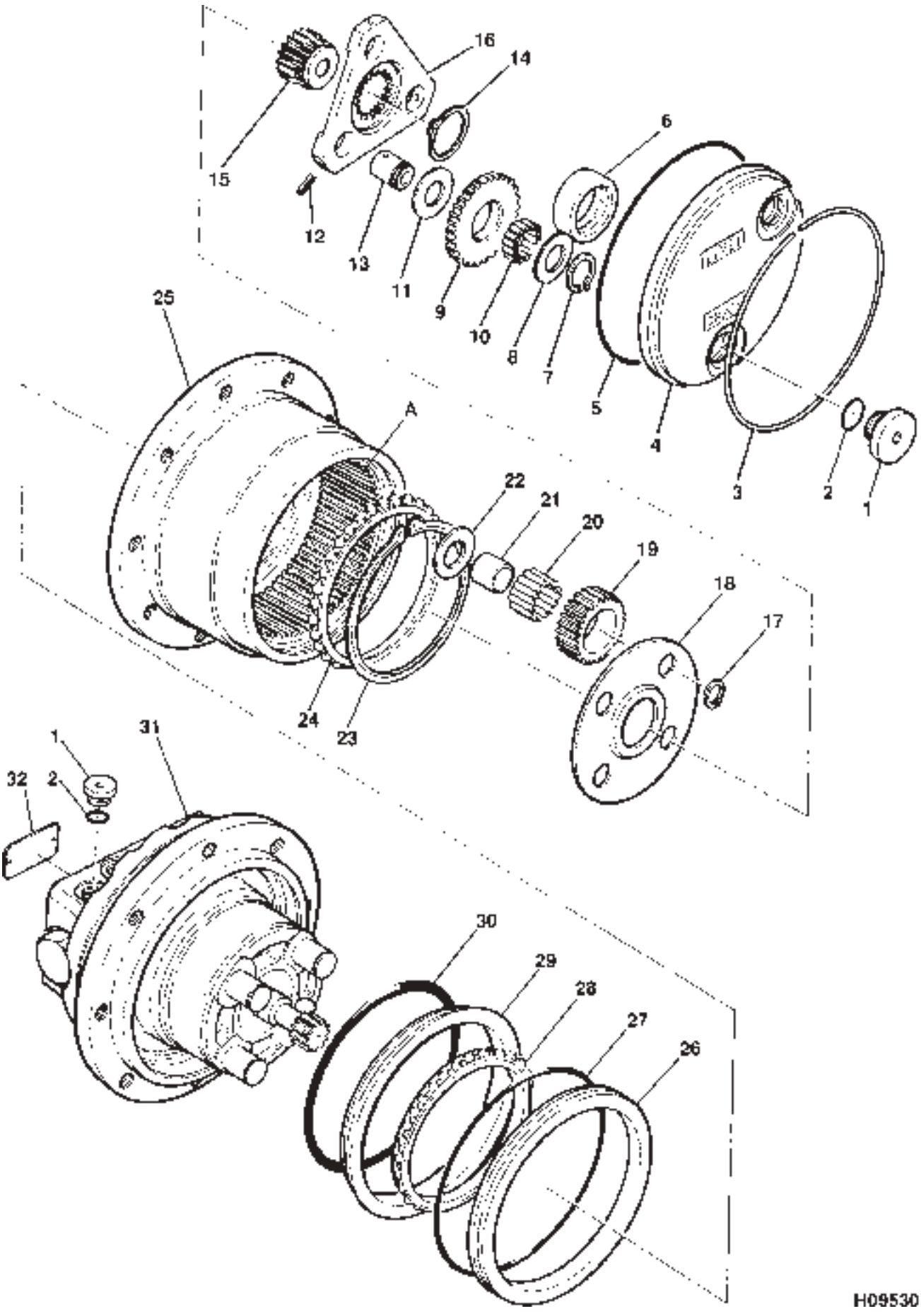
Before fitting cover **2**, fill the gear housing with the recommended oil and apply grease to 'O' ring **3**.

When fitting cover **2**, keep it at right-angles to the axis of the gears as tilting the cover will damage the 'O' ring. Insert snap ring **1** so that its ends are diametrically opposite the removal notch in the gear housing.

If plugs **C** have been disturbed, wrap the threads with sealing tape and tighten. to the specified torque settings.

Torque Settings

Item	Nm	kgf m	lbf ft
C	30 - 30	2.0 - 3.0	15 - 22



Dismantling and Assembly - Later machines

The numerical sequence shown on the illustration is intended as a guide to dismantling.

For assembly the sequence should be reversed.

When Dismantling

Remove planet carrier **16** as an assembly complete with planet gears, thrust washers, bearings and pivot pins etc. (items **7** to **15**).

Remove circlips **7** only to allow removal and inspection of bearings **10**. Planet pins **13** can then be inspected in position. If any of these parts are needing renewal, fit a new planet carrier assembly complete as components are not available separately.

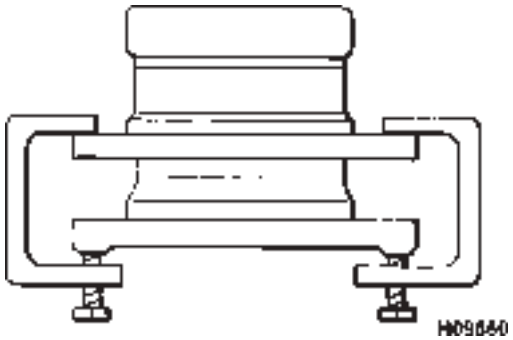
Remove circlips **17** to allow removal and inspection of bearings **20** and planet pins **21**. These parts may be renewed separately.

Remove circlip **23** to allow gear housing **25** to be withdrawn from motor housing **31**.

Note: *It may be necessary to clamp the two housings together to relieve the load from the circlip and allow it to be removed. When clamping, do not exceed a force of 4000N (890 kgf).*

Remove and discard 'O' rings **30** and **27** also floating seals **29** and **26**.

Do not remove bearings **28** and **24** unless requiring renewal.



When Assembling

When fitting new bearings, ensure that:

1 Bearing **24** has the narrower side of its outer race facing towards gear teeth **A**.

2 Bearing **28** has the narrower side of its outer race facing away from gear teeth **A**.

Apply grease to the floating seals to retain the 'O' rings and to facilitate fitting of the seal assemblies to the housings. After fitting, wipe away excess grease from the mating faces of the floating seals.

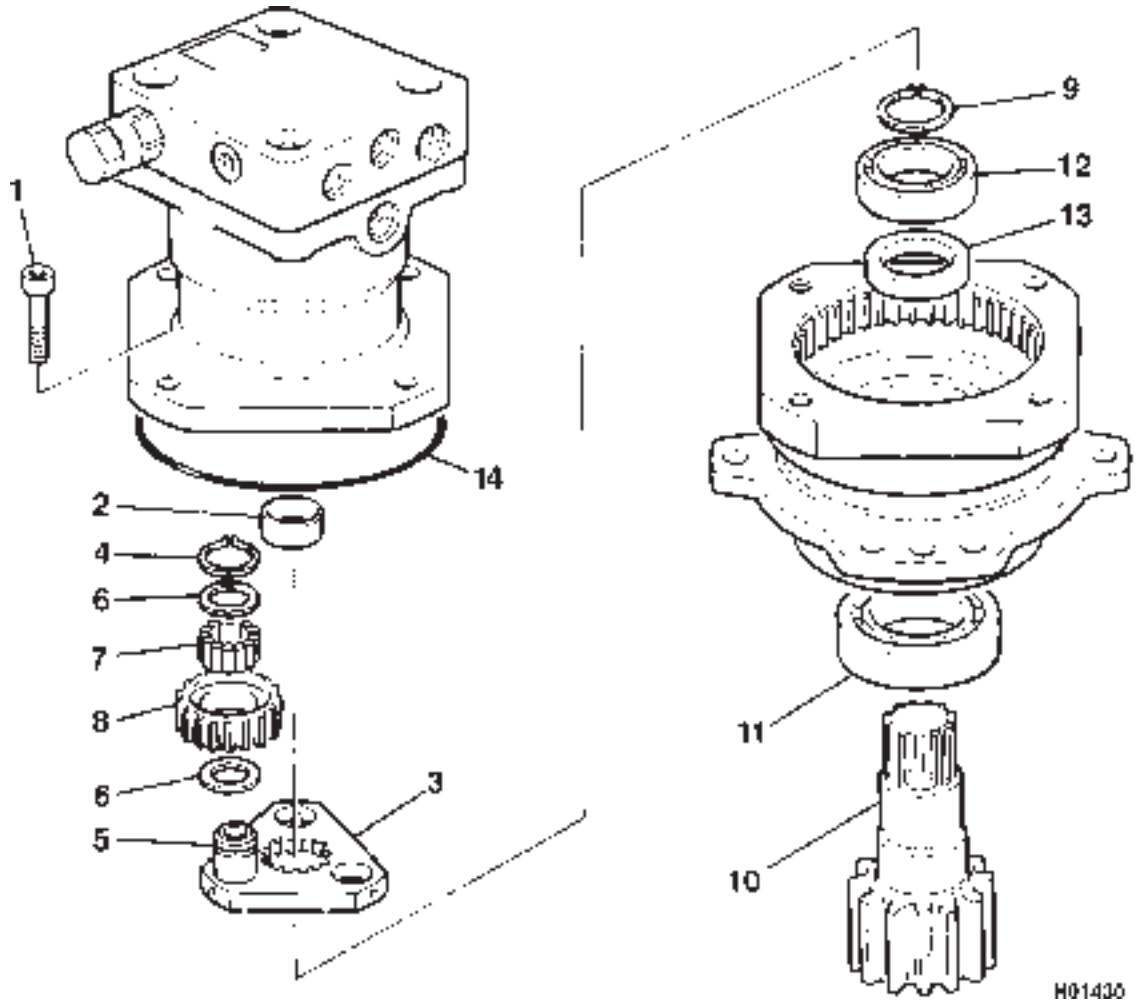
When fitting the gear housing **25** to the motor housing **31**, it may be necessary to clamp the two housings together to allow circlip **23** to be fitted. Compress the floating seals with 'G' clamps as shown.

Note: *When clamping, do not exceed a force of 4000N (890 kgf).*

Before fitting cover **4**, fill the gear housing with the recommended oil and apply grease to 'O' ring **5**.

When fitting cover **4**, keep it at right-angles to the axis of the gears as tilting the cover will damage the 'O' ring. Insert snap ring **3** so that its ends are diametrically opposite the removal notch in the gear housing.

If plugs **1** have been disturbed, renew 'O' ring **2**, wrap the plug threads with sealing tape and tighten.



Operation

***801.4 to M721136**
801.5 to M730003
801.6 to M728056

The slew gearbox is of the single step planetary gear arrangement. The gearing converts the high speed rotary motion transmitted from the hydraulic motor into low speed high torque, to obtain pinion shaft rotation.

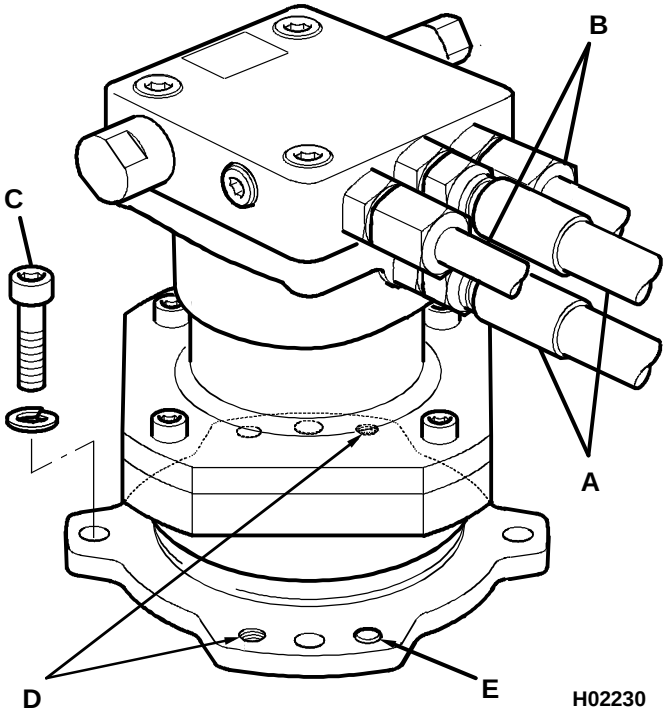
Removal and Replacement

1 Vent residual pressure from within the hydraulic tank by releasing the tank filler cap. Remove and plug both drain line hoses **A** from slew motor. If plugs are not available, the hydraulic tank must be drained.

2 Remove seat and floorplates complete. On cab machines the heater and heater floor plate must also be removed.

***3** Remove pipes or hoses **B** from valve block to motor, cap open ports.

4 Remove bolts **C** securing motor to slew frame. Thread two of the fixing bolts into tapped holes **D** in the motor flange, and progressively tighten. This will jack the motor off its retaining dowels **E** clear of the slew frame.



Dismantling

Drain the gearbox. Unscrew the four screws **1** securing the hydraulic motor to the reduction gear assembly.

Remove the motor shaft spacer **2**.

Remove the planet carrier assembly **3** from the pinion shaft.

Remove the circlip **4** and withdraw the gear assembly from the mounting pin **5**, remove the thrust washer **6** and needle bearings **7** from the gear **8**.

Remove the circlip **9** from the pinion shaft.

Using a suitable press remove the pinion shaft **10**. Press out the outer race of bearing **11**. Press out bearing **12** and oil seal **13**.

Remove 'O' ring **14**.

Assembly

Apply grease to both sides of the oil seal **13** and press fit into body **14.**

Press the inner race of bearing **11** onto the pinion shaft,

***Note:** The shielded side of the bearing should be next to the pinion.*

Fill the grease reservoir between the oil seal and the bearing with JCB MPL Grease.

Press the pinion and bearing into body **14**.

Press bearing 12 into body **15** and fit circlip **9**.

Assemble gear **8**, needles **7**, and thrust washer **6** to the mounting pins **5**, secure with thrust washer **6** and circlip **4**.

Place the carrier assembly **3** into body **15** engaging with the pinion shaft splines.

Apply grease to the recess in body **16** and fit a new O ring **14**.

Place the spacer **2** at the centre of carrier **3**.

Fit body **16** onto body **15** and secure with four screws, torque tighten to 25 - 32Nm.

Fill the motor with hydraulic fluid.

Slew Gearbox

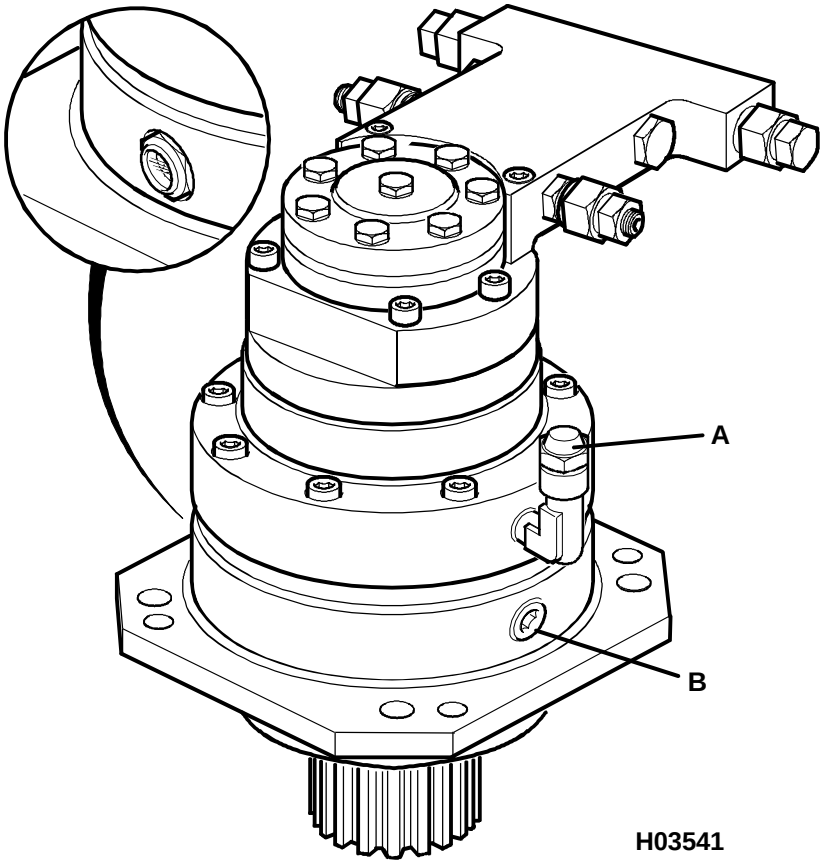
***801.4 from M721137 to M722495 (small valve)**
from M722496 on (large valve)

Checking The Slew Gearbox Oil Level

Position the machine on level ground and stop the engine. Remove floor mat and unbolt cab/canopy floor plate. Locate slew gearbox and remove breather cap **A** located in the level plug port. Oil should appear in the bottom of the elbow, on later machines an oil level sight gauge is fitted to the gearbox.

Changing The Oil

Operate the slew service to thoroughly warm the lubricating oil. Position the machine on level ground and remove the floor plate. Clean slew gearbox around drain plug **B**. Remove breather **A** and plug **B** to drain the oil. Clean magnetic drain plug **B** and refit. Fill with oil to correct level via breather tube. Refit breather **A**.



Removal and Replacement

WARNING

Fine jets of hydraulic oil at high pressure can penetrate the skin. Do not use your fingers to check for hydraulic oil leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leak and then inspect the cardboard for signs of hydraulic oil. If hydraulic oil penetrates your skin, get medical help immediately.

HYD-001

Access to the gearbox is simplified by removal of the cab.

When Removing

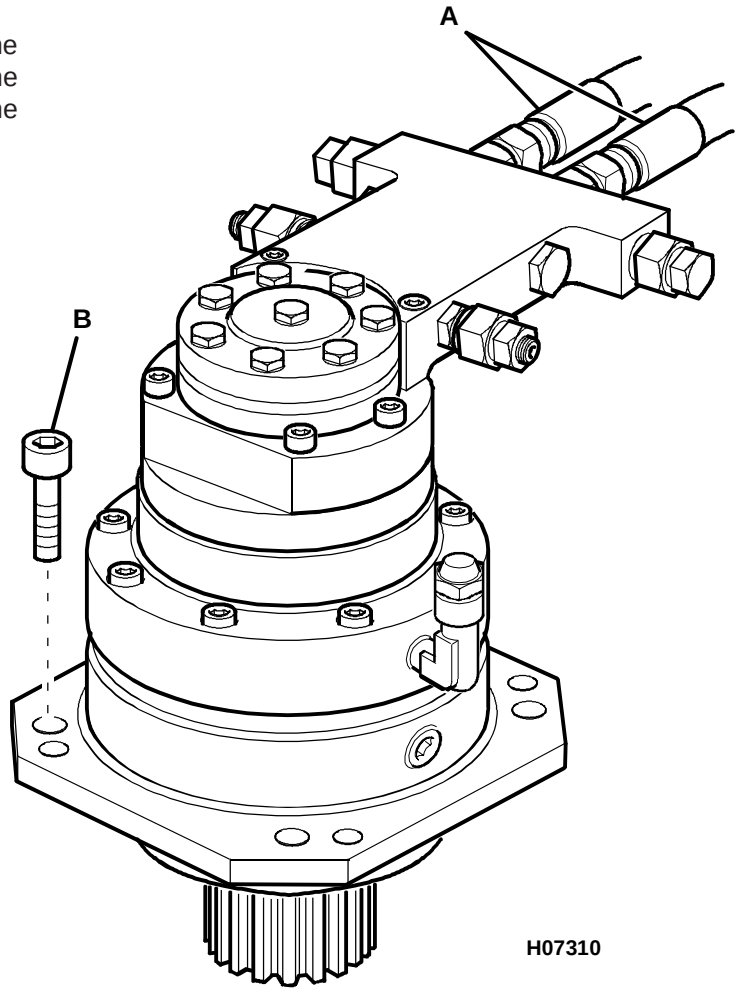
1 Vent residual pressure from within the hydraulic tank by releasing the tank filler cap. Remove seat, floor matting and floorplates as required to gain access to the slew motor.

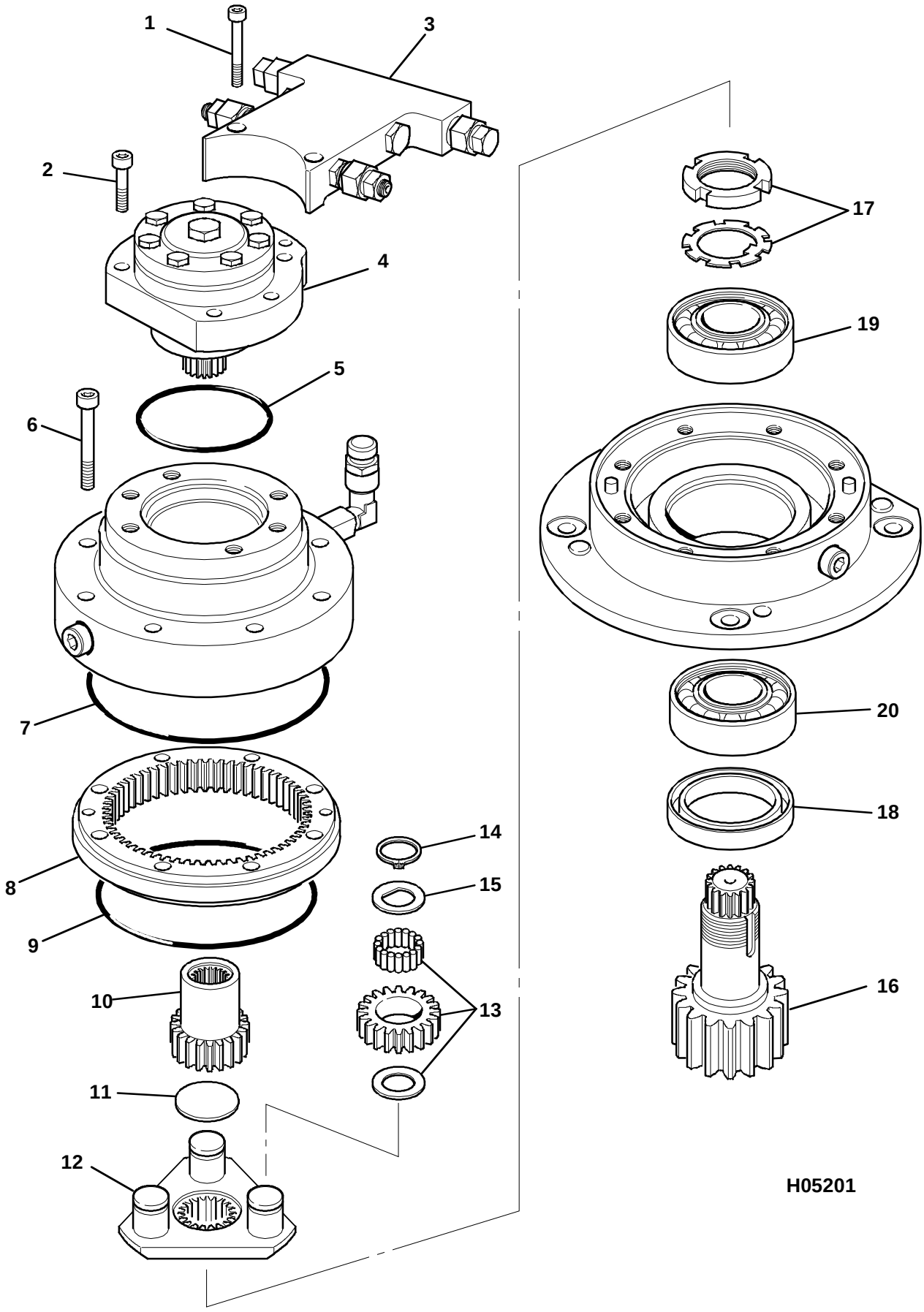
2 Remove hydraulic hydraulic hoses **A** from the slew motor. Blank off the hoses and ports.

3 Remove bolts **B** securing the slew gearbox to the slew frame. Using two M12 jacking bolts ease the gearbox from its mounting dowels and clear of the machine.

When Replacing

1 Replace in the reverse order of removal.





Dismantling and Assembly

When Dismantling

Note: *Before starting, mark the gearbox casing sections to ensure correct re-assembly.*

The numerical sequence is a guide to dismantling, for assembly the sequence should be reversed.

1 Ensure the gearbox has been drained of oil.

2 Remove capscrews **1** and **2.** to remove crossline relief valve assembly **3** and hydraulic motor **4.** Remove 'O' ring **5** and discard.

3 Remove capscrews **6** and separate gearbox casings. Discard 'O' ring **7**,

4 Mark the position of the annulus **8** and pry it free from the locating dowels. Discard 'O' ring **9**,

5 Remove coupling **10**, taking care not to loose the disc **11.** Lift out planet carrier **12** and if necessary withdraw planets **13** by removing circlip **14** and thrust washer **15.**

6 To dismantle pinion **16** from casing, remove nut and tab washer **17** and press out the pinion. Discard seal **18**. Carefully tap out and discard the bearings **19** and **20** if they show any signs of wear.

When Assembling

Assembly is a reversal of the disassembly procedure

If installing new bearings ensure that they seat completely into the casing recess.

1 Install new seal **18** packing with JCB MPL grease.

2 Press pinion into casing through bearings, install tab washer and nut **17**.

3 Renew 'O' ring **9** before replacing annulus **8** taking care to align it in its original position.

4 If necessary rebuild planet carrier **12** with its planet gears, new bearings and thrust rings.

5 Replace coupling **10** along with the disc. If necessary these can be held in place with JCB MPL grease.

***6** Renew 'O' ring **7** and replace gearbox top cover aligning marks made when dismantling. Reinstall capscrews **6** and torque tighten to 10.3 Nm (1.05 kgf m, 7.6 lbf ft).

***7** Replace hydraulic motor, renew 'O' ring **5** as the crossline relief valve assembly is reinstalled. Torque set capscrews to 24.8 Nm (2.5 kgf m, 18.3 lbf ft)

Contents **Page No.**

*Technical Data

	Nominal	Tolerance
Steel track (tension)	10 - 15 mm (0.394 - 0.590 in.) clearance	
Elongation of shoe link (length)	370 mm (14.6 in.)	four links + 10 mm (0.394 in.)
Wear of shoe link tread (height)	41 mm (1.6 in.)	- 5 mm (- 0.197 in.) minimum
Grouser wear (height)	7 mm (0.276 in.)	up to 50% of new machine size
Link pin wear (O/D)	12.5 mm (0.492 in)	- 1.5 mm (- 0.059 in) minimum
Link bush wear (O/D)	20.5 mm (0.807 in)	- 1.5 mm (- 0.059 in) minimum
Link bush wear (I/D)	15.5 mm (0.601 in)	+1.5 mm (- 0.059 in) minimum
Wear on idler external surface (width)	48 mm (1.890 in.)	- 8 mm (- 0.315 in.) minimum
Wear on idler external surface (guide width)	15 mm (0.590 in.)	- 6 mm (- 0.236 in.) minimum
Wear on idler (O/D)	213 mm (8.386 in.)	- 5 mm (- 0.197 in.) minimum
Wear on lower roller (guide width)	15 mm (0.590 in.)	- 6 mm (- 0.236 in.) minimum
Wear on lower roller (O/D)	93 mm (3.661 in.)	- 5 mm (- 0.197 in.) minimum
Driven sprocket tip end (O/D)	254 mm (10.000 in.)	- 8 mm (- 0.315 in.) minimum
Driven sprocket tip end (width)	19 mm (0.748 in.)	- 4 mm (- 0.157 in.) minimum

*General Description

The Mini Excavator track and running gear comprises the tracks fitted to the machine, these may be either of steel or rubber construction depending on the option selected, the associated sprockets that transmit drive from the track gearboxes to the tracks and the equipment that provides and maintains the tension of the tracks.

The track and running gear is located on and within the machine undercarriage track boxes.

Tracks

Clean

WARNING

If two people are doing this job make sure that the person operating the controls is a competent operator. If the wrong control lever is moved, or if the controls are moved violently, the other person could be killed or injured.

If you will be working with another person, make sure that you both understand what is to be done. Learn and use the recognised signalling procedures. Do not rely on shouting - he will not hear you.

To clean the tracks, you must turn them. When the tracks are turning, keep clear of rotating parts. Before starting this Job, make sure that you have no loose clothing (cuffs, ties etc.) which could get caught in moving parts. Keep people not involved with this job well away!

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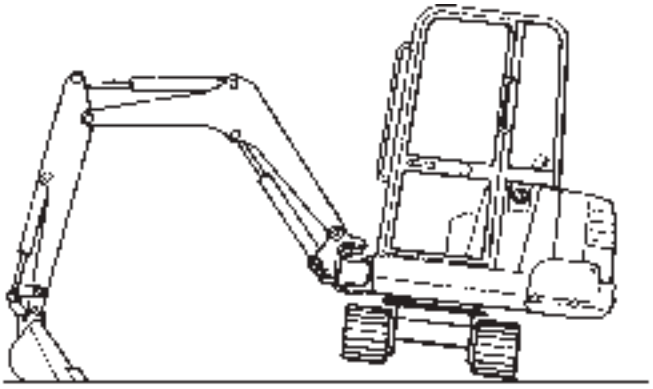
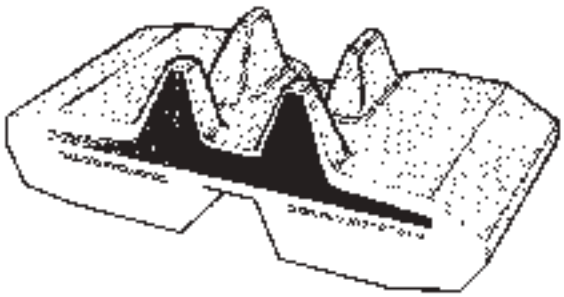


1 Park the machine on level ground. Operate the controls to slew the cab around as shown, lower the bucket to the ground.

2 Raise the track to be cleaned clear of the ground by operating the machine controls with the bucket grounded.

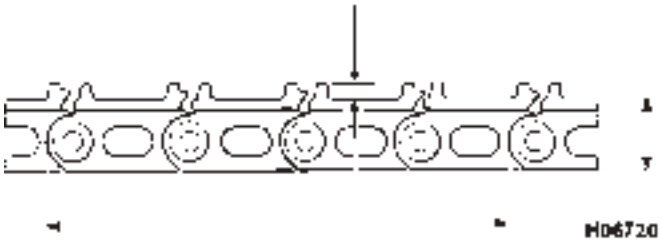
WARNING

Rotating the tracks off the ground may cause stones and other debris to be thrown with considerable force. If you are on the outside, keep well clear. Keep other people well clear.



3 Rotate the raised track in both directions until all mud is shaken off. If necessary hose down the track during rotation to aid cleaning.

Inspect



1 Track rollers, chain wheel sprockets and idler wheels for damage or oil leaks. Replace parts as necessary.

2 Tracks for damage and/or wear, refer to Technical Data, steel track option only. Replace tracks as necessary.

3 On machines fitted with the rubber track option, visually inspect the track and replace if:

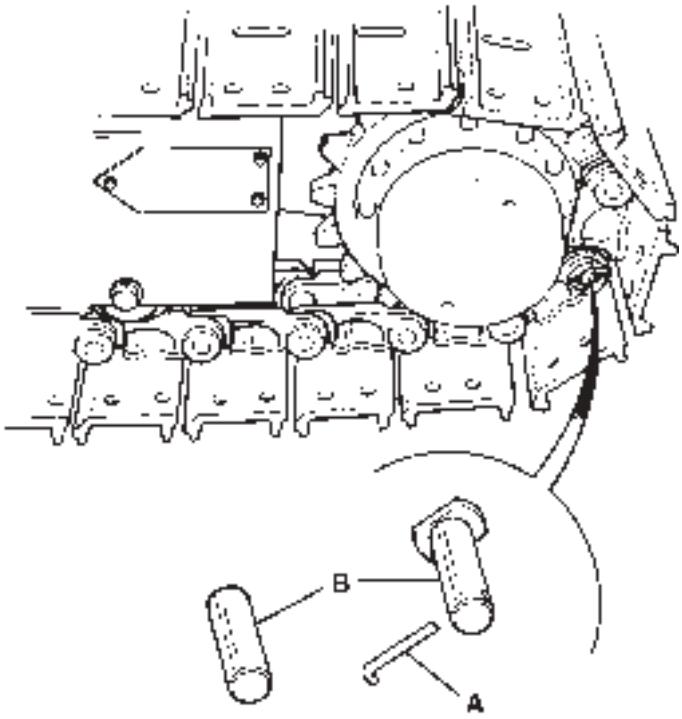
- one or more metal cores are missing.
- steel cord is exposed.
- more than half the track is missing.
- the track comes off although fully tensioned.

Tracks (cont'd)

Removal & Replacement - Steel Track

*__1__ Position the machine so that the master pin **B** is at the front of the track, as shown.

__*2__ Remove the cotter pin **A** (if fitted) and drive out the master pin **B.**



WARNING

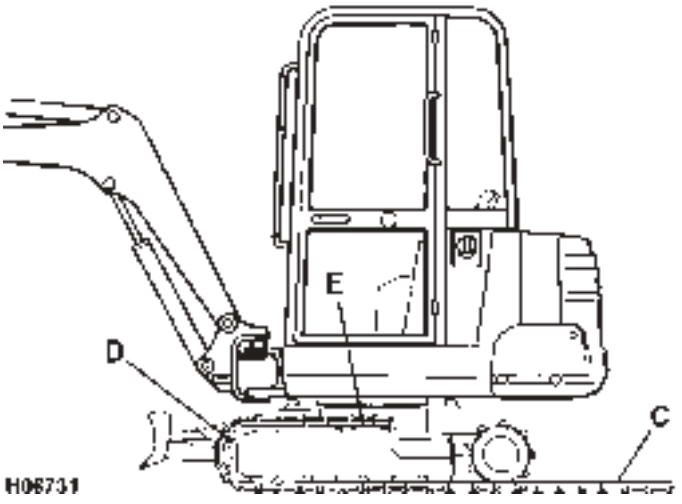
Ensure that all persons are clear of the track and especially of the driven sprocket during the following operations.

3 Slowly reverse the machine until the track is laid on the ground.

WARNING

The following operations must only be undertaken by persons familiar with track changing operations and who are qualified to perform the operations. All persons must keep clear of the machine driven sprocket.

4 Layout the replacement track **C**, behind the machine. Drive the machine onto the new track, guiding the track over the idler wheel **D** and skid plate **E**, until the ends can be joined.



__*5__ Fit the master pin **B** and (if fitted) lock using a new cotter pin **A**.

Tracks (cont'd)

Removal & Replacement - Rubber track

1 Position the machine as shown. Raise the track from the ground.

2 Remove the bolts **A** and take off the cover plate **B**.

3 Back off the adjusting screw **C** to relieve all tension from the track.

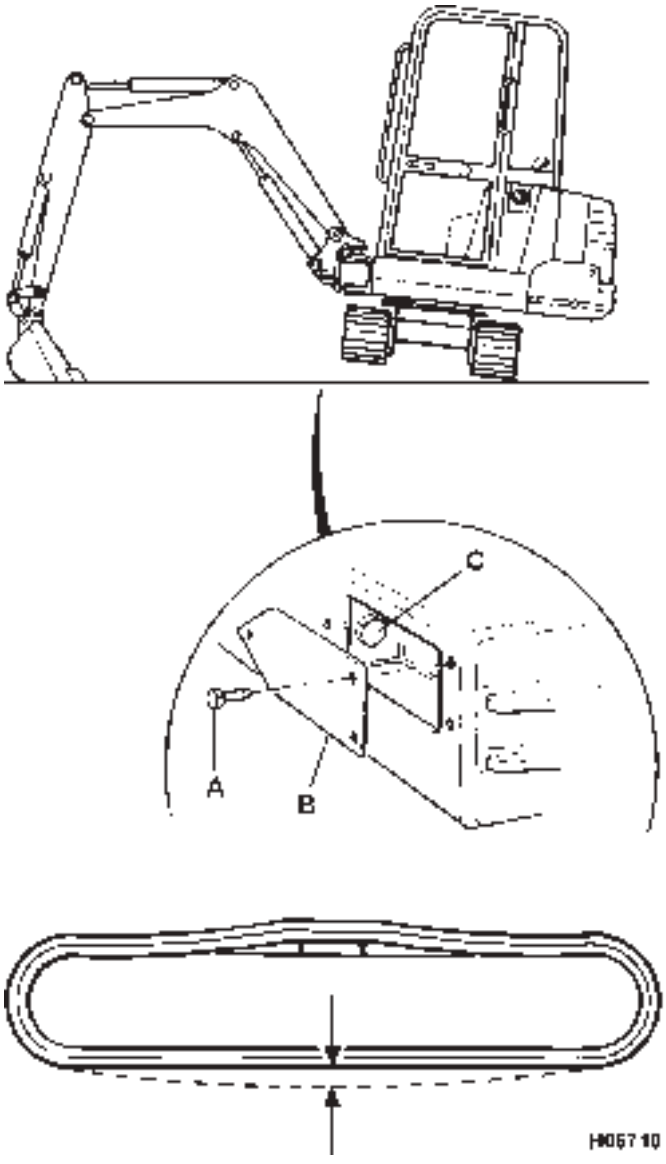
4 Pull the track clear of the machine.

5 Fit replacement track to the machine.

6 Tension the track, see 'Track Tensioning' below.

7 Replace the cover plate **B** and secure using the screws **A**.

8 Lower the track to the ground.



Track Tensioning

1 Position the machine as shown.

2 Remove the bolts **A** and remove the cover plate **B**.

3 Check the track tension at the position shown. The tension should be 10 - 15 mm (0.4 - 0.6 in.).

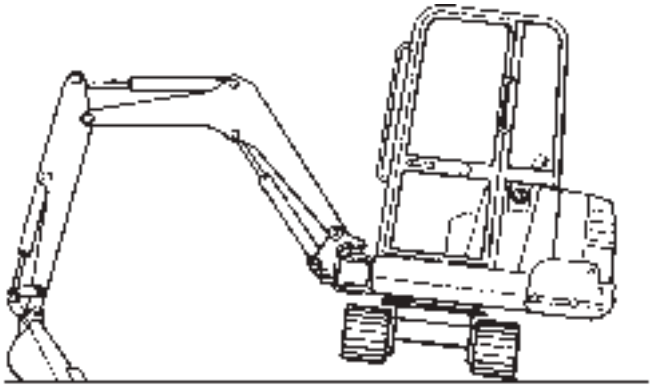
4 Turn the adjusting screw **C** to obtain the correct tension.

Note: *After adjustment the screw must be positioned so that the pin protruding from the head of the screw is pointing outwards in a horizontal attitude. This will allow the pin to locate correctly in the cover plate and prevent the adjusting screw from moving.*

5 Run track after adjustment. Stop the track and recheck the tension.

6 Refit the cover plate. Lower the track to the ground.

Track Rollers - Dismantling and Assembly



When Dismantling

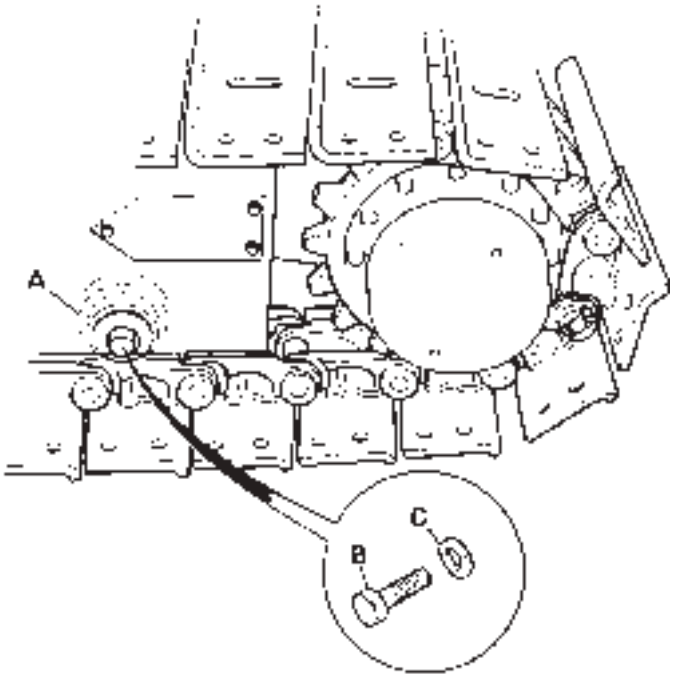
WARNING

A raised and badly supported machine can fall on you. Position the machine on a firm, level surface before raising one end. Ensure the other end is securely chocked. Do not rely solely on the machine hydraulics or Jacks to support the machine when working under it

Disconnect the battery, to prevent the engine being started while you are beneath the machine.

GEN-001

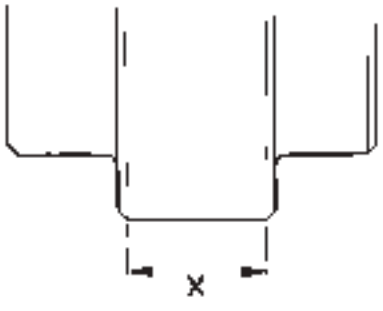
1 Set the machine in the posture shown. Fit suitable supports under the machine lower structure. If necessary adjust the track tension to allow the track to drop clear of the rollers.

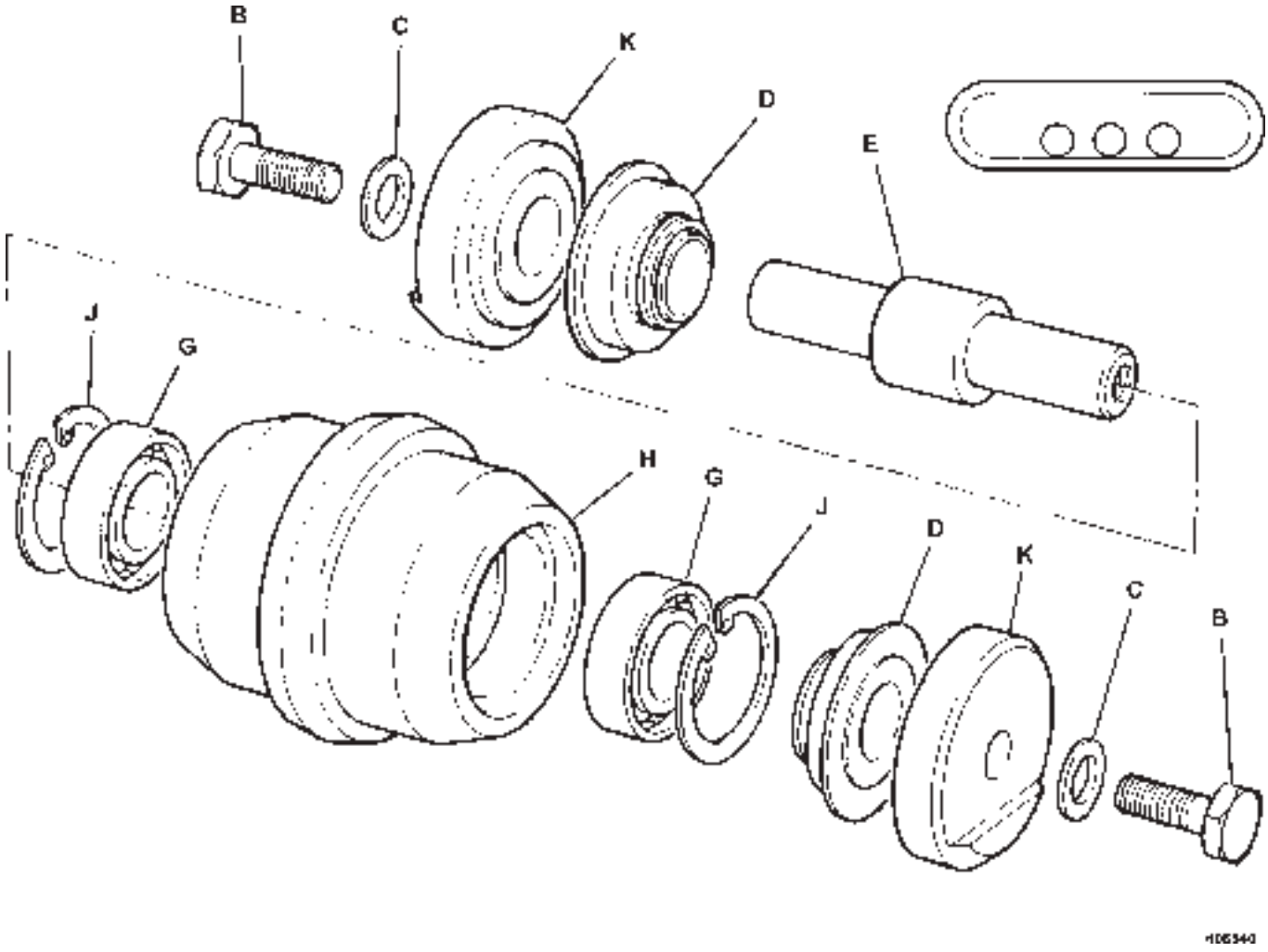


2 Support the roller assembly **A**. Remove the hexagon screws **B** and washers **C**. Lower the roller assembly from the machine.

3 Fit the washers **C** and hexagon screws **B** loosely to the roller assembly, transfer the assembly to a clean working area.

4 Check that the roller diameter, at the outer edges, and the guide width **X** are within permitted limits, see Technical Data. Renew complete roller assembly as necessary.





Track Rollers - Dismantling & Assembly

Note: *Every 2000 hours the seals and oil must be renewed.*

When Dismantling (cont'd)

5 Remove the hexagon screws **B** and washers **C** and take off the roller supports **K**.

6 Remove the lip seal **D** sections from the roller and roller supports **K**.

7 Press the roller shaft **E** from the roller **H**.

Inspection

1 Inspect and maintain the lip seals **D.**

2 Check that the roller bearings **G** run freely and smoothly and that there is no discolouration, scratching, pitting, or corrosion. Renew as necessary.

3 If necessary, remove circlips **J** and bearings **G** from roller **H**.

When Assembling

1 If necessary, press one of the bearings **G** into the roller **H**. Fit the circlip **J**. Fit the second bearing **G** and circlip **J**.

2 Press the shaft **E** into the roller, ensure that the dimension from each bearing to the shaft end is equal.

3 Fit the lip seals **D** to the roller **H** and roller support **K**.

***4** Fit one roller support **K** to the roller. Secure loosely with special washer **C** and screw **B**.

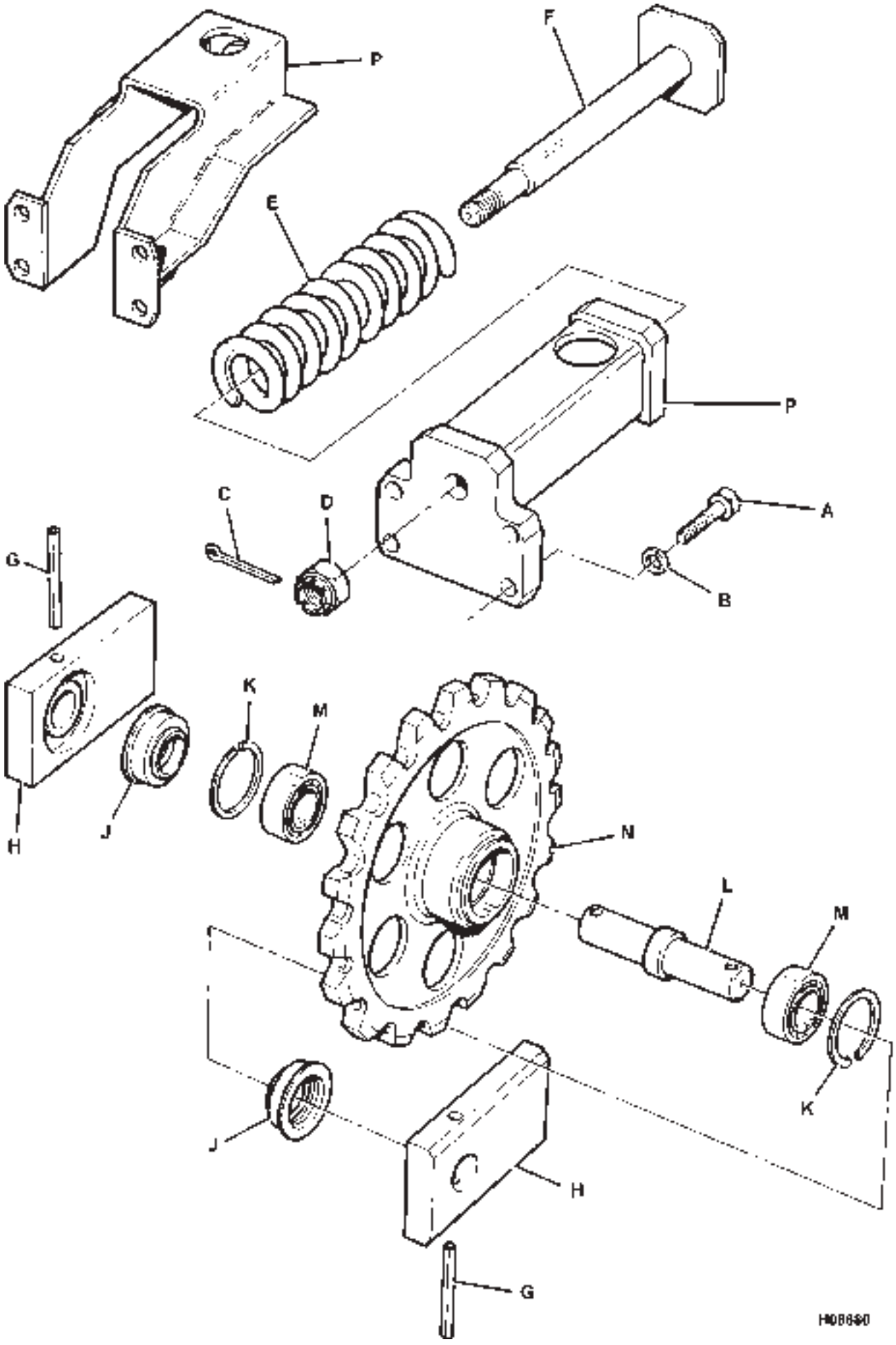
5 Fill assembly with 25 cc of oil, refer to Lubricants & Capacities.

6 Fit the remaining roller support **K**. Secure loosely with special washer **C** and screw **B**.

7 Remove screws **B** and special washers **C**. Locate the roller assembly into the machine, secure using the washers **C** and hexagon screws **B**. Torque the screws to 78-90 Nm (57-67 Ibf ft).

8 Tension the track,

9 Remove the support blocks from under the machine and lower the track.



Idler & Recoil Unit

Note: *Every 2000 hours the seals and oil must be renewed.*

Dismantling

WARNING

The recoil unit spring can cause serious injury if suddenly released. Take great care when removing and replacing the spring retaining nut.

Scrap recoil units must be dismantled before transfer from the workshop.

Do not use flame cutting equipment unless precautions are taken to release the spring pressure slowly.

TRACK 1-9

1 Set up the machine and remove the track (see **Track Removal and Replacement)**.

2 Pull the idler and recoil unit clear of the undercarriage.

3 Remove the bolts **A** and washers **B**, separate the idler wheel assembly from the recoil unit.

4 Remove the split pin **C** from the nut **D**.

5 Using a 2.5 to 3 tonne press, compress the spring **E** and remove the nut **D**.

***6** Carefully release the pressure on the unit. Separate the spring **E** and the retainer **F** from the yoke **P**.

7 Drive out the tension pins **G** and remove the end mountings **H**.

***8** Remove the seal section **J** from the idler wheel **N**.

***9** Remove circlips **K** and press the idler wheel shaft **L** with bearings **M** out of the idler wheel.

***10** Press the shaft **L** out of the bearings **M**.

Assembly

***1** Press the bearings **M** onto the shaft **L** until they abut the shoulder.

***2** Press the shaft and bearings assembly into the idler wheel until both circlip grooves are exposed. Fit circlips **K**.

3 Fit new seal sections **J** to the shaft. Fit an end mounting **H** to one end of the shaft **L** and secure with new tension pin **G**.

4 Fill the assembly with 25 cc of the recommended oil.

5 Fit remaining end mounting **H** to other end of the shaft and secure with tension pin **G**.

***6** Assemble the spring **E** and retainer **F** onto the yoke **P**.

7 Using a 2.5 to 3 tonne press, compress the spring until the threaded end of the retainer locates through the hole in the yoke plate.

8 Fit the nut **D** to the retainer **F** and tighten the nut to achieve a spring length of 225 mm (8.86 in.) when the press load is released.

9 Release the pressure on the spring. Re-check the spring length detailed in Step **8** and re-adjust until the length is correct with the press released. Lock with a new split pin **C**.

***10** Locate the idler wheel assembly into the yoke **P**.

11 Secure the idler wheeel assembly to the yoke using bolts **A** and spring washers **B**. Torque tighten the bolts to 98 Nm (72 lbf ft).

12 Fit the idler wheel/recoil unit into the undercarriage. Ensure the assembly moves freely in the undercarriage.

13 Refit the track (see **Track Removal and Replacement**).

14 Set the track tension (see **Track Tensioning**).

*Changing from Rubber to Steel Tracks

1 Remove the rubber tracks, see Rubber Tracks - Removal and Replacement, this section.

2 Remove the track rollers, see Track Rollers - Dismantling and Assembly, this section.

3 Fit track guides **A** on each side of the undercarriage and secure with spring washers **B** and screws **C**.

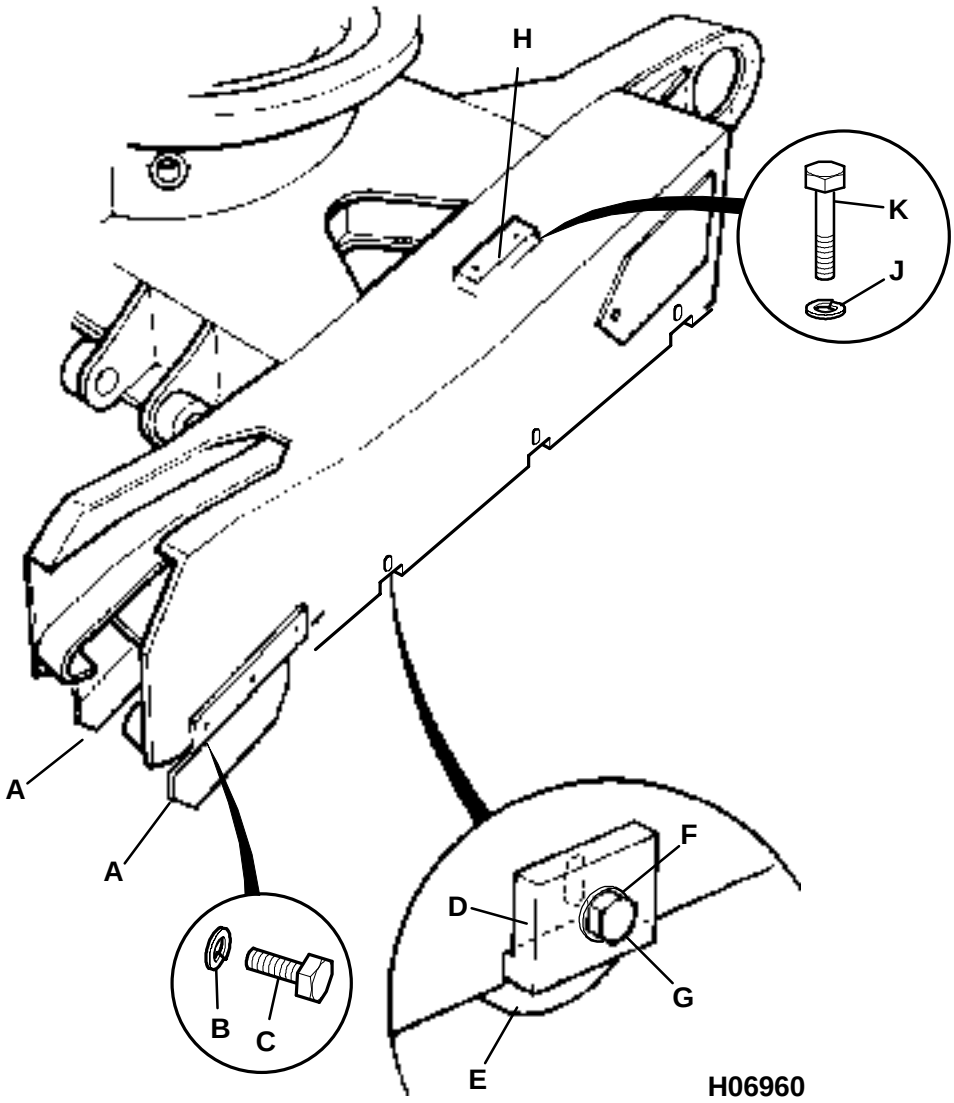
4 At each cut-out in the undercarriage fit a track roller E removed at 2 above, and secure with roller spacers **D**, spring washers **F** and screws **G**.

5 Fit skid plate **H** and secure with spring washers **J** and bolts **K**.

6 Fit the steel track, see Steel Tracks - Removal and Replacement, this section.

7 Tension the track, see Tracks - Track Tensioning, this section.

8 Repeat the above procedure for the other track.



Contents

Technical Data

General

Model		KD 103-10
Type		Vertical in-line, 3 cylinder, normally aspirated, 4 stroke, water cooled diesel.
Swept Volume		954 cm^3 (58.21 in^3)
Bore		75 mm (2.95 in.)
Stroke		72 mm (2.83 in.)
Firing Order		1, 2, 3
Valve Clearance (cold)		0.2 mm (0.0078 in.)
Compression Ratio		23:1
Compression Pressure		24.5 - 29.4 bar (25 - 30 kgf/cm^2, 355 - 425 lbf/in^2)
Injection Timing / Injection Pump		22 - 24^0 B.T.D.C.
Injector Setting	(Working)	112.8 - 122.6 bar (115 - 125 kgf/cm^2, 1636 - 1778 lbf/in^2)
	(Setting)	122.6 - 127.5 bar (125 - 130 kgf/cm^2, 1778 - 1850 lbf/in^2)
Oil Capacity		3.8 litres (0.8 U.K. gallons)
Oil Pressure		2.8 - 4.8 bar (2.9 - 4.9 kgf/cm^2, 42.71 lbf/in^2)
Weight (dry)		83 kg (183 lb)
Idling Speed		1050 rev/min.
Maximum No-load Speed	801.4 / 801.5	2210 - 2220 rev/min.
	801.6	2640 - 2650 rev/min.

Torque Settings	**Nm**	**kgf m**	**lbf ft**
Cylinder Head Bolts	48.81 to 51.53	5.0 to 5.3	36 to 38
Connecting Rod Bolts	29.83 to 33.90	3.0 to 3.5	22 to 25
Flywheel to Crankshaft Bolts	58.30 to 67.80	6.0 to 7.0	43 to 50
Injector Nozzle / Holder Assembly	78.65 to 84.07	8.0 to 8.5	58 to 62
Main Bearing Bolts	24.54 to 29.43	2.5 to 3.0	18.1 to 21.7
Big-end Bearing Bolts	29.43 to 34.30	3.0 to 3.5	21.7 to 25.3
Cooling Fan Bolts	8.81 to 12.88	0.9 to 1.3	6.5 to 9.5

Camshaft and Timing Gears

Cam Height	(new)	26.445 to 26.5 mm (1.041 to 1.043 in.)
	(service limit)	26.1 mm (1.0275 in.)
Timing Gear Backlash	(new)	0.08 mm (0.003 in.)
	(service limit)	0.33 mm (0.013 in.)

Connecting Rod

Gudgeon Pin O.D.	(new)	20.998 to 21.002 mm (0.8266 to 0.8268 in.)
	(service limit)	20.98 mm (0.8259 in.)

Gudgeon Pin Small End Bush

Clearance	(new)	0.008 to 0.023 mm (0.0003 to 0.0009 in.)
	(service limit)	0.08 mm (0.003 in.)
Small End Bush Bore	(fitted)	

Technical Data (cont'd)

Crankshaft

End-float		0.05 to 0.30 mm (0.002 to 0.012 in.)
Crankshaft Alignment	(new)	0.03 mm (0.001 in.) or less
	(service limit)	0.06 mm (0.002 in.)
Main Journal Diameter	(new)	45.964 to 45.975 mm (1.8096 to 1.8100 in.)
	(service limit)	45.9 mm (1.807 in.)
1st Regrind Diameter	(nominal 0.25 mm u/s)	45.714 to 45.725 mm (1.7997 to 1.8001 in.)
	(service limit)	45.65 mm (1.797 in.)
2nd Regrind Diameter	(nominal 0.5 mm u/s)	45.464 to 45.475 mm (1.7889 to 1.7903 in.)
	(service limit)	45.4 mm (1.787 in.)
Big End Journal Diameter	(new)	38.964 to 38.975 mm (1.5340 to 1.5344 in.)
	(service limit)	38.9 mm (1.531 in.)
1st Regrind Diameter	(nominal 0.25 mm u/s)	38.714 to 38.725 mm (1.5241 to 1.5246 in.)
	(service limit)	38.65 mm (1.5216 in.)
2nd Regrind Diameter	(nominal 0.5 mm u/s)	38.464 to 38.475 mm (1.5143 to 1.5147 in.)
	(service limit)	38.4 (1.5118 in.)
Crankshaft Bearing (bush)		
Diameter	(new)	45.964 to 45.975 mm (1.8096 to 1.8100 in.)
1st Regrind Diameter	(nominal 0.25 mm u/s)	45.714 to 45.725 mm (1.7997 to 1.8001 in.)
2nd Regrind Diameter	(nominal 0.5 mm u/s)	45.464 to 45.475 mm (1.7889 to 1.7903 in.)
Main Bearing Oil Clearance	(new)	0.039 to 0.092 mm (0.0015 to 0.0036 in.)
	(service limit)	0.2 mm (0.0078 in.)
Big End Bearing Oil Clearance	(new)	0.035 to 0.083 mm (0.001 to 0.003 in.)
	(service limit)	0.2 mm (0.0078 in.)
Crankshaft Bearing (bush)		
Oil Clearance	(new)	0.039 to 0.106 mm (0.0015 to 0.0041 in.)
	(service limit)	0.2 mm (0.0078 in.)
Fillet Radius (mains)		2.8 to 3.2 mm (0.110 to 0.126 in.)
Fillet Radius (big ends)		2.8 to 3.2 mm (0.110 to 0.126 in.)
Surface Finish of Journals and Thrust Faces		1.6Z
Oil Hole Radius		2.0 to 5.0 mm (0.0787 to 0.196 in.)

Cylinder Head

Distortion of Head Surface	(max)	0.12 mm (0.005 in.)
Piston Protrusion above Cylinder Block		0.45 to 0.75 mm (0.0177 to 0.0295 in.)
Gasket Thickness (tightened)		1.3 mm (0.0051 in.)
Gasket No.		111147280
Valve Seat Angle		45°
Valve Seat Width	(new)	1.7 to 2.1 mm (0.067 to 0.082 in.)
	(service limit)	2.5 mm (0.098 in.)
Valve to Valve Guide Clearance		
- intake	(new)	0.025 to 0.052 mm (0.001 to 0.002 in.)
	(service limit)	0.2 mm (0.008 in.)
- exhaust	(new)	0.045 to 0.072 mm (0.0018 to 0.0028 in.)
	(service limit)	0.25 mm (0.01 in.)

Technical Data (cont'd)

Cylinder Bores		
Bore Diameter	(new)	75.000 to 75.019 mm (2.9527 to 2.9534 in.)
	(service limit)	75.2 mm (2.9606 in.)
1st Rebore Diameter	(nominal 0.5 mm o/s)	75.500 to 75.519 mm (2.9724 to 2.9731 in.)
	(service limit)	75.7 mm (2.9803 in.)
2nd Rebore Diameter	(nominal 1.0 mm o/s)	76.000 to 76.019 mm (2.9921 to 2.9928 in.)
	(service limit)	76.2 mm (2.9999 in.)
Fuel Injectors		
Nozzle Opening Pressure		112.7 to 122.6 bar (115 to 125 kg/cm^2, 1636 to 1778 lbf/in^2)
Dry Nozzle at Valve Seat Pressure Tightness		98.07 bar (100 kg/cm^2, 1422 lbf/in^2)
Oil Pump		
Rotor Lobe Clearances	(new)	0.01 to 0.15 mm (0.0004 to 0.0060 in.)
	(service limit)	0.25 mm (0.01 in.)
Rotor to Cover Clearance	(new)	0.10 to 0.15 in. (0.004 to 0.006 in.)
	(service limit)	0.2 mm (0.008 in.)
Pistons and Rings		
Gudgeon Pin Boss I/D	(new)	20.998 to 21.002 mm (0.8266 to 0.8268 in.)
	(service limit)	20.98 mm (0.8259 in.)
Ring Gap		
- No. 1 ring	(new)	0.15 to 0.27 mm (0.0059 to 0.0106 in.)
	(service limit)	1.0 mm (0.039 in.)
- No. 2 ring	(new)	0.12 to 0.24 mm (0.0047 to 0.0090 in.)
	(service limit)	1.0 mm (0.039 in.)
- Oil ring	(new)	0.20 to 0.35 mm (0.0078 to 0.0137 in.)
	(service limit)	1.0 mm (0.039 in.)
Ring to Groove Side Clearance		
- No. 1 ring	(new)	0.06 to 0.10 mm (0.0020 to 0.0039 in.)
	(service limit)	0.25 mm (0.0098 in.)
- No. 2 ring	(new)	0.05 to 0.09 mm (0.0019 to 0.0035 in.)
	(service limit)	0.25 mm (0.0098 in.)
- Oil ring	(new)	0.02 to 0.06 mm (0.0007 to 0.0020 in.)
	(service limit)	0.15 mm (0.0059 in.)
Radiator		
Cap Opening Pressure		0.73 to 0.93 bar (0.75 to 0.95 kg/cm^2, 6.5 to 10.8 lbf/in^2)
Thermostat		
Opening Temperature		
- Starts to open		69.5 to 72.5 deg. C
- Fully open		82 deg. C
Lift		8 mm (0.315 in.)

Technical Data (cont'd)

Valve and Springs		
Valve Stem Diameter	(intake)	6.955 to 6.970 mm (0.2738 to 0.2744 in.)
	(exhaust)	6.94 to 6.95 mm (0.273 to 0.274 in.)
Valve Stem to Guide Clearance		
- intake	(new)	0.03 to 0.06 mm (0.001 to 0.002 in.)
	(service limit)	0.2 mm (0.007 in.)
- exhaust	(new)	0.050 to 0.075 mm (0.002 to 0.003 in.)
	(service limit)	0.25 mm (0.01 in.)
Valve Head Thickness	(new)	0.925 to 1.075 mm (0.036 to 0.042 in.)
	(service limit)	0.2 mm (0.007 in.)
Valve Face Angle		45°
Valve Recessing	(new)	0.85 to 1.15 mm (0.034 to 0.045 in.)
	(service limit)	1.8 mm (0.071 in.)
Spring Free Length	(new)	35 mm (1.4 in.)
	(service limit)	33.5 mm (1.3 in.)
Spring Fitted Length		30.4 mm (1.197 in.)
Load to Compress to Fitted Length	(new)	79.43N (8.1 kgf, 17.9 lbf)
	(service limit)	68.65N (7.0 kgf, 15.4 lbf)
Spring Squareness	(new)	3.4%
	(service limit)	6.0%
Rocker Shaft Diameter	(new)	11.65 to 11.67 mm (0.459 to 0.460 in.)
	(service limit)	11.57 mm (0.456 in.)
Rocker Arm Running Clearance	(new)	0.032 to 0.068 mm (0.001 to 0.002 in.)
	(service limit)	0.2 mm (0.008 in.)

Engine Oil

Draining and Filling - *for interval see Service Schedule*

Draining

1 Park the machine on firm level ground. Lower the excavator to the ground.

2 Stop the engine and remove the starter key.

3 Open the engine cover.

4 Place a suitable container beneath the engine oil drain plug to catch the oil.

5 Remove the drain plug **A** and let the oil drain out.

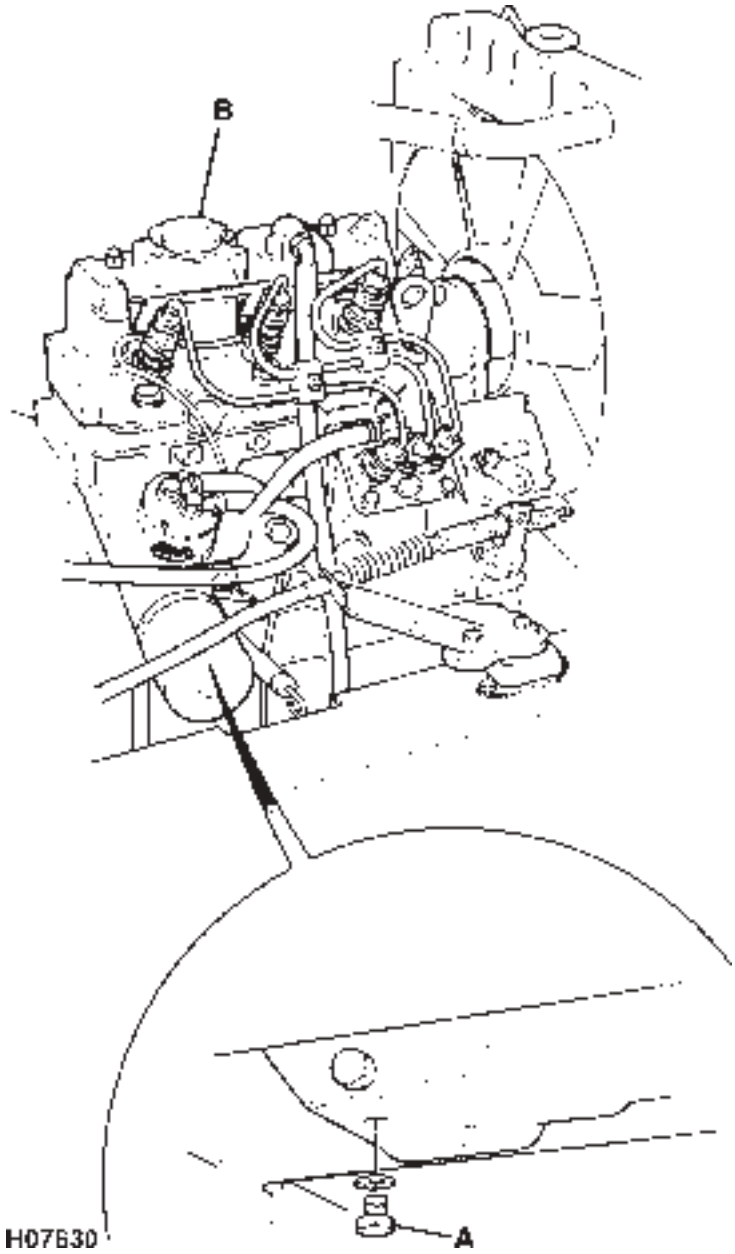
Filling

1 Clean the drain plug **A** and refit it. Make sure it is tight.

2 Fill the engine slowly with new oil through the filler cap **B**. Do not pour the oil in too quickly as it will come out and flow over the engine.

***3** Remove fuel solenoid fuse from fuse box to prevent engine starting. Turn the engine until the oil pressure warning light goes out. Replace fuel solenoid fuse.

4 Check for leaks and top up if necessary with new oil.



Oil Filter

Renewing - *for interval see Service Schedule*

***1** Drain the engine oil.

2 Unscrew the filter canister **A**. If necessary use a chain or strap wrench.

3 Clean the filter mounting head **B**.

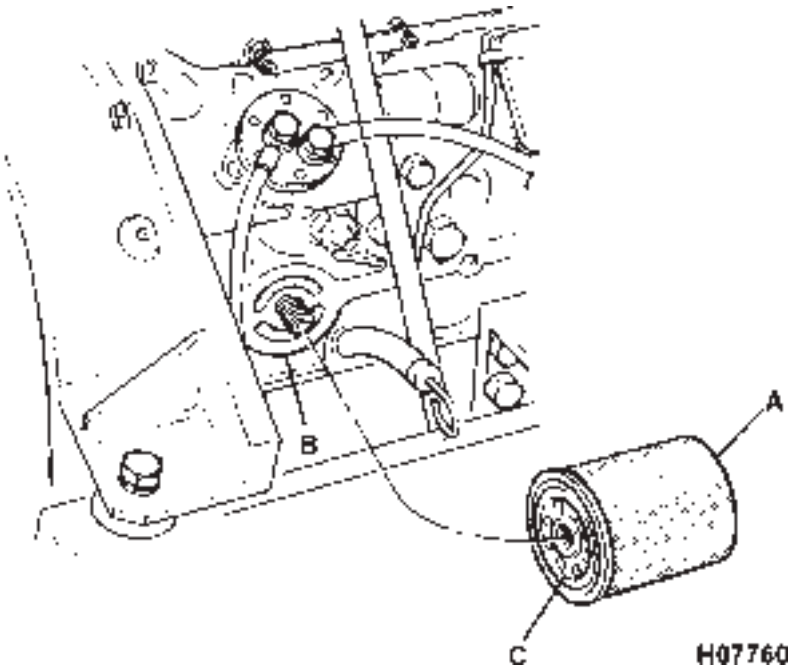
4 Smear the new seal **C** with oil.

5 Screw in the new filter canister - hand tight and thenone quarter turn.

6 Fill the engine with new oil.

***7** Remove fuel solenoid fuse from fuse box to prevent engine starting. Turn the engine until the oil pressure warning light goes out. Replace fuel solenoid fuse.

8 Check for leaks and top-up the engine with oil.



Oil Pressure Relief Valve

Removal and Replacement

Removing

1 Loosen and remove the relief valve **A**.

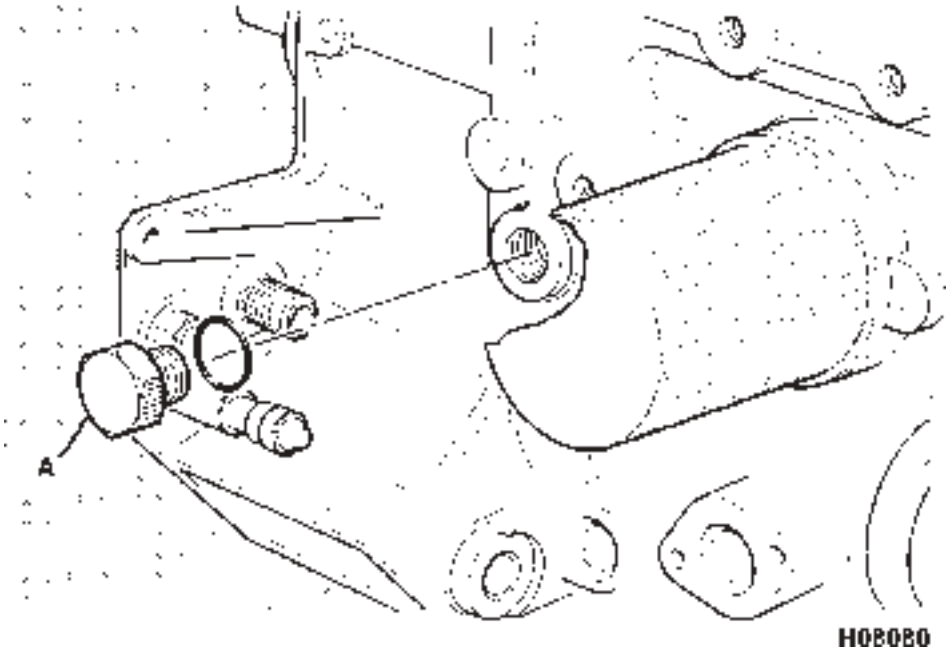
Replacing

1 Fit a new '0' ring to the relief valve **A**.

2 Insert the valve in the cylinder block and tighten.

Torque Settings

Item	Nm	kgf m	lbf ft
A	59-69	6.0-7.0	43-50



Oil Sump, Suction Pipe and Strainer

Removal and Replacement

Removing

1 Drain the engine oil.

2 Remove all the sump bolts and remove the sump and gasket.

3 Loosen and remove the bolts **A** and remove the strainer **B**.

4 Rotate the pipe **C** and remove the pipe from the cylinder block.

5 Remove and discard the '0' ring **D** from the pipe **C**.

Note: *Engine is shown inverted.*

Replacing

1 Fit a new 'O' ring **D** to the pipe **C** and insert the pipe into the cylinder block.

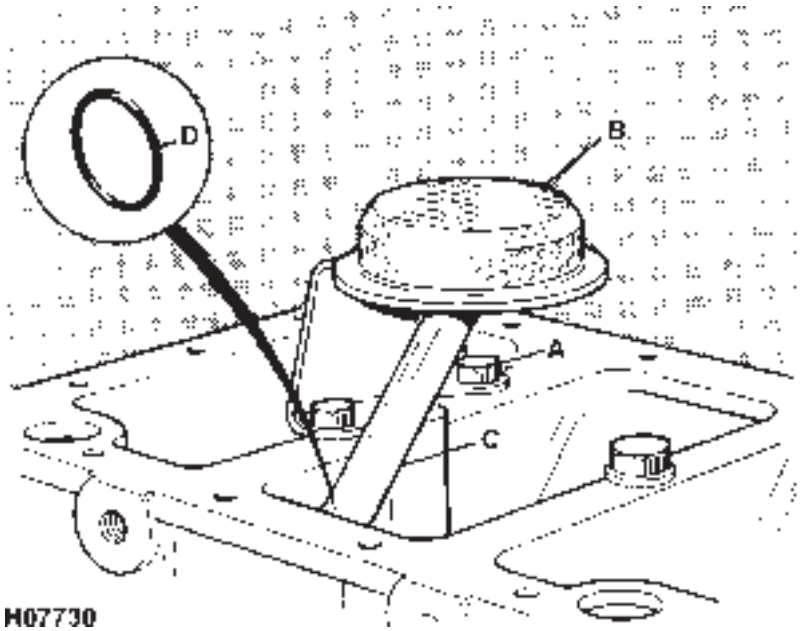
2 Fft the strainer **B** to the pipe **C**.

3 Fit the bolts **A** and tighten.

4 Fft the sump with a new gasket. Tighten the bolts diagonally and evenly.

Torque Settings

Item	Nm	kgf m	lbf ft
A	9-13	0.9-1.3	6.5-10



Fuel Filter

Renewing *for interval see Service Schedule*

1 Disconnect the battery.

2 Support the bowl **A**.

3 Unscrew bolt **B**.

4 Remove the bowl and element **C**.

5 Wash the bowl in clean fuel.

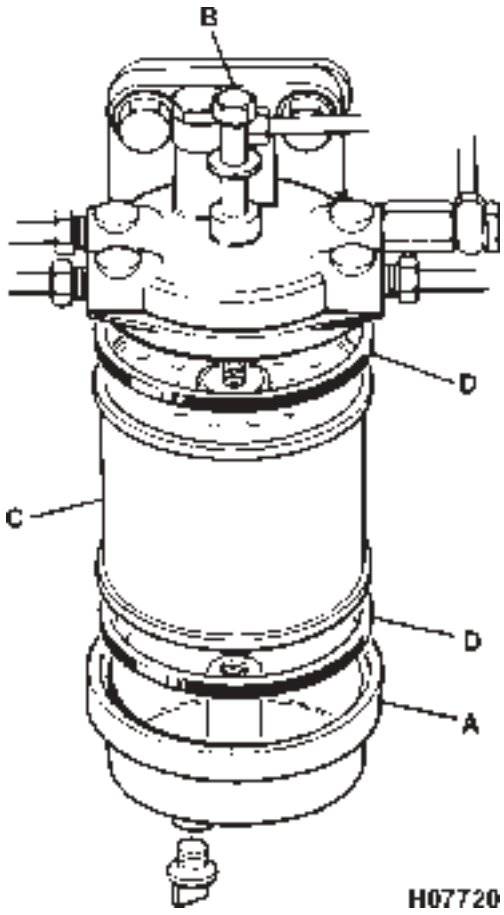
6 Install the element **C** with new seals **D**. Make sure they seat correctly.

7 Tighten bolt **B**.

8 Check for leaks.

9 Bleed the fuel system.

10 Reconnect the battery.



Fuel Lift Pump

Removal, Inspection and Replacement

Removing

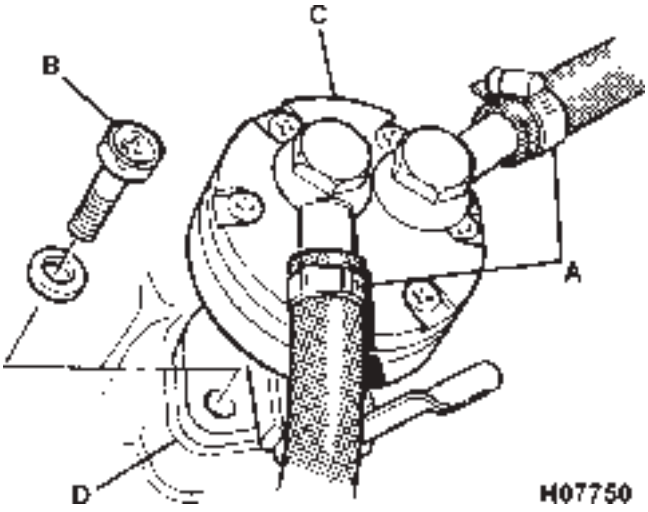
1 Loosen the clamp **A** and remove the fuel lines.

2 Remove the two securing bolts **B** complete with washers.

3 Remove the fuel lift pump **C**.

4 Remove the gasket **D**.

5 Drain any fuel from the lift pump.



Inspecting

1 Examine for damage, cracks etc.

2 Make sure that the bottom body **E** and the piston **F** are not seized.

3 Check the top body **G** as follows:
- draw air from the **IN** side using a vacuum and blow air into the **OUT** side.
- if the air stops in both cases, the body is normal.

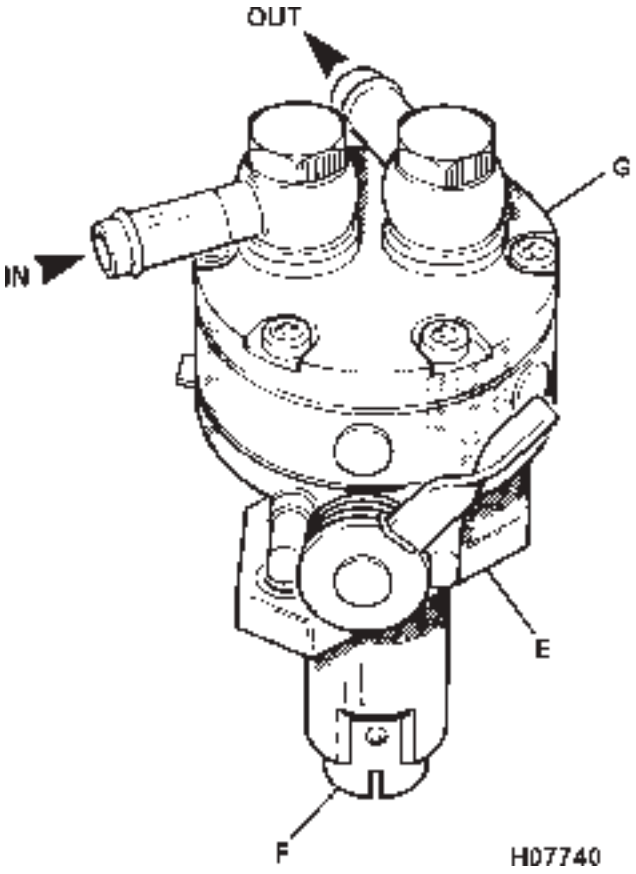
Replacing

1 Install a new gasket **D** on the fuel lift pump.

2 Insert the fuel lift pump **C** in its bore.

3 Fit the two securing bolts **B** and washers and tighten them.

4 Fit the fuel lines and tighten the clamps **A**.



Fuel Injection Pump Assembly

Removal and Replacement

Removing

1 Remove fuel pipe assembly from injectors and fuel pump.

2 Remove the two mounting bolts **A** and nuts **B**.

3 Carefully lift the fuel injection pump until access to the link snap pin **C** is gained.

4 Disconnect the link **D** and remove the fuel injection pump.

5 Remove the shim(s) **E**. Record the number and thickness of the shim(s) for re-assembly.

Replacing

1 Put the shim(s) **E** in position.

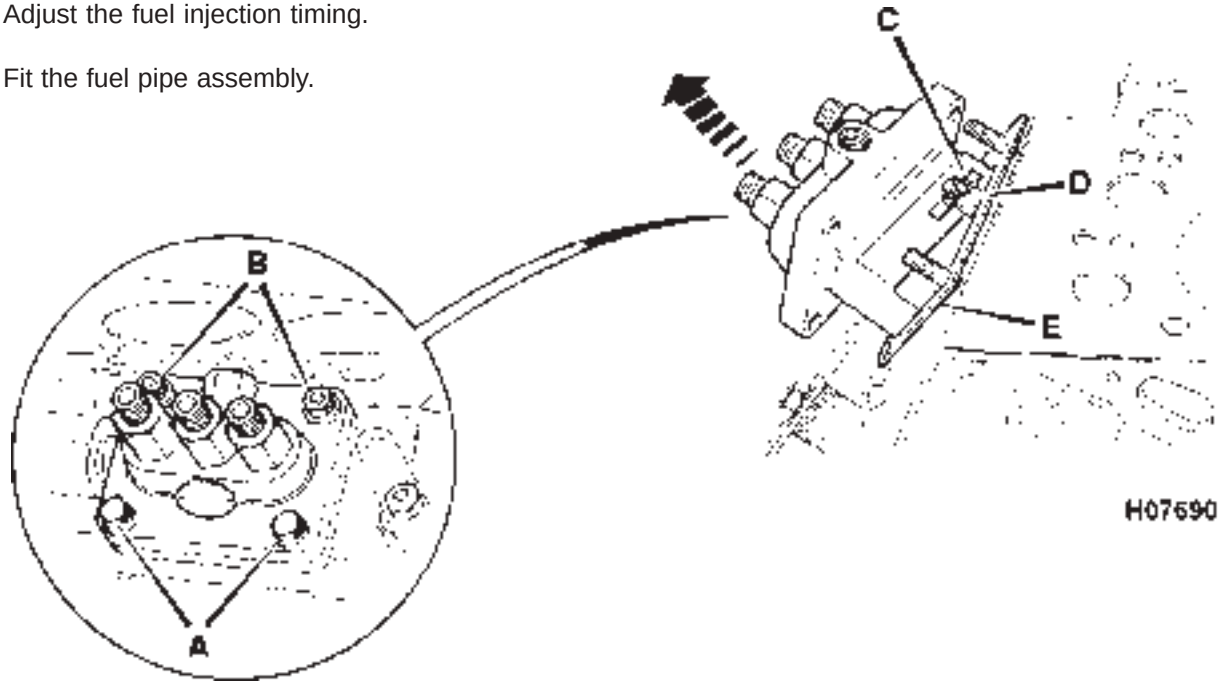
2 Position the fuel pump and connect the link **D**. Fit the snap pin **C**.

3 Install the fuel pump and fit the mounting bolts **A** and nuts **B**.

4 Tighten the mounting nuts and bolts.

5 Adjust the fuel injection timing.

6 Fit the fuel pipe assembly.



Fuel Injection Timing

Checking and Adjusting

- for interval see Service Schedule

This procedure provides the correct injection timing. If the fuel injection pump, the camshaft assembly, or the cylinder block have been renewed carry out this check. When renewing the fuel injection pump start with a shim of 0.5 mm (0.0197 in.) thickness.

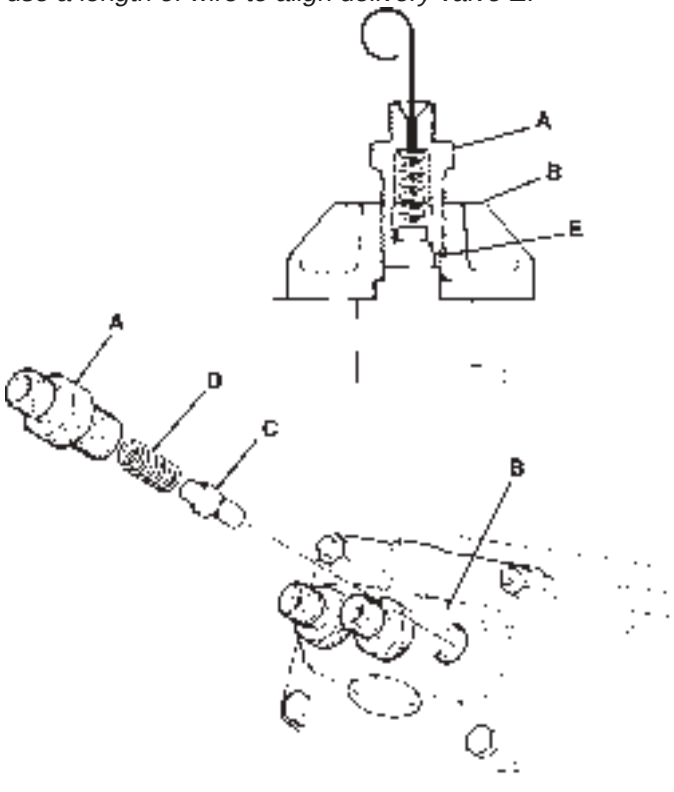
1 Remove the fuel pipe assembly.

2 Remove the delivery valve holder **A** at the front (radiator side) of the fuel injection pump **B**.

3 Remove the delivery valve (**IN**) **C**.

4 Refit the spring **D** and the delivery valve holder **A** in the injection pump **B**.

Note: *When re-assembling the delivery valve holder **A**, use a length of wire to align delivery valve **E**.*



H07490

Piston Position and Crankshaft Angle (BTDC)

Crankshaft Angle (°BTDC)	Piston Position mm (in.)
14	1.409 (0.0555)
15	1.615 (0.0636)
16	1.836 (0.0723)
17	2.069 (0.0815)
18	2.317 (0.1015)
19	2.577 (0.1116)
20	2.851 (0.1122)

Piston Position and Crankshaft Angle (BTDC)

Crankshaft Angle (°BTDC)	Piston Position mm (in.)
21	3.138 (0.1235)
22	3.438 (0.1353)
23	3.750 (0.1476)
24	4.075 (0.1604)
25	4.413 (0.1737)
26	4.763 (0.1875)
27	5.125 (0.2018)

5 Move the governor control lever to maximum fuel position. Slowly turn the crankshaft clockwise until No. 1 piston is a little before **'X'** degrees BTDC on its compression stroke and continue turning until fuel starts to flow from the delivery holder.

6 Then slowly turn the crankshaft clockwise until fuel flowing from delivery holder is stopped. Check the piston position at this point. If the position is before **'Y'** BTDC, use a thicker shim. If the position is later than **'Y'** BTDC, use a thinner shim.

Note: *Changing the shim thickness by 0.1 mm (0.004 in) will change the timing by approximately one degree. Increasing the shim thickness makes the timing later (i.e. decreases the angle), while decreasing the shim thickness makes the timing earlier (i.e. increases the angle). When no shims are needed, assemble with a coating of liquid sealant.*

Shims are available in the following thicknesses (for part numbers see parts microfiche): 0.2 mm, 0.3 mm, 0.4 mm, 0.5 mm.

Injection Timing and Crankshaft Positions

Engine Model No.	Degrees Crank BTDC		
	X	Y	Injection Timing
KD 503 16	24	23	22 - 24

7 Remove the delivery valve holder **A** and fit the delivery valve (**IN**) **C**.

8 Refit the delivery valve holder **A** and torque tighten.

9 Refit the fuel pipe assembly.

Torque Settings

Item	Nm	kgf m	lbf ft
A	39-45	4-4.5	29-33

Fuel Injectors and Fuel Pipe Assembly

Removal, Dismantling/Inspecting

Removing

1 Loosen the fuel pipe nuts **H** from the injectors and the fuel injector pump.

2 Remove the fuel pipes as an assembly.

3 Remove the spring clamp **J** and the fuel return hose **K**.

4 Loosen and remove the Banjo bolt and three securing nuts **L**. Remove the leak-off rail **M**. Remove and discard the three aluminium washers **N**.

5 Remove the injectors and discard the cap **P** and gaskets **Q**.

Dismantling/Inspecting

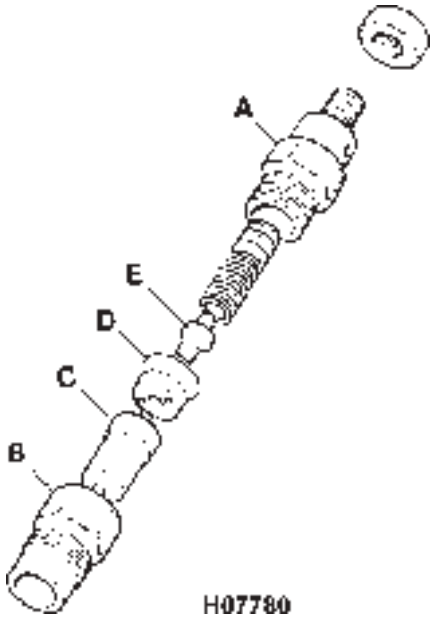
1 Carefully place the nozzle holder (body) **A** in a vice and turn the nozzle nut **B** to disassemble.

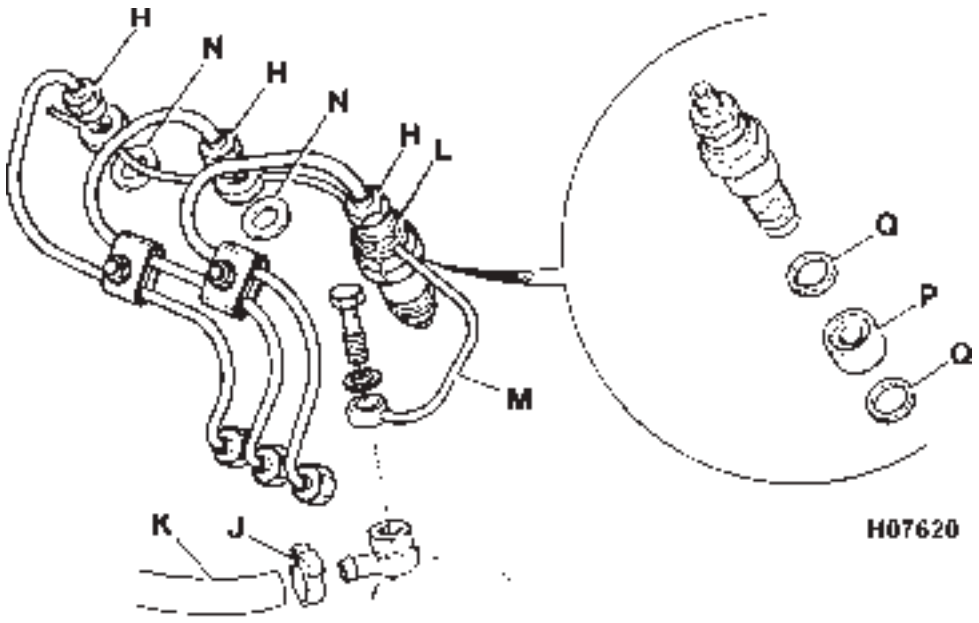
Note: *Care should be taken the needle valve does not fall when the nozzle **C** is removed.*

2 Wash the nozzle body and needle valve and inspect the nozzle for seizure, sticking and fuel leakage on the seat surface. If fuel leakage is detected, replace the nozzle.

3 Inspect the upper and lower contact surfaces of the distance piece **D** and correct so that positive contact can be obtained.

4 Check the nozzle needle valve-contact surface on the push rod **E** for wear, and spring seat for cracks.





Fuel Injectors and Fuel Pipe Assembly (cont'd)

Reassembly/Adjusting and Replacement

Reassembling/Adjusting

1 Before fitting a new nozzle assembly, soak it in heated light oil (50° - 60°C, 122° - 140°F) to remove anti-corrosive agent from the nozzle. Then slide the body on the needle valve so that they slide smoothly.

2 Turn the nozzle body upside down, fit the shims **F**, spring **G**, rod **E**, spacer **D** and nozzle **C**, in this order, and tighten with nozzle nut **B**.

3 After reassembly, check the injection pressure of the nozzle, adjust as required.

WARNING

Avoid contact with the fuel spray and do not inhale the fumes. Keep naked flames away and do not smoke while working on the Injector. There could be a fire and injury if you do not follow these precautions.

8-3-4-8

4 Adjust the pressure with adjusting shims using a nozzle tester so that the injection starts at 118 bar (120 kg/cm^2, 1,707 lbf/in^2). Note that the pressure increases or decreases about 10 bar (10 kg/cm^2, 142 lbf/in^2) with a shim of 0.1 mm (0.004 in.) thick.

Spray condition:

a Fuel drops should not be mixed in the spray pattern.

b Fuel should be sprayed in conical shape with respect to the nozzle axis.

c Check that the fuel is sprayed in a circular shape when tested.

d Hold the pressure at 98 bar (100 kg/cm^2, 1422 lbf/in^2) - i.e. lower by 19 bar (20 kg/cm^2, 284.5 lbf/in^2) than specified and check that no test oil drops from the nozzle tip.

5 When the adjustment is correct, torque tighten nozzle nut **B** on the body **A**.

Replacement

1 Fit new cap **P** and gaskets **Q** on injector body.

2 Fit the injector and torque the body to 79 - 84 Nm (8 - 8.5 kgf m, 58 - 62 lbf ft).

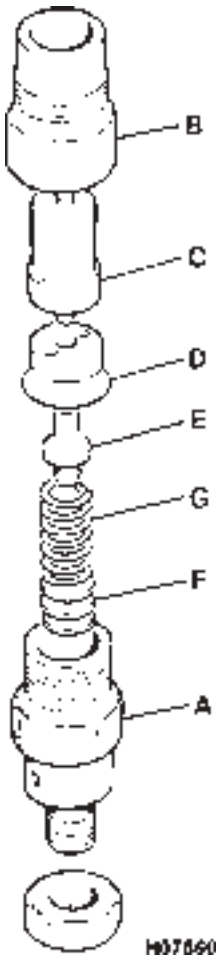
3 Fit the leak off rail **M** with new washers **N** and securing nuts **L**.

4 Fit the spring clamp **J** and the return hose **K**.

5 Fit the fuel pipe assembly and tighten the nuts **H**.

Torque Settings

Item	Nm	kgf m	lbf ft
B	79-98	8-10	58-72
H	20-24	2-2.5	15-18



Fuel System

Bleeding

WARNING

To bleed the injectors you must turn the engine. When the engine is turning, there are parts rotating In the engine compartment.

Before starting this job, make sure that you have no loose clothing (cuffs, ties etc) which could get caught In rotating parts.

When the engine is turning, keep clear of rotating parts.
2-3-3-8

Should the engine fail to start, misfire, or if any part of the system has been disconnected or become empty, bleed the system as follows:-

Note: The fuel injection pump is self-bleeding when the engine is cranked.

1 Loosen vent screw **A** on top of the fuel filter.

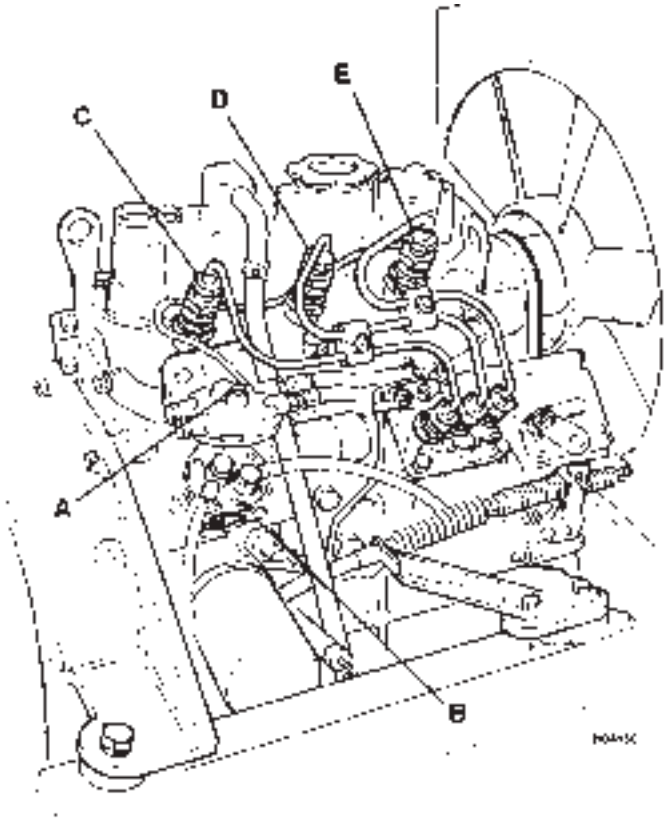
2 Operate the fuel lift pump priming lever **B** until air free fuel flows from the filter vent point. Tighten the vent screw **A**.

Note: *If the lift pump priming lever does not operate, turn the crankshaft one revolution to place the follower on the back of the cam.*

3 Loosen connecting union nuts **C**, **D** and **E** at the injectors.

4 Open the throttle a little, use the starter key to turn theengine until air-free fuel flows from the connections.

5 Tighten the union nuts.



Air Filter

Renew Outer Element - *for interval see Service Schedule*

1 Unscrew the wingnut **H**. Pull out the element **G**. Take care not to tap or knock the element as you remove it.

2 Clean the inside of the canister **C** and dust valve **D**.

3 Insert the new element into the canister. Make sure it seats correctly, by smearing the seal **J** with grease and checking for a witness mark on the canister base. Fit and tighten the wingnut **H**. Check all hoses for condition and tightness.

Renew Inner Element - *for interval see Service Schedule*

1 To prevent dust getting into the engine, remove the induction hose **A**. Cover the hose to prevent rain and dirt getting into the engine.

2 Unscrew wingnut **H**. Pull out the outer element **G**.

3 Unscrew nut **F**. Pull out the inner element **E**.

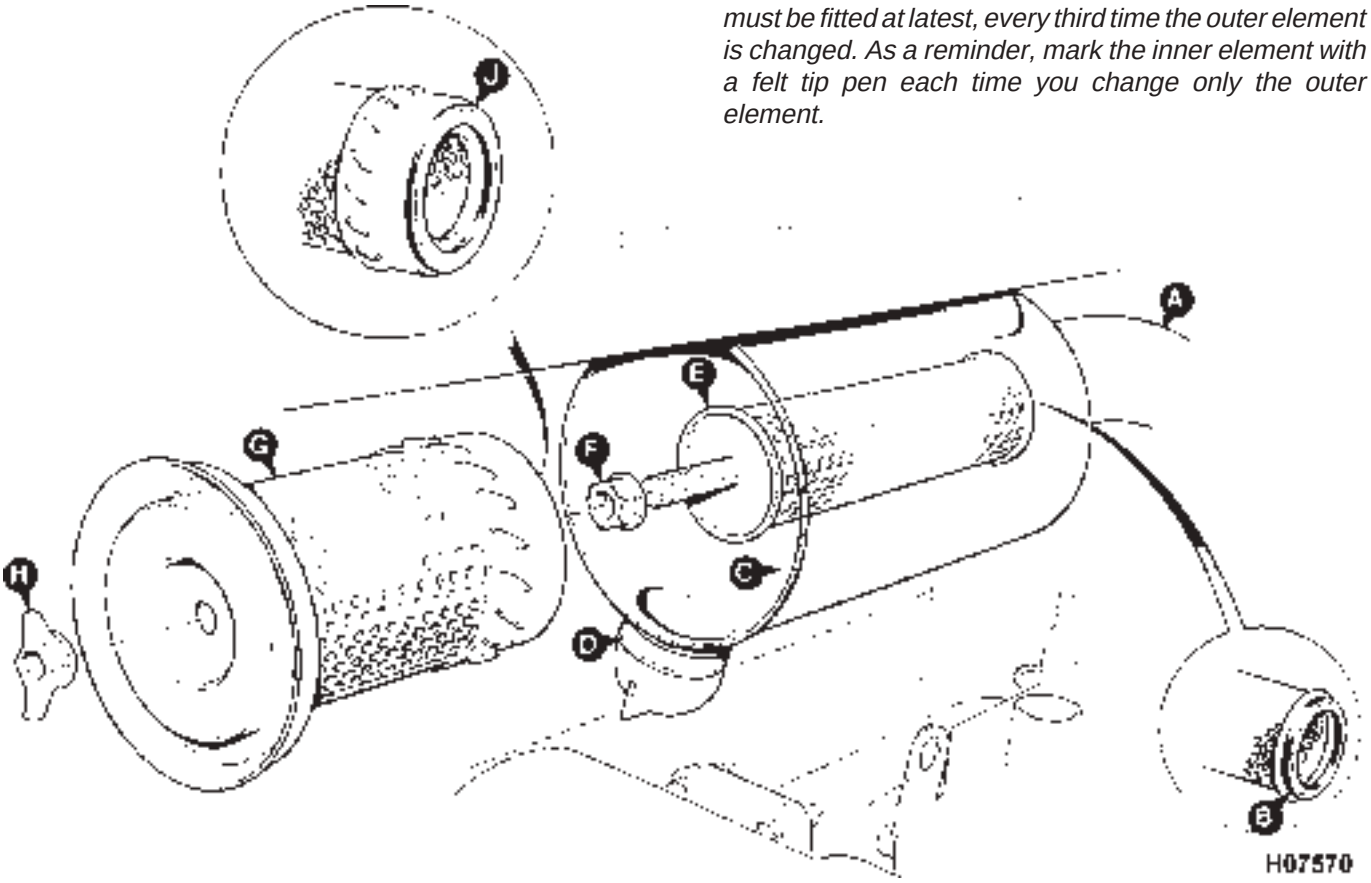
4 Clean the inside of the canister **C** and dust valve **D**.

5 Carefully insert the new inner element into the canister. Make sure it seats correctly, by smearing the seal **B** with grease and checking for a witness mark on the canister base. Fit and tighten nut **F**.

6 Carefully insert the new outer element. Make sure it seats correctly, by smearing the seal **J** with grease and checking for a witness mark on the canister base. Fit and tighten nut **H**.

7 Connect the induction hose. Check all hoses for condition and tightness.

Note: *In a dusty working environment, the outer element may have to be changed more frequently than the service schedule recommendation. A new inner element must be fitted at latest, every third time the outer element is changed. As a reminder, mark the inner element with a felt tip pen each time you change only the outer element.*



Engine Coolant

WARNING

The cooling system is pressurised when the coolant Is hot. Hot coolant will burn you. Make sure that the engine is cool before checking the coolant level or draining the system.

2-3-3-3

Draining and Filling - *for interval see Service Schedule*

Draining

1 Park the machine on level ground. Remove the starter key.

2 Open the engine cover.

3 Make sure that the radiator is cool and remove the filler cap **A**.

4 Undo the tap **B** on the engine block.

WARNING

Keep your face away from the drain hole when removing the drain plug.

2-3-3-4

5 Remove the radiator drain plug **C**.

6 Allow the coolant to drain.

7 If necessary flush the system with clean water.

Filling

1 Change the radiator, hoses and clips for security and damage. Renew if necessary.

2 Clean the radiator drain plug and refit it. Make sure it is tight.

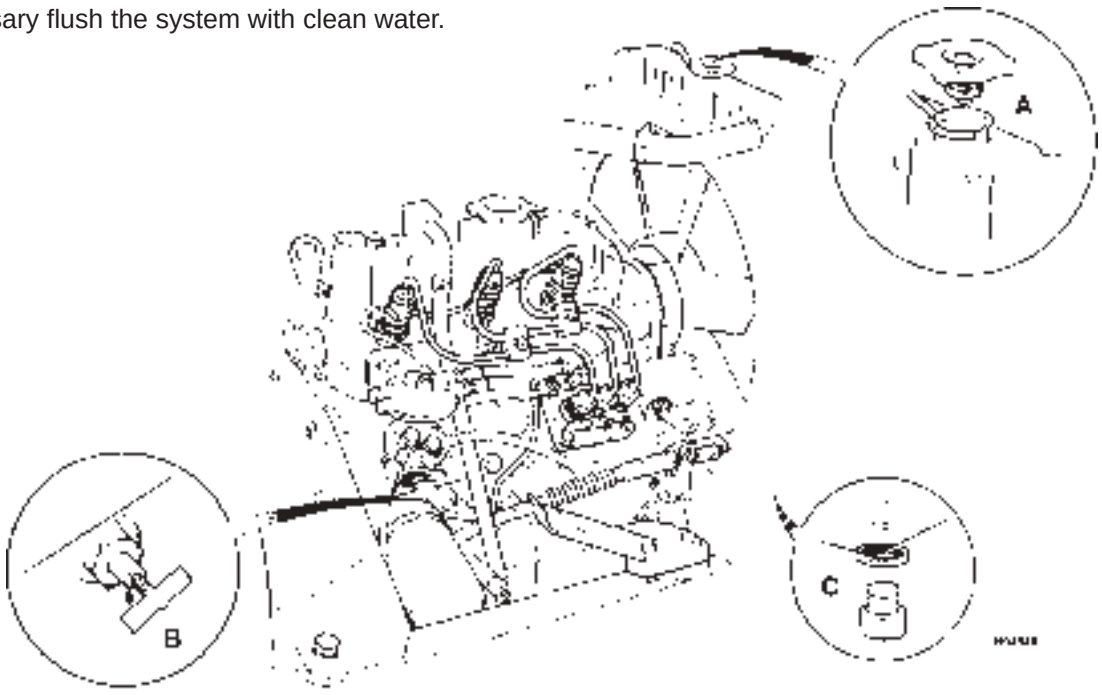
3 Close the engine block drain tap **B**.

4 Fill the radiator with the correct coolant mixture.

5 Refit the filler cap and make sure it is tight.

6 Start the engine and run it until engine working temperature is reached.

7 Stop the engine and check for leaks.



WATER PUMP ASSEMBLY

Removing, Inspecting and Fitting

1 Drain the coolant.

2 Remove the radiator shroud.

3 Remove the cooling fan mounting bolts **A** and remove the fan and pulley.

4 Remove the fan belt and alternator.

5 Loosen the clamps **8** and remove them with the hoses **C**.

6 Loosen the securing bolts **D** and remove the water pump assembly **E**, set plate **F** and gasket **G**.

7 Remove the thermostat **H** and spring **J** from the water pump body.

Inspecting

1 Place the thermostat into water. Raise the water temperature gradually and make sure that the valve opening temperature and the valve lift are correct (see Technical Data). if not, replace the thermostat.

Note: *3 to 5 minutes will be required before the valve starts to open.*

2 Examine the water pump for cracks, wear, leaks and damage. Check the bearing for roughness. If defective. replace the assembly.

Fitting

1 Fit the thermostat **H** and spring **J** in the water pump body **E**.

2 Fit the gasket **G** and set plate **F**,

3 Rotate the tan holder to make sure that there is no fouling.

4 Apply a layer of liquid packing (silicon RTV type) around the ports in the cylinder head and the cylinder block.

5 Put the water pump assembly in position and fit the bolts **A**. Tighten the bolts evenly.

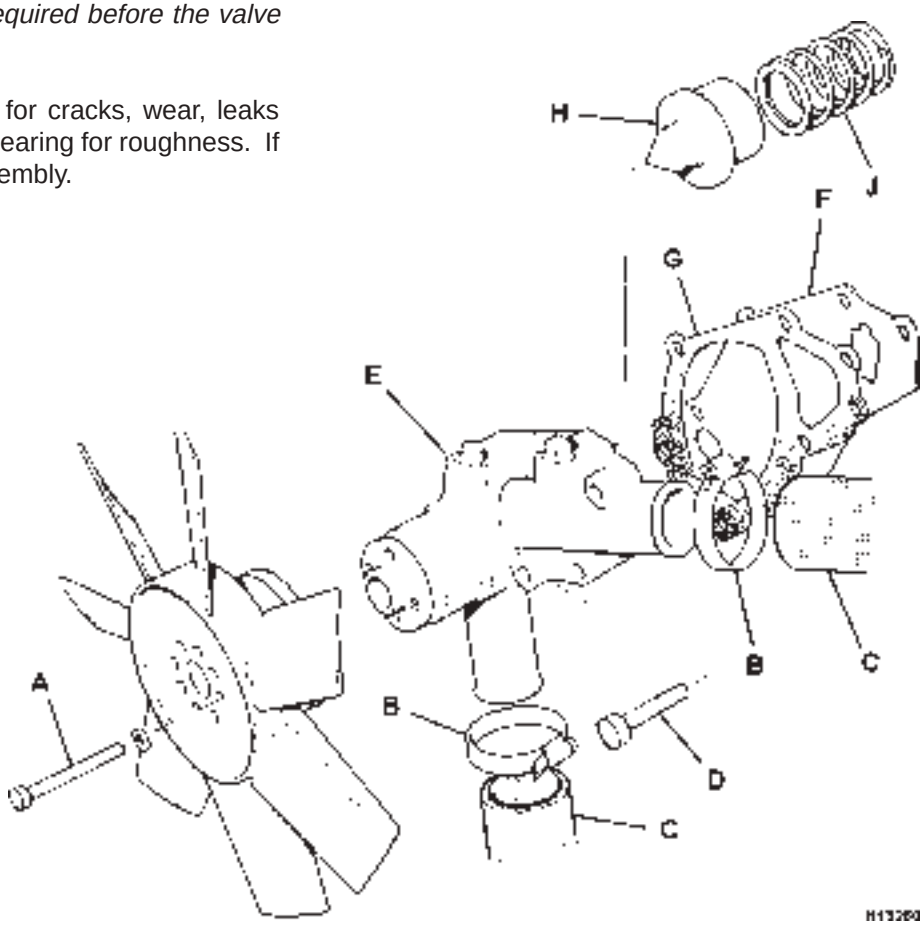
6 Put the clamps **8** over the hoses **C**.

7 Fit the hoses **C** to the water pump body and tighten the clamps **B**.

8 Fit the cooling fan and pulley to the water pump assembly. Torque the bolts to 0.9 to 1.3 kgf m (6.5 to 9.5 lbf ft).

9 Fit the fan belt and alternators

10 Fit the radiator shroud.



Fan Belt

Removal, Inspection and Replacement

Removing

1 Park the machine on firm, level ground and remove the starter key.

2 Open the engine cover.

3 Remove the engine access panel.

WARNING

Make sure that the engine cannot be started. Disconnect the battery. Disconnect the earth lead first.
ENG 6-3

4 Loosen the alternator mounting bolts **A** and the adjusting bolt **B.**

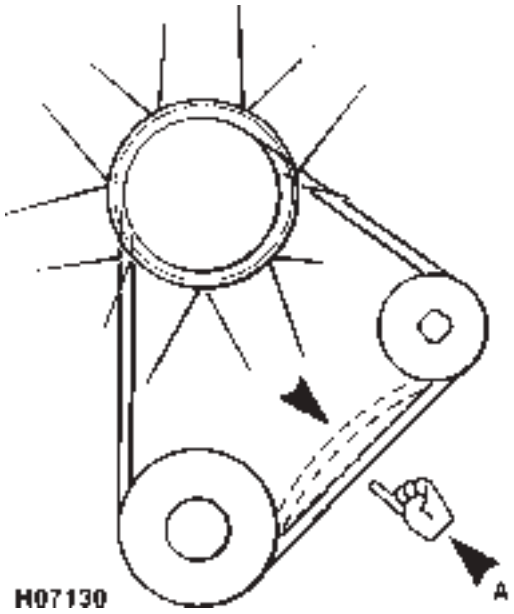
5 Move the alternator towards the engine block.

6 Remove the fan belt from the alternator pulley, water pump pulley and the crankshaft pulley.

7 Remove the fan belt over the fan.

Inspecting

1 Examine the fan belt and pulleys for damage. Renew as necessary.



Replacing

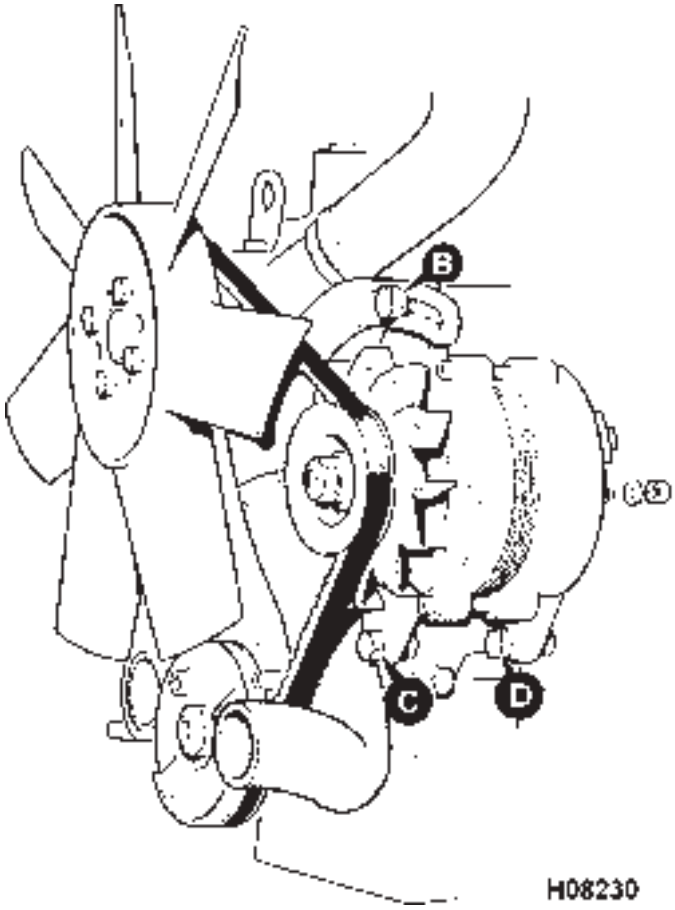
1 Install the fan belt so that it passes around the fan, crankshaft, water pump and alternator pulleys.

2 Use a wooden lever and move the alternator away from the engine block. Apply pressure at the drive end bracket only.

3 Adjust the position of the alternator, so that when the belt is depressed at the mid-point **C** between the crankshaft and alternator pulleys, the deflection is **5** mm (0.2 in.). Use a finger force of approximately 50 N (5 kgf, 11 lbf) for this check.

4 Tighten the mounting bolts **A** and the adjusting bolt **B**.

5 Reconnect the battery. **Connect the earth lead last**.



Alternator

Removal and Replacement

Removing

1 Raise the engine cover.

2 Remove the interior access panel.

3 Disconnect the battery. **Disconnect the earth lead first.**

4 Disconnect the electrical connections.

5 Support the alternator and remove the mounting nut **A** and bolt **B.**

6 Remove the adjusting bolt **C.**

7 Remove the alternator.

Replacing

1 Put the alternator in position and align with the fan belt.

2 Fit the mounting nut **A** and bolt **B** and the adjusting bolts **C**.

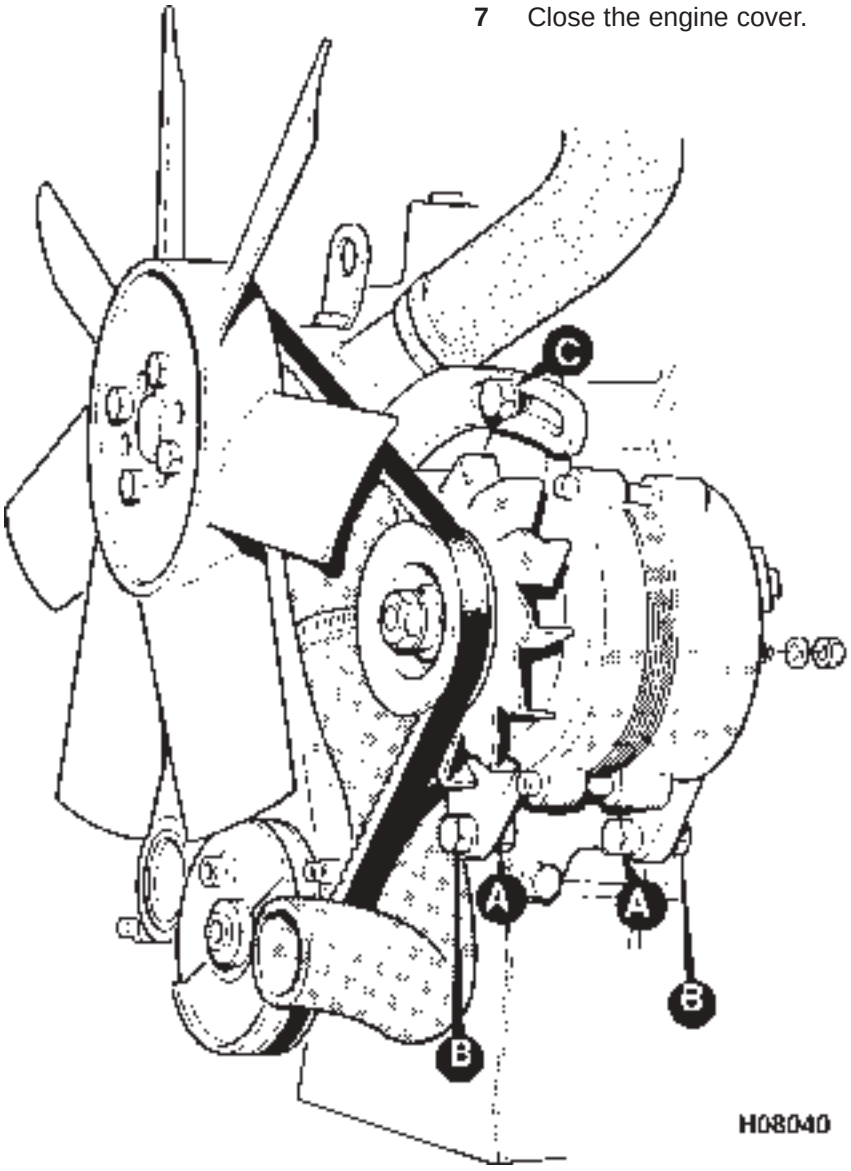
3 Adjust the fan belt tension, and tighten the mounting nut **A** and bolt **B,** and the adjusting bolt **C.**

4 Connect the electrical connections.

5 Reconnect the battery. **Connect the earth lead last.**

6 Refit the interior access panel.

7 Close the engine cover.



Starter Motor

Removal and Replacement

Removing

1 Raise the engine cover.

2 Remove the interior access panel.

3 Disconnect the battery. **Disconnect the earth lead first.**

4 Disconnect the starter electrical connections.

5 Support the starter motor **A,** loosen and remove the securing bolts **B.**

6 Disengage the pinion from the flywheel gear teeth and remove the starter motor.

Replacing

1 Put the starter motor in position and align the pinion in the flywheel gear teeth.

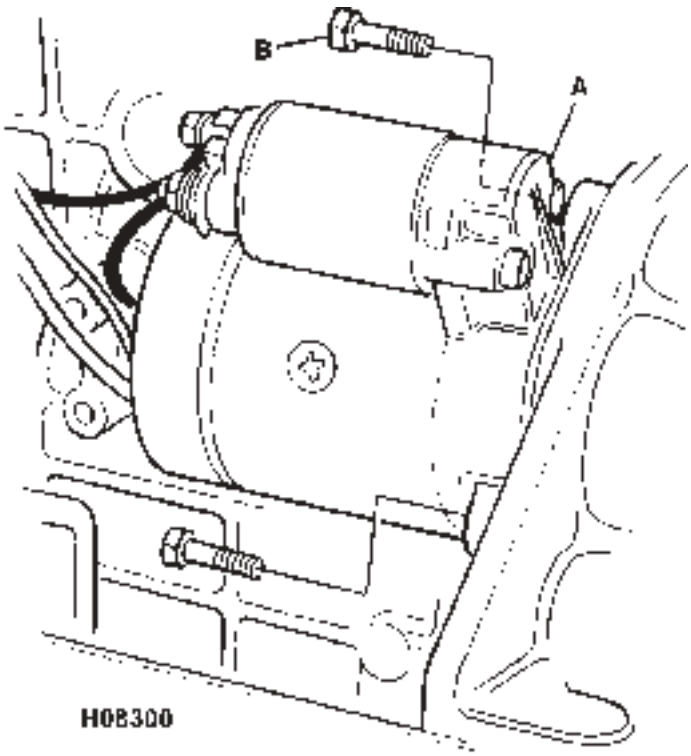
2 Fit and tighten the securing bolts **B.**

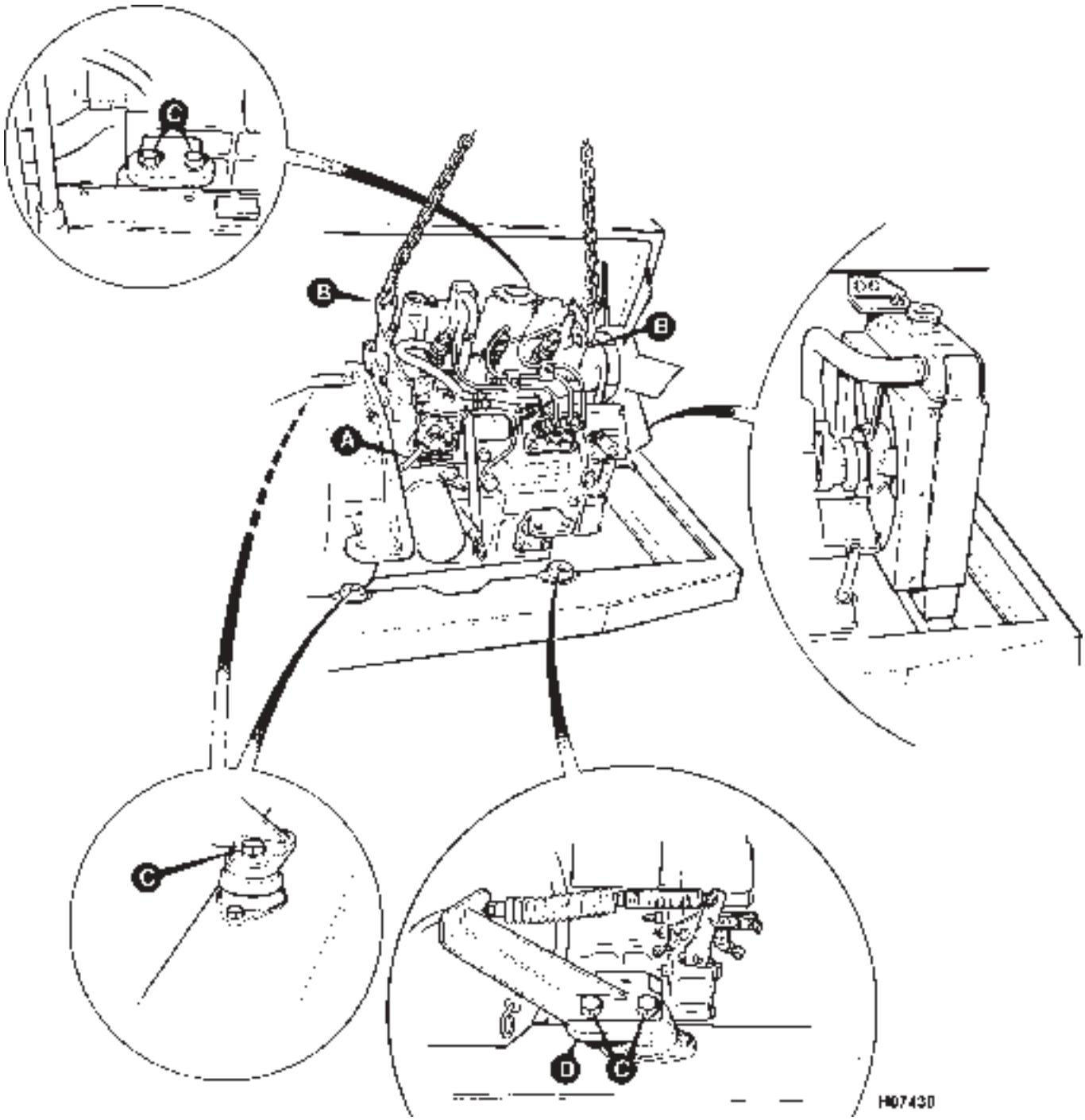
3 Connect the electrical connections.

4 Connect the battery terminals. **Connect the earth terminal last.**

5 Fit the interior access panel.

6 Close the engine cover.





Engine

Removal and Replacement

Removing

1 Park the machine on firm level ground and lower the bucket to the ground. Remove the starter key.

2 Remove operator's seat and base plate.

3 Disconnect and remove the battery and battery tray. Disconnect the earth lead first.

4 Remove the engine cover and access panel in the bulkhead.

5 Disconnect the battery. **Disconnect the earth lead first.**

4 Disconnect and plug the fuel feed **A** to the fuel lift pump.

6 Drain the engine oil.

7 Drain the engine coolant.

8 Remove the hydraulic pump and coupling from the engine but do not disconnect the pipework.

9 Remove the air cleaner.

10 Disconnect the throttle linkage.

11 Disconnect and note all electrical connections.

12 Disconnect the top and bottom radiator hoses and the heater hoses from the engine.

13 Disconnect and plug the hoses to the oil cooler.

14 Remove the radiator and oil cooler complete.

15 Disconnect the exhaust.

16 Attach a suitable lifting device to the engine lifting points **B** and support the engine.

17 Remove engine mounting bolts **C** and nuts **D**.

18 Carefully lift and remove the engine.

Replacing

1 Carefully lower the engine into position and fit the mounting bolts **C** and nuts **D**.

2 Remove the lifting device.

3 Fit the hydraulic pump and coupling.

4 Fit the radiator and oil cooler assembly.

5 Fit the radiator and heater hoses. Make sure the clamps are tight, ensuring that the bottom radiator hose does not rub on the fan belt.

6 Connect the hoses to the oil cooler.

7 Fit fuel feed line **A** to the fuel lift pump.

8 Fit the throttle cable to the mounting bracket and connect the throttle cable.

9 Fit the air cleaner.

10 Make sure that the radiator drain plug is tight and the engine block drain tap is closed.

11 Fill the cooling system with the correct coolant mixture. Make sure the radiator cap is tight.

12 Make sure the engine oil drain plug is tight.

13 Fill the engine with the correct quantity of oil. Make sure the filler cap is tight.

14 Reconnect all electrical connections.

15 Reconnect the exhaust.

16 Replace bulkhead cover and battery tray. Connect the battery. **Connect the earth lead last.** Coat the terminals with petroleum jelly.

17 Bleed the fuel system.

18 Start the engine and check for smooth running. If necessary, adjust the idle speed.

19 Stop the engine and check for leaks.

20 Refit the engine cover and operators seat.

Cylinder Head

Removal, Inspection and Replacement

Removing

Note: *For clarity, the illustrations show the engine removed from the machine. If the cylinder head is removed with the engine in situ, first carry out the following operations:*

- Drain the cooling system, remove the radiator and heater hoses.
- Disconnect the air cleaner and exhaust silencer from manifolds.
- Disconnect the water and oil sender units.

The following procedure applies if the engine is either in situ or has been removed:-

1 Loosen the fuel pipe nuts from the fuel injection pump and the injectors. Remove the pipes as an assembly.

2 Remove the injectors, if required, by removing the three securing nuts. Remove the three aluminium washers and discard them.

3 Remove the cooling fan and pulley.

4 Remove the water pump assembly and set plate.

5 Remove the breather hose **B**. Loosen and remove three cap nuts **C** with washers **D**. Lift the rocker cover assembly **E**.

6 Remove the oil-ring gasket **F**.

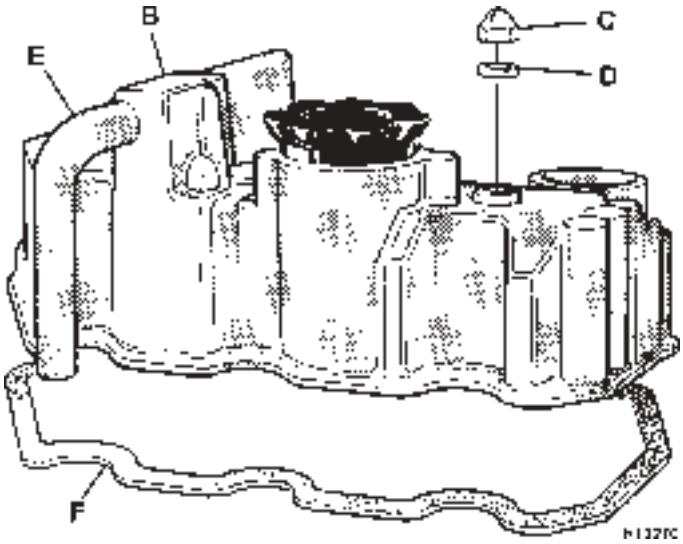
7 Loosen and remove three nuts **G**, lock washers **H** and flat washers **J** from the rocker pillar studs. Lift the rocker assembly **K**.

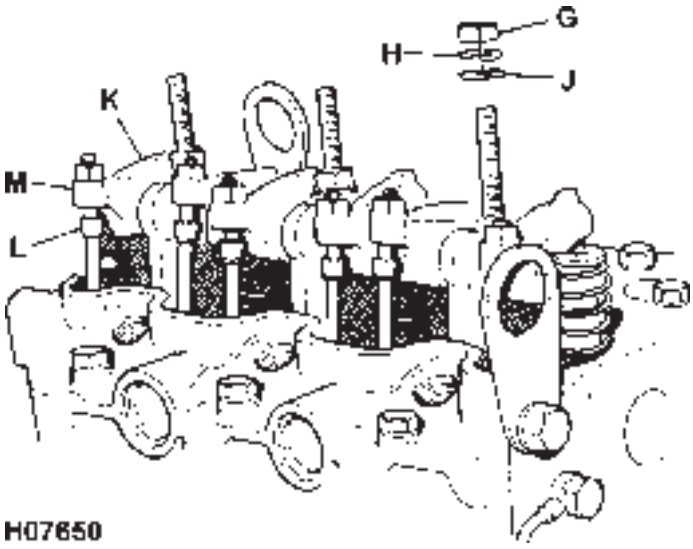
8 Remove the push rods **L** and the valve stem caps.

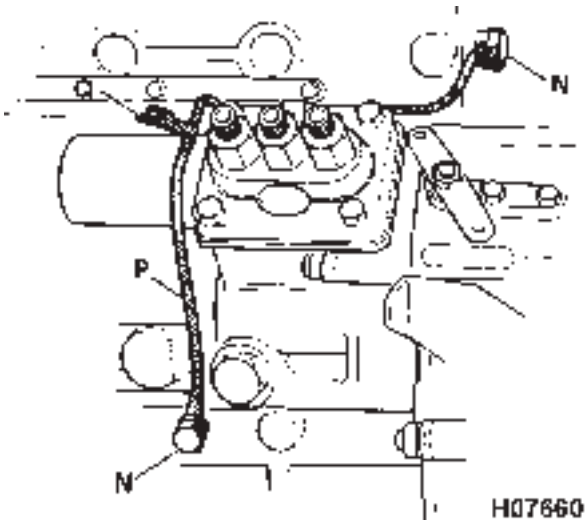
9 Loosen and remove the two banjo bolts **N** at the cylinder block main oil gallery and cylinder head assembly. Remove the oil pipe **P**.

10 Remove the clamp **Q** from the fuel injection pump.

11 Loosen the cylinder head bolts starting from the centre, in a circular pattern, using several steps of equal torque. Remove the head.







Cylinder Head (cont'd)

Inspecting

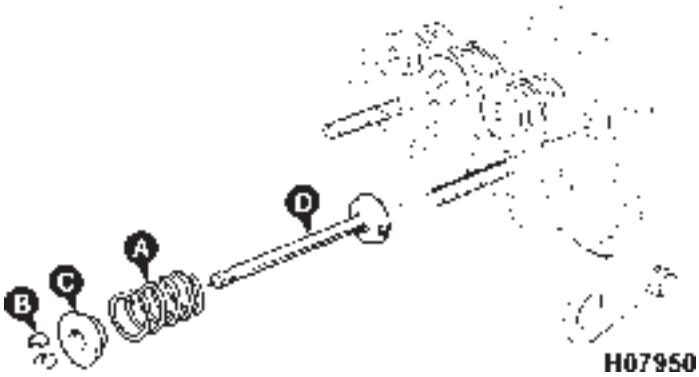
1 Using a valve spring compressor, compress the valve spring **A** and remove the valve collets **B**,retainer **C**, spring **A** and valve **D**.

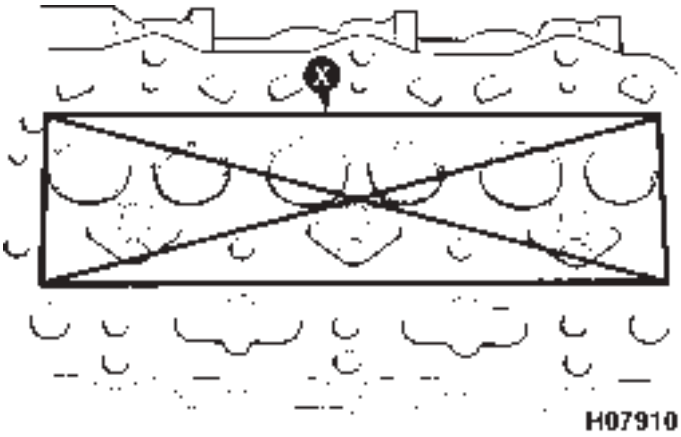
2 Clean off all the carbon from the cylinder head face, valves and parts.

3 With a straight edge and a thickness gauge, check for warping of the cylinder head lower face.

4 Check six positions, as shown at **X,** for distortion. If the distortion is excessive (see Technical Data), this must be corrected using a surface grinder.

5 Check the valve stem for excessive wear or damage. If it is found to be excessive, renew the valve.

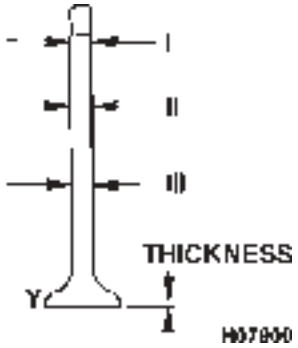




6 Check the valve stem diameters at positions I, II and Ill with a micrometer. If the diameter is less than the permitted value (see Technical Data), renew the valve.

7 Check the thickness of the valve head **Y.** If it is less than the permitted value, renew the valve.

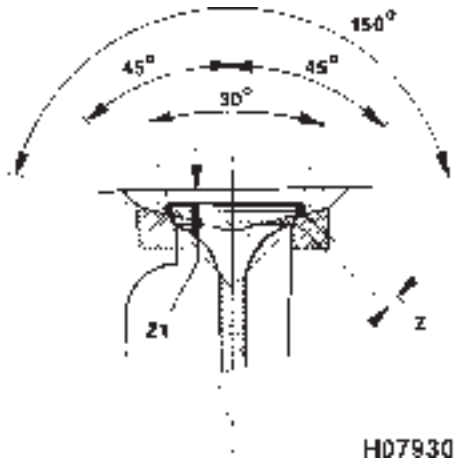
8 Insert the valves into the valve guides and check the clearance between the valve stem and the valve guide. If the clearance is excessive (see Technical Data), renew the guide, recut the valve seat and renew the valve.



Cylinder Head (cont'd)

Inspecting

9 Check the condition and width of the valve seats. If the width **Z** is more than specified (see Technical Data) or if the seat is excessively pitted, recut the seat as shown.



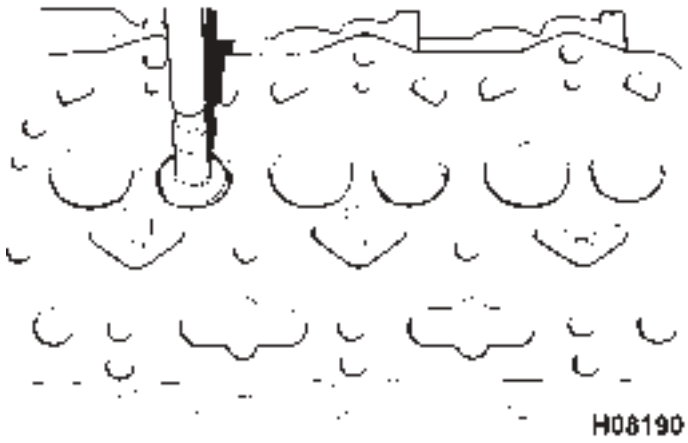
10 Check the recess dimension of the valves **Z1**. If the recess exceeds the limit specified (see Technical Data), renew the valve seat insert (if fitted).

11 Renewal of valve seat insert (where fitted):

- Either 1. Using a gas burner (700 - 800°C, 1292 - 1443°F), heat diagonally across the valve seat insert. Leave in air for 3 to 5 minutes and remove the valve seat insert by light tapping (ensuring head is not damaged).

- Or 2. Machine the insert out taking care not to damage the head.

- Clean up the insert bore and fit a new insert using a press (9800 - 14710 N, 1000 - 1500 kgf, 2204 - 3306 lbf) and a suitably smooth surface tool. To assist the process, chill the valve seat insert with liquid nitrogen etc. or heat the head to between 60 - 100°C (140 - 212°F).



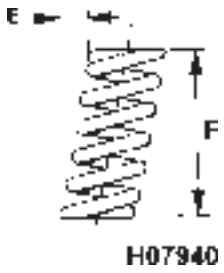
12 Correct the valve seat contact using a valve lapper and lapping compound. When using a new cylinder head, obtain correct seat contact width and seat recess using the seat cutter. Then carry out lapping.

13 Check the valve springs as follows and renew if outside the limits specified in Technical Data:

- measure the free length.

- Check the squareness by placing the spring against a set square positioned on a surface plate and rotating to obtain maximum dimension **E.** Measure dimension **E** and express as a percentage of free length **F.**

$$\text{i.e. squareness} \quad \frac{\mathbf{E}}{\mathbf{F}} \times 100\%$$



- check the spring tension by measuring the load required to compress the spring to its fitted length.

Cylinder Head (cont'd)

Replacing

1 Insert the valves **D** in the cylinder head and fit the spring **A** (using a spring compressor), the cotter **B** and the retainer **C**. Take care not to damage the valve guide seat.

2 Set each piston to T.D.C. and measure the amount of protrusion above the cylinder block with a depth gauge or dial gauge. Take the measurement by pressing the piston lightly. Use the highest reading as the reference.

3 Check that the cylinder head gasket meets the tolerance levels (see Technical Data). The last four digits of the code number are stamped on the head gasket.

4 Install the head gasket with the code numbers at the top.

5 Install the cylinder head.

6 Lubricate the cylinder head bolts with a molybdenum disulphide based grease and install them.

7 Tighten the cylinder head bolts in a three step procedure in the order shown.

8 Torque the cylinder head bolts to 49-52 Nm (5.0-5.3 kgf m, 36-38 lbf ft).

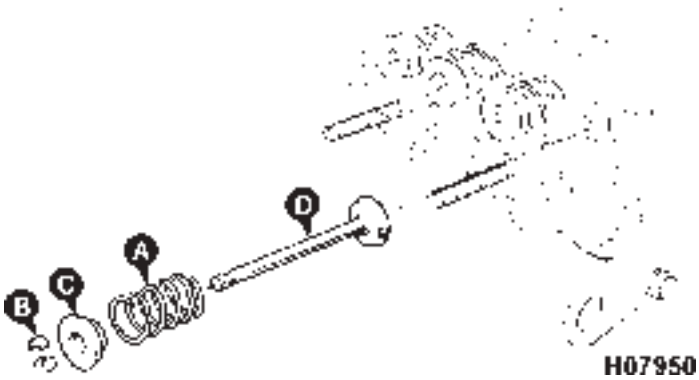
9 Put the oil pipe **P** in position and fit the banjo bolts **N** at the cylinder block main gallery and cylinder head assembly. Torque the banjo bolts to 10-13 Nm (1.0-1.3 kgf m, 7.2-9.4 lbf ft).

10 Fit the caps on the valve stems.

11 Install the push rods **L**.

12 Fit the rocker arm assembly on the rocker pillar studs. Fit the flat washers **J**, new lock washers **H** and the nuts **G** on the rocker pillar studs.

13 Tighten the nuts **G** and torque to 20-24 Nm (2.0-2.5 kgf m, 14.5-18.1 lbf ft).



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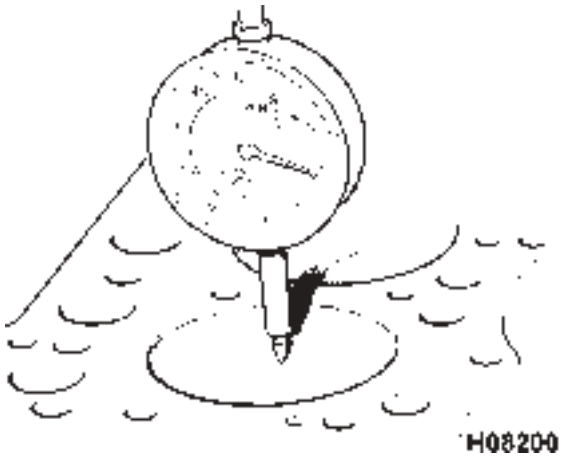
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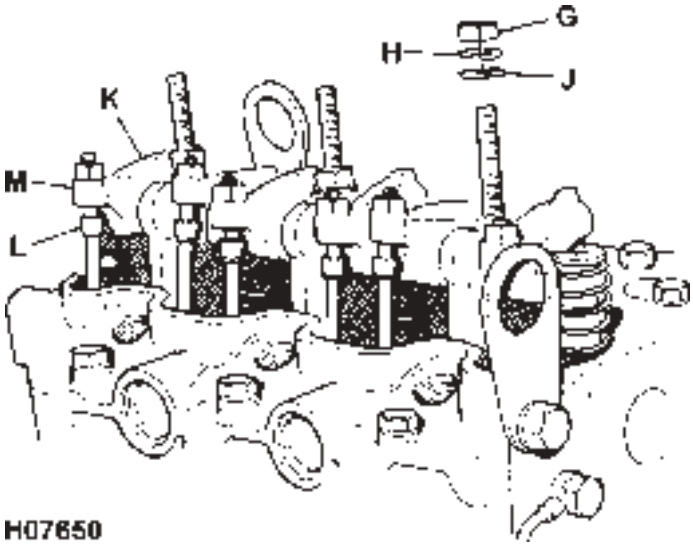

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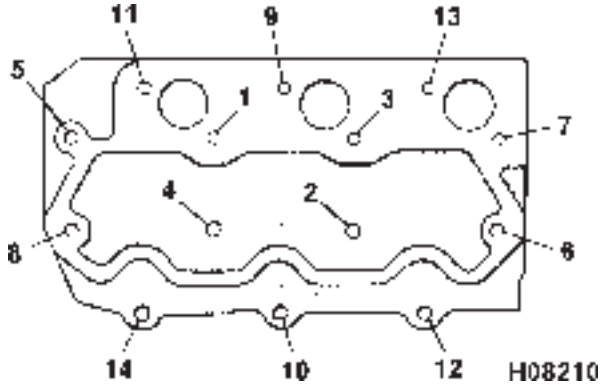


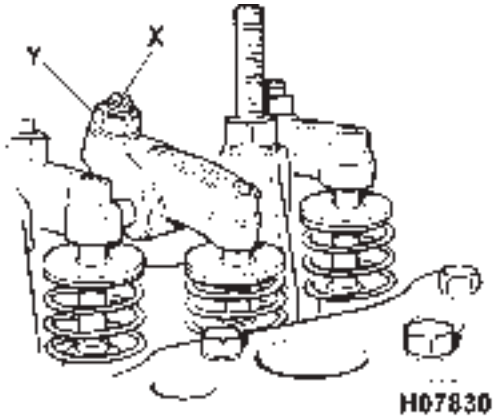
H08210

Cylinder Head (cont'd)

Replacing

14 Adjust the valve clearances (cold) of the inlet and exhaust valves to 0.2 mm (0.0078 in.) as follows:

- loosen nut **Z** and adjust the screw **X** on each tappet. When the clearance is correct, tighten the nut **Z**.



15 Adjust the valves in this sequence:

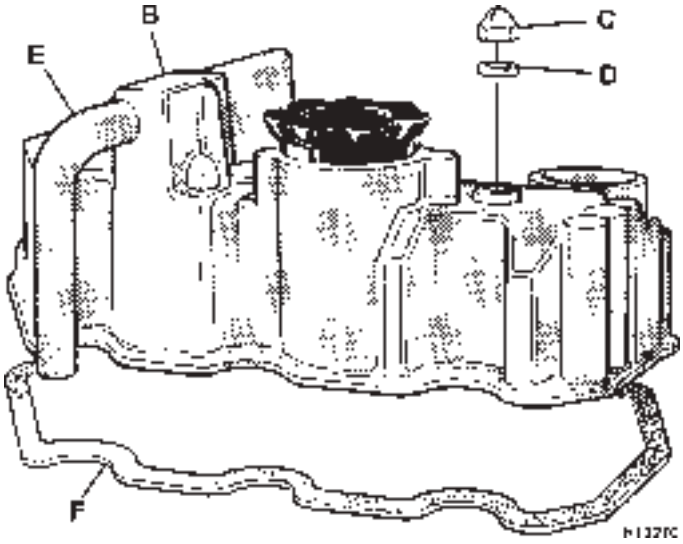
- Set the No.1 piston to T.D.C. and adjust both No.1 cylinder valves and No.2 cylinder exhaust valve.

- Turn the crankshaft counter-clockwise through 240° (viewed from the front).

- Adjust the No.2 cylinder inlet valve and both No.3 cylinder valves.

16 Put the rocker cover gasket **F** in position.

17 Carefully put the rocker cover **E** in position. Make sure the gasket **F** stays in position.



18 Fit the washers **D** and the cap nuts **C** on the rocker pillar studs and tighten them evenly. Torque to 10-12 Nm (1.0-1.2 kgf m, 7-9 lbf ft).

19 Fit the breather hose **B**.

20 Fit the water pump assembly, radiator and heater hoses.

21 If necessary, fit the injectors with new aluminium washers. Torque the injectors to 79-84 Nm (8-8.5 kgf m, 58-62 lbf ft). Fit the return pipe and the injection pipes. Torque the injection pipe unions to 20-24 Nm (2.0-2.5 kgf m, 14.5 -18 lbf ft).

22 Fit the cooling fan pulley and fan to the water pump assembly. Torque the bolts to 9-13 Nm (0.9-1.3 kgf m, 6.5-9.5 lbf ft).

23 Fit the fan belt and adjust to the correct tension.

Piston and Connecting Rods

Removal, Inspection and Replacement

Removing

1 Drain the coolant.

2 Drain the engine oil.

3 Remove the cylinder head assembly.

4 Remove the oil sump, suction pipe and strainer.

5 Remove the big-end nuts **F** and bolts **G** and remove the big-end cap **H.**

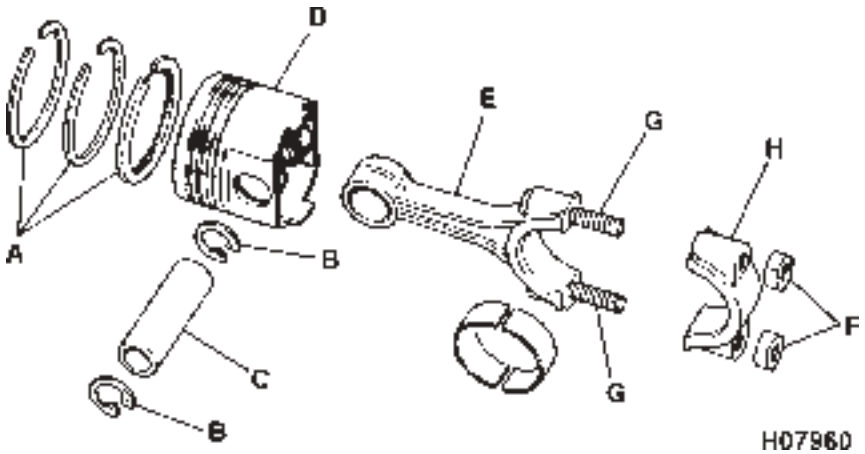
6 Remove any carbon from the cylinder bore. Push the piston and connecting rod through the cylinder block.

7 Refit the big-end cap on the removed piston and connecting rod. Attach a label to each of these assemblies to ensure replacement in the original bore.

8 Remove the piston rings **A.**

9 Remove the circlips **B** and drive out the gudgeon pin **C.**

10 Repeat for each cylinder.



Piston and Connecting Rods (cont'd)

Inspecting

1 Examine the outer surface of the piston **D** for cracks, scores and burns. If excessive, renew the piston.

2 Check the larger diameter of the piston skirt (10 mm (0.4 in.) from the bottom) and check the inside diameter (thrust direction) of the cylinder bore. Calculate the clearance between the cylinder and the piston. If this clearance is more than the permitted value, or the piston diameter is less than the permitted value (see Technical Data) renew the piston.

Note: *If the cylinder bore is oversized, make sure that an oversize piston is used.*

3 Measure the inside diameter of the gudgeon pin hole and the outside diameter of the gudgeon pin. Calculate the difference. If the clearance is excessive (see Technical Data), renew as necessary.

4 Measure the outside diameter of the gudgeon pin. If less than permitted value (see Technical Data) renew it.

5 Clean out the carbon from the piston ring grooves.

6 Examine the piston rings and renew as necessary.

7 Insert the rings into the cylinder bore at right angles to the bore and measure the clearance. If the clearance is excessive (see Technical Data), renew as necessary.

8 Measure the clearance between the piston ring groove and the ring. If the clearance is excessive (see Technical Data), renew the ring.

9 Check the connecting rod **E** for distortion between the large and small ends. If the distortion is excessive (see Technical Data), renew the connecting rod.

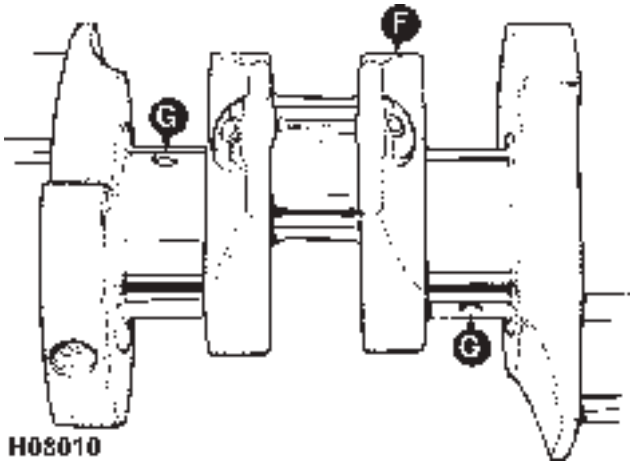
10 Measure the inside diameter of the connecting rod small-end bush and calculate the clearance between the small-end bush and the gudgeon pin. If the clearance is excessive (see Technical Data), renew as necessary.

11 Assemble the connecting rod to the crankshaft and measure the play in the shaft direction. If the play is excessive (see Technical Data), renew the connecting rod.

12 Check the oil clearance, using plastigauge, as follows:

- Remove oil or foreign matter from the bearing and crankshaft **F.**

- Cut the plastigauge to the same width as the bearing. Place it on the crankshaft. Avoid the oil hole **G.**



- Assemble the connecting rod and connecting rod cap and torque tighten to 29-34Nm (3.0-3.5 kgf m, 21.7-25.3 lbf ft).

Note: *Never rotate the connecting rod.*

- Remove the connecting rod cap. Measure the oil clearance with the scale printed on the gauge bag.

Note: *Measure the widest area.*

If oil clearance exceeds the permitted value (see Technical Data), renew the bearing. Or, grind the crankshaft and use underside bearings as follows (see Microfiche for part numbers):

Bearing Size	**Crankshaft Pin O.D.**
Standard	38.964 - 38.975 mm (1.5340 - 1.5344 in.)
0.25 mm (0.0098 in.)	38.714 - 38.725 mm (1.5241 - 1.5246 in.)
0.50 mm (0.0196 in.)	38.464 - 38.475 mm (1.5143 - 1.5147 in.)

Note: *When grinding the outside diameter of the crankshaft, make sure that the oil clearance is correct before reassemble.*

Piston and Connecting Rods (cont'd)

Replacing

1 Heat the piston to approximately 100°C (212°F).

2 Align the set marks **X** and the marks **Y** on the piston, as shown.

3 Insert the gudgeon pin **C** and fit the circlips **B**.

4 Fit the piston rings on the piston with the scribe mark towards the piston crown. Make sure that the rings are in the correct position as shown.

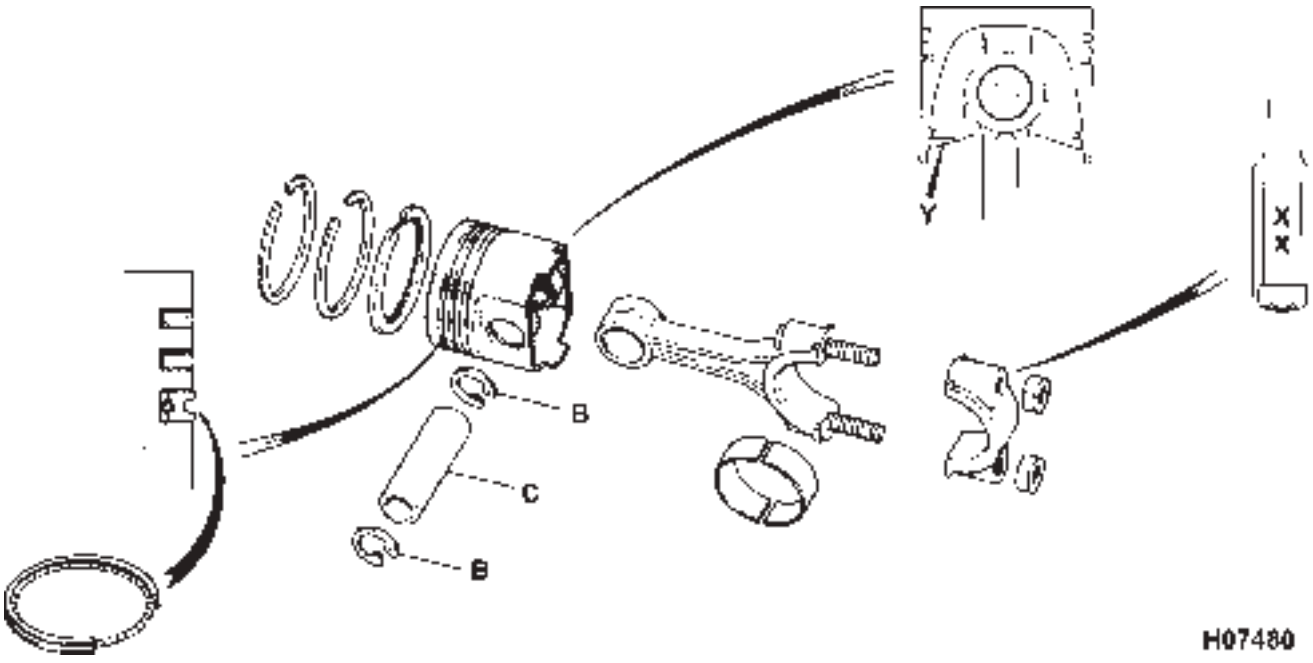
5 When the connecting rod, piston or gudgeon pin has been renewed, the difference in weight of the complete assembles should not exceed 10 grams between cylinders.

6 Refit the oil suction pipe and strainer and the sump.

7 Refit the cylinder head assembly.

8 Fill the engine with oil.

9 Fill the cooling system with coolant.



Timing Gear Case

Removal and Replacement

Removing

1 Remove nut **A** and washer **B**.

2 Pull the crankshaft pulley **C** from the crankshaft **D**.

3 Remove the securing bolts **E** and lift the case off the locating dowels

Note: *Ensure the engine is not rotated.*

Replacing

1 Install the start spring **J**.

2 Insert the link through the hole in the cylinder block.

3 Rotate oil pump cover **F** to position spring pin hole to the centre position.

4 Install the cover locating pin **G** in the oil pump cover plate.

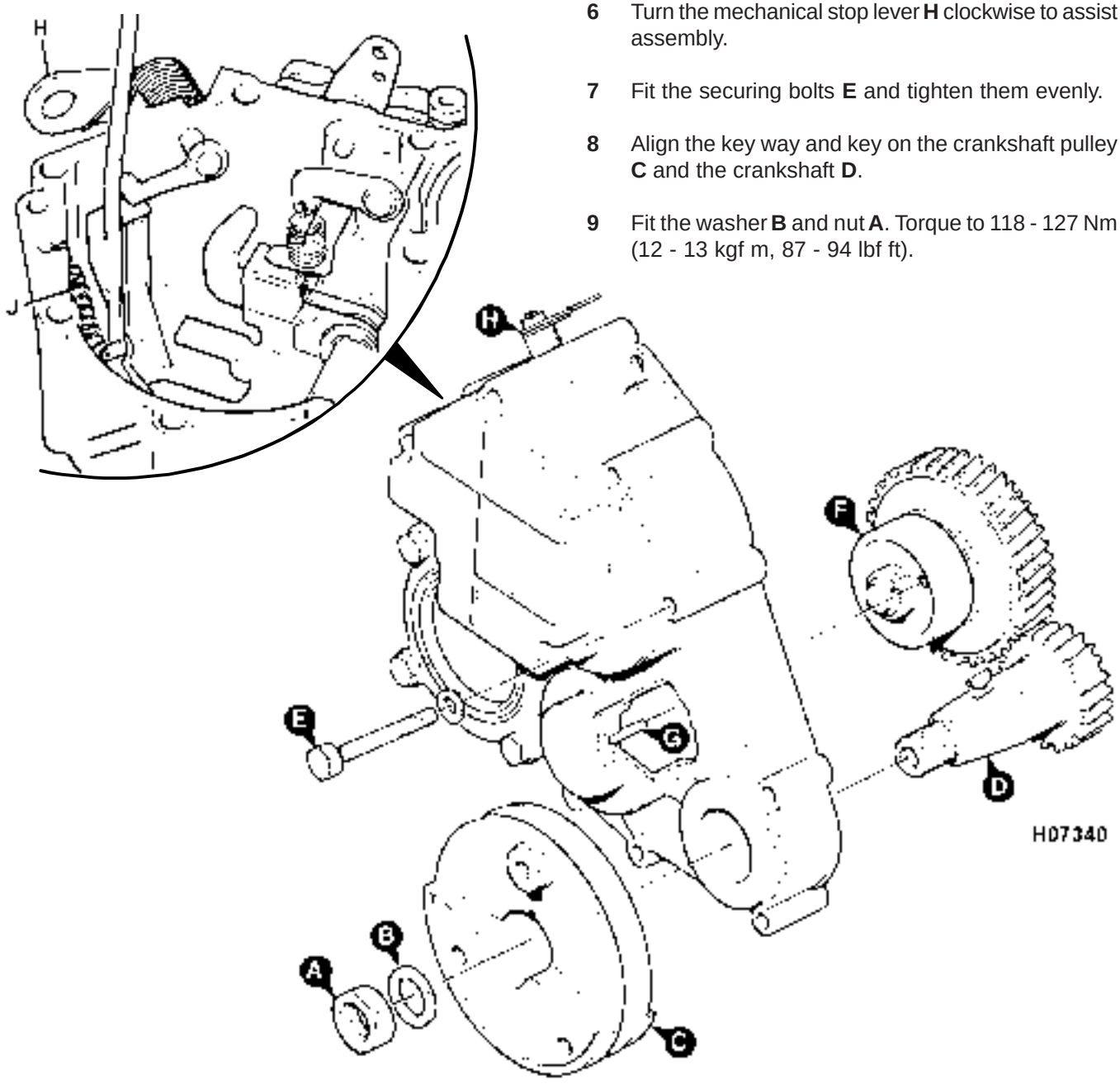
Note: *Take care not to damage the oil seal.*

6 Turn the mechanical stop lever **H** clockwise to assist assembly.

7 Fit the securing bolts **E** and tighten them evenly.

8 Align the key way and key on the crankshaft pulley **C** and the crankshaft **D**.

9 Fit the washer **B** and nut **A**. Torque to 118 - 127 Nm (12 - 13 kgf m, 87 - 94 lbf ft).



Idler Gear and Oil Pump Assembly

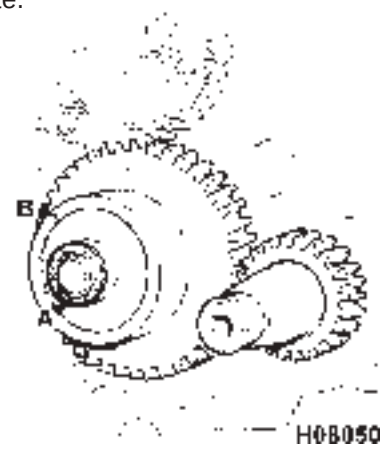
Removal, Dismantling, Inspection and Replacement

Removing

1 Remove the Timing Gear Case.

2 Remove the circlip **A**.

3 Remove the idler gear and oil pump assembly **B** complete.



1 Remove the snap ring **C**.

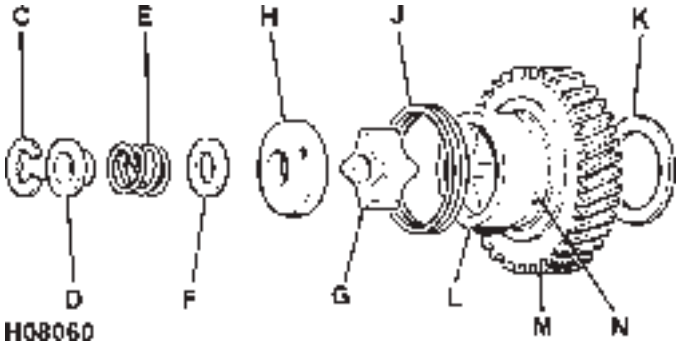
2 Remove the collar **D**, the spring **E** and the shim **F**.

3 Remove the idler gear vane **G** and the oil pump cover **H** together.

4 Remove the spring **J** and the pin **N**.

5 Remove the rotor **L** from the idler gear **M**.

Note: *When the idler gear assembly is removed,* ***DO NOT TURN*** *the camshaft and crankshaft gears.*

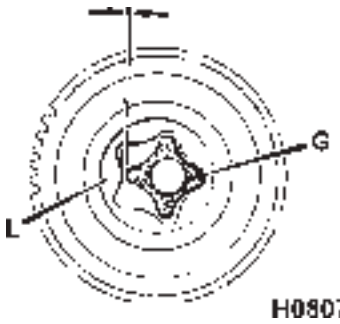


Inspecting

1 Check all the components for damage and wear and replace as necessary.

2 Measure the clearance between the rotor **L** and the vane **G**. If the clearance is excessive replace the vane and rotor.

3 If the idler gear needs replacing contact Perkins service department.



Replacing

Note: *Coat both faces of the rotor and vane with grease for assembly.* ***DO NOT TURN*** *the crankshaft with the timing gear case removed.*

1 Insert the rotor **L** in the idler gear **M**. Fit the pin **N** and the spring **J**.

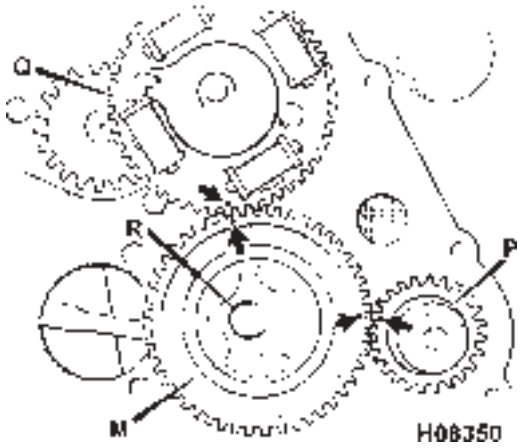
2 Insert the thrust washer **K**.

3 Align the set marks on the idler gear **M**, crankshaft gear **P** and camshaft gear **Q** and fit on to the idler gear shaft **R**.

4 Install the vane **G**, the cover **H**, the shim **F**, the spring **E**, the collar **D** and the snap ring **C**.

5 Adjust with shim 0.10, 0.15, 0.20, 0.50 mm (0.004, 0.006, 0.008, 0.02 in.) so that side clearance of the oil pump, rotor and vane is between 0.1 - 0.15 mm (0.0004 - 0.006 in.).

6 Fit the timing gear case.



Camshaft Assembly and Tachometer Drive

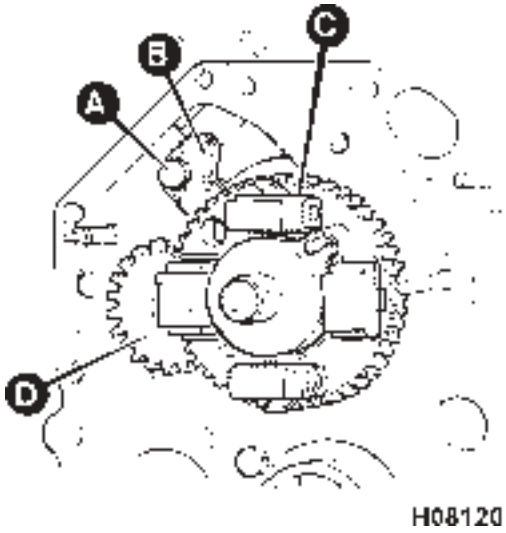
Removal, Inspection and Replacement

Removing

1 Remove the Timing Gear case.

2 Remove bolt **A** and then remove keeper plate **B**.

3 Slide the camshaft assembly **C** together with the flyweight retainer out of the camshaft bore.



H08120

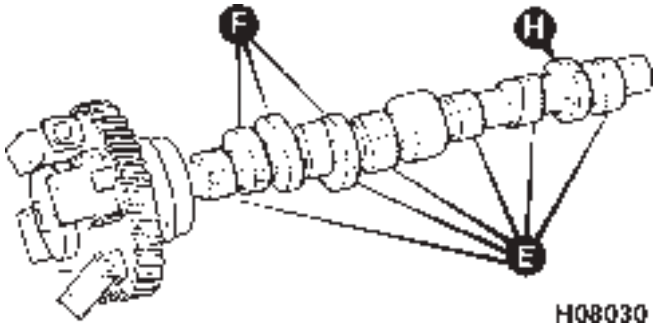
Inspecting

1 Check the journals and cams for wear and damage. Correct uneven wear and small scratches on the cam surface with an oil stone.

2 Measure the height of the inlet and exhaust cams at position **E**.

3 Measure the height of the injection pump cams at position **F**.

4 Measure the height of the fuel feed pump cam at position **H**.



H08030

5 If any of these cam heights is less than the specified value (see Technical Data), replace the camshaft.

6 Examine the crankshaft gears **J**, camshaft gear **K** and idler gear **L** for damage and wear on the contact area. Replace as necessary.

7 Measure the backlash of the gears. If the backlash is excessive (see Technical Data) replace **ALL** timing gears.

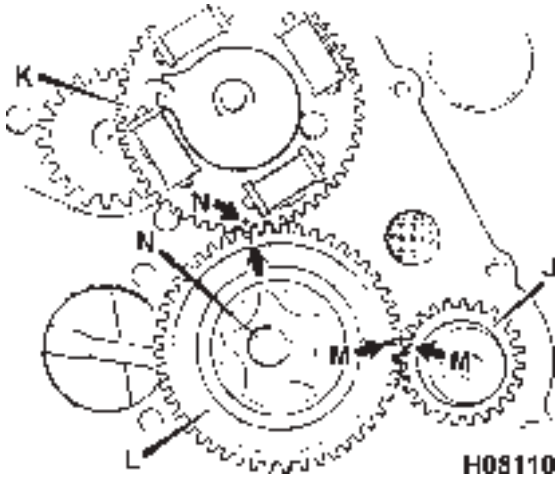
Replacing

1 Make sure that the set marks on the crankshaft gear **J** and the idler gear **L** are aligned as at position **M**.

2 Make sure that the set marks on the idler gear **L** and the camshaft gear **K** are aligned as at position **N** and install the camshaft assembly in its bore.

3 Fit the keeper plate **B** with the bolt **A**. Torque the bolt **A** to 9 - 14 Nm (0.9 - 1.3 kgf m, 6.5 - 10 lbf ft).

5 Fit the Timing Gear case.



H08110

Crankshaft

Removal, Dismantling, Inspection, Reassembly and Replacement

Removing

1 Remove the engine.

2 Remove the starter.

3 Remove the engine oil sump, suction pipe and strainer.

4 Remove the oil pump assembly.

5 Remove the cylinder head.

6 Remove the push rods and followers.

7 Remove the fuel lift pump.

8 Remove the fuel injection pump assembly.

9 Remove the timing gear case.

10 Remove the camshaft assembly.

11 Remove the bolts **A** and lift the front plate **B** off the locating dowels **C**. Remove the gasket **D** and discard,

12 Remove the bolts **E** and extract the flywheel **F**.

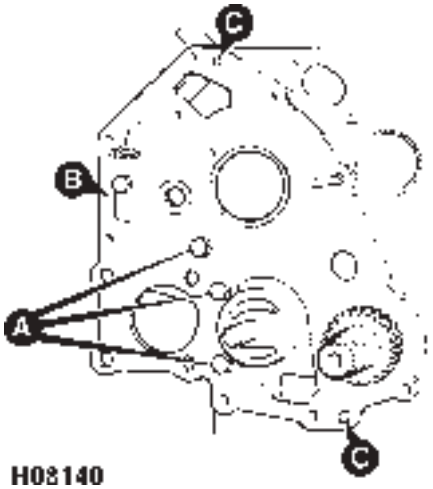
13 Remove the bolts and remove the backplate.

14 Remove the oil seal **G**.

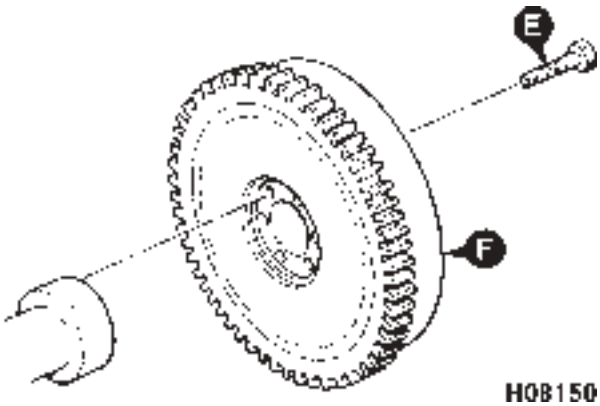
15 Remove the pistons and connecting rods.

16 Remove the bolts **H** fitted through the crankcase cross members and the two recessed bolts at the flywheel end.

17 Slide the crankshaft and main bearing assemblies out of the cylinder block.



H08140



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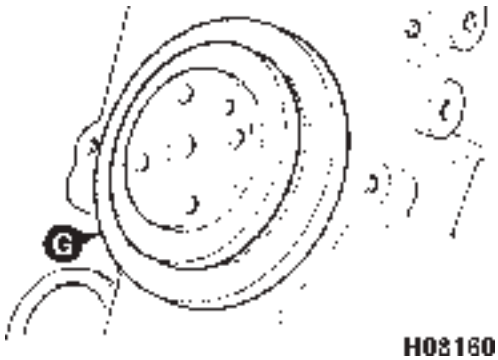

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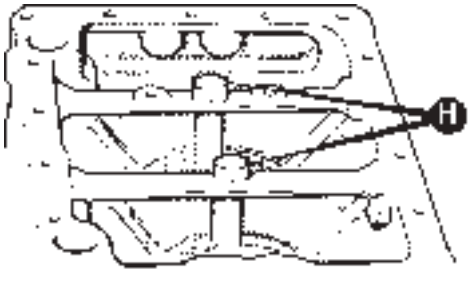


H08130

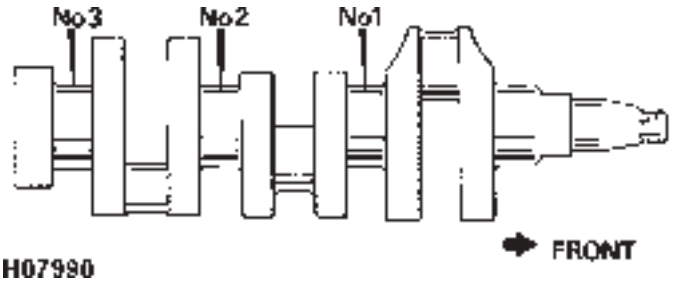
Crankshaft

Dismantling and Inspecting

1 Main bearings, No.l, No.2 and No.3.

a Remove the bearing holder. Check the bearing holder for peeling, melting, stepped wear and other damage. If it is excessively damaged, renew it.

b Using the plastigauge, measure the oil clearance between the crankshaft journal and the bearing. If the oil clearance is more than the allowable limit, renew the bearing. Or, grind the crankshaft journal and use undersize bearing (see Microfiche for part numbers).



H07980

Standard oil clearance	**Allowable** limit
0.039 **-** 0.092 mm	0.200 mm
(0.0015 - 0.0036 in.)	(0.0078 in.)

Bearing size	**Crankshaft journal diameter**
Standard	45.964 - 45.975 mm (1.7997 - 1.8001 in.)
0.25 mm u/size (0.0098 in.)	45.714 - 45.725 mm (2.2719 - 2.2724 in.)
0.50 mm u/size (0.0196 in.)	45.464 - 45.475 mm (1.7889 - 1.7903 in.)

***2 Crankshaft Bush**

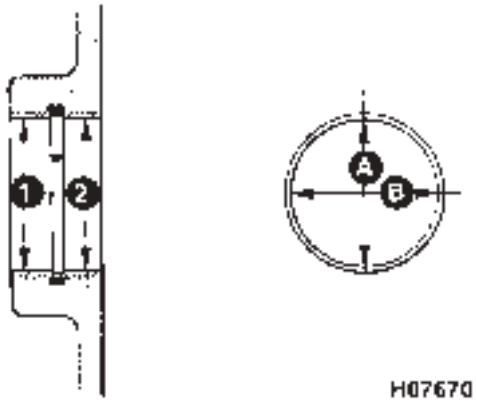
a Check the bearing (bush) for peeling, melting, seizure or poor contact. If found to be defective, renew.

b Using cylinder gauge and micrometer, measure the oil clearance between the bearing (bush) and the crankshaft journal.

c Measure the inside diameters at positions **1** and **2.** At each position, measure in both directions **A** and **B** as shown. The oil clearance can be obtained by subtracting the maximum crankshaft journal diameter from this value.

Crankshaft journal/bush clearance

Standard oil clearance	**Allowable limit**
0.039 - 0.106 mm	0.2 mm
(0.0015 - 0.0041 in.)	(0.0078 in.)



H07670

d If the oil clearance exceeds the allowable limit, renew the bearing (bush). Or, grind the crankshaft journal. In this case, use undersize bearing (bush).

e After grinding the crankshaft journal, check the oil clearance.

Crankshaft Journal Sizes

Size	**Outside diameter**
Standard	45.964 - 45.975 mm (1.8096 - 1.8100 in.)
0.25 mm u/size (0.0098 in.)	45.714 - 45.725 mm (1.7997 - 1.8001 in.)
0.50 mm u/size (0.0196 in.)	45.464 - 45.475 mm (1.7899 - 1.7903 in.)

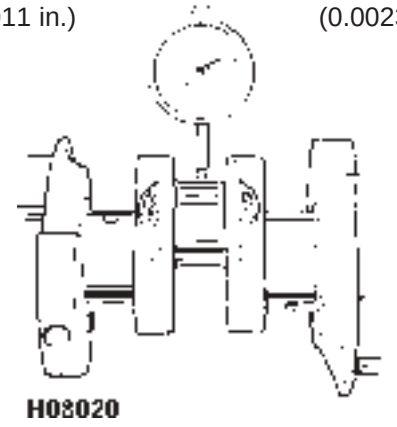
Crankshaft (cont'd)

Dismantling and Inspecting

***3 Crankshaft deflection**

a Support the crankshaft with V-blocks. Position a dial gauge on the crankshaft journal and turn the crankshaft gradually by one full turn. If the gauge reading is more than allowable limit, correction or replacement of the crankshaft is needed.

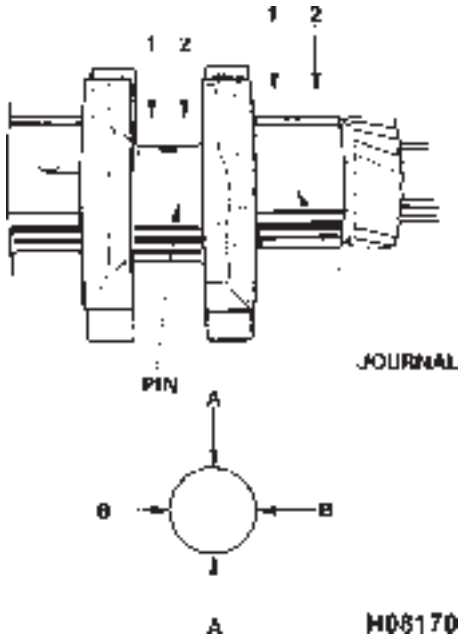
Standard deflection	**Allowable limit**
0.030 mm or less (0.0011 in.)	0.060 mm (0.0023 in.)


H08020

b Oil seal contact face and oil hole.
Check the oil seal contact face for damage or wear. Check oil holes for clogging.

c Crankshaft journal and pin for stepped wear.
Take four measurements **(AA** and **BB** diameters at positions **1** and **2**). If the maximum difference between the measurements is more than allowable limit, correction is required.

Allowable difference (stepped wear)
0.05 mm (0.0019 in.)



H08170

When the measured diameter is less than the allowable limit, correct by grinding and use undersize bearings and bush.

Shaft diameter of crankshaft journal

	Standard diameter	Allowable limit
Standard	45.964 - 45.975 mm (1.8096 - 1.8100 in.)	45.900 mm (1.807 in.)
0.25 mm u/size	45.714 - 45.725 mm (1.7997 - 1.8001 in.)	45.650 mm (1.797 in.)
0.50 mm u/size	45.464 - 45.475 mm (1.7899 - 1.7903 in.)	45.400 mm† (1.787 in.†)

Shaft diameter of crankshaft pin

	Standard diameter	Allowable limit
Standard	38.964 - 38.975 mm (1.5340 - 1.5344 in.)	38.900 mm (1.531 in.)
0.25 mm u/size	38.714 - 38.725 mm (1.5241 - 1.5246 in.)	38.650 mm (1.5216 in.)
0.50 mm u/size	38.464 - 38.475 mm (1.5143 - 1.5147 in.)	38.400 mm† (1.5118 in.†)

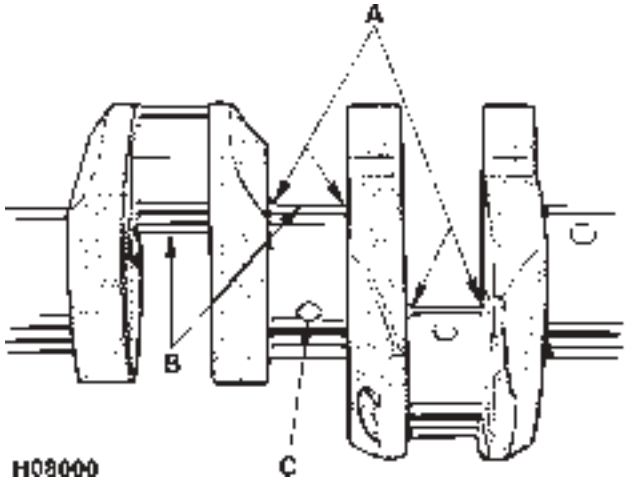
† If the diameter is less than this value, the crankshaft must be replaced

Note: *When grinding the crankshaft, work with the following specifications:*

A Radius at pin/journal — 3 mm ± 0.2 mm (0.118 ± 0.0078 in.)

B Finish precision — 1.6Z (VVV)

C Radius around oil hole:
2mm (0.0787in.) max
5mm (0.0196in.) min
Use No. 400 emery cloth for final polishing.



H08000

Crankshaft (cont'd)

Reassembling

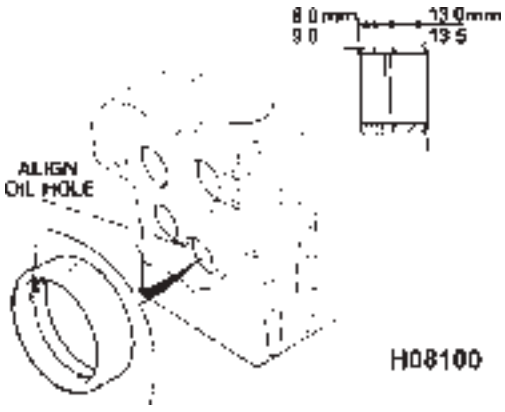
1 Replace the crankshaft bush if the crankshaft journal has been ground underside.

a Removal of bush

1 Remove the bush from the cylinder block using Bush Driving Tool to prevent damage.

2 Press fitting the bush

Note: *Prior to installing the bush inspect the bush housing for marks, scratches etc. The bush should be smoothly pressed in to correct depth by using Bush Driving Tool, adjusting the oil hole and direction of bush as shown and following sequence.*



- Press the bush into the cylinder block from the engine front side.

Note: *Do not press the bush into the cylinder block from the opposite side. The correct pressing side is chamfered etc. to allow smooth operation.*

- Align oil hole of the block and bush.
- Lubricate the outer surface of the bush.
- Press in the bushing to the block, until correct depth, by using Bush Driving Tool.
- Confirm the alignment of oil hole of the block and the bushing, also check inner diameter is within tolerance.

2 Precautions Before Reassembling

a Wash parts before reassembling. (Especially, oil gallery, bearings, pistons and cylinder bores which should be washed thoroughly.)

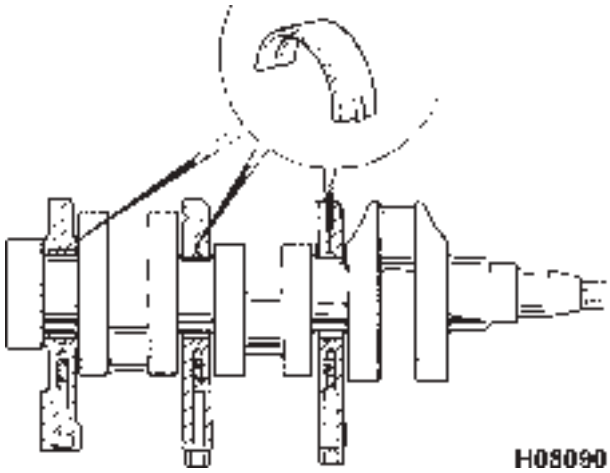
b Apply new oil to sliding and rotating surfaces of cylinder bores, pistons and bearings, etc.

c Replace gasket, packing etc. Use liquid gasket to prevent oil leakage where necessary.

d Never over tighten bolts and nuts used on aluminium alloy: tighten to specified tightening torques.

***3** Assemble the bearing holders, main bearings and thrust washer.

a Face the chamfered part of the bearing holder toward front. Install the bearing holder which has reference bit at the centre.



b Torque the bearing holder bolts to 25 - 30 Nrn (2.5 - 3.0 kgf m, 18.1 - 21.7 lbf ft).

c Set the bearing with oil groove to upper part, while setting the bearing without the groove to lower part.

Crankshaft (cont'd)
Replacing

4 With the bearing holders and thrust washers assembled, insert the crankshaft in the bush at the front end of the cylinder block.

5 Align the bolt holes in the cylinder block with the bearing holders on the crankshaft.

6 Install the bolts **H**, including the two recessed bolts at the flywheel end.

7 Torque the bolts to 25 - 30 Nm (2.5 - 3.0 kgf m, 18 - 22 lbf ft).

8 Measure the crankshaft end float.

Standard play	**Allowable limit**
0.050 - 0.300mm	0.500 mm
(0.0002 - 0.0120 in.)	(0.0200 in.)

9 Install the press-fit rear oil seal **G** in the rear of the cylinder block.

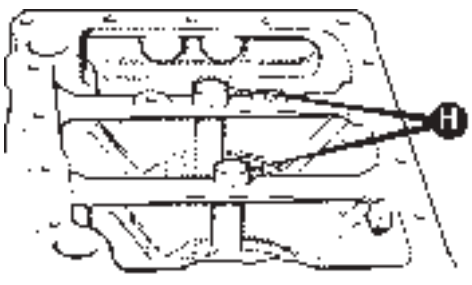
10 Install the back plate on the rear of the cylinder block.

a Coat the area around the M10 threaded holes with liquid packing (solvent based sealant) and fix the back plate with bolts.

b Torque the bolts to 46 - 54 Nm (4.7 - 5.5 kgf m, 34 - 40 lbf ft).

11 Install the flywheel **F** noting the location of the locating spring pin and retain with the bolts **E**. Torque the bolts to 58 - 68 Nm (6.0 - 7.0 kgf m, 43 - 50 lbf ft).

12 Locate the front plate **B** with gasket **D** on the dowels **C** and install the bolts **A**. Torque the bolts to 9 - 14 Nm (0.9 - 1.3 kgf m, 6.5 - 10 lbf ft).



H08130

13 Install the camshaft assembly and tachometer assembly.

14 Install the timing gear case.

15 Install the fuel injection pump.

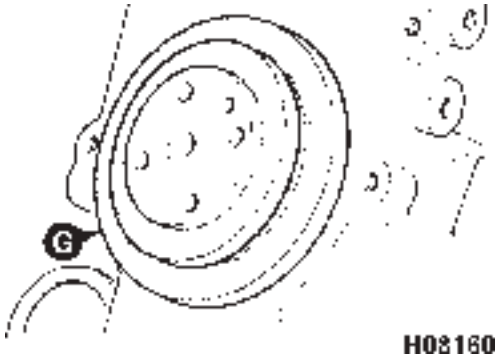
16 Install the fuel lift pump.

17 Install the pushrods with followers and the cylinder head.

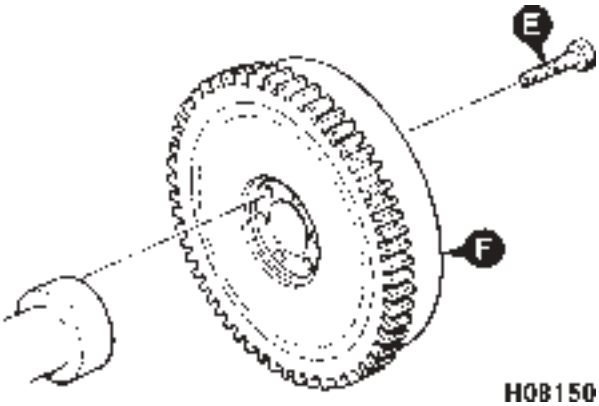
18 Install the oil pump.

19 Install the suction pipe and strainer and the oil sump.

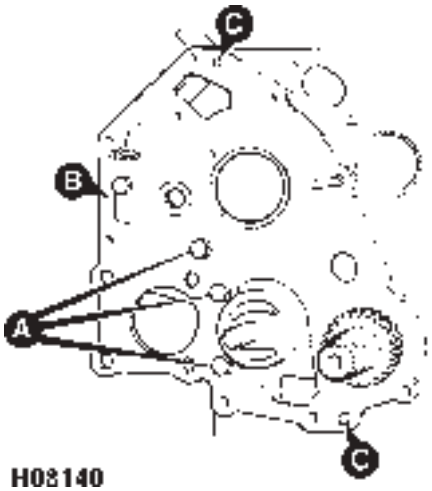
21 Install the starter and then install the engine.



H08160



H08150



H08140

Excessive Exhaust Emissions

If there is evidence of excessive exhaust emissions, check whether the engine breather tube is dry and clean, or is oily and passing a visible blue haze. Also determine which category of smoke is being emitted, then proceed as detailed below. In the event that the problem cannot be cured by any of the remedies suggested, contact your nearest JCB Hydrapower agent.

Black Smoke is Emitted

One of the following actions should effect a cure:

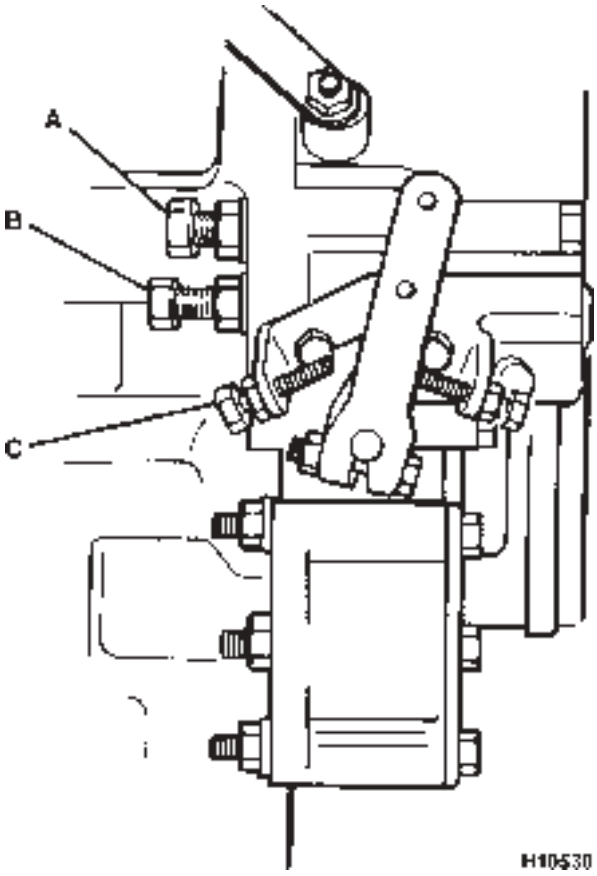
Note: *The emission of black smoke is normally the result of excess fuel injection.*

1 Note the setting of screw adjuster **A**. Screw the adjuster in by increments of 1/8 of a turn until the smoke is reduced. Do not exceed 1/2 a turn total movement.

If the amount of smoke emission is corrected but a loss of power is noticed, then the engine may be pre-governing. To prevent this, screw adjuster **B** out 1 or 2 complete turns. Check that the engine no-load speed is between 2400 and 2420 rev/min, adjust if necessary using adjuster **C**.

2 Change the fuel by draining and refilling.

3 Change the injection pump, spill timing and ejectors one by one until the problem is cured.



Blue Smoke is Emitted

If blue smoke is emitted and there is evidence that the engine is breathing through the breather, the problem lies with the bores/rings. Inspect and remedy as necessary.

Check the condition of the air filter and the engine oil for evidence of clogging and contamination etc. This could be caused by an excessively dusty or dirty working environment.

Light Grey Smoke is Emitted

If light grey smoke is emitted on fast idle under no load conditions, or at an intermediate speed under part load conditions, this is a sign of incomplete combustion, often accompanied by a sharp smell and stinging of the eyes.

Check that the flow of fuel to the injection pump is unrestricted, e.g. the filter is not blocked, or the fuel line under the fuel tank is not trapped. If no fault is found here, contact your nearest JCB Hydrapower agent.